A

MANUAL OF THE INFUSORIA.

VOLUME II.

663
576

"Our little systems have their day,
They have their day and cease to be ;
They are but broken lights of Thee,
And Thou, O Lord, art more than they."

TENNYSON, *In Memoriam.*

A

MANUAL OF THE INFUSORIA:

INCLUDING A DESCRIPTION OF ALL KNOWN

FLAGELLATE, CILIATE, AND TENTACULIFEROUS PROTOZOA,

BRITISH AND FOREIGN,

AND AN ACCOUNT OF THE

ORGANIZATION AND AFFINITIES OF THE SPONGES.

BOOK NO.
175

BY

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A

MANUAL OF THE INFUSORIA.

CHAPTER VIII.

SYSTEMATIC DESCRIPTION OF THE INFUSORIA-CILIATA.

Class II. CILIATA.

ANIMALCULES partly or more or less completely clothed with vibratile cilia, which constitute the essential organs of locomotion and prehension; no supplementary lash-like appendages or flagella; certain of the cilia often modified in the form of setæ, styles, or uncini; occasionally possessing more or less distinct membraniform expansions; a well-developed oral and anal aperture mostly present.

With the class Ciliata we arrive at a group of the Infusoria with which microscopists will feel comparatively at home, all its members being of relatively large size, and for the most part very giants when set side by side with their flagelliferous compeers described in the preceding volume. That no hard and fast line separates the two groups from each other is nevertheless clearly illustrated by the series of forms last described under the title of the Cilio-Flagellata, in many of which it requires but the suppression of either the flagelliferous or ciliary appendages to convert them into ordinary representatives of one or the other of the two leading ciliate or flagellate infusorial classes. That the first-named group has been phylogenetically derived from the Flagellata is by this annectant order fully demonstrated, its existence at the same time assisting substantially in the establishment of an unbroken line of increasingly complex Protozoic organisms, from the simplest Rhizopoda up to the highest Ciliata. The probable lines of evolution by which these latter have passed onwards into the Metazoic animal series will be presently discussed.

Among the numerous indications of augmented complexity manifested among the members of the class now about to be introduced, the following may be mentioned:—The cuticular or cortical element in the majority, if not all instances, exhibits a much more complex composition. In by far the larger number of instances it is delicately striate in a longitudinal direction, such striations conforming with a distinct subdivision of its substance in the direction indicated into delicate, highly elastic fibrillæ, whose properties and function are closely akin to that of the muscular tissue of the Metazoa, and has in consequence received the suggestive name of the myophan layer. The oral aperture, or cytostome, with the Ciliata is, excepting in the case of the endoparasitic Opalinidæ, always more or less conspicuously developed, and is frequently supplemented by a complex horny buccal apparatus, e. g. Prorodontidæ, Dysteriidæ, or it may be by an evertile proboscis, as in *Didinium*. A modification in the first-named direction has been already notified in the preceding volume in connection with the flagellate genera *Astasia* and *Anisonema*. An anal passage or cytopyge, rarely recognizable in the Flagellata, is of almost universal recurrence among the Ciliata, being sometimes, as in *Nyctotherus*, so extensively prolonged as, in conjunction with the oral aperture and pharyngeal tube, to constitute

a rudimentary alimentary tract. The rod-like bodies known as trichocysts, recorded in but one or two doubtful instances as yet in connection with the Flagellata (*Chilomonas* and *Merotricha*), represent a common elementary factor of the cortical layer of the Holotrichous Ciliata, and are next met with in the Metazoic section of the Turbellaria. Already, in the cases of *Anisonema grande* and *Entosiphon sulcatus*, attention has been directed to the exceptional composite rosette-shaped contour of the contractile vesicle. Among the Ciliata this organ often exhibits a yet higher degree of differentiation, not unfrequently (*Spirostomum*, *Stentor*, *Ophrydium*) being produced peripherally into one or more extensive canal-like prolongations, and may undoubtedly be accepted as foreshadowing the more or less complex water-vascular, segmental, and ambulacral systems of the Metazoic classes of the Turbellaria, Trematoda, Rotifera, higher Annelida, and Echinodermata. An important advance in the organization and physiology of the Infusoria Ciliata has to be recorded in connection with all matters pertaining to the phenomena of reproduction. Multiplication by longitudinal or transverse fission is, as among the Flagellata, a common form of propagation. The encystment and breaking up of the entire body-mass into sporular elements characteristic of the majority of the Flagellata, and in which form of reproduction they exhibit decided vegetable affinities, is of very rare occurrence among the Ciliata, the several Holotrichous genera *Colpoda*, *Otostoma*, and *Ichthyophthirius* constituting the chief exceptions. In place of this, new zooids with the Ciliata are usually produced by the subdivision of the nucleus or endoplast into germinal elements, which are liberated independently from the parent animal after the manner of the ova or embryos of the Metazoa. A first progress in this direction has nevertheless been recorded of certain of the higher Eustomatous Flagellata. The phenomenon of genetic union, or conjugation, directly or indirectly associated with the reproductive faculties, exhibits likewise, among the Ciliata, a decidedly advanced formula. While with the Flagellata, so far as is known, the conjugative process is complete and permanent, according with the genetic union or so-called zygosis of unicellular plants, this process, though similarly manifested among certain Ciliata, such as the Vorticellidæ, is more usually replaced by an incomplete and transient conjugative act that corresponds more nearly with the copulation of higher animals. Finally, while all Flagellata are essentially unicellular, possessing but a single, and in almost all instances very simple, nucleus or endoplast, among the Ciliata this structural element very commonly exhibits a highly complex type of composition, and being in many instances represented in plurality, demonstrates the further advance made by these organisms towards the condition of multicellular beings.

The character and mode of distribution of the cilia yield reliable data for the subdivision of this class into minor sections or orders, the following plan as here adopted being in accordance with the one first introduced by Professor Stein in the year 1857. While the more characteristic members of these several orders yield features which permit of their natural and readily appreciated distinction, intermediate forms occur in each such group indicative of their close relationship and common design. Special reference is made to the more prominent of these annectant or transitional types in the general description of the respective orders.

SYNOPSIS OF THE ORDERS OF THE INFUSORIA CILIATA.

Cilia distributed over the entire surface of the body, similar, or differing but slightly in character.	Order I.	HOLOTRICHA.
Cilia distributed over the entire cuticular surface; the oral series of conspicuously larger size.	,, II.	HETEROTRICHA.
Cilia not universally distributed, mostly limited to a conspicuous circular or spiral adoral wreath.	,, III.	PERITRICHA.
Locomotive cilia, confined to the inferior or ventral surface of the body.	,, IV.	HYPOTRICHA.

Before entering upon a systematic description of the Ciliata, it is worthy of remark that until within a comparatively recent date the assemblage of organisms included within this class were accepted by many eminent authorities as possessing the only sound claim to the title of the Infusoria. The Flagellata, previous to their more exhaustive scrutiny by recent investigators, were regarded for the most part as Protophytes or the so-called zoospores of higher Cryptogamic plants, while the Tentaculifera or Acinetidæ were pronounced to be embryonic conditions only of various Peritricha. Undoubtedly, this section of the Ciliata is one of the largest and most important groups of the Protozoic sub-kingdom. In no other of the equivalent subdivisions is histologic differentiation carried to such a marked extent; many of the higher forms being indeed so modified in this respect that they may be unhesitatingly cited as furnishing the most complex expression of unicellular organization. To the notice of the evolutionist, to an equal or even greater degree than to the histologist, the Ciliate Infusoria deservedly commend themselves. It is beyond question to the ranks of this extensive class that attention may be profitably directed in the search after those ancient stock-forms or archetypes out of which several of the more important groups or phyla of the Metazoa have been gradually evolved. That the group of the Spongida does not, as maintained by some contemporary aut[illegible]ties, furnish the long sought for interconnecting link between the Protozoic and Metazoic series is substantially supported by the evidence submitted by the author in Chapter V. of the preceding volume, in which it is shown that, notwithstanding the plausibility and fascination of external appearances, these organisms remain in all structural and developmental details thoroughgoing, though peculiarly modified, Protozoa.

Already, in vol. i., p. 103 *et seq.*, the homoplastic resemblances and possible biogenetic relationship that subsist between the Ciliate and other Infusoria and the Metazoic animal series have been discussed at some length. Further time devoted to the consideration of this important subject, enables the author to greatly extend the scope of the comparisons previously instituted, and to submit, in connection with the woodcut illustrations on p. 477, and succeeding Genealogical Table, a possible clue to the phylogeny of all of the more important Metazoic groups. That the Holotrichous Ciliata may be consistently regarded as the archetypes of the lower worms, has been frequently advocated, the likeness between the former and the simpler Turbellaria being so marked, see woodcut, Figs. 3 and 4, that many earlier authorities have proposed to include these Infusoria in the Annelidous class; K. M. Diesing, more especially, in recognition of such likeness, established for their reception the new order of the "Prothelmintha." As related in vol. i. p. 26, this authority included, however, in this order not only the Holotrichous Ciliata, but, with the exceptions of the Vorticellidæ and Stentoridæ, all the Ciliate and Flagellate animalcules. In addition to the resemblances subsisting between the Holotrichous Infusoria and the Turbellaria, as manifested by their minute size and corresponding form, by their entire and even ciliation, by their common possession of trichocysts, and by the development in the members of the last-named group of a water-vascular system, which may be regarded as a modification of the contractile vesicles of the Infusoria, it may be mentioned that many of the Rhabdocœlous Turbellarians multiply as do the Holotricha and other Infusoria by the simple process of transverse fission. Taken collectively, the numerous collateral characteristics cited yield almost overpowering evidence in favour of the biogenetic relationship that is here advocated.*

Other Metazoic groups, in addition to that of the Turbellaria, would seem to possess a substantial claim to an Holotrichous ancestry. In the sub-kingdom

* The near approach of the Ciliate Infusoria to the structural plan of the lower Turbellaria is briefly indicated by Professor Huxley at p. 678 of his 'Anatomy of Invertebrated Animals,' ed. 1877; while, in a communication addressed to the author since the publication of the first two parts of this Manual, this authority has more distinctly referred to the Holotricha as probably constituting, in connection with the Turbellaria, the proper line of evolution from the Protozoic to the Metazoic series. The Spongida are further alluded to as occupying in such case, with reference to the Metazoa, a position equivalent to that held by the Tunicata in relation to the Vertebrata.

Cœlenterata, including the Corals, Sea Anemones, and Hydrozoa, the initial term or larval form common to the group is an ovate, evenly ciliated body, or so-called "Planula," woodcut, Fig. 1, differing entirely from the parent organism, but in all ways comparable with a mouthless Holotrichous Infusorium, as delineated at Fig. 2. In a similar manner, the mostly endoparasitic Scolecida (Trematoda and Cestoidea) are traceable to a like origin, many Trematodes, such as *Monostomum*, giving birth to simple holotrichously ciliated embryos, while the aberrant Opalinidæ, with reference to their often highly differentiated organs of adherence and, in certain instances, e. g. *Anoplophrya prolifera*, peculiar mode of reproduction, indicate a no very distant connection with the Cestoidea. It is worthy of remark that while many of the higher Annelids, *Lumbricus* and *Nais*, commence life as similar holotrichous infusorium-like embryos, others, including the majority of the marine worms or Polychæta, conform for the most part, as do the larvæ of the Echinodermata, with the Peritrichous infusorial formula.

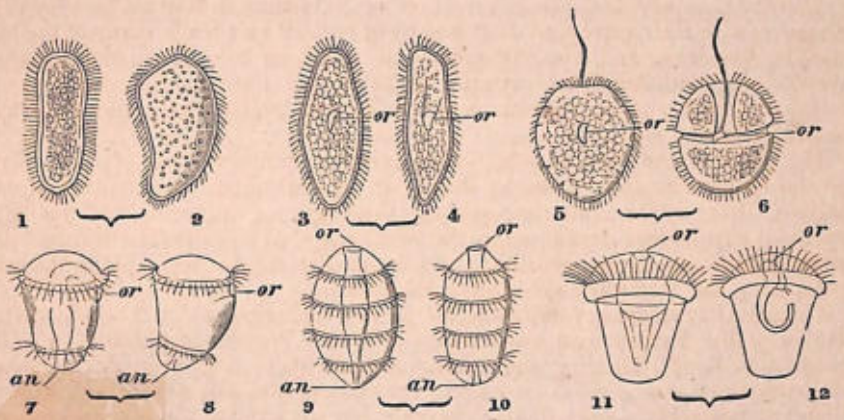
The order of the Heterotricha, whose members unite, in their plan of ciliation, both the Holotricha and Peritricha, do not at present suggest any distinct Metazoic affinities. It is at the same time perhaps deserving of attention that the ciliated lappet-like appendages developed in the larval stage, or so-called "*Pilidium*" of the Turbellarian genus *Lineus*, recall to some extent the ciliated lobes of the peristome developed in the Heterotrichous genus *Folliculariа*.

While, in the preceding volume, *loc. cit.* p. 103, a passing reference was made to the affinities of the Peritrichous Vorticellidæ with the Polyzoa, suggested by both L. Agassiz and K. M. Diesing, such faint external likeness as subsists between the adult structures and gave rise to such correlation, was not considered worthy of serious entertainment. Since then, however, it has occurred to the present author that from an entirely diverse standpoint the relationship suggested may be substantially upheld. A first impression in this direction was derived from a recognition of the close correspondence in external contour presented by the motile larvæ or so-called Trochospheres of the Polyzoon *Alcyonidium gelatinosum*, as delineated in a notebook placed at the author's disposal by Mr. H. E. Forrest, and reproduced at Pl. XXXI. Fig. 53, and such a free Peritrichous Infusorium as *Trichodina pediculus*. Following out this newly indicated clue, it was next found that the larval conditions of numerous other Polyzoa, as recently figured and described by Barrois,* bear out in a most remarkable manner the premised affinity. This last-named authority, furthermore, reduces all of the more or less modified embryos of this zoologic group to an ideal type, see Fig. 11 of the accompanying woodcut, which, without a pre-existing knowledge of its true import, would unhesitatingly be accepted as a slightly modified example of the ordinary Vorticellidæ, as given at Fig. 12. It is highly interesting to find that the class Mollusca, whose intimate relationship with the Polyzoa is universally conceded, abounds with larval forms reducible to the same Peritrichous formula. A suitable illustration of this fact is afforded by the figures representing the early larval condition of *Chiton cinereus*, as delineated by Lovén, and reproduced in Huxley's 'Manual of the Invertebrata,' and in other zoological textbooks.

Yet another leading section of the Metazoa, that of the Echinodermata, would appear to admit of being retraced phylogenetically to the group of the Peritricha. Here, as in the preceding instances, the clue has to be sought among the larval or embryonic, and not among the adult organisms. The embryo Echinoderm, or so-called Echinopædium (Huxley), on leaving the egg, is altogether distinct from the parent, consisting of a laterally symmetrical, ovate body having usually two, four, or more girdle-like bands of cilia. Through the process of histolysis or atrophy, this primary integument with its ciliary girdles becomes speedily obliterated, but there can be no doubt that during such transient larval existence the young Echinoderm resembles in a truly remarkable manner such Peritrichous Ciliate Infusoria as *Urocentrum turbo*, Pl. XXXIII. Figs. 7–9, and *Didinium nasutum*, Pl. XXXII. Figs. 50–57, and woodcut, Fig. 10, the latter type more especially being characterized in its normal

* 'Recherches sur l'embryologie des Bryozoaires,' 1877.

condition by the possession of two, and, preceding the act of fission, four, ciliary girdles. An approximate estimate of this resemblance may be gained by a comparison of the figures just cited with the accompanying woodcut illustration, Fig. 9, of the earliest larval or Echinopædium phase of a Feather-star, *Comatula*, reproduced from Haeckel's 'Natürliche Schöpfungs-Geschichte.' The Echinus, the Star-fish, or the Holothurian, one and all, present an identical or but slightly modified initial structure, and may therefore be consistently regarded as the descendants of a similar simple Peritrichous archetype.



The figures, bracketed in pairs, represent six larval Metazoa, with their respective Infusorial isomorphs, as correlated in the accompanying text.

Fig. 1, an Astomatous larval Cœlenterate or *Planula*; Fig. 2, an Astomatous Holotrichous Infusorium, *Opalina*; Fig. 3, a larval Aproctous Turbellarian; Fig. 4, a Stomatode Holotrichous Infusorium, *Paramœcium*; Fig. 5, a larval Nemertean, *Cephalothrix*, after Macintosh; Fig. 6, a Cilio-Flagellate Infusorium, *Melodinium*; Fig. 7, a Telotrochous Annelid larva, after Gegenbaur; Fig. 8, a Peritrichous Infusorium, *Telotrochidium*; Fig. 9, a Mesotrochous Echinoderm larva, after Haeckel; Fig. 10, a Peritrichous Infusorium, *Didinium* (prior to subdivision); Fig. 11, a typical larval Polyzoon, after Barrois; Fig. 12, a Peritrichous Infusorium, *Vorticella*.

The letters *or* and *an* indicate respectively the oral and anal apertures.

The small group of the Gephyrea, including notably *Sipunculus* and *Priapulus*, frequently cited as possessing structural modifications that unite the two groups of the Echinodermata and Annelida, is of interest in connection with the present subject of discussion since the embryonic zooids, in at least *Sipunculus*, accord in their Peritrichous plan of ciliation with those of both the first-named group and the Polychætous section of the Annelida. The ciliated embryos of the Polychætous Annelida, while thus conforming to the Peritrichous type, are found within such limits to exhibit three somewhat diverse modifications. As explained by Professor Huxley in his 'Anatomy of the Invertebrata,' p. 243, the cilia in some cases form a broad zone which encircles the body, leaving at each end an area which is either devoid of cilia, or, as is frequently the case, has a tuft of cilia at the cephalic end. Such larvæ are termed "Atrocha." In other embryos the cilia are arranged in one or more narrow bands which surround the body. Where two bands of cilia are developed, the one encircling the body immediately in front of the mouth, and the other around the anal end of the embryo, the larvæ are called "Telotrocha." In the third modification one or many bands of cilia surround the middle of the body between the mouth and the hinder extremity, such larvæ being distinguished by the title of "Mesotrocha"; a supplementary tuft of cilia also, in the case of the Telotrocha, being not unfrequently attached to the centre of the præstomium or preoral region. While such Peritrichous Infusoria as *Urocentrum* and *Didinium* conform more essentially to the Telotrochal larval type, in the intermediate structural form *Calceolus* (*Peridinium*) *cypripedium* of H. James-Clark, Pl. XXXII. Figs. 23 and 24, having, with the exception of a bare cap-like anterior region, the whole surface of the body clothed with vibratile cilia, a decided approach is made towards the

Atrochal formula.* It is a further significant fact that in this type a fascicle of long whip-like cilia is developed from the oral region, which may be regarded as homologous with the terminal tuft common to both the Atrochal and Mesotrochal Metazoic larvæ. A yet more interesting and significant modification of the Telotrochal plan is perhaps exhibited by the recently discovered Peritrichous Infusorium represented by Fig. 8 of the accompanying woodcut, and upon which, with reference to the likeness indicated, the author has conferred the generic name of *Telotrochidium*. While somewhat resembling at first sight a temporarily detached *Vorticella* with a supplementary posterior ciliary circlet, it differs fundamentally from such a type in that the anal aperture does not open, as with the typical Vorticellidæ, upon the oral vestibulum, but at the posterior extremity of the body and to the rear of the hinder circlet of cilia. The anal passage following upon the aperture is conspicuously visible for some distance within the surface of the cuticulum, and, as will be at once recognized, it requires but a further prolongation and juncture of the oral and anal passages to produce an organism indistinguishable from Gegenbaur's representation of a Telotrochous Annelid larva, reproduced at Fig. 7.

A remaining and very important section of the Metazoa, with which as yet no attempt has been made to demonstrate an infusorial phylogenetic origin, is that of the Arthropoda, including most notably the Crustacea, Arachnida, and Insecta. Such a connection, nevertheless, is, in the author's opinion, obscurely traceable in the direction of the Hypotricha, the interval separating the first-named highly differentiated Metazoa from the Protozoic order being bridged over by the group of the Wheel-animalcules or Rotifera. The passage from the Hypotrichous Ciliata to the Rotifera is indicated in two completely distinct directions. Firstly, in such a type as the *Dysteria armata* of Huxley, Pl. XLII. Figs. 27 to 30, in which the complex buccal armature and jointed caudal style are so strongly suggestive of its Rotiferan affinities that the animal was originally referred by Mr. P. H. Gosse to the class in question. Secondly, in that aberrant group of the Rotifera, including *Ichthydium*, *Chætonotus*, *Turbanella*, and a few others, recently incorporated together by Metschnikoff and Claparède under the title of the Gasterotricha,† which are all distinguished by the absence of the customarily developed trochal discs and complex mastax, while the entire ventral surface alone is clothed with fine vibratile cilia after the manner of the most simple Hypotricha. It is at the same time necessary to observe that among the generality of the Rotifera, both in their larval and frequently in their adult state, the cilia form a single terminal wreath around the so-called trochal disc, and consequently correspond closely with the Telotrochous larvæ of the Echinoderms and Polychætous Annelida previously described.‡ In common with these larvæ, they are likewise apparently phylogenetically derived from the infusorial order of the Peritricha. In this connection it may be further remarked that the two endoparasitic Peritrichous genera *Ophryoscolex* and *Entodinium*, distinguished by the possession of indurated carapaces and variously modified spinous appendages, were originally referred to the Rotifera. In one of these genera it is interesting to find that a second girdle of cilia is developed round the centre of the body. The affinities of the Rotifera with the Crustacea are, as indicated by Professor Huxley,§ possibly manifested in "*Pedalion*, with its jointed setose appendages and curious likeness to some *Nauplius* conditions of the lower Crustacea." It might be further added that many Rotifera, in common with

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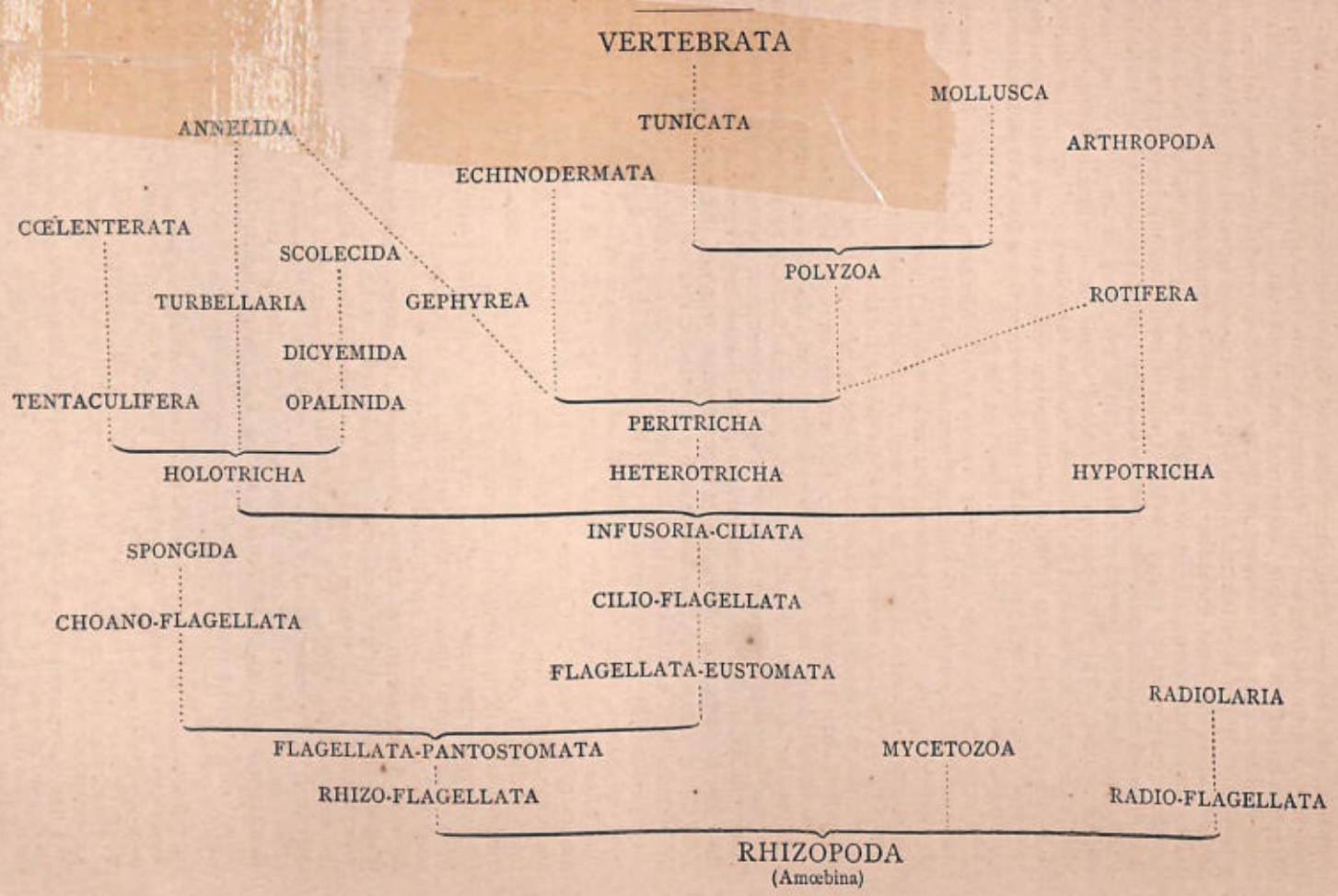
* The so-called Atrochal larva of the Chætopodous Annelid *Serpula*, as originally figured by Stossich, and reproduced in F. M. Balfour's treatise on Comparative Embryology, vol. i., 1880, conforms entirely to the Holotrichous plan of ciliation, and with its ventral oral, and postero-terminal anal apertures, may be directly compared with a *Paramæcium*, or an embryo Turbellarian.

† "Beiträge zur Kenntniss der Entwickelungsgeschichte der Chætopoden," 'Zeit. Wiss. Zool.', Bd. xix, 1869.

‡ The resemblance between Rotifers and the larvæ of Echinoderms was pointed out by Professor Huxley in his account of *Lacinularia socialis* in the 'Transactions' of the Microscopical Society for the year 1851, and is further advocated in his 'Anatomy of the Invertebrata, p. 193, 1877.

§ 'Anatomy of Invertebrated Animals,' p. 193, 1877.

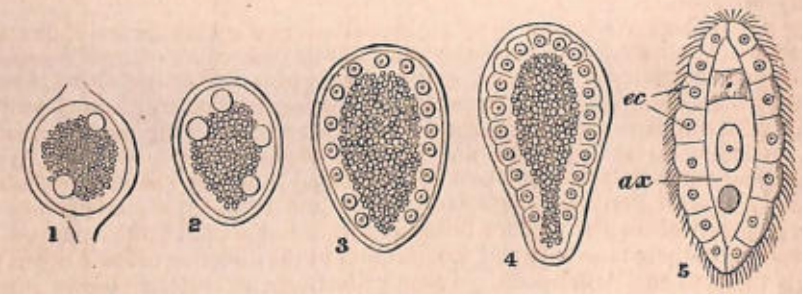
GENEALOGICAL TABLE SHOWING PROBABLE PHYLOGENETIC LINES OF EVOLUTION FROM THE RHIZOPODA THROUGH THE INFUSORIA TO THE VERTEBRATA.



Nauplian Crustaceous larvæ, are characterized by the possession of only a single median visual organ. Many of the higher Hypotrichous Ciliata, e. g. *Stylonychia* and *Euplotes*, would finally, by virtue of their not unfrequently branched setose appendages, appear to exhibit a latent Arthropodous bias.

With the aid of the evidence submitted here and in the preceding volume, it is finally found possible not only to predicate the probable lines of evolution by which, out of the Holotrichous, Peritrichous, and Hypotrichous orders of the Infusoria Ciliata, all of the more important Metazoic groups have been evolved, but also to produce a genealogic scheme, see p. 479, indicating an unbroken chain of animal organization of gradually increasing complexity from the lowest Rhizopod up to the Vertebrata. The broad and seemingly almost insuperable hiatus which, failing the group of the Spongida, seemed to intervene between the Protozoic and Metazoic series, need no longer present any substantial obstacle to the taxonomist. For while the three foregoing orders of the Ciliata still remain undoubted and easily recognized Protozoa, it as evidently needs but the interposition of some innate force, akin to that of crystallization, to transform their plastic and comparatively amorphous protoplasmic bodies into mullicellular aggregates or Metazoa. Nay more, numberless examples of the Ciliata are multinucleate, and therefore potentially multicellular, and furnish, by reason of such differentiation, the most perfect possible links of connection between the Protozoic and Metazoic series. Where, consequently, as in the several cases here submitted, these Protozoic organisms are more or less perfect isomorphs of the mature or larval phases of Metazoic structures, it may be consistently predicated that they are phylogenetically connected with them.

A beautiful and highly instructive illustration of the manner in which a unicellular and simply nucleated protoplasmic body may pass first into a multinucleate and then into a multicellular condition is afforded by the figures given by Metschnikoff,* copied in F. M. Balfour's 'Comparative Embryology,' and herewith reproduced, of the segmentation of the ovum of the Rose Aphis, *Aphis rosæ*. Fig. 3 in this series is



Figs. 1 to 4, illustrating four successive phases of the segmentation of the ovum of *Aphis rosæ*. A granular central yolk mass and an outer protoplasmic layer are distinctly visible in every instance. In Figs. 1 and 2, two and four nuclei have respectively appeared within the outer protoplasm. In Fig. 3 a number of nuclei have arranged themselves at regular distances throughout this region, while in Fig. 4 the protoplasmic layer has become divided into a number of columnar cells, which correspond with the nuclei (after Metschnikoff).

Fig. 5, an adult example of *Dicyema typus*, whose histologic composition accords closely with that exhibited by the aphis ovum represented in the preceding Fig. 4; *ax*, central nucleated axial cell; *ec*, multicellular ectodermal layer (after Ed. Van Beneden).

more especially noteworthy, since it corresponds with a typical *Opalina* and depicts that multinucleate and potentially multicellular state that is definitely assumed in the succeeding phase as delineated at Fig. 4. Metazoa whose adult structure may be said to be scarcely in advance of what obtains in the simplest multicellular condition of the ovum delineated at Fig. 4, are found embodied in the two recently discovered orders of the Dicyemida and Orthonectida. Both of these consist of mouthless, elongate ovate, more or less completely ciliated, essentially endoparasitic organisms, the former as yet having been obtained infesting exclusively the renal organs of various Cephalopoda, while the latter more extensively distributed

* "Embry. Stud. Insecten," 'Zeit. Wiss. Zool.,' Bd. xvi., 1866.

group affects the intestinal viscera and surrounding tissues of various Nemerteans, Turbellaria, and Ophiurida. In the case of *Dicyema*, see Fig. 5 of the accompanying woodcut, histological differentiation, as attained in the adult, takes the form of a single peripheral cellular layer, within which is enclosed a single long cylindrical or subfusiform axial cell. With the Orthonectida, *Rhopalura*, a slightly more complex structural formula is introduced through the subdivision of the central axial cell into cellular elements. The external resemblance that subsists between *Dicyema* and certain ciliated Infusoria was held by Claparède and Lachmann to be so close, that these authorities figured and described one species, *D. Muelleri*, in their 'Études sur les Infusoires,' as a type whose nearest affinities were probably to be sought for amongst the Opalinidæ. As constituting a stage in advance of these Ciliata, equivalent to that held by Fig. 4 with reference to No. 3 of the segmentation phases of the aphis ovum here delineated, this interpretation of *Dicyema* may perhaps be not inconsistently maintained. It might be further suggested, with reference to such affinity, that the single axial cell, the sole representative of the hypoblastic element or entoderm in *Dicyema*, is to some extent foreshadowed in the remarkably prolonged and correspondingly axial so-called nucleus, as developed in the more abnormal Opaline genera *Anoplophrya* and *Hoplitophrya*. In recognition of the essentially intermediate structural position with reference to the Protozoa and typical Metazoa, that is occupied by the Dicyemida, Ed. Van Beneden* has proposed to assign it to an altogether distinct and intermediate sub-kingdom, that to be distinguished by the title of the "Mesozoa." Professor Huxley† is likewise inclined to support this view, though with reference more to the remarkable developmental phenomena. In so far as the germs in *Dicyema* are produced from within the single axial cell, such reproductive cell is correlated by this authority with the central "capsule" of a Radiolarian; while the peculiar manner in which the peripheral cells in the embryo grow round and partly enclose the axial one, he maintains, corresponds with the phenomenon of "epiboly" as it occurs in many ordinary Metazoa.

The embryological evidence so far at disposal, as now submitted and indicated in the accompanying table, unquestionably points to the derivation of the Cœlenterata, Turbellaria, Chætopodous Annelida, and Scolecida from a Holotrichous archetype; the embryos in examples of all these Metazoa being completely clothed with fine vibratile cilia, and scarcely distinguishable from Holotrichous Infusoria. In a second series, including more especially the Polyzoa, Mollusca, Echinodermata, typical Rotifera, and many Polychætous Annelida, the larval forms are characterized almost exclusively by their Peritrichous plan of ciliation and remarkable conformance with certain members of the Peritrichous Infusoria; while in the third Ciliate group, that of the Hypotricha, there is an apparent modification in the direction of the Rotifera, and through them to the Arthropoda. Taken collectively, it is clearly shown that the peritrichously ciliated larval form represents a preponderating factor in the ontogenetic history of the Metazoic series; its protozoic isomorphs, as typified by a Peritrichous Infusorium, being, in accordance with the fundamental laws of evolution, the archetype or stock-form from whence the principal Metazoic groups were primarily derived, and out of which, as shown in the accompanying table, the genealogy even of the Vertebrata may with facility be defined. Though the biogenetic scheme here introduced is mainly tentative, and necessarily imperfect at many points, it may be confidently anticipated that a more extended acquaintanceship with the Ciliate Infusoria and initial or larval phases of the Invertebrata will be productive of data permitting of a yet closer and more perfect amalgamation of the Protozoic and Metazoic groups. In many instances, through the epitomization and abbreviation of their developmental course, the clue sought for is dim or even altogether obscured, but in other cases it is manifested with an amount of perspicuity that can scarcely escape the recognition of the earnest interpreter of Nature's problems.

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* "Recherches sur les Dicyemides," 'Bull. de l'Acad. Roy. de Belgique,' tom. xli. No. 6, and tom. xlii. No. 7, 1876.

† 'Anatomy of Invertebrated Animals,' 1877.

Order I. HOLOTRICHA, Stein.

Animalcules free-swimming, more or less completely ciliate throughout; cilia alike or differing but slightly in character from one another, sometimes supplemented by a variously modified extensile or undulating membrane; oral and anal orifices usually conspicuously developed; the cuticular layer or ectoplasm not unfrequently containing trichocysts.

The order of the Holotricha was originated by Stein for the reception of all those animalcules in which the surface of the integument is completely clothed with cilia that agree entirely with or differ but slightly from one another in size and character. It undoubtedly embodies the most simply organized members of the class Ciliata, the series as a whole, however, being subject to considerable range of complexity and offering a tolerably uniform series of gradations from the most simple types towards the succeeding order of the Heterotricha. In those forms, more especially such as *Lembus*, *Pleuronema*, *Panophrys*, and *Cyclotricha*, in which an extensile or undulating adoral membrane is borne in addition to larger adoral cilia, the highest differentiation and closest approximation to the Heterotrichous formula is apparently arrived at. It is noteworthy in connection with this circumstance that the larger adoral fringe of cilia in both the Heterotrichous and Hypotrichous orders of the class, as typified by the two genera *Stentor* and *Euplotes*, is represented in its earliest or initial state by a similar membraniform expansion. Evidence indicative of the comparatively lower organization of the Holotrichous group of the Ciliata, is afforded by their occasional sporular mode of reproduction. This, while common to the Flagellata previously described, is as yet unknown among the higher sections of the Ciliata. Illustrations of such exceptional developmental phenomena are hereafter recorded in connection more especially with the four genera *Colpoda*, *Otostoma*, *Ichthyophthirius*, and *Amphileptus*.

In accordance with Stein's scheme of classification of the Ciliata,* reproduced at page 210 of vol. i., the order of the Holotricha is, exclusive of the Opalinidæ, subdivided into the four minor groups or families only of the Trachelina, Enchelina, Paramæcina, and Cinetrochilina. It has been considered undesirable, however, to adhere strictly to that scheme in this volume, and this in consequence not only of the discoveries of numerous Holotrichous types requiring independent family grouping, that have been made subsequent to the appearance of Stein's work, but on account also of the evident incongruity in many instances of the generic groups united under his proposed family headings. Examining these five family groups in successive order, it will be found that the title of the last one, that of the Cinetrochilina, has to be entirely abandoned, since *Cinetrochilum* and its supposed near ally *Glaucoma* can no longer be accepted as independent generic types but as being developmental conditions only of certain Hypotricha. *Pleuronema* and *Cyclidium*, again, differ so remarkably in the character of their membraniform appendages from *Lembadion*, *Ophryoglena*, and the several other generic types with which Stein associates them, as to demand independent family distinction. In Stein's fourth family of the Paramæcina a still more heterogeneous assemblage of generic forms is encountered, the proposed group including, in addition to the simply and evenly ciliate *Paramæcia*, the diversely ciliated *Enchelys*, *Nassula* with its fish-trap-like pharyngeal armature, the membranous flap-bearing *Panophrys*, and various other distinct types. His third family of the Enchelina is composed of equally inconsistent elements as typified by such entirely dissimilar generic types as *Prorodon*—which is immediately allied to *Nassula*—*Coleps*, *Lacrymaria*, *Perispira*, and *Actinobolus*. The last-named generic form would seem indeed to have no

* 'Infusionsthiere,' Abth. ii., 1867.

claim for admission within the ranks of the Holotricha, but to be referable, if anywhere among the Ciliata, to the Peritricha. Stein's second family, of the Trachelina, is the only one which may be said to embrace generic groups that fairly harmonize with one another; even here, however, one out of the five genera named, *Loxodes*, is now shown by Wrzesniowski to belong to the Hypotrichous Ciliate group, while *Dileptus* cannot be generically separated from *Amphileptus*. While receiving its title and definition from Professor Stein, it is worthy of remark that, in common with the Peritricha, the order of the Holotricha is one of the important groups that yet awaits systematic description by that eminent authority.

The accompanying table of classification may now be submitted as embodying what, in accordance with our existing knowledge of the Holotricha, would appear to constitute the most natural family grouping of the numerous genera, while it at the same time provides a concise clue to their distinction. In accordance with Stein's classificatory system, the mouthless Opalinidæ are here admitted among the Holotricha, being regarded by the author as either peculiarly modified members of the order, which by long maintenance of an endoparasitic mode of existence, have become accustomed to absorb the nutrient juices of their host through the general surface of their integument, and thus gradually dispensed with the need of a distinct oral aperture, or which possibly, through having been primarily brought into existence amid similar surroundings, have failed to develop the requirement of such inceptive orifice. These alternative interpretations are discussed at length in connection with the systematic description of this singular organic group.

Fam. I. PARAMÆCIIDÆ, S. K.

Animalcules free-swimming, more or less flattened and asymmetrical, ciliate throughout, oral and cuticular cilia alike; dorsal and ventral surfaces distinct, the oral aperture opening on the ventral surface.

GENUS I. PARAMÆCIUM, Müller.

Animalcules free-swimming, ovate or elongate, asymmetrical, more or less flexible but persistent in shape, finely ciliate throughout, the cilia of the oral region not differing in size or character from those of the general surface of the body; an oblique groove or buccal fossa developed on the ventral surface, at the posterior extremity of which the oral aperture is situated; cortical layer usually enclosing trichocysts; contractile vesicle and endoplast conspicuous, the former under certain conditions sometimes assuming a stellate outline. Inhabiting fresh and salt water, and abundant in vegetable infusions.

Paramæcium aurelia, Müll. PL. XXVI. FIGS. 28–30.

Body elongate-clavate or subfusiform, slightly compressed, about four times as long as broad, narrower and truncate anteriorly, the posterior half somewhat inflated, terminating in a conical point; buccal groove prolonged, extending from the left side of the anterior extremity obliquely backwards on the ventral surface, towards the right-hand side, beyond the centre of the body; oral aperture situated at the posterior termination of the buccal groove; anal aperture ventral, situated midway between the oral orifice and the posterior extremity; contractile vesicles two in number, stellate when compressed, situated respectively at a distance of about one-third of the

Families and Genera of CILIATA-HOLOTRICHA.

A. Bearing cilia only.

Oral and cuticular cilia alike.

Fam. I. Paramæciidæ.
Animalcules asymmetrical, with distinct dorsal and ventral regions; oral aperture ventral.

- Cuticular surface soft and flexible
  - With an oblique adoral groove — 1. *Paramæcium.*
  - No adoral groove — 2. *Loxocephalus.*
- Cuticular surface indurated
  - Free-swimming, no distinct pharynx — 3. *Placus.*
  - Parasitic, pharynx highly developed — 4. *Conchophthirus.*

Fam. II. Prorodontidæ.
Animalcules symmetrically ovate or cylindrical; oral aperture terminal or lateral; pharynx distinct, often armed with rod-like teeth.

- Pharynx armed.
  - Persistent in form.
    - Mouth terminal or sub-terminal — 5. *Prorodon.*
    - Mouth lateral — 6. *Nassula.*
  - Soft and elastic, mouth lateral — 7. *Cyrtostomum.*
- Pharynx unarmed.
  - Pharynx straight.
    - Animalcules persistent in shape, oral aperture lateral or sub-terminal — 8. *Isotricha.*
    - Animalcules elastic and contractile, oral aperture terminal — 9. *Holophrya.*
  - Pharynx curved.
    - Pharynx short, convolute or ear-shaped — 10. *Otostoma.*
    - Pharynx long, terminating in a helicoidal flexure — 11. *Helicostoma.*

Fam. III. Trachelophyllidæ.
Animalcules flask-shaped or lanceolate; oral aperture terminal.

- Animalcules highly elastic and contractile
  - With a prolonged neck-like region — 12. *Trachelophyllum.*
  - No neck-like prolongation — 13. *Enchelyodon.*
- Animalcules persistent in shape, with a conspicuous caudal seta — 14. *Urotricha.*

Oral and cuticular cilia dissimilar.

Fam. IV. Colepidæ.
Animalcules symmetrically ovate; oral aperture terminal; cuticular surface indurated.

- No anterior or buccal seta.
  - Carapace with spinous processes — 15. *Coleps.*
  - Carapace without spinous processes — 16. *Plagiopogon.*
- With a conspicuous anterior or buccal seta — 17. *Polykrikos.*

Fam. V. Encheliidæ.
Animalcules more or less ovate, the apical extremity not separated from the body by an annular groove, nor produced in a neck-like manner; oral aperture terminal or lateral; cuticular surface soft and flexible.

- Mouth terminal.
  - Oral cilia forming a simple circular fringe.
    - Animalcules pyriform, obliquely truncate anteriorly — 18. *Enchelys.*
    - Animalcules evenly ovate, with a bare cyst-like posterior region — 19. *Metacystis.*
  - Oral cilia forming a prolonged spire — 20. *Perispira.*
- Mouth lateral or ventral.
  - Oral aperture evenly ovate.
    - No ciliated pharyngeal passage — 21. *Anophrys.*
    - With a ciliated pharyngeal passage — 22. *Tillina.*
  - Oral aperture asymmetrical, cleft-like — 23. *Colpoda.*

Fam. VI. Trachelocercidæ.
Animalcules flask-shaped or elongate, usually with a prolonged neck-like anterior extremity and an apical annular groove; oral aperture terminal or sub-terminal; cuticular surface soft and flexible.

- Apical extremity with a conspicuous annular groove.
  - Mouth terminal.
    - Neck-like portion highly elastic and extensile — 24. *Trachelocerca.*
    - Neck-like portion scarcely extensile — 25. *Lacrymaria.*
  - Mouth subterminal; opening in the apical annular groove.
    - Animalcules solitary, free-swimming — 26. *Phialina.*
    - Animalcules social, inhabiting an attached branching zoothecium — 27. *Maryna.*
- No apical annular groove.
  - Pharynx prolonged, longitudinally plicate — 28. *Lagynnis.*
  - Pharynx short, not plicate — 29. *Chœnia.*

Fam. VII. Trachelidæ.
Animalcules elongate, highly elastic; oral aperture situated at the base of an attenuate and often trunk-like anterior prolongation.

- Parenchyma highly vacuolar or reticulate — 30. *Trachelius.*
- Parenchyma homogeneous.
  - Anterior region produced as an elongate, flexible, trunk-like process — 31. *Amphileptus.*
  - Anterior region attenuate, but not trunk-like — 32. *Loxophyllum.*

Fam. VIII. Ichthyophthiriidæ.
Oral region adhesive, acetabuliform.

- Oral disc with inwardly radiating setose cilia — 33. *Ichthyophthirius.*

B. Bearing cilia and a membraniform expansion.

Fam. IX. Ophryoglenidæ. Membrane vibratile, flap-like, enclosed within or projecting slightly beyond the oral or œsophageal fossa.

- Mouth sub-terminal.
  - Without longer adoral cilia .. 34. *Ophryoglena.*
  - With longer adoral cilia ..
    - Adoral cilia spirally disposed .. 35. *Panophrys.*
    - Adoral cilia forming a simple circle .. 36. *Cyclotricha.*
- Mouth terminal.
  - Anterior border obliquely truncate; oral fossa small .. 37. *Trichoda.*
  - Anterior border evenly ovate; oral fossa very capacious .. 38. *Lembadion.*
- Mouth lateral or ventral.
  - Membrane protruding in a tongue-like manner from the oral fossa .. 39. *Colpidium.*
  - Membrane enclosed within the oral fossa.
    - Body evenly ovate.
      - With a distinct pharynx .. 40. *Plagiopyla.*
      - No distinct pharynx .. .. 41. *Meniscostomum.*
    - Body subreniform, with a convex dorsal and flattened ventral surface.
      - Oral fossa simply ovate .. 42. *Chasmatostomum.*
      - Oral fossa complex
        - ear-shaped .. 43. *Pleurochilidium.*
        - acetabuliform. 44. *Ptychostomum.*

Fam. X. Pleuronemidæ. Membrane non-vibratile, extending in front of and around the oral fossa in a hood-like manner.

- Oral aperture and hood-like membrane ventral .. ..
  - Cilia rigid, setose
    - Without a caudal seta. 45. *Pleuronema.*
    - With a prolonged caudal seta .. .. .. 46. *Cyclidium.*
  - Cilia flexible and vibratile .. .. .. 47. *Uronema.*
- Oral aperture and hood-like membrane terminal .. .. 48. *Bœonidium.*

Fam. XI. Lembidæ. Animalcules free-swimming, vermicular, natation vigorous; membrane forming a prolonged crest-like border.

- No anterior digitiform appendage or caudal seta .. .. 49. *Lembus.*
- With an anterior digitiform appendage and caudal seta .. .. .. 50. *Proboscella.*

Fam. XII. Trichonymphidæ. Animalcules vermicular, endoparasitic; movements sluggish, writhing; bearing cilia of various lengths and an apparently more or less conspicuous undulating membrane.

- Cilia forming apparently three or four distinct series .. .. 51. *Trichonympha.*
- Cilia forming a single series.
  - Having a conspicuous undulating lateral border .. .. 52. *Pyrsonema.*
  - Edges of body where bent presenting a serrated aspect. 53. *Dinenympha.*

Appendix A.—Holotricha-Astomata.

Fam. XIII. Opalinidæ. Animalcules finely and evenly ciliate throughout; endoparasitic, possessing no distinct oral aperture.

- Simply ciliate, possessing no special prehensile organs .. ..
  - Contractile vesicle absent, endoplast rarely conspicuous .. .. 54. *Opalina.*
  - One or more contractile vesicles, endoplast conspicuously developed .. .. 55. *Anoplophrya.*
- Provided with supplementary prehensile organs .. .. ..
  - Prehensile organs acetabuliform .. .. .. 56. *Haptophrya.*
  - Prehensile organs unciform .. .. 57. *Hoplitophrya.*

entire length of the body from the anterior and posterior extremities; endoplast ovate, subcentral; trichocysts numerously developed, forming an even, vertically disposed, subcuticular layer; natation vigorous, rotatory. Length of body 1–120″ to 1–96″.

HAB.—Pond water and in vegetable infusions.

This type, commonly known as the "Slipper Animalcule," is one of the earliest observed and most widely distributed members of its class. It occurs in countless numbers in artificial vegetable infusions, as also in its natural condition in stagnant marsh and pond water. Viewed by transmitted light the dominant colour is golden-brown, while by direct reflection it presents an almost opaline appearance; this circumstance, combined with the elongate contour of the animalcules, won for them from Joblot and other earlier writers the popular name of "gold and silver little fishes." The stellate contour of the two contractile vesicles at diastole, referred to by most authorities as an essential characteristic of this species, scarcely appears to belong to the natural or persistent state, but would seem to be the result merely of artificial and abnormal pressure. The examination by the author of numberless examples with the highest magnifying power, confined in space sufficient to allow of their free movement, has failed to elicit in connection with these structures otherwise than a perfectly even, spheroidal outline. Under those artificial conditions in which the assumption of a stellate contour has been observed, the contractile vesicles exhibit phenomena agreeing with those recorded later on of *Trachelophyllum apiculatum*, *Enchelyodon farctus*, and other types; minute, lateral, pyriform sinuses make their appearance round the periphery of each vesicle at the time of full diastole and, according to Carter, extend as thread-like canals through the substance of the parenchyma. With the act of systole, the central spheroidal portion of the vesicle disappears, leaving the stelliform peripheral sinuses, which now flow together and form the next central vesicular dilatation. During the process of transverse fission, as observed by Claparède and Lachmann, two new contractile vesicles make their appearance in advance of or anterior to the two old ones, these latter, on the accomplishment of the act, occupying in each instance the posterior region of the two newly developed zooids. The phenomenon of so-called longitudinal fission, Pl. XXVI. Fig. 30, accredited to this type by Ehrenberg, is now demonstrated, as in the succeeding species, to indicate the act of conjugation between two independent animalcules. The trichocyst layer in *Paramæcium aurelia* is very distinctly developed, taking the form of an even series of minute rod-like bodies disposed vertically immediately beneath the surface of the cuticle. An interesting account of the earliest record of the existence of these structures, with the description of a simple process by which the animalcule may be induced to extrude them, as communicated by Sir John Ellis to the 'Philosophical Transactions' for the year 1769, will be found at pages 81 and 82 of the preceding volume.

The *Paramæcium caudatum* of Ehrenberg, distinguished by its more attenuate posterior extremity, is regarded by Claparède and Lachmann as a mere variety of this species, if not, indeed, exemplifying its most characteristic form. *Paramæcium aurelia*, as figured by these last-named authorities, is represented as possessing a conspicuous brush-like tuft of longer cilia at the posterior extremity. The author has recently met with examples having this posterior brush-like tuft, and is inclined to regard the same as signalizing a well-marked local modification, but certainly not the predominant type of this cosmopolitan species.

Paramæcium bursaria, Ehr. sp. PL. XXVI., FIGS. 31 AND 32.

Body pouch-shaped, depressed, little more than twice as long as broad; rounded posteriorly, narrowest and obliquely truncate at the anterior extremity; buccal fossa infundibulate, very wide anteriorly, extending obliquely backwards from left to right to beyond the centre of the body;

oral aperture situated at the posterior extremity of the buccal fossa, followed by a distinct pharyngeal passage; anal aperture postero-terminal; contractile vesicles two in number, spherical or stellate; endoplast ovate, with a laterally attached endoplastule; trichocysts abundantly developed; endoplasmic and cortical layer in adult individuals usually coloured green through the presence of enclosed chlorophyll-like granules. Length of body 1–280″. HAB.—Marsh water.

This animalcule is referred by Ehrenberg, in his great work 'Die Infusionsthiere,' to the genus *Loxodes;* Focke, in the 'Isis' for the year 1836, being the first to distinguish it by the generic and specific titles that are here given. A highly characteristic feature of this species, and one which attracted the notice of the earliest investigators, is the powerful circulation of the endoplasmic constituents, constantly and uniformly maintained within the interior of the animalcule's body. Associated with the usual brilliant green hue of both the moving corpuscles and those of the more firm and motionless cortical layer or exoplasm, this circulating phenomenon imparts to the animalcule an aspect highly suggestive of the cyclosis or rotation of the cell-contents of certain aquatic plants, such as *Anacharis* and *Valisneria*. A similar circulation obtains, but is not so conspicuous, in the young and colourless individuals. As shown by Stein's figures, and confirmed by the author's investigations, this rotation of the body-contents exhibits a uniform motion, ascending on the left side and descending on the right when viewed from a dorsal aspect, and may be thus described as in conformity with the apparent motion of the sun or the hands of a watch when facing the observer.

The reproductive phenomena of *Paramæcium*, as manifested more especially with the present species, have received a considerable amount of attention at the hands of recent investigators. Balbiani's name is more especially worthy of notice in this connection, he having been the first to demonstrate* that the previously so-called process of multiplication by longitudinal fission of one animalcule was really the more important act of conjugation or genetic union between two independent zooids. In the accomplishment of this conjugative act two animalcules apply themselves closely to one another by their oral or ventral surfaces, the parts thus brought into immediate contact becoming intimately fused or united with each other. In this closely united state the two animalcules may remain for a period of five or six days or more, but ultimately separate and resume their previous indedendent career. As the result of this conjugation the endoplast and endoplastule undergo an important modification. Originally it was thought by Balbiani that the last-named of these two structures was interchanged by the two united animalcules, and fulfilled the part of a male fecundatory capsule or testis with reference to the endoplast, which remained stationary and was supposed to enact the rôle of a female organ or ovary. As fully related, however, in vol. i. p. 94 *et seq.*, more recent investigation has not tended to confirm this hypothesis. At the same time it has been demonstrated by Balbiani and numerous other later authorities that during or subsequent to this process of conjugation both the endoplast and endoplastule become turgid and enlarged, the latter assumes usually a more or less striated aspect, while the former breaks up into a variable number of spheroidal bodies, which become separated, and are ultimately cast out of the body, and probably constitute reproductive germs or ovules. In accordance with an earlier interpretation, it was assumed that the endoplastule, in its striated condition, represented a bundle of spermatic elements. The fact, however, that a similar striate aspect is frequently distinctive of this structure during the more simple process of multiplication by transverse fission, as also under like conditions of an ordinary cell-nucleus, has rendered this assumption no longer tenable. The similarly manifested process of conjugation of *Paramæcium aurelia*, as delineated by Ehrenberg, is reproduced at Pl. XXVI. Fig. 30.

* 'Comptes Rendus,' 1858.

Paramæcium putrinum, C. & L.

This species is described by Claparède and Lachmann as corresponding in external form with *Paramæcium bursaria*, but as differing from that animalcule structurally by its non-possession of trichocysts and by the presence of a single contractile vesicle only, which is situated near the anterior body-half; the anal aperture is located on the ventral surface, though not so far forward as in *P. aurelia*; endoplast band-shaped, curved, accompanied by an oval endoplastule.

HAB.—Stagnant water, among decaying vegetable matter.

Paramæcium glaucum, C. & L.

Body ovate or elliptical, rounded at each extremity, the anterior one slightly the narrower, about twice as long as broad; cortex enclosing trichocysts; colour glaucous green; buccal groove longitudinal, the oral aperture situated a little in front of the median line; two posteriorly situated, stellate, contractile vesicles. Length of body 1–147″.

HAB.—Salt water: Norwegian coast (Claparède and Lachmann).

Paramæcium marina, S. K. PL. XXXII. FIG. 9.

Body elongate-ovate, subclavate, about five times as long as broad, rounded and widest posteriorly, tapering and slightly curved in the anterior region; oral groove extending backwards to the centre of the body; contractile vesicle single, of large size, posteriorly situated; endoplast ovate, subcentral. Length 1–240″. HAB.—Salt water.

This species was obtained in some abundance in the small rock pools refilled only by the spring tides, at both Teignmouth and Anstey's Cove, South Devon, in July 1879. The motion of the animalcules in these pools, as observed with the aid of a pocket lens, was highly characteristic, consisting of progress backwards and forwards for long distances, and in the same straight line, accompanied by rotation on their longitudinal axes, after the manner of various Bacteria and Vibriones.

Supplementary Species.

The *Paramæcium inversum* and *P. ovale* of Claparède and Lachmann are referable to the genus *Trichoda* of Stein, while the *Paramæcium microstomum* of the same authorities would appear to belong to the genus *Isotricha*. The *Paramæcium chrysalis* of Ehrenberg is now referred to the genus *Pleuronema*, and his *Paramæcium colpoda* to *Colpidium*.

GENUS II. LOXOCEPHALUS, Eberhard.

Animalcules free-swimming, persistent in shape, elongate-ovate or subcylindrical, having an oblique constriction at a little distance from the anterior extremity, and bearing in this region, on one or both sides, one or more short, curved setæ; the anterior extremity somewhat obliquely truncate, and bent slightly to one side; one or more long, hair-like caudal setæ developed at the posterior extremity; cilia of the cuticular surface fine, even throughout; endoplasm more or less granular and opaque; oral aperture ventral, subterminal, indistinct.

Loxocephalus luridus, Eberhard. PL. XXXII. FIG. 16.

Body elongate-ovate, subcylindrical, three times as long as broad, widest centrally, tapering gradually towards the two extremities; the oblique anterior constriction bearing on the side nearest the apical extremity two short, conspicuous, adcurved setæ; four long, straight, hair-like caudal setæ developed from the posterior termination; endoplast subspherical, situated in the median line at a distance of one-third of the entire length from the anterior extremity; endoplasm granular, very dark and opaque. Length 1–75″. HAB.—Infusions with vegetable matter.

This species is figured and described by Dr. Ernst Eberhard in the 'Oster-Programm der Herzogl. Realschule zu Coburg' for the year 1862.

Loxocephalus granulosus, S. K. PL. XXVI. FIG. 47.

Body elongate-ovate or subreniform, two and a half times as long as broad, widest posteriorly, the anterior end curved slightly towards the left, the oblique anterior constriction bearing on each side, as viewed from a dorsal aspect, a single, short, adcurved seta; a single, straight, hair-like caudal seta projecting from the posterior termination; contractile vesicle situated in the median line at a distance of one-third of the length of the body from the posterior extremity; cilia short and fine throughout; parenchyma coarsely granular, dark and opaque. Length 1–428″.

HAB.—Marsh water with decaying vegetation.

The animalcule connected with the above title was obtained by the author in some abundance in marsh water from Le Marais, Jersey, November 1878, in company with *Spirostomum ambiguum*, *Paramœcium aurelia*, *Urocentrum turbo*, *Pleuronema chrysalis*, and other pond-frequenting types. The general contour, as seen with moderate magnification only, agrees so closely with that of *Colpidium* or *Pleurochilidium*, that at first sight the desirability of referring it to one of these two genera was anticipated. On closer examination, however, it was found to be entirely wanting in the special oral structure that distinguishes these latter. No trace of an undulating membrane or of a pharyngeal passage could be detected, while even with a magnification of eight hundred diameters the position of the oral aperture in the antero-ventral region could be predicated only by the more active ciliary vibration at that point. The two short adcurved setæ projecting from the anterior constriction, accompanied by the presence of a long hair-like posterior seta, demonstrate that we have here an animalcule closely allied to the *Loxocephalus luridus* of Eberhard, but from which, as a species, it may be at once distinguished by its considerably smaller size, and by the diverse number and disposition of the setose appendages. When disturbed the animalcules swim to and fro in a straight line with considerable rapidity, but otherwise remain quiescent in some selected spot, numerous examples being often found in close proximity. In consequence of the dense granular character of the endoplasm, some difficulty was experienced in ascertaining the position of the contractile vesicle and endoplast.

GENUS III. PLACUS, Cohn.

Animalcules free-swimming, ovate; cuticular surface indurated, reticulate; oral aperture inferiorly situated; fine, short, vibratile cilia distributed throughout the cuticular surface, none of a specialized character in the neighbourhood of the mouth; endoplast and contractile vesicle conspicuous.

Placus striatus, Cohn. Pl. XXVI. Figs. 39 and 40.

Body ovate, slightly flattened, about twice as long as broad, the two extremities rounded; oral aperture circular, situated on the ventral surface at a short distance from the anterior extremity; cuticular surface furrowed obliquely in opposite directions, and so producing a reticulate aspect. Endoplast spherical, central; contractile vesicle posteriorly situated. Movements swift, in a straight line, rolling or rotatory on its long axis. Length 1–780″. Hab.—Salt water, among *Confervæ*.

Excepting for the absence of the vibratory oral membrane, Cohn* regards this form as most nearly resembling *Glaucoma;* the indurated and reticulate cuticle at the same time corresponds to some extent with that of *Coleps*.

Genus IV. CONCHOPHTHIRUS, Stein.

Animalcules free-swimming, persistent in shape, ovate or suborbicular, with a convex dorsal and flattened ventral surface; oral aperture situated within a more or less funnel-shaped fossa or depression on the ventral surface, followed by a tubular, recurved pharynx; cuticular surface indurated, delicately striate and ciliate throughout; cilia fine, thickly set, usually presenting a tufted or matted aspect; endoplast and contractile vesicle conspicuous. Occurring within the body-mucilage of various Lamellibranchiate and Gasteropodous Mollusca.

Conchophthirus anodontæ, Ehr. sp. Pl. XXVI. Fig. 33.

Body elongate-oval, depressed, about twice as long as broad, bluntly rounded at the two extremities; oral fossa spacious, occupying the centre of the ventral surface, the pharyngeal tract recurved, extending to within a short distance of the posterior extremity; contractile vesicle simply spherical, subcentral; endoplast globular, posteriorly located. Length of body 1–200″.

Hab.—The body mucilage of Anodontidæ and other fresh-water Mollusca.

This animalcule, selected by Stein as the type of the genus *Conchophthirus*, is identical with the *Leucophrys anodontæ* of Ehrenberg, and apparently also the *Plagiotoma acuminata* of Claparède and Lachmann. The illustration here given of this species is reproduced from T. W. Engelmann's "Zur Naturgeschichte der Infusionsthiere," contained in the 'Zeitschrift für Wissenschaftliche Zoologie' for the year 1861, where it is figured by way of comparison with *Conchophthirus curtus*, described later on.

Conchophthirus Steenstrupii, Stein. Pl. XXVI. Figs. 34 and 35.

Body broadly oval, depressed, equally rounded at the two extremities, about one and a half times as long as broad; oral fossa widely infundibular, somewhat rectilinear, occupying the first third or quarter of the right-hand

* "Neue Infusorien im Seeaquarium," 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xvi., 1866.

lateral border of the ventral surface; cuticular surface delicately striate longitudinally, cilia closely set, long, fine, and matted; the anterior extremity apparently bearing a small fascicle of longer setose cilia; contractile vesicle spherical, subcentral, exhibiting at diastole minute, supplementary peripheral lacunæ; endoplast consisting of as many as seven nucleus-like corpuscles, disposed in a row parallel with the posterior and right-lateral border. Length 186″ to 1–270″.

HAB.—Body-slime of *Succinea amphibia*, and also that of many land snails, including *Helix hortensis*.

The more anterior location of the oral fossa, together with the animalcule's separate habitat, serves to distinguish this form from the two accompanying representatives of the genus.

Conchophthirus curtus, Eng.

Body shortly oval, nearly as broad as long, equally rounded at both extremities, the dorsal surface highly convex, the ventral one flattened; oral fossa subcentral, very small, continued into a long, recurved, tubular pharynx; cuticular surface delicately striate longitudinally, clothed throughout with long, fine, matted cilia; endoplast oval, subcentral, contractile vesicle located a little behind this structure, stelliform or rosette-shaped at the time of diastole. Length 1–200″

HAB.—Mucilage of the fresh-water mussel *Unio crassus*, in company with *C. anodontæ*.

Although found in company with *Conchophthirus anodontæ*, Engelmann considers that the shorter or more orbicular contour of the body, together with the smaller comparative size of the oral fossa, distinguishes it sufficiently for separate specific recognition; the character of the contractile vesicle affords another point of differentiation.

Fam. II. PRORODONTIDÆ, S. K.

Animalcules free-swimming, symmetrically ovate or cylindrical, entirely ciliate; oral and cuticular cilia alike in size and character; oral aperture terminal or lateral; pharynx distinct, usually plicate or armed with rod-like teeth.

This family group coincides most nearly with the *Decteria* of Max Perty (vol. i. p. 204), which is restricted exclusively, however, to those genera in which the pharynx is armed with rod-like teeth. By Stein, the very closely allied genera *Prorodon* and *Nassula* are, as shown in his classificatory system, reproduced at page 210 of vol. i., distributed among his two very heterogeneous families of the Enchelina and Paramæcina.

GENUS I. PRORODON, Ehrenberg.

Animalcules persistent in shape, symmetrically ovate, cylindrical or slightly compressed, rounded at the extremities, entirely and evenly ciliate throughout; the oral orifice situated at or closely adjacent to the anterior pole, and the anal aperture at the opposite or posterior one; pharynx strengthened by a special induration consisting usually of rod-like teeth, but sometimes

taking the form of a simple corneous tube; contractile vesicle mostly single, located close to the anal aperture; cortical layer sometimes enclosing trichocysts.

The apical position of the oral aperture alone distinguishes the representatives of this genus from those of *Nassula*. Most of the species frequent pond and stagnant water. Their motion in the water is rapid, and chiefly rotatory on the longitudinal axis. One form only is as yet recorded as having a marine habitat.

Prorodon niveus, Ehr. PL. XXVI. FIGS. 36 AND 49.

Body elliptical, compressed, about twice as long as broad, oral aperture terminal; pharyngeal armature consisting of a short, compressed fascicle of numerous closely approximated rod-like teeth; endoplast band-like, curved, often S-shaped; contractile vesicle single, spherical, postero-terminal; no trichocysts; colour white. Length of body 1–72″.

HAB.—Bog water, amongst *Confervæ*.

The large size of this animalcule, and the high development of the pharyngeal armature, readily distinguish it from the other members of the genus. Seventy and eighty-three of the characteristic rod-like teeth are reported by Ehrenberg as being respectively present in the one half only of the rod-fascicles exposed to view in two examples that were made the subject of careful examination.

Prorodon teres, Ehr.

Body ovate, cylindrical, twice as long as broad, slightly narrowed anteriorly; oral aperture exactly terminal; pharynx enclosing an elongate cylindrical fascicle of rod-like teeth; endoplast ovate; contractile vesicle single, postero-terminal; no trichocysts. Length of body 1–140″.

HAB.—Pond water.

The cylindrical fascicle with which the pharyngeal cavity of this species is strengthened has been estimated to contain from twenty to as many as forty-five of the characteristic rod-like teeth. Encystment, accompanied by the partition of the animalcule into two equal halves within its cyst, has been reported by Cohn.*

Prorodon griseus, C. & L.

Body ovate, cylindrical, rounded at the two extremities, slightly the widest anteriorly, from two to two and a half times as long as broad; cuticular surface finely and closely striate longitudinally; oral aperture subterminal; pharyngeal rod-fascicle large, cylindrical, slightly curved; endoplast oval, enclosing a small endoplastule; contractile vesicle single, postero-terminal, of large size; colour clear brown when viewed as a transparent object, white by reflected light; no trichocysts. Length of body 1–250″. HAB.—Stagnant water: Berlin (Claparède and Lachmann).

Prorodon armatus, C. & L.

Body nearly globular, slightly compressed, oral aperture subterminal; pharyngeal rod-fascicle cylindrical, wide, and comparatively short; endoplast

* 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. iii., 1853.

elliptical, of small dimensions; contractile vesicle single, postero-terminal, communicating at the time of systole with three or four spherical lateral sinuses; numerous trichocysts enclosed in the cortex of the anterior half of the body, none in the posterior one. Length 1–250″. HAB.—Pond water.

Prorodon edentatus, C. & L. PL. XXVI. FIG. 43.

Body elongate-ellipsoidal, cylindrical, nearly three times as long as broad, transparent, surface of cuticle longitudinally striate, striæ separated considerably from one another; oral aperture terminal, slightly eccentric; pharyngeal armature consisting of a simple, conical, corneous tube developed backwards to the centre of the body and gradually diminishing in size as it approaches the posterior end; endoplast oval, elongate; contractile vesicle single, spherical, postero-terminal; no trichocysts; cilia of the posterior extremity longer than those of the general surface, produced in a tuft-like manner. Length of body 1–250″. HAB.—Pond water.

Prorodon marinus, C. & L.

Body elongate, cylindrical, from two to two and a half times as long as broad, the cuticular surface not longitudinally striate; oral aperture exactly terminal; pharyngeal tube simple, edentulate, very small and short; contractile vesicle postero-terminal; endoplast ovate; colour transparent, enclosing numerous dark, refringent granules. Length of body 1–250″.

HAB.—Salt water: Norwegian coast (C. & L.).

Prorodon margaritifer, C. & L. PL. XXVI. FIG. 44.

Body elongate-elliptical, subcylindrical, three times as long as broad, slightly widest anteriorly; cuticular surface finely and closely striate longitudinally; oral aperture subterminal; pharyngeal tube large, consisting of numerous, short, rod-like teeth; contractile vesicles very numerous, comparatively small and spherical, distributed throughout the substance of the cortical layer; no trichocysts; endoplast double, consisting of two obliquely converging elliptical bodies, separated from one another at the nearest point of convergence by a smaller spherical body which apparently represents the nucleolus or endoplastule; colour of the general substance of the body clear brown, contents of the contractile vesicles pinkish. Length 1–75.″ Habitat unrecorded.

In the number of its contractile vesicles this species stands almost alone among those representatives of the class Infusoria with which we are as yet familiar. The figure here reproduced from Claparède and Lachmann's treatise,* shows over forty of these vesicles on that side only of the animalcule which is exposed to view, so that very few short of one hundred may be accepted as the total number of these structures contained within the cortical layer of a single zooid. These vesicles do not appear to have any communication with one another, but expand and contract independently. A closely similar but less numerical development of the contractile-vesicular system has recently been found by the author to obtain in *Trachelius ovum*. Claparède and Lachmann

* 'Études sur les Infusoires,' 1858.

have remarked of the singular-shaped endoplast of this species that it is not, as in most instances, imbedded within the cortical layer, but lies loosely in the semifluid internal endoplasm, permitting the body to revolve freely over and around it. This phenomenon of the revolution of the body over the endoplast has been reported by Siebold in connection with other infusorial types, but has been explained by Eckhard as being a mere optical illusion. Claparède and Lachmann are, however, so thoroughly convinced of the free suspension of the endoplast in this instance, that they are disposed to accept Siebold's statement as correct. It is a matter of regret that the discoverers of this species have omitted to place on record both the dimensions and habitat of this highly interesting type. Judging from the size of three species of the same genus, *Prorodon marinus*, *P. armatus*, and *P. griseus*, delineated in their treatise, it would appear to considerably exceed these in size and to most nearly approach *P. niveus*.

Doubtful Species.

The *Habrodon curvatus* of Max Perty, 'Kleinster Lebensformen,' 1852, characterized as follows, would appear to be rightly referable to the genus *Prorodon*: "Body subcylindrical, slightly curved, thickened posteriorly, mostly truncate in front; oral aperture anterior, associated with a very delicate dental apparatus; anal aperture postero-terminal; cilia disposed in longitudinal rows, colour grey or pale green; movements slow. Length 1–390″ to 1–132″. Hab.—Spring water, with *Chara*, Bern."

Genus II. NASSULA, Ehrenberg.

Animalcules ovate, cylindrical, flexible but not polymorphic, usually highly coloured; oral aperture lateral; pharynx armed with a simple horny tube, or with a cylindrical fascicle of rod-like teeth; entire surface of cuticle finely and evenly ciliate; the cortical layer sometimes containing trichocysts; contractile vesicle single or multiple. Inhabiting fresh water.

A prominent characteristic of the genus *Nassula* is the normally bright colouring of the parenchyma or body-contents—rose-colour, red, green, blue, yellow, and violet being separately developed or variously combined in the several species. In that form, *N. ornata*, with which the colour violet is more usually dominant, this pigment occurs distributed in scattered vesicular patches, which are most abundant in the anterior region. Ehrenberg was led to regard these coloured vesiculæ as glands possessing probably a biliary function. By Stein, however, both the generally dispersed and vesicular aggregations of colouring matter are pronounced to be merely the product of incepted food-material; certain Oscillatoriæ devoured by one variety, *N. ambigua*, having been observed by him to pass successively through the tints of green, blue, and red during the process of digestion. Claparède and Lachmann, while endorsing Stein's views so far as relates to the coloured material within the semifluid endoplasm, and which is in a constant state of circulation, are inclined to attribute to the stationary pigment-corpuscles imbedded within the cortical layer the character of organs whose special function is not as yet determined. Stein has recently proposed to separate *Nassula ornata*, *N. rubens*, and all other members of this generic group in which trichocysts are abundantly developed, under the distinct title of *Acidophorus*. Such importance is not, however, here conceded to the presence of these structures, their development being subject to considerable variations even among individuals of the same species. The distinct lateral location of the oral aperture serves to readily distinguish this genus from *Prorodon*.

Nassula ornata, Ehr. Pl. XXVI. Fig. 42.

Body ovate, cylindrical, two or three times as long as broad, brownish-green, variegated with violet vesicles; pharyngeal rod-fascicle forming an

even, straight, undilated tube; contractile vesicle single, spherical, subcentral; numerous vesicular spaces, with violet-coloured contents, usually present in the anterior region; no trichocysts. Length of body 1–96″.

HAB.—Pond water.

The *Nassula elegans* and *N. conica* of Ehrenberg appear to differ from this species merely in the subordinate character of colour, the former variety being white or greenish and the latter yellow or brown.

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Nassula flava, C. & L.

Body elongate, cylindrical, three or four times as long as broad, slightly depressed in the antero-dorsal region; colour mostly yellow or brick-red; pharyngeal armature consisting of numerous rod-like teeth, the tube they form being much dilated at the distal end; anterior extremity of the cortical layer usually containing numerous violet-coloured corpuscles, which do not circulate with the general contents; contractile vesicles two in number, simply spherical. Length of body 1–240″ to 1–125″.

HAB.—Pond water, among *Oscillatoria*.

This species, while differing from *N. ornata* Ehr., as explained by Claparède and Lachmann, in the form of the pharyngeal tube and the possession of two contractile vesicles, approaches it so closely in all other details as to render it doubtful whether it must not be regarded as a mere local variety of that type.

Nassula ambigua, Stein. PL. XXVI. FIG. 41.

Body shortly oval or elliptical, cylindrical, equally rounded at both extremities, not quite twice as long as broad; pharyngeal armature consisting of a simple horny tube dilated at its anterior extremity; contractile vesicle single, spherical or assuming a stellate outline, medianly located. Length of body 1–240″. HAB.—Pond water.

A species, apparently identical with this form, recently obtained by the author from ditch water at St. Heliers, Jersey, exhibited numerous trichocysts in the substance of its cortical layer, and was coloured deep green, more especially in the posterior region, through the inception of food-particles. While the first example observed showed apparently a simply tubular pharynx, other specimens, examined with a higher magnification, revealed the presence of the rod-like teeth characteristic of the two preceding forms.

Nassula rubens, C. & L.

Body elongate, cylindrical, three times as long as broad, equally rounded at the two extremities, brick-red or rose colour; pharyngeal armature consisting of separate rod-like teeth, the tube formed by them being slightly dilated anteriorly; trichocysts large and abundant; contractile vesicle single, spherical, subcentral. Length 1–500″. HAB.—Pond water.

This species is identified by Claparède and Lachmann with the *Cyclogramma rubens* of Perty. The genus *Cyclogramma*, as instituted by the last-named author, was distinguished from *Nassula* by the presence of concentric striæ in or upon the cuticular substance. These apparent striæ are now shown to represent the imperfect optical aspect of the closely approximated trichocysts, as seen with an insufficient defining power, that occur so abundantly in this and other species of the

genus. While most usually of a brick-red hue, Claparède and Lachmann mention that the colour in this species is sometimes entirely absent, while in other instances, through the presence of enclosed Oscillatoriæ, it assumes a brilliant glaucous hue.

Nassula lateritia, C. & L.

Body ovoid, cylindrical, twice as long as broad, rounded posteriorly, the anterior border obliquely truncate; pale red or rose colour; mouth opening on the truncate anterior portion; pharyngeal armature consisting of an anteriorly dilated tubular fascicle of rod-like teeth; contractile vesicles two in number, spherical; endoplast discoidal, posteriorly situated; trichocysts numerous, relatively smaller than in *N. rubens*. Length 1–500″.

HAB.—Pond water.

Nassula microstoma, Cohn.

Body persistent in shape, oblong, slightly compressed, the anterior extremity bluntly rounded, the posterior one somewhat pointed; a depressed area, which conducts to the circular oral aperture, developed on one side, near the anterior extremity; pharyngeal tube obliquely directed, simple and unarmed, dilated posteriorly; endoplast subcentral, obliquely placed, having an attached endoplastule; contractile vesicle small, spherical, located at a distance of one-third of the entire length of the body from the posterior extremity; surface of cuticle finely striate or furrowed longitudinally; cilia fine, set in these furrows, equally clothing the entire cuticular surface; colour flesh-red. Length 1–240″. HAB.—Salt water.

Cohn * remarks that this type most nearly resembles the *Prorodon marinus* of Claparède and Lachmann, and may possibly be identical with O. F. Müller's *Paramœcium chrysalis*, or the *Panophrys chrysalis* or *rubra* of Dujardin.

Doubtful Species.

The *Liosiphon Stromphii* of Ehrenberg, separated from *Nassula* on account of the great projection of the anterior region beyond the oral aperture, scarcely appears to possess a sound claim for separate generic distinction. Its form is obtusely ovate, colour green, length 1–432″, hab. pond water; the tubular pharyngeal passage encloses a cylindrical or somewhat clavate fascicle of rod-like teeth, as obtains among the majority of the members of the present genus.

GENUS III. CYRTOSTØMUM, Stein.

Animalcules ovoid or elliptical, highly contractile; oral aperture lateral, taking the form of a longitudinal cleft; pharynx tubular, its wider anterior extremity armed with two closely approximated rows of short, rod-like teeth; cilia of cuticular surface disposed in even longitudinal rows; trichocysts usually present. Inhabiting fresh water.

This genus, as founded by Stein on the *Bursaria* (*Frontonia*) *leucas* of Ehrenberg, differs chiefly from *Nassula* in the highly elastic consistence of the cuticular investment, which allows the animalcules to assume a variety of polymorphic contours.

* "Neue Infusorien im Seeaquarium," 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xvi. 1866.

The oral apparatus, though described as consisting of two closely approximated rows of rod-like teeth, is, as distinctly indicated in Ehrenberg's original drawings, a mere ovate-shaped modification only of the subcylindrical rod-fascicle distinctive of the genera *Nassula* and *Prorodon*.

Cyrtostomum leucas, Ehr. sp. PL. XXVI. FIG. 37.

Body ovoid or ellipsoidal, usually wider anteriorly, about twice as long as broad; cortical layer enclosing numerous trichocysts; oral aperture elongate-ovate, its lower extremity pointed. Length of body 1–144″.

HAB.—Fresh water.

This species, accepted by Stein as the representative of the new genus *Cyrtostomum*, is identified by that authority with both the *Bursaria leucas* and *Bursaria vernalis* of Ehrenberg (*Panophrys do. do.* Dujardin), the latter form, as also attested to by Claparède and Lachmann, being a mere variety coloured green through the ingestion of chlorophyllaceous food-substances. An account of the minute histology and behaviour of the trichocysts so abundantly developed in this species, as carefully worked out and described by Professor Allman, is contained in the section treating of these structures generally in pages 80–84 of the preceding volume, while a reproduction of that authority's figures of these elements is included in the supplementary plate at the end of the atlas devoted to the delineation of histological details.

GENUS IV. ISOTRICHA, Stein.

Animalcules free-swimming, obovate, persistent in shape, depressed or subcylindrical; oral aperture ventral, subterminal, followed by a short, smooth, tubular, membranous pharyngeal passage; anal aperture postero-terminal; cuticular surface clothed throughout with long, fine, densely disposed cilia. Occurring mostly as endoparasites within the first stomach or rumen of various higher Ruminantia.

In general contour and habits, and in their long, dense ciliary clothing, the animalcules of this genus are reported as closely resembling the Opalinidæ; the presence of a well-defined oral aperture serves, however, at once to distinguish them from the members of the last-named group.

Isotricha intestinalis, Stein.

Body obovate, slightly flattened, longitudinally striate; oral aperture ventral, situated within a semilunar depression at some little distance from the anterior border; cilia long and fine; contractile vesicles numerous, distributed chiefly in the anterior region; endoplast elongate oval, associated with a small, subglobose endoplastule. Dimensions unrecorded.

HAB.—Endoparasitic, within the first stomach or rumen of sheep and cattle.

Isotricha prostoma, Stein.

Having the oral aperture at the anterior extremity, nearly in the axial line. All other details, including habitat, corresponding with those of *I. intestinalis*.

Isotricha (?) microstomum, C. & L. sp. Pl. XXVI. Fig. 38.

Body subcylindrical, equally rounded at both extremities, slightly constricted centrally; about two and a half times as long as broad; cuticular surface finely striate longitudinally, entirely clothed with long, fine, even cilia; oral aperture minute, situated at a distance of one-third of the length of the entire body from the anterior extremity, followed by a short, tubular, backwards-directed pharyngeal tract; contractile vesicle single, spherical, located a little behind the centre of the right-hand border. Length 1–250″. Hab.—Salt water: Norwegian coast (C. & L.).

This species is referred by Claparède and Lachmann to the genus *Paramæcium*, from all the typical examples of which it, however, differs in its symmetrical contour and in its simple tubular oral aperture, unassociated with any adoral groove. This combination of characters accords so closely with those of Stein's genus *Isotricha* that it becomes requisite either to refer it to that group, or, in virtue of its non-endoparasitic habits, to establish a new genus for its reception. While the former alternative commends itself most favourably for adoption, it must at the same time be observed that the induration of the short tubular œsophagus is alone wanted to convert this type into a normal member of the genus *Nassula*, and it is just possible that such a structure has been overlooked by its observers. Among the examples of this animalcule examined by Claparède and Lachmann several were distinguished by their yellow-brown tint.

Genus V. HOLOPHRYA, Ehrenberg.

Animalcules free-swimming, ovate or globose, elastic and changeable in form, entirely ciliate; the mouth situated at the anterior pole, and the anal aperture at the opposite or posterior extremity; pharynx simple, having no corneous tube or rod-fascicle; no specially large cilia developed round the oral aperture; multiplying by transverse fission, and forming spherical encystments. Chiefly inhabiting fresh water.

The members of this genus somewhat resemble those of *Prorodon*, the most essential features of distinction being the unarmed character of the pharyngeal passage and elasticity of the cuticle, which permits the animalcules, as in *Cyrtostomum*, to assume a great variety of outline.

Holophrya ovum, Ehr. Pl. XXVI. Fig. 45.

Body ovate, more or less cylindrical, about one and a half times as long as broad; surface of cuticle obliquely striate or corrugate; cilia short, fine, and closely set; colour green or transparent; oral aperture apical, its border slightly projecting; contractile vesicle single, spherical, situated posteriorly, close to the anal aperture; endoplast rounded or ovate, subcentral. Length 1–210″. Hab.—Pond water, amongst *Confervæ*.

Although an ovate outline represents the typical contour of this species, it frequently assumes an inflated, subspheroidal shape, the characteristic cuticular striæ becoming entirely obliterated; it is often impossible, under these conditions, even to recognize the position of the mouth, the animalcule having the aspect of a complete sphere, which may be either perfectly transparent or more or less coloured with chlorophyll-granules, or opaque through the ingestion of food-particles.

Holophrya discolor, Ehr.

Body ovate, pointed posteriorly, about twice as long as broad; cilia long, disposed in widely separated longitudinal rows; parenchyma green or colourless. Length 1–240″. HAB.—Pond water.

Holophrya tarda, Quenn. PL. XXVI. FIGS. 59 AND 60.

Body when extended nearly three times as long as broad, elongate-pyriform, somewhat flask-shaped, rounded posteriorly, tapering gradually towards the narrower and truncate anterior extremity; cuticular surface finely ciliate, striate longitudinally; body in contraction subspherical, with the longitudinal striations obliquely set; contractile vesicle postero-terminal; endoplast elongate-ovate, stationed a little in front of the contractile vesicle. Length 1–300″. HAB.—Salt water.

This as yet single known salt-water species of the genus *Holophrya* is figured and described by August Quennerstedt in his "Bidrag til Sveriges Infusoriefauna," contributed to the 'Acta Universitatis Lundensis' for the year 1865. So far as its external contour and the relative form and position of the endoplast and contractile vesicle are concerned, it would appear to be most nearly related to the *Holophrya Kessleri* of Mereschkowsky next described.

Holophrya Kessleri, Mereschk.

Body contractile and variable in form, elongate-ovate, subcylindrical, sometimes slightly wider anteriorly, about twice as long as broad; cuticular surface alternately grooved and ribbed longitudinally, finely ciliate throughout; parenchyma transparent or with a yellowish tinge; contractile vesicle large, posteriorly situated; endoplast band-like, subcentral. Length 1–170″ to 1–130″.

HAB.—Fresh water: Lake Onega (Mereschkowsky), among aquatic vegetation.

This species is distinguished, according to Mereschkowsky,* by the ribbed character of the cuticular surface and the band-like contour of the endoplast, both of which characters are nevertheless shared by the salt-water *Holophrya tarda* of A. Quennerstedt. When viewed end-on, these longitudinal ribs are found to range from twenty-five to thirty in number, the animalcule under such circumstances presenting an almost melon-like appearance. It does not appear that these ribs become obliquely twisted when the animalcule is contracted, as obtains in *H. tarda*.

Holophrya brunnea, Duj.

Body elongate-cylindrical, equally rounded at the two extremities, two and a half times as long as broad; colour brown. Length of body 1–125″.

HAB.—Pond water.

This form, in common with *Holophrya ovum* and *H. discolor*, assumes after feeding a subglobose or perfectly spherical contour.

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* "Studien über Protozoen des nordlichen Russland," 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xvi., 1878.

Supplementary Species.

The *Holophrya coleps* of Ehrenberg, thus characterized :—"Body oblong, cylindrical, rounded at both extremities; colour whitish. Length 1–430″ to 1–280″."—is identified by Stein with the *Coleps inermis* of Perty, and elevated by him to the rank of a new genus, distinguished by the name of *Plagiopogon*.

Holophrya lateralis, S. K. Pl. XXVI. Fig. 46.

Body cylindrical, evenly ovate or elliptical, a little over twice as long as broad; cuticular cilia conspicuous, arranged in numerous closely approximated, even, longitudinal rows; contractile vesicle lateral, situated a little in advance of the median line; endoplast inconspicuous; endoplasm enclosing innumerable, minute, spherical corpuscles, in addition to the ordinary digestive vacuoles. Length 1–100″.

Hab.—Fresh water: Bombay (H. J. C.).

An animalcule answering to the above diagnosis, and possessing the characteristic terminal oral and anal apertures of the genus *Holophrya*, is figured and briefly described, without name, in the manuscript notes kindly placed at the author's disposal by Mr. H. J. Carter. The species differs essentially from all previously described members of the genus in the lateral instead of terminal location of the contractile vesicle. The flexibility of the integument of this type was demonstrated by the flattened or contorted shapes it assumed in passing and pressing against confervoid filaments or other objects in the water.

Genus VI. OTOSTOMA, Carter.

Animalcules free-swimming, ovate, subcylindrical, entirely ciliate; oral aperture inferior, subterminal, conducting to a short, recurved, indurated pharynx, the contour of which, in profile, resembles that of a human ear; anal aperture, endoplast, and contractile vesicles conspicuous.

Excepting for the peculiar conformation of the pharyngeal tube, the single type of this genus corresponds essentially with the genus *Nassula;* a still more marked divergence in the same direction is noticeable in Cohn's new generic type, *Helicostoma*, next described.

Otostoma Carteri, S. K. Pl. XXVI. Figs. 55–58.

Body ovate, rounded at each extremity, not quite twice as long as broad, slightly narrower anteriorly; oral aperture situated in a depression on the ventral surface, at a distance of about one-third of the length of the entire body from the anterior extremity; pharyngeal tube ear-shaped, longitudinally plicate, recurved towards the posterior extremity; anal aperture postero-terminal; cilia of cuticular surface short and even, disposed in fine parallel longitudinal lines; endoplast fusiform, subcentral; contractile vesicles two in number, separate from one another, often, as in *Paramœcium aurelia*, exhibiting a stellate outline. Length 1–100″.

Hab.—Fresh water, among *Nitella:* Bombay (H. J. C.).

Mr. H. J. Carter, in his brief description of this interesting form,* having omitted to confer upon it any other than a generic title, the author has much pleasure in

* 'Ann. Nat. Hist.,' Feb. 1856.

connecting the name of its discoverer with its future specific denomination. Although, as already intimated, the contour and habits of the animalcule agree closely with those of *Nassula* and *Helicostoma*, certain points have been recorded by Mr. Carter concerning its developmental manifestations which invite special attention. According to this observer the matured individuals become encysted within the internodes of semi-decayed Nitellæ, and then split up into two, four, or eight cleavage masses, each of which is subsequently liberated from the cyst in a form altogether identical with the parent *Otostoma*, but of smaller dimensions, and possessing at this early stage a single contractile vesicle only. This process of multiplication by encystment and segmentation, while of but rare occurrence among the more highly organized Ciliata, commonly obtains among the Infusoria Flagellata, treated upon in the preceding volume. Mr. Charles Stewart, of St. Thomas's Hospital, has recently reported to the author the occurrence of an animalcule apparently indistinguishable from *Otostoma Carteri*, from the neighbourhood of Plymouth, Devonshire. The *Sisyridion cochliostoma* of Ernst Eberhard * is evidently closely allied to, if not identical with, this same type.

GENUS VII. HELICOSTOMA, Cohn.

Animalcules free-swimming, elastic, more or less ovate, finely ciliate throughout; oral aperture ventral, circular, conducting to a tubular pharynx, which, after proceeding obliquely backwards to the centre of the body, terminates in a helicoidal flexure.

Excepting for the peculiar prolongation of the œsophagus with its terminal helicoidal flexure, this generic type corresponds closely with the genus *Nassula*, an intermediate form between the two being supplied by Mr. Carter's genus *Otostoma*.

Helicostoma oblonga, Cohn. PL. XXVI. FIG. 54.

Body oblong or almond-shaped, rounded posteriorly, pointed anteriorly, usually somewhat flattened, three or four times as long as broad; cuticular surface finely striate longitudinally and transversely; cilia short and fine, evenly distributed, sometimes vibrating irregularly, and presenting a tufted aspect; oral aperture situated at a distance of about one-fourth of the length of the whole body from the anterior extremity, pharyngeal tube continued obliquely backwards to the centre of the body, and there forming a loop-like or helicoidal twist; endoplast subcentral; contractile vesicle postero-terminal. Length 1–125″ to 1–75″.

HAB.—Salt water. Movements swift, rotatory.

This species, described, in company with many other interesting marine types, by Dr. Ferdinand Cohn in the 'Zeitschrift für Wissenschaftliche Zoologie' for the year 1866, is referred to by its discoverer as apparently coinciding to some extent with the *Leucophra signata* of O. F. Müller, but of which the figure and description given are not sufficiently explicit for actual identification. The transverse striæ of the cuticular surface, referred to in the foregoing diagnosis, are much less conspicuously developed than those taking a longitudinal direction, and are to be defined only with a careful adjustment of a high magnifying power, constituting in this respect a test-object equal to that of the cross-striation of the diatom *Pleurosigma attenuatum*.

* 'Oster-Programm der Realschule zu Coburg,' 1862.

Fam. III. TRACHELOPHYLLIDÆ, S. K.

Animalcules free-swimming, ciliate throughout, more or less flask-shaped; oral and cuticular cilia alike, the oral aperture perforating the extremity of the narrower anterior region, which is frequently highly elastic and extensile.

GENUS I. TRACHELOPHYLLUM, C. & L.

Animalcules elastic, flattened, lanceolate or flask-shaped, having an attenuate neck-like portion, the apical extremity of which is separated by an annular constriction from the preceding part, and is perforated at its apex by the oral aperture, as in the genera *Lacrymaria* and *Trachelocerca*, but has no circlet of larger cilia; pharyngeal passage tubular, conspicuously developed; contractile vesicle single, situated close to the postero-terminal anal aperture.

Claparède and Lachmann have founded the genus *Trachelophyllum* on the type first described by Perty under the title of *Trachelius apiculatum*, separating it from the last-named generic group on account of the terminal position of the oral aperture. The animalcules are further distinguished from those of *Lacrymaria*, which they still more nearly approach, by their compressed form and the absence of the annular circlet of stouter cilia at the anterior or oral region. As a consequence of their flattened contour, their movement in the water differs considerably from those of the cylindrical *Lacrymariæ*. This in the type-species, *T. apiculatum*, consists chiefly of a smooth, gliding motion, after the manner of *Chilodon* and *Loxophyllum*, in place of rotation on their axis as obtains in *Lacrymaria* and *Phialina*. The neck in *Trachelophyllum*, while possessing a considerable amount of elasticity, is inferior in this respect to *Trachelocerca*.

Trachelophyllum apiculatum, Perty sp. PL. XXVI. FIGS. 61 AND 62.

Body flattened, lanceolate; neck long, slender, and highly extensile, nearly equal in length to the body, perforated throughout the greater portion of its length by a narrow, straight, somewhat obscure pharyngeal tract, the walls of which are faintly striate longitudinally; cuticular surface entirely but thinly clothed with moderately long cilia, whose action is somewhat irregular and independent; contractile vesicle single, spherical or rosette-shaped, posteriorly situated; endoplasts multiple, ovate, two or four in number. Length of body 1–144." HAB.—Pond water.

This animalcule is identical with the *Trachelius apiculatum* of Perty. From two to as many as four nuclei or endoplasts were observed in the specimens as examined by Claparède and Lachmann, though the former and smaller number only is ascribed to it by Wrzesniowski. The character and varied aspect of the contractile vesicle under the respective conditions of systole and diastole, and during the passage of excreta through the terminal anal aperture, has formed the subject of careful investigation by the last-named authority,* the results arrived at yielding the strongest possible evidence in demonstration of the non-possession by this

* A. Wrzesniowski, "Anatomie der Infusorien," 'Archiv für Mikroskopische Anatomie,' Bd. v., 1869.

structure of a differential bounding wall or membrane, as also of its non-occupation of a restricted position in the substance of the cortex. At the time of fullest diastole a variable number of minute transparent lacunæ filled with water make their appearance round the border of the contractile vesicle, communicating to it a rosette-shaped contour, and remain as small independent vacuoles after the contents of the central reservoir have been discharged, these then coalesce, and, increasing in size, assume the same form and pursue a like course as the water globule or vacuole just discharged. The food-matter, after the extraction of its nutrient properties, is collected in the form of a globular pellet at the posterior extremity of the body, and on its way towards and through the anal aperture temporarily dislodges the contractile vesicle, forcing it to a considerable distance forwards from its original position, but to which it again returns after the evacuation of the excreta.

Trachelophyllum pusillum, C. & L.

Body elongate, flask-shaped, the anterior or neck-like portion very little narrower than the remainder of the body, four and a half times as long as broad; contractile vesicle single, postero-terminal; endoplasts two in number, elongate-ovate. Length of body 1–625″. HAB.—Stagnant water.

Claparède and Lachmann regard this form as probably identical with the *Trachelius pusillus* of Perty.

GENUS II. ENCHELYODON, C. & L.

Animalcules free-swimming, elastic and changeable in form; ovate or pyriform, not produced anteriorly in a neck-like manner; oral aperture apical, followed by a well-developed membranous pharynx, the walls of which are mostly longitudinally plicate; anal aperture postero-terminal; cuticular surface finely and entirely ciliate throughout. Inhabiting salt and fresh water.

In constructing this genus upon the type next described, Claparède and Lachmann left it in some doubt whether the walls of the conspicuous tubular pharynx were simply membranous and longitudinally plicate, or whether they were indurated or strengthened by a cylindrical fascicle of rod-like teeth, as in *Nassula* and *Prorodon*. Assuming the balance of evidence to be in favour of the latter of these two hypotheses, they placed it in close vicinity to *Prorodon*, and from which, indeed, they represent it as differing chiefly in the greater elasticity and finer ciliation of the cuticular investment, and in its slower movements. Wrzesniowski, however, who has more recently made this type the object of a special investigation,* has decided that the pharynx is membranous and longitudinally plicate, as half-anticipated by Claparède and Lachmann, this being demonstrated by the circumstance that the tube with its plications becomes bent upon itself, or in a sinuous manner, during the contractions of the animalcule. Accepting Wrzesniowski's interpretation, the natural position of *Enchelyodon* is evidently close to that of *Trachelophyllum*, from which it would, indeed, appear to differ only in the absence of a differentiated and elastic neck-like portion.

Enchelyodon farctus, C. & L. PL. XXVI. FIGS. 51–53.

Body elastic, ovate and somewhat flattened, slightly narrowest anteriorly, more than twice as long as broad; pharyngeal passage long and narrow,

* 'Archiv für Mikroskopische Anatomie,' Bd. v., 1869.

extending backwards to about one-third of the length of the body, its walls plicate longitudinally, the anterior border projecting slightly beyond the front margin of the body; contractile vesicle single, spherical or rosette shaped, situated posteriorly, close to the anal aperture; endoplast band-like, sinuous; cuticular surface longitudinally striate; cilia very short and fine. Length of body 1–125″. HAB.—Bog water: Berlin (C. & L.).

The contractile vesicle of this species has been shown by both Claparède and Wrzesniowski to exhibit phenomena closely corresponding with what has been already described of *Trachelophyllum apiculatum*, a portion of the accumulated fluid being driven at the time of systole into minute rounded sinuses, the contents of which afterwards coalesce together, and, increasing in volume, present all the characteristics of the preceding vacuole. These metamorphic phenomena exhibited by the contractile vesicle in *Trachelophyllum* and *Enchelyodon*, are directly comparable with the stellate modifications of this same structure already recorded of the two genera *Paramæcium* and *Otostoma*.

As shown by Wrzesniowski, a minute pore or aperture places the central lacuna of the contractile vesicle of *Enchelyodon farctus* in direct communication with the outer water. The aspect of this vesicle, in its fully dilated rosette-shaped condition, showing its central pore-like aperture, is reproduced from Wrzesniowski's delineations at Pl. XXVI. Fig. 53.

Enchelyodon elongatus, C. & L. PL. XXXII. FIG. 17.

Body attenuate, clavate, four or five times as long as broad, the anterior half narrowest; pharynx simple, short, and tubular; contractile vesicle single, spherical, posteriorly located; endoplast central, oval; cilia fine, short, and evenly distributed. Length unrecorded.

HAB.—Salt water: Norwegian coast (C. & L.).

Although not mentioned in the description, Lachmann's figure of this species indicates the presence of several symmetrically placed reflected setæ, four on each side, at the anterior extremity or oral region of the body. Should these setæ really exist, this form would seem to demand a generic title separate from that of *Enchelyodon* for its reception.

GENUS III. UROTRICHA, C. & L.

Animalcules free-swimming, ovate or elliptical, entirely ciliate, motion of cilia irregular and independent; oral aperture apical, terminal, a single long, projecting springing-hair or seta developed at the posterior extremity. Inhabiting fresh water.

The motion of the cilia in the representatives of this genus is peculiar, and serves at a glance to distinguish them from those of the ordinary Holotrichous types. Instead of vibrating in rhythmical cadence, each cilium waves independently and apparently without any order, the ciliary system as a whole consequently assuming a comparatively irregular and untidy aspect. In creating the genus *Urotricha*, Claparède and Lachmann remark that Professor Johannes Müller had indicated the possible identity of their *Urotricha farcta* with the *Pantotrichum lagenula* of Ehrenberg. M. Lieberkuhn, however, has supported them in regarding the two forms as separate. Having frequently encountered the animalcule described by Ehrenberg under the last-named title, the anthor is likewise enabled to establish its distinctness from the species introduced by the Genevan authorities, though it is obviously desirable to refer it to the same generic group. The original genus *Pantotrichum* of Ehrenberg includes, in addition to *P. lagenula*,

various minute entirely ciliate forms too indistinctly characterized for present identification, and in none of which is mention made of the terminal springing-hairs upon which the genus *Urotricha* is mainly founded.

Urotricha farcta, C. & L. PL. XXVII. FIG. 2.

Body ovate or ellipsoidal, surface of cuticle coarsely and obliquely striate; cilia short and evenly distributed, posterior springing-hair obliquely directed when at rest, about equal to the body in length; oral aperture perforating a small circular prominence at the anterior extremity. Contractile vesicle single, spherical, posteriorly situated; endoplast ovate, subcentral. Length 1–1250″. HAB.—Pond water and in infusions.

The movements of this animalcule are of two kinds, and somewhat remarkable. In its more ordinary mode of progression it swims slowly in a forward direction, describing circles of a considerable diameter, the organs of propulsion on such occasions being the irregularly vibrating cuticular cilia; now and then, however, this more even locomotion is interrupted by a spasmodic leap to one side or in some other direction, the motion in this instance being accomplished by the posterior seta or springing-hair. According to its discoverers, the oral aperture of this species is capable of slight protrusion anteriorly in a lip-like manner, and in a way apparently according with that characteristic of *Trachelophyllum apiculatum* and *Enchelyodon farctum*; its walls are at the same time highly elastic, and permit the passage of food-masses almost equal in size to its own body.

Urotricha lagenula, Ehr. sp. PL. XXVII. FIG. 1.

Body flask-shaped or pyriform, attenuate in front, rounded posteriorly, from one and a half to twice as long as broad; cuticular surface smooth; cilia longest in the anterior region, moving independently; posterior springing-hair always directed backwards in a straight line, exceeding the body in length; contractile vesicle single, spherical, posteriorly located. Length 1–570″. HAB.—Pond and marsh water.

This species, apparently identical with the *Pantotrichum lagenula* of Ehrenberg, differs from the preceding type, not only in its larger size, but in its flask-shaped contour, in the greater development of the cilia in the anterior region, and in the uniformly straight direction of the posterior springing-hair, which has, moreover, a greater proportional length. In common with *Urotricha farcta*, its movements through the water consist of slow rotation on its longitudinal axis in circles and in a forward direction, varied by occasional leaps from side to side after the manner of a *Halteria* or *Uronema*. In examples obtained from marsh water in the neighbourhood of Le Marais, Jersey, in company with *Paramæcium bursaria*, numerous green chlorophyll-granules occupied almost the entire space of the internal endoplasm; this colouring-matter was doubtless derived from the inception of zoospores, Thecomonads, and other chlorophylloid organisms which abounded in the same locality. The almost invariable occurrence of this form in company with *Halteria grandinella*, has afforded the author grounds for suspecting that *Urotricha lagenula* may eventually prove to be a developmental phase only of the last-named animalcule.

Fam. IV. COLEPIDÆ, Ehrenberg.

Animalcules free-swimming, symmetrically ovate, persistent in form, ciliate throughout, oral cilia slightly larger than those of the general cuticular surface.

Genus I. COLEPS, Ehrenberg.

Animalcules more or less evenly ovate, persistent in shape, cuticular surface usually longitudinally and transversely furrowed, and thus divided into numerous symmetrical quadrangular facets or interspaces; the quadrangular facets smooth and indurated, the narrow intervening furrows soft and clothed with cilia; oral aperture apical, terminal, surrounded with cilia, of slightly larger size than those of the general surface; anal aperture situated at the opposite or posterior extremity, the anterior and posterior margins usually mucronate. Dividing by transverse fission. Inhabiting salt and fresh water.

The genus *Coleps* is usually cited as one of the few ciliate infusorial groups whose members may be described as perfectly symmetrical; many of the representatives of the family of the Prorodontidæ or Trachelophyllidæ already described possess, however, an equal claim to such distinction. The cuticular ornamentation of the various species of the genus *Coleps* has been somewhat diversely interpreted by independent observers. Perty and Dujardin maintained the opinion that the quadrangular facets are indurated, and the narrow intervening furrows soft and clad with cilia. Claparède and Lachmann, however, upheld the view first expressed by Ehrenberg, to the effect that the furrows are indurated, and form a continuous symmetrical trellis-work, and that the quadrangular facets are of softer consistence and support the cilia. Having recently examined examples of the typical species, *Coleps hirtus*, with considerable care and the aid of the highest available magnifying power, the present author unhesitatingly adopts the interpretation of Dujardin and Perty. The facility and rapidity with which the animalcules of this genus divide by transverse fission is of itself a point in favour of the view here supported, for while the existence of a continuous trellis-like induration of the cuticular surface would offer a considerable obstacle to such transverse division, it takes place naturally and with the greatest ease along the line of one of the previously existing and softer intersecting furrows. Diesing, on very insufficient grounds, has proposed to separate this genus into three, abandoning the original title of *Coleps* altogether, and substituting in its place that of *Pinacocoleps* for *C. incurvus*, *Cricocoleps* for *C. amphacanthus*, while all the rest, including *C. hirtus* and Stein's *Plagiopogon coleps*, are collated together under the generic name of *Dictyocoleps*. The artificial character of such a plan of grouping is self-apparent.

Coleps hirtus. Pl. XXVII. Figs. 3 and 4.

Body ovate, subcylindrical, more or less barrel-shaped, about twice as long as broad, rounded posteriorly, slightly narrower and truncate in front; the anterior margin denticulate, three spinous processes or cusps developed at the posterior extremity; cuticular surface divided into quadrangular areas and presenting a reticulate aspect; endoplast spherical, subcentral; contractile vesicle single, posteriorly situated, colour whitish or light brown. Length 1–500″ to 1–400″.

Hab.—Pond water, among duckweed and *Confervæ*.

This widely distributed species is subject to some variation in contour and aspect. One of these varieties having a more elongate outline has received from Ehrenberg the title of *Coleps elongatus*, and another, with green-tinted parenchyma, that of *C. viridis*; both, however, are now accepted as being merely local phases of the present type. The active scavengering habits and voracity of *Coleps hirtus* have been

the subject of remark by numerous observers, a crushed Entomostracon, or any other dead or decaying organic substance contained in the water abounding with this animalcule, being surrounded and devoured with an amount of happy despatch that, comparing small things with great, would scarcely disgrace a troop of jackals collected around some desert carrion. It has been further remarked that the contour of these animalcules becomes considerably distended after their enjoyment of such a meal, a fact which of itself substantially supports the view here adopted as to induration of the quadrangular areas only of the cuticle, such a distension being altogether irreconcilable with a continuous and trellis-like hardening of the same surface. In the examples recently examined by the author, it was noted that when the animalcules were feeding or otherwise stationary, the cuticular cilia exhibit a continuous irregular and altogether independent vibratory action; the vigorous natatory movements, on the contrary, appeared to be accomplished through the agency of the more powerful oral cilia. It was further certified, in the course of this examination, that the cortex or body-substance immediately subjacent to the sculptured cuticle was independently and sparsely striate or grooved in a longitudinal direction, the body in such case, regarded independently of the external layer, presenting an elongate, ribbed, melon-like contour.

During the process of transverse fission the animalcules of this species, as shown at Pl. XXVII. Fig. 4, exhibit an altogether abnormal aspect. While the two extremities retain their usual corrugated appearance, the newly developed central area, having a median constriction, is entirely smooth, or marked only by the deeper longitudinal furrows just referred to. So also, when the two moieties become entirely separated, one half of each of these remains for a considerable interval smooth and transparent, the anterior and posterior halves of the same animalcule so contrasting with one another as to suggest the simile of a smooth acorn projecting from its rugose cup.

Quite recently, May 1880, the author has obtained in abundance, from a pond near Acton, in company with the Flagellate types *Trepomonas agilis* and *Trachelomonas volvocina*, a variety of this form or a most closely allied species, in which no cusps whatever were developed at the posterior extremity, the size, quadrangular corrugation, and deeper longitudinal lines or furrows being, in common with all other essential structural details, identical with what obtains in *C. hirtus*. At the same time the consistence of the cortical layer seemed to be thinner and more transparent than usually obtains in that species, permitting a clearer view of the internal contents, which were chiefly coloured green through the ingestion of food-matter. While the comparative length and breadth in the examples examined averaged in most instances the proportions of two to one, much shorter and almost subspheroidal specimens were not unfrequently encountered. This well-marked variety should perhaps be properly referred to the genus *Plagiopogon*, next described.

Coleps uncinatus, C. & L. Pl. XXVII. Fig. 6.

Body ovate, slightly flattened ventrally, two and a half times as long as broad; the anterior margin bearing two recurved uncini on the more flattened ventral side, four acuminate cusps developed at the posterior extremity. Contractile vesicle single, posteriorly situated; endoplast discoidal, central. Length of body 1–380″. Hab.—Fresh water.

Coleps fusus, C. & L. Pl. XXVII. Fig. 5.

Body fusiform, subcylindrical, nearly four times as long as broad; the anterior margin truncate, denticulate, attenuate and pointed posteriorly; no posterior cusps. Length 1–300″. Hab.—Salt water.

In their brief description and illustration of this type, Claparède and Lachmann mention that the rugose induration of the cuticular surface does not extend quite to the posterior extremity of the body, but leaves a short, soft, terminal portion exposed. This species was originally obtained by M. Lachmann at Glesnoes, on the Norwegian coast.

Coleps incurvus, Ehr.

Body oblong, subcylindrical, slightly curved, terminating posteriorly in five points. Length 1–430″. HAB.—Fresh water, among *Confervæ*.

Coleps amphacanthus, Ehr.

Body shortly ovate, cuticular surface divided by transverse furrows into numerous annular indurated segments, the anterior margin unequally denticulate, three strong spines or cusps at the posterior extremity. Length 1–280″. HAB.—Fresh water.

GENUS II. PLAGIOPOGON, Stein.

Animalcules free-swimming, persistent in shape, oval, subcylindrical, longitudinally furrowed; oral aperture anteriorly situated, surrounded by a circle of stiff setose cilia; fine, hair-like, vibratile cilia clothing the remaining cuticular surface; no apical or posterior spines; contractile vesicle and anal aperture posteriorly located.

Plagiopogon coleps, Stein. PL. XXVII. FIG. 7.

Body ovate, subcylindrical, a little over twice as long as broad, longitudinal furrows rather widely separated, the intervening spaces finely striate transversely. Length 1–300″. HAB.—Salt and fresh water.

This typical species of the genus *Plagiopogon* is founded by Stein * upon the *Holophrya coleps* of Ehrenberg and the *Coleps inermis* of Perty. As delineated by these two authorities, the animalcule resembles a *Coleps hirtus* devoid of posterior spines, and having its surface furrowed in a longitudinal direction only.

GENUS III. POLYKRIKOS, Bütschli.

Animalcules free-swimming, persistent in shape, subcylindrical or barrel-shaped; oral aperture terminal, having issuing from it a long bristle-like seta; numerous annular shortly ciliate grooves transversely encircling the body; endoplasm enclosing irregularly disposed trichocysts (?).

Polykrikos Schwartzii, Bütschli. PL. XXVII. FIGS. 8–10.

Body barrel-shaped, subcylindrical, slightly narrowed and truncate at the two extremities, about twice as long as broad; transverse ciliary zones, eight to twelve or more in number, converging forwards on one side so as to form an obtuse angle parallel with the projection of the succeeding ring; the border of the oral aperture four-lobed; a long stiff seta, similar to the oral one, produced obliquely forwards from the body at a distance of about

* 'Prager Lotos,' Bd. ix., 1859.

one-third of its entire length from the anterior extremity; trichocysts large and conspicuous, irregularly disposed (?); endoplasts two in number, elongate-ovate, placed usually one behind the other; contractile vacuole posteriorly-situated. Multiplying by transverse fission. Length 1–200".

HAB.—Salt water, Norwegian coast, and also at Kiel in brackish water.

This single representative species of the genus *Polykrikos* as established by Bütschli, accords so closely in general contour, and in the position of the mouth, with the members of the genus *Coleps*, the annulation of the cuticle more particularly approximating that of *C. amphacanthus*, that it appears desirable to retain it provisionally in the same family group. The long seta projecting from the oral cleft is possibly the homologue of the seta common to various members of the Hypotrichous genus *Trochilia*. The feature usually regarded as the most abnormal and important in this type is the enormous size of the contained trichocysts and the perfect correspondence of these structures with the nematocysts or thread-cells of the Cœlenterata or sea-anemones and hydroid zoophytes. The impression conveyed by a reference to Bütschli's original description and drawings of these structures,* reproduced at Pl. XXVII. Figs 9 and 10, are, it must be confessed, not unmingled with the suspicion that these so-called trichocysts have an entirely adventitious origin. Their disposition within the interior of the endoplasm is altogether irregular, and such as would occur if incepted as food-material. The species, furthermore, possesses a marine habitat, and not improbably feasts upon the débris of defunct zoophytes in the same manner as the more familiar *Coleps hirtus* preys upon the residual detritus of fresh-water organisms. The thread-cells of the Cœlenterate structures would in the former instance be extensively engulfed, and would, under such circumstances, present the aspect accredited to them by Bütschli. Until, therefore, further evidence is forthcoming proving the extrusion of these so-called trichocysts from the cuticular surface of *Polykrikos*, their admission in the foregoing diagnosis must be regarded as purely provisional.

Fam. V. ENCHELYIDÆ, S. K.

Animalcules free-swimming, more or less ovate, ciliate throughout, oral cilia slightly larger than those of the general cuticular surface; cuticle soft and flexible; oral aperture terminal or lateral; the anterior extremity of the body never prolonged in a neck-like manner.

The group of the Enchelyidæ, as here defined, while corresponding to some extent with that of the Enchelia and Enchelina of Ehrenberg and Stein, has a much more restricted limitation, the long extensile-necked *Trachelocercæ*, *Prorodon* and its allies, and *Coleps* with its indurated integument, being excluded and referred to independent families.

GENUS I. ENCHELYS, Ehrenberg.

Animalcules free-swimming, elastic and changeable in shape, pyriform or globose; oral aperture situated at the termination of the narrower and usually oblique truncate anterior extremity; anal aperture at the opposite or posterior termination; surface of cuticle entirely but very finely ciliate; cilia longer and more easily distinguishable in the region of the mouth. Inhabiting marsh and stagnant water.

* 'Archiv für Mikroskopische Anatomie,' Bd. ix., 1873.

The animalcules of this genus, while somewhat resembling those of *Holophrya*, are to be distinguished from the latter by their pointed and obliquely truncate anterior extremity, and by the fringe of larger cilia that encircles the oral region. The diagnoses and figures of the several species, as given by Ehrenberg, represent them as having no cilia on the general surface of the integument, these structures, while present, being so fine that they are liable to be overlooked unless glasses of the highest defining power are employed in their examination. From *Trichoda*, with which the animalcules of this generic group also closely correspond in form and habits, they are to be distinguished by the absence of a vibratile membrane in association with the oral fossa. The genus *Enchelys* of Dujardin does not correspond with that of Ehrenberg, but includes forms rightly referable to the genus *Cyclidium*.

Enchelys farcimen, Ehr. PL. XXVII. FIG. 15.

Body transparent, pyriform, slightly curved, attenuate and obliquely truncate anteriorly, inflated posteriorly, about one and a half times as long as broad; contractile vesicle single, spherical, posteriorly located; endoplast oval, subcentral. Length of body 1–1000″ to 1–430″.

HAB.—Stagnant water and infusions.

The author has encountered a species agreeing in every respect with this form but of smaller dimensions, in hay-infusions, the largest examples not exceeding the thousandth part of an inch in length. The characteristic movements of these animalcules consisted, when feeding, of routing about, snout downwards, among the vegetable débris, as shown in the accompanying figure, and at other times of swimming slowly through the water rotating on their longitudinal axis. In common with the members of the genus *Holophrya*, this and the other species of *Enchelys* become considerably distorted through the inception of food-substances, that may even exceed themselves in bulk, and also assume at will an entirely spherical outline. In this latter condition the oral aperture becomes completely obliterated, the position of the contractile vesicle only under these circumstances assisting in the distinction of the anterior from the posterior region of the body.

Enchelys pupa, Ehr.

Body inflated, attenuated anteriorly, frequently filled with green granules. Length 1–140″. HAB.—Stagnant bog water.

Enchelys arcuata, C. & L. PL. XXVII. FIG. 14.

Body pyriform, attenuate anteriorly, perfectly transparent, cilia of general surface very short and fine; contractile vesicles numerous, four or five in number, arranged in an arcuate manner along the ventral margin of the body; endoplast elongate-oval, subcentral. Length 1–300″.

HAB.—Bog water.

Doubtful Species.

The so-called Hematozoon from the blood of Ceylon red deer, described and figured by Dr. Boyd Moss in the 'Monthly Microscopical Journal' for October 1871, is apparently referable to the genus *Enchelys*. The animalcules there delineated exhibit roughly the characteristic aspect of the members of this genus, though the cilia, probably through imperfect illumination, were visible only upon the more pointed anterior half of the body. Their dimensions would appear to correspond most closely with the smaller size of those of *E. farcimen*. While the evidence given by Dr. Moss strongly favours the supposition that these ciliate

animalcules occupy a permanent position within the vital fluid of the mammal named, further corroborative testimony in the same direction is much to be desired.

GENUS II. METACYSTIS, Cohn.

Animalcules free-swimming, symmetrically ovate or elongate, persistent in form; the entire cuticular surface clothed with fine vibratile cilia, with the exception of a bare vesicular-like posterior portion; oral aperture anteriorly situated, encircled by a fringe of stouter cilia.

Metacystis truncata, Cohn. PL. XXVII. FIGS. 11–13.

Body ovate or elongate, subcylindrical, the posterior third or fourth smooth and vesicular-like, the remaining portion transversely annulate, and finely ciliate; the anterior extremity abruptly truncate, bearing a circlet of long, incurved cilia; endoplast spherical, central. Length of most elongate specimens 1–900". HAB.—Salt water, among decaying algæ.

As recognized by Cohn in his description given of this species,* it would seem by no means improbable that it is identical with the marine type figured and described by O. F. Müller† under the title of *Trichoda paxillus*, but which does not appear to have been encountered by any subsequent observer.

GENUS III. PERISPIRA, Stein.

Animalcules free-swimming, symmetrically ovate, persistent in shape but not encuirassed; oral aperture at the anterior extremity; cuticular surface entirely and finely ciliate; a raised border, bearing the adoral cilia, extending in a spiral manner from the anterior extremity round the body towards the posterior end; anal aperture and contractile vesicle postero-terminal.

Perispira ovum, Stein. PL. XXVII. FIG. 18 (?).

Body ovate, longitudinally striate, about twice as long as broad, oral aperture presenting the form of a transverse fissure; endoplasm usually filled with chlorophyll-granules. Dimensions unrecorded.

HAB.—Fresh water.

Stein suggests that this species is possibly identical with the *Holophryoa vum* of Ehrenberg; the elastic character of the parenchyma and cuticular covering in that type, as compared with Stein's diagnosis, would seem, however, to scarcely favour this interpretation. The accompanying figure, Pl. XXVII. Fig. 18, represents an animalcule apparently closely allied to it if not identical with Stein's species, delineated in the manuscript notes of Bombay Infusoria kindly placed at the author's disposal by Mr. Carter; the conspicuously larger size of the adoral spire of cilia affords perhaps sufficient grounds for its recognition as a second species of the genus *Perispira*.

GENUS IV. ANOPHRYS, Cohn.

Animalcules free-swimming, persistent in shape but highly flexible, elongate-ovate, rounded posteriorly, the anterior extremity pointed, more or

* "Neue Infusorien im Seeaquarium," 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xvi., 1866.
† 'Animalcula Infusoria,' 1786.

less curved; oral aperture ventral, remote from the apical extremity, of oblong shape, followed by a short, tubular pharynx; cuticular surface entirely ciliate; a fascicle of longer and stouter cilia issuing from the oral cleft; endoplast and contractile vesicle conspicuous.

According to Cohn, excepting for the absence of the minute enclosed oral membrane, the representatives of this genus closely correspond with those of *Trichoda* as modified by Stein; the chief distinction between the two being that, while in *Trichoda* the oral cilia form a small wreath round the subterminal buccal aperture, in *Anophrys* they depend in a fascicular manner from this structure. The still closer affinity of the type-form of this generic group with *Colpoda* is self-evident.

Anophrys sarcophaga, Cohn. PL. XXVII. FIGS. 16 AND 17.

Body elongate-ovate or clavate, subcylindrical, rounded posteriorly, pointed and curved anteriorly, from three to four times as long as broad; pale amber colour; oral aperture situated on the ventral surface at a distance of one-third of the length of the entire body from the anterior extremity, bearing a fascicle of about eight or nine large cilia; cuticular surface furrowed longitudinally and transversely; the cilia clothing the pointed anterior extremity of larger size than those of the remaining portion of the body, which are very fine and difficult to see; endoplast central, spherical, of large size; contractile vesicle postero-terminal. Length 1–400″.

HAB.—Salt water, with decaying animal matter.

As recognized by Cohn,* this species, excepting for the character of the oral cilia, closely resembles the *Trichoda* (*Leucophrys*) *carnium* of Ehrenberg, a species occurring in putrescent infusions, and in water from manure-heaps; the oral aperture in this latter type would seem, however, to be more nearly terminal. Reference is made by Cohn to a long tail-like seta at the posterior extremity, but is not indicated in his drawings. The fascicle of oral cilia in rapid motion is described as presenting the appearance of an undulating membrane.

GENUS V. COLPODA, Ehrenberg.

Animalcules free-swimming, persistent in shape, ovate or reniform, compressed; oral aperture ventral, lying in a cleft-like depression at some little distance from the anterior extremity, having no undulating membrane, but giving origin to a brush-like tuft of longer cilia; pharynx absent or rudimentary; cilia of the general surface very fine, sometimes conspicuous only towards the anterior extremity of the body. Inhabiting fresh and salt water and infusions.

Colpoda cucullus, Ehr. PL. XXVII. FIGS. 19–23.

Body subreniform, one and a half times as long as broad, rounded and inflated posteriorly, pointed anteriorly and recurved towards the ventral aspect; cilia of the oral region projecting in a tongue-shaped or tuft-like manner from the oral fossa, the shorter cilia of the general surface conspicuous only towards the anterior extremity of the body; endoplast

* 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xvi., 1866.

spherical, subcentral; contractile vesicle spheroidal, of large size, posteriorly located. Length of body 1–280″.

HAB.—Fresh water and infusions.

The distinction between this form and the *Colpoda cucullus* of Dujardin, or *Colpidium cucullus* of Stein, is explained in the description given of the last-named species. Although appearing under ordinary magnification, and formerly pronounced to be ciliated only at the anterior extremity, there is no longer room for doubt that the entire surface of the body of this animalcule is also finely ciliate. The multiplication by fission of this species has been described at length by the last-named author, this process in all instances, according to Stein's observations, being preceded by encystment. Within its cyst the animalcule divides variably into either two, four, eight, or as many as sixteen, spore-like bodies, which ultimately escape through the rupture of the wall of their prison-house in a form which, while smaller, is in all respects identical with that of the parent animalcule. Similar reproductive phenomena have been recorded in connection with the genus *Otostoma*, but are at the same time rare among the Ciliata, though of almost universal occurrence among the more simple Flagellata. No act of conjugation or fusion of two animalcules is mentioned by Stein as necessarily preceding the process of encystment and sporular form of multiplication as above described.

Colpoda parvifrons, C. & L.

Body ovate, nearly twice as long as broad, rounded at both extremities but widest posteriorly, the anterior end not recurved ventrally; the outer surface of the body distinctly though finely ciliate; contractile vesicle posteriorly situated but not precisely terminal as in *C. cucullus*. Length of body 1–600″. HAB.—River water: Spree, near Berlin (C. & L.).

Colpoda pigerrima, Cohn. PL. XXVII. FIG. 24.

Body elliptical, pointed at each extremity, about three times as long as broad, the anterior end most attenuate and curved towards the ventral aspect; oral cleft at a distance of about one-third of the entire length of the body from the anterior extremity; cuticular surface subdivided by longitudinal and transverse striations into minute quadrate areas; cuticular cilia very short and fine, of equal size throughout, oral cilia forming a projecting recurved tuft; contractile vesicle situated close to the base of the oral cleft. Length 1–780″.

HAB.—Sea water with decaying animal matter.

The greater proportional length, surface ornamentation, and position of the contractile vesicle readily distinguish this type from the two preceding species.

GENUS VI. TILLINA, Gruber.

Animalcules free-swimming, persistent in shape, subreniform; oral aperture ventral, followed by a long, curved pharynx; cuticular surface entirely clothed with very fine vibratile cilia, a circle of longer cilia developed round the oral aperture and continued down the pharyngeal passage; endoplast and contractile vesicle conspicuous.

Tillina magna, Gruber. PL. XXXII. FIG. 13.

Body subreniform or bean-shaped, compressed, rather over twice as long as broad; an irregular, broad, lobate process developed from the dorsal aspect of the posterior extremity and interrupting the symmetry of this region; oral aperture ventral, subcentral, followed by a tubular, strongly recurved pharynx, whose walls are conspicuously ciliate throughout; oral and pharyngeal cilia considerably larger than those covering the general cuticular surface; cuticular surface smooth, or finely and sparsely striate longitudinally, its deeper layer apparently striate radially, an aspect due most probably to the enclosure of trichocysts; endoplast elongate-ovate, situated in the anterior body-half; contractile vesicle posteriorly located, intrenching partly on the irregular lobate process. Length 1–125″.

HAB.—Fresh water.

This species, described by Dr. August Gruber, together with several other interesting forms, in the 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xxxv., 1879, and translated in the 'Journal of the Royal Microscopical Society' for April 1880, is regarded by its discoverer as exhibiting a type of structure intermediate between *Paramæcium* and *Colpoda*. In the peculiar form of pharynx, however, it much more closely approaches *Conchophthirus*, but is necessarily referred to the present family group on account of the more conspicuous development of the oral cilia. Reproduction accompanied by encystment and subdivision into four equal spore-like masses after the manner of *Colpoda*, has been observed. In the accompanying drawing the anterior and posterior regions have been accidentally reversed.

Fam. VI. TRACHELOCERCIDÆ, S. K.

Animalcules free-swimming, flask-shaped or elongate, soft and flexible, ciliate throughout, the oral cilia slightly exceeding in size those of the general cuticular surface; the anterior extremity usually prolonged in a neck-like manner, an annular groove or furrow often present near the apical extremity; oral aperture terminal or subterminal.

GENUS I. TRACHELOCERCA, Ehrenberg.

Animalcules highly elastic and changeable in form, the anterior portion produced as a long, flexible, narrow, neck-like process, the apical termination of which is separated by an annular constriction from the preceding part, and is perforated apically by the oral aperture; the entire cuticular surface finely and evenly ciliate, a circle of longer cilia developed round the oral region. Anal aperture postero-lateral or subterminal. Contractile vesicles usually multiple, irregularly distributed. Inhabiting fresh and salt water.

The diagnosis of the genus *Trachelocerca* as above given, and as constructed in accordance with the results of more recent investigation, differs materially from that first introduced by Ehrenberg. In accordance with the representations of this last-named authority, the cuticular surface of the animalcules of this genus was entirely devoid of cilia, and the oral aperture, instead of being situated at the apical extremity of the anterior neck-like prolongation, as is now determined, was pronounced to be located in the annular groove that separates the extreme anterior portion from the

remainder of the body, and which antero-lateral position of the mouth forms the essential characteristic of the genus *Phialina*.

By Dujardin, and Claparède and Lachmann, it has been considered desirable to amalgamate the genus *Trachelocerca* with that of *Lacrymaria*, and to retain the last-named title only, the single hitherto well-characterized member of the former genus *T. olor*, being represented by them as differing too slightly from the ordinary *Lacrymariæ* to claim independent generic recognition. It has been decided here, however, to retain both of these two titles, numerous animalcules being now known that form collectively two natural groups, between which it is easy to discriminate when thus separated, but whose specific identification would be attended with much inconvenience were they collectively compared. In pursuance of this decision, all those forms are retained in the genus *Trachelocerca* which agree with *T. olor* in the possession of a specially elongate and highly extensile neck-like anterior portion, in mostly having several irregularly distributed contractile vesicles, and in the usually subterminal position of the anal aperture. In *Lacrymaria*, on the other hand, as typified by the *L. lagenula* of Claparède and Lachmann, there is no specially elongate and elastic neck, the contractile vesicle is single and postero-terminal, and the anal aperture exactly terminal and immediately behind the contractile vesicle. It is further a fact of note that all the short-necked specific forms hitherto discovered, and here referred to the genus *Lacrymaria*, are strictly inhabitants of salt water. While thus readily distinguishable in their adult conditions, a developmental phase of *Trachelocerca olor* is presently shown to correspond in a remarkable manner with the typical adult condition of *Lacrymaria lagenula*.

Trachelocerca olor, Müll. sp. PL. XXVII. FIGS. 29–31.

Body subfusiform, usually attenuate posteriorly, the neck-like anterior portion exceedingly elastic and contractile, often, in extension, equal to four or five times the length of the body; cuticular surface finely ciliate, obliquely striate in two directions; contractile vesicles two or three in number; endoplast double, with a distinct endoplastule. Length of extended body 1–140″. HAB.—Pond water.

This species was one of the earliest known infusorial forms, it having been first figured and described by Baker in the year 1752 under the title of the "proteus," while in Müller's works it receives the three names of *Vibrio proteus*, *V. olor*, and *V. cygnus*; its relegation to the genus *Trachelocerca* was subsequently accomplished by Ehrenberg. The aspect of the animalcules of this species, as they swim gracefully through the water, extending and contracting their attenuate and wonderfully extensile necks, or thrusting them from side to side in search of food among the confervoid filaments or vegetable debris which they usually affect, is, as implied by its specific title, not unlike that of a swan, or is perhaps still more suggestive of the restored figures of the long-necked mesozoic *Plesiosauri*, contained in popular geological treatises. It has been frequently observed by the present author that two individuals of this species are almost invariably found in close proximity, and appear to be guided in all their movements by a certain community of action. The *Trachelocerca viridis*, *T. linguifera*, and *T. biceps*, and also the *Lacrymaria proteus* of Ehrenberg, are regarded by Claparède and Lachmann as varieties only, or imperfectly observed examples, of this exceedingly protean and variable species. In this manner the first-named is distinguished merely by the presence of engulfed and incorporated chlorophyll-granules; *T. biceps* would be a monstrosity with a double neck, or a zooid undergoing longitudinal fission; while the variety with a rounded posterior extremity, described under the title *Lacrymaria proteus*, probably represents an animalcule whose contour is abnormally rounded and inflated by the ingestion of food-particles. The *Trachelocerca linguifera* of Perty, said to differ from *T. olor* in the form of the oral region, which is described as being surmounted by a movable flap or tongue-like process, practically corre-

sponds with the normal aspect of this region in the present species. Claparède and Lachmann observe of the terminal oral region of this animalcule that the circlet of oral cilia is capable of being adpressed against the distal extremity, and assists in the prehension of food-particles. Under high magnification the walls of the conical oral fossa are shown to be longitudinally striate, and are probably plicate in a manner closely corresponding, though in a more marked degree, to what obtains in the two genera *Trachelophyllum* and *Enchelyodon*.

In a gathering containing this animalcule, *T. olor*, in abnormal abundance, examined by the author so recently as February 1880, it was observed that a form corresponding in external contour with the marine *Lacrymaria lagenula* of Claparède and Lachmann, was equally plentiful; furthermore, that every intermediate condition, having gradually lengthened and more or less flexible neck-like prolongations, were intermingled, the two extreme forms being thus closely amalgamated with one another. Finally, by patient watching, the short, stiff-necked *Lacrymaria*-like zooids were found to develop into the long and graceful necked *Trachelocercæ*, the primary simply flask-shaped zooid gradually acquiring a distinct attenuate and extensile neck, the two being thus demonstrated to be transitional phases only of the same species. The observation of this type being still further prolonged, it was at length determined that the short-necked zooids were the derivatives by transverse fission of an ordinary long-necked animalcule, and represented the hinder moiety of the fissive process pending the subsequent rapid development of the characteristic neck.

Trachelocerca versatilis, Müll. sp. Pl. XXVII. Fig. 33.

Body attenuate fusiform, pointed posteriorly; neck long and thread-like, its distal extremity expanded and conspicuously ciliated underneath; cilia of the general cuticular surface exceedingly fine and difficult to detect. Length, when extended, 1–40″; retracted, 1–120″.

In the autumn of the year 1870, a salt-water species of *Trachelocerca* was obtained by the author at Bognor, Sussex, evidently identical with the form briefly characterized as above by both O. F. Müller and Dujardin under the respective titles of *Trichoda* and *Lacrymaria versatilis*. Unfortunately, the amount of attention requisite for the framing of a more complete diagnosis was not bestowed upon it at the time. Compared with *T. olor*, with which Perty has proposed to identify this species, it may, however, be stated that the body was much more narrow and attenuate, and the distal extremity of the neck or oral region proportionally thicker; the subterminal circle of oral cilia was likewise observed to be more obliquely set, a circumstance communicating to this region, when seen in profile, the aspect of being ciliated underneath, attested to by the authorities quoted. In the great length and elasticity of the neck-like prolongation this species rivals the form previously described.

The salt-water *Trachelocerca sagitta* of Ehrenberg, briefly described as of fusiform contour, with a very long neck, colour white, head terminal and opaque, length 120″, would seem to correspond closely with *Trachelocerca versatilis*, or may be identical with Cohn's *T. phœnicopterus*.

Trachelocerca phœnicopterus, Cohn. Pl. XXVII. Fig. 32.

Body elongate, ribbon-like, flattened, highly elastic and retractile, finely annulate transversely, prolonged anteriorly into an attenuate, transparent neck, and posteriorly into a long, pointed, tail-like portion; oral aperture terminal, circular, with a rigid annular border, followed by a funnel-shaped pharyngeal cleft; the distal end of the neck slightly widened, its

extremity abruptly truncate; contractile vesicles multiple, lineally disposed. Length of body when most extended 1–24″, retracted 1–60″.

HAB.—Salt water.

The rigid annular border surrounding the apical extremity in this form would seem to take the place of the conical prominence in the ordinary species, unless it is that Cohn's figure and description apply to examples in which at the time of examination this usually conspicuous structure was concealed by invagination. Although a single contractile vesicle only is seen in the figure here reproduced from Cohn's original account of this species,* the two other examples delineated by this authority exhibit respectively two and eight of these structures, and which in the last instance are disposed at even intervals throughout the centre of the thicker central region of the body. In one example the endoplasmic layer has a vacuolar or reticulate aspect somewhat analogous to that of *Trachelius ovum*.

Trachelocerca tenuicollis, Quenn.

Body elongate-lanceolate, pointed posteriorly; neck long and very slender, scarcely dilated at the apex; cuticular surface finely ciliate, feebly striate longitudinally; contractile vesicle posteriorly situated; endoplast subcentral. Length in extension 1–75″. HAB.—Salt water.

GENUS II. LACRYMARIA, Ehrenberg.

Animalcules free-swimming, more or less cylindrical, clavate or flask-shaped, moderately elastic, the anterior end narrowest, the apical extremity conical in outline, and separated from the remaining portion of the body by an annular constriction, the intervening region not produced into a separate, slender, and highly elastic neck-like region, as in *Trachelocerca*; oral aperture surrounded by one or more ciliary circlets, perforating the apical extremity of the anterior conical prolongation; the cuticular surface finely and entirely ciliate; contractile vesicle single, postero-terminal; anal aperture situated immediately behind the contractile vesicle. Mostly inhabiting salt water.

The *Lacrymaria lagenula* of Claparède and Lachmann is here adopted as the type-form of this genus, to which two additional forms possessing the same broad general characters are here added. The *Lacrymaria proteus*, *L. olor*, *L. gutta*, *L. rugosa*, *L. tornatilis*, and *L. farcta*, of Ehrenberg, Perty, and Dujardin, are long flexible-necked animalcules, referable, so far as it is possible to identify them, to the genera *Trachelocerca* and *Amphileptus*.

Lacrymaria lagenula, C. & L. PL. XXVII. FIG. 34.

Body clavate or flask-shaped, attenuate anteriorly, nearly four times as long as broad; cuticular surface obliquely striate, finely and entirely ciliate, a single circlet of longer cilia surrounding the oral region; contractile vesicle single, spherical, postero-terminal; endoplast elongate-oval, subcentral. Length of body 1–350″. HAB.—Salt water: Norwegian coast (C. & L.).

As suggested by its discoverers, the contour of this animalcule corresponds remarkably with that of a soda-water bottle, the posterior inflated portion answering

* "Neue Infusorien im Seeaquarium," 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xvi., 1866.

to the body, the more attenuate anterior portion to the neck, while the conical extremity, separated off by the annular ciliated groove or furrow, may be said to represent the cork. Under the name of *Lacrymaria versatilis* Quennerstedt * has figured and described a marine animalcule which agrees closely with the form under notice, excepting that its contour is slightly more slender and attenuate, the length equalling as much as six times that of the greatest breadth. It has the same elongate, bottle-shaped contour; the cuticular surface is obliquely channelled or striate in a similar manner, and the endoplast and contractile vesicle correspond similarly in both character and position. Quennerstedt proposes to identify this variety, or possibly independent type, with the *Trichoda versatilis* of O. F. Müller, which is, however, undoubtedly rightly referable to the preceding genus. This is shown both by Müller's description in the following terms of the movements of the animalcule in the water: "*Motus natando celerrimus, collum hinc et illinc pro lubitu dirigit*," and by his additional indication in the figures of the species of the attenuate and extensile character of the neck.

Lacrymaria coronata, C. & L. PL. XXVII. FIG. 28.

Body elongate-clavate, slightly narrowed anteriorly, nearly five times as long as broad; two ciliary circlets developed around the apical extremity, the anterior one bearing the longest cilia, each occupying an annular groove or furrow; surface of cuticle obliquely striate, entirely and finely ciliate; contractile vesicle spherical, postero-terminal; endoplast elongate, band-like. Length of body 1–150″.

HAB.—Salt water, Norwegian coast.

The double circlet of cilia at the apical extremity and band-like form of the endoplast, independently of the greater porportionate length of the body, assist in distinguishing this type from the preceding one. The characteristic apical region only of this animalcule is delineated in the accompanying figure.

Lacrymaria Cohnii, S. K. PL. XXVII. FIGS. 25–27.

Body highly elastic and changeable in form, when extended oblong cylindrical, slightly broader and somewhat truncate anteriorly, about four times as long as broad, contracting from this to an almost spherical contour, the posterior third often flattened out and twisted like the blade of a ship's screw; surface of cuticle finely ciliate throughout, faintly striate longitudinally; body usually opaque through the enclosure of numerous fat-like corpuscles; contractile vesicle largely developed, postero-terminal. Length 1–240″. HAB.—Salt water.

The above specific title is herewith conferred upon the form figured and described by Cohn, in his 'Neue Infusorien im Seeaquarium,' 1866, under the title of *Lacrymaria lagenula* C. & L. From this last-named type it is evidently totally distinct. The flask-like contour, with a tapering anterior extremity distinctive of that form, would appear to be never assumed by the present animalcule, but in its place a highly remarkable screw-like shape, which would scarcely have escaped the attention of Claparède and Lachmann in connection with their species; the surface of the cuticle in Cohn's type is, further, entirely wanting in that conspicuous oblique striation, and the general substance of the body would appear to be much more soft and contractile. The figures given by Cohn, here reproduced, entirely support the views here held relative to the invertile nature of the apical portion of the conical anterior

* 'Sveriges Infusoriefauna,' tab. i. fig. 5, 1867.

prolongation; in two instances this part, Figs. 26 and 27, is shown to project conspicuously beyond the oral fringe of cilia, while in the other, Fig. 25, these cilia seem to issue from the apical extremity itself, an aspect which would necessarily result from the withdrawing inwards of this structure. The *Trichoda ambigua* of O. F. Müller * would seem to agree with this type in the flattened screw-like contour of the posterior region of the body, and is possibly identical with it. At the same time the body of Müller's species would appear to have a more elongate and vermiform shape, and it is apparently not capable of contracting into a globular form. Like the present species, it is an inhabitant of salt water.

GENUS III. PHIALINA, Ehrenberg.

Animalcules free-swimming, subcylindrical or flask-shaped, slightly elastic, narrowest anteriorly, a portion of the apical region separated from the rest of the body, as in *Trachelophyllum* and *Lacrymaria*, by a circular groove, and bearing a circlet of longer, usually reflected cilia; the oral aperture situated in the anterior annular groove, and not terminal as in the two last-named genera; cuticular surface finely and entirely ciliate; contractile vesicle single, adjacent to the postero-terminal anal aperture.

With the exception of the antero-lateral, instead of apical position of the mouth, the animalcules of this genus correspond essentially with those of *Lacrymaria*, and, unless the exact position of this aperture is seen and determined, are liable to be confounded with them.

Phialina vermicularis, Ehr. PL. XXVII. FIGS. 36.

Body subcylindrical, ovate or pyriform, narrowest anteriorly, two and a half times as long as broad, the apical portion in advance of the annular furrow short and broadly cylindrical, its anterior margin truncate and bearing a single circlet of cilia, these cilia usually directed backwards; oral aperture opening on the annular furrow; surface of integument smooth, finely and entirely ciliate; contractile vesicle single, spherical, postero-terminal; endoplast ovate, subcentral, obliquely directed. Length of body 1–240″. HAB.—Pond water.

The lateral position of the mouth of this animalcule has been very clearly indicated by Ehrenberg, but, as intimated by Claparède and Lachmann, the figure referred to most probably depicts an example observed at the moment of engulfing food, the organ at other times being difficult to recognize. By Ehrenberg and various earlier writers the cuticular surface of *Phialina*, as in the case of *Lacrymaria*, *Trachelocerca*, and other forms, is described as being entirely glabrous. More recent observation, assisted by the employment of superior magnifying lenses, has, however, determined the presence of fine cilia throughout its whole extent. The aspect of *Phialina vermicularis*, with its reflected anterior circlet of larger cilia only visible, has been not inaptly compared with that of a minute *Echinorhynchus*.

Doubtful Species.

The *Phialina viridis* of Ehrenberg, Pl. XXVII. Fig. 37, is suspected by Claparède and Lachmann to be a coloured variety only of *P. vermicularis*; according to Ehrenberg's figures, however, the body also is differently proportioned, the posterior

* 'Animalcula Infusoria,' p. 200, pl. xxviii. figs. 11–16, 1786.

extremity being slightly narrower than the shoulder portion of the bottle-shaped body, while the projecting neck is more attenuate. Colour bright green. Length 1–288″.

Genus IV. MARYNA, Gruber.

Animalcules ovate or cup-shaped, with an anterior projecting funnel-shaped neck, which is cleft on its ventral aspect and fringed along its anterior edge with a single row of long cilia; finer vibratile cilia distributed over the whole cuticular surface; oral aperture situated at the base of the anterior cleft, followed by a fissure-like pharyngeal passage. Habits social, secreting and inhabiting a common tubular zoothecium, to the walls of which they are not permanently united.

Maryna socialis, Grüber. Pl. XXXII. Figs. 11 and 12.

Zoothecium dichotomously branched, granular and finely striate transversely, narrower or constricted at the commencement of each bifurcation; colour light brown or yellowish; contained zooids projecting slightly from their respective thecæ; cup-shaped, one-and a half times as long as broad; the posterior border rounded, the anterior one truncate, with a centrally developed, ventrally cleft, funnel-like neck, a cleft on the ventral aspect of the anterior border corresponding with that in the neck; pharynx continued backwards to within a short distance of the posterior border; anterior wreath of cilia very long and fine; contractile vesicle situated near the termination of the ventral cleft; endoplast unobserved. Length 1–165″.

Hab.—Salt water.

The position of this animalcule is obviously near *Lacrymaria* and *Phialina*, from both of which it most conspicuously differs in its social habits and construction of a common zoothecium. A translation of the original description of this species, as figured and described by Dr. Gruber,* in common with various other interesting infusorial forms, is given in the 'Journal of the Royal Microscopical Society' for April 1880. A closely corresponding branching zoothecium is constructed by the Hypotrichous type *Stichotricha socialis*, described by Dr. Gruber in the same serial.

Genus V. LAGYNUS, Quennerstedt.

Animalcules free-swimming, elastic, more or less flask-shaped; oral aperture terminal, followed by a longitudinally plicate tubular pharynx; a circle of longer cilia surrounding the oral aperture, but not, as in *Trachelocerca* and *Lacrymaria*, set in a distinct annular groove or furrow; general cuticular surface entirely ciliate; contractile vesicle and endoplast conspicuous.

Quennerstedt† has adopted as the type of this genus the *Lacrymaria elegans* of Engelmann,‡ adding to it a second species observed by himself. The peculiar structure of the pharyngeal tube, which approximates that of *Trachelophyllum* and

* 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xxxv., 1879.
† 'Sveriges Infusoriefauna,' 1867.
‡ "Zur Naturgeschichte der Infusionsthiere," 'Zeit. Wiss. Zool.,' Bd. xi., 1862.

Enchelyodon, and the entire absence of a separated conical prolongation at the anterior extremity, supply ample grounds for its generic isolation from *Lacrymaria*.

Lagynus elegans, Engl. sp. PL. XXVII. FIG. 35.

Body elastic, flask-shaped, about three times as long as broad, rounded and widest posteriorly, produced anteriorly in a neck-like manner; oral aperture at the apex of this neck-like portion conducting to a funnel-shaped longitudinally plicate pharynx; cuticular surface coarsely ciliate, traversed longitudinally by faint, widely separated striations, the more attenuate neck-like portion exhibiting three or four transverse annulations; contractile vesicle single, postero-terminal: endoplast central, ovate, associated with a laterally attached endoplastule. Length 1–150″ to 120″.

HAB.—Fresh water.

Conjugation, effected by the close application of the oral surfaces of two individual zooids, was in one instance observed by Engelmann.

Lagynus lævis, Quenn.

The form and proportions of this animalcule, as figured by Quennerstedt, correspond closely with those of *L. elegans*, but the cuticular cilia are much finer, and the narrower, neck-like portion is not interrupted, as in that species, by transverse annulations.

GENUS VI. CHŒNIA, Quennerstedt.

Animalcules free-swimming, highly elastic, elongate or vermicular; oral aperture at the anterior extremity, widely dilated during the passage of food-substances, otherwise inconspicuous; cuticular surface ciliate throughout, a brush-like tuft of larger cilia surrounding the apical or oral extremity.

Chœnia teres, Duj. sp. PL. XXVII. FIGS. 41–44.

Body linear-lanceolate or vermicular, highly flexible, ranging, according to degree of extension, from about eight times to as much or more than twenty-three times as long as broad, the posterior extremity obtusely rounded, the anterior one conically pointed; cuticular surface finely ciliate, faintly striate longitudinally; oral cilia forming a forward-directed, brush-like tuft, a few slightly longer cilia developed at the posterior extremity; contractile vesicle single, postero-terminal. Length variable, 1150″ to 1100″ when contracted, 1–50″ to 1–30″ when fully extended.

HAB.—Salt water.

In describing this type, and instituting a new genus for its reception, Quennerstedt* confers upon it the title of *Chœnia vorax*, but at the same time suggests the possibility of its being identical with one of those widely diverse forms, the *Enchelys farcimen* of Ehrenberg, the *Enchelyodon elongatus* of Claparède and Lachmann, or the *Trachelius teres* of Dujardin. Having recently encountered this animalcule in sea water at St. Heliers, Jersey, the author is satisfied that Quennerstedt's conjecture with reference to the last-named species is correct, and hence the specific name originally given to it by Dujardin is here retained. In the examples personally

* 'Sveriges Infusoriefauna,' 1867.

examined it was observed that the animalcules possessed the capacity of extending to a much greater length than is indicated in Quennerstedt's drawings, which must be accepted as a comparatively contracted state; the new figure, Pl. XXVII. Fig. 40, as here given, more correctly illustrating its typical and fully extended condition. The elasticity of the oral region is well represented in Quennerstedt's delineations reproduced at Figs. 43 and 44.

The *Trachelius striatus* of Dujardin * is apparently a fresh-water variety of the genus *Chœnia;* its shape and proportions are identical with those of *C. teres*, but it is of much smaller size.

Fam. VII. TRACHELIIDÆ, Ehr.

Animalcules free-swimming, ovate or elongate, highly elastic, ciliate throughout; oral cilia slightly larger in size than those of the general cuticular surface; oral aperture situated at the base of a more attenuate and often trunk-like anterior prolongation.

Genus I. TRACHELIUS, Ehrenberg.

Animalcules free-swimming, ovate or subglobose, the anterior portion produced in a snout or trunk-like manner, the oral aperture being situated at the base of this anterior prolongation; pharyngeal tract apparently ramifying within the interior of the body, and presenting the aspect of a branched alimentary canal, such appearance, however, being entirely due to the highly vacuolar or reticulate character of the internal sarcode or endoplasm; anal aperture postero-terminal; cuticular surface entirely and finely ciliate, oral cilia differing but slightly in size from those of the general surface.

This genus is now limited to those forms only that coincide with *Trachelius ovum* in the possession of an apparent internally ramified alimentary tract. The numerous other species formerly placed in it by the older writers are chiefly assignable to the genera *Amphileptus* and *Loxophyllum*.

Trachelius ovum, Ehr. Pl. XXVII. Fig. 38.

Body subglobose or ovoid, prolonged anteriorly in the form of a short, flexible, trunk-like appendage, whose length does not exceed, and rarely equals, the diameter of the body; oral aperture succeeded by a short, conical, longitudinally plicate pharynx, which is apparently continued as a wide, central, longitudinal and tubular prolongation, giving off at right angles numerous smaller, lateral, ramifying diverticula; cuticular cilia fine, distributed in even longitudinal rows; contractile vesicles numerous; endoplast ovate or band-like, subcentral. Hab.—Bog water.

The possession by this species of a complex and profusely ramifying œsophageal canal, as first reported by Ehrenberg, and since maintained by Lieberkuhn and Claparède and Lachmann, is not endorsed in this volume. In examples obtained in bog water from Dartmoor, Devonshire, in August 1879, and examined by the present author, the suspicion hitherto maintained that the endoplasmic substance would be found to be highly vacuolate, somewhat as in *Loxodes rostrum*, and thus lend a branched, intestine-like appearance to the intervening granular sarcode, was

* 'Histoire des Zoophytes Infusoires,' pl. vii. fig. 15, 1854.

entirely confirmed. The oral aperture, situated at the base of the anterior snout-like prolongation, is followed by a short, conical, longitudinally plicate pharynx, as in various species of *Amphileptus*, and there the oral system terminates. The more granular or solid endoplasmic layer is at the same time usually developed more conspicuously in a straight axial line backwards from the termination of the pharynx, and receives all food-matters that pass through the oral aperture. Thus physiologically, though not morphologically, it performs the part of an alimentary tract. More slender ramifying diverticula from the main axial trunk are given off at frequent but irregular intervals, their ultimate twigs spreading out upon and anastomosing with the inner layer of the cortex. The closest resemblance to this special modification of internal structure is encountered in the Flagellate genus *Noctiluca*. In *Loxodes* there is no such distinct radiating disposition of the internal endoplasm, this element being simply honeycombed by the intercalation of irregularly developed ovate or subspheroidal lacunæ. The number of contractile vesicles possessed by this animalcule, while approached by *Amphileptus gigas*, is surpassed only by the *Prorodon margaritifera* previously described; they are very minute, spheroidal, distributed throughout the peripheral region of the body, and contract quite independently. On an average, it was estimated that as many as fifty of these vacuoles were possessed by each single animalcule. Excepting for the highly differentiated internal structure of the present type, it may be said to accord in all essential points with the representatives of the genus *Amphileptus* next described.

Supplementary Species.

The *Trachelius trichophora* of Ehrenberg, and also the more recently recorded *Trachelius dendrophilus* of the same authority, are Flagellate types referable to the genus *Astasia*.

GENUS II. AMPHILEPTUS, Ehrenberg.

Animalcules highly elastic, ovate or elongate, usually more or less flattened or compressed, the anterior region produced in the form of a trunk-like appendage, at the base of which the oral aperture is situated; cuticular surface entirely and finely ciliate; a comb- or mane-like row of longer cilia often present on the inferior border of the trunk-like prolongation; anal aperture postero-terminal or subterminal; contractile vesicles single or multiple, trichocysts frequently present. Mostly inhabiting fresh water.

A signal service has been rendered by Claparède and Lachmann by their amalgamation, under the generic title of *Amphileptus*, of the various forms originally distributed by Ehrenberg and Dujardin among the separate genera *Amphileptus*, *Dileptus*, and *Trachelius*, all of these, with the exception of *Trachelius ovum*, presenting no features sufficiently distinctive for separate generic recognition. Almost all the animalcules referable to this generic group are of large size, and are easily recognized by the presence of the anterior trunk-like prolongation. This appendage is completely under the control of its owner, being thrust hither and thither as the creature progresses through the water, or carried stiffly in an arched, neck-like manner. As seen under the last-named conditions, their appearance is so forcibly suggestive of that of various long-necked aquatic birds as to have won for them the several specific titles of *Amphileptus cygnus*, *anas*, and *anaticula*. From the long-necked *Trachelocercæ*, with which they are most liable to be confounded, the representatives of the genus *Amphileptus* may be readily distinguished by the position of the mouth, which is at the base instead of at the apex of the trunk-like appendage. Although normally of a more or less flattened form, these animalcules frequently become distorted through the inception of food, assuming under such conditions a cylindrical or almost spheroidal contour.

Amphileptus gigas, C. & L. Pl. XXVII. Fig. 68.

Body elongate-lanceolate, compressed or subcylindrical, attenuate posteriorly; the anterior trunk-like appendage equalling from one-fifth to one-half or even the total length of the entire body, its inferior surface bearing cilia of larger size, and enclosing throughout an even row of trichocysts; cuticular surface striate longitudinally; pharynx conical, longitudinally plicate; contractile vesicles numerous, spherical, distributed throughout the body-sarcode, frequently in a distinct row along the dorsal border; endoplast band-like, S-shaped. Length 1–25″ to 1–16″. Hab.—Fresh water.

This species, which was found in tolerable abundance by Claparède and Lachmann in the neighbourhood of Berlin, represents one of the largest known infusorial forms; the number of contractile vesicles possessed by a single animalcule, as recorded by these authorities, approaches that of *Trachelius ovum* and *Prorodon margaritifer*, previously described, many being met with even in the anterior trunk-like process. Wrzesniowski * has recently proposed to distinguish the two extreme short and thick, and slender varieties of this animalcule, as encountered by himself respectively at Grogec and Warsaw, by the subspecific names of *Dileptus* (*Amphileptus*) *gigas grojecensis* and *D.* (*Amph.*) *gigas varsaviensis*. In the former of these the proboscis never exceeds one-half of the length of the body proper, while in the second and more attenuate form (see Pl. XXVII. Fig. 68) this organ equals or even surpasses the body in length. It was further observed by this authority that the short infundibulate pharynx in the first-named variety was distinctly plicate, while in the second one it was perfectly smooth. In no instance, even with the assistance of various reagents, was Wrzesniowski successful in demonstrating the existence of a nucleus or endoplast in the numerous examples that fell under his observation; the characters of this structure, as given in the foregoing diagnosis, being derived from Claparède and Lachmann's description. Wrzesniowski, on the other hand, records an instance of multiplication by fission which was effected centrally in an oblique direction. The habits of *Amphileptus gigas*, as attested to by the same observer, are essentially predatory; living food only is appreciated, and consists chiefly of other Infusoria, such as *Stylonychia histrio* and *S. pustulata*, and various Rotiferæ. These are seized and at once transferred to the oral aperture with the assistance of the proboscis, as the animalcule pursues its way through the water. Its powers of natation are highly developed and unceasingly employed, locomotion consisting chiefly of swift progression in a straightforward direction, accompanied by rotation of the body on its long axis, the proboscis meanwhile being thrust around in a tentative manner in search of prey. As figured by Wrzesniowski, the contractile vesicles are by no means so numerous as reported by Claparède and Lachmann, numbering at the outside less than twenty, the greater portion of which are distributed in an even row from one extremity to the other of the dorsal border.

Amphileptus cygnus, C. & L.

Body lanceolate, compressed; the trunk-like prolongation flattened, equal to the body in length, bearing cilia of slightly larger size on its inferior surface; posterior extremity of body attenuately pointed; contractile vesicle single, spherical, of large size, situated near the base of the proboscis. Length of body, including the trunk, 1–60″. Hab.—Pond water.

Amphileptus anas, Müll. sp.

Body elongate, subcylindrical, attenuate posteriorly; trunk-like process equal to one-half of the length of the entire body, thick and obtuse; con-

* "Infusorien von Warschau," 'Zeit. Wiss. Zool.,' Bd. xx., 1870.

tractile vesicle single, spherical, situated near the posterior extremity; endoplasts two in number, round or ovate; cuticular cilia disposed in even longitudinal lines. Length of body 1–280″ to 1–120″.

HAB.—Pond water and infusions.

This species corresponds with the *Trachelius anas* of Ehrenberg, and with the *Trichoda anas* and *T. index* of O. F. Müller. Through the inception of vegetable food-particles it is frequently coloured bright green, examples so tinted representing, probably, the type upon which Ehrenberg conferred the title of *Amphileptus viridis*.

Amphileptus vorax, Ehr. sp.

Body elongate-pyriform or clavate, rounded posteriorly; the anterior trunk-like portion thick and obtuse, not equalling one-half of the body in length, flexible and curved in various directions; oral aperture situated towards the centre of the body, and at some little distance from the base of the proboscis; endoplast single, ovate. Length of body 1–120″.

HAB.—Pond water, among *Confervæ*.

This species is referred by Ehrenberg to the genus *Trachelius*.

Amphileptus moniliger, Ehr.

Body elongate-ovate, rounded posteriorly; trunk-like process short; endoplast ribbon-like or moniliform. Length of body 1–96″ to 1–72″.

HAB.—Fresh water, amongst *Lemnæ*.

Amphileptus anser, Ehr. PL. XXVII. FIGS. 39 AND 40.

Body elongate-lanceolate, pointed posteriorly; trunk-like process equalling the body in length; contractile vesicle single, spherical, posteriorly situated; endoplasts ovate, two in number. Length of body 1–120″.

HAB.—Fresh water, among decaying vegetation.

According to Claparède and Lachmann, the pharynx of this animalcule presents a longitudinally striate aspect, as in *Amphileptus gigas*. Although it was left undetermined by these authorities whether these apparent striations were due to membranous plications or to the presence of separate rod-like indurations, as in the genus *Prorodon* and *Chilodon*, there appears to be but little doubt that the former of these two premises may be accepted as the correct one.

Amphileptus margaritifer, Ehr.

Body elongate-fusiform, trunk-like process slender, equalling the body in length; contractile vesicles numerous, usually disposed in a necklace-like manner along the dorsal border, sometimes a few others scattered irregularly throughout the remaining portions of the body; cuticular cilia fine and inconspicuous. Length 1–72″. HAB.—Fresh water.

Although the numerous contractile vesicles of this species were not recognized as such by Ehrenberg, but are figured and described rather as accessory vacuoles possessing some digestive function, their existence and true nature, as above intimated, has been fully confirmed by the investigations of Claparède and Lachmann.

Amphileptus meleagris, Ehr. sp. Pl. XXVII. Figs. 45 and 46.

Body lanceolate, compressed; trunk-like process short and thick, scarcely prominent; oral aperture situated towards the centre of the body; contractile vesicles numerous, including a row of ten or twelve arranged along the dorsal border; endoplasts two in number, centrally located. Length of body 1–96″ to 1–60″. Hab.—Fresh water.

This species is identical with the *Trachelius meleagris* of Ehrenberg, but not with the *Amphileptus meleagris* of the same authority, this latter form being referable to the genus *Loxophyllum*. An interesting phenomenon connected with the life-history of this animalcule is recorded by Claparède and Lachmann. By various previous investigators its occurrence, in association with cyst-like bodies attached to the extremities of the branches of *Epistylis plicatilis* and other Vorticellidæ, had been noted, and by some of these, including notably D'Udekem, it was supposed that the ciliated *Amphileptus* was a transitional condition of the Peritrichous type. The Genevan authorities quoted have demonstrated, however, that the *Amphileptus* repairs to the *Epistylis* colony for the express purpose of satisfying its hunger, and having detached, swallowed, and digested a selected victim, fixes itself to and becomes encysted at the extremity of the vacant stem. From this encystment the animalcule, after a short interval of repose, makes its exit, sometimes in the simple condition under which it entered, but more often in an augmented form, through its having divided by segmentation within the cyst into two or four portions, each of which, while of smaller calibre, corresponds entirely in form and structure with the original single zooid. This interesting observation of Claparède and Lachmann has been confirmed by various recent observers. An instance of an example attacking and devouring a simple *Vorticella*, and then developing its characteristic cyst upon the extremity of the semi-retracted and spirally curved pedicle of its victim, has been noted by the present author. A Rhizopodal type, *Vampyrella gomphonematis*, has been lately shown by Professor Haeckel to devour in a somewhat identical fashion the cell-contents of the frustules of a species of *Gomphonema*, and upon the branching pedicle of which diatom it afterwards affixes itself and becomes encysted.

Amphileptus longicollis, Ehr.

Body dilated and rounded posteriorly, attenuate and trunk-like anteriorly; the oral aperture situated nearer to the posterior than to the anterior extremity of the body; a conspicuous border of larger cilia developed on the lower surface of the trunk-like portion; contractile vesicles numerous, consisting of nine or ten vacuoles arranged in a line along the dorsal border. Length of body 1–120″ to 1–96″.

Hab.—Pond water, amongst *Confervæ*.

Amphileptus anaticula, C. & L.

Body pyriform, widest and subspherical posteriorly, tapering towards the anterior extremity; the trunk-like process attenuate, equal to one-third of the length of the entire body, covered with longer cilia than those of the general surface; contractile vesicle single, postero-terminal; endoplast single, rounded. Length 1–570″ to 1–280″.

Hab.—Fresh water, among *Confervæ*.

Except when feeding, the oral aperture of this species appears only as a small depression at the base of the attenuate proboscis; but in its elasticity and

capacity to engulf organisms of considerable size it surpasses the ordinary representatives of the genus. Among the figures given by Claparède and Lachmann an example is delineated that has thus devoured a *Peridinium* whose diameter was nearly equal to its own previous to the ingestion of its prey.

Amphileptus gutta, Cohn.

Body elongate-pyriform, rounded and widest posteriorly; the anterior extremity pointed, uncinate, curved towards the ventral aspect; the dorsal margin convex, the ventral one concave; oral aperture situated on the ventral surface at a distance of about one-third of the length of the body from the anterior extremity; pharynx taking the form of a smooth, conical, corneous tube; cuticular surface striate longitudinally, densely clothed with short, fine, even cilia, no differentiation apparently exhibited by those clothing the anterior or oral regions; contractile vesicle single, postero-terminal; endoplasm enclosing numerous large, spherical water-vacuoles; numerous refringent, nucleus-like corpuscles scattered throughout the cortical layer; movements constant in a forward direction, rotating on its long axis. Length 1–200″. HAB.—Salt water.

In general contour this species would appear to closely resemble Ehrenberg's *Trachelius* (*Amphileptus*) *vorax*.

Amphileptus sphagni, Ehr.

Body depressed, linear-lanceolate, the rostrum or trunk-like portion carinate, truncate, one-quarter the length of the body; posterior extremity tail-like, acutely pointed, the median region of the body coloured green, with enclosed spheroidal corpuscles, elsewhere transparent; cuticular cilia forming spiral series. Length 1–576″ to 1–144″.

HAB.—Bog water, amongst *Sphagnum*, near Berlin.

This species, imperfectly described by Ehrenberg under the above title,* is possibly referable to one of the other several genera into which his generic group *Amphileptus* has been more recently divided.

Supplementary Species.

Among the species that must be referred with some degree of doubt to the genus *Amphileptus*, and which are not sufficiently well characterized for exact identification, are the *Dileptus granulosus*, *Acineria incurvata* et *acuta*, and the *Trachelius falx* of Dujardin, and also the *Amphileptus papillosus* of Ehrenberg. The *Amphileptus fasciola* of this last authority, referred by Claparède and Lachmann to the genus *Loxophyllum*, will be found under the generic heading *Litonotus*.

GENUS III. LOXOPHYLLUM, Dujardin.

Animalcules free-swimming, flattened and leaf-like, flexible, finely and entirely ciliate; the anterior extremity usually more attenuate and elastic; oral aperture opening on the ventral border, the anal aperture situated close to the posterior extremity; contractile vesicle single or multiple,

* 'Bericht Akad. Berlin,' 1853.

frequently complex through the addition of lateral diverticula; trichocysts usually present.

The animalcules of this genus most nearly resemble those of *Amphileptus*, but are much more flattened in shape, while the anterior extremity, though usually more flexible and attenuate, is not developed so as to form a separate trunk or proboscis. As instituted by Dujardin* the genus *Loxophyllum* included only the *Amphileptus meleagris* of Ehrenberg, his diagnosis as constructed thereon including such forms only in which the margins of the leaf-like body are sinuous or undulate, and the cuticular cilia distributed in widely separated parallel rows. As shown, however, by Claparède and Lachmann, these last-named characters have merely a specific value. In common with the other representatives of the *Trachelidæ* the members of the genus *Loxophyllum* are apt to become distended and inflated, through the inception of food-particles, though at the same time not to such an extent as to completely disguise their normal lamellate contour, a thin flattened marginal border at all times remaining conspicuous. The *Loxophyllum fasciola* of Claparède and Lachmann, identical with the *Amphileptus fasciola* of Ehrenberg and the *Dileptus folium* of Dujardin, has been removed, in accordance with the recent discoveries of Wrzesniowski, to the Hypotrichous genus *Litonotus*.

Loxophyllum meleagris, Ehr. sp. Pl. XXVII. Fig. 52.

Body leaf-like, obliquely lanceolate, highly elastic, about three times as long as broad, the anterior extremity pointed and curved towards the dorsal aspect; the dorsal border crenulate; oral aperture situated on the ventral side close to the anterior extremity; contractile vesicle spherical, postero-terminal, communicating with a canal-like prolongation, that extends along the dorsal margin nearly to the anterior extremity of the body; cuticular cilia disposed in distinct longitudinal parallel rows; endoplast single, ribbon-like, or forming a moniliform chain of bead-like nodules; trichocysts abundantly developed, usually forming a continuous series along the ventral border. Length 1–75″. Hab.—Pond water.

This species, which is identical with the *Amphileptus meleagris* of Ehrenberg, is the type upon which Dujardin instituted the present genus. The *Trachelius meleagris* of the first authority is, as already mentioned, referable to the genus *Amphileptus*. According to the recent researches of Wrzesniowski,† considerable differences exist between animalcules referable to this type obtained from separate localities. Thus, while at Warsaw the examples gathered conformed entirely with the diagnosis above given, those at Grogec were of extremely attenuate proportions, no less than seven or eight times as long as broad, and exhibited a further important difference in the number and arrangement of the trichocysts. The latter structures formed not only a continuous row throughout the ventral border but were also present in bundles on the dorsal one; these bundles, again, were not distributed in regular order, but one occupied a position corresponding with the projecting portion of each marginal undulation. This so-called variety, seeming to merit separate specific distinction, the present author is disposed, in honour of its discoverer, to provisionally confer upon it the title of *Loxophyllum Wrzesniowskii*. The character of the contractile vesicle of *L. meleagris*, with its diverging canals, and also that of the endoplast, is well illustrated in Wrzesniowski's excellent figures of this species. The breaking up of the primary band-like contour of this latter structure results in the production of a number of fragments of variable size which, while apparently scattered at random

* 'Histoire des Zoophytes Infusoires,' Paris, 1854.
† 'Archiv für Mikroskopische Anatomie,' Bd. v., 1869.

through the body-substance, remain, as in *Loxodes rostrum*, connected with one another through the medium of a hyaline cord-like filament or funiculus. The employment of reagents such as iodine and carmine tincture is requisite for the satisfactory demonstration of this phenomenon. The peculiar canal-like modification of the contractile vesicle, while occurring frequently among the higher Heterotricha, has not, with the exception of *Haptophrya*, been yet reported of any other Holotrichous form. It evidently represents a more specialized development, through coalescence, of the dorsal row of spherical vesicles common to many species of the preceding genus, and shared likewise by *Loxophyllum setigerum*.

Loxophyllum armatum, C. & L. Pl. XXVII. Fig. 53.

Body leaf-like, semicircular, having no attenuate anterior portion, the posterior termination revolute; oral aperture situated at a distance of one-third of the entire length from the anterior extremity, the dorsal border entire, not undulate; the ventral margin arcuate, containing abundant trichocysts; cuticular surface finely ciliate, the cilia disposed in even longitudinal rows; contractile vesicle spherical, posteriorly located, sometimes exhibiting a stellate outline, or dividing at the time of systole into two segments. Increasing by transverse fission. Length 1–150″.

Hab.—Bog water: Berlin (C. & L.).

With the aid of the large trichocysts which arm the ventral border, this species has been observed by Claparède and Lachmann to paralyze and capture other smaller animalcules.

Loxophyllum lamella, Ehr. sp.

Body elongate, linear-lanceolate, attenuate anteriorly, rounded posteriorly; the dorsal margin not crenulate; contractile vesicle single, postero-terminal; endoplast double; no trichocysts. Length 1–200″.

Hab.—Fresh water.

This species is identified by Claparède and Lachmann with the *Trachelius lamella* of Ehrenberg, but not with the many forms similarly named by Dujardin, and which, together with the *Trachelius stricta* of the same writer, they consider, while possibly belonging to the genus *Loxophyllum*, as too insufficiently characterized for identification.

Loxophyllum rostratum, Cohn.

Body leaf-like, highly elastic and retractile; the ventral surface flattened, the centre of the dorsal one convex, surrounded by a thin, transparent, laminate border; rounded posteriorly, developed anteriorly into a flexible, pointed, dorsally reflected, uncinate prolongation or rostrum; cuticular surface delicately furrowed longitudinally, clothed throughout with fine cilia, those in the region of the uncinate anterior prolongation slightly longer than the others; the centre of the dorsal border conspicuously undulate, a row of trichocysts extending from this undulated border half-way to the apical extremity of the rostrum; one, two, or three contractile vesicles posteriorly situated; endoplast double, centrally located; a row of refringent bodies frequently present near the base of the dorsal border. Length 1–144″.

HAB.—Salt water; movements smooth and even, or rotating on its long axis.

The general contour of this species, as recently figured and described by Cohn,* closely resembles that of the fresh-water type *Loxophyllum meleagris*.

Loxophyllum setigerum, Quenn.

Body flattened, irregularly rhomboidal, widest centrally, most attenuate anteriorly; the dorsal border nearly straight, neither undulate nor bearing trichocysts, the ventral one strongly and gibbously arcuate, three or four seta-like structures projecting irregularly from its posterior half; contractile vesicles numerous, forming a continuous row down the dorsal margin. Endoplast moniliform. Length 1–150″. HAB.—Salt water.

Fam. VIII. ICHTHYOPHTHIRIIDÆ, S. K.

Animalcules adherent, more or less ovate, ciliate throughout, oral cilia of larger size than those of the general cuticular surface, oral region adhesive, acetabuliform.

GENUS I. ICHTHYOPHTHIRIUS, Fouquet.

Animalcules more or less ovate, highly elastic, entirely ciliate, oral orifice terminal, situated in the centre of an adherent, discoidal, acetabuliform area, the inner margin of which bears numerous inwardly projecting, setose cilia. Endoplast and contractile vesicles conspicuously developed. Occurring as parasites on the epidermal surface of various fishes.

Ichthyophthirius multifiliis, Fouquet. PL. XXXII. FIGS. 1–8.

Body subglobose or ovate, flexible and elastic; cuticular surface finely and evenly ciliate throughout, the cilia arranged in fine, intercrossing, obliquely parallel rows; an aspect as of trichocysts underlying the entire cuticle apparent in the younger zooids; adhesive suctorial disc apical, minute, and cup-like, its inner surface bearing about twenty, inwardly radiating, larger, setose cilia; contractile vesicles numerous, minute, scattered throughout the cortical layer; endoplast band-like, curved; endoplasm densely granulate. Length 1–150″.

HAB.—Parasitic on the common Trout, *Salmo trutta*, and other soft-skinned fresh-water fish.

The occurrence of this animalcule as a parasite of various fresh-water fish, including more notably the Loach, *Cobitis fossilis*, was notified by MM. F. Hilgendorf and A. Paulicki of Hamburg, in the 'Centralblatt' for January 1869. The account then given of it was, however, very incomplete, and the animalcule was provisionally referred to Ehrenberg's genus *Pantotricha*. The first full description of this type, accompanied by the bestowal upon it of the distinctive title above given, did not appear until some years later, when M. Fouquet figured and described it at length in the 'Archives de Zoologie Expérimentale,' tom. v. pp. 159–165, for the year 1876. According to this authority, the species had then for the last ten years proved very destructive to the young trout raised in the artificial basins of the fish-houses

* "Neue Infusorien im Seeaquarium," 'Zeit. Wiss. Zool.,' Bd. xvi., 1866.

of the Collége de France, the inflammation of the epidermal tissues induced by their presence in large quantities proving fatal within a very short interval. In a fish affected by these parasites, prominent, rounded, milk-white spots are to be observed on the eyes, fins, branchiæ, or general cuticular surface, in depressions in which, when examined with the aid of the microscope, the animalcules will be found lodged, sometimes singly and in other instances in great numbers. Each animalcu xed to the bottom of the depression by the apical adhesive disc, and rotates ba...wards and forwards from right to left and left to right upon its longitudinal axis, by the movement apparently of the cilia of the cuticular surface, and thus bores it way deeper into the skin of its victim. The reproductive phenomena of this species, as recorded by Fouquet, are highly interesting. Arriving at maturity, the animalcules become detached from their host, and falling to the bottom of the water, encyst and become divided by repeated segmentation, accompanied by a like division of the endoplast, into a morula-like mass consisting of at least a thousand ovate ciliated bodies which ultimately escape from the ruptured cyst, and grow by degrees to the parent form. This reproductive process occupies an interval of from forty to fifty hours. At first, the young animalcules thus developed, Pl. XXXII. Figs. 5 and 6, are much more elongate than the parent zooids, and have no apical suctorial disc; the endoplast is likewise simply ovate, and accompanied by an endoplastule which disappears a little later, while the contractile vesicle is single and laterally developed. The close correspondence of this form of multiplication with the sporular reproductive process of the simpler Flagellata is eminently noteworthy. The two or three months extending from the end of May till August are those in which the young trout are most liable to be affected by the attacks of this Infusorium. The placing of fragments of tiles or other substances against which the fish can rub themselves, and thus get rid of their puny assailants, supplemented by the maintenance of the water at a low temperature, are recommended as the best checks to their inroads.

Some uncertainty would seem to exist respecting the precise import of the suctorial organ developed at the apical extremity of *Ichthyophthirius*. According to Fouquet, this structure does not constitute a perfect oral apparatus, it consisting merely of a circular opening, bordered by larger cilia, which leads into a small cul-de-sac, and is not continued into the deeper substance of the body. Carmine administered in a pulverized condition was not assimilated, a circumstance, correlated with the structural peculiarities just cited, Fouquet considers sufficient to indicate that the animalcule is strictly mouthless, and that the apical acetabuliform organ, while possibly representing a degraded oral aperture, is subservient merely for the purposes of adhesion. Viewed in this light, the animalcule is regarded as possessing probable affinities with the Opalinidæ, in which group, indeed, one genus, *Haptophrya*, is distinguished by its possession of a somewhat analogous acetabuliform organ. It is at the same time worthy of remark that the densely granular character of the endoplasm of *Ichthyophthirius*, as indicated by Fouquet's figures—certain of which are further distinguished by the incorporation of so-called pigmentary corpuscles—is highly suggestive of the presence of extraneously derived solid nutriment. To this it may be added that all mouthless organisms, in the strict sense of the term, are, so far as known, essentially endoparasites, subsisting by absorption on the nutrient juices provided within the intestinal viscera of the hosts they respectively inhabit. Under these circumstances it has been considered advisable to at least provisionally retain the present highly interesting type among the ordinary Stomatode Holotrichous Ciliata, apportioning it there, with reference to its remarkable oral or pseud-oral system, an independent family distinction.

Fam. IX. OPHRYOGLENIDÆ, S. K.

Animalcules free-swimming, ciliate throughout, oral and cuticular cilia uniform in size; oral aperture terminal, lateral or ventral, situated at the bottom of a distinct oral fossa or vestibulum, within which is enclosed a vibratile flap or membrane.

With the Ophryoglenidæ commences an important and extensive series of the Holotrichous Ciliata, distinguished in all instances by the possession of a more or less extensively developed membraniform appendage, in addition to the usual complement of cuticular and oral cilia. Where such a supplementary membrane is extensively developed, as in the genera *Lembus* and *Proboscella*, there can be but little doubt that we have foreshadowed the system of conspicuously larger adoral cilia characteristic of the ordinary Heterotricha, and which system not unfrequently originates as a similar simple band-like membrane. A partial recognition of the natural affinity of the membrane-bearing Holotricha is recorded by Stein in his classification scheme, reproduced at p. 210 of vol. i. He at the same times places the genus *Panophrys* among the ordinary Paramæcina, while all the rest are collected together in the single family group of the Cinetrochilina, without regard to the essentially distinct plans upon which, in so many of these genera, the membraniform appendage is constructed.

Genus I. OPHRYOGLENA, Ehrenberg.

Animalcules free-swimming, persistent in shape, more or less ovate and depressed, having a convex dorsal and flattened ventral surface, the oral fossa opening on the ventral aspect at a little distance from the anterior extremity, enclosing an ovate, vibratile, flap-like membrane; anal aperture subterminal; general surface of the body entirely and evenly ciliate; no larger adoral cilia; cortical layer usually containing thickly set trichocysts; endoplast and contractile vesicle conspicuous. Inhabiting pond and bog water.

An additional and leading distinction of the genus *Ophryoglena*, as instituted by Ehrenberg, is the presence, near the anterior extremity of the body, of a coloured eye-like pigment-spot. More recent investigation has, however, shown that this character is altogether subordinate, such a pigment-spot not being constant, either with respect to its presence or location, even among zooids of the same species.

Ophryoglena acuminata, Ehr.

Body ovate, flattened, pointed and acuminate posteriorly, little over one and a half times as long as broad; colour brown; oral fossa extending backwards to about the centre of the body; a scarlet pigment-spot usually present near the anterior extremity; contractile vesicle single, spherical, situated in the median line towards the anterior extremity; endoplast rounded, located a short distance behind the contractile vesicle. Length 1–180″. Hab.—Bog water.

The habits of this animalcule are essentially phytophagous; the diatom *Navicula gracilis*, which, according to Ehrenberg, is an especially favourite food, being often found in great numbers within the body-substance.

Ophryoglena atra, Ehr. Pl. XXVI. Figs. 63 and 64.

Body ovoid, flattened, pointed posteriorly, nearly twice as long as broad; colour very dark and opaque, usually with a bluish pigment-spot near the anterior extremity; oral fossa broad and deep, extending backwards to nearly one-half of the length of the entire body, the membranous flap occupying the posterior half of its cavity; contractile vesicle single

situated a little in advance of the median line, presenting at diastole a stellate outline; the cortical layer containing abundant closely set trichocysts. Length 1–180″. HAB.—Bog water.

Ophryoglena oblonga, Stein.

Body ovate, rounded posteriorly; oral fossa elliptical, straight, set more forwards than in *O. atra*; endoplast spheroidal, no endoplastule; eye-like pigment-spot usually present. HAB.—Fresh water.

Ophryoglena cæca, Stein.

Form, and position of oral aperture coinciding with *C. oblonga*, but larger and thicker; endoplast oval, having an attached endoplastule; no eye-like pigment-spot. HAB.—Fresh water.

This and the preceding form are briefly characterized by Stein as above in the 'Sitzungsberichte der königl. Böhmischen Gesellschaft der Wissenschaften' for December 1860.

Ophryoglena Wrzesniowskii, Mereschk. sp.

Body scarcely twice as long as broad, transparent, somewhat variable in form, more or less evenly ovate, rounded at each extremity, the posterior end usually slightly the wider; oral fossa situated a little to the right of the median line at a short distance from the anterior extremity, enclosing apparently two opposed membranous flaps; cuticular surface longitudinally striate, finely ciliate throughout; the cortical layer completely filled with large, closely approximated, rod-like trichocysts; contractile vesicle single, located close behind the oral fossa; endoplast spherical, subcentral. Length 1–175″.

HAB.—Fresh water: river Dwina and Lake Onega (Mereschkowsky).

This species is figured and described by Mereschkowsky, in his account of the Infusoria of Northern Russia,* as a species of *Glaucoma*; from his figure and diagnosis given, it is however evident that the animalcule is a true *Ophryoglena*, differing but slightly from the common forms *O. atra* and *O. acuminata*. The bilabiate aspect of the oral membrane, upon which alone its claim for admission to the first-named genus is based, has been frequently noted by the author in connection with the last-named types.

Supplementary Species.

The *Ophryoglena flavicans* of Ehrenberg, and *O. citreum* of Claparède and Lachmann, characterized by the presence of a fringe of larger cilia round the oral aperture, are here referred to the genus *Panophrys* of Dujardin. The *Ophryoglena griseo-virens* of Perty, is apparently a variety only of *O. atra*.

GENUS II. PANOPHRYS, Dujardin.

Animalcules ovoid, more or less persistent in shape; oral aperture situated at the bottom of a pocket-like fossa, which originates on the

* 'Archiv f. Mikrosopische Anatomie,' Bd. xvi., 1878.

ventral surface near the anterior extremity, its outer margin bordered by a spiral circle of cilia of larger size than those which cover the general surface of the body; the upper portion of the posterior extremity of the oral fossa bearing an undulating membrane. A coloured eye-like pigment-spot often present near the anterior extremity; the cortical layer frequently containing trichocysts.

The conspicuous fringe of larger adoral cilia serves to distinguish the representatives of this genus from those of *Ophryoglena*, with which they otherwise closely correspond; the spiral disposition of these adoral cilia separates it in a distinct manner from the succeeding genus *Cyclotricha*.

Panophrys flavicans, Ehr. sp. PL. XXVI. FIGS. 65 AND 66.

Body elongate-ovoid, convex above, flattened beneath, rounded anteriorly, pointed at the posterior extremity, about twice as long as broad; colour yellow; entrance to oral fossa subterminal, crescentic, associated with a spirally winding adoral fringe of larger cilia, its cavity capacious, extending back to within a short distance of the median line; an anterior red eye-like pigment-spot usually present; the cortical layer enclosing numerous evenly developed trichocysts; endoplast oval. Length 1–144″. HAB.—Bog water.

This species, which constitutes the type-form of the genus *Panophrys* of Dujardin and Stein, is identical with the *Ophryoglena flavicans* of Ehrenberg.

Panophrys flava, Ehr. sp.

Body normally pear-shaped, flattened, narrowest posteriorly, little over twice as long as broad, flexible and somewhat changeable in form; colour yellow; adoral cilia spirally arranged; no eye-like pigment-spot nor trichocysts. Length 1–96″. HAB.—Fresh water.

While most nearly resembling *Panophrys flavicans*, Claparède and Lachmann remarks that it is readily distinguished from that species by its non-persistent shape, and by the absence of a pigment-spot and trichocysts. It was first described by Ehrenberg under the title of *Bursaria flava*, but subsequently transferred to the present genus by Dujardin.

Panophrys chrysalis, Duj.

Body ovoid or oblong, depressed, rounded at the two extremities, twice as long as broad, margin of oral fossa projecting; cortical layer apparently armed with trichocysts. Length of body 1–138″. HAB.—Salt water.

Supplementary Species.

The species described by Ehrenberg under the two titles of *Bursaria leucas* and *Bursaria vernalis*, referred to the genus *Panophrys* by Dujardin, has been selected by Stein as the type of the new genus *Cyrtostomum*, previously described. Other forms, included in the genus *Panophrys* by Dujardin and Perty under the titles of *P. rubra*, *farcta*, *conspicua*, *sordida*, *zonalis*, *griseola*, and *paramecioides*, are characterized too insufficiently for present identification.

GENUS III. CYCLOTRICHA, S. K.

Animalcules free-swimming, more or less ovate, persistent in shape, entirely ciliate; oral aperture ventral, situated at the bottom of a pocket-shaped oral fossa, the entrance to which is surrounded by a simple and entire circlet of cilia, larger than those of the general cuticular surface, the further confines of oral fossa supporting a watchglass-shaped undulating membrane.

This genus is herewith established for the reception of the *Ophryoglena citreum* of Claparède and Lachmann. From *Ophryoglena* and *Meniscostomum* it is to be distinguished by the larger calibre of the oral cilia, in comparison with those of the general surface; their simply circular disposition serves at the same time to separate it from *Panophrys*.

Cyclotricha citrea, C. & L. sp. PL. XXVI. FIGS. 67 AND 68.

Body lemon-shaped, pointed at each extremity, about one and a quarter times as long as broad; the entrance to the oral fossa situated at a distance of one-quarter of the total length from the anterior extremity of the body; the adoral cilia forming a simple circular fringe; no pigment-spot or trichocysts; endoplast elongate, band-like; contractile vesicle single, spherical, located near the dorsal margin. Length of body 1–225″.

HAB.—Bog water.

GENUS IV. TRICHODA, Müller.

Animalcules free-swimming, elastic, but more or less persistent in shape, ovate or pyriform; oral aperture situated at the pointed and obliquely truncate anterior extremity, approached by an ovate oral fossa, whose inner wall gives attachment to a single, vibratile, flap-like membrane; cuticular surface finely ciliate throughout, a circlet of larger cilia surrounding the entrance to the oral fossa. Especially abundant in putrid infusions.

The animalcules of this genus, while corresponding closely in external contour and habits with those of *Enchelys*, are to be distinguished from them by the presence of the minute vibratile membrane that is enclosed within the oral fossa. *Trichoda*, in common with *Enchelys*, was originally distinguished by Ehrenberg with reference to the apparent absence of cilia throughout the general surface of the cuticle. Fine body cilia are now known to exist in all the species.

Trichoda pura, Ehr. PL. XXVII. FIG. 47.

Body elongate-pyriform or clavate, slightly curved towards the ventral aspect, about three times as long as broad, widest and rounded posteriorly, tapering gradually towards the anterior extremity; oral fringe of cilia alone conspicuous, those of the general cuticular surface very fine; endoplast spherical, subcentral; contractile vesicle posteriorly located. Length 1–720″.

HAB.—Pond water and vegetable infusions in company with *Cyclidium glaucoma*.

This species, in common with *Enchelys farcimen*, is one of the most abundant Ciliate types developed in hay and other vegetable infusions, the attraction there being the abundant harvest of monadiform animalcules upon which it in like manner feeds voraciously. The cuticular surface in this animalcule is exceedingly soft and flexible, permitting it to assume the most protean contortions as it forces its way among the vegetable debris contained in the infusion. When swimming freely in the water, it moves swiftly forwards or backwards in a straight line, or progresses leisurely, mouth downwards, after the manner of an *Enchelys*.

Trichoda carnium, Ehr. sp.

Body elliptical, slightly narrower anteriorly, rather over twice as long as broad, the oblique oral fossa of considerable dimensions; oral and cuticular cilia conspicuous; contractile vesicle single, postero-terminal; endoplast subcentral, spheroidal; colour white. Length 1–430".

HAB.—Animal macerations, and water from dung-hills.

This species is identical with the *Leucophrys carnium* of Ehrenberg.

Trichoda pirum, Müll. sp.

Body pyriform, widest posteriorly, narrowest and pointed anteriorly, twice as long as broad; cuticular and oral cilia conspicuous, oral fossa not so distinct as in *T. carnium;* colour white. Length 1–1250" to 1–400".

HAB.—Pond water, with *Euplotes charon*, and *Polytoma uvella*.

This animalcule is apparently identical with the form first described by Bory de St. Vincent under the name of *Enchelys pyriformis*, and since referred by Ehrenberg to the genus *Leucophrys*. It was originally figured by O. F. Müller under the title of *Kolpoda pirum*. It would seem highly probable, as already suggested by Dujardin, that Ehrenberg's *Trichoda carnium* must be also accepted as a synonym of this species.

Doubtful Species.

The four following species, referred by Ehrenberg to the genus *Trichoda*, are too meagrely described for present identification. No evidence as to their possessing vibratile oral membranes being recorded, they might with equal justice be referred to the genus *Enchelys*.

Trichoda nasamomum, Ehr.—Body cylindrical, extremities equally obtuse; mouth large, elongated laterally. Length 1–288".

Trichoda ovata, Ehr.—Body ovate, turgid, attenuated anteriorly; mouth small, lateral. Length 1–480". HAB.—Egypt.

Trichoda (?) æthiopica, Ehr.—Body oblong, attenuated posteriorly; under side flat; mouth large. Length 1–600".

Trichoda asiatica, Ehr.—Body oval, oblong, cylindrical, rounded at both ends; mouth small. Length 1–800".

The *Trichoda angulata* of Dujardin—thus defined: Body oblong, obliquely angular, often containing one or more superficial vacuoles. Length 1–300". Inhabiting water with decaying plants—is apparently, from the figure given, allied to or identical with *Colpoda cucullus*.

GENUS V. LEMBADION, Perty.

Animalcules free-swimming, persistent in form, more or less ovate, entirely ciliate; oral fossa terminal, capacious, its right side supporting

an ovate undulating membrane, its left one ciliate; the posterior extremity of the body usually bearing supplementary setose cilia.

Lembadion bullinum, Perty. PL. XXVII. FIG. 54.

Body ovate, compressed, nearly twice as long as broad, slightly widest posteriorly; oral fossa capacious, extending through two-thirds of the entire length of the body; two long hair-like setæ projecting from the posterior extremity; endoplast spherical, posteriorly located; contractile vesicle single, situated near the centre of the right lateral border. Length 1–240″ to 1–192″. HAB.—Marsh water.

This species was formerly referred, even by Stein, to the family of the Bursarina, the undulating membrane which that authority has since demonstrated to exist within the oral fossa being then regarded as a fringe of larger adoral cilia. For such larger adoral cilia this membrane has likewise been mistaken by Claparède and Lachmann, who have consequently placed it in their treatise next to the genus *Bursaria*. These last-named investigators remark that under disturbing or uncongenial influences the animalcules of this species swim rapidly backwards, turning upon their long axis, while, when seeking for food or moving at leisure, they progress slowly forwards without any revolving action. Ernst Eberhard* represents this type as bearing three postero-terminal setæ.

Doubtful Species.

The *Lembadion* (?) *duriusculum* of Perty is a doubtful form, certainly not referable to the genus under notice, and whose exact relationship cannot at present be decided. Its diagnosis, as given by Perty, is as follows: Body persistent in form, elliptical, colourless, with usually a keel or ridge along its upper surface; the under surface somewhat concave; cilia very fine; movements sluggish. Length 1–720″ to 1–620″. HAB.—Fresh water.

GENUS VI. COLPIDIUM, Stein.

Animalcules free-swimming, entirely ciliate, persistent in form, more or less kidney-shaped; oral aperture inferior, subterminal, pharynx supporting throughout its length an undulating membrane which projects exteriorly in a tongue-like manner.

Colpidium cucullus, Schrank sp. PL. XXVII. FIG. 49.

Body kidney-shaped, narrower and curved towards the ventral aspect anteriorly, two or three times as long as broad; cuticular cilia distributed in even longitudinal rows; endoplasts two in number, rounded, subcentral; contractile vesicle located near the centre of the dorsal border. Length 1–500″ to 1–250″. HAB.—Fresh water and infusions.

This species was first figured and described by Schrank, 'Fauna Boica,' 1803, under the title of *Colpoda cucullus*. It is identical with the *Paramecium kolpoda* of Ehrenberg, and Claparède and Lachmann, and with the *Kolpoda cucullus* of Dujardin, but not with the *Colpoda cucullus* of Ehrenberg, which is a more simple-formed animalcule, having a conspicuous tuft of oral cilia but no vibratile membrane.

* 'Osterprogramm zu Coburg,' 1862.

Chilodon cucullulus, a second species, which also corresponds closely with this type in its reniform external contour, is easily distinguished from it by the cylinder of rod-like teeth with which the pharynx is armed, and by the unilateral distribution of its cilia. According to Ehrenberg, *Colpidium cucullus* sometimes possesses two closely approximated contractile vesicles, as well as a double endoplast. It is one of the commonest forms developed in vegetable infusions.

Genus VII. PLAGIOPYLA, Stein.

Animalcules free-swimming, persistent in shape, ovate or subcylindrical, ciliate throughout; oral fossa ventral, located slightly in advance of the median line, sometimes approached by a transversely directed groove, its inner border bearing a narrow, non-projecting, undulating membrane, followed by a short tubular pharynx; anal aperture postero-terminal; the cortical layer often enclosing trichocysts.

The enclosure of the undulating membrane within the oral fossa distinguishes this generic type from *Colpidium*.

Plagiopyla nasuta, Stein. Pl. XXVII. Figs. 50 and 51 (?).

Body subreniform, rounded at each extremity; oral fossa pocket-shaped, produced at right angles to the cuticular surface to the centre of the body, enclosing an elongate, tongue-shaped, undulating membrane, not followed by a distinct pharyngeal passage; trichocysts conspicuous; endoplast elongate-oval, located in the right body-half behind the peristome; contractile vesicle postero-terminal; anal aperture subterminal. Length 1–240″ to 1–190″. Hab.—Fresh water.

This typical species of the genus *Plagiopyla* is described by Stein as somewhat resembling *Pleuronema chrysalis*, but without the longer ventral cilia or extensile membrane. The animalcule figured by Quennerstedt* under the title of *Paramæcium cucullus*, corresponds so nearly with Stein's diagnosis of the present species that the Swedish authority's delineations are herewith reproduced as probably representing the same type.

Plagiopyla (?) Carteri, S. K. Pl. XXVI. Fig. 69.

Body elliptical, cylindrical, equally rounded at the two extremities, about twice as long as broad; oral aperture situated nearly midway between the centre and the anterior extremity of the body, enclosing a minute, lunate, undulating membrane, followed posteriorly by a conically pointed tubular pharynx; the anal aperture lateral, situated on the same side as the mouth, midway between the median line and the posterior extremity; cuticular cilia short, disposed in even longitudinal rows; contractile vesicle lateral, subcentral, located on the opposite side to the oral and anal aspect; endoplast undetermined. Length 1–125″.

Hab.—Fresh water: Bombay (H. J. C.).

* 'Sveriges Infusoriefauna,' 1867.

This species, figured and briefly described by Mr. H. J. Carter in his manuscript notes under the title of *Paramœcium*?, as also the form next described, would perhaps be more rightly referred to the genus *Ophryoglena*, though in all essential details, with the exception of the transverse groove-like approach to the oral aperture, it would seem to conform with Stein's diagnosis. While no mention is made of the lunate vibratile membrane within the oral fossa, its presence is clearly indicated in Mr. Carter's sketch as here reproduced. The backward continuation of the pharyngeal cleft beyond the attachment of the enclosed vibratile membrane, both in this and the succeeding species, in addition to the smaller size and more ventral location of the oral aperture, distinguishes them from the ordinary members of the genus *Ophryoglena*.

Plagiopyla (?) fusca, Quenn. sp. PL. XXVI. FIG. 70.

Body persistent in shape, elliptical, evenly rounded at each extremity, twice as long as broad; cuticular surface delicately striate longitudinally, finely ciliate throughout, the cortical layer enclosing closely set trichocysts; oral aperture opening a little in advance of the median line, enclosing a conspicuous undulating membrane, followed by a short, backward directed, tubular pharynx; contractile vesicles two in number, small, spheroidal, one stationed in the anterior, and the other in the posterior third of the body; endoplast oval, subcentral. Length 1–200". HAB.—Salt water.

This animalcule is figured and described in connection with the above specific name, by Quennerstedt * as a new form of *Panophrys*; the non-existence, however, of a fringe of larger cilia round the oral aperture necessitates its removal from that genus, while the construction of the oral aperture and pharyngeal passage indicates its close affinity with the type last described.

GENUS VIII. MENISCOSTOMUM, S. K.

Animalcules free-swimming, ovate, persistent in shape, entirely ciliate; oral fossa lateral, shallow, meniscoidal, enclosing a narrow, lunate, vibratile membrane, no cilia of larger size round its outer border, and not followed by a tubular pharynx; contractile vesicles usually two in number.

This new generic appellation is here instituted for the reception of a single Holotrichous type whose form and structure, while most closely approaching that of the preceding genera *Ophryoglena* and *Plagiopyla*, differs from the former in the simple cup-like contour of the oral fossa, and from the latter by the absence of an accompanying tubular pharyngeal passage. The cup-like oral fossa, as seen in profile, presents a very characteristic aspect, appearing under such conditions as a clean-cut lunate notch in the antero-lateral border, as shown in the figure illustrative of the single type described.

Meniscostomum stomioptycha, Eck. sp. PL. XXVII. FIG. 48.

Body obtusely ovate or elliptical, evenly rounded at both extremities, about twice as long as broad; oral fossa forming a shallow circular excavation at a distance of one-third of the entire length of the body from the anterior extremity, its inner border bearing a lunate vibratile membrane; cuticular cilia even, forming dense longitudinal series; contractile vesicles

* 'Sveriges Infusoriefauna,' 1869.

two in number, of large size, assuming at full diastole a stellate contour, situated in the same median line towards the anterior and posterior regions of the body; endoplast elongate-ovate, longitudinally disposed, located a little to the rear of the oral fossa. Length 1–288″ to 1–180″.

HAB.—Fresh water.

This species was first figured and described by Eckhard * under the name of *Paramæcium stomioptycha*, and has been referred to later on by Ehrenberg † in connection with the same title. Although the surface ciliation and character of the contractile vesicles accord closely with those of certain *Paramæcia*, the oral structure, as delineated in Eckhard's original drawing, herewith reproduced, is essentially distinct.

GENUS IX. CHASMATOSTOMA, Engelmann.

Animalcules free-swimming, persistent in shape, ovate or kidney-shaped, somewhat flattened; cilia long, matted, equally distributed; oral fossa situated near the centre of the flattened ventral surface, enclosing a minute undulating membrane.

While the contour of the body, the matted character of the cilia, and the position of the oral fossa in this genus correspond closely with those of *Conchophthirus*, the possession of a supplementary undulating membrane indicates its affinity with *Ophryoglena* and *Meniscostomum*.

Chasmatostoma reniforme, Eng. PL. XXVI. FIG. 48.

Body kidney-shaped, about one and a half times as long as broad, obtusely rounded at each extremity, the anterior one slightly the narrower, the dorsal surface convex, the ventral one flattened; oral fossa subcentral, small, and of ovate contour; undulating membrane attached to the right inner side of the oral cavity; cilia long, fine, and thickly set over the entire cuticular surface, presenting a tufted or matted aspect; contractile vesicle postero-terminal, rosette-like during systole; endoplast spherical, situated in front of the contractile vesicle. Length 1–400″.

HAB.—Fresh water, with *Colpoda cucullus*.

This species is figured and described by T. W. Engelmann in the 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. ii., for the year 1862.

GENUS X. PLEUROCHILIDIUM, Stein.

Animalcules free-swimming, persistent in shape, not encuirassed, subreniform and flattened, entirely ciliate; oral fossa antero-ventral, ear-shaped, having attached to its right margin a narrow undulating membrane; trichocysts often present.

This and the following genus, *Ptychostomum*, were instituted by Stein in the 'Böhmischen Sitzungsbericht,' Bd. ii., for the year 1860. Unfortunately, no figures of either of the several specific forms referred to these genera have as yet been published.

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* 'Wieg. Archiv,' p. 219, Taf. vii. fig. 4, 1846.
† 'Bericht Akad. Berlin,' 1853.

Pleurochilidium strigilatum, Stein.

Body subreniform, depressed, the anterior extremity narrowest, obliquely truncate, turned toward the right, the margin of this region crenulate; endoplast spherical, subcentral; contractile vesicle situated posteriorly, close to the right-hand border; trichocysts large and scattered. Length 1–700″. HAB.—Fresh water, among *Lemnæ*.

GENUS XI. PTYCHOSTOMUM, Stein.

Animalcules free-swimming, persistent in shape, not encuirassed, asymmetrical, more or less ovate, depressed or plano-convex, the right-hand margin convex, the left one concave, the posterior margin obliquely truncate, oral aperture ventral, located towards the anterior extremity, anal aperture situated on the left-hand side of the posterior extremity. Occurring as endoparasites within the intestinal viscera of various Annulosa and Mollusca.

Ptychostomum sænuridis, Stein.

Body subovate, slightly depressed; the right border convex, the left one indented centrally; the ventral surface flat, the dorsal one convex, the obliquely truncate posterior extremity curved towards the left in a spur-like manner; oral aperture subtriangular or acetabuliform, antero-ventral; anal aperture tubular, located near the left posterior border, enclosing a bristle or lappet-like structure; cuticular surface longitudinally striate, entirely ciliate, cilia long and fine; endoplast elongate-ovate, transversely placed; contractile vesicle situated close to the right posterior margin, rosette-shaped at systole. Length 1–288″. HAB.—Alimentary tract of *Sænuris variegata*.

The bristle or lappet-like organ described by Stein as situated within the anal tube, is so anomalous that it appears an open question whether the so-called acetabuliform mouth is not an independent sucker or acetabulum, as in *Haptophrya*, permitting the animalcule to fix itself to any desired point of the intestinal wall of its host, and the so-called anal tube, with its bristle or undulating membrane, an oral system corresponding closely with that of *Panophrys*, *Microthorax*, or *Trochilia*.

Ptychostomum paludinarum, Stein.

Similar in shape to *P. sænuridis*, but the posterior extremity on the right side obliquely truncate, bounded by a narrow undulating border, which is at its left angle reflected inwards and projects to a short extent upon the ventral surface; oral aperture anteriorly located, cleft-like, occupying a transverse semicircular furrow that is parallel with the anterior margin of the body; endoplast elongate-oval, subcentral; contractile vesicle single, spherical, located immediately behind the endoplast. Length 1–168″.

HAB.—Intestinal tract of *Paludina impara* and *P. similis*.

Diesing, 'Prothelminthen,' 1866, has proposed to distinguish this species generically from the preceding animalcule under the title of *Hysterocineta*, but until

figures and further details of the form and structure of the two specific types are supplied such a separation is premature. Stein suggests that the posterior membranous border in this species is possibly the analogue of the membranous sucking-disc of the *Trichodinopsis paradoxa* of Claparède and Lachmann, which occurs under similar conditions within the intestinal tract of *Cyclostoma elegans*. On the other hand, it would appear to exhibit an affinity with the genus *Conchophthirus*. The position and structure of the so-called anal aperture, which exhibits so remarkable a modification in the preceding species, has not been determined in the present form.

Fam. X. PLEURONEMIDÆ, S. K.

Animalcules free-swimming, more or less ovate, ciliate throughout; oral cilia diverse in character to those of the cuticular surface; oral aperture terminal or ventral, supplemented by an extensile and retractile hood-shaped membrane or velum.

Genus I. PLEURONEMA, Dujardin.

Animalcules ovate; oral aperture situated in a depressed area near the centre of the ventral surface, supplemented by an extensile hood-shaped transparent membrane or velum, which is let down or retracted at the creature's will; numerous longer vibratile cilia stationed at the entrance of the oral cavity; the general surface of the body clothed with long, stiff, hair-like setæ, occasionally accompanied by a few additional and longer setæ at the anterior extremity; no abnormally developed posterior or caudal seta; the cortical layer usually containing trichocysts; contractile vesicle single, anteriorly situated.

By but few of the investigators of the Infusorial class of the Protozoa, up to the present date, has the structural organization of the genus *Pleuronema* and its allies been correctly estimated. The type of the genus, the *Paramæcium chrysalis* of Ehrenberg, as first separated by Dujardin and subsequently studied by Perty and Claparède and Lachmann and De Fromentel, has been altogether misinterpreted. All these authorities agree in characterizing this form as being distinguishable from *Paramæcium*, merely in the development around the ventrally situated oral fossa of numerous, abnormally long, recurved, retractile and vibratile cilia. That the outermost of these so-called recurved vibratile cilia truly mark the peripheral contour of a delicate hyaline membrane, has been conclusively ascertained by the present author, and it is gratifying to find that Stein, in the very brief reference he makes to the genus in the second volume of his 'Organismus,' expresses a corresponding view. This interpretation of the characteristics of the genus was arrived at so long since as the year 1870, before having access to Stein's observations, and has been reconfirmed upon innumerable occasions. An identical type of structure has likewise been found by the author to obtain among the representatives of the genera *Cyclidium* and *Uronema* of Dujardin, and exists also apparently in the genus *Bæonidium* of Fresenius. This transparent extensile membrane is by no means identical in form or function with the tremulous flap or membrane possessed by the ciliate animalcules previously described. Among these, this oral membrane has mostly an independent vibratory action, and is immediately subservient to the purpose of bringing food-particles to the mouth. In the case of *Pleuronema*, on the other hand, such membrane is not vibratory, but fulfils the purpose of an exquisitely constructed bag-like trap, raised or lowered at will, into which food-particles are swept by the action of the special longer cilia stationed close to the mouth and enclosed within its borders. In

form, and in the manner of its extension and retraction, this membranous trap may be appropriately compared with the extensile hood of a carriage or an outside window-shade, forming, when expanded, a capacious hood-shaped awning, and when not in use being packed away in neat folds close around the animalcule's mouth. Some distant homological relationship not improbably subsists between the hood-like membrane of *Pleuronema* and its allies, and the delicate funnel-shaped membrane characteristic of the recently discovered and extensive group of collared flagellate Infusoria described in the preceding volume.

Pleuronema chrysalis, Ehr. sp. PL. XXVII. FIG. 55.

Body elongate-ovoid, compressed, from two to two and a half times as long as broad, convex above, slightly concave beneath, subequally rounded at the two extremities; oral fossa situated near the centre of the ventral surface, followed by a tubular pharyngeal passage; the extensile membrane or velum largely developed, its depth in full extension corresponding with that of the body. Fine hair-like setæ equal in length to one-half of the diameter of the body, developed in even longitudinal rows over the whole cuticular surface; contractile vesicle anteriorly located; endoplast spheroidal, subcentral. Length 1–360″ to 1–192″. HAB.—Fresh water.

This species is identical with the *Paramæcium chrysalis* of Ehrenberg, but is referred to the present genus by Dujardin under the title of *Pleuronema crassa*. Its habits are eminently social, closely resembling those of the more minute *Cyclidium glaucoma*, but it is much less active. When first transferred to the stage of the microscope for examination the animalcules rush to and fro across the field, their setose cilia being the only appendages visible. In a little while, however, they become quiescent, and letting down their delicate hyaline traps or vela, angle for their accustomed food, often remaining anchored, as it were, in one spot for an hour or more at a time. When disturbed, they spring briskly from one side to the other with the aid of their fine body setæ, after the manner of *Cyclidium*.

Pleuronema marina, Duj.

Body elongate-ovoid, slightly compressed, three times as long as broad, obtusely pointed at each extremity; the cuticular surface finely striate longitudinally. Length 1–250″. HAB.—Sea water.

Claparède and Lachmann have proposed to regard this form as identical with *P. chrysalis*, but its average larger size and longer proportions, as given by Dujardin, together with its marine habitat, seem sufficient to warrant its separate specific recognition. According to the figure given by its discoverer, the oral membrane is not relatively so large as in *P. chrysalis;* the vibratile cilia of the oral system, on the other hand, appear to be more extensively developed.

Pleuronema natans, C. & L.

Body subspherical, scarcely longer than broad, oral fossa very large and deep; extensile oral membrane or velum protrusible to a short distance only; fine short setæ distributed throughout the cuticular surface. Length of body 1–300″. HAB.—Fresh water.

Pleuronema coronata, S. K. Pl. XXVII. Fig. 56.

Body ovoid, compressed, twice as long as broad, extremities subequally rounded, or slightly wider anteriorly; oral fossa almost central; cuticular surface dotted with short, fine, rigid cilia or setæ, whose length equal one-sixth only of the diameter of the body; a few supplementary, considerably longer, fine, rigid setæ projecting at various angles from the anterior extremity. Length of body 1–290″. Hab.—Fresh water.

The author, not concurring with Claparède and Lachmann in referring the form answering to the above diagnosis, and as figured by those authorities, to the *Pleuronema chrysalis* of Ehrenberg, Dujardin, and Perty, a new specific title has been created for its reception. The contour of its body is shorter and thicker than that of *P. chrysalis*, from which it may also be readily distinguished by the short character of the setæ of the general cuticular surface and by the presence of supplementary longer setæ at the anterior extremity. The *Pleuronema chrysalis*, as figured by Quennerstedt,* is apparently also identical with this type.

Genus II. CYCLIDIUM, Ehrenberg.

Animalcules free-swimming, persistent in form, ovate, more or less compressed; oral aperture ventral, supplemented by a hood-shaped extensile membrane; body clothed with fine, rigid, hair-like setæ, one or more abnormally long caudal setæ developed at the posterior extremity; contractile vesicle single, posteriorly situated; cortical layer not containing trichocysts. Inhabiting salt and fresh water.

This genus, originally instituted by Ehrenberg, corresponds with the *Alyscum* and *Enchelys*, *in pars*, of Dujardin, both of which are now accepted as comprising forms fundamentally identical with *Cyclidium glaucoma*. Claparède and Lachmann, as well as Stein, have further proposed to incorporate with this genus the *Uronema* of Dujardin—a decision, however, from which the present author dissents, he having frequently met with an animalcule which, while accurately corresponding with Dujardin's *Uronema marinum*, differs essentially from *Cyclidium* as here defined, in the character of the body cilia. The long caudal seta, and the situation of the contractile vesicle, serve at the same time to distinguish the animalcules of this genus from those of *Pleuronema*, which they otherwise closely resemble. The several known species of *Cyclidium* are exceedingly minute, and require the employment of the higher magnifying powers of the compound microscope for the satisfactory illustration of their characteristic membraneous trap. All the species are very agile, springing about rapidly when disturbed by aid of the stiff setæ with which the general surface of their cuticle is beset, while at other times they progress forwards leisurely by means of the vibratile cilia adjacent to the oral fossa.

Cyclidium glaucoma, Ehr. Pl. XXVII. Figs. 57 and 58.

Body ovate, compressed, somewhat reniform, convex above, concave beneath, little over twice as long as broad; the oral aperture situated a little in advance of the centre of the ventral surface; setæ of the general surface very long and fine, their length equalling or exceeding that of the breadth of the body, disposed in even longitudinal lines, the posterior or caudal seta conspicuous, twice the length or more of those of the general

* 'Sveriges Infusoriefauna,' Lunds Universitets Ars-skrift, Tab. I. fig. 19, 1871.

surface; contractile vesicle postero-terminal; endoplast spheroidal, subcentral. Length of body 1–1250″. HAB.—Pond water and infusions.

This species is one of the first Ciliate animalcules that makes its appearance in hay or other vegetable infusions, in which it often swarms in countless numbers. In addition to being essentially social in its habits, a certain community of action appears to be maintained between the numerous individuals that are found together. In this manner the springing to one side of a single zooid in the crowd is sure to be responded to by another one in its vicinity, and the whole assemblage is presently set whirling and sporting together like a colony of house-flies in the genial sunshine. As with flies, moreover, a strong light apparently offers a remarkable attraction to these animalcules, it having been observed on many occasions that they crowd to that portion of the microscopic field which is illuminated by the small but brilliant pencil of light produced by the achromatic condenser when employing a $\frac{1}{16}$-inch object-glass, and follow it as different portions of the field are brought into its focus by the stage movements. This tendency to assemble in the area of strongest illumination was exhibited to an equal extent during the employment of either lamp-light or ordinary daylight.

When actively darting about or swimming leisurely forwards, the characteristic membraneous trap or velum of this species is, as in the case of *Pleuronema*, stowed snugly away in transverse folds around the margin of the mouth, but is at once lowered again to its full extent when, the moment's sport being over, the little creatures come to anchor. The rapid multiplication of this form is chiefly accomplished by the process of transverse fission, in connection with which it has been observed that the characteristic membraneous velum takes its share. In young individuals developed from germs, it was, however, ascertained by the author that the extensile membrane, as in *Uronema*, does not make its appearance until the animalcule has attained its adult dimensions, its aspect prior to this matured condition closely resembling that of Dujardin's *Enchelys triquetra*, and which, in company with the *Alyscum saltans* of that authority, and the *Pleuronema cyclidium* of Claparède and Lachmann—wrongly represented as having the contractile vesicle and characteristic seta at the anterior extremity—must undoubtedly be identified with the immature state of the present species. Presuming the last-named form to be distinct, Stein has proposed to confer on it the title of *Cyclidium Claparèdi*.

Cyclidium citrellus, Cohn sp. PL. XXVII. FIG. 59.

Body ovate or lemon-shaped, somewhat compressed, flattened ventrally in the neighbourhood of the subcentral oral aperture, tapering abruptly at the two extremities, about twice as long as broad; surface of the integument faintly striate longitudinally, cuticular setæ fine and evenly distributed, not equalling the breadth of the body in length; one long and two shorter caudal setæ developed at the posterior extremity; contractile vesicle postero-terminal. Length 1–600″. HAB.—Salt water.

The presence of the two supplementary caudal setæ, as well as the symmetrical lemon-like contour of the body of this species, seem to distinguish it readily from the preceding form; by Cohn, who describes it under the title of *Pleuronema citrellus*, the hood-shaped oral membrane is represented as a mere long, recurved seta.

Cyclidium arboreum, Ehr.

Body minute, suborbicular, ventral border slightly excavate, dorsal surface rugose; cilia hair-like, scattered throughout. Length 1–1200″.

HAB.—Among moss on trees.

It is almost impossible to decide whether this species, briefly characterized as above by Ehrenberg,* is rightly referable to the genus *Cyclidium*, or even in such a case whether, though smaller, it is specifically distinct from *C. glaucoma*.

Genus III. URONEMA, Dujardin.

Animalcules free-swimming, ovate or elongate, persistent in shape; oral aperture ventral, supplemented externally by an extensile trap-like membrane or velum; the general surface of the body covered with vibratile cilia; one or more long caudal setæ developed at the posterior extremity.

This genus is readily distinguished from *Pleuronema* and *Cyclidium* by the character of the appendages of the general cuticular surface, which, in this instance, consist of flexible vibratile cilia in the place of stiff, hair-like setæ.

Uronema marinum, Duj. Pl. XXVII. Figs. 60 and 61.

Body elongate ovate, crenulate or rugose, from two and a half to three times as long as broad, rather thicker posteriorly; cilia of the general surface of even length throughout, dispersed in parallel rows, about five of which are exposed to view by the body as seen in profile; caudal seta equalling the body in length; contractile vesicle posteriorly located; endoplast spherical, subcentral. Length 1–800″.

Hab.—Vegetable infusions in salt and fresh water.

In its earlier condition this animalcule closely resembles the immature state of *Cyclidium glaucoma*, it possessing no trap-like membrane, which is an after development. In some of the youngest examples observed, only the longer oral cilia were visible, the general surface of the body being apparently completely naked, closely corresponding, in this condition, with the figure given by Dujardin of his marine *Acomia cyclidium*.† Dujardin's *Enchelys corrugatum*,‡ again, an inhabitant also of sea water, is likewise indistinguishable from the young of *Uronema*. The extensile hood-shaped membrane in this species is smaller and far more difficult to discern than in *Cyclidium* or *Pleuronema*, the animalcules but rarely presenting the profile view requisite for its conspicuous exhibition. Although most abundantly developed in salt water, a form, agreeing in all essential details with the present species, has been recently obtained by the author from fresh water.

Genus IV. BÆONIDIUM, Perty.

Animalcules free-swimming, persistent in form, elongate-ovate, or subcylindrical; the anterior border obliquely truncate, perforated by the oral aperture, bearing circumferentially an extensile hood-like membrane or velum.

Bæonidium remigens, Perty. Pl. XXVII. Fig. 64.

Body elongate, subcylindrical, straight or more or less curved, from three to four times as long as broad, the posterior extremity rounded, the anterior one obliquely truncate, perforated by the oral fossa, and bearing an extensile hood-like membrane or velum, whose width equals that of the breadth of

* 'Bericht Akad. Berlin,' 1853.
† Dujardin, 'Hist. des Zoophytes Infusoires,' pl. vii. fig. 5, 1841.
‡ Ibid., pl. vii. figs. 11*a* and 11*b*.

the body, numerous long vibratile cilia enclosed within the hood-like membrane; cuticular cilia setose; endoplasm usually enclosing green granules. Length 1–840″ to 1–650″. HAB.—Fresh water, among *Chara*.

The presence of an undulating membrane at the anterior extremity, corresponding closely with that of *Pleuronema*, while suspected by Perty, is more conclusively demonstrated by the figures and description of Fresenius,* from which the accompanying illustration is derived. According to the two authorities quoted, it swims through the water, revolving on its long axis, creeps slowly, or springs from one side to the other after the manner of *Cyclidium*, aided, apparently, under the last conditions, by its setose cuticular cilia. Multiplication by transverse fission is reported by its original discoverer.

Fam. XI. LEMBIDÆ, S. K.

Animalcules free-swimming, elongate or vermicular, ciliate throughout, oral and cuticular cilia diverse in character; oral aperture ventral, associated with a prolonged crest-like membranous border.

The members of this very natural family group are characterized by the peculiar crest- or sail-like contour of their supplementary adoral membranes. As yet but two generic forms, *Lembus* and *Proboscella*, can be included in it. Both represent the fruits of the most recent investigation.

GENUS I. LEMBUS, Cohn.

Animalcules free-swimming, elongate-clavate or vermicular, highly elastic; oral aperture ventral, subcentral, an extensile, subtriangular or band-like, undulating membrane produced along a furrow on the ventral surface, which extends from the anterior extremity backwards to the oral aperture, cilia of larger size than those of the cuticular surface usually developed along its inner border; contractile vesicle conspicuous, posteriorly located. Inhabiting salt water.

With reference to the peculiar modification of its characteristic undulating membrane, the genus *Lembus* occupies among the Holotrichous Infusoria a position corresponding to that held by *Condylostoma* and *Blepharisma* with relation to the higher Heterotricha. Three species are now added to the type form introduced by Cohn.

Lembus velifer, Cohn. PL. XXVII. FIGS. 62 AND 63.

Body elongate, lanceolate or clavate, from five to eight or ten times as long as broad; undulating membrane and adoral furrow commencing at a short distance from the anterior extremity, extending backwards through two-thirds of the length of the entire body, this portion of the body narrow and linear, the posterior third cylindrical, more or less rounded posteriorly. Adoral cilia long and fine, produced beyond the outer border of the undulating membrane; cilia of the cuticular surface rather longer towards the anterior extremity; surface of the posterior half of the body finely annulate transversely; contractile vesicle posteriorly located. Length 1–480″ to 1–240″.

* 'Beiträge zur Kenntniss Mikroskopischer Organismen,' Frankfurt, 1858.

HAB.—Salt water. Locomotion rapid, forwards or backwards in a straight line, with the undulating membrane rapidly vibrating; sometimes stationary.

Cohn* compares the contour of the animalcules of this species, with their undulating membranes expanded, to that of small boats with their sails spread; multiplication by transverse and longitudinal fission, but chiefly the latter, was observed. The attenuate anterior extremity of the body in advance of the oral region is described as being very elastic, and capable of flexure in various directions, so much so, indeed, that, divested of the characteristic undulating membrane, this type would closely resemble a minute *Loxophyllum* or *Amphileptus*. Cohn suggests the probable identity of this species with the *Vibrio verminus* of O. F. Müller, and also, perhaps, with the *Cyclidium elongatum* of Claparède and Lachmann. While there can be little doubt that this latter form should be rightly referred to the genus *Lembus*, the description and figure supplied by its describers would appear to indicate its claim to separate specific recognition. No indication is given of the transverse annulations of the posterior body-half, nor of a difference in calibre between the cilia that clothe the general cuticular surface and those developed along the oral furrow which is so distinctly observable in Cohn's species. Müller's type, on the other hand, may be more readily identified with the form upon which the new genus *Proboscella* is here established.

Lembus pusillus, Quennerstedt.†

Body elongate, subcylindrical, about three times as long as broad, rounded at each extremity, the anterior one slightly narrower; undulating membrane extending backwards to a distance of about one-half of that of the entire body, not supplemented by a fringe of conspicuously larger adoral cilia; cuticular surface striate longitudinally, evenly and finely ciliate throughout; contractile vesicle postero-terminal. Length 1–900″ to 1–625″.

HAB.—Salt water.

The longitudinal direction of the surface markings and smaller size of this species serve to distinguish this type from that last described.

Lembus subulatus, S. K. PL. XXVII. FIGS. 66 AND 67.

Body elongate, subulate, four or five times as long as broad, rounded and subcylindrical posteriorly, tapering gradually from the centre of the body, and terminating anteriorly in a subulate, somewhat upturned point; oral aperture ventral, subcentral; undulating membrane extending backwards from the anterior extremity to the oral aperture, continuous with a conspicuous fringe of larger adoral cilia; cuticular surface exhibiting neither longitudinal nor transverse striæ; endoplasm transparent, finely granulate; contractile vesicle postero-terminal, endoplast spheroidal, situated a little in advance of the median line. Length 1–750″.

HAB.—Salt water, among decaying vegetable matter.

This species has been recently obtained by the author in considerable abundance at St. Heliers, Jersey, associated with the Bacterial glœa-like film rising to the surface of sea water containing seaweeds, Polyzoa, and other organisms in an

* "Neue Infusorien im Seeaquarium," 'Zeit. Wiss. Zool.,' Bd. xvi., 1866.
† 'Sveriges Infusoriefauna,' Lunds Universitets Ars-skrift, 1869.

advanced state of decomposition. From *L. pusillus*, which it most closely resembles in point of size, it may be distinguished by the relatively larger size of its adoral cilia, by its more pointed anterior extremity, and by the absence of cuticular striation. The extreme mobility or elasticity of this type would seem to surpass that of any of the forms as yet referred to the genus. While occurring abundantly in the open water,—where its comportment corresponds with that of the species previously described, numbers were found imbedded in the substance of the glœa-film itself, and through which they were busily occupied in slowly boring their way in a worm-like manner, each body adapting itself readily to every vacuole within this matrix, and assuming the most contorted and fantastic shapes. One of the more ordinary sinuous contours exhibited under these last-named conditions is represented at Pl. XXVII. Fig. 67. Natation is usually accomplished in an even straightforward direction, or through rotation upon its long axis.

Lembus elongatus, C. & L. sp. PL. XXXII. FIG. 10.

Body very narrow, elongate, somewhat bent, sub-even throughout, about seven times as long as broad; oral aperture in the centre of the ventral surface, oral and cuticular cilia fine and short, even throughout, a long, recurved, buccal seta (margin of the undulating membrane) extending forwards from the oral aperture to the anterior extremity; contractile vesicle large, postero-terminal; anal aperture in front of the contractile vesicle. Length 1–300″. HAB.—Salt water, Norwegian coast.

This animalcule, originally described by Claparède and Lachmann* under the title of *Cyclidium elongatum*, cannot be referred with absolute certainty to the genus *Lembus*, although the figure given of it, as here reproduced, would appear to favour such location. Its habits, as recorded by these authorities, differ considerably from those of either *L. velifer* or the succeeding species, it remaining for the most part stationary among vegetable debris, and forming within the same an irregular tube-like excavation, into which it rapidly retreats at will.

GENUS II. PROBOSCELLA, S. K.

Animalcules free-swimming, highly flexible, elongate-lanceolate, or vermicular; oral aperture ventral; an elongate, undulating membrane extending backwards from the anterior extremity to the oral aperture, associated with a fringe of longer adoral cilia; a slender, extensile, digitiform or snout-like appendage produced from the apical extremity; the posterior extremity bearing one or more caudal setæ. Inhabiting salt water.

Proboscella vermina, Müll. sp. PL. XXVII. FIGS. 65 AND 65*a*.

Body elongate-clavate, compressed, seven or eight times as long as broad, the posterior half cylindrical or subfusiform, more or less rounded posteriorly, the anterior portion linear, about one-half the diameter only of the posterior part, terminating apically in a short, flexible, curved, retractile and extensile fingerlike process; oral aperture ventral, subcentral, situated close to the junction of the more inflated posterior and narrower anterior regions of the body; undulating membrane irregularly triangular, extending from the oral aperture to within a short distance of the anterior

* 'Études sur les Infusoires,' 1868.

extremity; cilia of the oral groove longer than those of the general surface, but not projecting beyond the margin of the undulating membrane; cuticular surface delicately striate longitudinally, clothed with short, even cilia; a single, fine, straight, hair-like seta, about equal in length to the greatest breadth of the body, produced from the centre of the posterior extremity; contractile vesicle conspicuous, postero-terminal; endoplast double, consisting of two equal-sized spheroidal moieties, situated one behind the other a little in advance of the centre of the thicker posterior body-half. Length 1–250″. HAB.—Salt water.

It was at first proposed to include this species in the preceding genus *Lembus*, but in the presence of the various forms now referable to that generic group, none of which possess the anterior or posterior appendages that characterize the present type, it has been deemed desirable to institute a new generic title for its reception. The mobile and exceedingly flexible finger-like anterior process of *Proboscella* presents, at first sight, some resemblance to the peculiarly modified apical extremity of *Trachelocerca* or *Lacrymaria*, though it is not, as in those types, perforated by the oral aperture. Its function appears to be entirely tentative, and when not in use is, in common with the undulating membrane, packed away out of sight. The habits of this species closely resemble those of *Cyclidium glaucoma* and *Uronema marina*, it assembling in similar social companies, and for the most part remaining stationary with its undulatory membrane extended and adoral cilia rapidly vibrated. Under any disturbing influence it darts hither and thither with great rapidity, exhibiting on such occasions, in common with *Lembus velifer*, the faculty of swimming either forwards or backwards with equal facility. The examples upon which this new genus is here instituted were obtained in abundance from sea water with decaying vegetation brought from Brighton in the month of May 1874.

It is only quite recently, February 1881, on referring to O. F. Müller's original figures and description of *Vibrio verminus* * to ascertain the extent of the resemblance subsisting between that form and *Lembus velifer*, suggested by Cohn, that the author has been enabled to positively identify Müller's organism with the type now under consideration, such identification justifying the adoption of Müller's original specific title in the place of the new one of *P. mucronatus* that had been previously decided on. Although in Müller's illustrations of this species no trace whatever is given of either the cilia, caudal seta, undulating membrane, or anterior tactile appendage, the identity here maintained is substantially established with reference not so much to their corresponding clavate outlines, which perfectly agree, but to the fact that Müller has clearly indicated in several of his figures the existence of a subcentrally located vesicular structure, at once recognizable as representing the peculiarly modified double nucleus or endoplast of the author's type, while a third structure of apparently the same nature, as delineated by Müller, corresponds in a similar manner with the contractile vesicle. Any further doubts that might yet remain are immediately disposed of by a reference to Müller's original description, which confirms the account of the structure and habits of this animalcule already submitted, in so full and interesting a manner as to invite quotation *in extenso*. This description runs as follows:—

"Vibrio linearis compressus, antice quam postice angustior.

"Animalculum hyalinum teres, motu vero lentiore crystallinum compressum, seu membrana crystallina elongata, postica quam antica parte latior, apice subtruncata, basi obtusata. Interanea nulla perceptibilia; in medio tantum vesiculæ duæ sphæricæ distantes, ac tertia intra marginem posticam observabilis; raro quasi linea longitudinalis prospicitur.

"Motus festinans antrorsum et retrorsum vacillatorius, antea parte aliquantum elevata."

Müller further testifies to having on rare occasions observed animalcules either in the act of conjugation or dividing by longitudinal fission. The examples he

* 'Animalcula Infusoria,' p. 57 and Tab. viii. figs. 1–6, 1786.

figures as thus occupied are joined only by their central or oral regions, leaving the two extremities free and often so far separated as to communicate to the conjoint zooids a contour aptly compared by Müller with that of a St. Andrew's Cross. It is evident that the former of his two conjectures is the correct one; the phenomena presented being precisely parallel to those exhibited by two conjugating *Paramœcia*, while in no instance as yet known does the fissive process progress simultaneously from the two opposite extremities leaving the central or oral region last connected. No more fitting example than the present could perhaps be cited in illustration of the advantages that may be derived from a consultation of the too often neglected earlier authorities; the case in point, moreover, furnishes substantial evidence of the comprehensive knowledge of the Infusoria that was capable of attainment by skilled workers even with the indifferent instruments of the past century. A reproduction of O. F. Müller's most characteristic outline illustration of his so-called *Vibrio verminus* is given at Pl. XXVII. Fig. 65A.

Fam. XII. TRICHONYMPHIDÆ, S. K.

Animalcules freely motile, but rarely swimming, their movements being confined chiefly to twisting and writhing motions, more or less elongate or vermicular; cuticular surface entirely ciliate, accompanied apparently, in some instances, by an undulating membrane. Occurring as endoparasites within the intestinal tracts of certain Neuropterous Insecta.

It seems desirable to comprise provisionally in one small family group the three remarkable infusorial types, *Trichonympha*, *Pyrsonympha*, and *Dinenympha*, discovered by Professor Leidy in the intestinal tract of the American white ant, *Termes flavipes*. These, while first briefly described by him in the 'Proceedings of the Academy of Natural Sciences of Philadelphia,' for the year 1877, form the subject of a more extensive communication, with accompanying illustrations, to the same journal, published in March 1881.* All three animalcules were found by Professor Leidy associated together under the following circumstances. Seeking for microscopic animals beneath stones and fragments of wood in the American forests, his attention was attracted to the white ants in question, their intestines, as seen through their translucent abdomens, being considerably distended with a brown substance. Feeling curious to ascertain the nature of this matter, it was examined and found to consist largely of the three infusorial parasites here described, mingled with minute particles of decayed wood, an abundance of *Spirillum* and the filaments of an algal referable apparently to the genus *Arthromitus*. In many instances, however, the Infusoria were present in such prodigious quantities as to make up the greater portion of the bulk of the intestinal pulp.

The decision previously arrived at by the author to provisionally retain these three genera in the single family group of the Trichonymphidæ is in no way affected by the more recent accounts and illustrations of the several species now to hand, and is indeed fortified by the following extract from Professor Leidy's latest description: "Of the parasites of our termite there appear to be three or four, or perhaps more, distinct species of remarkable protozoans, but of this I am not positive, for I have suspected that several, which I at first viewed as such, may be only different stages of the same. On the other hand, certain forms which I have regarded as younger stages of the species as I have distinguished them, may on future investigation prove to be equally distinct." Or again, "In the following descriptions I have of course attempted to represent them as they have appeared to me from time to time, but I

* Through the receipt of a separate copy of this communication, immediately on publication, the author is especially indebted to Professor Leidy for the opportunity of reproducing in this treatise his exquisite drawings and latest data elicited concerning the structure and habits of these remarkable organisms.

am not altogether satisfied with the results, and apprehend that in some cases I have not interpreted the appearances correctly." It is in connection with this amount of uncertainty that for the present pertains to these organisms that they are likewise here provisionally correlated with the series of Holotrichous Ciliata distinguished by the possession of supplementary membraniform expansions. In *Pyrsonema*, which attains to the largest calibre, and may not improbably therefore be a more matured condition of the companion forms, the lateral margin, see Pl. XXVIII. Fig. 18, is often so modified as to closely resemble the simple membraniform type *Trypanosoma sanguineus* delineated at Pl. I. Figs. 1 and 2; while in other instances, Pl. XXIII. Figs. 16 and 17, an independently mobile cord-like structure, apparently indicating an undulating membrane, is distinctly manifested.

M. C. Lespes, in a memoir on the "Organization of the European White Ant *Termes lucifugus*," published in the 'Annales des Sciences Naturelles' for 1856, has remarked that the contents of the intestines of that species consists also of a brown pulp composed chiefly of a living agglomeration of Infusoria, an account of which he proposed at some future time to give. This promise has not, however, so far been redeemed, and it is greatly to be desired that some Continental histologist should take the matter up, and ascertain whether these parasitic forms correspond with the Trans-Atlantic types. A valuable suggestion respecting the examination of these and other endoparasitic animalcules is contributed by Professor Leidy. Water proving too thin a fluid for their preservation in a living state, a little white of egg was added, and in this denser medium their normal form and characteristics were successfully maintained for a considerable interval.

Genus I. TRICHONYMPHA, Leidy.

Animalcules freely motile, exceedingly flexible and elastic, often convolute, mostly separable into two distinct regions consisting of a smaller ovate head-like portion and a larger more or less inflated body; cilia various in length, apparently comprising three or four distinct series, one of these exceedingly long and projecting considerably beyond the posterior extremity. Endoparasitic within the intestine of white ants.

Trichonympha agilis, Leidy. Pl. XXVIII. Figs. 1–15.

Body elongate-ovate or fusiform, from two to three or four times as long as broad, the posterior extremity obtusely rounded or subacute, according to the condition of contraction, the anterior extremity mammilliform and headlike; cilia clothing the body forming apparently three or four distinct series, the first and second shortest produced outwards and downwardly from the anterior extremity; the third longer, extending from the anterior extremity through the whole length of the body, waving downwards and outwards like the last; the fourth set, longest of all, extending from the apical end beneath the others in a longitudinal spiral manner, beyond the posterior extremity of the body, and forming there a loosely twisted fascicle with divergent ends; oral aperture indistinct, apparently taking the form of a rounded pore at the summit of the apical extremity; a narrow pharyngeal tube apparently extending thence backwards to a stomach-like dilatation which occupies the posterior two-thirds of the body, and is usually filled with food-particles; a granular nucleus-like body located centrally close to the junction of the pharyngeal and food-filled portion; no contractile vesicle as yet detected. Length 1–300″.

HAB.—Endoparasitic within the intestine of the American white ant, *Termes flavipes* (Jos. Leidy).

The movements of this animalcule, as described by Professor Leidy, consist of an incessant retraction or shortening and bending to and fro of the head-like anterior region, accompanied by the rapid waving and swelling outwards of the long ciliary hairs. Locomotion from one position to another is of rare occurrence, and accomplished merely by a feeble jerking forwards for a short distance. The motions of the longer cilia, forming the third series, are compared to the "flowing of a thin sheet of water over the brim of a fountain vase or basin, swayed to one side or to the other by a current of wind." The longest cilia, or fourth series, extending beyond the posterior end of the body in a loosely twisted fascicle, are the least active, but at times stretch outwardly and become more divergent at the ends, or are applied more closely to the sides of the body. The most characteristic delineation of *Trichonympha*, illustrating the respective lengths and positions of attachment of its four ciliary series as interpreted by its discoverer, is given at Pl. XXVIII. Fig. 2. In Fig. 3, while the two longer series are clearly separated, those belonging to the first and second orders are indistinguishably blended. Pursuing another simile, Professor Leidy remarks that the arrangement of the long cilia clothing the body reminded him of the nymphs personified in a recent American spectacular drama, the performers in which appeared having as their sole vesture and adornment long cords suspended fringewise from their shoulders, and which, as they danced, were whirled around them in mazy undulations. This last-named likeness quoted, originally suggested some affinity of the animalcules now under discussion with the similarly endoparasitic *Hexamitæ* described in the preceding volume. These, when attached by their two posterior flagella, and spinning to and fro with their four anterior appendages thrown into graceful convolutions around their bodies in the manner recorded by the author (*loc. cit.*, p. 320), might also with some appropriateness lay claim to the nymph-like simile suggested by *Trichonympha;* the distinctness of their respective types is, however, clearly demonstrated in connection with the fuller data concerning *Trichonympha* now to hand.

As shown by Professor Leidy's recent drawings of this singular organism, here reproduced, the variations of contour that a single zooid is able to assume in accordance with the degree of extension, contraction, or contortion of the body are almost infinite. Attention, in this connection, may be more especially directed to those shorter and longer symmetrically helicoidal body-contours exhibited at Pl. XXVIII. Figs. 4 and 5. At Fig. 3, while the anterior portion alone is spirally revolute, the several series of cilia are so disposed as to communicate to the organism a *tout ensemble* suggestive of the expanded plumes of a bird-of-paradise (*Paradisea apoda*). In his later description of *Trichonympha*, Professor Leidy expresses himself in very doubtful terms concerning the existence of a definite oral aperture; so that the indication given of such a structure, together with that of a pharyngeal passage, derived from his earlier account, must for the present be accepted as provisional. That an oral aperture does exist is inferred from the almost invariable presence internally of what appear to be fragments of woody tissue derived from the food-materials of their hosts the termites. He at the same time remarks, "If the irregular particles so commonly observed in the body-endosarc of *Trichonympha* are really food-particles, I have been sorely puzzled and have failed to ascertain how they obtained entrance into the body. I have watched myriads of individuals hours together, without ever having seen one of them swallow or discharge a particle of food. I have been unable to detect anything like a mouth. I could detect no trace of a passage through the head-endosarc, nor ever saw a particle within it which might be on its way to the body-endosarc."

Although the movements of *Trichonympha agilis*, when set free in an artificial medium, are mostly limited to simple twistings, elongations, and contractions of its body-mass, it would appear to possess the power of active locomotion within the intestinal fluids of its host, wherein, as related by Dr. Leidy in his recent paper, it may be detected amidst the dense concourse of its associates, gliding

through and displacing them as it advances. The accredited immature phases of this animalcule, as represented by Figs. 8 to 15 of the accompanying plate, are remarkable both for their dissimilarity in general from one another and from the parent form, circumstances which, as fully recognized by their discoverer, render their identification with *Trichonympha*—pending the actual tracing of their development into the adult type—purely tentative. In the imbricated modification delineated at Pl. XXVIII. Figs. 9 and 11 more especially, it is worthy of note that a far closer resemblance subsists between them and the phases of *Pyrsonema vertens* illustrated by Figs. 19 and 20 of this plate, than between the same and the adult form of *Trichonympha*. Respecting the zoological position and affinities of the type now under discussion, Professor Leidy declares himself to be in some doubt whether to regard it as a Ciliate Infusorian, a Gregarine, or a Rhabdocœlous Turbellarian, the evidence, however, to his mind, favouring its relegation to a position with the first or midway between the first and second groups. Affinities with the Gregarinida are, in his opinion, indicated in connection with the separation of the adult body into two distinct regions. A similar degree of differentiation is nevertheless manifested in various ordinary Ciliate Infusoria. As illustrated by the generic types *Lacrymaria*, *Trachelocerca*, *Phialina*, and *Mesodinium*, in all of which a separate head-like region is distinctly recognizable. In all other respects *Trichonympha* conforms essentially with the normal Holotrichous plan, the greater length and fineness of the ciliary appendages being, seemingly, a more pronounced development of what commonly obtains among the Opalinidæ and other endoparasitic Infusoria, and in which a matted or tufted character of the cilia is of frequent recurrence. It is at the same time worthy of remark that the great length and apparently serial plan of disposition of the cilia in *Trichonympha* confer upon these organisms no inconsiderable resemblance to the larvæ of certain Chætopodous Annelids, such as *Nerine*, in which fascicles of long fine setæ are in a somewhat similar manner produced, chiefly from the anterior region of the body.

Genus II. PYRSONEMA, Leidy.

Animalcules freely motile, more or less elongate, exceedingly flexible and elastic, apparently finely ciliate throughout; possessing in addition a narrow, cord-like, undulating border which extends the whole length of the body; an oral aperture seemingly existing, but its position undetermined. Endoparasitic within the intestine of white ants.

Pyrsonema vertens, Leidy. Pl. XXVIII. Figs. 16–20.

Body highly flexible and contractile, elongate-fusiform when extended, clavate or pyriform in the contracted state; while moving, exhibiting longitudinally spiral and parallel lines, these at the extremities or at the angles of flexure presenting the aspect of serrated projections, having a rapid waving motion, resembling the movement of flames, and often communicating to the body a screw-like aspect; cilia when present short and of even length, distributed throughout the entire surface of the body; a narrow cord-like prominence or membrane frequently extending the whole length of the body, sometimes projecting at one extremity, moving in long, angular waves, and flexing the body in accordance with its movements; endoplasm finely granular, enclosing a round or oval endoplast, which is located a little in advance of the median line; contractile vesicle not observed; position of

the oral aperture undetermined, but its existence made apparent by the abundant presence of incepted food-particles. Length 1–200″.

HAB.—Endoparasitic within the intestine of the American white ant, *Termes flavipes* (Jos. Leidy).

Like *Trichonympha agilis*, this animalcule is recorded by Professor Leidy as usually retaining a stationary position; while stationary it at the same time frequently exhibits an actively writhing or apparently twisting motion, or bends in a waving manner from one extremity to the other. The consistence of the body-sarcode appears to be of more delicate consistence than in the form last-described, the animalcule undergoing rapid dissolution after removal from the intestine of its host, and no clear distinction between the ectoplasmic and endoplasmic layers being recognizable.

In the more recent account and figures of this species given by Professor Leidy, its possession of cilia, previously supposed to exist but not actually determined, is in certain cases fully verified. In a very considerable number of instances, however, including both smaller and full-sized examples, the most rigid scrutiny failed to detect the presence of any such appendages, this peculiarity being more particularly distinctive of the larger, flattened, membraniform or screw-like zooids illustrated by Pl. XXVIII. Figs. 18–20. While, excepting for the absence of cilia, these screw-shaped animalcules considerably resemble the accredited immature phases of *Trichonympha* depicted at Figs. 9 and 11 of the same plate, the membraniform example with a serrated border, represented at Fig. 18, is far more appropriately comparable with the simple membraniform organism referred to the genus *Trypanosoma*, described at pp. 218 *et seq.* of the preceding volume and delineated at Figs. 1–6 of Pl. I. According to its discoverer, *Pyrsonema vertens* is a constant companion of *Trichonympha*, frequently occurring in even greater abundance than that type. As with the last-named form, the bodies of the present species are usually more or less gorged with fragments, apparently of wood fibres and cellular tissue, derived from the food of their host, though the channel by which it obtained access to this position remains to be defined.

GENUS III. DINENYMPHA, Leidy.

Animalcules freely motile, more or less elongate; exceedingly flexible and elastic, finely and uniformly ciliate throughout; oral aperture apparently existing, but its position undetermined. Endoparasitic within the intestine of white ants.

Dinenympha gracilis, Leidy. PL. XXVIII. FIGS. 21–24.

Body highly elastic, elongate-fusiform, flattened and band-like, frequently twisted; cuticular surface longitudinally striate, finely ciliate throughout, a tuft or crest of apparently longer cilia frequently developed at the anterior extremity; the termination of the body, when contracted, or the edges of the flexures when the body is bent, exhibiting a serrated aspect; parenchyma translucent, enclosing numerous globular structures, including apparently a subcentral endoplast and one or more vacuolar excavations; position of oral aperture not determined, but its existence predicated through the abundant presence of enclosed particles of solid food. Length 1–500″ to 1–350″.

HAB.—Intestinal tract of American white ant, *Termes flavipes* (Jos. Leidy).

This type is described by Professor Leidy as being the most minute and at the same time the most abundant of the three forms with which *Termes flavipes* was found endoparasitically infested. Its movements correspond almost precisely with those of *Trichonympha* and *Pyrsonympha*, being limited mostly to active writhing motions and to a lengthening and contraction of the body, accompanied by occasional rotation on its long axis; the animalcule otherwise maintains a nearly stationary position. It has been recently suggested by its discoverer as by no means improbable that *Dinenympha* may eventually prove to be a younger condition of *Pyrsonympha*. If, however, his interpretation of the internal development of sporular elements, as represented at Pl. XXVIII. Fig. 21, is correct, its claim for independent recognition would appear to be fully substantiated.

Appendix A. HOLOTRICHA-ASTOMATA.

Animalcules free-swimming, more or less completely and evenly ciliate throughout; possessing no oral aperture.

Fam. XIII. OPALINIDÆ, Stein.

Animalcules free-swimming or temporarily adherent, mouthless, finely and equally ciliate throughout, the cilia usually presenting a tufted or matted aspect; the anterior extremity sometimes armed with differentiated organs of prehension, which may take the form of a suctorial disc, or of one or more horny bands or uncini; endoplast conspicuously developed, sometimes multiple; contractile vesicle present or absent. Occurring as endoparasites within the recta and intestinal viscera of Amphibia and Invertebrata.

The representatives of this family group were originally separated by Siebold from the ranks of the ordinary Ciliate Infusoria and placed together with the Peridiniidæ, Euglenidæ, and other Flagellate Protozoa—then supposed to be mouthless—in a separate section denominated by him the Astomata. All these flagellate forms are now, however, with but few exceptions, known to possess either a distinct oral aperture or the faculty of ingesting solid food-substances through a more or less widely distributed area of their periphery; while, in accordance with the views of Stein and other recent authorities, the Opalinidæ are to be regarded rather as an aberrant and retrograde group of the ordinary Holotrichous series than as an entirely distinct order of the Ciliata. Accepted upon such terms, the mouthless condition of these aberrant Infusoria may be consistently interpreted as representing the outcome of long subjection to that endoparasitic mode of existence which, among the normal Rhizopoda, Annelida, and Crustacea, has apparently in an equivalent manner produced the correspondingly mouthless groups of the Gregarinida, Cestoidea, and Rhizocephala. The isomorphic, or more correctly the homoplastic, external resemblance that subsists between many Opalinidæ and certain Cestoid worms or Entozoa, is truly remarkable, lending considerable weight to the opinion maintained by many earlier writers that these animalcules are not independent beings, but embryonic or larval conditions only of these higher Metazoa. The superficial resemblance cited is more especially manifested in connection with the structural modifications exhibited by the two genera *Haptophrya* and *Hoplitophrya*, in which, respectively, adhesive acetabula or corneous hooklets, similar to those of many higher Entozoa, are developed

anteriorly and in a like manner enable their possessors to effect a tenacious hold upon the intestinal walls of their selected hosts. A yet more remarkable peculiarity suggestive of affinities in this same direction is, however, exhibited by certain species of the genus *Anoplophrya*, in which, as exemplified most conspicuously in the type presently described under the title of *Anoplophrya prolifera*, multiplication is effected through the multiple segmentation of the posterior region of the body in a manner closely resembling what obtains in the characteristic "proglottid" condition of the tapeworms or Cestoidea.

A very marked diversity of internal structure subsists between the several generic forms of the present family group, all of which were formerly included in the single genus *Opalina*. Thus, while in *Opalina* proper, as here defined, no trace has yet been detected of the existence of a contractile vesicle, in the two generic forms *Anoplophrya* and *Hoplitophrya* such an organ exists not only in a multiple form, but more usually exhibits a regular serial plan of disposition, which may be regarded as pretypifying the extended canal-like development of this element that obtains in the allied genus *Hoplitophrya* and other higher Ciliata. The modifications observable in the development of the endoplast or nucleus among the generic members of the Opalinidæ are also very extensive. With the majority of species this structure is found to present a simple linear or band-like aspect, while in others it takes the form of one or two simple ovate bodies. The most abnormal formula of endoplastic development is, however, met with in the typical member of the genus *Opalina*, *O. ranarum*, originally supposed to be entirely destitute of any such structure, but in which, through the recent investigations more especially of Engelmann* and Ernst Zeller,† a perfect multitude of minute spheroidal endoplasts or nuclei, each with a contained endoplastule or nucleolus, are shown to exist. Such multinucleate infusorial forms are not inconsistently held by some authorities to possess a sound claim for acceptance as multicellular organisms, and while not eligible for admission into the ranks of the typical Metazoa, it would seem questionable whether they might not be appropriately relegated to such an intermediate zoologic series as the "Mesozoa," proposed by Ed. van Beneden for the reception of the singular endoparasitic genus *Dicyema* of Kölliker, and which is actually treated by Claparède and Lachmann, in their 'Études sur les Infusoires,' as a form most closely allied to the genus *Opalina*. It has been more recently shown by Van Beneden, however, that *Dicyema* is composed structurally of a central fusiform or subcylindrical axial cell around which is superimposed a single layer of smaller, flattened, peripheral or cortical cells, each possessing well-defined limits and a central nucleus, and having their external surface covered with long, fine, vibratile cilia. As already suggested at page 481 of the present volume, it would seem just possible that this long axial cell in *Dicyema* is represented or pretypified among the Opalinidæ by the abnormally developed axial element or so-called nucleus that is met with in the genera *Anoplophrya* and *Hoplitophrya*. The homoplastic resemblance subsisting between the multinucleate *Opalinæ* and the larval phases or "Planulæ" of the Cœlenterate sub-kingdom has been also referred to at page 480 of the present volume.

Taken in their entirety, the group of the Opalinidæ can by no means be regarded as representing the most lowly organized section of the Infusoria-Ciliata, as has been maintained by Stein and some other authorities, for while the oral aperture, by reason of the special surroundings, has either remained undeveloped or become entirely obliterated, other structural features equal or excel in complexity those encountered in any other infusorial types, and point indirectly, as just intimated, to a relationship beyond the pale of the Protozoa.

Through the *Dicyemida* and *Orthonectida*, a direct relationship would appear to be established between the Opalinidæ and Scolecida, but it yet remains to be determined by what ontogenetic process these several mouthless and essentially endoparasitic organic groups have been primarily produced. With many, the interpretation that they are retrograde offshoots only of the ordinary stomatode

* 'Morphologische Jahrbuch,' Bd. i. Heft. iv., 1876.
† 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xxix. Heft. iii., 1877.

Annelidous and Infusorial classes is deemed sufficient. An altogether distinct explanation, however, may be tentatively submitted for the consideration of those who are disposed to concede to them an independent origin. In this connection attention may be more especially directed to that correlation of an Opaline animalcule with an undeveloped Metazoic ovum that has been instituted at page 480, previously quoted. As an afterthought to such correlation, the author has been impressed with the idea that the Opalinidæ may actually have originated from the ova of the respective hosts which they are found inhabiting; these ova, failing the vital force requisite to carry them through the later segmentation phases and thence to the parent form, having yet possessed a sufficient store of such force to permit of their prolonged existence as independent beings able by the simple process of fission to reproduce their kind. The very facts of these remarkable organisms being without exception mouthless, and without exception endoparasitic, might be quoted as evidence in favour of this interpretation. The fact, again, that side by side with the mouthless *Opalinæ*, as found in the common frog, there subsists a ciliated Infusorium, *Nyctotherus*, possessing not only an oral but also a highly differentiated anal aperture, militates against the consistent acceptance of the former as degenerate scions of the ordinary Ciliate stock, and favours, on the other hand, the alternative of their independent derivation.

The several genera into which this family group has been recently subdivided by Professor Stein are readily distinguished by the characters afforded by the presence or absence of contractile vesicles and by the nature of the supplementary prehensile organs developed at the anterior extremity. The locomotive appendages, or cilia, in the group of the Opalinidæ, demand brief notice. Among the majority of the forms included, they are distinguished from those of the more ordinary Ciliata by their conspicuously matted or tufted aspect; this peculiarity is, nevertheless, shared by various other endoparasitic Infusoria, such as the genera *Conchophthirus*, *Balantidium*, and *Nyctotherus*, and doubtless fits them for locomotion in the denser fluid medium which they inhabit.

Genus I. OPALINA, Purkinge.

Animalcules mouthless, free-swimming, ovate or elongate; cuticular surface delicately striate; evenly ciliate throughout, furnished with no supplementary organs of prehension; endoplast spherical or ovate, single in the youngest individuals, usually breaking up by repeated segmentation, as growth proceeds, into innumerable minute, rounded, nucleolar bodies, having a clear peripheral zone and a central nucleolus or endoplastule; no contractile vesicle. Entirely endoparasitic.

In accordance with the results of the latest investigation of the members of this genus, as obtained by Ernst Zeller, the external surface of *Opalina* is not sufficiently indurated to form a distinct and continuous cuticle, being composed of numerous closely approximated, elastic, finely granular, muscular fibrillæ, which remain bound together during the life of the animalcule, but fall apart, as shown at Pl. XXVI. Fig. 20, on being treated with dilute acetic acid. It is the interstices or lines of juncture between these fibrillæ that impart to the *Opalinæ* their characteristic striated aspect. In the abnormal multiplication of the endoplast by duplication, as manifested in the adult zooids, the representatives of this genus differ not only from the remaining genera of the *Opalinidæ*, but from all ordinary Ciliata. The method of separation of each endoplastular fragment, as reported by Zeller, exhibits an additional peculiarity. The simply rounded form of the primitive single endoplast, under such conditions, is exchanged for a more or less elongate-ovate outline, and is eventually separated into two equal halves through a central constriction; the original, minute, central, granular, endoplastule-like body or nucleolus does not, however, take part in this division, but remains intact in one half of the divided endo-

plast, a new and independently developed endoplastule subsequently making its appearance in the other moiety. The members of the genus *Opalina* proper, as at present known, are parasites exclusively of the intestinal viscera of various tailed or tailless *Amphibia*.

Opalina ranarum, Purk.

PL. XXVI. FIGS. 1–9, AND 20, AND PL. XXXI. FIG. 19.

Body broadly ovate or elliptical, flattened, scarcely twice as long as broad, evenly rounded posteriorly, the anterior extremity bluntly pointed; the anterior half of the right-hand border projecting in a keel-like manner, the opposite one evenly arcuate; the cuticular surface finely striate throughout, the striation on the dorsal surface taking a rectilinear-oblique course, and on the ventral one an undulate or arcuate direction; endoplast single in the youngest animalcules, multiple in the adult zooids; parenchyma enclosing numerous minute, refringent, discoidal corpuscles; increasing by oblique or transverse fission. Length 1–45″ to 1–30″.

HAB.—Intestine and rectum of the common frog, *Rana temporaria*, and toads, *Bufo variabilis et cinereus*.

This, the largest and most widely known representative of the genus *Opalina*, while receiving its characteristic title from Purkinge and Valentin in the year 1835, was figured and described by J. A. E. Göze under the name of the "Flimmerwalzen" or "Flimmerquadrate" so long since as the year 1782. Through the recent investigations of Zeller we are now made familiar with the entire reproductive and developmental cycle of this form, and with the various modifications undergone by it in its onward growth from the embryo to the adult state. The minute cysts of this animalcule, Pl. XXVI. Fig. 6, were abundantly met with by Zeller in the rectum and excreta of *Rana temporaria* during the earlier months of the year, and on being placed in vessels with the tadpoles or frog-larvæ were abundantly devoured by the young amphibia during the inception of their customary food. Within the intestinal tract of their new host the wall of the cyst is ruptured, releasing the contained embryo. On first making its exit from its transparent capsule, Pl. XXVI. Fig. 7, the animalcule is of an ovate shape, slightly flattened, with a rounded and widest anterior end and pointed posterior extremity, the proportions being exactly the reverse of what is met with in the parent form. Centrally, the parenchyma encloses a single conspicuous spheroidal endoplast, and has, dispersed through its substance, an indefinite number of the characteristic discoidal refringent corpuscles. Within a short interval, Pl. XXVI. Fig. 8, the body assumes a more elongate shape, is curved anteriorly slightly towards the right, while the endoplast becomes divided into two or four equal spheroidal portions. As growth proceeds a still more attenuate shape is arrived at, the endoplast meanwhile multiplying within the parenchyma by progressive segmentations. In the most characteristic stage of its development the young *Opalina ranarum* presents an elongate-lanceolate contour, with a prominent keel-like anterior border that agrees closely with the normal adult state of *Opalina dimidiata* and *Opalina similis*, as delineated at Figs. 16 and 19 of the same plate. The length of the animalcule at this epoch of its existence is equal to four or five times that of its greatest breadth, but it now begins to diminish these proportions and to increase in width. Widening out until the length scarcely exceeds twice its breadth, the posterior extremity still retains its narrower and pointed outline, and the right anterior angle its projecting keel. In this stage its contour corresponds remarkably with that of the adult form of *Opalina obtrigona*, as illustrated by Pl. XXVI. Fig. 10. The posterior region of the body commences now to fill out, and becoming wider and more rounded than the anterior or apical extremity, the normal shape and size of the adult zooid, as represented by Pl. XXVI. Fig. 1, is ultimately attained.

The reproductive phenomena, and origin of the primary encysted bodies, as reported by Zeller, remain to be recorded. These, so far as it has been yet ascertained, are brought about by a process of repeated binary fission of the primary animalcule, agreeing in its earlier manifestations with that characteristic of the majority of the members of the Infusorial sub-kingdom, but which in its later phases follows a remarkably distinct plan. The subdivision of the adult zooids of *Opalina ranarum* is accomplished in a twofold manner, partly by oblique and partly by transverse fission. The first subdivision always takes an oblique direction, Pl. XXVI. Fig. 2, separating the animalcule into two halves, the foremost of which has a broader anterior and sharply-pointed posterior extremity, communicating to it a close resemblance in contour to the ordinary zooids of *Opalina obtrigona*, or to the half-grown examples of the present species, as already described. The hinder half remains bluntly rounded posteriorly, and differs but slightly in aspect from the adult form. The separated moieties continue multiplying by further fission alternately in an oblique and transverse direction, until at length the divided fragments do not exceed the 1–700th to 1–550th part of an inch in length. These, as delineated at Pl. XXVI. Fig. 5, have an evenly ovate outline, their movements gradually grow more languid, and in a little while they contract into a subspherical form, and secreting around them a transparent indurated membrane, become metamorphosed into cyst-like bodies, resembling those out of which the adult zooids had been observed to develop. The average diameter of these cysts varies from 1–1250″ to 1–1000″, though occasionally larger ones measuring 1–625″ were met with. The minutely divided *Opalinæ* were observed by Zeller at the time of their encystment to enclose within their parenchyma a variable number of the spheroidal endoplasts that characterize the parent zooid, though subsequent to their encystment an important metamorphosis of these structural elements was effected. So long as the spore-like cysts remained isolated in the outer water, as voided with the excreta of the adult frogs, no modification in the character or number of the contained endoplasts occurred, but on the cysts being devoured by the young frog-larvæ or tadpoles, these numerous endoplasts disappeared and were replaced by a single larger spheroidal one. It was with such a single endoplast that the zooid usually broke its way from its cyst into the intestinal tract of its new host, though occasionally the single endoplast did not take the place of the more numerous minute ones until a little while after its exit from the cyst. Whether the single larger endoplast is built up through the coalescence of the several smaller elements, or whether these latter entirely disappear prior to the appearance of the former, was not definitely ascertained, though the evidence elicited most strongly supports the last alternative. The growth onward from the minute newly released animalcule is but a recapitulation of the data already recorded. In addition to the multiplication by fission productive of animalcules of gradually diminished volume, and terminating in encystment, a simpler process of fission, corresponding with that of the more ordinary Infusoria, and producing zooids which grew again directly to the parent form, was found to take place later in the year, including more especially the months of August and September. A more abnormal elongate contour is not unfrequently presented by the animalcules of this species when first emerging from the most minute cysts. Sometimes both these and the smaller zooids resulting from the final phases of duplicative division, possess, as shown at Pl. XXVI. Fig. 9, an altogether ragged outline, indicative of the soft and glutinous consistence of the ectoplastic element.

In living examples of *Opalina ranarum* recently examined by the author when dissecting frogs at the South Kensington Laboratory, it was observed that the movements of the cilia during the progress of the animalcules over the smooth surface of the glass object-carrier, exhibited a very singular aspect—vibrating rhythmically in more or less even, parallel, wave-like series, and temporarily conveying the appearance, as shown at Pl. XXXII. Fig. 19, of their disposition in such order upon the surface of the cuticle.

Opalina dimidiata, Stein. Pl. XXVI. Figs. 16–18.

Body elongate, irregularly ovate, flattened, widest anteriorly, tapering and more or less pointed posteriorly, three or four times as long as broad; the right border of the anterior extremity produced outwards in a keel-like manner, the left border evenly arcuate throughout; striations of the cuticular surface straight and slightly oblique on the dorsal surface, arcuate on the ventral one, entirely clothed with long, fine, matted cilia; no contractile vesicle; endoplasts multiple, inconspicuous, first appearing in the young zooids as a single central spherical body, afterwards breaking up by repeated segmentation into innumerable smaller spherules, which become dispersed through the substance of the parenchyma; increasing by longitudinal and transverse fission. Length of adults, 1–75″ to 1–50″.

Hab.—Intestine and rectum of the Edible Frog, *Rana esculenta*, and *Bufo cinereus*.

This species, as pointed out by Zeller, is identical with the form figured and described by T. W. Engelmann* under the title of *Opalina ranarum*, but from which it differs essentially both in the more attenuate contour of the adult zooids and in the distinct hosts with which it is found associated. Overlooking this slight matter of mistaken specific identity, the credit must be awarded to Engelmann of contributing the earliest data of importance with reference to the structural and developmental history of the *Opalinæ*. Previous to his researches connected with the present species, the existence of an endoplast was entirely denied to the representatives of the genus; the development of the animalcules from the minute encysted bodies, as here described, was likewise unknown, while Zeller, taking as a basis and following up with advantage the results of Engelmann's investigations, has left but little to be added to our knowledge of their entire life-cycle. Engelmann's report of the developmental phenomena of this *Opalina dimidiata* may be thus summarized: On examining frogs in their larval or tadpole state, at a period when their bodies measured a little more than a quarter of an inch in length, their intestinal tracts were found to contain numerous spherical transparent cysts having a diameter of about the 1–2000th part of an English inch. The riper of these contained a small, elongate, ciliated body, curled upon itself and almost filling the cavity of the cyst. Numerous elongate ciliate bodies, identical with those contained in the cysts, were swimming freely in the surrounding fluid, presenting all the characteristics of typical *Opalinæ*, but of smaller size and much more attenuate proportions even than the adult examples. These free-swimming larval zooids, see Pl. XXVI. Fig. 18, are described as highly flexible, of elongate-lanceolate contour, with an attenuate and tail-like posterior extremity; the cuticular surface is finely striate longitudinally, and covered with a dense clothing of very fine cilia, which are often produced posteriorly as a brush-like tuft. In both the free-swimming and in the cyst-enclosed animalcules a single, central, spherical endoplast of considerable relative size was, while clearly visible under ordinary conditions, rendered still more conspicuous by the addition of dilute acetic acid. Investigating more matured specimens of the frogs' larvæ, it was found that *Opalinæ* of gradually increasing size and stouter proportions were contained within them, yielding at length examples in no ways distinguishable in either shape or size from the ordinary adult zooids of *Opalina dimidiatum*. Conjointly with this increase in the dimensions of the animalcules it was further found that the endoplast or nucleus presented a progressively compound character. Though single or simply spherical in the youngest individuals, it consisted of two similar spheroidal bodies in rather older ones; of four, eight, and sixteen such bodies in still further developed zooids; while in the full-grown and

* 'Morphologische Jahrbuch,' Bd. I. Heft 4, 1876.

perfectly matured representatives of the species, this primarily simple endoplast had resolved itself into innumerable spheroidal fragments.

Although demonstrating the existence and extensive distribution of the endoplastic system in this species, and the development of the adult forms from the minute encysted bodies, Engelmann has contributed nothing further towards its reproductive history, though he was inclined to infer that the minute encystments first observed were derived immediately from the ultimate spheroidal segmentations of the endoplast of the fully matured zooids. This hiatus in the developmental cycle of the type now under consideration has been successfully filled in by Zeller, who has shown that the fully grown animalcules break up by continuous fission in the manner already described of *Opalina ranarum*, the ultimate fragments forming similar encystments. A slight variation in this process of fission is exhibited by *O. dimidiatum*, the subdivision being accomplished alternately in a longitudinal and transverse direction instead of in an oblique and transverse one, as occurs in the preceding type. In the latter instance it frequently happens that the two separated portions are of very unequal dimensions, the posterior moiety being considerably the smaller. This unevenness of the calibre of the segmented moieties recurs, as presently shown, in a yet more conspicuous form among certain representatives of the allied genus *Anoplophrya*.

Opalina obtrigona, Stein. Pl. XXVI. Figs. 10 and 11.

Body flattened, subtriangular, about twice as long as broad; the anterior border considerably the widest, tapering thence gradually backwards towards the attenuately pointed posterior, the right margin convex, the left one concave; cuticular striations taking a rectilinear-oblique course on the dorsal surface, and an arcuate direction on the ventral one; endoplasts numerous, spheroidal, dispersed throughout the substance of the parenchyma; parenchyma enclosing also minute discoidal corpuscles; segmentation longitudinal and transverse. Length 1–50″ to 1–40″.

Hab.—Intestine of the Tree-Frog, *Hyla Europæa*.

The normal adult contour of this species closely resembles that of the half-grown condition of *Opalina ranarum*, and also the anterior zooid produced by the first act of fission of that type. The development of the ordinary zooids from cyst-like bodies resulting from the minute subdivision of the adult animalcules, as also the multiplication of the species by simple fission, has been observed by Zeller. The formation of cysts takes place in the spring months, April and May, when the frogs are spawning and lead a temporary aquatic life. Being then cast out with the ordinary excreta into the surrounding water they are there devoured by the young tadpoles, and begin anew their cycle of development.

Opalina intestinalis, Ehr. sp. Pl. XXVI. Fig. 19.

Body identical in form with *Opalina dimidiata*, but smaller in size, enclosing a single ovate endoplast only, or two such endoplasts situated toward the anterior extremity of the body, and united to one another by a thread-like commissure or funiculus; dividing by longitudinal and transverse fission. Length 1–100″ to 1–75″.

Hab.—Intestine of *Pelobates fuscus* and *Rana esculenta*.

This species, upon which Ehrenberg conferred the name of *Bursaria intestinalis*, represents one of the oldest known infusorial forms, it finding a place among the text and figures of Leeuwenhoek's 'Opera Omnia,' p. 49, fig. A, 1683, under the

title of 'Animalcula in stercore Ranarum.' By Stein it has been more recently referred to the next genus, *Anoplophrya*, but in the absence of all trace of the contractile vesicle, which forms so distinctive a feature of the members of that generic group, it appears desirable to retain it among the ordinary *Opalinæ*. Subdivision by longitudinal and transverse fission, and the production through this process of reproductive cysts, as in the previously described species, has been observed by Zeller, who has, however, without sufficient apparent cause, proposed to substitute for this form the title of *Opalina similis*.

Opalina caudata, Zeller. PL. XXVI. FIGS. 23 AND 24.

Body irregularly ovate, about twice as long as broad; the dorsal surface convex and inflated, the ventral one flattened; the posterior extremity produced as a short, conical, tail-like appendage; cuticular striæ obliquely directed, widely separated in comparison with those of the preceding species; endoplasts two in number, subcentral, united to each other by a sinuous thread-like commissure; dividing by longitudinal and transverse fission. Length 1–120″. HAB.—Intestine of *Bombinator igneus*.

The multiplication of this species through the minute subdivision and cyst-formation of the primary zooids, as in the four preceding types, was observed by Zeller to take place during the months of April, May, and June. A distinctive feature of this species, in addition to its characteristic contour, is afforded by the wide separation of the cuticular striations, and by the apparent density of the clear cuticular layer. In the possession of two connected endoplastic bodies this type agrees with the form last described. At the time of segmentation these two structures become isolated within the anteriorly and posteriorly separated moieties, but quickly double themselves again by redivision. Not unfrequently, the subdivision of the endoplasts precedes the segmentation of the animalcule's body, which is therefore for a while provided with four endoplastic structures.

GENUS II. ANOPLOPHRYA, Stein.

Animalcules mouthless, free-swimming, ovate or elongate, entirely ciliate; endoplast conspicuous, mostly band-like, and axial; contractile vesicle or vesicles well developed; possessing no supplementary organs of prehension. Occurring as parasites within the intestinal viscera of various Invertebrata.

Anoplophrya naidos, Duj. sp. PL. XXVI. FIG. 12.

Body variable in form, elongate-ovate or elliptical, considerably flattened, bluntly rounded at each extremity, the anterior one sometimes obliquely truncate, averaging from three, to four or five times as long as broad; cuticular surface longitudinally furrowed or striate, entirely ciliate; contractile vesicles numerous, usually disposed in a single line down one lateral border, occasionally forming a second line on the opposite side; endoplast axial, thick and band-like, coarsely granular, extending nearly the whole length of the body. Length 1–200″.

HAB.—Intestine of *Nais serpentina*.

The highly developed contractile vesicles of this species were not recognized by Dujardin when he first described it under the name of *Opalina naidos*, but have

been since successfully demonstrated by Professor E. Ray Lankester.* As intimated by this last-named authority, a satisfactory exhibition of these structures in their natural condition is best attained by examining the creatures immersed within the intestinal fluids of the host they infest. Placed in pure water the pulsating action is at once suspended, while by the process of endosmosis their form and character becomes entirely metamorphosed. A species apparently identical with the present one, but of much larger size, 1–50″, was obtained by Professor Lankester from a species of *Lumbriculus;* no less than thirty contractile vesicles were observed in some of the larger examples of this variety.

Anoplophrya nodulata, Müller sp.

Body elongate-ovate or elliptical, usually somewhat widest anteriorly; cuticular surface longitudinally striate; entirely and finely ciliate; endoplast axial, band-like; contractile vesicles numerous, forming a linear series on each side of the band-like endoplast. Length 1–200″.

HAB.—Marine, within the intestine of *Nais littoralis.*

This species, more generally known by the name of *Opalina lineata*, conferred upon it by Max Schultze,† is undoubtedly identical with the type inhabiting the same host figured and described by O. F. Müller, 'Zoologia Danica,' 1788, under the title of *Leucophrya nodulata.* This earlier investigator has not only clearly indicated in his drawings, *loc. cit.* Taf. lxxx. figs. *a–i*, the respective contours and plan of disposition of the central endoplast and double line of contractile vesicles, but also attests to the manner of multiplication through the separating-off of a small nodular segment only of the posterior region of the body. Sometimes two imperfectly separated segments are recorded as remaining consentaneously attached to the primary zooid, such reproductive phenomenon preparing the way for the very remarkable modification of the process that obtains in the species next described.

Anoplophrya prolifera, C. & L. sp. PL. XXVI. FIG. 14.

Body elongate-linear, widest anteriorly; cilia of cuticular surface disposed in longitudinal lines in correspondence with the superficial longitudinal striations; endoplast axial, elongate, subcylindrical; contractile vesicles numerous, disposed in two longitudinal rows, one on each side of the central endoplast; increasing by multiple transverse segmentation of the posterior body-half. Length 1–70″.

HAB.—Within the intestinal cavity of various marine Annelids, Norwegian coast.

This species, described by Claparède and Lachmann under the title of *Opalina prolifera*, is acknowledged by them to so closely resemble the *O. lineata* of Schulze (Müller's *Leucophrya nodulata*) as to be possibly identical with that type. A most remarkable feature of this form, however, and one which seemed to justify its description by Claparède and Lachmann as a distinct form, is connected with its mode of increase. This is effected by multiple instead of by simple transverse fission, the posterior portion being often, as shown in the accompanying figure, divided into as many as five nodular segments, each of which becomes consecutively separated off to form an independent zooid. This singular mode of multiplication, while occurring in no other known member of the Infusorial class, is highly characteristic of what obtains among certain lower Annelida, such as *Syllis* or *Nais*,

* 'Quarterly Journal of Microscopical Science,' p. 143, 1870.
† 'Beiträge zur Naturgeschichte der Turbellarien,' Greifswalde, 1851.

and is still more suggestive of the strobiloid mode of reproduction presented by *Tænia* and other Cestoidea. The Rhabdocœlous Turbellarian genus *Catenula*, again, so called from the chain-like aggregate of imperfectly separated zooids distinctive of its normal growth-form, may be cited as yielding yet another appropriate simile. To the advocates of the lower Annelidan affinities of the *Opalinæ*, this interesting species would seem to offer special inducements for further investigation.

Anoplophrya mytili, Quenn. sp. PL. XXVI. FIGS. 26 AND 27.

Body ovate, rounded at both extremities, slightly narrower posteriorly; about one and a half times as long as broad; flattened and meniscoidal in lateral view; contractile vesicle single, posteriorly located; endoplast elongate-ovate, subcentral; entire cuticular surface covered with long, fine, tufted cilia. Length 1–400″.

HAB.—Marine, occurring as a parasite of the common mussel.

Figured and described by A. Quennerstedt* under the title of *Opalina mytili*.

Anoplophrya inermis, Stein.

Size and contour agreeing with that of *Hoplitophrya secans*, but without the ventral horny band. HAB.—Intestine of *Clepsine binoculata*.

Anoplophrya striata, Duj. sp.

Body elongate-ovate or elliptical, rounded at each extremity, about twice as long as broad; endoplast band-like, extending axially through nearly the whole length of the body; contractile vesicles numerous, disposed in somewhat uneven lines on each side of the axial endoplast. Length 1–170″.

HAB.—Intestinal cavity of the common earth-worm.

This species, while figured and described by Stein under the title of *Opalina lumbrici*, is identified by him with the form that previously received from Dujardin the name of *Leucophrys striata*, and should undoubtedly retain the prior specific designation. The *Leucophrys nodulata* of Dujardin does not agree with Müller's type bearing that name, but represents an altered condition only of the species now under notice. Excepting for the absence of the horny armature this animalcule corresponds in size and aspect with *Hoplitophrya armata;* the habitat being likewise identical, it is not improbable, as suggested by Stein, that it is an imperfectly developed phase of that form.

Anoplophrya branchiarum, Stein.

Body shortly cylindrical, equally rounded at the two extremities, about one and a half times as long as broad; endoplast band-like, axial, extending throughout the body; contractile vesicles numerous, minute; increasing by transverse fission. Length 1–216″

HAB.—Occurring as an endoparasite of the fresh-water shrimp, *Gammarus pulex*.

This species, first described by Stein in the year 1852,† occurs in swarms within the branchial appendages of the Amphipodous Crustacean above named, its frequent

* 'Sveriges Infusoriefauna,' 1867.

† 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. iii.

companions as ectoparasites of the same host being *Spirochona gemmipara*, *Lagenophrys ampulla*, and *L. nassa*, and the remarkable Acinete type *Dendrocometes paradoxus*.

Anoplophrya clavata, Leidy sp. PL. XXVI. FIG. 21.

Body clavate, about five times as long as broad, obliquely and concavely truncate anteriorly, the front margin often expanded and hatchet-shaped, the posterior region attenuate, rounded, or acuminate; cuticular surface longitudinally striate; parenchyma granulate, colourless; endoplast not observed; an even row of six or eight spherical contractile vesicles disposed along the longer or dorsal border. Length 1–200″ to 1–100″.

HAB.—The visceral cavity of *Lumbriculus limosus*.

This species, originally described by Professor Leidy as *Leucophrys clavata*, is apparently referable to the present genus. Multiplication by even transverse fission was frequently observed. The characteristic anterior truncation is not conspicuous in the posteriorly produced zooid until some time subsequent to its separation from the anterior moiety.

Anoplophrya cochleariformis, Leidy sp. PL. XXVI. FIG. 25.

Body elongate, curved, somewhat variable in form; the anterior half or third ovate and inflated, the posterior portion narrow and subcylindrical, gradually tapering to its extremity, but sometimes exhibiting a secondary smaller terminal inflation; contractile vesicles six or seven in number, forming a row along the margin of the narrower posterior region; endoplast broadly ovate, filling the larger portion of the inflated anterior segment. Length 1–175″ to 1–130″.

HAB.—Intestinal cavity of *Lumbriculus tenuis*.

This species was originally described by Professor Leidy * under the name of *Leucophrys cochleariformis*. The contractile vesicles and endoplast, although not mentioned in his brief description, are clearly indicated in his accompanying drawings.

Anoplophrya (?) socialis, Leidy sp.

Body highly contractile and variable in form, ovate, cordate, fusiform, or globular; cuticular surface longitudinally striate, entirely ciliate; enclosing numerous internal vacuoles. Length 1–75″ to 1–100″.

HAB.—Intestinal tract of the American fresh-water Polyzoon, *Urnatella gracilis*, Leidy.

This animalcule, likewise briefly described by Professor Leidy as a species of *Leucophrys*, apparently belongs to the present generic group.

Anoplophrya vermicularis, Leidy sp.

Body subcylindrical, eight or ten times as long as broad, slightly tapering or subacute posteriorly; the anterior end rounded and flattened; cuticular surface striate longitudinally, shortly and finely ciliate; parenchyma white, finely granular; contractile vesicles numerous, twenty to thirty in

* 'Journal Academy Natural Science Philadelphia,' ser. ii. vol. iii., 1855.

number, forming usually a single but sometimes a double longitudinal series; endoplast band-like, axial; nearly as long as the body. Length 1–60″.

HAB.—Rectum and intestine of the fresh-water snail, *Paludina decisa*.

Professor Leidy, in describing this species * also as a species of *Leucophrys*, remarks that it is often so abundantly developed in its selected host as to completely distend that portion of the intestine occupied, resembling in their crowded condition a mass of writhing worms. Besides swimming with the aid of its cilia the species is capable of effecting progress after the manner of a worm by the contortions of its body, which may be flexed into a sigmoid contour or be even doubled upon itself. The endoplast, while scarcely perceptible in the fresh condition, becomes clearly delineated as the animalcules approach dissolution.

Anoplophrya convexa, Clap. sp.

Body oval, meniscoidal, obtusely rounded at each extremity, about one and a half times as long as broad; cuticular surface finely striate longitudinally; contractile vesicles very large, varying in number from four to six, forming a unilateral row; endoplast axial, about half the length of the body. Length 1–178″.

HAB.—Marine, within a species of *Phyllodoce*, separate from that infested by *Anoplophrya ovata*. Multiplication by fission or segmentation not observed.

This and the three succeeding species are not included by Claparède and Lachman in their larger work 'Études sur les Infusoires,' but are described by Claparède only, in his 'Recherches sur les Annélides Turbellariés observés dans les Hébrides,' published at Geneva in the year 1860. All four are there referred to the typical genus *Opalina*.

Anoplophrya ovata, Clap. sp.

Body ovate, equally rounded at each extremity, not quite twice as long as broad; cuticular surface longitudinally striate; contractile vesicles spherical, five or six in number, forming a single lateral row; endoplast axial, elongate, about one-half the length of the body. Length 1–200″.

HAB.—Marine, within a species of *Phyllodoce*. Multiplying abundantly by segmentation of the posterior region, the endoplast taking its share in the division.

Anoplophrya filum, Clap. sp. PL. XXVI. FIG. 13.

Body ribbon-like, flattened, long and slender, about twelve times as long as broad; cuticular surface finely ciliate throughout, the cilia at the posterior extremity slightly longer, forming a somewhat brush-like tuft; cuticular surface granular, not conspicuously striate; contractile vesicles minute, numerous, about twenty in number, forming a single subcentral row; endoplast not observed; increasing, as in *Anoplophrya lineata* and *A. prolifera*, by posterior segmentation. Length 1–65″.

HAB.—Marine, within the alimentary canal of *Clitellio arenarius*.

* 'Proc. Acad. Nat. Sci. Philadelphia,' 1877, p. 259.

Anoplophrya pachydrili, Clap. sp.

Body irregularly ovate or subpyriform; widest and truncate posteriorly, pointed and narrowest anteriorly; two or three contractile vesicles forming a row on each lateral border; endoplast not observed. Length 1–350″.

HAB.—Marine, within the intestine of *Pachydrilus verrucosus*.

GENUS III. HAPTOPHRYA, Stein.

Animalcule mouthless, ovate or elongate, the anterior extremity modified so as to form an adhesive sucking-disc; the remaining cuticular surface ciliate; contractile vesicle and endoplast conspicuous, the former mostly canalicular. Entirely endoparasitic.

Stein, in his original subdivision of the somewhat heterogeneous assemblage of animalcules previously referred to the single genus *Opalina*, into four groups of corresponding taxonomic value, proposed to distinguish those characterized by the possession of an adhesive acetabulum by the title of *Discophrya*. This generic name he introduces in his essay relating to the subdivision of the Holotrichous Infusoria contributed to the 'Sitzungsberichte der königl. böhmischen Gesellschaft der Wissenschaften' for the year 1860, and uses also in his sketch of the Holotrichous order contained in vol. ii. of his 'Organismus der Infusionsthiere,' published in the year 1867. In his final classification table of the Ciliata, reproduced at p. 210* of vol. i., he, however, without any explanation, substitutes in its place that of *Haptophrya*. This name, having been since adopted by other Continental authorities, is accordingly preferentially adhered to in the present treatise. A distinctive feature of the genus, shared also by some few members of the armed *Hoplitophryæ*, is connected with the contractile vesicular system. 'In the previous genus *Anoplophrya*, this is generally found to take the form of one or two linear series of independently pulsating spheroidal vacuoles, while in the present one, *Haptophrya*, it—in all species so far known—consists of a single canal-like reservoir that is produced throughout the greater extent of the creature's body. Under abnormal conditions, such as the transfer of the animalcules to pure water, it has been shown by Ray Lankester, in the case of *Anoplophrya naidos*, that two or more of the normal spheroidal vesicles may run together, producing a more or less extensive canal-like lacuna. There can, therefore, be but little doubt that the characteristic canal-like contractile vesicle of *Haptophrya* represents a more highly differentiated modification of the linear series met with in the preceding genus.

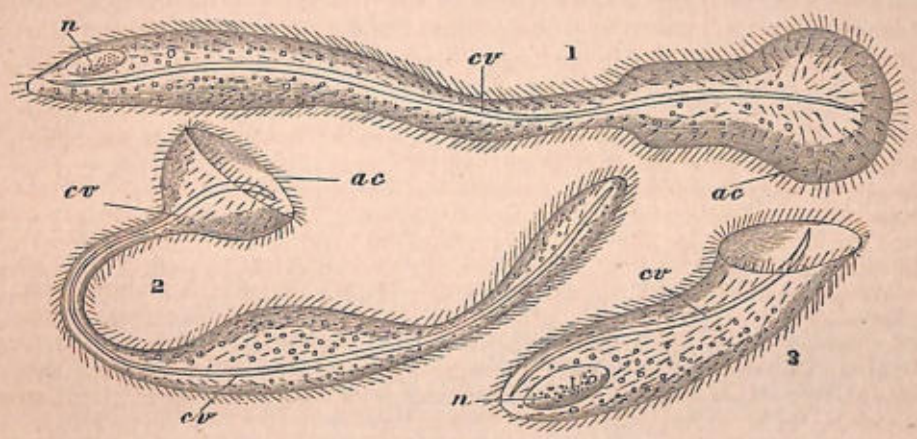
Haptophrya planariarum, Siebold sp. Woodcut, p. 569.

Body wedge-shaped or subcylindrical, about six or seven times as long as broad; rounded and widest anteriorly; the posterior extremity pointed; the anterior region bearing a semicircular adhesive disc, the central portion of which is apparently naked, while its outer margin is provided with a fringe of cilia of larger size than those which clothe the remaining cuticular surface; contractile vesicle canal-like, extending nearly the whole length of the body; endoplast elongate-ovate, granular. Length of body 1–36″.

HAB.—Intestinal cavity of various Planarians, including more especially *Planaria torva*.

* By accident, the two generic names *Hoplitophrya* and *Haptophrya* have in this table been misspelt *Hoplophrya* and *Haplophrya*.—ED.

This form, selected by Stein as the type of his new genus *Haptophrya* (*Discophrya*), is identical with the *Opalina planariarum* of Siebold and the *Opalina polymorpha* of Max Schultze. In the original illustrations of this species given by the last-named authority,* and reproduced in the accompanying woodcut, the acetabuliform organ, as delineated most distinctly at Fig. 2, forms a complete circle and is not bordered with cilia of conspicuously larger size than those which clothe the general cuticular surface. The body is also seen, from Figs. 1 and 2, to exhibit in its fully developed state a remarkable disparity of size in different regions, the part succeeding the anterior disc-like organ being much strangulated and neck-like. The endoplast is represented as a small, granular, ovate body, located close to the posterior extremity.



Haptophrya planariarum, Siebold sp.—1 and 2. Adult, fully extended animalcules in dorsal and lateral aspect. 3. Undeveloped zooid; *n*, endoplast or nucleus; *c*, canal-like contractile vesicle; *ac*, acetabulum. × 250. (After Max Schultze.)

Haptophrya gigantea, Maupas. PL. XXXII. FIGS. 14 AND 15.

Body elongate, cylindro-conical or wedge-shaped, tapering from the front backwards, a little over twice as long as broad; the anterior extremity depressed, about twice the breadth of the posterior region, provided with a circular adhesive disc; the ectoplasmic layer or cuticle longitudinally striate, but non-contractile, thickly clothed with fine, short, vibratile cilia, which are disposed in close-set longitudinal rows; cilia of somewhat larger size bordering the inner margin of the adhesive disc; contractile vesicle canal-like, irregularly sinuous, extending from the adhesive disc to the posterior extremity of the body; endoplast elongate ovate or ellipsoidal, freely movable within the internal parenchyma or endoplasm. Length 1-25″. Increasing by multiple transverse segmentation.

HAB.—Intestine of *Bufo pantherinus* and *Discoglossus pictus*, Algiers.

This fine Opalinid, first discovered and described by M. E. Maupas † in connection with the two above-named Batrachians obtained from Algiers, has been found more recently by M. A. Certes ‡ inhabiting examples of *Bufo pantherinus*, derived from the neighbourhood of Constantine. Through the independent investigations of these

* 'Ein Beitrag zur Naturgeschichte der Turbellarien,' Greifswalde, 1851.
† 'Comptes Rendus,' lxxxviii. p. 921, 1879.
‡ 'Bulletin de la Société Zoologique de France,' tom. iv., 1880.

two authorities, a tolerably exhaustive knowledge of its structure and developmental history has been arrived at. Some of the more important data thus placed on record are herewith epitomized. Maupas, in his account of the circular sucker occupying the depressed portion of the anterior extremity, and other details, states that the first-named structure is formed by the retreat inwards of the wall of that broader surface, which may be denominated the ventral one. The action of the sucker is compassed by cords of sarcode which, starting from its inner wall, are attached to the opposite or dorsal body-wall. The surface of the body is clothed with very close rows of cilia. Four or five rows may be counted within the space of ·01 mm. (1–2500″ Eng.), and in the concavity of the sucker they are half as numerous again. The cilia are set very closely together—about thirteen or fourteen in ·01 mm. They form the only organs of locomotion, the progress of the animalcule being never very rapid. The cuticle or ectoplasmic layer is composed of two distinct elements, the one external, in which the prolongation of the cilia in the form of bacilli may be traced, while the inner one is composed of transparent and apparently absolutely amorphous sarcode. The cuticle is entirely destitute of contractility, the animalcule consequently being unable to alter its form spontaneously. It is at the same time highly flexible and elastic, allowing the body to become bent and to immediately regain its normal contour on and after contact with external objects. The central endoplasm is composed of clear liquid sarcode, having a peripheral layer of large opaque granules. The nucleus or endoplast is free in the general cavity of the body, and is shifted with the movements of the body from one extremity to the other. If a fresh endoplast, through rupture of the body, is brought in direct contact with the water, its substance contracts, leaving, as in many other Infusoria, a fine, amorphous, superficial membrane. The sinuous, canal-like, contractile vesicle, according to Maupas, is provided with distinct walls—a feature which, if correctly recorded, distinguishes it from the structure bearing the same name found in any other Infusorium—and communicates with the outer water by means of seven or eight lineally disposed, clearly visible oval pores. The species propagates by multiple transverse segmentation. The first stage of the reproductive process is accomplished through the appearance of a clear band across the centre of the body. The endoplast, now occupying a central position, and also the contractile vesicle, divides in two, and a constriction, following the course of the clear band, separates the body into two equal halves, which nevertheless remain organically united. This operation is repeated first across the centre of each previously segmented moiety, producing four equal-sized segments or quarters, and then again across the middle of each of these four new subdivisions, thus producing an aggregate of eight equal-sized segments, which ultimately become detached from each other, after the manner of the proglottids or zoonites of a Cestoid worm. Phenomena closely coinciding with these just recorded of *Haptophrya gigantea* have been already related of *Anoplophrya prolifera*. In this last instance, however, it is only the posterior half of the body which undergoes multiple segmentation.

M. Certes' later investigations, while generally confirming the account given by M. Maupas, have elicited some additional points of interest. It is more especially noteworthy that he declares the anterior sucker-like organ to be, if not a true mouth, at least an organ *sui generis*, wherein the first acts of nutrition are localized. The thickness of the external cuticle added to the clear layer which separates it from the internal body-mass, he considers sufficient to preclude all possibility of the phenomenon of endosmosis, though, on the other hand, he is inclined to believe that the imbibition of fluid nutriment may take place through the thinner walls of the adhesive disc. Upon these grounds M. Certes regards *Haptophrya gigantea* as supplying a bond of union between the more typical entirely mouthless Opalinidæ and the ordinary stomatode Ciliata.

Supplementary Species.

An animalcule closely resembling *Haptophrya gigantea* in external contour was obtained by M. R. Blanchard, in the year 1878, from the intestine of an Alpine Triton. On examining preserved examples, M. Certes reports that they differ from

the first-named species in the contour of the sucker, which is horseshoe-shaped, or presents the aspect merely of an oval depression armed with very strong cilia. The cuticular surface is further destitute of the longitudinal striations that form so conspicuous a feature in *H. gigantea*. The title of *Haptophrya tritonis* is proposed by M. Certes for the distinction of this apparent new species.

The animalcule described by Dr. E. Evarts * under the name of *Opalina discoglossi*, and obtained by him at Naples from the intestine of *Discoglossus pictus*, is evidently referable to the genus *Haptophrya*. While differing somewhat in general form from *H. gigantea*, it agrees with that species in size, in its possession of a sucking-disc, single endoplast, and canal-like contractile vesicle, as also in the phenomena of reproduction.

GENUS IV. HOPLITOPHRYA, Stein.

Animalcules mouthless, ovate or elongate, entirely ciliate, developing on the ventral surface, towards the anterior extremity, a corneous, keel-like band or one or more horny hooks, by which they are enabled to attach themselves to the intestinal wall of their selected host; endoplast and contractile vesicle conspicuously developed. Entirely endoparasitic.

Hoplitophrya lumbrici, Duj. sp. PL. XXVI. FIG. 15.

Body elongate-ovate, somewhat flattened; armature consisting of a single bifid, horny hook, which is developed on the ventral surface near the anterior extremity; endoplast band-like, axial, extending through nearly the entire length of the body; contractile vesicles numerous, spherical, forming an irregular line along each lateral border. Length 1–144″ to 1–108″. Dividing by sub-even transverse fission.

HAB.—Intestine of the common earth-worm, *Lumbricus terrestris*.

Stein has proposed to confer upon this animalcule the title of *Hoplitophrya armata*, but since he himself acknowledges its identity with the previously described *Opalina lumbrici* of Dujardin, it is desirable that the earlier applied specific name should be retained. It would, as suggested by Stein, seem to be by no means improbable that the *Anoplophrya* (*Leucophrys*) *striata* of Dujardin, tenanting the same host, represents an immature condition only of the present type.

Hoplitophrya uncinata, Schultze sp.

Body ovoid, ventral uncini two in number of unequal length, developed one on each side of the median line, towards the anterior extremity of the body; contractile vesicle elongate, canal-like; endoplast band-like, axial. Length 1–120″. Inhabiting various marine Planarians.

According to Max Schultze this animalcule, first described by him under the title of *Opalina uncinata*, inhabits only *Planaria ulvæ*: it has more recently, however, been found by Claparède and Lachmann abundantly infesting a member of the genus *Proceros*.

Hoplitophrya falcifera, Stein.

Body slightly flattened, sometimes shortly ovate, sometimes triangular, widest posteriorly, the length rarely exceeding the greatest breadth;

* 'Tijds. nederl. dierk. Vereeniging,' Bd. iv., 1879.

prehensile apparatus corneous, hammer-shaped, somewhat resembling that of *H. armata*, but eccentric, and situated towards the right lateral border of the ventral surface; the stem or shaft of this hammer-like structure fastened to the cuticula in a line parallel with the adjoining margin; its thickened anterior end produced outwards and at right angles as a stout, recurved, pointed hook, a second slender, horny prolongation, which is recurved and continued down and parallel with the left-hand border, being fastened to it, produced from the same thickened distal extremity of the handle-like portion; the cuticular interspace between the stem of the hook and the adherent recurved prolongation obliquely furrowed from the front and right towards the posterior and left, these furrows further continued as fine longitudinal striæ over the remaining dorsal and ventral cuticular surfaces; a row of contractile vesicles developed along both the right and left-hand borders; endoplast almost as long as the body, cord-like, disposed longitudinally towards the right body-half, its anterior end curved more or less towards the left; on the right side, a little behind the centre of the endoplast, is attached a small oval endoplastule. Length 1–240″.

HAB.—Intestinal tract of *Lumbricus anatomicus*.

As many as fifteen examples of this animalcule were found by Stein * in company with several specimens of *Anoplophrya striata*, his *A. lumbrici*, within a single specimen of the above-named annelid; the occurrence of an exteriorly developed endoplastule or nucleolus has not so far been recorded in connection with any other member of the Opalinidæ.

Hoplitophrya pungens, Stein.

Body elongate-clavate, somewhat flattened, widest anteriorly; a transversely placed, arcuate, or obtusely-angled horny band, the centre of which is produced forward as a slightly projecting spine, developed immediately behind the centre of the anterior border; endoplast band-like, longitudinally placed; contractile vesicles numerous, arranged lineally along the right and left borders of the body. Dimensions unrecorded. Multiplication as in *H. secans*.

HAB.—Intestinal tract of *Sænuris variegata*.

Hoplitophrya secans, Stein.

Body elongate, band-like, slightly widest and rounded anteriorly, a horny keel-like band, widest in front and tapering posteriorly, developed on the ventral surface from the anterior end backwards to the median line; contractile vesicles numerous, located close to one another along the centre of the dorsal line; endoplast cord-like, axial, thicker than in *H. securiformis*. Dimensions unrecorded.

HAB.—Intestinal canal of *Lumbriculus variegatus*, and *Enchytræus vermicularis*.

When multiplying by transverse fission this species does not divide into two equal portions, but through the constriction and subsequent separation off of small

* 'Sitzungsberichte d. königl. Böhmischen Ges. d. Wiss.,' 1861.

fragments of the posterior region of the body; as in many *Anoplophryæ*, the hinder of the two zooids may be four or five times smaller than the anterior one and resembles at first sight a bud-development from the same.

Hoplitophrya securiformis, Stein.

Body small, elongate-ovate, flattened and widest anteriorly; the front margin obliquely truncate, often curved to one side and hatchet-shaped; the anterior region of the ventral surface bearing a slender horny band, which is bent abruptly posteriorly and extends backwards to the centre of the right-hand margin; contractile vesicles four or five in number, disposed in a line along the left-hand border; endoplast slender and cord-like, nearly equalling the body in length. Dimensions unrecorded, but smaller than *H. secans*.

HAB.—Intestinal tract of *Lumbriculus variegatus*.

Hoplitophrya recurva, Clap. & Lach. sp. PL. XXVI. FIG. 22.

Body elongate-ovate, rounded and widest posteriorly; the anterior extremity pointed, curved to one side, its ventral face bearing a single corneous uncinus; contractile vesicle elongate, sinuous, extending nearly the entire length of the body; endoplast ovate, posteriorly situated. Length 1–125″.

HAB.—Marine, within the intestinal cavity of *Planaria limacina*: Norwegian coast.

As many as thirty or forty zooids of this species were observed by Claparède and Lachmann tenanting a single example of the above-named marine Planarian. It was originally described by these authorities under the name of *Opalina recurva*.

Addendum to Opalinidæ.

The organisms described by Claparède under the name of *Pachydermon acuminatum*, found in company with *Anoplophrya* within the seminal receptacles of *Clitellio arenarius*, and supposed to most closely resemble Opalinidæ with a distinct and thickened cortical layer, are determined by Professor E. Ray Lankester* to be rope-like aggregations of seminal cells.

Order II. HETEROTRICHA, Stein.

Animalcules free-swimming or attached, naked or loricate, entirely ciliate; cilia forming two widely distinct systems, those of the general cuticular surface short and fine, those pertaining to the oral region of much larger size, cirrose, and constituting a linear or more or less spiral or circular adoral or peristomal series; the cortical layer usually highly differentiated, and enclosing an even, parallel series of longitudinally disposed muscular fibrillæ.

* "Remarks on Opalina," 'Quarterly Microscopical Journal,' 1870.

The order of the Heterotricha includes by far the largest known representatives of the Infusoria, many of its members being not only individually visible to the unaided eye, but in certain cases, as in the genera *Stentor* and *Spirostomum*, attaining a magnitude in their extended state ranging from the one-twentieth to as much as the one-twelfth, or even the one-sixth of an English inch. Although the large comparative size of the adoral cilia or cirri and presence of conspicuously developed muscular fibrillæ in the cortical layer serve to distinguish the members of this order from the more ordinary representatives of the Holotricha, the two groups are separated from each other by but a narrow line of demarcation. In a number of the animalcules referred to the Holotrichous group even by Stein himself the adoral cilia are of considerably larger calibre than those of the general cuticular surface; while in many of these again, including notably the Opalinidæ, the cortical layer presents a closely parallel fibrillate structure. The Holotrichous genera *Panophrys*, *Cyclotricha*, *Lembus*, and *Pleuronema* have been already referred to as most completely bridging over these two orders. Although including in the Heterotricha all those genera which were originally relegated to it by Stein, it has been considered desirable in this volume to add to them *Tintinnus* and its allies, hitherto placed by that authority with the Peritricha, but from which they must necessarily be disassociated on account of the ciliation of their cuticular surface. Upon corresponding grounds also the generic types *Trichodinopsis*, *Calceolus*, and *Codonella* demand a similar position among the Heterotricha, each of these, however, differing so essentially among themselves as to necessitate the institution of separate family groups for their reception. Taken as a whole, the various generic groups from *Tintinnus* onwards in the accompanying tabular view may be said to indicate the line of deviation from the Heterotricha towards the more highly organized order of the Peritricha, from certain of which, excepting for the presence of cilia on the general cuticular surface, they are scarcely to be distinguished. In addition to the affinities of the Heterotricha with the two groups of the Holotricha and Peritricha, just indicated, it will be found that types are not wanting to bring them in close relationship with the remaining order of the Hypotricha also. This affinity is more especially marked in the genus *Condylostoma* and its allies, in which, as pointed out by Stein, the peristome-field and adoral fringe of cilia are scarcely distinguishable from what obtains among the typical Hypotricha, as represented by the genus *Oxytricha*.

An analytical key to the families and genera of the Order Heterotricha is herewith subjoined.

Fam. I. BURSARIADÆ, Stein.

Animalcules free-swimming, persistent in shape, more or less oval, often considerably flattened; peristome-field excavate, extending obliquely backwards from the frontal border, widest anteriorly, the oral aperture situated in the posterior and narrowest confines of this region, frequently followed by a well-developed pharyngeal passage; larger adoral cilia developed in a straight or oblique line on the left-hand margin of the peristome only, not encircling the mouth in a spiral manner; anal aperture posteriorly situated; no undulating membrane.

Genus I. BURSARIA, Müller.

Animalcules free-swimming, broadly ovate, somewhat flattened on one side, anteriorly truncate; peristome-field pocket-shaped, deeply excavate, situated obliquely on the anterior half of the body, having a broad oral fossa in front, and a cleft-like lateral fissure, which extends from the left corner

FAMILIES AND GENERA OF CILIATA-HETEROTRICHA.

	Family.			Genus.
A. Oral cilia forming a simple, straight, or oblique adoral fringe.	I. BURSARIADÆ. Animalcules free-swimming, adoral cilia confined to the left border of the peristome, not enclosing the mouth in a spiral manner; no undulating membrane.	Peristome-field excavate, confined chiefly to the right side of the body, rarely median.	Peristome-field enclosing the anterior border.	Peristome and oral fossa pocket-shaped, pharynx fully developed	1. *Bursaria.*
				Oral fossa cleft-like, pharynx rudimentary or absent	2. *Balantidium.*
			Peristome-field originating at some distance from the anterior border.	Peristome straight, linear, restricted to the right-hand border	3. *Nyctotherus.*
				Peristome oblique, extending backwards from the left towards the right-hand border. — No caudal setæ.	4. *Metopus.*
				Peristome oblique, extending backwards from the left towards the right-hand border. — With caudal setæ.	5. *Metopides.*
		Peristome-field not excavate, occupying the left side of the body			6. *Plagiotoma.*
B. Oral cilia describing a spiral or circular course around the oral aperture.	II. SPIROSTOMIDÆ. Animalcules free-swimming, peristome and adoral fringe confined to the ventral surface; anal aperture postero-terminal.	Peristome supplemented by an undulating membrane.		Undulating membrane extending along the entire right-hand border of the peristome	7. *Condylostoma.*
				Undulating membrane confined to the posterior region of the peristome	8. *Blepharisma.*
		No undulating membrane.		Peristome elongate, linear	9. *Spirostomum.*
				Peristome short, broad, harp-shaped	10. *Leucophrys.*
	III. STENTORIDÆ. Animalcules permanently or temporarily adherent; peristome and adoral cilia enclosing the entire funnel-shaped or variously expanded frontal border.	Peristome-field		Subcircular or infundibulate	11. *Stentor.*
				Divided into two lappet-like moieties	12. *Folliculina.*
				Forming a simple, twisted, ligulate extension	13. *Chætospira.*
	IV. TINTINNODÆ. Animalcules ovate or pyriform, adoral cilia surrounding the anterior extremity in a simply circular manner.	Animalcules loricate.	Animalcules adherent to lorica by retractile pedicle.	Lorica floating freely in the water	14. *Tintinnus.*
				Lorica attached to submerged objects	15. *Tintinnidium.*
			Animalcules without pedicle, freely motile		16. *Vasicola.*
		Animalcules illoricate, free-swimming			17. *Strombidinopsis.*
	V. TRICHODINOPSIDÆ. Animalcules illoricate, free-swimming, the proximal end adhesive, acetabuliform.	Acetabulum strengthened by a non-denticulate, horny ring			18. *Trichodinopsis.*
	VI. CODONELLIDÆ. Animalcules loricate, free-swimming, oral cilia forming two circlets, those of the outer circle attenuate, tentaculiform.	Cilia of the inner circlet spathulate or lappet-like			19. *Codonella.*
		Cilia of the inner circlet simple, cirrose			20. *Tintinnopsis.*
	VII. CALCEOLIDÆ. Animalcules free-swimming, pyriform, with one or more annular grooves and corresponding girdles of larger cirrose cilia; oral aperture ventral.	Body encircled by two annular grooves, the anterior one only bearing long cirrose cilia, oral aperture opening on ventral surface of the posterior groove			21. *Calceolus.*

of the contour border to the middle of the ventral side; no tremulous flap; pharynx very long, funicular, bent towards the left, and forming an immediate continuation of the peristome excavation; adoral ciliary wreath very broad, much concealed, lying completely within the peristome cleft; the cilia of general surface very fine, disposed in longitudinal rows; anal aperture postero-terminal; endoplast band-like, curved or sinuous; contractile vesicles distinct, usually multiple. Inhabiting fresh water.

By writers previous to the time of Stein and Claparède and Lachmann the genus *Bursaria* has been made to include a vast number of widely diverse infusorial forms, now distributed, with one or two exceptions, among the genera *Plagiotoma*, *Nyctotherus*, *Leucophrys*, *Ophryoglena*, *Balantidium*, *Paramæcium*, and *Opalina*. It thus happens that out of a score or more of animalcules associated with the title of *Bursaria* by Ehrenberg, and included in Pritchard's 'Infusoria,' one species only, the *Bursaria truncatella* of Müller, is now left to represent the genus.

Bursaria truncatella, Müller. Pl. XXIX. Figs. 1 and 2.

Body broadly ovate, purse or sac-shaped, the ventral border flattened, the dorsal one convex, scarcely half as long again as broad, widest posteriorly, narrowed slightly at the truncate anterior extremity, the frontal angles rounded, the margin of the right side convex, usually longer than that of the left, the margin of the shorter left side slightly concave; endoplast band-like, flexuose; contractile vesicles minute, spherical, many in number, distributed throughout the substance of the cortex. Length of body 1–48″ to 1–36″. Hab.—Pond and marsh water.

As originally figured by Ehrenberg, this species is represented as possessing but one large terminal contractile vesicle, and Claparède and Lachmann, adopting the view of Lieberkuhn, have accordingly considered it desirable to recognize the many-vesicled form as a distinct species under the title of *Bursaria decora*. It is maintained, however, by Stein that in all details of form and structure the two animalcules so essentially agree with each other that their separation as two distinct species cannot be recognized. Supposed embryos of this animalcule, Pl. XXIX. Fig. 2, were observed by Stein to the number of from thirty to as many as two hundred inside a single adult. These embryos were simply ovate, clothed all over with fine cilia, a minute tubular prominence being developed at the anterior extremity. The accredited parent *Bursaria*, in certain of these instances, was observed to be in a quiescent condition, perfectly ovate in form, and having all trace of the peristome and oral fossa obliterated. Singularly to remark, however, the endoplast was still present in its characteristic band-like form; this last-named circumstance justifies a doubt as to whether or not these so-called embryos were parasitic organisms, and more especially since their further development into typical *Bursariæ* was not traced by Stein. From *Condylostoma stagnalis* and *Leucophrys patula*, which at first sight, perhaps, presents a considerable resemblance to it, *Bursaria truncatella* may be readily distinguished by the extraordinary development of the pocket-like oral fossa. The present species is apparently by no means a cosmopolitan form, but where found usually occurs in considerable abundance. The author has recently obtained this fine animalcule through Mr. Thomas Bolton from the neighbourhoods of Stourbridge and Birmingham. It was observed of the examples from the last-named locality that the ordinary contour exhibited was compressed, curved, and elongate to an extent that clearly assimilated them to the characteristic shape of *Leucophrys patula*, as delineated at Pl. XXIX. Fig. 18. The smaller *Bursaria vorticella* of Ehrenberg is held by Stein to be identical with the younger and immature conditions of *B. truncatella*.

GENUS II. BALANTIDIUM, C. & L.

Animalcules free-swimming, ovate or fusiform, subcylindrical, slightly truncate in front; peristome-field but little excavate, straight, somewhat triangular, widest anteriorly, terminating posteriorly towards the centre of the ventral surface in a narrow cleft, the left border only bearing the large adoral cilia; pharynx absent or rudimentary; anal aperture postero-terminal; endoplast ovate or linear; contractile vesicles usually numerous. Occurring mostly as parasites within the intestinal viscera of vertebrate animals.

The *Bursaria entozoon* of Ehrenberg is made the type of this genus by Claparède and Lachmann, to which Stein has added three new forms. These are to be distinguished from *Bursaria* proper by the more simple and non-excavate character of the peristomal area, and by the absence of the extensively developed pharynx, which constitutes so essential a characteristic of the single representative of the last-named genus.

Balantidium entozoon, Ehr. sp. PL. XXIX. FIG. 3.

Body ovate or pyriform, narrowest anteriorly, from one and a half to twice as long as broad, the narrower anterior end somewhat curved to one side, obliquely truncate; peristome-field extending backwards to the centre of the ventral surface, almost median, but inclining obliquely slightly towards the right, of considerable width in front, forming a short narrow throat posteriorly; contractile vesicles usually four in number, two situated on either side, often rosette-shaped; endoplast sausage-shaped, curved, with a distinct, subcentrally attached endoplastule. Length 1–240″ to 1–40″.

HAB.—Parasitic within the rectum of the common and edible frogs, *Rana temporaria et esculenta.*

This species typifies one of the earliest known infusorial forms, it corresponding in part with the "Animalcula in stercore Ranarum" described and figured by Leeuwenhoek in the year 1722. In addition to its identity with the *Bursaria entozoon* of Ehrenberg, it is now recognized as synonymous also with the *Bursaria nucleus* of that authority, with the *Paramecium nucleus* of Schrank, and with the *Leucophrys entozoon* of Stein. Experiments made by the last-named investigator elicited the fact that this animalcule cannot survive more than a day or two's isolation in ordinary fresh water, unless this medium is mingled with the contents of the frog's intestine, thus proving the creature's essentially parasitic nature.

Balantidium elongatum, Stein.

Body elongate-fusiform, subcylindrical, from two to two and a half times as long as broad, the anterior end pointed or slightly obliquely truncate; peristome-field median, narrow, cleft-like, not extending backwards beyond a quarter of the length of the entire body; no distinct pharynx; contractile vesicles two in number, situated medially towards the posterior extremity of the ventral surface; endoplast ovate. Length 1–120″ to 1–84″.

HAB.—The intestinal canal of *Triton tæniatus* and *Rana esculenta.*

Balantidium coli, Malmsten sp. Pl. XXIX. Figs. 16 and 17.

Body shortly oval, almost egg-shaped, subcylindrical, from one and a half times to twice as long as broad, the anterior extremity to a small extent obliquely truncate; peristome-field very short, median, triangular, curved towards the right; no distinct pharynx; endoplast elongate-ovate; contractile vesicles two in number, located medianly and posteriorly towards the right side of the ventral surface. Length 1–360″ to 1–168.″

Hab.—Rectum of swine and of the human subject.

Attention was first directed in a notable manner to this animalcule by Professor P. H. Malmsten, of Stockholm, who described it in Virchow's 'Archiv für Pathologische Anatomie' in the year 1857, under the title of *Paramecium* (?) *coli*. The specimens forming the subject of this description were discovered in profusion within the fæcal evacuations of two patients admitted to the Stockholm Hospital, both suffering from chronic diarrhœa, and one of whom succumbed to this disease. A post-mortem investigation showed the surface of the large intestine to be considerably ulcerated, and its cavity above the sigmoidal flexure to be filled with a pungent, fetid liquid. A number of these *Balantidia* were found both in this liquid and in the neighbourhood of the ulcerated portions, but not in such abundance as in connection with the mucus-lining of the more healthy parts of the cæcum and vermiform appendage. This circumstance renders it doubtful whether or not these animalcules were the cause, or merely an accompaniment of the disease in question, the subject being at all events well worthy of further investigation. No trace of these Infusoria was detected above the valve of the colon. This endoparasitic species has been since found by Stein in great abundance in the rectum and fæcal evacuations of the common hog.

Balantidium duodeni, Stein.

Body shortly ovate or broadly almond-shaped, scarcely longer than broad, considerably flattened; the ventral surface much less convex than the dorsal one, and from which in profile it seems separated by a line or angle of demarcation; peristome-field narrow, cleft-like, produced on the right side nearly as far as the centre of the lateral line; no distinct pharyngeal prolongation; endoplast ovate; contractile vesicle single, situated towards the right-hand side of the posterior extremity. Length 1–288″ to 1–192″. Hab.—The duodenum of the edible frog, *Rana esculenta*.

This species, while found enjoying the hospitality of the same amphibian as *Balantidium entozoon*, is reported by Stein to be entirely confined to the mid-intestine or duodenum of that host, which position it monopolizes to the exclusion of all other infusorial forms. The general surface ciliation of this animalcule is highly characteristic, being longer and finer than in the species previously described, mostly directed forwards, and having a tendency to group itself, as with *Conchophthirus* and many Opalinidæ, into even, longitudinally disposed, pencil-like tufts. Multiplication by transverse fission has been frequently observed.

Balantidium medusarum, Mereschk. Pl. XXXII. Fig. 22.

Body soft and flexible, variable in form, more or less ovate or subcylindrical, almost two and a half times as long as broad, the posterior extremity rounded, the anterior one from left to right obliquely truncate; peristome-field produced backwards in the median line to the centre of the

body, its left-hand border bearing an even row of powerful adoral cilia; cuticular surface with well-marked longitudinal striations, and frequently with finer and less conspicuous interconnecting transverse striæ; cuticular cilia very long, fine, and widely scattered, presenting the aspect of fine setæ; contractile vesicles one or two in number, situated near the posterior extremity; endoplast ovate or subspheroidal, centrally located. Length 1–600″.

HAB.—Salt water: White Sea (Mereschkowsky), within the alimentary and radial canals of various small Medusæ (*Eucope* and *Bougainvillea*) and also in certain marine worms (*Brada*).

This species, which is referred with some doubt to the present genus by its discoverer, is remarkable for the great length and setose character of the cuticular cilia; these appendages, though much less thickly distributed, would appear to correspond closely with the similarly long, fine, setose cilia of the Holotrichous genera *Cyclidium* and *Pleuronema*. Probably it will be found desirable to institute a new generic title for its reception.

GENUS III. NYCTOTHERUS, Leidy.

Animalcules free-swimming, ovate or bean-shaped, more or less compressed, the dorsal border convex, the ventral one usually bent inwards centrally; peristome-field excavate, commencing a little behind the apical extremity, continued in a cleft-like manner on the ventral side to the centre of the body, and there produced backwards and inwards to meet the well-developed ciliated pharynx; the left border of the peristome only bearing the adoral cilia; anal aperture permanently conspicuous as a chink-like fissure, and continuous with a short tubular rectal passage; contractile vesicle usually single, subterminal; endoplast more or less ovate, situated mesially in advance of the pharyngeal cleft. Occurring as parasites within the intestinal cavities of Amphibia and Invertebrata.

This genus was founded by Professor Leidy* for the reception of the form hereafter described under the title of *Nyctotherus velox*, to which various supplementary species have since been added. From *Plagiotoma*, which it to a considerable extent resembles, it is to be distinguished by the excavate character of the peristome-field, and by the highly developed, permanently conspicuous anal passage. In connection with this last-named structural differentiation *Nyctotherus*, indeed, stands almost alone among the entire infusorial series. As will be at once recognized it needs the intercalation of but a short continuation inwards of the inceptive and excretory passages to produce as physiologically complete an alimentary tract as is possessed by the Proctuchous Turbellaria and other lower Metazoa. It is a somewhat remarkable circumstance that an Infusorium provided with so complex an alimentary organization should, as in the case of *Nyctotherus cordiformis*, subsist side by side with the Holotrichous Opalinidæ, in which all trace even of an inceptive aperture has either remained undeveloped, or become completely obliterated. It might be suggested, in this connection, that while these Holotricha have adapted themselves, like babes in evolution, to an entirely fluid nutriment, *Nyctotherus* has retained and further developed a partiality for the more solid meats of the rich feasting grounds among which it delights to rove.

It is desirable to remark that that aspect in *Nyctotherus* and other allied genera

* 'Proc. Acad. Nat. Sci., Philadelphia,' 1849.

is referred to in this volume as the ventral one upon which the oral aperture debouches. Stein, on the contrary, in his figures and descriptions of these animalcules, distinguishes by such title the region lying to the right-hand of this aperture.

Nyctotherus cordiformis, Stein. PL. XXIX. FIG. 4.

Body bean- or kidney-shaped in profile, somewhat pointed anteriorly, much compressed, the breadth equal to two-thirds or three-quarters of the total length; pharyngeal cleft considerably surpassing in length the preceding peristome-border, produced inwards to the centre of the body and then recurved towards the ventral aspect; the widened entrance or vestibulum to the pharynx bearing on its lower edge a single long, stiff seta; striæ of the cuticular surface forming two convergent parallel systems, which meet one another anteriorly, those forming the dorsal series occupying the larger area; endoplast elongate-oval, with a minute centrally attached endoplastule; contractile vesicle single, postero-terminal. Length of body 1–168″ to 1–108″.

HAB.—Parasitic within the intestinal viscera of frogs and toads.

Nyctotherus ovalis, Leidy.

Body broadly egg-shaped or shortly pyriform, often scarcely longer than broad, the anterior extremity rounded; pharyngeal cleft scarcely as long as the peristome border, produced obliquely inwards to the centre of the body, bearing no supplementary vestibular bristle; cuticular striæ forming a single series, disposed in the same straight line from the apical to the posterior extremity; the anterior half of the body usually containing a well-defined granular interspace; endoplast elongate-oval, curved; no distinct endoplastule; contractile vesicle single, subterminal. Length of body 1–384″ to 1–72″.

HAB.—Within the intestine of orthopterous insects, including various species of *Blatta* and *Gryllotalpa*.

This species is identical with the *Plagiotoma blattarum* of Claparède and Lachmann, and also of Stein in his earlier works.

Nyctotherus gyoeryanus, Stein. PL. XXXII. FIGS. 20 AND 21.

Body oval or obovate, truncate or slightly kidney-shaped as seen in, profile, moderately compressed; pharynx equal in length to the peristome, directed abruptly and obliquely inwards, having no supplementary vestibular bristle; cuticular striæ or fibrillæ of the sinistral region forming two obliquely convergent, distinct fasciæ, those of the dextral and ventral surface forming a single oblique parallel series; a clearly defined, granular, kernel-like interspace enclosed at the anterior extremity; endoplast elongate-fusiform; contractile vesicle single, postero-terminal. Length 1–288″ to 1–108″.

HAB.—The intestinal canal of *Hydrophilus pisceus*, and other water beetles.

Nyctotherus velox, Leidy. PL. XXIX. FIG. 5.

Body ovate, white and translucent, the front border obtusely rounded, posteriorly somewhat angular and pointed, enclosing an anterior granular trapezoidal area; peristome directed abruptly downwards and inwards; pharyngeal cleft not equalling the peristome in length; anal aperture conspicuous, postero-terminal, presenting the form of an inwards and downwardly produced tubular cleft; cuticular striæ forming a single uninterrupted longitudinal series; contractile vesicle large, spherical, postero-terminal; endoplast ovate. Length 1–254″ to 1–180″.

HAB.—Intestinal tract of *Julus marginatus*.

Thousands of examples of this animalcule are reported by Professor Leidy as being frequently found infesting the intestinal canal of a single individual of the above-named American myriapod. A form apparently identical with this species, has been more recently obtained by D'Udekem from the European *Julus terrestris*. While the contour of the peristome in *N. velox* accords most nearly with that of *Nyctotherus gyoeryanus*, the cuticular striation and proportionate size of the pharyngeal cleft resemble that of *N. ovalis*.

GENUS IV. METOPUS, C. & L.

Animalcules free-swimming, highly elastic and changeable in shape, normally elongate-oval or fusiform, rounded at both extremities, cylindrical or only slightly flattened; the anterior portion usually twisted obliquely towards and overlapping the left side of the ventral surface, sharply separated from the posterior portion; peristome-field furrow-like, commencing on the left side at a little distance from the anterior extremity, produced obliquely downwards towards the right in the groove formed by the oblique curvature of the body, and terminating in a short pharynx at about, or shortly past, the median line; on the contraction or shortening of the body, the peristome with the pharynx, for the time, describes a complete spiral circuit, the animalcules presenting in this condition a totally different aspect; anal aperture postero-terminal; contractile vesicle single, posteriorly located. Inhabiting salt and fresh water.

The singular spiral twist of the body exhibited by the animalcule of this genus seems to be to some extent foreshadowed by those species of the genus *Nyctotherus* in which the muscular fibrillæ of the antero-posterior cuticular surface take opposite directions, such peculiarity being most prominently exemplified in the form described under the title of *N. gyoeryanus*.

Metopus sigmoides, Müll. sp. PL. XXIX. FIGS. 6–9.

Body in its normal aspect cylindro-fusiform, three to three and a half times as long as broad, the two extremities rounded, the anterior one twisted on the ventral aspect obliquely towards the left; peristome-field produced backwards to the centre of the body, and then continued inwards as a short, tubular pharynx, a tuft of longer cilia developed at the posterior extremity; endoplast ovate, situated near the termination of the peristome,

associated with a minute centrally attached endoplastule; contractile vesicle of large size, occupying a median position adjacent to the posterior extremity. Length 1–300″ to 1–96″.

Hab.—Mostly fresh water, among *Lemna trisulca* and other aquatic plants, rarely in sea water.

Although receiving both its characteristic generic and specific title at the hands of Claparède and Lachmann, this singular species had been already observed by several of the earlier writers, being first figured indeed by O. F. Müller* as a species of *Trichoda*, and also as an unknown form by Max Perty. Stein, who in his fine monograph of the Heterotricha gives the most exhaustive description and illustrations of this type, represents it as assuming at will three very distinct and highly characteristic aspects. The first and most normal of these (Pl. XXIX. Fig. 6) accords with that given in the foregoing diagnosis, and in which the animalcule is so extended that the entire length is equal to or somewhat exceeds three times the greatest breadth, while the anterior region is twisted obliquely across the body on the ventral side. In the second instance (Pl. XXIX. Fig. 7) the body is much foreshortened, the length now scarcely exceeding twice the breadth, while the peristome, with its row of larger adoral cilia, is caused by this contraction to describe a more or less complete spire around the animalcule's body, and which in some instances is composed of two or even three turns. The third characteristic aspect presented by this animalcule (Pl. XXIX. Fig. 8) is produced through its assumption of a completely extended and flattened shape, and in which no trace of the normal oblique flexure of the anterior region being exhibited, its contour corresponds closely with that of a *Plagiotoma* or *Balantidium*. It is with this form, which would appear to represent a very distinct local variety if not a separate species, that the largest dimensions recorded in the foregoing diagnosis are encountered. Under the name of *Strombidium polymorphum*, a great variety of the protean contours assumed by this animalcule have been figured by Dr. Ernst Eberhard in the 'Osterprogramm der Coburger Realschule,' 1862. Among these, however, as already pointed out by Stein, are several representations that must be undoubtedly separated from the present type and referred to the Peritrichous form *Gyrocorys oxyura*. This type while exhibiting an axial convoluted spire of adoral cilia that closely corresponds with that of *Metopus* in its second described characteristic stage differs in that the finer cilia of the general cuticular surface, which is of itself indurated instead of soft and flexible, are entirely wanting, the posterior extremity being further supplemented by a long, pointed, tail-like style. The frequent occurrence of these two forms in close association with each other would seem to favour Eberhard's conjecture that *Metopus* may possibly represent the earlier or larval condition of *Gyrocorys*, though such an anticipation is not supported by the result of Stein's researches. The animalcule described by De Fromentel under the title of *Metopus inflatus* would appear from the very insufficient details given to correspond with *M. sigmoides* in that third named and rarer condition in which the oblique flexure of the anterior region of the body is straightened out and obliterated. The occasional occurrence of this species in salt water is recorded by Stein. Possibly, however, such marine example belonged to the type next described.

Genus V. METOPIDES, Quennerstedt.

Animalcules free-swimming, persistent in form, more or less ovate, the anterior part twisted or folded obliquely towards the left across the remaining portion, the groove between the two regions strongly ciliate, and perforated at its posterior end by the oral aperture; cilia of the general cuticular surface fine, two or more conspicuous setæ developed at the posterior extremity.

* 'Animalc.,' tab. xxvii. figs. 7 and 8, 1786.

Excepting for the presence of the posterior setæ, the single representative of this genus would appear to coincide entirely with *Metopus*. Similar, though more numerous, setæ are indeed, according to Stein, possessed by *Metopus* in the earlier phases of its growth.

Metopides contorta, Quenn. PL. XXXII. FIG. 18.

Body elongate-ovate, about two and a half times as long as broad, rounded posteriorly; the anterior third folded obliquely to the left, across the ventral aspect; cuticular surface striate longitudinally, cilia long and fine, matting together in a tuft-like manner; posterior setæ two in number; contractile vesicle postero-terminal. Length 1–275″. HAB.—Salt water.

GENUS VI. PLAGIOTOMA, Dujardin.

Animalcules free-swimming, persistent in shape, ovate, compressed or lamellate, the ventral margin straight, the dorsal one convex; oral aperture situated on the ventral surface; peristome-field extending from the anterior extremity to the oral aperture, bearing a row of adoral cilia on the left side only, continued inwards at the oral entrance so as to form an obliquely directed tubular pharynx, a single long bristle protruding from the lower border of the pharyngeal cleft; anal aperture postero-terminal, not conspicuous. Inhabiting the intestinal viscera of invertebrate animals.

Plagiotoma lumbrici, Duj. PL. XXIX. FIG. 10.

Body from three to four times as long as broad, compressed, lanceolate or almond-shaped, transparent, margin of the ventral surface straight, that of the dorsal one convex, posterior termination usually obliquely truncate; oral aperture situated a little way behind the centre of the ventral surface; pharyngeal cleft curved, produced downwards and backwards nearly to the central axis of the body; endoplast ribbon-like, convolute or racemose; contractile vesicle single, located close below the pharyngeal cleft. Length 1–192″ to 1–120″.

HAB.—Intestine of the common earthworm, *Lumbricus terrestris.*

This species is identical in part with the *Paramecium compressum* of Ehrenberg, and was first noticed by Gleichen in the year 1781 under the title of the Bean-animalcule or "*Bohnenthierchen.*"

Fam. II. SPIROSTOMIDÆ, S. K.

Animalcules free-swimming, usually more or less flattened, rarely cylindrical, often attenuate; peristome-field excavate, extending along the left side of the ventral surface from the anterior extremity towards the centre of the body, the oral aperture located in the angle formed by the posterior border of the peristome; larger adoral cilia forming a right-winding or dextrotropous spire, continued along the entire outer margin of the peristome-field, or confined to the posterior portion only of this area, the inner border of the peristome occasionally bearing an undulating membrane; anal aperture posteriorly situated.

Genus I. CONDYLOSTOMA, Dujardin.

Animalcules free-swimming, changeable in form, ovate or elongate almost cylindrical, slightly flattened and obliquely truncate anteriorly; the peristome-field restricted to the anterior extremity of the body, presenting the aspect of a harp-shaped excavation, the upper and outer or left-side border of which bears the strong adoral cilia, while from its entire inner or right margin is produced a flap-like undulating membrane; endoplast elongate, moniliform; contractile vesicle single or multiple, sometimes associated with elongate canal-like extensions; anal aperture postero-terminal. Inhabiting salt and fresh water.

Condylostoma patens, Müll. sp. Pl. XXIX. Fig. 12.

Body highly elastic, elongate-elliptical or ribbon-shaped, more or less undulate, nearly cylindrical, its length when extended equal to seven or eight times its greatest breadth, widest posteriorly, somewhat flattened anteriorly, slightly contracted behind the region of the peristome; peristome-field consisting of an irregularly triangular or harp-shaped excavation occupying an almost median position at the anterior extremity of the ventral surface, its length equal to about from one-fifth to one-sixth of the entire body, succeeded by a narrow tubular pharynx equal to one-half the length of the peristome; undulating membrane conspicuous, extending over the whole length of the right side of the peristome-border, its width equal to one-half of that of the peristome-field; peristome-field unciliated, very transparent; cuticular striæ fine, distributed equally and in parallel longitudinal lines throughout the surface of the body; endoplast elongate, moniliform, located towards the right side; contractile vesicle canal-like, often breaking up into vesicular spaces that extend along the entire left border of the animalcule. Length of extended body 1–72″ to 1–48″.

Hab.—Sea water.

This animalcule was first figured and described by O. F. Müller as a species of *Trichoda*, its present generic title being conferred upon it by Dujardin. Claparède and Lachmann have proposed to add a new species to the genus *Condylostoma* under the title of *C. patulum*. As shown by Stein, however, there does not appear to be sufficient evidence to permit of this type being regarded as otherwise than identical with one of the many protean forms assumed by *C. patens*.

Condylostoma stagnale, Wrz. Pl. XXIX. Fig. 11.

Body slightly contractile only, broadly ovate, not twice as long as broad, rounded and widest posteriorly, the anterior border obliquely truncate; peristome-field broadly triangular, extending backwards through nearly one-half of the length of the body, its right border bearing a well-developed undulating membrane, its left one a vigorous fringe of large adoral cilia; longitudinal muscular fibrillæ large and coarse; contractile vesicle presenting the form of an irregular-shaped vacuole at the posterior extremity; endoplast elongate, moniliform. Length 125″.

Hab.—Stagnant water.

The rounded contour of this species, as first figured and described by Wrzesniowski,* at once distinguishes it from the previously enumerated salt-water representative of the genus. The author has recently received examples of this animalcule from the neighbourhood of Birmingham through Mr. Thomas Bolton.

GENUS II. BLEPHARISMA, Perty.

Animalcules free-swimming, persistent in form, the anterior region much compressed, pointed, sickle-shaped, and curved towards the left; peristome-field consisting of a long, deep, fissure-like cleft situated on the left-hand border of the body, extending to the median line of this border and continued inwards as a short funicular pharynx; the outer or left-hand margin of the peristome only bearing the larger adoral cilia, a short undulating membrane protrusible from the basal portion of the right-hand margin; endoplast ovate or elongate; contractile vesicle single, subterminal; anal aperture postero-terminal. Inhabiting fresh water, usually brightly coloured.

The two types *Blepharisma hyalinum* and *B. persicinum* referred to this genus as instituted by Perty, are identified by Stein as varieties only of the same form and equivalent to the *Bursaria lateritia* and *Loxodes cithara* of Ehrenberg, these corresponding again with the *Plagiotoma lateritia* of Claparède and Lachmann. From *Plagiotoma* the representatives of this genus are to be distinguished by the presence of the delicate undulating membrane and by the slightly spiral instead of perfectly straight disposition of the peristomal cilia.

Blepharisma lateritia, Ehr. sp.

Body lanceolate or almond-shaped, three or four times as long as broad; peristome reaching to the centre of the median line or sometimes beyond it, the undulating membrane in profile presenting a bristle-like aspect; endoplast oval, situated in the anterior half of the body; colour peach-bloom, purple-red, or brick-red, rarely transparent. Length 1–456″ to 1–120″. HAB.—Fresh water.

Although individually persistent in form, the animalcules of this species vary considerably in contour among themselves according to their age and stage of development. Thus while the lancet-shaped contour with sharply-pointed extremities represents the most normal and constant shape, it not unfrequently happens that examples occur in which these terminations are nearly equally rounded, the animalcules under such conditions closely approaching the form of an almond. The conjugation of two zooids by the application of their oral surfaces, as in *Paramœcium* and other types, was first observed by O. F. Müller and subsequently seen by Stein. After such conjugation, according to the last-named authority, the endoplast breaks up into from three or four to as many as eight spheroidal fragments, which doubtless represent the germs of new individuals.

Blepharisma undulans, Stein. PL. XXIX. FIG. 15.

Body elongate-lanceolate, four or five times as long as broad; the peristome extending to one-third only of the length of the whole body; undulating membrane conspicuous, lamellar, occupying about one-half of

* "Infusorien aus der Umgebung von Warschau," 'Zeit. Wiss. Zool.,' Bd. xx. 1870.

the right-hand peristome-border; an ovate endoplast usually present in both the anterior and posterior body-half, frequently connected by a cord-like funiculus or commissure; colour deep purple-red. Length 1–96″ to 1–72″. HAB.—Fresh water.

This species is distinguished from the preceding type by the greater length of its body, the smaller proportionate extent of the peristome field, and the more highly-developed undulating membrane. Stein obtained it from the neighbourhood of Prague, and identifies it (*in pars*) with the *Blepharisma persicum* of Eberhard, but not with the animalcule bearing that name as recorded by Perty.

GENUS III. SPIROSTOMUM, Ehrenberg.

Animalcules free-swimming, highly elastic, contractile and changeable in shape, usually of great length in proportion to their width, cylindrical or slightly flattened, rounded in front, truncate posteriorly; peristome-field elongate, extending down the left-hand side of the ventral surface as far or farther than the middle of the body, widest at this point and continued obliquely inwards as a short funicular œsophagus; adoral cilia bordering the outer or left-hand side only of the peristomal area; no undulating membrane; endoplast ovate or moniliform; contractile vesicle canal-like, usually with a large posterior dilatation; anal aperture postero-terminal. Inhabiting fresh water.

Among the innumerable protean forms assumed by the representatives of this genus, that associated with a spiral contraction upon their long axis is most frequent, such contraction imparting to the peristome the appearance of being spirally convolute around the animalcule's body. In Pritchard's 'Infusoria,' ed. iv. 1861, the possession of an undulating oral membrane has been wrongly accredited to this genus.

Spirostomum teres, C. & L.

Body linear-fusiform, from ten to fifteen or twenty times as long as broad, the anterior region slightly narrowest, the anterior extremity rounded obliquely towards the left side only or in an even manner, the posterior border truncate; peristome-field not reaching to the centre of the body, frequently occupying a third only of its entire length; endoplast simple, ovate; contractile vesicle canal-like, extending through the entire length of the body, usually exhibiting a conspicuous posterior dilatation. Length of extended body 1–72″ to 1–60″. HAB.—Pond water among *Lemnæ*.

Spirostomum ambiguum, Ehr. PL. XXIX. FIGS. 13 AND 14.

Body elongate, thread-like, from twelve to sixteen times as long as broad, nearly or entirely cylindrical, the antero-posterior extremities often equally rounded, but the posterior one occasionally truncate; the peristome extending quite to the centre of the body, frequently beyond this point; endoplast cord-like, moniliform when fully developed; contractile vesicle canal-like, extending throughout the whole of the body, often much dilated posteriorly. Length of extended body varying from 1–48″ to as much as 1–12″ or even 1–6″. HAB.—Pond water among *Lemnæ*.

This form is distinguished from the preceding by its larger size, the greater proportionate development of the peristome and more elongate and composite character of the endoplast. Stein unites in this species both the *Spirostomum ambiguum* and *S. virescens* of Perty. The author has obtained this species in great abundance in pond water with *Lemna trisulca* near St. Heliers, Jersey, its comrades being *Urocentrum turbo*, *Paramæcium chrysalis*, and *Spirillum volutans*; the examples then collected lived healthily for many weeks within the restricted limits of a wide-mouthed bottle. Their long, filiform bodies, which exceed in length the dimensions of any other Infusorial type, are quite conspicuous to the unassisted eye, and gleam in the sunlight like golden threads. As shown in the accompanying figures, the contractile vesicle in this animalcule is of very considerable relative size, its lower extremity more particularly being often so greatly dilated as to occupy almost the entire area of the posterior third of the body.

The *Spirostomum filum* of Claparède and Lachmann is regarded by Stein as possessing insufficient characters for separate specific diagnosis.

GENUS IV. LEUCOPHRYS, Ehrenberg.

Animalcules free-swimming, persistent in form, more or less oval or egg-shaped, the anterior extremity truncate; peristome-field confined to the anterior third of the ventral surface, short, and widely harp-shaped; oral fossa continued into the interior of the body as a long, tubular pharynx; the outer or left border of the peristome alone bearing the fringe of adoral cilia, no supplementary undulating membrane; the peristome-field covered with short cilia, similar to those which clothe the general surface of the body; endoplast band-like; contractile vesicle and anal aperture postero-terminal. Inhabiting fresh water.

Leucophrys patula, Müll. sp. PL. XXIX. FIG. 18.

Body elongate-oval, compressed, somewhat kidney-shaped, one-half to twice as long again as broad; either transparent or coloured deep green through the enclosure of chlorophyll-granules; the two extremities slightly curved towards the left, the anterior extremity truncate, the right-hand corner of this frontal region angular, the opposite one rounded; peristome-field harp-shaped, equal in length to about one-quarter only of the entire body; oral aperture followed by a long tubular pharynx first produced towards the right and then bent downwards and descending nearly to the centre of the body; endoplast band-like, convolute; contractile vesicle single, of large size, situated close to the posterior extremity, frequently exhibiting two lateral prolongations which extend in a canal-like manner up either side of the body. Length 1–120″ to 1–72″.

HAB.—Fresh water.

This species, synonymous with the *Trichoda patula* of O. F. Müller, and the *Spirostomum virens* and *Leucophrys patula* of Ehrenberg, has been the subject of some contention among more modern investigators. Stein, regarding Ehrenberg's *Spirostomum virens* as a morphologically distinct type, has conferred upon it the new generic title of *Climacostomum*; that of *Leucophrys* he retains only for a form which he affirms to be identical with the *Leucophrys patula* originally figured by Ehrenberg in the year 1830* and reproduced in part only in his greater work 'Die Infusions-

* 'Abhand. Berl. Akad.,' S. 42 and 76, Taf. ii., figs. 1–6, 1830.

thiere,' 1838, and which form he further pronounces to be properly referable to the Holotrichous order, differing from the type as here recognized only, but at the same time essentially, in the non-possession of a fringe of larger adoral cilia or cirri. On consulting the works cited, however, the author has been able to recognize the presence of these differentiated cilia in every instance, such circumstance rendering the retention of Stein's genus *Climacostomum* undesirable. If, as Professor Stein maintains, an animalcule exists which agrees with his so-called *Leucophrys patula* in the absence of specialized adoral cilia, such type is not referable to the *Leucophrys* of Ehrenberg, and will have necessarily to be relegated, in his promised monograph of the Holotricha, to a new genus.

In both general contour and variation of colour *Leucophrys patula* resembles in a remarkable manner contracted examples of *Stentor polymorphus*, for which type at a first glance it might easily be mistaken. From such, however, it is readily distinguishable by the posterior location of the anal aperture and contractile vesicle, and by the less complete circle formed by the ciliary spire. Notwithstanding these differences, however, the present type evidently represents a link of connection between the families of the Stentoridæ and Spirostomidæ, uniting with the same the characteristics of the Bursariidæ as exhibited in the genus *Balantidium*. By Perty, 'Kleinsten Lebensformen,' 1852, the green and colourless varieties of this species are figured and described under the title of *Bursaria virens* and *B. patula*.

Fam. III. STENTORIDÆ, Stein.

Animalcules free-swimming or temporarily adherent, highly elastic and contractile, more or less elongate and cylindrical; often inhabiting, either singly or socially, a mucilaginous or indurated sheath or lorica; the entire frontal border embraced by the peristome; peristome-field circular or produced into a single central spiral or two lappet-like lateral prolongations; oral aperture perforating the margin or deeper confines of the peristome-field; larger adoral cilia or cirri describing a complete dextrotropous or right winding spire; anal aperture situated anteriorly immediately beneath the peristome.

Genus I. STENTOR, Oken.

Animalcules sedentary or freely motile at will, in the former case attaching themselves by their softer adherent posterior extremity to submerged aquatic objects, sometimes secreting a mucilaginous investing sheath; bodies highly elastic and variable in form: when swimming and contracted, clavate, pyriform or turbinate; when fixed and extended, trumpet-shaped, broadly expanded anteriorly, tapering off and attenuate towards the attached posterior extremity; peristome describing an almost complete circuit around the expanded anterior border, its left-hand extremity or limb spirally involute, forming a small infundibulate or pocket-shaped fossa, which conducts to the oral aperture, the right-hand limb free and usually raised considerably above the opposite or left-hand one; peristomal cilia cirrose, very large and strong; cilia of the cuticular surface very fine, distributed in even longitudinal rows, occasionally supplemented by sparingly scattered hair-like setæ; endoplast band-like, moniliform or rounded, contractile vesicle usually complex, consisting of an anterior circular dila-

tation, which gives off an horizontal annular branch which underlies the circumference of the peristome, and a canal-like diverticulum which is continued towards the posterior extremity of the body. Increasing by oblique fission, and by germs separated from the band-like endoplast. Inhabiting fresh and salt water; mostly social.

The Stentors or trumpet animalcules represent, by reason of their large dimensions, social habits, often brilliant colouring, and cosmopolitan distribution, not only the most familiar but the very earliest known members of their class. The first record of the group is given by our illustrious countryman Abraham Trembley, noted chiefly for his researches connected with the fresh-water polypes *Hydra vulgaris* and *H. viridis*, and who, premising that these animalcules possessed a closely identical organization, described them under the title of the "Funnel-like Polypes" in the 'Philosophical Transactions' for the year 1744. Three modifications of this so-called polype were observed by this early investigator, and distinguished by him under the names of the "green," "blue," and "white" varieties, the same evidently corresponding with the three types familiar to recent investigators under the respective technical appellations of *Stentor polymorphus*, *S. cæruleus*, *S. Rœselii*. In Mr. Baker's treatise, a few years later, 'Employment for the Microscope,' 1753, these several varieties recur under the title of the "Funnel Animal," while one of them, *S. Rœselii*, is included in Linnæus's 'Systema Naturæ,' ed. x., 1758, under the name of *Hydra stentorea*. The first employment of the generic title of *Stentor* was made by Oken,* 1815, who, however, included under the same generic category the totally dissimilar organisms *Ophrydium versatile* and the social Rotifer *Lacinularia*. By O. F. Müller numerous representatives of the genus are embodied in his comprehensive generic group *Vorticella*, Ehrenberg being the first to secure to the genus *Stentor* that well-defined limitation by which, from then up to the present time, it has been distinguished.

A noteworthy feature connected with the life-history of the representatives of this genus is afforded by their mode of multiplication by fission, and which, instead of taking a transverse or longitudinal direction, as in almost all other animalcules, describes an oblique course. The phenomena accompanying this duplicative process are of much interest, and were first recorded in a manner leaving but little to be added by Trembley, their first discoverer. The earliest indications given of the impending subdivision is the appearance down that side of the body of the animalcule which accords with the one on which the peristome makes its spiral descent into the oral aperture, and may be hence termed the ventral aspect, of a raised crest or border, which in its earliest condition presents the appearance of an undulating membrane, but subsequently splits up and forms a fringe of long cirrhate cilia similar to those which bound the expanded peristome. Up to within a comparatively recent date this lateral crest or fringe has been regarded as a permanent and distinctive feature of the type with which it has been seen associated, and is cited in Pritchard's 'Infusoria' as largely developed in certain species, slightly only in others, while in a third series it is altogether wanting. By Stein, Claparède and Lachmann, and numerous other observers, including among our own countrymen Dr. W. Moxon,† it has, however, been clearly demonstrated that this lateral crest represents the rudimentary condition only of the adoral or peristomal fringe of cilia of the posteriorly-produced zooid or resultant of the process of segmentation, and which gradually shapes itself so as to correspond in form and character with that of the pre-existing anterior adoral wreath as follows. In the first place the simple lateral crest or line of cilia becomes spirally involute at its lower or proximal extremity, and, penetrating in a conical form into the substance of the parenchyma, forms the oral aperture of the new zooid now in course of development. This oral aperture, with its simple linear fringe of adoral cilia, may be said at this particular stage of development to correspond closely with the normal

* 'Lehrbuch der Naturgeschichte,' Th. iii.
† 'Journal of Anatomy and Physiology,' May, 1869.

and permanent conditions of the same structures as met with in the genus *Spirostomum*. The anterior or distal end of the lateral fringe now begins to retreat from its position immediately beneath the peristome of the parent zooid, and descending from thence gradually curls round to meet the lower or oral termination. The area enclosed within the almost conjoined extremities of this supplementary lateral fringe represents now the peristome-field of the newly developed zooid, and corresponds closely in both form and size with the pre-existing anterior one. The anterior half of the body, leaving the original adoral wreath, further elongates, and becoming gradually thinner at its posterior extremity, permits at length of its entire separation from the posterior half now bearing the new peristome, and swimming off selects a new point of attachment. In this process of segmentation, as above detailed, the usually band-like endoplast takes its share, while at an early date a second contractile vesicle makes its appearance in close proximity to the newly-formed adoral fringe. Various phases of the process of subdivision, as above described, commencing with the first appearance of the second peristome, will be found at Pl. XXX. Figs. 14, 22, 24, 25, and 26.

The so-called muscular or myophan layer in the members of this genus is perhaps more conspicuously developed than in any other representative group of the Infusoria, taking the shape of transparent thread-like fibrillæ, which form a single, superficial, closely approximated layer, and extend in an unbroken longitudinal series from the peristome-border to the posterior extremity of the body. It is through the aid of these highly elastic elements that the rapid and characteristic metamorphoses of external contour are produced. A second series of hyaline fibrillæ, surrounding concentrically the peristome-border and enclosed area, acts sphincter-wise in closing up this region when the animalcule is contracted. By not a few authorities the special contractile or muscular properties have been wrongly accredited to the intervening coloured and granular elements of the cortex. The posterior and adherent termination of various species of this genus is frequently represented as provided with a special suctorial disc. Such, however, does not exist, this region being simply abnormally soft and plastic, permitting its free adherence to any selected object, this adhesion being somewhat further assisted in many instances by the protrusion of fine pseudopod-like extensions from the substance of the inner parenchyma or endoplasm, as represented at Pl. XXX. Fig. 23.

The new generic title of *Salpistes* has been proposed by Dr. Strethill Wright * for the reception of those species of Stentor which secrete gelatinous sheaths; the development of this accessory structure appears, however, to be so uncertain among individuals even of the same species, that it has not been considered desirable to adopt it in this treatise.

Stentor polymorphus, Müll. sp. Pl. XXIX. Figs. 10-20.

Body of large dimensions, the expanded anterior end when fully extended equalling in diameter one-third of the total length, the otherwise transparent cortical layer usually containing a rich layer of green chlorophyll-granules; endoplast distinct, moniliform. Length when fully expanded 1–20″, in contraction 1–120″.

Hab.—Standing water among both living and decayed vegetation, eminently social.

Stein embodies with this species the *Stentor Mülleri* of Ehrenberg, which he pronounces to be merely a variety of *S. polymorphus* without the more usually enclosed green chlorophyll-granules. The *Stentor polymorphus*, as figured and described by Claparède and Lachmann, in the second volume of their 'Études,' is referred by the same authority to the species next described. Although pre-

* 'Edinburgh Philosophical Transactions,' vol. x. 1858.

viously known to Trembley and Baker, the present specific title of this animalcule was conferred upon it by O. F. Müller in the year 1773, who figured and described it under the name of *Vorticella polymorphus*. Not unfrequently the colonies of this type are found socially inhabiting a common more or less granular gelatinous matrix somewhat resembling that of *Ophrydium*, but of less substantial consistence. A fragment of such a colony, as observed by the author developed upon the leaves and rootlets of plants of *Anacharis* in a small aquarium containing axolotls kept in the Zoological Department of the British Museum in the year 1871, is represented at Pl. XXX. Fig. 11. Fig. 16 of this plate illustrates a zooid from the same colony as observed in the act of discharging fæcal matter from the anal aperture, the matter being shot out with such force as to alight at a considerable distance. At Fig. 14 an example from the same stock is delineated in which the rudimentary peristomal fringe of a zooid preparatory to dividing by oblique fission presents, at *pr*, the aspect of a laterally developed membranous crest.

Stentor Rœselii, Ehr. PL. XXX. FIGS. 22 AND 23.

Body large, the anterior extremity in full extension, scarcely equalling in width one-quarter of the total length; usually excreting around it and inhabiting an independent, transparent, gelatinous sheath; parenchyma soft, completely transparent; cuticulum often bearing in addition to the ordinary ciliary covering numerous fine long setæ which stand out at a right angle to the surface of the integument, these setæ inserted basally in the inner substance of the cortex and extensile or retractile at will; a brush-like fascicle or circlet of fine setæ surrounding the adhesive posterior extremity; endoplast at first serpentine or ribbon-like, subsequently moniliform. Length of extended body 1–24″.

HAB.—Standing water among decaying vegetation; mostly solitary.

According to Ehrenberg, the only difference subsisting between this species and the preceding is represented by the form of the nucleus or endoplast, which is described by him as moniliform in *Stentor polymorphus*, but simply band-like in the present type. This distinction, however, has been shown by Stein to be entirely unreliable, a moniliform contour being assumed likewise by the endoplast of *S. Rœselii* in the more matured condition of its development. At the same time there are other far more important points of divergence, overlooked by Ehrenberg but pointed out by Stein, which leave no doubt as to the claim held by the present type for independent specific recognition. Among the most prominent distinctive features of the animalcules of the present species, as amended by Stein, may be enumerated the almost invariable presence in connection with their fixed condition of an independent mucilaginous lorica or investing sheath, within the cavity of which they at once retreat upon disturbance; the presence of the numerous scattered hair-like setæ which project from the cortex to a considerable distance beyond the external cuticular surface, and the circlet or brush-like fascicle of finer setæ at the posterior extremity. All of these three characteristics are wanting in *Stentor polymorphus*, and while, on the other hand, fine cuticular setæ sometimes occur in *S. cæruleus*, they attain a much less considerable degree of development, and there is no investing sheath or tuft of caudal setæ. This posterior tuft of setæ would appear to be subservient to the purpose of anchoring or attaching the animalcule in a root-like manner to the mucilaginous substance of the bottom of its sheath, fulfilling the part of the simply adhesive adaptation of the posterior extremity that obtains in various other forms. The presence in this species of supplementary cuticular setæ was first observed by Lachmann in the year 1856,* and was well

* Müller's 'Archives.'

illustrated in the third part of his and Claparède's joint work on the Infusoria bearing the date of 1858. It has, however, to be observed that these authorities regarded the four Ehrenbergian species of *Stentor*, viz. *S. polymorphus*, *S. Muelleri*, *S. Rœselii*, and *S. cæruleus*, as varieties only of the same species, and consequently associated the results of their investigations of the present type and all illustrations of the same with the title of *Stentor polymorphus*. These fine hair-like setæ do not maintain a permanently extended state, but are thrust out or retracted at the will of the animalcule, and would seem, as indicated by Stein, to possess a tactile function and to correspond most closely in their nature with the fine pseudopodia-like threads emitted from the adherent posterior extremity of many other species in their fixed or sedentary conditions.

The multiplication of *Stentor Rœselii* through the means of internally produced germs has been ably demonstrated by Claparède and Lachmann and also ostensibly by Stein. By the first-named authorities, treating of this species as *S. polymorphus*, it has been shown that spheroidal embryos are developed and become detached from the band-like nucleus or endoplast. These embryos vary in diameter from the 1–700th to the 1–450th part of an English inch, and already possess within the body of their parent, in their earlier stage, the fine cuticular cilia only of the general surface, supplemented by a simple spheroidal contractile vesicle; later on an anterior and short crescentic line of larger cilia makes its appearance, and this ultimately develops into the extensive adoral wreath of the adult animalcule. Claparède and Lachmann, while not successful in tracing the direct passage of the embryos from their parent's body into the outer water, encountered numbers of them in a free-swimming condition, and from these were able to trace every phase of development into the parent form. Although the derivation of these spheroidal embryos from the band-like endoplast has been first authenticated by the authorities just quoted, the internal production of such embryos in connection with *Stentor cæruleus* was attested by Eckhard so long since as the year 1846,* and was confirmed a few years later by Oscar Schmidt, both of whom witnessed what escaped the observation of Claparède and Lachmann, viz. the actual birth of embryos from the body of the parent. The majority of the supposed internal embryos of *Stentor Rœselii*, as figured and described by Stein,† present nothing in common with those just described, but are parasitic Acinetæ referable to the genus *Sphærophrya*. Their foreign nature is shown not only by their possession of suctorial tentacles and general conformity with the representatives of the genus named, but from the fact also that the endoplast within the bodies of the Stentors with which they are associated remains intact and retains its normal band-like contour in spite of their presence. Stein, however, records, with accompanying illustrations, his occasional observation of a modification of the endoplast unrecorded by any other observer, and which possibly plays an important part in the reproductive history of this species. In these instances the normal band-like or moniliform contour of the endoplast was entirely obliterated and its place occupied by three oval or irregular-shaped cyst-like structures entirely filled with minute, sharply outlined, spindle-shaped corpuscles whose longest diameter did not exceed the 1–4560th part of an English inch. On slight compression these cysts, as represented at Pl. XXX. Fig. 31, were expelled through the cuticle of the parent animalcule, and bursting their own walls released the enclosed corpuscular contents mixed with finer molecular matters. By Stein the occurrence of this remarkable transformation of the endoplast is dismissed as representing either a kind of fatty degeneration of that structure or as the result of the intrusion and development within its substance of some parasitic organism. The present author is inclined, however, to regard it as an open question whether this does not represent one phase of an as yet imperfectly understood method of multiplication through the medium of minute microspores, harmonizing with similar phenomena of general occurrence among the more lowly organized Flagellate section of the Infusoria. A circumstance slightly in favour

* Wiegman's 'Archives.'

† 'Infusionsthiere,' Abth. ii. p. 254, pl. viii. figs. 3, 4, and 9.

of this hypothesis is afforded by Stein's record of the occurrence of this peculiar modification of the endoplast during the months only of September, October, and November, or towards the approach of the winter months, when the ordinary processes of reproduction by fission are frequently arrested.

Stentor Barretti, Barrett. PL. XXX. FIG. 21.

Body attenuate, highly extensile, its length in full extension equalling five or six times the diameter of the expanded peristome; peristome field distinctly bilobate, earshaped, the larger lobe usually elevated perpendicularly; fine supplementary setose appendages developed throughout the body portion and around the margin of the peristome; endoplast elongate, sinuous; excreting and inhabiting an erect tubular gelatinous sheath, which is usually of a light brown colour when young, but becomes darker and more opaque as age advances. Length of extended body 1–25″.

HAB.—River and pond water; solitary.

This animalcule was first figured and described by Mr. C. A. Barrett in the 'Monthly Microscopical Journal' for April, 1870, as a "New Tube-dwelling Stentor," this observer there taking the somewhat unusual course of associating his own name with its specific designation. In this original description it is reported as entirely wanting the fine body cilia which characterize the ordinary species of *Stentor*, these being replaced by long hair-like setæ; the possession of a distinct nervous system, consisting of an anteriorly located ovate body, which gave off branches that extended down the whole length of the body, and another to the expanded peristome, was also reported. If these two last-named structural characteristics really existed, the organism described by Mr. Barrett was no *Stentor*, but possessed a type of organization that precluded its retention among the Protozoa. It was at the time, however, suspected by the author that this form represented an imperfectly examined species closely allied to, if not identical with, *Stentor Rœselii*, and in which a mucilaginous domicile and long hair-like setæ are similarly developed. This anticipation has been completely verified. The animalcule has been since met with by a number of observers, and is included among the many interesting infusorial types that have been supplied to the author by Mr. Thomas Bolton, such examples furnishing the material for the illustration of the species given at Pl. XXX. Fig. 21. Through this personal examination it was soon made evident that Mr. Barrett's so-called nervous system represented the imperfectly observed contractile vesicle with its canal-like diverticula, while finer cilia clothing the whole body, in addition to the hair-like setæ, were speedily detected, thus reducing it to the structural formula of an ordinary *Stentor*. As a trumpet animalcule, the present species is undoubtedly closely allied to *T. Rœselii*, but manifests its distinctness from that type in its more attenuate proportions, in the erect instead of horizontal comportment and distinctly bilobate contour, of the peristome, in the more abundant development of the setose appendages, which are produced not only from the body but from the entire circumference of the peristome, and in the much firmer consistence of its mucilaginous domicile. The examples of this species, as originally discovered by Mr. Barrett, were found on water weeds taken from the river Thames at Moulsford, another interesting form, referable to the genus *Folliculina*, apparently *F. Boltoni*, being likewise found in its close vicinity.

Stentor cæruleus, Ehr.

Body large, the width of the anterior extremity or peristomal border when fully extended equal to one-third of the total length; the substance of the intermuscular longitudinal striæ coloured a more or less intense blue;

the fine ciliary clothing of the general surface of the integument occasionally supplemented with a few long, fine setæ, which are not, however, so conspicuously developed as in the two preceding species; endoplast transparent, moniliform. Length 1–192″ to 1–96″.

HAB.—Fresh water, on aquatic plants; social.

As previously related,* the pigmentary substance distributed throughout the cortex that communicates to this species its characteristic cerulean hue has been submitted by Prof. E. Ray Lankester to spectroscopic analysis with highly interesting results. Two absorption bands of remarkable intensity were clearly exhibited whether examples were examined either singly or *en masse*, these differing so essentially from the bands yielded by all other organic substances that this investigator has conferred upon it the distinctive title of "Stentorin." *Velella*, an organism which from its relatively low position in the zoological scale might have been expected to yield a closely corresponding spectrum, was found on similar submission to the micro-spectroscope to produce no band or bands of absorption whatever. The spectroscopic examination of the Stentors in quantity was greatly facilitated by the presence in the aquarium that contained them of numbers of the annelid *Chætogaster diaphanus*, many of which had gorged themselves with the infusoria, thus proving convenient collectors of the material required.

Stentor igneus, Ehr. PL. XXX. FIGS. 1–4.

Body of moderate size, changeable in shape to a very limited extent; the width of the peristome, when most fully extended, equal to about one-half of the entire length; internal parenchyma coloured bright green through the presence of a rich layer of chlorophyll-granules; the more transparent superficial layer containing in addition finely granular pigment of an intense scarlet hue, this being usually most abundant in the neighbourhood of the peristome; endoplast ovate or spherical. Length of extended body 1–72″.

HAB.—Pond water, on *Hottonia*, *Ranunculus*, and other water plants; social.

The author obtained this species, in May 1876, in considerable abundance attached to the leaves of the water crowfoot, *Ranunculus aquatilis*, taken from a small pond on Wandsworth Common. On many occasions it was noted that the breadth of the extended peristome in this short, trumpet-shaped animalcule considerably exceeds that given by Stein, it in some instances being equal to that of its entire height. The rich colouring of this form renders it perhaps one of the most attractive and ornamental representatives of its genus, more especially as exhibited with the aid of the parabolic condenser, when every tint is thrown up on the dark background with intensified distinctness. On one occasion, in connection with the death and disintegration of an adult example, the release was observed from its debris of a spheroidal embryo, possessing an anterior crescent-shaped row of larger adoral cilia and a general covering of finer ones, the germ in its entirety thus agreeing essentially with those already described by Claparède and Lachmann in relationship with *Stentor Rœselii*.

Stentor niger, Ehr.

Body of moderate size, exceedingly changeable in shape, when fully extended nearly three times as long as broad, the surface parenchyma

* Vol. I. p. 79.

thickly filled with minute blackish, yellow, and coffee-coloured pigment-granules; endoplast spherical. Length of body when extended 1–96″.

HAB.—Bog water.

Stein embodies with this species the *Stentor* or *Salpistes castaneus* of Strethill Wright, with which it seems fully to agree, with the exception that, as observed by the last-named writer, the animalcules are in the habit of exuding an independent or common mucilaginous investing sheath, similar to that already described of *S. Rœselii*. In shape and size this form most nearly approaches *S. igneus*, from which, however, it may be readily distinguished by its more plastic character and the finer granulation of its parenchyma, which never contains green chlorophyll-granules, though more especially by the greater length in comparison with its breadth, which it exhibits in its expanded state. In this latter respect it more nearly approaches *S. Rœselii*, *S. polymorphus*, and other previously described species. *Stentor niger* has been obtained by the author in some abundance in bog water at Lustleigh Cleave on the borders of Dartmoor.

Stentor multiformis, Müll. sp. PL. XXX. FIGS. 8 AND 9.

Body moderately large, exceedingly plastic and variable in form; expanded peristome equal in width to about one-third or one-quarter of the entire length of the body; the longitudinal intra-muscular bands of the cortical layer coloured an intense blue or sea-green; endoplast spherical or ovate. Length of extended body 1–180″.

HAB.—Salt water; social.

This marine type of the genus *Stentor* was first described by O. F. Müller under the title of *Vorticella multiformis*, and has since been rediscovered and investigated by Stein. In aspect and colour it most nearly resembles the fresh-water *Stentor cæruleus*. It is, however, usually of much smaller size, and has at the commencement a simply oval or spheroidal endoplast. It further exhibits a greater range of variation in external contour than is associated with any other hitherto described type of this genus. Among these protean diversities of outline, that depicted at Pl. XXX. Fig. 8, is, perhaps, the most remarkable, the body as a whole being in this instance flask-shaped and produced anteriorly into a long, slender neck, with the expanded peristome-border equal to about one-third only of the inflated posterior portion. Under the condition of complete extension it rarely, if ever, appears to assume that elegant trumpet form so characteristic of the ordinary species, and in which, as a necessary consequence, the peristome-border represents the widest diameter, but is more usually either clavate or pyriform.

Stentor auricula, S. K. PL. XXX. FIGS. 6 AND 7.

Body colourless, in extension shortly trumpet-shaped or turbinate, the width of the expanded peristome equal to, or even exceeding, the height of the body, the latter tapering very abruptly towards its posterior extremity or point of attachment; the peristomal border interrupted on its ventral aspect by a deep cleft or sulcus which gives to the entire structure a bilobate or auriculate appearance; endoplast ovate, subcentral. Length of extended body 1–130″.

HAB.—Salt water.

This species is readily distinguished from all previously described forms by the great breadth of the peristomal area in proportion to the length of the body, combined with its peculiar lobate contour. In this last respect it may be said to make a

step towards the genus *Follicularia*, in which the bilobate shape of this area forms a leading characteristic. It was discovered, in February 1877, in some abundance on the vacated polyparies of polyzoa and hydroid zoophytes obtained from the Westminster Aquarium. Being at the time specially occupied in investigating certain more minute flagellate Infusoria, the author unfortunately neglected to note the form and position of the contractile vesicle or any reproductive data. The brief description and figure here given will doubtless, however, suffice for its re-identification and as a basis for a future more exhaustive examination.

Stentor pediculatus, From. PL. XXX. FIG. 5.

Body trumpet-shaped when extended, elongate-ovate or fusiform when contracted; colour clear brown; width of the expanded peristome equal to about one-quarter of the length of the entire body; the area enclosed within the peristome-border ornamented with numerous raised papillæ, the apex of each of which gives origin to several long, fine, hair-like setæ; the posterior and adherent extremity of the body divided into six digitiform prolongations, out of each of which four similar fine hair-like setæ take their origin. Length of extended body 1–120″. HAB.—Fresh water.

Doubtful Species.

The form temporarily referred to this genus by Stein under the title of *Stentor cucullus*, is synonymous with the *Vorticella cucullus* of Müller. It is a large, bright yellow, salt-water variety, so closely corresponding in shape and size with *Stentor Rœselii* that Stein would have referred it without hesitation to that species had he encountered it in fresh water. In consideration, however, of its marine habitat, he thinks it desirable for the present to regard it as a distinct type. In the only example observed by this authority the endoplast was long, cord-like, and of undulating outline.

Out of the nine varieties of the genus *Stentor* introduced by De Fromentel in his 'Microzoaires' as hitherto undescribed species, his *S. pediculatus* appears to be the only one with which are included characters sufficiently distinct to warrant its recognition as a new and independent form. In all other cases the diagnoses and figures given embody no character which can be cited as distinguishing them from those earlier known varieties made familiar to us through the researches of Ehrenberg, Stein, and Claparède and Lachmann, while in almost every instance the diagnosis and figure given represent the animalcule in that free-swimming and semi-contracted condition in which it is almost impossible to discriminate between closely allied species. Briefly examined, the *Stentor roseus* of this author, with its spherical nucleus and bright rose colour, is apparently referable to *S. igneus* Ehr., his *S. fuscus* to *S. niger* Ehr., *S. fimbriatus* to *S. Rœselii* prior to fission; while his *S. anceps*, *S. elegans*, *S. nanus*, *S. deformis*, and *S. albus* appear to represent merely young or imperfectly developed conditions of other previously established forms. Of this, in fact, De Fromentel in several instances expresses himself prepared to admit the probability. In all De Fromentel's figures relating to the genus *Stentor*, the oral aperture is wrongly delineated as being circumscribed by a continuation of the right-hand limb of the peristomal border.

GENUS II. FOLLICULINA, Lamarck.

Animalcules highly elastic and contractile, secreting a horny sheath or lorica, to the inner wall of which they remain affixed by their posterior extremity; peristome-field embracing the entire anterior border, produced

into two more or less elongate and usually symmetrical, flattened, lappet-like lobes or processes, the cleft between which is deepest on the oral or ventral side; peristomal fringe originating on the ventral side at the base of the right-hand lobe, skirting the entire margin of the bilobate frontal border, descending in a shortly revolute spiral manner into the oral aperture on its arriving at its point of origin or base of the left-hand lobe; peristomal or adoral cilia very long, those of the general cuticular surface exceedingly fine, disposed in even longitudinal rows; anal aperture situated close to the base of the left-hand peristomal lobe. Mostly inhabiting salt water.

A somewhat subtle question of priority has arisen in connection with the adoption of the correct title for the various members of the present genus. The earliest efficient diagnosis of the group was given by Claparède and Lachmann in Müller's 'Archives' for the year 1856, and in which they bestowed upon it the title of *Freia*, a name borrowed from the pages of Scandinavian mythology. This generic title is retained in their subsequent larger work 'Études sur les Infusoires,' 1858–1861, the *Vorticella ampulla* of O. F. Müller being there recognized and fully described as its type form. Meanwhile Dr. Strethill Wright published in the Edinburgh 'New Philosophical Journal' for 1858, the account of several animalcules possessing similar structural characteristics and, unaware of Claparède and Lachmann's discoveries in a similar direction, conferred upon them the generic name of *Lagotia*. Two years later* Dr. Wright acknowledged the priority of Claparède and Lachmann's title, and described a supposed new form under the title of *Freia obstetrica*. As shown, however, by Stein, in his monograph of the Heterotricha,† the *Vorticella ampulla* of O. F. Müller, which stands as the typical representative of this genus, was recognized as the type of a new generic group by Lamarck so long since as the year 1816,‡ and for which he proposed the name of *Folliculina*. Stein furthermore points out that the name of *Freia* has been previously employed by C. L. Koch in the year 1850 for the distinction of a genus of Arachnida, but at the same time elects to retain Claparède and Lachmann's designation on the ground of its widespread adoption. Paying strict regard to the laws of scientific nomenclature there can be no question, however, that in a double sense the generic name of *Freia*, as representing an infusorial group, must make way for the Lamarckian one of *Folliculina*, which is herewith adopted. The structural features of this genus correspond considerably with those of *Stentor*, the chief deviation from the latter type being the abnormal bilobate development of the peristome-border and the permanent occupation by the animalcules of a rigid sheath or lorica. Although so widely distributed, no examples of this generic group appear to have fallen within the cognizance of Ehrenberg, who has in consequence passed over Müller's *Vorticella ampulla* as an imperfectly observed representative of the genus *Vaginicola*, under which name it reappears in Pritchard's 'Infusoria.' A characteristic feature exhibited by many of the representatives of the genus *Folliculina* is afforded by the colour of the body-substance or parenchyma, which, in the majority of instances, presents a remarkable dark bottle-green or blackish hue. This coloration does not, as in most animalcules, result from the inception and temporary retention of coloured food-particles, but is so intimately and inseparably interblended with the substance of the parenchyma as to communicate its characteristic tint to the externally secreted tests or loricæ.

Folliculina ampulla, Müll. sp. Pl. XXIX. Figs. 21–28.

Adult sheath or lorica glaucous or sea-green, when young transparent, more or less ovate or flask-shaped, attached laterally with the neck bent

* 'Quart. Journ. Mic. Science,' 1862. † 'Infusionsthiere,' Abth. ii., 1877.
‡ 'Hist. des Anim. sans Vert.,' tom. ii. p. 30.

upwards; neck short in young individuals, but becoming much prolonged with age and usually ornamented with either horizontal or spirally ascending annulations or with longitudinal flutings; margin of aperture even, circular; animalcules similar in colour to the sheath; peristomal lobes subequal, attenuate, from three to six times as long as broad, their extremities more usually bluntly, but sometimes sharply pointed. Length of body of lorica 1–380″ to 1–60″, neck varying from one-quarter to the entire length of the body portion. HAB.—Salt water.

This species, representing the *Vorticella ampulla* of O. F. Müller, the *Folliculina ampulla* of Lamarck, and the *Freia ampulla* of later writers, varies so greatly in the form and aspect both of the lorica and contained animalcule, in accordance with its age or local derivation, that it has received a variety of names from the several authorities who have encountered and described it. Stein, however, who has made this genus the subject of special study, unhesitatingly refers to different stages or varieties of a single species all those types described under the respective titles of *Freia ampulla* and *F. aculeata* by Claparède and Lachmann, the *Lagotia viridis*, *L. hyalina*, and *L. atro-purpurea* of Strethill Wright, and the *Freia americana* of Dr. Leidy. While concurring with Stein generally as to the necessity of abolishing, as mere synonyms of the present type, the several nominal species above enumerated, the author is disposed to regard as a possible distinct form Claparède's variety illustrated by Pl. XXIX. Figs. 21 and 22, distinguished by the exceedingly acuminate contour of the peristomal lobes; this at any rate may be retained as a well-marked subspecies under the title of *Folliculina ampulla* var. *aculeata*. The *Lagotia viridis* of Strethill Wright accords with the normal adult condition of the present species, while his *L. hyalina*, distinguished merely by the transparence or absence of colour in the lorica and contained animalcule, is evidently the young condition only of the same form. The *Lagotia* (*Follicularia*) *atro-purpurea* is admitted by the last-named authority to be probably a mere variety only of his *L. viridis*, it being found in company with that type, and differing from it only in the more inky hue of the parenchyma and the yellowish-brown colour of the lorica.

Stein reports the occurrence of *Folliculina ampulla* in countless numbers upon the spiral shells of the tubicolous annelid *Spirorbis nautiloides*, these themselves being attached to the fronds of the bladder-wrack, *Fucus vesiculosus*. In those older examples in which the neck-like portion of the lorica is greatly prolonged and annulate, some approach would seem to be made towards the still more elongate lorica of *F. producta*. The enclosed animalcule of this last-named type would, however, appear to differ essentially in the narrow, ligulate shape of the peristomal lobes. As already recorded in the 'Midland Naturalist' for May 1880, examples of both the short smooth-necked and attenuate annulated form of this species were obtained by the author growing upon the single shell of a *Pecten* dredged from a depth of 50 fathoms, off Falmouth, in July 1879. By an oversight, the *Lagotia* (*Folliculina*) *producta* of Strethill Wright, presently described, has been there included among the synonyms of the present type.

Folliculina elegans, C. & L. sp. PL. XXIX. FIGS. 33–35.

Lorica flask- or bottle-shaped, transparent or pale green, attached laterally; the neck bent upwards, very much shorter than the body of the sheath, everted at its margin, frequently with a lateral lunate excision, containing interiorly several angular valve-like appendages which close the aperture when the animalcule is contracted; body of animalcule transparent or pale sea-green, lobes of the peristome of equal size, ovate, about

twice as long as broad, their extremities broadly rounded; endoplast spheroidal, subcentral. Length of entire lorica 1–192″ to 1–120″.

HAB.—Salt water.

The favourite haunt of this species is, according to Stein, among the angles formed by the finer divisions of the fronds of *Ceramium*, *Polysiphonia*, and other filamentous seaweeds. It frequently happens, as shown at Pl. XXIX. Fig. 35, that the attached basal portion of the lorica is supplemented anteriorly by a small keel-like lamina of similar consistence, and presenting in profile the aspect of a triangular, wedge-shaped fulcrum, while in the rear the lorica is made fast to the object of support by a backward directed lamina of similar shape and character. The examples of this species, as met with by Stein, and Claparède and Lachmann, by the former in the Baltic, and by the latter authorities in the North Sea, present some slight differences in both the character of the lorica and contained animalcule. In the original form of *Freia* (*Folliculina*) *elegans*, as described by the Swiss authorities, a conspicuous lunate excision was always observed on the left-hand side of the aperture of the lorica, two or more triangular valve-like laminæ projected forwards from within the interior of the short tubular neck, while the contractile vesicle was simply spherical and situated on the median line a little behind the endoplast. In the examples referred to this type by Stein, on the other hand, the oral aperture of the lorica is even and entire, a single sickle-shaped valvular lamina projects backwards from the upper wall of the interior of the neck, while the contractile vesicle is stationed on the ventral side of, and slightly in advance of, the central endoplast, and, in place of being simply spheroidal, exhibits at diastole supplementary lateral extensions. If not entitled to the rank of an independent species, Stein's type would appear to represent at the least a well-marked local variety.

Folliculina producta, Str. Wright sp. PL. XXIX. FIGS. 29–32.

Lorica pale yellow-brown, inflated at its base, produced anteriorly into a neck-like extension, often equal to five or six times the length of this body portion; the neck regularly and transversely annulate throughout its extent; animalcule deep blackish-green, exceedingly attenuate, projecting to a considerable distance beyond the aperture of the lorica; peristomal lobes much prolonged, of equal size, ligulate or ribbon-like, curved at their extremities. Length of fully developed lorica 1–100″.

HAB.—Salt water: Queensferry, Ireland (Strethill Wright).

While the transversely annulate neck-like prolongation of the lorica of this species approximates it somewhat to one variety of *Folliculina ampulla*, it may be readily distinguished from that type by the extraordinary development of this region, which often contains as many as twenty-seven transverse annulations. The lobes of the peristome are also, in comparison with that form, much more lengthened and attenuate. Several phases of the free-swimming larval condition of *Folliculina producta* have been observed and figured by its discoverer, Dr. Strethill Wright, and will be found reproduced at Pl. XXIX. Figs. 30–32. At these early periods of its existence there was no trace of a sheath or of the ear-like peristomal lobes, the animalcule being either ovate or of cylindrical form, pointed at the posterior extremity, and abruptly truncate at the anterior one, which bore rather larger cilia than those of the general surface of the body. One of these larvæ was observed to attach itself and complete the construction of its lorica, including the prolonged annulated neck, within the course of a single night. Whether the free-swimming peristomeless larvæ are produced by fission or through internal gemmation from the parent form remains to be discovered.

Folliculina stylifer, Str. Wright sp. Pl. XXIX. Figs. 19 and 20.

Lobes of the peristome even, spatulate, about three times as long as broad, the left-hand lobe bearing at its apical extremity a single, straight, rigid, rod-like style, which equals in length the lobe to which it is attached, and projects beyond and guards the aperture of the lorica when the animalcule is contracted; body of lorica usually concealed from view, the exposed anterior portion straight, cylindrical, its margin even, not expanded.

Hab.—Salt water.

The anterior region of the lorica, with the projecting peristome, as here reproduced, is alone depicted in Dr. Strethill Wright's delineation of this species. The stylate appendage projecting from the left-hand peristome lobe, which acts as efficiently as the valvular apparatus of *Follicularia elegans* in protecting the retracted animalcule from intrusion from without, serves, notwithstanding our imperfect knowledge of the remaining characteristics, to distinguish this type from all other known representatives of the genus.

Folliculina hirundo, S. K. Pl. XXIX. Fig. 39.

Lorica flask-shaped, pale sea-green when young, dark bottle-green when old; attached posteriorly; constricted centrally and again dilated before narrowing off to form the short, circular, and slightly everted distal aperture. Animalcule bottle-green; peristomal lobes very long and narrow, uniform in size, eight or ten times as long as broad, or equal in length when extended to that of the entire body; endoplast ovate, subcentral; contractile vesicle posteriorly located. Length of lorica 1–200″.

Hab.—Salt water: Channel Islands.

This species was obtained by the author, at Guernsey, in the autumn of the year 1870 and on subsequent occasions, attached in some abundance to various marine Polyzoa and seaweeds, the swallowtail-like aspect presented by the peristomal lobes when seen from the dorsal or ventral aspect in their fully extended state, suggesting the title conferred upon it. The alternately constricted and inflated anterior portion of the lorica of this species, in addition to the slender and attenuate contour of the peristomal lobes, distinguishes it readily from the forms previously described. The basis of attachment of the lorica in *Folliculina hirundo* occupies a very small area of the surface, being limited entirely to the posterior region.

Folliculina Boltoni, S. K. Pl. XXIX. Fig. 36.

Lorica flask-shaped, attached laterally, transparent when young, chestnut-brown when old; neck bent upwards, very short, its margin even, circular, not everted. Animalcule transparent; peristomal lobes rounded, of unequal size, one of these, usually the left, attaining twice the dimensions of the other. Length of lorica, 1–200″.

Hab.—Fresh water, on *Anacharis* and other aquatic plants.

This species is named after its first discoverer, Mr. Thomas Bolton, to whom the author is indebted for the opportunity of examining examples of this and many other interesting infusorial forms described in this volume. So far it would appear to be the only representative of the genus *Folliculina* yet obtained in fresh water, and may be otherwise distinguished from its several marine congeners by the unequal size of its

peristomal lobes; the lorica most nearly resembles that of *F. elegans*, but the margin is even and not everted, and there are no internal valves. The colour and consistence of this structure apparently agree with those of various species of the genera *Cothurnia* and *Vaginicola*, and in the absence of the animalcule might be mistaken for the lorica of *Vaginicola* (*Platycola*) *longicillis*. The species of *Lagotia* (*Folliculina*) referred to though not described by Mr. Barrett * as occurring in company with *Stentor Baretti*, in the river Thames, near Moulsford, is probably identical with the present type.

GENUS III. CHÆTOSPIRA, Lachmann.

Animalcules highly elastic and contractile, inhabiting an attached mucilaginous or horny sheath or lorica, to the inner wall of which they are not, however, organically united; peristome represented by a slender, ligulate extension of the anterior region, which, when the animalcule is expanded, projects beyond the aperture of the lorica and is twisted into a more or less extensive læotropous or left-ascending spire; a hyaline membraniform expansion extending laterally along the broad portion of the ligulate peristome and forming with it a gutter-like channel, which conducts to the oral aperture; this adoral groove continued backwards into the substance of the parenchyma as a narrow tubular pharynx; a row of large, prominent, cirrate adoral cilia bordering the entire length of one side of the ligulate peristome, commencing at the apical extremity and terminating in the vicinity of the mouth; cilia of the general cuticular surface fine, distributed in even longitudinal rows; supplementary, delicate, hair-like setæ sometimes projecting in an irregular manner from the surface of the integument. Inhabiting fresh and salt water.

Lachmann, when instituting the generic title of *Chætospira*,† hazarded the opinion that the animalcule to which he gave that name might possibly be identical with the, at that time, very imperfectly described *Stichotricha secunda* of Perty. Stein, who has since met with this last-named type, and figured and described it in his monograph of the Hypotricha, adopts this view, and has no hesitation in pronouncing the two to be the same. The present author is inclined, however, to dissent from this decision, having observed an animalcule which, while corresponding in all important points with Lachmann's species, is altogether distinct from the one figured by Stein, and referred correctly, so far as it is possible to decide, to Perty's *Stichotricha*. This latter form, as made known by the more recent investigations of Stein, and described further on in this volume is, as first premised by Perty, an unmistakable representative of the Hypotrichous family of the *Oxytrichidæ*, sharing with the more ordinary members of that group the characteristic ciliation, which is restricted to the ventral surface of the body, and there limited, in addition to the adoral fringe, to a few widely separated rows of short, non-vibratile, ventral and marginal, setose cilia. In *Chætospira*, on the other hand, the character and distribution of the cuticular cilia is entirely diverse, taking the form of fine vibratile cilia, which are distributed in close parallel rows throughout the surface of the integument as in an ordinary Holotrichous animalcule, the anterior fringe of powerful adoral cirri necessitating, however, its reference to the higher order of the Heterotricha. Among these it is evident that its correct position is not very remote from the genus *Folliculina*, and with certain representatives of which, such as *F. producta* or *F. hirundo*—premising one of the ligulate peristome-lobes to be suppressed and the remaining one to be twisted in a spiral manner—it might be appropriately

* 'Monthly Microscopical Journal,' April 1870.

† Müller's 'Archives,' p. 362, 1856.

compared. Although thus demonstrating the essential distinctness of the two genera *Chætospira* and *Stichotricha*, and the necessity of referring them to even diverse orders of the Ciliata, the likeness between the two in both habits and in certain important structural characteristics cannot be overlooked. This is most prominently manifested in the peculiar form and deportment of the peristome, and in the custom of each to build and inhabit a mucilaginous or horny sheath. These two generic types would appear to afford indeed but one among the many instances that occur in demonstration of the close approximation to one another of two seemingly widely diverse groups, as circumscribed by the necessarily artificial boundaries of zoological taxonomy.

Chætospira Muelleri, Lachmann. PL. XXIX. FIGS. 37 AND 38.

Sheath or lorica flask-shaped, transparent, of horny consistence, the enclosed animalcule adapting the contour of its body to the shape of the lorica; the spire formed by the flexure of the ligulate peristome describing more than a single turn; cilia of adoral fringe longest centrally, diminishing gradually in length towards the apical and basal extremities; fine, and apparently retractile, setose cilia sometimes forming a conspicuous series down the border of the peristome, opposite to that fringed by the adoral cilia; endoplast spherical, subcentral; contractile vesicle anteriorly situated. Length of extended body 1–160″. HAB.—Fresh and salt water.

This species, while originally characterized as a fresh-water inhabitant occurring only in the open cells of decaying leaves of *Lemna trisulca*, has been met with by the author under numerous varying conditions, not unfrequently with its transparent, flask-shaped lorica independently attached to growing leaves of *Myriophyllum* and other water plants, while on more than one occasion examples were encountered that had built their habitations within the vacated egg-capsules of various species of Rotiferæ. Although Claparède and Lachmann have mentioned that it is only in relationship with the following type that supplementary fine setæ have been detected upon the general surface of the body, these structures, as figured in the accompanying illustration, have been frequently observed by the author in the present variety. It seems highly probable that these supplementary setæ, as in the case of certain *Stentors*, are not of constant recurrence, but are extruded and retracted at the will of their possessor. The contractile vesicle in the examples personally examined occupied a much more anterior position than is given by Lachmann, being indeed considerably in advance of the oral aperture and, as shown in the accompanying illustration, in close vicinity to the distal termination of the lateral membranous expansion, and to the first abrupt flexure of the peristome; the systole of this organ was found to recur with unvarying regularity every fifteen seconds. The anal aperture is reported by Lachmann as occupying a position closely adjacent to that of the contractile vesicle as here given.

A species superficially so closely resembling *C. Muelleri* has been obtained by the author from salt water that it is not thought desirable at present to introduce it under a new title, this marine form being probably also identical with the animalcule briefly described some years since by Dr. Strethill Wright under the name of *Chætospira marina*.*

Chætospira mucicola, Lachmann.

Sheath or lorica entirely mucilaginous, transparent; the anteriorly produced ligulate peristome forming, in the expanded state, less than a complete spiral turn, the long adoral cilia that fringe its border being longest at the

* 'Quarterly Journal of Microscopy,' vol. ii. 1862.

anterior extremity, the foremost one in particular being twice as long and thick as any of the succeeding ones; supplementary fine setæ developed throughout the general surface of the body. Dimensions unrecorded.

HAB.—Fresh water, among confervoid algæ.

Supplementary Species.

In the 'Monthly Microscopical Journal' for October 1875, an animalcule is figured and described by Dr. C. T. Hudson under the title of *Archimedea* (*Chætospira*) *remex*. As seen only with the twisted anterior extremity protruded from the opaque attenuate lorica, it would seem to possess a strong claim for admission to the present genus; Dr. Hudson's representation, however, of the animalcule in its free-swimming state, demonstrates it to be a Hypotrichous form referable to Perty's genus *Stichotricha*, under which heading it receives fuller attention later on. This same species has been met with by Mr. Thomas Bolton, and has been referred to by him in the 'Midland Naturalist' for 1875 under the name of *Chætospira cylindrica*, a title provisionally conferred upon it by the present author when familiar only with Mr. Bolton's delineations of the animalcule as seen in its sedentary semi-extended condition.

Fam. IV. TINTINNODÆ, C. & L.

Animalcules free-swimming or sedentary, mostly inhabiting an indurated sheath or lorica, to the bottom or side of which the ovate or pyriform body is usually attached by a retractile pedicle or thread-like prolongation of the posterior extremity. Oral aperture eccentric, terminal or subterminal, peristome subcircular, bordered by a single or complex, evenly circular or spiral fringe of large cirrate cilia; the general cuticular surface more or less completely clothed with fine vibratile cilia.

By Stein the representatives of *Tintinnus*, the type genus of the family, are included among the Peritricha, he having failed to detect in the few examples he examined the presence of the fine cuticular cilia so amply demonstrated to be present in a number of species through the more extensive researches prosecuted by Messrs. Claparède and Lachmann with reference to this especial group.

GENUS I. TINTINNUS, Schrank.

Animalcules ovate or pyriform, attached posteriorly by a slender retractile pedicle within a more or less indurated sheath or lorica; the lorica floating freely in the water, not attached to foreign organisms; peristome-field occupying the entire anterior border, circumscribed by a more or less complex spiral wreath of long, powerful, cirrose cilia, the left limb or extremity of which is spirally involute and forms the entrance to the oral fossa; this fossa continued into the substance of the parenchyma as a short, tubular pharynx; anal aperture posteriorly situated, subterminal; cuticular cilia very fine, distributed evenly throughout, clothing both the body and the retractile pedicle.

The genus *Tintinnus* was instituted by Schrank * for the reception of the *Trichoda inquilinus* of Müller and two other doubtful loricate forms whose specific identity

* 'Fauna Boica,' 1803.

cannot at present be determined. The generic group, even as more explicitly circumscribed by Ehrenberg and later authorities is, however, by no means so clearly defined as might be wished. Under this title are indifferently included animalcules that live, as indicated in the foregoing diagnosis, an entirely free-swimming or pelagic life, and others whose loricæ, like those of *Vaginicola* or *Folliculina*, are permanently attached to water-plants or other submerged objects; the genus indeed, as defined by Eichwald, is erroneously represented as composed entirely of such sedentary forms. In recognition of the essential difference that subsists between these respective pelagic and sedentary types, it has been considered desirable to separate from *Tintinnus* all those animalcules that belong to the last-named category and to confer upon them the new generic title of *Tintinnidium*. The genus *Tintinnus*, as limited only to the free-swimming or pelagic forms, still presents structural characteristics upon which modern investigators have as yet arrived at a by no means harmonious interpretation. Although Claparède and Lachmann have succeeded in demonstrating that the entire cuticular surface in the majority of the species examined by them, inclusive of the type form *T. inquilinus*, is clad with fine vibratile cilia, as in *Stentor*, *Folliculariа*, and other Heterotricha, no such finer supplementary cilia were observed by the founder of the genus or other more recent authorities. Even Stein, whose personal acquaintance, however, is apparently limited only to the two species *Tintinnus inquilinus* and *Tintinnus* (*Tintinnidium*) *fluviatilis*, failed to detect the presence of these cilia, and has in consequence referred the genus, together with *Tintinnopsis*, to the order of the Peritricha. The positive evidence afforded by Claparède and Lachmann's investigations nevertheless outweighing that of a negative nature only as produced by Stein in connection with this structural characteristic, the author has felt constrained to support the views of the first-named authorities, and to concede to the genus a corresponding position among the Heterotrichous order. It is at the same time by no means improbable that many Tintinnoid forms exist which differ from the typical members of the genus through the absence of a cuticular ciliary clothing, for which it will be requisite to institute a new generic title, allocating them to the order of the Peritricha. The *Tintinnus subulatus* of Ehrenberg is not improbably of this number.

All the known representatives of the genus *Tintinnus*, as here defined, inhabit salt water, and are notable for the extraordinary rapidity of their movements. Placed under the microscope they dart to and fro across the optic field with the swiftness of an arrow, a considerable amount of difficulty being necessarily involved in the apprehension of their more minute structural characters, and it is only indeed in examples that have become entangled among other objects present, or are held tight by compression between the slide and covering-glass, that these details can be sufficiently investigated. Through the researches of Claparède and Lachmann a very considerable addition has been made to the number of species included in the genus *Tintinnus* by Ehrenberg. It is necessary, however, to remark that in a large number of them the empty sheaths or loricæ alone have been observed, and it is therefore quite possible that certain of these structures may hereafter be found to belong to such other pelagic loricate types as *Codonella*, *Tintinnopsis* and *Dictyocysta*. In their adoral ciliary system and general contour the animalcules of *Tintinnus* correspond to some extent with those of the free-swimming illoricate Peritrichous genus *Strombidium*, with which again they are still more intimately united through the newly introduced and essentially Heterotrichous type *Strombidinopsis*.

Tintinnus inquilinus, Müll. sp. Pl. XXXI. Fig. 15.

Lorica subcylindrical, diaphanous, four or five times as long as broad, slightly attenuate posteriorly, the extreme ends abruptly truncate, anterior margin smooth, not everted; body of animalcule often fixed to one side instead of to the bottom of the lorica, elongate-conical, pedicle not quite

as long as the body; peristome-field circular, excavate, its inner margin bordered by several cycles of long, powerful adoral cilia; contractile vesicle anteriorly situated. Length of lorica 1–200″ to 1–130″.

HAB.—Salt water: Norwegian coast.

Transverse fission has frequently been observed by Stein in association with this species, this phenomenon being heralded by the development around the centre of the elongated body of the animalcule of a second girdle of powerful cirrose cilia. The *Tintinnus inquilinus* of Ehrenberg represents two essentially distinct animalcules; the free-swimming type, obtained by him from the harbour of Copenhagen, only being identical with the present species. The second form, encountered at Kiel, inhabiting a lorica which is permanently attached posteriorly to algæ and other objects, and which is alone represented in his illustrations of *T. inquilinus*,* is not a true *Tintinnus* and will be found described further on in connection with the name of *Tintinnidium marinum*. The fine cuticular cilia of the present species, clearly indicated in Claparède and Lachmann's drawing, have been accidentally omitted by the artist in the accompanying reproduction of their figure.

Tintinnus subulatus, Ehr. PL XXXI. FIG. 5.

Lorica elongate-cylindrical, diaphanous, from twelve to fifteen times as long as broad, terminating posteriorly in a long, sharp, and sometimes slightly curved spine-like point, the anterior region ornamented with several parallel transverse annulations, the front margin not everted; animalcule elongate, subcylindrical, having a very long, slender, retractile pedicle, entirely enclosed within its protective sheath. Length of lorica 1–120″.

HAB.—Salt water: abundant in the North Sea.

It is possible, as already intimated by Ehrenberg, that the *Vorticella vaginata* of O. F. Müller† is identical with this species, though at the same time the body of the animalcule in the last-named type presents a more globose outline, and there is a faint indication in Müller's figures, though not referred to in the text, of the lorica being attached posteriorly as in *Tintinnidium*, or an ordinary *Vaginicola*. To some extent, again, the figures referred to recall the initial condition of *Zoothamnium arbuscula* or *Z. alternans* (Pl. XXXVII. Figs. 6 and 7), in which a single large subglobose zooid surmounts the relatively thick transparent pedicle, the distal extremity of which alone encloses the retractile filament, and bears consequently no inconsiderable resemblance to a hyaline lorica.

Tintinnus mucicola, C. & L. sp. PL. XXXI. FIG. 16.

Lorica subcylindrical, mucilaginous, transparent, its surface somewhat uneven, little over twice as long as broad; body of animalcule ovate or pyriform, occupying about one-third of the cavity of the lorica, retractile pedicle very long, fixed to the bottom of the sheath and permitting the animalcule to protrude considerably beyond its anterior margin. Length of lorica 1–150″. HAB.—Salt water: Norwegian coast (C. & L.).

It is rather doubtful whether this species is not rightly referable to the closely allied sedentary genus *Tintinnidium*, and in that case would scarcely be distinguished from *Tintinnidium marinum*. Claparède and Lachmann testify to its close resem-

* 'Infusionsthierchen,' pl. xxx. fig. 2.
† 'Animalcula Infusoria,' pl. xliv. figs. 12 and 13, 1786.

blance to, and possible specific identity with, the fresh-water *Tintinnus* (*Tintinnidium*) *fluviatilis* of Stein, but are at the same time altogether silent upon the subject of its either attached or pelagic habits.

Tintinnus obliquus, C. & L. PL. XXXI. FIG. 26.

Lorica elongate, subcylindrical, transparent, homogeneous, seven or eight times as long as broad, narrower and conical posteriorly, the anterior margin even, straight; animalcule conical, its anterior margin very obliquely truncate, projecting, when extended, to nearly its entire length beyond the anterior margin of its lorica. Length of lorica 1–150″.

HAB.—Salt water: coast of Norway (C. & L.).

This species differs from *T. inquilinus* in the oblique contour of the peristomal margin of the animalcule only, and in the regular conical shape of the posterior extremity of the lorica; this structure is likewise proportionally much more elongate. In common with the last-named type the animalcule is often found with the pedicle attached high up on one side of the lorica; Lachmann's sketch represents an example so fixed to the centre of the interior of its sheath, and with the body almost entirely extruded from the aperture.

Tintinnus amphora, C. & L. PL. XXXI. FIG. 12.

Lorica transparent, homogeneous, elongate vase-shaped, about three and a half times as long as broad, inflated most a little below the centre, the anterior margin even, circular, slightly everted, followed by a narrower neck-like portion. Animalcule undescribed. Length of lorica 1–125″ to 1–80″. HAB.—Salt water: Sartorö, Norway (C. & L.).

No description of the living animalcule of this species has been recorded, but a motionless stalked cyst was on several occasions observed within the lorica. Sometimes this cyst contained a single granular body, while at other times it was broken up into numerous smaller granular spherules, each of which contained a colourless vesicle. Claparède and Lachmann were undecided whether or not to regard these cysts as intruding organisms or as encysted conditions of the original inhabitants. The latter interpretation may, however, probably be accepted, taking into consideration their stalked condition and the almost universal occurrence of an encysted stage throughout the whole class of infusorial animalcules. Similar encysted bodies were observed by these authorities in connection with various other members of the genus *Tintinnus*.

Tintinnus acuminatus, C. & L. PL. XXXI. FIG. 14.

Lorica diaphanous, homogeneous, elongate-cylindrical, ten or twelve times as long as broad, the posterior extremity acuminately pointed, the anterior margin even, everted. Animalcule not observed. Length of lorica 1–80″. HAB.—Salt water: Norwegian coast (C. & L.).

No account of this animalcule has been recorded; the lorica, while most nearly resembling that of *T. subulatus*, differs from that species in its everted and non-annulate anterior margin and in its acuminate posterior termination, which is described as being facetted in an elongate-pyramidal manner.

Tintinnus Steenstrupii, C. & L. PL. XXXI. FIG. 20.

Lorica diaphanous, homogeneous, subcylindrical, elongate vase-shaped, seven or eight times as long as broad; the posterior extremity slightly

inflated and ornamented with four longitudinal grooves or sulci, the anterior margin widely everted. Animalcule elongate-ovate, occupying, when retracted, the entire posterior half of the lorica. Length of lorica 1–125″.

HAB.—Salt water: Norwegian coast (C. & L.).

Tintinnus quadrilineatus, C. & L. PL. XXXI. FIG. 13.

Lorica transparent, homogeneous, shortly vase-shaped, about three times as long as broad; anterior margin widest and largely everted, gradually tapering towards the posterior extremity where it terminates in an obtuse point; four deep grooves extending from the posterior extremity nearly as far as the anterior margin. Animalcule undescribed. Length of lorica 1–150″. HAB.—Norwegian coast (C. & L.).

Tintinnus denticulatus, Ehr. PL. XXXI. FIGS. 18 AND 19.

Lorica diaphanous, cylindrical, two or three times as long as broad, terminating posteriorly in a long acute point, surface regularly shagreened with minute hexagonal facets; the anterior margin finely denticulate, not everted. Animalcule unobserved. Length of lorica 1–175″.

HAB.—Salt water: Baltic Sea and Norwegian coast.

Claparède and Lachmann, who met with this species abundantly on the coast of Norway, remark that the lorica is of very variable form, the width being sometimes equal to the length, while occasionally the posterior portion, before narrowing off to the terminal subulate point, is considerably inflated. The very beautiful hexagonal facetted structure of the test, as reproduced at Pl. XXXI. Fig. 19, is only exhibited under a high magnification, the facets under a moderate magnifying power presenting the appearance of minute circular areas. Unfortunately no account of the animalcule inhabiting this elegant lorica has been placed on record by Ehrenberg, or Claparède and Lachmann, which thus leaves it doubtful whether we have here the protective sheath of a true *Tintinnus*, or the facetted test of a *Dictyocysta* or *Codonella*. *Tintinnus denticulatus*, while described by Ehrenberg in the year 1840,* was first met with abundantly by Professor C. Boeck, in the vicinity of Spitzbergen, in the year 1839, and subsequently by the same investigator in the Fjord of Christiania. Its distribution would appear to be general and abundant throughout the seas of Northern Europe.

Tintinnus Ehrenbergii, C. & L. PL. XXXI. FIGS. 1 AND 2.

Lorica colourless, evenly cylindrical, very thick, finely granulate, about three times as long as broad; posterior extremity rounded, and then produced into a short, obtuse and usually curved, spur-like point; anterior margin even, not everted. Animalcule pyriform, attached posteriorly by a pedicle which equals its body in length, occupying, when retracted, about one-third of the interior of the lorica; contractile vesicles two in number, posteriorly located. Length of lorica 1–120″.

HAB.—Salt water: Norwegian coast (C. & L.).

Claparède and Lachmann describe this form as exceeding, in both the dimensions of the animalcule and in the size and thickness of the lorica, any other species met

* 'Monats. Berl. Akad.,' p. 201, 1840.

with by them. The surface of the exceedingly thick and massive lorica, while seeming to be simply granulate under a magnifying power of 300 diameters, is shown, when still further enlarged, to be ornamented with hexagonal facets in a manner corresponding with that of *T. denticulatus*, though on a much finer scale.

Tintinnus lagenula, C. & L. PL. XXXI. FIGS. 21 AND 22.

Lorica broadly flask- or helmet-shaped, nearly as wide as long, with a very short and slightly narrower everted neck, and inflated body-portion; posterior region verrucose and opaque, divided into somewhat coarse polygonal areas or facets, the anterior end smooth and diaphanous; extended animalcule nearly equal in length to the lorica, two zooids sometimes inhabiting the same domicile. Length of lorica 1–80″.

HAB.—Salt water: Norwegian coast (C. & L.).

The contour of the lorica of this species, combined with the verrucose and facetted aspect of its posterior region, coincides remarkably with that of *Codonella galea*, Hkl., described later on. As seen with a magnification of 700 diameters, each of these polygonal facets exhibits a central spot which Claparède and Lachmann are disposed to regard as a perforation. A similar formation, as represented in the lorica of *Codonella galea*, is interpreted by Haeckel as due to the enclosure within each facet of a minute siliceous corpuscle.

Tintinnus cinctus, C. & L. PL. XXXI. FIG. 10.

Lorica cylindrical, slightly opaque, everted at its anterior margin, about three times as long as broad, terminating posteriorly in an elongate, often recurved point; the whole surface ornamented with widely separated transverse annulations. Animalcule unobserved. Length of lorica 1–200″.

HAB.—Salt water: coast of Norway.

The possible identity of this type with the *Codonella orthoceras* of Professor Haeckel receives attention in the description given of that species.

Tintinnus cothurnia, Ehr.

Lorica cylindrical, diaphanous, attenuate and truncate posteriorly; transversely but indistinctly annulate throughout. Length of lorica 1–440″.

HAB.—Fresh water: Baltic Sea.

This species is described by Ehrenberg in company with *T. denticulatus* in the 'Monatsbericht d. Berliner Akademie,' p. 201, 1840. Its nearest ally would appear to be the *Tintinnus cinctus* of Claparède and Lachmann.

Tintinnus helix, C. & L. PL. XXXI. FIG. 24.

Lorica cylindrical, four times as long as broad, slightly opaque from the incorporation of minute granular particles; grooved or sulcate posteriorly in a spiral or helicoidal manner, the anterior extremity transversely annulate; the distal margin even, not everted, the opposite or posterior end terminating in a short and often slightly recurved point. Animalcule unobserved. Length of lorica 1–165″.

HAB.—Salt water: Norwegian coast (C. & L.).

Tintinnus annulatus, C. & L. Pl. XXXI. Fig. 25.

Lorica subcylindrical, irregularly inflated posteriorly, terminating in a short acuminate point, the anterior margin not everted; consistence opaque and coarsely granular through the incorporation of foreign particles; the posterior body-portion exhibiting several annular constrictions. Animalcule not observed. Length 1–120″.

Hab.—Salt water: Norwegian coast.

Tintinnus campanula, Ehr. Pl. XXXI. Fig. 11.

Lorica campanulate, widely dilated anteriorly, tapering posteriorly, terminating in an attenuate point; substance coarsely granulate through the incorporation of foreign particles. Body of animalcule occupying when retracted about one-half of the cavity of the lorica. Length of lorica 1–166″ to 1–125″. Hab.—Salt water: Norwegian coast (C. & L.).

Claparède and Lachmann propose to identify the form, as here figured, with the species first introduced under the same title by Ehrenberg, but with no illustration, in the 'Monatsb. der Berlin. Akad.,' p. 201, 1840. While, however, Ehrenberg's brief diagnosis of his *Tintinnus campanula* appears to accord with the present type, the dimensions of the lorica, as given by him, are much more minute, not exceeding 1–288″.

Tintinnus ventricosus, C. & L. Pl. XXXI. Fig. 31.

Lorica coarsely granulate, ventricose or bottle-shaped, nearly as broad as long; the wider anterior portion surmounted by a short, narrow, slightly everted neck, terminating posteriorly in an obtuse point. Animalcule unobserved. Length of lorica 1–250″.

Hab.—Salt water: Norwegian coast.

Tintinnus urnula, C. & L. Pl. XXXI. Fig. 3.

Lorica cylindrical, transparent and homogeneous, of a slightly smoky hue, little over twice as long as broad, terminating posteriorly in a sharp subulate point; the anterior region not everted, ornamented at a little distance from its terminal margin with a raised border or annulation. Length of lorica 1–175″. Hab.—Salt water: Norwegian coast (C. & L.).

Claparède and Lachmann merely remark of this animalcule that it possesses a single contractile vesicle. In their drawing of the species, here reproduced, they represent an example that is apparently preparing to increase by fission. In this instance a second fascicle of cirri is in course of development at the posterior extremity, its position corresponding closely with that assumed by the posteriorly affixed zooid of a *Vorticella* during the act of conjugation. It is just possible that a similar interpretation might be applied in the present case.

Tintinnus Ussowi, Mereschk. Pl. XXXI. Fig. 4.

Lorica transparent, attenuate, straight, subcylindrical, ten or twelve times as long as broad, slightly widest anteriorly, tapering gradually backwards, and terminating posteriorly in a sharply acuminate or subulate prolongation; the anterior third ornamented with from twelve to fifteen finely

denticulate transverse annulations, the remainder of its surface perfectly smooth; enclosed animalcule as in *Tintinnus inquilinus*. Length of lorica 1–192″. HAB.—Salt water: White Sea (Mereschkowsky).

Excepting for the presence of the denticulate annuli at the anterior extremity, the lorica of this species is indistinguishable from that of *T. subulatus*.

Tintinnus mediterraneus, Meresch.

Lorica transparent and homogeneous, urceolate, scarcely longer than broad, abruptly narrowed in a neck-like manner anteriorly, not everted, the posterior extremity obtusely rounded or terminating in an acute point; four or five closely approximated parallel linear annulations ornamenting the neck-like portion. Animalcule not observed. Length of lorica 1–160″.

HAB.—Salt water: Black Sea and Bay of Naples (Mereschkowsky)

This species is figured and described by Mereschkowsky in company with several other interesting marine types in the 'Annals and Magazine of Natural History' for April 1881. The two forms of this species, distinguished respectively by the rounded or acuminate termination of the posterior extremity of their loricæ, were obtained respectively from the Black Sea and Bay of Naples, and receive from their discoverer the separate designations of *Tintinnus mediterraneus* var. *pontica* and *T. med.* var. *neapolitana*.

Supplementary Species.

Quite recently, Professor H. Fol has contributed to the 'Archives des Sciences Physiques et Naturelles,' tom. v., January 1881,* a memoir on the organography of the genus *Tintinnus*. Among other important points, he therein maintains that the oral ciliary system exhibits a far more complex structural plan than that of either one or more concentric circles or spiral revolutions, as represented by previous authorities. In place of this he reports of two new Mediterranean species, *Tintinnus ampulla* and *T. spiralis*, as examined by himself, that the cilia of the peristome are all arranged in accordance with about twenty curved lines, which, starting from the interior of the disc, become tangential to its margin, the longest and strongest cilia being developed at the periphery. Presuming that such a structural plan of the ciliary system as is described and delineated by Professor Fol of these two types actually exists, the author is unable to regard them as eligible for admission into the genus *Tintinnus*, the broad petaloid modification of the peripheral border, with its associated cilia, being altogether distinct from what obtains in the typical members of that genus as verified in so large a number of species by Claparède and Lachmann and other recent observers, and as also certified by the author in the case of *Tintinnus subulatus*. These two forms are hence provisionally referred to the Peritrichous order in connection with the new generic title of *Petalotricha*.

Professor Fol has further proposed to subdivide *Tintinnus*, as here defined, into two subordinate generic groups with reference to the consistence of their protective loricæ or tests. Following out this plan, he suggests the title of *Tintinnus* for those forms only in which the test is entirely smooth and plane, and that of *Coniocyclis* for those species in which the test is more or less marked with transverse striæ and impregnated, especially in parts, with foreign mineral particles. This suggested innovation is not, however, advocated in this treatise, the composition of the test being regarded by the author as a character entirely subordinate to the structure of the animalcules by which they are fabricated. If, indeed, such a distinction must be recognized, it would be also desirable to establish a third genus for such forms as *Tintinnus subulatus* and *T. Ussowi*, in which the test or lorica,

* This paper is translated by Mr. W. S. Dallas in the 'Annals and Magazine of Natural History' for April 1881.

while homogeneous, is transversely annulate; and a fourth for such as *T. ventricosus*, in which the test is coarsely granular but not annulate. So far, indeed, as the granular consistence of this excreted element is concerned, it is without doubt dependent to no small extent upon surrounding conditions, such as the clearness or turbidity of the waters which the animalcules inhabit.

GENUS II. TINTINNIDIUM, S. K.

(*Tintinnus*; *oidos*, form.)

Animalcules ovate or pyriform, resembling those of the genus *Tintinnus*, but excreting a sheath or lorica, usually of a mucilaginous consistence, which is permanently affixed to foreign objects. Inhabiting salt and fresh water.

This new genus is here instituted for the reception of the *Tintinnus inquilinus*, in part, of Ehrenberg, and the *Tintinnus fluviatilis* of Stein—two forms closely allied to one another, and which differ from the typical representatives of the last-named genus in their essentially sedentary habits.

Tintinnidium marinum, Ehr. sp. PL. XXXI. FIG. 9.

Lorica transparent, subcylindrical, two and a half to three times as long as broad; animalcule when retracted filling two-thirds of the cavity of the lorica, projecting beyond its orifice, when extended, to a distance of one-half of its total height; retractile pedicle in full extension equal in length to the body, sometimes attached to the bottom and sometimes to one side of the inner surface of the lorica. Length of lorica 1–240″.

HAB.—Salt water, attached to various marine algæ.

The above specific title is here associated with that variety of the so-called *Tintinnus inquilinus* met with by Ehrenberg attached to algæ at Kiel, and as figured by him at pl. xxx. fig. ii. 1 and 2, of his 'Infusionsthierchen.' This animalcule is altogether distinct from the typical free-swimming representatives of the species first described by Schrank, and as also encountered by Ehrenberg in the harbour of Copenhagen. Its possible identity with the *Tintinnus mucicola* of Claparède and Lachmann, delineated at fig. 16 of the same plate, is adverted to in the description given of that species.

Tintinnidium fluviatilis, Stein sp. PL. XXXI. FIG. 8.

Lorica cylindrical, transparent, mucilaginous, surface uneven, frequently with incorporated foreign particles; body of animalcule conical or campanulate, occupying about one-half of the cavity of the lorica, projecting when extended to nearly one-half its length beyond its aperture; retractile pedicle attached to either the side or the bottom of the cavity of the lorica; contractile vesicle spherical, subcentral; endoplast elongate-ovate, laterally located, having attached to it a minute, round endoplastule. Length of lorica 1–200″. HAB.—Fresh water, on aquatic plants.

With the exception of its fresh-water habitat, this species seems to differ very little from the form previously described. In addition to its observation by both Stein and Claparède and Lachmann, the present author has received drawings of an apparently identical form through Mr. Thomas Bolton, the originals of which

were obtained by him from the neighbourhood of Stourbridge, Worcestershire, attached to the leaves and stems of *Anacharis alsinastrum*. In one of the sketches forwarded two examples are affixed to the rigid footstalk of a large *Epistylis*. Although Stein * failed to detect in the examples examined by him the presence of fine vibratile cilia on the general cuticular surface, he reports the existence, towards the anterior extremity, of fine, scattered, hair-like setæ, which appear to assist in maintaining the animalcule in its extended state, and are apparently identical in character with the similar structures present in certain species of *Stentor* and *Chætospira*. The record of the existence of these setæ must be accepted as additional and important evidence in support of the Heterotrichous affinities of the genus *Tintinnidium* and its allies, as advocated in this volume.

Tintinnidium semiciliatus, Sterki sp. PL. XXXI. FIGS. 6 AND 7.

Lorica subcylindrical, mucilaginous, flocculent and semi-opaque, through the more or less abundant incorporation of vegetable debris, about three times as long as broad; enclosed animalcule conical or pyriform, truncate and widest anteriorly, tapering posteriorly, and there continued in the form of a slender, retractile pedicle, which equals the body in length and attaches it to the bottom of the lorica; cilia of the adoral wreath very large and stout, flattened or lamellate, apparently pectinate at their distal extremities; the peristome-border enclosing an inner circlet of shorter and finer simple cilia; cuticular cilia limited to the anterior region of the body; oral cleft conspicuous, infundibuliform, produced backwards to a distance of about one-third of the length of the entire body, associated with a movable lip- or tongue-like organ; contractile vesicle single, spherical, situated near the termination of the oral cleft; endoplast ovate, with a posteriorly enclosed endoplastule, located on the opposite side and a little posterior to the contractile vesicle; adoral cilia only, during full extension, projecting beyond the surface of the lorica. Length of body without the pedicle or adoral cilia 1–625″ to 1–416″. HAB.—Fresh water, attached to *Confervæ*.

This species is referred by Sterki † to the genus *Tintinnus;* its distinctness from *Tintinnus* (*Tintinnidium*) *fluviatilis* being, as he maintains, manifested in the limited anterior distribution of the cuticular cilia, and in the peculiar character of those forming the adoral wreath. These last-named appendages, according to Sterki, are not simply cirrose, as with most ordinary Heterotricha, but are flattened and lamellate, and thus coincide in structure with the so-called "membranellæ," of which, in accordance with the investigations of this authority, the homologous adoral system of the Oxytrichidæ is composed. Like the corresponding appendages of this last-named group, they are inserted basally deep within the substance of the cortex, and are further complicated by being split up in a laciniate or pectinate manner at their free or distal end. Such a pectinate aspect is presented in the illustration reproduced at Pl. XXVIII. Fig. 7; but it would seem to be an open question whether or not such delineation represents the optical aspect only of two or more concentric ciliary circlets, and which, as they exist in many Peritrichous forms, have been frequently depicted incorrectly as possessing a similar complex pectinate contour. Sterki, nevertheless, is so satisfied as to the accuracy of his interpretation of these structures as to give a drawing of an isolated pectinate cirrus, and reports that from fifteen to twenty of these elements are associated in the complete series. While normally found attached within their mucilaginous loricæ, the animalcules of this species are capable

* 'Infusionsthiere,' Abth. ii., 1867, p. 152.
† 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xxxii., 1879.

at will of severing such attachment, and swimming freely in the water. The pedicle under such conditions is entirely retracted, and the body, as shown in the figure last quoted, presents an evenly ovate contour. Multiplication by transverse fission was observed, the process being preceded, as in *Tintinnus urnula*, by the development of a new and smaller adoral fascicle of cilia toward the posterior region of the lateral border. Since Stein has, as above mentioned, recorded the presence of fine hair-like setæ towards the anterior region of *Tintinnidium fluviatilis*, it would seem to be by no means improbable that the present form may eventually prove to be but a synonym of that type.

GENUS III. VASICOLA, Tatem.

Animalcules more or less ovate, elastic and changeable in form, inhabiting adherent, transparent loricæ, within the cavities of which they remain freely suspended, and from out of which they emerge at will; oral aperture at the anterior extremity, surrounded by a circlet of long cirrate cilia; anal aperture postero-terminal; cilia of the general cuticular surface equal in size, evenly distributed.

Vasicola ciliata, Tatem. PL. XXX. FIGS. 27 AND 28.

Lorica hyaline, erect, shortly flask-shaped, about twice as high as broad, truncate posteriorly, slightly widest centrally, narrowing anteriorly into a short, wide neck, its surface finely corrugate transversely; animalcule ovate or pyriform, filling the greater portion of the cavity of the lorica, the oral orifice in extension usually level with the front border of the lorica, the longer oral cilia springing from a more prominent raised lip or peristome; cuticular cilia fine, evenly distributed; parenchyma usually enclosing numerous light, claret-coloured food-globules. Length of body 1–180″, height of lorica 1–150″.

HAB.—Pond water with decaying animal and vegetable matter.

No reference is made by Mr. Tatem in his description of this type* to the presence of either an endoplast or contractile vesicle, the exact form and position of the oral aperture being left in similar uncertainty. While under examination the animalcules were found to be exceedingly impatient of restraint, usually issuing from their loricæ, and swimming freely in the water soon after their transfer to the stage of the microscope. The ingestion of food-particles, including chiefly vibriones, monads, and minute fragments of decaying vegetation, was abundantly observed, as also on repeated occasions the increase of the animalcules within their loricæ by transverse fission. The brilliant colour of the food-globules, recorded in the foregoing diagnosis, is not conspicuous until after their retention for some little time within the substance of the parenchyma, and is, as suggested by Mr. Tatem, in all probability attributable to the chemical action of the assimilative process. A somewhat analogous coloration of the incepted food-particles has been already observed to take place in relationship with certain species of the genus *Nassula*.

GENUS IV. STROMBIDINOPSIS, S. K.

(*Strombidium*; *opsis*, like.)

Animalcules free-swimming, illoricate, ovate or pyriform, persistent in shape; peristomal cilia enclosing the entire frontal border, consisting of a spiral wreath of one or more turns of long, powerful, cirrose cilia; the whole

* 'Monthly Microscopical Journal,' vol. i. p. 117, 1869.

surface of the body clothed with short, fine, vibratile cilia; contractile vesicle posteriorly located.

The animalcules of this genus closely resemble those of the Peritrichous genus *Strombidium*, but are to be distinguished from them by the fine ciliation of the entire general surface of the body, and which, corresponding with that of *Stentor* or *Tintinnus*, necessitates its relegation to the Heterotricha. The only species so far observed is an inhabitant of fresh water.

Strombidinopsis gyrans, S. K. PL. XXXI. FIG. 29.

Animalcule elongate-ovate, about twice as long as broad, the anterior margin truncate, the posterior extremity conical; cilia of the peristome very strong and powerful, bent outwards, their length equal to that of the entire body, forming a spiral wreath of rather more than one turn, which commences at some little distance from the anterior margin; its left limb or extremity descending into the oral fossa, which is further continued to the centre of the body as a distinct pharyngeal passage; cilia of the cuticular surface very fine and short. Length of body 1–350″.

HAB.—Pond water.

The animalcules forming the type of this species were met with in a pond containing *Myriophyllum* and other aquatic plants, obtained from the neighbourhood of Stoke Newington, London, in the month of February, 1874. The extremely long outward-bent peristomal cilia, taken together with the ovate form of the body, convey to this species an aspect not unlike that of a miniature shuttlecock. Its movements in the water are extremely vigorous, and difficult to follow, consisting of a swift gyratory motion, interrupted by rapid dartings to and fro across the field of view.

Fam. V. TRICHODINOPSIDÆ, S. K.

Animalcules free-swimming, persistent in shape, illoricate, posterior border discoidal, acetabuliform, and adherent at will; oral aperture subterminal, approached by a spiral fringe of larger adoral cilia; general cuticular surface finely ciliate throughout.

GENUS I. TRICHODINOPSIS, C. & L.

Animalcules freely movable, of more or less conical outline, having an anterior adoral ciliary system and posterior adhesive sucking-disc, strengthened with a horny ring, similar to that of *Trichodina*, but the entire surface of the body covered with fine vibratile cilia. Occurring as parasites or commensals upon various aquatic Mollusca.

Trichodinopsis paradoxa, C. & L. PL. XXXI. FIGS. 39–43.

Body conical or cap-shaped, slightly curved, gradually tapering from the broadly expanded base to the bluntly pointed anterior extremity; the posterior sucking-disc occupying about two-thirds only of the diameter of the basal region, slightly eccentric; ciliary zone surrounding this structure longer and stronger than those of the oral region or general cuticular surface; interior corneous ring having no denticulations, but spirally striate

or plicate; cilia of the general surface long and fine, presenting a tufted or matted aspect, all directed towards the anterior extremity; endoplast laminate, nodular; contractile vesicle single, spherical, anteriorly situated. Length when extended 1–190″.

HAB.—Fresh water, parasitic within the intestinal and pulmonary cavities of various species of *Cyclostoma*. Geneva (C. & L.).

Claparède and Lachmann, the discoverers of this remarkable form—which, excepting for the presence of the fine cuticular cilia, closely resembles a *Trichodina*—have recorded the existence, within its oral cavity, of two transparent triangular plates of considerable size, but whose nature and use they did not succeed in determining. They likewise observed in close proximity to and immediately above the posterior sucker a solid cap-shaped body, to which might possibly be attributed the function of a muscular apparatus for the elevation or depression of the subjacent disc. The movements of the cilia of the general surface of the body are referred to as exhibiting a tufted aspect and elegant undulating action resembling that of *Opalina*, *Conchophthirus*, and *Plagiotoma*. The species here described was found in countless numbers within the intestinal and pulmonary cavities of *Cyclostoma elegans;* a further investigation among other aquatic Mollusca will probably reveal the existence of many closely related forms. Through the intermedium of *Trichodinopsis* the Heterotrichous order is clearly connected with that of the Peritricha, as represented by *Trichodina* and its allies.

Fam. VI. CODONELLIDÆ, S. K.

Animalcules free-swimming, conical or elongate, inhabiting an indurated sheath or lorica, to the inner wall of which they are attached by the more attenuate posterior extremity; oral aperture terminal, surrounded by an outer circle of long, flexible, tentaculiform cilia, and an inner circlet of shorter, cirrate cilia or lappet-like appendages.

The animalcules of this small family group are to be recognized by the presence of the long tentacle-like cilia which form an outer fringe around the frontal border, a type of structure which recurs again, however, in the smooth-bodied and consequently Peritrichous genus *Dictyocysta*. Floating mouth downwards with these tentaculiform appendages actively deployed in various directions, the resemblance of these elegant Infusoria to minute Medusæ is very striking. All the representatives of this group as at present known are essentially pelagic.

GENUS I. CODONELLA, Haeckel.

Animalcules conical or trumpet-shaped, solitary, free-swimming, highly contractile, inhabiting a helmet- or bell-shaped lorica, to which they are attached by their posterior extremity; the anterior region truncate or excavate, forming a circular peristome having an outer fringe of about twenty long, tentacle-like cilia, and an inner collar-like border or frill, which bears an equal number of slender, lappet-like appendages; entire cuticular surface clothed with fine, vibratile cilia; lorica imperforate, of chitinous consistence, sometimes sculptured or mixed with granular foreign substances. HAB.—Salt water, pelagic.

The several species referred to this genus were originally discovered by Professor Haeckel in the Mediterranean, and described by him in an article

" Ueber einige neue pelagische Infusorien," contributed to the 'Jenaische Zeitschrift' for the year 1873.

Codonella galea, Hkl. Pl. XXXI. Figs. 32 and 33.

Lorica helmet-shaped, slightly longer than broad, rounded and inflated posteriorly, expanding at the frontal margin, constricted behind this region, its substance verrucose, transparent anteriorly, apparently tesselated through subdivision into regular polygonal areas, each of which encloses a minute, siliceous (?) particle; animalcule twice the length of the lorica when extended, dilated anteriorly to a width equal to or surpassing the aperture of that structure, entirely filling the lorica when retracted; tentacular cilia equalling the lorica in length; inner membranous border or collar bearing the lappet-like appendages, shallow, not exceeding in depth the length of the lappets; colour golden yellow; endoplast band-like, curved, longitudinally disposed; contractile vesicle posteriorly located. Length of lorica 1–250″. Hab.—Salt water: Messina and Lanzarote (Haeckel).

The lorica of this species corresponds so remarkably in shape and structure with that of *Tintinnus lagenula*, that, compared in their uninhabited condition, it is scarcely possible to separate the two. The animalcule of this last-named type, as figured by Claparède and Lachmann, appears, however, to exhibit no essential deviation from the ordinary members of the genus to which it is allocated, though at the same time there would seem to be an indication of an inner circular peristomal border corresponding with the membranous collar of the present species, but showing no trace of the lappet-like appendages.

Codonella orthoceras, Hkl. Pl. XXXI. Fig. 38.

Lorica elongate, conical, about two and a half times as long as broad, tapering backwards from the wide oral aperture towards the sharply pointed posterior extremity, but interrupted in the posterior half by a globose inflation; the posterior half rough and coarsely nodular, the anterior smooth and finely annulate transversely; animalcule when contracted retreating to the inflated posterior region of the lorica. Length of lorica 1–125″. Hab.—Salt water: Messina.

Haeckel considers the *Tintinnus cinctus* of Claparède and Lachmann, Pl. XXXI. Fig. 10, of which the lorica only has been observed, as probably closely allied to, if not identical with this form. Its contour and structure, on comparing the two, is found, however, to be too distinct for the admission of their absolute identity. In *T. cinctus* the lorica, with the exception of the abruptly dilated oral aperture and distinct tooth-like posterior termination, is cylindrical throughout, smooth, and delicately annulate transversely from one end to the other. It is at the same time possible that this form, in common with many others referred to in the genus *Tintinnus* by the authorities quoted, on the strength only of the contour and structure of the lorica, will, when the enclosed animalcule is known, have to be referred to the present or some other equally distinct pelagic genus.

Codonella campanella, Hkl. Pl. XXXI. Figs. 34–37.

Lorica bell- or helmet-shaped, about one and a half times as long as broad, the posterior extremity produced into a long, subulate, conical point, the anterior border widely dilated, transversely annulate throughout, but

this ornamentation concealed in the posterior region through the incorporation of coarsely nodular foreign particles; animalcule as in *C. galea*, but with a relatively deeper lappet-bearing membranous collar. Length of lorica 1–170″. HAB.—Salt water: Lanzarote (Haeckel).

Professor Haeckel proposes to identify this species with the *Tintinnus campanula* of Claparède and Lachmann. The animalcule of that type, as figured by the Swiss authorities, however, presents the essential characters of an ordinary *Tintinnus*, possessing a shuttlecock-like oral wreath of stout vibratile cilia that cannot be consistently compared with the long, flexible, tentacle-like appendages of Haeckel's *Codonella*. The lorica, again, is coarsely granular throughout, and presents no trace of transverse annulation. Spherical, spore-like bodies, varying in number from ten to twenty, were observed within the parenchyma of this species by Haeckel on various occasions, and in one instance some fully developed embryos. These germs, when liberated, were, as represented in the accompanying illustration, Pl. XXX. Fig. 36, of ovate form, finely ciliate throughout, and contained a central band-like endoplast and posteriorly located contractile vesicle.

GENUS II. TINTINNOPSIS, Stein.

Animalcules campanulate or pyriform, attached posteriorly by a slender, retractile pedicle within a membraneous free-floating sheath or lorica, this lorica frequently enclosing sand-grains or other adventitious particles; peristomal cilia forming two complete and independent ciliary circlets, those of the outer series being flexible and tentaculiform, those of the inner one short and cirrose; general surface of the body traversed longitudinally from one end to the other by rows of short cilia, between which intervene bare interspaces of considerable extent. Habits pelagic.

The only type of this genus yet observed is an inhabitant of salt-water. As pointed out by Stein,* the peculiar band-like distribution of the cilia upon the general surface of the body, essentially distinguishes it from *Tintinnus*, which he regards as its most near ally, placing the two, indeed, in one family group. The peculiar character of the outer series of oral or peristomal cilia is, however, entirely different from what obtains in that genus, and corresponds more closely with what is met with in Haeckel's recently described genera *Codonella* and *Dictyocysta*. Haeckel, when referring to the genus *Tintinnopsis*, in his account of these two last-named types, inadvertently quotes Stein as embodying as its diagnostic character the presence of fine cilia throughout the cuticular surface in place of their restriction to well-marked longitudinal bands, and further misrepresents the universal distribution of these cilia in the one case and their entire absence in the other as the essential distinction between the two genera *Tintinnopsis* and *Tintinnus*. In this latter instance he simply reproduces Stein's interpretation of the characteristics of the genus *Tintinnus*, which, as already explained, do not harmonize with the results obtained through the more extensive investigation of this group made by Claparède and Lachmann.

Tintinnopsis beroidea, Stein.

Lorica helmet- or thimble-shaped, the anterior margin widest, slightly everted; pointed posteriorly, composed of a transparent parchment-like substance, enclosing numerous angular, dissimilar, siliceous particles; body of animalcule pear-shaped; peristome bearing an outer and even circle of

* 'Infusionsthiere,' Abth. ii., p. 154, 1867.

long, stout, widely separated cilia, and an inner spiral wreath of fine, closely set shorter ones; cilia of the general cuticular surface short and fine, arranged in widely separated longitudinal rows; endoplast linear, curved, anteriorly located; contractile vesicle situated at a short distance from the posterior extremity. Dimensions unrecorded.

HAB.—Salt water: Baltic Sea.

According to Stein's observation the animalcules of this species become readily detached from their loricæ, and withdrawing the stem portion within the general substance of the body, swim freely in the water. The outer circle of long and widely separated peristomal cilia was frequently observed to be flexed backwards, reaching at such times to a distance of one-third of the total length of the body from the posterior extremity. These structures in their great length and flexibility would appear to closely resemble the tentaculiform cilia of *Codonella* and *Dictyocysta*, the lorica at the same time closely corresponding with that of *Codonella campanella*. The specific title bestowed on this type by its discoverer bears reference to the superficial likeness of the surface bands of cilia in both aspect and distribution to those of a *Beroe*.

Fam. VII. CALCEOLIDÆ, S. K.

Animalcules free-swimming, illoricate, ovate or pyriform, persistent in shape; general cuticular surface entirely ciliate, the body encircled by one or two zone-like grooves and girdles of larger cirrate cilia; the oral aperture ventral, perforating one of the equatorial grooves of cilia; a closely adpressed fascicle of long flexible setose cilia, presenting the aspect of a stylate caudal appendage, projecting backwards from behind the oral aperture.

GENUS I. CALCEOLUS, Diesing.

Animalcules free-swimming, unsymmetrical, obliquely pyriform, persistent in shape, but not encuirassed; cuticular surface finely ciliate throughout, two groove-like channels encircling the body, one or both of which give origin to a wreath of larger cilia than those of the cuticular surface; oral aperture ventral, situated in the posterior of the two transverse annular grooves, followed by a tubular pharynx; a tail-like fascicle of long setose cilia, usually held bound to one another, and resembling a single stylate process, projecting backwards from behind the mouth; endoplast and contractile vesicle posteriorly located.

This genus is instituted by Diesing* for the form described that same year by Professor H. James-Clark under the title of *Peridinium cypripedium*. Regarding, in common with the last-named authority, the fascicle of setose cilia forming the caudal appendage as an ordinary flagellum, Diesing has placed his newly created genus among other Cilio-flagellate animalcules midway between *Mallomonas* and *Prorocentrum*. From this low position in the infusorial scale it is here proposed to advance it to one among the Heterotricha corresponding closely with that occupied by *Urocentrum* in the division of the Peritricha.

* 'Revision der Prothelminthen,' p. 379, 1865.

Calceolus cypripedium, J.-Clark sp. PL. XXXII. FIGS. 23 AND 24.

Body obliquely pyriform, widest anteriorly, hollowed on the ventral side by a broad longitudinal depression, which commencing at a little distance from the larger and rounded anterior end extends in a straight line to the more attenuate posterior extremity; encircled by two annular furrows, the anterior and narrower one bearing a wreath of long powerful locomotive cirri, the whole body from this point backwards clothed with finer vibratile cilia, these more crowded and conspicuous on the posterior furrow, the ventral surface of which is perforated by the oral aperture. A fascicle of closely approximated setose cilia, presenting in their agglomerate condition the aspect of a single flexible caudal appendage, originating from the posterior furrow at a little distance behind the mouth, and projecting beyond the posterior extremity to an extent equal in length to that of one-third of the whole body. Contractile vesicle large, spherical in diastole, situated centrally close to the posterior extremity; endoplast band-like, curved, located immediately above the contractile vesicle, its two extremities descending and embracing that structure on each side. Length of body 1–300″ to 1–150″. HAB.—Fresh water. Colour, light brown.

Although introduced by H. James-Clark * as a representative of the genus *Peridinium*, there can be little or no doubt, as first pointed out by Stein, that the true place of this species is much nearer to that of *Urocentrum turbo*. In general contour and in habits it in fact corresponds so closely with this type as to be apparently referable to the same generic group. The one distinctive character, however, afforded by the complete ciliation, with the exception of the anterior skull-cap-shaped border, of the general cuticular surface, necessitates its isolation from the typical smooth-bodied Peritricha. While thus separated, it may at the same time be said to represent one of the most conspicuous annectant forms between the two orders of the Heterotricha and Peritricha, and to exhibit the same relationship with reference to the genus *Urocentrum* as is held by *Trichodinopsis* and *Strombidinopsis* respectively with regard to the genera *Trichodina* and *Strombidium*. The movements of this animalcule in the water accord entirely with those of *Urocentrum turbo*, consisting chiefly of a vigorous rotatory motion to and fro on its long axis, it being often temporarily attached under such circumstances to some solid substance by the extremity of its adhesive caudal appendage, and upon which it revolves as though on a pivot. This sedentary condition is in like manner frequently changed for a more active natatory one, and in which it darts in a straight line from one place to another with amazing swiftness, tacking, as it were, now and then to one side or the other, and apparently utilizing its posterior caudal fascicle after the manner of a rudder. Multiplication by transverse fission is the only reproductive phenomenon that has so far been observed with reference to this type. The contractile vesicle was observed by Professor Clark to assume a somewhat irregular outline between diastole and systole, but does not appear to possess distinct lateral sinuses as has been observed by the present author of *Urocentrum turbo*.

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* 'Proceedings of the American Academy of Science,' February 1865.

Order III. PERITRICHA, Stein.

Animalcules free-swimming or attached, solitary or united in social colonies, often in the latter instance forming branched tree-like growths; oral aperture terminal or subterminal; ciliary system consisting of an anterior, circular or spiral, adoral wreath with occasionally one or more supplementary equatorial or postero-terminal locomotive circlets, the remaining cuticular surface entirely smooth; in those instances in which the adoral wreath takes a spiral form the right limb more usually involute and descending into the oral fossa; anal aperture posteriorly located or debouching upon the vestibular or oral fossa; endoplast mostly elongate, band-like; multiplying by longitudinal or transverse fission. Inhabiting salt and fresh water. Trichocysts rare.

Excepting for the presence of one or two aberrant types, the representatives of the Peritricha constitute collectively the most sharply defined and natural group of the class Ciliata. The smooth rounded bodies and restriction of the cilia to a circular or spiral anterior wreath, and an occasional median or posterior circlet affords a ready clue to their recognition, while the fixed and sedentary life led by the larger proportion of its members affords facilities for their examination met with in no other infusional section. In addition to the very substantial augmentation of the number of generic groups embodied in this treatise, a considerable departure is made in the subdivision of this order into families, as here pursued, from the plan adopted by Stein in the second volume of his 'Organismus,' and reproduced at page 210 of vol. i. Among the more important alterations accomplished in this direction, *Tintinnus* and its allies have been removed to the preceding order of the Heterotricha, the fine ciliation of their entire cuticular surface, as demonstrated through the researches of Claparède and Lachmann, precluding their further retention in that of the present order. Through the Peritrichous *Strombidium* and Heterotrichous *Strombidinopsis* the more remote affinity of *Tintinnus* to the typical Peritricha is, however, doubtless indicated; a similar amalgamation of the two orders being likewise apparently brought about between the three genera *Codonella*, *Dictyocysta*, and *Petalotricha*. The family of the Vorticellidæ is here made to include the three sections of equivalent value comprised by Stein under the respective titles of the Vorticellina, Ophrydina, and Spirochonina; all of these, as shown in the succeeding descriptions, passing from one to the other by easy stages of gradation, and preserving at the outside distinctive features sufficient only for their separation into groups holding the position of sub-families. Among the more aberrant types included in the order Peritricha, the three genera *Torquatella*, *Actinobolus*, and *Urocentrum* may be especially alluded to; the abnormal features of these forms and the question of their more immediate apparent affinities being discussed at length in their generic or specific description. One of these, *Urocentrum*, corresponding closely in general form and structure with the entirely ciliate *Calceolus*, may be cited as an additional annectant form between the two orders of the Heterotricha and Peritricha.

By most authorities the order of the Peritricha has been regarded as typifying the highest and most specialized group of the Infusoria Ciliata. The present author, however, is not disposed to coincide with this view. Specialization apparently reaches its zenith of development in the succeeding order of the Hypotricha, in which the cilia or their modified homologues are differentiated and made subservient to the performance of a variety of functions to an extent that is not found among any other representatives of the sub-kingdom Protozoa. Evidence in support of the lower comparative position occupied by the Peritricha

as here maintained is further afforded by the marked sedentary and vegetative mode of growth exhibited by so large a proportion of its members, and yet more noticeably with reference to the phenomena of reproduction as elicited by the light of recent investigation. In this last-named connection it has been abundantly shown that the process of conjugation or genetic union is accomplished through the complete and permanent fusion of two independent zooids, as obtains among the lower sections of the Flagellata and unicellular Protophytes, and which thus differs essentially from the temporary union only of the sexually matured zooids which occurs amongst the Hypotricha and even many Holotricha, and among which, consequently, a far nearer approach is made to the typical mode of sexual concourse that subsists among the higher zoologic groups.

A tabular form of the family and generic groups of the Peritricha, as delimited in this volume, is given overleaf.

Fam. I. TORQUATELLIDÆ, S. K.

Animalcules free-swimming, illoricate, more or less ovate; the anterior ciliary wreath replaced by a membranous extensile and contractile collar-like structure, which is perforated centrally by the oral aperture.

The relegation of the single type included in this family group to the Peritricha is effected with some diffidence, it possessing, perhaps, an equal claim for recognition as the representative of a new and distinct order. Regarding, however, the terminal frill or collar-like membrane as an incipient or only partially developed fringe of cilia, its affinity to the more ordinary members of the section in which it is here placed is apparent. A similar though at the same time transitory assumption by the adoral cilia of a membraniform character is especially alluded to in this volume in the case of *Stentor* and *Aspidisca*, while in many Hypotricha, Heterotricha, and Holotricha such a membrane permanently fills the place otherwise occupied by the adoral or pre-oral fringe. On the other hand, the membraniform collar of *Torquatella* may perhaps be regarded as homologous with the umbrella-like peristomal membrane of *Codonella*, or indeed as an exaggerated development of the peristome of such a typical Peritrichan as *Vorticella patellina*, as represented at Pl. XXXIV. Fig. 22.

GENUS I. TORQUATELLA, Lankester.

Animalcules free-swimming, more or less ovate, entirely devoid of cilia, but possessing at the anterior extremity a projecting plicate membranous frill, by the more or less vigorous expansion and contraction of which motion through the water is effected, and food-particles brought within reach of the mouth; oral aperture situated within the centre and at the base of the projecting frill, guarded by a tongue-shaped valve or velum.

Torquatella typica, Lankester. PL. XXXII. FIGS. 32–34.

Body elongate-ovate, nearly twice as long as broad, rounded posteriorly; the anterior membranous frill highly expansile, its front margin abruptly truncate or emarginate, its surface obliquely plicate. Dimensions unrecorded. HAB.—Salt-water, Mediterranean.

This remarkable animalcule was met with on one occasion only by Professor E. Ray Lankester at Naples in association with a mass of eggs of *Terebella* in a decaying state, and fragments of which had been freely incepted. The anterior

FAMILIES AND GENERA OF CILIATA-PERITRICHA.

A. Animalcules free-swimming.

Family.		Genus.
I. TORQUATELLIDÆ. Adoral cilia replaced by a membraniform collar.	Collar extensile, plicate; oral aperture with a tongue-like valve	1. *Torquatella.*
II. DICTYOCYSTIDÆ. Animalcules loricate.	Lorica siliceous, fenestrate, animalcules with tentaculiform cilia	2. *Dictyocysta.*
	Lorica membranous, entire, no tentaculiform cilia	3. *Petalotricha.*
III. ACTINOBOLIDÆ. Animalcules illoricate; having retractile tentacula.	Animalcules ovate or globose; retractile tentacula interspersed between the adoral cilia.	4. *Actinobolus.*
IV. HALTERIIDÆ. Animalcules ovate or globose; oral aperture terminal or subterminal; adoral wreath spirally involute or simply circular; sometimes with a supplementary girdle of springing-hairs or locomotive cilia.	Oral aperture eccentric, peristome spirally involute. — With a girdle of supplementary springing-hairs	5. *Halteria.*
	Oral aperture eccentric, peristome spirally involute. — Without supplementary springing-hairs	6. *Strombidium.*
	Oral-aperture central, peristome simply circular. — A single circlet of locomotive cilia. — Locomotive cilia cirrate. — Animalcules naked	7. *Mesodinium.*
	Oral-aperture central, peristome simply circular. — A single circlet of locomotive cilia. — Locomotive cilia cirrate. — Body enclosed within a transparent lorica	8. *Acarella.*
	Oral-aperture central, peristome simply circular. — A single circlet of locomotive cilia. — Locomotive cilia flexible, tentaculiform	9. *Arachnidium.*
	Oral-aperture central, peristome simply circular. — Two equatorial circlets of locomotive cilia	10. *Didinium.*
V. GYROCORIDÆ. Animalcules pyriform; oral aperture lateral; body encircled equatorially by a circular or spiral fringe of cilia.	With a distinct caudal appendage. — Equatorial ciliary girdle spirally disposed	11. *Gyrocoris.*
	With a distinct caudal appendage. — Equatorial girdle or girdles simply annular	12. *Urocentrum.*
	No caudal appendage	13. *Telotrochidium.*
VI. URCEOLARIIDÆ. Animalcules turbinate or discoidal; oral aperture subterminal; posterior extremity acetabuliform, adhesive; bearing a marginal fringe of cilia.	Posterior acetabulum with an internal corneous ring. — No supplementary setose appendages. — Corneous ring of acetabulum denticulate	14. *Trichodina.*
	Posterior acetabulum with an internal corneous ring. — No supplementary setose appendages. — Corneous ring of acetabulum entire	15. *Urceolaria.*
	Posterior acetabulum with an internal corneous ring. — With a posterior fringe of rigid and erect hair-like setæ	16. *Cyclochæta.*
	Acetabulum without an internal corneous ring, body with a central stalk-like region	17. *Licnophora.*
VII. OPHRYOSCOLECIDÆ. Animalcules ovate or elongate; oral aperture terminal, associated with a spiral adoral wreath of cilia; posterior extremity bearing one or more stylate caudal appendages.	Animalcules encuirassed. — With a supplementary equatorial ciliary girdle	18. *Ophryoscolex.*
	Animalcules encuirassed. — No equatorial girdle of cilia	19. *Entodinium.*
	Animalcules not encuirassed; two terminal caudal styles	20. *Astylozoon.*

B. Animalcules sedentary or attached.

VIII. VORTICELLIDÆ. Animalcules ovate, campanulate, or subcylindrical; oral aperture terminal, eccentric, associated with a spiral fringe of adoral cilia, the right limb of which descends into the oral aperture, the left limb encircling a more or less elevated, protrusible, and retractile ciliary disc.

- **Sub-Fam. 1, VORTICELLINA.** Animalcules naked.
  - Animalcules solitary.
    - Attached in a sessile manner.
      - With no differentiated adhesive organ .. .. .. 21. *Gerda.*
      - With an acetabuliform adhesive disc.
        - Peristome normally developed .. 22. *Scyphidia.*
        - Peristome developed as a spirally convolute membranous expansion .. .. 23. *Spirochona.*
    - Attached through the medium of a rigid or retractile pedicle.
      - Peristome forming a spirally convolute membranous expansion .. .. 24. *Stylochona.*
      - Peristome normally developed.
        - Ciliary disc axial .. .. 25. *Rhabdostyla.*
        - Ciliary disc laterally attached .. 26. *Pyxidium.*
      - Pedicle retractile .. .. 27. *Vorticella.*
  - Animalcules associated in dendriform colonies.
    - Pedicle retractile.
      - Contractile stalk of each zooid disconnected .. 28. *Carchesium.*
      - Contractile stalk of entire colony continuous throughout .. .. 29. *Zoothamnium.*
    - Pedicle rigid.
      - Ciliary disc axial, no collar-like membrane .. .. 30. *Epistylis.*
      - Ciliary disc laterally attached, peristome with a supplementary collar-like membrane .. .. 31. *Opercularia.*
- **Sub-Fam. 2, VAGINICOLINA.** Animalcules secreting indurated loricæ.
  - Lorica erect.
    - Body sessile, or attached to lorica through the medium of a short pedicle.
      - Lorica sessile.
        - No internal valve to lorica .. .. 32. *Vaginicola.*
        - Lorica with a door-like valve .. 33. *Thuricola.*
      - Lorica pediculate.
        - No operculum .. .. 34. *Cothurnia.*
        - Body with an attached operculum.
          - Operculum corneous .. .. 35. *Pyxicola.*
          - Operculum fleshy 36. *Pachytrocha.*
    - Body attached to lorica through the medium of several stylate processes .. .. 37. *Stylocola.*
  - Lorica decumbent.
    - Animalcules adherent to posterior extremity of lorica .. .. .. 38. *Platycola.*
    - Animalcules adherent to one side of the lorica .. .. 39. *Lagenophrys.*
- **Sub-Fam. 3, ORPHRYDINA.** Animalcules secreting a soft gelatinous investment.
  - Animalcules solitary .. .. 40. *Ophionella.*
  - Animalcules forming social colonies .. .. 41. *Ophrydium.*

membranous collar, whose contour is compared by its discoverer * to that of an Elizabethan frill, is described as being in a state of constant vibration, alternately closing up and expanding with a twisting movement, and exhibiting the same rapidity and regularity in this motion as do a series of cilia in a similar position. The movements of the collar may in short be compared to those of a series of cilia united throughout their length by a delicate membrane, progress through the water being at the same time accomplished with the aid of this mechanism in a manner closely analogous to the locomotion of the free-swimming Medusæ. Unfortunately, no note was taken at the time of the position or character of the endoplast or contractile vesicle, nor of the reproductive phenomena.

Fam. II. DICTYOCYSTIDÆ, Haeckel.

Animalcules free-swimming, secreting and inhabiting siliceous or corneous, fenestrate or imperforate, helmet- or bell-shaped loricæ; peristome terminal, subcircular, associated with a more or less complex ciliary system; oral aperture eccentric, cuticular cilia entirely absent.

The family of the Dictyocystidæ was originally instituted by Professor Haeckel † for the reception only of Ehrenberg's genus *Dictyocysta*. To this is here added the new generic group *Petalotricha*, including the so-called *Tintinnus ampulla* and *Tintinnus spiralis* of Professor Fol, which differ from the true *Tintinni*, but resemble *Dictyocysta*, in the non-ciliation of their cuticular surface and in the compound character of the peristomal appendages.

Genus I. DICTYOCYSTA, Ehrenberg.

Animalcules solitary, free-swimming, extensile and contractile, excreting and inhabiting more or less perforated, bell- or helmet-shaped, siliceous loricæ; the enclosed body globular or campanulate, attached to or dependent from the posterior extremity of the lorica, and protruding, when extended, to some distance beyond its aperture, the oral or distal extremity truncate, circular, bearing an outer fringe of long, tentacle-like cilia, and an inner circle of short, thick, uncinate cilia or cirri; oral aperture eccentric, located close to the inner circle of uncinate cilia; general cuticular surface entirely smooth. Hab.—Salt water, pelagic.

The animalcules of this genus closely resemble those of *Codonella* previously described, and but for the absence of fine cilia upon the general cuticular surface would be necessarily placed in the same family. The singular anterior fringe of lappet-like appendages is likewise wanting in *Dictyocysta*, being replaced by a circlet of cirrose adoral cilia, corresponding with those of the more ordinary Peritricha. The beautiful perforated siliceous loricæ of the various species are scarcely to be distinguished from the tests of certain Polycistinæ, and were indeed, previous to the examination and report upon their living inhabitants by Professor Haeckel, referred by Ehrenberg ‡ to that Radiolarian group.

Dictyocysta cassis, Hkl. Pl. XXXII. Figs. 29–31.

Lorica helmet-shaped or inflated conical, about one and a half times as long as broad, pointed posteriorly, gradually widening towards the

* 'Quarterly Journal of Microscopical Science,' vol. xiii., 1874.
† "Ueber einige neue pelagische Infusorien," 'Jenaische Zeitschrift,' Bd. vii., 1873.
‡ 'Monatsbericht Berliner Akademie,' p. 236, 1854.

expanded anterior aperture; perforations minute, polygonal, subequal, and closely approximated; animalcule elongate-conical, projecting some little distance beyond the orifice of the lorica; tentacular-like cilia nearly equal in length to the extended body; contractile vesicle spherical, posteriorly situated. Length of lorica 1–225″.

HAB.—Salt water: Messina (Hkl.); British Channel, Falmouth (S.K.).

Among the examples of this species figured and described by Professor Haeckel,* one was observed to contain about twenty spherical spore-like bodies, each of which enclosed a conspicuous central endoplast. In July 1879, an empty lorica of this type was obtained by the author in association with *Tintinnus subulatus*, *Ceratium fusus*, and other pelagic forms, off the coast of Falmouth, mention of such capture being recorded in the 'Midland Naturalist' for April 1880. As there intimated, its occurrence at a station so considerably to the north of the apparent head-quarters of this type, is a feature of some interest. Upon the grounds that the lorica in this species is not actually perforated but simply pitted, Professor Fol† has proposed to make it the type of a new genus, *Cyttarocysta*. Such structural character, however, is not regarded by the author to be sufficiently substantiated, or of sufficient import as to render such subdivision desirable. This authority further dissents from Professor Haeckel in declaring that the body of the animalcule does not gradually taper off to its point of attachment as delineated in the accompanying figure, but that it is subdivided into a distinct inflated body and an attenuate stalk-like portion, as occurs among many typical *Tintinni*.

Dictyocysta mitra, Hkl. Pl. XXXII. FIGS. 25 AND 26.

Lorica mitre-shaped, nearly as broad as long, widest centrally, obtusely pointed posteriorly, slightly constricted immediately behind the slightly everted anterior aperture, its walls pierced by numerous rounded perforations of various sizes, including a single series of about five larger somewhat quadrate perforations arranged in a circle close to the anterior border, and about four transverse circles of largish rounded perforations between this and the posterior extremity; various smaller loculi interspersed among the larger ones and developed exclusively towards the posterior extremity; animalcule campanulate, subglobose; tentaculate cilia equal to or surpassing the body in length; contractile vesicle posteriorly located; endoplast band-like, curved, transversely placed. Length of lorica 1–375″.

HAB.—Salt water: Messina and Lanzarote (Hkl.).

Professor Fol considers this species to be synonymous with the *Dictyocysta elegans* of Ehrenberg.

Dictyocysta templum, Hkl. Pl. XXXI. FIG. 27.

Lorica inflated, cupola-shaped or hemispherical, nearly as broad as long, pointed posteriorly, the anterior aperture dilated; fenestrations of variable dimensions; seven exceedingly large, equal sized, irregular quadrate areas, separated from one another only by slender, obliquely parallel, pillar-like trabeculæ, bordering the frontal margin; seven roundly polygonal

* "Neue pelagische Infusorien," 'Jenaische Zeitschrift,' Bd. vii., 1873.
† 'Archives des Sciences Physiques et Naturelles,' tom. v., 1881.

fenestræ of about half the dimensions of those last-named, forming an equatorial girdle round the centre of the lorica; between the equatorial and marginal series, a ring of fourteen still smaller, but considerably sized, circular lacunæ; the remaining surface of the lorica perforated by innumerable irregularly disposed fenestræ of rounded form and variable size, few of which equal the dimensions of those of the smallest annular series. Length 1–400″. HAB.—Salt water: Messina and Lanzarote (Hkl.).

Dictyocysta tiara, Hkl. Pl. XXXII. FIG. 28.

Lorica elongate-conical, or tiara-shaped, over twice as long as broad; pointed posteriorly, inflated centrally, slightly constricted before expanding outwards again to form the anterior opening; ten large elliptical loop-like fenestræ, equal in height to one-third of that of the entire lorica, and separated from each other by slender trabeculæ, bordering the frontal margin; a circlet of ten oval fenestræ of about half the dimensions of the frontal series forming a zone round the centre of the lorica, and ten similar shaped perforations of about one-quarter the size of the marginal series, forming a circle between the equatorial girdle and the pointed posterior extremity; several smaller supplementary annular series and innumerable irregularly shaped lacunæ distributed through the remaining area of the lorica. Length 1÷250″. HAB.—Salt-water: Lanzarote (Hkl.).

Dictyocysta elegans, Ehr.

Lorica oblong, urceolate, its frontal region narrowest, subcylindrical, truncate, perforated by two rows of about eight large quadrangular fenestræ; the wider basal portion obtusely rounded, perforated by smaller irregularly scattered, rounded lacunæ. Length 1–480″, breadth 1–576″.

HAB.—Salt water: Newfoundland, among phosphorescent surface-skimmings.

This species, while founded by Ehrenberg* on examples brought from the vicinity of Newfoundland, is also identified by him with one of the many microscopic organisms figured by Johannes Müller many years previously,† and obtained by him from the intestinal tract of the Echinoderm *Alecto Europea*. Excepting for the relatively narrower diameter of the distal region of the lorica, this species as recognized by Professor Fol, is scarcely to be distinguished from the *Dictyocysta mitra* of Professor Haeckel.

Dictyocysta lepida, Ehr.

Lorica oblong, urceolate; distal region cylindrical, loosely reticulate, comprising a single series of nine circular perforations; proximal portion subglobose, sparsely perforate. Length 1–400″, breadth 1–576″.

HAB.—Salt water: Newfoundland.

* 'Monatsberichte der Berliner Akademie,' p. 236, 1854.

† "Ueber den Bau des *Pentacrinus Caput-medusæ*," 'Abhandlungen der Berliner Akademie,' 1841.

Dictyocysta acuminata, Ehr.

Lorica oblong, campanulate, acuminate posteriorly; the distal border truncate, widely expanded, perforate by a series of long narrow lacunæ. Length 1–432″, breadth 1–576″.

HAB.—Salt water: Newfoundland, among phosphorescent surface-skimmings.

GENUS II. PETALOTRICHA, S. K.

(Greek, *petalon*, petal; *trichos*, hair.)

Animalcules free-swimming, excreting and inhabiting imperforate corneous loricæ; enclosed body conical or campanulate, attached to the fundus of the lorica by a retractile peduncle; ciliary system restricted to the excavate distal region, consisting of a series of larger marginal motor cilia, which are developed upon petaloid or lappet-like prolongations of the peristome-border, and an internal series of short vibratile cilia, which, starting from the interior of the disc, follow about twenty curved lines tangential to the margin of the peristome, and which are continuous at the periphery with the external motor series; oral aperture eccentric, continued into a pouch-like pharynx, which stands out separately from the walls of the body, and into which several of the rows of cilia of the disc are prolonged; anal aperture located near the insertion of the peduncle. Inhabiting salt water.

This genus is provisionally instituted by the author for the reception of the two species referred to the genus *Tintinnus* by Professor Fol,* under the titles of *Tintinnus ampulla* and *T. spiralis*. The restriction of the cilia to the distal region, added to the abnormal disposition of these appendages, separates these species in a marked manner from the typical members of the genus as defined in this volume, and apparently indicates their nearer zoological position to the genus previously described.

Petalotricha ampulla, Fol. sp. WOODCUT, p. 628, FIGS. 1 AND 2.

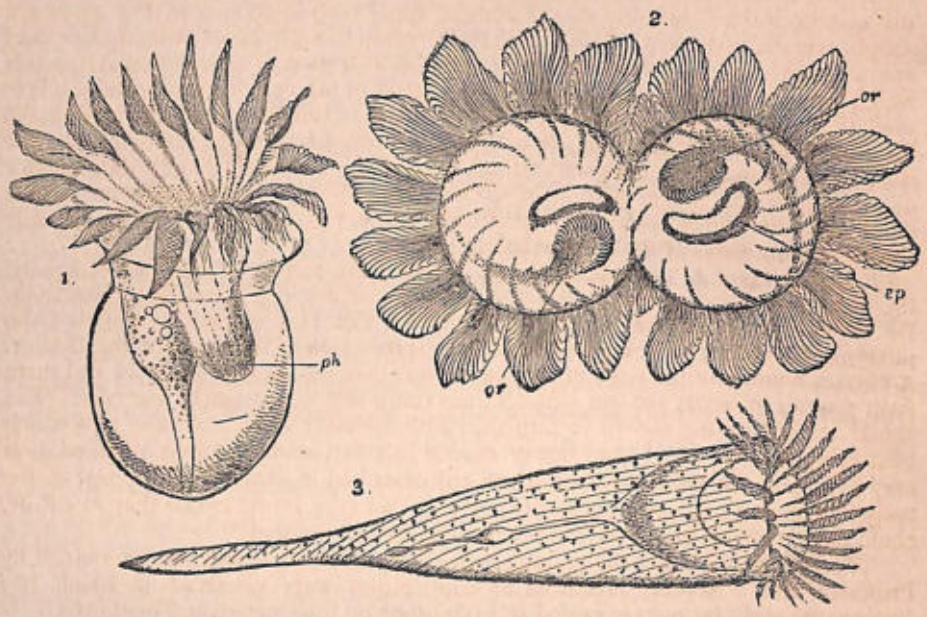
Lorica ovoid, terminated posteriorly by a slight projection in the form of a point, widely open above, where an expanded funnel-like portion is superposed upon the ovoid part; the widened portion composed of two zones, of which the superior is more turned out than the inferior one; a slight circular projection, notched into the likeness of an arcade, developed on the inner surface along the boundary between the two zones; body of animalcule apparently smooth; peristomal cilia arranged in twenty-four curved lines, produced from the interior towards the margin of the disc. Length of lorica, 1–280″.

HAB.—Salt water: Villefranche-sur-Mer.

The above diagnosis is reproduced *verbatim* from Professor Fol's description of his so-called *Tintinnus ampulla*, to which is herewith appended an abstract of his elaborate description of the oral and ciliary systems. With reference to the notched

* 'Archives des Sciences Physiques et Naturelles,' tom. v., 1881.

petaloid modification of the peristomal border, it would seem to most nearly approach Haeckel's genus *Codonella*. In, however, the possession of a distinct pharyngeal pouch, which, in accordance with Professor Fol's delineation, Woodcut, Fig. 1, *ph*, stands out separate from the body like the gibbous pouch or spur of a floral envelope, this type has no parallel among the entire infusorial series. Professor Fol's general account of this new type runs as follows :—



FIGS. 1 and 2. *Petalotricha ampulla*, Fol sp. 1. Lateral aspect, showing at *ph* pharyngeal pouch, × 300. 2. Two conjugating zooids viewed from above; *or*, oral aperture; *ep*, raised boss or epistome.
FIG. 3. *Petalotricha spiralis*, Fol sp., × 200. (After Professor Fol.)

"The superior discoidal extremity or peristome, when the animal is in a state of perfect extension, is placed a little obliquely with relation to the aperture of the test. The disc itself, instead of being flat or slightly convex, as is the case in the Vorticellina, is hollowed out like a saucer, and the vibratile cilia, instead of forming a single row round the margin of the disc, are implanted in great number and in several lines over the greater part of the surface. The arrangement of these vibratile cilia is exceedingly curious and interesting, and deserves attention, the more because it has not been described by any of the authors who have busied themselves with the Tintinni. The whole margin of the disc is occupied by long and strong motor cilia, which strike the water vigorously, and give the animal an exceedingly rapid rectilinear movement of translation. It is thus, in fact, that the animals habitually swim; but they can readily deviate from the direct line when they have to avoid an obstacle. Moreover, the animal is constantly turning upon itself during its progress, which is therefore comparable to that of a rifle ball. As soon as the great motor cilia commence their action, they present the so-called phenomenon of rotation in a high degree. The undulation is propagated from right to left, the observer being supposed to be placed at the axis of the animal. The other cilia are arranged in parallel lines, all curved in the same direction, and running from the margin of the disc or peristome towards the mouth. In the present species, *T. ampulla*, twenty-four of these lines were counted. The mouth occupying an eccentric position, *or* Fig. 2, the lines which start from the margin nearest to that aperture are of course much shorter than those which start from the more distant margin. There are, however,

only a few lines of cilia that actually reach the entrance of the mouth, and these are precisely the shortest ones. The others stop so as to leave the central part of the disc naked. All the rows just mentioned are formed of thick, short, slightly recurved cilia, scarcely attenuated at their free extremity, and only beating for moments. Their length decreases regularly from the margin of the peristome, which bears the thickest and longest, to the inner extremity of the line, which is formed of much shorter and more slender cilia. On returning to the motor cilia to ascertain what relation they bear to the cilia of the disc, it is noticeable, in the first instance, that the margin of the peristome, viewed from its upper surface (Woodcut, Fig. 2), is not simply rounded, but denticulate. The teeth resemble those of an ordinary saw, and are all turned in the same direction, and this direction is precisely that towards which the rows of short thick cilia deviate. Each of the rows indeed corresponds to one of the denticulations in such a manner that it terminates at the base of the longer side of the denticulation, or that which forms a tangent to the margin of the disc. The arrangement once understood, it is easy to ascertain that the large motor cilia are upon the longer margin of each denticulation, hence they do not form a continuous circular or spiral line, but a broken line, the segments of which are only simple continuations of the rows of short cilia."

"The entrance to the mouth, *or* Fig. 2, meets the surface of the disc obliquely, the pharynx being directed towards the left, at the same time gradually contracting. By looking at the animal in profile (Woodcut, Fig. 1) it is easy to see that the pharynx, *ph*, is lodged in a pouch-like lateral projection of the body of the Infusor. A certain number of the rows of cilia of the disc descend into the pharynx and there form a series of nearly straight parallel lines composed of extremely fine cilia. The actual margin of the mouth is furnished with tolerably stout and long cilia which beat energetically; but I have not succeeded in ascertaining precisely what relation may exist between these cilia and those just described in detail. All the rest of the body was smooth; at least, it is hardly probable that cilia, however fine they might be, could have escaped my observation had they actually existed."

The position of either the endoplast or contractile vesicle was not determined by Professor Fol. Several instances of conjugation were observed in which two animalcules were intimately united to each other by their peristomal margins.

Petalotricha spiralis, Fol. WOODCUT, p. 628, FIG. 3.

Lorica greatly elongated, pointed, drawn out; the posterior third nearly cylindrical, very narrow, terminated by an acute point; the anterior two-thirds having the form of an elongated cone, slightly inflated; near the orifice a thickening in the form of a cushion projecting outwardly; substance of lorica composing two very distinct layers, presenting at the surface some faintly marked and somewhat irregular striæ, generally parallel, disposed obliquely to the axis of the test, and describing very elongate dextrogyrous spirals; small points arranged in spiral lines parallel to the striæ, and alternating with them; the cushion that surrounds the orifice formed solely by the outer layer; animalcules short, peduncle much elongated, attached at a considerable distance from the apex of the test, or even presenting two points of attachment; curved lines of peristomal cilia numbering about twenty; body apparently smooth. Length of lorica 1–62″.

HAB.—Salt water: Villefranche.

Described by Professor Fol under the title of *Tintinnus spiralis*.

Fam. III. ACTINOBOLIDÆ, S. K.

Animalcules free-swimming, ovate or globose; oral aperture terminal, surrounded by a fringe of adoral cilia, supplemented by numerous retractile tentaculiform appendages.

Although the tentaculiform appendages in the as yet single known animalcule referred to this family are described by Stein as resembling those of the *Acinetidæ*—between which and the Ciliata he regards it as an annectant type—it seems hardly probable that such structures actually exist in company with a well-developed oral aperture. It would seem more likely, on the other hand, that they find their homologues in the retractile setæ of *Stentor*, or in the springing-hairs of *Halteria* and *Mesodinium*. To the family group embracing the two last-named generic forms it is not improbable, indeed, that *Actinobolus* may have hereafter to be transferred.

GENUS I. ACTINOBOLUS, Stein.

Animalcules free-swimming, ovate or globular; oral aperture perforating the centre of the apical extremity, encircled by short even-sized cilia, among which are scattered numerous thread-like tentacula capable of extension or retraction within the substance of the parenchyma, like those of the Acinetidæ; anal aperture postero-terminal; endoplast and contractile vesicle conspicuous.

Actinobolus radians, Stein.

Body irregularly ovate or subglobose, the anterior extremity produced as a short nipple-shaped or snout-like projection pierced by the oral aperture and bearing the oral cilia and retractile tentacula; endoplast elongate, cord-like, irregularly curved; contractile vesicle large, spherical, postero-terminal. Dimensions unrecorded.

HAB.—Fresh water, among *Lemnæ*.

It is to be regretted that Stein has not published a more exhaustive account, with an illustration, of this remarkable animalcule; the only description at present available for reference being a few lines in a footnote, p. 169 of the second volume of his 'Organismus.' Although placed by him among the Holotricha, it is not stated that the cuticular surface bears cilia throughout, those around the oral aperture alone being mentioned.

Fam. IV. HALTERIIDÆ, Clap. & Lach.

Animalcules free-swimming, persistent in shape, more or less globose or ovate, bearing a spiral or subcircular wreath of adoral or locomotive cilia, these occasionally supplemented by a girdle of long hair-like springing-setæ; oral aperture terminal, central or eccentric; trichocysts sometimes developed.

The several genera here united under the family title of the Halteriidæ, while harmonizing tolerably with one another in general contour and comportment, present among themselves so considerable a variation in the composition of their oral and ciliary systems, that their separation into more numerous, but less comprehensive, groups of equivalent value, was at first determined. A closer study of them, how-

ever, has elicited that these several genera, although diverging considerably from one point of view, approach each other so closely when regarded from another, while in many cases, again, so imperfect a knowledge is as yet possessed of their more essential structural details, that it has been considered desirable for the present to keep them associated. The most important structural deviations exhibited by the members of this family, as here defined, is manifested by *Halteria* and *Strombidium*, with their eccentric oral aperture and spirally involute adoral fringe, as compared with the four remaining genera, in which the oral aperture is perfectly central, and more or less disconnected from the ciliary system. Even here, however, *Mesodinium* corresponds so closely in its general structure and comportment with *Halteria*, that the marine species *M. pulex* was unhesitatingly referred by Claparède and Lachmann to that genus. By Stein both *Didinium* and *Mesodinium* are separated as types of a distinct family—his Cyclodina; but, strangely enough, with these are included by him an animalcule, *Urocentrum turbo*, with which they can scarcely be said to possess a single point in common, and whose natural position is obviously close to *Gyrocoris*. With but one or two exceptions all the members of the Halteriidæ are of exceedingly minute size, swift and restless in their movements, and consequently form one of the as yet least perfectly investigated divisions of the Peritrichous order.

GENUS I. HALTERIA, Dujardin.

Animalcules free-swimming, more or less globose; oral aperture terminal, eccentric, associated with a spiral or subcircular wreath of large cirrose cilia; a zone of long hair-like setæ or springing-hairs developed around the equatorial region, the sudden flexure of which appendages enables the animalcules to progress through the water by a series of leaping movements, in addition to their ordinary swimming motions.

The animalcules of this genus are easily recognized by their globose form and peculiar movements in the water, which consist of a slow rolling or rotatory motion, interrupted at short intervals by a sudden leap backwards or to one side. It was originally supposed by Dujardin that their springing motions were effected by the contraction of the setæ in connection with some fulcrum of support; as, however, the same motions may be readily observed when the animalcules are swimming freely at a distance from any foreign bodies, this hypothesis becomes untenable, and it is evident that the leaps are produced simply by the sudden reflex action of the hair-like setæ. By the above authority this central girdle of setæ is also represented as following an oblique direction; such interpretation, however, represents an erroneous optical impression frequently produced as the animalcules rotate through the water at various angles divergent from their longitudinal axes. The exact position of the oral aperture and relationship of the associated adoral cilia has not up to the present time been decisively determined, the restless and rapid motions of the animalcules rendering these two points especially difficult to interpret. By many writers the oral opening is described as perfectly central, and the accompanying cilia as forming an unbroken circular wreath. Claparède and Lachmann, however, go so far as to report the existence on one side of the peristome of a small notch-like interruption. The author's impression, derived from repeated examinations of the cosmopolitan form, *H. grandinella*, is that this adoral wreath is neither symmetrically circular nor interrupted in the simple manner above indicated, but that the right-hand limb or extremity of this wreath is, at the apparent notch, curled spirally inwards, and there descends into the oral aperture. This interpretation, reproduced in the accompanying illustration of the species quoted, demonstrates, if correct, the character of the peristome or adoral fringe in *Halteria* to agree with that of *Strombidium* and the Vorticellidæ, and to be the converse of what obtains in *Stentor* and other Heterotricha. In these, as explained in a previous page, it is the left limb of the adoral fringe that spirally encircles and descends into the oral fossa.

Halteria grandinella, Müll. sp. Pl. XXXII. Figs. 35–38.

Body subglobose, transparent, usually terminating posteriorly in a somewhat narrower obtusely rounded point; springing-setæ very long and fine, forming a central girdle, but not situated in an equatorial groove or furrow, the circle of adoral cilia exhibiting at one point a short interruption or spiral involution; contractile vesicle and endoplast spherical, located close to each other near the centre of the body. Length 1–1500″ to 1–860″.

Hab.—Pond water.

This species, while receiving its characteristic generic title from Dujardin, is identical with the *Trichoda* and *Trichodina grandinella* of O. F. Müller and Ehrenberg. It is of common occurrence in pond water, and has been described and portrayed by almost all the earlier writers. With the exception, however, of those by Claparède and Lachmann, none of these figures or descriptions given are to be relied upon, all having misinterpreted the true form and structure of both the oral ciliary wreath and that central girdle of setæ by which the animalcule accomplishes its leaping movements. As first shown by Müller, *Halteria grandinella* increases by transverse fission, the process of separation into two of a single individual being extremely rapid. When examining examples of this or other species of the genus, Claparède and Lachmann recommend the introduction upon the same slide of a few suctorial Acinetæ. Against these the Halterias are sure to strike while making their characteristic bounds, and being immediately seized and held immovably, an unprecedented opportunity is afforded for studying their structural characters. In a gathering containing a large number of these animalcules recently collected in the neighbourhood of St. Heliers, Jersey, the author found associated with them numerous examples of a species of *Urotricha* closely allied to, if not identical with, *U. farcta*. Their dimensions equalled about one-half that of the Halterias, while their rolling and springing movements corresponded so closely with those of their larger comrades, that it is considered highly probable by the author that *Urotricha* may eventually prove to be an immature or larval condition only of *Halteria*.

Halteria volvox, Eichwald sp. Pl. XXXII. Fig. 39.

Contour of body as in *H. grandinella*, but rather larger; leaping-hairs taking the same form and position, but supplemented by an equatorial zone of long, recurved, filamentous cilia. Hab.—Fresh water.

Claparède and Lachmann observed this species as here figured on one occasion only, and refer it with some doubt to the *Trichodina volvox* described in Eichwald's 'Infusorienkunde Russland,' 1852.

Halteria viridis, From.

Body globose, anteriorly truncate, surface smooth, colour green; median circlet of setæ very stout and conspicuous; motion rotatory and leaping. Length 1–1600″. Hab.—Fresh water.

Halteria verrucosa, From.

Body subspherical, truncate anteriorly, acuminately pointed posteriorly, having a central depression on one side which imparts to it a gibbous contour; colour green. Length 1–600″. Hab.—Fresh water.

Halteria lobata, From.

Body globose, the frontal margin projecting in the form of three raised papillæ; colour green; movements very swift. Length 1–800″.

HAB.—Fresh water.

Supplementary Species.

As many as five additional species are added to the genus *Halteria* by De Fromentel,* in none of which, however, with one exception, are the characters given sufficiently distinct for separate specific recognition. This exceptional form, his *H. bipartita*, is, however, not a *Halteria*, but apparently belongs to the genus *Arachnidium*. The *Halteria pulex* of Claparède and Lachmann is evidently referable to Stein's genus *Mesodinium*.

GENUS II. STROMBIDIUM, C. & L.

Animalcules free-swimming, globose, or turbinate; oral aperture terminal, eccentric, associated with a spiral wreath of powerful, erect, cirrose cilia; no accessory springing-hairs; endoplast and contractile vesicle conspicuous. Inhabiting salt and fresh water.

The animalcules of *Strombidium* surpass those of *Halteria* in the restlessness and rapidity of their movements, much difficulty consequently attending the interpretation of the true nature of their oral system. Claparède and Lachmann have, however, decided that the peristomal cirri in *Strombidium turbo* describe an incomplete spiral course, while Stein expresses a similar opinion with reference to the several types that have fallen under his observation. The investigations of the present author have elicited that a like disposition of the adoral cirri obtains in various other species, which may therefore now be accepted as diagnostic of the genus. This spire, furthermore, coincides with that of *Halteria*, it being its right limb that is involute and descends into the oral fossa. Excepting for the absence of the equatorial springing-setæ, this genus might be compared with the one last named, but in the length and shuttlecock-like disposition of the adoral cirri its members still more nearly resemble those of *Tintinnus*, and with which they are more immediately united through *Strombidinopsis*. The movements of the animalcules of the genus *Strombidium* consist of a vigorous oscillating or rolling motion to and fro, as though on a pendulum, interrupted, mostly when disturbed, by locomotion in a straight line, combined with rapid rotation on their longitudinal axis. A similar oscillating comportment has been already reported of *Strombidinopsis* and *Calceolus*, and recurs again in *Urocentrum* and *Gyrocoris*. When exchanging their oscillatory or rotatory motion for a rectilinear course, the likeness of these animalcules to detached roving *Vorticellæ* is very noteworthy; the earlier phases of *Vorticella nebulifera*, as elicited by the recent investigations of Everts, as delineated at Pl. XXXV. Fig. 39, are furthermore scarcely distinguishable from the matured zooids of *Strombidium turbo* or *S. Claparèdi*.

Strombidium sulcatum, C. & L. PL. XXXII. FIG. 47.

Body subglobose, truncate, and longitudinally furrowed posteriorly; adoral cilia stout, equalling half the body in length; contractile vesicle spherical, subcentral; colour brownish yellow. Length 1–400″.

HAB.—Salt water: Bergen (C. & L.).

* 'Études sur les Microzoaires,' Paris, 1876.

The discoverers of this species record that its motions in the water are remarkably swift and difficult to follow, as also that specimens occasionally in the midst of their impetuous course suddenly fall to pieces, as though by magic, undergoing diffluence with a rapidity observed of no other animalcule, though to some extent approached in *Arachnidium globosus*. According to the recent investigations of Bütschli,* the cuticular layer in this species is armed midway between the centre of the body and the anterior margin with an even girdle of elongate, close-set trichocysts. The figure accompanying the account of this variety seems, however, to represent a distinct species, possessing a more elongate contour, and exhibiting no trace of the posterior furrows that characterize Claparède and Lachmann's type. It is here proposed to provisionally distinguish this last-named animalcule by the title of *Strombidium Bütschlii*.

Strombidium turbo, C. & L.

Body globose, slightly conical posteriorly, its surface smooth; adoral cirri equalling the body in length, very rigid. Length 1–700″.

HAB.—Fresh water.

Strombidium Claparèdi, S. K. PL. XXXII. FIG. 46.

Body smooth, transparent, elongate-pyriform, tapering posteriorly, about twice as long as broad. Length 1–300″.

HAB.—Pond water, among *Conferva*.

This, the largest recorded species of the genus, is easily recognized by its elongate outline, and seems to be identical with a fresh-water species imperfectly observed by Claparède and Lachmann,† but for which they have not proposed a distinct specific title. Its movements agree with those recorded in the above generic description, and correspond remarkably with those of *Urocentrum turbo*. On several occasions this species has been observed by the author to attach itself to aquatic plants, or other objects, by its posterior extremity, which appears to be of softer consistence than the remainder of the body, and thus fixed draws currents of food-laden water towards it by the vigorous vibratory action of its powerful adoral cilia, after the manner of a *Vorticella*. Such a sedentary condition was only temporarily maintained, the animalcule soon resuming its more active gyratory course.

Strombidium urceolare, Stein.

Body contracted centrally, anteriorly moderately, and posteriorly considerably enlarged, almost pitcher-shaped; peristome produced towards the posterior extremity as an oblique furrow, bearing towards its anterior extremity two or three closely set, large-sized vibratile cilia; endoplast small, oval; contractile vesicle posteriorly situated. Dimensions unrecorded. HAB.—Salt water: Baltic Sea.

Strombidium acuminatum, Stein.

Body attenuate, conical, acuminate anteriorly; peristome produced backwards nearly to the centre of the body; the hinder half of the ventral surface bearing an oblique supplementary row of fine vibratile cilia; colour yellow. Dimensions unrecorded.

HAB.—Salt water: Baltic Sea.

* 'Archiv für Mikroskopischer Anatomie,' Bd. ix., 1873. † 'Études sur les Infusoires,' p. 372.

Strombidium viride, Stein.

Body obovate, obtusely conical anteriorly; parenchyma coloured green by the presence of innumerable enclosed chlorophyll-granules; peristome produced backwards as in *Strombidium acuminatum*, the ventral aspect not having a supplementary row of fine cilia as in that species; the cuticle containing numerous minute staff-like bodies whose nature was not ascertained, but which probably correspond with the trichocysts that form an equatorial girdle in *S. Butschlii*. Dimensions unrecorded.

HAB.—Fresh water.

Strombidium caudatum, From.

Body ovate, tapering posteriorly, and terminating in an elongate caudal filament; contractile vesicle posteriorly situated. Length, without filament, 1–1000". HAB.—Fresh water.

But for the posterior location of the contractile vesicle, the author is disposed, from the figure and brief description given by De Fromentel, to regard this type as a *Vorticella* detached, with its pedicle, from its fulcrum of support.

Strombidium globosum, From.

Body spherical, transparent; ciliary wreath very small and inconspicuous; contractile vesicles large, two in number, posteriorly located. Length 1–800". HAB.—Fresh water.

GENUS III. MESODINIUM, Stein.

Animalcules free-swimming, ovate or pyriform, the anterior extremity prolonged in a snout-like manner, and perforated apically by the oral aperture; bearing between the snout-like prolongation and more inflated posterior portion of the body a circular fringe of setose or cirrate locomotive cilia. Inhabiting salt and fresh water.

The representatives of this genus appear to unite the characters of *Halteria* and *Didinium*, they possessing the protrusible snout of the latter combined with a wreath of locomotive cirri, which, while discharging the more ordinary natatory functions, are also endowed with saltatory properties.

Mesodinium acarus, Stein. PL. XXXII. FIG. 40.

Body subturbinate, the posterior portion globose, the anterior one conical, the two regions separated from one another by a raised annular border, from out of which are produced the circle of locomotive cirri; contractile vesicle spherical, posteriorly located. Length of body 1–800".

HAB.—Pond and marsh water.

This species, as here figured, and obtained by the author from a number of localities, is apparently identical with the type for which Stein first instituted the generic title of *Mesodinium*. It may be readily distinguished from the two succeeding salt-water forms by the raised border, bearing the locomotive cirri, which divides the inflated posterior half from the conical anterior one. It has been frequently

observed by the author that examples of this species can attach themselves to surrounding objects by the distal end of their snout, which thus fulfils the purpose of an adhesive sucker. The almost setose locomotive cirri, when such an attachment is effected, quiver for a short interval with great rapidity, but finally become entirely quiescent. The animalcules under these conditions, when seen from above, may easily be mistaken for minute examples of the Radiolarian genus *Actinophrys*.

The adherent snout in this type is, as in *Didinium*, capable of protrusion for the seizure of prey to a considerable distance. When swimming, its locomotion is rotatory, varied by occasional leaps from side to side after the manner of an *Halteria*. This leaping motion is apparently effected by a similar sudden flexure of the locomotive cirri, which, while not so long and slender as in the last-named type, are of an almost setose character. On a recent occasion the author noted, in an animalcule apparently belonging to this species, what appeared to be a circlet of minute vibratory cilia at the base of the conical snout, in addition to the normal setose series, but this observation has not since been confirmed.

Mesodinium pulex, C. & L. PL. XXXII. FIG. 44.

Body turbinate, globose posteriorly, conical and tapering as it approaches the anterior projecting snout; wreath of cirrose cilia developed on an annular groove or constriction half-way between the centre of the animalcule's body and the base of the snout-like process. Length of body 1–1650″. HAB. Salt water.

This species, described by Claparède and Lachmann under the title of *Halteria pulex*, is recognized by Stein as probably belonging to his genus *Mesodinium*. In the diagnosis and description given by its discoverers it is represented as possessing three long stylate processes, or bristle-like cirri, in advance of the mouth. Stein regards these simply as three forward-projected locomotive cirri; but the present author is inclined to accept them as an optical misinterpretation of the everted attenuate proboscis, the two so-called outer styles representing the lateral walls, and the central one the pharyngeal perforation of this structure. An almost identical appearance is exhibited by *Mesodinium acarus* during the protrusion of this organ.

GENUS IV. ACARELLA, Cohn.

Animalcules free-swimming, more or less ovate, divided by an annular constriction into a globose posterior and conical anterior portion, the annular furrow bearing a wreath of long, slender, setose cilia; the body enclosed wholly or in part within an ovate or subglobular, transparent sheath or lorica.

The type form of this genus, as described by Cohn,* closely resembles the species first described by Stein under the title of *Mesodinium acarus*, and also the *Halteria* (*Mesodinium*) *pulex* of Claparède and Lachmann, but is of very much smaller size, and has the posterior portion of its body enclosed within a transparent lorica.

Acarella siro, Cohn. PL. XXXII. FIG. 45.

Body elongate-ovate, the posterior portion the larger, rounded and subglobular, the anterior one conical, apically truncate; setose cilia of the intervening annular constriction equalling in length the larger posterior

* "Neue Infusorien im Seeaquarium," 'Zeit. Wiss. Zool.,' Bd. xvi., 1866.

portion; lorica subglobular, reaching, when the animalcule is swimming and extended, as far as the annular constriction. Length 1–1000″. Movements like those of *Halteria*, sometimes swimming smoothly and at others springing from side to side. HAB.—Salt water.

GENUS V. ARACHNIDIUM, S. K.

(Greek, *arachne*, spider; *eidos*, like.)

Animalcules free-swimming, ovate or spherical; oral aperture terminal, central, surrounded by a circular wreath of large, flexible, tentaculiform cilia, which constitute the only locomotive or prehensile organs; endoplast and contractile vesicle conspicuously developed. Inhabiting salt and fresh water.

This new genus holds a position midway between *Mesodinium* and *Strombidium*, it having the central mouth and even oral circle of cilia characteristic of the former, but wanting, as with the latter, its special supplementary leaping setæ. This single oral wreath of cilia at the same time attains a much greater development, and assumes a character completely distinct from either of the above-named genera; these cilia, indeed, resemble rather small flexible tentacula than the ordinary cilia or setæ of the normal representatives of this group. In their more ordinary condition these organs are recurved gracefully towards the posterior extremity of the body, and when in active use exhibit a perfectly independent motion. The spider-like aspect of the animalcules of this genus, with their rounded bodies and straggling tentacle-like cilia, has suggested the title adopted for their distinction. More correctly they may perhaps be likened to the free-swimming Cœlenterate genus *Arachnactis*.

Arachnidium globosum, S. K. PL. XXXII. FIGS. 48 AND 49.

Body nearly spherical, smooth, transparent; oral cilia sixteen to twenty in number, thick and tentaculiform, equalling the body in length; endoplast very large, band-like, curved; contractile vesicle spherical, subcentral. Length 1–2000″. HAB.—Pond water, among *Confervæ*.

The normal mode of motion exhibited by this species is a rolling to and fro, somewhat after the manner of *Strombidium*, but in a more sluggish manner. Occasionally it darts backwards through the water with the tentacle-like cilia collected in a bundle behind in the manner indicated at Pl. XXXII. Fig. 49. Under these last-named circumstances it presents a fanciful resemblance to a miniature *Octopus* swimming backwards through the water in its accustomed manner. The endoplast attains a very large relative size, closely resembling in contour that of many typical Vorticellidæ. On one occasion the author observed an example rapidly dissolve, as though by diffluence, in the water, leaving the thick band-like endoplast as the only trace of its previous existence. This, no doubt, subsequently breaks up, releasing the germs of a future progeny. The few examples of this minute but beautiful animalcule so far encountered were obtained by the author from a pond at Stoke Newington, in February 1874, in company with *Dinobryon sertularia*, *Salpingœca amphoridium*, and other Flagellate types, then the subject of special investigation. The drawings of the species, as here reproduced, were accomplished with the assistance of a magnifying power of 1200 diameters, obtained through the use of a $\frac{1}{25}$-inch object-glass by Messrs. Powell & Lealand.

Arachnidium convolutum, S. K. PL. XXXII. FIG. 41.

Body egg-shaped, tapering slightly posteriorly, somewhat opaque, spirally furrowed or convolute throughout its length; oral cilia nearly as long as the body, more numerous but not so thick as in *A. globosus*; endoplast band-like, curved; contractile vesicle spherical, subcentral. Length 1–750". HAB.—Salt water.

The form and proportions of this animalcule, in addition to its considerably larger size and salt-water habitat, readily distinguish this type from the preceding one. A single example only has up to the present time been met with, this having been obtained by the author at Bognor, on the Sussex coast, in September of the year 1872.

Arachnidium bipartitum, From. sp. PL. XXXII. FIGS. 42 AND 43.

Body subpyriform, with a subglobose inflated posterior, and a smaller but also rounded anterior portion, the constriction dividing these two regions from one another bearing the tentaculate locomotive cilia, these long and slender, equalling the body in length, sometimes used as ambulatory organs; parenchyma transparent, enclosing numerous spheroidal, refringent corpuscles. Length 1–800". HAB.—Fresh water.

This species is briefly described by De Fromentel* as a species of *Halteria*, but is obviously more nearly related to the present genus. The faculty it possesses of walking over the surface of submerged objects with the aid of its locomotive cilia is as yet not known to be possessed by any other members of the Halteriadæ, but is possibly shared by the preceding representatives of the genus *Arachnidium*. The locomotive cilia in this type are more slender, and evidently of firmer consistence, than in the two preceding species, and would seem to possess an almost stylate character. The characteristic mode of progress through the water, as depicted by De Fromentel, agrees essentially with that previously noted by the author of *Arachnidium globosus*, all the locomotive cirri being gathered together and extended in front of the oral aperture, while the animalcule swims backwards after the manner of an *Octopus*. What, during such translation, constitutes the actual motile agency has not yet been ascertained, but it would seem probable that additional fine locomotive cilia are developed upon the oral region. Although not represented by De Fromentel in his figures, he would seem to hint, in his brief description of the present species, that such fine, scarcely perceptible cilia fringe the free margin of the anterior border.

GENUS VI. DIDINIUM, Stein.

Animalcules free-swimming, ovate or subcylindrical, provided with an anterior and posterior ciliary wreath; the anterior extremity snout-like, enclosing a tubular, protrusible, prehensile proboscis, whose distal extremity is perforated by the oral aperture; anal aperture and contractile vesicle posteriorly located; multiplying by transverse fission, and by the subdivision of the endoplast into germinal elements.

Neither of the ciliary wreaths in *Didinium* immediately surround the mouth or take an important place in connection with that organ as in *Halteria* and *Strombidium*,

* 'Études sur les Microzoaires,' 1876.

but are subservient merely to the purpose of locomotion. It is perhaps desirable, in recognition of this circumstance, that in conjunction with *Mesodinium*, it should be separated as the representative of an independent family group.

Didinium nasutum, Müll. sp. Pl. XXXII. Figs. 50–57.

Body ovate or barrel-shaped, about twice as long as broad, rounded posteriorly, the anterior border produced in a snout-like manner; parenchyma coarsely granular, cuticular surface smooth; the foremost ciliary wreath developed close to the base of the snout-like anterior projection, the hindermost girdle encircling the body at about a distance of one-third of its total length from the posterior extremity; proboscis slender, protrusible to a distance equalling the entire length of the body; endoplast band-like, curved; contractile vesicle spherical, of large size, debouching upon the anal aperture. Length 1–300". Hab.—Pond water.

The *Vorticella nasuta* of O. F. Müller, which furnishes the type of both the genus and species now under consideration, has recently been the subject of investigation by Balbiani,* who has elicited details of high interest concerning both its structure and life-history. By this authority it has been first recorded that the animalcule is able to evert from its snout-like anterior extremity a proboscidiform organ of considerable length, with which it seizes upon and sucks out the contents of other animalcules, such as *Paramæcium*, in the same manner that an *Acineta* devours its living prey, or transports it bodily, with the retraction of its proboscis, to its own interior. Balbiani further ascribes to this form a tubular central digestive canal, presenting at the pharyngeal or post-oral portion of its course a longitudinally striated aspect, which is produced by the presence in its walls at this point of numerous rigid rod-like filaments. These pharyngeal rods are, according to his observations, capable of extrusion and are used by the animalcule for the purpose of paralyzing its prey. From the account given of these elements, however, the author is inclined to identify this rod-system as a whole with the pharyngeal rod-fascicles of *Chilodon*, *Prorodon*, and other Hypotrichous and Holotrichous forms. A very regular protoplasmic circulation has been observed by Balbiani, flowing in a continuous stream, immediately beneath the cuticle, towards the apical or oral pole, and returning along the central axis formed by the digestive tract.

With *Didinium nasutum* must be identified the so-called *Chytridium Steinii*, figured and described by Dr. Ernst Eberhard in the 'Osterprogramm der Realschule zu Coburg' for 1862, as also the more recent *Wagnerella cylindroconica*, described, with an accompanying woodcut, by Wladimir Alenitzin, of St. Petersburg, in the 'Archiv f. Mikroskopische Anatomie,' Bd. x., 1874. Increase by transverse fission is of very common occurrence in this type, such an approaching duplicative act being always heralded by the accession to the body surface of two supplementary ciliary girdles. In some instances spheroidal germ-like bodies were observed by Balbiani occupying the place of the normal band-like endoplast, and through the breaking up of which they were apparently produced. Subsequently these germs were liberated as minute pyriform animalcules, bearing a single anterior circlet of cilia, and corresponding closely with the adult state of the preceding genus *Mesodinium*. The growth of these germs into the perfect form has not as yet been traced. The present author has on one occasion obtained this interesting animalcule in the neighbourhood of Stoke Newington, London. A reference to the homoplastic resemblance that subsists between *Didinium* and the embryos of certain metazoic organisms will be found at pages 576 and 577.

* "Sur le *Didinium nasutum*," 'Archives de Zoologie Expérimentale,' 1873.

Fam. V. GYROCORIDÆ, Stein.

Animalcules free-swimming, persistent in shape, but not encuirassed, ovate or pyriform, provided with one or more spiral or circular wreaths of cirrose cilia; oral aperture lateral or ventral; anal aperture postero-terminal; the posterior extremity frequently bearing a conspicuous stylate or more or less flexuose caudal appendage.

The three genera included in this family group differ from all remaining representatives of the Peritricha in the lateral location of the oral aperture. Through *Urocentrum* a close relationship with the Heterotrichous genus *Calceolus* is evidently established.

Genus I. GYROCORIS, Stein.

Animalcules free-swimming, persistent in shape, separated into two conspicuously distinct regions, the anterior one helmet-shaped or campanulate, more or less rounded anteriorly, with a free mantle-like posterior border, the hinder portion produced from the centre of this border as a long claw-like style or tail; a ciliated groove extending backwards from the anterior extremity along the ventral surface, then ascending obliquely and continued as a right-winding spire of long, powerful locomotive cilia, which form a fringe round the free truncate margin of the anterior or body portion; oral aperture situated apparently near the centre of the ventral ciliated groove; anal aperture posteriorly located; contractile vesicle and endoplast conspicuous.

Gyrocoris oxyura, Stein. Pl. XXXIII. Figs. 1–6.

Body bell- or helmet-shaped, subpyriform; claw-like tail or style produced from the hinder margin, equalling the body in length; cilia forming the posterior marginal fringe very long and fine; contractile vesicle large, spherical, situated close to the base of the tail-like portion; endoplast represented by three or four, more rarely two, transversely disposed ovate corpuscles; a bluish, granular, crescent-shaped spot, corresponding probably with the so-called eye-speck of other infusorial forms, often present at the anterior extremity. Length, including tail, 1–200″.

Hab.—Stagnant water.

This form was first obtained by Stein in great profusion in stagnant water near Prague, and is described by him* as exhibiting such rapidity of motion, through revolution on its axis in a screw-like manner, that the greatest difficulty attends the interpretation of its true form and character; the oral aperture under these conditions, while suspected to be situated in the ciliated ventral groove, was not absolutely observed. The possible affinity of this form with the imperfectly described *Cœnomorpha medusula* of Perty and the *Trichodina tentaculata* of Ehrenberg has been recognized by Stein; in both of these, however, the body portion appears to be more nearly hemispherical or discoidal; there is, again, no indication of a ventral ciliated groove, and such cilia as are represented, though possibly erroneously, form a fringe round the anterior border. An animalcule figured by Mr. Tatem in the 'Quarterly

* 'Sitzungsbericht der K. Böhmischen Ges. d. Wiss.,' S. 48, 1860.

Journal of Microscopical Science' for the year 1868, under the title of *Cœnomorpha convoluta*, here reproduced at Pl. XXXIII. Figs. 1–3, is evidently identical with Stein's type. His brief account of the species, though it leaves much yet to be recorded concerning this remarkable form, supplies some additional data of importance. The body as described by this later observer, and as delineated at Fig. 1, is colourless, smooth, and conical, the anterior extremity curved somewhat downward, and the posterior margin fringed at its edge with long, close-set cilia. The tail-like portion is swollen at its base, somewhat eccentric, is as long or longer than the body, and tapers to a point which is curved slightly upwards at its distal extremity. In addition to its swift natatory mode of progression, Mr. Tatem relates that from twelve to twenty of the cilia on the ventral surface present the character of long stiff setæ, and that with their aid the animalcule is enabled to creep over the surface of algæ or other submerged bodies; the tail-like style is likewise described by him as being sometimes bifid. The character and position of the oral aperture were not determined, nor are any details recorded concerning the nature of the contractile vesicle and endoplast. The former structure, although not recognized as such in Mr. Tatem's description, is clearly indicated in his drawings in the same locality first ascribed to it by Stein. Representations of a supposed earlier condition of this organism are given by Mr. Tatem, one of which, Pl. XXXIII. Fig. 2, excepting for the position of the ciliary wreath, corresponds remarkably with Perty's figures of *Cœnomorpha medusula*. This circumstance suggests the possibility that Perty grounded his description of the last-named species upon young and certainly very imperfectly observed examples of the present form. To complete the record of this puzzling Peritrichous form, it is desirable to add that it is figured by Dr. Ernest Eberhard in the 'Osterprogramm der Realschule zu Coburg' for 1862, under the title of *Strombidium polymorphum*, and there associated with *Metopus sigmoides*, which is regarded by him as merely its earlier or larval condition. This presumed affinity is referred to at greater length in the account given of the last-named species.

The diagnosis and more characteristic figures of Perty's *Cœnomorpha medusula* are herewith reproduced, and should future investigation successfully establish the identity of the two, this authority's generic and specific title will, in accordance with the laws of priority, have to supplant that of Stein's. So far as can be at present decided, the author is inclined to regard the species as distinct, but the genus identical.

Cœnomorpha medusula, Perty. Pl. XXXIII. Figs. 26–28.—Body colourless, transparent, bell-like or hemispherical, its surface sometimes plicate, the base concave and truncate, with an irregularly notched border; a tail-like process comparable to the clapper of the bell depending from the centre of the body; the margin of the bell fringed with long cilia, which sometimes present the aspect of an undulating membrane. Movements swift, rotating on its longitudinal axis. Length, with tail, 1–240″ to 1–192″. Hab. Standing water.

GENUS II. UROCENTRUM, Nitzsch.

Animalcules free-swimming, ovate or pyriform, persistent in shape; body encircled by one or two circular girdles of cilia, and traversed on its ventral surface by a longitudinal groove or furrow; oral aperture ventral, perforating the centre of the more posterior ciliary girdle; an apparently stylate, but more or less flexuose and adherent, caudal appendage produced from the posterior region of the body; endoplast and contractile vesicle conspicuously developed. Inhabiting salt and fresh water.

Urocentrum turbo, Müll. sp. PL. XXXIII. FIGS. 7–10.

Body unevenly pyriform, largest and inflated anteriorly, constricted centrally, narrower and triquetrous posteriorly, the ventral surface somewhat

flattened; caudal appendage nearly equalling one-half the body in length, flattened and flexible, distally adhesive; ciliary girdles two in number, the anterior wreath encircling the body at a short distance only from the frontal border, the posterior one subcentral; endoplast and contractile vesicle posteriorly situated, the former band-like, curved, transversely placed, the latter median, exhibiting at diastole a rosette-like contour; parenchyma transparent, colourless or pale yellow, enclosing anteriorly numerous spheroidal globules. Length 1–500″ to 1–280″.

HAB.—Fresh water, among *Lemnæ*.

This animalcule was originally described by O. F. Müller under the title of *Cercaria turbo*, its present generic name being first employed by Nitzsch,* and afterwards by Ehrenberg. By none of these earlier writers have the details of the ciliary system been accurately interpreted, the small size and exceedingly active motions of the species accounting mainly, no doubt, for this discrepancy. In no instance as yet has this type been represented as possessing more than a single ciliary girdle, this being further described as encircling the anterior border. The present author has examined this same animalcule on repeated occasions, and has on each of these determined with facility the presence under normal conditions of two such girdles; the more anterior girdle, composed of slightly larger cilia, encircles the periphery at a short distance only from the anterior extremity, leaving a small, bare, cap-like border, while the more posterior circlet is continuous with the transverse line of constriction that separates the wider and inflated anterior from the narrower and more usually triangular hinder region of the body. At one period only of its existence does the animalcule possess but a single girdle of cilia, this being immediately after the process of transverse fission, in which case the old ciliary girdle in each separated segment is retained as the posterior or oral one, and a new anterior wreath subsequently developed between that and the anterior extremity. The close resemblance in both general contour and comportment, that subsists between *Urocentum turbo* and the *Calceolus* (*Peridinium*) *cypripedium* of Professor H. James-Clark has been already referred to in the description given of that species. In recognition of such likeness the author has recently examined examples of *Urocentrum*, obtained in the neighbourhood of St. Heliers, Jersey, with the special object of ascertaining whether or not the few distinctive characters possessed by Professor Clark's type were not also represented here. These features, as previously explained, consist of the exceedingly fine ciliation of the entire surface of the body behind the, in *Calceolus*, single anterior wreath of powerful cirrose cilia, and the composite structure of the caudal appendage, which was found under high magnification to consist of a bundle of agglomerated hair-like flexible setæ in place of a single stylate organ, as was at first premised. Specimens subjected to the most rigid examination in both the living condition and as killed with osmic acid and other reagents, betrayed no trace of cilia at any point separate from the two characteristic annular wreaths, while the caudal appendage was equally proof against resolution into a compound fasciculate structure, as reported by James-Clark of *Calceolus*. This last-named organ was found, however, under increased amplification, to exhibit certain structural peculiarities not previously observed. In place of being rigid and stylate as at first supposed, it was now shown to be flattened and band-like, to possess a considerable amount of flexibility, and to be soft and adhesive at its more attenuate distal extremity. As with *Calceolus*, the movements of this animalcule consist variously of free rotation in the water to and fro upon its long axis as though mounted on a pendulum, while at other times it darts to and fro in a straight line with great velocity, or it fixes itself by the extremity of its caudal appendage to some solid object and spins

* 'Beiträge zur Infusorienkunde,' p. 4, 1817.

rapidly backward and forwards upon it as if on a pivot. It is under the last named circumstances that the flexibility of this organ is manifest. When closely observed it is then seen that with each rotation it is thrown into a twist of many coils after the manner of a pliant band or cord, the next rotation relaxing this flexure and coiling it in a similar manner in an opposite direction. The aspect of the caudal appendage in its twisted state is so like that of a bundle of smaller thread-like filaments or of a long drawn-out and sharply pointed screw, as observed by Professor Clark of the homologous organ in *Calceolus*, that it is difficult to refrain from a suspicion that in that type also it may eventually prove to possess a similar band-like character. It is at the same time requisite to remark that in some instances the caudal appendage of that organism appeared to him to be divided into equal halves, representing possibly, however, an abnormal development, while at other times it presented distally a brush-like aspect.

The contractile vesicle in *Urocentrum* is a very conspicuous object, exhibiting at full diastole, as seen in profile, apparently two, but actually four, rounded lateral sinuses whose diameter equals about one-half of that of the large spheroidal central lacuna. With the act of systole the greater portion of the liquid contents is discharged into the outer water, leaving, however, a small portion behind in each of the four sinuses; these now become distended, and coalescing with one another form the characteristic spheroidal central vesicle, to which again lateral diverticula are added and systole is repeated as before. The various aspects of the contractile vesicle during these successive stages is shown at Pl. XXXIII. Fig. 10, *a* to *f*, the phenomena as a whole corresponding closely with what has been recorded by Wrzesniowski of *Enchelydon farctus* and *Trachelophyllum apiculatum*. In August 1872, the author met with a salt-water representative of the genus *Urocentrum* at Bognor, Sussex. From the sketches and brief notes made at the time, it would appear to present little or no points of distinction from *U. turbo;* the triangulation of the posterior region of the body was perhaps more decidedly marked, while the caudal appendage appears to have been more curved and claw-like. It is proposed to provisionally distinguish this salt-water form of the species under the name of *Urocentrum turbo* var. *marinum*. Under the action of dilute osmic acid the animalcules of *U. turbo* speedily disintegrate, demonstrating the absence of an indurated cuticle or cuirass, which under normal conditions might be suspected to exist.

GENUS III. TELOTROCHIDIUM, S. K.

(*Telotrocha*, worm-larva; *eidos*, form.)

Animalcules entirely free-swimming, ovate or campanulate, possessing no caudal appendage; ciliary girdles two in number; oral aperture opening on the ventral surface, immediately behind the anterior wreath of cilia; anal aperture postero-terminal; contractile vesicle and endoplast conspicuously developed. Increasing by longitudinal fission. Inhabiting fresh water.

Telotrochidium crateriforme, Müll. sp. PL. XXXIII. FIGS. 11–13.

Body campanulate or subquadrate, with an indented dorsal and convex ventral or oral aspect; ciliary wreaths developed at a short distance only from the anterior and posterior extremities, the anterior one associated with a thick annular border; anal aperture postero-terminal, tubular, permanently visible; contractile vesicle single or double, subcentral; endoplast band-like, curved; parenchyma transparent, pale brown or amber-

coloured. Movements swift, rotating in alternate directions. Length 1–250″. HAB.—Pond water.

Examples of this species were abundantly developed in a sample of water containing *Euglena acus* and *Distigma proteus* remitted to the author by Mr. Thos. Bolton, in November 1880. While at first sight presenting no inconsiderable resemblance to detached *Vorticellæ*, the recognition, on a more intimate acquaintance, of the posterior location and conspicuous development of the anal aperture—from which the passage of excreta was directly observed—together with the character of the oral system, speedily indicated the necessity of assigning to this type a position altogether independent of the Vorticellidæ. Excepting, indeed, for the absence of an adherent caudal appendage, it in many respects agrees with *Urocentrum*, and may be most conveniently referred to that family group. The likeness suggested is manifested in addition to the number and position of the ciliary girdles and ventral location of the oral aperture, in the texture and pale brownish hue of the parenchyma, and in its mode of locomotion. This, while accomplished in a forward direction, is accompanied by the rotation of the animalcule in alternate directions, a slight displacement of the generated force being alone required to convert it into that oscillating or pendulum-like motion so highly characteristic of *Urocentrum*. While in most instances a single subcentral contractile vesicle was alone to be detected, some few examples occurred in which, as shown at Pl. XXXIII. Fig. 11, two such structures were distinctly developed. It would seem, however, to be by no means improbable that such zooids were about to multiply by the process of fission, which, contrary to that of *Urocentrum*, takes a longitudinal direction. It was remarked that the animalcules varied very considerably among each other in their relative lengths and in the contour of the posterior region. While more ordinarily the length nearly equalled twice the breadth, the posterior extremity being in such case rounded or obtusely pointed, examples were not unfrequently met with whose length did not surpass more than one-half of the breadth, and the posterior extremity being abruptly truncate, the body as a whole presented, as shown at Pl. XXXIII. Fig. 12, a short discoidal contour. Although the anterior ciliary wreath, with its thickened border, was in all instances distinctly recognizable, the simple and smaller posterior girdle was not so clearly perceived, and more often, indeed, presented the aspect only of a few lateral setose appendages. At the end of a week's preservation in the living state all the specimens received affixed themselves to the sides of the glass zoophyte trough to which they had been transferred, and speedily entered upon the encysted state. The band-like endoplast became subdivided into nodular fragments, but further developmental phases were not observed. The remarkable homoplastic resemblance that subsists between the animalcules of this species and the so-called telotrochous larvæ of certain Annelids, and which has suggested the generic title here conferred upon it, is referred to, with an accompanying illustration, at pages 447 and 478 of the previous volume.

The identification of this type with the *Vorticella crateriformis* of O. F. Müller, figured and described by that authority close upon a century ago,* but which since then up to the present time does not appear to have come within the notice of any other investigator, has been quite recently and unexpectedly accomplished during a final examination of the Müllerian species of *Vorticella* proper. The very clear indication given in both Müller's figures and accompanying text of the posteriorly located anal aperture, added to all other details relating to contour, structure, colour, and comportment in the water, has enabled the author to establish this identity in the most conclusive manner, and to perpetuate a time-honoured specific title in place of the new one which previously seemed unavoidable. In one of the figures given by its original discoverer, *l. c.* pl. xxxix. fig. 7, an example of so-called conjugation between two zooids is delineated, that must evidently be identified with the process of longitudinal fission as observed by the author and figured in this treatise.

* 'Animalcula Infusoria,' p. 278, and pl. xxxix. figs. 7–13, 1786.

Fam. VI. URCEOLARIIDÆ, Stein.

Animalcules free-swimming or adherent at will, discoidal, turbinate, or hourglass-shaped ; the anterior border more or less circular, associated with a spirally convolute ciliary wreath, the right limb of which is usually involute, and descends into the oral aperture ; oral system closely resembling that of the Vorticellidæ, consisting usually of a widened anterior entrance or vestibulum, and a somewhat prolonged pharyngeal passage ; posterior border acetabuliform and adhesive, ciliate round its peripheral margin, and mostly strengthened internally with a simple or denticulate horny ring.

With the typical genera of this family, *Trichodina* and *Urceolaria*, are here included two additional forms, *Cyclochæta* and *Licnophora*, which exhibit in connection with their oral systems a marked deviation from these normal types. In the first of these, the anterior adoral ciliary wreath is entirely obliterated, or represented only by that extremity which descends into the greatly prolonged pharyngeal passage. In *Licnophora* it is the left-hand limb of the adoral wreath instead of the right, as in most Peritricha, that is spirally convolute, a circumstance which, together with the oblique setting and more elongate contour of the peristome-field, likens it, as pointed out by Claparède, to the corresponding region in *Stylonychia* and other Hypotricha. The adoral ciliary system in the two earlier established genera first named closely resembles that of the ordinary Vorticellidæ, but is more simplified through the non-existence of a protrusible ciliary disc. To these last-named animalcules, in their free-swimming state, having a supplementary circlet of locomotive cilia temporarily developed at their posterior extremity, the *Trichodinæ*, indeed, exhibit a most remarkable likeness. Such temporary free-swimming Vorticellidæ, as here illustrated, more especially in the case of *Epistylis digitalis*, see Pl. XXXVIII. Fig. 16, are able in a similar manner to adhere to, and creep over the surface of submerged objects with the aid of their temporarily flattened posterior extremity and adventitious ciliary circlet, which may without doubt be regarded as homologous with the ciliary wreath that permanently fringes the acetabuliform posterior extremity of *Trichodina* and its allies.

All the representatives of this family group are distinguished by their essentially parasitic or commensal habits.

GENUS I. TRICHODINA, Ehrenberg.

Animalcules free-swimming, highly elastic and changeable in shape, conical or discoidal ; oral aperture terminal, eccentric, continued into a cleft-like pharynx, and associated with a horizontal, spirally convolute, adoral wreath of cilia, the right limb of which is involute and descends into the oral aperture ; anal orifice debouching into the vestibulum ; posterior extremity discoidal, acetabuliform, its outer margin fringed by a circle of long even cilia, its inner border strengthened by a more or less indurated horny ring and supplementary denticles ; endoplast band-like or moniliform ; contractile vesicle spherical, located near the termination of the pharynx. Inhabiting salt and fresh water, usually infesting the cuticular surface of hydroid zoophytes and other Invertebrata.

Trichodina pediculus, Ehr.

Pl. XXXI. Figs. 48–52; Pl. XXXIII. Figs. 14–18; and Woodcut, p. 647.

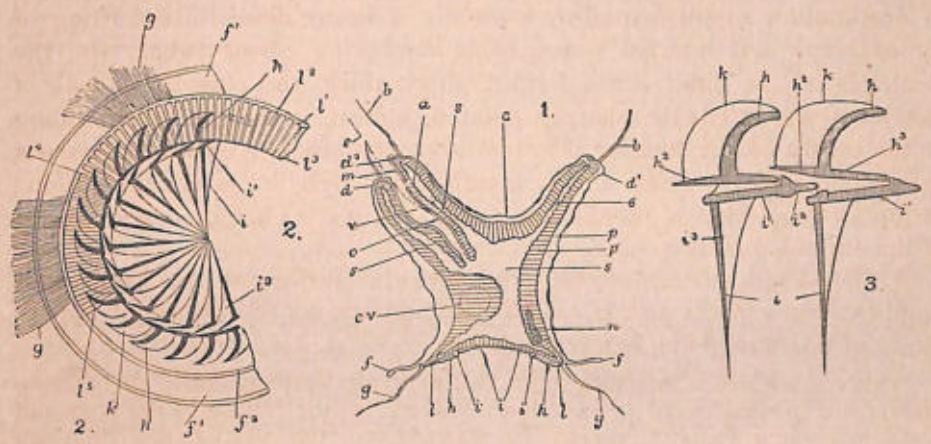
Body conical, discoidal, or hourglass-shaped, according to the condition of contraction or expansion, the elevation, when fully expanded, equal to, but scarcely exceeding, the greatest diameter; cilia of the posterior margin exceeding in length those of the adoral wreath, inserted on the inner side and at the base of a thin, transparent, annular membrane or velum, into which the border of the posterior margin is produced; horny ring of acetabulum supplemented by a wreath of horny denticles consisting of an external and internal series, each numbering about twenty-six, the denticles of the outer series largest, short, thick and claw-like, those of the inner set attenuate, sharply pointed, almost straight, and extending to the centre of the interior discoidal area, composed in each instance of a more solid radial portion and a membranous web-like lateral extension; endoplast band-like or moniliform, curved. Greatest height and diameter of the extended body 1–360".

Hab.—Fresh water, infesting the cuticular surface of the fresh-water polypes *Hydra fusca* and *H. viridis*; sometimes on the branchial appendages of the amphibian *Triton cristatus*.

This species, which may be regarded as the typical representative of its family and genus, is often found in countless numbers on the surface of the body and tentacles of the fresh-water polypes *Hydra viridis* and other allied species, to which chosen hosts it either adheres firmly by its posterior acetabulum, or scrambles rapidly over them with the aid of the girdle of cilia developed in the same region; leaving its adopted fulcrum of support, it is further capable of swimming through the water with considerable velocity. Under these last conditions it may retain its fully expanded form or contract itself into an almost wheel-like shape, and progresses rotating on its axis, or, turning end over end, performs as it were a series of somersaults. The numerous forms this animalcule is able to assume by reason of the great plasticity of the whole anterior portion of the body, has given rise to much diversity in the accounts and figures of this species handed down to us by the earlier writers. By far the most characteristic attitude presented is that subcylindrical or discoidal one, with a slightly constricted centre and perfectly parallel anterior and posterior edges, as shown at Pl. XXXI. Fig. 49, and in which condition, with its somewhat hollowed extremities, it presents a contour that may be suitably compared with that of a dice-box or with a fish's amphicœlous vertebra. Not unfrequently the area within the anterior ciliary wreath or peristome is protruded in a conical form and in such a manner that the entire body presents the hemispherical or turban-shape shown at Pl. XXXIII. Figs. 14 and 15. Stein was the first to show that in addition to the apparently continuous circlet of corneous uncini which forms so conspicuous a feature of the acetabuliform posterior extremity, there exists in the same region, and lying without the last-named structure, a second finely striated, flexible, horny, annular ring of a pale amber colour, and which, no doubt, adds materially to the efficacy of the adhesive organ. This second corneous ring, though more transparent than the circlet of uncini, was pronounced by Stein to be of much firmer consistence, since it resisted the action of acetic acid after the latter had become disintegrated.

An exhaustive and masterly essay on the anatomy and physiology of *Trichodina pediculus*, to which the author is indebted for many points embodied in the foregoing diagnosis, was contributed by Professor H. James-Clark to the 'Memoirs' of the

Boston Society of Natural History, vol. i., 1865, and is reprinted in 'Annals of Natural History' for June 1866. Several of the more important structural features elicited through this investigator are reproduced in the accompanying woodcut. According to this authority the elongate dicebox-like contour referred to and reproduced in the figure first cited, represents the normal one maintained by this animalcule in a state of health, the turban-shaped or conical ones given by Stein and other writers being assumed only when in a sickly condition, or when confined within too small a space for perfect freedom of motion. The periphery of the body behind the adoral ciliated disc is described by Professor Clark as exhibiting in transverse optical section an exceedingly irregular outline, arising from the fact that the body is fluted and ribbed exteriorly from one end to the other by irregular



Trichodina pediculus, Ehr.—1. Diagrammatic illustration of longitudinal optical section. 2. A basal view of the adherent apparatus, velum, and part of the posterior row of cilia, × 950. 3. Two of the uncini with their corresponding radii from the adherent apparatus of a dead specimen × 2000. The lettering is alike throughout: *a*, anal aperture; *b*, vibratory crown; *c*, bottom of the cupuliform disc; *d*, peristome opposite and beneath the vestibular aperture; *d* 1, peristome, dorsal region; *d* 2, peristome, ventral region; *e*, lumen of the edge of the row of vibrating cilia, hitherto supposed to be a distinct vestibular seta; *f*, profile of the velum; *f* 1, free edge of the velum; *f* 2, the basal edge or line of attachment of the velum; *g*, basal wreath of cilia; *h*, hooks or uncini of the adherent organ; *h* 2, the spur, and *h* 3, the horizontal limb of the uncinus; *i*, the radii; *i* 1, the "nail-shaped piece"; *i* 2, its head; *i* 3, the membranous web; *k*, the membranous crest of the uncini; *l*, the profile of the "striated membrane"; *l* 1, its distal edge; *l* 2, the coarser striæ as seen on its front face; *l* 3, its proximal edge; *l* 4, *l* 5, a portion of the posterior face of the striated membrane showing the finer striæ; *m*, entrance to the vestibule; *n*, nucleus or endoplast; *o*, œsophagus; *p*, the outer, and *p* 1, the inner walls of the body; *s*, general digestive cavity; *v*, vestibule. (After Prof. H. James-Clark.)

longitudinal furrows and projections. At first it was presumed that these rib-like structures were of a muscular nature, but they were ultimately determined to be merely folds and thickenings of the body-wall. The production of the truncate posterior margin of the body as a thin transparent membrane, into the base of which, and on its inner side, the cilia of the posterior fringe are inserted, as established by Professor Clark, reconciles in a most satisfactory manner the somewhat conflicting accounts of this region given by other observers. By the majority of these the posterior margin is represented as simply fringed with cilia, while by others, including more especially Siebold, it has been reported as consisting solely of a thin, non-ciliate, undulating membrane. Upon the accessory membrane now demonstrated to exist in combination with a fringe of cilia, Professor Clark has proposed to confer the appropriate title of the "velum." The endoplast in the examples examined in the beginning of October by this same authority was found to form a thick, knotted, or moniliform band, extending over three-quarters of a circle in close vicinity to the truncated base. An apparent instance of the genetic union of a larger and smaller zooid of the species after the manner of the Vorticellidæ, and in the accomplishment of which process the smaller unit presents the aspect of a mere bud-like excrescence attached to the periphery of the larger one, has been reported by

Busch,* his figure of the same, as here reproduced, Pl. XXXI. Fig. 52, being at that time interpreted as an example of gemmation. An approximate estimate of the exceedingly diverse contours that may be presented by *Trichodina pediculus* under varying conditions may be gained through a reference to the numerous figures of the species given in the accompanying illustrations, and among which will also be found a representation of its characteristic aspect as crowded socially upon the portion of a tentacle of *Hydra vulgaris*. A somewhat remarkable isomorphic likeness is found to subsist between the representatives of the genus *Trichodina*, as typified by the present species, and the free-swimming embryos, or so-called "*trochospheres*," of certain Polyzoa; a representation of one such larva, reproduced from a drawing placed at the author's disposal by Mr. H. E. Forrest, is delineated for the purpose of comparison at Pl. XXXI. Fig. 53.

Examples of *Trichodina pediculus* have been recently obtained by the author from a new habitat, namely, in company with *Spirochona tintinnabulum* on the branchial appendages of larvæ of *Triton cristatus* remitted him from the neighbourhood of Dundee by Mr. John Hood in December 1880. Through a careful investigation of the horny armature of the acetabulum, the author has been able to entirely confirm Professor Clark's structural interpretation of this element embodied in Fig. 1 of the accompanying woodcut, on all points save one, which relates to the development of the membranous expansions or webs of the internal teeth or radii. According to Professor Clark, see Woodcut, Fig. 3 *i*, these webs are produced on the inner and larger of the two angles formed by the juncture of the shaft or transverse piece, while in those examined by the author, obtained from the triton, such structure, as represented in Pl. XXXIII. Fig. 18, is developed on the external or smaller of these angles. This composition of the structure which appears at first sight, or without the aid of a very high magnifying power, to be a simple continuous denticulate ring out of a number of separate elements, as first demonstrated by the American authority and confirmed by the author's observation, accounts for its rapid disintegration under treatment with acetic acid, previously recorded. As observed by Professor Clark, the more delicate striations of the posterior face of the second simple ring afford a suitable test object for the resolving qualities of a one-eighth inch objective. The structure, indeed, in its isolated form, bears no inconsiderable resemblance to the discoidal frustules of certain diatoms. Taken in its entirety, the complex adhesive apparatus of *Trichodina*, with its horny ring and denticles, would seem to find its nearest parallel in the adherent organs or acetabula of the Cephalopoda, which are likewise commonly strengthened by a correspondingly striated, and for the most part denticulate, horny annulus. The structure as reproduced, or more correctly pretypified, in this minute animalcule is, however, the more remarkable as being the product of a unicellular organism. The *Hydræ* infested with *Trichodina pediculus* often entertain as a second infusorial guest numbers of the Hypotrichous form *Kerona polyporum*. Where the two abound it may be not unfrequently observed that the *Trichodinæ* mount upon the backs of their companions, and thus utilize them, as a man might a horse, for the enjoyment of locomotion without having to participate in the labour of its production. It is of interest to record that so late as the year 1850,† Professor Louis Agassiz made the attempt to demonstrate that the parasitic *Trichodinæ* represented the medusoid form of the associated *Hydræ*, while still later‡ the same authority proposed to identify the ordinary Vorticellidæ as an aberrant group of the Polyzoa.

Trichodina Steinii, C. & L. Pl. XXXI. Fig. 45.

This species agrees in all respects with *T. pediculus*, with the exception of the structure of the posterior horny ring, which, according to Claparède and Lachmann, and as represented on the accompanying illus-

* 'Müller's Archiv,' 1854. † 'Proceedings Boston Society of Natural History,' p. 354.
‡ 'Essay on Classification,' 1857.

trations, appears under moderate amplification to be continuous and denticulate only on its outer edge; the number of denticulations as figured by these authorities corresponds with that of the form last described.

HAB.—Fresh water, on a species of Planarian.

Trichodina digitodiscus, Stein.

Animalcules similar in aspect to *T. pediculus*, but of smaller size, the posterior adhesive disc, as seen under moderate magnification, apparently containing two horny rings, the outer and more slender one being finely denticulate on the outer margin only, and the smaller but thicker inner one having from twelve to fourteen stout uncini on the outside, and also numerous very fine, short, bristle-like denticulations on the interior margin.

HAB.—Fresh water, on the brown polype *Hydra vulgaris*, more than on *H. viridis*.

Trichodina baltica, Quenn. PL. XXXIII. FIGS. 19–21.

Body turban-shaped, the height when elevated nearly equalling the diameter; horny ring of the suctorial disc toothed on both its outer and inner border, the outer teeth slender, uncinate, and recurved outwards, the inner ones smaller, straight, and aculeate. Diameter of body 1–575″ to 1–400″. HAB.—Salt water, on *Neritina fluviatilis*.

Apart from its marine habitat, this species may be distinguished from *T. pediculus* by the character of the denticles of the chitinous ring that lines the posterior acetabulum. These are of a considerably more slender character, and are united with each other, as shown in the accompanying figure, reproduced from Quennerstedt,* on an apparently entirely distinct system.

Trichodina scorpæna, Robin. PL. XXXI. FIGS. 46 AND 47.

Body turban-shaped, the superior surface convex, dome-like, the inferior one concave; cilia of circular peristomal wreath larger than those of the posterior border; horny armature of acetabulum apparently resembling that of *Trichodina pediculus*. Diameter of body 1–600″.

HAB.—Salt water, on the branchia of fish belonging to the genera *Scorpæna* and *Trigla*.

This species is figured and briefly described by Professor Ch. Robin in the 'Journal de l'Anatomie et Physiologie,' tom. xv., 1879. See also 'Journal of the Royal Microscopical Society,' London, October 1880.

GENUS II. URCEOLARIA, Stein.

Animalcules similar to those of *Trichodina*, but the adherent sucking-disc or acetabulum provided with a simply striated, non-denticulate corneous ring; the anterior region usually more attenuate, and with the peristome obliquely set.

* 'Sveriges Infusoriefauna,' Heft iii., 1869.

Urceolaria mitra, Stein. Pl. XXXI. Fig. 44 and Pl. XXXIII. Fig. 22.

Body cylindrical or conical, its height when extended equal to about twice its breadth, inclined at a considerable angle from its base of attachment; the anterior ciliary wreath somewhat obliquely set, capable of being completely withdrawn within the substance of the body, the peristome then contracting over it; pharyngeal cleft conspicuous, produced through about one-half of the extent of the body; the contractile vesicle stationed near the centre of this cleft; endoplast posteriorly situated, linear, curved. Length of extended body 1–1600".

Hab.—Fresh water, on *Planaria torva*.

As originally pointed out by Claparède and Lachmann, the figure and description of this species given by Stein,* reproduced at Pl. XXXIII. Fig. 22, in which cilia are represented as forming a marginal band on each side of the anterior portion and disposed at right angles to those of the posterior wreath, is a misinterpretation, the anterior ciliary system agreeing essentially with that of *Trichodina pediculus*, excepting that the disc as a whole is somewhat obliquely tilted. Stein, in his more subsequent writings, has fully recognized the accuracy of this emendation of the diagnosis of the species on the part of the Swiss authorities.

Genus III. CYCLOCHÆTA, Jackson.

Animalcules free-swimming, discoidal or turban-shaped, the ventral surface forming a circular adherent sucker, as in *Trichodina*, its margin bordered with a fringe of locomotive cilia, and strengthened interiorly by a toothed horny ring; oral aperture situated laterally in the angle formed by the junction of the body with the adherent disc, not associated with a buccal ciliary spire, but continued deeply into the substance of the body as a finely ciliated pharynx; a row of long, erect, bristle-like appendages forming a circle round the body immediately behind the border of the acetabulum.

The distinction of the type form of this genus from *Trichodina* and *Urceolaria* consists in the absence of the anterior adoral groove and spire of cilia, which would appear to be entirely obliterated, but is perhaps to a certain extent replaced by the more posterior circlet of long, erect setæ. On the other hand, however, as suggested by its discoverer, these abnormally developed setæ would seem to coincide to some extent with the characteristic equatorial girdle of setose springing-hairs of the genus *Halteria*.

Cyclochæta spongillæ, Jackson. Pl. XXXIII. Figs. 23 and 24.

Body elastic and changeable in form, usually depressed, turban-shaped, about twice as broad as high; pharynx produced inwards to the centre of the body, its interior wall finely ciliate; the horny ring within the adherent disc apparently forming one continuous piece having thirty-seven short external hooklets, and an equal number of long, slender, inwardly projecting radii; posterior setæ sixteen in number, forming an erect fringe whose altitude equals about twice that of the body; contractile vesicle situated a little

* 'Die Infusionsthiere,' 1854.

above the termination of the ciliated pharynx; endoplast elliptical, located a little to one side of the same. Diameter of body 1–416".

HAB.—River water, infesting the interstices of the fresh-water sponge *Spongilla fluviatilis*.

This species, described by Mr. N. H. J. Jackson in the 'Quarterly Journal of Microscopical Science' for July 1875, was found by him infesting the outer or cortical layer of examples of the fresh-water sponge *Spongilla fluviatilis*, taken from the river Cherwell at Oxford, and were obtained by tearing up small fragments of this organism under the microscope. Its motions from one portion of the sponge to the other were observed to be very rapid, like those of *Trichodina pediculus*, it in the same manner swimming with the adherent disc projecting forwards. The characteristic external circlet of long spine-like setæ are recognizable only when the animalcule is at rest. The locomotive cilia fringing the periphery of the adherent disc were found, under high magnification, to have a small bulbous enlargement at their point of junction with the periphery. The presumed endoplast, with one exception invariably present, took the form of an ovate, greenish, granular body, situated a little above the centre of the ciliated pharynx.

GENUS IV. LICNOPHORA, Claparède.

Animalcules free-swimming or temporarily attached to a selected host, highly elastic and changeable in shape, somewhat hourglass-shaped, having an expanded, suctorial, posterior extremity or foot, a slender, flexible, more or less compressed, stalk-like central region, and a dilated anterior body-portion or capitulum; the dilated capitulum obliquely flattened or concave anteriorly, bearing a peristomal or adoral ciliary wreath, the left limb of which is involute and descends into the oral fossa, the latter not followed by a conspicuous ciliated pharynx; the adherent posterior extremity enclosing a delicate membranous ring, and bearing a single peripheral fringe of cilia.

This genus has been instituted by Claparède* for the type originally described by Cohn under the name of *Trichodina Auerbachii*, to which a second species has been added by the first-named writer. Although at first sight the character of the adhesive posterior extremity and the habits of the animalcule closely correspond with those of the genus *Trichodina* and its allies, the structure of the peristomal region is so distinct that Claparède regards it merely as a "mimetic" form of the latter, requiring an independent family position. No details of the developmental phenomena of either of the two known species have been as yet recorded, nor has the presence of an endoplast or contractile vesicle been determined. The food-substances received at the oral aperture do not pass beyond the posterior border of the capitulum. The parenchyma in both instances is exceedingly soft, rapidly breaking up by diffluence when experimented on with reagents, or if subjected to abnormal tension.

Licnophora Auerbachii, Cohn sp. PL. XXXIII. FIG. 30.

Body irregularly hourglass- or dumb-bell-shaped, the posterior adhesive part having a raised rim or border, the pedicle-like central portion thickened and compressed, the anterior capitulum ovate or pyriform, with an elongate, somewhat harp-shaped fringe of large adoral cilia. Length 1–500" to 1–400".

HAB.—Salt water, occurring plentifully on the cuticular surface of the Planarian *Thysanozoon tuberculata*: Naples (Claparède).

* 'Annales des Sciences Naturelles,' tom. viii., 1867.

This species, as originally described by Cohn,* was met with in considerable abundance on and among the dorsal papillæ of a small deep-water Nudibranch, apparently *Doris muricata*. A species of *Trichodina* referred to but not described by Moebius and Meyer in their 'Fauna of Kiel,' as occurring on another Nudibranch, *Æolis alba*, is probably also identical with this type.

Licnophora Cohnii, Clap. PL. XXXIII. FIG. 25.

Body proper or capitulum more orbicular than in the preceding species, joined to the suctorial foot by a slightly compressed and usually more attenuate pedicle; peristomal ciliary wreath of relatively larger size than in *L. Auerbachii*, describing an almost circular spire, its cilia very long and slender. Length 1–500″ to 1–400″.

HAB.—Salt water, on the branchiæ of the Annelid *Psyrmobranchus protensus*.

Fam. VII. OPHRYOSCOLECIDÆ, Stein.

Animalcules free-swimming, ovate or elongate, soft or encuirassed, possessing a peristome and protrusible ciliary disc as in the Vorticellidæ; one or more style-like caudal appendages usually developed at the posterior extremity; anal aperture postero-terminal or opening into the vestibulum or oral fossa.

As originated by Stein, this family group includes only the two endoparasitic genera *Ophryoscolex* and *Entodinium*, animalcules which have up to the present time been examined by no other special student of the Infusoria, and are but briefly described by him, without illustration, in the year 1858.† There can be but little doubt, however, that Stein's types include the infusorial forms reported by MM. Gruby and Delafond,‡ as inhabiting in prodigious numbers the first and second stomachs —rumen and reticulum—of various ruminants, the majority of these animalcules being encuirassed and comparable in aspect to Rotifera. One species, more especially, represented by them as having a long, flattened body and projecting tail, with a convex dorsal and plane ventral surface, indented posteriorly, and a girdle of cilia round the centre of the body, length 1–100″, is apparently identical with Stein's *Ophryoscolex Purkynjei*, while another, described as closely resembling the Rotifer *Brachionus polyacanthus* of Ehrenberg, is probably the *Entodinium dentatum* of the same writer. The numbers of these animalcules found by the French savants infesting the indicated viscera of the sheep are something astounding. In five centigrammes of alimentary matter taken from the two first stomachs of this ruminant it was ascertained that no less than one-fifth of this total weight was composed of the bodies of these organisms. In the third and fourth stomach—psalterium and abomasum—of the same animal only dead or empty carapaces were to be found, the softer and nutrient parenchyma having apparently been digested. From these facts MM. Gruby and Delafond argue that the food-supply of ruminants, though ostensibly of a purely vegetable nature, consists to a very considerable extent of microscopic animal organisms, which develop freely and with great rapidity in the first and second stomachs of their associated host, but are killed and assimilated on passing into the third and fourth. Like results were obtained by them on examining the viscera of a horse, for while found living in vast numbers in the cæcum and dilated colon, dead and empty carapaces were alone encountered in connection with the contracted colon and rectum. It was found possible to preserve these

* "Neue Infusorien im Seeaquarium," 'Zeit. Wiss. Zool.,' Bd. xvi., 1866.
† 'Abhandlungen d. Königl. Böhmischen Gesellschaft d. Wiss.,' Bd. x. p. 69.
‡ 'Comptes Rendus,' Dec. 1843.

animalcules in health for a considerable interval—nine hours or more—by placing them in glass tubes containing the stomachal fluids of their host, maintained at a temperature of from 30° to 35° centigrade.

The present author provisionally refers to this family group the *Astylozoon fallax* of T. W. Engelmann, which, while included by Stein among the ordinary Vorticellidæ, appears to exhibit in its free-swimming condition, and possession of stylate caudal appendages, a closer relationship to the two genera above named. The trend of the adoral wreath and the assumed position of the anal aperture may perhaps be deemed of sufficient import for their isolation, but as in either case the animalcules have been examined by no means exhaustively, and by but one observer, their provisional alliance appears desirable.

GENUS I. OPHRYOSCOLEX, Stein.

Animalcules free-swimming, ovate or elongate, cuticular surface densely indurated or encuirassed; oral aperture anteriorly situated, associated with an extensile and retractile peristome; ciliary wreath like that of *Vorticella*, except that the left limb, instead of the right, descends into the oral fossa; the centre of the body half encircled dorsally by an arcuate row of stout uncinate cilia or setæ; a long, stylate, tail-like appendage produced backwards from the post-ventral surface, the anal aperture situated close to the base of this style; endoplast conspicuous; contractile vesicles usually multiple. HAB.—Endoparasitic.

Ophryoscolex Purkynjei, Stein.

Body elongate, somewhat vermicular, rounded posteriorly, bearing in addition to the tail-like style three short, curved, claw-like spines; the anterior margin truncate, closing in a sphincter-like manner over the peristome when retracted; the ventral surface flattened, the dorsal and lateral ones convex; endoplast elongate-ovate, having a round attached endoplastule, situated on the right side of the body; contractile vesicles two or three in number, spherical. Dimensions unrecorded.

HAB.—Endoparasitic, within the first and second stomachs of sheep and cattle.

Ophryoscolex inermis, Stein.

This species corresponds with *O. Purkynjei*, but is devoid of the short, claw-like spines at the posterior extremity; increase by transverse fission has been observed in this, but not in the last-named type.

HAB.—Identical with that of *O. Purkynjei*.

GENUS II. ENTODINIUM, Stein.

Animalcules free-swimming, ovate, more or less flattened; cuticular surface smooth and densely indurated; oral aperture and peristome as in *Ophryoscolex;* anal aperture postero-terminal; no central girdle of setose cilia, often with one or more terminal spines; endoplast band-like, having

an attached endoplastule; contractile vesicles usually two in number, the one anteriorly and the other posteriorly located.

HAB.—Endoparasitic within the first and second stomachs of various ruminant Mammalia.

This genus differs from *Ophryoscolex* in the absence of the central girdle of uncinate or setose cilia. Three species are very briefly distinguished by Stein, and in no case has a representation of any one of these been published.

Entodinium bursaria, Stein.—Body long, rounded posteriorly, having a depression in this region, in which the anal aperture is situated; no caudal spines.

Entodinium dentatum, Stein.—Posterior border armed with six inwardly curved claw-like spines.

Entodinium caudatum, Stein.—Inflated dorsally, excavate or emarginate posteriorly; the one side bearing a long tail-like spine, and the opposite one two tooth-like points.

GENUS III. ASTYLOZOON, Engelmann.

Animalcules free-swimming, soft and contractile, more or less campanulate or pyriform, attenuate posteriorly, and terminating at that region in one or two tail-like, setose appendages; peristome, ciliary disc, and vestibular cleft as in *Vorticella*; anal aperture opening into the vestibulum; cuticular surface naked, smooth or delicately striate.

Astylozoon fallax, Eng. PL. XXXIII. FIG. 29.

Body irregularly pyriform, tapering posteriorly, and there terminating in two caudal setæ equal in length to about one-quarter of that of the entire body; the dorsal border evenly convex, the ventral one gibbous; peristome slightly dilated, sloping obliquely towards the dorsal aspect; ciliary disc not elevated much above the margin of the peristome; vestibular cleft produced obliquely backwards towards the ventral border; cuticular surface finely striate transversely; contractile vesicle situated close beneath the peristome; endoplast kidney-shaped, subcentral. Length 1–250″.

HAB.—Fresh water.

This interesting species was described by T. W. Engelmann in the year 1861,* being obtained by him from river water that had been kept isolated for three months, and which yielded under examination no other species of animalcule. Deprived of the characteristic caudal spines, its likeness to a detached zooid of *Vorticella* or *Epistylis* was very manifest. Spheroidal encystments were observed on several occasions.

Fam. VIII. VORTICELLIDÆ, Ehr.

Animalcules mostly highly contractile, ovate, subcylindrical or campanulate; sedentary or temporarily free-swimming, stalked or sessile; solitary or united in social, dendriform, or mucus-immersed colonies; naked, or secreting indurated sheaths or loricæ; oral aperture terminal, eccentric, associated with an adoral ciliary spire of one or more convolutions, the right limb of which usually descends into the oral entrance or vestibulum, the left one

* 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. 4.

being more or less convolute around an elevated and protrusible central area which constitutes the so-called ciliary disc; vestibulum continued backwards upon the substance of the body as a conspicuous or cleft-like pharynx, and often further prolonged as a narrow, more or less distinct, tubular œsophagus; a long, solitary, setose appendage, the vestibular seta or "*soie de Lachmann*," often attached to the upper wall and projecting a considerable distance beyond the entrance of the vestibulum, the entire anterior extremity of the body, including the protrusible ciliary disc and oral entrance, encircled by a usually conspicuously raised border or peristome, this border or peristome closing sphincter-wise over the ciliary disc and oral entrance when the former is retracted; anal aperture opening into the vestibulum; contractile vesicle single, spherical, located close to the anal aperture, and debouching upon the vestibulum; endoplast mostly band-like; increasing usually by longitudinal, rarely by transverse fission, the liberated zooid in these instances usually developing prior to, and retaining during its short free-swimming existence, a posterior circlet of powerful locomotive cilia, which are again absorbed on a suitable site for attachment being secured; the survival or rejuvenation of the species further provided for through the conjugation or genetic union of two dissimilar zooids, the one (male ?) minute and migrant, and the other (female ?) normal and sedentary, and by development out of the endoplast of minute, free-swimming germs. Inhabiting salt and fresh water; rarely, if ever, possessing trichocysts.

The family of the Vorticellidæ represents one of the largest and at the same time the most natural and typical group of the Peritrichous order. All its members are at once recognized by their normal sedentary condition and by the characteristic structure of the oral system detailed at length in the foregoing diagnosis and in that of the more essentially representative genus *Vorticella*. In but few of the numerous genera included in this family is there any marked divergence from this formula, that which exists being manifested by a greater development of some one element at the expense of another constituent part of this last-named system. Thus, in the genus *Spirochona*, the external edge of the prominent encircling border or peristome is mostly suppressed, while its inner one is abnormally developed as a transparent and highly elevated spiral membrane. On a less conspicuous scale a similar deviation of the peristome-border from its more normal form obtains in the genera *Pyxidium*, *Opercularia*, and *Lagenophrys*; the ciliary disc, however, exhibits an additional modification in these three instances, being isolated, laterally attached, and presenting in its extended condition the aspect of a stalked operculum. By Ehrenberg, Siebold, Perty, and other early writers the family of the Vorticellidæ as here constituted is separated into two or even three groups of equivalent value; *Vaginicola* and its loricate allies being comprised under the family title of either the Ophrydina or Vaginifera, the first of these two titles being reserved by Perty for the reception only of *Ophrydium*. By Stein even,* a similar separation of the naked from the loricate or mucus-immersed forms is maintained, though that the two are too intimately related for such a broad separation is amply exemplified by the following examples. Thus in certain species of *Opercularia*, such as *O. nutans* and *O. berberina*, the cuticular surface is considerably indurated, and remains, like the empty sheath of a *Cothurnia*, after the decay of the enclosed parenchyma; while in *Lagenophrys* the adnate lorica is scarcely distinguishable from an indurated cuticle. Through *Gerda fixa*, and the newly described *Ophionella picta*, on the other hand,

* 'Organismus,' Abth. ii., 1867.

the apparent gulf between *Ophrydium* and the more ordinary naked or loricate Vorticellidæ is effectually bridged. This last-named genus may, in fact, in accordance with the results of Wrzesniowski's and the author's investigations, be regarded as a slime-immersed *Epistylis*, all the zooids comprising a colony-stock being in a like manner united by a slender branching unretractile pedicle. The elegant tree or shrub-like colonies and variously modified loricæ formed by many of the genera of this family have hitherto won for them an amount of interest and popularity possessed perhaps by no other members of the Ciliate group, but, as already shown in the preceding volume, these have now to contend for the palm of beauty with formidable rivals among the humble Flagellata, and wherein, on a comparatively Lilliputian scale, we find mimetically foreshadowed as many or even more variations of tree or vase-like growths than are embodied in the present more familiar and highly attractive group. As a necessary accompaniment of the combined sedentary and eminently social habits of the majority of the representatives of this family, many of them build up associated colony-stocks of so considerable a size as to form in their natural habitats an appreciable and even conspicuous feature to the unassisted vision. Hence also it is that the Vorticellidæ are found to comprise the earliest known of infusorial types, certain of them having been discovered by Leeuwenhoek over two centuries ago, while the typical genus *Vorticella* lays claim to the illustrious Linnæus as its founder.

A moot point concerning the structural features of the Vorticellidæ is connected with the apparently long bristle-like appendage frequently seen projecting to a greater or less extent from the vestibular fossa of the various members of this group, to which attention was first directed by Lachmann. This debatable structure, as recognized by various recent investigators, has been usually distinguished by the title of the "*soie de Lachmann*," first given to it by M. Claparède, but is here more often referred to as the "vestibular seta." A few authorities, on the other hand, and more especially Professor H. James-Clark,* have called in question the existence of such an appendage, and consider it to be merely the optical image produced by the descending adoral fringe of cilia as seen in profile, or as he puts it, by the intersection of two such rows. In certain instances again—see *Opercularia stenostoma*—there can be but little doubt that this so-called organ is rightly the optical outline of a delicate hyaline membrane. In many species of *Vorticella* and *Epistylis*, nevertheless, the author is quite satisfied that such a structure exists, quite independent of the adoral cilia, and such a decision is fully supported by the recent investigations of Greeff and Wrzesniowski. The more intimate structure of the pedicle in *Vorticella*, the typical representative of the family group, is treated of in the account given of that genus, but a few of its more important modifications in other allied genera may be here enumerated. In *Carchesium* and *Zoothamnium* it consists similarly of a contractile central cord enclosed within a tubular hyaline sheath, which two elements are respectively homologous with, or indeed attenuate prolongations of, the delicate subcutaneous myophan or muscular layer and superimposed hyaline and structureless cuticle of the zooid's body-wall. In *Zoothamnium* it is noticeable that the basal portion or main trunk of the branching pedicle or zoodendrium is devoid of such an enclosed cord, and therefore non-contractile, and represented by the last only of the two elements just named. This more simple type of structure partly developed in *Zoothamnium* characterizes the entire extent of the compound pedicle of *Epistylis* and *Opercularia*, and also the simpler ones of a numerous host of solitary, short-stalked forms. By Stein it has been maintained that the indurated lorica of *Cothurnia*, *Vaginicola*, and their allies is morphologically identical with the pedicle of such forms as *Epistylis*. In some of these, however, as for example the newly described *Pyxicola operculigera*, a long supporting pedicle is found co-existent with an indurated lorica, this last-named structure being evidently, as with the rigid pedicle, a modification or redundant development only of the hyaline cuticular layer, the passage of the one to the other being

* 'Proceedings Boston Society Natural History,' vol. x., 1866.

manifested, as already observed, in such types as *Opercularia nutans* and *O. berberina*. In all the loricate species the sheath or lorica is in its earliest state soft and gelatinous, this transient state, considerably exaggerated, characterizing the permanent condition of the mucilaginous habitations of *Ophionella* and *Ophrydium*. The highly interesting data connected with the more recently observed reproductive phenomena of this family group are detailed at length in the account given of the representative genus *Vorticella*.

Sub-Family I. VORTICELLINA.

Animalcules naked, neither inhabiting sheaths or loricæ, nor immersed within a mucilaginous investment.

GENUS I. GERDA, C. & L.

Animalcules solitary, elongate, subcylindrical, recumbent upon or simply adherent to submerged bodies, not possessing a distinct sucker or specialized organ of attachment as in the genus *Scyphidia;* oral system including a peristomal border, vestibulum, and ciliary disc, as in the ordinary *Vorticellæ*. Increasing by longitudinal fission. Inhabiting fresh water.

To the single species referred to this generic group by Claparède and Lachmann, a second form has been recently added by D'Udekem.

Gerda glans, C. & L. PL. XXXIII. FIGS. 36–38.

Body elongate, subcylindrical, highly contractile, three or four times as long as broad, the wider posterior region, during contraction, assuming with reference to the then conical anterior part a cup-like form; surface of the integument above this posterior portion transversely striate; oral aperture narrow, pharyngeal cleft deeply prolonged; endoplast ribbon-like, placed longitudinally; contractile vesicle spherical, posteriorly situated, giving off a slender, canal-like ramification, occasionally branching a second time, which extends to within a short distance of the ciliary disc. Length of extended body 1–125″.

HAB.—Fresh water, among vegetable debris: near Berlin (C. & L.).

Among the more interesting features of this singular type may be mentioned the position and structure of the contractile vesicle, its posterior situation being the converse of what obtains among all the more ordinary members of the Vorticellidan group, while its canal-like diverticulum finds a counterpart only in the genus *Ophrydium*. Although usually found by Claparède and Lachmann lying about among water plants and vegetable debris, this animalcule was occasionally observed, as shown at Pl. XXXIII. Fig. 38, to develop a posterior circlet of cilia, and to progress through the water after the manner of a detached *Vorticella*.

Gerda fixa, D'Udk. PL. XXXIII. FIGS. 34 AND 35.

Body elongate, its surface entirely smooth, the length when extended equalling five or six times that of the greatest breadth; the posterior third inflated, tapering abruptly and terminating in a blunt point, the two anterior thirds narrower, subcylindrical; peristome-border thickened, reflected;

ciliary disc convex, moderately elevated; cilia long and thick, vestibular cleft produced backwards to a considerable distance, giving origin to a conspicuous vestibular seta; contractile vesicle large, spherical, situated close to the vestibulum; endoplast band-like, longitudinally disposed. Dimensions unrecorded. HAB.—Pond water.

This species, as described by D'Udekem,* was obtained in some quantity on *Myriophyllum* from the neighbourhood of Brussels; except for the absence of the mucilaginous investing sheath, its aspect closely resembles the animalcule introduced later on under the title of *Ophionella picta*. Among the examples figured by its discoverer, two zooids, Pl. XXXIII. Fig. 34, are represented as united by their posterior extremities, the second animalcule having been apparently developed by the process of longitudinal fission, after the manner of the ordinary *Vorticellæ*.

GENUS II. SCYPHIDIA, Dujardin.

Animalcules solitary, elongate or pyriform, highly contractile, adherent posteriorly to foreign bodies, through the medium of a specially developed acetabuliform organ of attachment; surface of the integument often transversely or obliquely furrowed; oral system as in *Vorticella*.

Although originally instituted by Dujardin and embodied in Perty's system of classification, Lachmann and Claparède were the first to confer upon this genus its present distinctive import. With the exception possibly of the *Scyphidia rugosa* of Dujardin, the forms included in it by the two former writers are apparently ordinary *Vorticellæ* which at the time of observation had not developed their characteristic pedicles. In their parasitic habits and mode of attachment *Scyphidia limacina* and *S. physarum* exhibit a bond of affinity with *Spirochona*, but are at the same time wanting in the characteristic membraniform spire that so essentially distinguishes the members of that genus.

Scyphidia limacina, Lachm. PL. XXXIII. FIG. 32.

Body nearly cylindrical, tapering slightly at either extremity, annulate transversely; the posterior extremity truncate, its margin thickened; peristome narrow, not everted; ciliary disc narrow, considerably elevated. Length 1–360″ to 1–240″.

HAB.—Fresh water, attached to small specimens of *Planorbis*.

Scyphidia physarum, C. & L.

PL. XXXI. FIGS. 54 AND 55 AND PL. XXXIII. FIG. 31.

Body elongate, highly flexible and contractile, evenly cylindrical throughout, coarsely annulate transversely; peristome having a distinct thickened border; ciliary disc scarcely exsert, provided with a prominent central umbilicus. Length 1–200″.

HAB.—Fresh water, attached to the skin of *Physa fontinalis*.

This species is readily distinguished from the preceding one by its more attenuate and perfectly cylindrical outline, and also by the larger relative size of its peristome, which is completely evertile, and occupies the entire anterior border.

* "Infusoires de la Belgique," 'Mém. Acad Royale de Belgique,' tom. xxxiv., 1864.

According to the figures given by Claparède and Lachmann, the annulate and flexible body presents an almost worm-like contour, and is capable of assuming a variety of gracefully curved positions. Excellent illustrations of this type, as reproduced at Pl. XXXI., are given by Quennerstedt.*

Scyphidia rugosa, Duj. Pl. XXXIII. Fig. 33.

Body pyriform, the attached posterior extremity most attenuate, surface of the integument obliquely and coarsely furrowed, pharyngeal cleft deeply prolonged. Length when extended 1–280".

Hab.—Pond water, among vegetable debris.

This form, in addition to the *Vorticella ringens*, *inclinans*, and *pyriformis* of Müller, included in this genus by Dujardin and Perty, as also the *Scyphidia patula* of the latter writer, are regarded by Claparède and Lachmann as representing merely recently attached and imperfectly observed *Vorticellæ*. *Scyphidia rugosa*, however, seems to possess claims for recognition as a good species, and is therefore retained.

Scyphidia Fromentellii, S. K. Pl. XXXIII. Fig. 53.

Body elongate-clavate, anteriorly truncate, the posterior extremity contracted, stalk-like, longitudinally plicate; the remainder of the body smooth; possessing apparently two or more contractile vesicles. Length of extended bodies 1–300". Hab.—Fresh water.

This form is referred with some doubt to *Scyphidia rugosa* Duj., by De Fromentel,† from which, however, it is found to differ in every essential detail. De Fromentel describes it as having a very short, stout, separate footstalk, but according to his drawings there is no such distinct organ, the attenuate, stalk-like posterior extremity being soft and fleshy, and becoming entirely obliterated or amalgamated with the general substance of the body when the animalcule is contracted. His delineations of this species also indicate this form as possessing several contractile vesicles; one zooid delineated has two such structures situated anteriorly, and another specimen one vesicle anteriorly and the other posteriorly placed. A third example is represented as possessing no less than three contractile spaces, a circumstance so anomalous in the Peritrichous order that the student is bound to infer that a misinterpretation of these organs has been made.

Very recently, May 1880, the present author has received, through Mr. Thomas Bolton, specimens of the Entomostracon *Daphnia pulex* extensively infested with a minute sessile Vorticellidan agreeing in all respects, except for the presence of a single and normally located contractile vesicle, with the species now under discussion as figured and described by De Fromentel. It was noted in several instances that the parenchyma was more or less conspicuously vacuolate, the separate vacuoles presenting much the same size and contour, but not exhibiting the pulsatory motions of the single anteriorly located contractile vesicle.

Scyphidia inclinans, D'Udk. sp. Pl. XXXIV. Fig. 2.

Body elongate-gibbous, highly contractile, rather over twice as long as broad, dilated centrally, tapering posteriorly and terminating in a small adherent disc; peristome-border even, thickened, ciliary disc elevated obliquely above the peristome; vestibular cleft produced backwards to the centre of the body; parenchyma transparent, granular; cuticular surface smooth; contractile vesicle spherical, situated close to the vestibulum,

* 'Sveriges Infusoriefauna,' 1869. † 'Études sur les Microzoaires,' 1876.

immediately beneath the peristome-border. Animalcule when retracted bent to one side and transversely puckered on its shorter concave border, the anterior margin projecting centrally as a small snout-like prominence. Dimensions unrecorded. HAB.—Fresh water, on *Nais*.

No complete diagnosis of this species is given by D'Udekem * in his brief reference to it under the title of *Gerda inclinans*, he being rather doubtful whether or not to regard it as a variety only of either the *Scyphidia ringens* of Dujardin or as the single and immature condition of his own *Epistylis tubificis*. The excellent figure, however, that accompanies his brief description, and in accordance with which the present diagnosis is framed, leaves no doubt as to the specific distinction of this type from either of the two forms mentioned. Its occurrence abundantly always as separate individuals, apart from the basal sucker, sufficiently distinguishes it from the *Epistylis*, while the smooth surface of the integument assists in separating it from Dujardin's type.

GENUS III. SPIROCHONA, Stein.

Animalcules solitary, elongate-fusiform or campanulate, attached posteriorly by an adherent sucking-disc or acetabulum; peristome developed wholly or in part as a hyaline, spirally convolute, membranous funnel, the right or left limb of which descends into the oral fossa; endoplast ovate or elongate; increasing by gemmation or transverse fission. Inhabiting fresh, salt, or brackish water.

The remarkable funnel-shaped modification of the anterior region in this and the succeeding genus may be regarded as an exaggerated development of the membranous collar-like extension of the peristome-border in *Opercularia* and *Lagenophrys* hereafter described. All the species so far discovered occur as parasites or commensals upon other aquatic animals. To the two forms originally introduced by Stein a third, *S. tintinnabulum* is here added.

Spirochona gemmipara, Stein. PL. XXXIII. FIGS. 43–49.

Body elongate-fusiform, narrowing at both extremities, attached posteriorly by a circular, radiately striate, adhesive disc; peristome contracted at its base, produced into an elevated, funnel-shaped, spirally convolute lamina of three turns, whose height nearly equals that of one-half of the entire body. Length of body 1–750″ to 1–216″.

HAB.—Fresh water, attached to the ova-capsules of *Gammarus pulex* and various Entomostraca.

The structure and development of this species is the subject of a valuable communication contributed by Professor R. Hertwig to the 'Jenaische Zeitschrift,' Bd. ii., 1877, in which it is shown that the animalcule is adherent to its fulcrum of support through the medium of a special sucker-like modification of its basal extremity, in place of being mounted on a short and simple pedicle, as originally described by Stein. The production of new zooids by gemmation is accompanied by the separation and embodiment within the gemma of a portion of the parent endoplast, an exhaustive account being given by Hertwig of the successive aspects exhibited by the bud during its growth to the adult form. Certain of these phases, as shown at Pl. XXXIII. Figs. 45 and 46, resemble in a remarkable manner such a

* 'Infusoires de la Belgique,' 1864.

simple Hypotrichous type as *Chlamydodon*, and at the same time also the ciliated embryos of *Hemiophrya gemmipara*, *Dendrocometes paradoxus*, and other Acinetidæ.

Spirochona Scheutenii, Stein. Pl. XXXIII. Figs. 50–52.

Body elongate, subfusiform, narrowed posteriorly; organ of attachment apparently agreeing with that of *S. gemmipara*, but this not yet definitely ascertained; peristome produced as a wide, funnel-like, spiral lamina, having only a single horizontal turn, and bearing on one side numerous fimbriated processes. Length of body 1–300″.

Hab.—Salt or brackish water, attached to *Gammarus marinus* and other Entomostraca.

Further investigation will probably demonstrate that this species, in common with the preceding form, is adherent to its basis of support through the medium of a sucker-like expansion of its posterior extremity, instead of by a short pedicle, as described by Stein. A closely corresponding, but even more strongly marked, fimbriated ornamentation of the border of the infundibulum, occurs in the type hereinafter described under the title of *Stylochona coronata*. There can be but little doubt that the so-called *Vaginicola* figured by Messrs. Bates and Westwood,* reproduced at Pl. XXXII. Figs. 51 and 52, found attached to the natatory appendages of *Gammarus marinus*, is synonymous with this type. An identical or closely allied species has likewise, they record, been reported by Mr. Rentsch as occurring on *Gammarus ornatus*. According to the figures given by the two first-named authorities, the species is attached in a sessile or sub-sessile manner to its fulcrum of support.

Spirochona tintinnabulum, S. K. Pl. XXXIII. Figs. 39–42.

Body elongate-campanulate, tapering posteriorly, and attached by a well-defined adherent disc, widening out and attaining its greatest breadth at its anterior border; membranous funnel springing from the inner margin of a well-defined peristomal border, equal in height to one-half the length of the body, rising abruptly and elevated in a tongue-like manner, not constituting more than a single turn, its right limb descending into the oral fossa; endoplast elongate, band-like; the posterior third of the body frequently enclosing a subtriangular hyaline corpuscle; the cuticular surface usually finely striate transversely. Length of body 1–650″.

Hab.—Fresh water: on the epidermis and branchial appendages of young newts, *Triton cristata*.

This species differs essentially from the previously described representatives of the genus *Spirochona* in the form of its body, which is campanulate, and more like that of an ordinary *Vorticella*. In the two former species there is, moreover, a strongly marked constriction between the body and the expanding funnel, which is entirely wanting in the present instance. A still more important character is associated with the funnel itself, which in the new species here introduced takes its origin within the margin of a well-defined peristome, instead of being continuous with the general surface of the body as represented in each of Stein's types, and it being the right limb, as in the more ordinary Vorticellidæ, that descends into the oral fossa. Histologically considered, the convoluted funnel of *Spirochona* would seem to represent the peristome itself drawn out into a membranous spire, the third or basal

* 'British Crustacea,' vol. i. p. 374, 1863.

turn, according to Stein, in *S. gemmipara* being homologous with the peristome proper. As in *S. tintinnabulum* this organ is less complex than in either of the preceding species, the partial retention by the peristome of its typical character, as found to exist, might be anticipated. Although the funnel is less convolute in this type, the character it imparts to its general aspect is none the less conspicuous, its height, one-half that of the body, being indeed greater relatively than in either of the preceding forms. The examples supplying the figures and description of this new species were originally met with by the author scattered sparingly over the whole surface of the integument of a young newt measuring about one inch in length, taken from a pond at Stoke Newington, London, in August 1871. Those stationed on the delicate ramifications of the branchial appendages were found to be especially suitable for examination, a portion of one of these organs bearing several being removed and subjected to a magnifying power of 800 diameters. The external surface of the cuticle in this species appears to be less firm than in *S. gemmipara* and *Scheutenii*, the peristome contracting over the mouth and giving the anterior margin a rounded contour on the withdrawal of the funnel. The wreath of cilia springing from the base of the funnel are very long and powerful; a distinct pedicle could not be detected in any instance, but simply a sucker-like disc of adherence, as shown by Hertwig to occur in *S. gemmipara*. Still more recently, July 1878, the author has obtained this species attached to young newts collected in the neighbourhood of St. Heliers, Jersey, and was in this instance fortunate enough to observe examples undergoing the process of multiplication by transverse fission. In such a case the membranous funnel and peristome were retracted, and a circlet of long, powerful cilia developed round the centre of the body, as shown at Pl. XXXIII. Fig. 41; the anterior portion with this circlet of cilia became detached and swam off like a free *Vorticella*, while the remaining moiety shortly developed a new peristome and spiral membrane, presenting in its half-matured state the aspect given in Fig. 42 of the same plate. The elongate, band-like endoplast was observed in one instance to share in the process of division. Excepting in *Ophrydium*, division by transverse fission has not as yet been recorded of any other representative of the present family group.

Further evidence of the cosmopolitan distribution of *Spirochona tintinnabulum* is afforded by the recent receipt of specimens attached to the same specific host, through Mr. John Hood, from the neighbourhood of Dundee.

Genus IV. STYLOCHONA, S. K.

(Greek, *stulos*, stem; *chone*, funnel.)

Animalcules solitary, ovate or elongate, mounted on a distinct rigid pedicle; peristome differentiated as in the genus *Spirochona*, forming a more or less convolute, funnel-shaped, membraniform expansion.

This genus is here instituted for the reception of two marine types which differ from *Spirochona* in their possession of distinctly developed, rigid pedicles. Until quite recently such a structure was supposed to be rudimentarily represented in the last-named genus. It has, however, been recently shown by Hertwig of *S. gemmipara* that such element is there replaced by a somewhat complex acetabuliform organ of adherence.

Stylochona nebalina, S. K. Pl. XXXIII. Figs. 56 and 57.

Body elongate, obconical, tapering posteriorly, widest at the anterior margin, attached by a slender rigid footstalk, often equal in length to one-third of the entire body; membranous funnel contracted at its base, describing little more than a single spiral turn, its terminal border slightly

elevated in a tongue-like manner, equal in height to nearly one-half of that of the body. Length of the body without the funnel and pedicle 1–500″.

HAB.—Salt water, on *Nebalium bipes*.

This species most nearly resembles the brackish-water form *Spirochona Scheuteni*, from which, however, it may be distinguished, apart from the possession of a pedicle, by the obconical instead of fusiform contour of the body, and by the entire absence of those fibrous or fimbriated processes which ornament one side of the border of the funnel of that type. A large number of zooids of this new species were found attached to the thoracic appendages of the Branchiopodous Crustacean *Nebalium bipes* collected in St. Clement's Bay, Jersey, in February 1878, having associated with them as messmates or commensals on the same host, examples of the singular Trematode *Saccobdella nebaliæ* of Van Beneden, and in one instance also, as presently related, an example of *Cothurnia gracilis*. Many of the animalcules were undergoing a process of gemmation resembling that already observed of *Spirochona gemmipara*. In examples placed in dilute alcohol the membranous funnel retained its characteristic form, but became unrolled as shown at Pl. XXXIII. Fig. 57.

Stylochona coronata, S. K. PL. XXXIII. FIGS. 54 AND 55.

Body elongate-fusiform, somewhat gibbous, about three times as long as broad, widest centrally, tapering subequally towards each extremity, mounted on a short, slender, rigid pedicle; infundibuliform membranous expansion largely developed, forming a convolute spire of two coils, the external and basal one equal in width to nearly twice the diameter of the body, its free border fimbriated or fibrillate; fibrillæ setaceous, of two sizes, collectively approximating the number of fifty, and consisting alternately of one longer and four shorter ones, the inner and apical coil projecting considerably above the basal one, equalling only one-half of the diameter of the latter, its free border not fimbriate; vestibular fossa much dilated, continued backward into a distinct pharyngeal cleft; contractile vesicle located close to the vestibulum; endoplast elongate-ovate, subcentral. Length of body including the infundibulum 1–400″.

HAB.—Salt water, attached to the thoracic appendages of *Gammarus* sp.

This very elegant species was obtained by the author attached in some abundance to the thoracic limbs of a common shore-frequenting species of *Gammarus* collected in St. Clement's Bay, Jersey, in the month of March 1879. It was at first premised that the animalcule was identical with the *Spirochona Scheuteni* of Stein, previously described, the most substantial evidence in favour of such identity being afforded by the fibrillate ornamentation of the free border of the basal coil of the collar or infundibulum. A closer acquaintance, however, with the structural details revealed the existence of so many important distinctive features that it has been found requisite to confer upon it an independent specific title. In the first instance, the presence of a well-defined rigid pedicle has indicated the necessity of separating it from *Spirochona* proper, in which an acetabuliform modification of the posterior extremity replaces such an organ of attachment. From *Spirochona Scheuteni*, which may eventually prove, as indicated in Stein's drawings, to possess a short pedicle, it is to be distinguished, in addition to the conspicuous development of this last-named organ, by the more attenuate proportions of the body, but most essentially with relation to both the general and more minute structure of the anteriorly developed membranous funnel or collar. This highly characteristic element in the present form is both far more extensively developed and of more complex

design. In *Spirochona Scheuteni* it forms a simple uniform horizontal coil of but one revolution, whose greatest altitude scarcely equals one-quarter of the height of the body, and with which its greatest width is at the same time subequal. In the present type there are two distinct revolutions to the membranous funnel, the inner and lesser one projecting a considerable distance beyond the margin of the external or basal one, whose height attains to or exceeds one-half of the length of the entire body, while its diameter at its anterior and everted edge equals no less than twice that of the subjacent body. The character of the fimbriation of the anterior border of the external or basal revolution of the membranous funnel is very remarkable. As developed in *Spirochona Scheuteni* such fimbriation is represented by Stein as forming a series of less than a score of equal-lengthed setiform processes which extend along one side only of the expanded structure. In the present species the homologous elements are developed throughout the whole extent of the basal revolution of the funnel, and are, moreover, of two distinct lengths, numbering fifty or sixty in all, every fifth element being over twice the length of the four uniform and comparatively short intervening ones. The entire circle is thus geometrically subdivided after the fashion of the dial of a watch, or suggests perhaps still more significantly the delicately ruled and similarly proportioned subdivisions of a micrometric scale. Taken in their entirety, the contour of an animalcule of this species, with its fusiform body and expanding fimbriated funnel, is not unlike that of the seed and attached pappus of certain plants, such as *Valerian* or many of the Compositæ. Earlier conditions of this type, in which the funnel was yet undeveloped, were frequently met with, but in no instance could there be detected an example of lateral gemmation as obtains in the preceding form and in various species of *Spirochona*.

GENUS V. RHABDOSTYLA, S. K.

(Greek, *rhabdos*, rod; *stulos*, stem.)

Animalcules solitary, resembling those of *Vorticella*, but seated on a rigid, unretractile instead of a flexible, contractile pedicle.

This new genus has been instituted for the reception of a series of animalcules, several of which have at the time of discovery been described as solitary members of the genus *Epistylis*. Their position relative to the last-named group, however, is evidently parallel to that which subsists between the solitary genus *Vorticella* and the compound type of the same form distinguished by the title of *Carchesium*. The majority of the species so far discovered are inhabitants of fresh water, and are mostly remarkable for the extreme shortness of their rigid footstalk; in but two instances only does this structure exceed the length of the animalcule's body.

Rhabdostyla ovum, S. K. PL. XXXIV. FIGS. 5 AND 6.

Body ovoid, truncate anteriorly when expanded, attached to a slender rigid pedicle of about one-quarter of its own length; the surface of cuticle delicately striate transversely; ciliary wreath forming two circlets, cilia very long and strong; endoplast band-like, curved, disposed longitudinally. Length of body 1–500″. HAB.—Fresh water.

This species was obtained by the author in some abundance on aquatic plants from a pond in the neighbourhood of Stoke Newington, London. The band-like endoplast, as shown in the accompanying illustration, was conspicuously developed. When disturbed or not feeding it closed its peristomal border up tightly, presenting under such circumstances a perfectly ovoid contour. On several occasions it was observed, when thus contracted, to rapidly jerk its body backwards and forwards upon its short pedicle, as though irritated or trying to free itself from some obstruc-

tion. The fine transverse striations of the cuticular surface have been accidentally omitted by the artist in the figure given of the type.

Rhabdostyla sertularium, S. K. Pl. XXXIV. Figs. 3 and 4.

Body broadly campanulate, dilated anteriorly when expanded, globose, with a puckered anterior border when contracted, the cuticular surface finely striate transversely; pedicle somewhat stout, variously curved, occasionally equalling twice the length of the body, but usually much shorter. Length of body 1–600″.

Hab.—Salt water, on the polyparies of Hydroid zoophytes.

The short-stalked variety of this as yet first observed marine representative of the genus *Rhabdostyla* was met with by the author in some abundance, in February 1878, attached to the polyparies of the Hydrozoon *Aglaophenia pluma*, from St. Clement's Bay, Jersey, one or two animalcules usually occurring in almost uninterrupted order on the lowermost spur of each calycle of this elegant little zoophyte. The pedicle, under high magnification, exhibited what appeared to be a central cavity, corresponding in this respect with that of *Epistylis flavicans*. When closing up, the animalcules simply contract into a spherical form upon their rigid pedicles. On one occasion only was an endoplast-like structure observed; it was in that instance ovate in shape and on the point of dividing transversely. Examples of this species, characterized by the possession of stalks which nearly equalled twice the length of the body, Pl. XXXIII. Fig. 4, were subsequently obtained from St. Aubin's Bay, in the same island.

Rhabdostyla brevipes, C. & L. sp. Pl. XXXIV. Fig. 8.

Body subcylindrical, attenuate, about three times as long as broad; cuticular surface smooth, but presenting several transverse folds posteriorly when contracted; pedicle exceedingly short, about one-tenth the length of the entire body; endoplast oval, subcentral. Length of body 1–300″.

Hab.—Fresh water, on aquatic insects.

Claparède and Lachmann, conferring upon this species the title of *Epistylis brevipes*, have figured and described it only in its retracted state, in which the posterior extremity is plicate in three folds, and the anterior border contracted in a snout-like form. Under the conditions noted, it closely resembles a single zooid of *Epistylis plicatilis*, but possesses a longer and more cylindrical outline. The species was originally found in some abundance on the larvæ of various Diptera in the Berlin Zoological Gardens, the individual zooids being fixed very closely to each other. Its discoverers remark that, if this type is persistent, it merits, as recognized in this volume, a new generic title.

Rhabdostyla nebulifera, From. sp. Pl. XXXIV. Figs. 11 and 12.

Body subglobose, anteriorly truncate, surface smooth; pedicle short, about one-half as long as the body, fimbriate at its point of attachment, expanded in a cup-like manner where it joins the animalcule's body. Length of body 1–200″. Hab.—Fresh water.

This species is described by De Fromentel * as *Epistylis nebulifera*. One of the two figures given by him represents an example dividing by longitudinal fission—a phenomenon not yet witnessed in the species examined by the author.

* 'Études sur les Microzoaires,' 1876.

Rhabdostyla sphæroides, From. sp. Pl. XXXIII. Fig. 10.

Body when expanded forming through the dome-like elevation of the ciliary disc, above the peristomal margin, an almost perfect sphere; slightly contracted beneath the peristome; the cuticular surface smooth; pharyngeal cleft curved, greatly prolonged; peristomal cilia long and stout; pedicle moderately stout, one-half the length of the body, considerably expanded at both its distal and proximal extremities. Length of body 1–400".

Hab.—Fresh water.

While somewhat resembling the last species, it may be readily distinguished from it by its smaller size and the dome-like elevation of the ciliary disc. According to De Fromentel's illustration, the contractile vesicle is larger and located nearer the centre instead of towards the peristomal region of the body as in the preceding form. Its discoverer originally described this animalcule as a species of *Epistylis*.

Rhabdostyla ringens, From. sp. Pl. XXXIV. Fig. 1.

Body elongate-conical or trumpet-shaped, attenuate, over twice as long as broad, widest at the dilated anterior margin, gradually tapering towards its point of juncture with the pedicle; cuticular surface smooth, colour brown; pedicle short, slender, about one-third the length of the body. Length of body 1–300'. Hab.—Fresh water.

De Fromentel refers this species, under the title of *Epistylis ringens*, with doubt to the *Vorticella ringens* of Chevalier, of which an illustration but no description has yet been given.

Rhabdostyla longipes, S. K. Pl. XXXIV. Fig. 29.

Body elongate-campanulate, more attenuate posteriorly, about twice as long as broad when expanded, symmetrically ovate in its contracted state; parenchyma transparent, finely granulate; cuticular surface smooth; pedicle slender, sinuous, two or three times as long as the body, enclosing centrally an even series of minute granular particles. Length of body 1–350".

Hab.—Pond water, social.

This species was found by the author in company with *Vorticella campanula*, in February 1879, attached in small social patches to a Water Crowfoot taken from a pond near St. Heliers, Jersey. The rigid footstalk in all cases enclosed, as represented in the accompanying illustration, an even line of granular particles most nearly resembling, except for the absence of colour, what obtains in *Vorticella picta*.

Genus VI. PYXIDIUM, S. K.

(Latin, *pyxidium*, a little box.)

Animalcules solitary, ovate, adherent posteriorly through the medium of a simple rigid pedicle; ciliary disc, as in the genus *Opercularia*, separate from the peristome and attached to one side of the oral fossa.

This genus is instituted for the reception of such solitary animalcules as accord in structure with the zooids of the compound genus *Opercularia*, and towards which it occupies the same near relationship that subsists between *Rhabdostyla* and *Epistylis*, or *Vorticella* and *Carchesium*. Two species only, both inhabiting fresh water, have as yet been observed.

Pyxidium cothurnoides, S. K. PL. XXXIV. FIG. 7.

Animalcules ovate, somewhat gibbous, twice as long as broad; peristome margin truncate, entire; ciliary disc minute, furnished with two circlets of cilia, projecting conspicuously beyond the border of the peristome; surface of cuticle smooth, considerably indurated; endoplast linear, curved, longitudinally placed; contractile vesicle adjacent to the vestibulum; pedicle very short, less than one-quarter the length of the body, which it supports in a slightly inclined or oblique position. Length of body 1–500″.

HAB.—Fresh water, attached to Entomostraca.

The examples which served as a basis for this new species and genus were obtained by the author, in March 1874, attached in considerable quantities, singly or in small groups, to the carapace of a species of *Cypris*. Deprived of its short pedicle and with its body laterally attached, this type would have to be referred to the genus *Lagenophrys*, and may be regarded as intermediate between *Opercularia* and that genus. The zooids on contracting exhibit a nodding action, and become bent obliquely on their short pedicles, but in consequence of the rigidity of the integument scarcely alter their general contour. Although looked for, no distinct membranous collar, as in *Opercularia*, could be detected. More than twenty specimens of this animalcule were observed on a single *Cypris* obtained from a pond at Stoke Newington. Some of the older zooids were a pale amber colour, the younger ones being perfectly transparent.

Pyxidium inclinans, Müll. sp. Pl. XXXIV. Fig. 9.

Body erect, ovato-cylindrical, posterior extremity rounded and widest; the cuticular surface finely striate transversely; peristome-border longitudinally plicate; ciliary disc protrusible to a considerable distance beyond the margin of the peristome, bearing one ciliary circlet, supplemented by a collar-like membrane; pharyngeal cleft conspicuous, prolonged through two-thirds of the length of the body; pedicle very short and stout; body when contracted transversely folded posteriorly, remaining erect or bent to an entirely recumbent position. Length of body 1–300″.

HAB.—Fresh water.

This species, introduced by De Fromentel* under the title of *Scyphidia inclinans*, and identified by him with the *Vorticella inclinans* of O. F. Müller, is apparently referable to the present genus. From the form last described it may be easily distinguished by its more regularly ovate form and by the various transverse and longitudinal striæ and plications of the cuticular surface. No details of the special habitat of this variety are recorded by De Fromentel, but the two examples are apparently attached to a Confervoid filament.

GENUS VII. VORTICELLA, Linnæus.

Animalcules ovate, spheroidal or campanulate, attached posteriorly by a simple, undivided, more or less elongate and contractile, thread-like pedicle; the pedicle enclosing an elastic, spirally disposed, muscular fibrilla, and assuming suddenly on contraction a much shortened and usually cork-screw-like contour; adoral system consisting of a spirally convolute

* 'Microzoaires,' 1876.

ciliary wreath, the right limb of which descends into the oral or vestibular fossa, the left one obliquely elevated and encircling the so-called rotatory or ciliary disc; the entire adoral wreath contained within and bounded by a more or less distinctly raised annular border—the peristome—between which and the elevated ciliary disc, on the ventral side, the widely excavated oral fossa or vestibulum is situated; the vestibulum further continued into a conspicuous cleft-like pharynx, and finally terminating in a narrower tubular œsophagus, the junction of which with the pharynx exhibits an ovate and thick-walled dilatation; anal aperture opening into the vestibular fossa, the upper wall of this same fossa usually bearing apparently a more or less distinct setose appendage known as the vestibular seta or "*soie de Lachmann*";* contractile vesicle single, spherical, situated close to and debouching into the vestibulum; endoplast more or less elongate and band-like; zooids multiplying by longitudinal fission, and gemmation, and by the development of germs through the disruption of the endoplast. Inhabiting salt and fresh water.

The *Vorticellæ* or "Bell-Animalcules" include, perhaps, the most familiar and graceful representatives of the entire class of the Ciliata. All the members of the genus are readily distinguished by their transparent wineglass- or bell-shaped bodies and accompanying elastic, thread-like pedicles. These organs of attachment during life are in many species in an almost constant state of alternate contraction and prolongation, a circumstance which, in connection with a large colony of these elegant microscopic beings, produces a spectacle of unparallelled beauty and activity. The details of the adoral system, and more especially those relating to the œsophageal and pharyngeal regions as here embodied, have been demonstrated more particularly by Richard Greeff,† and are now admitted as fundamentally identical throughout all the members of the *Vorticellidæ*. The central muscular thread or fibrilla that gives to the stalk of *Vorticella* its characteristic power of contraction is, as indicated by so early an authority as Ehrenberg, disposed in an extended spiral form within its hyaline outer sheath, and is also now demonstrated to be continuous with a delicate muscular sheet or layer that passes up into the walls of the body and immediately underlies the cuticle. More correctly, the pedicle in its entirety may be described as an attenuate posterior prolongation of the subcuticular muscular or myophan system, enclosed throughout its length, as in the body, within a tubular sheath of the hyaline, structureless cuticle. In diverse species of the genus *Vorticella* a considerable amount of variation is found to exist in the ultimate construction of the central muscle-like fibre of the characteristic contractile pedicle. In many of these, as seen under high magnification, a coarse granulation of this element, sometimes produced more conspicuously along one edge or in a spiral manner around the central axis, is distinctly visible; while in some few, such as *Vorticella picta* and *V. appuncta*, larger refringent corpuscles of a brilliant hue are found imbedded in it. In *Vorticella nebulifera*, as represented by Everts, see Woodcut, p. 674, this central contractile fibrilla exhibits a longitudinally striate pattern; while in *V. margaritifera*, according to De Fromentel, it is distinctly striate in a transverse direction. In addition to the longitudinal muscular fibrillæ, Greeff has endeavoured to show that the transverse striæ that form so conspicuous a feature in many representatives of the genus are also of a muscular character, and describe a continuous and closely set spiral convolution around the animalcule's body. This last interpretation is not, however, elsewhere supported; overwhelming evidence, on the

* For a more detailed account of this appendage, see family Vorticellidæ, p. 656.

† "Untersuchung über den Bau und die Naturgeschichte der Vorticellen," 'Wiegmann's Archiv,' Bd. xxxiii., 1870.

other hand, tending to demonstrate that such markings are mere superficial annulations of the cuticle. The entire absence of these transverse markings in a very large proportion of the numerous species, sufficiently indicates their non-essential nature, while further evidence of their correct relegation to the category of surface ornamentation is afforded by the species here described under the title of *Vorticella monilata*, in which the more usual linear markings are replaced by a closely set series of bead-like elevations.

The phenomena pertaining to the various processes of reproduction, as manifested by the Vorticellidæ generally, and typically by the representative genus *Vorticella*, are of high interest, and may, at this point, be appropriately narrated. As among all members of the infusorial tribe, that mode of increase which is most prominently and commonly exhibited takes the form of simple fission, one primary zooid or animalcule giving rise by more or less frequently repeated subdivision to an innumerable progeny of daughter zooids. This fissive process in the genus *Vorticella*, and, so far as known, with the exception only of the genera *Spirochona*, *Lagenophrys* and *Ophrydium*, throughout the Vorticellidæ, takes a longitudinal direction. The circumstances attending this mode of increase are nevertheless considerably more complex than those which obtain among the various infusorial groups previously described, and are well exemplified in connection with the delineations of this process in *Vorticella marina* as given by Greeff and reproduced at Pl. XXXV. Figs. 1–5. The initial step towards the consummation of this duplicative act is accomplished through the withdrawal by the animalcule of its ciliary disc and assumption of a subspheroidal or pyriform contour, as under the ordinary conditions of contraction. The body itself has by this time become abnormally dilated, and presently develops an indentation or notch in the centre of its anterior border. The contracted and lunate vestibular cleft divides into two equal halves, or as observed by the author in the case of *Vorticella nebulifera*—such observation being also in accord with that of Everts—becomes entirely obliterated, a new vestibular cleft and oral system being developed on each side of the median line. A line of division is now gradually produced from the pre-existing anterior median notch, through the centre of the animalcule's body, cleaving in twain in its onward passage both the spheroidal contractile vesicle and the band-like endoplast. The ultimate result of this cleavage process is the production upon the single stalk of two zooids similar to the original or parent unit, and differing but little from it in point of calibre. While one zooid remains attached to the parent pedicle, and expanding its newly developed peristome pursues its ordinary food-ingesting avocations, its duplicate undergoes a further and highly characteristic metamorphosis. The peristome border more usually remains closely contracted, while a new element is introduced through the development round the posterior region of the body of a girdle of powerful vibratile cilia. These, by their vigorous and continued motion, produce an abnormal tension on the thinnest and weakest point, namely at the junction of the body with the stalk; this finally giving way, the animalcule is launched into the surrounding water, and propels itself whither it pleases with the assistance of its posteriorly developed ciliary girdle. This nomadic phase of existence is, however, of but short duration; the natatory motions of the zooid grow more languid, and it soon resorts to creeping over adjacent objects with its posterior border and ciliary circlet applied to their surface, presenting under such auspices, as shown at Pl. XXXIV. Fig. 18, a considerable resemblance to an ordinary repent *Trichodina*. Having at length lit upon a spot adapted to its tastes or exigencies, it adheres to it by its posterior extremity, and the girdle of temporarily developed locomotive cilia becomes absorbed and entirely obliterated. The peristome-border with its enclosed ciliary disc is now everted, and the stalk rapidly developing, the animalcule is soon in no way distinguishable from the normal sedentary zooid that gave it origin.

The temporary locomotive phase of *Vorticella* just described, is, however, by no means exhibited only by zooids liberated through the process of longitudinal fission. The ordinary singly attached animalcules, if submitted to uncongenial conditions, develop in a like manner a supplementary girdle of cilia, and becoming

disconnected from their pedicles, swim off in search of a more suitable location. Similar phenomena are furthermore common to all the compound stock-building representatives of this family group, in which, as familiarly illustrated by such examples as *Epistylis digitalis* and *E. anastatica*, the entire branching zoodendrium may become as bare as a leafless tree, through a parallel migration of its associated zooids, within a brief interval of its transfer from its native pond to the stage of the microscope. A peculiar modification of this migratory phenomenon obtains in the genus *Zoothamnium*, where, in certain species, zooids of abnormal size are periodically produced, which developing in a similar manner a posterior circlet of locomotive cilia, swim off to lay the foundations of new colonies. In intimate connection with the process of equal or subequal longitudinal subdivision already recounted, has to be recorded the production, through a closely parallel course of development, of the comparatively minute bud-like zooids, whose ultimate mission is not that of establishing itself independently and growing to the parent form, but—as first demonstrated by Stein, and since confirmed by the more recent investigations of Greeff, Engelmann, and various other authorities—of contracting intimate fusion or genetic union with some other normally developed sedentary animalcule. Such a more minute animalcule or microzooid is, as shown at Pl. XXXV. Figs. 10–12, usually developed under conditions precisely parallel to those already related of ordinary fission; not unfrequently, however, these microzooids are produced through a further repetition of the duplicative process, in connection with one of the two equal or subequal primarily separated moieties, the result being, as shown at Pl. XXXIV. Fig. 23*a* and Pl. XXXV. Fig. 19, the production of two or it may be as many as eight such microzooids, each with its posteriorly developed ciliary girdle, that remain temporarily attached to the parent stalk.

In the compound stock-form *Epistylis flavicans*, according to Greeff, whose illustrations are reproduced at Pl. XXXVIII. Fig. 1 *r r*, the entire parent animalcule becomes subdivided into four or eight locomotive microzooids. Having separated themselves from the parent stem, these microzooids swim hither and thither, until they come into contact with a normal sedentary *Vorticella*, to whose lateral periphery it then affixes itself by its anterior or oral pole, and gradually boring its way into its interior, the two becoming indissolubly and indistinguishably united. The accomplishment of this conjugative act is undoubtedly directly comparable with and analogous to the union of the male and female elements, or germ-cell and sperm-cell, of the higher Metazoa. The phenomena succeeding such conjugation are, furthermore, physiologically, and indeed morphologically, identical. While it is now made manifest that the sexual theory, as originally propounded by Balbiani, and referred to at length in the preceding volume, see page 94, cannot be maintained, and in which distinct sexual elements were premised to be represented in, and exchanged between, each conjugating zooid, the ovum and spermatozoon are here practically represented in each animalcule, themselves simple cells, and whose union confers, in a like manner, upon the former a renewed capacity of multiplication by binary subdivision. According to the recent investigations of Bütschli and Engelmann, it is only such a rejuvenating influence, or capacity to further subdivide by longitudinal fission, that is accomplished by the conjugative act. It would seem highly probable, however—the supposition being further substantially supported by what follows upon the conjugative process among the Flagellata—that if not directly, yet more or less remotely, this genetic union of the migrant and sedentary zooids brings about that mode of multiplication by encystment, and the subdivision of the entire body into sporular elements, that yet remains to be described. This phenomenon, while previously recorded by numerous investigators, has been as yet traced with the nearest approach to completeness by Eduard Everts.* As reported by the last-named authority in the case of *Vorticella nebulifera*, it is an animalcule set free by the process of ordinary longitudinal fission, as already described, that enters upon this reproductive phase of encystment. It, however, takes place quite as, if not more,

* "Untersuchungen an *Vorticella nebulifera*," 'Zeit. Wiss. Zool.,' Bd. xxxiii., 1870.

frequently in association with an ordinary undivided zooid that has become liberated from its stalk; or, as more rarely happens, the same zooid may enter upon this condition of encystment without becoming separated from its pedicle. The subsequent metamorphoses are in all cases identical. The animalcule contracts into a subspheroidal form, and secretes around it a hyaline, chitine-like, ovate or subspheroidal cyst, whose surface is frequently ornamentally facetted. The oral system, contractile vesicle, and, with the exception of the nucleus or endoplast, all other distinct features of the enclosed animalcule become next entirely obliterated. The band-like endoplast, which previous to the process of encystment had already become abnormally conspicuous, represents now the only essential differentiated structure, and it is out of this that the sporular elements are evolved. Increasing in dimensions at the expense of the surrounding protoplasm, it grows relatively larger, much convoluted, or even branched. It next becomes constricted at regular intervals, presenting a moniliform appearance, and finally separating at each constriction, the cyst is more or less completely filled with subspheroidal spore-like fragments. Becoming matured, these sporular bodies are discharged, through rupture of their capsule, as minute ovate or pyriform free-swimming animalcules, possessing an anterior crown of cilia, which are likened by Everts to *Trichodina* (*Halteria*) *grandinella*, but more correctly resemble the adult form of the genus *Strombidium*. These free-swimming embryos multiply abundantly by transverse subdivision, incept food by an oral aperture developed in close proximity to the anterior ciliary wreath, and finally, becoming languid in their motions, attach themselves by their oral pole to some submerged object. The pre-existing oral aperture and accompanying cilia are now obliterated, new ones, as in an adult *Vorticella*, are developed at the opposite extremity, and the attached portion, gradually lengthening, assumes the contour and characters of the ordinary contractile pedicle. Illustrations of all the more characteristic phases of this developmental process, as given by Everts, are reproduced at Pl. XXXV. Figs. 33–46.

An interesting example of the above reproductive form of encystment has been recently recorded by Professor G. J. Allman,* in connection with a compound Vorticellidan, apparently a species of *Epistylis*, obtained by him from a pond in Brittany. Of this he states: "Among the ordinary zooids which are grouped in spherical clusters on the extremities of the branches, there were usually some which had become encysted in a very remarkable way, and without any previous conjugation having been noticed. These encysted forms were much larger than the others, and had assumed a nearly spherical shape. The peristome and ciliary-disc had become entirely withdrawn; the contractile vesicle was still obvious, but had ceased to manifest contractions; brownish spherical corpuscles with granular contents, probably the more or less altered chlorophyll-granules of the unencysted zooid (food-material ?), were scattered through the parenchyma; and the nucleus was not only distinct, but had increased considerably in length. Round the whole a clear gelatinous envelope had become excreted. In a later stage there was formed between the gelatinous envelope and the cortical layer of the body a strong, dark brown, apparently chitinous case, the surface of which, in stages still further advanced, had become ornamented by very regular hexagonal spaces with slightly elevated edges. In this state the chitinous envelope was so opaque that no view could be obtained through it of the included structures, and in order to arrive at any knowledge of these it was necessary to rupture it. The nucleus thus liberated was found to have still further increased in length, and to have become wound into a convoluted and complicated knot. Along with the nucleus were expelled multitudes of very minute corpuscles, with active Brownian movements. In a still later stage the nucleus had become irregularly branched, and at the same time somewhat thicker and of a softer consistence, while finally this element had broken up into spherical fragments, each with an included corpuscle resembling a true cell-nucleus, the place of a nucleolus being taken up by a cluster of minute granules." It is clearly evident that the form

* Brit. Assoc. Reports, 1873, and President's Address to the Linnæan Society, 1875.

of reproduction just recounted represents but a slight modification only of the phenomenon of encystment and endogenous multiplication so prevalent among the class Flagellata, and where, as exemplified more especially in such forms as *Heteromita lens*, *Spiromonas angustata*, and *Euglena viridis*, such a reproductive process may take place either with or without the intercalation of a conjugative act. The only recognizable distinction between the two correlated processes is manifested by the fact that, while in the Flagellate species the reproductive germs or spores are produced by the segmentation of the complete body-mass *pari passu* with that of the nucleus, and a portion of which is enclosed within each protoplasmic fragment, after the manner of normal cell-multiplication, in the case of *Vorticella* the endoplast alone, increasing at the expense of, and assimilating the body protoplasm into its own substance, undergoes segmentation. The result ultimately arrived at is in both cases precisely identical, the mode of their accomplishment alone being divergent. As it obtains in the group of the Vorticellidæ, this reproductive process may be further accepted as yielding a condition intermediate between that simplest form of endogenous multiplication, just cited as encountered among the simpler Flagellata, and that more complicated form which obtains in the Heterotrichous genera *Stentor*, *Spirostomum*, and some few Peritricha, such as *Didinium*. In all of these the band-like endoplast or nucleus assumes the character of an internal proliferous stolon, the germs produced through its disintegration being liberated independently, and in association with the unimpaired maintenance by the parent of its normal form and vital functions.

In addition to the reproductive form of encystment just recounted, that simpler phase of the same process, assumed merely as a temporary or "resting state" during seasons of drought or other uncongenial conditions, is in common with almost all other infusorial forms, abundantly displayed by the members of the present genus. An illustration of this phenomenon, as exhibited by *Vorticella infusionum*, is represented in company with the encysted and sporular conditions of various Flagellate types, as attached to hay-fibres, in Fig. 1 *a a* of Pl. XI. Not unfrequently, as observed by Stein and Everts, these encysted *Vorticellæ* fall a prey to parasitic flagellate organisms, apparently allied to or identical with *Heteromita caudata*, which having gained access to the body of their host previous to its encystment, subsequently escape from the cyst in place of the original tenant, much after the manner that a brood of Ichneumon-flies swarms out of the pupa case of some Lepidopterous insect.

A rare form of conjugation, hitherto unnoticed, has been reported by Stein and Claparède and Lachmann, in which two, or—according to the last-named authorities,—it may be even three, sedentary zooids accomplish an intimate union with one another, and, developing a posterior circlet of cilia, become detached from their stalks and finally enter upon an encysted state. Examples of this form of conjugation, as exhibited by the cosmopolitan type *Vorticella microstoma*, are reproduced from Claparède and Lachmann's work at Pl. XXXV. Figs. 22–24. Both here and in the case of the conjugation or zygosis between a migrant and sedentary zooid, the tendency to conjugate, while of rare occurrence, spreads like an epidemic throughout every neighbouring colony, and may therefore, where once detected, be usually examined in detail in a mass of instances.

On account of the very considerable number of species that have been added as the result of recent investigation, and of the great similarity in external contour which in many cases subsists between them, the genus *Vorticella* has undoubtedly become one of the most numerically abundant specific groups of the entire infusorial class, while its members present to the working microscopist difficulties in connection with their correct identification closely parallel to those experienced by the botanist in association with the genus *Carex*. In order to lighten his labours as far as possible in this direction, a scheme, supplemented by Pl. XLIX., is here submitted, which, while susceptible of considerable extension and improvement, will afford a convenient clue to the elimination of the more formidable obscurities. As a preliminary step towards the accomplishment of the end in view the some three dozen or more species belonging to the genus are divided into two primary sections,

the one containing those forms in which the cuticular surface is smooth or glabrous, and the other those in which with the moderate magnification of three or four hundred diameters only, transverse striæ or other surface ornamentations are clearly perceptible. Both of these two sections admit of subdivision into subordinate groups based upon the contour of the body of the zooids as presented in their most typical or fully expanded state. Among the most abundant smooth cuticled series it will be found that the body exhibits three leading modifications. In the first of these it is simply ovate or elongate, having a length equalling at least twice that of the greatest width, while the frontal margin is but slightly dilated. The characteristic features of this series attain their highest development in such forms as *V. cucullus* and *V. quadrangularis*. In the second series the body is normally broadly campanulate or bell-shaped, having the frontal margin much dilated, and often exceeding in diameter the longitudinal measurement of the animalcule. The *Vorticella campanula* of Ehrenberg typifies this section, the *V. citrina* and *V. patellina* affording further examples of this group in which the peristome-border is dilated to such an extent as to approach a contour to which in botanical terminology the title of "hypocrateriform" would be applied. In a third, and as at present known, not very extensive series, fitly typified in the recently described *Vorticella spherica* of D'Udekem, the body in its most complete state of expansion presents an almost perfectly spheroidal contour. In that section, distinguished by the striate or otherwise ornate character of the cuticular surface, no representative of the spheroidal series has been as yet recorded, while the *Vorticella elongata* and *V. appuncta* of De Fromentel may be cited respectively as characteristic examples of the elongate-conical and broadly campanulate groups. To the last-named series has also to be relegated the *Vorticella monilata* of Tatem, remarkable for the bead-like elevations which replace the simple striæ of the more ordinary species. That in many instances the several groups as above distinguished, and more especially the conical and campanulate series, closely approach and amalgamate with one another, is readily admitted, a hard and fast line of separation being indeed entirely arbitrary and artificial. Applied, however, in its broad sense, and aided by the special characteristics noted in the technical diagnoses, the recognition and identification of the various specific forms, with the assistance of this scheme, is greatly facilitated.

For the future guidance of investigators of this exceedingly attractive generic group, attention may be profitably directed to the very incomplete data from which in many cases the specific descriptions given in this treatise have been framed, and to which it is exceedingly desirable that more comprehensive details should be added. The large number of new species recently introduced by De Fromentel* are particularly unsatisfactory in this respect. In not a single instance does he record whether the animalcule figured is social or solitary in its habits, whether a denizen of ponds, running water, or infusions, while in but few instances even is the comparative length of the supporting pedicle indicated in his drawings or mentioned in the accompanying text. All of these characteristics are of high importance, and should be registered in drawing up an account of a doubtful or supposed new species. The form assumed by the body in its contracted state should likewise receive attention, this phase, as exemplified in *Vorticella citrina* and *V. telescopica*, often yielding data of as high value for specific discrimination as those afforded by the fully expanded zooids.

A.—Cuticular Surface Smooth.

* *Bodies conical or elongate.*

Vorticella nebulifera, Ehr.

Pl. XXXIV. Fig. 20, Pl. XXXV. Figs. 32–47, and Pl. XLIX. Fig. 1.

Body when extended conical-campanulate, somewhat gibbous, about three times as long as broad, tapering posteriorly, slightly constricted

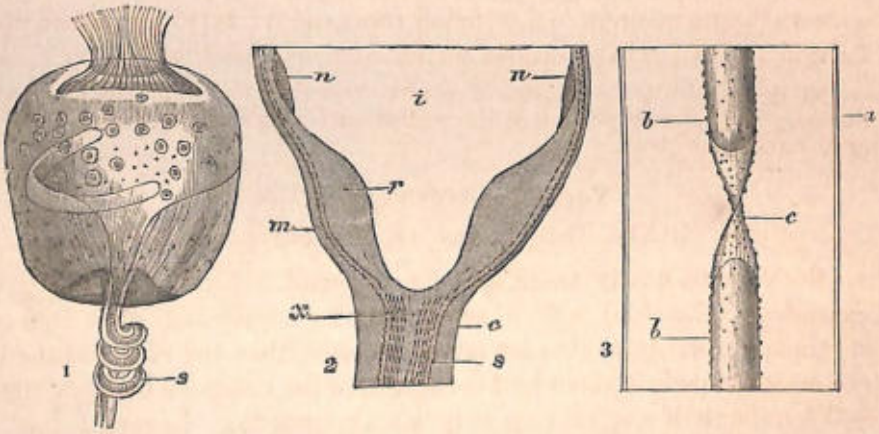
* 'Études sur les Microzoaires,' 1876.

beneath the obliquely set and moderately dilated peristome; contour when contracted pyriform, with the anterior border lobate; parenchyma transparent, colourless; cuticular surface smooth, soft and plastic, often puckered; pedicle slender, four or five times longer than the body. Length without pedicle 1–570″ to 1–280″.

HAB.—Pond-water, forming social clusters on the roots of *Lemnæ* and other aquatic plants.

This species may be abundantly obtained at all seasons of the year under the conditions above indicated. By Ehrenberg it has been identified with the *Vorticella convallaria*, in part of Linnæus and O. F. Müller, and also with the *Vorticella nebulifera* of the last-named authority. On referring, however, to Müller's original account of the type agreeing in name with the present one, the author finds that it relates to a marine species having a much wider bell-like contour, which has not apparently been since observed. That the title of *nebulifera* belongs properly to the marine animalcule is evident, though custom has so long associated it with the present fluviatile form, that the introduction of a new title for the distinction of the latter type appears undesirable. As seen under the high magnification of six or eight hundred diameters, the cuticular surface is shown to be finely striate transversely, but it does not exhibit such character with one of two or three hundred only, which is employed for establishing that distinction between the smooth and conspicuously striate types here adopted as an aid to their specific identification. Full details of the reproductive phenomena of the present species, as elicited by Everts, are embodied in the preceding general account of the genus *Vorticella*, illustrated by Figs. 32–47 of Pl. XXXV.

Everts' interpretation of the minute histology of the contractile footstalk of *Vorticella nebulifera* is illustrated by the figures from his drawings reproduced in Figs. 1 and 2 of the accompanying woodcut. According to this investigator, the central muscle-like cord exhibits, under the moderately high magnification of 600 diameters (Fig. 1) the aspect of being finely and evenly striate transversely, after the



FIGS. 1 and 2. *Vorticella nebulifera*, Ehr. 1. Contracted zooid with at *s* muscle-like element of the pedicle exhibiting a transversely striated aspect, × 600 (after Everts). 2. Diagrammatic longitudinal section of lower half of the body; *c*, cuticle; *s*, central muscle-like cord of pedicle continued at *m* into the myophan layer of the body-wall; *x*, its central cavity; *r*, cortical layer; *i*, central cavity of the body; *n*, nucleus or endoplast, × 1800 (after Everts).

FIG. 3. *Carchesium polypinum*, Lin. sp. Portion of stem as observed by the author; *a*, external sheath or cuticle; *b*, central contractile cord, with *c* its granular sarcolemma-like investing membrane, which has become exposed and twisted on itself through the fracture and shrinking of the central cord, × 2000.

manner of the striated muscular fibre of an ordinary metazoic organism. Under the yet higher amplification of 1800 diameters (Fig. 2) each of these apparent transverse striæ, however, became resolved into parallel rows of minute longitudinal striæ,

having, as seen in optical section, ten to each row, divided by a hyaline central space. The author has entirely failed to corroborate Everts' interpretation of this structure, but has at the same time observed, in the case of *Vorticella nebulifera*, *V. campanula*, and many other species, the presence of a more or less even layer of granular corpuscles intervening between the hyaline outer sheath and the denser, but apparently homogeneous central cord. A similar composition has been also observed to obtain in the homologous structure of the compound type *Carchesium polypinum*, of which indeed the author has succeeded in making preparations that distinctly show the existence of these three elements, as indicated in Fig. 3 of the accompanying woodcut. As there shown, this granular layer is distributed upon the surface of a delicate hyaline membrane which encloses the central cord that both wonderfully resembles, and physiologically corresponds with, the delicate external sheath or "sarcolemma" of ordinary muscular tissues.

Vorticella picta, Ehr. PL. XLIX. FIG. 2.

Body conical-campanulate, about twice as long as broad, frontal margin widest, slightly everted, parenchyma transparent; cuticular surface smooth; pedicle slender, four or five times the length of the body, enclosing an even linear series of minute scarlet corpuscles. Length 1–1150″ to 1–570″. Inhabiting fresh water, social.

This species was obtained by Ehrenberg, growing abundantly on *Salvinia natans*, at Pickelsburg, in the neighbourhood of Spandau on the Spree, in the year 1831, but does not appear to have fallen beneath the observation of any subsequent investigator. The peculiar character of the pedicle affords a ready clue to its future identification.

Vorticella gracilis, Duj. PL. XLIX. FIG. 3.

Body evenly conical, about twice as long as broad, the anterior margin widest, slightly everted; parenchyma transparent; cuticular surface smooth. Length 1–520″. HAB.—Marsh water, after long keeping.

No description of this species is given by Dujardin, but simply an illustration of the body and a small portion of the pedicle of a single zooid, with a notification of its habitat, as above.

Vorticella brevistyla, D'Udekem.

PL. XXXIV. FIGS. 13 AND 14, AND PLATE XLIX. FIG. 4.

Body ovate, nearly twice as long as broad, tapering posteriorly when extended, spheroidal with a small anterior nipple-like projection when contracted; peristomal border rather narrower than the centre of the body, not everted; pedicle about half the length of the extended body, decumbent, and forming half a spiral turn only when contracted. Length 1–300″.

HAB.—Pond water.

This species, as described by D'Udekem * and obtained from pond water near Brussels, closely resembles, with reference to the shortness of the pedicle, the forms already described under the titles of *Pyxidium* and *Rhabdostyla*. The encystments of the animalcule, as observed by D'Udekem, are of a brownish hue, subspherical, with numerous angular asperities.

* 'Infusoires de la Belgique,' 1864.

Vorticella dubia, From. PL. XLIX. FIG. 5.

Body smooth, campanulate, one and a half times as long as broad, the anterior margin scarcely everted, exhibiting no distinct peristomal border; pedicle thick, not twice the length of the body. Length 1–640″.

HAB.—Fresh water.

The description of this species is very imperfect, but if the figure given by De Fromentel is to be relied on, a permanent feature for diagnosis is supplied by the character of the anterior or oral margin of the animalcule, the peristome altogether wanting that raised band-like contour characteristic of almost all other species of the genus. As a consequence of this peculiarity, the anterior border presents an undulating and uneven edge that contrasts strongly with the smooth and sharply defined margin usually associated with this region.

Vorticella alba, From. PL. XXXIV. FIG. 33, AND PL. XLIX. FIG. 6.

Body in extension symmetrically ovate or turbinate, one and a half to twice as long as wide, truncate anteriorly; pyriform when contracted; peristome-border slightly constricted; parenchyma very transparent; cuticular surface smooth, finely granulate or punctate; contractile vesicle conspicuous; pedicle three or four times the length of the body. Length 1–400″. HAB.—Fresh water, social.

A species evidently agreeing with De Fromentel's type, as above characterized, has been recently obtained by the author in some abundance and in company with *Vorticella hamata*, attached to *Chara* and *Confervaceæ* obtained from an aquarium of some years' standing, in the Biological Laboratory, South Kensington. The exceedingly neat and symmetrical contour of the body, together with the transparency of the parenchyma, serves to distinguish this species readily from the numerous other forms comprehended in this generic group. In one or two examples, as indicated in the zooid to the left-hand side of the group here figured, it was observed that a more or less conspicuously developed annular line or plication divided the narrower posterior third from the two wider anterior thirds of the body, while the cuticular surface under high magnification exhibited in all instances fine longitudinally disposed granulations.

Vorticella fluviatilis, From. PL. XLIX. FIG. 7.

Body ovate, smooth, one and a half times as long as broad, truncate anteriorly, having an indentation or depression at the posterior end or point of insertion of the pedicle; peristome-border narrow, scarcely everted; cuticular surface smooth; oral fossa relatively large; pedicle three or four times longer than the body. Length 1–640″. HAB.—Fresh water.

Vorticella crassicaulis, S. K.

PL. XXXIV. FIGS. 25 AND 26, AND PL. XLIX. FIG. 8.

Body when extended ovate or subfusiform, widest centrally, tapering towards each extremity, but more so posteriorly, about twice as long as broad, pyriform, with a snout or nipple-like anterior projection when contracted; peristome-border truncate, constricted and not everted; pedicle equal to or but slightly exceeding the body in length, very thick at its

point of junction with the body, gradually tapering from thence towards its proximal extremity, its external surface conspicuously wrinkled, the central muscular fibrilla produced only through the distal moiety of its total length, simply flexed and not coiled spirally when retracted; cuticular surface smooth; parenchyma transparent; endoplast elongate, band-like. Length 1–600″.

HAB.—Pond water, on *Asellus aquaticus*, social.

This minute species was obtained by the author attached in small colonies to the above-named crustacean taken from a pond near Ashby-de-la-Zouch, Leicestershire, in January 1880. A like deportment of the pedicle during contraction—as manifested by its simple flexure in place of spiral convolution—is shared by the *Vorticella brevistyla* of D'Udekem, already described, while a similar development of the central muscle-like cord within the distal moiety only of this structure frequently recurs in *V. spectabilis*.

Vorticella cucullus, From. PL. XLIX. FIG. 9.

Body elongate-conical, attenuate, nearly three times as long as broad, widest and slightly everted anteriorly, tapering gradually towards the posterior extremity, the ciliary disc raised cushion-wise above the border of the peristome; surface smooth; pedicle slender, relative proportions unrecorded. Length of body 1–265″. HAB.—Fresh water.

Vorticella longifilum, S. K.

PL. XXXIV. FIG. 30, AND PL. XLIX. FIG. 10.

Body conical, attenuate, about twice as long as broad, surface smooth; peristome slightly dilated; pedicle exceedingly long and slender, contracting spirally, ten or twelve times as long as the body. Length of body 1–370″. HAB.—Fresh water, solitary.

This species in some respects resembles the *Vorticella cucullus* of De Fromentel last described, but the body is less attenuate, while the pedicle—excepting only the form mentioned below—exceeds in length and tenuity that of any species previously described. The few specimens observed were obtained in October 1872, in pond water containing *Myriophyllum* and other water-plants, from the neighbourhood of Stoke Newington, London. An Egyptian species closely allied to and possibly identical with this type, distinguished by the possession of an equally attenuate pedicle, is described and figured by Schmarda,* under the title of *Vorticella macrostyla*. The body is, however, apparently evenly ovate, and the peristome-border contracted, but the figure given is on too small a scale for an exact apprehension of its more minute specific characteristics.

Vorticella telescopica, S. K.

PL. XXXIV. FIGS. 31 AND 32, AND PL. XLIX. FIG. 11.

Body conical or elongate-pyriform, tapering towards the posterior extremity, a little over twice as long as broad; cuticular surface smooth, interrupted posteriorly by two transverse sulci, behind each of which it becomes successively abruptly narrower; when contracted the wider portions

* 'Denkschrift der Kaiser. Akad. der Wiss. Wien,' 1854.

of the body in advance of each of these sulci overlapping the preceding one after the manner of a telescope; pedicle slender, scarcely exceeding the body in length, contracting spirally. Length of body 1–500″.

HAB.—Fresh water, solitary.

Obtained sparingly from pond water, in October 1872, in company with *Vorticella longifilum*.

** *Bodies broadly campanulate.*

Vorticella campanula, Ehr.

PL. XXXIV. FIG. 36, AND PL. XLIX. FIG. 12.

Body usually broadly campanulate or hemispherical, but soft and very variable in contour; subspheroidal, with a puckered anterior margin when contracted; the frontal margin widely dilated, often exceeding in width the length of the body; the ciliary wreath apparently forming two or more spiral convolutions; pedicle thick, varying from three or four to six or seven times the length of the body; cuticular surface smooth, highly elastic; parenchyma densely granular centrally. Length of body 1–250″ to 1–120″. HAB.—Pond water, social.

The zooids of this species are clearly visible to the unaided eye, and often occur in such abundance as to conspicuously cover the surface of submerged leaves or other objects in the form of a thick bluish-white slime. A characteristic by which, as pointed out by D'Udekem, this type may be easily recognized, is furnished by the densely granular consistence of the internal parenchyma, which imparts to the central region of the body, when viewed with transmitted light, a black and opaque aspect. It would seem probable, as anticipated by Ehrenberg, that the *Vorticella lunaris* of O. F. Müller, Pl. XLIX. Fig. 42, is identical with this species.

In none of the numerous examples examined by the present author has the larger size, quoted from Ehrenberg in the foregoing diagnosis, been encountered, that of 1–250″ to 1–200″ being most dominant, and such dimensions being considerably inferior to those of *V. spectabilis*, described later on.

Vorticella citrina, Ehr. PL. XXXV. FIG. 29, AND PL. XLIX. FIG. 13.

Animalcules broadly campanulate, hemispherical, plastic and changeable in form, the frontal border much dilated, crateriform, often considerably exceeding in diameter the entire length of the body; depressed with a puckered anterior border when contracted; parenchyma transparent, usually pale yellow; cuticular surface smooth; pedicle slender, four or five times longer than the body. Length 1–430″ to 216″.

HAB.—Fresh water, on *Lemna* and various aquatic plants, social.

This species represents one of the most abundant fresh-water types. In the plasticity of the parenchyma and capacity to assume a great variety of contours, it rivals the form last described, while in the patellate or crateriform expansion of the peristome-border it more nearly approaches *Vorticella hemisphærica* and *V. patellina*. In its contracted state the body of this animalcule, as observed by the author, exhibits a very characteristic contour; the anterior margin in all these instances assuming a more or less lobate or puckered aspect, while the body as a whole sometimes retains a subspheroidal form, but more often presents a much depressed melon- or tomato-like outline. Under a magnification of three or four hundred diameters,

the cuticular surface was shown, by a careful adjustment of the light, to be very finely striate transversely, this ornamentation being more especially apparent in specimens whose life was nearly extinct. These striations not being visible under ordinary conditions, this type has been retained among the smooth-surfaced series.

Vorticella cratera, S. K. Pl. XXXIV. Fig. 22, and Pl. XLIX. Fig. 14.

Body broadly campanulate, inflated and hemispherical, the breadth often two or three times greater than the total length; peristome-border flattened and expanded, crateriform, often revolute; ciliary disc but slightly elevated; parenchyma white, cuticular surface smooth; pedicle stout, five to seven or eight times the length of the body, contracting spirally. Length 1–480″. Hab.—Fresh water, social.

The above specific title is here proposed for the reception of the so-called *Vorticella patellina* of Ehrenberg, but which is entirely distinct from the essentially marine animalcule upon which the same name was originally conferred by O. F. Müller. This latter form has been recently met with by the author, and is described in the next paragraph. D'Udekem gives a highly characteristic drawing of the present species in his 'Infusoires de Belgique,' as here reproduced, in which for the first time full justice is done to the exceedingly elegant frill-like aspect presented by the peristome-border in its typical expanded state.

Vorticella patellina, Müll.

Pl. XXXV. Fig. 26, and Pl. XLIX. Fig. 15.

Body conical-campanulate in extension, widest at the anterior border, and tapering thence in a straight line to its point of junction with the pedicle; pyriform with a puckered anterior margin when contracted; the diameter of the expanded frontal border equalling or but slightly less than the total length of the body; the peristome-edge exceedingly thin, expanding in a flattened or rotate form around the frontal margin; ciliary disc but slightly elevated; parenchyma transparent; cuticular surface smooth; pedicle slender, three or four times the length of the body, contracting spirally. Length 1–350″. Hab.—Salt water, social.

The animalcule corresponding with the foregoing diagnosis was obtained by the author, attached to algæ and zoophytes, at Guernsey, in September 1871, and evidently represents the true marine *Vorticella patellina*, as originally named and figured by O. F. Müller,* with which Ehrenberg and subsequent writers have proposed to correlate the fresh-water type last described. The exceedingly straight lateral walls, and consequently angular aspect of the bodies of this species, as presented during their most characteristic expanded state, distinguish it conspicuously from all other representatives of the genus; this lateral outline, joined to that of the equally straight frontal border, communicates in fact to the animalcules, as seen in optic section, the contour of an almost perfect equilateral triangle.

Vorticella nutans, Müll.

Pl. XXXIV. Fig. 28, and Pl. XLIX. Fig. 16.

Body broadly campanulate in extension, nearly as wide as long, pyriform or globose when contracted, soft and elastic, cuticular surface smooth;

* 'Zoologia Danica,' 1776.

the peristome-border dilated, but not crateriform or greatly revolute, a deep notch or constriction usually separating it from the remainder of the body; oral fossa large, pharynx deeply prolonged; the posterior extremity of the body, immediately preceding its junction with the pedicle, conical and attenuate; pedicle transparent, slender, three or four times longer than the body, mostly assuming in connection with this structure a more or less inclined position; parenchyma transparent or pale yellow, finely granulate. Length 1–430″ to 1–300″. HAB.—Fresh water, social.

This species, originally described by O. F. Müller, and since lost sight of, has been re-discovered by De Fromentel, and has more recently, February 1879, been met with in some abundance by the author in the neighbourhood of St. Heliers, Jersey. The distinctive feature by which it may be readily identified, is afforded by the gracefully inclined or pendulous position almost invariably assumed by the broad campanulate body with reference to its supporting pedicle. The pedicle itself, again, when the zooid is fully expanded, frequently remains curved, and on contraction assumes a more or less loose and imperfect spiral coil. The substance of the body and overlying cuticle is soft and plastic, permitting of a considerable puckering of the contour of the periphery, but this to a much less degree than is observable in either *Vorticella campanula* or *V. citrina*.

The majority of the examples examined exhibited a pale yellowish hue, and were found both solitary and forming small scattered colonies, attached to *Confervæ* taken from a roadside ditch, containing much decaying vegetable matter, running during the winter months, but habitually dry in summer. These specimens were found to live for a long while in the close confinement of a small glass vessel. In his list of synonyms, De Fromentel has proposed to identify this type with the *Vorticella infusionum* of Dujardin, a species, however, with which it certainly cannot be said to exhibit a single point in common. The marine *Vorticella gemella* of O. F. Müller would appear to be a type closely corresponding with the present type, if not indeed a merely salt-water variety of it. In many cases the presence of two zooids upon one stalk, resulting from longitudinal fission, was noted by that early investigator, and being interpreted by him as the normal expression of the species, suggested the title given.

Vorticella aperta, From. PL. XLIX. FIG. 17.

Body conical-campanulate, or pyriform, one and a quarter times longer than wide, tapering posteriorly, slightly constricted beneath the peristome; surface smooth and transparent; the substance of the inner layer of the body contracted at its junction with the pedicle, and presenting the appearance of a supplementary thick bounding membrane or cortical layer around this point; pedicle stout, about three times longer than the body. Length 1–400″. HAB.—Fresh water.

Vorticella procumbens, From. PL. XLIX. FIG. 18.

Animalcules exceedingly transparent, campanulate, scarcely longer than broad; peristome everted; pharyngeal cleft much prolonged; pedicle decumbent, three or four times longer than the body. Length 1–530″.

HAB.—Fresh water.

The most important character of this species, as described by De Fromentel, is the procumbent position always assumed by the pedicle when in a state of full extension.

Vorticella dilatata, From. PL. XLIX. FIG. 19.

Body broadly campanulate, truncate and widely expanded anteriorly, its breadth equalling the total length, no constriction behind the peristome-border, the posterior extremity narrowly truncate; oral fossa large; pharyngeal cleft produced almost through the length of the body; ciliate throughout, vestibular seta conspicuous; pedicle short, comparatively slender; parenchyma white, granular; cuticular surface smooth. Length 1–350″. HAB.—Fresh water.

Although of small size, this species would seem, from De Fromentel's illustration and brief description, to correspond closely with one of the many aspects assumed by *Vorticella campanula.* As in the case of so many other forms described by him as new, no details, however, are given of the comparative length of the pedicle, of its social or solitary habits, or other data that would assist in its future identification.

Vorticella fasciculata, Müll. PL. XLIX. FIG. 20.

Body broadly campanulate, the anterior margin reflected; pedicle from three to five or six times the length of the body.

HAB.—Pond water, on *Confervæ;* colour green; social.

This species, according to Müller, forms green gelatinous masses upon aquatic plants, not only distinctly visible to the unassisted vision, but of considerable extent. The broadly campanulate contour of the body, as indicated in the original figures and description given by Müller, preclude its identification with *Vorticella chlorostigma* as suggested by Ehrenberg. The parenchyma would appear to be very clear and homogeneous, as in *V. citrina*, which species, indeed, except for its dark olive-green colour, it would seem to much more nearly resemble. De Fromentel figures as representing this form an animalcule whose body is entirely colourless and mounted on a pedicle of much greater relative length. He makes no reference to the essentially gregarious habits which so prominently distinguish Müller's type.

Vorticella communis, From. PL. XLIX. FIG. 21.

Body even, conically campanulate, the length equalling or slightly exceeding the greatest breadth; peristome-border everted; ciliary disc but little elevated; parenchyma transparent; cuticular surface smooth; pedicle stout, about four times longer than the body. Length 1–800″.

HAB.—Fresh water.

This minute type is represented by De Fromentel as a very abundant fresh-water form, whose identity with any of the species of the older writers cannot be satisfactorily established.

*** *Bodies spheroidal.*

Vorticella globularia, Müll. PL. XLIX. FIG. 22.

Body spherical; peristome small, contracted, and not everted; pedicle slender, six or seven times longer than the body, retracting spirally. Dimensions unrecorded.

HAB.—Fresh water, social, attached to a species of *Cyclops.*

This species, as figured and described by O. F. Müller,* possesses a just claim for recognition in this treatise, no spheroidal type with a pedicle of so great a relative length having up to the present time been recorded by any more recent investigator. So far as it is possible to judge, comparing Müller's drawings with the figures given by him of other well-known species, the diameter of the body of this animalcule is about 1–150″. Its habitat being so clearly defined, its rediscovery may be anticipated.

Vorticella sphærica, D'Udek. Pl. XLIX. Fig. 23.

Body spherical, nearly as broad as long, its surface smooth; pedicle short, about twice the length of the body, comparatively thick; peristome-border and ciliary disc small and contracted, the latter structure but slightly elevated. Length 1–820″. Hab.—Fresh water.

This species was obtained by D'Udekem from the Willebroeck Canal, near Brussels. No allusion is made in his description to either its solitary or social habits.

Vorticella margaritifera, From. Pl. XLIX. Fig. 24.

Body spherical, hyaline, granulate, enclosing brilliant refringent corpuscles; ciliary wreath very minute, vestibular fossa large; pharyngeal cleft deeply prolonged, conspicuously ciliate; pedicle short and stout, twice the length of the body, its attached or proximal extremity conspicuously discoidal. Length 1–400″. Hab.—Fresh water.

De Fromentel† remarks of this species that it can close its ciliary disc without contracting its pedicle; as also, that the pedicle does not retract in a spiral form but is simply shortened by the closer apposition of its annular rings, its external transparent sheath becoming at the same time transversely wrinkled. The body in general form, while of smaller size, corresponds closely with the species last described.

Vorticella mamillata, From. Pl. XLIX. Fig. 25.

Body almost spherical, smooth and transparent, slightly granular; peristome narrow, projecting when expanded in the form of three nipple-like papillæ; pedicle moderately thick, two or three times longer than the body. Length 1–750″. Hab.—Fresh water.

Vorticella constricta, From. Pl. XLIX. Fig. 26.

Body subspheroidal, smooth, granular, slightly flattened; peristome-border very narrow, taking the form of two raised papillæ surmounted by prominent vibratile cilia; oral fossa situated between these papillæ, followed by a short pharyngeal cleft; the posterior extremity exhibiting at its junction with the pedicle a short conical prolongation; pedicle slender, about twice the length of body, contracting in a zigzag and not in a spiral manner. Length 1–530″. Hab.—Fresh water.

This species appears to be closely allied to the *Vorticella mamillata* of the same author, last described. The papilliform prominences in either case possibly represent an abnormal condition only of the peristome and ciliary disc.

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* 'Animalcula Infusoria,' p. 313, tab. xliv. fig. 14. † 'Études sur les Microzoaires,' 1876.

B.—Cuticle distinctly Striate or otherwise ornamented.

* *Bodies conical or elongate.*

Vorticella microstoma, Ehr.

Pl. XXXV. Figs. 9–24, and Pl. XLIX. Fig. 27.

Body somewhat variable in form, usually ovate or subpyriform, about one and a half times as long as broad, but sometimes almost spheroidal; cuticular surface finely striate transversely; peristome-border very narrow and constricted, not everted, about one-half of the width of the centre of the body; pharyngeal cleft greatly prolonged; pedicle varying from two or three to five or six times the length of the body, usually inserted into a narrower conical posterior prolongation of the body proper. Length 1–750″ to 1–240″.

Hab.—Stagnant water and infusions; solitary or in social clusters.

This species represents one of the most widely distributed members of the genus; it occurs in almost all water containing decaying vegetable matter, and may be abundantly developed, in company with *V. putrinum*, from artificial hay-infusions. Under the last-named conditions it usually makes its appearance so early as from a week to ten days after placing the hay to macerate, while the characteristic encystments that give rise to the active animalcules may be detected imbedded in the substance of the hay within a few hours of its first immersion. The species multiplies very rapidly by longitudinal fission, the few first released from the primary cysts soon producing extensive colonies by the constant repetition of this process. Prior to its separation from the parent, a girdle of cilia is produced round the posterior extremity of the migrant zooid, which, as it hangs from the parent stalk, presents the aspect of an independent gemmule. It not unfrequently happens that while thus pendent this zooid again subdivides into two of less magnitude, while D'Udekem records and figures one example, see Pl. XXXV. Fig. 19, in which, while yet attached, the migrant animalcule split up into as many as eight minute pyriform zooids, which were presently scattered into the surrounding water. It would seem probable that these rarely produced, more minute zooids represent those whose mission it is to coalesce with the typical sedentary forms, and secure in a sexual generative manner the further multiplication or rejuvenescence of the parent stock, those formed by the simple subequal division of the parent zooid, as a rule, reaffixing themselves, and soon, by the growth of a new pedicle, becoming indistinguishable from the latter. Fuller details of the reproductive phenomena of this species are recorded in the general description of the genus given in a previous page. The striations of the cuticular surface of *Vorticella microstoma* are clearly visible only in association with a careful manipulation of the light, and indeed this surface is represented by many authorities as perfectly smooth and transparent. Both Ehrenberg, and Stein in his earlier writings, figure with this type minute stalked animalcules having a length of less than 1–2000″, and which are described as its young. There can be but little doubt, however, that these minute stalked organisms are independent flagellate forms, such as *Spumella* or *Oikomonas*, which are abundantly developed in the water that contains this species. On the other hand, the author has never as yet met with examples attaining the largest size given by Ehrenberg, viz. 1–240″, the majority of examples observed varying in length from 1–750″ to 1–600″. In infusions containing an abundance of this form the author has frequently met with zooids detached from their pedicles, having no posterior ciliary wreath, but swimming with the aid of their peristomal cilia only, and presenting an inflated subglobose contour, as shown at Pl. XXXV. Fig. 17. These detached zooids were subsequently found to develope into the ovate encystments, with a

crenated border, as delineated in the succeeding figure. The *Vorticella plicata* and *V. striata* of De Fromentel, admitted by that authority to be probably varieties of the same species, seem to be referable to the present type; the transverse striæ are apparently coarser and more pronounced, and in this respect more closely coincide with those of the marine *Vorticella striata* of Dujardin. By the last-named investigator the animalcule now under discussion is figured and described under the title of *Vorticella infusionum*; the cuticular striations are, however, misrepresented as taking an oblique direction.

Vorticella putrinum, Müll.

Pl. XXXIV. Figs. 23 and 24, and Pl. XLIX. Fig. 28.

Body elongate, subfusiform, widest centrally and tapering towards each extremity, the posterior region being most attenuate, from two to three times as long as broad; ovate, with a nipple-like anterior projection, when contracted; peristome-border constricted, scarcely everted; the cuticular surface finely striate transversely; pedicle three or four times as long as the body. Length 1–430″ to 1–300″.

Hab.—Vegetable infusions in both salt and fresh water.

The species, as above characterized, has been obtained abundantly by the author in hay-infusions in both salt and fresh water, and is undoubtedly identical with the form first associated with the foregoing title by O. F. Müller, and figured by him in his 'Zoologiæ Danicæ Prodromus,' in the year 1776. From *Vorticella microstoma*, of which in fresh-water infusions it is a frequent companion, it may be readily distinguished by the much more elongate contour of the body. An example in which two smaller migrant zooids are being produced through a repetition of the ordinary fissive act of a normal animalcule, is depicted at Pl. XXXV. Fig. 23*a*.

Vorticella striata, Duj.

Pl. XXXIV. Figs. 15–19, and Pl. XLIX. Fig. 29.

Body ovate or pyriform, about one and a half times as long as broad, widest centrally, conically pointed posteriorly, constricted towards the border of the peristome, which is narrow, not dilated, and measures one-half the width of the centre of the body, the ciliary disc slightly prominent; cuticular surface conspicuously striate transversely; pedicle slender, about twice the length of the body. Length 1–850″ to 1–600″.

Hab.—Salt water; solitary or in scattered groups.

This species, like *Vorticella gracilis*, is figured but not described by Dujardin, an appended note indicating only its size and salt-water habitat. The present author has recently, January 1879, obtained an animalcule corresponding with Dujardin's type in all essential points, on the Jersey coast, finding it attached to zoophytes and seaweeds freshly dredged from a depth of ten fathoms, off St. Aubin's Bay. In size and general contour it very nearly resembles the *V. microstoma* of stagnant pond water and infusions, but the transverse striæ are coarser and more conspicuous, and the body is much more retentive of its typical pyriform or urn-like shape. Multiplication by longitudinal fission, and the reattachment of the migrant zooid, as in the last-named form, was observed, the latter at the time of, and anterior to, its separation from the parent stalk, assuming, as shown at Pl. XXXIV. Fig. 16, a somewhat eccentric contour, the conical posterior extremity being as it were invaginated, or thrust into the central body-portion. In one example carefully followed, the migrant zooid occupied half an hour in wandering

about and selecting a site for the initiation of its independent sedentary life, another hour elapsing between this and its development of a pedicle and the disappearance and absorption of the posterior circlet of locomotive cilia. During its nomadic existence the animalcule expended a considerable interval in creeping, after the manner of a *Trichodina*, over the surface of the glass slide and algoid filaments with the aid of its flattened posterior extremity and associated wreath of cilia, and which for the nonce fulfilled all the essential purposes of the complex acetabuliform organ of the last-named genus. The species figured by Mereschkowsky in his 'Protozoa of Northern Russia,'* under the name of *Vorticella pyrum*, must be regarded as a local variety only of the present type. The examples there figured, as found attached to algæ and hydroid zoophytes in the White Sea, differ from the present form merely in the greater relative length of the pedicle, which equals three or four times that of the body; the contour of the body, together with its characteristic striation, is otherwise essentially identical.

Vorticella marina, Greeff.

PL. XXXV. FIGS. 1–8, AND PL. XLIX. FIG. 30.

Body conical, campanulate, tapering posteriorly, slightly constricted beneath the peristome, about one and a half times as long as broad; peristome-border thick, dilated and revolute, ciliary disc moderately elevated; cuticular surface distinctly and coarsely striate transversely; pedicle somewhat thick, four or five times the length of the body, contracting spirally. Length 1–375″.

HAB.—Salt water, scattered or in small social groups.

This species, described by Greeff,† has been obtained by the author both at Bognor, Sussex, in August 1872, and also attached to the algæ and zoophytes on the Jersey coast. From the *Vorticella striata* of Dujardin, which it to some extent resembles, it may be distinguished by the considerably more dilated and revolute character of the peristome-border. The conjugation of the more minute migrant zooids with the sedentary individuals forms the especial subject of Greeff's account of the species, and has been referred to in detail in the general account given on a preceding page of the reproductive phenomena of the genus *Vorticella*.

Vorticella quadrangularis, S. K.

PL. XXXIV. FIG. 34, AND PL. XLIX. FIG. 31.

Body attenuate, subcylindrical, three and a half times as long as broad, tapering posteriorly, with a projecting angle at within a short distance of both the anterior and posterior extremities, faintly striate transversely, slightly constricted beneath the peristome, ciliary disc projecting hemispherically above the border of the peristome; pedicle slender, comparatively short, about one and a half times longer than the body. Length of body 1–125″. HAB.—Pond water; social.

In proportion to its width, the present species represents the most attenuate representative of the genus yet recorded. The specimens from which the accompanying figures and description are derived were found growing on *Myriophyllum* in pond water derived from the neighbourhood of Stoke Newington, London, in September 1871.

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* 'Archiv für Mikroskopische Anatomie,' Dec. 1878.
† Wiegmann's 'Archiv für Naturgeschichte,' 1871.

Vorticella elongata, From.

PL. XXXV. FIG. 25 (?) and PL. XLIX. FIG. 32.

Body subcylindrical or elongate-conical, from two to three times as long as broad; the posterior extremity conically pointed; the anterior margin slightly expanded; peristome forming a conspicuously raised border round the somewhat elevated dome-like ciliary disc; cuticular surface transversely striate; pedicle stout, its relative length unrecorded, contracting spirally or in folds. Length 1–400″. HAB.—Fresh water.

An animalcule has been recently obtained by the author from pond water in the neighbourhood of St. Heliers, Jersey, that would appear to correspond with the *Vorticella elongata* of De Fromentel, but it is of somewhat larger size, varying from 1–300″ to 1–250″. Its habits are solitary, a few only, scattered at distant intervals, being found on each small fragment of *Conferva* examined. The pedicle was slender, and four or five times longer than the attenuately-conical and conspicuously striated body. Its internal muscular cord presented, in all instances, as shown at Pl. XXXV. Fig. 25, a finely granulate aspect, closely resembling, except for the absence of colour, that attributed by Ehrenberg to *Vorticella picta.* De Fromentel figures and describes a second animalcule under the title of *Vorticella multangula* which agrees so closely with *V. elongata* that the author cannot regard the two as otherwise than identical. This second species is associated by him with the title given in reference to the apparent zigzag course described by the muscular fibrilla within the pedicle, and which he reports as having been observed by him in but one other species, his *V. margaritata.* Such a disposition of the muscular fibre, correctly spiral, is common, however, to all the members of the genus, and is actually delineated by him in the majority of the species he describes, including even the present form.

Vorticella chlorostigma, Ehr. PL. XLIX. FIG. 33.

Body conical-campanulate, about twice as long as broad, the frontal margin considerably dilated; parenchyma green, densely granular; cuticular surface transversely annulate; pedicle thick, four or five times longer than the body. Length 1–240″. HAB.—Fresh water; social.

This species, excepting for its bright coloration, would appear to agree entirely in shape, size, and cuticular striation with *Vorticella convallaria;* it is reported by Ehrenberg as occurring abundantly in the neighbourhood of Berlin, where it is often found covering the stem of grasses and other submerged objects so densely as to present to the unassisted eye the appearance of bright green slime, resembling that formed by the still larger green Trumpet-animalcule, *Stentor viridis.* The *Vorticella fasciculata* of O. F. Müller is referred to by Ehrenberg as being possibly identical with this species. It forms similar dense green masses upon the surface of aquatic plants, but the separate zooids would appear to possess a shorter, broadly campanulate contour, which more closely corresponds with that of *V. citrina.*

Vorticella convallaria, Linn. PL. XLIX. FIG. 34.

Body conical-campanulate, about twice as long as broad, the frontal region dilated, slightly revolute; parenchyma whitish or hyaline; cuticular surface transversely annulate; pedicle rather thick, from three to six times the length of the body. HAB.—Stagnant water and infusions; social.

As previously mentioned, this species represents one of the first discovered infusorial forms, it being identical with the so-called "animalcules of the first size"

described by Leeuwenhoek in the 'Philosophical Transactions,' London, 1675, and which subsequently (*ib.* 1703) received from him the more distinctive title of Bell-like animals. Linnæus, in his 'Systema Naturæ,' 1758, embodies the same species under the name of *Hydra convallaria*, conferring upon it its generic title of *Vorticella* in ed. xii. of the same work published in the year 1767. By some authorities this species has been supposed to be synonymous with Ehrenberg's *Vorticella microstomum*. The dilated form of the frontal border in the present instance, however, as compared with the constricted contour of this region in the last-named species, precludes the serious entertainment of such a proposed identification.

Vorticella hamata, Ehr.

PL. XXXIV. FIG. 27, AND PL. XLIX. FIG. 35.

Body elongate-conical, somewhat gibbous, about twice as long as broad, constricted beneath the peristome-border and tapering towards the posterior extremity, obliquely set upon its pedicle, evenly and elongate pyriform when contracted; cuticular surface finely striate transversely; pedicle short, rarely exceeding twice the length of the body, usually less. Length 1–600″. HAB.—Fresh water; solitary or in small social groups.

This species, as figured and briefly described by Ehrenberg, would appear to accord more nearly with the *Vorticella inclinans* of O. F. Müller than the so-called *V. hamata* of that authority, which is apparently a free-swimming type allied to *Strombidium*. A form entirely agreeing with the Ehrenbergian species, as here figured and characterized in the foregoing diagnosis, has been met with on various occasions by the present author, and notably in company with *Vorticella alba* attached to *Chara* and confervoid growths obtained from an aquarium of some years' standing in the South Kensington Biological Laboratory, during the months of January and February 1880. The contour of this animalcule, with its rigidly extended pedicle and obliquely set, gibbously ovate body, corresponds in a remarkable manner with the spore-receptacle, theca or sporangium, of a *Hypnum* or other moss form.

Vorticella spectabilis, S. K.

PL. XXXIV. FIG. 35, AND PL. XLIX. FIG. 36.

Body plastic and somewhat variable in form, elongate-conical, widest anteriorly, tapering posteriorly, nearly three times as long as broad when fully extended, subspheroidal in its contracted state; the peristome dilated and widely everted; cuticular surface finely striate transversely; parenchyma coarsely granulate, lightish brown; pedicle short and stout, rarely exceeding two or three times the length of the body, more usually of the same length or even shorter. Length 1–150″. HAB.—Pond water; social.

This species has been obtained by the author on one occasion only, being then found, in June 1879, attached in social clusters to the leaves of duckweed, *Lemna minor*, taken from a roadside pond near Ashby-de-la-Zouch. While most closely approaching *Vorticella campanula* in the large size of the individual zooids, it is readily distinguished from that type by the more attenuate contour of the body, by its simple spheroidal and unpuckered outline in the contracted state, and by the very short comparative length of the pedicle. A distinctive character connected with this last-named element, that is well shown in permanently preserved examples, is afforded by the fact that in the majority of instances the central muscle-like fibrilla is not developed throughout the length of the pedicle, but from its junction with the animalcule's body to a point midway only between this and its

basal extremity. It might be predicted that the compound stock-form *Carchesium* has been developed from a simple Vorticellidan that exhibited a similar structural peculiarity.

** *Bodies broadly campanulate.*

Vorticella microscopica, From. PL. XLIX. FIG. 37.

Body conical-campanulate, its surface striate; peristome-border everted, constricted beneath, its diameter equalling the length of the body, vestibular seta moderately developed; pedicle slender, contracting spirally, five or six times longer than the body. Length 1–2000″. HAB.—Fresh water.

According to the description and figure given by De Fromentel,* this species closely resembles in shape his *V. fasciculata*, though the stem is shorter and thicker in proportion, and the surface of the body is described as striate, though it is not so figured in the accompanying illustration. The same writer hazards the opinion that the species is possibly identical with the *Vorticella picta* of Ehrenberg, though upon what grounds such an identity is premised it is difficult to conjecture.

Vorticella appuncta, From. PL. XLIX. FIG. 38.

Body broadly campanulate, widely everted anteriorly, nearly as wide as long; the ciliary disc elevated obliquely in a tongue-shaped form above the margin of the peristome; cuticular surface finely striate transversely; pedicle rather thick, its relative length unrecorded, enclosing numerous brilliant green corpuscles. Body when contracted globular, invaginate around or overlapping the insertion of the pedicle. Length 1–420″. HAB.—Fresh water.

The granular composition of the internal structure of the pedicle of this species finds its analogue in the *Vorticella picta* of Ehrenberg and in the apparent variety of *V. elongata* figured by the author at Pl. XXXV. Fig. 25.

Vorticella monilata, Tatem.

PL. XXXV. FIG. 27, AND PL. XLIX. FIG. 39.

Body broadly campanulate, widest and everted anteriorly; the peristome-border thick, often revolute, its diameter when fully expanded equalling or exceeding the length of the body; subspheroidal when contracted; pharyngeal cleft deeply prolonged; parenchyma transparent, colourless; the entire cuticular surface ornamented with hemispherical bead-like elevations, which are disposed in closely set annular series, those on the peristome-border of the largest size; pedicle stout, four or five times longer than the body; endoplast comparatively short, band-like. Length 1–400″ to 1–350″.

HAB.—Fresh water; forming small social colonies.

This species was first discovered by Mr. J. G. Tatem, who figured and described it under the above name in the 'Monthly Microscopical Journal' for April 1870 as a probable malformed or monstrous variety of *Vorticella convallaria*. Subsequently, 1876, De Fromentel has most imperfectly figured and described it in his 'Microzoaires,' in connection with the newly proposed title of *Vorticella margaritata*. By neither of these two writers, however, can full justice be said to have been done to the contour

* 'Études sur les Microzoaires,' 1876.

of the expanded body or to the ornamentation of the cuticular surface of this exceedingly elegant form, although of the two Mr. Tatem's delineations are by far the more characteristic and complete. According to this last-named authority, it is by no means an uncommon form, he having obtained it from various widely different localities. The present author has also had the good fortune to meet with this very distinct type on several occasions, receiving it first, in March 1874, growing upon *Myriophyllum* in company with *Epistylis grandis* and other animalcules, through Mr. Thomas Bolton, from the neighbourhood of Stourbridge, Worcestershire, and has more recently obtained it in the neighbourhood of Ashby-de-la-Zouch. From the notes and sketches made at these times, it is now found possible to fill up certain of the very extensive lacunæ left by its original describers. In the first place, the beading of the cuticular surface has been demonstrated by examination with a high magnifying power to be much more even, closely set, and generally distributed than is indicated by either Mr. Tatem or De Fromentel. The symmetrically annular disposition of these bead-like prominences, and their correspondence in that respect with the transverse cuticular striæ of various other species, is recognized by the former writer, but he has at the same time represented the separate beads as much more distinctly isolated from one another than is actually the case, while the elevated and in certain aspects dome-like ciliary disc is, in accordance with Mr. Tatem's drawing, entirely smooth and deficient in the ornamentation that distinguishes the remaining portion. The surface of the ciliary disc was found by the author to be similarly decorated, the hemispherical elevations being, indeed, of slightly larger size than on the walls of the body. This cuticular ornamentation, however, attains its most conspicuous development on the surface of the peristome-border, in which region the bead-like markings are quite twice the size of those of the subjacent area. When expanded to its full extent the peristome-border is everted and revolute to an extent apparently unobserved by its previous biographers, the contour of the body also assuming at such times a more elongate, conoidal outline. Between this conical shape and the perfectly spheroidal one assumed in its contracted state, every gradational contour may be exhibited. De Fromentel cites as a special character of this type the zig-zag, or more correctly spiral, disposition of the contractile muscular cord within the pedicle. This is, however, common to all *Vorticellæ*, but in this type, on account of its large size, is particularly prominent. For a similar reason, the continuation of this cord up the walls of the body as distinct fibrillæ is also clearly shown in this species. About six or eight zooids usually made up the colonies of this species as examined by the author; in most instances a conspicuous but comparatively short band-like endoplast was observed.

Supplementary Species.

The following Müllerian species are too insufficiently defined for inclusion among the preceding series, their original diagnoses being however here reproduced with a view to their possible rediscovery and more exhaustive description.

Vorticella cyathina, Müller, Pl. XLIX. Fig. 40.—Body crateriform, stalk spirally retractile. Hab. Salt water preserved in glass vessels.

The shape of the body of this species as figured by O. F. Müller,* coincides most nearly with that of *Vorticella campanula* or *V. nutans*. The average length of the pedicle is from three to four times that of the body.

Vorticella annularis, Müller. Pl. XXXIX. Figs. 27 and 28.—Body elongate-conical, the anterior margin truncate, the distal end of the footstalk alone retractile, this region thickened and smooth when extended, annulate when contracted. Hab. Fresh water, attached to *Planorbis* sp.

According to Müller's figures and description of this species, the separate zooids are of a very considerable size, being distinctly visible to the unaided eye, and measuring in length the 1–30th or even the 1–25th of an English inch. Excepting for their large size and the fact that each zooid in the colony he delineates is

* 'Zoologia Danica,' 1788.

attached to an independent pedicle, this type might have been identified with the immature condition of *Epistylis plicatilis*, with which it agrees both in habitat and in the apparent annulate character of the posterior extremity of the body—identified by Müller with the pedicle—in its contracted state. Should this species be rediscovered, it will probably be found desirable to refer it to the author's newly instituted genus, *Rhabdostyla*.

Vorticella hians, Müller, Pl. XLIX. Fig. 41.—Body elongate, pyriform or lemon-shaped, widest and inflated posteriorly, about twice as long as broad; pedicle very short, scarcely as long as the body. Hab. Long-standing vegetable infusions.

The above diagnosis and figure refer to what Müller designates var. β of *Vorticella hians*, which is alone figured, and appears to be the most distinct form. In more normal examples the pedicle equals three times the length of the body.

Genus VIII. CARCHESIUM, Ehrenberg.

Animalcules ovate or pyriform, alike in shape and size, resembling those of *Vorticella*, but united in social clusters, and forming compound dendritic colony-stocks or zoodendria through repeated longitudinal fission, accompanied by the regular or irregular branching of their flexible primary pedicle; the muscular fibre within the compound pedicle not continuous throughout, but interrupted at each bifurcation, so as to permit of the independent extension and contraction of the separate zooids. The species so far discovered mostly inhabit fresh water.

The compound colony-stocks of the genus *Carchesium*, in common with those of the genera *Zoothamnium*, *Epistylis*, and *Opercularia*, may be said to represent the sum total of the normal fissive process of an ordinary *Vorticella*, but in which the entire number of zooids so produced have, in place of becoming separately dispersed, remained permanently united by their respective pedicles. The non-continuity of the central muscular fibrilla, which permits the associated animalcules to contract separately or in limited numbers on their compound footstalk, serves to distinguish this genus from its nearest ally *Zoothamnium*.

Carchesium polypinum, Lin. sp.

Pl. XXXV. Figs. 30, 31, and 51, and Pl. XXXVI. Figs. 1–8.

Bodies conical-campanulate, somewhat gibbous, the anterior or peristomal border dilated, revolute; parenchyma transparent, colourless; cuticular surface smooth; compound pedicle or zoodendrium not articulate, subumbellate, consisting usually of an erect main rachis, from the summit of which subtend a greater or less number of horizontal or oblique, simple or ramifying branchlets which support the pedicellate animalcules, these more usually exhibiting a unilateral plan of disposition. Length of bodies 1–570″ to 1–430″.

Hab.—Mostly fresh, but sometimes salt water.

This species frequently occurs in ponds in such profusion as to form, as in the case of *Vorticella campanula* and *Epistylis grandis*, a conspicuous, bluish-white, mucilaginous film upon the surface of the water-plants or other objects to which it may be attached. While among the commonest, it is undoubtedly one of the most beautiful and luxuriantly growing representatives of the present family group, the branching tree-like colonies, resulting from the multiple fission of a single primary individual, often including as many as several hundred animalcules. Although

each separate zooid is able, through the isolation of the muscular fibre of its pedicle, to contract independently of its fellows, it more usually happens that a whole branch, or if much disturbed, the entire colony, as shown at Pl. XXXVI. Fig. 2, becomes drawn together into a spheroidal mass, the basal portion or main stem in this case assuming a spiral or closely adpressed zigzag contour. It is not to be wondered at that so prominent and widely distributed a species as *Carchesium polypinum* attracted the notice of the older investigators. It is included as one variety of the "Bell-like animalcule" described by Leeuwenhoek in the 'Philosophical Transactions' for 1703, and receives the respective names of *Sertularia polypina* and *Vorticella polypina* from Linnæus in the tenth and twelfth editions of his 'Systema Naturæ,' A.D. 1758 and 1767. Trembley,* again, accepting this type as akin to the fresh-water polype, with which his name is so eminently familiar, bestowed upon it the suggestive title of "*Polypes à bouquet.*" Both Ehrenberg and O. F. Müller report of this species that it is an inhabitant of both salt and fresh water, but the present author is induced to think that under the former conditions it has been confounded with the somewhat similar, and more essentially marine type *Zoothamnium arbuscula*. De Fromentel † represents the internal muscular fibrilla of the branching pedicle in this species as transversely striate and capable of contracting spirally within its outer sheath; this outer sheath is also delineated by him as exhibiting closely approximated transverse annulations. The somewhat similar interpretation of this structural element submitted by Mr. H. E. Forrest in the 'Midland Naturalist' for April 1879, is reproduced at Pl. XXXVI. Fig. 6. The author has on numerous occasions sought to corroborate this accredited striated aspect of the central contractile fibrilla as given by various writers in connection with *Carchesium* and other members of the Vorticellidan family, but in no instance with success. In place of this, as recorded in the preceding description of *Vorticella nebulifera*, see p. 674, the central muscular cord was found to be of apparent homogeneous consistence, but enclosed within a separable delicate hyaline membrane, a representation of such structural differentiation as observed in *Carchesium polypinum* being given at Fig. 3 of the accompanying woodcut. According to the most recent investigations of T. W. Engelmann,‡ the posterior or aboral circlet of cilia developed by the migrant zooids of this and other Vorticellidæ originates, as shown at Pl. XXXV. Figs. 30 and 31, from a distinct annular ectoplasmic band, having the appearance, under moderate magnification, of being simply obliquely striate, but which under more minute analysis is resolved into closely approximated rows of granules upon which the cilia are elevated. A diagrammatic outline of the oral and peristomal elements of the present species, typifying likewise the same structures as common to all representatives of the Vorticellidæ, as given by Greeff, is reproduced at Pl. XXXV. Fig. 51.

Carchesium spectabile, Ehr. Pl. XXXVI. Fig. 26.

Bodies broadly and evenly campanulate, dilated anteriorly, subspheroidal when contracted; zoodendrium two lines in height, forming an obliquely conical, or irregularly branching bush. Hab.—Fresh water.

The original illustration of this species, as given by Rösel,§ is herewith reproduced. The form next described, referred with doubt to this type by Claparède and Lachmann, is regarded by the author as possessing sound claims for separate specific recognition.

Carchesium Lachmanni, S. K. Pl. XXXVI. Fig. 21.

Bodies elongate-conical or thimble-shaped, truncate and not dilated anteriorly, pyriform and plicate anteriorly when contracted; cuticular surface finely striate transversely; endoplast curved, longitudinally disposed,

* 'Phil. Trans.,' 1744.
‡ Pflüger's 'Archiv Physiol.,' Bd. xxiii., 1880.
† 'Microzoaires,' 1876.
§ 'Insectenbelustigungen,' 1755.

presenting numerous sinuosities; compound pedicle or zoodendrium not articulate, branching in a subumbellate manner. Length of zooids 1–250″.

HAB.—Fresh or almost stagnant water.

The figure and diagnosis of this species, as given by Messrs. Claparède and Lachmann,* suffice to prove its distinctness from *Carchesium spectabile*, with which they originally proposed to identify it. The authors quoted met with it in abundance on the edges of the canal near the Place de l'Opéra, Berlin, the water of which is usually in a more or less fetid state. The individual animalcules, they report, are nearly twice the size of those of *C. polypinum*.

Carchesium epistylidis, C. & L. PL. XXXVI. FIGS. 12–14.

Bodies elongate-conical, abruptly narrowed near their point of juncture with the pedicle; the peristome-border slightly dilated, pyriform but not plicate when contracted; the cuticular surface smooth; zoodendrium branching subdichotomously, more or less distinctly articulate, such articulations usually occurring immediately beneath each bifurcation; endoplast band-like, curved, transversely disposed. Length of bodies 1–500″.

HAB.—Pond and river water.

This species is described by Claparède and Lachmann as manifesting in its general bearing the more rigid aspect of an *Epistylis* rather than that of a *Carchesium*, the independently contractile properties of the separate pedicles determining, however, its true position. The examples furnishing the original description of this type were found attached in small colonies of five or six animalcules only to the bodies and protective cases of the larvæ of Phryganidæ and other water insects. In the figure and description given by the authors quoted, the former being reproduced at Pl. XXXV. Fig. 12, some four or five zooids only are reported as being included in a single colony-stock. During the spring of the year 1879, the author, however, received from Mr. H. E. Forrest, of Birmingham, drawings and specimens of a species agreeing in all essential particulars with the present type, excepting that the colony-stocks usually supported a considerably larger quantity of animalcules—varying in number from eight or ten to as many as twenty or thirty—while the reported habitat differed to the extent that they were found attached to willow-roots, the polyzoaria of *Plumatella repens*, and other stationary objects. It was further observed that the surface of the branching pedicle or zoodendrium was usually more or less encrusted with a granular or flocculent deposit. In the original communication received respecting this form, Mr. Forrest indicated its distinctness from *Carchesium polypinum* in the following points:—"(1) In being more sluggish in its movements; (2) in the contours of the animalcules, which are comparatively narrower; (3) in the presence of brown flocculent matter covering the surface of the pedicle (this possibly accidental); (4) in the distinct division of the pedicle at intervals by transverse septa, which usually occurs just below the point of dichotomy." It was at first anticipated by the author that this very distinct form was probably identical with the little known *Carchesium spectabile* previously described, but a subsequent reference to the original delineation of that type, as given by Rösel, here reproduced, has not supported such identification. A more careful analysis of its leading characteristics has since elicited its entire correspondence, excepting for its more luxuriant form of growth and non-parasitic habitat, with the *C. epistylidis* of Claparède and Lachmann, and it is therefore here accepted as a local and prolific variety only of that form. As all ecto- and endo-parasitic and commensal species may be held to have originally led an independent existence, it might be reasonably predicated that the present luxuriant and independent growth-form represents the more normal and primitive expression of

* 'Études sur les Infusoires,' 1868.

the type now under consideration. The illustrations given at Figs. 13 and 14 of the accompanying plate, are reproduced from drawings of the species remitted by Mr. Forrest, who obtained it in some abundance both in the river Avon, near Evesham, and from the neighbourhood of Birmingham. Anticipating that the form might be new to science, Mr. Forrest originally proposed to confer upon it the distinctive title of *Carchesium septatum*.

Carchesium aselli, Engelmann. PL. XXXVI. FIG. 10.

Bodies elongate, subcylindrical, slightly constricted beneath the peristome, about twice as long as broad; peristome-border turgid, not dilated; ciliary disc raised but slightly above its margin; vestibular cleft continued but a short way backwards; cuticular surface smooth; contractile vesicle close to the peristome-border; endoplast band-like, curved; zoodendrium stout, branching at short intervals, not annulate or striate, largest colonies including about twelve animalcules, usually two or four only. Length of bodies 1–250″. HAB.—Fresh water, on *Asellus aquaticus*.

Supplementary Species.

The minute *Carchesium pygmæum* of Ehrenberg, with animalcules that do not exceed the 1–2400″ in their greatest length, is evidently a Flagellate form, whose exact identity cannot be predicated, but is apparently referable to one of the two genera *Anthophysa* or *Codosiga*.

GENUS IX. ZOOTHAMNIUM, Ehrenberg.

Animalcules structurally identical with those of *Vorticella*, ovate, pyriform or globular, often dissimilar in shape and of two sizes, stationed at the extremities of a branching, highly contractile pedicle or zoodendrium; internal muscle of pedicle continuous throughout, not disconnected as in *Carchesium*. Inhabiting both salt and fresh water.

As originally instituted by Ehrenberg, this genus was distinguished from *Carchesium* merely on account of its bearing zooids of two forms and sizes on the same tree-like colony. This character has, however, been found too uncertain for retention, and has given way to the more substantial one, first pointed out by Stein, having reference to the continuity throughout the branching pedicle of the contained contractile muscular fibre. This last-named structural feature confers upon the aggregated communities of this genus, as observed in the living state, a modification of comportment that readily distinguishes them from those of *Carchesium*; for while in that genus each animalcule, having a separate contractile pedicle, is able to extend itself and contract independently, the movements of the whole community in the case of *Zoothamnium* are affected by that of a single unit, and one contracting all the others follow suit. An additional feature distinctive of the genus *Zoothamnium* is afforded by the position occupied by the contractile fibre with relation to its hyaline investing sheath. In both *Vorticella* and *Carchesium* this contractile cord exhibits a spiral, or optically a zigzag, disposition within its sheath, such circumstance accounting for the elegant spiral form assumed by the structure as a whole when contracted. In *Zoothamnium*, on the other hand, there is no such spiral disposition, the contractile cord being axial and straight throughout: the pedicle in its contracted state, as a necessary sequence, may present a plicate but never a symmetrical spiral flexure. Examined with a high magnifying power, the central cord in this genus, as first observed by Ehrenberg, displays a faintly longitudinal striate aspect, and is pronounced by Claparède and Lachmann, and more

recently by Greeff, to be composed of distinct but closely approximated muscular fibrillæ.

The numerous species of the genus *Zoothamnium* may, for the purposes of diagnosis, be conveniently separated into two groups, *a* and *b*, that shall include respectively those in which the zooids of the same colony-stock resemble or differ from each other in shape or size. In the polymorphic series the usually fewer and larger zooids developed become separated from their pedicles, and after a short migratory existence reattach themselves and lay the foundation of new colonies.

A.—Zooids Polymorphic.

Zoothamnium arbuscula, Ehr. Pl. XXXVII. Figs. 1–8 and 25.

Bodies of two shapes and sizes, mostly conical-campanulate, others spherical, grouped on a compound pedicle or zoodendrium which consists of an upright main rachis, from the summit of which divaricate horizontally or obliquely a greater or less number of attenuate, more or less dividing secondary branches; the more abundant and smaller campanulate zooids thickly distributed upon these secondary ramifications, interspersed here and there, mostly at the axillæ, with the larger, comparatively rare, spheroidal animalcules; main rachis very thick, highly elastic, contracting in a zigzag form. Length of the ordinary zooids 1–430″, height of the entire zoodendrium 1–4″. Hab.—Fresh and salt water.

The colonies of this species often occur in such abundance on the front glasses of the tanks of marine aquaria as to obscure clear vision, constant and considerable labour being necessitated in their removal. Examined separately, each colony-stock may be compared to a minute crystalline standard fruit-tree, of which the ordinary campanulate zooids may be likened to the leaves and the spheroidal or reproductive units to the fruit. Except for the presence of the larger reproductive zooids, these tree-like zoodendria bear no inconsiderable resemblance to those of *Carchesium polypinum*, such similarity probably giving rise to the circumstance of the last-named species being accredited by some authorities with both a salt- and fresh-water habitat. That *Zoothamnium arbuscula* flourishes indifferently in both these media is at the same time a well-authenticated fact, both salt- and fresh-water examples having been recently remitted to the author by Mr. Thomas Bolton. The representation of the contractile pedicle, given at Pl. XXXVII. Fig. 25, is derived from the delineations of the species given by Mr. H. E. Forrest in the 'Midland Naturalist' for May 1879. While succeeding in detecting an obscure longitudinal striation of the central muscular fibre, the author has been unable to define the existence of transverse striæ as depicted in this figure, neither does such a differentiation of this element appear to have been recognized by any other investigator. The developmental phenomena of the larger spheroidal zooids, also reproduced from Mr. Forrest's drawings, in Figs. 6 and 7 of the same plate, accord with those hereafter described of *Zoothamnium alternans*.

Zoothamnium niveum, Ehr. Pl. XXXVII. Figs. 13 and 14.

Bodies of two sizes, the majority elongate-campanulate; main stem of the pedicle prolonged, sinuous or spiral, giving off short alternate or almost verticillate branches, the spherical zooids of large size, situated near the bases of the primary branches. Length of the ordinary zooids 1–210″.

Hab.—Salt water.

The *Zoothamnium plumosum* of Dr. Strethill Wright,* and also the *Zoothamnium spirale* of Mr. P. H. Gosse† must be regarded as identical with this form. The lower branches are frequently entirely bare, the animalcules apparently dying off as the zoodendrium becomes distally extended, while the upper portion, bending under the weight of the living zooids, assumes an ostrich-plume-like aspect. The delineation of this species, given in the accompanying plate, is derived from an example dredged—attached to a Sertularian zoophyte—from a depth of fifty fathoms, off the coast of Falmouth in July 1879, representing one of the several interesting infusorial types obtained by the author in connection with the summer excursion of the Birmingham Natural History Society. As first figured and described by the author in the 'Midland Naturalist' for March 1880, this form was included as a variety only of *Zoothamnium alternans*. A further acquaintance with the more important modifications of the last-named species has, however, determined the recognition of *Z. niveum* as a distinct type.

Zoothamnium alternans, C. & L.

PL. XXXVI. FIGS. 22 AND 23, AND PL. XXXVII. FIGS. 20–24.

Bodies of various sizes, mostly subpyriform or fig-shaped, a few of the larger ones spheroidal; peristome thick, widely everted, its front border in contracted examples puckered or plicate; cuticular surface finely striate transversely; zoodendrium consisting of an erect and basally very thick main rachis, from which are given off, at sometimes opposite but mostly alternate intervals, a greater or less number of but rarely subdivided primary branches, upon which are borne at evenly separated intervals the smaller and larger pyriform zooids, the still larger sized spheroidal zooids situated usually at the axes or junctures of the branches with the main stem; the external surface of the compound pedicle finely striate or annulate throughout. Length of smallest pyriform zooids 1–555″ to 1–425″, of the largest pyriform and subspheroidal zooids 1–200″.

HAB.—Salt water.

This species, while first discovered by Messrs. Claparède and Lachmann on the Norwegian coast, was also met with by Greeff at Ostend, and has been frequently obtained by the author, both in the Channel Islands and on the Devonshire coast, attached to sea-weeds and to the polyparies of *Sertularia* and other littoral Hydrozoa. It has been previously mentioned that the dendritic colonies of *Zoothamnium arbuscula* present in their general mode of growth a fanciful resemblance to a symmetrically grown standard fruit-tree; adopting a like simile in the present instance, *Z. alternans*, in its most luxuriantly developed state, may be compared to a carefully trained espalier. Examples taken from widely separated or even contiguous localities exhibit nevertheless a considerable latitude of variation, in some the side branches being much longer than in others, while the zooids attached to these branches are as often oppositely as alternately disposed. The chief illustration given of this species, Pl. XXXVII. Fig. 20, reproduced from Greeff,‡ represents an example in which the branches are very long, and the former formula of arrangement predominates, while at Fig. 21 is a colony, from the author's sketch-book, in which the branches themselves are reduced to their minimum, and represented by one or at the most only two zooids; between these two extremes every gradation of development may be found. The striation of the cuticular surface of the zooids, as also the annulation of the branching pedicle, is likewise subject to individual variation, being

* Pritchard's 'Infusoria,' p. 595, 1860. † 'Tenby,' pl. iv. fig. *b*, 1856.

‡ "Untersuchungen über die Naturgeschichte der Vorticellen," 'Wiegmann's Archiv,' xxxvii. 1871.

strongly marked in some instances and scarcely visible in others. In the two colonies only of this species examined by Claparède and Lachmann, and in most of those observed by the author, these striæ and annulations were very conspicuous; while in those figured by Greeff the zooids are represented as perfectly smooth, while the annulations of the branching pedicle are very few and far between. As explained by its original discoverers, the somewhat abnormal alternate divarication of the lateral branches, and more usually similar disposition of the zooids upon these branches, are produced by the unequal growth of the two animalcules which result from the primary process of longitudinal fission; while one of these remains stationary or produces but a short pedicle, the other passes on and after a short interval repeats the process of subdivision.

It is upon the larger spheroidal zooids, as first intimated by Ehrenberg with regard to the similar individuals in *Z. arbuscula*, that devolves the mission of becoming detached and laying the foundation of future colonies. These larger animalcules are at first similar in shape and size to the smaller pyriform units, but taking no share in the further extension of the branching pedicle, increase greatly in size, retaining for a time their pyriform outline, and ultimately assuming their characteristic spheroidal contour. This last-named stage arrived at, a circlet of cilia is developed posteriorly, as in the migrant zooids of *Vorticella*, and the animalcule shortly becomes detached from the parent stalk and wanders away in search of a suitable site for reattachment. The abnormal thickness of the basal portion of the branching pedicle in both *Zoothamnium arbuscula* and the present species is explained by the light of these developmental phenomena, its greater calibre being the natural product of a zooid of so much greater a relative size than those which contribute to its further prolongation. The development by these spheroidal animalcules of the posterior ciliary circlet, or their detachment from the parent stock, as observed by the author, and in part by Claparède and Lachmann, does not appear to have been seen by Greeff.

Very recently, September 1880, the author has received through Mr. Thomas Bolton, from the Aston Aquarium, examples of this species among which were scattered one or two colony-stocks that bore supplementary zooids of an altogether abnormal size and contour; these, as shown at Pl. XXXVI. Figs. 22 *a a* and 23, equalled in length the ordinary pyriform zooids, but were very slender—five or six times as long as broad—while their cuticular surface was relatively coarsely annulate. It is anticipated by the author that these attenuated zooids represent male units destined to compass genetic union with the large subspheroidal and subsequently detached animalcule of the normal colony-stocks. Phenomena substantiating this anticipation have yet to be recorded; even should this not be forthcoming, *Zoothamnium alternans* will afford one of the most remarkable known instances of polymorphism among the Infusoria, in no other type being there three distinctly differentiated zooidal forms.

Zoothamnium Cienkowskii, Wrz. Pl. XXXVII. Fig. 15.

Animalcules of two sizes, but similar in shape, campanulate, attenuate posteriorly; cuticular surface smooth; peristome-border thick, widely dilated; ciliary disc slightly elevated, the cilia surrounding it very long and fine; pedicle massive, dichotomously branched, supporting but few zooids, at most seven or eight, but more usually only two or four, the basal portion of the pedicle thickest, smooth, or finely striate longitudinally, the remaining portion from the commencement of the branches transversely wrinkled; the main rachis slightly exceeding in height the length of the larger zooids, the primary branches shorter than the secondary ones; contractile vesicle of extraordinary size; endoplast band-like, curved, transversely placed. Length of smaller zooids 1–665″, of larger ones 1–500″. Hab.—Salt water.

This species as described by Wrzesniowski* is distinguished by the varied character of the pedicle in its basal and distal regions, and by the abnormal size of the contractile vesicle. This latter structure attains its fullest development in the more abundant smaller zooids, and in which at full diastole it is of such large proportions as to fill not only the ciliary disc, but to invade a large area of the parenchyma beneath the peristome-border and in the neighbourhood of the pharynx. The contractile fibrilla in this species commences a little beneath the junction of the smooth basal with the wrinkled branching region of the pedicle, the entire colony-stock in its state of contraction bending down obliquely from this point. The examples supplying the type of this species were discovered by Wrzesniowski attached to drifted seaweeds (*Florideæ*) at Rugen in the Baltic.

Zoothamnium dichotomum, Wright. Pl. XXXVII. Figs. 9–12.

"Stem very regularly dichotomous; pedicles long; zooids cylindrical, resembling the fruit of the *Rosa canina*."

The above brief diagnosis is simply reproduced as it appears in Pritchard's 'Infusoria,' no dimensions or habitat that might assist towards the establishment of its identity being furnished. The examples figured at Pl. XXXVII. Figs. 9–12, as presumably identical with the above-named species originally discovered by Dr. Strethill Wright, were collected by the author in July 1879, off the coast of Falmouth, being dredged in company with *Zoothamnium spirale* from a depth of about fifty fathoms. The colony-stocks thus obtained differed, however, from those examined by Dr. Wright in the circumstance that zooids of two shapes and sizes were developed on the dichotomously branching zoodendria. The majority and smaller of these were simply campanulate, while it was only the few larger reproductive units, produced mostly toward the bases of the branches, either singly or in clusters of two or three, that coincided by reason of their ovate shape with the foregoing diagnosis. As some few examples were met with in which while all the ordinary campanulate animalcules had become detached, the larger ovate zooids remained *in situ*, it would seem highly probable that the specimens upon which Dr. Wright framed his brief description were similarly imperfect. It was observed of the Falmouth specimens that while the normal campanulate zooids were, under a magnification of two hundred diameters, perfectly smooth, the cuticular surface of the larger ovate ones was very distinctly striate in a transverse direction.

B.—Zooids Similar in Shape and Size—Homomorphic.

Zoothamnium gleniscum, C. & L. Pl. XXXVI. Figs. 24 and 25.

Animalcules pyriform, similar in shape and size, disposed alternately on the parent branch; their cuticular surface smooth; pedicle finely striate transversely, usually articulate at intervals about midway between each subdivision. Dimensions unrecorded.

Hab.—Salt water, North Sea (C. & L.).

This species is described by Claparède and Lachmann as closely resembling *Zoothamnium alternans*, from which, however, it is to be distinguished by the more slender articulate pedicle. The zooids are, moreover, estimated to be twice as large as those of the last-mentioned variety, although their exact dimensions were not recorded. The articulations of the pedicle do not correspond with each bifurcation of the stem as in the *Carchesium epistylidis* of the same authors, which it also closely resembles, but one or more joints intervene between each such subdivision.

* 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xxix., 1877.

Zoothamnium affine, Stein. Pl. XXXVI. Fig. 16.

Bodies of animalcules ovate, twice as long as broad, somewhat contracted posteriorly, truncate in front, and surmounted by a thick tumid peristome of rather less diameter than that of the centre of the body; cuticular surface smooth; pedicle very thick, dividing dichotomously, the branches often attaining a nearly equal degree of elevation, but the general contour varying considerably in different colonies; surface of the pedicle smooth during extension, but transversely plicate in the contracted state; endoplast semicircular, band-like, lying transversely with the axis of the body; no secondary spherical zooids. Length of individual 1–380″ to 1–270″. Hab.—Fresh water, on aquatic insects and Entomostraca.

The relatively abnormal thickness of the pedicle of this species serves to distinguish it readily from most other known forms; while this structure is described in its diagnosis as being perfectly smooth except in its contracted conditions, the figures given by Stein, here reproduced, represent it with equally conspicuous transverse plicæ in both its extended and contracted states. The author has recently, February 1879, met with small colonies of this animalcule attached to the Amphipod *Gammarus pulex* taken from a running stream among *Callitricha*, in the neighbourhood of St. Heliers, Jersey. In no instance were more than four zooids attached to a single zoodendrium, while the greatest height of the latter structure was less than that of the extended bodies.

Zoothamnium parasita, Stein. Pl. XXXVII. Fig. 16.

Animalcules minute, ovato-fusiform, tapering posteriorly, scarcely one and a half times as long as broad; peristome-border thick, narrower than the centre of the body; ciliary disk slightly elevated; cuticular surface smooth; a few, usually two, zooids only supported upon a short, smooth, and comparatively slender, dichotomously dividing pedicle, whose entire height does not equal that of a single zooid. Length of bodies 1–350″.

Hab.—Fresh water, on *Cyclops quadricornis* and other Entomostraca.

The form referred to this species by D'Udekem * and found on *Asellus aquaticus*, would seem to be more correctly referable to the species last described. The bodies of the zooids are comparatively larger and the pedicle thicker and more corrugate than is reported by Stein of the present type.

Zoothamnium nutans, C. & L. Pl. XXXVI. Figs. 9 and 15.

Animalcules few in number, one or two zooids only associated in a single colony-stock, campanulate, slightly gibbous, attached obliquely to a long, smooth, slender and articulate pedicle; peristome-border widely dilated; surface of the cuticle finely and obliquely striate; pedicle contracting in a zigzag and not a spiral manner. Length of zooids 1–350″.

Hab.—Salt water: Bergen (C. & L.).

Zoothamnium aselli, C. & L.

Animalcules elongate, subcylindrical, three times as long as broad, attenuate posteriorly, attached in numbers to a very thick, smooth, inarticu-

* 'Infusoires de la Belgique,' 1864.

late, dichotomously branching pedicle; endoplast small, oval. Dimensions of individual zooids unrecorded. Height of entire colony-stock 2 lines Fr.

HAB.—Fresh water: on *Asellus aquaticus* and various aquatic insects and Crustacea.

M. Claparède, in describing this species from the drawings only of M. Lachmann, remarks upon the very robust aspect of the animalcules, the outer cuticle being more indurated than in any other known representative of the genus. In this last respect, and also in the shape of the zooids, it is recognized by him as presenting some resemblance to *Epistylis plicatilis*. It would seem to be by no means improbable that the *Carchesium aselli*, subsequently described by T. W. Engelmann, is identical with this form.

Zoothamnium elegans, D'Udk.

Bodies subpyriform, slightly gibbous; the peristomal border widely dilated, tapering and attenuate posteriorly; pedicle slender, smooth, and transparent, neither striate nor articulate, sparsely branching at its distal extremity, supporting but a small number of zooids, which occupy a closely approximate altitude; ciliary disc projecting conspicuously beyond the peristome-border; pharyngeal cleft distinct, extending backwards beyond the centre of the body; endoplast ribbon-shaped, curved; contractile vesicle situated close to the entrance of the vestibulum. Length of bodies 1–300″. HAB.—Salt and fresh water: Ostend (D'Udk).

The occurrence of *Amphileptus meleagris* as a devouring parasite of the colonies of this species, as first observed by Claparède and Lachmann, in association with *Epistylis plicatilis* and *Carchesium polypinum*, was frequently observed by D'Udekem, and receives attention in the description given of the above-named Holotrichous animalcule.

Zoothamnium macrostylum, D'Udk. PL. XXXIX. FIG. 30.

Bodies elliptical or subcylindrical, about twice as long as broad, equally rounded at the two extremities; cuticular surface smooth, colony usually consisting of two animalcules only, seated on a short, very massive, slightly contractile, and longitudinally striate pedicle, whose height does not equal that of the bodies of the zooids; vibratile disc projecting but little beyond the front border of the peristome; endoplast rounded. Dimensions unrecorded. HAB.—Fresh water, on *Asellus fluviatilis*.

This species would appear to closely resemble the *Opercularia Lichtensteinii* of Stein.

Zoothamnium pictum, From.

Animalcules few in number, subspherical, smooth, hyaline, attached by long pedicles to the slender main rachis, each zooid enclosing posteriorly two green corpuscles. Length of bodies 1–1600″. HAB.—Fresh water.

This form is so insufficiently described and figured by De Fromentel as to be difficult to identify as a genuine *Zoothamnium*. While referring it to this genus its describer hazards a doubt whether or not it is referable to the *Vorticella picta* of Ehrenberg, he having likewise a short while previously expressed uncertainty concerning the identity of his newly introduced *Vorticella microscopica* with the

same Ehrenbergian species, both of which possess a broadly campanulated contour altogether distinct from the present type. Only two animalcules constitute the colony-stock of this species as figured by De Fromentel, their aspect corresponding most nearly with that of two abnormally united *Vorticellæ*.

Zoothamnium marinum, Mereschk. Pl. XXXVI. Fig. 11.

Bodies conical, campanulate, somewhat gibbous, pyriform and evenly puckered anteriorly when contracted; the peristome-border dilated and obliquely truncate; the ciliary disc moderately elevated; pharyngeal cleft conspicuously developed; cuticular surface entirely smooth; parenchyma finely granulate; endoplast ovate, minute; pedicle neither striate nor articulate, branching in a perfectly even dichotomous manner, supporting from four to eight or twelve animalcules only. Length of bodies (in spirit) 1–240″.

Hab.—Salt water: White Sea (Mereschkowsky), attached to seaweeds and zoophytes at depths of from 5 to 12 fathoms.

A species apparently allied to, if not identical with, this type has been obtained by the author at St. Heliers, Jersey, attached to the carapace and setose appendages of the common shore-crab *Carcinus mænas*, and will be found figured at Pl. XXXVII. Figs. 17–20, in connection with the provisional title of *Zoothamnium carcini*.

Zoothamnium simplex, S. K. Pl. XXXVI. Figs. 17–20.

Bodies when extended elongate-conical, the anterior border widest, tapering gradually thence to the attenuate posterior extremity, from three to four times as long as broad; pyriform when contracted; stationed in a single cluster of seldom more than half a dozen zooids at the extremity of a simple, unbranched, rarely and slowly contracting pedicle, whose altitude equals about twice the length of an extended zooid; ciliary disc moderately elevated above the peristome-border; cuticular surface smooth, finely granular; endoplast elongate, attenuate, longitudinally placed. Length of extended bodies 1–300″. Hab.—Pond water.

This species was obtained by the author in November 1880, attached in some abundance to the leaves of *Myriophyllum* and other aquatic plants growing in a fresh-water aquarium, its original derivation being uncertain. The disposition of the animalcules in a single group at the extremity of a simple pedicle distinguishes it conspicuously from all known representatives of the genus, the elongate contour of the bodies, at the same time, while differing from all members of the allied genera *Zoothamnium* and *Carchesium*, closely resemble those of *Epistylis plicatilis*. The pedicle, as in *Carchesium epistylidis*, is remarkable for its rare and sluggish contraction. In one instance, as represented at Pl. XXXVI. Fig. 20, the conjugation of a minute migrant and normal sized sedendary zooid was observed.

Genus X. EPISTYLIS, Ehrenberg.

Animalcules campanulate, ovate or pyriform, corresponding structurally with those of *Vorticella*, attached in numbers to a rigid, uncontractile, more or less branching, tree-like pedicle or zoodendrium; the zooids usually of similar size and shape. Inhabiting salt and fresh water.

Epistylis galea, Ehr. Pl. XXXIX. Fig. 6.

Bodies elongate-conical, about three times as long as broad, attenuate posteriorly, the frontal margin dilated; cuticular surface smooth and plastic, exhibiting transverse folds posteriorly when contracted; vestibular entrance prominent, projecting laterally in a spout-like manner; zoodendrium relatively short, thick, profusely and dichotomously branched; secondary branches not exceeding the zooids in length, articulate at each bifurcation. Length of bodies 1–120″; height of entire colony 1–24″.

Hab.—Fresh water, on *Ceratophyllum* and other water-plants.

In its general mode of growth the branching pedicle of this species accords most nearly with that of *Epistylis digitalis*, but is readily distinguished from that type by its simply articulate ornamentation; the contour of the supported zooids at the same time somewhat resembles that of *Epistylis plicatilis*, a similar transverse plication of the posterior region of the body being furthermore exhibited during contraction.

Epistylis anastatica, Linn. sp. Pl. XXXVIII. Figs. 19–22.

Bodies in extension conical-campanulate, nearly three times as long as broad, attenuate posteriorly, the frontal margin dilated, spheroidal or ovate, with a snout-like projection when contracted; cuticular surface smooth, or finely striate transversely; the ciliary disc raised above the border of the peristome in a tongue-like form; pedicle moderately thick, entirely smooth, neither striate nor articulate, often squamose through the adherence of other minute parasitic forms, branching profusely and dichotomously, secondary branches attenuate, equal to or exceeding the length of the zooids. Length of bodies 1–280″; height of entire colony 1–15″. Hab.—Fresh water, on Entomostraca and aquatic plants.

The entirely smooth pedicle and more attenuate character of the secondary branches, as well as the considerably smaller size of the zooids, distinguishes this species from the preceding; this same character of the pedicle, added to the greater dilation of the peristome-border, separates it also from *E. digitalis*, in whose company it not unfrequently occurs. In examples recently examined the author has detected the presence of fine transverse striæ upon the cuticular surface, though these are not so conspicuous as to be generally observable. Ehrenberg remarks that the branching pedicle of the colonies found growing on water-plants is usually more attenuate than when attached to *Cyclops quadricornis* or other animal hosts. By Linnæus,* as also by O. F. Müller, this species is described under the title of *Vorticella anastatica.*

Epistylis plicatilis, Ehr.

Pl. XXXVIII. Figs. 6–8, and Pl. XXXIX. Figs. 12–15.

Bodies elongate-conical, attenuate posteriorly, three or four times as long as broad; cuticular surface soft and flexible, plicate, or exhibiting several annular folds posteriorly when contracted; the frontal margin dilated; the ciliary disc much elevated; pedicle slender, finely striate longitudinally, profusely and dichotomously branched, often corymbose, the secondary

* 'Systema Naturæ,' Ed. xii., 1767.

branches attenuate, three or four times longer than the extended bodies, the thicker and undivided basal portion comparatively short. Length of zooids 1–280″ to 1–145″; height of entire colony 1–9″.

HAB.—Fresh water, attached to the shells of Mollusca, *Limnæus stagnalis*, and various water-plants.

This species may be easily recognized by the characteristic plicate or folded contour of the posterior extremity of the zooids at the time of contraction, and by the great relative length of the secondary divisions of the pedicle. The conjugation of neighbouring animalcules of this species and the development from the endoplast of ciliate embryos has been observed by Claparède and Lachmann; illustrations of the last-named phenomenon, reproduced from their drawings, are given at Pl. XXXIX. Figs. 12–15. The branching pedicle or zoodendrium of *Epistylis plicatilis* frequently gives support to colonies of a minute collared flagellate type apparently identical with *Monosiga Steinii*. These may either completely encrust it with their aggregated numbers or be distributed in isolated or scattered groups, as shown at *a a* in Pl. XXXVIII. Fig. 6.

Epistylis flavicans, Ehr.

PL. XXXV. FIGS. 48–50, AND PL. XXXVIII. FIGS. 1–5.

Bodies in extension broadly campanulate, soft and flexible, widely dilated anteriorly, subspherical when concentrated; parenchyma usually of a yellowish hue; cuticular surface very finely striate transversely; peristome-border not thickened, much revolute, the ciliary wreath bearing five or six convolutions of long, powerful cilia; pedicle exhibiting two leading modifications: in its younger and more robust phase dendriform, slender, erect, profusely and dichotomously branching, the ultimate ramifications short, not half the length of the zooids, widely divergent; the older colonies decumbent, the pedicle weak and straggling, rarely branching. Length of zooids 1–192″ to 1–70″. HAB.—Fresh water, on aquatic plants.

Under the title of *Epistylis flavicans* is here included the *E. flavicans* and *E. grandis* of C. G. Ehrenberg. Both Stein and Claparède and Lachmann expressed doubts concerning the specific independence of these types, and Professor Wrzesniowski, with whom the author's investigations in this same direction accord, has recently * brought forward conclusive evidence in demonstration of their identity. As shown by this last-named authority, the type described by Ehrenberg under the title of *E. flavicans* represents the earlier, erect, and more robust growth of the animalcules, which in later generations lose their power of secreting a rigid stalk, become larger and more turgid, and falling down develop a more or less matted, horizontal layer of lax, thread-like, rarely dividing filaments, presenting under such conditions all the characteristics of Ehrenberg's *Epistylis grandis*. Data of the highest interest have been recorded by Greeff† respecting the reproductive phenomena of this species. By him, certain members of the erect colonies were observed to become divided by fission into two, four, and ultimately into rosette-like groups of eight minute, pyriform zooids, which developing respectively a posterior circlet of cilia, were liberated into the surrounding water. These minute liberated zooids were further observed to effect a junction, or to coalesce, with the ordinary attached animalcules, fixing themselves to their sides, and penetrating into the substance of

* 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xxix., 1877.
† 'Archiv für Naturgeschichte,' 1870.

their parenchyma after the manner of conjugating *Vorticellæ*. At Pl. XXXVIII. Fig. 1, Greeff's admirable illustration of a colony of this species is reproduced, showing the various stages of development of the rosette-shaped clusters, and the conjugation of the detached units with the normal zooids. This same authority reports having observed, scattered beneath the cuticular layer of *E. flavicans*, minute ovate capsular bodies (Pl. XXXVIII. Figs. 4 and 5) that contain an extensile filament, and closely corresponding in structure with the thread-cells, or nematocysts, of the Cœlenterata. Such structures have not been detected in connection with this species by any other observer, and the irregularity of their distribution as figured by Greeff inclines the author to regard them, as in the case of *Polykrikos*, as of adventitious origin. Two peculiarities pertain to the pedicle of the normal or erect type of this species that serve to distinguish it from any other known representative of the genus. In the first place, between the joints, which are solid, the structure is hollow throughout, like the culm of a grass; while secondly, these joints are tumid, and each limb of the accompanying bifurcation exhibits towards its base a more or less conspicuous lyrate or coarctate curvature. As with various other species of *Epistylis*, this branching pedicle is frequently found incrusted with minute Flagellate and other infusorial types. Greeff figures as growing upon examples examined by him, a species evidently identical with Stein's *Salpingœca convallaria*, while upon the same host the author has frequently observed a species of *Monosiga* and extensive colonies of the minute Acinete form *Podophrya carchesii*.

The soft-stemmed recumbent variety of this species, synonymous with the *Epistylis grandis* of Ehrenberg, and which may be appropriately distinguished by the title of *E. flavicans* var. *decumbens*, is perhaps better known and apparently more plentifully distributed than the upright form, in consequence of the great extent of the colony-masses it produces. These often constitute prominent objects to the unassisted vision, taking the form of a white, granular slime, which may completely cover the roots and leaves of water-plants, or spread like a grey felty mass over the side walls of the tanks of an aquarium. The bodies of this recumbent variety attain a considerably larger size than those found in the stiff-stemmed examples, and are usually of a brownish hue, and exceedingly granular and opaque; their substance is also more soft and plastic, permitting the animalcules to assume a great variety of plicate and variously distorted contours. No member of the family of the Vorticellidæ probably possesses so powerful and voluminous an adoral fringe of cilia as appertains to the present species. It is represented by Wrzesniowski as forming four and a half convolutions only; the author, has, however, ascertained that there are no less than five and a half or six turns to the spire. This was clearly demonstrated in examples isolated for some time in a damp chamber; the zooids at the end of two days became detached from their supporting pedicles, assumed a subglobose form, and shed all their cilia, presenting then the aspect shown at Pl. XXXVIII. Fig. 3, in which the convolution of this structure was most clearly exhibited. The detached cilia remained scattered around them for a considerable interval, but ultimately disintegrated. The under surface of dead leaves fallen into the water, as also the roots and leaves of water-lilies, *Nymphæa* and *Nuphar*, are always a favourite haunt of this attractive species. As evidence of its longevity it may be mentioned that colony-stocks cultivated by the author in an aquarium have lasted for a period of no less than six months, dating from November 1880 to June 1881, becoming metamorphosed within that period from erect tree-like colonies of two, four, or eight animalcules only, to sessile masses equalling or exceeding the size of hazel-nuts. It was further noted in connection with these colonies that examples isolated for examination in a zoophyte-trough abandoned, within a few hours, their compact and erect mode of growth for the lax and attenuate formula characteristic of the variety *decumbens*. The brief absence of their customary food-supply was apparently quite sufficient to bring about the recorded metamorphosis.

Epistylis digitalis, Ehr. Pl. XXXVIII. Figs. 12–16.

Bodies in extension elongate, cylindrical-campanulate, somewhat gibbous, from two or three to nearly four times as long as broad; elongate-pyriform, with an anterior nipple-like projection, when contracted; the frontal margin but slightly dilated, obliquely truncate; ciliary disc considerably elevated; cuticular surface conspicuously striate transversely; pedicle thick, profusely and dichotomously branched, coarsely and closely annulate, secondary ramifications of the pedicle short, rarely equalling the length of the extended zooids. Length of bodies 1–430″ to 1–240″; height of the tree-like colony 1–16″.

Hab.—Fresh water, on various species of *Cyclops* and other Entomostraca.

This species is one of the most abundant representatives of the genus, being rarely absent where *Cyclops* is plentiful, the limbs and carapace of this little Entomostracon being often completely hidden beneath a perfect forest of its tree-like colonies. Difficulty is sometimes experienced in separating this type from *Epistylis anastatica* and *E. galea* previously described, but disappears on attention being directed to the exceedingly distinct annulation of the entire pedicle and the elongate and subcylindrical shape of the extended zooids. The more usually somewhat gibbous, anteriorly oblique truncate contour of the animalcules, as seen in profile, so nearly resembles that of the flower of the foxglove, *Digitalis*, as to have suggested the title conferred upon it by Ehrenberg. When first taken from its native pond it is remarkable, unless carefully handled, how soon the zooids of this species develop a posterior circlet of cilia and become detached from the parent tree, nothing but the bare twigs of this last-named structure being frequently left within a few hours from the time of their collection. The detached animalcules will, however, on such occasions be found abundantly distributed in the water, swimming rapidly about, and, as observed by the author, with the posterior extremity directed in advance, or creeping over the surface of submerged objects, with the aid of the closely applied basal region and supplementary ciliary girdle, after the manner of a *Trichodina* or migrant *Vorticella*. Left undisturbed, and with an abundant supply of water, for a few days, many of these nomadic individuals find their way back to their previous hosts, and commence severally the edification of a new family tree. At Pl. XXXVIII. Fig. 13 is given an illustration of an exceedingly attenuate variety of this species observed on one occasion. In this instance the bodies of the extended zooids were almost vermicular, their diameter in the centre scarcely exceeding twice that of the supporting pedicle.

Epistylis leucoa, Ehr. Pl. XXXIX. Fig. 4.

Bodies broadly campanulate, convex anteriorly, somewhat gibbous; peristome-border dilated; ciliary disc projecting in a dome-like manner; parenchyma transparent, cuticular surface smooth; pedicle erect, thick, smooth, solid, and articulate at the joints; its branches very short, capitate; endoplasts band-like or S-shaped. Length of bodies 1-120″; of the entire zoodendrium 1–24″. Hab.—Fresh water.

This species was obtained by Ehrenberg attached to the leaves of sedges in the ponds of the Berlin Zoological Gardens, in January 1835, ice at the time covering the surface of the water. In shape and size the zooids would appear to most closely resemble those of *E. flavicans* var. *decumbens*, but the ciliary disc is represented as much more prominent; the pedicle is also, in addition to being articulated, considerably

stouter, solid, and with very short secondary branches. According to Ehrenberg's figures, this type appears to form but small colonies, six zooids only being included in the one selected by him for illustration. No recent investigator would appear so far to have made the acquaintanceship of this animalcule. The examples referred to this type by Mr. H. E. Forrest in the 'Midland Naturalist' for April 1879, undoubtedly represent the erect variety of *Epistylis flavicans*.

Epistylis branchiopyla, Perty. PL. XXXIX. FIGS. 1 AND 2.

Bodies shortly ovate or subspheroidal, nearly as broad as long, widest centrally, tapering posteriorly, slightly constricted beneath the border of the peristome; ciliary disc slightly protrusible; cuticular surface smooth; pedicle erect, slightly curved, finely striate longitudinally, branching dichotomously but somewhat unevenly, one limb at each bifurcation, and continually on the same side, considerably exceeding the opposite one in height; endoplast band-like, transversely placed. Length of bodies 1–360″ to 1–280″.

HAB.—Fresh water, on the larvæ of *Phryganidæ*.

The species according with the above diagnosis and delineated in the accompanying plate, is referred by Stein with some doubt to the *E. branchiopyla* of Perty, which is but imperfectly described and illustrated. In accordance with Perty's original figure, the pedicle consists of a thick erect main trunk, from which diverge laterally and at close alternate intervals a few short slender stalks bearing the subspheroidal zooids, a group of three or four similarly stalked zooids crowning the summit of this trunk. Should this interpretation be correct, Perty's species, as recognized by Stein, differs in the formation of its pedicle from all ordinary representatives of the genus *Epistylis*, and more nearly approaches that of *Zoothamnium alternans*. It is at the same time possible that this aberrant formula represents the impression conveyed to Perty by the irregular branching of the pedicle characteristic of Stein's examples, the size of the animalcules and the nature of the associated host being in both instances identical. It may be mentioned that the zooids as figured and described by Perty, while subspheroidal, exhibit a somewhat different outline from that given by Stein, the posterior region being usually the broadest and somewhat flattened, while the peristome-border is contracted, and represents the narrowest region of the body.

Epistylis crassicollis, Stein. PL. XXXIX. FIG. 19.

Bodies ovate, or shortly fusiform, tapering posteriorly, as also in a less degree anteriorly, about twice as long as broad; peristome-border greatly thickened, its diameter less than that of the centre of the body; ciliary disc scarcely exsert; cuticular surface smooth; pedicle branching dichotomously, and at an acute angle, the individual zooids being usually brought near together on the same level; both main stem and branches smooth, or faintly wrinkled transversely, the latter straight and of uniform thickness, equalling in length the supported zooids, frequently with a conspicuous raised annulus at the point of bifurcation; endoplast band-like, horseshoe-shaped. Length of bodies 1–240″.

HAB.—Fresh water, attached to the limbs of various Entomostraca.

The largest colonies of this species contain from twelve to twenty zooids, but a less number is more abundant. In its general mode of growth it most closely approaches *Epistylis anastatica*.

Epistylis digitalis, Ehr. Pl. XXXVIII. Figs. 12–16.

Bodies in extension elongate, cylindrical-campanulate, somewhat gibbous, from two or three to nearly four times as long as broad; elongate-pyriform, with an anterior nipple-like projection, when contracted; the frontal margin but slightly dilated, obliquely truncate; ciliary disc considerably elevated; cuticular surface conspicuously striate transversely; pedicle thick, profusely and dichotomously branched, coarsely and closely annulate, secondary ramifications of the pedicle short, rarely equalling the length of the extended zooids. Length of bodies 1–430″ to 1–240″; height of the tree-like colony 1–16″.

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HAB.—Fresh water, on the larvæ of *Phryganidæ*.

The species according with the above diagnosis and delineated in the accompanying plate, is referred by Stein with some doubt to the *E. branchiopyla* of Perty, which is but imperfectly described and illustrated. In accordance with Perty's original figure, the pedicle consists of a thick erect main trunk, from which diverge laterally and at close alternate intervals a few short slender stalks bearing the subspheroidal zooids, a group of three or four similarly stalked zooids crowning the summit of this trunk. Should this interpretation be correct, Perty's species, as recognized by Stein, differs in the formation of its pedicle from all ordinary representatives of the genus *Epistylis*, and more nearly approaches that of *Zoothamnium alternans*. It is at the same time possible that this aberrant formula represents the impression conveyed to Perty by the irregular branching of the pedicle characteristic of Stein's examples, the size of the animalcules and the nature of the associated host being in both instances identical. It may be mentioned that the zooids as figured and described by Perty, while subspheroidal, exhibit a somewhat different outline from that given by Stein, the posterior region being usually the broadest and somewhat flattened, while the peristome-border is contracted, and represents the narrowest region of the body.

Epistylis crassicollis, Stein. PL. XXXIX. FIG. 19.

Bodies ovate, or shortly fusiform, tapering posteriorly, as also in a less degree anteriorly, about twice as long as broad; peristome-border greatly thickened, its diameter less than that of the centre of the body; ciliary disc scarcely exsert; cuticular surface smooth; pedicle branching dichotomously, and at an acute angle, the individual zooids being usually brought near together on the same level; both main stem and branches smooth, or faintly wrinkled transversely, the latter straight and of uniform thickness, equalling in length the supported zooids, frequently with a conspicuous raised annulus at the point of bifurcation; endoplast band-like, horseshoe-shaped. Length of bodies 1–240″.

HAB.—Fresh water, attached to the limbs of various Entomostraca.

The largest colonies of this species contain from twelve to twenty zooids, but a less number is more abundant. In its general mode of growth it most closely approaches *Epistylis anastatica*.

Epistylis invaginata, C. & L. Pl. XXXIX. Fig. 18.

Bodies of animalcules conical, thimble-shaped, one and a half times as long as broad; peristome-border widest, everted; cuticular surface smooth; pedicle erect, unstriate; secondary branches long and slender; endoplast ribbon-shaped, slightly curved, longitudinally disposed; colonies comprising but few zooids. Length of bodies 1-400".

Hab.—Fresh water, on aquatic insects.

Claparède and Lachmann remark that the species most nearly resembling this type is the *E. branchiopyla* as described by Stein, but from which it may be distinguished by the more elongate form of the body, the smooth surface and even development of the pedicle, and the longitudinal instead of transverse position of the endoplast. The specific name conferred upon this type bears reference to the contour assumed by the animalcule in its migrant or free-swimming state, the posterior extremity being at such times invaginated or thrust into the substance of the body, in a manner closely identical with that observed by the author under similar conditions of *Vorticella striata*. The examples of this species examined by its discoverers were found attached to the abdominal segments of the larvæ of a *Hydrophilus*.

Epistylis umbilicata, C. & L. Pl. XXXVIII. Fig. 9.

Bodies ovoid, narrowest and slightly constricted anteriorly; the peristome-border not dilated; ciliary disc produced centrally in the form of an umbilicus; pedicle thick, short, smooth, and evenly branched, its total height scarcely exceeding that of an expanded zooid. Length of extended bodies 1–400."

Hab.—Fresh water, on the larvæ of the common gnat, *Culex pipiens*, forming colonies of but few zooids.

Although not mentioned by Claparède and Lachmann in their descriptive text, their drawing given of the species represents the surface of the integument as finely striate transversely. D'Udekem * has since obtained this variety from the neighbourhood of Brussels, his illustration of an adult colony-stock being here reproduced. In their contracted state, according to this observer, the zooids become plicate posteriorly, while the anterior region is produced in a snout-like manner.

Epistylis coarctata, C. & L. Pl. XXXVIII. Figs. 10 and 11.

Bodies ovato-fusiform, a little over twice as long as broad, inflated centrally, tapering subequally towards both the anterior and the posterior extremities; cuticular surface smooth; peristome-border very narrow and contracted; endoplast band-like, curved, transversely placed; pedicle sinuous, very slender, smooth, sparingly branched, secondary ramifications supporting the zooids usually very short. Length of bodies 1–500".

Hab.—On Mollusca and vegetable débris from pond and sometimes stagnant water, in the neighbourhood of Berlin (C. & L.). Colonies small, consisting usually of but three or four animalcules.

This very graceful type is distinguished by its slender, fusiform contour, and exceedingly narrow peristome, in both of which respects it would appear to somewhat resemble the *Opercularia stenostomata* of Stein. From this last-named

* 'Infusoires de la Belgique,' 1864.

species its describers report it as differing in its larger size, and in the more slender and attenuate proportions of the secondary pedicles, which while short are never so abridged as to impart to the bodies that sessile aspect which characterizes Stein's species. The author refers without hesitation to Claparède and Lachmann's type the unnamed *Epistylis* figured by Mr. H. J. Slack, in his 'Marvels of Pond-life,' p. 95, 1861. The group there delineated, and reproduced at Pl. XXXVIII. Fig. 11, would appear to be a remarkably luxuriant example, the branching pedicle supporting no less than seven zooids in place of the three, or four at most, only observed by its original discoverers.

Epistylis tubificis, D'Udk. Pl. XXXIX. Figs. 7 and 8.

Bodies subcylindrical, thimble-shaped, about twice as long as broad, the frontal margin truncate, widest, moderately dilated, the posterior extremity rounded and slightly tapering; pendulous, and irregularly plicate transversely when contracted; pedicle short, slender, smooth, and transparent, branching dichotomously; basal stem scarcely equalling the length of an extended zooid and each successive ramification decreasing in length; entire colony-stock comprising six or eight zooids only. Length of bodies 1–250″.

Hab.—Fresh water, on *Tubifex rivulorum*.

Among the figures given of this species D'Udekem represents an animalcule having the posterior portion of its body extended in an irregularly lobate manner (see Pl. XXXIX. Fig. 8), and which may perhaps be interpreted as a semi-amœboid phase, analogous to that prevalent among the Flagellata previous to entering upon an encysted state. In their contracted condition the zooids assume a reflected or pendulous posture closely resembling that of *Opercularia nutans*.

Epistylis pyriformis, D'Udk.

Bodies when extended, subfusiform, rather over twice as long as broad, narrowest posteriorly, the cuticular surface smooth; pyriform, with several transverse posterior plications, when contracted; peristomal border slightly everted; ciliary disc elevated but a small way above its margin; pedicle moderately stout, smooth and transparent, forming short, regular, widely divergent dichotomous branchlets, neither these nor the main stem equalling in length an extended animalcule. Colonies small, including five or six zooids only. Length of body 1–250″.

Hab.—Pond water, on the larvæ of *Tipula*, mostly attached to the posterior extremity.

Excepting for the more fusiform contour of the zooids, and the normal posture maintained by them when contracted, this species may be readily confounded with the one previously described.

Epistylis articulata, From. Pl. XXXIX. Fig. 3.

Bodies elongate-conical, tapering posteriorly, somewhat gibbous, nearly three times as long as broad; cuticular surface smooth; peristome-border slightly dilated; ciliary disc moderately elevated; vestibular seta conspicuously developed; pedicle dichotomous, short, stout, and sparingly

branched, striate longitudinally, articulate at one or two intervals between each bifurcation. Length of bodies 1–325″. HAB.—Fresh water.

In shape the animalcules of this species appear to closely resemble those of *Epistylis plicatilis*, and it is a question whether the chief point of difference cited by De Fromentel, that of the articulation at distant intervals of the pedicle, is sufficient to distinguish them; more especially as, in the last-named form, Stein has remarked that old specimens are similarly jointed. No mention is made as to the form assumed by the zooids when in the state of contraction, which would have been useful in the settlement of this supposed identity, nor as to whether the species forms large or small colonies. In the example figured, upon which the above diagnosis is based, there are four ultimate branches to the pedicle, the lengths of the main shaft and of the two primary ramifications in both cases scarcely exceeding respectively those of the extended zooids.

Epistylis nympharum, Eng. PL. XXXVIII. FIG. 18.

Bodies elongate, subfusiform, about two and a half times as long as broad, tapering chiefly posteriorly, and more slightly towards the anterior border; peristome somewhat oblique, its border turgid, not dilated; ciliary disc slightly elevated; vestibular cleft developed backwards to or beyond the centre of the body, exhibiting on the ventral side a knee-like flexure; cuticular surface smooth; contractile vesicle located beneath the border of the peristome; endoplast elongate, band-like, longitudinally placed; pedicle short, smooth, or obscurely wrinkled, moderately thick, sparsely and dichotomously branched. Length of bodies 1–166″.

HAB.—Fresh water, on aquatic larvæ; colonies including but a few zooids.

The contour of the zooids in this species are recognized by Engelmann* as in some respects resembling that of *Epistylis digitalis*, from which, however, it may be readily distinguished by the smooth character of both the pedicle and cuticular surface.

Epistylis Steinii, Wrz. PL. XXXVIII. FIG. 17.

Bodies conico-campanulate, tapering posteriorly, about twice as long as broad; peristome-border thick, moderately dilated; ciliary disc dome-shaped, scarcely exsert; cuticular surface finely striate transversely; pharyngeal cleft prolonged beyond the centre of the body; pedicle short, exceedingly thick, sparingly divided, coarsely and irregularly wrinkled transversely, its diameter increasing as it approaches its junction with the animalcule's body, and whose width at this point it nearly equals, perforated by a conspicuous central canal; endoplast band-like, transversely placed; contractile vesicle situated beneath the peristome-border, on the right-hand side of the vestibulum. Length of bodies 1–640″; altitude of pedicle less than that of the extended zooids.

HAB.—Fresh water, on *Gammarus pulex*; colonies including but few animalcules.

The short wrinkled character of the pedicle distinguishes this species from any known representative of the genus; this structure, however, as remarked by

* 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xi., 1862.

Wrzesniowski,* closely resembles that of *Opercularia Lichtensteinii*, and it might be added, certain species of *Podophrya*. With the exception of *E. flavicans*, it is furthermore the only representative of the genus *Epistylis* in which the pedicle is perforated by a central canal; in the present instance, however, this canal is continuous to the junction of the pedicle with the body of the zooid, while in the former case it is solid both at this point and at the axes of the divergent branches.

Epistylis balanorum, Mereschk. PL. XXXIX. FIG. 5.

Body subcylindrical, tapering posteriorly, about two and a half times as long as broad, having a deep groove or constriction immediately beneath the peristome; the ciliary disc continued above the peristome-border as a prominent, elevated, median, boss-like projection, having several annulations around its base, and a pointed conical anterior termination; cuticular surface entirely smooth; parenchyma finely granulate; endoplast band-like, curved; pedicle smooth, branching in a more or less regular dichotomous manner, bearing but a small number of animalcules. Length of zooids 1–240″.

HAB.—Fresh water: White Sea, attached to the embryos of *Balanus* sp.

As indicated by Mereschkowsky,† the zooids of this species correspond closely in the remarkable modification of the ciliary disc with the fresh-water *Epistylis umbilicata* of Claparède and Lachmann.

Supplementary Species.

The three following species, included in Pritchard's 'Infusoria' without any notification of their original authorship, are too indistinctly defined for present identification.

Epistylis barba.

Bodies of animalcules ovate, oblong, white; pedicle branching dichotomously, longitudinally and regularly striate. Dimensions unrecorded.

HAB.—Fresh water, on the larvæ of aquatic insects.

Epistylis euchlora.

Bodies of animalcules oblong, slightly expanded anteriorly, containing green granules; pedicle smooth, branching dichotomously. Altitude 1–13″.

HAB.—Fresh water, on *Planorbis cornea*, Berlin.

Epistylis pavonina.

Bodies of animalcules very large, helmet-shaped, elongate anteriorly; pedicle very high, longitudinally striate, dichotomously branched. Altitude of entire colony 1–3″. HAB.—Fresh water, Berlin.

The *Epistylis botrytis* of Ehrenberg, "Bodies exceedingly minute, not exceeding the 1–2400″, clustered at the extremity of a simple hyaline pedicle," is undoubtedly identical with the *Anthophysa vegetans* of Fresenius, and *Codosiga pulcherrimum* of

* 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xxxix., 1877.

† "Protozoen des Nördlichen Russland," 'Archiv f. Mikroskopischer Anatomie,' Bd. xvi., 1878.

Professor H. James-Clark. The *Epistylis vegetans* of the same writer: "Bodies very small, ovate, disposed in clusters on a branched yellow pedicle; length 1–345o", is synonymous with *Anthophysa Muelleri*." A third species, Ehrenberg's *Epistylis arabica*—"Small, oval, campanulate, pedicle but little branched, smooth and hyaline; entire height 1–140"; hab. Red Sea"—is probably a Flagellate form belonging to the genus *Codosiga*, nearly related to the author's *C. pyriformis*. The *Epistylis minutus* of R. Greeff,* whose colony-stocks resemble in miniature those of *Ep. flavicans*, but the length of whose bodies does not exceed 1–3000", is apparently referable to the genus *Dendromonas*.

Genus XI. OPERCULARIA, Stein.

Animalcules ovate, pyriform, or campanulate, seated at the extremities of a rigid, more or less branching, tree-like pedicle or zoodendrium; ciliary disc attached to one side of the wide oral entrance or vestibulum, isolated and usually elevated to a considerable distance above the margin of the peristome, after the manner of an operculum; a delicate hyaline collarlike membrane taking its origin from the inner border of the peristome, usually protruded with and forming a sort of under-lip to the ciliary disc; other structural details as in *Epistylis* or *Vorticella*.

The rigid, mostly ramifying pedicle of the members of this genus corresponds essentially with that of *Epistylis*, but the animalcules attached to the summits of the branches are readily distinguished by the more complex structure of their oral or peristomal region. In the lateral attachment and operculum-like elevation of the ciliary disc the zooids of *Opercularia* also considerably resemble those of the genus *Lagenophrys*, while the membranous collar-like expansion, forming as it were a supplementary under-lip to the ciliary region, represented feebly in *Lagenophrys*, may certainly be accepted as homologous with the more complex funnel-like membrane of the genus *Spirochona*. An additional feature which serves to indicate the affinity of *Opercularia* with *Lagenophrys* is the usually more hardened texture of the cuticular membrane, which in many instances is indurated to such an extent as to remain as a distinct chitinous shell after the decomposition of the soft interior. These two genera thus prepare a passage to the distinct shell-producing or loricate Vorticellan types *Cothurnia* and *Vaginicola*.

When first instituted by Stein, the presence of two sorts of zooids, as occurs frequently in the genus *Zoothamnium*, was included among the points for diagnosis; more recent investigation has, however, demonstrated that the supposed secondary zooids were merely parasitic or commensal *Acinetæ*. All the species of *Opercularia* so far discovered are inhabitants of fresh water, and are for the most part met with attached to various aquatic insects and Entomostraca.

Opercularia nutans, Ehr. sp. Pl. XXXIX. Figs. 22 and 23.

Bodies ovate or attenuate fusiform, about two and a half times as long as broad, tapering towards each extremity, the anterior end the wider, the posterior one often transversely plicate; ciliary disc considerably elevated above the margin of the peristome, bearing two circlets of cilia; membranous collar largely developed, obliquely set; endoplast band-like, curved; pedicle tree-like, slender, branching profusely and dichotomously, attaining a considerable proportionate altitude, distinctly annulate

* 'Wiegmann's Archiv,' Bd. xxxvii., 1871.

transversely. Length of bodies 1–430″; height of the entire polypidom, 1–24″ to 1–9″.

HAB.—Fresh water, on aquatic plants and animals; colonies including a large number of zooids, which assume a nodding or pendent position with relation to their stalks at the time of contraction.

This species is described by Ehrenberg under the title of *Epistylis nutans*, being rightly referred to its present position by Stein. Its large, handsome, symmetrical tree-like colonies attain an altitude and luxuriance of growth unequalled by any other representative of the genus, and among which it is more eminently distinguished on account of the singular and sudden nodding action displayed by the zooids when disturbed, in place of the more ordinary phenomena of contraction. In a less conspicuous degree a like property is possessed by *Opercularia berberina*. As with the last-named species, the cuticular surface of the animalcules is considerably indurated, in proof of which it may be mentioned that the author has on several occasions seen the isolated cuticular investments left as empty vase-shaped transparent sheaths after their detachment from the pedicle, and the complete dissolution of the previously enclosed protoplasm. Among the figures of this species given by Ehrenberg (Pl. XXXIX. Fig. 23) he delineates one animalcule having attached to its side what he interprets to be a lateral bud, but which more probably represents the conjugation of a migrant zooid with an ordinary sedentary unit.

Opercularia articulata, Ehr. PL. XXXIX. FIGS. 24–26.

Bodies elongate-ovate, or fusiform, truncate at each extremity; peristome-border not thickened, but forming a simple terminal edge, with often a few longitudinal plications; remaining cuticular surface smooth and soft, parenchyma usually densely granular posteriorly; ciliary disc greatly elevated, bearing three circlets of cilia, membranous collar conspicuous; endoplast horseshoe-shaped, transversely placed; pedicle variously but usually profusely and dichotomously branched, often delicately striate in a longitudinal direction, exhibiting at remote distances more or less distinct transverse articulations. Length of extended zooids 1–324″ to 1–96″, average 1–192″; altitude of tree-like colony 1–72″ to 1–48.″

HAB.—Fresh water, on *Dytiscus marginalis* and other aquatic Coleoptera.

The very remarkable diversity exhibited in the sizes of the zooids of this species might be expected to pertain to stocks collected from widely separated localities. According to Stein, however, they may be met with in separate colonies upon the same Coleopterous hosts. An almost equal amount of variation would appear to obtain in the build and comparative lengths of the ramifications of the pedicle; in some neither the main shaft nor the associated branches equal more than one-half of the length of an extended zooid, while in other colonies the extended zooids are as proportionately small, or even smaller, with reference to their attenuately branched supporting stem.

Opercularia berberina, Linn. sp. PL. XXXIX. FIG. 27.

Bodies elongate, subcylindrical, slightly contracted at the two extremities, two and a half times longer than broad; peristome obsolete; ciliary disc bearing a single circlet of cilia, protrusible but a short distance beyond the margin of the peristome; membranous collar small, not easily

defined; vestibular cleft capacious, produced backwards through one-half the length of the body; cuticular surface membranous, transversely striate; contractile vesicle located near the termination of the vestibulum; endoplast ovate, or slightly elongate; pedicle irregular, dichotomously branched, its ramuscles curved outwards, and supporting the animalcules at various heights, presenting transverse lines or joints at variable distances, no conspicuous longitudinal striæ. Length of bodies 1–190″.

HAB.—Fresh water, on various aquatic insects; zooids in the state of contraction assuming a pendent posture.

The tree-like colonies of this species exhibit as wide a range of variation in their external contour as is reported of *Opercularia articulata*, but the pedicle throughout all these deviations presents a similar unequal and non-corymbose formula of growth. The cuticular surface is reported by Stein to be considerably indurated, and to remain, as observed by the author of *O. nutans*, as a transparent shell after the entire disintegration of the previously enclosed parenchyma. This animalcule is synonymous with the *Epistylis berberiformis* of Ehrenberg and the *Hydra* and *Vorticella berberina* respectively of the 'Natursystem' and 'Systema Naturæ,' ed. xii., of Linnæus.

Opercularia Lichtensteinii, Stein. PL. XXXIX. FIG. 20.

Bodies short, subcylindrical or barrel-shaped, their length not equalling double the width, slightly narrower at each extremity, the anterior one longitudinally plicate when contracted; ciliary disc slightly elevated above the peristome, bearing a single circlet of cilia; membranous collar conspicuous, notched, or crenulate; endoplast short, oval or completely round; pedicle sparingly branched, short, exceedingly thick, not equalling the height of the extended zooids, longitudinally striate, and exhibiting prominent transverse rugæ, dividing close to its point of attachment, the ramifications increasing in width towards their juncture with the bodies of the zooids, and at which point they equal or exceed one-half of the diameter of these latter. Length of bodies 1–190″.

HAB.—Fresh water, on various aquatic Crustacea and Mollusca; colony-stocks including but a few animalcules.

The short, thick, wrinkled, sparsely dividing stem of this type closely resembles that of *Epistylis Steinii*, but is wanting in the conspicuous central canal that characterizes that species.

Opercularia stenostoma, Stein. PL. XXXIX. FIG. 17.

Bodies elongate-pyriform or fusiform, widest in advance of the median line, strongly contracted and almost stalk-like posteriorly; peristome-border and ciliary disc very narrow, the latter bearing a single circlet of cilia; membranous collar inconspicuous, appearing only as an annular ridge above the edge of the peristome; endoplast long, horseshoe-shaped; pedicle relatively small, rigid, dichotomously divided, bearing but from four to six animalcules, striate longitudinally and obscurely wrinkled in a transverse direction, the secondary branches so short that the zooids are

closely approximated and appear to be attached in a sub-sessile manner. Length of extended zooids 1–200″.

HAB.—Fresh water, on the crustacean *Asellus aquaticus*.

In the absence of any figure of this species given by Stein, the illustration of the same form accompanying D'Udekem's account of the animalcule as obtained by him on *Asellus aquaticus* in the neighbourhood of Brussels, is herewith reproduced. It is at the same time desirable to remark that while in D'Udekem's examples as here figured the length of the extended zooids agrees with that given in the above diagnosis, Stein attributes to them one of the 1–900″ only, and that of 1–360″ to the entire colony-stock.

Opercularia microstoma, Stein. PL. XXXIX. FIG. 16.

Bodies irregularly pyriform, constricted behind the middle line, and thence tapering towards the posterior extremity, about one and a half times as long as broad; peristome and ciliary disc exceedingly narrow, the last-named structure but slightly elevated; membranous collar obliquely set, presenting a tongue-like aspect; endoplast curved, hamate; pedicle very short, its entire height not equalling that of a single extended zooid, the ramifications comparatively slender, usually marked by thickly set annular constrictions, which render it more or less crooked or knotty, but sometimes entirely smooth. Greatest length of bodies 1–280″.

HAB.—Fresh water, attached to the limbs of various Entomostraca; colonies including but few animalcules.

Stein remarks that this species, in both the form of the zooids and in the growth and proportionate size of the pedicle, presents a strong resemblance to *Opercularia stenostoma*, from which, however, it may be distinguished by its larger size, thicker proportions, and more conspicuously developed hyaline collar. While the colonies more usually include two or four zooids only, instances are cited in which about twenty were observed grouped upon a single pedicle; this last-named structure, notwithstanding its branched condition, did not exceed the relative height quoted in the foregoing diagnosis. The author has recently, January 1878, obtained small colonies of this animalcule in company with *Cothurnia astaci* attached to the Entomostracon *Canthocamptus minutus* taken from a roadside pond near Acton. The pedicle in all the examples examined was completely smooth, while the cuticular surface, under a magnification of eight hundred diameters, was shown to be finely striate transversely.

Opercularia cylindrata, Wrz. PL. XXXIX. FIG. 21.

Bodies elongate, cylindrical, slightly tapering posteriorly, truncate anteriorly, about two and a half times as long as broad; peristome-border scarcely differentiated, not dilated; ciliary disc very slightly elevated; vestibular cleft spacious, produced backward to a distance of one-third of the length of the body; cuticular surface finely and closely striate transversely; endoplast elongate, band-like, longitudinally disposed; pedicle tall, with subequally long, slightly curved, secondary branches, closely striate transversely throughout its entire length, its main stem coloured brown, colonies including numerous individuals. Length of bodies 1–500″.

HAB.—Fresh water, on *Cyclops quadricornis*.

This species is distinguished by its discoverer, A. Wrzesniowski,* from *O. berberina*, which it most nearly approaches, by the abruptly truncate non-contracted anterior border, by the closely striate pedicle, and by the less considerable development of the vestibular cleft; the endoplast is likewise much more elongate.

Opercularia hospes, From. sp. PL. XXXIX. FIGS. 9–11.

Bodies clavate, about two and a half times as long as broad, the peristome-border widest, the posterior end attenuate; ciliary disc large, moderately elevated; membranous collar conspicuous, obliquely set; the whole surface of the body covered with minute fibrillæ, which, whether belonging to the organism or of a parasitic nature, has yet to be determined; pedicle stout, cylindrical, punctate. Length of bodies 1–200".

HAB.—Fresh water.

This species is founded upon the type described by Fromentel † under the title of *Epistylis hospes*, but which, as is shown by both his drawings and description, is a true *Opercularia*. The membranous collar, as represented by him in outline, he takes for the vestibular bristle of an ordinary *Epistylis* bent round upon itself. The singular fibrillate structures with which the surface of the body is invested are regarded by Fromentel as possibly constituted of minute parasitic growths, but their extreme abundance and equal distribution in every specimen examined scarcely supports his view. Each distinct fibrilla is characterized as hair-like, with a globular head, but the general aspect conveyed by Fromentel's figures, here reproduced, is that of a froth-like exudation, or it may be a layer of trichocysts. It is to be regretted that no details are given as to habitat, the proportions and form of growth of the pedicle, or whether its ramifications support a large or small number of zooids. The small portion of this element figured exhibits a remarkable punctate character.

Sub-Family II. VAGINICOLINA.

Animalcules excreting and inhabiting indurated sheaths or loricæ.

GENUS XII. VAGINICOLA, Lamarck.

Animalcules elongate-subcylindrical, enclosed singly or in pairs within an indurated vase-shaped sheath or lorica, to the bottom of which they are affixed directly, or by means of a short pedicle; lorica erect, attached by its posterior margin to the selected fulcrum of support, in a sessile manner, or through the medium of an exceedingly short, rudimentary, rigid pedicle; oral and ciliary system as in *Vorticella*; increasing by longitudinal fission or gemmation; in the former instance the zooids temporarily occupying the same domicile. Inhabiting salt and fresh water.

The genus *Vaginicola*, since the date of its first institution by Lamarck and further extension at the hands of Ehrenberg, Dujardin, Stein, Claparède and Lachmann, and other more recent writers, has become so unwieldy in point of numbers, that its subdivision into a plurality of generic groups, each possessing well-marked structural characteristics, has been decided on and will materially assist the student in his

* 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xx., 1870.
† 'Études sur les Microzoaires,' Paris, 1876.

identification of the numerous species. Ehrenberg's primary separation of the stalked from the sessile types under the title of *Cothurnia*, while not assented to by many recent authorities, and formerly deprecated by the author,* may, it has been decided upon, after fuller investigation, be conveniently retained. From among the sessile series, or ordinary *Vaginicolæ*, may be further eliminated for independent generic distinction the *Vaginicola decumbens* of Ehrenberg and several other species corresponding with that type in the decumbent or adnate attachment of the lorica recently described by De Fromentel, and upon which group as a whole the title of *Platycola* is here conferred. A similar distinction may with justice also be allotted to the *Vaginicola valvata* of Dr. Strethill Wright, with its remarkable door-like valve, and to which are now added two other species, the three being collated under the new generic name of *Thuricola*. Lastly, among the erect and stalked *Cothurniæ* are found several forms agreeing with each other, but distinguished from the more normal species by the possession of an attached operculum; upon these it is proposed to confer the new generic name of *Pyxicola*.

The considerable number of animalcules retained in the genus *Vaginicola* as here defined are readily distinguished by their simple erect loricæ, whose bases are attached immediately to the chosen fulcrum of support without the intermedium of a separate and distinct pedicle, and which possess, furthermore, no accessory hinged valve or operculum-like stopper as a safeguard to the entrance to their domicile. In many types varieties occur in which the posterior extremity tapers off to such an extent as almost to present the aspect of such a distinct pedicle, but it will be found on closer examination, that it never actually assumes, as in the genus *Cothurnia*, the character of such an independent structure. De Fromentel† has proposed a partial subdivision of this genus, which while according in some respects with the author's system, yields other features that do not recommend themselves for adoption. His genus *Vaginicola* is thus made to include only the decumbent or adnate *V.* (*Platycola*) *decumbens* and its allies, all the rest, either stalked or sessile, being referred to the genus *Cothurnia*, which he again divides into three subordinate or subgeneric sections, reserving the title of *Cothurnia* proper for the stalked forms, *Planicola* for the stalkless ones, and that of *Stylocola* for certain types in which the animalcule is attached posteriorly to the wall of the lorica through the intermedium of several stylate processes. This last subgeneric group is here advanced to the position of a new and distinct genus; the author, however, is unable to concur with the proposed substitution of the title of *Planicola* for those species universally accepted as typical representatives of the genus *Vaginicola*. No distinction is suggested by De Fromentel for the types included in the two genera *Pyxicola* and *Thuricola*.

Vaginicola crystallina, Ehr. PL. XL. FIG. 1.

Lorica transparent, subcylindrical or elongate pitcher-shaped, rounded at the attached posterior extremity, slightly contracted towards the anterior border, about three times as long as broad; body of animalcule projecting, when fully extended, for one-third of its total length beyond the orifice of the lorica; the parenchyma usually enclosing numerous bright green chlorophyll-granules; endoplast elongate, band-like. Length of lorica 1–210".

HAB.—Fresh water, on *Lemna*, *Myriophyllum*, and other water-plants.'

In common with other species of the genus *Vaginicola* and its allies, two animalcules produced through the longitudinal fission of one originally single zooid, are frequently, as delineated in the accompanying illustration, found occupying the same sheath or lorica.

* 'Monthly Microscopical Journal,' vol. i., 1869. † 'Études sur les Microzoaires,' 1876.

Vaginicola tincta, Ehr.

Lorica urceolate or subcylindrical, brownish-yellow, about twice as long as broad, rounded or truncate posteriorly, the anterior border everted; body hyaline, not much exsert. Length of lorica 1–280″ to 1–150″. HAB.—Fresh water, on *Zygnema* and other water-plants.

The author has recently received examples of this species from Loch Lundie, Dundee, through Mr. John Hood, its companions on the same weed being *Platycola longicollis*, *Thuricola valvata*, *Codosiga umbellata*, and other sedentary Flagellata. According to their age the loricæ varied in colour from perfectly transparent through yellow to dark chestnut. The larger size included in the foregoing diagnosis represented the more normal dimensions of the lorica, whose contour might be appropriately compared to that of a short test-tube.

Vaginicola grandis, Perty.

Lorica subcylindrical, but of slightly undulating outline, narrower and truncate posteriorly, the anterior margin slightly everted, nearly three times as long as broad; animalcule projecting but little beyond the orifice of the lorica; parenchyma enclosing green chlorophyll-granules. Length of lorica 1–108″. HAB.—Fresh water, on aquatic plants.

Stein, and Claparède and Lachmann consider this form to be identical with *Vaginicola crystallina*, but its considerably larger size, different contour of the anterior margin of the lorica, and the fact, according to Perty's figure, that the animalcule when outstretched projects but slightly beyond its protective sheath, seem to warrant its retention as a distinct species.

Vaginicola gigantea, D'Udk. sp.

Lorica transparent, subcylindrical, two and a half times as long as broad, rounded, and slightly inflated posteriorly, the anterior border even or somewhat irregular; animalcule extending beyond the anterior margin of the lorica for fully half its length; peristome widely dilated and revolute; ciliary disc much elevated and having a thickened border; vestibular cleft extending backwards to a considerable distance; vestibular seta largely developed; contractile vesicle situated close to the entrance to the vestibule; endoplast exceedingly long, cord-like, more or less convolute, extending through the greater portion of the length of the body. Length of lorica 1–125″. HAB.—Pond water.

This form, which is described by D'Udekem* under the title of *Cothurnia gigantea*, most closely resembles *Vaginicola grandis*, but is distinguished from that type by the rounded instead of truncate posterior extremity of the lorica and by the great distance to which the body is protruded beyond its anterior border.

Vaginicola globosa, D'Udk. sp. PL. XL. FIG. 3.

Lorica scarcely one and a half times as long as broad, dilated and subglobose centrally, bluntly pointed posteriorly, narrowing and slightly

* 'Infusoires de la Belgique,' 1864.

prolonged towards the somewhat uneven anterior border; the extended body projecting but slightly beyond the aperture of the lorica; peristome-border thickened; ciliary disc obliquely elevated; endoplast cord-like, convolute. Dimensions unrecorded. HAB.—Fresh water.

Figured and described by D'Udekem as a species of *Cothurnia*.

Vaginicola ingenita, From. sp.

Lorica very short, only one and a half times as long as broad, narrow at the aperture, inflated posteriorly; body transparent, granular, very elastic, extending considerably beyond the aperture of the lorica. Length of lorica 1–400″. HAB.—Fresh water.

Identical with the *Planicola ingenita* of De Fromentel.*

Vaginicola attenuata, From. sp.

Lorica subcylindrical, sharply and abruptly attenuate towards its point of attachment, truncate and not everted anteriorly, about twice as long as broad; animalcule small, protruding but little beyond the aperture of the lorica, urn-shaped when contracted. Length of lorica 1–300″.

HAB.—Fresh water.

Vaginicola vestita, From. sp.

Lorica vase-shaped, twice as long as broad, the anterior border narrow, bulging posteriorly, but rapidly tapering again towards its point of attachment, the upper two-thirds transparent, colourless, the lower one brown and opaque; animalcule trumpet-shaped when extended, protruding to a moderate extent beyond the aperture of the lorica. Length of lorica 1–400″.

HAB.—Fresh water.

The two colours of the lorica of this animalcule, referred to the genus *Planicola* by De Fromentel, form a very remarkable feature. Its discoverer does not, however, say whether many specimens were encountered exhibiting a like peculiarity, a circumstance which leaves it open to conjecture whether the upper transparent portion of the lorica may not possibly represent a repaired portion or even the newly formed lorica of a young individual built up from the fragmentary basal portion of a deserted test. In other respects the aspect of this type coincides closely with that of D'Udekem's *Vaginicola globosa*.

Vaginicola inclinata, From. sp.

Lorica transparent, subcylindrical, rounded and widest posteriorly, nearly three times as long as broad, never fixed perpendicularly to, but deviating at a sharp angle from its base of attachment; body transparent, granular, trumpet-shaped, extending for nearly half its length beyond the aperture of the lorica. Length of lorica 1–500″. HAB.—Fresh water.

Included by De Fromentel in the genus *Planicola*.

* 'Études sur les Microzoaires,' 1876.

Genus XIII. THURICOLA, S. K.

(Greek, *thuris*, door; *colo*, to inhabit.)

Animalcules and loricæ as in *Vaginicola*, but the latter structure having hinged to its inner wall a simple or complex valve-like apparatus, which closes obliquely after the manner of a door when the animalcule contracts, and protects it from intrusion from without. Inhabiting salt and fresh water.

This new genus is established by the author upon the *Vaginicola valvata* of Dr. Strethill Wright, to which is added the *Cothurnia operculata* of Gruber and a fresh-water type, apparently identical with the *Vorticella folliculata* of Müller, found by recent investigation to exhibit a remarkable modification of the characteristic door-like valve.

Thuricola valvata, Wright sp. Pl. XL. Figs. 4 and 5.

Lorica subcylindrical, truncate posteriorly, four or five times as long as broad, bearing internally at some distance from its aperture an oval valve-like organ, which, falling down when the animalcule retreats, effectually protects it from intrusion from without; body hyaline, capable of extension for about one-third of its total length beyond the orifice of the lorica. Length of lorica 1–200″. Hab.—Salt and fresh water.

This animalcule, originally described by Dr. Strethill Wright under the title of *Vaginicola valvata*, was discovered by him in sea-water and is usually recorded as a strictly marine form. D'Udekem * reports, however, a species from fresh water that is apparently indistinguishable from this type, and an identical animalcule has been frequently observed by the author. In accordance with the description of its original discoverer, the characteristic valvular apparatus is of an ovate shape and horny consistence, developed within and covered by a fleshy plate, which is attached by one edge and continuous with a pellicle that lined the entire cavity of the lorica. This fleshy plate alone forms the hinge-joint to the horny valve, and is consequently separated and absent from the dead and empty tubes. In specimens recently received from Mr. John Hood of Dundee, the presence of a lining membrane in connection with the operculum as above reported, and similar to that figured by Gruber of *Thuricola operculata*, was found to exist. Excepting for the presence of this peculiar valve, the animalcule and its tube in the present species closely approximates in form and size the fresh-water *Vaginicola crystallina*.

Thuricola folliculata, Müll. sp. Pl. XL. Figs. 6–8.

Lorica subcylindrical, rounded and slightly widest posteriorly, about four times as long as broad; valvular apparatus consisting of a flattened comb-like fascicle of horny setæ, which opens outwards or closes down on the retracted animalcule in the same manner as the single valve-like structure in *T. valvata;* the body projecting, when extended, for nearly or quite one-half its length beyond the aperture of the lorica; peristome expanding, revolute; parenchyma frequently enclosing chlorophyll-granules. Length of lorica 1–200″ to 1–150″. Hab.—Salt and fresh water.

* 'Infusoires de la Belgique,' 1864.

Seen from either a front or dorsal aspect, and viewed with insufficient magnifying power, the complex mechanism which here takes the place of the simple valve of the form last described, presents the appearance, indicated at Pl. XL. Fig. 6, of two oppositely opposed arcuate cusps. It is under these conditions that the author has been able to establish its identity with the *Vorticella folliculata* of O. F. Müller. Viewed again in profile, its aspect corresponds so closely with that of the ovate valve of *Thuricola valvata* that it is scarcely to be distinguished from that form. Examined with a power of 600 or 800 diameters, the comb-like character of the valve is, as shown at Pl. XL. Figs. 7 and 8, very clearly demonstrated, and when once recognized, may be easily defined with a much lower power. The author has obtained this type abundantly in pond water in the neighbourhood of London, and has likewise received it through Mr. Thomas Bolton from Stourbridge, Worcestershire. An animalcule in no essential points distinguishable from the fresh-water species has been obtained by the author in salt water at Bognor, Sussex.

Thuricola operculata, Gruber sp. PL. XL. FIGS. 13–15.

Lorica sessile, transparent, subcylindrical, slightly constricted towards the anterior border, over three times as long as broad, one side of the anterior margin developed greatly in advance of the other; valve or operculum circular, attached to the lorica by a delicate membranous ligament, which is continued down one side and joined to the base of the animalcule's body; animalcule slender, subcylindrical, projecting when fully extended for nearly half its length beyond the aperture of the lorica, its cuticular surface finely striate; transversely attached basally to the lorica through the medium of a distinct footstalk. Dimensions and habitat unrecorded.

This species differs essentially from *Thuricola valvata* in the uneven or emarginate contour of the anterior border of the lorica, in the usually more slender proportions and greater extensility of the enclosed animalcule, and in its mode of fixation through the medium of a separate footstalk to its excreted domicile. The data recorded by Gruber relating to the opercular structure, in describing this animalcule under the title of *Cothurnia operculata*,* are of high interest, and are thus summarized: "In empty loricæ the operculum is always open, so that its closure must be due to the contraction of the animal. There is, in fact, attached to its under surface, one end of a delicate cuticular membrane (Pl. XL. Figs. 14 and 15, *r t*), bent longitudinally into a long cylinder, and with its other end embracing the proximal extremity of the animal. When the latter retracts, the membrane is pulled upon and the operculum closed. The membrane is so delicate that under ordinary circumstances all that can be seen of it are its edges, which look like two delicate threads passing from the base of the animal to the operculum." It will probably be found that a similar delicate membrane connects the operculum with the body and fulfils a similar function in the preceding species.

GENUS XIV. COTHURNIA, Ehrenberg.

Loricæ erect, attached posteriorly to their basis of support through the medium of a conspicuously developed pedicle; animalcules, as in *Vaginicola*, either adherent in a sessile manner to the posterior extremity of the lorica, or fixed to the same by a continuation from without of the external supporting pedicle. Inhabiting salt and fresh water.

* 'Zeit. Wiss. Zool.,' Bd. xxxiii., p. 439, 1879. (Translation in 'Journal of Royal Microscopical Society,' April 1880.)

Cothurnia imberbis, Ehr. PL. XL. FIGS. 9 AND 10.

Lorica ovate, about twice as long as broad, narrowest anteriorly, its margin not everted, transparent when young, assuming a yellow tinge when old; pedicle shorter than the lorica, sometimes curved; body of extended animalcule projecting but little beyond the margin of the lorica; endoplast linear, slightly curved. Length of lorica 1–288″ to 1–240″.

HAB.—Fresh water, on Entomostraca and aquatic plants.

This, the most familiar representative species of the genus *Cothurnia*, is frequently found in great abundance on the Entomostracon *Cyclops quadricornis*. It is not, however, confined to an animal host, being as often met with upon the thread-like filaments of various species of *Conferva*. The pedicle is occasionally so short as to present a mere button-like aspect. Sometimes it is continued through the wall of the lorica, thus imparting to the animalcule a doubly pedicellate character.

Cothurnia maritima, Ehr.

Lorica ovate, transparent, one and a half times as long as broad, slightly inflated posteriorly; pedicle much shorter than the lorica; parenchyma hyaline, whitish. Length of sheath 1–570″ to 1–350″.

HAB.—Salt water, on algæ, &c.

Excepting for its smaller size, this species closely resembles *C. imberbis*. It was observed by the author of specimens developed in great abundance in a jar containing decomposing algæ, at St. Heliers, Jersey, that the cuticular surface as viewed with a $\frac{1}{4}$-inch objective was distinctly striate in a transverse direction.

Cothurnia havniensis, Ehr. PL. XL. FIG. 19.

Lorica wineglass-shaped, transparent, truncate and widest anteriorly, scarcely one and a half times as long as broad; pedicle slender, three or four times the length of the hyaline sheath; body whitish. Length of sheath, without stalk, 1–280″. HAB.—Salt water.

This species was obtained by Ehrenberg in company with *Acineta Lyngbyei* on *Ceramium* and Sertularian zoophytes at Copenhagen. According to his figures given, here reproduced, the animalcule presents a much more broadly ovate form than obtains among all ordinary *Cothurniæ*, and occupies only the distal portion of the lorica. Excepting for the presence of the anterior fringe of cilia, the general contour of both the lorica and contained zooid corresponds with that of a long-stalked *Acineta*, and as an imperfectly observed representative of which genus the author is much inclined to regard it.

Cothurnia Sieboldii, Stein. PL. XL. FIGS. 24 AND 25.

Lorica gibbously urceolate, strongly compressed in front, dilated posteriorly, more especially on the dorsal aspect; the two frontal angles extended upwards and outwards, and again curving inwards at their extremities, so as to resemble two horns; walls of the sheath hyaline when young, turning from yellow to deep rusty brown with age; pedicle colourless, short, thick, curved, and transversely wrinkled, much thickened at its point of juncture with the sheath; body of animalcule small in comparison

with the size of the lorica, but little exsert beyond its margin when extended. Length of large-sized lorica 1–190″.

HAB.—Fresh water, on various Entomostraca, but more especially abundant on the branchial appendages of the fresh-water crayfish, *Astacus fluviatilis*.

Cothurnia astaci, Stein. PL. XL. FIG. 26.

Lorica urceolate, about twice as long as broad, the posterior half rounded and slightly ventricose, narrowest and contracted behind the slightly everted and even anterior border; colourless or pale yellow; pedicle thick, short, slightly curved, transversely plicate; animalcule slender, subcylindrical, protruding some distance beyond the margin of the sheath. Length of lorica 1–288″.

HAB.—Fresh water, on *Astacus fluviatilis* and various Entomostraca.

During a fatal epidemic among the fresh-water cray-fish of Lombardy and Venetia in the year 1863, it is reported by Ninni* that the dying crustacea were completely infested with an Infusorium, referable to the genus *Vaginicola*, probably identical with the present species, its abnormal development on the branchial appendages apparently producing the death of the crustacean through asphyxia.

Cothurnia curva, Stein. PL. XL. FIG. 27.

Lorica gibbous, ventricose posteriorly, curved to such an extent anteriorly as to impart to the aperture an oblique direction; transparent when young, but of a dull rusty-red colour in the adult state; animalcule agreeing in form with *C. astaci* and *C. Sieboldii* but not protruding to so great a distance beyond the orifice of the lorica. Length of lorica 1–360″.

HAB.—Fresh water, attached to various Entomostraca.

Stein rather doubts whether this species may not be considered as a distorted variety of *C. astaci*. The author, however, is inclined to regard it as an independent type, having found it abundantly at different times upon *Canthocamptus minutus* in the neighbourhood of London. In all instances the curved or gibbous contour of the lorica was constant, and the animalcules were never observed to protrude themselves to that distance beyond the orifice of the aperture which has been described of *C. astaci*. On one occasion a lorica was met with in which numerous spore-like bodies, probably representing the reproductive gemmules of the former occupant, were found attached by a short peduncle or funiculus to the bottom of its internal cavity. A species so closely resembling the present form that the same diagnosis serves for its description, has been obtained by Professor Boeck attached to marine Entomostraca on the coast of Norway. Claparède and Lachmann have proposed to distinguish it by the title of *Cothurnia recurva*, but there does not appear to be sufficient reason for regarding it as otherwise than a salt-water variety of the species just described. The contour of the lorica in this type is perhaps slightly more slender, and the curvature of the neck scarcely so strongly pronounced.

Cothurnia nodosa, C. & L.

Lorica transparent, subcylindrical, somewhat narrowed anteriorly, about twice as long as broad, frequently with one or more symmetrical transverse

* 'Atti del Imp. Reg. Istituto Veneto,' 1864.

annular constrictions across the centre; pedicle varying in its proportions from one-quarter to the same length as the lorica, produced usually to some distance within the lorica, having frequently a button-like node or boss immediately beneath its point of juncture with the lorica, this node, however, often produced inside the lorica, or supplemented by a second boss-like enlargement where the pedicle joins the animalcule's body. Length 1–570″.

HAB.—Salt water, on algæ, &c.

This form was first met with by the author at Bognor, Sussex, in the autumn of the year 1872, and has been since obtained in great abundance from the Menai Straits, North Wales, and has been also remitted by Mr. John Hood from Dundee. The pedicle in most examples examined was produced a considerable way inside the lorica, and the single boss developed at the base of this internal prolongation. The surface of the animalcule, as seen with a magnifying power of 200 diameters, was also distinctly striate transversely, after the manner of *Cothurnia marina* which it closely resembles. Among the several modifications of this type reported by C. Mereschkowsky from the White Sea, the one possessing a slender, rigid footstalk equal in height to the lorica which it supports, is figured under the name of *C. nodosa* var. *longipes*.

Cothurnia compressa, C. & L. PL. XL. FIGS. 17 AND 18.

Lorica transparent, ovate, three times as long as broad, compressed anteriorly, so as to leave a long, narrow, slit-like terminal aperture; pedicle exceedingly short, supplemented by a boss-like inflation within the interior of the carapace, to which the animalcule is attached. Length of lorica 1–178″. HAB.—Salt water, on seaweeds and Bryozoa.

The author met with this well-marked variety attached to seaweeds and zoophytes gathered in the vicinity of St. Peter's Port, Guernsey, in the autumn of the year 1871. The animalcules were in all instances a pale amber colour, the anterior or peristome region being widely dilated, so as to give it a trumpet shape when expanded, while the cilia were very long and powerful. Claparède and Lachmann's figures, here reproduced, represent the species in its contracted or semi-contracted conditions only.

Cothurnia ovata, Duj.

Lorica transparent, ovate, very short, scarcely one and a half times as long as broad, truncate and slightly dilated at the aperture; pedicle short and stout. Animalcules trumpet-shaped when expanded, protrusible to a considerable distance beyond the aperture of the lorica. Length of lorica 1–200″.

HAB.—Fresh water, on *Conferva* and other aquatic plants.

This species may be distinguished from *Cothurnia imberbis*, with which it is most likely to be confounded, by the much shorter and more truncate contour of the lorica and by the capacity of the contained zooid to protrude to a longer distance beyond the orifice of its domicile.

Cothurnia patula, From. PL. XL. FIGS. 20 AND 21.

Lorica transparent, cup-shaped, very short and broad, the breadth slightly exceeding the length, the anterior margin conspicuously everted; pedicle short and stout; animalcules trumpet-shaped when expanded, pro-

truding for half their length beyond the aperture of the lorica. Length of lorica 1–450″. HAB.—Fresh water, on *Confervæ*.

Cothurnia elongata, From.

Lorica subcylindrical, slightly widest posteriorly, twice as long as broad, rugose or granular, colour yellow; pedicle exceedingly short, inconspicuous. Animalcule elongate, subcylindrical, possessing two contractile vesicles, both of which are situated towards the centre of the body, in the rear of the pharyngeal cleft, not protruding far beyond the aperture of the lorica. Length of lorica 1–400″. HAB.—Fresh water.

The two contractile vesicles reported by De Fromentel,* if persistent—though their number and position indicated is so abnormal that the author is inclined to regard them as simple parenchymal vacuoles—distinguish this form in a marked manner from all the ordinary members of the Vaginicolina. A more important and reliable character of distinction is, perhaps, afforded by the granular consistence of the lorica.

Cothurnia spissa, From.

Lorica tumbler-shaped, slightly narrower and rounded posteriorly, the anterior margin nearly as wide as the lorica is long, the sides straight, not everted at the anterior margin; pedicle short and stout; animalcule vase-shaped; the peristomal region much constricted, not protruding when extended beyond the margin of the lorica. Length of lorica 1–400″.

HAB.—Fresh water, on *Confervæ*.

The lorica in this species closely resembles that of *C. patula*, but may be distinguished from that variety by its straight lateral borders, as also by the small capacity of extension possessed by the contained animalcule.

Cothurnia irregularis, S. K.

Lorica transparent, subcylindrical, one and a half times as long as broad, the anterior margin not everted, the posterior region slightly inflated, irregularly notched; pedicle curved, produced a short distance within the lorica; animalcule obconical, narrowest posteriorly, very wide at the anterior margin, protruding when extended but little beyond the aperture of the lorica. Length 1–450″. HAB.—Fresh water.

This form in no way agreeing with the *C. nodosa* of Claparède and Lachmann, to which De Fromentel has with doubt referred it, it has become incumbent on the author to propose a new specific title for its distinction.

Cothurnia Cohnii, S. K. PL. XL. FIG. 22.

Lorica elongate-ovate, subcylindrical, about three times as long as broad, rounded and inflated posteriorly, narrowest and attenuate towards the anterior extremity, the frontal margin abruptly truncate, the aperture circular, the posterior third ornamented with four or five conspicuous annular furrows, the remaining portion perfectly smooth; pedicle short and stout, not exceeding one-quarter the length of the lorica; enclosed

* 'Études sur les Microzoaires,' 1876.

zooid attached to the lorica through the medium of a short, transversely annulate, elastic pedicle, which in the extended state nearly equals the body of the animalcule in height; peristome-border very prominent and massive, exserted but a short distance beyond the margin of the lorica. Height of lorica 1–400″.

HAB.—Salt water.

The non-conformance of this type with the *Cothurnia pupa* of Eichwald, as tentatively suggested by Cohn in his description of this elegant type,* has necessitated the substitution of the new title, associated with his own name, that is here proposed. That it is perfectly distinct from the last-named species is at once demonstrated on reference to the original figures and description of that form in Eichwald's 'Infusorienkunde Russlands,' reproduced at Pl. XL. Fig. 23. In the present species the grooves or annulations are confined entirely to the posterior portion of the lorica, which as a whole presents an elongate subcylindrical contour. In Eichwald's *C. pupa*, on the other hand, the general contour is almost evenly ovate, three prominent transverse annulations being distributed at equal distances throughout its length. The lorica of the present species, as described by its discoverer, is remarkable for its brilliant coloration, the margins, as in certain Cryptomonads, reflecting a brilliant scarlet hue, while a paler roseate tint suffuses the intervening area.

Cothurnia pupa, Eichw. PL. XL. FIG. 23.

Lorica symmetrically ovate, widest centrally, tapering evenly towards each extremity, about twice as long as broad, sometimes slightly constricted beneath the terminal aperture; surface ornamented with three raised transverse annuli, one encircling the centre of the lorica, the two others at equal distances between the centre annulus and the anterior and posterior extremities; colour brown; pedicle short, about one-fourth the length of the lorica. Dimensions unrecorded. HAB.—Fresh water.

Cothurnia gracilis, S. K. PL. XL. FIG. 12.

Lorica attenuate, curved, three and a half times as long as broad, widest and rounded posteriorly, gradually tapering towards the narrow and curved anterior region, the anterior aperture minute, truncate, and not everted; pedicle short, thick, and transversely rugose; animalcule, when contracted, ovate, with a nipple-like anterior projection. Length of lorica 1–250″.

HAB.—Salt water, on minute Crustacea.

The author obtained a single example only of this species, in February 1878, at St. Heliers, Jersey, attached to a thoracic appendage of the crustacean *Nebalia bipes*, having there associated with it as messmates *Spirochona Nebalii*, previously described, and the singular Trematode *Saccobdella Nebaliæ* of Professor C. J. Van Beneden. The exceedingly attenuate and graceful contour of the lorica of this species readily distinguishes it from all previously recorded types, its curvature, however, to some extent, approximating it to the *Cothurnia curva* of F. Stein. The animalcule was not observed in its expanded state, the crustacean to which it was attached having unfortunately been immersed in a preservative fluid prior to its discovery.

* 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xvi., 1866.

Cothurnia arenata, Mereschk.

Lorica transparent, subcylindrical, slightly curved, about twice as high as broad, its walls irregularly undulate; the anterior aperture even, neither constricted nor everted, obliquely set; supporting pedicle stout, one-third the height of the lorica, dilated at its base or point of attachment; enclosed animalcule elongate, pyriform, contracted and attenuate posteriorly, attached to the bottom of the lorica without any intermediate prolongation of the pedicle. Height of lorica 1–200″.

HAB.—Salt water: White Sea (Mereschkowsky).

Cothurnia pontica, Mereschk. PL. XL. FIG. 11.

Lorica urceolate or pitcher-shaped, about twice as long as broad, the two sides of the anterior margin elevated and expanded in a lip-like manner, terminating posteriorly in an exceedingly short boss-like pedicle, which is supplemented by a somewhat longer interiorly produced hollow conical peduncle, to which the body of the animalcule is attached; the posterior half of the lorica ornamented by four or five strongly developed transverse annulations. Animalcule not observed in the living state. Length of lorica 0·0171 millim. HAB.—Salt water: Black Sea (Meresch.).

This species is figured and described by M. C. Mereschkowsky in the 'Annals and Magazine of Natural History' for March 1881.

GENUS XV. PYXICOLA, S. K.

(Lat., *pyxis*, box; *colo*, to inhabit.)

Animalcules attached posteriorly within a corneous lorica, the lorica erect and usually mounted on a pedicle; a discoidal corneous operculum, similar in consistence to the lorica, developed beneath the border of the peristome, and which, when the zooid is retracted, effectually closes the orifice of the lorica.

Excepting for the presence of the corneous operculum, which closes down and protects the animalcule from interference from without, the representatives of this genus agree entirely with those of *Cothurnia*. So long, indeed, as a single representative only of this type was known, it seemed desirable to retain it in that genus; recent investigation has, however, elicited the existence of so many additional operculiferous forms, that it has become desirable to institute a new generic group for their reception.

Pyxicola operculigera, S. K. PL. XL. FIG. 39.

Lorica transparent when young, dark chestnut brown when old, ovate, slightly gibbous, about twice as long as broad, posteriorly attenuate, the anterior margin slightly oblique; pedicle transparent, slender, straight, often twice the length of the lorica; enclosed animalcule subcylindrical, protruding to a considerable length beyond the aperture of the lorica, bearing beneath the peristome a circular opercular-like disc similar in colour

and consistence to the substance of the lorica. Length of the lorica 1–400″. HAB.—Brackish water.

This species was originally figured and described by the author in the 'Monthly Microscopical Journal' for May 1st, 1869, under the title of *Cothurnia operculigera*. The specimens furnishing this description were obtained from the brackish waters of the Victoria Docks, in connection with one of the periodical excursions of the Quekett Microscopical Club, and were first submitted to the author's notice by Mr. Walter Reeves, of the Royal Microscopical Society. The most distinctive feature of this form is afforded by the great relative length of the pedicle, which, with the exception of *P. socialis*, is equalled by no other known species. An essential distinction subsisting between the present species and the last-named type is afforded by the contour of their respective loricæ, which is in the one case perfectly smooth and in the other transversely annulate, to which it may be added that the pedicle, while more often curved in *Pyxicola socialis*, is in *P. operculigera* invariably rectilinear. The species now under notice was found abundantly on the polyparies of *Condylophora lacustris*, as also on other aquatic plants and animals growing upon the timber in the docks; in one instance as many as four individuals were met with attached to the lorica of a larger and closely allied member of the same family group, i. e. *Vaginicola crystallina*; this particular example is figured in the original description and illustration above quoted.

Pyxicola pyxidiformis, D'Udk. sp. PL. XL. FIG. 41.

Lorica symmetrical, subfusiform, widest and angular in the centre, tapering towards the two extremities, each of which is truncate, the posterior one being the narrower; the front margin bearing a disc-shaped operculum which closes the aperture when the animalcule is retracted; pedicle transparent, about one-fourth the height of the lorica; the lorica and operculum in the mature zooids opaque, rich chestnut brown, transparent when young. Animalcule when extended protruding to some distance beyond the aperture of the lorica. Height of lorica 1–150″.

HAB.—Fresh water.

D'Udekem* remarks that the operculum of this interesting form, described by him under the title of *Cothurnia pyxidiformis*, is apparently attached to the body of the animalcule, but at the same time, as shown in the accompanying illustration, figures it as though fastened in a hinge-like manner to the front margin of the lorica.

Pyxicola pusilla, S. K.

Lorica urceolate, curved and slightly gibbous, the anterior aperture obliquely set, narrowest anteriorly, rounded and inflated posteriorly, about twice as long as broad; colour dark chestnut brown when old, transparent when young; pedicle very short, permanently transparent, averaging one-tenth of the length of the entire lorica. Contained animalcule regularly conical, widest anteriorly and tapering gradually towards its attachment to the lorica, which is effected through the medium of a short boss-like protuberance; the operculum conspicuous only in the older individuals, elevated to but a short distance beyond the aperture of the lorica; endoplast band-like, spirally curved. Length of lorica 1–500″.

HAB.—Fresh water, among *Lemnæ*.

* 'Infusoires de la Belgique,' 1864.

Pyxicola affinis, S. K. PL. XL. FIGS. 28 AND 29.

Lorica urceolate, slightly curved, gibbously inflated, about twice as long as broad, rounded and widest posteriorly, slightly constricted beneath the narrow and obliquely truncate distal aperture; colour deep chestnut brown when old, transparent when young, amber-colour at an intermediate stage; pedicle always transparent, varying from one-third to nearly one-half the height of the lorica. Contained animalcule protruding but little beyond the orifice of the lorica, thick and subcylindrical, tapering posteriorly, attached to the bottom of the lorica without the intermedium of a boss-like prominence; operculum massive and conspicuous. Length of lorica 1–300″.

HAB.—Pond and marsh water.

The contour of the lorica in this species so nearly resembles that of *Pyxicola pusilla* that the author was at first disposed to regard it as a mere variety of that form. Having, however, obtained examples from several remote localities, namely, Wandsworth Common, London; Leicestershire, and the Channel Islands, that in all instances possessed the characters given in the above diagnosis, its claim for separate specific recognition can scarcely be set aside. The distinction between these at first sight apparently closely allied forms is moreover found on closer examination to be considerable. The dimensions of the lorica of the present type are, in the first instance, very much longer, added to which may be cited the much greater relative length of the pedicle, the thicker and more cylindrical contour of the enclosed animalcule, and the direct and more simple character of its attachment to its domicile. The species appears to be of solitary habits, only two or three examples being found on each occasion where it was met with. Like *Pyxicola pusilla*, it was usually obtained attached to *Lemna* or other aquatic plants, its companion in the Channel Islands habitat being the interesting biflagellate type *Eutreptia viridis*.

Pyxicola furcifer, Hutton sp.

Lorica ovate, narrower and slightly constricted anteriorly, its aperture obliquely set; pedicle short, one-sixth of the length of the lorica. Animalcule transparent, subcylindrical, dilated anteriorly, attached directly to the bottom of the lorica; ciliary disc apparently bearing at its lateral angles four robust bifurcating stylate cilia; operculum conspicuous only in the adult individuals; colour of lorica, operculum, and basis of attachment of the pedicle deep chestnut brown, the pedicle transparent. Height of lorica 1–500″. HAB.—Fresh water: New Zealand.

This species, figured and described by Professor F. W. Hutton, of Otago, New Zealand, in the 'Journal of the Royal Microscopical Society' for May 1878, under the title of *Cothurnia furcifer*, finds its natural place in the present genus. The contour and proportions of the lorica agree most nearly with those of *Pyxicola pusilla*, but the contained animalcule, according to the figure and description quoted, presents in the adornment of its ciliary disc an altogether anomalous characteristic. In no known representative of the Vorticellidæ has the presence of similar stylate appendages in this region been recorded. A somewhat similar optical aspect to that represented in Professor Hutton's woodcut is, however, frequently produced through the intersection at their lateral edges of the inner and outer peristomal wreaths of cilia, and it is not improbable that a like interpretation is applicable in the present instance.

Pyxicola socialis, Gruber sp. PL. XL. FIGS. 16, 30, AND 31.

Lorica ovate or urceolate, produced anteriorly into a narrower distally expanded neck, the central region ornamented with three distinct grooves or annulations; pedicle equalling or slightly exceeding the length of the lorica, straight or irregularly curved; body extending but slightly beyond the aperture of the lorica; the oral side of the peristome bearing a circular indurated operculum of the same colour and consistence as the lorica. Length of lorica 1–250".

HAB.—Salt water, social; colour of lorica dark brown in adult examples, yellow or colourless in younger specimens.

This species, originally described by Dr. August Gruber,* in company with *Thuricola operculata* and other interesting forms, under the title of *Cothurnia socialis*, is appropriately named in allusion to its eminently gregarious habits. While isolated specimens are met with, it more usually happens that a single primary lorica, as shown at Pl. XL. Fig. 30, gives support to three or four more, producing in the aggregate a pseudo-compound colony-stock remarkably suggestive of the compound "polythecia" of the flagellate genera *Dinobryon*, *Stylobryon*, and *Polyœca*, described in the preceding volume. In other words, as Dr. Gruber suggests, "the species affords an example of the least modified form of a compound animal or 'stock'; the connection of the various personæ forming it being of the loosest description." According to its discoverer, there is developed in this type, on the inner edge of the peristome on the oral side, a very delicate funnel-shaped or collar-like membrane, identical, he says, with the structure usually described as a bristle-like cilium (*soie de Lachmann*). This membrane, which is evidently homologous with the collar-like membrane of *Opercularia*, bounds the mouth externally as an outwardly sloping wall, being highest immediately opposite this orifice, and gradually sloping away on either side. Particles of food hurled against it by the action of the cilia of the disc are at once swept into the oral entrance, while those missing it are whirled away from the animal.

It appears desirable to identify with *Pyxicola socialis* the somewhat nondescript organism, half Rotifer and half Infusorium, figured and described by Mr. John Davies in the 'Journal of the Royal Microscopical Society' for October 1879, under the title of *Cothurnia corrugata*. The contour of the lorica agrees entirely with that of Gruber's species, except that two cusp-like processes would appear, in accordance with the figures given, to be usually developed at the posterior extremity. Mr. Davies' summary of the morphological characters of the contained animalcule, as shown in the following quotation, serve no other purpose beyond that of revealing a surprising lack of acquaintance with even the most elementary details of the organic beings among which he would allocate the subject of his discovery:—

"The cephalic extremity of the animal (Rotifer) when extended is of an oval form, hardly as long or as broad as the aperture of the lorica. The head is furnished with two strong cilia, or more properly speaking, setæ, which are forked to about half their length, a follicle being observed at their base. The thread-like appendages (setæ?) move with a spasmodic jerk, and are very irregular in their action. They may be probably covered with a glutinous matter, as they are frequently observed to bend towards the central vortex, possibly to deposit particles that have adhered to them. At the end of the thoracic tube is what seemed to be a mastax. In this part of the animal are situated two contractile vesicles, one on either side of the jaws. No eyes were apparent. Towards the posterior extremity is a light coloured and rather large vessel, which I believe to be the anus. The footstalk has, I believe, a central cord as in *Vorticella*, but I am not certain on this point. It does not at any time contract its stalk; in fact, it exhibits no motion in this part of its organization."

A serious analysis of the foregoing diagnosis will not be attempted, but it may be suggested that the so-called forked setæ or thread-like appendages therein

* 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xxxiii., 1879.

mentioned may be accepted, as in the case of *P. furcifer*, as representing the intersecting peripheral elements of the ordinary Vorticellidan ciliary wreath, and which are for the most part alone distinctly visible during energetic action. From the time of Leeuwenhoek, who in the year 1675 first described a bell-animalcule or *Vorticella* as possessing two little anteriorly developed horns,* similar horn-like or setose appendages have been ascribed to various members of the same family group. This misinterpretation, while excusable to the early investigators labouring with simple lenses of their own manufacture, is however scarcely expected of an F.R.M.S. of the nineteenth century, working, as Mr. Davies admits, with a $\frac{1}{12}$-inch objective, and having the accumulated experiences of two centuries to fall back upon.

Pyxicola socialis has been recently reported by Mereschkowsky † from the Solowetz Islands, in the White Sea.

Pyxicola Carteri, S. K. PL. XL. FIG. 40.

Lorica elongate subcylindrical, three times as long as broad, rounded and attached posteriorly by a very short or rudimentary pedicle, constricted at a little distance below the even, slightly oblique, anterior margin, the side walls more or less irregularly undulate; animalcule attenuate, projecting when extended to a considerable distance beyond the orifice of the lorica; the operculum borne on the infero-lateral surface of a conspicuous conical protuberance that projects from beneath the peristome-border; colour of lorica and operculum yellow or dark brown according to age, animalcule transparent. Dimensions unrecorded.

HAB.—Fresh water: Bombay (H. J. C.); *Victoria Regia* House, Botanic Gardens, Regent's Park (S. K.).

The above name was first conferred upon an infusorial form included in some MS. notes upon the Infusoria of Bombay, kindly placed at the author's disposal by Mr. Carter, and which has been since personally obtained developed in great abundance on *Confervæ* and other water-plants growing in the comparatively hot water of the *Victoria Regia* House in the Regent's Park Botanic Gardens. The irregular undulation of the walls of the lorica readily distinguishes it from all of the species previously enumerated. In his original drawing, Mr. Carter has represented the anal aperture as debouching at the apex of the conical projection which supports the operculum; but in this particular the author anticipates there has been some misconception, so essential a deviation from the typical histological formula being scarcely probable.

GENUS XVI. PACHYTROCHA, S. K.

(Greek, *pachus*, thick; *trochos*, wheel.)

Animalcules loricate, corresponding in all points with those of *Pyxicola*, with the exception that a fleshy pad is developed in place of the indurated operculum distinctive of that genus.

Pachytrocha cothurnoides, S. K. PL. XL. FIG. 32.

Lorica transparent, urceolate, somewhat gibbous, widest and inflated posteriorly, the anterior aperture somewhat obliquely set, about twice as long as broad, mounted on a pedicle which rarely equals one-quarter of its

* See Vol. I. pp. 4 and 8. † 'Annals of Natural History,' March 1881.

total length; animalcule subcylindrical, projecting but little beyond the orifice of the lorica; fleshy operculum thick and tumid, enclosing, in common with the body sarcode, numerous refringent corpuscles. Length of lorica 1–500″. HAB.—Pond water.

This remarkable type was obtained by the author in June 1880 attached to leaves of *Myriophyllum* taken from the lake in Kew Gardens. The singular swelling beneath the peristome which occupies the place of the horny operculum in *Pyxicola*, and acts as effectually as a cork or plug to bar the aperture of the lorica from intrusion when the animalcule is retracted, may be appropriately compared to that abnormally swollen condition of the human throat known as goitre. Excepting for its perfect transparency, the lorica of this species corresponds essentially in both size and contour with that of *Pyxicola pusilla*.

GENUS XVII. STYLOCOLA, De Fromentel.

Loricæ and enclosed animalcules as in *Vaginicola*, but the zooids attached to the bottom of their loricæ through the medium of numerous stylate processes.

Two representatives of this genus only have so far been recorded, both of which inhabit fresh water. It is desirable that the nature of the posterior attachment of the animalcules to their loricæ should be further investigated, as the brief description and figures given by De Fromentel,* leave room for a doubt whether or not these so-called stylate processes may not prove to be the longitudinal striation of an internal pedicle, or the rays of an adhesive organ as in *Spirochona*. Should De Fromentel's interpretation prove correct, the posterior stylate appendages would appear to correspond with the posterior setæ of *Astylozoon* rather than with the short pedicle of many ordinary *Vaginicolinæ*.

Stylocola striata, From. PL. XL. FIG. 2.

Lorica short, vase-shaped, the breadth almost equalling the length, slightly inflated posteriorly, the anterior margin slightly everted, united with its basis of support by a boss or button-like protuberance; animalcule attenuate, cylindrical, very elastic, protruding when expanded beyond the margin of the lorica to a distance equal to one-half of its total length, attached to the bottom of the lorica by a fan-shaped expansion of numerous long, stout, stylate processes; the cuticular surface coarsely striate transversely. Length of lorica 1–450″. HAB.—Fresh water.

Stylocola ampulla, From.

Lorica transparent, sessile, subcylindrical, attenuate, rather over twice as long as broad, slightly inflated posteriorly, contracted towards the anterior end; animalcule cylindrical, attached to the bottom of the lorica by a few short, stout, stylate processes, not protruding far beyond the aperture of the lorica; surface smooth. Length of lorica 1–400″.

HAB.—Fresh water.

* 'Études sur les Microzoaires,' 1876.

GENUS XVIII. PLATYCOLA, S. K.

(Greek, *platus*, flat; *colere*, to inhabit.)

Animalcules as in *Vaginicola*, but the lorica always decumbent and attached throughout one entire side to its fulcrum of support.

To the type form of this genus, the *Vaginicola decumbens* of Ehrenberg, a large number of species recently figured and described by De Fromentel are here added; all of these are included by him, in his 'Microzoaires,' as representatives of the typical genus *Vaginicola*.

Platycola decumbens, Ehr. sp. PL. XL. FIGS. 33 AND 34.

Lorica decumbent, oval, depressed, transparent when young, becoming dark brown when older, not developed anteriorly in a neck-like manner; body hyaline, considerably exserted during extension, and projected at right angles to the part contained within the sheath. Length of lorica 1–280″. HAB.—Fresh water, on various aquatic plants and animals.

The author has not unfrequently found small specimens of the pond-snail *Planorbis* sp., whose shells were almost entirely encrusted with the loricæ of this abundant species. As in *Vaginicola* and *Cothurnia*, two zooids are often developed by longitudinal fission within the same domicile.

Platycola mollis, From. sp.

Lorica decumbent, bottle-shaped, three times as long as broad, somewhat wrinkled and irregular posteriorly, produced anteriorly towards one side into a short and straight, abruptly truncate, not everted neck; animalcule very contractile, yellow, scarcely reaching, when extended, to the aperture of its lorica; integument finely punctate. Length of lorica, with neck, 1–300″. HAB.—Fresh water.

Platycola dilatata, From. sp. PL. XL. FIG. 43.

Lorica broadly bottle-shaped, the breadth almost equalling the total length, bordered round its side of attachment with a frill-like extension of its substance; neck short, narrow, constricted at its base; colour pale yellow; animalcule large, subcylindrical, broadest anteriorly, transparent, extensile to a considerable distance beyond the aperture of the lorica; parenchyma finely granulate. Length of entire lorica 1–300″.

HAB.—Fresh water.

Platycola regularis, From. sp.

Lorica smooth, elliptical, about one and a half times as long as broad, ventricose, developed anteriorly into a short, narrow, and somewhat dilated neck, which is usually bent slightly upwards, colour pale yellow; animalcules when contracted ovate, transparent, not yet observed in their extended state. Length of lorica 1-350″. HAB.—Fresh water.

Platycola truncata, From. sp.

Lorica oval, rounded at the base, truncate anteriorly, having no projecting neck, occasionally with a few transverse plicæ, the margin of attachment slightly expanded in a frill-like manner; colour yellow; animalcule transparent, subcylindrical, posteriorly attenuate, extensile to a considerable distance beyond the margin of the lorica. Length of lorica, 1–400″. HAB.—Fresh water.

Platycola striata, From. sp. PL. XL. FIG. 42.

Lorica colourless, elliptical, ventricose, one and a half times as long as broad, developed anteriorly into a very short truncate neck, the surface of the inflated body portion ornamented with numerous, usually eight, transverse striæ, distributed at even distances between the neck and the posterior extremity, the surface of attachment supplemented with a narrow frill-like lamina; animalcule cylindrical, transparent, surface finely punctate. Length of lorica 1–350″. HAB.—Fresh water.

Platycola gracilis, From. sp.

Lorica transparent, subcylindrical, about twice as long as broad, rounded and slightly inflated posteriorly, aperture obliquely truncate, not taking the form of a separate neck; surface of attachment expanding in a frill-like manner; animalcule trumpet-shaped, massive, transparent; vestibular bristle very conspicuous. Length of lorica 1–400″.

HAB.—Fresh water.

De Fromentel mentions that the vestibular bristle, in addition to being conspicuous, is often reflexed in a ring-like form, and so figures it; from his description and illustration given it would appear that the animalcule possesses a distinct membranous lip or collar as occurs in the genera *Opercularia* and *Lagenophrys*.

Platycola longicollis, S. K. PL. XL. FIG. 35.

Lorica smooth, evenly ovate, depressed, prolonged at its anterior extremity into a long, narrow, obliquely elevated neck, whose length equals that of one-third of the ovate body portion; colour varying from yellow to chestnut-brown; the animalcule projecting when extended to a distance equal to the length of the neck of the lorica from the aperture of that structure. Length of entire lorica 1–200″. HAB.—Fresh water.

This species, as first figured, without an independent specific description, by De Fromentel,* is referred by him to the *Vaginicola decumbens* of Ehrenberg, from which type, however, it may be at once distinguished by its long obliquely directed neck. Examples of this species have been recently received by the author through Mr. John Wood from the neighbourhood of Dundee. In external contour the lorica closely resembles that of the Heterotrichous form *Follicularia Boltoni* previously described.

* 'Études sur les Microzoaires,' 1876.

GENUS XIX. LAGENOPHRYS, Stein.

Loricæ ovate or pyriform, adnate or laterally attached, with a small, contracted, and often valvular anterior aperture; animalcules irregularly ovate, occupying the anterior region of the lorica, and adherent throughout the peristomal region to the margin of the aperture; ciliary disc laterally attached, separately stalked as in *Opercularia*, protrusible to a considerable distance beyond the aperture of the lorica, the free edges of the peristome usually produced around the base of the extended disc in the form of a membranous frill or collar; the remainder of the oral system, endoplast, and contractile vesicle as in all ordinary Vorticellidæ. Increasing within the cavity of the lorica by oblique fission or gemmation. Inhabiting fresh water; mostly ectoparasitic or commensal.

The animalcules of this genus exhibit in the lateral attachment of their ciliary disc and membranous collar a close affinity with the genera *Opercularia* and *Pyxidium*. *Lagenophrys* may further be accepted as connecting the loricate and illoricate Vorticellan groups, the more indurated cuticle of certain representatives of the genus *Opercularia*, as already shown, frequently remaining in a loricate form after the decay of the internal body-substance. The species so far discovered are all inhabitants of fresh water, and are to be found attached to Entomostraca and other aquatic animals.

Lagenophrys vaginicola, Stein. PL. XL. FIGS. 36–38.

Lorica elongate, cordate, having at its broader anterior end a circular aperture with two even, semicircular, prominent, valvular or lip-like processes, which are raised or depressed when the enclosed animalcule protrudes or retracts itself; enclosed animalcule ovate, adherent by its narrow peristome to the orifice of the lorica. Length of lorica 1–380″, greatest width 1–640″. HAB.—Fresh water, attached to *Canthocamptus minutus*.

The author has frequently obtained this species attached to the caudal hairs of the above-named Entomostracon.

Lagenophrys ampulla, Stein. PL. XL. FIGS. 44–46.

Lorica depressed, nearly orbicular, resembling a plano-convex circular lens, but having an anterior, projecting, everted rim in front of the oral aperture, this projecting rim ornamented with a moniliform pattern; animalcule similar in form to the sheath. Diameter of sheath 1–480″ to 1–360″.

HAB.—Fresh water, attached to the branchial appendages of *Gammarus pulex* and *Asellus aquaticus*.

Lagenophrys nassa, Stein. PL. XL. FIG. 47.

Lorica nearly spherical, plano-convex as seen in profile and emarginate at the anterior or oral extremity; mouth of the lorica prolonged at its margin into a subcylindrical, flexible, longitudinally plicate and toothed lip-like extension, which, when closed on the retreat of the animal, some-

what resemble in shape the mouthpiece of a clarionet. Length of lorica 1–400″.

HAB.—Fresh water, attached to the leg joints of *Gammarus pulex*.

This species, while closely resembling the preceding in size and general contour, is readily distinguished from it by the peculiar character of the lip-like anterior prolongation, or free edge of the peristome-border. As remarked by Stein, the longitudinally plicate structure of this organ exhibits a remarkable conformity with the longitudinally plicate membrane or pharyngeal rod-fascicle of *Prorodon*, *Chilodon*, and other Holotrichous and Hypotrichous types, and with which indeed it is apparently homologically identical. Examples of this species associated with *Spirochona gemmipara* have been recently received by the author through Mr. Thomas Bolton.

Sub-Family III. OPHRYDINA.

Animalcules excreting and inhabiting a soft mucilaginous solitary sheath or compound zoocytium.

GENUS XX. OPHIONELLA, S. K.

(Dim. Greek, *ophis*, snake.)

Animalcules solitary, elongate, highly contractile, secreting a mucilaginous investing sheath, to the bottom of which they are not permanently attached; oral system as in *Vorticella* and *Ophrydium*; endoplast linear; contractile vesicle spherical, anteriorly situated.

The representatives of this genus resemble isolated stalkless zooids of the genus *Ophrydium*, from which, however, they differ in not being permanently attached to the bottom of their mucilaginous domicile in either a sessile manner or through the medium of a pedicle. The single species so far observed is an inhabitant of fresh water.

Ophionella picta, S. K. PL. XLI. FIGS. 22 AND 23.

Body transparent, elongate vermiform, subcylindrical, slightly inflated posteriorly, highly elastic, protruding when expanded to a considerable distance beyond the aperture of its sheath, the cuticular surface smooth or finely granular. Length of extended body, 1–150″.

HAB.—Fresh water, on aquatic plants.

This species was obtained by the author in some abundance in the spring of the year 1874, its characteristic mucilaginous dwellings being constructed within the angles formed by the filamentous branchlets of a leaf of *Myriophyllum spicatum*. A single example of the same form was likewise encountered, but at the time imperfectly observed, on *Anacharis* received from Mr. Thos. Bolton, of Birmingham, in December of the year 1872. The attitude assumed by the animalcules in their expanded condition is very elegant, they at such times protruding nearly one-half of their body beyond the aperture of the sheath, and throwing the extended portion into various graceful curves. On the slightest disturbance the body is withdrawn to the bottom of its sheath, and contracted into a small ovate mass. In demonstration of the non-permanent character of the attachment of the animalcule to the bottom of its domicile, an example was observed on one occasion to vacate it and to wander off in quest probably of a more productive feeding ground. In addition to

the similarity that subsists between the animalcules of this species and the detached zooids of *Ophrydium*, a still more marked one perhaps exists between the same and the permanently attached naked animalcules of D'Udekem's *Gerda fixa* previously described.

GENUS XXI. OPHRYDIUM, Ehrenberg.

Animalcules elongate, subcylindrical, highly contractile, growing in attached or free-floating social clusters, and exuding a common coalescent mucilaginous investing matrix or zoocytium, within which the bodies are withdrawn at the time of contraction, generally united to each other or to their basis of support by a simple or branching pedicle, but occasionally sessile; peristome and adoral system as in the ordinary Vorticellidæ; ciliary disc on the oral or ventral side usually greatly elevated; contractile vesicle spherical, subcentral, with a canal-like diverticulum, which ascends to and surrounds the peristome; endoplast elongate, cord-like, often convolute. Inhabiting salt and fresh water. Increasing normally by longitudinal, but occasionally by transverse fission.

By many writers *Ophrydium* has been separated from the ordinary Vorticellidæ, and been made the type of a distinct family group under the title of the Ophrydina. It is evident, however, that its distinctive feature, as represented by the common mucilaginous matrix, may be regarded as a compound modification only of the lorica of *Vaginicola* and its allies, being in conjunction with that more indurated structure derived through a redundant development of or exudation from the hyaline cuticle. The passage from one group to the other is moreover clearly indicated through the newly introduced genus *Ophionella*, the sheath of which permanently retains the soft and plastic consistence characteristic of the lorica of *Vaginicola* in its earliest or immature condition. An essentially analogous socially constructed mucilaginous matrix or zoocytium has been already described in connection with the several Flagellate genera *Phalansterium*, *Spongomonas*, and *Proterospongia*, and in the author's opinion obtains also, with various complex modifications, throughout the entire class of the Spongida. A further reference to this premised analogy is included in vol. i. pp. 171 and 176.

Ophrydium versatile, Müll. sp. PL. XLI. FIGS. 1–9.

Bodies flask-shaped, ovate or globular when contracted, attenuate when extended, usually exhibiting a slightly inflated, subfusiform central portion, a conically pointed posterior extremity, and a cylindrical and neck-like anterior region; the cuticular surface finely annulate throughout and also longitudinally plicate towards the posterior region; vestibular fossa very capacious, occupying the entire space between the highly elevated ciliary disc and border of the peristome, continued into a wide ciliated pharynx, and terminating in an elongate œsophagus, the entrance to which is dilated and double-walled, and thence developed backwards to the centre of the body as a narrow and, except when food is passing, scarcely visible tube; parenchyma coloured more or less brilliant green through the presence of innumerable imbedded chlorophyll-granules; zooids forming extensive and mostly free-floating social clusters of a more or less globose

form, united to each other by a slender, even, dichotomously branching, thread-like pedicle. Length of extended bodies 1–80″ to 1–35″.

HAB.—Salt and fresh water.

Ophrydium versatile is a species remarkable for the very considerable dimensions attained by its social colonies; while the more normal size of these colonial aggregates may be compared with that of a walnut, it not unfrequently happens that old established stocks present an almost spherical contour with a diameter of no less than five inches. The number of united zooids in these larger colonies must be reckoned at least by millions, and when drifting upon the surface of the water they bear so close a resemblance to similarly shaped detached masses of the fresh-water sponge, *Spongilla lacustris*, that without a nearer examination they may easily be mistaken for that organism. Although a type that has attracted the notice of all the earlier and most modern writers—it being identical with the *Vorticella versatilis* of Müller, and probably also the *Ulva* and *Tremella pruniformis* of Linnæus—it is but quite recently that an exhaustive and accurate account of its more minute anatomy has been placed on record. This has been contributed by Professor A. Wrzesniowski to the number of the 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xxix. Heft. 3, 1877, containing the results of his investigation of *Dendrocometes paradoxus* and other infusorial types already alluded to. Previously it had been represented by the chief authorities, including even Stein, that the adjacent animalcules were quite independent of one another, and simply immersed within or adherent posteriorly to the peripheral layer of their common gelatinous matrix. By Fresenius, nevertheless, so long since as the year 1849, it was reported that an independent thread-like stalk was produced from the posterior termination of each zooid and penetrated nearly to the centre of this matrix, but this observation was not confirmed by subsequent investigation. As now shown, however, by Wrzesniowski, such a thread-like stalk is not only possessed by each animalcule, but all of these stalks are united in a dichotomous manner to one another, and form in the aggregate a symmetrical bifurcating thread-like pedicle comparable to that of an *Epistylis*, and produced in a like manner by the repeated longitudinal fission and centrifugal outgrowth of the primary zooids. The common gelatinous matrix within which the whole of this branching pedicle is immersed has also been more generally represented as forming a single, continuous, homogeneous investment, but the authority quoted has shown that by treatment with osmic acid this element is resolvable into distinct subcylindrical areas, each representing the portion formed by a separate individual, and having at its latest produced or distal region an ovate cavity, resembling that of the lorica of a *Cothurnia* or *Vaginicola;* it is within this cavity that the animalcule is found in its contracted state after treatment with the reagent named. Illustrations of this matrix thus treated and of the branching pedicle, reproduced from Wrzesniowski's delineations, will be found in Figs. 4 and 8 of the accompanying plate. In addition to the more ordinary green form of this animalcule Wrzesniowski obtained another in which the colouring matter was entirely absent. Upon this he has proposed to confer the title of *Ophrydium versatile* var. *hyalinum*, retaining that of *O. versatile* var. *viride* for the more normal coloured type. This hyaline variety is shown, however, to differ in so many other more important points that the author is inclined to regard it as a distinct species identical probably with the form next described. Among the chief distinctions cited may be mentioned more especially the considerably smaller size of the zooids, which never attain to one-half of that of the coloured ones, and are only found inhabiting small attached gelatinous matrices of but a few millimetres' diameter, while their supporting stalks are simple or but slightly branched. It was further observed that the stalk in the green variety, immediately beneath its juncture with the body, exhibited frequently three or four prominent annulations, which were never detected in the hyaline form. The phenomena attending the establishment of new colonies by these respective varieties or types present likewise an important divergence. The zooids separated from the parent mass of the coloured form attached themselves freely to whatever substance with which they

come in contact, often selecting as a nucleus for their new establishment the minute gas-bubbles on the surface of the water, and from which were developed the floating spheroidal clusters. In this green variety more usually, also, a number of animalcules congregated together and assisted in the fabrication of the common gelatinous matrix. In the hyaline type, on the other hand, a single zooid only laid the foundation of the new colony, while the leaves of some water-plant were invariably selected as the fulcrum of attachment.

Ophrydium Eichornii, Ehr. PL. XLI. FIGS. 10–18.

Bodies attenuate, cylindrical, subfusiform and tapering posteriorly, mounted on a slender pedicle whose length equals or exceeds that of the extended body, and which is continuous and undivided to its basis of attachment; the cuticular surface finely annulate transversely, very elastic, and enabling the animalcule to assume a variety of positions; parenchyma perfectly transparent and colourless; forming attached hemispherical gelatinous colonies of numerous closely approximated individuals, occasionally dividing by transverse fission. Length of expanded zooids 1–100″ to 1–50″. HAB.—Fresh water, on *Anacharis*.

The author received a species corresponding with the above diagnosis, in some quantity, growing on *Anacharis*, in November 1871, and also in March 1874, from Mr. Thomas Bolton, he having collected it in the neighbourhood of Stourbridge, Worcestershire. At that earlier date it was proposed to distinguish this variety by the title of *Ophrydium longipes*, no other representative of the genus having so far been authentically certified to possess a pedicle which penetrated to the basis of attachment of the common gelatinous mass. A similar feature has nevertheless been since shown by Wrzesniowski to obtain in *O. versatile*, though in the ordinary form of that species it presents a more complex, ramifying aspect.

Since formulating the foregoing diagnosis, the author has obtained access to Ehrenberg's brief diagnosis of his *Ophrydium Eichornii*,* which may be thus summarized:—

Animalcules elongate, hyaline, subfusiform, forming small, hemispherical, transparent polyparies, with centrally radiating caudal setæ, attached to Ceratophyllum and other water-plants. Length of bodies 1–44″ *to* 1–72″.

This *Ophrydium* is further identified by Ehrenberg with a so-called species of *Vorticella*, imbedded in a gelatinous matrix, described by Eichorn in the year 1838. There can be little doubt that the so-called caudal setæ of Ehrenberg's type correspond with the characteristic pedicles of the present form, which exhibit in profile, as shown at Pl. XL. Fig. 10, a similar radiating aspect, while the size, habits, and other details, so far as recorded, agree so completely with those of the author's *Ophrydium longipes* that the two must be regarded as identical and the earlier name of *O. Eichornii* be retained. The author is also inclined to accept Wrzesniowski's var. *hyalinum* of *O. versatile* as synonymous with the present species, this identity being self-evident upon a comparison of the diagnoses of the two forms.

The colonies of *Ophrydium Eichornii* first received from Mr. Bolton contained at the most about one hundred zooids, the entire hemispherical mass yielding in its longest diameter a measurement of about the one-eightieth part of an English inch. Still more recently, April 1881, colony-stocks of much larger dimensions have been obtained through the same source, the finest of them measuring no less than the one-eighth of an inch across and enclosing many hundred animalcules. In some of the smallest colonies examined there were no more than four enclosed zooids, each possessing a long and fully developed pedicle; this last named circumstance is of special importance as distinguishing it from the

* 'Bericht. der Akad. zu Berlin,' p. 191, 1853.

type next described. In no instances was the pedicle branched or even bifurcated, though in some of them nearly double the length of the extended zooid. In *O. viride*, as described by Wrzesniowski, the ramification of this structure is manifested at a very early period, more usually on arriving at a length of one-half or even one-quarter only of that of the animalcule's body. The plasticity of the parenchyma and cuticle in this type would seem to exceed that of either the foregoing or succeeding forms, such plasticity allowing the animalcules to throw themselves into a complicated folded contour as delineated at Pl. XLI. Fig. 11*b*. The increase of this species by transverse fission—a phenomenon of rare occurrence among the Vorticellidæ—was noted on numerous occasions, the zooids so multiplying dividing across the centre, and the ultimately detached anterior half acquiring, a little in advance of this line, an annular zone of locomotive cilia as in the motile zooids of an ordinary *Vorticella*. In the last-named type, however, it is the whole animalcule that becomes disconnected, while in the present instance the posterior half is left attached to the pedicle, and developing a new contractile vesicle and oral system, assumes the form of an ordinary zooid. In this process of subdivision the characteristic cord-like endoplast takes its share. The detached portion swims away in a conical form, as delineated at Pl. XLI. Fig. 19, and settling down lays the foundation of a new colony, or in some instances coalesces probably with other sedentary animalcules to ensure the sexual rejuvenation of the species. This last phenomenon has not, however, up to the present time been actually observed.

As a more recent synonym of *Ophrydium Eichornii* must be included the type figured and described by Dr. H. C. Evarts in the 'American Monthly Microscopical Journal,' vol. i., 1880, under the title of *Ophrydium Adæ*.* The colony-masses obtained from American waters measured in diameter from one-half to two lines, the larger examples including as many as a thousand zooids. No new data are recorded by Dr. Evarts with reference to their structure or development.

Ophrydium sessile, S. K. Pl. XLI. Figs. 19–21.

Bodies hyaline, colourless or of a slightly brownish hue, attenuate, subcylindrical, truncate or tapering posteriorly, sometimes slightly inflated centrally, attached immediately, without the medium of a peduncle, to the fulcrum of support; the cuticular surface finely annulate transversely; zooids forming small hemispherical masses of closely approximated individuals not exceeding one-eighth of an inch in diameter. Length of extended bodies 1–80″. Hab.—Fresh water, on *Anacharis* and other aquatic plants.

This animalcule was received by the author in November 1871, from Mr. Bolton, in company with the species last described, and of which it was at first regarded as the initial or immature condition. Amongst the points favouring its specific distinctness from the type *Ophrydium Eichornii*, it may be mentioned that no examples of this sessile form were found associated with the consignment remitted in the year 1874, and that colonies of as many as from forty or fifty to several hundred stalkless individuals have been met with, while in the last-named type the stalks were fully developed in clusters of as few as four zooids. There can be little doubt that this stalkless species of *Ophrydium* is identical with the animalcule described and somewhat roughly delineated by Mr. H. J. Slack in his 'Marvels of Pond Life,' p. 152, 1st ed., 1861, and there referred with hesitation to the genus *Vaginicola*. The zooids in this instance presented, as at first observed and figured, a more evenly cylindrical contour and a more abruptly truncate base than was exhibited by the examples forwarded by Mr. Bolton, while the parenchyma, instead of being white and transparent, was tinged a brownish hue. After being kept a day, their bodies were

* See also 'Journal of the Royal Microscopical Society,' April 1880.

observed by Mr. Slack to become more pointed posteriorly, and to exhibit towards the centre a fusiform dilatation as in the more normal examples examined by the author.

Quite recently, October 1881, the author has obtained luxuriant colonies of this species attached to *Myriophyllum* growing in a pond in Epping Forest, visited in connection with a field-day of the Epping Forest Naturalists' Field Club. It was observed of examples preserved for some few days that the zooids freely abandoned their original mucilaginous zoocytium, and, reattaching themselves independently, were scarcely distinguishable during such isolated condition from those of *Gerda fixa*, described in a previous page.

Order IV. HYPOTRICHA, Stein.

Animalcules free-swimming, mostly flattened or compressed; locomotive cilia confined to the inferior or ventral surface, often variously modified; the superior or dorsal surface usually smooth or glabrous, but occasionally bearing a few scattered or longitudinal rows of immotile setose cilia; oral and anal apertures conspicuously developed, ventrally located; trichocysts rare.

Excepting for the very considerable augmentation of the number of genera they contain, the several family groups of the Hypotricha embodied in the present volume correspond substantially with those introduced by Stein in the first and second parts of his 'Organismus,' published respectively in the years 1859 and 1867. The only important modification of that author's scheme is accomplished through the transference to this order from the Holotricha of the genera *Loxodes* and *Litonotus* recently shown by Wrzesniowski to be ciliate only on their ventral aspect, and by the slight alteration that has necessarily been effected in the diagnosis of the order through the demonstration by Engelmann and other investigators that certain Oxytrichidæ bear immotile setose cilia upon their dorsal surface. These dorsal appendages are, however, altogether distinct from those which clothe the ventral aspect, being rigid and immotile and taking no part in either the locomotive or prehensile functions. While in many of the more specialized genera of the Oxytrichidæ and Euplotidæ the members of the Hypotricha appear to arrive, though by an entirely different path, at an even higher structural organization than is exhibited by any of the preceding groups, the subordination of others as embryonic or more simple types of the order Peritricha is likewise apparent. This is more especially evidenced in such genera as *Phascolodon* and *Chlamydodon*, and which, excepting for their dental armature, remarkably resemble the embryonic condition of the Peritrichous genus *Spirochona*. But a slight modification would again be required to convert *Psilotricha* into a typical representative of the free-swimming Peritrichous family Halteriidæ; the earlier condition of *Styloplotes appendiculatus* exhibits also a closely analogous affinity. The passage of the Hypotricha to or from the Holotricha and Heterotricha is clearly indicated by such genera as *Chilodon*, *Loxodes*, and *Litonotus*, the characteristic dental armature of the whole of the Chlamydodontidæ pointing more especially to a no very distant union with the Holotrichous forms *Prorodon* and *Nassula*. The more specialized structure of the higher Hypotricha receives full attention in the account given of the family Oxytrichidæ. As typified by this highly differentiated group, the Hypotrichous order occupies the summit of the graduated scale of Ciliate complexity, and may be said, in virtue of the diverse modifications and functions of the appendicular organs, to claim with relation to the preceding sections a position closely corresponding with that held by the Insecta with reference to the lower divisions of the Arthropoda.

In accordance with our present state of knowledge, the succeeding schedule would appear to supply the simplest key to an intelligent apprehension of the numerous families and genera referable to the order Hypotricha.

FAMILIES AND GENERA OF CILIATA-HYPOTRICHA.

A. Cilia of ventral surface uniform, fine and vibratile, not taking the form of setæ, styles, or uncini.

Family.				Genus.
I. LITONOTIDÆ. Animalcules soft and flexible, ventral surface finely ciliate throughout; pharynx unarmed; trichocysts abundant.	Anterior region produced as a more attenuate neck-like prolongation at the base of which the mouth is situated			1. *Litonotus.*
II. CHLAMYDODONTIDÆ. Ventral surface wholly or in part finely ciliate, pharynx indurated or armed with rod-like teeth, no caudal style or fascicle of setæ.	Body inflated, subcylindrical, ventral surface bent obliquely upwards at the anterior extremity			2. *Phascolodon.*
	Body flattened, ventral surface plane throughout.	Cilia distributed over entire area of ventral surface.	Mouth in anterior body-half.	Pharynx armed with a cylindrical fascicle of rod-like teeth	3. *Chilodon.*
				Pharynx armed with a horny tube, having an anteriorly produced sickle-shaped prolongation	4. *Loxodes.*
			Mouth in posterior body-half; pharynx armed with rod-like teeth	5. *Opisthodon.*
		Cilia limited to restricted area of ventral surface.	Body rounded posteriorly, ciliated field with distinct annular border	6. *Chlamydodon.*
			Body attenuated and pointed posteriorly, no annular border to ciliated area	7. *Scaphidiodon.*
III. DYSTERIIDÆ. Ventral surface wholly or in part finely ciliate, pharynx armed or indurated, a caudal style or fascicle of setæ developed at the posterior extremity.	Animalcules encuirassed; caudal appendage stylate.	Carapace formed of two distinct lateral valve-like segments.	Valves of carapace entirely separate throughout	8. *Iduna.*
			Valves of carapace united posteriorly.	Pharyngeal armature complex, consisting of many dissimilar horny pieces	9. *Dysteria.*
				Pharyngeal armature represented by a simple horny tube	10. *Cypridium.*
			Valves of carapace united along the entire dorsal border	11. *Ægyria.*
		Carapace forming a simple convex dorsal shield		12. *Trochilia.*
	Not encuirassed; caudal appendage stylate or setose.	Body subcylindrical; caudal appendage stylate		13. *Huxleya.*
		Body compressed; caudal appendage represented by a fascicle of hair-like setæ		14. *Trichopus.*
IV. PERITROMIDÆ. Ventral surface finely ciliate throughout, supplemented by an arcuate row of powerful adoral cirri; pharynx unarmed.	Animalcules flexible, subreniform, rounded at each extremity			15. *Peritromus.*
	Ventral setæ irregularly scattered, or forming five or more rows, or more or less completely covering the ventral surface.	No frontal or anal styles.	Ventral setæ irregularly scattered	16. *Psilotricha.*
			Ventral setæ forming six oblique rows	17. *Kerona.*
		Frontal and anal styles rudimentary or well developed.	Ventral surface setose throughout; frontal and anal styles rudimentary	18. *Trichogaster.*
			Five or more rows of ventral setæ; frontal and anal styles well developed	19. *Urostyla.*

B.

Cilia of ventral surface variously modified, taking the form of setæ, styles, and uncini.

V. Oxytrichidæ.

Animalcules not encuirassed, flexible or persistent in shape, having usually frontal, ventral, and anal styles, uncini, or setæ; marginal setæ also conspicuously developed.

- Less than five, and mostly only two longitudinal or oblique rows of ventral setæ.
  - Anal styles well developed.
    - Three or four longitudinal rows of ventral setæ; animalcules elliptical, persistent in shape .. — 20. *Onychodromus.*
    - Two straight median rows of ventral setæ.
      - Marginal setæ close to, and resembling the ventral series .. .. — 21. *Amphisia.*
      - Marginal setæ peripheral .. .. — 22. *Holosticha.*
    - One to three oblique rows of ventral setæ.
      - Animalcules evenly ovate or elliptical .. .. — 23. *Plagiotricha.*
      - Animalcules with an inflated central and attenuate anterior and posterior region .. .. — 24. *Epiclintes.*
      - Animalcules with a neck-like anterior prolongation .. .. .. — 25. *Stichochæta.*
  - Anal styles entirely absent.
    - One to three oblique rows of ventral setæ.
      - Inhabiting a mucilaginous domicile.
        - Domicile simple .. — 26. *Stichotricha.*
        - Domicile compound — 27. *Schizosyphon.*
      - Free-swimming .. .. — 28. *Strongylidium.*
    - Two straight median rows of ventral setæ.
      - Attenuate, with a more or less developed caudal prolongation — 29. *Uroleptus.*
      - Ovate or elliptical; no caudal prolongation .. .. — 30. *Stylonethes.*
- Five large, central and usually quincuncially disposed, ventral styles, occasionally supplemented by one or more lateral rows of ventral setæ.
  - With one or more supplementary rows of ventral setæ.
    - With two supplementary rows of ventral setæ.
      - Animalcules soft and elastic, polymorphic .. .. — 31. *Allotricha.*
      - Animalcules persistent in shape .. — 32. *Pleurotricha.*
    - With a single oblique row of supplementary ventral setæ .. .. — 33. *Gastrostyla.*
  - With no supplementary rows of ventral setæ.
    - Animalcules soft and elastic, polymorphic.
      - With three or four caudal setæ .. — 34. *Opisthotricha.*
      - Without caudal setæ .. .. .. — 35. *Oxytricha.*
    - Animalcules persistent in shape.
      - Without caudal setæ.
        - No abnormally developed adoral cirri .. .. .. — 36. *Histrio.*
        - The five anterior adoral cirri abnormally developed .. — 37. *Actinotricha.*
      - Caudal setæ three in number, eight frontal styles .. .. — 38. *Stylonychia.*

VI. Euplotidæ.

Animalcules encuirassed, with ventral and anal styles or uncini; marginal setæ absent or rudimentary.

- Adoral cilia not developed upon the anterior border .. .. — 39. *Aspidisca.*
- Adoral cilia forming a conspicuous fringe along the anterior and left-hand border.
  - Frontal and ventral styles or uncini entirely absent .. .. .. — 40. *Uronychia.*
  - Frontal and ventral styles well developed.
    - Caudal styles five in number, entirely isolated .. .. — 41. *Euplotes.*
    - Caudal styles five in number, united in two fascicles .. .. — 42. *Styloplotes.*

Fam. I. LITONOTIDÆ, S. K.

Animalcules free-swimming, soft and flexible, lanceolate or elongate, having a narrower and often highly elastic neck-like anterior prolongation; the entire ventral surface flat, finely ciliate throughout; the dorsal surface smooth and glabrous, mostly convex; the oral aperture ventral, a series of larger pre-oral cilia mostly developed in advance of the oral aperture; pharynx unarmed; trichocysts usually abundant.

The Litonotidæ, including at present the single genus *Litonotus*, represents one of the lowest groups of the Hypotricha. But for the absence of cilia on the dorsal surface, which up to a very recent date were presumed to exist, the several species closely resemble such simply organized Holotricha as *Amphileptus* and *Loxophyllum*, and to which two genera they have, indeed, been previously relegated. In no other Hypotricha have as yet the existence of trichocysts been demonstrated, and in no other members of this order does the cuticular investment possess so great an amount of elasticity.

Genus I. LITONOTUS, Wrzesniowski.

Animalcules free-swimming, highly flexible, more or less elastic, of elongate outline, the anterior extremity attenuate and neck-like, often exceedingly prolonged; the ventral surface flattened and ciliate throughout, the dorsal aspect smooth and convex; oral aperture situated at the base of the neck-like prolongation, close to the left-hand border; the cortical layer usually enclosing trichocysts; endoplasts two in number, ovate or spherical, closely approximated and united by a cord-like commissure.

The generic title of *Litonotus* has been instituted by Wrzesniowski* for the reception of those animalcules previously referred to the genus *Loxophyllum*, but which he has demonstrated by more precise investigation to be ciliate only on their lower or ventral surface. This last-named structural characteristic has necessitated the transfer of these types from the Holotrichous to the Hypotrichous order of the Ciliata; at the same time they may be regarded as constituting a bond of union between the two, their affinity with *Loxophyllum* and *Amphileptus* on the one hand, and through *Loxodes* to the more typical Hypotricha on the other, being self-evident.

Litonotus Wrzesniowskii, S. K. Pl. XLII. Figs. 12 and 13.

Body elongate, linear-lanceolate, the posterior extremity pointed, depressed, and tail-like, produced anteriorly into a long, flat, very slender, highly flexible and contractile neck-like portion, which is slightly dilated at the distal end, and whose length equals that of about three-fifths of the entire body; oral aperture situated at the base and to the left-hand side of the neck-like prolongation; ventral surface of the body furrowed longitudinally, the cilia short and fine, disposed in even lines along these furrows; the cilia fringing the neck of larger size than those clothing the ventral

* "Infusorien aus der Umgebung von Warschau," 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xx., 1870.

surface of the body proper and tail-like region; an even row of obliquely set trichocysts bordering the entire left-hand margin of the neck; contractile vesicle single, situated towards the posterior extremity of the central body; endoplasts two in number, spherical, located a little in advance of the contractile vesicle; parenchyma of the central portion granulate and opaque, that of the flattened neck and tail-like parts perfectly transparent. Length of extended animalcule 1–75″. HAB.—Pond water, among *Lemnæ*.

Wrzesniowski figures and describes this species under the title of *Litonotus folium*, proposing to identify it with the *Dileptus folium* of Dujardin; a reference to the illustrations and diagnosis of that type as given by the last-named authority, shows, however, that the two are perfectly distinct. In the present instance we have an animalcule corresponding most closely in contour and in the extreme tenuity of the elastic neck with the form already described under the title of *Trachelocerca olor*. In the *Dileptus folium* of Dujardin there is no such extreme attenuation of the anterior extremity, the granulation of the parenchyma is equally diffused from one extremity of the animalcule to the other, and the cuticular surface is described as nodular and presenting a reticulate aspect suggestive of the venation of a leaf, and from which character it received its title. The relative dimensions of the two animalcules are likewise very distinct, for while the length of *Dileptus folium* in its normally extended state equals no more than six or seven times that of its greatest diameter, the same proportions in the present species are as 12 or 13 to 1. It being clearly evident that the form now under notice cannot be held as synonymous with Dujardin's type, it becomes necessary to find a substitute for the specific title given by Wrzesniowski, and it is therefore proposed to confer upon it a name associated with that of the able investigator to whom we are indebted for the true interpretation of the structural characters of this interesting generic group.

Litonotus fasciola, Ehr. sp. PL. XLII. FIGS. 5–11.

Body linear-lanceolate, flexible but not contractile, from five to seven times as long as broad; the dorsal surface smooth and naked, the ventral one longitudinally grooved or striate; the neck-like portion scarcely equalling in length one-half of the entire body, curved at its extremity towards the right, gradually narrowing towards this region, and not sharply distinguished from the body by its greatly diminished diameter as in the preceding species; the tail-like region short, obtusely pointed; oral aperture situated towards the left and a little in advance of the centre of the body; the cilia clothing the under surface of the neck and in advance of the oral aperture, of larger size than those on the remaining ventral surface; trichocysts obliquely set along the left-hand border of this region; contractile vesicle single, situated near the base of the short, tail-like prolongation; endoplasts spheroidal, subcentral. Length 1–300″ to 1–200″.

HAB.—Pond water and vegetable infusions.

This animalcule is identical with the *Amphileptus fasciola* of Ehrenberg and the *Loxophyllum amphileptus* of Claparède and Lachmann. In concurrence with the two last-named authorities, the author is inclined to regard the *Dileptus folium* of Dujardin as likewise synonymous with this species, while the *Amphileptus fasciola* of the same writer is apparently identical with one of the two forms next described. Its reference to the Hypotrichous order under the generic title of *Litonotus* was

effected by Wrzesniowski,* in company with the foregoing and two following species. The observation of this animalcule by so many investigators sufficiently indicates its plentiful and cosmopolitan distribution, it being indeed one of the most familiar of its class, and, though not social in its habits, is rarely absent from pond water containing the commoner species of duckweed, such as *Lemna minor* or *trisulca*.

The author has recently, December 1878, met with examples of this species at an earlier period of growth than has apparently been previously described, and an attentive observation of these onwards to the assumption of their normal adult form has yielded data of high interest closely parallel to those placed on record at page 794 concerning the more typical Hypotrichous species *Aspidisca costata*. This earlier condition of *Litonotus fasciola*, represented at Pl. XLII. Fig. 8, was, when first discovered, regarded as a strange and apparently undescribed infusorial type. Its contour was remarkable, most closely resembling the husk or palea of a barleycorn or some other cereal, the broader end representing the anterior, and the pointed one the posterior extremity of the animalcule. The dorsal surface was inflated, and with the exception of one long central and two proportionally shorter lateral keel-like ridges, smooth and glabrous throughout. These ridges jutted out slightly at the anterior margin, imparting to this region a dentated aspect. A spherical contractile vesicle was conspicuous towards the posterior extremity, the parenchyma in its immediate vicinity being slightly granular, though everywhere else perfectly transparent; no trace of an endoplast or nucleus could be detected at this early period of its development. With the utmost difficulty, using a power of 300 diameters, the flattened or somewhat concave ventral surface was discovered to be clothed throughout with exceedingly fine, closely set, vibratile cilia, these cilia, as time progressed, becoming longer and more distinctly visible. At the end of about half an hour after commencing the observation of this animalcule, the first indications of an impending metamorphosis were perceived. The body, which had hitherto appeared to be enclosed by a rigid and, as already remarked, palea-like dorsal shield, gradually assumed a flexible consistence, while the previously broader and denticulate frontal border became rounded and contracted. The several linear keel-like ridges on the dorsal surface likewise grew more obscure, and finally, with the exception of a faint remaining trace towards the anterior extremity of the central and longest ridge, entirely obliterated. A series of slightly larger pre-oral cilia was now distinctly visible along the left-hand border of the anterior region, and also, with careful manipulation of the light, the central double endoplast characteristic of the adult representatives of the genus. At this stage of its growth, and after the expiration of a little over one hour from the commencement of the author's investigation, the animalcule presented the appearance indicated at Pl. XLII. Fig. 9; the passage onwards to the fully matured specific form, involving little beyond the greater prolongation, curvature towards the right, and increased flexibility of the anterior or neck-like region, was completely accomplished within the succeeding hour. It is worthy of remark that *Litonotus fasciola*, in its most abnormal and earliest observed condition of development, as above described, resembles, to a great extent, excepting for the absence of the pharyngeal armature, the adult form of *Scaphidiodon navicula*, and more especially the shorter and broader varieties of the species represented by O. F. Müller at pl. xxvii. figs. 9–12 of his 'Animalcula Infusoria,' under the title of *Trichoda navicula*. The so-called *Drepanomonas dentata* of Fresenius† is apparently also identical with the immature condition of *Litonotus fasciola* as just described.

Litonotus varsaviensis, Wrz. Pl. XLII. Fig. 4.

Body elongate, linear, transparent, flexible but scarcely contractile, five or six times as long as broad, rounded posteriorly and not produced into a distinct tail-like portion, tapering gradually towards the anterior extremity,

* 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xx., 1870.
† 'Beiträge zur Kenntniss Mikroskopischer Organismen,' Taf. x. figs. 25–28.

which is usually curved towards the right; the oral aperture nearly median; cuticular surface striate longitudinally; pre-oral cilia most conspicuous; trichocysts distributed unevenly throughout the anterior or neck-like region; contractile vesicles five in number, dispersed in a line along the left border of the body; endoplasts spheroidal, subcentral. Length 1–250″.

HAB.—Fresh water.

The large number of contractile vesicles serves to distinguish this species from *L. fasciola*, which in other respects it closely resembles.

Litonotus diaphanus, Wrz.

Body elongate-lanceolate, elastic and flexible, flattened, about six times as long as broad, tapering at each extremity, the anterior one most attenuate and neck-like, directed slightly towards the left; parenchyma granular throughout, food-substances permeating the neck-like region as well as the general body portion; the cuticular surface longitudinally striate on the ventral aspect; trichocysts very long and slender, distributed irregularly throughout the cortical layer; contractile vesicles six in number, disposed in a line along the right-hand border; endoplasts two in number, ovate, united by a cord-like filament. Dimensions unrecorded.

HAB.—Fresh water.

This type is distinguished by the character of the parenchyma, which is granular throughout, and permits the passage of food-particles into the more attenuate neck-like portion, whereas in the preceding species it is retained within the central or body portion only. The trichocysts are also longer and more slender, and irregularly distributed throughout the substance of the cortex. Wrzesniowski has regarded these two characters of the parenchyma and trichocysts as of sufficient importance for the institution on this animalcule of a separate subgenus, which he proposes to distinguish by the title of *Hemiophrys*.

Fam. II. CHLAMYDODONTIDÆ, S. K.

Animalcules free-swimming, ovate, with a convex dorsal and flattened ventral surface; the cuticle elastic or indurated; the ventral surface more or less completely clothed with fine vibratile cilia; the oral aperture opening on the ventral surface, followed by a tubular pharynx, the walls of which are strengthened by a cylindrical fascicle of corneous rods or a simple corneous tube; no stylate appendage or fascicle of caudal setæ at the posterior extremity.

The members of this family group, which corresponds with the Chlamydodonta of Stein, as characterized in the second but not the first volume of his 'Organismus,' are to be distinguished from those of the following family or Dysteriidæ by the entire absence of the caudal style or fascicle of setæ at the posterior extremity. Otherwise, and more especially with regard to the character of pharyngeal armature, the two groups are closely related.

GENUS I. PHASCOLODON, Stein.

Animalcules free-swimming, persistent in form, truncate in front, rounded or pointed posteriorly; the dorsal region convex; the ventral surface plane,

widest anteriorly, and bent upwards towards the dorsal aspect, entirely ciliate; the oral aperture anteriorly situated, pharynx enclosing a cylindrical rod-fascicle. HAB.—Fresh water.

Phascolodon vorticella, Stein. PL. XLII. FIGS. 14 AND 15.

Width of the truncate anterior margin equal to or exceeding half the length of the body, sharply pointed posteriorly; the dorsal surface much elevated and inflated; cilia most conspicuously developed round the anterior margin and the posterior half of the ventral surface; endoplast central, oval, containing a minute spheroidal endoplastule; contractile vesicles two in number, one stationed in front of and the other behind the endoplast. Length of body 1–288″. HAB.—Fresh water.

Viewed from the dorsal surface, this animalcule, with its convex back and ciliated anterior margin towards the observer, presents the aspect of a free *Vorticella*, and it is only when turning over and thus exhibiting its flat ventral surface and characteristic pharyngeal rod-fascicle, that its true nature becomes apparent. Stein never observed this species creep over aquatic substances after the manner of *Chilodon* and its other nearest allies, its habitual motion being that of uninterrupted rotation through the water. This peculiarity, together with its characteristic form, distinguishes this type essentially from the ordinary Hypotricha, and would seem, as intimated by Stein, to indicate its true position as transitional between the last-named order and that of the Peritricha. The younger forms of *Phascolodon*, with the exception of being somewhat more attenuate, differ but little from the adults, and are referred to by Stein as presenting some superficial resemblance to Ehrenberg's *Trichodina vorax*.*

GENUS II. CHILODON, Ehrenberg.

Animalcules persistent in shape, but more or less flexible, subovate, produced anteriorly into a lamellar, lip-like prominence; the dorsal region convex, the ventral surface perfectly flat, entirely ciliate; oral aperture debouching upon the centre of the anterior body-half, succeeded by a tubular pharynx, associated with a cylindrical rod-fascicle, the anterior or distal edges of which are protrusible beyond the cuticular surface; anal aperture postero-terminal; dividing by both transverse and longitudinal fission. Inhabiting salt and fresh water.

Chilodon cucullulus, Müll. sp. PL. XLII. FIGS. 16–22.

Body very flexible, subovate, twice as long as broad, rounded posteriorly, the lip-like projection of the anterior extremity sharply pointed, curved towards the left; the ventral surface ciliate throughout, but the cilia larger and more conspicuous on the front margin and left side of the anterior extremity; an undulating line or groove leading diagonally from the apex of the lip-like prominence to the oral aperture; endoplast ovate or

* A reference to this very doubtful species was inadvertently omitted in the account already given of the genus *Trichodina* (pp. 645 to 649). So far as it is possible to judge from Ehrenberg's figures and brief description the type would appear to represent either an elongate species of *Strombidium* or the detached zooid of some attenuate sedentary Vorticellidan, such as *Epistylis digitalis* or *E. anastatica*.

fusiform, median, with a distinct centrally enclosed endoplastule; contractile vesicles many in number, irregularly distributed. Length of body 1–250″ to 1–84″. HAB.—Salt and fresh water.

This species represents one of the commonest infusorial forms, it abounding in both fresh and salt water and in stagnant infusions. Since under different conditions it presents a variety of aspects, it has, as might be anticipated, received at the hands of independent observers a multiplicity of titles. Among the numerous synonyms that Stein has thus found it necessary to divest this species of in his admirable monograph of the Hypotricha, the following may be mentioned:—*Colpoda cucullulus* and *C. cuculio* of O. F. Müller, *Loxodes cucullulus* and *Chilodon uncinatus* of Ehrenberg, *Loxodes cucullulus*, *L. cuculio*, and *L. dentatus* of Dujardin, and *Chilodon uncinatus*, *Loxodes cucullulus*, *L. cuculio* and *L. brevis*, and *Chilodon uncinatus* of Max Perty. All of these so-called species are now shown to be mere transitional growths or imperfectly observed examples of one and the same type, and for which the distinctive title of *Chilodon cucullulus*, as first applied to it by Ehrenberg, must be retained. A large number of the synonyms above quoted would seem to have arisen from the observation and description of the animalcule in its immature state, and at which period, as shown by Stein, its aspect differs considerably from that of the adult form. Thus while in its mature condition the animalcule, through the greater induration of its dorsal cuticular surface, is tolerably rigid and constant in form, this does not apply to the species when first released from the egg or spore, or when liberated from their characteristic capsular encystments. Under these conditions the entire body is completely soft and plastic, the anterior extremity is more rounded, and the general appearance of the animalcule more nearly approximates that of the Holotrichous genus *Colpoda*. Multiplication by both transverse and longitudinal fission is common in this species, the last named process, according to Stein, being likely to be mistaken for the phenomenon of conjugation. The characteristic oral or pharyngeal rod-fascicle makes its appearance at a very early stage, before indeed the appearance of the cilia or its extrusion from the sporocyst, and is likewise developed in duplicate as a preliminary to the process of longitudinal or transverse fission. Examples of this species were recently obtained by the author in vast quantities from a small road-side gutter near St. Heliers, Jersey. Every individual almost was found to be gorged with small *Naviculæ* and other minute Diatomaceæ, which constitute a favourite diet of this animalcule. Examined with a power of about 700 linear, the disposition of the ventral cilia in fine parallel lines was clearly shown, as also that the cilia upon these lines work in an opposite direction on each side, finally converging at the oblique anterior linear groove, and conducting the current of water down this channel to the mouth. Stein represents this groove as a simple oblique line clothed with a differentiated and more closely approximated fringe of cilia. In specimens killed by the application of osmic acid it was clearly demonstrated, however, that this line is not specially ciliated, but forms a narrow gutter-like channel for the conduct of food-particles to the oral aperture. The elongate ovate endoplast with its enclosed endoplastule was very distinctly exhibited in the majority of examples examined.

The author is indebted to Mr. Charles Stewart, of St. Thomas's Hospital, for the opportunity of examining preserved examples of *Chilodon cucullulus* that are distinguished by a highly interesting development of the elements entering into the composition of the pharyngeal armature. In place of contributing towards the formation of a symmetrical subcylindrical tubular fascicle, as usually obtains, the inferior or proximal denticles more especially are developed backwards to a remarkable extent and recurved upon themselves in the manner illustrated in Pl. XLII. Fig. 20. The general effect produced is suggestive to some extent of the not infrequent development of a rodent's incisor teeth, as brought about through the loss or injury of the opposing set, and which under ordinary conditions restrain their growth beyond the normal limit.

Genus III. LOXODES, Ehrenberg.

Animalcules free-swimming, elastic, but persistent in form, more or less elongate and lamellate; the dorsal surface slightly convex, perfectly smooth and naked, with a marginal border of short, hispid setæ; the ventral surface furrowed longitudinally, clothed throughout with fine, even cilia; oral aperture ventral, subterminal, approached by a channel-like ciliated groove, continued posteriorly into a tubular pharynx; the walls of the pharynx and adoral groove strengthened by a continuous sigmoidal or sickle-shaped indurated membrane; contractile vesicles numerous (?); endoplast compound, racemose.

Out of the numerous species formerly referred to the genus *Loxodes* by Ehrenberg, Dujardin, and Perty, a single type only, *L. rostrum*, is now retained, the remainder being referred in the majority of instances, by more modern investigators, to the several genera *Paramæcium*, *Aspidisca*, *Chilodon*, and *Amphileptus*. Engelmann,* who was the first to recognize the distinctive character of the dorsal and ventral surface of the type form—the cuticle being described by Claparède and Lachmann and all previous writers as evenly ciliate throughout—added to his detection of the marginal border of setæ, presumed he had an undescribed Infusorium under examination, and proposed for it the generic and specific title of *Drepanostoma striata*. Its identity, however, with the *Loxodes rostrum* of Ehrenberg has since been clearly demonstrated by Wrzesniowski,† and its entire structure most carefully worked out. As first intimated by Engelmann, the limitation of the cilia to the lower surface, combined with the presence of the border of marginal setæ, necessitates the relegation of this type to the Hypotrichous section. Among these it claims, with reference to the last-named structural characteristic, a relationship with the setiferous *Oxytrichæ*, while with reference to the oral armature and character of the ciliation, it more nearly approaches *Chilodon*. Through the genus *Litonotus* of Wrzesniowski, *Loxodes* may be further said to retain its connection with the group of the Holotricha with which, up to a recent date, it has been identified.

Loxodes rostrum, Ehr. Pl. XLII. Figs. 1–3.

Body very flexible, flattened, somewhat scimitar-shaped, about four and a half times as long as broad; the anterior extremity curved slightly to the left and terminating in a beak-like point, the posterior extremity also curving slightly inwards in the same direction, and angular on its left-hand border; the oral aperture debouching on the left side of the ventral surface at a little distance from the apical extremity, a distinct adoral groove produced from thence in an arcuate form to the apex of the anterior beak-like point; the tubular pharyngeal cleft extending backwards in an oppositely directed curve towards the right-hand border; the walls of the pharynx and inner surface of the adoral groove strengthened by a continuous brown-coloured, sickle-shaped, corneous induration, the posterior or pharyngeal portion of which alone is tubular, this structure as a whole extending to a distance of nearly one-third of the length of the entire body from the apical extremity; vibratile cilia distributed throughout the longitudinal furrows of the ventral surface, those bordering the anterior and posterior extremities most conspicuous; a fringe of somewhat larger

* 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xi., 1861. † Ibid., 1870.

cilia bordering the adoral groove; marginal setæ very short and fine, scarcely equalling the cilia in length; parenchyma tawny yellow, highly vacuolar; contractile vesicles numerous, posteriorly situated (?); endoplasts numerous, spherical, usually with laterally attached endoplastules, distributed throughout the length of the parenchyma, and connected with each other by a cord-like filament or funiculus; a row of spherical refringent corpuscles usually developed in the vicinity of the right-hand margin of the anterior region of the body; animalcules swimming evenly or rotating on their axis and creeping over foreign substances. Length 1–150″ to 1–50″.

HAB.—Stagnant water.

The vacuolation of the substance of the parenchyma in this species closely resembles that of *Trachelius ovum* or *Noctiluca*, and is sometimes developed to such an extent as to leave beneath the cuticular surface a mere network of protoplasmic trabeculæ. As a rule, the vacuolation is most conspicuous towards the posterior extremity. The incepted food-particles transported from the oral region pass freely into this protoplasmic network and are retained within its substance, in no case intruding into the intervening vacuolar spaces. Claparède and Lachmann, in accordance with the more highly organized multicellar structure claimed by them for the Ciliate Infusoria, have conceded to this food-enclosing network the function of a tubular, ramifying, membrane-bounded intestinal tract, allotting at the same time to the intervening lacunæ the *rôle* of a rudimentary abdominal cavity. The inconstant character of this vacuolar system, however, it presenting a diverse aspect in different examples, and not being permanent in character in even the same animalcules, sufficiently demonstrates the untenability of this interpretation. The possession by *Loxodes rostrum* of distinct contractile vesicles has not up to the present time been definitely established. Claparède and Lachmann are, however, inclined to regard as equivalent to such structures the rounder and more persistent vacuolæ developed at the posterior extremity of the body, and record the periodic inflation and contraction of this entire region. As first pointed out by Johannes Müller, some structures of a peculiar and as yet unexplained nature are found attached to the inner surface of the cortical parenchyma; these are of spherical shape, clear and transparent, enclose a central nucleolar-like body, and are distributed in an even line adjacent to and parallel with the right marginal border. A possible secretive function has been relegated to these bodies by Claparède and Lachmann and other authorities. The racemose development of the numerous spherical endoplasts or nuclei, with their attached endoplastules, is best illustrated, as demonstrated by Wrzesniowski, see Pl. L. Fig. 14, through the employment of a one per cent. solution of acetic acid. In many instances, as pointed out by the last-named authority, the endoplastule, instead of being affixed to the endoplast, is found attached separately to the connecting cord or funiculus, while in other cases it may be entirely absent. The specialized corneous armature of the pharynx and adoral groove, interpreted correctly in the first place by Engelmann, was noticed and described by earlier observers as a mere local aggregation of dark-brown pigment-granules. The peculiar hue of this structure, dark chestnut brown in adult examples, and more transparent in younger individuals, is at once suggestive of the similarly coloured corneous loricæ of various Vaginicolinæ; the chemical composition of the two is probably identical.

GENUS IV. OPISTHODON, Stein.

Animalcules free-swimming, ovate or egg-shaped, the dorsal surface more or less convex, the ventral surface plane, entirely ciliate; oral aperture situated towards the posterior half of the body, supplemented by a cylindrical pharyngeal rod-fascicle. Inhabiting fresh water.

Opisthodon niemeccensis, Stein. Pl. XLII. Fig. 23.

Body elongate-ovate, rounded and widest posteriorly, attenuated and pointed at the anterior extremity, its apex curved slightly towards the right; the centre of the body circumscribed by an inner line or band parallel with that of the outer margin; the dorsal surface moderately convex, the ventral one flat and even; cilia most conspicuously developed towards the anterior region; the oral aperture opening at a distance of about one-quarter the length of the entire body from the rounded posterior end; endoplasts two in number, spherical, located centrally towards the left side; contractile vesicles numerous, a larger one usually situated on the right side, immediately opposite the two endoplasts. Length of body 1–150″. Hab.—Fresh water.

Genus V. CHLAMYDODON, Ehrenberg.

Animalcules free-swimming, persistent in form, ovate or kidney-shaped, the dorsal surface convex, the ventral one plane, bounded by a raised border, its central area alone entirely ciliate; oral aperture situated in the anterior half of the body, supplemented by a pharyngeal rod-fascicle.

Chlamydodon Mnemosyne, Ehr. Pl. XLII. Figs. 41 and 42.

Body short, kidney-shaped, the two extremities equally rounded, the anterior end somewhat the wider, both curved slightly towards the left; the dorsal surface convex, its lateral margin evenly elevated; the ventral surface bounded by a raised, transversely striate border; cilia most conspicuous at the anterior extremity, whence they project as a fringe beyond the margin of the body; mouth debouching upon the centre of the anterior body-half; endoplast single, ovate, subcentral; contractile vesicles numerous, minute; dividing by transverse fission. Length of body 1–300″.

Hab.—Salt water.

Genus VI. SCAPHIDIODON, Stein.

Animalcules free-swimming, scaphoid or boat-shaped, convex above, flattened below; the posterior extremity produced in a beak- or spur-like form, the anterior edge having a lip-like border; the centre field of the ventral surface thickly ciliate; oral aperture anteriorly situated, supplemented with a pharyngeal rod-fascicle. Hab.—Salt water.

Scaphidiodon navicula, Müller sp. Pl. XLII. Figs. 49 and 50.

Body boat-shaped, the breadth equal to about one-third of the total length; the anterior margin truncate, the posterior region attenuate, continued in a spur-like form, with its extremity curved towards the left; the ciliary system of the ventral surface produced in a fringe-like manner beyond the truncate anterior margin; endoplast central, oval; contractile

vesicles two in number, occupying an antero-posterior position on the right side of the body. Length of body, including spur, 1–240″.

HAB.—Sea water.

The type of this species and genus as instituted by Stein is the *Trichoda navicula* of Müller. The likeness that subsists between this animalcule and the immature condition of *Litonotus fasciola* is referred to in the account given of that species.

Fam. III. DYSTERIIDÆ, S. K.

Animalcules free-swimming, more or less ovate, cylindrical, flattened, or compressed, mostly encuirassed, the carapace simple or consisting of two lateral, subequal, conjoined or detached valves; cilia confined to the more or less narrow and constricted ventral surface; the oral aperture followed by a distinct pharynx, the walls of which are strengthened by a simple horny tube, by a cylindrical fascicle of corneous rods, or by otherwise differentiated corneous elements; a conspicuous, tail-like style or compact fascicle of setose cilia, presenting a style-like aspect, projecting from the posterior extremity. Mostly inhabiting salt water.

The representatives of this family were included in Stein's monograph of the Hypotricha,* as a sub-family only of the Chlamydodonta, with which they present many points in common, but are elevated in his succeeding volume,† to the rank of an independent family group for which he retains Dujardin's previously conferred title of the Ervilina, as instituted by the last-named authority for the reception only of the two genera *Ervilia* and *Trochilia*. As shown, however, later on—see genus *Ægyria*—the name of *Ervilia*, adopted by Dujardin, had been previously occupied by Turton to denote a genus of Mollusca, and has consequently, in common with the family title derived from it, to be expunged from the nomenclature of the Infusoria. While closely allied to the Chlamydodontidæ, with which they are most directly united perhaps through the genus *Trochilia*, all the members of the Dysteriidæ may be distinguished by the presence of the peculiar caudal appendage developed at the posterior extremity, and which, with one exception only, takes the form of a pointed spine or style. This caudal spine or style, while rigid in itself, is movable upon its point of attachment as though on a hinge-joint, or rather a cup-and-ball socket, and is utilized by the animalcules for the same purpose as the so-called "foot" or caudal style of the free Rotifera. The aspect of its possessor, indeed, when attached by this *point d'appui* to any convenient fulcrum of support, fishing for its food with its oral cilia, and turning or bending upon its terminal style as though on a pivot, is so strongly suggestive of certain members of the above-named higher class of organisms, that it is scarcely to be wondered that in certain instances, as, for example, in the case of *Dysteria armata*, the rotiferal or infusorial affinities of the organisms should have been a matter of dispute. Certain representatives of the Dysteriidæ, again, manifest a mimetic resemblance to an entirely distinct organic group. Reference is here made to those genera distinguished by their possession of a bivalved carapace, often variously grooved and sculptured, and which, together with their long projecting ventral cilia, imparts to them, as alluded to in the account of the genus *Cypridium*, a remarkable superficial likeness to minute Ostracodous Crustacea. No such compound modification of the carapace is as yet known to exist in any of the remaining groups or orders of the Infusoria. The number of specific types referable to the Dysteriidæ

* 'Organismus,' vol. i., 1859. † Ibid., vol. ii., 1867.

has been greatly augmented by the researches of Messrs. Claparède and Lachmann, recorded in their well-known 'Etudes sur les Infusoires,' published in the years 1858–60.

Genus I. IDUNA, C. & L.

Animalcules free-swimming, encuirassed, oblong, bilaterally compressed; carapace formed of two distinct, entirely separate plates or valves, one being developed on each side of the body; a tail-like style or spine projecting from the posterior extremity of the narrow and finely ciliated ventral groove; the oral aperture opening on the antero-ventral border; pharyngeal armature consisting of a single subcylindrical horny tube.

Iduna sulcata, C. & L. Pl. XLII. Figs. 24–26.

Right valve of the carapace convex, raised into four longitudinal, elevated, angular costæ; the left valve plane, perfectly smooth, not descending so low on the ventral border as the opposite one; tail-like style short and conical; contractile vesicles two in number; pharyngeal tube bent. Length of body 1–175″. Hab.—Salt water: Norwegian coast (C. & L.).

Genus II. DYSTERIA, Huxley.

Animalcules free-swimming, ovoid, encuirassed, bilaterally compressed; the ventral surface entirely ciliate, narrow, and groove-like; carapace composed of two lateral pieces, united to each at the posterior end only of the dorsal margin; pharyngeal armature complex, consisting of an annular, compound, anterior, horny portion, and a long, posteriorly produced stylate process; a tail-like spine projecting from the posterior region of the ventral groove.

Dysteria armata, Hux. Pl. XLII. Figs. 27–30.

Valves of carapace oval, the right one more convex, its surface smooth; the left valve traversed near its dorsal margin by a longitudinal angular ridge, not extending so far forward as the right one; ventral style lanceolate, situated at a distance of one-fifth of the length of the body from the posterior extremity, its proximal portion hollow; stylate process of the pharynx produced upwards and backwards through the centre of the body to the point opposite the origin of the ventral style; the contractile vesicle single, subcentral; an amethyst-coloured globule or pigment-spot invariably developed immediately above the anterior or annular portion of the pharynx. Length of body 1–350″ to 1–250″. Hab.—Salt water.

Immediately succeeding the description of this animalcule by Professor Huxley* some discussion arose concerning the question of its true affinities. While its discoverer pointed out, what is now a generally acknowledged fact, that it exhibited a close structural correspondence with the *Euplotes* (*Ægyria*) *monostyla*, misquoted "*macrostyla*," and the *Chlamydodon mnemosyne* of Ehrenberg, Mr. P. H. Gosse, dissenting from this interpretation, advocated the opinion† that the structure

* 'Journal of Microscopical Science,' 1857, p. 78.

† Ibid., p. 138.

of *Dysteria* was altogether too complex for an infusorial animalcule, and that its correct position was more probably among the more highly organized Rotifera somewhere near the genera *Monocerca* and *Mastigocerca*. Mr. Gosse at the same time suggested that this type might be regarded as an annectant form between the Rotiferæ and the Ciliate Infusoria. Among the large number of undoubted Infusoria now known to possess an essentially equivalent type of structure, and here included under the family title of the Dysteriidæ, those assembled under the new generic title of *Cypridium* most closely resemble the present type. These in a like manner possess a somewhat unsymmetrical bivalvular carapace, the dorsal borders of which are posteriorly united to one another, and are also provided with a similar posteriorly attached caudal style. The only substantial point of distinction between the two is found in the character of the pharyngeal armature, which in *Dysteria* is far more complex than in other members of the same family group.

The more minute details of the indurated pharyngeal apparatus of *Dysteria*, as described by Professor Huxley, may be suitably reproduced. The oral fossa is, in the first instance, strengthened by a curious curved rod, which terminates superiorly in a bifid tooth, while inferiorly it appears to become lost in the walls of the fossa. This is followed by the pharyngeal apparatus proper, which may be said to consist of two portions—an anterior, somewhat rounded mass, in apposition with a much elongated, styliform posterior portion. As intimated by Prof. Huxley, it is very difficult to assure oneself of the precise structure of the complex anterior portion. It appears, however, to form a deep ring composed of three pieces—two supero-lateral and mutually corresponding, united with a third, inferior, azygos portion. The element last named is somewhat triangular, with a broad base and rounded obtuse apex. This apex is directed forwards and immediately underlies the oral aperture, while the base is turned backwards and unites with the two supero-lateral pieces. Each of these latter is concave internally, and convex externally, so as to form a segment of a circle, and presents a clear median space, the optical expression either of a perforation or of a much-thinned spot. The anterior edge of each supero-lateral piece is nearly straight, but the posterior border is convex, and articulates with, or is apposed to, the anterior extremity of the posterior or styliform division of the apparatus. Viewed laterally, this posterior portion appears to consist of two styles which are somewhat like nails in shape, their anterior extremities being truncated so as to somewhat resemble a nail-head, while the posterior extremity seems to taper to a fine point. Rather in front of the middle of its inferior edge each style apparently gives off a short process downwards, which process is, in botanical language, decurrent upon the style. Careful examination of the dorsal or ventral aspect of these parts shows that the decurrent process is in fact only the optical expression of a delicate membrane, which is bent so as to have a ventral convexity, and connects together the two styles. It might be said, therefore, that the posterior part of the apparatus is a triangular membrane, deeply excavated in front, bent so as to be convex downwards, and having its margins thickened and produced into styliform enlargements. This curious piece of mechanism is directed upwards and backwards, and terminates in the substance of the body without any apparent connection with other parts.

From the foregoing description of the pharyngeal armature of *Dysteria* as recorded by Professor Huxley, it is evident that the elongate and backward produced so-called styliform appendage or posterior portion only of this apparatus coincides with the more ordinary pharyngeal armature of *Iduna*, *Ægyria*, and other representatives of the same and preceding family groups, the components of the complex annular anterior portion being entirely accessory. It may be further remarked that this coincident pharyngeal portion, as above described, exhibits a type of structure midway between that of the simply tubular corneous induration of *Iduna* and the cylindrical rod-fascicle of such types as *Chlamydodon* and *Chilodon*. The animalcules which furnished the material for Professor Huxley's description were remitted him by Mr. Dyster, in whose honour the genus was named, and were found in swarms among confervoid algæ that coated the shells of a *Patella* and a *Littorina* which had

long inhabited a small marine aquarium. A reproduction of the illustrations accompanying the original description of this relatively complex type will be found at Pl. XLII. Figs. 27–30.

Genus III. CYPRIDIUM, S. K.

(*Cypris ; oidos*, like.)

Animalcules free-swimming, encuirassed, elongate ovate or oblong, bilaterally compressed ; the ventral surface ciliated, narrow and groove-like ; the right and left valves of the carapace coalescing with one another at the posterior end only of the dorsal border ; a tail-like spine or style projecting from the posterior extremity of the ventral groove ; pharyngeal armature consisting of a simple, cylindrical horny tube. Mostly inhabiting salt water.

The author has conferred this new generic title upon various species referred by Claparède and Lachmann* to the genus *Dysteria*, from which, however, they are to be distinguished by the simple tubular character of the pharyngeal armature. The superficial resemblance of these bivalved Infusoria to certain Ostracodous Crustacea, such as *Cypris*, has suggested the generic name adopted.

Cypridium lanceolatum, C. & L. sp. Pl. XLII. Figs. 31–33.

Valves of carapace ovate, much narrower posteriorly, the left one having a raised, arcuate, longitudinal costa, extending the whole length of and adjacent to the dorsal region, emarginate at its anterior border ; the right valve perfectly smooth and rounded ; pharyngeal tube slender, straight, developed backwards to the centre of the body ; the posterior or caudal style lanceolate, equal in length to nearly one-half the diameter of the carapace ; the cilia longer and more thickly developed at the anterior extremity ; contractile vesicles two in number, situated near the ventral surface ; endoplast single, spherical, subcentral. Length of body, 1–350″.

Hab.—Salt water : Norwegian coast (C. & L.).

This species is identical with the *Dysteria lanceolata* of Claparède and Lachmann.

Cypridium spinigerum, C. & L. sp. Pl. XLII. Fig. 34.

Valves of carapace elliptical, the more convex valve having a single longitudinal sulcus and two spinous prominences on the dorsal border ; the opposite one plane, smooth, and entire ; caudal style long and slender. Length of body 1–400″. Hab.—Salt water.

A very imperfect description of this genus is given by Claparède under the title of *Dysteria spinigera*, and in which it is left undetermined whether it is the right or left valve that is sulcated and bears the spinous processes, while no details are recorded concerning the pharyngeal tube, nor as to the dimensions of the animalcule. It is stated, however, to be smaller than the species last described, *C. lanceolatum*.

Cypridium aculeatum, C. & L. sp.

Valves of carapace elliptical, subequal ; the right valve the more convex, having a marginal dorsal crest which terminates anteriorly and posteriorly

* 'Études sur les Infusoires,' 1858-60.

in a minute spine; the left valve with a less developed crest and a posterior spine only; pharyngeal tube simple, slightly curved. Length of body 1–250″. HAB.—Salt water: Norwegian coast.

This species corresponds with the *Dysteria aculeata* of Claparède and Lachmann.

Cypridium crassipes, C. & L. sp.

Valves of carapace elliptical, widest posteriorly, united throughout the posterior half of their dorsal surfaces; both equally and entirely smooth; the caudal style very thick, its proximal extremity hollow, its distal one sharply pointed; pharyngeal tube simple, short, and straight; contractile vesicles two in number; endoplast spherical, subcentral. Dimensions unrecorded. HAB.—Salt water.

Identical with the *Dysteria crassipes* of Claparède and Lachmann.

GENUS IV. ÆGYRIA, C. & L.

Animalcules free-swimming, encuirassed, oblong, more or less bilaterally compressed, valves of carapace two in number, united throughout the dorsal border. A movable tail-like style projecting from the posterior extremity of the ventral groove. Pharyngeal armature consisting of a simple horny tube. Inhabiting salt and fresh water.

The more extensive coalescence of the valves of the carapace upon their dorsal border serves to distinguish this genus from the preceding one. Many of its members have been described, in the first place by Dujardin and subsequently by Stein, under the generic name of *Ervilia;* but as this title has been previously employed by Turton in the year 1822 for a genus of the Mollusca, and also by Link for a genus of leguminous plants, the one of *Ægyria*, proposed as a substitute by Claparède and Lachmann, is here retained.

Ægyria monostyla, Ehr. sp. PL. XLII. FIGS. 35 AND 36.

Valves of carapace elongate-rectangular, rather wider posteriorly, with rounded corners, about twice as long as broad, the left valve having a raised longitudinal border along the dorsal margin; endoplast ovate, subcentral; contractile vesicles two or three in number. Length of body 1–300″. HAB.—Salt water.

This species is described by Stein under the name of *Ervilia monostyla*, it being regarded by him as identical with the *Euplotes monostyla* of Ehrenberg and the *Ervilia legumen* of Dujardin. In Claparède and Lachmann's work it takes its place under the generic title here retained, as *Ægyria legumen;* since, however, its identity with Ehrenberg's type is considered proved, the specific title first conferred upon it by that earlier authority must necessarily take the precedence.

Ægyria angustata, C. & L. PL. XLII. FIGS. 39 AND 40.

Valves of carapace irregularly ovate, the left valve convex, the right one plane, abruptly narrowed and obliquely truncate anteriorly, the width immediately following this narrower anterior portion nearly equal to the

total length and so continuing to the posterior extremity; the surface of both valves smooth and entire; caudal style short and sharply pointed; pharyngeal tube long and slender, extending nearly to the centre of the body; contractile vesicles two in number. Length of body 1–300″.

HAB.—Salt water.

Ægyria oliva, C. & L. PL. XLII. FIGS. 43 AND 44.

Valves of carapace ovate, but slightly compressed, smooth and entire throughout; the ventral groove wide; caudal style short, conical, situated at some little distance from the posterior extremity, and not projecting beyond its border; a dark eye-like pigment-spot developed towards the anterior end; pharyngeal tube short and straight. Length of body 1–250″.

HAB.—Salt water: Norwegian coast.

The less compressed contour of this form, compared with that of the preceding species, approximates it towards the genera *Phascolodon* and *Chlamydodon* of Stein, from which, however, it differs in its possession of a caudal style and in the character of pharyngeal tube. The dark eye-like pigment-spot at the anterior extremity, observed by its discoverers, is apparently homologous with the so-called amethystine spot or globule in Professor Huxley's *Dysteria armata*, and with the eye-like pigment-spot of *Ophryoglena* and many Flagellata.

Ægyria pusilla, C. & L.

Valves of carapace ovate, small, narrowed anteriorly, their surface smooth and even; ventral groove somewhat widened; caudal style conical, projecting posteriorly. Length 1–600″. HAB.—Salt water.

This form is briefly described by Claparède and Lachmann as being of much smaller size than any other members of the genus they examined, its dimensions not allowing them to ascertain the character of the pharyngeal tube. An animalcule closely resembling this one in size and aspect was observed by the same writers in fresh water from the river Spree, and is regarded by Stein as probably identical with his *Ervilia* (*Ægyria*) *fluviatilis*, next described.

Ægyria fluviatilis, Stein sp.

Valves of carapace ovate, compressed obliquely, truncate anteriorly; the right valve convex, ornamented by five longitudinally raised costæ, the left valve smooth and plane; pharyngeal tube simple throughout, extending backwards to the centre of the body; endoplast ovate, subcentral. Length of body 1–750″. HAB.—Fresh water.

Stein observed examples of this species, which is described by him under the title of *Ervilia fluviatilis*, undergoing the process of transverse fission. The specimens examined were discovered in the clear water of a mountain stream in the neighbourhood of Tharaunch.

GENUS V. TROCHILIA, Dujardin.

Animalcules free-swimming, ovate, encuirassed, with a convex dorsal and plane ventral surface, the anterior extremity usually curved towards

the left; a movable stylate appendage attached to the posterior extremity; cilia confined to a subcentral, curved, band-like area of the ventral surface; oral aperture opening on the anterior half of the body, supplemented by a simple horny tubular pharynx, a single long, stiff cilium or seta projecting externally from the oral fossa. HAB.—Salt and fresh water.

Trochilia palustris, Stein. PL. XLII. FIGS. 51 AND 52.

Body ovate, gibbous, its breadth equal to about two-thirds of its total length, the anterior extremity obliquely truncate, curved towards the left, the stylate caudal appendage equal to one-third of the length of the body, directed towards the left side; the central ciliated band following the curvature of the right side of the body, slightly widest at the anterior end, and gradually tapering towards the posterior extremity; endoplast oval, situated towards the centre of the left side; contractile vesicle single, spherical, occupying a similar position on the right-hand border. Length of body 1–750″. HAB.—Fresh water.

A species having only about half the dimensions of *T. palustris*, but otherwise resembling it, has been described by Wrzesniowski under the title of *T. polonica*.

Trochilia sigmoides, Duj. PL. XLII. FIGS. 47 AND 48.

Body ovate, the posterior extremity rounded, the anterior one pointed, curved towards the left; the dorsal surface of the carapace ornamented with five or six conspicuous longitudinal, somewhat oblique ribs or flutings. Length of body 1–1150″. HAB.—Salt water.

The *Huxleya sulcata* of Claparède and Lachmanni s identified by Stein with this form, and a comparison of the original figure and description of the type given by Dujardin with that of the more recent Swiss authorities, here reproduced, would seem to justify the endorsement of Stein's conclusions.

Trochilia marina, Meresch.

Body oval, slightly compressed; dorsal surface ornamented with two grooves which extend throughout the entire length of the body. Length 1–750″. HAB.—Salt water: Black Sea (Mereschkowsky).

GENUS VI. HUXLEYA, C. & L.

Animalcules free-swimming, persistent in form, but not encuirassed, more or less ovate or subcylindrical, having a narrow entirely ciliate ventral furrow, and a posteriorly developed caudal style; no anteriorly projecting oral seta.

As first pointed out by Stein, the *Huxleya sulcata* of Claparède and Lachmann is synonymous with the *Trochilia sigmoides* of Dujardin. The *Huxleya crassa* of the same authorities is, however, an animalcule exhibiting structural differences sufficient to permit of its being retained as the type of a distinct genus, and simultaneously of rescuing from extinction a world-honoured title that must otherwise

have been banished from zoological taxonomy. The genus *Huxleya*, as typified by *H. crassa*, differs from *Trochilia* in its naked, non-encuirassed cuticular surface, in its almost perfectly cylindrical instead of flattened contour, and in the absence of the long cilium or seta that projects from the oral region. Unfortunately, Claparède and Lachmann failed to ascertain whether the pharynx was armed after the manner of the ordinary Dysteriidæ, though no doubt this structural element will be found, on further investigation, to exhibit characters of important diagnostic value.

Huxleya crassa, C. & L. PL. XLII. FIGS. 37 AND 38.

Body oval, subcylindrical, equally rounded at the two extremities, about one and a half times as long as broad; a raised circular border developed at a short distance from the posterior extremity, such border imparting to the animalcule, in conjunction with the rounded caudal region and appended style, an acorn-like aspect. Length of body 1–350".

HAB.—Salt water: Norwegian coast (C. & L.).

GENUS VII. TRICHOPUS, C. & L.

Animalcules free-swimming, not encuirassed, compressed, the narrow band-like ventral surface entirely ciliate, terminating posteriorly in a compact fascicle of setose cilia, which takes the place of the caudal style in the preceding Dysteriidæ; oral aperture followed by a cylindrical pharyngeal rod-fascicle; endoplast single, ovate; contractile vesicle single, spherical, situated near the posterior extremity.

Trichopus dysteria, C. & L. PL. XLII. FIG. 46.

Body subpyriform, about twice as long as wide, largest and inflated posteriorly, abruptly narrowed towards the anterior extremity; the dorsal and lateral surfaces entirely smooth; the posterior ciliary fascicle short and pointed, having a styloid aspect. Length of body 1–200".

HAB.—Salt water: Norwegian coast.

Though no reference to such a structure is made in the text, Claparède and Lachmann represent, in their illustration of this species, a single long recurved cilium as projecting from the anterior extremity, and which, if it actually exists, probably corresponds with the somewhat similar projecting oral cilium or seta developed in the genus *Trochilia*. The posterior fascicle of cilia in this type—apparently homologous with the single stylate appendage occupying the same position in the ordinary Ervilinæ—is of especial interest, its origin and significance being comparable with the analogous structure subsisting in the Peritrichous *Urocentrum*, with reference to the genus *Gyrocorys*.

Fam. IV. PERITROMIDÆ, Stein.

Animalcules free-swimming, ovate or reniform, with a plane ventral and convex dorsal surface; the oral aperture ventral, debouching upon the posterior angle of an excavated peristome-field, the outer or left-hand border of which bears an arcuate fringe of large powerful adoral cilia or cirri;

the remaining portion of the ventral surface dotted with fine vibratile cilia only, never developing supplementary setæ, styles, or uncini.

The as yet single known representative of this family combines the characters of the two groups of the Chlamydodontidæ and Oxytrichidæ, it uniting the simply ciliate ventral surface of the former—as typified by the genus *Chilodon*—with the edentulate pharynx, excavate peristome-field, and arcuate fringe of adoral cilia characteristic of the latter. Its passage to the ordinary Oxytrichidæ is clearly through the genus *Kerona*, with which, except for the presence of vibratile cilia in place of fine setæ on the ventral surface, it would appear to closely correspond. The isolation of *Peritromus* as the type of an independent family group, upon which he confers the title of the Peritromina, is accomplished by Stein in the second volume of his 'Organismus.'

GENUS I. PERITROMUS, Stein.

Animalcules free-swimming, reniform, depressed; peristome-field extended backwards to the centre of the ventral surface; no ventral or anal styles or setæ; the whole under surface dotted with short fine cilia which are distributed in closely approximated longitudinal lines; endoplast double; contractile vesicle situated near the posterior edge of the peristome; anal aperture sub-terminal.

Peritromus Emmæ, Stein.

Body reniform, widest posteriorly, about twice as long as broad, both extremities equally rounded; the right lateral margin convex, the left one indented centrally; peristome-field bow-shaped or arcuate, extending backwards to the median line, its outer edge bordered with long powerful adoral cirri; fine, short, vibratile cilia distributed in many parallel lines over the remaining ventral surface. Dimensions unrecorded.

HAB.—Salt water.

In general contour, and in the form and character of the peristome, this species closely resembles *Kerona polyporum;* added to which, however, is the uniform ciliary clothing of the under surface characteristic of *Chilodon cucullulus.* No illustration of this interesting form, which has so far been observed by Stein only, has as yet been published.

Fam. V. OXYTRICHIDÆ, Ehr.

Animalcules free-swimming, ovate or elongate; usually with a flattened or concave ventral and a more or less convex dorsal surface; peristome-field ventral, triangular or arcuate; oral ciliary system consisting of an outer or right-hand marginal fringe of powerful adoral cirri, which is frequently supplemented by an oppositely reflected or left-hand marginal series of smaller pre-oral cilia, and more rarely by a median series of lax and attenuate endoral cilia; locomotive cilia setose, stylate, or uncinate, variously distributed upon the remaining ventral surface and forming separate sets or groups, distinguishable as the *frontal, ventral, anal, marginal,* and *caudal* series; supplementary, immotile, hispid, or hair-like

setæ occasionally developed upon the lateral margin, and more rarely on the dorsal aspect; oral aperture debouching upon the posterior angle of the peristome-field, followed by a short tubular unarmed pharynx; the anal aperture ventral, located at a little distance from the posterior extremity; contractile vesicle single, endoplasts usually two or four in number. Inhabiting salt and fresh water; movements ambulatory or natatory.

With the Oxytrichidæ we arrive not only at the most highly specialized group of the Hypotricha, but, in many respects, at that also of the entire class of the Infusoria-Ciliata. Structural differentiation is manifested more particularly in this family in the remarkable development and relegation to varied purposes of the appendicular or locomotive organs, and which, while in all instances more or less complex modifications of ordinary cilia, exhibit mostly a wide departure from the structures bearing that title as met with in the orders previously described. By many earlier writers, indeed—as explained more at length in the introductory chapter, see pp. 64 and 65—these appendages were regarded as distinct organs, and have been distinguished by the respective titles of setæ, styles, and uncini, &c.; these terms are, however, in this treatise retained only in an adjective or qualitative sense. Although at first sight

FIG. 1.

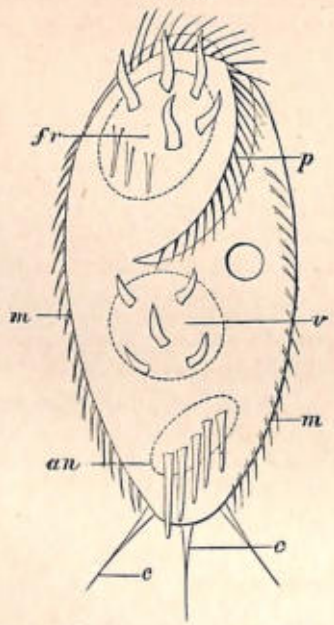


FIG. 2.

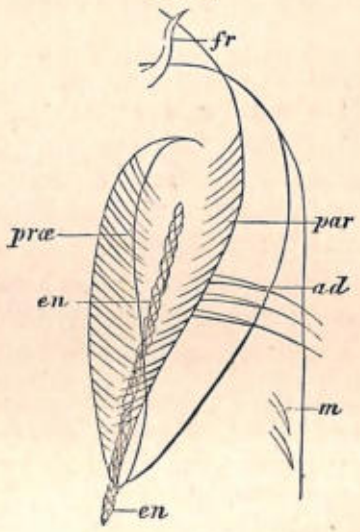


FIG. 1.—Diagrammatic outline of *Stylonychia mytilus*, illustrating the several ciliary systems; *p*, peristomal ciliary series; *fr*, frontal, *v*, ventral, *an*, anal styles; *m*, marginal, and *c c*, caudal setæ.

FIG. 2.—Peristomal ciliary system of *Gastrostyla Steinii* (after Sterki); *ad*, adoral, *præ*, præoral, *par*, paroral, and *en*, endoral series; *fr* and *m*, isolated elements of the frontal and marginal systems.

there appears to be but little uniformity in the character and distribution of the cilia upon the under surface of the more highly differentiated members of this family, it will be found on closer examination that a certain common plan underlies and is predominant throughout. What this plan is, is best understood by a brief study of the formula of arrangement exhibited in such a type as *Stylonychia mytilus*, diagrammatically represented in Fig. 1 of the annexed woodcut, and which is found to include all the elements, suppressed in some instances and exaggerated in others, that occur in any of the numerous genera belonging to the group of the

Oxytrichidæ. Apart from the peristome and its special series, presently referred to, the modified cilia of the ventral surface may in this form be resolved into as many as five distinct systems or groups. The first of these (*fr*) occupying the anterior and right-hand region of the ventral aspect, or the one closely corresponding with that relegated on the left side to the peristome-field, is distinguished by the title of the "frontal" series. The normal number of the variously modified frontal cilia in *Stylonychia* and certain other allied genera is seven or eight, out of which the more anterior three or four are of unusually large proportions and claw-like or uncinate in shape, the remaining smaller ones being stylate or setose; all of these elements are more or less elastic, capable of flexure in various directions, and fulfil the *rôle* of anterior ambulatory appendages. The several genera, *Psilotricha*, *Kerona*, *Stichotricha*, and *Stichochæta*, furnish examples in which the frontal styles are entirely undeveloped or suppressed, while in *Stylonethes* and certain species of *Urostyla* the more normal number of eight is considerably exceeded.

The second and, for the purposes of generic discrimination, most important group is that known by the name of the "ventral" series, and which, as its name implies, occupies the most central area of the ventral aspect. In *Stylonychia*, as indicated at *v* in the accompanying woodcut, and in some other genera, this ventral group consists of five setose, stylate, or uncinate cilia only, whose disposition is more or less quincuncial. These five primary ventral cilia are, in a few genera, supplemented by one or more rows of usually smaller ventral setæ, or, as occurs in considerably the larger number of genera, is entirely replaced by a greater or less number of such rows. In no member of the Oxytrichidæ, as at present known, are the ventral styles or setæ entirely unrepresented, and the value of the characters afforded by these elements, as an index to the leading generic subdivisions, becomes apparent on reference to the schedule of the families and genera of the Hypotrichous Order given on a preceding page.

The anal ciliary series (*an*), forming the third group, is stationed towards the posterior extremity of the body and in close contiguity to the anal aperture. These cilia are mostly of a stylate form, and often of more considerable size than those of the co-associated groups. In the majority of instances, as exemplified in *Stylonychia*, they are five in number and of a more or less rigid consistence, though not unfrequently, as in *Pleurotricha*, they are flexible and participate with the ventral and frontal series in the office of perambulation. In four genera only, among the Oxytrichidæ, viz. *Stichotricha*, *Strongylidium*, *Uroleptus*, and *Stylonethes*, is the anal series entirely unrepresented. The fourth or "marginal" ciliary series (*m*) is composed usually of short setose cilia, which form a more or less even fringe down each lateral border; these mostly meet together or are uninterrupted posteriorly, and present but a slight amount of variation. In no member of the family is the marginal series entirely absent, though in certain types, such as *Amphisia*, its normal character of a bilateral peripheral fringe is departed from, the two lateral rows being removed far inwards, close to the two central rows of ventral setæ, with which in both size and aspect they closely correspond. The fifth and but rarely represented group is the caudal series (*c*), consisting of from two to four long hair-like setose cilia, which project in a tail-like manner from the posterior border. In those animalcules in which caudal setæ occur, such as *Stylonychia*, it is worthy of note that the marginal series is posteriorly interrupted, and that the former may therefore be interpreted as representing abnormally developed elements only of the marginal set and not as a wholly independent group. In addition to the from four to five ventral groups of cilia just enumerated, it has been recently shown by Engelmann* that, in *Stylonychia mytilus* and many other species, a supplemental peripheral fringe of fine immotile hispid cilia is developed externally to the marginal series, these in certain cases—e. g. *Plagiotricha* (*Gonostomum*) *affinis* and *Oxytricha pelionella*—being produced likewise in even longitudinal rows over the entire dorsal aspect.

The peristomal or oral ciliary system of the Oxytrichidæ is somewhat complex

* 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xi., 1861.

As already indicated in the diagnosis of the family characteristics, the peristome field or oral region is of a more or less triangular or arcuate form, and may be associated with no less than three or even four distinct ciliary series. The most conspicuous and essential of these series, being indeed never absent, is that bordering the outer or left-hand margin, distinguished by the title of the "adoral" fringe. The constituent cilia of this series are long and powerful, of a cirrate aspect, and admirably adapted for the production, while the animalcule is stationary, of a constant food-laden stream towards the oral aperture, while in the natatory condition they constitute the chief organs of propulsion. According to Sterki,* each individual cilium of this series is much compressed or lamellate, broad at its base, and gradually tapering towards its distal extremity. A similar contour prevails also in the adoral cilia of *Stentor* and other Heterotricha, and likewise in those of *Halteria*. As mentioned on a previous page,† it has been proposed by the authority last mentioned to distinguish such lamellate cilia by the name of "membranellæ." The second series of cilia, mostly but not invariably associated with the peristome-field, is that fringing its reflected right-hand or inner border, and which is not unfrequently, as in *Stylonychia mytilus* and *Onychodromus grandis*, supplemented with or even entirely replaced by a band-like undulating membrane. This second fringe of cilia has received from Sterki the title of the "pre-oral" series. The third series, of still less common occurrence, while indicated by Stein in *Pleurotricha* and certain species of *Oxytricha* and *Urostyla*, but described by him as an elongate groove, conducting to the oral aperture, also owes its correct interpretation to the investigations of Sterki. It occupies a position midway between that of the adoral and pre-oral fringes, and consists of a linear series of exceedingly attenuate vibratile cilia, which taken separately present a close resemblance to flagella. This central series, which descends posteriorly through the oral aperture into the tubular œsophagus, is denominated by Sterki the "endoral" system. A fourth, but as yet rarely observed series has been reported by the same authority as obtaining in *Gastrostyla*, and this he proposes to distinguish as the "paroral" one. It occurs as an even fringe of fine cirrose cilia, corresponding with those of the pre-oral system, but of still smaller size, produced down the whole inner margin of the band-like border, from the right side of which the powerful adoral cirri or cilia project. The relationship of all the several ciliary systems here enumerated is clearly indicated in Fig. 2 of the accompanying woodcut illustrating the peristomal region of *Gastrostyla Steinii*, as interpreted by Sterki. A diagrammatic outline of the same region as developed in *Stylonychia mytilus*, will be found at Pl. XLV. Fig. 1.

Genus I. PSILOTRICHA, Stein.

Animalcules encuirassed, flattened, more or less oblong; having two rows of long median ventral setæ, and a border of similar setæ developed around the periphery, but possessing no frontal or anal styles; endoplast double. Inhabiting fresh water.

The indurated carapace and absence of the frontal styles serve to distinguish this genus from *Uroleptus*.

Psilotricha acuminata, Stein. Pl. XLIII. Figs. 1–3.

Body shortly oblong, about twice as long as broad, widest and broadly truncate anteriorly, tapering abruptly backwards from the centre, curved towards the left and terminating in an oblique sharply acuminate point; peristome-field extending nearly to the centre of the body, broadly tri-

* "Beiträge zur Morphologie der Oxytrichinen," 'Zeit. Wiss. Zool.,' Bd. xxxi., 1878.
† Vol. I. p. 65.

angular, its reflected border ciliate; setæ of the median ventral rows few in number, including about five or six in the right and three in the left-hand row, long, slender, and widely separated; marginal setæ few, distant, and similar in character to those of the ventral series; contractile vesicle developed close to the centre of the left lateral border, exhibiting at systole short canal-like prolongations; endoplasts double, median, one situated in advance of and the other posterior to the terminal border of the peristome. Length 1–300″ to 1–240″.

HAB.—Fresh water.

The scattered and irregular disposition of the ventral and marginal setæ, together with their attenuate form, lend to this species an untidy aspect that serves to distinguish it readily from all other members of the Hypotrichous group. The irregular development of the stylate appendages is found to extend itself to the large adoral cirri, which are also comparatively few in number and widely separated.

GENUS II. KERONA, Ehrenberg.

Animalcules free-swimming, persistent in shape, flattened or plano-convex, subreniform; possessing no true frontal, ventral, or anal styles, but in place of these several arcuate rows of short ventral setæ; a row of similar but longer marginal setæ forming a continuous fringe around the peripheral border; endoplast usually double; contractile vesicle single, spherical, situated near the posterior border of the peristome. Inhabiting fresh water.

Kerona polyporum, Ehr. PL. XLIII. FIGS. 4 AND 5.

Body kidney-shaped, plano-convex, the anterior end evenly rounded, the posterior extremity slightly pointed, the right border convex, the left one deeply indented centrally; setæ of the ventral surface disposed in six subparallel rows, three of which originating close to the right-hand margin of the peristome, extend obliquely nearly to the left-hand border of the posterior half of the body, the other three shorter rows confined to the anterior body-half; the five hindermost setæ of the most posterior row larger than any of the preceding and apparently representing the five anal styles of the more normal Oxytrichidæ; peristome-field extending backwards nearly to the centre of the body, its inner border ciliate, reflected at an acute angle, and almost parallel with the outer one; cilia of the external or left-hand peristome-border very long and fine, forming with the marginal setæ an almost uninterrupted fringe around the animalcule's body. Length 1–190″ to 1–120″.

HAB.—Fresh water, occurring as an ectoparasite or commensal on various species of *Hydra*.

This animalcule is among the first discovered infusorial forms, it having attracted attention through its frequent occurrence—in company with *Trichodina pediculus*—upon the surface of the fresh-water polypes *Hydra fusca* and *H. vulgaris*. By many earlier writers the distinctions between *Kerona* and *Stylonychia* have been very insufficiently defined, but in accordance with the diagnosis of the present genus as

amended by Stein and here abbreviated, the distinction is shown to be clear and decisive. It was originally premised that this species preyed upon the living tissues of the polype which serves it as a host, the characteristic thread-cells of the higher organism being frequently found inside it. Such structures, however, are only incepted with other waste matter thrown off from the surface of the polype's integument, and in the removal of which its tiny guest undoubtedly plays the *rôle* of a useful scavenger. Other food-matters, such as monads, desmids, and diatoms, are devoured with equal avidity, and form an important addendum to its customary bill of fare.

The generic title of *Alastor* was proposed for this type by Max Perty.

Genus III. TRICHOGASTER, Sterki.

Animalcules free-swimming, more or less ovate, the entire ventral surface clothed with minute setose cilia, a few of slightly larger size representing the frontal, and four or five of similar size the anal series.

Trichogaster pilosus, Sterki.

Body elongate oval; peristome as in *Urostyla*, extending backwards to one-third of the length of the entire body; adoral cilia short, fine, and very closely set. Length 1–115″. Hab.—Fresh water.

A single example only of the animalcule upon which this genus and species is founded has been met with by Sterki, and as indicated by that writer,* it more nearly approaches *Urostyla* and *Kerona* in the character and distribution of its ciliary appendages than any other representative of the Oxytrichidæ. Except, indeed, that the ventral setæ were not determined to be distributed in even longitudinal rows, and that the frontal and anal styles are relatively smaller, there would appear, in the absence of an illustration or fuller descriptive details, to be little distinction between this type and the ordinary members of the genus *Urostyla*.

Genus IV. UROSTYLA, Ehrenberg.

Animalcules free-swimming, flexible and elastic, ovate or elongate, rounded at the two extremities, bearing three or more uncinate frontal styles, five or more rows of median ventral setæ, from five to twelve slender anal styles, and an uninterrupted border of marginal setæ; endoplast single or multiple; contractile vesicle usually situated near the left marginal border. Inhabiting fresh water.

This genus is distinguished from the Oxytrichidæ previously enumerated by the much more luxuriant development of the ventral setæ. While in some species there are not more than five rows of these elements, they very frequently clothe the entire area of the ventral surface outside the peristome-field.

Urostyla Weissii, Stein.

Body elongate-elliptical, about three and a half times as long as broad, widest centrally, gradually tapering towards the two extremities, the anterior end the narrower; peristome-field forming an acute triangle, extending to a little beyond the anterior third of the body, its reflected border

* 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xxxi., 1878.

ciliate, nearly straight; from three to five anteriorly developed ventral styles, which are supplemented by five even median rows of short ventral setæ; the marginal setæ forming a continuous projecting row; anal styles from seven to eight in number; endoplast ovate, double. Length 1–84″.

HAB.—Fresh water.

The *Oxytricha urostyla* of Claparède and Lachmann is identified by Stein with this type, from which furthermore it does not seem possible to distinguish the *Oxytricha multipes* of the same writers. A variety of this species is reported by Mereschkowsky from Lake Onega, that is distinguished by the possession of six instead of five rows of ventral setæ.

Urostyla grandis, Ehr. PL. XLIII. FIGS. 6–8.

Body oblong or ovate, very variable in form, when extended about four times as long as broad, usually widest posteriorly, the anterior extremity tapering and obtusely pointed; peristome-field triangular, its reflected border ciliate, curved inwards at the apical extremity, the intervening space between the inner and outer borders, and more especially towards the right, thickly clad with fine vibratile cilia; the entire angle to the right of the reflected inner border, or that corresponding with that of the peristome-field on the left side of this line, beset with the numerous claw-shaped frontal styles, those nearest the anterior margin being the largest; median ventral setæ usually developed in even longitudinal rows in such luxuriance as to completely cover the remaining ventral surface, but occasionally a few only of these rows represented; marginal setæ rather longer than the ventral ones, forming an uninterrupted projecting fringe; from ten to twelve short anal styles; endoplast cord-like, breaking up into numerous separate ovate nodules; contractile vesicle situated on the left side, near the posterior angle of the peristome. Length 1–60″.

HAB.—Pond water, among *Confervæ*, &c.

Stein attests to having carefully examined innumerable examples of this species without finding, except in a few isolated instances, any trace of a nucleus or endoplast, a circumstance which would seem to supply important evidence with respect to the unessential character of this structure and to its nonconformity with the nucleus of an ordinary histologic cell. The voracity of this large animalcule is remarkable, several rotifers, a *Coleps*, and numerous diatoms and monads representing, as drawn by Stein, the contents of a single individual's internal parenchyma. Although the number of rows of the median ventral setæ vary considerably in this form, the location and arrangement of the anterior styles are constant and afford a safe guide to the recognition of the species, which is moreover the largest known representative of the Hypotrichous order.

The *Oxytricha fusca* of both Perty and Claparède and Lachmann is regarded by Stein as identical with this type.

Urostyla viridis, Stein.

Body lanceolate, three and a half times as long as broad, the two extremities pointed, the anterior one curved slightly towards the left; peristome-field narrow, extending obliquely backwards to about one-third of the length of the entire body, exhibiting no reflected inner border; frontal

styles large, uncinate, three in number only; the entire body surface from the frontal series and the peristome-border backwards covered with closely approximated longitudinal rows of short ventral setæ; marginal series similar to the ventral setæ but a little longer; five inconspicuous non-projecting anal setæ; contractile vesicle spheroidal, located near the centre of the left-hand border; endoplasts two in number, with attached endoplastules; parenchyma usually filled with green chlorophyll-granules. Length 1–215″ to 1–144″. HAB.—Fresh water.

The fine even clothing of short setæ that covers the entire ventral surface of this animalcule imparts to it, in conjunction with the flexible character of its body-substance, an aspect strongly suggestive of a *Paramæcium* or other Holotrichous form, and for which, without the detection of the characteristic but not very conspicuous frontal and anal styles, it might easily be mistaken.

Urostyla flavicans, Wrz.

Body elongate-elliptical, rounded at each extremity, slightly wider posteriorly, three times as long as broad; peristome-field extending backwards to a distance of about one-third of the length of the entire body, its reflected border bearing a conspicuous undulating membrane; frontal ciliary system consisting of three large uncinate styles and four or five scattered setæ; ventral setæ forming five somewhat oblique longitudinal rows, a row each side of similar setæ constituting the marginal series which projects beyond the periphery only at the posterior extremity; anal styles subequal, eight in number, disposed in an oblique row, the posterior one only reaching but scarcely projecting beyond the posterior border; endoplasts ovate, two in number, with attached endoplastules; contractile vesicle canal-like, extending along the whole left-hand posterior peripheral border. Length 1–110″. HAB.—Fresh water.

GENUS V. ONYCHODROMUS, Stein.

Animalcules free-swimming, elliptical, encuirassed; the cuticular surface indented but scarcely flattened, peristome extending backwards to the centre of the body; ventral surface bearing three anterior oblique rows of claw-like frontal styles; from three to four similar central rows of ventral styles, and five or six anal styles; outline of body excluding the peristome-field fringed with an even continuous row of small marginal setæ; endoplasts multiple; contractile vesicle single, spherical, situated near the posterior angle of the peristome. Inhabiting fresh water.

The carapace in the as yet single known species of this genus is described by Stein as being less indurated than that of *Euplotes*, but more so than in *Stylonychia*. From the last-named type, which it somewhat resembles, it is distinguished by the linear arrangement of the ventral styles and by the total absence of caudal setæ.

Oxychodromus grandis, Stein. PL. XLIII. FIG. 13.

Body elliptical, almost rectangular, about two and a half times as long as broad, the two lateral margins parallel, occasionally bent slightly inwards

at the centre, the left angle of the anterior margin of the upper surface of the carapace in adult individuals somewhat obliquely truncate, but in younger ones symmetrically rounded and overlapping the ventral surface; peristome-field triangular, its inner or right-hand border reflected back along the median line, bearing a band-like undulating membrane and a row of fine cilia; three rows of uncinate frontal styles containing collectively from sixteen to twenty-eight elements, the three more anterior of which are much the largest; from fifteen to twenty-one ventral styles disposed in the three or four central rows, and from five to six or seven large, straight, anal styles; endoplasts ovate, usually four in number, each having a minute attached endoplastule. Length 1–240″ to 1–72″.

HAB.—Fresh water.

GENUS VI. AMPHISIA, Sterki.

Animalcules free-swimming, oval or elongate, not encuirassed, soft and elastic; the ventral surface more or less flattened, bearing three or four frontal styles, two or three continuous median rows of ventral setæ, and five or more anal styles; the marginal setæ not projecting at the periphery but forming two outer rows in close proximity to the ventral setæ, with which they correspond in size and character; contractile vesicle single, spherical, situated near the centre of the left-hand lateral border. Mostly inhabiting salt water.

The representatives of this genus have been recently separated by Sterki * from the typical members of the genus *Oxytricha* as here amended, as also from those of *Holosticha*, which they still more nearly approach, with reference to the modification of their marginal setæ. These structures are here removed to a considerable distance from their normal peripheral position and stationed more or less towards the centre of the ventral field; their size and character at the same time correspond so closely with those of the ventral series that they appear to be merely supplementary rows of the same. A closely identical form and disposition of the marginal setæ occur in certain species of *Uroleptus*.

Amphisia gibba, Müll. sp.

PL. XLIII. FIG. 15, AND PL. XLIV. FIGS. 15 AND 16.

Body thick, elongate-elliptical, three and a half times as long as broad, widest in the centre, smaller and equally rounded at the two extremities; the peristome-field narrow, fissure-like, exhibiting no reflected border, extending obliquely to the centre of the anterior third of the body; ventral setæ forming two even, continuous, closely approximated central rows, the marginal setæ similar in character, stationed so close to the ventral setæ as to present the aspect of a third or fourth median series; anal styles five in number, sub-even, projecting for nearly half their length beyond the posterior margin. Length 1–144″. HAB.—Salt water.

Stein regards this species as corresponding with the *Trichoda gibba*, and probably also the *T. fœta* of O. F. Müller. An apparent variety of this type, possessing an additional row of ventral setæ, see Pl. XLIV. Figs. 15 and 16,

* 'Zeitschrift tür Wissenschaftliche Zoologie,' Bd. xxxi., 1878.

here retained under the name of *Amphisia gibba* var. *crassa*, has received from Claparède and Lachmann the title of *Oxytricha crassa*.

Amphisia velox, Quenn. sp.

Body elongate-lanceolate, about four times as long as broad, rounded at the two extremities, the anterior end somewhat wider and curved slightly towards the left; the right border evenly arcuate, the left-hand one bulging centrally in a gibbous manner; frontal styles uncinate, three in number; ventral setæ fine, forming three even median longitudinal rows; a row of similar sized marginal setæ developed outside these on each side and at some distance within the peripheral border; five small, straight, slightly projecting anal styles. Length 1–200″. HAB.—Salt water.

This species is described by Quennerstedt * under the name of *Oxytricha velox*.

Amphisia pernix, Wrz. sp. PL. XLIII. FIG. 12.

Body extensile, highly flexible, much thickened, lancet-shaped, about three times as long as broad, slightly narrower anteriorly; peristome contracted, extending obliquely backwards to the centre of the anterior third of the body; frontal styles entirely absent; ventral setæ minute, forming two closely approximate central rows; marginal setæ equally minute, developed on the ventral surface at a considerable distance from the periphery, and presenting the appearance of two supplementary rows of ventral setæ; anal styles five in number, disposed in an even oblique row, projecting for nearly half their length beyond the posterior border; contractile vesicle situated on the left-hand margin at a little distance behind the median line. Length 1–230″. HAB.—Salt water, Baltic Sea.

Described by Wrzesniowski † under the title of *Oxytricha* (*Holosticha*) *pernix*.

Amphisia Kessleri, Wrz. sp.

Body flexible and highly retractile, elongate-lanceolate, flattened, widest centrally and narrowed towards the two extremities, nearly four times as long as broad; four uncinate frontal styles; two median closely-approximated rows of minute ventral setæ; marginal setæ stationed at a short distance only from the ventral series, to which they correspond in size and character; from twelve to fifteen anal styles, the five posterior only of which present the characteristic stylate aspect and project beyond the posterior border, the three more posterior of these five set further back than the other two and curved slightly towards the right, the remaining seven to ten minute and setose, forming a linear series between the left-hand marginal and central ventral setæ; minute hispid setæ, bordering the peripheral margin of the anterior two-thirds of the body; contractile vesicle situated close to the centre of the left-hand lateral border. Length 1–160″.

HAB.—Salt water: Baltic Sea (Wrz.).

* 'Sveriges Infusoriefauna,' Heft iii., 1869.
† 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xxix., 1877.

The author scarcely concurs in regarding the linear series of minute setæ developed anteriorly to the five large typical anal styles in this species—referred by Wrzesniowski to the genus *Oxytricha*—as belonging to the anal group, their contour and disposition indicating rather their identity with an imperfectly developed supplementary row of ventral setæ. The close affinity of this type to the *Amphisia* (*Oxytricha*) *velox* of Quennerstedt—from which species, indeed, it would appear to differ most essentially, the above interpretation of the so-called anal setæ being correct, in the possession of two and a half instead of three complete rows of ventral setæ—is fully recognized by its discoverer.

Amphisia multiseta, Sterki.

Resembling *A. gibba*, but of smaller size; the ventral region concave, and bearing as many as ten anal setæ.

GENUS VII. HOLOSTICHA, Wrz.

Animalcules free-swimming, not encuirassed, more or less elastic, and changeable in form, oval or elongate; the ventral surface bearing three or four claw-like frontal styles, five or more anal styles, two or three uninterrupted median rows of short ventral setæ, and a continuous projecting border of marginal setæ; endoplast double; contractile vesicle single, spherical, usually occupying a median position close to the left lateral margin. Inhabiting salt and fresh water.

The genus *Holosticha* has been instituted by Wrzesniowski * for the reception of those species hitherto included in the genus *Oxytricha*, in which the ventral setæ form two or three uninterrupted median rows, in place of the more or less irregularly scattered plan of distribution which obtains among the typical members of the last-named generic group. Through the preceding genus, *Amphisia*, the passage from *Holosticha* to *Uroleptus* and *Urostyla* is apparently accomplished.

Holosticha mystacea, Stein sp. PL. XLIII. FIG. 11.

Body ovate, flattened, nearly three times as long as broad, rounded and widest posteriorly, the right side convex, the left concave, the upper lip developed anteriorly into a bluntly rounded point; peristome-field extending backwards nearly to the centre of the body, its reflected border arcuate, distinctly ciliate; ventral setæ forming two irregular, curved, central rows supplemented anteriorly with a few additional styles; marginal setæ constituting a continuous projecting border, the posterior ones longest; anal styles of medium size, not projecting beyond the posterior body margin. Length 1–190″ to 1–144″. HAB.—Fresh water.

Identical with the *Oxytricha mystacea* of Stein.

Holosticha flava, Cohn sp. PL. XLIII. FIGS. 19 AND 20.

Body elongate, flattened and band-like, flexible but not retractile, six or seven times as long as broad, rounded at both extremities, slightly narrower at the posterior one; peristomal ciliary band fringing the anterior border and extending backwards to a distance of one-third of the length of the body;

* 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xxix., 1877.

a row of fine marginal setæ developed along each lateral border; two median rows of similarly fine ventral setæ; an even transverse row of eight or more slender anal styles projecting beyond the posterior extremity; contractile vesicle situated in the posterior third of the body; colour of parenchyma yellow or light brown. Length 1–130″ to 1–120″.

HAB.—Salt water.

This animalcule is recorded by Cohn * as a species of *Oxytricha*. The same authority further describes as a variety of this type, under the title of *Oxytricha flava* var. *carnea*, a flesh-coloured species having twice the breadth and thickness of the typical form, and which is abruptly truncate and not narrower at the posterior extremity. The variety in question is further distinguished by the possession of four longitudinal rows of bright red corpuscles which ornament the parenchyma, as seen from the ventral surface.

Holosticha rubra, Ehr. sp. PL. XLIII. FIG. 17.

Body highly flexible and retractile, elongate-lanceolate, almost four times as long as broad, slightly tapering towards and equally rounded at each extremity; the peristome-field extending backwards to a distance of one-third of the length of the entire body; a transverse row of eight or nine slender projecting anal styles developed at the posterior extremity; parenchyma brick-red, enclosing two central and two marginal longitudinal rows of minute bright red corpuscles; contractile vesicle located centrally at a distance of one-fourth of the body-length from the posterior extremity. Length 1–140″. HAB.—Salt water.

This species, imperfectly figured and described by Ehrenberg and Dujardin under the title of *Oxytricha rubra*, was formerly adjudged by Stein and Claparède and Lachmann to be correctly referable to the genus *Uroleptus*. The presence of a well-developed series of anal styles, as recently demonstrated by Cohn, however, re-establishes its position among the typical *Oxytrichæ*, or rather with that offshoot from the genus with which it is here associated. The author has obtained this brilliantly coloured marine species from a variety of sources, including salt water remitted from the Aston Aquarium, Birmingham, by Mr. Thomas Bolton, as also from among decaying zoophytes collected at St. Heliers, Jersey, and Bangor, N. Wales. Ehrenberg, its first discoverer, has recorded the occasional occurrence of the species in such abundance in the North Sea as to communicate a red hue to the water.

Holosticha oculata, Mereschk. sp. PL. XLIV. FIG. 21.

Body somewhat variable in form, usually subovate or pyriform, gibbous and inflated in lateral view, about three times as long as broad; peristome-field arcuate, extending through one-third of the length of the body; frontal styles uncinate, subequal, four in number; ventral setæ very fine, forming two closely approximated median rows; marginal setæ slightly larger than the preceding, those on the right side projecting entirely, and those on left side only partially, beyond the lateral margin; anal setæ five or six in number, continuous with the left-hand marginal series, projecting beyond the posterior extremity; endoplast and contractile vesicle not

* 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xvi., 1860.

observed; a spheroidal eye-like corpuscle located in the median line near the anterior extremity, and a similar one of slightly smaller dimensions near the posterior extremity. Dimensions unrecorded.

HAB.—Salt water: White Sea (Mereschkowsky).

In general form this species is recognized by Mereschkowsky* as closely approaching the *Oxytricha* (*Amphisia*) *crassa* of Claparède and Lachmann, while the spheroidal anterior and posterior "eye-like corpuscles" find their equivalent in the *Actinotricha saltans* of F. Cohn. In the absence of any other distinctly recognized endoplast or nucleolar structure, it would seem highly probable, however, that these so-called eye-like spots are in both cases modified homologues only of this last-named element. Although not usual among the Hypotricha or other Ciliata, a similar spheroidal endoplast, embodying a more densely granular central portion and a hyaline peripheral border, obtains normally throughout the Flagellata.

Holosticha Wrzesniowskii, Mereschk. sp.

Body elongate-oval, rounded and slightly widest posteriorly, more pointed and curved slightly towards the left anteriorly, a little over three times as long as broad; peristome-field narrow, rounded posteriorly, extending backwards almost to the centre of the body; six large, subequal, uncinate frontal styles; two median rows of fine ventral, and two rows of similar-sized marginal setæ, the elements of the last-named series not projecting beyond nor reaching the lateral periphery; anal setæ nine in number, forming an even, slightly projecting posterior row; endoplasts ovate, two in number; contractile vesicle located close to the left lateral border. Length 1–120″.

HAB.—Salt water: White Sea (Mereschkowsky). Motions sluggish.

GENUS VIII. PLAGIOTRICHA, S. K.

(Greek, *plagios*, oblique; *trichos*, hair.)

Animalcules free-swimming, ovate or elliptical, highly elastic; peristome-field narrow, arcuate, confined almost entirely to the left-hand antero-lateral margin, and without any conspicuous reflected inner border; the ventral surface bearing eight or more frontal styles, one or more oblique rows of ventral setæ, a projecting fringe of marginal setæ, and four or five anal styles; two or more slender caudal setæ projecting from the posterior extremity; endoplasts two in number; contractile vesicle single, spheroidal, developed near the left-hand lateral border.

This generic group is instituted for the reception of the *Oxytricha strenua* of Engelmann, that species differing from all typical representatives of the genus *Oxytricha* as here amended, in the characteristic oblique distribution of the ventral setæ—which thus closely approaches that of *Gastrostyla*—in the greater number of frontal styles, and in the possession of hair-like caudal setæ; the peristome-field likewise presents a well-marked modification. But for the absence of caudal setæ, the *Oxytricha affinis* of Stein might be also included in the same genus, and is here temporarily associated with it. Sterki, indeed, as intimated further on, has already

* "Protozoen des nördlichen Russland," 'Archiv für Mikroskopische Anatomie,' Bd. xvi., 1878.

proposed for that type the generic title of *Gonostomum*—which name, however, so closely resembles those of *Gonostoma* and *Gonostomus*, already employed to designate certain genera of Fishes and Mollusca, that the substitution of a new one appears desirable.

Plagiotricha strenua, Eng. sp. PL. XLIII. FIG. 34.

Body flexible and contractile, elongate-elliptical, about four and a half times as long as broad, evenly rounded at the two extremities, but slightly narrower anteriorly; peristome-field very narrow, confined to the left-hand lateral border, extending backwards to nearly the centre of the body; the adoral cirri very long; ten uncinate frontal styles; one and a half oblique rows of even-sized ventral setæ, which are developed backwards from right to left, the complete row only approaching the left-hand border at a distance of one-third of the entire length of the body from the posterior extremity; four anal styles, and two long fine caudal setæ; a marginal row of very minute hispid setæ developed on the right and left peripheral borders, these in company with the ordinary marginal series, projecting most conspicuously towards the posterior extremity; contractile vesicle located near the posterior extremity of the peristome; endoplasts oval, two in number. Length 1–160″. HAB.—Fresh water.

In describing this form as a species of *Oxytricha*, Engelmann * remarks upon its general resemblance to *Oxytricha* (*Plagiotricha*) *affinis*, from which it, however, differs in the number and disposition of the frontal, ventral, and anal styles, and in the presence of terminal or caudal setæ. Although not actually observed, Engelmann is inclined to believe that the fine hispid setæ that form a second and scarcely perceptible peripheral fringe are developed also, as in *Oxytricha parallela*, throughout the dorsal region. The anal styles in this species appear to be of a softer and more plastic consistence than is usually found among the Oxytrichidæ, two of them, which are set a little in advance of the others, being flexible and subservient for ambulatory purposes, after the manner of ordinary ventral setæ, which are here unrepresented towards the posterior extremity of the body.

Plagiotricha (Gonostomum) affinis, Stein sp. PL. XLIII. FIG. 25.

Body elongate-lanceolate, three and a half to four times as long as wide, narrowed and pointed at each extremity; peristome-field arcuate, confined chiefly to the left-hand lateral border, but its posterior extremity bent abruptly inwards and terminating near the centre of the body; ventral setæ five or six in number, disposed obliquely from right to left, but not extending further backwards than the posterior termination of the peristome-field; the marginal setæ forming an unbroken projecting peripheral fringe, somewhat larger posteriorly; anal setæ very short and inconspicuous, not reaching to the posterior extremity of the body; no caudal setæ. Length 1–288″ to 1–216″. HAB.—Marsh water.

This type, representing the *Oxytricha affinis* of Stein and *Gonostomum affinis* of Sterki, is, as previously stated, retained in the present generic group in recognition of its general conformity, excepting for the absence of caudal setæ, with the pre-

* 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xi., 1861.

ceding form, combined with the unsuitability of the generic name with which Sterki has proposed to associate it. Its distinctness from the ordinary *Oxytrichæ* is recognized by Stein in his original account of the species; in this connection he indicates that the structure of the peristome conforms more closely with that of *Stichotricha secunda*, and further remarks that it requires only the greater prolongation of the anterior extremity to transform it into an essentially identical animalcule. Additional evidence in support of this suggested relationship, though not mentioned by Stein, is yielded by the development of the ventral setæ, which, though few in number, exhibit a similar oblique disposition. The short and scarcely conspicuous anal setæ are, as in *Plagiotricha strenua*, highly flexible and frequently utilized as ambulatory organs.

GENUS IX. EPICLINTES, Stein.

Animalcules free-swimming, highly flexible and elastic, elongate, divided as it were into three distinct regions, including an inflated and widest central region, a narrower anterior, and an elongate posterior or tail-like portion; peristome-field extending to the posterior end only of the narrowest anterior region; three or four rows of short claw-like frontal styles clothing the ventral surface of the anterior extremity; six or seven oblique rows of short ventral styles or setæ developed upon the central part, and two or more straight parallel rows of short ventral setæ upon the elongate caudal region; a peripheral row of short marginal setose cilia bordering the caudal and central parts; terminal anal styles four or five in number; anal aperture debouching upon the posterior end of the inflated central portion; contractile vesicle single, subcentral or situated near the termination of the peristome-field. Inhabiting salt water.

The luxuriant development of the ventral setæ in this genus approximates it most closely to *Kerona* and *Urostyla*, while in the specially prolonged caudal portion it exhibits some resemblance to the genus *Uroleptus*. Diesing* has proposed to associate with the form previously selected by Stein as the type of the present group, the generic title of *Claparedia*.

Epiclintes auricularis, C. & L. sp. PL. XLIII. FIGS. 28–30.

Body elongate, about six times as long as broad, the distal region oval, rounded anteriorly, the central portion elongate-fusiform, about twice the length of the anterior one, but not much wider; caudal prolongation band-like, nearly equalling in length the two preceding portions of the body; three oblique rows of short styles developed upon the ventral surface of the anterior portion, six or seven obliquely parallel rows of setæ on the central part, and three straight parallel rows and a peripheral border of similar setæ on the caudal prolongation. Length of extended body 1–82″.

HAB.—Sea water.

This species, which is to be identified with the *Oxytricha auricularis* of Claparède and Lachmann, is adopted by Stein as the type of his genus *Epiclintes*, and is shown by that authority to differ most essentially from all ordinary *Oxytrichæ*. The fuller details of this species, as supplied by Stein, he having himself obtained it on the Baltic sea-board, differ slightly from those originally recorded

* "Revision der Prothelminthen," 'Sitz. d. K. Akad. Wien,' 1866.

by the Swiss authorities. Thus, while they have described the central ventral surface as entirely covered with oblique rows of short setæ, no definite number of rows is mentioned, and in their illustrations they are entirely left out, an omission which also applies to the marginal setal series of the same region. The position of the contractile vesicle as given by Claparède and Lachmann is also at variance with Stein's description, the first-named investigators describing and delineating it as situated at the posterior end of the central division of the body, while Stein declares it to occupy that position near the termination of the peristome common to the majority of the Oxytrichidæ.

Epiclintes auricularis has been recently met with in tolerable abundance by Mereschkowsky among algæ in the White Sea. According to this observer,* no less than five or six oblique rows of fine setæ are distributed upon the ligulate anterior prolongation, nine similar rows upon the central or ventral region, and five parallel rows upon the posterior or caudal prolongation. The marginal series on either side towards the anterior extremity are represented by Mereschkowsky, as shown at Pl. XLIII. Fig. 30, as taking the form of minute, immotile, bead-like, or columnar prominences.

Epiclintes retractilis, C. & L. sp. Pl. XLIII. Figs. 23 and 24.

Body elongate, about five times as long as broad, the central portion much inflated, shortly and broadly fusiform, the anterior region very narrow, its width equal to one-quarter only of that of the centre part, and about one-half its length, the posterior or tail-like prolongation ligulate, still narrower than the anterior one, nearly equal in length to the conjoined preceding portions, highly contractile, and capable of being almost entirely withdrawn into the more inflated central region ; three nearly straight rows of setæ developed on the anterior part of the ventral surface, those of the central region numerous, but their actual number and arrangement undetermined ; two central straight rows developed upon the caudal portion in addition to a marginal set on each side ; four terminal projecting anal setæ. Length when extended 1–150″.

Hab.—Salt water: Norwegian coast (C. & L.).

This animalcule is identical with the *Oxytricha retractilis* of Claparède and Lachmann. While the details of the ventral setæ, as given by its discoverers, are not quite so explicit as might be desired, it is evident that we have here a type closely allied to *Epiclintes auricularis*, and with which Stein has considered himself justified in associating it. The remarkable retractile character of the attenuate caudal extremity, together with the wider expansion of the central part, serve to distinguish it specifically from the last-named form.

Epiclintes radiosa, Quenn. sp. Pl. XLIII. Figs. 31 and 32.

Body elongate, about five times as long as broad, central and anterior portion compressed fusiform, slightly narrowed anteriorly and bearing at its summit five very large, straight, radiating frontal styles, the posterior or caudal prolongation narrow or linear, exceeding the entire anterior region in length ; a single row of marginal setæ developed upon each side of the fusiform anterior and central portions, and a double row of similar setæ

* "Protozoen des nördlichen Russland," 'Archiv für Mikroskopische Anatomie,' Bd. xvi., 1878.

bordering the attenuate caudal prolongation; contractile vesicle situated towards the posterior end of the thicker central region. Length 1–250″.

HAB.—Salt water.

The abnormal size of the five radiating frontal styles, which in this respect closely resemble those of *Actinotricha saltans*, in addition to the less attenuate contour of the anterior extremity, suffices to distinguish this animalcule from the two preceding types. As originally described and figured by Quennerstedt,* that authority, apparently unaware of Stein's new generic appellation, has proposed to confer upon it the title of *Mitra radiosa*. Even in the absence of this prior title, Quennerstedt's suggested name of *Mitra* could not, however, have been retained, it having been long since preoccupied for the distinction of a genus of the Mollusca.

GENUS X. STICHOCHÆTA, C. & L.

Animalcules free-swimming, elastic but not contractile, the anterior extremity attenuate and neck-like; a row of long peristomal cirrose cilia extending backwards from the apical extremity to the oral aperture which lies at the base of the neck-like prolongation; a border of small marginal setæ and two or three ventral rows of similar ventral setæ usually present; a group of long slender anal styles developed at the posterior extremity.

The author retains as the type of this genus the *Stichochæta pediculiformis* of Cohn,† which differs essentially from the several specific forms of *Stichotricha*, with which it otherwise closely corresponds, through its possession of well-developed anal styles. The *Stichochæta cornutum* of Claparède and Lachmann is rightly referred by Stein to the last-named generic group.

Stichochæta pediculiformis, Cohn. PL. XLIV. FIGS. 13 AND 14.

Body linear-oblong, rounded posteriorly, flexible but not retractile, the anterior third produced as a narrower neck-like process, and bearing at its summit about six long, movable setæ, a spiral row of similar setæ extending backwards from these to the oral aperture; a row of short, fine marginal setæ developed down each lateral border of the ventral surface, and between these three rows of short ventral setæ; five long, slender anal styles, disposed in two groups of three and two each, at the posterior extremity; oral aperture situated at the base of the neck-like prolongation, having issuing from it a bundle of several long, flexible oral cilia; contractile vesicles two in number, one located near the oral aperture and the other towards the posterior extremity; parenchyma very opaque, through the enclosure of innumerable fat-like corpuscles. Length 1–250″.

HAB.—Salt water. Movements alternately creeping and springing backwards.

GENUS XI. STICHOTRICHA, Perty.

Animalcules elongate, elastic, and changeable in form, the anterior extremity attenuate and neck-like; peristome-field narrow, fissure-like, extend-

* 'Bidrag til Sveriges Infusoriefauna,' Heft ii., 1867.
† "Neue Infusorien im Seeaquarium," 'Zeit. Wiss. Zool.,' Bd. xvi., 1866.

ing from the anterior extremity to about the centre of the body; cilia of the external or left-hand peristome-border remarkably long; no ventral or anal styles; merely a peripheral border of fine marginal setæ, and one or more oblique rows of small ventral setæ; endoplast ovate, sometimes double; contractile vesicle single, spherical, situated near the posterior angle of the peristome; often excreting and inhabiting a mucilaginous or granular sheath or lorica; the anterior half of the body, when protruded from this sheath, usually twisted in a screw-like manner. Inhabiting salt and fresh water.

Stein has proposed to identify as members of this genus the forms referred by Lachmann to the genus *Chætospira*. As shown, however, on a previous page, such animalcules are undoubted Heterotrichous forms, closely allied to *Follicularia*.

Stichotricha secunda, Perty. PL. XLIV. FIGS. 1 AND 2.

Body highly elastic, lanceolate-fusiform, broadest in the centre, and tapering to each extremity, the anterior end being the more attenuate; peristomal or adoral cilia longest at the anterior extremity, gradually diminishing in size as they approach the oral aperture, continued a short way up the inner or reflected border of the peristome; ventral setæ short, forming a single oblique row; marginal setæ long and slender; endoplasts ovate, two in number, having minute attached endoplastules; contractile vesicle single, spherical, situated between the two endoplasts close to the posterior angle of the peristome-field; animalcules usually secreting a mucilaginous sheath, which they often vacate to swim freely in the water; the anterior half of the body, when extended from this tube, twisted to the right in a screw-like manner. Length 1–190″ to 1–120″.

HAB.—Fresh water, among *Sphagnum*.

Stichotricha cornuta, C. & L. sp. PL. XLIV. FIG. 11.

Body somewhat flask- or bottle-shaped, its apex attenuate, bearing a single, long, straight, acerate spine or seta; cilia of the peristome shortest anteriorly, increasing in length as they approach the oral aperture; marginal setæ continued up the left side of the peristome as very long hair-like setæ; three parallel oblique rows of fine ventral setæ developed in addition to the peripheral border of larger marginal setæ; endoplasts oval, two in number. Length 1–300″. HAB.—Fresh water.

This species is identical with the *Stichochæta cornuta* of Claparède and Lachmann. While evidently referable to Perty's genus *Stichotricha*, as more recently amended by Stein, it must certainly not be merged with *Stichotricha secunda*, as that authority has proposed, and from which it is shown, by Stein's own description and illustrations, to differ in all essential specific details. In attempting their amalgamation, Stein has sought to demonstrate that a renewed examination of *Stichotricha secunda* has revealed to him the existence of the apical spine, of three rows of ventral setæ, and of the long marginal elements on the left border of the attenuate anterior extremity, characteristic of Claparède and Lachmann's type. Accrediting Stein, however, with that faithfulness of description and delineation that usually

characterizes his diagnoses, it is difficult to assume otherwise than that he had in the second instance the actual type of the last-named authorities, and not his original *Stichotricha secunda* under examination.

For the advantage of further comparison the drawings of the two forms, as represented respectively by Stein and by Claparède and Lachmann, are reproduced in Plate XLIV. The building up by *Stichotricha cornuta* of an artificial mucilaginous domicile has not so far been determined.

Stichotricha aculeata, Wrz. Pl. XLIV. Fig. 3.

Body elongate-lanceolate, about four and a half times as long as broad, tapering from the centre towards the posterior as well as towards the narrower anterior region; the apical extremity of the anterior portion bearing two stout, slightly curved, uncinate styles, each lateral border of this region fringed with very long, fine, hair-like setæ; peristomal cilia largest anteriorly, gradually diminishing in size as they approach the oral aperture, continued as finer cilia up the right-hand or reflected inner border; two oblique rows of ventral setæ and an even border of similar-sized marginal setæ; contractile vesicle situated immediately below the oral aperture; endoplasts ovate, two in number, with attached endoplastules. Length 1–375″ to 1–250″. Hab.—Fresh water, among *Lemnæ* and Sphagnaceæ.

The two apical styles, double anterior fringe of fine hair-like setæ, and two instead of three oblique rows of ventral setæ, distinguish this form from *Stichotricha cornuta*. The species was obtained by Wrzesniowski * in the neighbourhood of Warsaw, and is reported to pass an entirely free-swimming existence. When swimming the two anterior style-like processes are vibrated with such rapidity as to be scarcely visible.

Stichotricha remex, Hudson sp. Pl. XLIV. Figs. 9 and 10.

Animalcule building and inhabiting a long, slender, cylindrical, brown-coloured tube, whose height may equal or exceed three or four times the length of the body; body lanceolate, its anterior half when extended from the tube twisted spirally; the cilia at the anterior or apical extremity of the adoral fringe the longest. Length of body 1–90″, of the cylindrical tube 1–20″.

Hab.—Pond water, often clustered in groups on the leaves of *Anacharis* and other water-plants.

This animalcule is figured and described by Dr. C. T. Hudson in the 'Monthly Microscopical Journal' for October 1875, under the title of *Archimedea* (*Chætospira?*) *remex*. So far as it is possible to decide from his representations, reproduced at Pl. XLIV. Figs. 9 and 10, and accompanying account given of the character and disposition of the cilia upon the surface of the body, it would appear to correspond most closely with *Stichotricha secunda*. That it is not a *Chætospira*, as was to some extent premised by its describer, is made evident by the setose character of the cilia and their restriction to the ventral aspect. A single spheroidal contractile vesicle was observed near the base of the adoral fringe, and adjacent to this, on the right side, an anal aperture. With respect to the habits of this infusorium Dr. Hudson is more explicit. As a rule it resides at the top of its slender brown-coloured tube, occasionally backing down to the bottom of it, or if suddenly alarmed, as by a tap

* "Infusorien aus der Umgebung von Warschau," 'Zeit. Wiss. Zool.,' Bd. xx., 1870.

on the table, flashing out of sight after the manner of a serpula with the rapidity of lightning. Confidence being restored, it once more makes its appearance at the entrance of its abode, at first protruding a short distance only from the aperture, maintaining a perfectly straight position, and with its frontal cilia quivering. No further cause of alarm arising, the entire anterior half of the body is now thrust out and twisted into the characteristic screw-like form depicted in the accompanying figures. The tubes formed by these animalcules are described as being of very frail consistence, rarely retaining their inhabitants for more than four days, and then quickly dropping to pieces; the animalcules are also exceedingly restless in captivity, deserting their abodes and swimming freely in the open water without any apparent provocation. The fact that the tubes are built by the animalcules themselves, and are not the vacated and re-inhabited residences of Rotiferæ or other tube-forming organisms, was amply proved by the preservation of very young individuals possessing at the time tubes whose construction had only just commenced, but which after the lapse of two days exhibited all the characters and proportions of the adult types.

Through Mr. Thomas Bolton the author received, in the years 1871–2, from the neighbourhood of Stourbridge, Worcestershire, the tubes, deserted *en route*, of an animalcule apparently identical with this species, and upon which, guided only by Mr. Bolton's sketches, and in the absence of any positive evidence respecting the character of the cuticular or ventral cilia, he provisionally conferred the name of *Chætospira cylindracea*. This manuscript title is referred to by Mr. Bolton in the 'Midland Naturalist' for 1878, but the specific one, should the animalcule be a veritable *Stichotricha*, must necessarily give way to the earlier published, though later suggested, name employed by Dr. Hudson.

Stichotricha marina, Stein.

This species is briefly alluded to by Stein* as closely resembling *S. secunda*, but is of larger size, inhabits sea water, and exhibits a slight difference in the arrangement of the ventral setæ.

Genus XII. SCHIZOSIPHON, S. K.

(Greek, *schizo*, to cleave; *siphon*, tube.)

Animalcules structurally resembling those of *Stichotricha*, but forming social colonies which build up by excretion a compound branching tube or zoothecium.

This new genus is established by the author for the reception of the interesting type recently figured and described by Dr. Ernest Gruber† under the title of *Stichotricha socialis;* its distinctive feature, which separates it indeed from all previously known Hypotricha, is manifested in the habit the animalcules have of constructing by exudation a ramifying colonial habitation or zoothecium. In this connection they may be said to occupy a position with relation to *Stichotricha* corresponding with that which subsists between such compound types as *Epistylis* or *Carchesium* and the simple genus *Vorticella.*

Schizosiphon socialis, Gruber sp. Pl. XLIV. Figs. 4–8.

Body elongate-ovate, obliquely truncate and attenuate anteriorly; the peristomal cilia longest at the anterior extremity, diminishing in size as they approach the oral aperture, and continued up the interior or left peristomal border, surmounted apically by a tuft of three or four distinctly

* 'Infusionsthiere,' Abth. ii., 1867.

† 'Zeit. Wiss. Zool.,' Bd. xxxi., 1879; also translation in 'Journal of Royal Microscopical Society,' April 1880.

differentiated setose cilia; ventral cilia disposed in four oblique spiral parallel lines; a few scattered caudal setæ developed at the posterior extremity, and a row of similar marginal setæ developed along the right-hand border of the anterior body-half; endoplasts axial, two in number, with attached endoplastules; contractile vesicle single, subcentral; compound tube or zoocytium pendulous, of granular consistence, branching in an even dichotomous manner. Length of zooids 1–120″, of branching zoothecium 1–15″ to 1–10″. HAB.—Fresh water.

GENUS XIII. STRONGYLIDIUM, Sterki.

Animalcules free-swimming, elongate, soft and elastic, bearing about six stout frontal styles, two oblique rows of ventral setæ, three caudal, but no anal setæ; the dorsal surface clothed with very fine, short, immotile, hispid setæ.

A single species, *Strongylidium crassum*, is briefly referred to by Sterki,* as corresponding in general contour with *Uroleptus piscis*, but having a thicker, almost cylindrical body, which is twisted upon its axis towards the left. The large number of frontal styles, and the presence of caudal setæ, would appear to be the chief grounds upon which a new genus has been established for its reception.

GENUS XIV. UROLEPTUS, Ehrenberg.

Animalcules free-swimming, elongate, highly elastic, but maintaining the same general contour; the posterior extremity usually produced in an attenuate, tail-like manner; the ventral surface bearing three or four anterior or frontal styles, and usually two closely approximated median lines of ventral setæ; a marginal border of similar setæ continuous with or situated at a little distance within the periphery; no anal styles; endoplast double or multiple; contractile vesicle single, spherical, located towards the posterior termination of the peristome. Inhabiting fresh water.

Uroleptus musculus, Müll. sp. PL. XLIII. FIG. 14.

Body but little elastic, elongate-pyriform, three times as long as broad, cylindrical anteriorly, dilated to its greatest width posteriorly, abruptly rounded off in that region, and ending in a short, conical, tail-like termination; the anterior end curved slightly to the left, the posterior one to the right; peristome-field extending backwards to about one-third of the length of the entire body, its reflected border ciliate; the border of marginal setæ encroaching considerably on the median area, projecting beyond the periphery at the posterior extremity only; central rows of ventral setæ two in number, produced to the extremity of the posterior termination; anal aperture located close to the base of the conical posterior termination; contractile vesicle adjacent to the centre of the right lateral border. Length 1–195″ to 1–120″.

HAB.—Fresh water, among *Callitricha* and other aquatic plants.

* "Morphologie der Oxytrichinen," 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xxxi., 1878.

This species represents the relatively shortest and widest member of its genus, all other known forms being characterized by their exceedingly attenuate outlines. It was first described by O. F. Müller under the title of *Trichoda musculus*, being afterwards referred to the present genus by Ehrenberg.

Uroleptus gibba, C. & L. sp.

Body straight, lanceolate, three and a half times as long as broad, rounded anteriorly, somewhat pointed posteriorly; possessing four rows of ventral setæ and a continuous projecting peripheral or marginal series, whose separate elements are rather the longest posteriorly. Length 1–250″.

HAB.—Fresh water.

Stein has referred to this species, described by Claparède and Lachmann under the title of *Oxytricha gibba*, as probably belonging to the genus *Uroleptus*, and finding its nearest ally in *U. musculus*. The number of rows of ventral setæ distinguish it, however, from this and all other known representatives of the genus.

Uroleptus piscis, Müll. sp. PL. XLIII. FIG. 21.

Body exceedingly elastic and somewhat variable in shape, broadly linear-fusiform or band-like, from six to eight times as long as broad; the anterior end rounded, curved slightly to the left; widest in the centre, tapering gradually towards the posterior extremity, and thence terminating in a strap-shaped, bluntly pointed, tail-like prolongation, which is curved somewhat towards the right; peristome-field extending backwards to about one-fourth of the length of the whole body, its reflected border ciliate; marginal setæ projecting beyond the peripheral border throughout its length, considerably longer around the tail-like posterior prolongation; median rows of ventral setæ two in number, not produced into the tail-like region; contractile vesicle located close to the left-hand margin, opposite or even anterior to the posterior angle of the peristome; endoplasts two in number, posterior to the contractile vesicle. Length of body 1–48″. HAB.—Fresh water.

This animalcule is identical with the *Trichoda piscis* of Müller, the *Uroleptus piscis* and *Oxytricha caudata* of Ehrenberg, and with the *Oxytricha caudata* of Claparède and Lachmann.

Uroleptus ratulus, Stein. PL. XLIII. FIG. 33.

Body persistent in shape, linear-fusiform, about ten times as long as broad; the anterior end rounded, curved slightly to the left, tapering gradually from the centre and terminating in a long, thin, acutely pointed tail; peristome-field extending backwards to one-fifth of the length of the whole body, very narrow, its reflected border unciliate; the marginal setæ projecting throughout the periphery, very little longer at the posterior or tail-like portion; the central ventral setæ forming two rows, not produced to the extremity of the caudal appendage; contractile vesicle developed near the left lateral margin, at a considerable distance from the termination of the peristome; endoplasts two in number, situated at equal distances one in front of the other behind the contractile vesicle. Length 1–60″. HAB.—Fresh water.

Uroleptus violaceus, Stein. PL. XLIII. FIG. 18.

Body persistent in shape, broadly linear, flattened, five to six times as long as broad; the anterior extremity widest, truncate, its corners rounded, gradually tapering towards the truncate and rounded posterior end, the width of which, at its termination, is equal to nearly half that of the anterior one; peristome-field developed backwards to about one-fifth of the length of the body, its reflected border arcuate, unciliate; marginal setæ projecting beyond the periphery, lengthening as they approach the posterior extremity; median rows of ventral setæ two in number, produced nearly to the extremity of the tail-like termination; position of contractile vesicle and endoplasts similar to that of *U. ratulus;* the parenchyma usually enclosing numerous brilliant violet granules. Length 1–160″ to 1–100″. HAB.—Fresh water.

Uroleptus mobilis, Eng. PL. XLIII. FIGS. 9 AND 10.

Body flexible, elongate-linear, cylindrical, about twelve times as long as broad, attenuate posteriorly and terminating in an abruptly truncate point; peristome exceedingly narrow, extending backwards to about one-ninth of the length of the entire body, its inner or reflected border bearing an undulating membrane; frontal styles uncinate, three in number; ventral setæ undescribed; marginal setæ long, fine, and evenly developed, but widely separated; contractile vesicle situated at a distance of one-third of the length of the body from the anterior extremity; endoplasts elongate oval, six in number. Length 1–75″. HAB.—Fresh water.

This species may be distinguished from *U. ratulus* by the abruptly truncate contour of the tail-like posterior extremity, the longer and more scattered marginal setæ, and by the comparatively shorter peristome-field.

Uroleptus agilis, Eng.

Body flexible but persistent in form, elongate-lanceolate, four or five times as long as broad, widest centrally, tapering to the two extremities, the posterior one slightly the narrower; peristome-field moderately wide, extending backwards to a distance of about one-fifth of the length of the body; frontal styles four in number, bearing immediately behind them three antero-ventral setæ, a few additional ventral setæ developed in the centre of the body; marginal setæ set far inwards, projecting beyond the periphery only at the posterior extremity of the body, the hindermost setæ of this series much larger than the preceding, forming a terminal projecting fascicle; contractile vesicle situated near the centre of the left lateral border; endoplasts elongate-ovate, two in number. Length 1–300″ to 1–100″.

HAB.—Fresh water.

As remarked by Engelmann,* this species intimately connects the two genera

* 'Zeit. Wiss. Zool.,' Bd. xi., 1861.

Uroleptus and *Oxytricha*, the form of the body according with the former, and the character and disposition of the setæ corresponding more closely with those of the last-named genus.

Genus XV. STYLONETHES, Sterki.

Animalcules free-swimming, widest and rounded posteriorly, narrowed anteriorly, more or less thick or inflated; the anterior half of the frontal region bearing numerous, from fifteen to twenty, scattered frontal styles or setæ; two rows of ventral setæ; no anal styles; the marginal setæ forming a continuous projecting border.

A single form is referred by Sterki* to this genus under the name of *Stylonethes tardus*, but no specific description or illustration of it has as yet appeared. So far as it is at present possible to determine, this single type connects the two genera *Holosticha* and *Uroleptus*.

Genus XVI. ALLOTRICHA, Sterki.

Animalcules free-swimming, soft and elastic, more or less ovate; frontal, ventral, anal, and marginal setæ corresponding with those of *Oxytricha* or *Stylonychia*, added to which are two supplementary rows of external ventral setæ as in *Pleurotricha;* structure of peristome, movements, and general appearance coinciding with those of *Urostyla*.

A single species, yet awaiting description, is referred to this genus by Sterki,† under the title of *A. mollis*.

Genus XVII. PLEUROTRICHA, Stein.

Animalcules free-swimming, persistent in form, elongate or elliptical, with from five to eight claw-like frontal styles, the three anterior of which are usually most conspicuously developed; four or five scattered ventral styles and in addition to these one or more supplementary rows of smaller ventral setæ; anal styles five or six in number, forming two distinct groups; peristome-field not extending to the median line, its reflected border ciliate, usually bearing a conspicuous, band-like, undulating membrane; endoplast ovate, sometimes multiple; contractile vesicle situated near the posterior angle of the peristome. Inhabiting fresh water.

While in its general characters this genus closely corresponds with *Stylonychia*, its members are distinguished from the latter by the absence of caudal setæ, by the more luxuriant development of the ventral setæ, and by the separation of the anal styles into two distinct groups.

Pleurotricha grandis, Stein. Pl. XLIII. Fig. 26.

Body elliptical, about twice as long as broad, peristome-field not extending to the median line, its reflected inner border ciliate, bent round towards the opposite one at its distal extremity, the central area of the peristome-field bearing a conspicuous line of endoral cilia; the four or five sub-central ventral uncini supplemented on each side by two parallel rows of smaller

* 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xxxi., 1878. † Ibid.

ventral setæ; the two right-hand anal styles removed towards the posterior extremity, and projecting to a considerable distance beyond its margin; contractile vesicle developed close to the posterior angle of the peristome-field. Length of body 1–120″ to 1–60″. HAB.—Fresh water, among *Callitricha*.

Pleurotricha lanceolata, Ehr. sp. PL. XLIII. FIG. 27.

Body elongate-lanceolate, two and a half times as long as broad, pointed posteriorly, the anterior end curved slightly towards the left; the supplementary ventral setæ less developed than in the preceding species, forming a single complete and the half of a second row only on the right-hand side of the larger ventral uncini, no such setæ developed on the opposite or left-hand side of the ventral area; anal and ventral styles, peristome-field, and other details, as in *P. grandis*. Length 1–144″ to 1–84″.

HAB.—Fresh water, among aquatic plants.

This species is identified by Stein with the *Stylonychia lanceolata* of Ehrenberg. The accompanying figure is illustrative of the encysted condition of the animalcule as delineated by the first-named authority.

Pleurotricha echinata, C. & L. sp. PL. XLIII. FIG. 22.

Body elongate-lanceolate, rather more than four times as long as broad, the extremities rounded, the right side nearly straight, the left one gibbous; peristome-field produced backwards to a little more than one-quarter of the length of the whole body; one row of ventral setæ developed on each side of the five scattered ventral uncini; marginal setæ forming a continuous peripheral fringe, long, slender, situated far apart from one another, and projecting at a right angle from the cuticular border; anal styles five in number, forming two groups, the two right-hand styles projecting posteriorly and directed to the right; contractile vesicle situated near the centre of the left-hand lateral border. Length 1–275″.

HAB.—Fresh-water ponds, in the Berlin Zoological Gardens.

This animalcule, which is described by Claparède and Lachmann under the title of *Stylonychia echinata*, is referred with some doubt to the present genus. It is not improbable that the peripheral fringe of fine hair-like setæ are of a supplementary character, and homologous with the minute hispid setæ which occur in a similar position in *Stylonychia mytilus* and other Oxytrichidæ, and in which case the two rows of so-called ventral setæ represent the true marginal series in this instance set far inwards as in *Amphisia*. Should this premise prove correct, this form will furnish the type of a new generic group to which, with reference to the characteristic marginal fringe of setæ, the title of *Mesotricha* might be appropriately applied.

GENUS XVIII. GASTROSTYLA, Engelmann.

Animalcules free-swimming, persistent in shape, elongate or elliptical; frontal styles usually five or six in number, the three anterior being most conspicuously developed; ventral setæ forming a single oblique row extending from the right-hand border towards the anal styles, occasionally supplemented by a few isolated central uncini; anal styles five or six in number;

marginal setæ forming a continuous border, usually longest posteriorly; peristome-border reflected, bearing an undulating membrane; endoplasts two or four in number.

This genus, as established by Engelmann,* is to be distinguished from *Pleurotricha* by the single oblique series of ventral styles, which here takes the place of the several supplementary rows that characterize the last-named genus.

Gastrostyla Steinii, Eng. PL. XLIII. FIG. 16.

Body elliptical, rounded at each extremity, slightly widest posteriorly, nearly three times as long as broad; peristome-field extending backwards to a distance of about one-third of the length of the entire body, its reflected border bearing a conspicuous undulating membrane; frontal styles six in number; about three scattered ventral styles developed in addition to the oblique linear series; anal styles four or five, forming a single oblique row, not projecting beyond the posterior extremity; marginal setæ coarse, increasing in length as they approach the hinder extremity of the body; contractile vesicle situate close to the posterior angle of the peristome; endoplasts ovate, four in number, arranged in a line down the centre of the body, each with a minute laterally attached endoplastule. Length 1–150″ to 1–75″. HAB.—Fresh water.

Gastrostyla setifera, Eng. sp.

Body elongate lanceolate, slightly gibbous, widest centrally, equally narrowed at the two extremities, about two and a half times as long as broad; peristome-field extending backwards nearly to the centre of the body, its reflected border bearing a band-like undulating membrane, and its central area supplemented by a conspicuous median line of endoral cilia; frontal styles five in number, uncinate, the three anterior being the largest; an oblique row of central and a few scattered ventral styles; anal styles five in number, forming two groups of three and two each, the latter only projecting beyond the posterior border; marginal setæ coarse, longest posteriorly; contractile vesicle situated near the centre of the left-hand lateral border; endoplasts two in number, ovate. Length 1–80″. HAB.—Fresh water.

This species has been described by Engelmann under the title of *Pleurotricha setifera*, but, as shown by his illustration, the character and arrangement of the ventral styles coincide so completely with those of *Gastrostyla Steinii*, that it appears desirable to refer it to the same genus. The four or five additional frontal setæ mentioned by Engelmann would appear to correspond with the anterior setæ of the oblique ventral row, as none separate from these are exhibited in his drawing, while at the same time the oblique row is not referred to in the text, the ventral styles being described merely as five or six in number. Diesing,† premising that there is a separate group of frontal setæ, in addition to the five uncinate styles and oblique ventral row, has proposed for this type the new generic title of *Nothopleurotricha*.

Sterki‡ intimates that he has encountered two new large-sized species

* 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xi., 1861.
† 'Revision der Prothelminthen,' 1866.
‡ 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xxxi., 1878.

of this genus, both distinguished from the preceding by the thickened or inflated contour of their bodies and conspicuous pre-oral and endoral ciliary fringes; full details of these types, as also their specific titles, await publication. The *Oxytricha mystacea* of Stein, with its central double row of ventral setæ, is apparently regarded by Sterki as referable to the present genus, but except for the somewhat irregular disposition of the component setæ of these rows, it agrees in all essential points with the ordinary members of the genus *Holosticha* of Wrzesniowski, to which it is here relegated.

GENUS XIX. OPISTHOTRICHA, S. K.

(Greek, *opisthen*, behind; *thrix*, hair.)

Animalcules free-swimming, soft and elastic, ovate or elliptical; frontal, ventral, and anal styles as in *Oxytricha*, but bearing in addition a variable number of tail-like caudal setæ at the posterior extremity.

This genus is here instituted for the reception of the *Oxytricha parallela* of Engelmann, and all other types corresponding with that form in the possession of several caudal setæ in addition to the ordinary characteristics of the genus *Oxytricha*. In this respect it exhibits the same relationship to the last-named genus as is presented by *Stylonychia* in comparison with *Histrio*. Although the single species quoted can alone be referred at present to this new generic group, Sterki records his acquaintanceship with several species of *Oxytricha* sharing the same characteristics, the specific descriptions of which, however, still await publication.

Opisthotricha parallela, Eng. sp. PL. XLIII. FIGS. 35 AND 36.

Body elastic and contractile, elongate-elliptical, bluntly rounded at each extremity, about four times as long as broad; peristome-field moderately broad, extending backwards to a distance of about one-quarter of the entire length; five uncinate and three setose frontal styles; five scattered central ventral setæ and a continuous peripheral border of large, scarcely projecting marginal setæ, the four most posterior of these so greatly exceeding the others in length as to constitute a distinct caudal series; anal styles five in number, projecting but slightly beyond the posterior border; several longitudinal rows of very fine, hair-like or hispid setæ developed on the dorsal surface; contractile vesicle situated close to the centre of the left-hand border; endoplasts ovate, two in number. Length 1–125″.

HAB.—Fresh water.

The great development of the fine dorsal setæ constitutes a conspicuous feature of this species, in addition to the presence of the four terminal or caudal setæ. But for the agreement in number and disposition of the ventral setæ with those of the ordinary *Oxytrichæ*, this animalcule exhibits many points of affinity with *Plagiotricha strenua*.

Opisthotricha similis, Eng. sp.

Body elliptical, equally rounded at each extremity; the marginal setæ stationed close to and projecting beyond the lateral borders, two long supplementary caudal setæ developed at the posterior extremity; other details agreeing with those of *Oxytricha pellionella*. Length 1–300″.

HAB.—Fresh water.

GENUS XX. OXYTRICHA, Ehrenberg.

Animalcules free-swimming, not encuirassed, more or less flexible and elastic, ovate or elliptical; bearing three or four uncinate and usually a few supplementary setose frontal styles, five or more anal styles, a continuous border of projecting marginal setæ, and only a few, mostly five, scattered or isolated ventral setæ; endoplasts two in number; contractile vesicle single, spherical, situated near the centre of the left-hand lateral border. Inhabiting salt and fresh water.

The genus *Oxytricha*, as amended in accordance with the foregoing diagnosis, differs materially from the generic group bearing the same name as first originated by Ehrenberg and included in all later works on the subject of the Infusoria. In accordance with the recently published views of Wrzesniowski and Sterki, all those forms characterized by the presence of two or more uninterrupted median rows of short ventral setæ have been eliminated and referred to the new genus *Holosticha*, from which latter again have been separated a third generic group bearing the name of *Amphisia*, differing in the structure and disposition of the marginal setæ, which are scarcely to be distinguished from those of the ventral series. In the considerable assemblage of forms yet remaining to represent the genus *Oxytricha* the number and disposition of the few isolated ventral setæ correspond essentially with the formula common to *Stylonychia* and *Histrio*, and from the latter of which two genera *Oxytricha* is to be distinguished only by the soft and elastic instead of more or less indurated character of the cuticular investment. The author has additionally separated in this volume, as the type of the new genus *Plagiotricha*, the *Oxytricha strenua* of Engelmann, which differs from all typical *Oxytrichæ* in its possession of two bristle-like caudal setæ and an arrangement of ventral setæ which most nearly approaches that of *Gastrostyla*.

Oxytricha pellionella, Müll. sp. PL. XLV. FIGS. 3–5.

Body moderately elastic, not contractile, linear-elliptical, rather over four times as long as broad, widest in the centre, the two extremities equally rounded; peristome-field narrow, triangular, extending to the centre of the anterior third of the body; no conspicuous reflected inner border; ventral setæ represented by five irregularly disposed styles and setæ only; marginal setæ stationed at some distance from the periphery, the posterior ones only projecting beyond its hinder border; anal styles five in number, long and stout, recurved towards the left, sometimes uncinate at their extremities, and all projecting to a considerable distance beyond the posterior margin. Length 1–288″. HAB.—Fresh water.

This type corresponds with the *Trichoda pellionella* of O. F. Müller.

Oxytricha ferruginea, Stein sp.

Body linear-oblong, about five times as long as broad, rounded and widest posteriorly, the anterior end bluntly pointed, curved somewhat obliquely towards the left; peristome-field wide, extending backwards to the centre of the anterior third of the body, its inner border reflected to a considerable distance and curved inwards to the left, bearing a distinct undulating membrane; median ventral setæ represented by a few irregularly disposed styles; marginal setæ uninterrupted, projecting throughout the

periphery; anal styles large, but not reaching to the posterior extremity of the body. Length 1–144″. HAB.—Fresh water.

Oxytricha fallax, Stein. PL. XLV. FIG. 7.

Body ovate, flattened, two and a half times as long as broad, rounded and widest posteriorly, tapering towards and bluntly pointed at the anterior end; peristome-field wide, extending backwards nearly to the centre of the body; its reflected inner border ciliate, curved to the left at its anterior extremity; ventral setæ represented by a few scattered styles; marginal setæ forming a continuous projecting fringe, longest towards the posterior extremity; three only of the anal styles produced beyond the posterior margin. Length 1–168″ to 1–144″. HAB.—Fresh water.

Oxytricha platystoma, Ehr. sp. PL. XLV. FIGS. 8 AND 9.

Body elongate, obovate, two and a half times as long as broad, widest towards the anterior extremity, gradually tapering thence to the rounded but narrowest posterior end; peristome-field deeply excavate, helicoidal, not extending to the centre of the body, its reflected inner border curved inwards to the left in a spiral manner, bearing a row of fine pre-oral cilia and an undulating membrane; ventral setæ five in number, marginal series forming an uninterrupted, prominent peripheral fringe, two of the anal styles only projecting a slight way beyond the posterior body-margin.

This species is identical with the *Oxytricha platystoma* of Ehrenberg and Stein. The elegant helicoidal contour of the peristome-field distinguishes it from all the preceding species of this genus, and is at the same time so deeply cut as to show clearly through from the dorsal aspect. Diesing * has proposed to separate both this and *O. ferruginea* from the ordinary *Oxytrichæ*, and to create for them the new generic title of *Steinia*; but in face of the more comprehensive partitioning of the genus *Oxytricha* by Wrzesniowski and Sterki, as here adopted, the further generic separation of these two types does not at present appear desirable.

Oxytricha micans, Eng.

Body highly contractile; anal styles slender, eight to ten in number, those towards the right-hand side being largest and most prominent; shape of the body and disposition of the other styles and setæ agreeing with that of *Oxytricha pellionella*. Length 1–300″. HAB.—Fresh water.

Oxytricha æruginosa, Wrz. PL. XLIV. FIGS. 19 AND 20.

Body very flexible, slightly contractile, elongate-elliptical, about three and a half times as long as broad, the two extremities rounded, the anterior one slightly narrower and curved somewhat to the left; peristome-field extending backwards to a distance of a little over one-fourth of the length of the entire body; three uncinate frontal styles and three or four frontal setæ; ventral setæ five in number, two situated immediately behind the peristome, one central, and the other two adjacent to the anal styles; anal styles five in number, slender, and not projecting beyond the posterior

* 'Revision der Prothelminthen,' 1866.

border; marginal setæ set within the periphery, and excurrent only at the posterior extremity; a supplemental border of very short, hair-like, or hispid setæ projecting at right angles down each lateral margin; endoplasts two in number, ovate; contractile vesicle situated close to the left-hand border a little in advance of the median line. Length 1–200″ to 1–150″.

HAB.—Fresh water; parenchyma usually enclosing rust-coloured granules.

This and the two following species are described by Wrzesniowski in his account of the Infusoria of Warsaw.*

Oxytricha macrostyla, Wrz.

Body flexible, but not contractile, elongate-lanceolate, about five times as long as broad, the anterior extremity rounded, gradually tapering from the centre, narrowest and somewhat pointed posteriorly; peristome-field extending backwards to a distance of about one-quarter of the length of the entire body, furnished with a double, lip-like process; possessing seven or eight uncinate frontal styles, five ventral styles, disposed quincuncially as in *O. æruginosa*, and five large, stout, incurved anal styles, which do not project beyond the posterior extremity; marginal setæ forming an even, projecting lateral border, increasing in length and prominence towards the posterior extremity; a supplemental border of fine hispid setæ developed down the right and left peripheral margins; contractile vesicle situated close to the left-hand margin, in front of the median line; endoplasts two in number, ovate. Length 1–200″. HAB.—Fresh water.

Oxytricha sordida, Wrz.

Body lanceolate, about three and a half times as long as broad, the right-hand border convex, the left one indented, the anterior extremity narrower and curved slightly towards the left; bearing three anterior uncinate and three more posterior setose frontal styles; five scattered ventral setæ, and four or five slender, projecting anal styles; marginal setæ forming a continuous peripheral border, longest towards the posterior extremity; contractile vesicle situated close to the centre of the left lateral border. Length 1–200″. HAB.—Fresh water.

Oxytricha scutellum, Cohn. PL. XLIV. FIGS. 17 AND 18.

Body highly retractile, oblong, flattened, rounded posteriorly, pointed anteriorly, about twice as long as broad when extended, nearly orbicular when contracted; peristome-field extending backwards to a distance of one-third of the length of the expanded body; a transverse row of about twelve slender anal styles projecting at the posterior extremity; contractile vesicle single, central; parenchyma grey, more or less granular. Length 1–480″ to 1–360″. HAB.—Salt water.

Cohn omits, in his figures and description of this species, to record the character

* 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xx., 1870.

of the ventral and marginal setæ; under these circumstances its retention among the typical representatives of the genus *Oxytricha* must be regarded as provisional.

Supplementary Species.

Oxytricha tubicola, Gruber. Pl. XLIV. Fig. 12.—This species is briefly described by Dr. August Gruber,* in company with *Stichotricha socialis* and several other interesting marine and fresh-water species. Excepting, however, for its habit of excreting and inhabiting a short tube, open at both ends, as shown in the accompanying figure, the data recorded are insufficient to define its true position with relation to the other members of the Oxytrichidæ. The character of this protective element, if confirmed by future observation, at the same time suffices to indicate the necessity that will probably arise of instituting a new generic title for its reception.

GENUS XXI. HISTRIO, Sterki.

Animalcules free-swimming, persistent in shape, ovate or elliptical, bearing three large uncinate and a few smaller setose frontal styles, five scattered ventral and five anal styles; an uninterrupted projecting fringe of marginal but no caudal setæ; peristome-field with a reflected inner border; endoplasts two in number; contractile vesicle situated near the centre of the left lateral margin.

This genus is instituted by Sterki † for the reception of the *Stylonychia histrio* of Ehrenberg and more recent writers, which differs from the typical *Stylonychiæ* in the entire absence of caudal setæ.

Histrio Steinii, Müll. sp. PL. XLV. FIGS. 13 AND 14.

Body elongate-elliptical, somewhat lancet-shaped, slightly curved towards the left; the marginal setæ continuous throughout; no longer caudal setæ developed at the posterior extremity, and none of the anal styles projecting beyond the posterior border; endoplasts ovate or nearly spherical. Length 1–190″ to 1–168″. HAB.—Fresh water, among aquatic plants.

This animalcule is identical with the *Kerona histrio* of O. F. Müller, and the *Stylonychia histrio* of Ehrenberg and Stein. The conversion of the old specific title into a new generic one, and the adoption of a new name to replace the former as accomplished by Sterki, is a course perhaps scarcely to be commended.

Histrio similis, Quenn. sp.

Body elongate-elliptical, straight, not quite three times as long as broad, rounded at each extremity; the marginal setæ forming an even and continuous lateral border; no caudal setæ; anal styles five in number, simple, straight, and slender, projecting for about half their length beyond the posterior extremity. Length 1–225″. HAB.—Salt water.

The straight and more regularly elliptical form of this species, in addition to the prominence of the anal styles and salt-water habitat, distinguish this species from *Histrio Steinii*, which it otherwise most nearly resembles.

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* 'Zeit. Wiss. Zool.,' Bd. xxxiii., 1879. Also translation, 'Journal Royal Microscopical Society,' vol. iii., No. 2, April 1880.

† 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xxxi., 1878.

Genus XXII. ACTINOTRICHA, Cohn.

Animalcules free-swimming, slightly flexible, ovate or elliptical, the anterior border of the ventral surface bearing five or six abnormally thick, sharply-pointed frontal styles, a row of smaller styles produced down each lateral margin, and a transverse row of five or six anal styles developed at the posterior extremity; adoral row of cilia very large, uncinate.

Actinotricha saltans, Cohn. Pl. XLV. Fig. 6.

Body elliptical, equally rounded at both extremities, about twice as long as broad; the five large frontal styles radiating symmetrically from the anterior border, the central style the largest, and the remaining ones gradually diminishing in size backwards; eight or nine smaller styles entering into the composition of each of the latero-ventral rows, the four posterior styles in each row being about twice the length of the preceding four; anal styles long and stout, six in number, equal in size, forming an even transverse series, often branched at their distal terminations; peristome and adoral cilia produced backwards to a distance of about one-third of the length of the entire body; parenchyma transparent, colourless. Length 1–360″.

Hab.—Salt water, swimming evenly in a straight line, springing or creeping.

It is difficult to decide whether the latero-ventral series of setæ represented by Cohn in his description and illustration of this species, belong rightly to the ventral or to the marginal series; the author is inclined, however, to believe that they appertain to the latter, and that the true ventral and probably also the frontal styles have been overlooked. Should this inference prove correct, this single generic type, excepting for the abnormal development of the six frontal styles, is closely allied to *Stylonychia*.

Genus XXIII. STYLONYCHIA, Ehrenberg.

Animalcules free-swimming, persistent in shape, encuirassed, ovate or elliptical; peristome-field extensively developed, its reflected inner border finely ciliate, usually bearing a band-like undulating membrane; anterior or frontal styles usually eight in number, occupying a more or less distinct circular area; five claw-like ventral styles or uncini, and five straight anal styles; the marginal setæ forming on each side an even and continuous border; three long, hair-like caudal setæ usually developed at the posterior extremity; endoplasts two in number, oval or elongate, sometimes cylindrical or bacillar, dividing into separate ovate nodules; contractile vesicle single, spherical, situated near the posterior angle of the peristome. Inhabiting salt, fresh, and stagnant water.

Stylonychia mytilus, Ehr. Pl. XLV. Figs. 1 and 18–22.

Body elongate-elliptical, more than twice as long as broad, rather wider anteriorly, with a slight left curvature, tapering backwards from the centre, the posterior third frequently becoming abruptly narrowed and bent towards the left, the posterior termination mostly truncate; peristome-

field occupying the entire left side of the anterior ventral surface, its reflected inner border ciliate and supporting a conspicuous, band-like, undulating membrane; the two right-side anal styles projecting beyond the posterior extremity; three long, widely separated, caudal setæ springing from the truncate posterior end, in which region the otherwise even and prominently developed marginal series is considerably interrupted; both the anal and frontal styles occasionally fibrillate or branched at their extremity. Length 1–280″ to 1–72″.

HAB.—Fresh water; also abundant in infusions.

Sterki alludes briefly in his 'Morphologie der Oxytrichinen'* to a variety of this animalcule, upon which he confers the sub-specific name *Stylonychia mytilus* var. *pusilla*. The caudal setæ in this modified type attain the length of one-half of the body, and are either bi- or tri-furcate at their free extremities; there are but from twelve to eighteen marginal setæ on the right, and from ten to fourteen only on the left-hand lateral border, while the lengths of the larger examples range from 1–275″ to 1–200″.

Stylonychia pustulata, Ehr. PL. XLV. FIGS. 15–17.

Body elongate-ovate, equally wide in front of and behind the median line, the posterior extremity evenly rounded, bearing three long, closely approximated caudal setæ which scarcely interrupt the marginal series; three or four of the anal styles projecting beyond the posterior border; endoplasts oval. Length 1–280″ to 1–120″.

HAB.—Salt, fresh, and stagnant water.

This animalcule is common in infusions, and may be distinguished from the preceding type, in addition to its smaller size, by its rounded posterior extremity, by its more closely approximated caudal setæ, and by the more numerously projecting anal styles.

Stylonychia fissiseta, C. & L. PL. XLV. FIG. 22.

Form and dimensions of the body identical with those of *S. pustulata*; marginal setæ fewer, larger, wider apart, and not projecting beyond the peripheral border; each of the five anal styles feather-like or fibrillate at their distal extremity; three very long, widely separated caudal setæ, branched in a trifid manner at their free end, projecting from the posterior extremity.

HAB.—Fresh water: Berlin Zoological Gardens (C. & L.).

The illustration given by Claparède and Lachmann, here reproduced, represents eleven anterior or frontal uncini, while their description testifies to only eight, the normal number associated with this genus. The elegant branched or fimbriate character of the anal styles in a manner resembling the feathering of an arrow, and trifurcation of the caudal setæ, as also the non-prominence of the marginal setæ, serve to distinguish it readily from either of the preceding forms.

Stylonychia macrostyla, Sterki.

Corresponding closely with *S. mytilus*, more or less flexible, rounded anteriorly, the posterior margin broadest and truncate; all the styles and

* 'Zeitschrift für Wissenschaftliche Zoologie,' 1878.

setæ exceedingly long, the frontal series placed further back; caudal setæ equalling half the body in length, flexible and trailing, not branched or fimbriate at their extremities. Inhabiting fresh water.

Fam. VI. EUPLOTIDÆ, Ehr.

Animalcules free-swimming, encuirassed, more or less ovate, with a plane ventral and convex dorsal surface; oral aperture ventral, situated at the posterior extremity of an arcuate or subtriangular peristome-field, the outer or left-hand border of the peristome bearing a linear series of stout cirrose adoral cilia, shorter cilia of the same description sometimes continued up the reflected or right-hand border of the peristome; anal styles always present, those of the frontal and ventral series more or less conspicuously developed, also occasionally a few postero-marginal or caudal, but never a continuous series of latero-marginal setæ.

Excepting for the absence of latero-marginal setæ, and the difficulty experienced in discriminating between the groups of frontal and ventral styles, the members of this family group correspond closely with those of the Oxytrichidæ last described. The peristomal system is also simpler, for while in some instances it possesses a reflected inner border with an associated fringe of pre-oral cilia, no instance is as yet known in which either an endoral or paroral series is represented. At the same time, this little family group exhibits in certain points an advance upon that of the Oxytrichidæ, the cilia of the ventral aspect being more concentrated, and their constituent elements being in all instances highly differentiated in the form of styles and uncini. In the Oxytrichidæ, on the other hand, the last-named appendages may, as in *Kerona* and *Trichogaster*, take the form of minute setose cilia, and thus lead the way through *Peritromus* and *Litonotus* to the more simply organized Holotricha. By Stein the four genera here assembled under the title of the Euplotidæ are divided into the two family groups of the Euplotina and Aspidiscina, the second one being instituted for the reception only of the single genus *Aspidisca*. As this type differs from the three other genera only in the more rearward location of the peristome-field and consequent non-projection of the adoral fringe of cilia beyond the anterior border, it has not been considered desirable to retain this distinction in the present volume. The indurated and more or less ovate or orbicular carapace or cuirass of the members of this family group, combined with their truly ambulatory mode of progress over the surface of submerged objects by aid of their frontal and ventral styles, imparts to many of them an insect-like appearance. The passage from the preceding family of the Oxytrichidæ is possibly accomplished through the genus *Uronychia*, in which two rudimentary latero-marginal setæ are found developed on each side in close contiguity to the anal styles.

Genus I. ASPIDISCA, Ehrenberg.

Animalcules free-swimming, encuirassed, orbicular or shield-shaped, with a convex dorsal and plane ventral surface, the right-hand border of the ventral surface having a thickened margin; peristome-field set far back on the left-hand side, associated with a simple arcuate fringe of adoral cirri, which do not project beyond the anterior or left lateral margin; several large claw-like styles usually developed towards the anterior end and in the centre of the ventral region, and from five to ten or twelve posterior or anal styles; anal aperture placed far back, debouching a little in advance of the posterior or anal styles. Mostly inhabiting salt water.

Aspidisca lyncaster, Stein. PL. XLV. FIGS. 23 AND 24.

Body ovate, rounded on the right side and at the two ends, the anterior border of the left side incised so as to produce a posteriorly directed spur-like projection, a similar aculeate spur, curved slightly outwards, projecting from the ventral surface of the carapace on the same side, within a short distance of the posterior margin; ventral styles short and thick, seven in number; five anal styles; endoplast band-like, curved; contractile vesicle single, situated a little in advance of the anal styles. Length of body 1–450″ to 1–360″. HAB.—Salt water.

Aspidisca lynceus, Ehr.

Body ovate, widest and somewhat truncate posteriorly; the marginal border of the carapace entirely even, the left one straight, the right one somewhat convex; the dorsal surface smooth, or marked longitudinally with three feeble furrows; the inferior surface bearing seven ventral and five anal styles. Length of body 1–540″. HAB.—Salt water.

Aspidisca turrita, C. & L. PL. XLV. FIGS. 31–33.

Carapace suborbicular, widest and somewhat truncate posteriorly, its marginal border entirely even, the left side nearly straight, the opposite one rounded, a thorn-like recurved spine developed from the centre of the dorsal surface; ventral styles as in *A. lynceus.* Length 1–450″.

HAB.—Sea water.

Aspidisca polystyla, Stein.

Carapace oval, its margin entire, the left side border nearly straight; the dorsal surface slightly convex, traversed by three longitudinal grooves; ventral styles seven in number, forming two anterior, oblique, parallel rows of three each, the seventh style stationed by itself to the right and rear of the other six; anal styles from ten to twelve in number. Length 1–510″.

HAB.—Sea water.

This species, by reason of the greater number of the ventral styles, has formed the type of Stein's sub-genus *Onychaspis* and, in connection with the last-named title, has been elevated by Diesing* to the rank of an independent generic group.

Aspidisca hexeris, Quenn.

Carapace elliptical, about one and a half times as long as broad, equally rounded at each extremity; the right-hand border armed, close behind its centre, with a single, backwards directed, spur-like projection; ventral styles short and thick, seven in number; six anal styles. Length 1–500″. HAB.—Salt water.

Aspidisca sedigita, Quenn.

Body broadly ovate, suborbicular, the right border smooth and rounded, the left one incised so as to produce a central, anterior, and posterior spur-

* 'Revision der Prothelminthen,' 1866.

like projection; ventral styles seven in number, short and thick, centrally disposed; six stout, scarcely prominent anal styles. Length 1–325".

HAB.—Salt water.

From *Aspidisca lyncaster*, which it would appear to most closely resemble, this form may be distinguished by the presence of three instead of two lateral spur-like projections on the left-hand border; it is figured and described by Quennerstedt, in company with the preceding type, in Part II. of his 'Sveriges Infusoriefauna,' 1867.

Aspidisca Andrewii, Mereschk.

Body elongate-ovate or subreniform, one and a half times as long as broad, rounded at the two extremities, the posterior one being the wider, the right-hand border evenly convex, the left one deeply indented at a distance of one-third of its entire length from the anterior extremity; the dorsal surface of the carapace traversed by five parallel longitudinal grooves or striæ, a triangular or somewhat heart-shaped plate developed on the ventral surface close to the posterior extremity, having its apex directed backwards and reaching to but not projecting beyond the dorsal border of the carapace; ventral styles very large and short, seven in number, distributed in two rows of four and three styles each; anal setæ long and fine, six in number, four developed in a line to the right and two to the left of the ventral plate. Length 1–480".

HAB.—Salt water: White Sea, abundant among algæ (Mereschkowsky).

In its possession of six anal setæ this species corresponds with the *Aspidisca sedigita* of Quennerstedt.

Aspidisca costata, Duj. sp. PL. XLV. FIGS. 25–29.

Carapace nearly ovate, the ventral portion developed outwards and backwards in the form of a triangular plate towards the posterior extremity of the left side; the dorsal surface traversed by six longitudinal furrows; ventral styles as in *A. polystyla*. Length 1–690". HAB.—Pond water.

This animalcule is identified by Stein with the *Coccudina costata* of Dujardin and Perty, and with the *Aspidisca cicada* of Claparède and Lachmann. The author has on a recent occasion witnessed a highly interesting developmental phenomenon in association with this cosmopolitan species that does not so far appear to have been recorded by any other observer. In pond water abounding with this type there were likewise observed large numbers of a minute, oval, depressed form closely allied to the *Glaucoma margaritaceum* of Claparède and Lachmann, which is identified by them with the *Cyclidium margaritaceum* of Ehrenberg and the *Cinetrochilum margaritaceum* of Perty. The only point of distinction to be discovered in the variety personally examined consisted in the fact that there were three long, hair-like, posterior or caudal setæ in place of the single one observed by Claparède and Lachmann. As shown by these last-named authorities, the oral orifice is situated towards the posterior extremity, and has projecting from its aperture a delicate vibratile membrane, described by Stein in *Glaucoma scintillans* as consisting of two separate tremulous flaps, and with which structure that of *G. margaritaceum* is stated to coincide. Prolonging the examination of a single individual for a lengthened interval, the author was greatly surprised to notice the gradual appearance, towards the posterior end, of two thick style-like appendages, at first very weak and flexible, followed by the development of others both here and towards the anterior extremity, the animalcule shortly becoming transformed through these and the following modi-

fications into an *Aspidisca*, undistinguishable from the adult forms abundantly present with it in the surrounding water. Simultaneously with the growth of the ventral and anal styles, the fine vibratile ventral cilia and terminal hair-like setæ were gradually absorbed and obliterated, the vibrating oral membrane unrolled and extended itself, became transversely striate at regular intervals, and eventually split up to form the characteristic adoral fringe of cilia. The whole of these metamorphoses occupied a space of less than an hour, the animalcule at this early stage of its adolescent career being, however, decidedly weak on its "legs," as its locomotive styles may be appropriately designated, and staggering about after the manner of a newly-born calf or colt. Both in its adult and larval or *Glaucoma* stage *Aspidisca costata* exhibits an eccentricity of gait, which may be cited as correlative evidence in demonstration of their identity. This peculiarity alluded to is manifested by the tendency of the animalcule in either case to rotate upon a fixed point as though upon a pivot, or to persevere in the maintenance of a restricted circuitous course within the area of the microscopic field; the action in this latter instance is highly suggestive of the gait exhibited by a playful child as it pushes itself round and round in a circle, one leg only being permitted to exert a locomotive function.

With reference to the foregoing observation, the author, in place of conceding to the genus *Glaucoma* the rank of an independent generic type, is inclined to regard its members as mere larval conditions of *Aspidisca* and other allied Hypotricha. To which species the *Glaucoma scintillans* of Ehrenberg ultimately develops has yet to be determined. In accordance, nevertheless, with Stein's more recent drawings and description of this type, the oral aperture is situated near the anterior extremity, and the contractile vesicle at the opposite end, and from these circumstances it may be predicted as more likely representing the earlier stage of a *Euplotes* or *Uronychia*, in both of which the oral orifice is more anteriorly located than in *Aspidisca*. The bi-labiate structure of the oral membrane of *Glaucoma*, as described by Stein and Claparède and Lachmann, is evidently a misinterpretation of the optical aspect of a revolute single lamina. No trace of an endoplast could be detected by the author in the *Glaucoma* condition of this species, and only in the older examples of the adult *Aspidiscæ*. Increase by transverse fission was frequently observed during this embryonic phase, such circumstance demonstrating that this reproductive process is not confined to the adult stage, and is therefore not diagnostic of it even among the higher Ciliata. The diagnosis of the genus *Glaucoma*, with its two species herewith subjoined, as also that of the genus *Microthorax* of Engelmann, are allotted, in this treatise, a provisional status only, being regarded by the author as representing, in all probability, mere transitional or embryonic phases of higher Hypotrichous forms.

GENUS II. GLAUCOMA, Ehrenberg.

Animalcules free-swimming, persistent in shape, more or less ovate, with a convex and frequently grooved dorsal and a plane or flattened ventral surface; oral aperture ventral, associated with a minute, vibrating, flap-like membrane; fine vibratile cilia more or less completely clothing the ventral surface, these occasionally supplemented by one or more hair-like caudal setæ.

Glaucoma scintillans, Ehr. PL. XLV. FIGS. 39 AND 40.

Body ovate, depressed, the margin entire and equally rounded at the two extremities; the oral aperture with its projecting vibratile membrane developed towards the anterior extremity; the contractile vesicle posteriorly located; cilia projecting all round the periphery as a marginal fringe, and

covering the entire ventral surface of the body; no caudal setæ. Length 1–280″. HAB.—Pond water and infusions.

The relatively large size of this animalcule suggests the probability of its being the imperfect or larval form of a species of *Euplotes*.

Glaucoma margaritaceum, Ehr. sp. PL. XLV. FIG. 30.

Body oval, with an emargination or notch on the left-hand side of the posterior border; contractile vesicle situated posteriorly in close vicinity to this notch, and the oral aperture with its tremulous membrane on the opposite or right-hand side of the same region, but a little more forward; the dorsal surface obliquely or nearly longitudinally grooved or striate; a single long hair-like seta projecting obliquely towards the left from the posterior extremity. Length 1–1500″ to 1–720″. HAB.—Pond water and infusions.

This type is identical with the *Cyclidium margaritaceum* of Ehrenberg and the *Cinetrochilum margaritaceum* of Max Perty.

GENUS III. MICROTHORAX, Engelmann.

Animalcules of minute size, free-swimming, more or less oval, flattened, persistent in shape; the cuticular surface indurated; the oral aperture debouching upon a small fossa on the left-hand side of the hinder extremity of the ventral surface, associated with a flap-like vibrating membrane; cilia confined to the ventral surface, most conspicuous at the two extremities; endoplast and contractile vesicle subcentral.

In general aspect, and in the character of the oral organ with its vibrating membrane, the minute animalcules referred by Engelmann * to this genus so closely resemble those of the genus *Glaucoma* here treated as developmental conditions only of more highly organized Hypotrichous forms, that their present retention under a separate generic heading must be regarded as provisional.

Microthorax sulcatus, Eng. PL. XLV. FIG. 37.

Body oval, depressed, rounded posteriorly, somewhat pointed anteriorly and curved slightly towards the left, the left border flattened or slightly concave, the right one convex; the dorsal surface traversed by three deep, widely separated, longitudinal grooves; oral aperture developed at the posterior extremity, close to the left-hand border; the cilia longest and most conspicuous at the two extremities, confined to the ventral surface; contractile vesicle situated a little in advance of the oral fossa; endoplast ovate, subcentral. Length 1–425″. HAB.—Fresh water.

A second species, *Microthorax pusillus*, Eng., differs from *M. sulcatus* only in its smaller size, 1–750″, and in the absence of the dorsal furrows; it probably represents a younger phase of the same animalcule. The resemblance of this type to the *Cinetrochilum margaritaceum* of Perty (*Glaucoma scintillans*, Ehr.) has been already remarked by Wrzesniowski.

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* 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xi., 1862.

GENUS IV. URONYCHIA, Stein.

Body oval, encuirassed, turgid, the sides rounded, truncate in front, with a prominent membranous upper lip; the hinder extremity having developed on the ventral surface two converging bow-shaped fissures, into which the short, claw-shaped, anal and marginal uncini or styles are inserted; ordinary ventral and frontal styles entirely absent; the peristomal excavation pocket-shaped, closing sphincter-wise at will, its inner or right-hand border bearing a band-shaped undulating membrane.

The type and as yet single known species of this genus is the *Trichoda transfuga* of Müller and *Plæsconia scutum* of Dujardin and Stein's earlier writings. The present generic title was conferred upon it by Stein * in the year 1865.

Uronychia transfuga, Müll. sp. PL. XLV. FIGS. 34-36.

Body ovate, truncate in front, slightly narrower posteriorly, more usually obliquely truncate, angular, and bent towards the left, but sometimes evenly rounded, the lateral margins symmetrical; peristome-fossa extending from the anterior end to the centre of the body, widened posteriorly; the surface of the dorsal region sometimes smooth, sometimes longitudinally ribbed; anal uncini and styles variable in character and number, usually from three to seven or eight recurved and occasionally fimbriate uncini inserted in the right-hand posterior cleft, but not more than two on the opposite one; each of these fascicles occasionally supplemented by two fine simple setæ. Length of body 1-288". HAB.—Salt water.

This species appears to be subject to a wide range of both local and individual variation with respect to the number and character of the stylate appendages of the posterior extremity of the body. In some instances these appendages are straight, or but slightly bent, in others strongly curved or uncinate, while in a third series they are branched in an elegant feather-like manner. The posterior termination of the carapace, and also the character of its dorsal surface, as shown in the diagnosis, exhibits a similar tendency to vary. There can be but little doubt, the above facts considered, that the *Campylopus paradoxus* of Claparède and Lachmann † is, as anticipated by Stein, identical with this species, though these last-named authorities seem to have failed in detecting the undulating membrane on the right border of the peristome, and which without very careful examination is likely to escape notice. The author has obtained this singular animalcule from Brighton and the Jersey coast, and also in sea-water from the Aston Aquarium, Birmingham, remitted by Mr. Thos. Bolton.

GENUS V. EUPLOTES, Ehrenberg.

Animalcules free-swimming, encuirassed, shield-shaped, elliptical, or orbicular, with sharp laminate marginal edges, and usually a plane ventral, and convex, sometimes furrowed, dorsal surface; peristome-field arcuate, extending backwards from the frontal border to or beyond the centre of the ventral surface, sometimes with a reflected and ciliate inner border; frontal styles or uncini six or seven in number; three or more irregularly

* 'Böhmische Gesellschaft der Wiss.,' Bd. x.
† 'Études sur les Infusoires,' 1858.

scattered ventral styles, and five anal styles; four isolated and often fimbriated caudal styles or setæ developed along the posterior margin; endoplast linear, curved; contractile vesicle single, spherical, situated immediately beneath the origin of the right-hand anal styles. Inhabiting salt and fresh water. Multiplying rapidly by transverse fission.

Euplotes patella, Ehr. PL. XLIV. FIGS. 23–25.

Carapace elliptical, anteriorly truncate, its upper lip or lamina triangular, projecting above and considerably overlapping the anterior margin of the peristome; the inner and reflected border of the peristome represented by a simple unciliated groove or channel; frontal styles six in number, three scattered ventral styles, the two more posterior caudal styles branched or fimbriated; the dorsal surface usually traversed by seven longitudinal furrows; endoplast band-like; contractile vesicle single, situated near the anal aperture. Length 1–196″. HAB.—Salt and fresh water.

This species, like many other Hypotricha, is subject to considerable local and individual variation, chiefly evinced in this instance in the varying contour of the carapace and in the character of its ornamentation. This carapace or cuirass, while normally oval or elliptical, may be nearly circular or lozenge-shaped, broad in the centre and much narrower at the antero-posterior extremities. The longitudinal sulci again, which usually form a well-developed series extending from one end to the other of the dorsal surface, are sometimes developed only in the posterior region, or may be altogether absent. The number, character, and arrangement of the various stylate appendages appear always in this species to accord with that normal formula given in the foregoing diagnosis.

So long since as the year 1869 * the author placed on record an observation concerning an example of the species that up to within a recent date he has been entirely unable to reconcile with the characteristic structure of either this special type or any representative of the present order. In this instance long flagella-like cilia were reported as projecting from the anterior extremity, of a length and character altogether distinct from those usually entering into the composition of the peristomal fringe of either *Euplotes* or its nearest allied generic types. Assisted, however, by the light contributed by the developmental phenomena of *Aspidisca costata*, recorded in a previous page, and in which it has been shown that the peristomal fringe of cilia commences its existence as a simple vibratile membrane, the phenomenon now referred to becomes more intelligible. In numerous instances the permanent vibratile membranes of various Infusoria, such as obtain in the genera *Condylostoma*, *Blepharisma*, *Pleuronema*, and others, have been first interpreted and figured as flagella, their true significance being demonstrated only through more recent and carefully conducted investigation; and in like manner it may be consistently predicated that the supposed flagella observed on the occasion quoted represented the undulating outline of the primary vibratile membrane of the type in question previous to its splitting up into the ciliary adoral wreath that characterizes the adult form. Inferring at the time that this animalcule represented a fully developed adult individual, we proposed to distinguish it by the title of *Euplotes paradoxa* in reference to the apparent abnormal presence of long flagella. The author is now satisfied, however, that the form represented an example of *Euplotes patella*, previous to the complete perfect development of its adoral ciliary wreath.

A variety of *Euplotes patella* having evenly parallel sides and a more elongate elliptical contour, has recently received from Wrzesniowski the subspecific title *E. patella* var. *eurystomus*.

* 'Monthly Microscopical Journal,' vol. i. pl. xii. fig. 5, p. 291.

Euplotes harpa, Stein. PL. XLIV. FIG. 22.

Carapace elongate-oval, nearly twice as long as broad, the anterior extremity widest, rounded, having a projecting tooth-like process at the right-hand corner; two similar but larger and blunter denticulations developed on the anterior margin of the ventral surface; seven frontal and nine scattered ventral styles; five anal, and four isolated unbranched postero-marginal setæ; the reflected or inner border of the peristome extensively developed, finely ciliate; eight straight longitudinal furrows traversing the dorsal surface of the carapace. Length 1–168″ to 1–144″.

HAB.—Salt water.

This species, which is the largest representative of the genus, may be readily distinguished from the preceding type by the toothed edge of the lower surface of the carapace, the reflected and ciliate peristomal border, and by the simple unbranched character of the posterior marginal styles.

Euplotes longipes, C. & L.

Carapace elliptical, its right and left borders nearly straight and parallel to one another, the anterior and posterior margins equally rounded; the front edge of the lower surface of the carapace simply curved, not denticulate; no ciliated reflection of the peristome-border; the dorsal surface smooth; seven frontal and three ventral styles, the postero-marginal ones unbranched. Length 1–180″. HAB.—Salt water.

Stein anticipates that this specimen may possibly be identical with his *Euplotes harpa*. The author has, however, met with a form precisely agreeing with the description given by Claparède, in sea-water at Bognor, Sussex, in September 1873. The even elliptical contour and undenticulate anterior ventral margin, together with the simpler character of the peristome of the examples examined, assisted at once in distinguishing it from Stein's type.

Euplotes charon, Müll. sp. PL. XLIV. FIGS. 26–29.

Carapace shortly oval or suborbicular; the anterior and posterior extremities obliquely truncate, parallel to one another; the right side feebly but the left side strongly convex; the dorsal surface usually ribbed longitudinally; the anterior margin of the lower surface of the carapace entire, or slightly indented; the reflected peristome-border simply grooved, unciliate; seven frontal and three ventral styles; the posterior marginal setæ small, unbranched. Length 1–320″ to 1–260″.

HAB.—Salt and fresh water.

The shorter and almost orbicular contour of the carapace of this species serves at a glance to distinguish it from either of the preceding varieties, while from *E. patella*, with which it is most likely to be confused, it substantially differs in the larger number of the frontal styles and in the unbranched character of the postero-marginal setæ. Sharing the extensive or cosmopolitan distribution of the last-named type, it is subject to considerable local variation, and more especially with reference to the ornamentation of the dorsal surface of the carapace, and which, while usually more or less extensively furrowed, is not unfrequently perfectly smooth. Examples derived from salt water only have been observed to attain the larger of the two dimensions

quoted in the foregoing diagnosis. Among the numerous synonyms with which this abundantly distributed species has been connected by the earlier writers, the following, as given in Stein's monograph of the Hypotricha, may be more especially mentioned: *Trichoda charon* and *cimex* of Müller; *Euplotes charon* and *appendiculatus* of Ehrenberg; and *Plæsconia charon*, *affinis*, *subrotunda*, *radiosa*, and *longiremis* of Dujardin.

Genus VI. STYLOPLOTES, Stein.

Animalcules free-swimming, encuirassed, elliptical, turgid, the carapace rounded and thickened at the lateral margins, with a projecting antero-dorsal lip; the hinder extremity obliquely truncate; a band-shaped median channel or excavation extending from one end to the other of the ventral surface, in which are situated the arcuate peristome-field and also the stout frontal, ventral, and anal styles or uncini. In addition to these last-named elements, a supplementary postero-marginal fascicle of caudal styles is usually developed.

Styloplotes appendiculatus, Ehr. sp. Pl. XLIV. Figs. 30 and 31.

Body elliptical, the anterior end ovoid, somewhat pointed, the posterior extremity obliquely truncate, curved to the right; five frontal and four ventral styles, two of the latter situated in the centre of the median groove, and two near the left lateral border; anal styles very long, five in number, variously curved, closely approximated, and forming a single transverse row, which projects considerably beyond the posterior margin; a supplementary postero-terminal or caudal series, composed of three recurved uncini, developed upon the posterior border. Length of body 1–380″ to 1–260″.

Hab.—Salt water.

Stein identifies this species with the *Stylonychia appendiculata* of Ehrenberg, the *Plæsconia scutum* (in pars) and *Diophrys marina* of Dujardin, and with the *Euplotes excavatus* and *Schizopus norvegicus* of Claparède and Lachmann.

The author has recently obtained it in abundance in the neighbourhood of St. Heliers, Jersey, and had then under examination an apparent embryonic form. The complete life-history was not fully traced, but it was observed that in an early stage of development it differs remarkably from the adult animalcules, possessing no frontal, ventral, or anal styles, but simply an anterior or adoral fringe of cilia. Under these conditions its movements are almost exclusively natatory, its translation through the water being very swift, and its general aspect somewhat approaching that of a *Strombidium*.

The type referred to the family Euplotina by Ehrenberg, under the title of *Himantophorus charon*, is regarded by Stein as not improbably identical with *Onychodromus grandis*. The *Discocephalus rotatorius* of the same author is apparently an imperfectly observed representative of the genus *Aspidisca*.

CHAPTER IX.

SYSTEMATIC DESCRIPTION OF THE INFUSORIA-TENTACULIFERA.

Class III. TENTACULIFERA, Huxley.

Animalcules bearing neither flagellate appendages nor cilia in their adult state, but seizing their food and effecting locomotion, when unattached, through the medium of tentacle-like processes developed from the cuticular surface or internal parenchyma; these tentacles simply adhesive, or tubular and provided at their distal extremity with a cup-like sucking-disc; an endoplast and one or more contractile vesicles usually conspicuously developed; trichocysts rarely, if ever, present; increasing by longitudinal or transverse fission or by external or internal bud-formation. Inhabiting salt and fresh water.

The Tentaculiferous Section of the Infusoria, comprising *Acineta* and its allies, while including, in comparison with the classes of the Flagellata and Ciliata already described, a relatively small number of generic and specific forms, invites, with reference to the remarkable structural and developmental features of its members, an equal or even greater share of the biologist's attention. Although, as previously shown,* the Tentaculifera, during their normal adult phase of existence, betray no sign of affinities with either of these preceding classes, they are in their embryonic condition more or less completely clothed with vibratile cilia, and may also, under certain conditions (see *Podophrya fixa*) temporarily develop cilia in place of their tentacula. It may be hence logically predicated that this class of the Infusoria is an offshoot from the Ciliata, and that it consequently occupies a relatively higher position in the zoological scale than do the members of the last-named class. Supplementary evidence is afforded in this direction in connection with the fact that the ciliation of the embryos of the Tentaculifera conforms roughly among the various species and genera with that of the three more important groups of the Ciliata distinguished by the titles of the Holotricha, Peritricha, and Hypotricha; the cilia in like manner being in one series developed upon the entire cuticular surface, in a second being restricted to an anterior tuft or annular girdle, while in a third the cilia are developed exclusively on the ventral surface of the body. It is further worthy of remark that the holotrichously ciliated embryos are derived from the simplest Tentaculifera, such as *Podophrya*, while the hypotrichous embryos are the more exclusive produce of such higher types as *Dendrocometes* and *Ophryodendron*.

The recognition of the Tentaculifera as a distinct class or order of the Infusoria has been accomplished at a comparatively recent date. By Ehrenberg, as shown in his Classificatory System, Vol. I. p. 201, they were referred together with the Diatoms and Desmids to the group of the Bacillaria, while Perty included them with *Actinophrys* in his group of the Actinophrina. Stein for many years advocated the opinion that its members represented developmental phases only of various

* See Vol. I. p. 107 *et seq.*

Vorticellidæ, such inference being arrived at in connection with the circumstances that many *Acinetæ*, e. g. *Podophrya quadripartita*, *Podophrya carchesii*, and *P. phryganidarum* are found usually closely associated with certain compound Vorticellidæ, while in their ciliated embryonic state their resemblance to free *Vorticellæ* is very remarkable. In accordance, indeed, with Stein's theory, every one of the earlier known Acinete forms represented but the immature or embryonic condition of a Vorticellidan type, the respective species to which they were in his opinion related being indicated in the following specific descriptions.* It was the researches more especially of Messrs. Claparède and Lachmann, having as their end in view the solution of the vexed question of their affinities, that conduced chiefly to the elucidation of the true nature of this remarkable group of organisms, and which won for them that independent position which has since been universally accorded. As a distinct section of the Infusoria, possessing the same status as that of the Ciliata and the Flagellata previously described, and with reference more particularly to their manner of ingesting food, and the character of their tentacle-like appendages, Claparède and Lachmann conferred upon these Infusoria the title of the Suctoria. More recent investigations having, however, elicited the existence of forms allied to *Acineta* in which a portion only of the tentacles are suctorial, or which again may be entirely non-suctorial and simply prehensile, Professor Huxley † has proposed to substitute for the Suctoria the more appropriate title of the Tentaculifera, which is here utilized, Claparède and Lachmann's name, with the new one of the Actinaria, being at the same time retained for the distinction of respectively the suctorial and non-suctorial series.

The histological composition of the Tentaculifera corresponds substantially with that of the two classes hitherto described; an external cuticular layer, internal granular protoplasm, and the essential structures, an endoplast or nucleus and one or more contractile vesicles, are usually recognizable. The endoplast, it may be remarked, is in many forms, e. g. *Hemiophrya gemmipara*, and *Podophrya Steinii*, extensively ramified, though in no instance as yet known is there a multiplicity of endoplastic structures as obtain among many of the Ciliata. The majority of species are sedentary in their habits, thus offering an additional point of resemblance to the Vorticellidæ, with which they were originally correlated. In like manner, while some are sessile, others are stalked, and may be either naked or enclosed within a transparent sheath or lorica. Although up to the present time no Tentaculiferous type has been discovered in which the individual zooids are united by their pedicles, and thus form, precisely as in *Carchesium* or *Epistylis*, a compound zoodendrium, an almost equivalent colonial modification obtains in the genus *Dendrosoma*. Here, however, the separate zooids, as represented by each tentaculiferous ramuscule, are indissolubly united, possess in addition a common creeping stolon, and more nearly approach the constitution of a multicellular animal or metazoon than can perhaps be predicated of any of the forms previously noticed. A less decisive advance in the same direction is apparently accomplished in the form hereafter described under the title of *Ophryodendron multicapitata*, while potential multicellularity, as with the multinucleate Ciliata, would also appear to obtain in all those types distinguished by the ramifying character of their endoplast. Although among the majority of loricate species, the protective sheath or lorica differs in no essential respect from those formed by the Ciliate or Flagellate groups of the Infusoria, in certain other forms it presents a more complex character.

Thus in *Acineta vorticelloides* and *A. divisa* it has been shown by M. Fraipont ‡ that the fundus of the lorica is separated from the anterior region by a distinct membranous septum or platform, upon which the animalcule's body rests, while in *Acineta tuberosa* the membranous wall of the lorica covers in also the anterior

* Following Stein's lead, a similar subordinate position is accorded to the Acinetidæ in Prichard's 'Infusoria,' latest edition, 1861.

† 'Anatomy of the Invertebrata,' 1877.

‡ "Recherches sur les Acinetiens de la Côte d'Ostende," 'Bull. de l'Acad. de Bruxelles,' 1877 and 1878.

border of the periphery, leaving two small orifices open only for the passage of the tentaculate appendages. In *Acineta mystacina* a series of triangular plates or valves, having slit-like interspaces for the exit of the tentacles, protect in a like manner the more ordinarily exposed anterior margin of the body. Some difference of opinion exists respecting the significance and point of origin of the tentacles of the Acinetidæ. By some authorities, including Hertwig and Koch, it has been represented that these organs are independent of and perforate the external cuticular membrane, being produced from the central endoplasmic region of the body. Stein, Zenker, and Fraipont, on the other hand, maintain that the tentacles consist essentially of tubular prolongations of the external cuticle only. Still more recently, M. E. Maupas, in his important memoir devoted to the consideration of this group,* has arrived at the conclusion that, while in the majority of cases these appendages are direct prolongations of the cuticular region, in certain instances, including more particularly the members of the genus *Hemiophrya*, the suctorial tentacles originate, as interpreted by Hertwig, from the deeper endoplasmic layer. So far, notwithstanding the number of species carefully examined, the author has been unable to connect the origin of the external or main-wall of the tentacles of either description belonging to this class with any other than the cuticular element, though in all instances their axial substance or central cavity, as the case may be, is in direct communication with the endoplasm or internal body-substance.

While the extension of the tentacles would appear to be accomplished by the injection into them of the fluid protoplasm of the body, their retraction is visibly brought about, in many species, and most probably in all, through the medium of an exceedingly delicate membranous fibrilla which is developed spirally throughout the length of the tentacles, in some species apparently on the inner, and in others on the external surface. When the tentacle is fully extended, the fibrilla is usually so straightened and attenuate as to be imperceptible, while conversely, on being retracted, it is thrown into more or less closely approximated transverse folds. *Podophrya elongata*, as recently examined by the author, has been found to illustrate this type of differentiation in a marked degree, while an apparent homologue of this contractile element is developed in a yet more conspicuous manner in the proboscidiform organ of *Ophryodendron*. As intimated by Fraipont, the fluid contents of the tentacles, discharged by their contraction or derived by suction from captured prey, on arriving at and being emptied into the soft protoplasmic substance of the body, continue, as the necessary resultant of the forces set in motion, in a straight line with the axis of the tentacle, producing the optical appearance in many instances that these appendages, as interpreted by Hertwig, really originate at some distance within the central protoplasm. In *Acineta tuberosa* an identical aspect is brought about by the fact that the two lateral bundles of tentacula are, when contracted, invaginated to a considerable distance beneath the surface of the cuticle.

The phenomena of food-ingestion as manifested by the typical Tentaculifera or Acinetidæ are highly remarkable. Their food, which consists mainly of other ciliate Infusoria, is seized by the adherent infundibulate or capitate extremities of the extended tentacles, a perforation in the cuticle of the captured prey at the point of contact is almost immediately effected, and the fluid or semi-fluid contents of the victim's body are transferred by suction in a continuous stream through the tubular tentacle into the body of the Acinetan. While this ingestive process is recognisable in most instances, and while in many cases the tubular character of the tentacles is so well defined that the two walls of the tube are clearly shown in optic section when viewed with sufficient magnification, in some species, such as *Sphærophrya magna*, the axis of the tentacle, according to Maupas, consists of clear homogeneous sarcode continuous with that of the body, and the incorporation of the protoplasmic

* "Contribution à l'Etude des Acinetiens," 'Archives de Zoologie Expérimentale,' tom. ix. No. 3, November 1881.

material of its captured prey is brought about on an entirely distinct principle. The interpretation arrived at by Maupas in this connection is indeed of such importance that a quotation *in extenso* from his description of this process may be appropriately introduced. Referring especially to the above species named, he states :—

" When an Infusorium is securely caught by an Acinetan and held at the extremity of one of its tentacles, a rupture is produced in the cuticle of the victim at this point of contact. The axillary substance of the tentacle penetrating this perforation then passes into the body of the Infusorium, and probably accelerates its death. The tentacle now increases greatly in thickness, this thickening being without doubt due to the afflux of sarcode from the body of the Acinetan, and of which indeed the axillary substance of the tentacle is but a continuation. A current is thus established from the Acinetan in the direction of its prey, which is, however, not visible in consequence of the transparency and freedom from granulation of the sarcode stream. On penetrating the body of its victim this sarcode mixes freely with that of the captured prey, and loading itself with all assimilable substances, returns to its point of departure and thus produces the inflowing current that is so distinctly seen by reason of the opaque granular particles held in suspension." M. Maupas proceeds to explain that this phenomenon is directly comparable with the sarcode circulation observable in the extended pseudopodia of the Foraminifera, or with the intracellular rotation or cyclosis in certain vegetable cells. The chief difficulty in the way of such interpretation consists, he admits, in the fact that in the tentacle of the *Sphærophrya* an incurrent stream is alone visible, while in the pseudopodium of a Foraminifer one in each direction is distinctly developed. Such apparent inconsistence is, however, explained by the fact above mentioned that the excurrent stream, while doubtless existing, is invisible through the absence of granular particles, or, as likewise intimated by the same investigator, the two streams are probably not coexistent, the returning or food-laden centripetal stream setting in independently subsequent to the suspension of the invisible outflowing or centrifugal one. This continuous centripetal current exhibited by the Acinetan during the act of ingestion, is finally, by the above interpretation, likened to the simple inflowing stream generated by a Foraminifer when withdrawing the entire mass of its greatly extended pseudopodium into the substance of its body. The effort made by Maupas to reconcile the anomaly in structure and function that seemingly subsists between the suctorial tentacles as represented by such distinct types as *Hemiophrya gemmipara* and *Sphærophrya magna*—these in the first-named form being distinctly tubular, and, as so far reported, literally suctorial, and in the second case solid and bringing about the ingestion of food-matter through the circulatory movements of its central core—appears to be scarcely needed. The author is of opinion, indeed, that the interpretation arrived at by this investigator in connection with *Sphærophrya magna* is also applicable to *Hemiophrya* and its allies, the functional and structural properties and characters not differing absolutely in kind, but only in degree. It may thus in the first instance be submitted that the more solid contents of *Hemiophrya*, with its central canal, is as fully *en rapport* with the endoplasmic substance of the body as that of the *Sphærophrya*, the difference alone being that whereas this sarcode matter in the last-named type is retained permanently within the soft-walled tentacle as a rod-like central core, in the other form, except when the animalcule is feeding, it is entirely withdrawn into the substance of the body, leaving the relatively indurated walls of the tentacle standing apart with a distinct central canal or lumen. The phenomena attending the ingestive process would under the circumstances premised be precisely identical, with the slight difference that while in the *Sphærophrya* the sarcode is continuous from the body to the orifice of the soft-walled tube, and available for the immediate invasion and assimilation of the protoplasmic contents of the captured prey, in the *Hemiophrya* it, under ordinary conditions, remains inert at the base of the tentacle, and has to be projected through its axial cavity before placing itself in communication with its food.

Under any circumstances the new interpretation of the ingestive phenomena of the Acinetidæ, as represented in *Sphærophrya magna*, arrived at by Maupas, is of the highest import, inasmuch as it indicates, in a yet more decisive manner, the probable affinity subsisting between this remarkable group and the Rhizopodal and Radiolarian Protozoa. As pointed out by him, indeed, the tentacles of certain members of the last-named group, such as *Actinosphærium*, are constructed on a precisely identical form as those of the Acinetan, consisting in like manner of a central shaft or axis of clear transparent sarcode communicating with the central substance of the body, and a more granular cortical layer which is continuous with the peripheral or ectoplasmic layers. Maupas finally cites, in support of the probable Rhizopodal affinities of the Acinetidæ, an instance of a Rhizopod most nearly agreeing with the *Lieberkuhnia* of Claparède and Lachmann, found by him in company with a minute species of *Arcella*, and upon which it preyed in a manner coinciding remarkably with that described of *Sphærophrya magna* in connection with captured ciliate Infusoria. The extremity of an extended pseudopodium was first thrust into the aperture of the test of the Arcella and a double current set up in its substance, which was not suspended until the entire protoplasmic substance of the Arcella was transferred to its own body-mass in a manner identical with that recorded of *Sphærophrya Magna* and *Cyclidium glaucoma*.

The possibility of a more or less remote relationship subsisting between the Tentaculifera and the Hydroid polypes is tentatively discussed at page 104 of the preceding volume; further thought concentrated in this direction has suggested one or two additional points of correlation. More especially the author has been struck with the similarity of contour, and to no small extent of structure, that subsists between the zooids of the remarkable Tentaculiferous genera *Ophryodendron*, *Acinetopsis*, and *Urnula*, and the so-called "nematophores" of certain Hydroidea, such as *Plumularia setacea*, *Aglaophenia pluma*, and *Ophiodes mirabilis*, as figured and described by Mr. Hincks in his 'British Hydroid Zoophytes.' *Acinetopsis rara* and *Urnula epistylidis*, possessing membranous sheaths or loricæ, are more especially suited for comparison in this connection. These nematophores which, in a similar manner as the "Dactylozooids" of the genus *Millepora*, would appear to represent a degraded or imperfectly developed form of the normal alimentary zooids, take the shape of granular protoplasmic masses enclosed in a cup-shaped cell, and capable of protruding tentaculiform pseudopodic processes nearly resembling the proboscis of *Acinetopsis* or *Ophiodendron*, in various directions. It is a remarkable coincidence again that both of these infusorial genera occur as parasites, or rather commensals, of Sertularian zoophytes distinguished for the production of these homoplastic nematophores. A point of relatively minor importance in this connection, but possessing at the same time some slight interest, attaches itself to the fact that, while in no present known Ciliate or Flagellate type is the anterior border of the lorica protected by a series of converging triangular plates or valves forming an operculum such as obtains in *Acineta mystacina*, a like structural modification is common to the protective loricæ or "hydrothecæ" of a large number of Hydroid zoophytes such as *Campanulina repens* and *Cuspidella costata*, Hincks.

The author has found that the representatives of this group are specially suited for permanent preservation, the tentacles remaining extended and retaining all the characters of the living zooids on treatment with osmic acid. The addition of a drop of picrocarmine assists materially in developing the form and position of the endoplast where this structure is not distinctly visible.

In accordance with the system adopted in this volume, the Tentaculifera may be divided into two natural subsections or orders as below :—

Tentacles wholly or partially suctorial	ORDER I. SUCTORIA.
Tentacles entirely non-suctorial, merely adhesive ..	ORDER II. ACTINARIA.

And further into groups having family and generic significance in accordance with the accompanying schedule.

[GENERA OF TENTACULIFERA-SUCTORIA.

GENERA OF TENTACULIFERA-SUCTORIA.

A. Simple.	Fam. I. RHYNCHETIDÆ. Animalcules with one or two tentacles only.	Freely motile, naked			1.	*Rhyncheta.*
		Sedentary, loricate			2.	*Urnula.*
	Fam. II. ACINETIDÆ. Animalcules multitentaculate, tentacles simple.	Naked.	Tentacles similar.	Motile.	Free-swimming.	3. *Sphærophrya.*
					Repent	4. *Trichophrya.*
				Affixed to a rigid pedicle		5. *Podophrya.*
			Tentacles dissimilar			6. *Hemiophrya.*
		Loricate.	Tentacles dissimilar			7. *Podocyathus.*
			Tentacles similar.	Lorica sessile		8. *Solenophrya.*
				Lorica pedicellate		9. *Acineta.*
	Fam. III. DENDROCOMETIDÆ. Multitentaculate, tentacles branched.	Animalcules sessile, with an indurated cuticle.			10.	*Dendrocometes.*
B. Compound.	Fam. IV. DENDROSOMIDÆ. Animalcules multitentaculate, forming branching colonies.	Colonies naked, sessile			11.	*Dendrosoma.*

GENERA OF TENTACULIFERA-ACTINARIA.

Fam. I. EPHELOTIDÆ. Tentacles simple, ray-like.	Animalcules naked, pedicellate	1.	*Ephelota.*
	Animalcules loricate, pedicellate	2.	*Actinocyathus.*
Fam. II. OPHRYODENDRIDÆ. Tentacles represented by one or more retractile proboscidiform organs.	Proboscidiform organ simple	3.	*Acinetopsis.*
	Proboscidiform organ with terminal cirri	4.	*Ophrydendron.*

Order I. TENTACULIFERA-SUCTORIA.

A greater or less proportion of the tentaculate appendages suctorial in character, usually capitate, and adhesive only at their distal extremities.

GENUS I. RHYNCHETA, Zenker.

Animalcules motile or temporarily attached, stalkless, consisting of a more or less ovate body, bearing at the anterior extremity a single long, essentially suctorial tentacle. HAB.—Epizoic.

Rhyncheta cyclopum, Zenker. PL. XLVI. FIGS. 1 AND 2.

Body freely motile, contractile, usually when extended elongate-conical, three or four times as long as broad, widest and more or less truncate posteriorly, attenuate and pointed anteriorly, and continued into a long, slender, flexible and retractile tentacle-like sucker, which may be extended to two or three times the length of the body; endoplast broadly ovate, central; contractile vesicle situated between the endoplast and the anterior extremity. Length of extended body 1–165″.

HAB.—Fresh water, attached by the posterior extremity to the thoracic limbs of *Cyclops coronata*.

The contour of this singular animalcule, with its conical body and attenuate tentaculate appendage, is, as remarked by Zenker, not unlike that of a *Euglena*, or, perhaps, may be described as approaching still more closely that of *Astasia trichophora*; the tubular and suctorial character of the terminal appendage demonstrates at once, however, its relationship with the ordinary *Acinetæ*. In this connection it more especially accords with that developmental condition of *Acineta ferrum-equinum*, described and figured by the same authority, in which a single terminal suctorial tentacle only has made its appearance. The present species is of comparatively rare occurrence, from twelve to twenty examples of the Cyclops in question yielding, on examination, but one specimen of *Rhyncheta*. Treated with reagents the parenchyma of this type contracts and separates from the investing cuticle, which then presents the aspect of a delicate transparent lorica.

GENUS II. URNULA, C. & L.

Animalcules bearing a single retractile, simple or sparsely branched, filiform tentaculate appendage; excreting and inhabiting a sessilely attached, membranous lorica. Multiplying by the production of free-swimming ciliated embryos, and by the subdivision of the entire body-mass into sporular elements.

Urnula epistylidis, C. & L. PL. XLVIII. FIGS. 1–4.

Lorica transparent, gibbously ovate or urceolate, about twice as long as broad, attached by a short obliquely developed attenuation of its posterior region; body nearly filling or occupying one moiety only of the cavity of the lorica; tentaculate appendage laterally developed, single filiform, extensile for a distance surpassing twice the length of the body, usually with one or two lateral branchlets, its substance distinctly granular; contractile vesicle single, subcentral; endoplast unobserved. Length of lorica 1–200″.

HAB.—Fresh water, attached to the branching pedicle or zoodendrium of *Epistylis plicatilis*.

As originally figured and described by Claparède and Lachmann,* *Urnula epistylidis* was referred to the group of the Rhizopoda, they being led by their observations to regard the filiform tentaculate appendage of this organism as the homologue of the pseudopod of a typical Rhizopod rather than as the tubular suctorial organ of an Acinetan. That the position here assigned to it is the correct one is, however, sufficiently proved by the more recent investigations of Stein, Engelmann, and Wrzesniowski. The multiplication of this species through both the production of ciliated embryos and by the resolution of the entire body into spore-like elements is recorded by Claparède and Lachmann. The ciliated embryos, produced singly from the parent body, are finely striate in an oblique direction, and apparently completely or holotrichously ciliate. The existence of these embryos constitutes of itself substantial evidence in support of the Acinetan affinities of *Urnula*, no known Rhizopodal type developing cilia at any period of its existence.

* 'Études sur les Infusoires,' 1855.

Genus III. SPHÆROPHRYA, C. & L.

Animalcules illoricate, usually more or less spherical in form, with distinctly capitate suckers scattered irregularly throughout the periphery; freely movable, and never developing a fixed pedicle as in the genera *Podophrya* and *Acineta*. Occurring frequently as endoparasites within other animalcules.

The unattached and earlier developmental phases of *Podophrya* and other Acinete types are liable to be mistaken for representatives of this genus, and it is only through definitely ascertaining their persistence of form and reproduction of zooids similar to themselves that a place under this title may be accurately assigned them. To the genus *Sphærophrya* must be referred the majority of the tentaculate animalcules formerly pronounced by Stein to be the Acinetiform embryos of *Stylonychia*, *Urostyla*, *Stentor*, *Paramæcium*, and other Ciliata, but since demonstrated to be merely parasites or consociates of these types, and which have doubtless gained access to the bodies of their respective hosts, in the germinal condition, in connection with their ciliary currents or ordinary food-ingestion. It would seem highly probable that the minute peritrichously ciliate animalcules that have in a like manner been described by Stein and other authorities as similarly infesting various Vorticellidæ, represent embryonic states of either *Sphærophrya* or allied *Acinetidæ*. The contour and plan of ciliation of these organisms, it may be mentioned, corresponds more especially with that of the germs of the genus *Podophrya*. The so-called embryos of *Epistylis plicatilis*, as observed and figured by Claparède and Lachmann, reproduced at Pl. XXXIX. Figs. 13–15, are not improbably referable to the same category. Engelmann * has recently proposed to confer upon these Vorticellidan parasites the distinct generic title of *Endosphæra*, and to relegate them to a position among the Infusoria Ciliata. Lacking evidence, however, to show that these organisms propagate independently, it is not considered desirable by the author to separate them from the group with which phylogenetically they would appear to possess the closest affinities.

Sphærophrya pusilla, C. & L. Pl. XLVI. Fig. 6.

Body minute, spherical, bearing a variable number of short widely scattered suckers; contractile vesicle single; endoplast ovate. Diameter 1–650″. Hab.—Fresh water.

Claparède and Lachmann attest to having encountered myriads of this animalcule at Geneva in water containing *Oxytrichæ*, and to which larger ciliate types they were usually found singly attached. Other examples, floating freely in the water, were observed to fix themselves in a similar manner to those *Oxytrichæ* † that chanced to pass within reach of their short adhesive suckers, and almost invariably to select for their point of attachment the left side of the ciliated oral groove of their host. From this *coin d'avantage* these minute animalcules no doubt enjoy unprecedented opportunities of intercepting on their own account an abundant supply of food-material otherwise destined for the digestive cavity of their more agile and powerful companions.

Sphærophrya magna, Maupas. Pl. XLVIII. Figs. 6 and 7.

Body evenly spherical; tentacles distinctly capitate, moderately numerous, not exceeding fifty in number, rarely as many, their length,

* "Entwickelung von Infusorien," 'Morphologisches Jahrbuch,' Bd. i., 1876.
† The figure given by Claparède most closely resembles *Urostyla Weissei*, St.

when extended, equal to that of the diameter of the body, produced from all parts of the periphery; contractile vesicles one or two in number; endoplast spherical, finely granulate, excentric: parenchyma usually granular and opaque. Diameter of body 1–600". HAB.—Fresh water, Algeria.

The discoverer of this species, M. Maupas, in figuring and describing it,* has placed on record some interesting data in connection with the structure of the tentacles and the phenomena of food-ingestion. On many occasions it was observed by him that the suctorial appendages exhibited during their extended state a greater or less number of oval or spherical dilatations or varicosities, these varicosities from time to time altering in shape or totally disappearing. Submitted to high magnification it was shown that these dilatations were composed only of the external or cortical element of the tentacles, the internal or axial part passing straight through them, and remaining undisturbed by the alteration of contour that they undergo. Maupas has been thus led to the conclusion that in this *Sphærophrya magna* and certain other Acinitidæ the tentacles consist of a central axial filament of amorphous sarcode upon which is superimposed an external layer of the same element of much more delicate consistence, and possessing marked polymorphic properties. He further anticipates that the button-like inflation of the extremity of the tentacles in this and kindred species consists of an excurrent spheroidal mass of the axial sarcode only, such interpretation being supported by his observation that on a ciliated infusorian coming into contact with its substance, but succeeding in escaping, this normally spheroidal mass presented under high magnification, as shown at Pl. XLVIII. Fig. 7*b*, a lacerated or ragged contour. By introducing into the same water an abundant supply of the ciliate type *Colpoda parvifrons* and *Cyclidium glaucoma*, the Sphærophryæ fed upon them voraciously, one example having been observed by Maupas to seize and devour simultaneously no less than half-a-dozen of these Holotrichous animalcules. The phenomena of ingestion, as described by this investigator, are referred to at length in the section devoted to the general description of the Tentaculiferous class. In common with other species of the genus, *Sphærophrya magna* was observed to multiply abundantly by transverse fission, the body becoming first elongated, then centrally constricted, and finally separating into two subequal moieties. While one of these products soon assumed the spheroidal contour and normal aspect of an adult zooid, the other one, withdrawing its tentacles, became yet more elongated, its surface grew rugose, and ultimately developing fine cilia at its anterior extremity, it swam away, the data observed being thus closely analogous to those previously reported by the same authority of *Podophyra libera*.

Sphærophrya urostylæ, Maupas. PL. XLVI. FIGS. 3–5.

Body subspherical; suckers slender, their length about equal to the diameter of the body, scattered irregularly over the surface of the periphery; one or two contractile vesicles; endoplast spherical. Diameter of body 1–500." Embryos elongate-ovate, from three to four times as long as broad, densely clothed with cilia, which exceed in length the scattered suckers. HAB.—Fresh water, associated with *Urostyla grandis*.

The above title, originally adopted by the author in manuscript, has been recently bestowed by Maupas on the species figured and described by Stein as the Acineta-phase of *Urostyla grandis*, and with which last-named type, according to the representations of that authority, it is found associated in vast numbers; whether, however, these minute globular *Acinetæ* occupy the digestive cavity of their host of their own accord, or are engulfed within the same by the ciliary currents of the

* "Contribution à l'Étude des Acinétans," 'Arch. de Zoologie Expérimentale,' tom. ix., Nov. 3, 1881.

Urostyla, it is difficult to determine. The position taken up by *Sphærophrya pusilla* with reference to an allied ciliate type, namely externally, but close to the oral aperture, favours the supposition that in other instances, like the present, they may prefer to cultivate a still more intimate acquaintance with the commissariat of their foster-parent. It is at all events certain that they are not incepted as food-material or destined to be digested, as after being so enclosed, they are able to bore their way out again through the parenchyma of their host, in either their adult condition or in the form of ciliated embryos.

Sphærophrya stylonychiæ, S. K.

Body subspherical, suckers short and slender, few in number, thinly scattered throughout the periphery; contractile vesicle single; endoplast spherical. Diameter 1–700″. Embryos ovate, about three times as long as broad, having a dense covering of cilia in addition to the scattered suckers, which they equal or exceed in length.

HAB.—Fresh water, associated with *Stylonychia mytilus*.

The shorter proportions of the embryos of this species, as well as the distinct specific nature of the host—accepting the form as parasitic—seem to distinguish it from *Sphærophrya Urostylæ* last described. In accordance with the views originally entertained but since abandoned by Stein, this form was presumed to be the acinete embryo of *Stylonychia mytilus*.

Sphærophrya sol, Mecz. PL. XLVII. FIGS. 6 AND 7.

Body spherical; tentacles numerous, protruding from all parts of the periphery, extensile to a length exceeding the diameter of the body; contractile vesicle single; endoplast ovate. Diameter 1–500″.

HAB.—Parasitic within *Paramæcium aurelia*.

The multiplication of the species by transverse fission accompanied by the subdivision of the endoplast is recorded by Mecznikow.* Preparatory to this mode of increase the body of the animalcule assumes an elongate-ovate contour. Being unaware, apparently, of Mecznikow's work, E. Maupas has more recently proposed to confer upon this type the title of *Sphærophrya paramæciorum*. A closely allied, if not identical type has been observed by both Stein and Claparède and Lachmann, as an endoparasite of *Paramæcium bursaria*, and has, in both instances, been treated as an embryonic condition of that Holotrichous form.

Sphærophrya stentorea, Maupas. PL. XLVI. FIG. 7–9.

Body subspheroidal, ovate or elongate, frequently with one or two annular constrictions; the posterior end of the body bearing eight or ten short, irregularly scattered, capitate tentacles, the opposite extremity usually clothed with long fine cilia; endoplast ovate, developed toward the anterior region of the body; contractile vesicles two in number, located posteriorly to the endoplast. Length 1–600″.

HAB.—Fresh water, occurring as an endoparasite of the Trumpet Animalcule, *Stentor Rœselii*.

This type was originally figured and described by Stein as an embryonic condition of the Infusorian with which it is found associated. It would seem highly

* 'Müller's Archiv für Anatomie u. Physiologie,' 1864.

probable that the examples having an elongate contour with cilia developed at their anterior extremity, as chiefly figured by Stein, represent migratory conditions only or zooids about to divide by transverse fission. If, on the other hand, this condition should prove on further acquaintance to be typical of the adult state, it will be desirable to establish a new genus for its reception, and the position it will occupy as an annectant form between the Ciliate and Tentaculiferous classes will be highly significant. A species closely resembling the present form, but possessing a somewhat larger number of tentaculate appendages, has been observed by Stein in connection with *Stentor cæruleus*.

Sphærophrya hydrostatica, Eng.

Body spherical, bearing numerous, thirty to forty, long, irregularly distributed, distinctly capitate tentacles; contractile vesicles minute, variable in number, supplemented by a large non-contractile gas-vacuole, having a diameter of one-half that of the body, and which confers upon the animalcule remarkable buoyancy in the water. Diameter of body 1–300″.

HAB.—Pond water, among *Lemna*, floating near the surface.

The possession of a large supplementary non-contractile vacuole, which apparently contains air and thus renders the body of the animalcule remarkably light and buoyant in the water, serves to distinguish the form from any of the preceding species. The original account of this type was communicated by T. W. Engelmann to the 'Zoologischer Anzeiger,' Bd. i., 1878.

GENUS IV. TRICHOPHRYA, C. & L.

Animalcules illoricate, ovate or elongate, resembing those of *Podophrya*, but temporarily affixed in a sessile manner to various objects without the intermedium of a supporting pedicle; tentacles suctorial, variously distributed.

Trichophrya epistylidis, C. & L. PL. XLVI. FIGS. 12 AND 13.

Body elongate, flattened, bearing from four or five to as many as seven or eight fascicles of capitate suckers which are distributed irregularly throughout its length; contractile vesicles numerous; endoplast band-like, curved. Long diameter 1–120″.

HAB.—Fresh water, usually attached throughout its ventral surface to various water plants, or to the branching pedicle of *Epistylis plicatilis*.

This Acinetan has been recently obtained in this country by Mr. John Badcock, who in the first place submitted his drawings for the identification of the species to the author. Subsequently, however, in figuring and describing it,* Mr. Badcock is inclined to regard it as an immature condition only of the stalked species *Podophrya quadripartita* rather than as an independent type. A careful examination of Mr. Badcock's evidence has however failed to satisfy the author with respect to this presumed identity, and the chief data upon which this result has been arrived at may be thus stated. In the first place, no direct connection was established between these two forms by Mr. Badcock. *Trichophrya* was first observed by him on some *Conferva* taken from one of the ponds in the Victoria Park, and it was some weeks subsequently that *Podophrya quadripartita*, also identified for Mr. Badcock by the author, was found growing abundantly on a portion of this Algal that had been

* "Notes on Acinetina," 'Journal of the Royal Microscopical Society,' Aug. 1880.

transferred to a friend's aquarium, and where it had not improbably developed independently. Of yet weightier import, however, are the facts that while *Trichophrya* has normally half-a-dozen or more distinct fascicles of tentacula, *Podophrya quadripartita*, its supposed mature form, has only four, and while the endoplast or nucleus in the last-named type is simply ovate, in *Trichophrya*, as demonstrated by Claparède and Lachmann, it is exceedingly attenuate or band-like. Mr. Badcock further testifies, this being a new and important observation, that the tentacles of the *Trichophrya* in their contracted state exhibit an apparent spiral plication, which is evidently due, as shown by his drawings, to the existence of a delicate externally developed spiral filament as observed by the author in *Podophrya elongata* and other species described in this volume. No such histologic differentiation of the substance of the tentacles is referred to in the case of *Podophrya quadripartita*, and that such does not exist in this species the author is enabled to affirm through having received from Mr. Badcock specimens for identification of the very examples he described, and subjected them to a searching examination in both the living and preserved condition. This circumstance of the essentially distinct histologic composition of their tentacular appendages would of itself suffice to indicate the specific independence of these two forms. It has yet to be stated, that Mr. Badcock himself records observing the development of the adult *Podophryæ* from ciliated embryos that were present in the water, and which, as has been already observed by Bütschli and other investigators, are produced by a process of internal gemmation from the parent. In the series of examples examined by the author it was further found that the smallest and youngest specimens possessed but one or two tentacular fascicles, four such fascicles being the full complement only of the adult zooid. The intercalation of a *Trichophrya*-like or multi-fasciculate phase as an embryonic state cannot therefore be logically maintained. It is worthy of remark in this connection, that a variety of species of Acinetidæ frequently occur in company, a fact which is well calculated to mislead the amateur investigator as to their true import and affinities. As an illustration of this fact it may be mentioned that the author has recently received from Dundee fragments of weeds upon which are thus associated the three very distinct types *Podophrya elongata*, *P. mollis*, and *Acineta mystacina*, and in a similar manner, through Mr. Thos. Bolton of Birmingham, examples of *Acineta grandis*, *A. lemnarum*, *A. mystacina*, var. *longipes*, and *Dendrosoma radians*, growing on the same or neighbouring branchlets of the weed *Nitella*. Mr. Badcock, finally, in his laudable attempt to establish the identity between *Trichophrya epistylidis* and *Podophrya quadripartita*, figures as substantial evidence in the proof of his assumption * what is an undoubted example of the loricate bifasciculate type *Acineta lemnarum*. *Trichophrya epistylidis*, upon the weight of evidence submitted in these pages, is hence unhesitatingly retained as a well-marked independent species. Among the examples of this type examined by Messrs. Claparède and Lachmann an internally developed ciliated embryo was on one occasion observed.

Trichophrya digitata, Stein sp. PL. XLVI. FIGS. 10 AND 11.

Body ovate, discoidal, adherent throughout the whole, or the central portion only, of the under surface; tentacles thick and digitiform, not distinctly capitate, scattered irregularly over the entire free surface; contractile vesicle single; endoplast band-like, sinuous. Length 1–360″.

HAB.—Fresh water, on Entomostraca.

This species, originally described by Stein as the "gefingerte Acinete," was believed by that authority to represent the embryonic or Acinete condition of some higher ciliate Infusorium; later on, however, it received from him the name of *Acineta digitata*, and is referred to the present genus by Claparède and Lachmann.

* 'Journ. Roy. Mic. Soc.,' Aug. 1880, pl. xiv. fig. 6.

Neither in the text, nor in any of the numerous illustrations given by that authority, from which our figure is borrowed, are the suckers shown to assume the extended state with capitate extremities that characterize the typical *Acinetæ*, and under these circumstances, it seems doubtful whether it should not be more accurately referred to the family of the Ephelotidæ. The *Trichophrya Ophrydii* of Claparède and Lachmann, the equivalent of Stein's Acinete phase of *Ophrydium versatile*, would seem to differ in no important respect from this species.

GENUS V. PODOPHRYA, Ehr.

Animalcules solitary, illoricate, globose, ovate, or elongate, attached posteriorly to foreign objects by a more or less extensively developed rigid pedicle; tentacles suctorial, usually distinctly capitate, united in fascicles or distributed irregularly over the surface of the periphery.

HAB.—Salt and fresh water.

The identification of the numerous species belonging to the genus *Podophrya* may be greatly facilitated by dividing the entire series into two sections distinguished respectively by the irregular or fasciculate disposition of their tentacles.

A.—TENTACLES IRREGULARLY DISTRIBUTED.

Podophrya fixa, Müll. sp. PL. XLVI. FIGS. 24–30.

Body spherical, attached to a slender and more usually sinuous pedicle, the distal extremity of which is abruptly expanded, and whose length rarely exceeds the diameter of the body; tentacles numerous, slender, distinctly capitate, not exceeding the body in length, distributed throughout the surface of the periphery; contractile vesicle single or double; endoplast elongate-ovate, subcentral. Length of body 1–400". HAB.—Fresh water.

This animalcule, identical with the *Trichoda fixa* of O. F. Müller, was originally regarded by Stein as both synonymous with *Actinophrys sol*, and as a transitional Acinete condition of *Vorticella microstoma*. From Dujardin, who also relegated it to the Radiolarian class, it received the title of *Actinophrys pedicellata*. In its resting or encysted condition, Pl. XLVI. Fig. 28, the external cuticular layer, becoming indurated, assumes a pyriform outline, ornamented by three or four prominent transversely annular crests or ridges, the interspaces between which are, to a greater or less extent, longitudinally striate. The presence of such cysts has been detected by Engelmann among other food-matter within the parenchyma of *Stylonychia mytilus*, a circumstance which suggests the possibility of *Sphærophrya stylonychii* being the embryonic condition only of the present type, developed through the breaking up into spore-like bodies of the encysted Podophrya.

Podophrya ferrum-equinum, Ehr. sp. PL. XLVI. FIGS. 19–22.

Body flattened, reniform, having a raised nipple-like protuberance in the centre of the anterior surface; tentacles irregularly distributed along the anterior border; pedicle very short, thick, and turgid, longitudinally striate, its diameter nearly equal to that of the body of the animalcule; contractile vesicles numerous, forming a continuous row along the margin of the frontal border; endoplast horseshoe-shaped. Greatest diameter of body 1–120".

HAB.—Fresh water, on *Hydrophilus piceus*.

The species is to be distinguished from *P. cothurnata*, which it most closely resembles, by the great proportional thickness of the foot-stalk, and the protuberance on the frontal margin of the body. Zenker, who has recently studied its development, reports that the free-swimming embryos exhibit a holotrichous plan of ciliation. These embryos, after attachment, develop at first only a single terminal or axial suctorial tentacle, which thus conveys to them a close resemblance to the permanently mono-tentaculate genus *Rhyncheta*. Claparède and Lachmann, who have referred this type to the present genus, indicate in their drawings the production of an embryo by internal gemmation, which would seem, however, to be ciliated on one only of its lateral surfaces; preparatory to its liberation a fissure-like aperture was observed to be developed in the wall of the parent body, similar to that which has been subsequently observed by Bütschli and Wrzesniowski of *Podophrya quadripartita* and *Dendrocometes paradoxus*.

Podophrya libera, Perty.

Body spherical; tentacles numerous, distinctly capitate, distributed throughout the peripheral surface, their length, when extended, equalling three or four times the diameter of the body; pedicle slender, its length equal to or slightly exceeding the width of the body; zooids often detached and freely motile. Diameter of body 1–300″. HAB.—Pond water.

This species, originally described by Perty, in its detached or free condition only, has more recently been rediscovered by E. Maupas in the neighbourhood of Algeria. This last-named investigator, being unable at the time to refer to Perty's work, regarded it as a variety only of *Podophrya fixa*, and figured and described it under the title of *Podophrya fixa* var. *Algeriensis*,* but has since † fully recognized its claims for recognition as an independent species. This is more especially manifested by the much greater relative length of the tentaculate appendages and the tendency of the animalcules to abandon their stalks and lead a free roving life after the manner of a *Sphærophrya*. It was observed by Maupas that, pending the transformation from the fixed to the free-swimming state, the tentacles are withdrawn into the substance of the parenchyma and become entirely obliterated, the body then becomes elongate, and the cuticular surface more or less completely clothed with fine vibratile cilia. In this condition the animalcule detaches itself and moves freely in the water until, finding a locality more suited to its wants, it again fixes itself by the posterior extremity. Suctorial tentacles are now protruded as formerly from the inner parenchyma, the cilia are reabsorbed into the cuticular layer, and the animalcule becomes indistinguishable from its pristine characteristic state. In addition to the motile condition just described, it not unfrequently happens that *Podophrya libera* detaches itself from its pedicle without the development of cilia, and creeps from place to place with the assistance of its adhesive tentacles.

Podophrya cylindrica, Perty. PL. XLVIII. FIG. 20.

Body elongate-cylindrical, about four times as long as broad, mounted on a short slender pedicle; tentacles distinctly capitate, developed irregularly from the distal extremity of the body only; endoplast elongate ovate, subcentral; contractile vesicles not observed. Length 1–250″.

HAB.—Fresh water, on *Lemna*.

This species, originally found in Switzerland and figured and described by Perty, has been recently rediscovered among *Lemnæ* in the neighbourhood of St. Petersburg by C. von Mereschkowsky.

* 'Archives de Zoologie Expérimentale, tom. iv., 1876.

† Ibid., tom. ix., 1881.

Podophrya Lyngbyi, Ehr. sp.

Body globose or pyriform ; tentacles capitate, scattered irregularly over the entire distal extremity ; pedicle thick, two or three times the length of the body ; contractile vesicles two in number ; colour yellowish-brown. Length 1–500″. HAB.—Salt water, on marine algæ and *Sertulariæ.*

Embryos of this species, as observed by Claparède and Lachmann, are released from the parent body in a form identical, except for the absence of a footstalk, with the latter ; or, in other words, they may be said to correspond in this early state with the adult condition of the genus *Sphærophrya.* By Ehrenberg this type is figured and described under the title of *Acineta Lyngbyi.*

Podophrya Steinii, C. & L. PL. XLVI. FIGS. 58 AND 59.

Body pyriform, tapering posteriorly ; tentacles numerous, slender, not conspicuously capitate, distributed irregularly over the entire peripheral surface ; pedicle about equal in length to the body, slender at its base, very widely expanded at its point of junction with the body, finely striate longitudinally, and coarsely wrinkled transversely ; contractile vesicles multiple ; endoplast central, radiately branching. Length 1–150″.

HAB.—Fresh water, on *Dytiscus marginalis.*

This species was first figured and described by Stein as an Acineta-phase of *Opercularia articulata,* but was afterwards invested with the above specific title by Claparède and Lachmann. Engelmann has shown that each contractile vesicle in this type possesses a distinct tubular outlet.

Podophrya cothurnata, C. & L. sp.

Body discoidal, flattened, oval or reniform, pedicle very short and thick, less than one-half the length of the body ; tentacles not fasciculate, forming a crown at the anterior extremity ; contractile vesicles numerous, disposed in a continuous row around the periphery ; endoplast horseshoe-shaped or band-like. Length 1–240″.

HAB.—Fresh water, on various species of *Lemna* and *Callitricha.*

This form is identical with the *Acineta cothurnata* of Weisse, and the "diadem-artige Acinete" of Stein. In Pritchard's 'Infusoria' it is embodied under the title of *A. diademiformis,* but is confounded with the *Podophrya ferrum-equinum* previously described.

Podophrya conipes, Mereschk. PL. XLVIIIA. FIG. 4.

Body subspheroidal or pyriform, soft, plastic, and frequently with irregular prominences and depressions ; tentacles with conspicuous acetabulate extremities, not very numerous, produced in young individuals from the anterior region only, but extending in the adult zooids irregularly from all parts of the periphery, slender, and exceeding the length of the body when fully exsert ; pedicle five to eight or ten times longer than the body, narrowest and pointed at its proximal extremity or point of attachment, and gradually increasing in diameter as it approaches its junction with the

body, finely striate transversely throughout its length, and usually bearing two conspicuous central annuli; contractile vesicle single, subcentral; endoplast elongate-ovate. Length of body 1–240″ to 1–144″.

HAB.—Salt water: White sea (Mereschkowsky), on Rhodospermous Algæ (*Ptilota* and *Ceramium*), at various depths.

This characteristic form which, excepting for its tapering and transversely striate pedicle, most nearly approaches *P. Lyngbyi*, is regarded by Mereschkowsky, in common with *Tintinnus Ussowi*, as belonging essentially to the Arctic zoological zone.

Podophrya limbata, Maupas. PL. XLVIII. FIG. 5.

Body subspherical, with a usually more attenuate posterior prolongation, the periphery frequently surrounded by an evenly developed, tenacious, hyaline, gelatinous film; tentacles slender, irregularly distributed, distinctly capitate, from ten to fifteen in number, their length when extended equal to about one and a half times the diameter of the body; pedicle transparent, rectilinear and even throughout the greater portion of its length, but expanding abruptly at the distal extremity to four or five times its normal width, and thus forming a platform of support to the animalcule's body; parenchyma yellow or colourless; contractile vesicle single, laterally located; endoplast ovate, subcentral. Length 1–850″. HAB.—Salt water.

This species is reported by Maupas* as occurring on Hydroid zoophytes both at Roscoff, Brittany, and in the neighbourhood of Algiers. Its discoverer proposes to identify the frequently developed peripheral gelatinous film with the external gelatinous layer that surrounds the denser body-mass or so-called "central capsule" of the typical Radiolaria. This external film in *Podophrya libera* was observed to be of exceedingly tenacious consistence, readily entangling foreign particles held suspended in the surrounding water, and thus when gathered from a turbid source was so opaque as to preclude a distinct view of the body proper. Possibly this secretion of a mucilaginous investment may be a preliminary step towards the process of encystment.

Podophrya infundibulifera, Hartog.

Body subspherical or pyriform, mounted on a short rigid pedicle; tentacles varying from six to fourteen in number, distributed throughout the peripheral surface; when at rest, short, thick, with obtusely rounded distal terminations, and a circular constriction a little below the joint; when extended in quest of food dilated funnelwise in this region, and exhibiting throughout their length equidistant circular wrinkles. Contractile vesicle single, contracting at intervals of 34″ to 44″. Endoplast spherical. Dimensions unrecorded.

HAB.—Fresh water, on *Cyclops gigas*, especially females, on and about the bases of the oral appendages.

This species is briefly described by Mr. Marcus Hartog in the 'Proceedings of the Manchester Literary and Philosophical Society,' vol. xix., 1880. It is distinguished from *Podophrya cyclopum* by the scattered plan of distribution of the tentacles and by the non-capitate aspect they ordinarily exhibit.

* "Contribution à l'Étude des Acinetiens," 'Arch. de Zool. Exp.,' tom. ix., 1881.

Podophrya Wrzesniowskii, S. K. PL. XLVI. FIG. 31.

Body elongate-ovate or elliptical, about twice as long as broad; pedicle thick, subcylindrical, increasing slightly towards its point of junction with the body, internally longitudinally, and externally finely transversely striate; tentacles very minute and slender, distinctly capitate, distributed irregularly over the entire peripheral surface, but most abundant anteriorly; contractile vesicles two or three in number; endoplast irregularly ovate; numerous minute spherical vacuolæ containing refringent granules usually present towards the posterior extremity. Length of body 1–400″.

HAB.—Fresh water, on the elytra of the aquatic Coleopteron *Hydroporus picipes*.

This species has been recently figured and described by Wrzesniowski * and referred by him to the *Podophrya Leichtensteinii* of Claparède and Lachmann, and *Acineta* (*Podophrya*) *hyphydri* of Stein. A comparison, however, of the accounts and illustrations of these respective forms has convinced the author that we have in the present instance a type differing considerably from the one last-named. The characters which serve to distinguish this present form from Stein's species may be thus summarized:—The body, while exhibiting a somewhat similar but at the same time more regularly elliptical contour, is mounted on a pedicle which does not expand widely at its point of junction with the body as in *P. Leichtensteinii*, and whose surface is finely striate transversely instead of coarsely wrinkled. The characters afforded by the tentacula are still more decisive, for while in Stein's species they exhibit a distinct fascicular arrangement and are confined to the anterior region of the body, in the present one they are distributed without any definite arrangement throughout the peripheral surface; individually examined, the irregularly scattered tentacles are further much more minute, their proportionate size with relation to the body of the animalcule being about half that of *P. Leichtensteinii*. These dimensions, associated with their distinctly capitate extremities, contrast in a marked manner with the slender non-capitate appendages of the species with which Wrzesniowski has proposed to identify it. The presence of the numerous vacuolæ with their enclosed refringent granules appears to afford an additional and permanent feature of this species that would scarcely have been overlooked by Stein in his account of *P. Leichtensteinii*. Being unable in face of these highly divergent characteristics to unite under one specific title the two forms here submitted to comparison, the author has much pleasure in associating with the type requiring a new specific title the name of the investigator to whom we are indebted for its discovery, and who has proved himself so industrious a worker in this field of biological research. Wrzesniowski records, in connection with the contractile vesicle of this type, a distinct tubular exit similar to that of *Dendrocometes paradoxus*, *Acineta opercularia*, and other representatives of the same order, as also that the same vesicle is not always constant in its form or position, sometimes breaking up in a fragmentary manner. This latter circumstance is rightly held as yielding conclusive evidence of the non-possession by this structure of a distinct membranous wall, or its occupation of a distinctly differentiated interspace in the substance of the parenchyma. Under high magnification, as in *P. Leichtensteinii*, the species presents a well-developed cuticular layer, but this membrane is not separated from the subjacent parenchyma so as to constitute an independent external pellicle or lorica, as among the true *Acinetæ* to which Wrzesniowski has proposed to refer it.

* 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xxix. p. 268, 1877.

B.—TENTACLES FASCICULATE.

Podophrya carchesii, C. & L. PL. XLVIII. FIG. 23.

Body subspheroidal, ovate, or irregular in shape, the distal or anterior extremity rounded, bearing on one side a single fascicle of tubular suckers; pedicle as short as, or shorter than one-half the length of the body, usually asymmetrically inserted; contractile vesicle single, situated near the anterior extremity. Length of body 1–950″ to 1–350″.

HAB.—Fresh water, usually attached in social colonies to the stalks of *Carchesium polypinum*.

The author obtained examples of this type developed in great abundance on the branching pedicle or zoodendrium of *Epistylis flavicans*, remitted from the neighbourhood of Stourbridge, Worcestershire, by Mr. Thos. Bolton, in April 1874.

Podophrya cyclopum, C. & L. PL. XLVI. FIG. 23.

Body ovate or globular, tapering posteriorly, the anterior extremity rounded or lobate, bearing from two to four fascicles of capitate suckers; pedicle usually very short, rarely exceeding one-third of the length of the body; contractile vesicles one or two in number; endoplast oval. Length of body 1–800″ to 1–300″.

HAB.—Fresh water, mostly parasitic on *Cyclops quadricornis* and other Entomostraca, but occasionally on aquatic plants.

This species was originally figured and described by Stein under the title of "*Acinete der Cyclopen*," being at that time regarded by him as the embryonic form of some higher ciliate animalcule.

Podophrya Leichtensteinii, C. & L.

Body ovate or pyriform; tentacles slender, not distinctly capitate, forming two antero-lateral fascicles; pedicle about one-half the length of the body, widely expanded at the point of junction with the latter, tapering posteriorly, transversely wrinkled; endoplast oval, subcentral. Length 1–300″. HAB.—Fresh water, on aquatic Coleoptera.

This species, first described by Stein as the Acineta-phase of *Opercularia Leichtensteinii*, subsequently received from him the title of *Acineta hyphydri*. Claparède and Lachmann had, however, in the interim conferred upon it the name above given, and which necessarily takes the precedence.

Podophrya phryganidarum, Stein sp.

Body pear-shaped, flexible, slender and tapering somewhat abruptly posteriorly; pedicle about half the length of the body, more or less curved, narrowest at its point of attachment, increasing slightly in diameter as it approaches its point of union with the body, finely striate longitudinally; tentacles long and fine, not distinctly capitate, forming two antero-lateral fascicles; contractile vesicle single, anteriorly situated; endoplast elongate-ovate or band-shaped. Length of body 1–240″.

HAB.—Fresh water, associated with *Epistylis branchiophila*, on the larvæ of Phryganidæ.

In accordance with his original views concerning the nature and affinities of the Acinetidæ, this type was originally accepted by Stein as a developmental form of the Vorticellan *Epistylis branchiophila*, upon whose pedicle it occurs as a parasite. In the first volume of his 'Organismus' it receives from him the title of *Acineta phryganidarum*, but the entire absence of any trace of a lorica or distinct pellicular investment necessitates its relegation to the genus *Podophrya;* the slender pointed, non-capitate tentacles of this species, in addition to the shorter flexuose pedicle, serve to distinguish it from *P. pyrum* or any other of its more near allies.

Podophrya infusionum, Stein sp.

Body subspheroidal or pyriform, attached by its more attenuate posterior extremity to a short sinuous pedicle, whose length rarely exceeds one-half that of the body; tentacles short, distinctly capitate, developed in two lateral fascicles; contractile vesicles two in number; endoplast elongate-ovate, subcentral. Length of body 1–350″.

HAB.—Pond water and infusions.

This species was originally figured by Stein* as an elongate variety only of *Podophrya fixa*, but has an independent position awarded to it under the title of *Acineta infusionum* in the first volume of his more recent treatise.† It may be readily distinguished from the Podophrya named, in addition to the more elongate contour of the body, by the fasciculate instead of the distributed disposition of the tentacles.

Podophrya astaci, C. & L. PL. XLVI. FIGS. 14–17.

Body elongate, subquadrate, scarcely twice as long as broad; tentacles forming two groups at the anterior and posterior extremities; pedicle thick, transversely wrinkled, gradually enlarging from its point of attachment to that of its junction with the animalcule's body; contractile vesicles numerous, irregularly distributed; endoplast oval, central. Length 1–300″.

HAB.—Fresh water, on the river crayfish (*Astacus fluviatilis*).

This species is figured and described by Stein under the name of "*Acinete des Flusskrebses.*" From *Podophrya elongata*, which it somewhat resembles, it may be distinguished by the absence of the two median lateral fascicles of suckers and by the tapering or conical contour of the pedicle.

Podophrya pyrum, C. & L.

Body pyriform, attenuated posteriorly, the rounded and inflated anterior extremity bearing one apical and two lateral fascicles of capitate tentacles; pedicle from one to one and a half times the length of the body; contractile vesicles two in number, one near the anterior and the other adjacent to the posterior extremity; colour brown, opaque; endoplast oval, subcentral. Length of body 1–150″.

HAB.—Fresh water, on *Lemna trisulca.*

* 'Die Infusionsthiere auf ihre Entwickelungsgeschichte,' 1854.
† 'Der Organismus der Infusionsthiere,' tom. i. p. 48, 1859.

Podophrya quadripartita, C. & L. Pl. XLVI. Fig. 18.

Body more or less ovate, tapering posteriorly, the anterior extremity divided into four blunt rounded lobes, each of which bears a fascicle of tubular suckers; pedicle elongate, from one to one and a half times the length of the body, expanding slightly towards its point of junction with the body; contractile vesicles varying in number from one or two to as many as five or six; endoplast oval, central. Length of body 1–300″ to 1–200″.

Hab.—Fresh water, on *Epistylis plicatilis;* also attached to various water plants and to *Paludina* and other fresh-water Mollusca.

This form is identical with Stein's originally supposed *Acineta*-phase of *Epistylis plicatilis*, afterwards receiving from him the name of *Acineta quadriloba*, but which has necessarily to give place to the prior one of Claparède and Lachmann here employed. Internal embryos of two sizes are, according to Claparède and Lachmann, developed in this species: larger ones which enclose a portion only of the parent endoplast, and are liberated, according to Bütschli, through a specially developed orifice, as in the case of *Dendrocometes paradoxus;* and smaller ones, to the number of sixteen or twenty, produced through the subdivision of the entire endoplastic mass. In both cases the free-swimming gemmules at the time of liberation exhibit a peritrichous type of ciliation, having an equatorial girdle supplemented by an anterior tuft of cilia. The number of contractile vesicles which characterize the parent form are found to be hereditarily represented in this embryonic phase. The endoplast, at the time of partition, as observed by Bütschli, exchanges its customary granular structure for a striate or fibrillate one, assuming its normal aspect again after the birth of the embryo. Among the innumerable examples of this species developed on a species of *Conferva*, recently remitted to the author by Mr. Badcock, and referred to in the account given of *Trichophrya epistylidis*, it was observed that the posterior moiety of the body was in many instances very attenuate, not exceeding twice the diameter of the adjacent pedicle, and while in some cases the transition from the thick anterior to the attenuate posterior region was abrupt, in others the attenuation was gradual and uniform. Specimens preserved with a one per cent. solution of osmic acid were found to retain their characteristic form in a most remarkable manner, the central ovate endoplast being furthermore by the application of this reagent most conspicuously developed. In their earlier pedicellate condition the zooids of this species possess but a single fascicle of tentacles which is shortly replaced by two, the full complement of four such bundles being characteristic only of the adult state. The suggested relationship of *Trichophrya epistylidis* to *Podophrya quadripartita* is discussed in the account given of that species.

Podophrya elongata, C. & L. Pl. XLVIII. Figs. 21 and 22.

Body elongate, subfusiform, five or six times as long as broad, bearing a fascicle of suckers at the anterior extremity, one on each side at the posterior extremity, and two oppositely disposed lateral groups; pedicle thick, even in width, longitudinally striate and often transversely plicate, usually about one-third the length of the body, but occasionally greatly exceeding these proportions; contractile vesicles multiple, one larger one frequently developed near the apical extremity, and other smaller ones irregularly distributed; endoplast band-like, vertical. Length 1–120″.

Hab.—Fresh water, on the mollusc *Paludina vivipara* and various water plants.

Examples of this species were received by the author as recently as November 1881, growing in tolerable abundance in company with *Acineta mystacina* and *A. lemnarum* on *Ranunculus* and other water-weeds from the neighbourhood of Dundee, remitted by Mr. John Hood. As first figured and described by Claparède and Lachmann, the species of mollusc named in the foregoing diagnosis is cited as the only habitat; the fact, however, that this type is restricted to a much more southern area suffices to indicate that the infusorian species is not strictly a commensal of *Paludina*. As examined by the author, the tentacles of *Podophrya elongata*, were found, in their contracted state, even under moderate enlargement, to be distinctly annulate in a spiral direction, and on being submitted to the relatively high magnification of six or eight hundred diameters presented the aspect given at Pl. XLVIII. Fig. 22, the spiral element being thus demonstrated to consist of a spiral crest or ridge of granular consistence, developed externally to the shaft of the tentacle, its convolutions becoming more widely separated or attenuate until vanishing with the extension of the tentacle, and the more closely approximated and thickened in proportion to its contraction. The function of this crest-like element is apparently intimately connected with the contractile movements of the tentacle, being in this manner analogous to the spirally disposed fibrilla of the stalk of a *Vorticella*, and also histologically and functionally homologous with the spiral granular ridges developed on the external surface of the proboscis-like appendage of the genus *Ophryodendron*.

Podophrya mollis, S. K. PL. XLVI. FIGS. 53–56.

Body highly flexible, usually more or less triangular in outline when expanded, sometimes ovate or pyriform, tapering posteriorily, bearing two antero-lateral fascicles of conspicuously capitate tentacles; pedicle slender, about twice the length of the body, straight, and even throughout; contractile vesicles one or two in number; endoplast ovate. Length of body 1–1000″ to 1–240″. HAB.—Pond water, on various aquatic plants.

Excepting for the entire absence of the separate investing pellicle or lorica this type corresponds closely in contour and habits with Stein's "*Acineta lemnarum*," originally regarded by that authority as a developmental condition only of *Vorticella nebulifera*. The author has met with it abundantly on *Lemna* and other aquatic plants, and on one occasion witnessed the process of transverse fission which as manifested in this instance does not appear to have been previously recorded among the representatives of this group. As a prelude to this process of fission two of the tubular tentacles were extended to a great length, until finding a suitable fulcrum for support they become firmly adherent to it; within a short interval these two tentacles coalesced, and becoming indurated, constituted as it were a second pedicle joined on to the anterior extremity of the animalcule; the body of the zooid meanwhile grew more attenuate, and a considerable portion of the substance of its soft plastic parenchyma passed over towards the newly formed pedicle. A constriction now appeared in the centre of the body between the two attenuate extremities and gradually deepened until a perfect separation was effected, the newly formed product of this fission thus commencing its independent existence with an attached pedicle and organization as complete as the zooid of which it but a short while previously formed merely a constituent part. At Pl. XLVI. Figs. 55 and 56 representations of drawings made during the progress of this fissive process are herewith reproduced. The stage represented by Fig. 56, if unaccompanied by the explanation here given might be easily interpreted for an act of conjugation. This species of *Podophrya* is remarkable among the other representatives of the same genus for its great elasticity, the body assuming various attitudes on its stem and undergoing considerable modifications in external contour. When abandoning its more normal triangular-shape for an ovate or pear-shaped outline it presents a close

resemblance to the *Podophrya pyrum* of Claparède and Lachmann; the three fasciculi of suckers serve however to distinguish that species from the present one.

Podophrya Buckei, S. K.

Body elongate, slender, subcylindrical, bearing two antero-lateral fascicles of distinctly capitate tentacles; not possessing a distinct pedicle but affixed basally by a simple contracted sucking-disk; contractile vesicle anteriorly located; endoplast subcentral. Dimensions unrecorded.

HAB.—Fresh water.

This species, which has recently been briefly described by E. Bucke,* without any accompanying title, must be accepted as a new species, apparently most closely resembling *Podophrya cylindrica* and *P. elongata* in the contour of its body, but differing distinctly from either of these types in the character of its basal supporting element and in the disposition of its tentacles. With reference to the acetabuliform modification of its basal region it will be probably found desirable hereafter to make this species the type of a new genus.

GENUS VI. HEMIOPHRYA, S. K.

(Greek, *hemi*, half; *ophrys*, eyebrow.)

Animalcules stalked, illoricate, bearing tentacles of two orders, the one series being suctorial, as with the ordinary Acinetidæ, the others simply prehensile; multiplying chiefly by exogenous terminal gemmation; the endoplast usually more or less irregularly branched. Inhabiting salt water.

This genus is instituted by the author for the reception of the *Podophrya gemmipara* of Hertwig, a form which differs conspicuously from the typical members of the genus *Podophrya* in the dimorphic character of the tentaculate appendages, which are differentiated for the two separate functions of prehension and food-ingestion. With reference to the presence of supplementary tentacula having a simply prehensile function, it forms an interesting and important link between the two groups of the Suctoria and Actinaria, as recognized in this treatise. Two additional species recently described by M. Fraipont, one by M. Koch, and two by E. Maupas, have to be added to the single form upon which the genus was first established. Maupas, the most recent investigator of this group of organisms, has, in his recent very important memoir,† fully recognized the desirability of creating a new generic name for Hertwig's type, and, although having previously selected an independent one, has courteously substituted for it the title proposed by the author, though necessarily without any diagnostic details, in the earlier pages of this work (see pp. 66, 97, and 215). It may be further mentioned here, however, that the new generic name of *Hemiophrya*, with a figure and brief description of the peculiarities of this species, were included by the author in a paper entitled "Notes on Marine Infusoria," communicated to the meeting of the Birmingham Natural History Society, held on January 20th, 1880, such paper, with illustrations, being published both in the 'Midland Naturalist' for March and in the Society's Transactions for that year. As rightly indicated by Maupas, *Hemiophrya* differs from *Podophrya* in several important details, irrespective of those furnished by the character of the tentacles.

In this connection, attention may be more especially directed to the phenomena of reproduction, which in all of the several known species takes the form of external or exogenously produced buds or gemmules in place of by endogenous

* "Die Acineten im Aquarium," 'Der Zoologische Garten,' Jahrgang xv., 1875.

† "Contributions à l'Étude des Acinétiens," 'Archives de Zoologie Expérimentale,' tom. ix. No. III. November 1881.

embryos, as obtains in the genus *Podophrya*. The nucleus or endoplast has a tendency likewise to become branched or complex, sending out diverticula into the substance of the anteriorly produced gemmules, instead of being simply ovate as in the last-named genus. A third more subordinate but at the same time noteworthy distinctive feature, pointed out by Maupas, is afforded by the mode of union between the animalcule's body and its supporting pedicle. In *Podophrya* no abnormal feature is discernible, but in *Hemiophrya* it mostly happens that the pedicle seems to be continued into the substance of the body, such appearance being due to the fact that the body is hollow or invaginated at this point, and thus overlaps the adjoining regions of the pedicle.

Hemiophrya gemmipara, Hertwig.

PL. XLVI. FIGS. 48–51 AND PL. XLVII. FIGS. 9–14.

Body contractile and somewhat variable in form, usually cup-shaped or subpyriform, widest anteriorly and tapering gradually towards its point of junction with the pedicle; tentacles protruded in a crown-like manner from the entire anterior border; those of a suctorial character subcentrally developed, short, usually five or six in number; the prehensile tentacles three or four times as numerous, their length when extended exceeding the diameter of the body, their external surface granulate in a spiral direction; pedicle about four times the length of the body, most slender at its point of attachment, and gradually increasing in diameter towards its distal extremity, hollow interiorly, its external surface both transversely and longitudinally striate; contractile vesicles two or more in number, situated towards the anterior border; endoplast usually scimitar-shaped, subsequently more or less ramified; multiplying by the production of gemmules from the anterior border, which are liberated in the form of oval embryos clothed with cilia on one side of the body only, after the manner of the Hypotrichous Ciliata; parenchyma transparent or enclosing reddish-brown granular matter. Length of body 1–400" to 1–125". HAB.—Salt water.

This animalcule, which is figured and described at length by Dr. R. Hertwig, in the 'Morphologisches Jahrbuch,' Band i., 1875, under the title of *Podophrya gemmipara*, yields many points of interest. In its possession of certain tentacles, which are not suctorial, but simply prehensile, it may be regarded as a transitional form between the families of the Acinetidæ and Ephelotidæ, while the released embryos in their hypotrichous form of ciliation correspond closely with those of *Acineta cucullus* and *Dendrocometes paradoxus*. Of these ciliate embryos, it not unfrequently happens that as many as six or eight are clustered upon the anterior border, and into each one of these there divaricates a prolongation of the parent nucleus, which is constricted off and retained within the body of the embryo prior to its liberation into the surrounding water. The supplementary or simply prehensile tentacles of this species present, in addition to their non-possession of suctorial terminations, a marked distinction, as seen under high magnification, from the more characteristic ones of their class. The boundary walls of these appendages, instead of being smooth and even, are more or less coarsely nodular, the component particles of externally developed granular protoplasm being usually disposed in a spiral manner around the central axis. These prehensile tentacular appendages would seem to correspond to some extent with the non-suctorial and muricate tentacula of *Actinocyathus cidaris*. In this respect the structure of the prehensile tentacles is shown to correspond essentially with that of the ordinary suctorial appendages of such a type as *Podophrya elongata*, in which, as recently observed by the author, a very distinct

granular protoplasmic crest is developed in a spiral fashion around the central shaft of the tentacle.

Hemiophrya gemmipara would appear to enjoy a relatively cosmopolitan distribution, having been met with by Hertwig at Roscoff, by Lieberkuhn in the Grand Canal at Venice, and by Maupas in the vicinity of Algiers, while the author has collected it in considerable abundance in the Channel Islands and on the Devonshire, Cornish, and North Wales coasts. Among certain of the examples derived from the last-named locality in August 1881, it was observed that the embryos produced by gemmation from the anterior border of the animalcule's body were of an irregular pyriform contour, and provided with short tentacles in addition to, or in place of, a more or less conspicuously developed ciliary covering. A somewhat similar observation has been made by M. C. Robin in connection with specimens gathered at Conçarneau,* but in this case the gemmules were simply tentaculiferous, and are treated of by this authority as an independent form of bud. It would seem more probable, however, that these abnormal gemmules represent instances in which the typical ciliated embryos have undergone their metamorphoses while still adherent to the parent's body, in place of becoming severed from it during the initial or simply ciliate condition, as more usually happens; this interpretation is substantially supported by the evidence of an intermediate condition, as observed by the author. The successive phases undergone by the detached ciliated embryos during the growth to the adult stalked condition, as observed by M. Robin, are well illustrated at Pl. XLVII. Figs. 11–14. It must be mentioned that this investigator proposes to identify this species with the *Podophrya Lingbyi* of Ehrenberg and Claparède and Lachmann; as pointed out, however, by M. Maupas,† the last-named type is a normal species of *Podophrya*, having relatively short capitate tentacles only. Prof. E. Perceval Wright has recently reported the present species from the Irish coast.

Hemiophrya Benedeni, Fraip. sp.

PL. XLVII. FIG. 15 AND PL. XLVIII. FIGS. 30 AND 31.

Body subquadrangular or pyriform, widest anteriorly, tapering towards its point of junction with the pedicle; prehensile tentacles numerous, about forty in number, their length when extended averaging twice the diameter of the body, their substance spirally fibrillate; suctorial tentacles short, subconical, their extended length not exceeding one-third of the diameter of the body; pedicle quadrangular, from ten to fifteen times the length of the body, its central or medullary substance transversely striate, its external layer transparent and homogeneous; parenchyma opaque dirty yellow; contractile vesicles four in number, two developed in each lateral body-half; endoplast originally horseshoe-shaped, becoming with age diversely ramified, rendered visible only by the action of reagents; increasing by terminal gemmation. Length of body 1–300″. HAB.—Salt water.

This species differs substantially from *Hemiophrya gemmipara* in the greater relative length and quadrangular contour of the pedicle, in the greater numerical development of the prehensile tentacles, and in the shorter conical contour of those endued with a suctorial function. Examined with a sufficiently high power, it was found that the whole length of the prehensile tentacles, from a short distance from their base, was traversed by a very delicate spiral filament, which, according to M. Fraipont, is developed on the internal surface of the membranous walls of the

* 'Journal de l'Anatomie et Physiologie,' 1879.
† 'Archives de Zoologie Expérimentale,' tom. ix., 1881.

tentacle, in place of forming a crest-like ridge upon its external surface, as obtains in *H. gemmipara*. The embryos produced by terminal gemmation are, as in Hertwig's species, hypotrichously ciliated, and manifest closely identical developmental phenomena. It is recorded that the bodies of the adult animalcules easily become detached from their supporting pedicles; and on one occasion a ciliated embryo was observed to crawl up and down, and finally affix itself to the summit of a deserted pedicle, and there develop to the adult form. This circumstance is accepted by M. Fraipont as explanatory of the frequent occurrence of fully developed pedicles having only very minute attached zooids. A similar result is, nevertheless, not unfrequently brought about in allied species through the ordinary process of transverse fission.

Hemiophrya truncata, Fraipont sp. PL. XLVIII. FIG. 46.

Body elliptical or subquadrangular; pedicle massive and irregular, three or four times the length of the body; usually for some little distance equalling the breadth of the body in thickness, and thence tapering gradually to its point of attachment, its distal end articulate or transversely plicate; suctorial tentacles developed from the centre of the distal region of the body, the prehensile tentacles numbering in adult zooids as many as fifty or sixty, more slender and prolonged than those of the suctorial series, and around which they are chiefly disposed in a fringe-like manner; parenchyma densely granular; endoplast and contractile vesicle not observed. Length of body 1–500″.

HAB.—Salt water, on the Zoophyte *Sertularia cupressina*.

This form is described by M. Fraipont as a species of *Podophrya* from specimens collected and preserved at Ostend, by Professor Ed. Van Beneden. In the massive character of the pedicle it differs in a marked manner from the two preceding species, but at the same time somewhat resembles in this respect the *Podophrya Steinii* of Claparède and Lachmann. In an encysted example observed the body-substance had become subdivided into a mass of granular spore-like spherules.

Hemiophrya microsoma, Maupas.

Body subspherical or ovate, attached to a very long, cylindrical, irregularly sinuous pedicle, the breadth of which is greatest at the distal end, there equalling one-quarter or one-half the diameter of the body, and gradually tapering towards its point of attachment, its length varying from four or five to as much as eighteen times that of the body; suctorial tentacle single, subcentral, originating from the centre of the body; prehensile tentacles short, not exceeding eight or ten in number, developed superficially, and irregularly scattered, their distal ends slightly inflated; contractile vesicle single or double; endoplast elongate, irregularly nodulate. Length 1-900″. HAB.—Salt water: Algiers.

The short dimensions of the body with relation to its supporting pedicle, combined with the very small proportionate number of the suctorial tentacles, separates this type very distinctly from its congeners. From the fact recorded by Maupas that the tentacles belonging to the prehensile series are slightly dilated instead of subulate at their free extremities, this species would seem to represent an annectant form between the typical members of the two genera *Hemiophrya* and *Podophrya*.

Hemiophrya Thouleti, Maupas. Pl. XLVIII. Fig. 19.

Body usually subquadrate or trapeziform in lateral aspect, the anterior border being the wider; pedicle not exceeding one-half the length of the body, thick and inflated superiorly, abruptly constricted at its proximal or adherent extremity; suctorial tentacles short, ranging from two to five in number, originating distinctly from the internal or endoplasmic region; prehensile tentacles more numerous, attenuate, superficially developed, grouped in an irregular circle round the anterior border of the body, verrucose and granulate when contracted; contractile vesicle single or double, anteriorly located; endoplast subcentral, horseshoe-shaped or irregular, often nodulate; parenchyma brownish-yellow. Length of body 1–900″ to 1–500″. Hab.—Salt water.

This species was obtained on one occasion only by E. Maupas in the neighbourhood of Algiers, the animalcules being in that instance, however, so abundantly developed as to literally cover the Hydroid polyps which gave them support. *Hemiophrya gemmipara* was found sparingly in its company. Multiplication by abundant external gemmation after the manner of the last-named species was observed.

Hemiophrya crustaceorum, Haller sp. Pl. XLVII. Fig. 8.

Body subspherical, of a yellowish hue, mounted on a long cylindrical pedicle, whose greatest width, at the distal end, equals one-half the diameter of the body, and thence tapers off to its point of attachment, its total length averaging eight or ten times that of the body, its external surface throughout the anterior half finely striate transversely, that of the succeeding or basal moiety entirely smooth; suctorial tentacles short, few in number, distinctly capitate, those of the prehensile series attenuate, very numerous, exceeding the body in length, the external surface subspirally granulate, radiating from all parts of the periphery; reproductive granules developed in great abundance over the entire surface of the body, but chiefly upon the anterior body-half. Length of body 1–300″.

Hab.—Salt water, upon a species of *Caprella*.

This type has been recently described incidentally as a species of *Podophrya*, by G. Haller, in an article devoted to the morphology of the Lemodipodous Crustacea.* In its general contour it to some extent resembles the *Podophrya conipes* of Mereschkowsky, but is necessarily, with reference to the dimorphic character of the tentacles, referable to the genus *Hemiophrya*. The number of reproductive gemmules produced upon the external surface of the body, as indicated in the figure given by Haller, exceeds that hitherto recorded of any other species of the genus.

Hemiophrya pusilla, Koch sp.

Body and other structural details closely resembling those of *Hemiophrya Thouleti*, but the pedicle two or three times as long as the body. Length of body 1–300″. Hab.—Salt water, on *Plumularia setacea*.

* "Beiträge zur Kenntniss der Lœmodipodes filiformes," 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xxxiii., 1878.

The author has been unable to obtain access to Koch's original description of this species,* as a type of the genus *Podophrya*, and is dependent for the brief details above given to the short reference to it made by Maupas in his account of *Hemiophrya Thouleti* previously described.

GENUS VII. PODOCYATHUS, S. K.

(Greek, *pous*, foot; *kuathos*, cup.)

Animalcules developing tentacles of two orders, some suctorial, and the remainder simply prehensile, excreting and occupying stalked membranous sheaths or loricæ. Inhabiting salt water.

Podocyathus diadema, S. K. PL. XLVII. FIGS. 1–5.

Lorica conical or cup-shaped, transparent, of very delicate consistence, obscurely wrinkled or rugose transversely; pedicle slender, flexuose, two or three times the length of the lorica; animalcule subspheroidal, resting upon a platform-like involution of the front border of the lorica, and in adult examples usually projecting for about one-half of its total dimensions beyond this structure; suctorial tentacles short, few in number, occupying a central position; circumjacent prehensile tentacles numerous, extensile to a length equalling twice the diameter of the body, their substance finely granulate; contractile vesicles two in number, basally located; endoplast ovate, subcentral. Length of lorica 1–600″. HAB.—Salt water.

This as yet single known representative of the newly established genus *Podocyathus* may be said to occupy, with relation to the preceding type, *Hemiophrya*, a position analogous to that held by the loricate genus *Acineta*, as compared with *Podophrya*. Examples of this species were obtained by the author in some abundance, in the years 1878 and 1879, at St. Heliers, Jersey, being chiefly found attached to Hydroid zoophytes and Polyzoa, dredged from a depth of about 10 fathoms. Among these were zooids in every condition of development, the younger ones, as shown at Fig. 4 of Pl. XLVII., being naked and simply pedicellate, and thus resembling, except for the character of their tentacles, ordinary *Podophryæ*. It was observed that even in the fully matured examples the loricæ were of very delicate consistence, mucilaginous rather than membranous, and oscillating perceptibly with every motion of the water. The transverse wrinkling of the substance of this structure referred to in the foregoing diagnosis, is evidently produced through the weight of the animalcule's body resting upon it. In the fact that the zooid reclines upon the involuted external wall of its lorica, it may be said to possess a commodious water-cushion rather than a true lorica; a somewhat similar structural composition is apparently characteristic of the more indurated membranous loricæ of the two species recently described by M. Fraipont under the title of *Acineta divisa* and *A. vorticelloides*. Under a magnification of 600 diameters the attenuate prehensile tentacles of *Podocyathus diadema* were shown to be finely granulate exteriorly, the granules, however, not taking a definite form of disposition, or being developed to the extent that obtains in the homologous appendages of *Hemiophrya gemmipara*. It was further observed that these prehensile tentacles were at frequent intervals flexed towards the body, as in *Ephelota coronata;* monads and other Infusoria being also intercepted and brought by the same action within reach of the centrally developed suctorial organs, which then speedily seized them, and appropriated their body-contents after the manner of an ordinary *Acineta*.

* 'Zwei Acineten auf Plumularia setacea.' Jena, 1876.

Genus VIII. SOLENOPHRYA, C. & L.

Animalcules solitary, more or less ovate, secreting a membranous investing sheath or lorica, which is attached in a sessile manner and without the intermedium of a pedicle to the chosen object of support; tentacles suctorial, capitate, distributed in distinct fascicles.

The representatives of this genus may be said to occupy, with relation to *Acineta*, the same position that is held by the similarly sessile but illoricate type *Trichophrya*, with reference to the pedicellate genus *Podophrya*. A single species only has been so far recorded.

Solenophrya crassa, C. & L. Pl. XLVI. Fig. 52.

Lorica oval, depressed, resembling a shallow basin; body nearly filling the same, not adherent to it laterally; tentacles forming four distinct fascicles; contractile vesicles multiple; endoplast indistinct. Diameter of lorica 1–150″.

Hab.—Pond water, on the roots of *Lemna minor*: Zoological Gardens, Berlin (C. & L.).

Genus XI. ACINETA, Ehr.

Animalcules solitary, ovate or elongate, secreting a protective lorica, to the sides of which they are adherent or within which they may remain freely suspended; the lorica supported upon a rigid, more or less extensively developed pedicle; tentacles suctorial, capitate, variously distributed. Inhabiting salt and fresh water.

The transparent membranous sheaths or loricæ, that distinguish the members of the genus *Acineta* from those of *Podophrya*, are held by the author to be homologous with the protective structures bearing the same title that characterize the several generic types *Cothurnia*, *Vaginicola*, *Freia*, *Bicosœca*, *Salpingœca*, and others previously described. While this view of their homology is fully sustained by Maupas,* a contrary opinion is advocated by Hertwig, Fraipont, and some few other authorities, who propose to identify this protective element with an ordinary cuticular investment. That its true character is that of a lifeless excretion, such as a shell or lorica, is, however, amply demonstrated by the fact that it never takes part in the subdivision of the body as invariably happens in the case of a living cuticular investment.

As in the genus *Podophrya*, the numerous species may, as an aid to their identification, be conveniently divided into two groups, in accordance with the fasciculate or irregular disposition of their tentacular appendages.

A.—Tentacles fasciculate.

Acineta livadiana, Meresch. Pl. XLVIII. Fig. 12.

Lorica transparent, evenly ovate or urceolate, with its anterior border truncate, nearly twice as long as broad; pedicle slender, straight or flexuose, its height usually corresponding with that of the lorica; animal-

* "Contribution à l'Etude des Acinétiens," 'Archives de Zoologie Expérimentale,' tom. ix., 1881.

cule subspheroidal or pyriform, rarely occupying more than the anterior moiety of the lorica; tentacles distinctly capitate, forming a single anteriorly developed sheaf or fascicle, their length when extended equal to that of the body; contractile vesicle single, lateral; endoplast unobserved. Length of lorica 1–300″.

HAB.—Salt water, on various Hydroid zoophytes, seaweeds, and Polyzoa.

The distribution of this species, figured and described by M. C. Mereschkowsky in the 'Annals and Magazine of Natural History' for March 1881, is not, as its title would imply, limited to the Livadian seaboard. So long since as July 1879 the author obtained it in abundance attached to zoophytes and Polyzoa collected on the coasts of Devonshire and Cornwall, and more recently, August 1881, from the Menai Straits, North Wales, growing in company with *Acineta tuberosa* and *Ophryodendron sertulariæ* on *Sertularia abietina*. The symmetrically ovate contour of the lorica distinguishes it readily from any of the species previously described.

Acineta tuberosa, Ehr. PL. XLVIII. FIGS. 25–28 AND PL. XLVIIIA. FIG. 7.

Lorica compressed, subtriangular, widest at its distal margin, and thence tapering gradually towards its point of junction with the pedicle, the lateral walls continuous over the frontal border, leaving two ovate apertures at the anterior angles for the extrusion of the tentacles; pedicle slender, rectilinear, varying from equal to, to as much as four or five times the length of the lorica; body of animalcule mostly attenuate posteriorly, rarely filling the cavity of the lorica except towards the anterior border, invariably adherent to it by its posterior extremity, in the region of the tentacles, and usually along four perpendicular lines extending from the posterior extremity towards the anterior border, such lines of adhesion communicating to the body as seen in vertical optic section a distinct quadrilateral contour; tentacles forming two antero-lateral fascicles, protruding when extended through the corresponding ovate apertures in the lorica, withdrawn in a sheaf-like manner into the substance of the body by invagination when retracted; contractile vesicle single, anteriorly located; endoplast elongate-ovate or cord-like, often contorted and branched. Length of lorica 1–500″ to 1–300″. HAB.—Salt water.

The synonymy of this species has become somewhat involved in consequence of its close resemblance to a fresh-water type, originally connected with the same title by Stein,* and which is here held to be identical with the *Acineta lemnarum* of the last-named investigator. The species first distinguished by the title of *Acineta tuberosa* by Ehrenberg, is essentially a salt-water form, having a cosmopolitan distribution, and although but imperfectly figured and described by that authority, the attention bestowed upon it by several more recent investigators has resulted in the elucidation of almost every important structural detail. In this connection, attention may be more especially directed to the elaborate account and illustrations given of it by M. Julien Fraipont in his memoir upon the Acinetidæ of the coast of Ostend.† As indicated by this authority, the essential difference subsisting

* 'Die Infusionsthiere,' pl. iii. figs. 48–50, 1854.
† 'Bulletins de l'Académie Royale des Sciences de Belgique,' 1878.

between this species and its fresh-water homotype consists of the respective modes in which they are united to their loricæ, and the relative portions of the cavities of the same that they usually occupy. In the present type adhesion always subsists between the posterior extremity of the body and the fundus of the loricæ, which does not obtain in *A. lemnarum*, and while in the last-named species the body more or less completely fills the cavity of its domicile, in *A. tuberosa* the posterior region is usually very attenuate, quadrilateral in shape, and united to the sides of the lorica at each angle in such a manner that, as seen in transverse optical section, the cavity of the lorica is as it were divided by four membranous septa into as many vertical compartments. This structural peculiarity is well shown in the drawings by M. Fraipont reproduced at Pl. XLVIII. Figs. 26 and 28. The last-named authority adduces as an additional point of distinction between the two forms under discussion, that while in the fresh-water variety the pedicle is relatively short, varying from much less to about one and a half times the length of the body, in the examples of *A. tuberosa* he examined and figures, the pedicles measured no less than four or five times such dimensions. The author is, however, disinclined to accept this distinction as diagnostic, the same length to twice the length of the body representing the proportions of the pedicle commonly exhibited out of a very large series of examples derived from different localities as personally examined, and the same proportions obtaining in the specimens originally figured by Ehrenberg. Fraipont's types would thus seem to represent indeed a well-marked long-stalked variety differing in the same manner as the variety *A. longipes* does from the normal examples of *Acineta mystacina*. A much more reliable distinction is apparently afforded by the relative dimensions of the loricæ of *A. tuberosa* and *A. lemnarum*, as specified in the figures quoted in their respective diagnoses, derived in each instance from examples personally examined.

The character of the endoplast in the present type, not previously recorded, was clearly demonstrated by Fraipont in specimens treated with picrocarmine, and is also clearly shown in specimens preserved by the author with osmic acid. Endogenous peritrichously ciliated embryos, as observed by Stein of *A. lemnarum*, are produced singly in connection with the constriction and separation off of a fragment of the endoplast. Although collected in the Channel Islands and on the Devonshire coast, the most abundant development of this species was obtained by the author in August 1881, growing, in company with *Acineta livadiana* and *Ophryodendron sertulariæ*, on examples of *Sertularia abietina* collected in the Menai Straits, North Wales.

Acineta lemnarum, Stein.

Lorica subtriangular, compressed, widest anteriorly, tapering gradually towards the posterior extremity, its walls thin and readily adapting themselves to the contour of the body; the body soft and plastic, almost completely filling the cavity of the lorica, often transversely folded or puckered posteriorly, but not distinctly adherent to the lorica in this region; tentacles finely capitate, forming two antero-lateral fascicles; pedicle rarely exceeding one and a half times the length of the body, frequently much less, increasing very slightly in diameter towards its point of junction with the lorica, slightly curved; contractile vesicles two in number; endoplast ovate; embryos peritrichous, formed singly in connection with a separation off of a portion of the endoplast. Length of body 1–600″ to 1–500″.

HAB.—Fresh water, on *Lemna* and other aquatic plants.

The author includes under the above title both the *Acineta lemnarum* and the so-called *A. tuberosa* of Stein, figured in Pl. III. of his earlier work, 'Die Infusionsthiere,' published in the year 1854. From the typical marine *Acineta tuberosa* it differs

essentially in its smaller dimensions and in the character of the posterior region of the body, which is never contracted, quadrangular and distinctly adherent to the lorica, as obtains in that type. In common with many other representatives of the present genus, *A. lemnarum* was originally described by Stein as the immature or "Acinete" condition only of some higher Peritrichous Ciliate Infusorium, the habitat of this particular type inducing him to regard it as a transitional form of either *Vorticella nebulifera* or *Epistylis* (*Opercularia*) *nutans*. Having satisfied himself later on that these Acinetæ hold a substantial claim for independent recognition, the title here applied was conferred upon it. The author has recently received examples of this species from Mr. Thomas Bolton, of Birmingham, growing, in company with *Dendrosoma radians*, *Acineta grandis*, and *A. mystacina* var. *longipes*, on various aquatic plants.

Acineta grandis, S. K. PL. XLVIII. FIG. 24.

Lorica subtriangular, compressed, widest at the anterior border, tapering gradually towards the posterior extremity, communicating externally by a cleft-like aperture, which extends throughout the entire length of the anterior border; pedicle slender, rectilinear, three or four times the length of the lorica; enclosed animalcule ovate or elliptical, usually occupying the anterior half or an even less considerable area of the cavity of the lorica; tentacles distinctly capitate, very numerous, forming two antero-lateral bundles; contractile vesicle spherical, subcentral; endoplast band-like, rendered conspicuously visible only by the action of reagents; parenchyma transparent, finely granular. Length of lorica 1–100″ to 1–75″.

HAB.—Fresh water, on *Anacharis*, *Nitella*, and *Potamogeton*: Birmingham and Stratford Canal.

Examples of this new and handsome species have been remitted to the author in November of the two consecutive years 1880 and 1881. While at first sight it would appear to differ but little, except in size, from the respective salt- and fresh-water forms *Acineta tuberosa* and *A. lemnarum*, it is found, on closer inspection, to yield many distinctive features. The lorica, in the first place, has a much more simple structure, it being freely open throughout the anterior margin, in place of being arched over by a continuation of its lateral walls, leaving slit-like apertures only for the extrusion of the tentacles, as obtains in those two forms. The body of the animalcule is finally of much less relative size, it usually occupying, as shown in the accompanying figure, scarcely one-half of the cavity of its protective sheath, and adhering to it only by its frontal border. The comparatively colossal dimensions of this species, as compared with its homotype *Acineta lemnarum*, found growing close beside it, is well illustrated in the same drawing, and where, at *a*, an outline of the more familiar but smaller species has been added for the purpose of comparison. Although the form and position of the nucleus or endoplast was not readily detected in living specimens, this structure was rendered distinctly visible in examples killed with osmic acid and then treated with picrocarmine.

Acineta linguifera, C. & L. PL. XLVI. FIGS. 36–39.

Lorica subtriangular, compressed, tapering posteriorly, developed anteriorly into two everted, bilaterally even, lip-like expansions, frequently annulate transversely, each annulation representing a new cycle of growth; pedicle very short; body filling the entire cavity of the lorica, and adherent to it, projecting in a tongue-like form beyond the anterior margin, bearing

two antero-lateral fascicles of capitate tentacula; contractile vesicles numerous, situated near the anterior border; endoplast band-like, sinuous. Length 1–150″. HAB.—Fresh water, on aquatic Coleoptera.

This species was originally described by Stein as an Acinete condition of *Opercularia berberina*, but subsequently received from Claparède and Lachmann the title as above given. A yet later name proposed by Stein is that of *Acineta ligulata*. The embryos of this type, as figured by the last-named authority, see Pl. XLVI. Fig. 39, are flattened, and holotrichously ciliate.

Acineta fœtida, Maupas. PL. XLVIII. FIGS. 13–17.

Lorica compressed, subtriangular, the anterior border widest, gradually diminishing towards the usually obtusely pointed posterior extremity, the surface of the lorica frequently evenly plicate in an oblique direction, the anterior border closed in excepting for the presence of a narrow slit-like opening, supplemented at the two lateral angles by a larger ovate aperture for the passage of the tentacles; body almost completely filling the cavity of the lorica; the tentacles distinctly capitate, disposed in two antero-lateral fascicles which protrude through the corresponding apertures in the lorica; pedicle short and rudimentary, usually eccentric; contractile vesicle single, occupying an antero-lateral position; endoplast elongate-ovate, subcentral, with a minute laterally attached endoplastule. Length of lorica 1–600″. HAB.—Salt water, among decaying seaweeds.

The general contour of this species very closely resembles that of the fresh-water form *Acineta linguifera* previously described, but may, in addition to its distinct habitat, be distinguished from that type by the relatively close application of the front walls of the lorica, these, in that last-named species, being everted to such an extent as to admit of the protrusion of the body, in addition to the tentacles, beyond their edges. In the conformation of the internally developed embryos there is likewise a most remarkable divergence, for, while in *A. linguifera*, as observed by Stein, they are flattened and holotrichously ciliate, in the present type, as figured and described by E. Maupas, they are elongate-ovate or pyriform, with five obliquely distinct or continuous spiral ciliate grooves, which communicate to them a singular helicoidal contour. As many as four represented the common number of these embryos developed in the brood-cavity of the parent, while in its apparently near ally, *Acineta linguifera*, the embryos are usually produced singly. The earlier phases following upon the attachment of the embryos and their development towards the adult form in *Acineta fœtida*, are remarkable from the fact that the lorica in no way resembles that of the parent, being quite smooth, as broad or broader than long, and, excepting for the circumstance that the tentacles have a fasciculate arrangement, might easily be mistaken for that of *Acineta emaciata* described further on.

Acineta cucullus, C. & L.

Lorica infundibulate or obconical, tapering posteriorly, one side of the anterior margin deeply emarginate; pedicle long and slender, even throughout; body freely suspended within the lorica, protruding but little from its orifice, bearing two fascicles of suctorial tubes. Length of lorica 1–100″.

HAB.—Salt water.

The single example upon which Claparède and Lachmann have instituted this species was captured by them floating in the sea in the neighbourhood of Bergen,

and had evidently become detached from its original basis of support. The external surface of the lorica was observed to be densely and finely hispid, but they were unable to determine whether this feature was due to the presence of some foreign growth or an essential part of the organism. The single specimen examined enclosed six germs, one of which was seen to escape as a free-swimming pear-shaped embryo, bearing several circlets of cilia at its more attenuate posterior extremity, and being devoid of all trace at that time of the tentacula of the adult form.

Acineta notonectæ, C. & L. PL. XLVI. FIG. 44.

Lorica subcylindrical, tubular, gradually tapering towards the posterior extremity, the anterior margin somewhat oblique; pedicle absent or rudimentary; body adherent to the lorica, and occupying its entire cavity; tentacle distinctly capitate, forming two fascicles at the anterior extremity; endoplast oval. Length of lorica 1–150″.

HAB.—Fresh water, on *Notonecta glauca*.

The rudimentary condition of the pedicle in this species, the lorica being mostly adherent only by its more attenuate posterior extremity, would seem to almost justify its transfer to the genus *Solenophrya*.

Acineta compressa, C. & L.

Lorica shortly cup-shaped, as broad as long, exceedingly compressed, the antero-lateral angles obliquely truncate; pedicle long, slender and straight, having a short nodular thickening at its point of junction with the lorica, but below this entirely even; body nearly filling the lorica, freely suspended within the same, bearing two antero-lateral fascicles of capitate tentacles; contractile vesicle single. Length of lorica 1–275″.

HAB.—Salt water: Norwegian coast (C. & L.).

Acineta poculum, Hertwig.

Lorica obconical, or wineglass-shaped, nearly as broad as long, widest at the antero-border, and tapering gradually towards its point of junction with the pedicle; body scarcely occupying the anterior half of the cavity of the lorica; tentacles distinctly capitate at their distal terminations, forming two antero-lateral fascicles, the proximal or intra-parenchymal terminations of which interlace with one another along the posterior margin of the body; pedicle slender, not constricted at its point of junction with the lorica; endoplast subspherical. Dimensions unrecorded.

HAB.—Salt water.

The lorica of this type, excepting for the absence of the narrow constriction at its point of juncture with the pedicle, is apparently closely identical with that of *Acineta patula*. The fasciculate distribution of the tentacula, however, affords an additional means of distinguishing it from that species.

Acineta cothurnia, C. & L.

Lorica wineglass-shaped, rounded posteriorly, the anterior margin obliquely bevelled, and split into four or five triangular valve-like segments as in *A. mystacina*, mounted on a short slender pedicle; body freely sus-

pended within the lorica, occupying about one-half of its cavity, bearing two antero-lateral fascicles of suckers; contractile vesicle single; endoplast ovate. Length of lorica 1–150″. HAB.—Salt water.

This species was originally figured by Stein as the probable Acinete phase of *Cothurnia maritima*.

Acineta mystacina, Ehr.

PL. XLVI. FIGS. 40–43 AND 57, AND PL. XLVIII. FIG. 41.

Lorica urceolate, subdivided at the anterior or distal margin into five or six acuminate, triangular, valve-like lobes, which are bent inwards and cover the aperture in a lid-like manner; body subspherical, freely suspended within the lorica, bearing five or six fascicles of capitate tentacula, which are extended through the fissure-like clefts between the valves of the lorica; contractile vesicle single; endoplast rounded or ovate; pedicle varying in length from a less magnitude to four or five times the length of the lorica, formed out of a hollow, attenuate, posterior extension of the walls of the lorica. Length of lorica 1–120″.

HAB.—Fresh water, on *Lemnæ* and other aquatic plants.

This form was originally described and figured by Stein as the Acinete phase of *Vaginicola crystallina*. Claparède and Lachmann observed this species multiply by the process of transverse fission, and ascertained that the separated product was, at the time of its release, densely clothed with fine cilia, in addition to bearing the characteristic suctorial tentacles. In accordance with the observations of Stein, the propagation of this species may be accomplished in a yet more abundant manner, through the development of hypotrichously ciliate embryos, which are passed out of the body and deposited singly within pocket-like diverticula of the parental membrane; these being extruded between the valves of the lorica, remain for some little time attached apparently to the outer wall of this structure, as shown at Pl. XLVI. Figs. 40 and 43. In some instances no less than four or five of these embryonic bodies are represented by Stein as attached to the distal border of a single zooid. As recognized by the authority last quoted, the length of the hollow pedicle in this type with relation to that of the lorica it supports varies very considerably, being in some instances quite rudimentary or represented by a short conical elongation only of the substance of the lorica, or in opposite cases equalling or surpassing the altitude of the lorica. Mereschkowsky * has figured and described a variety of this type in which the pedicle is very much more attenuate, being equal in length to from five to seven times that of the lorica. Examples of this variety, for which Mereschkowsky has proposed the title of *Acineta mystacina* var. *longipes*, have been quite recently, October and November 1881, received by the author from two different localities, namely, through Mr. J. Thomas from the neighbourhood of Epping, and through Mr. Thomas Bolton from the Birmingham district. In the last-named instance the animalcules were very abundantly developed, in company with *Acineta grandis*, *A. lemnarum*, and *Dendrosoma radians*, on the leaves of *Nitella*. Many of these were observed undergoing the process of transverse fission in the manner described by Claparède and Lachmann. Some interesting drawings and very abundant colonies of the more typical short-stalked variety of this species were remitted to the author by Mr. F. W. Phillips in August 1881. Among the new data elicited by Mr. Phillips may be mentioned the fact that the tentacles, when contracted, exhibit, under high magnification, a distinct zigzag or spiral aspect, such appearance being due to the presence of a delicate external spiral fibrilla analogous

* "Protozoen des Nordlichen Russland," 'Archiv für Mikr. Anatomie,' Bd. xvi., 1878.

to that more conspicuously developed in *Podophrya elongata*, as also that the tentacles, when extended, are capable of flexure in various directions. Mr. Phillips has attested in his communication to having on one occasion observed a brood of flagellate organisms escape from an otherwise uninhabited lorica. At first sight these were supposed to have had some connection with the developmental phenomena of the species, but is interpreted by the author as representing a case only of the intrusion and reproduction of a Flagelliferous form within the vacated domicile of the Acinetan.

Acineta Jolyi, Maupas. PL. XLVIII. FIGS. 34 AND 35.

Lorica exceedingly compressed, irregularly quadrate, about one and a quarter times as long as broad, the lowermost angle, which is united with the pedicle, being the most attenuate; the anterior and two lateral angles abruptly truncate, leaving ovate apertures for the extrusion of the tentacles; pedicle slender, rectilinear, somewhat longer than the lorica; contained animalcule occupying the greater portion of the cavity of the lorica; tentacles forming three—one anterior median and two lateral—fascicles corresponding in position with the apertures in the lorica, their bases apparently produced into the central region of the body; contractile vesicle subcentral, anteriorly located; endoplast discoidal, occupying a similar position towards the posterior region of the body. Length of lorica 1–120″. HAB.—Salt water, Algiers.

This species, on account of its greatly compressed contour and corresponding tenuity as seen in profile, is exceedingly transparent. With respect to its possession of three tentacular fascicles, it differs distinctly from all species of the genus previously described, while *Podophrya pyrum* is the only type among the illoricate forms in which an analogous plan of distribution obtains. According to M. Maupas, its discoverer, the contractile vesicle is remarkable for the length of time that intervenes between its contractions, as much or more than an hour not unfrequently representing this interval. As in many allied species, this vesicle is formed by the flowing together of numerous smaller lacunæ. The nucleus or endoplast in examples treated with a one per cent. solution of osmic acid was found to enclose numerous transparent vacuoles having a central refringent corpuscle, while in many instances there was attached to the lateral periphery of this structure a minute spherical body, which probably represents an endoplastule.

B.—TENTACLES IRREGULARLY DISTRIBUTED.

Acineta patula, C. & L. PL. XLVI. FIGS. 45–47.

Lorica cup-shaped or infundibulate, tapering posteriorly, widest at its anterior margin, seated on a long rectilinear stem with a narrow constriction at the point of junction between the two; body equal in height to the lorica, ovate or spherical, its lower extremity only resting within the lorica and not adherent to it; tentacles distinctly capitate, very long and slender, protruded from every portion of the periphery. Height of lorica without the stalk 1–85″ to 1–50″. HAB.—Salt water, on Algæ.

The aspect of this elegant animalcule, seated in its long-stalked cup-like lorica, and with the tentacula withdrawn, is fancifully suggestive of the children's toy distinguished by the familiar title of "cup and ball." Both conjugation and the production by the individual animalcules of a single embryo, apparently ciliated

throughout, have been observed by Claparède and Lachmann in association with this species.

Acineta Saifulæ, Meresch. PL. XLVIII. FIG. 29.

Lorica elongate-conical, two or three times as long as broad, widest anteriorly and gradually tapering towards its narrowest posterior region, finely striate or annulate transversely, the anterior half of the lorica separated from the posterior one by a membranous septum or platform, upon which the body of the animalcule reclines; pedicle slender, about twice the length of the lorica, straight or slightly arcuate, hollow and continuous with the walls of the lorica; animalcule elongate-ovate, projecting for a distance of about one-half of its entire length beyond the aperture of the lorica; tentacles slender, distributed throughout the exposed periphery; endoplasm granular, pale yellow; endoplast spherical, subcentral; contractile vesicle unobserved. Length of lorica 1–400″.

HAB.—Salt water: White Sea (Mereschkowsky).

This species is described by Mereschkowsky * from spirit-preserved examples only. While in the contour of its lorica it to some extent resembles the *Acineta divisa* of Fraipont, it may be readily distinguished from that form by the distinct annulation of the surface of the lorica, and by the continuity of its cavity throughout the substance of the pedicle. In this last-named respect it stands alone among the known salt-water representatives of the genus, while *Acineta mystacina*, and more particularly the variety *A. longipes*, is the only fresh-water form that is similarly characterized.

Acineta divisa, Fraipont. PL. XLVIII. FIGS. 8–11.

Lorica symmetrically conical or wineglass-shaped, widest and somewhat expanded at the anterior border, tapering thence towards the posterior extremity, divided subcentrally by a delicate transverse membranous septum upon which the body of the animalcule reclines; pedicle slender, five or six times the length of the lorica, not constricted at its point of junction with it; animalcule subspherical or ovate, elevated above the aperture of the lorica, capable of considerable extension; tentacles numerous, distinctly capitate, developed equally over the anterior peripheral border; parenchyma pale yellow, finely granular; endoplast ovate or nodular, subcentral. Length of lorica 1–600″. HAB.—Salt water.

Excepting for its smaller size, the more solid mode of junction of the lorica with its pedicle, and the presence of an internal membranous septum upon which the animalcule rests, this species very closely resembles the *Acineta patula* of Claparède and Lachmann previously described. According to its discoverer, M. Fraipont,† this species exhibits remarkable reproductive phenomena. Small pyriform capsular diverticula are developed from the anterior surface of the animalcule's body—not accompanied by an outgrowth of the parent endoplast as in *Hemiophrya gemmipara*—within which are independently generated minute peritrichously ciliated embryos, which effect their exit through an operculum-like modification of the distal wall of their respective capsules. A somewhat analogous reproductive process has been shown by Stein to obtain in *Acineta mystacina*, though in that type it would appear

* 'Ann. Nat. Hist.,' March 1881.
† "Acinétiens de la Côte d'Ostende," 'Bull. Acad. Bruxelles,' 1879.

that ciliated embryos are passed from the body of the parent into pocket-shaped extensions of the cuticular membrane. Somewhat similar reproductive phenomena have been likewise recently observed by the author in connection with *Dendrosoma radians*.

Acineta crenata, Fraipont. PL. XLVIII. FIGS. 32, 33.

Lorica transparent, elongate-conical, about twice as long as broad, its external surface finely crenulate and irregularly striate transversely; pedicle slender, about twice the length of the lorica; enclosed animalcule ovate or pyriform, occupying the anterior half of the lorica, and projecting to some distance beyond its anterior border; tentacles about twenty-six in number, distributed over the anterior surface of the periphery; usually one large contractile vesicle developed towards the wider posterior region of the body, and one smaller towards the narrower posterior region; endoplast subspherical or irregular in shape. Length of lorica 1–500″.

HAB.—Salt water, on the zoophyte *Clytia volubilis*.

Acineta vorticelloides, Fraipont. PL. XLVIII. FIG. 42.

Lorica rudimentary, consisting of a small cup-shaped expansion only of the distal extremity of the supporting pedicle; pedicle slender, four or five times the length of the body; body subspherical; tentacles developed throughout the exposed peripheral surface, widest at their base, extensile to a length equal to the diameter of the body; parenchyma dirty yellow, often enclosing oleaginous corpuscles; contractile vesicle single, of large size; endoplast ovate, posteriorly located, rendered visible only by the action of reagents, frequently enclosing minute granular endoplastules. Length of body 1–500″. HAB.—Salt water, on the zoophyte *Clytia volubilis*.

This species is of special interest on account of the rudimentary condition of the lorica, which is little more than a shallow cup-shaped expansion of the substance of the pedicle. In this connection *Acineta vorticelloides* may be regarded as an annectant type between the two genera *Acineta* and *Podophrya*.

Acineta pusilla, Maupas.

Lorica minute, compressed, subquadrate or lozenge-shaped as seen in front view, having the anterior and posterior borders evenly rounded, and the two lateral angles acuminate, the width somewhat exceeding the greatest depth; pedicle slender, rectilinear, slightly exceeding the lorica in length; enclosed animalcule almost completely filling the cavity of the lorica; tentacles short, four or five in number, distributed irregularly along the frontal border; contractile vesicle unobserved; endoplast ovate, situated towards the basal region of the body. Length of lorica 1–1800″.

HAB.—Salt water, on Bryozoa dredged off the port of Algiers (Maupas).

Acineta emaciata, Maupas. PL. XLVIII. FIG. 18.

Lorica compressed, subquadrate, often wider than broad, the anterior median angle being rounded so as to form an almost complete semi-

circle, the two lateral and a median posterior angle being left intact, a narrow fissure-like cleft slightly widened at its two extremities, extending along the front border between the two lateral angles; pedicle slender, rectilinear, very short, not exceeding one-half of the diameter of the lorica; body of animalcule rarely occupying more than the anterior moiety of the cavity of the lorica, often limited to a narrow lunate or fusiform granular band adherent to its upper wall; tentacles distinctly capitate, very short, varying from two or three to as many as fifteen in number, distributed irregularly along the frontal border, and protruding from the fissure-like cleft of the lorica; contractile vesicle single; endoplast spheroidal or ovate. Diameter of lorica 1–350″. HAB.—Salt water: Algiers.

Acineta stellata, S. K. PL. XLVI. FIGS. 32–35.

Lorica subpyriform, its cavity continued inferiorly into a short, gradually tapering, hollow, stalk-like attachment, its lateral walls at the points of exit of the tentacula produced outwards as fine radiating tubuli; contained body subglobose or stellate, the tentacles capitate, their length when extended exceeding the diameter of the body, varying in number from six or seven to as many as twelve, radiating from all parts of the periphery, and perforating the substance of the lorica; contractile vesicle, single; endoplast spheroidal, subcentral. Height of entire lorica 1–1500″; diameter of body 1–3000″. HAB.—Pond water, on *Confervæ*.

This species was obtained by the author, in August 1871, attached in considerable quantities to *Confervæ* taken from a pond at Stoke Newington, London. Its excessively minute size readily distinguishes it from all the forms hitherto described, while, at the same time, the general contour, with its characteristic attachment, consisting rather of a tapering prolongation of the lorica than of a distinct pedicle, corresponds to some extent with that of the short-stalked variety of *Acineta mystacina*, delineated at Fig. 41 of the same Plate. The characters afforded by the disposition of the tentacles and their relationship with the investing lorica are entirely at variance with that form or any previously recorded type. As intimated in the foregoing diagnosis, these tentacula radiate in all directions, and appear to as it were perforate the wall of the lorica rather than to issue from any definite apertures or fissures in its substance. Such perforation of the walls of the lorica must evidently take place during its newly formed, mucilaginous condition, it being only at this time sufficiently soft to permit the tentacles to push before and carry out with them slender tubular prolongations of its substance. That these tubular prolongations of the walls of the lorica have a substantial existence is best demonstrated by an examination of the animalcule in its encysted condition. In this state, notwithstanding that the body is shrunk up into a compact globular form within the central cavity, tentacule-like processes are still to be seen radiating from the walls of the lorica; these, however, have no capitate extremities, and are found, on closer investigation, to be entirely disconnected from the central encysted body, and to be merely slender, hollow extensions of the lorica-wall, as shown at Pl. XLVI. Figs. 33 and 34. It was not unfrequently observed that the body of the animalcule inside these characteristic encystments, as delineated in the first of the two figures quoted, had divided into two by transverse cleavage. Sometimes the pedicle-like portion is so short and inconspicuous as to present the character only of the ordinary tubular prolongations of the lorica associated with an extruded tentaculum, and with which this structure, as demonstrated in the case of *Podophrya mollis*, is without doubt originally homologous. Not unfrequently, again, the lorica was

found moored to its fulcrum of support by two much smaller basal extensions, in place of the more ordinary single and larger one. An example of this modification is given at Fig. 34. Minute spherical freely floating *Sphærophrya*-like organisms, Pl. XLVI. Fig. 35, were frequently found in the neighbourhood of these animalcules, and represented apparently the earlier conditions of this species.

Acineta dibdalteria, Parona.

Lorica wineglass-shaped; peduncle slender, rectilinear, about half the length of the lorica; tentacles two in number only, placed opposite one another, both suctorial and prehensile, movable in all directions; endoplasm granular, more transparent at the periphery; contractile vesicle single, of large size; endoplast horseshoe-shaped. Length of lorica 1–500″.

HAB.—Salt water.

This species is reported by Dr. C. Parona* from the Gulf of Genoa, its essentially distinctive features consisting of the small number of the tentacles, their great mobility, and adaptation to distinct functions. With reference to their mobile properties, it may be mentioned that a similar character is shared by various other forms, among which *Acineta mystacina* and *Podophrya elongata*, as examined by the author, may be specially cited. In connection with the first-named of these two species, a similar phenomenon has likewise been recently observed by Mr. F. W. Phillips, of Hertford.

GENUS X. DENDROCOMETES, Stein.

Animalcules solitary, sessile, discoidal or subspherical; the surface of integument indurated; tentacles slightly flexible, but not contractile, more or less branched and finely perforate at their extremities. Endoplast and contractile vesicle conspicuous; increasing by internal gemmation.

Dendrocometes paradoxus, Stein. PL. XLVIIIA. FIGS. 8–12.

Body plano-convex or discoidal; tentacles springing from the peripheral margin, equal to or slightly exceeding the diameter of the body in length, rarely more than five in number, usually branched in a bi-tripartite manner; contractile vesicle single; endoplast subtriangular. Diameter of body 1–300″.

HAB.—Fresh water, on *Gammarus pulex*. Embryos hypotrichously ciliate.

This singular organism was originally supposed by Stein to represent an Acinetiform condition of *Spirochona gemmipara*; the occurrence of the two as parasites or commensals of the same host, together with the circumstance that the external gemmæ of the Vorticellidan, in the earliest stages of their development, bear a considerable resemblance to the internally developed ciliate embryos of *Dendrocometes*, affording him at that time considerable foundation for this opinion. Although the independent nature of this type is now fully substantiated, its relegation to this group of the Tentaculiform Infusoria has been presumably tentative and provisional, no evidence having hitherto been adduced as to the use made by the animalcule of its constantly extended and almost rigid tentacles, or as to what manner, if any, they are subservient to the purposes of food-inception. Through,

* 'Arch. Sci. Phys. et Nat.,' 1881, also 'Trans. Royal Mic. Soc.,' June 1881.

however, the investigations of Wrzesniowski,* the mystery up to the present time associated with this very remarkable organism has been satisfactorily dissipated, and *Dendrocometes* is demonstrated to share all the essential characteristics of the order to which it has been hitherto but provisionally relegated. While in their more ordinary condition the distal terminations of the characteristic antler-like appendages of this type present a simply conical and pointed aspect, Wrzesniowski shows that their terminations are capable of foreshortening and expansion, and that under such conditions they exhibit with a magnifying power of 1200 diameters minute tubular axial canals, forming a channel of communication from the exterior down the main branches into the body of the animalcule. It was further proved by this investigator that these distal terminations of the branchlets possess the faculty of closing upon and holding other Infusoria, the contents of which are then sucked out and transferred to the parenchyma of its own body, after the same manner as an ordinary *Acineta* incepts the life-juices of its prey through the one or more suctorial tentacles wherewith it holds it captive. Adopting a somewhat fanciful simile, the phenomena attending this seizure and inception of food by *Dendrocometes*, as represented at Pl. XLVIIIA. Figs. 8*a* and 9, might be appropriately compared to that of a man, his normal alimentary functions being suspended, endowed with the capacity of grasping an orange with his hand, and transferring its juices to his own body through perforations in the tips of his fingers.

The embryos, as first figured and described by Stein, and more recently investigated with great success by Bütschli,† present a hypotrichous aspect, corresponding closely with those of *Podophrya gemmipara* and *Ophryodendron abietinum*, being ovate with a flattened ventral and convex dorsal surface, the peripheral margin of the former bearing a border of cilia, and having a curved excavated central area of somewhat variable form. These embryos, which are matured singly within the parent, occupy a very considerable portion of its body-cavity, and, without some special provision for their release, their liberation would seem impossible. As shown, however, by the authority last quoted, a fissure-like aperture makes its appearance in the indurated cuticle of the parent zooid when the embryo is ripe, and through this it is gradually expressed into the outer water. A portion of the endoplast of the parent animalcule, it is also shown by Bütschli, becomes separated off and incorporated into the body of the ciliated embryo, while at the time of its liberation it possesses also a conspicuous contractile vesicle. This latter structure in the adult zooid is demonstrated by Bütschli to communicate externally through the medium of a minute persistent tubular aperture.

Professor E. Ray Lankester has recently informed the author that this interesting species occurs abundantly on *Gammarus pulex* in the neighbourhood of Hampstead.

Genus XI. DENDROSOMA, Ehrenberg.

Animalcules intimately fused with one another, and forming an erect branching colony-stock or zoocaulon, or several such erect zoocaula united basally by a creeping adherent stolon; the terminations of the erect branches bearing numerous capitate suctorial tentacles similar to those of the ordinary Acinetidæ; the compound colony-stock increasing in size by the extension of the adherent stolon and development from it of new zoocaula, and by the repeated fission and outgrowth of the terminal branches; local distribution effected by the production of endogenous ciliated embryos, and by exogenous gemmation; contractile vesicles and endoplast distinctly developed. Inhabiting fresh water.

* 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xxix. p. 270. 1877.
† Ibid., Bd. xxviii. p. 49, 1877.

The type of the genus, *Dendrosoma radians*, may be said to represent one of the most remarkable forms described in this treatise. Not only does it occupy an isolated position as the only known compound member of the Tentaculiferous class, but it is furthermore the only example throughout the entire Infusorial series in which the individuality of the component zooids is so far obliterated that the entire colony-stock may be justly described as a homogeneous multicellular organism or "syncytium." In many of the Flagellata and Ciliata previously described—including notably among the latter the compound Vorticellidæ such as *Carchesium* and *Epistylis*—somewhat analogous colonial aggregates occur; but in all of these the individual zooids are distinctly isolated from each other, the genus *Zoothamnium* affording the only instance in which they are more intimately united through the interposition of a living tissue, as represented by the axial muscle-like element or fibrilla of the branching pedicle. In *Dendrosoma*, however, not only are the component zooids indistinguishably fused with each other, but a common nutritive fluid circulates throughout the creeping rhizome and ramifying branches. An adult colony-stock of *Dendrosoma radians*, such as is represented at Pl. XLVII. Fig. 17, presents, indeed, an extraordinary resemblance to the colony-stock of some Hydroid zoophyte, such as *Coryne* or *Cordylophora;* and, notwithstanding the fact that the component zooids of *Dendrosoma* must be regarded as potentially unicellular, which precludes a direct homological comparison with such higher metazoic types, the points of agreement that can be cited are most remarkable. In both cases we find in the fully developed organism a basal adherent stolon or rhizome, which gives origin to a greater or less number of erect diversely ramifying stems, the hydrocaulus or hydrosoma of the zoophyte and zoocaulon or zoocaula of the Acinetan, these developing in either case at their extremities tentaculiferous zooids, the tentacles, it is worthy of remark, in *Coryne* further resembling those of *Dendrosoma* in being capitate. It is found that the analogy suggested extends even beyond these more obvious superficial characters. The processes and products of the reproductive phenomena singularly coincide with each other, but in the case of *Dendrosoma* are, as might be anticipated, much more generalized. The Hydroidea, as is well known, produce embryos of two kinds, these being either simply ciliated larvæ or *Planulæ*, or medusiform gonozooids, which are, strictly speaking, natatory modifications only of the ordinary alimentary zooids or polypites. In but few, if any, members of this class are these two descriptions of embryos developed in the same species. In *Dendrosoma radians*, however, as hereafter shown, reproductive bodies analogous to both of these structural types may be produced by the same colony-stock, free-swimming ciliated germs being liberated from the more massive basal region of the erect trunks, while more minute tentaculiferous embryos, developed by gemmation in membranous capsules, corresponding with the gonothecæ of the Hydroid polype, are produced towards the distal extremities of the branches, in close vicinity to the alimentary acinetiform zooids. All these points being considered, added to the evidence in a similar direction previously submitted, see vol. i. pp. 104 and 105, it is difficult to arrive at a conclusion otherwise than that the Acinetidæ, more particularly as typified by *Dendrosoma*, represent the archetypes or direct lineal ancestors of the Hydroidea. If Mr. Levick's observations concerning the development of spermatic elements in certain colony-stocks and ova in others, as hereafter described, should be confirmed, thus demonstrating the existence of true generative reproduction on a dicœcious plan, the arguments here brought forward in favour of the advanced affinities of *Dendrosoma* will be immeasurably strengthened.

Dendrosoma radians, Ehr. Pl. XLVII. Figs. 16–22.

Stolon depressed, repent, giving origin to a greater or less number of erect tentaculiferous zoocaula; zoocaula simple or variously ramified, thickest at the base, tapering evenly towards their distal terminations, the secondary branchlets or ramuscules produced by longitudinal fission, divari-

cating mostly at angles of from 30 to 50 degrees from the main stem, but not unfrequently decussating at right angles or even reflected backwards, their extreme ends usually slightly dilated; tentacles distinctly capitate, highly extensile, developed in a sheaf-like or fasciculate manner from the slightly dilated terminations of the ramuscules; contractile vesicles numerous, spherical, irregularly distributed throughout the main stem and secondary branches; endoplast ribbon-like, ramifying and much contorted in the stolon and basal portions of the main stem, continued as a simple band into the distal region and secondary branchlets; endogenous, hypotrichously ciliated embryos of relatively large size developed in nodular enlargements of the main stem or primary branchlets; more minute, pyriform, tentaculiferous germs produced by gemmation towards the terminations of the ultimate branchlets. Height of adult colony-stock 1–25″ to 1–10″; average diameter of tentaculiferous distal terminations 1–500″.

HAB.—River and pond water, on *Anacharis*, *Myriophyllum*, and other aquatic plants.

Dendrosoma radians was originally described by Ehrenberg * as a compound species of *Actinophrys;* Perty, Dujardin, and other contemporary investigators placed it on Ehrenberg's authority in the same category, while Pritchard, in his 'History of the Infusoria,' p. 562, 1861, suggested the probability of its being more nearly allied to *Anthophysa*. Claparède and Lachmann, who were the first to carefully re-examine this organism, at once recognized its Acinetan affinities, and described it at length, with an accompanying highly characteristic illustration, in their well-known 'Etudes sur les Infusoires,' published in the 'Mémoires de l'Institut Genevois,' between the years 1858 and 1860. These investigators, nevertheless, failed to recognize, or rather misinterpreted, certain of the more important structural features of this species, and were altogether unacquainted with any phenomena of propagation apart from those connected with the increase in dimensions of the parent colony by repeated fission of the terminal branches, or by the outgrowth of the creeping stolon or main trunk. The chief error committed by these authorities consists of the fact that they figured and described the contractile vesicle as a long canal-like lacuna, extending throughout the substance of the main trunk, with offshoots to the secondary branches, and having spherical dilatations at irregular intervals. The nucleus or endoplast was at the same time entirely overlooked, or its outline apparently mistaken for that of the so-called contractile vesicle. Both of these last two structures, while not referred to in Ehrenberg's original description, are distinctly indicated in his drawings, then mislaid but subsequently published in the 'Abhandlung der Berliner Akademie' for the year 1862. Stein, who was also personally acquainted with this form, fully recognized its true position, and rightly interpreted its structural characters in a brief reference made to it in the first volume of 'Organismus' (p. 90, 1859), but adds nothing with reference to the phenomena of reproduction. The honour of placing on record the first authentic account of the propagation of *Dendrosoma radians* by any other method than that of the outgrowth of the parent stock belongs to Mr. J. Levick, of Birmingham. This microscopist has published, in the 'Transactions of the Birmingham Natural History Society' for the year 1880, an account, with accompanying illustrations, of a prolonged examination of this species, and in the course of which he observed the release of ciliated embryos from the parent-stock, and their attachment and development of tentaculate appendages. Mr. Levick further describes what he interprets to be the propagation of this species by a distinct genetic process, capsular bodies being produced as outgrowths of the stem

* 'Die Infusionsthierchen,' 1838.

and branches, to which he assigns the distinct characters of ovaries and testes, and in connection with which he maintains he observed the development respectively of ova and spermatic elements. His statement with reference to this phenomenon is of such importance that it is herewith reproduced. After describing the ciliated embryos he thus proceeds :—"The same group of organisms which had now been under frequent and sometimes protracted observation for eight weeks, furnished me with two specimens, showing what were evidently true sperm and germ elements, these features occurring in two separate individuals in close proximity to each other. They bore so much resemblance to the testis and ovary of the Hydra that I felt no doubt whatever of their function from the first, though I had never seen the phenomenon before in *Dendrosoma*, and was not aware of its having been noted in this or any other form of the Acinetina. After a little patient watching, I was rewarded by seeing the spermatozoa, not only in active motion within the sperm cell, but also escaping freely into the surrounding water. At the same time the ovary on the other individual, which at first showed only a slight circular mark, had now a decided opening; though I could not positively trace the contact of the fertilizing agents with the germ, the process was so conclusive as to leave no doubt of its meaning in my mind." Mr. Levick further records the observation of egg-like bodies, apparently derived through the union of these elements, they having some resemblance to minute statoblasts of a fresh-water Polyzoon and probably remaining in a like manner in a state of rest through the winter.

Should Mr. Levick's observations concerning the reproduction of *Dendrosoma radians* by a distinct genetic process be confirmed by further investigation he will undoubtedly have made one of the most important discoveries yet recorded in connection with the Infusorial series. In none of these so far is the development of distinct sexual elements and the production of embryos through the concourse of these elements known to occur, and should such phenomena actually take place, it affords more substantial evidence than any yet adduced with reference to the relatively high organization of the Acinetidæ advocated in this treatise. Concerning the reproduction of *Dendrosoma* by two independent germinal processes, the author is in a position to entirely confirm the observations of Mr. Levick, though he cannot proceed so far with relation to its accredited development of distinct sexual elements. On many occasions within the past few years the author has had an opportunity of examining examples of the type now under discussion, but it is only in connection with specimens remitted from Birmingham by Mr. Thomas Bolton so recently as December 1881, that the phenomena referred to have been observed. Unfortunately, not being aware at the time of the nature of Mr. Levick's evidence, the opportunity was lost for effecting, in connection with living specimens, an investigation of that specially important point to which attention has just been drawn, though, on the other hand, the results obtained have the advantage of being arrived at independently, while in addition, with the use of reagents, examples, in which all of the more important features as hereafter described, have been permanently preserved.

The example of *Dendrosoma radians* delineated at Pl. XLVII. Fig. 17 has been specially selected by the author from among the specimens recently remitted by Mr. Thomas Bolton, on account not only of its containing both of the two sorts of reproductive bodies produced, but also as representing the largest and most extensive colony-stock of which an account has so far been published. The one of very considerable size originally figured by Claparède and Lachmann, and hitherto acknowledged to be the largest recorded example, exhibited a total altitude of as much as one millimetre (1–25th of an English inch). In the example here delineated the height of the main trunk measured no less than 1–10th of an inch, with a lateral extension of equal measurement, and was distinctly visible to the unaided vision. The creeping stolon, not figured or referred to in Mr. Levick's description, and not observable in young colony-stocks, was very extensively developed. It had a more depressed form than is indicated in Claparède and Lachmann's figure, and distinctly anastomosed, leaving a central perforation, wherever it came in contact with a neighbouring outgrowth of the same element. By treating examples with osmic acid and

subsequently with picrocarmine the component protoplasm of the stolon was distinctly coloured, and the limits of its extension upon the surface of the plant to which it was attached distinctly defined. By the same process it was also shown that the nucleus or endoplast was largely developed in this region, assuming a more or less convoluted or ramifying contour, the same modification of this element being noticeable in the larger of the erect trunks. Of such erect branches there were in the example under special notice no less than nine, all of them giving off a greater or less number of secondary branchlets, the central one being specially conspicuous for its thickness, and yet more extensive subdivision. The terminations of all the ultimate ramifications were, for the most part, alike, in so far as they bore a sheaf or coronet of capitate, highly extensile tentacles. This uniformity did not, however, extend to the composition of the axial regions of the main trunks or branches. Certain of these, more especially towards the left-hand region of the colony-stock delineated in the accompanying illustration, exhibited an altogether abnormal zigzag contour, the knee-shaped joints produced by this form of growth being much swollen or cyst-like, and enclosing a distinctly differentiated ovate or subspheroidal body. It was at first supposed that these structures represented either a diseased condition or some parasitic growth. After prolonged examination, the enclosed bodies were, however, observed to make their escape, through rupture of the parent, as single large hypotrichously ciliated embryos, whose reattachment and development to the parent form was subsequently followed. That these ciliated embryos were produced, as in many other Acinetidæ, by a separating off of a fragment of the parental endoplast accompanied by a circumferential portion of its body-substance, was clearly traced in the less developed examples.

In addition to the nodular excrescences which gave birth to the ciliated embryos, developed mostly towards the basal region of the main trunks, the distal extremities of the ultimate branchlets of the same colony-stock bore in many instances one or two, or it might be a considerable number of laterally attached subspherical or pyriform capsular bodies, having clearly also a reproductive function. These, as compared with the bodies previously described, were relatively of small size, and coincide apparently with the structures to which Mr. Levick has assigned properties identical with those of a testis and ovarium. As examined independently, without being cognizant at the time of Mr. Levick's interpretation, as also subsequently, in connection with preserved examples, the author has not been able to arrive at a like result. On the contrary, it would seem to him that these bodies agree as nearly as possible with the exogenously produced germs described by Stein of *Acineta mystacina*. In the majority of instances these in a like manner possessed a distinct membranous or capsular investment, derived from the pushing outwards and subsequent hardening of the parent cuticle. Within this capsule the protoplasmic matter separated from the parent had usually contracted into subspheroidal form, showing distinctly a large central nucleus, and in some instances a pulsating contractile vesicle. The front walls of the capsule were evidently of greater tenuity than the remaining area, being often lacerated and broken, leaving the germ freely exposed to the surrounding water, and forming the point of least resistance at which it was normally set free, as evidenced by the fact that many of these capsules remained in an empty state attached to the parent stock, a ragged perforation at their distal end indicating the point of exit of the previously contained body. Although in no instance so far has the author been able to detect the presence of cilia in any form upon these encapsuled germs, it was in several instances observed that short capitate tentacles were developed at various parts of the periphery, as shown at Pl. XLVII. Fig. 18, so that on being liberated from the parent stock they would be scarcely distinguishable from minute *Sphærophryæ*. Similar short capitate tentacles, it was likewise noticed, were frequently developed from the bud-like processes of the parent stem previous to their isolation from it by constriction and the formation of a distinct capsule.

While the further development of the more minute, encapsuled, subterminally developed embryos has not so far been traced, the numerous phases of the larger

ciliated germs developed from the substance of the erect trunks were abundantly observed. These in the main agree substantially with what has been recorded by Mr. Levick, though in some few details the author is in a position to supply new data. Thus with the aid of picrocarmine it was demonstrated that the endoplast or nucleus, not recognized in either the adult or embryonic state by Mr. Levick, is already well developed and more or less ramified by the time the embryo has developed its first erect tentaculiferous ramuscule, and moreover that short capitate tentacles are produced irregularly from all parts of the free periphery prior to the appearance of the early bud-like outgrowth of this stem, and are retained for a considerable interval after its appearance. These several points are fully illustrated in Figs. 19–22 of the Plate already quoted. It is there shown, see Fig. 22, that one branch of the endoplast is developed towards and finally ascends the initial stem, while the other branches follow the various directions of growth taken by the adherent stolon. As indicated in the same figures, a number of contractile vesicles are developed not only in the initially fixed but also in the free-swimming condition of the ciliated embryos.

Attention may be suitably directed at this point to the very considerable resemblance that subsists between that early developmental phase of *Dendrosoma radians*, in which it consists simply of a flattened adherent body out of which is produced a single erect stem with its apical sheaf of tentacles, and the normal condition of the proboscidiform zooids of an *Ophryodendron* such as *A. sertulariæ*, assuming that the proboscidiform organ with its terminal cirri is homologous with the erect stem and tentacular sheaf of the first-named type. It is recorded by Mr. Levick that the growing terminations of the branches of the adult colony-stocks of *Dendrosoma radians* are not only soft and plastic, but highly polymorphic, the granular particles of its component protoplasm flowing from one part to another and altering the contour much after the manner of the body of an *Amœba*. Such plasticity is, however, by no means characteristic of the fully matured parts, throughout which the author has satisfied himself that a distinct cuticular membrane is developed, such, indeed, showing under high magnifying power, as treated with osmic acid and picrocarmine, a conspicuously marked double contour. In its first-formed condition it is nevertheless soft and tenacious, permitting the adhesion of foreign bodies, which are often present in such quantity as to entirely preclude distinct vision of its true limits.

The author has very recently, March 1882, obtained fine examples of this interesting type, through Mr. F. J. Fry, from a pond in the neighbourhood of Clifton, Bristol, its tolerable abundance in the same neighbourhood having been further certified to the author by Dr. C. T. Hudson. Among the nearly allied associates of this type observed by the author in connection with the specimens remitted from Birmingham may be more especially mentioned *Acineta grandis*, *A. lemnarum*, and *A. mystacina* var. *longipes*. Professor Leidy* has reported the occurrence of *Dendrosoma radians* in American waters.

Dendrosoma Astaci, Stein.

Under the above title, Stein † briefly refers to a species of *Dendrosoma* found by him attached to the fresh-water crayfish, *Astacus fluviatilis*. No characters, however, have as yet been cited by which it may be distinguished from the preceding type, and taking into consideration the usually fluviatile habitat of *D. radians* it would seem highly probable that the two are identical.

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* 'Proc. Acad. Nat. Hist. Philadelphia,' 1874.

† 'Der Organismus der Infusionsthiere,' Abth. i. p. 93, 1859.

Order II. TENTACULIFERA-ACTINARIA, S. K.

None of the tentacles suctorial or capitate.

Fam. I. EPHELOTIDÆ, S. K.

Tentacles filiform or ray-like, prehensile, developed separately from the body as in the ordinary Acinetidæ.

Genus I. EPHELOTA, Str. Wright.

Animalcules solitary, fixed, elevated on a rigid pedicle, having no indurated lorica or investing membrane; tentacles flexible, more or less retractile or invertile, not suctorial or capitate at their extremities.

The genus *Ephelota*, as instituted by Dr. Strethill Wright,* was formed for the reception of certain infusorial types apparently closely allied to *Podophrya*, but having pointed flexible tentacles in place of the suctorial ones that distinguish the last-named genus. Of the two species described by this writer, there can be no doubt that the first-named and typical species, *Ephelota apiculosa*, is identical with the *Podophrya Trold* described a short time previously by Claparède and Lachmann, and which is distinguished by these authorities from all other members of the genus by the pointed and ray-like instead of suctorial character of the tentacles, and which tentacles are further characterized by the abrupt thickening and comparative rigidity of their basal portions. The much fuller details of the species given by Claparède and Lachmann, and more especially those recorded by them in reference to the manner in which food is ingested, unmistakably indicate that the form not only requires a separate generic position, as recognized by Strethill Wright, but must likewise be accepted as the type of a separate and highly important family group, which it is here proposed to distinguish by the title of the Ephelotidæ. Thus, while *Podophrya* and other ordinary Acinetæ merely absorb the semi-fluid contents of their prey through their tubular suckers, *Ephelota* is found to seize the same with the attenuate and apparently adhesive distal extremity of its tentacula, and by an inverted action to drag its prey bodily through the more expanded basal portion of these structures, and thence into the substance of its body. The author was at first disposed to refer the *Zooteira relegata* of Strethill Wright to this same family of the Tentaculiferous Infusoria, but from a recent examination of that organism has determined its close structural correspondence with the Radiolarian genus *Actinophrys*, of which it may be regarded as a stalked representative.

Ephelota coronata, Str. Wright. Pl. XLVIIIA. Figs. 1–3.

Body ovate, pyriform, or subquadrate; tentacles numerous, slender, and acuminate, flexible and almost completely retractile, radiating from all points of the periphery, or forming a crown at the anterior border, gradually tapering towards their apex, and not exhibiting an abrupt basal dilatation, as in *E. Trold;* pedicle diaphanous, usually longitudinally striate, three or four times the length of the body, widest at its point of junction with the same; gradually narrowing as it approaches the attached or proximal end. Length of body 1–400″. Hab.—Salt water.

An animalcule corresponding essentially with the above diagnosis has been met with by the author attached to zoophytes and Polyzoa on both the Guernsey and

* 'Edinburgh New Philosophical Journal,' 1858.

Jersey coasts, and is evidently identical with that form upon which the above title was first conferred by Strethill Wright. In describing the tentacles of this species more minutely, that authority remarks that in some examples he found "a bundle or framework of fine parallel rods imbedded in the soft contractile sarcode," while other examples exhibited a "beaded" structure only. In all the specimens personally examined, this last-mentioned beaded or coarsely granular structure was apparent, but no trace could be detected of the rod-like bodies, which were therefore possibly adventitious substances. As observed by Dr. Wright, the tentacles are flexible, and capable of being curved inwards, but in a more active manner than he has described; one or more of these tentacles, in fact, as observed in association with fully expanded examples, were constantly being bent down and inwards until their points touched the margin of the periphery, and were then immediately raised up and extended to their former erect position. The method by which food is incepted in this form has up to the present time eluded all efforts to determine. This may be accomplished by the withdrawal into the substance of the body of a single tentacle carrying with it its captured prey, as in the species next described; or, possibly, the food, after capture by the extended tentacles, is deposited upon the surface of the periphery simultaneously with the systematic inward flexure of the same just noticed, and then incepted through the soft cuticular sarcode. Should this last hypothesis, however, prove to be correct—and it is almost impossible to get rid of the idea that some such function is associated with the persistent deflection of the tentacles—this form cannot be retained among the Stomatode Infusoria, but will find its true place, under a new generic title, among the Radiolaria somewhere near Schulze's *Actinolophus pedunculatus*. That it is not identical with this last-named type, the author is in a position to determine, through having encountered that interesting type in the neighbourhood of Jersey, under very similar conditions.

As intimated by Dr. Strethill Wright, the tentacles of *Ephelota coronata* cannot be completely withdrawn. In the most contracted conditions personally observed, the animalcules presented the aspect shown at Pl. XLVIII. Fig. 3, in which the tentacula form a small crown of short incurved digitiform prolongations around the apical extremity. The form and position of the endoplast or nucleus in this species remains as yet undetermined.

Ephelota Trold, C. & L. sp. Pl. XLVIIIa. Fig. 5.

Body subspheroidal; tentacles distributed singly and irregularly over the entire surface of the periphery, each consisting of a short, thickened, slightly elastic but not entirely retractile, tubular basal portion, and a slender, elongate, completely retractile, ray-like distal part; pedicle twice the length of the body, sinuous, moderately thick and even throughout; contractile vesicle single. Diameter of body 1–350″.

Hab.—Salt water, attached to seaweeds and *Sertulariæ*.

This species, as previously intimated, is identical with the *Podophrya Trold* of Claparède and Lachmann and the *Ephelota apiculosa* of Dr. Strethill Wright, the specific title of the latter authority having, however, in accordance with the laws of priority, to give way to the earlier one bestowed upon it by the French *savants*, who first discovered the type on the Norwegian coast in September of the year 1858. As shown by these last-named investigators, the thickened basal portion of the tentacles of this species, although not retractile, are highly dilatable, permitting the passage of food-particles of considerable size. In illustration of this fact, it is recorded by the Swiss observers that examples were seen to seize specimens of *Tintinnus denticulatus* and to pass them whole through the tubular basal portion of their tentacles, while in one instance a zooid was similarly observed to seize a Tintinnus simultaneously by two of its tentacula, and, after tearing it in half by their united

action, to engulph the divided fragments at separate regions of its body. The extrusion from and withdrawal into the thicker basal portion of the ray-like distal extremities of the tentacula of this species may be compared to the introversion and extension of the fingers of a glove. The thickened and tubular basal parts, with the fine, ray-like distal portions entirely retracted, are slightly dilated at their free end and present, as shown at *a a*, in Pl. XLVIIIA. Fig. 5, an aspect closely resembling the shortened tubular suckers of the ordinary Acinetæ. When, on the other hand, the ray-like part is completely everted, the basal part exhibits, as shown in the same figures, a more elongate, conical outline. Two embryos having the surface of their bodies entirely ciliated were observed by Claparède and Lachmann to make their escape from one of the examples that formed the subject of their investigations.

GENUS II. ACTINOCYATHUS, S. K.

(Greek, *actin-*, ray; *kuathos*, a cup.)

Animalcules solitary, fixed, secreting an indurated pedicellated lorica; tentacles more or less retractile, not furnished with suctorial or capitate extremities.

This genus is herewith instituted for the reception of those infusoria which, while corresponding with *Ephelota* in individual form and structure, exhibit by their secretion of a membranous sheath or lorica a relationship with that type parallel to that which exists between the respectively loricate and illoricate genera, *Acineta* and *Podophrya*. A single species only can at present be referred to this genus, the same being an inhabitant of salt water.

Actinocyathus cidaris, S. K. PL. XLVIIIA. FIG. 6.

Body subspherical, slightly flattened, with numerous and, when partly contracted, thickened muricate or echinulate tentacles, issuing chiefly from the anterior extremity; lorica cup-shaped or patellate, tapering posteriorly, mounted on a slender, rectilinear pedicle of about three or four times the length of the lorica; contractile vesicle single or double. Diameter of body 1–650″. HAB.—Salt water.

Three or four examples of this animalcule were met with in February 1878, attached to the external surface of the calcareous sponge *Grantia compressa*, obtained at St. Heliers, Jersey. In none of these specimens, although watched for a considerable interval, were the tentacles seen protruded to a greater extent than is represented in the accompanying figure, though it may be anticipated that their capacity of extension is much more considerable. The body of the zooid, whose height and diameter closely correspond with those of the lorica, is never completely enclosed within this structure, but merely rests upon it with all but the basal portion exposed, in a manner almost identical with that previously described of *Acineta patula*. Taken separately, indeed, the protective sheaths of these two species present considerable resemblances, the chief point of distinction being the absence in the type now under consideration of the narrow constriction of the pedicle at its point of junction with the lorica that distinguishes the *Acineta*. This form does not appear to be permanently connected with its lorica, an entirely naked, freely detached zooid having been met with in close vicinity to the attached, loricate examples. It is at the same time possible that this individual represented the newly formed product by fission or gemmation of an ordinary loricated specimen. The specific name proposed for this animalcule bears reference to the likeness to a minute *Cidaris* presented by the subspherical body, taken in conjunction with the

radiating muricate or echinulate tentacles. These last-named organs, viewed separately, might in a like manner be appropriately compared with certain echinulate hairs of the larvæ of *Dermestes lardarius*.

Fam. II. OPHRYODENDRIDÆ, S. K.

Tentacles apparently united so as to form one or more distinct proboscidiform appendages, the distal terminations of which are naked or cirrate.

Genus I. OPHRYODENDRON, C. & L.

Animalcules mostly associated in colonies, but not organically connected, attached in a sessile manner, or through the medium of a pedicle, usually dimorphic, or including two distinct structural types; zooids of the first order ovate or pyriform, with a long, extensile and retractile, anterior, proboscidiform organ bearing numerous flexible cirrose appendages at its distal extremity; zooids of the second order vermiform or flask-shaped, developed anteriorly into a slender and apparently tubular neck having a small terminal orifice; contractile vesicle single or multiple; endoplast nodular or ramifying, rendered visible only by the action of reagents. Increasing by gemmation and by the production of ciliated embryos. Inhabiting salt water.

Attention was first directed to the singular organisms referred to this genus by Claparède and Lachmann, who discovered the type-form *O. abietinum* on the coast of Norway in the autumn of the year 1855, and included a description of it in their *Mémoire* on the Infusoria communicated to the Paris Academy of Sciences that same year. Dr. Strethill Wright subsequently described a closely allied type under the title of *Corethria sertularia* in the 'Edinburgh Philosophical Journal' for July 1859 (description and figures reproduced in Pritchard's 'Infusoria,' ed. iv. 1861); and the Rev. Th. Hincks has since given a more exhaustive account of *O. abietinum*, supplemented with the description of a third species, *O. pedicellatum*, in the 'Quarterly Journal of Microscopical Science' for January 1873. Several species have been yet more recently discovered, but notwithstanding the attention bestowed upon them by these various independent investigators, it cannot be said that the true nature and affinities of the genus have as yet been accurately determined, and neither, on the other hand, has a sufficiently satisfactory explanation so far been accorded concerning the apparently anomalous phenomenon of dimorphism associated with the several representatives of the genus. By Claparède and Lachmann, the vermiform or non-proboscidiform zooids of *O. abietinum*, though figured, are passed over as merely normal proboscidiform animalcules or varieties of the same with their probosces retracted. Mr. Hincks, on the contrary, favours the opinion that the two represent adult and dimorphic conditions of the same form. The author's opinion concerning this anomalous generic group, gained from a personal acquaintance with a variety of species, combined with a study of the evidence adduced by the several authorities already quoted, is that the non-proboscidiform or vermiform zooids must be regarded as the larval or transitional condition of the fully developed zooids provided with their characteristic probosces. It is clear from the testimony contributed in all these instances, that the simpler vermiform zooids are produced by gemmation from the proboscidiform ones, but never these latter from the former, while the true internal embryos, corresponding with those of other typical *Acinetæ*, are also forthcoming in a similar manner from the proboscis-bearing animalcules only. Again, while frequently encountering these latter alone, or in isolated groups, the vermiform zooids appear almost invariably to occur only in companionship with the proboscidiform ones, or as derivatives by gemmation from them.

Although the further development of the vermiform into the proboscidiform zooids has not so far been determined, it is clear that little beyond the everting of the neck-like anterior region of the former is requisite to bring about such a result. The view here expressed is substantially supported by the evidence given by Fraipont in connection with his very recent description of *Ophryodendron Belgicum*, in which type, indeed, he records the occurrence of and figures intermediate phases.

The affinity of the members of the genus *Ophryodendron* with the normal *Acinetæ* is predicated through the assumed correspondence of the proboscis-like prolongation and terminal cirri of the typical zooids with the suctorial tentacles of the latter. No evidence has, however, yet been adduced showing that these filaments or the extensile proboscis itself possess a similar suctorial capacity, nor, indeed, is it yet known in what manner the organism grasps or incepts its food. Pending the satisfactory elucidation of this most important point, it seems most reasonable to premise that food-substances are seized by the brush-like filamentous tuft or distal end of the proboscis itself, and then withdrawn with it into the parenchyma of the body. Should this view prove correct, the retractile proboscis will be shown to be homologous with the non-suctorial but adhesive tentacles of the genus *Ephelota*, concentrated, however, into the form of a single and proportionately larger terminal tentaculum. In this connection it may be further submitted that the transverse subspirally disposed rugæ that form so conspicuous a feature of the proboscis of *Ophryodendron* when examined under high magnification, are both functionally and morphologically identical with the delicate granular fibrillæ which in a similar manner encircle the individual tentacles, whether suctorial or simply adhesive, of various ordinary Acinetidæ, such as *Podophrya elongata* and *Hemiophrya gemmipara*.

Ophryodendron abietinum, C. & L. Pl. XLVIIIa. Figs. 13–15 and 32.

Primary or proboscidiform zooids cup-shaped or pyriform, with a cleft on one side of the anterior margin, tapering posteriorly, and adherent by an annular disk-like expansion; proboscis long, slender, cylindrical, highly extensile, pointed at its apex, and bearing a brush-like tuft of twenty or thirty tentacular filaments; secondary or vermiform zooids (larvæ?) ovate or vermiform, rounded or slightly pointed posteriorly, produced at the opposite extremity into a long, slender, tubular neck, and usually mounted on a straight setose pedicle; parenchyma of the body generally enclosing innumerable minute refringent navicula-shaped corpuscles. Length of body of primary or proboscidiform zooids, without the proboscis, 1–175″ to 1–30″; of the vermiform zooids 1–150″ to 1–30″.

Hab.—Salt water, attached to the polyparies of *Sertularia*, *Plumularia*, and other Hydrozoa.

Oval ciliated embryos were liberated artificially by pressure from the parenchyma of examples of this species examined by Claparède and Lachmann. This ciliation is limited to one surface only of the embryo, as occurs in *Podophrya cothurnata*, *Hemiophrya gemmipara* and *Dendrocometes paradoxus*, and may be thus said to follow a hypotrichous plan. The further development of these embryos remains to be traced, and is likely to be of much interest. In addition to the ordinary production by gemmation of the vermiform zooids, Claparède and Lachmann figure an example in which a proboscidiform zooid is in course of production in a somewhat similar manner from another of the same form. On reference to the figure cited, however, one is inclined to interpret this example as illustrating the phenomenon of longitudinal fission rather than that of peripheral gemmation. The specific name of *abietinum* has been conferred upon this species by its discoverers, with reference

to the fanciful resemblance of the extended proboscis with its terminal tuft of cirri to a miniature fir or larch. These cirri, in the form now under consideration, are longest at the basal part, becoming gradually shorter as the apex is approached, and in the living state are in a condition of constant agitation, as though seeking for appropriate food. The proboscis becomes transversely annulate in its semi- or completely retracted state, and is extended or withdrawn with remarkable rapidity.

The navicula-shaped bodies observed by Claparède and Lachmann in examples of this species, and regarded by them as "trichocysts," are apparently of an adventitious nature, not being equally constant in individuals derived from the same locality, and are altogether absent in the specimens from the Welsh coast examined by Mr. Hincks. In consequence of the dark granular nature of the parenchyma, these same authorities, while suspecting the existence of an endoplast and contractile vesicle, were not able absolutely to determine its presence.

Prof. C. Robin, in a recent reference to *Ophryodendron abietinum*,* expresses the opinion that the vermiform zooid is a parasitically attached worm-larva, and describes it as being affixed to its host through the medium of a slender chitinous rod, one end of which is imbedded in its own body-substance, while the other penetrates the cuticle of its host, and is armed, see Pl. XLVIIIA. Fig. 32, with four or five hooklets which serve to anchor it in its attached position. The intermediate phases which have been observed by Fraipont, Claparède and Lachmann, and other authorities do not appear to have fallen within the notice of this investigator.

Ophryodendron sertulariæ, Str. Wright sp. PL. XLVIII. FIGS. 38–40.

Body of primary or proboscidiform zooids subcircular or elliptical, sessilely attached, very much depressed or flattened; the proboscis flattened, transversely rugose, developed eccentrically in close proximity to the lateral periphery; terminal cirri of the proboscis varying from about twenty to forty or fifty in number; vermiform zooids elongate, attached without the medium of a distinct pedicle to the body of the primary zooids, or to some foreign object; a branching endoplast and one or more contractile vesicles discernible in the more transparent proboscidiform zooids. Diameter of bodies of primary zooids 1–300″; length of vermiform animalcules 1–200″. HAB.—Salt water, on *Sertularia pumila.*

This species, which is synonymous with the *Corethra sertulariæ* of Dr. Strethill Wright, has been regarded by many authorities as identical with the *Ophryodendron abietinum* of Claparède and Lachmann. That the two are distinct from each other has, however, been anticipated by Koch and Fraipont, and that such opinion is correct, the author, through a personal acquaintance with Strethill Wright's type, is in a position to substantiate. So recently as August and September 1881, this form has been obtained by him in great numbers, attached to the polyparies of the zoophyte on which it was originally discovered, growing on Fuci collected in the Menai Straits, North Wales, *Acineta tuberosa* and *A. livadiana* being abundantly represented in its vicinity. The most conspicuous features, by which it may be readily distinguished from the forms which it most nearly resembles, viz. *O. abietinum* and *O. porcellanum*, consist of the remarkably depressed contour of the body of the primary zooids and the essentially eccentric or peripheral development of the proboscis. This last-named feature, though indicated in Strethill Wright's original drawings, has not so far been specially mentioned by any writer. In some of the more transparent specimens preserved with osmic acid, a band-like, variously branching endoplast or nucleus, and one or more contractile vacuoles were distinctly visible. The proboscis, under

* 'Journal of Anatomy and Physiology,' 1879; also 'Journal of the Royal Microscopica Society,' October 1880.

high magnification, corresponds in contour, structure, and comportment with that of *Ophryodendron porcellanum*, next described, but the terminal cirri are much less numerous. These cirri, under the same conditions, were observed to be very distinctly granular and adhesive. Attempts to make the animalcules incept carmine particles, or to ingest any other food, were not rewarded with success. The independent vermiform zooids in the process of mounting became readily detached from their fulcra of support, their surface of adhesion being demonstrated in this connection to be simply acetabulate.

Ophryodendron porcellanum, S. K. PL. XLVIIIA. FIGS. 20–25.

Body of primary zooids sessile, subspherical, or cushion-shaped; the proboscis highly extensile, developed subcentrally, flattened and transversely rugose; its apex bearing a brush-like tuft of innumerable cirrate processes; secondary zooids sessile, attenuate vermiform, independent or associated with a basal cushion-like body similar to that of the primary animalcules. Length 1–400".

HAB.—Salt water: Jersey (S.K.), on the limbs of the flat-crab, *Porcellana platycheles*.

When first discovered by the author at St. Heliers, Jersey, in March 1878, this species was supposed to be identical with either the *Ophryodendron sertulariæ* of Strethill Wright or the *Ophryodendron abietinum* of Claparède and Lachmann. While a subsequent acquaintance with the first-named type enables the author to distinguish it from the first-named form, in connection more especially with its less depressed body and redundant development of cirri at the extremity of the proboscis, the following points may be cited, in addition to its habitat, as separating it distinctly from *O. abietinum*. In the first place, the body of the proboscidiform zooids is never elongate cup-shaped or pyriform, as in *O. abietinum*, but always presents a subspherical or slightly flattened contour. The zooids of the second order are, again, when isolated, much more elongate or vermiform. More often, however, as personally examined, these vermiform individuals have been associated with a subspherical body similar to that of the primary zooids (Pl. XLVIIIA. Fig. 23), and from which, indeed, they are indistinguishable but for the exception that the characteristic proboscis is here replaced by a long spout-like tube. This tube, it may be reasonably anticipated, is homologous with the proboscis of the primary forms, and develops later on into the same In other minor details, such as the flattened form of the proboscis, as also in the greater number of the cirrose filaments, this species is readily distinguished from either of the preceding types. On no occasion could less than fifty or sixty of these cirrose filaments be counted, while in many instances they were found to exceed one hundred. These terminal cirri, when examined with the aid of a magnifying power of from 800 to 1000 diameters, were found to be eminently tenacious, adhering readily to the surface of the glass object-carrier, and at times, during the act of extension of the proboscis, progressing over its plane surface by an apparently independent creeping action.

Ophryodendron pedicellatum, Hincks. PL. XLVIIIA. FIG. 16–19.

Zooids of both classes furnished with slender curved pedicles: body of primary or proboscidiform zooids symmetrically cup-shaped, with an even, sharply defined anterior border; proboscis cylindrical, attenuate, highly extensile, bearing at its extremity eight or ten subequal tentacular processes; secondary zooids flask-shaped, attenuate anteriorly. Dimensions unrecorded.

HAB.—Salt water, on *Plumularia pinnata*: Ilfracombe, Devonshire.

A full account of this interesting and very distinct species was communicated by Mr. Th. Hincks to the 'Quarterly Journal of Microscopical Science' for January 1873. The regular cup-shaped body seated on its slender curved pedicle at once distinguishes the primary zooids of this form from those of the preceding one, while in addition, the group of tentacular processes, depressed during extension in a radiate rather than in a brush-like manner, at the distal extremity of the proboscis, are much fewer in number and apparently of equal size, instead of being longest at the base and gradually diminishing as the apex is approached. The secondary or vermiform zooids closely correspond with those of *O. abietinum*, and are only distinguishable from them by their curved instead of rectilinear pedicle. In one instance two zooids of this denomination were observed with their pedicles united for a portion of their length, and in all probability represented an instance of longitudinal fission. These secondary vermiform zooids, of both this and the preceding species, are described by Mr. Hincks as being particularly active in their movements, constantly swaying themselves gracefully to and fro in all possible directions, now sweeping the surrounding water, now passing the oral extremity of the neck over the surface of the polypary on which the colony is planted, and now reaching over towards the proboscidian zooids, and bringing themselves into frequent contact with the trunks and probosces of this series. The primary or proboscidian zooids are, on the other hand, comparatively quiescent, restricting their motions chiefly to the extension and retraction of their trunk-like proboscis, but which may be thus extended or withdrawn with amazing swiftness.

The species of *Ophryodendron* described by Koch* under the title of *O. pedunculatum*, and obtained by him at Messina, is, as recognized by Fraipont, apparently identical with Mr. Hincks's type.

Ophryodendron Belgicum, Fraipont. PL. XLVIII. FIGS. 36 AND 37.

Proboscidiform zooids elongate-pyriform or clavate, often furrowed anteriorly, attached by a sucker-like expansion of the more attenuate posterior extremity; proboscis evertile to about one-half of the length of the extended body, its distal end bearing from five or six to not more than eight tentaculoid cirri; parenchyma opaque, frequently inclosing numerous refringent navicular corpuscles; endoplast, rendered visible only by the action of reagents, in adult examples more or less irregularly branched; a vacuolar space, apparently representing the contractile vacuole, usually developed towards the anterior region of the body, and occasionally a second one near the posterior extremity. Vermiform zooids subcylindrical or clavate, seven or eight times as long as broad, affixed posteriorly by a slender rigid pedicle when young, but subsequently attached in a sessile manner; parenchyma resembling that of the proboscidiform zooids, and in a similar manner frequently inclosing refringent corpuscles; endoplast and vacuolar spaces as in the proboscidiform examples, but the first-named structure less complex. Length of proboscidiform zooids 1–400″; of vermiform zooids 1–400″.

HAB.—Salt water: Ostend, on the hydrothecæ of *Clitia volubilis*.

Apart from its size and habitat, the chief distinction between this type and *Ophryodendron abietinum* would seem to subsist in the less luxuriant development of the tentacular appendages of the proboscis. Notwithstanding, however, such

* "Zwei Acineten auf Plumularia setacea." Jena, 1876.

similarity as exists, M. Fraipont* has succeeded in eliciting, through a careful study of its structural and developmental history, many points of high interest not hitherto recorded in connection with this very remarkable generic group. Among the most important data thus determined must be mentioned his demonstration that this form, in common with the more normal Acinetidæ, possesses a well-developed nucleus or endoplast. Such a structure, while not visible during life, and not hitherto observed in any other species of *Ophryodendron*, was rendered distinctly visible in examples first treated with absolute alcohol, and afterwards immersed in picrocarmine. Although not observed to contract, M. Fraipont has no hesitation in identifying the vacuolar space, in most cases conspicuous towards the anterior extremity of the body, as identical with the pulsatory contractile vesicle of the ordinary Acinetidæ and other Infusoria. In *Podophrya gemmipara*, as attested to by Hertwig, an interval of several hours may elapse between the systolic contractions of this vesicular structure, and may consequently in the present instance recur at even longer intervals. With reference to the vermiform zooids, M. Fraipont adheres to Claparède and Lachmann's original interpretation that they represent an immature condition only of the proboscidiform individuals, and supports his decision with figures and descriptions of transitional phases between the two. These vermiform zooids, as in *O. abietinum*, are derived as gemmules from the proboscidiform units, into which a portion of the parent endoplast is extended; in this species, however, the gemmules either take a vermiform contour or pass directly to the proboscidiform condition. The navicular refringent corpuscles enclosed within the parenchyma of this species in common with *O. abietinum*, M. Fraipont is inclined to identify with the trichocysts of the Infusoria Ciliata.

Ophryodendron multicapitatum, S. K. Pl. XLVIIIa. Figs. 26–31.

Bodies of primary proboscidiferous zooids variable in shape, ovate, subspherical, or pyriform, distinctly pedicellate when young or half-grown, sessile in their adult state; the adult zooids usually supporting as many as four subterminally developed proboscidiform organs, whose distal extremities bear from thirty to forty cirrose appendages; the secondary or vermiform zooids elongate, developed in company with a variable number of ovate or subspheroidal gemmules around the bases of the proboscidiform organs; endoplast or contractile vesicle not observed. Height of adult proboscidiferous zooids 1–300".

Hab.—Salt water, attached to the limbs of an Isopodous crustacean.

This very remarkable form was obtained by the author in March 1879, during a few days spent in the collection of marine specimens among the group of rocks lying midway between France and the island of Jersey, known to fishermen as the "Minquières." Some dozen specimens in various stages of development were thus obtained, attached chiefly to the antennæ and ambulatory appendages of a small Isopod apparently most nearly allied to the fresh-water genus *Asellus*. The most remarkable feature concerning this species, which will be immediately recognized, consists of the abnormal number of proboscidiform organs, these in the adult examples numbering no less than four, and two or three being commonly present in those less developed. In a like manner, the number of germs developed simultaneously upon the anterior border of the body usually coincide more or less nearly with that of the probosces, and in both instances exceed what obtains in any species hitherto described. The metamorphoses undergone by the anteriorly developed germs after detachment from the parent zooid, and prior to their arrival at the adult state, are of considerable interest. In the first place, as shown at Pl. XLVIII. Fig. 29, the body, as in the

* "Acinetiens de la Côte d'Ostende," 'Bull. Acad. Bruxelles,' 1879.

adult form, is simply spheroidal, but attached to its fulcrum of support by a distinct rigid pedicle. A little later the zooid assumes a pyriform contour, a single terminal proboscis is developed, and the animalcule, as delineated at Fig. 30, most nearly resembles the typical form of *O. pedicellatum*, represented by Figs. 16 and 17 of the same plate. This pedicle may be retained even after the zooid has attained to a considerable size, developed a plurality of proboscidiform organs, and commenced to propagate by gemmation, as shown at Fig. 28; by the time, however, that the full size and complete number of probosces are developed, the pedicle has invariably disappeared, having become either completely surrounded and enclosed within the distended body-mass, or possibly reabsorbed into its substance. The densely granular and opaque character of the parenchyma in this type prevented the clearing up of this point, and neither, owing to the same conditions, was it found possible to detect the presence of either contractile vesicle or endoplast. The vermiform larvæ were but sparingly observed in the examples examined; they corresponded essentially in form and structure with those of *Ophryodendron sertulariæ*, previously described.

It will probably be found convenient hereafter to introduce a new generic title for this and any allied species that may be discovered possessing a plurality of proboscidiform appendages. In connection with this distinctive feature, it might, perhaps, be maintained that *Ophryodendron multicapitatum* potentially represents a polyzoidal colony-stock after the manner of *Dendrosoma;* on the other hand, a near comparison with reference to these appendages might be instituted with *Dendrocometes paradoxus*, illustrated immediately above it in Pl. XLVIIIA., assuming necessarily in this case that each proboscis of the *Ophryodendron* is, as in the branch-like extensions of *Dendrocometes*, the homologue of the number of tentaculate organs normally developed by the simpler Acinetidæ.

GENUS II. ACINETOPSIS, Robin.

Animalcules ovate, excreting and inhabiting a stalked, membranous, transparent lorica, bearing a single, anteriorly developed, contractile, proboscidiform tentacular appendage, the distal extremity of which is not, as in *Ophryodendron*, beset with supplementary cirri. Inhabiting salt water.

Acinetopsis rara, Robin. PL. XLVIII. FIGS. 43–45.

Lorica wineglass-shaped, transparent, about one and a half times as long as broad, mounted on a very slender, straight or flexuose pedicle that equals or slightly exceeds the lorica in length; body almost completely filling the cavity of the lorica, its substance uniformly granular; proboscidiform tentacle very attenuate or filiform when extended, its length then equalling five or six times that of the body, exhibiting throughout when contracted an exteriorly developed, very delicate, plicate, spiral fibrilla; contractile vesicle single, subspherical; endoplast unobserved. Length of lorica 1–300″.

HAB.—Salt water, on various Sertularian zoophytes: Concarneau (Ch. Robin).

This very remarkable form is figured and described by Prof. Ch. Robin in the 'Journal de l'Anatomie et de la Physiologie,' tom. xv. 1879,* and is of more than

* See also translation in 'Journal of the Royal Microscopical Society,' Oct. 1880.

ordinary interest since it serves to unite the anomalous genus *Ophryodendron* with the more typical Acinetidæ. This is more especially manifested in connection with its possession of a membranous lorica, and in the non-development of motile cirri at the extremity of the single proboscidiform tentacle. This tentacle, moreover, in addition to its simple structure, coincides in the circumstance of its delicate externally developed spiral fibrilla with the slender prehensile tentacle of *Hemiophrya gemmipara*. Taken as a whole, the general structure of *Acinetopsis* would appear to be not so very remote from that of *Urnula;* it is an open question, indeed, whether the two extremities of the Tentaculiferous series might not be consistently united at this point. The act of food-ingestion, as in the case of *Ophryodendron*, has not as yet been witnessed, but it was observed that the extended tentacle was capable of motion in every direction. The resemblance subsisting between a zooid of this species and the peculiar thecated sarcodic appendages, the so-called "nematophores" of certain Hydroid zoophytes, has been referred to at page 805.

APPENDIX TO VOL. II.

NOTICE OF SUPPLEMENTARY SPECIES AND MORE IMPORTANT DISCOVERIES CONCERNING THE INFUSORIA RECORDED DURING THE PUBLICATION OF THIS WORK, OR ACCIDENTALLY OMITTED FROM INSERTION UNDER THEIR RESPECTIVE HEADINGS.

CLASS I. Flagellata.

GENUS **Dimorpha**, Gruber.—Animalcules free-swimming, dimorphic, reverting at will from a Heliozoidal or Actinophrys-like phase to a simple monadiform condition, or *vice versâ;* in either state bearing two long, closely approximated vibratile flagella.

Dimorpha mutans, Gruber.—Zooid in its monadiform condition symmetrically ovate, wider and somewhat truncate at the anterior border, tapering gradually towards the posterior extremity; flagella subequal, about twice the length of the body, inserted close to each other near the centre of the anterior border; parenchyma transparent near the front margin, granular throughout the remaining area, usually enclosing digested food-substances in the posterior region of the body; contractile vesicle single, subcentral; endoplast imperfectly observed. In its Actinophrys phase, the body spheroidal or slightly elongated, bearing in addition to the two vibratile flagella numerous slender, finely granular, ray-like pseudopodia, having a fully extended length of two or three times the diameter of the body, and which decussate from the periphery in every direction. Diameter of body of Actinophrys-like phase 1–1600″. HAB.—Fresh water.

This highly interesting species, recently figured and described by Dr. August Gruber,* was obtained by him in some abundance from a slowly flowing canal in the neighbourhood of Lindau. As rightly inferred by its discoverer, it constitutes an intermediate or annectant type between the respective groups of the Flagellata and the Heliozoarian section of the Radiolaria. It is indeed very closely allied to the two marine forms, apparently unknown to Dr. Gruber, figured and described by the

* "*Dimorpha mutans*, eine Mischform von Flagellaten und Heliozoen," 'Zeitschrift für Wissenschaftliche Zoologie,' Band xxxvi. Heft 3, December 1881.

author in Vol. I. p. 227 of this treatise under the title of *Actinomonas mirabilis* and *A. pusilla*,* and is in like manner referable to the there newly established order of the Radio-Flagellata.

The essential distinctions between these two forms subsist chiefly in the facts that *Dimorpha* leads an entirely free-swimming condition, never developing a pedicle as in the case of *Actinomonas*, and possesses two in place of a single flagellate appendage, as obtains in the last-named type. The highest interest attached to this form is connected with the facility with which the metamorphoses from the simply flagellate to the more complex Heliozoidal condition, or the converse, are brought about, such changes, as observed by Dr. Gruber, being effected many times by the same zooid within a single hour. In its simpler biflagellate condition *Dimorpha* is scarcely to be distinguished from an ordinary member of the genus *Heteromita*, progression being effected in a similar manner with one flagellum vibrating in advance and the other trailing in the rear. Food-ingestion, as observed of the Heliozoidal condition only, is accomplished at all parts of the periphery. A somewhat doubtful instance of transverse fission was witnessed in which one of the segmented moieties retaining the two flagella swam off as a monadiform zooid, while the other, throwing out pseudopodia, assumed an Actinophrys-like aspect.

Urceolus (Phialonema) Alenizini, Meresch.—Surface of the body smooth, without striæ: neck cylindrical, with the margins abruptly truncated and not turned out. Dimensions unrecorded. HAB.—White Sea.

This species, though previously figured and described by Mereschkowsky in his 'Studien über Protozoen des Nördlichen Russland,' published in the 'Archiv für Mikroskopische Anatomie,' Bd. xvi, December 1878, was inadvertently passed over by the author when chronicling the associated forms. In his more recent notice of this species ('Annals,' March 1881), Mereschkowsky declares its generic identity with the animalcule upon which Stein † has conferred the title of *Phialonema cyclostoma* (see Vol. I. p. 373), but from which form it is readily distinguished by the non-striation of the cuticular surface and the evenly truncate contour of the frontal border. Mereschkowsky further maintains that his name of *Urceolus* having been bestowed upon the species he discovered, in a yet earlier Russian memoir which appeared in 1877,‡ it will have to take the place of Stein's *Phialonema* in both instances. It is at the same time worthy of remark that in Mereschkowsky's figures and description no indication whatever is given of the existence of the prolonged, posteriorly dilated pharyngeal passage that eminently distinguishes Stein's type, and which is here accepted as affording a diagnostic generic character.

Anisonema quadricostatum, Meresch.—Body oval, strongly depressed, ornamented on the dorsal surface with four longitudinally disposed ribs or costæ. Dimensions unrecorded. HAB.—Salt water: Bay of Naples, Sorrento.

"The oval body is characterized by its strong depression; the cuticle, which covers the whole body, is very firm and on the dorsal part it forms at the surface four longitudinal elevations, four ribs, slightly spirally curved. The mouth, which is widely open in the form of a vertical fissure, is very visible on the ventral surface, from which originate two flagella, one of which trained along behind, attains two and a half times the length of the body." §

Künckelia gyrans, Künstler.—This species is briefly described by J. Künstler ‖ as a fresh-water Noctiluca. The body is capable of elongation, and so enabled to creep about. There is an enormous tentacle which exhibits very active movement when the animal is swimming. Under its cuticle there are two

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* In Vol. I. pp. 226 and 227, and Pl. I. Figs. 7, 8, and 10, published in Parts I. and II., October and November 1880.

† 'Infusionsthiere,' Abth. iii. Heft 1, 1878.

‡ 'Travaux de la Soc. des Naturalistes de St. Pétersbourg,' vol. viii., 1877.

§ "C. Mereschkowsky on some new or little-known Infusoria," 'Annals and Magazine of Natural History,' March 1881.

‖ 'Comptes Rendus,' xciii., 1881.

muscular layers which are continued into the tentacle. The mouth appears to lead into a very large cavity. No phosphoric properties have been as yet observed.

A new species of *Astasia* receives from Künstler the name of *Astasia costata*; it is distinguished by its ribbed aspect, which is due to the presence in the integument of regular rows of starch-grains; the digestive apparatus consists of a narrow œsophagus, a large gastric pouch, and an intestine leading to an anal aperture.

Genus **Proterospongia**, S. K. Gr. *proteros*, earlier; *spoggos*, sponge.—This generic title is herewith substituted for that of *Protospongia*, employed by the author at Vol. I. p. 363, and which, though not included in either Agassiz' or Marschall's 'Nomenclator Zoologicus,' has, he finds, been preoccupied by Zittel for the distinction of a genus of fossil sponges.

Order **Cilio-Flagellata.**

An extensive and highly important memoir relating to that larger section of the Cilio-Flagellata included in this treatise in the family group of the Peridiniidæ, has been recently published by R. S. Bergh, of Copenhagen.* In addition to supplying elaborate details concerning the more minute histology and tendency to variation of the many forms already known to science, some half a dozen species are here figured and described for the first time; no less than three of these being recognized as types of new generic groups. Phylogenetically, Bergh is inclined to accept the genus *Prorocentrum* rather than *Gymnodinium* as the stock-form or architype of the Peridiniidæ, and further predicates the evolution of the Peritrichous Ciliata through *Mesodinium* from out of the Cilio-Flagellate order. Evidence that somewhat favours this last-named speculation, but which does not appear to have attracted Bergh's attention, might perhaps be adduced on the grounds that the characteristic oral flagellum of the Peridiniidæ finds its homologue in the abnormally prolonged cilium or so-called "soie de Lachmann," developed from the same region in many of the Vorticellidæ.

One important change in the position that has been hitherto allotted to it has, as a result of M. Bergh's recent investigations, to be made in connection with Bütschli's somewhat problematical form *Polykrikos Schwartzii*, referred provisionally by the author at page 509 to the Holotrichous family Colepidæ. As demonstrated by the Copenhagen authority in connection with a closely allied species, *Polykrikos auricularis*, the generic group must be accepted as a somewhat abnormal Cilio-Flagellate type, differing from the ordinary Peridiniidæ in the more abundant development of its ciliary girdles, the oral opening being at the same time sub-terminal. The so-called oral seta, apparently produced in duplicate in the example figured by Bütschli, is clearly shown by Bergh, in connection with *P. auricularis*, to differ in no way from an ordinary attenuate vibratile flagellum.

The several new genera and species established by R. S. Bergh are as follows:—

Gymnodinium gracile, Bergh.—Body elongate-conical, from two and a half to three and a half times as long as broad, subdivided by the transverse ciliary furrow into a shorter acuminately pointed anterior and a longer obtusely rounded posterior segment; the longitudinal furrow very wide posteriorly; the external or ectoplasmic layer folded and wrinkled; no myophan layer; colour pale pink. Length 1–250″. Hab.—Salt water: Baltic Sea.

Gymnodinium spirale, Bergh.—Body subfusiform, about three and a half times as long as broad, the anterior abruptly narrowed and curved towards the right, the posterior end forming terminally a short conical sword-like point; the transverse ciliary furrow taking a very oblique spiral course; the ectoplasmic surface smooth, inclosing a longitudinally striate myophan layer; colour grey. Length of body 1–400″ to 1–250″. Hab.—Salt water: Baltic Sea.

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* "Der Organismus der Cilio-flagellaten, eine phylogenetische Studien," 'Morphologisches Jahrbuch,' Band vii. Heft. 2, 1881, Ss. 177–288 und Taf. xii.–xvi.

Glenodinium Warmingii, Bergh.—Body suborbicular, compressed, about twice as broad as long, subreniform as seen in horizontal section, divided by the equatorial furrow into two distinct segments, the anterior one being much the smaller; cuirass membraneous, entirely smooth and homogeneous; endoplasm orange-coloured, inclosing chlorophyll, diatomin, and starch. Diameter of body 1–700″ to 1–550″. HAB.—Salt water: Baltic Sea.

GENUS **Diplopsalis**, Bergh.—Animalcules resembling those of *Glenodinium*, the cuirass divided by a subcentral equatorial furrow into two subequal segments, but neither reticulate nor separated into secondary plates or facets; two delicate membraneous crests, as in *Dinophysis*, developed from the sides of the longitudinal furrow.

Diplopsalis lenticula, Bergh.—Body depressed lenticular, subcircular in horizontal optic section, the membraneous crests of the longitudinal furrow not strengthened by decurrent linear thickenings; endoplasm inclosing chlorophyll and diatomin, also a large transparent vacuole, representing probably the contractile vesicle. Diameter of equatorial region of the body 1–125″.

HAB.—Salt water: Baltic Sea.

GENUS **Protoperidinium**, Bergh.—Animalcules resembling short-horned or cuspidate examples of the genus *Ceratium*, such as *C. divergens*, but their horn-like processes, which consist of excurrent developments of the edges of the longitudinal groove, united by membraneous crests to the general surface of the cuirass.

The membraneous crests developed as cuspidate processes of the carapace are regarded by Bergh as modified homologues of the membraneous ventral plates of *Dinophysis*, this last-named genus, in accordance with such interpretation, being thus united to the typical genus *Peridinium*.

In addition to the following newly discovered type he proposes to include in the same genus the *Peridinium* (*Ceratium*) *Michaelis* of Ehrenberg.

Protoperidinium pellucidum, Bergh.—Body subspheroidal, divided into two even areas by the subcentral horizontal furrow, with two anterior membraneous cusps, the posterior extremity developed into an attenuate, terminally toothed, acuminate extension; cuirass composed of numerous finely reticulate facets. Length of body 1–450″. HAB.—Salt water: Baltic Sea.

GENUS **Protoceratium**, Bergh.—Animalcules resembling those of *Peridinium*, the cuirass divided by the equatorial furrow into two distinct segments, but these segments simply reticulated and not separated into distinct secondary plates or facets; the longitudinal furrow, with the exception of the oral fissure and appended flagellum, enclosed by the cuirass.

Protoceratium aceros, Bergh.—Contour of body ovate or subspheroidal, closely resembling that of *Peridinium tabulatum*, but the ventral aspect not so distinctly flattened or concave; the entire surface of the cuirass finely reticulate but not subdivided into distinct parts; endoplasm inclosing chlorophyll, diatomin, and apparently starch-like corpuscles; often with an eye-like pigment-spot. Length of body 1–700″. HAB.—Salt water: Baltic Sea.

Ceratium hirundinella, Müll. sp.—This species has been described in Vol. I. p. 457, in connection with the title of *Ceratium longicorne* conferred upon it by Perty. Bergh, however, would appear to be justified in identifying it with the *Bursaria hirundinella* of O. F. Müller, originally passed over by the author as probably representing the larva of some Turbellarian such as *Monostomum*, and this specific name must consequently take the precedence. The so-called *Ceratium hirundinella* of Dujardin is, as already shown at p. 462, identical with the *Peridinium* (*Dimastigoaulax*) *cornutum* of Ehrenberg.

Polykrikos auricularia, Bergh.—Body subcylindrical or barrel-shaped, with a scalloped or crenated lateral outline, obtusely rounded at the two extremities, about two and a half times as long as broad, indented along the centre of the ventral

surface by the ventral groove in such a manner that the body as seen in optic transverse section presents a kidney-shaped aspect: ciliary girdles eight in number, disposed somewhat obliquely; flagellum as long or longer than the body, issuing from the ventral region of the apical ciliary girdle, distinctly thickened at its proximal extremity; endoplasts four in number, distributed in rectilinear order through the central region of the body; endoplasm coloured pink, enclosing scattered apparent trichocysts, identical in structure with the thread-cells or nematocysts of the Cœlenterata. Length of body 1–700″. HAB.—Salt water: Baltic Sea.

As demonstrated by Bergh, the members of the genus *Polykrikos* must be referred to the Cilio-flagellate order of the Infusoria, their distinction from the more ordinary Peridiniidæ consisting only in the greater numerical development of the equatorial ciliary girdles. The so-called seta issuing from the oral region, as interpreted by Bütschli, is distinctly proved to be an elongate flagellum, the thickened basal region only of which appendage was recognized by the last-named authority. The apparent second seta developed near the first, as reported by Bütschli, of *Polykrikos Schwartzii* (see Vol. I. p. 508 and Pl. XXVII. Fig. 8), not improbably represents the basal region of a second flagellum, developed as a preliminary to the phenomenon of transverse fission. *Polykrikos auricularia* differs from the last-named type in its more minute dimensions, in the smaller number of ciliary girdles, these never exceeding eight, and four being the number of the subdivided zooids, in the larger number of endoplasts, and in the pinkish hue of its endoplasmic substance. The so-called trichocysts, irregular in both number and position, reported of this species also by Bergh, agree precisely with the nematocysts of the Cœlenterata, and are most probably incepted with its usual food-material. The fact recorded by its discoverer, that the vegetable colouring substances chlorophyll and diatomin are never present in this form, indirectly points to its carnivorous habits, and further substantiates the author's interpretation of these problematic structures.

CLASS **Ciliata.**

Benedenia elegans, Fœttinger.—Body elongate subcylindrical, somewhat enlarged at the anterior extremity; cilia distributed over the entire surface; muscular fibrillæ developed upon a spiral plan throughout the length of the body; contractile vesicles not detected; endoplast band-like or represented by numerous homogeneous granular rods or spheres, rendered visible only with the assistance of reagents; movements complex, either forwards or rotary upon its axis, the body frequently folded upon itself. Multiplying by segmentation, a portion towards the hinder extremity of the body becoming first separated by a transverse groove, which is again divided into as many as eight nodular segments which are detached separately from the parent. Length 1–25″.

HAB.—Endoparasitic within the renal organs of the Cephalopod *Sepia elegans*.

This type, which is referred by Fœttinger to the Opalinidæ,* would appear in many respects to resemble the Termite parasite *Dinenympha gracilis* of Leidy, described and figured at p. 555 and Pl. XXVIII. Figs. 21–24. A second species, having a more marked development of the cilia in the anterior region, inhabiting the renal organs of the common Octopus, *Octopus vulgaris*, receives from the same authority the name of *Benedenia coronata*. An ovoid Infusorium without mouth or digestive tube, having a similar holotrichous plan of ciliation, a distinct layer of muscular fibrillæ below the surface of the cuticle, length about 1–250″, and inhabiting the liver of *Sepiola rondeletii*, is distinguished by M. Fœttinger by the title of *Opalinopsis sepiolæ*, and a very similar type, derived from the liver of *Octopus tetracirrhus*, as *Opalinopsis octopi*.

Chilodon propellens, Engelmann.†—Closely allied to *C. cucullulus*, but of more slender form and with a rounded posterior extremity; swims in circling paths;

* 'Bull. Acad. Royal Belgique,' and 'Archives de Biologie,' Band ii., 1881.
† Notice in 'Nature,' p. 303, July 24th, 1879.

the contractile vesicle contracts quickly every thirty seconds and gives an impulsive acceleration of the forward motion, or if at rest, causes at systole a forward movement of the body for one-quarter of its length.

Stentor amethystinus, Leidy.*—Body trumpet-shaped when extended, oval when contracted, somewhat resembling *S. igneus*, existing in attached groups; endoplasm containing an abundance of chlorophyll, but the exterior structure invariably of a distinct lilac or amethystine colour; endoplast ovate. Length, when extended, 1–40″. HAB.—Fresh water.

The larger size of this animalcule serves to distinguish it from *Stentor igneus*, which is also reported by Stein to sometimes assume a brownish or lilac-coloured in place of the more normal scarlet hue.

Sparotricha vexillifer, Entz.—This title is bestowed by Entz† on a form obtained by him from the salt-pans of Hungary, and which he describes as differing from its near ally *Stichotricha* in the circumstances that the peristomal cilia are disposed in a continuous banner-like series, in the irregularity of the arrangement of the other cilia, and in its incapacity to rapidly change its form. The absence of frontal styles distinguishes it, on the other hand, from the genus *Uroleptus*. Two other new forms, *Litonotus grandis* and *Ervilia salina*, were obtained by Entz from the same locality, but the author has not so far been able to obtain access to their original description.

Drepanostomum pectinatum, Ehr.—This proposed new generic and specific type is very vaguely described by Ehrenberg‡ as most nearly resembling *Vaginicola*, but having in place of the ordinary ciliary disk a slender flattened anterior process, the two extremities of which bear vibratile cilia, the chamber-like centre, presumably the pharyngeal cleft, being also ciliate.

Opercularia arenicola, Greef.§—Colony-stock usually consisting of two zooids only, which are situated close to each other at the extremity of a very short stiff pedicle; bodies oval, pointed at the extremities; the peristome and ciliary disk very narrow; endoplast cord-like. Length of bodies 1–300″. HAB.—Bog water.

GENUS **Arachnella**, S. K. Dim. of Gr. *arachne*, spider.—Here substituted by the author in place of *Arachnidium*, Vol. II. p. 637, preoccupied by T. H. Hincks ('Ann. Nat. Hist.,' Sept. 1877) for the distinction of a genus of Polyzoa.

Pulsatella convolutæ, Geddes.—The foregoing title is conferred by Mr. Patrick Geddes‖ on some curious cells, apparently independent organisms, observed by him to occur in large quantities within the mesoderm of the marine Planarian *Convoluta Schulzii*. The cells are a little smaller than the red blood-corpuscles of the frog, are nearly in the form of a slightly curved pear, and have a large central vacuole filled with fluid. On the wall of this cavity and towards the more convex side of the cell, almost parallel with its principal axis, there is a row of homogeneous transparent fibrillæ, which are inserted at their upper and lower extremities in the ordinary protoplasm of which the other parts of the cell is composed. If these cells are examined free in sea-water, it is seen that they are in a state of rhythmical contraction, the rapidity and vigour of which are equally surprising, the most active pulsating from 100 to 180 times per minute; each time the principal axis becomes more strongly curved and the cell shorter and broader. This change of form depends exclusively on the contraction of the inner fibres, the other parts of the cell remaining quite passive. The movements of the cell soon begin to slacken, become irregular and feeble, finally cease, and the cell bursts. Its protoplasm soon perishes, but the fibres resist for a longer time the action of the water, and even

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* 'Proc. Acad. Nat. Sci. Philadelphia,' 1880.

† "Ueber einige Infusorien des Salzteiches zu Szamosfalva." 'Termeszetrazii füzetek,' vol. iii. p. 219.

‡ 'Bonplandia,' 1861.

§ "Protozoenfauna der Moos," 'Marburger Sitzungsbericht,' S. 22, 1873.

‖ 'Comptes Rendus,' xciii. (1881); also Abstract in 'Journ. Roy. Micr. Soc.,' April 1882.

exhibit a trace of contractility like dying cilia. Numerous observations have convinced Mr. Geddes that these cells are really parasites. Other species of Planarians yield nothing like them. The delicacy of their protoplasm distinguishes them from the true tissue of the *Convoluta*. Moreover, they do not form tissue, and have no definite disposition. Regarded as parasites, their structure, apparently so abnormal, is readily derived from the type of ordinary Infusoria by the suppression of the cilia, which would not be available for locomotion among the cells of the mesoderm, and the differentiation of the contractile vesicle. This differentiation of the vacuole is remarkable with reference to its relative enormous proportions, the development of contractile fibres which limit it, and the rapidity of its contraction. Being altogether distinct from the ordinary Flagellate, Ciliate, and Suctorial (Tentaculiferous) sections of the Infusoria, its discoverer proposed to establish a new sub-class, the Pulsatoria, for its reception.

GENERAL HISTOLOGY AND PHYSIOLOGY.

Fertilization of Seaweeds by Infusoria.

The very interesting discovery has been made by Dr. Dodel-Port, of Zürich,* that Infusoria, Vorticellæ, are instrumental to a large extent in the fertilization of certain Floridaceous Algæ. In *Polysiphonia subulata* the antherozoids, produced from antheridia on separate plants, are of a simple spheroidal form and possess no cilia or other locomotive organs. Their union with the reproductive structures or carpogonia of the female plants, which would be otherwise very hazardous, is greatly facilitated by the usual presence upon the fruit-bearing branches of numerous Vorticellæ. The characteristic ciliary currents produced by these animalcules attract the antherozoids floating in the neighbourhood, and cause some one or more to strike upon and adhere to the trichogyne or slender tubular hair which is produced from the distal region of the carpogonium, and which subserves the purpose of the pistil in an ordinary flowering plant. In this manner fertilization is effected by a process closely analogous to what obtains among the wind-fertilized or so-called "anemophilous" diœcious phanerogams.

Muscle or Nerve-fibres in Stylonychia mytilus.

T. W. Engelmann † remarks of the above-named Infusorian that it unquestionably possesses a system of ventral fibres trending from near the middle line, beneath the ectoplasm, to the two conspicuous series of large admarginal cilia which so powerfully aid in the motions of this animalcule. These fibres are not like the fibres of ordinary ciliated cells, nor are the lashes which they supply cilia properly so called. The lashes (cirri) are complex appendages remote from one another, moving independently under the control of their possessor. Each has its own fibre, which is pale, soft, and homogeneous. The fibres are parallel, and so delicate that they can only be seen for a short time in specimens starved during some hours in filtered water and then killed in osmic acid. Their interpretation as true nerve-fibres is favourably entertained by Engelmann.

Method for Colouring Infusoria during Life.

M. A. Certes ‡ finds that Infusoria placed in a weak solution of chinolin or cyanine—proportion from 1 to 500,000 and not exceeding 1 to 100,000 of ordinary filtered water—are coloured a pale blue, and may continue to live for as long as thirty-six hours. The coloration is concentrated round the fat-granules of the protoplasm, but affects feebly or leaves altogether untouched the cilia, cuticle, nucleus, nucleolus, and vacuoles. The colour disappears on long exposure to light or if the objects are mounted in glycerine.

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* 'Kosmos,' 1879; also 'Nature,' No. 515, Sept. 11, 1879.
† "Pflüger's Archiv Physiologie," Bd. xxiii., 1880.
‡ 'Comptes Rendus,' xci., 1881.

Glycogen in Infusoria.

Glycogen, or animal starch, having been demonstrated by M. Claude Bernard to be present as a product of nutrition in all higher animals, M. Certes * successfully experimented with a view to its detection in Infusoria. Under the reaction of iodine it is revealed by the wine-red, purplish, or mahogany-red colour exhibited by the component elements of the tissues that contain it. The action of the reagent being regulated, it was found to be abundantly developed among the Infusoria, it imparting to the various specimens examined the characteristic tints to the sarcode element generally, but sparing the cuticle, vibratile cilia, nuclei, nucleoli, and contractile vesicle; and also, in the case of *Vorticella*, the contractile filament.

Preservative Fluid for Infusoria, &c.

Dr. T. F. Allen† finds the following solution suited to the permanent preservation of Infusoria :—

Wood vinegar, sp. gr. 1·04	100 parts.
Salicylic acid	1 part.

The above compound he calls salicylic vinegar; to this add for salicylic vinegar 1 part, glycerine 10 parts, and water 40 parts.

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* 'Comptes Rendus,' xc., p. 77, 1880.

† 'American Monthly Microscopical Journal,' p. 98, 1881; also 'Journ. Roy. Mic. Soc.,' October 1881.

GLOSSARY

OF TECHNICAL TERMS EMPLOYED IN THIS TREATISE.

ABIOGENESIS. Gr. *a*, without; *bios*, life. The doctrine of *de novo* or spontaneous generation, assuming that living bodies may be evolved from inorganic matter without the interposition of a parent.

ACETABULIFORM. Lat. *acetabulum*, a cup or sucker; *forma*, form. Having a cup- or sucker-shaped outline.

ADORAL. Lat. *ad*, to; *os*, *oris*, the mouth. The fringe of cilia conducting to the oral aperture of many Infusoria.

AFFERENT. Lat. *ad*, to; *fero*, I carry. Conveying from the surface towards the centre.

AMŒBIFORM. Amœba; *forma*, shape. Resembling an *Amœba*.

AMORPHOUS. Gr. *a*, without; *morphe*, shape. Having no definite form or structure.

AMPHIBLASTULA. Gr. *amphi*, on both sides; *blastos*, germ. Term proposed by Haeckel for that modification of the so-called ciliated sponge-larva in which its respective poles are composed of dissimilar cellular elements.

AMPULLACEOUS-SACS. Lat. *ampulla*, a bottle. Name applied by Mr. Carter to the hollow ciliated or monad-lined chambers of many sponges.

AMYLACEOUS. Gr. *amulon*, starch. Having a starch-like consistence.

ANALOGOUS. Gr. *ana*, similar to; *logos*, ratio. Applied to parts performing similar functions but having a different nature, as the wing of a bird and the wing of a butterfly.

ANTHEROZOIDS. Gr. *anthos*, a flower; *zoon*, an animal. The flagelliferous locomotive elements in cryptogamic plants which are the homologues of the spermatozoa of animals.

ARCHEGASTRULA (Haeckel). Gr. *arche*, beginning; *gastrula*. Hypothetical primæval gastrula-like organism (see GASTRULA), out of which, by the process of evolution, the entire Metazoic animal series is supposed to have been gradually developed. Such an architype Haeckel announced the discovery of in the genus *Haliphysema*, vol. i. p. 160 et seq.

ARCHENTERON. Gr. *archos*, chief; *enteron*, intestine. The primitive alimentary tract as developed in the Metazoic embryo.

ARCHITYPE. Gr. *arche*, beginning; *tupos*, image. The original or ancestral type of a race or species.

ATROPHIED. Gr. *a*, without; *trophe*, nourishment. A condition of being wasted away through defective nourishment.

BACILLAR. Lat. *bacillum*, a small staff or rod. Having a rod- or staff-like contour.

BIFLAGELLATE. Lat. *bis*, twice; *flagellum*, whip. Having two whip-like appendages or flagella.

BILABIATE. Lat. *bis*, double; *labium*, lip. Having the appearance of possessing two lips.

BIOGENESIS. Gr. *bios*, life; *genesis*, origin. The doctrine that all life springs from antecedent life.

BIOGENETIC. Gr. *bios*, life; *genesis*, origin. Relating to the doctrine that all life springs from antecedent life, in contradistinction to *Abiogenesis* or *de novo* generation.

BIOPLASM. Gr. *bios*, life; *plasma*, what is formed. The essential vital element of all organic bodies, equivalent to *Protoplasm*.

BLASTOMERE. Gr. *blaston*, a germ; *meros*, a portion. The areas delimited by the segmentation of the ovum.

BUCCAL. Lat. *bucca*, the mouth. Relating to the mouth or oral aperture.

CAMPANULATE. Lat. *campanula*, a little bell. Having the shape of a bell.

CANCELLATE. Lat. *cancelli*, a lattice or grating. Having an open network- or lattice-like structure.

CARAPACE. Gr. *karabos*, a crustaceous animal. The indurated dorsal shield possessed by such infusorial forms as *Euplotes* and *Aspidisca*.

CAPILLITIUM. Lat. *capillitium*, the hair collectively. The thread or hair-like filaments developed within the spore-capsules or sporangia of certain Mycetozoa.

CAPITULUM. Lat. *capitulum*, a little head. Term applied to the stalked spheroidal spore-receptacles or sporangia of certain Mycetozoa.

CATACLYSMIC. Gr. *kataklysmos*, an inundation, deluge. Having reference to sudden and abnormal alterations of the conditions of the universe, such as by a deluge or an earthquake.

CHITINOUS. Gr. *chiton*, a coat of mail. Corresponding in nature with chitine or the horny material which forms the protective covering and skeletal elements of Insects and other Arthropoda.

CHLOROPHYLL. Gr. *chloros*, grass-green; *phullon*, a leaf. The green colouring-matter of vegetable organisms.

CHLOROPHYLLACEOUS. Having the nature of chlorophyll.

CILIA. Lat. *cilium*, an eyelash. The fine hair-like appendages that constitute the locomotive organs of a large group of Infusoria and many lower animals.

CIRRI. Lat. *cirrus*, a lock of hair. The elongate, flattened modifications of ordinary cilia, developed upon the peristomal region of many Ciliate Infusoria.

CLOACA. Lat. *cloaca*, a common sewer. The common cavity upon which the interstitial canal-systems of a sponge body open, and are thence discharged into the surrounding water.

CŒNOBIUM. Gr. *koinos*, common; *bios*, life. Term applied by Stein to the spherical monad clusters developed at the terminations of the branching pedicle of such a type as *Anthophysa*.

COMMENSAL. Lat. *cum*, together; *mensa*, table, board. Term applied by Van Beneden to those *pseudoparasitic* organisms which do not live at the expense of the organisms to which they are usually attached, but are associated with them simply as comrades or messmates.

COMMENSALISM. Lat. *cum*, together; *mensa*, table, board. The state of existence as a commensal.

CONJUGATION. Lat. *conjugo*, to unite. The temporary or permanent growing together of two or more infusorial bodies, such union conducing to reproduction by germs or spores or to the renewal of their capacity to multiply by simple fission.

CONVOLUTE. Lat. *con*, together; *volutus*, rolled. Rolled upon itself.

CORTICAL. Lat. *cortex*, bark. Relating to the bark or external layer of an organism.

CRATERIFORM. Lat. *cratera*, a cup; *forma*, form. Having the shape of a cup.

CRENULATE. Dim. of Lat. *crena*, notch. Finely notched or serrated.

CUIRASS. Fr. from *cuir*, leather. An indurated defensive shield, synonymous with Carapace.

CUTICULUM. Lat. *cuticula*, a little skin. The more indurated pellicle which forms the outer layer of the body of Infusoria.

CYCLOSIS. Gr. *kuklosis*, a moving round. The protoplasmic circulation observable in the cells of certain plants, and also in many Protozoic organisms such as within the body of *Paramæcium bursaria* and the pseudopodia of the Foraminifera.

CYTOBLASTEMA. Gr. *kutos*, a cell; *blastano*, I bud. The viscid fluid in which animal and vegetable cells are produced. Here applied to the glairy structureless matrix in which the collared and amœbiform cells of the sponge-body are immersed and generated.

CYTOBLASTS. Gr. *kutos*, a cell; *blastano*, I bud. The amœbiform cells immersed and generated within the hyaline matrix or cytoblastema of a sponge-body.

CYTODES. Gr. *kutos*, a cell. A term applied by Haeckel to unicellular organisms or elements, that have the value of a simple cell but possess no distinct nucleus.

CYTOPYGE. Gr. *kutos*, cell; *puge*, the rump. A term introduced by Haeckel for the distinction of the so-called excretory or anal aperture of unicellular animals.

CYTOSTOME. Gr. *kutos*, cell; *stoma*, a mouth. A term proposed by Haeckel for the distinction of the so-called oral aperture of unicellular animals.

DACTYLOZOOIDS. Gr. *daktulos*, a finger; *zoon*, animal. Term proposed by H. N. Mosely for the distinction of the attenuate mouthless zooids developed by *Millepora*, *Stylaster*, and other coral-building Hydrozoa.

DIAPHANOUS. Gr. *dia*, through; *phaino*, I show. Transparent, permitting the passage of light.

DIASTOLE. Gr. *diastello*, to dilate. A term expressive of the expanding action of the contractile vesicle of Infusoria and other Protozoa.

DIATOMIN. Gr. *diatemno*, to separate. A term applied to the essential brown colouring matter of the vegetable organisms known as Diatoms.

DICHOTOMOUS. Gr. *dicha*, in two parts; *tome*, a cutting. Having the divisions of its substance arranged in pairs; furcate or forked.

DECURRENT. Lat. *de*, down; *currens*, running. Running out or projecting beyond.

DIFFERENTIATED. Lat. *differo*, I separate. Applied to an organic body or structure which exhibits a distinct separation into diverse elementary components.

DIFFLUENCE. Lat. *diffluens*, dissolving. A term introduced by Dujardin to indicate that peculiar phenomenon of dissolution exhibited by many Infusoria, in which the sarcode substance of their bodies as it were gradually melts away.

DIŒCIOUS. Gr. *dis*, double; *oikos*, a house. Having the male and female sexes represented in two distinct individuals.

DIPLOBLASTIC. Gr. *diploos*, double; *blastos*, germ. Relating to that condition of the Metazoic embryo in which two germinal cellular layers are distinctly represented.

DEXTROGYROUS. Lat. *dextra*, the right hand; *gyros*, a circle. Circling towards the right.

DEXTROTROPOUS. Lat. *dexter*, to the right; Gr. *trope*, a turning. Turning to the right.

ECTODERM. Gr. *ektos*, outside; *derma*, skin. The external of the two germinal cellular layers, common to all multicellular or Metazoic animal organisms, out of which are developed the protective and sensory elements, including the skin, cuticle, nervous system, and organs of special sense.

ECTOPARASITIC. Gr. *ektos*, outside; *parasitos*, parasite. Having the nature of an external parasite.

ECTOPLASM. Gr. *ectos*, outside ; *plasma*, that which is formed. A term applied by the author for the distinction of the denser external substance of Infusoria and other unicellular organisms.

EFFERENT. Lat. *ex*, out ; *fero*, I bear. Conveying from the centre towards the periphery.

EMARGINATE. Lat. *e*, out of ; *margo*, the margin. Having a notched or excised margin.

ENCUIRASSED. Fr. *en*, in ; *cuir*, leather. Having an indurated dorsal shield or cuirass.

ENCYSTMENT. Gr. *en*, in ; *kustos*, a bladder. The phenomenon of becoming motionless and excreting a membranous investment or cyst, common to the majority of the Infusoria.

ENDOCHROME. Gr. *endon*, within; *chroma*, colour. The colouring matter developed within the interior of many Protozoa and Protophytes.

ENDODERM. Gr. *endon*, within ; *derma*, skin. The interior of the two germinal cellular layers common to all multicellular or Metazoic animal organisms, out of which are developed the digestive and secretory systems, including the epithelium which lines the alimentary tract and its connected glands.

ENDOPARASITIC. Gr. *endon*, within ; *parasitos*, parasite. Pertaining to an internal parasite.

ENDOPLASM. Gr. *endon*, within ; *plasma*, that which is formed. A term applied by the author for the distinction of the inner more fluid substance of the body of Infusoria and other unicellular organisms.

ENDOPLAST. Gr. *endon*, within ; *plastos*, formed or moulded. Title conferred by Huxley on the structure homologous with the cell-nucleus as developed in the Infusoria and other Protozoa. For an account and illustration of the more important modifications of this structure see vol. i. p. 73 et seq. and Pl. L.

ENDOPLASTULE. Gr. *endon*, within ; *plastos*, formed. Title applied by Huxley to the more solid particles developed singly or in varying number within, or in many cases external to, the endoplast of Protozoic organisms, the same being regarded as homologous with the *nucleoli* of the component cells of ordinary tissue structures.

ENDORAL. Gr. *endon*, within ; Lat. *os*, *oris*, mouth. The fringe of cilia developed between the adoral and pre-oral series of certain Oxytrichidæ (see woodcut, vol. ii. p. 760).

ENDOSKELETAL. Gr. *endon*, within ; *skeleton*. Relating to the internal skeleton ; such as the bony human framework.

EPIBLAST. Gr. *epi*, upon ; *blastos*, germ. The external or outer germinal layer of the Metazoic embryo, equivalent to the *Ectoderm*.

EPITHELIUM. Gr. *epi*, upon ; *thallo*, I grow. The layer of cells being a modification of the epidermis which forms the surface of all mucous membranes.

EXOSKELETAL. Gr. *exo*, outside ; *skeleton*. Relating to an external skeleton, such as the shell of a lobster.

EVERTED. Lat. *eversio*, a turning out. The condition of being turned out or backwards.

EVERTILE. Lat. *eversio*, a turning out. Capable of eversion or protrusion.

FENESTRATE. Lat. *fenestra*, a window. Having holes or perforations.

FIBRILLÆ. Lat. dim. of *fibra*, a fibre. The delicate thread-like structures developed in the cortical layer of many Infusoria, as also in the footstalk of *Vorticella*, and possessing a rudimentary muscular function.

FIBRILLATE. Lat. dim. of *fibra*, a fibre. Containing or enclosing fibrillæ.

FIMBRIATED. Lat. *fimbriæ*, threads or fringe. Fringed at the margin.

FLAGELLIFEROUS. Lat. *flagellum*, a whip or lash ; *fero*, I bear. Bearing one or more flagella or lash-like appendages.

FUNICULUS. Lat. *funiculus*, a little cord. A term here applied to the slender thread-like filament which connects the component nuclear masses in such infusorial types as *Loxodes* and *Loxophyllum*.

GASTRŒA or GASTRULA. Dim. Gr. *gaster*, a belly. That stage of the embryo in various animals in which it consists of two fundamental cellular membranes, ectoderm and endoderm, enclosing a central cavity.

GASTROZOOIDS. Gr. *gaster*, the belly; *zoon*, animal. Title proposed by H. N. Mosely for the distinction of the ordinary alimentative or mouth-bearing zooids of *Millepora*, *Stylaster*, and other coral-building Hydrozoa.

GIBBOUS. Lat. *gibbus*, hunchbacked. Unsymmetrically distended or swollen at some part of the surface.

GLABROUS. Lat. *glaber*, smooth. Having a smooth surface.

GUBERNACULUM. Lat. *gubernaculum*, a helm or rudder. A title utilized by H. James-Clark for the distinction of the trailing flagellum, having an apparent guiding function, developed in such infusorial forms as *Anisonema* and *Heteromita*.

HELICOIDAL. Gr. *helix*, a spiral; *eidos*, resemblance. Having a twisted or spiral contour, like a snail-shell.

HETEROGENEOUS. Gr. *heteros*, different; *genos*, kind. Having a mixed or compound constitution, the converse of *Homogeneous*.

HETEROGENY. Gr. *heteros*, different; *genos*, birth. The doctrine maintaining that living organisms are produced out of inorganic matter; identical with *Abiogenesis*.

HETEROTRICHOUS. Gr. *heteros*, different; *thrix*, hair. Having hair or cilia of diverse character.

HISTOLOGY. Gr. *histos*, a web or tissue; *logos*, discourse. The study of the more minute or cellular elements of organic structures.

HOLOTRICHOUS. Gr. *holos*, whole; *thrix*, hair. Having hair or cilia of a uniform character developed over the entire surface.

HOMOGENEOUS. Gr. *homos*, same; *genos*, kind. Having a simple or uniform constitution, in contradistinction to *Heterogeneous*.

HOMOLOGOUS. Gr. *homos*, same; *logos*, expression. Having the same morphologic or structural value, though possibly differing in form and function, as the arm of a man and the wing of a bird.

HOMOPLASTIC. Gr. *homos*, same; *plastikos*, moulded or formed. Having a similar or corresponding form.

HOMOPLASTS. Gr. *homos*, same; *plastikos*, what has been formed. Objects corresponding in external form though of a distinct nature.

HYPOBLAST. Gr. *hupo*, under; *blastos*, germ. The internal germinal layer of the Metazoic embryo, equivalent to the *Endoderm*.

HYPOTRICHOUS. Gr. *hupo*, under; *thrix*, hair. Having hair or cilia developed only on the under surface.

ILLORICATE. Lat. *il* for *in*, not, without; *lorica*, coat of mail. Devoid of a protective sheath or lorica.

INDURATED. Lat. *induratus*, hardened. Having a hardened consistence.

INFUNDIBULIFORM. Lat. *infundibulum*, a funnel; *forma*, shape. Funnel-shaped.

INTERSTITIAL. Lat. *inter*, between; *sisto*, I stand. Relating to intervening parts or spaces.

ISOMORPHIC. Gr. *isos*, equal; *morphe*, shape. Exhibiting an equal or corresponding contour.

KERATOSE. Gr. *keras*, a horn. The fibrous horn-like material out of which the skeletal elements of many sponge-forms are constructed.

LÆOTROPOUS. Gr. *laia*, left; *trope*, a turning. Turning to the left.

LIGULATE. Lat. *ligula*, a little tongue or strap. Having a strap-shaped contour.

LORICA. Lat. *lorica*, a coat of mail. The organically distinct protective sheath or domicile, excreted and inhabited by many Infusoria such as *Vaginicola*, *Tintinnus*, and *Salpingœca*.

MACROSPORES. Gr. *macros*, long; *spora*, seed. The spore-like elements, few in number but of relatively large size, into which the bodies of many monads become subdivided.

MASTIGOPODA. Gr. *mastix*, a whip; *pous*, a foot. A term conferred by Huxley on all those Protozoa which possess cilia or flagella, and thus embracing the two Infusorial Classes of the Ciliata and Flagellata as delimited in this treatise.

MEMBRANELLÆ. Lat. dim. of *membrana*, membrane. A term proposed by Sterki for the distinction of the relatively large flattened cilia that constitute the peristomal fringe in many Ciliate Infusoria, synonymous with *Cirri*.

MESOBLAST. Gr. *mesos*, middle; *blastos*, germ. The middle germinal layer of the Metazoic embryo, equivalent with the *Mesoderm*.

MESODERM. Gr. *mesos*, middle; *derma*, skin. The middle germinal layer developed in all forms more highly organized than the Cœlenterata, and out of which are chiefly developed the general connective tissue, internal skeleton, the muscular system, the lining of the body-cavity, the vascular and excretory systems.

METABOLIC. Gr. *meta*, change; *ballo*, I throw. Changeable in form; applied by Cohn to the Infusoria in the same sense as polymorphic.

METAMORPHIC. Gr. *meta*, change; *morphe*, shape. Changeable in form.

METAZOA. Gr. *meta*, change, beyond; *zoon*, animal. Term applied to all those animals above the Protozoa, which in the course of their development undergo certain metamorphoses, consisting of the primary segmentation of a true egg or ovum, and subsequent passage through an embryonic condition in which they possess two distinct germinal cellular layers.

METAZOIC. Gr. *meta*, change; *zoon*, animal. Relating to the *Metazoa*.

MICROSPORES. Gr. *mikros*, small; *spora*, seed. The spore-like elements, of exceedingly minute size but very numerous, produced through the encystment and subsequent subdivision of many monads.

MICROZOOIDS. Gr. *mikros*, small; *zoon*, animal. Title here conferred upon the free-swimming zooids of abnormally minute size, which conjugate with or become buried within the substance of the bodies of the normally sized sedentary animalcules of many Vorticellidæ.

MENISCOIDAL. Gr. *meniskos*, a little moon; *eidos*, resemblance. Having a lens-shaped or watch-glass-like contour, convex on the one side and concave on the other.

MOLECULAR. Fr. *molécule*, a small particle of matter; from Lat. *moles*, mass. Relating to the ultimate quantitative elements of an organic body.

MONADIFORM. Monad; *forma*, shape. Having the aspect of a simple monad.

MONADIGEROUS-LAYER. Monad; *gero*, I bear. Applied by H. James-Clark to that stratum in the sponge-structure which is chiefly composed of monadiform elements.

MONILIFORM. Lat. *monile*, a necklace; *forma*, shape. Jointed so as to resemble a string of beads.

MONOBLASTIC. Gr. *monos*, single; *blastos*, germ. Relating to that condition of the Metazoic embryo, immediately succeeding segmentation, in which a single germinal layer is alone represented.

MONŒCIOUS. Gr. *monos*, single; *oikos*, house. Having the male and female sexes represented in a single individual.

MONOFLAGELLATE. Gr. *monos*, alone; *flagellum*. Bearing a single flagellum only.

MORULA. Lat. dim of *morum*, a mulberry. That stage of the ovum when, after segmentation, it is represented by a berry-like spheroidal mass of nucleated cells.

MORULOID. Having the character of a *Morula*.

MORPHOLOGICAL. Gr. *morphe*, shape; *logos*, description. Having relation to the general structure of organic forms whether animals or plants.

MULTICAPITATE. Lat. *multus*, many; *capitatus*, having a head. Having many heads.

MULTIFLAGELLATE. Lat. *multus*, many; *flagellum*, whip. Possessing many flagella or whip-like appendages.

MULTINUCLEATE. Lat. *multus*, many; *nucleus*, a kernel. Possessing a plurality of nuclei, e. g. *Opalina*.

MYCELIUM. Gr. *mukes*, a fungus. The aggregation of cellular filaments or hyphæ of a fungus, and from out of which the reproductive structures are developed.

MYOPHAN. Gr. *muon*, a muscle; *phaino*, I show. Term applied by Haeckel to that layer, developed in many Infusoria, that contains muscle-like fibrillæ.

MYXOPODA. Gr. *muxa*, mucus; *pous*, a foot. Term applied by Huxley to those Protozoa whose locomotive appendages take the form of pseudopodia, synonymous with *Rhizopoda*.

NAPIFORM. Lat. *napus*, a turnip; *forma*, shape. Turnip-shaped.

NUCLEOLAR. Lat. *nucleus*, a kernel. Having the character of a nucleus.

NUCLEOLUS. Lat. *nucleolus*, a little kernel. An exceedingly minute more solid particle developed singly or in varying number within the substance of the nucleus of an animal or vegetable cell. Its homologue among the unicellular protozoic organisms is distinguished in this volume by the title of the *Endoplastule*.

NUCLEUS. Lat. *nucleus*, a small nut or kernel. A minute refringent or more densely granular corpuscle developed within the substance of most animal and vegetable cells, its homologue in unicellular protozoic organisms being distinguished by the title of the *Endoplast*.

ŒSOPHAGEAL. Gr. *oisophagus*, the gullet. Relating to or connected with the œsophagus.

ŒSOPHAGUS. Gr. *oisophagus*, the gullet. A distinct gullet or œsophageal tube has been recognized as existing in certain Vorticellidæ.

ONTOGENY. Gr. *on*, *ontos*, being; *genos*, lineage. The circumstances relating to the entire developmental metamorphoses or life-history of any individual animal or plant.

OPERCULUM. Lat. *operculum*, a lid or cover. The lid-like structure developed within the sheath or lorica, or attached to the body of certain Vorticellidæ.

PANICULATE. Lat. *panicula*, a tuft on plants. That form of inflorescence consisting of spikelets on long peduncles which are developed in the manner of a raceme.

PANSPERMISTS. Gr. *pan*, all, everywhere; *sperma*, seed. A name conferred upon those who, in the controversy upon the subject of Spontaneous Generation, advocated the opinion that invisible germs of Infusoria and other microscopic organisms were distributed throughout the atmosphere.

PARENCHYMA. Gr. *para*, together; *encheo*, to pour in. The secreting tissue of glands, also applied to cellular tissue of plants, and (by Stein) to the more fluid internal substance of Infusoria, synonymous in the last-named case with *Endoplasm*.

PARORAL. Gr. *para*, beside; Lat. *os*, *oris*, mouth. The fringe of cilia developed at the side of the adoral series on certain Oxytrichidæ. (See woodcut, vol. ii. p. 760.)

PECTINATE. Lat. *pecten*, a comb. Divided into narrow segments like the teeth of a comb.

PEDUNCULATE. Lat. *pedunculus*, a little foot. Provided with a stalk or pedicle.

PERIDIUM. Gr. *perideo*, I wrap round. The membranous outer wall of the spore-capsule or sporangium of the Mycetozoa.

PERISTALTIC. Gr. *peristaltikos*, drawing together all round. Applied to the circular contractions from above downwards, exhibited by the intestines, and also in the locomotion of many worm-like animals.

PERISTOME. Gr. *peri*, around ; *stoma*, a mouth. The oral region with its accompanying cilia, as applied to the Infusoria.

PERISTOMAL. Gr. *peri*, around ; *stoma*, the mouth. Relating to the peristome or oral region.

PERITRICHOUS. Gr. *peri*, around ; *thrix*, hair. Having hair or cilia developed in the form of a wreath or girdle round the body.

PHARYNGEAL. Pertaining to or connected with the pharynx.

PHARYNX. Gr. *pharunx*, the throat or windpipe. As applied to the Infusoria, denoting that part of the alimentary tract, sometimes with indurated walls, that immediately succeeds the oral orifice.

PHYCOCHROME. Gr. *phukos*, sea-weed ; *chroma*, colour. The essential brown colouring matter of the olive-tinted or Melanospermous sea-weeds.

PHYLOGENY. Gr. *phulon*, tribe ; *genos*, lineage. That branch of biology which attempts to deduce the ancestral history of an animal or plant from its ontogeny or individual developmental metamorphoses.

PHYLUM. Gr. *phulon*, tribe. Stock or tribe.

PHYTOPHAGOUS. Gr. *phuton*, a plant ; *phago*, I eat. Feeding upon plants.

PLANULA. Lat. *planula*, a little plane. The flattened, mouthless, ciliated embryo of many Cœlenterata.

PLASMODIUM. Gr. *plasma*, a thing moulded ; *eidos*, resemblance. The gelatinous protoplasmic mass, possessing distinct locomotive properties, formed by the coalescence of the flagelliferous monadiform elements of the Myxomycetes or Mycetozoa.

PLASTIDS. Gr. *plastos*, formed. A term occasionally applied to unicellular organisms or elements that possess the value of a simple cell.

PLICATE. Lat. *plicatus*, folded. Disposed in pleats or folds.

POLYMORPHIC. Gr. *polys*, many ; *morphe*, shape. Exhibiting a diversity of outline, e.g. *Euglena*.

POLYTHECIUM. Gr. *polys*, many ; *theke*, a sheath or case. Title conferred by the author on the compound structure, consisting of many conjoint sheaths or loricæ, developed by such infusorial types as *Dinobryon* and *Stylobryon*.

PREORAL. Lat. *præ*, before ; *os*, *oris*, mouth. The fringe of cilia developed in front of the mouth of certain Oxytrichidæ. (See woodcut, vol. ii. p. 760.)

PROBOSCIDIFORM. Lat. *proboscis*, a trunk ; *forma*, form. Having a trunk-like aspect.

PROGLOTTIDS. Gr. *pro*, before ; *glottis*, the opening into the windpipe. The detached sexually mature segments of a tape-worm, *Tænia*.

PROTEINACEOUS. Gr. *protos*, first. Having a composition analogous to or containing Protein.

PROTEIN. Gr. *protos*, first. A nitrogenous substance analogous to fibrin, manufactured by plants out of inorganic compounds, and upon which all animals are dependent for food, and for the sustentation of their vital functions.

PROTOPHYTES. Gr. *protos*, first; *phuton*, a plant. Organisms lowest in the scale of the vegetable kingdom, having an essentially unicellular composition.

PROTOPLASM. Gr. *protos*, first; *plasma*, what has been formed. The physical basis of life, or elementary formative matter of all organic tissues.

PROTOZOA. Gr. *protos*, first; *zoon*, animal. The simplest, unicellar, animals.

PSEUDOPODIA. Gr. *pseudes*, false; *podes*, feet. Prolongations of the sarcode substance of the body of Rhizopods and other Protozoa, which subserve the purpose of locomotive appendages or feet.

PULSELLUM. Lat. *propello*, *pulsum*, to push or drive. Term conferred by Ray Lankester on that modified form of flagellum chiefly characteristic of Spermatozoa, but possessed by some few flagellate Infusoria, whose action serves to drive the body backwards through the water.

RACEMOSE. Lat. *racemus*, the stalk of a cluster of grapes. Having a clustered form of growth, like grapes.

RENIFORM. Lat. *renis*, a kidney; *forma*, shape. Shaped like a kidney.

REVOLUTE. Lat. *re*, back; *volvo*, I roll. Rolled back upon itself.

RHIZOPODA. Gr. *rhiza*, root; *pous*, a foot. That group of the Protozoa whose locomotive organs take the form of extensile root-like processes, or pseudopodia.

RHYTHMICAL. Gr. *rhuthmos*, measured motion. Denoting the regular pulsations of an organ such as the contractile vesicle of an Infusorium.

ROTULATE. Lat. *rotula*, a wheel. Wheel-shaped.

SARCODE. Gr. *sarx*, flesh; *eidos*, resemblance. The simple glutinous matter which constitutes the chief body or vital mass of all Protozoa.

SARCOLEMMA. Gr. *sarx*, flesh; *lemma*, skin. The delicate investing membrane of muscular fibre.

SETÆ. Lat. *seta*, a stiff hair or bristle. The stouter bristle-like cilia possessed more abundantly by the Hypotrichous order of the Ciliate Infusoria.

SHAGREENED. Fr. *chagrin*, skin of a shark. Having a roughened consistence like shark-skin.

SIGMOIDAL. Gr. letter ς; *eidos*, resemblance. Having a shape resembling the letter S.

SILICIOUS. Lat. *silex*, flint. Partaking of the nature and qualities of silica; composed of flint.

"SOIE DE LACHMANN." Name conferred by Claparède upon the oral seta of the Vorticellidæ, here distinguished as the vestibular seta.

SPATULATE. Lat. *spatula*, a broad blade or slice. Having a broad blade-shaped outline.

SPORANGIUM. Gr. *spora*, seed; *anggos*, vessel. The spore-capsule or spore-receptacle of the Mycetozoa.

SPORIPAROUS. Gr. *spora*, seed or spore; *pario*, I produce. Producing spores.

STOLON. Lat. *stolon*, a lax trailing branch. The procumbent adherent basal region of the colony-stock of such a type as *Dendrosoma*.

SWARM-GEMMULE. Name applied by the author, Vol. i. p. 183, to the so-called ciliated sponge-larvæ, and maintained by him to represent not individual germs or larvæ, but ovate aggregations of typical collared monads.

STYLATE. Gr. *stulos*, a pen. Having a pointed stalk, or style-like character.

SYNCYTIUM. Gr. *sun*, together; *kutos*, cell. Term applied by Haeckel to the hypothetic ectodermal layer of a sponge, and in which, according to his interpretation, the cells are indistinguishably fused with one another, their respective nuclei alone being visible. Such a potential, though unsubstantial, multicellular structure is most nearly realized in the *Opalina* and other multinucleate Infusoria.

SYSTOLE. Gr. *sustello*, to draw together. A term applied to the contracting action of the structure known as the contractile vesicle of Infusoria and other Protozoa.

TAXONOMY. Gr. *taxis*, arrangement; *nomos*, law. The systematic statement and generalization of the facts of morphology, in such a manner as to arrange living beings in groups, according to their degrees of likeness.

TENTACULIFEROUS. Lat. *tentaculum*, a tentacle; *fero*, I bear. Bearing or possessing tentacles.

TENTACULIFORM. Lat. *tentaculum*, a tentacle or feeler; *forma*, form. Having the form of a tentacle.

TRABECULÆ. Lat. *trabecula*, a little beam. Connecting rod- or bar-like structures.

TRACTELLUM. Lat. *traho*, *tractum*, to draw. Term introduced by Ray Lankester for the distinction of the anteriorly projected flagellum of ordinary flagellate Infusoria, whose movements serve to draw the body through the water.

TRICHOCYSTS. Gr. *thrix*, *trichos*, hair; *kustos*, a bladder. Minute rod-like bodies developed in the cortical layer of many Infusoria.

UNCINI. Lat. *uncinus*, a hook. The claw-like modification of ordinary cilia possessed by many hypotrichous ciliate Infusoria.

VACUOLATE. Lat. dim. of *vacuus*, empty. Having a number of clear spaces or interstices.

VELUM. Lat. *velum*, a veil. Here applied to the delicate veil-like membrane bordering the oral orifice in such forms as *Cyclidium* and *Pleuronema*.

VERMICULAR. Lat. *vermiculus*, a little worm. Resembling a worm in shape.

VESTIBULUM. Lat. *vestibulum*, a forecourt. The excavated chamber or fossa into which both the oral and anal apertures debouch, as developed in the Vorticellidæ.

VESTIBULAR-SETA. The bristle-like cilium or seta that projects from the vestibulum or oral fossa of many Vorticellidæ.

ZOOCAULON. Gr. *zoon*, animal; *caulos*, a stem. Title conferred by the author on the erect tentaculiferous branching colony-stocks of the genus *Dendrosoma*.

ZOOCYTIUM. Gr. *zoon*, animal; *kutos*, a cell. A term applied by the author to the gelatinous matrix excreted and inhabited by various colonial Infusoria, such as *Proterospongia*, *Phalansterium*, and *Ophrydium*.

ZOODENDRIUM. Gr. *zoon*, animal; *dendron*, a tree. A term applied by the author for the distinction of the dendritic or tree-like colony-stocks of such Infusoria as *Dendromonas* and *Epistylis*.

ZOOID. Gr. *zoon*, animal; *eidos*, shape. An animal organism not independently developed from a fertilized egg or ovum, but derived from a preceding individual by the process of fission or gemmation. Specially applicable to the Infusoria and other Protozoa, and to the component members of all stock-building communities, such as Polypes, Corals, and Polyzoa.

ZOOSPORES. Gr. *zoon*, an animal; *spora*, seed. The ciliated locomotive germs of Algæ and Protophytes.

ZOOTHECIUM. Gr. *zoon*, animal; *theca*, sheath. A term applied by the author to the compound tubular structures excreted and inhabited by such colonial Infusoria as *Rhipidodendron* and *Schizosiphon*.

ZYGOSIS. Gr. *zugon*, a yoke. The genetic union or conjugation of two Infusoria.

ZYMOTIC. Gr. *zumotos*, fermented. Pertaining to or caused by fermentation. *Zymotic diseases*, that large class of contagious diseases supposed, and in many cases proved, to be caused by the reception into the system of a protophytic virus which acts as a ferment.

CHRONOLOGICAL LIST

OF THE MORE IMPORTANT WORKS AND PAMPHLETS RELATING TO THE INFUSORIA PUBLISHED SINCE THEIR FIRST DISCOVERY IN A.D. 1675 TO THE YEAR 1882.

1677. ANTONY VAN LEEUWENHOEK, Observations concerning little Animals observed in Rain, Well, Sea, and Snow Water, as also in Water wherein Pepper had lain infused. 'Philosophical Transactions,' vol. xii. p. 821.

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1683. ———, Opera Omnia.

1685. ———, Onttedingen en Ontdekkingen.

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1694. A. VAN LEEUWENHOEK, Concerning Animalcula found in Teeth. 'Philosophical Transactions,' vol. xvi. p. 646.

1695. ———, Arcana Naturæ detecta. 4to, Delphis Batavorum.

1696. STEPHEN GRAY, Several Microscopical Observations and Experiments. 'Philosophical Transactions,' vol. xix. No. 221.

1696. JOHN HARRIS (Rector of Winchelsea), Some Microscopical Observations of vast numbers of Animalcula seen in water. 'Philosophical Transactions,' vol. xix. p. 254.

1702. A. VAN LEEUWENHOEK, Concerning the Worms in Sheeps' Livers, Gnats, and Animalcula in the Excrements of Frogs. 'Philosophical Transactions,' vol. xxii. No. 261.

1702. ———, Continuatio Arcanorum Naturæ. 4to, Delphis Batavorum.

1703. ———, Concerning Green Weeds growing in Water, and some Animalcula found about them. 'Philosophical Transactions,' vol. xxiii. No. 283.

1703. ANONYMOUS, An Extract of nine Letters sent to Sir C. H., relating to some Microscopical Organisms. 'Philosophical Transactions,' vol. xxii. No. 284.

1703. A. VAN LEEUWENHOEK, Observations on some Animalcula in Water; the dissolution of silver, &c. 'Philosophical Transactions,' vol. xxiii. No. 286.

1704. ———, A letter concerning Animalcula on the roots of Duckweed. 'Philosophical Transactions,' vol. xxiv. p. 1784.

1708. ———, A letter containing some further microscopical observations on the Animalcula found upon Duckweed. 'Philosophical Transactions, vol. xxviii. p. 160.

1713. ———, Further Microscopical Observations on the Animalcules found upon Duckweed.

1718. LOUIS JOBLOT, Descriptions de Nouveaux Microscopes, avec de nouvelles Observations faites sur une multitude d'insectes qui naissent dans les liqueurs préparées. 4to, Paris.

1722. A. VAN LEEUWENHOEK, Opera Omnia Anatom. et Contempl.

1740. HENRY BAKER, An Account of Leeuwenhoek's Microscopes. 'Philosophical Transactions,' vol. xli. No. 458.

1742. ———, The Microscope made Easy. 8vo, London.

1743. ———, A Contribution towards the Natural History of the Polype. 8vo, London.

1744. ABRAHAM TREMBLEY, Observations upon several newly discovered Species of Fresh-water Polypi. 'Philosophical Transactions, vol. xliii. No. 476.

1745. T. NEEDHAM, An Account of some new Microscopical Discoveries. 8vo, London.

1746. UNGER, Ueber Infusorien. 'Göttinger Zeitung von gelehrt. Sachen.'

1748. T. NEEDHAM, Summary of some late Observations upon the Generation, Composition, and Decomposition of Animal and Vegetable Substances. 'Philosophical Transactions,' vol. xlv.

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1791. J. G. BRUGUIÈRE, Tableau Encyclopédique et Méthodique, contenant l'Helminthologie ou les vers infusoires, les vers intestins et les vers mollusques. 4to, Paris.

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CORRIGENDA.

Vol. I. p. 77, line 2 from bottom, for "Pl. XLIX." read "Pl. L."

" 210, line 4 from top, for "*Hoplophrya* and *Haplophrya*" read "*Hoplitophrya* and *Haptophrya*."

" 215, line 12 from top, for "DYSTERIADÆ" read "DYSTERIIDÆ."

" " line 7 from bottom, to Family Acinetidæ add Genus *Sphærophrya*.

" 252, line 22 " for "obliquus" read "obliqua."

" 253, line 8 " for "rostratum" read "rostrata."

" 254, line 26 " for "quadratum" read "quadrata."

" 259, line 19 from top, for "typicus" read "typica."

" 272, line 11 from bottom, for "cæspitosa" read "cæspitosum." Also in Explanation of Plates XVII. and XVIII.

" 280, line 3 from top, for "Pl. XI." read "Pl. XII."

" " line 13 " " "

" " line 12 from bottom, " "

" 287, line 12 from top, " "

" " line 12 from bottom, " "

" 298, line 13 from top, for "distortum" read "distorta."

" 300, line 8 from bottom, for "consociatum" read "consociata."

" 301, line 5 " for "the ordinary phytozoa" read "ordinary protophytes."

" 305, footnote No. 2, for "Bd. ii." read "Bd. vi."

" 312, line 12 from top, for "marina" read "marinus." Also in Explanation of Plate XIX.

" 323, line 15 from bottom, for "polyflagellate" read "multiflagellate."

" 328, footnote, for "Bd. xxxi." read "Bd. xxxii."

" 395, line 7 from bottom, for "*C. arbusculum*" read "*C. arbuscula*."

" 419, line 13 from bottom, for "*C. cordata*" read "*C. cordiformis*."

" 422, line 3 from bottom, for "tuberculatus" read "tuberculata."

" 429, footnote No. 1, for "1878" read "1868."

" 438, line 15 from top, for "octocostatus" read "octocostata."

" 451, line 9 from bottom, for "æqualis" read "æquale." Also in Explanation of Plate XXV.

" 462, line 19 from bottom, for "cornutum" read "cornutus."

Vol. II. p. 488, line 17 from top, for "marina" read "marinum."

" 498, first line, for "microstomum" read "microstoma." Also in Explanation of Plate XXVI.

Vol. II. p. 520, footnote No. 1, for "Bd. xxxv." read "Bd. xxxii."

" 561, footnote, for "Morphologische" read "Morphologisches."

" 600, first line, for "stylifer" read "stylifera."

" 611, line 13 from bottom, for "fluviatilis" read "fluviatile."

" 612, line 12 from top, for "semiciliatus" read "semiciliatum."

" 623, line 5 from bottom, for "Sub-Fam. 3. ORPHRYDINA" read "Sub. Fam. 3. OPHRYDINA."

" 650, line 9 from top, for "1–1600"" read "1–600"."

" 654, in footnote, for "Bd. iv." read "Bd. xi. Hft. 4."

" 660, line 4 from bottom, for "Bd. ii." read "Bd. xi."

" 676, line 13 from bottom, for "*Vorticella fluviatilis*" read "*Vorticella fluvialis.*"

" 700, line 19 from top, for "Figs. 17–20" read "17–19."

" " line 6 from bottom, for "sedendary" read "sedentary."

" 709, footnote No. 1, for "Bd. xxxix." read "Bd. xxix."

" 780, line 5 from top, for "gibba" read "gibbus."

" " 13 lines from bottom, for "*Uroleptus ratulus*" read "*Uroleptus rattulus.*"

Vol. III. Explanation of Pl. XXVIII., for "PYRSONYMPHA" read "PYRSONEMA."

" Pl. XXXIV. Figs. 5 and 6.—Transverse striation of cuticle of *Rhabdostyla ovum* accidentally omitted by the artist.

" " Figs. 23 and 24.—Transverse striation of cuticle of *Vorticella putrinum* similarly omitted.

INDEX.

[*Synonyms are printed in Italics.*]

	PAGE
Acarella	636
„ siro	636
Acidophorus	494
Acineria acuta	527
„ *incurvata*	527
Acineta	828
„ compressa	833
Acineta cothurnata	815
Acineta cothurnia	833
„ crenata	837
„ cucullus	832
Acineta diademiformis	815
Acineta dibdalteria	839
Acineta digitata	812
„ divisa	836
„ emaciata	837
„ fœtida	832
„ grandis	831
Acineta hyphydri	817, 818
„ *infusionum*	819
Acineta Jolyi	835
„ lemnarum	830
Acineta ligulata	832
Acineta linguifera	831
„ livadiana	828
Acineta Lyngbyi	815
Acineta mystacina	834
„ notonectæ	833
„ patula	835
Acineta phryganidarum	819
Acineta poculum	833
„ pusilla	837
Acineta quadriloba	820
„ Saifulæ	836
Acineta socialis	335
Acineta stellata	838
„ tuberosa	829
„ vorticelloides	837
Acinetopsis	855
„ rara	855
Acomia cyclidium	546
Actinobolidæ	630
Actinobolus	630
„ radians	630
Actinocyathus	848
„ cidaris	848
Actinolophus pedunculatus	226
Actinomonadidæ	226
Actinomonas	226
Actinomonas mirabilis	227
„ pusilla	227
Actinophrys	225
Actinophrys pedicellata	813
Actinophrys sol	376
Actinotricha	790
„ saltans	790
Ægyria	755
„ angustata	755
„ fluviatilis	756
Ægyria legumen	755
Ægyria monostyla	755
„ oliva	756
„ pusilla	756
Alastor polyporum	764
Allotricha	782
„ mollis	782
Alyscum saltans	545
Amblyophis	385
„ ægyptiaca	386
„ viridis	386
Amœba lacerata	222
Amœba monociliata	222
Amœba radiosa	225
Amœba rotatoria	220
„ *villosa*	221
Amphidinium	461
„ operculatum	461
Amphileptus	523
„ anas	524
„ anaticula	526
„ anser	525
„ cygnus	524
Amphileptus fasciola	743
Amphileptus gigas	424
„ gutta	527
„ longicollis	526
„ margaritifer	525
„ meleagris	526
Amphileptus meleagris	528
Amphileptus moniliger	525
Amphileptus papillosus	527
Amphileptus sphagni	527
„ vorax	525
Amphimonadidæ	280
Amphimonas	280
Amphimonas brachiata	281
„ *caudata*	281, 432
„ *dispar*	281

	PAGE
Amphimonas divaricans	282
„ exilis	282
„ globosa	281
Amphisia	767
„ gibba	767
„ Kessleri	768
„ pernix	768
„ velox	768
Ancyromonas	247
Anisonema	434
Anisonema acinus	435
„ *concavum*	435
Anisonema grande	434
„ griseolum	437
„ intermedium	436
„ ludibundum	436
„ quadricostatum	857
Anisonema sulcata	437
Anisonema truncatum	436
Anisonemidæ	429
Anophrys	511
„ sarcophaga	512
Anoplophrya	563
„ branchiarum	565
„ clavata	566
„ cochleariformis	566
„ convexa	567
„ filum	567
„ inermis	565
„ mytili	565
„ naidos	563
„ nodulata	564
„ ovata	567
„ pachydrili	568
„ prolifera	476, 564
„ socialis	566
„ striata	565
„ vermicularis	566
Anthophysa	266
Anthophysa Bennetti	266
„ *cæspitosa*	272
„ *Mülleri*	267
Anthophysa socialis	272
Anthophysa solitaria	334
Anthophysa vegetans	267
Aporea ambigua	285
Arachnella	861
Arachnidium	637
„ bipartitum	638
„ convolutum	638
„ globosum	637
Archimedea remex	603, 777
Ascetta primordialis	186
Ascoglena	393
„ vaginicola	393
Aspidisca	792
„ Andrewii	794
Aspidisca cicada	794
Aspidisca costata	794
„ hexeris	793
„ lyncaster	793
„ lynceus	793
„ polystyla	793
„ sedigita	793
„ turrita	793

	PAGE
Astasia	375
Astasia acus	430
„ *crassa*	378
Astasia contorta	377
Astasia costata	858
„ *deformis*	378
Astasia flavicans	377
Astasia flavicans	418
„ *fusiformis*	378
„ *inflata*	377
„ *limpida*	376
Astasia longifilis	377
„ pusilla	377
Astasia pusilla	418
„ *regularis*	378
Astasia trichophora	376
Astasia turbo	378
„ *utriculus*	377
Astasiadæ	375
Asthmatos	466
„ ciliaris	467
Astrosiga	341
„ disjuncta	341
Astylozoon	654
„ fallax	654
Atractonema	373
„ teres	373
Bæonidium	546
„ remigens	546
Bacterium rubescens	245
Balantidium	577
„ coli	578
„ duodeni	578
„ elongatum	577
„ entozoon	577
„ medusarum	578
Benedenia coronata	860
„ elegans	860
Bicosœca	274
„ gracillipes	276
„ lacustris	275
„ pocillum	277
Bicosœca socialis	290
Bicosœca tenuis	276
Bikœcidæ	273
Blepharisma	585
Blepharisma hyalinum	585
Blepharisma lateritia	585
Blepharisma persicinum	585
Blepharisma undulans	585
Bodo	254
Bodo caudata	432
Bodo colubrorum	257
Bodo globosus	295
„ *gracilis*	299
„ *grandis*	435
Bodo helicis	256
„ hominis	256
„ intestinalis	255
„ julidis	256
„ lymnæi	257
„ maximus	257
„ melolonthæ	257
Bodo muscæ-domesticæ	245

PAGE

Bodo muscarum 257
Bodo ovatus 295
Bodo ranarum 256
Bodo saltans 434
„ *socialis* 255
Bodo urinarius 258
Bursariadæ 574
Bursaria 574
Bursaria decora 576
„ *entozoon* 577
„ *intestinalis* 562
„ *lateritia* 585
„ *leucas* 497
„ *nucleus* 577
„ *patula* 588
Bursaria truncatella 576
Bursaria vernalis 497
„ *virens* 588
„ *vorticella* 576

Calceolidæ 618
Calceolus 618
„ cypripedium 477, 619, 642
Callodictyon 307
„ triciliatum 307
Campylopus paradoxus 797
Carchesium 690
„ aselli 693
„ epistylidis 692
„ Lachmanni 691
„ polypinum 690
Carchesium pygmæum 693
„ *septatum* 693
Carchesium spectabile 691
Catallactidæ 322
Cephalothamnium 272
„ cæspitosum 272
„ cuneatum 273
Cephalothamnium cyclopum 273
Ceratium 452
„ biceps 455
„ bicorne 453
„ candelabrum 456
Ceratium cornutum 462
Ceratium delitiense 454
Ceratium delitiense 455
Ceratium divergens 453
„ eugrammum 456
„ furca 455
„ fusus 456
Ceratium hirudinella 462
Ceratium hirundinella 859
„ Kumaonense 458
„ lineatum 456
„ longicorne 457
Ceratium macroceras 457
Ceratium Michaelis 453
„ pyrophorum 453
Ceratium pyrophorum 455
Ceratium seta 457
„ trichoceros 457
„ tridens 453
„ tripos 454
Cercaria pleuronectes 387
„ *tripos* 454

PAGE

Cercaria turbo 642
Cercomonadidæ 249
Cercomonas 258
Cercomonas acuminata 261
Cercomonas crassicauda 260
Cercomonas curvata 261
Cercomonas cylindrica 260
Cercomonas detracta 261
„ *facula* 261
Cercomonas fusiformis 260
„ globulus 260
Cercomonas hominis 256
„ *intestinalis* 255
„ *lacryma* 261
„ *lobata* 261
Cercomonas longicauda 259
Cercomonas muscæ-domesticæ 245
„ *muscarum* 245
„ *obesa* 236
„ *ramulosa* 235
„ *ranarum* 261
„ *termo* 253
„ *truncata* 261
Cercomonas typica 259
Cercomonas viridis 261
„ *vorticellaris* 261
Chætoglena 389
„ *caudata* 391
„ *volvocina* 390
Chætospira 601
Chætospira cylindracea 778
„ *marina* 602
Chætospira mucicola 602
„ Mülleri 602
Chætospira remex 603, 777
Chætotyphla 389
„ *armata* 391
„ *aspera* 391
Chasmatostoma 540
„ reniforme 540
Chilodon 746
„ cucullulus 746
„ propellens 860
Chilodon uncinatus 747
Chilomonadidæ 423
Chilomonas 423
„ amygdalum 426
„ cylindrica 425
Chilomonas granulosa 424
„ *obliqua* 424
Chilomonas paramæcium 424
Chlamydodon 750
„ Mnemosyne 750
Chlamydodontidæ 745
Chlorangium 407
„ stentorinum 407
Chloraster 315
„ agilis 317
„ gyrans 316
„ tetrarhynchus 316
Chloromonas 401
„ pigra 401
Chloropeltis 387
„ hispidula 388
„ ovum 388

	PAGE
Choano-Flagellata	324
Chœnia	521
„ teres	521
Chœnia vorax	521
Chonemonas hispida	390
„ *Schrankii*	390
Chrysomonadidæ	401
Chrysomonas	402
„ flavicans	402
„ ochracea	402
Chrysopyxis	408
„ bipes	408
Chytridium ampullaceum	345
Chytridium Steinii	639
Ciliata	473
„ -Heterotricha	575
„ -Holotricha	484
„ -Hypotricha	739
„ -Peritricha	622, 623
Cilio-Flagellata	439, 440
Cinetrochilum margaritaceum	794
Cladomonas	284
„ fruticulosa	284
Cladonema	264
„ laxa	265
Class Ciliata	473
„ Flagellata	216
„ Tentaculifera	801
Classification of Infusoria	195–215
Coccudina costata	794
Codonella	615
„ campanella	616
„ galea	616
„ orthoceras	616
Codonellidæ	615
Codonocladium umbellatum	336
Codonodesmus phalanx	342
Codonœca	261
„ costata	261
„ inclinata	261
Codonosigidæ	329
Codosiga	333
„ allioides	337
„ assimilis	340
„ botrytis	334
„ candelabrum	339
„ cymosa	337
Codosiga echinata	334
Codosiga furcata	339
„ grossularia	338
„ pyriformis	339
Codosiga pulcherrima	334
Codosiga Steinii	340
„ umbellata	335
Cœlomonas	392
„ grandis	393
Cœnomorpha medusula	641
Colacium	393
„ arbuscula	394
„ calvum	395
„ multoculata	396
„ Steinii	395
„ vesiculosum	359
Colepidæ	505
Coleps	506
Coleps amphacanthus	508
Coleps elongatus	506
Coleps fusus	507
„ hirtus	506
„ incurvus	508
Coleps inermis	508
Coleps uncinatus	507
Coleps viridis	506
Colouring Infusoria during Life	862
Colpidium	537
„ cucullus	537
Colpoda	512
Colpoda cuculio	747
„ *cucullulus*	747
„ *cucullus*	537
Colpoda cucullus	512
„ parvifrons	513
„ pigerrima	513
Colpodella	378
„ pugnax	378
Colponema	297
„ loxodes	279
Conchophthirus	490
„ anodontæ	490
„ curtus	491
„ Steenstrupii	490
Condylostoma	584
„ patens	584
Condylostoma patulum	584
Condylostoma stagnale	584
Corethra sertularia	849
Cothurnia	719
„ arenata	725
„ astaci	721
„ Cohnii	723
„ compressa	722
Cothurnia corrugata	728
Cothurnia curva	721
„ elongata	723
Cothurnia furcifer	727
„ *gigantea*	716
Cothurnia gracilis	724
„ havniensis	720
„ imberbis	720
„ irregularis	723
„ maritima	720
„ nodosa	721
Cothurnia operculata	719
„ *operculigera*	726
Cothurnia ovata	722
„ patula	722
„ pontica	725
„ pupa	724
Cothurnia pyxidiformis	726
Cothurnia recurva	721
Cothurnia Sieboldii	720
Cothurnia socialis	728
Cothurnia spissa	723
Cricocoleps	506
Cryptobia helicis	256
Cryptoglena	419
„ angulosa	420
Cryptoglena cæruleus	420
Cryptoglena conica	419
Cryptoglena cordiformis	315

	PAGE
Cryptoglena lenticularis	419
„ *pigra*	402
Cryptomonas	404
Cryptomonas curvata	404
Cryptomonas erosa	404
„ ovata	404
Cryptomonas polymorpha	425
Cyathomonas	241
„ alba	242
„ elongata	243
„ emarginata	243
„ lychnus	242
„ spissa	242
„ turbinata	242
„ turbo	242
„ viridis	242
Cyclidium	544
Cyclidium abscissum	371
Cyclidium arboreum	545
„ citrellus	545
Cyclidium Claparèdi	545
„ *crassum*	372
„ *elongatum*	549
Cyclidium glaucoma	544
Cyclidium margaritaceum	794
„ *nodulosum*	372
Cyclochæta	650
„ spongillæ	650
Cyclogramma rubens	495
Cyclotricha	535
„ citrea	535
Cypridium	754
„ aculeatum	754
„ crassipes	755
„ lanceolatum	754
„ spinigerum	754
Cyrtostomum	496
„ leucas	497
Dallingeria	309
„ Drysdali	310
Deltomonas	283
„ cyclopum	283
Dendrocometes	839
„ paradoxus	839
Dendromonadidæ	262
Dendromonas	265
„ pusilla	266
„ virgaria	266
Dendrosoma	840
„ astaci	845
„ radians	841
Desmarella	341
„ moniliformis	341
„ phalanx	342
Dictyocoleps	506
Dictyocysta	624
„ acuminata	627
„ cassis	624
„ elegans	626
„ lepida	626
„ mitra	625
„ templum	625
„ tiara	626
Dictyocystidæ	624
Dicyema	481
Dicyemida	480
Didinium	638
„ nasutum	476, 639
Dileptus folium	743
„ *gigas*	524
„ *granulosus*	527
Dimastigoaulax	462
„ cornutus	462
Dimorpha	856
„ mutans	856
Dinamœba mirabilis	221
Dinema griseolum	437
„ *pusilla*	431
Dinenympha	555
„ gracilis	555
Dinobryon	409
Dinobryon gracile	411
Dinobryon juniperinum	412
Dinobryon petiolatum	278, 411
Dinobryon sertularia	409
Dinobryon sociale	411
Dinobryon stipitatum	410
Dinomonas	421
„ tuberculata	422
„ vorax	235, 422
Dinophysis	458
„ acuminata	459
„ acuta	459
„ arctica	460
„ atlantica	459
„ caudata	460
„ lævis	460
„ Michaelis	459
„ norvegica	459
„ ovata	460
Dinophysis rotundata	460
„ ventricosa	459
Diophrys marina	800
Diplomastix	431
„ affinis	433
„ caudata	432
„ saltans	433
Diplomita	289
Diplomita insignis	435
Diplomita socialis	289
Diplopsalis	859
„ lenticula	859
Diploselmis	435
Discocephalus rotatorius	800
Discophrya	568
Discostomata	35
Discostomata-Gymnozoida	325
Discostomata-Sarcocrypta	365
Distigma	418
„ proteus	418
Distigma proteus	418
„ *tenax*	418
„ *viridis*	418
Drepanomonas dentata	744
Drepanostoma striata	748
Drepanostomum pectinatum	861
Dysteria	752
Dysteria aculeata	755
Dysteria armata	478, 752

PAGE

Dysteria crassipes 755
„ *lanceolata* 754
„ *spinigera* 754
Dysteriidæ 751

Enchelyidæ 509
Enchelyodon 503
„ elongatus 504
Enchelyodon elongatus 521
Enchelyodon farctus 503
Enchelys 509
„ arcuata 510
Enchelys corrugatum 546
Enchelys farcimen 510
„ pupa 510
Enchelys pyriformis 536
„ *triquetra* 545
Endosphæra 808
Entodinium 653
Entosiphon 437
„ sulcatus 438
Ephelota 846
Ephelota apiculosa 847
Ephelota coronata 846
„ Trold 847
Epiclintes 773
„ auricularis 773
„ radiosa 774
„ retractilis 774
Epipyxis 409
„ utriculus 409
Epistylis 700
„ anastatica 701
Epistylis arabica 710
Epistylis articulata 701
„ balanorum 709
„ barba 709
Epistylis berberiformis 712
„ *botrytis* 334, 709
Epistylis branchiopyla 705
Epistylis brevipes 665
Epistylis coarctata 706
„ crassicollis 705
„ digitalis 704
„ euchlora 709
„ flavicans 702
„ galea 701
Epistylis grandis 702
„ *hospes* 714
Epistylis invaginata 706
„ leucoa 704
Epistylis minutus 710
„ *nebulifera* 665
Epistylis nympharum 708
„ pavonina 709
„ plicatilis 701
Epistylis pusilla 266
Epistylis pyriformis 707
Epistylis ringens 666
„ *sphæroides* 666
Epistylis Steinii 708
„ tubificis 707
Epistylis umbellatus 336
Epistylis umbilicata 706
Epistylis vegetans 710

PAGE

Epistylis virgaria 266
Ervilia fluviatilis 756
„ *legumen* 755
„ *monostyla* 755
Euchitonia 228
„ Bœkmanni 228
„ Gegenbauri 228
„ Köllikeri 228
„ Krohnii 228
„ Leydigii 228
„ Mülleri 228
„ Virchowii 228
Euchitonidæ 228
Euglena 379
„ acus 383
„ agilis 384
„ deses 383
„ fusiformis 384
„ geniculata 384
Euglena hispidula 388
„ *hyalina* 381
Euglena longicauda 387
Euglena mucronata 385
„ *obscura* 385
„ *ovum* 388
Euglena oxyuris 383
Euglena pyrum 387
Euglena rostrata 384
Euglena sanguinea 381
Euglena spirogyra 382
„ Supplementary 385
Euglena triqueter 387
Euglena tuba 385
„ viridis 381
Euglena zonalis 388
Euglenidæ 379
Euplotes 797
Euplotes appendiculatus 800
Euplotes charon 799
Euplotes excavatus 800
Euplotes harpa 799
„ longipes 799
Euplotes monostyla 755
Euplotes patella 798
Euplotidæ 792
Eustomata 35
Eustomata-Dimastiga 401
Eustomata-Monomastiga 367
Eutreptia 416
„ viridis 416

Fertilization of Seaweeds by Infusoria 862
Flagellata 216, 856
„ -Discostomata 324
„ -Eustomata 366
„ -Pantostomata 229
Folliculina 596
„ ampulla 597
„ Boltoni 600
„ elegans 598
„ hirundo 600
„ producta 599
„ stylifera 600
Foraminifera 45
Freia 597

PAGE

Freia aculeata 598
„ *Americana* 598
„ *ampulla* 598
„ *elegans* 599
Frontonia leucas 496

Gastrophysema dithalamium 160
Gastrostyla 783
„ setifera 784
„ Steinii 784
General History of Infusoria 1–30
Gerda 657
„ fixa 657
„ glans 657
Gerda inclinans 660
Glaucoma 795
„ margaritaceum 796
„ scintillans 795
Glaucoma Wrzesniowskii 533
Glenodinium 446
„ acuminatum 446
„ cinctum 446
„ Warmingii 859
Glenopolytoma typicum 304
Glycogen in Infusoria 863
Glyphidium marinum 426
Goniomonas 280
„ truncata 280
Gonostomum affinis 772
Gonyaulax 463
Grantia ciliata 173
Grantia compressa 173
Gymnodinium 442
Gymnodinium apiculatum 449
Gymnodinium corpusculum 443
„ fuscum 443
„ gracile 858
„ Lachmanni 444
„ marinum 444
„ monadicum 443
„ pulvisculus 443
„ roseolum 444
„ spirale 858
Gyrocoridæ 640
Gyrocoris 640
„ oxyura 640

Habrodon curvatus 494
Haliphysema Tumanowiczii 160
Halisarca lobularis 169, 335
Halteria 631
Halteria bipartita 633
Halteria grandinella 505, 632
„ lobata 633
Halteria pulex 636
Halteria verrucosa 632
„ viridis 632
„ volvox 632
Halteriidæ 630
Haptophrya 568
„ gigantea 569
„ planariarum 568
„ tritonis 571
Hedræophysa 274
„ bulla 274
Helicostoma 501
„ oblonga 501
Hemidinium 442
„ nasutum 442
Hemiophrya 822
„ Benedeni 824
„ crustaceorum 826
„ gemmipara 823
„ microsoma 825
„ pusilla 826
„ Thouleti 826
„ truncata 825
Herpetomonas 245
„ Lewisi 245
„ muscæ-domesticæ .. 245
Heteroaulax 463
Heteromastigidæ 463
Heteromastix 463
„ proteiformis 463
Heteromita 290
„ adunca 297
„ amyli 296
Heteromita angustata 298
„ *crassa* 435
Heteromita cylindrica 297
„ exigua 296
„ globosa 295
Heteromita granulum 292
Heteromita lens 291
„ ovata 295
„ pusilla 296
„ rostrata 293
„ sulcata 296
„ uncinata 294
Heteromitidæ 290
Heteronema 430
„ acus 430
„ globuliferum 430
„ marina 431
„ pusillum 431
Heterotricha 573
Hexamita 318
„ inflata 319
„ intestinalis 318
„ nodulosa 321
„ rostrata 320
Hexamitidæ 318
Himantophorus charon 800
Histology and Physiology 862
Histrio 789
„ similis 789
„ Steinii 789
Holophrya 498
„ brunnea 499
„ coleps 508
„ discolor 499
„ Kessleri 499
„ lateralis 500
„ ovum 498
Holophrya ovum 511
Holophrya tarda 499
Holosticha 769
„ flava 769
„ mystacea 769
„ oculata 770

	PAGE
Holosticha rubra	770
„ Wrzesniowskii	771
Holotricha	482, 484
„ -Astomata	556
Hoplitophrya	571
Hoplitophrya armata	571
Hoplitophrya falcifera	571
„ lumbrici	571
„ pungens	572
„ recurva	573
„ secans	572
„ securiformis	572
„ uncinata	571
Huxleya	757
„ crassa	758
Huxleya sulcata	757
Hydra convallaria	687
Hymenomonas	408
„ roseola	408
Hypotricha	739
Ichthyophthirius	530
„ multifiliis	530
Iduna	752
„ sulcata	752
Isotricha	497
„ intestinalis	497
„ microstoma	498
„ prostoma	497
Kerona	763
Kerona histrio	789
Kerona polyporum	763
Kolpoda cucullus	537
„ *pirum*	536
Künckelia gyrans	857
Labyrinthula	43
Lacrymaria	517
„ Cohnii	518
„ coronata	518
Lacrymaria elegans	520
„ *farcta*	517
„ *gutta*	517
Lacrymaria lagenula	517
Lacrymaria olor	517
„ *proteus*	517
„ *rugosa*	517
„ *tornatilis*	517
„ *versatilis*	516
Lagenella	389
„ *acuminata*	391
„ *euchlora*	390
Lagenœca	359
„ cuspidata	360
Lagenophrys	733
„ ampulla	733
„ nassa	733
„ vaginicola	733
Lagotia atro-purpurea	598
„ *hyalina*	598
„ *viridis*	598
Lagynus	520
„ elegans	521
„ lævis	521

	PAGE
Lembadion	536
„ bullinum	537
Lembadion duriusculum	537
Lembidæ	547
Lembus	547
„ elongatus	549
„ pusillus	548
„ subulatus	548
„ velifer	547
Leptodiscus	400
„ medusoides	400
Leptomonas	243
„ Bütschlii	243
Leucophrya nodulata	564
„ *signata*	501
Leucophrys	587
Leucophrys anodontæ	490
„ *carnium*	536
„ *clavata*	566
„ *cochleariformis*	566
„ *entozoon*	577
„ *nodulata*	565
Leucophrys patula	587
Leucophrys striata	565
Leucosolenia botryoides	173
„ coriacea	173
Licnophora	651
„ Auerbachii	651
„ Cohnii	652
Litonotidæ	742
Litonotus	742
„ diaphanus	745
„ fasciola	743
Litonotus folium	743
Litonotus varsaviensis	744
„ Wrzesniowskii	742
Lophomonas	321
„ blattarum	321
„ striata	322
Lophomonadidæ	321
Loxocephalus	488
„ granulosus	489
„ luridus	489
Loxodes	748
Loxodes brevis	747
„ *bursaria*	487
„ *cithara*	585
„ *cuculio*	747
„ *cucullulus*	747
„ *dentatus*	747
Loxodes rostrum	748
Loxophyllum	527
Loxophyllum amphileptus	743
Loxophyllum armatum	529
„ lamella	529
„ meleagris	528
„ rostratum	529
„ setigerum	530
„ Wrzesniowskii	528
Magosphæra	323
„ planula	323
Mallomonadidæ	464
Mallomonas	464
„ Fresenii	465

PAGE

Mallomonas Plosslii 412, 464
Maryna 520
„ socialis 520
Mastigamœba 221
„ aspera 221
„ monociliata 222
„ ramulosa 222
„ simplex 221
Melodinium 445
„ ruberrimum 445
Meniscostomum 539
„ stomioptycha 539
Menoidium 374
„ pellucidum 374
Merotricha 249
„ bacillata 249
Mesodinium 635
„ acarus 635
„ pulex 636
Mesotricha 783
Metacystis 511
„ truncata 511
Metopides 582
„ contorta 583
Metopus 581
Metopus inflatus 582
Metopus sigmoides 581
Microcystis Noltii 381
„ *olivacea* 381
Microglena 403
„ monadina 403
„ punctifera 403
Microthorax 796
Microthorax pusillus 796
Microthorax sulcatus 796
Mitophora 469
„ dubia 469
Mitra radiosa 775
Monadidæ 232
Monas 232
Monas amyli 296
„ *astasioides* 241
Monas attenuata 237
Monas bipunctata 238
Monas concava 237
Monas consociata 287
„ *consociatum* 362
Monas constricta 237
Monas cordata 241
„ *crepusculum* 240
„ *cylindrica* 240
Monas Dallingeri 233
„ depressa 240
Monas deses 371
„ *Dumalii* 241
Monas elongata 237
Monas enchelys 240
„ *erubescens* 240
„ *excavata* 241
„ *farcimen* 241
„ *flavicans* 402
Monas fluida 234
„ gibbosa 239
Monas gliscens 240
„ *globosa* 370

PAGE

Monas globulus 239
Monas grandis 393
„ *hilla* 241
„ *hyalina* 240
„ *inanis* 241
„ *intestinalis* 256
Monas irregularis 236
„ Kolpoda 238
„ lamellula 238
Monas lens 291
Monas mica 239
„ nitellarum 237
„ nodosa 239
„ Oberhauserii 238
„ obesa 236
„ oblonga 237
Monas ochracea 403
„ *Okeni* 238, 240
Monas ovalis 238
„ ovata 240
Monas ovum 370
Monas parasitica 236
Monas piscatorum 241
„ *prodigiosa* 241
Monas pulvisculum 240, 291
„ *punctum* 240, 291, 418
Monas ramulosa 235
Monas rotulus 241
„ *rubra* 239
Monas scintillans 241
Monas semen 392
„ *simplex* 241
„ *socialis* 240
Monas sphærica 240
Monas succissa 235, 240
„ *termo* 251
„ *truncata* 280
„ *umbra* 240
„ *urceolaris* 241
„ *uva* 301
Monas varians 237
„ vinosa 239
„ viridis 239
Monas vivipara 307
Monera 45
Monocystis tenax 418
Monosiga 329
„ angustata 330
„ brevipes 332
„ consociata 330
„ fusiformis 331
„ globosa 332
„ gracilis 331
„ longicollis 333
„ ovata 332
„ Steinii 331
Muscle or Nerve-fibres in Stylonychia mytilus 862
Mycetozoa 42, 187, 192, 470
Myxomycetes 42, 187, 192, 470

Nassula 494
„ ambigua 495
Nassula conica 495
„ *elegans* 495

PAGE

Nassula flava 495
„ lateritia 496
„ microstomata 496
„ ornata 494
„ rubens 495
Nephroselmis 405
„ olivacea 405
Nerve-fibres or Muscle in Stylonychia mytilus 862
Noctiluca 397
„ miliaris 397
Noctilucidæ 396
Nothopleurotricha setifera 784
Nuclearia simplex 421
Nyctotherus 579
„ cordiformis 580
„ gyœryanus 580
„ ovalis 580
„ velox 581

Oikomonas 250
„ mutabilis 250
„ obliqua 252
„ quadrata 254
„ rostrata 253
„ Steinii 253
„ termo 251
Onychaspis polystyla 793
Onychodromus 766
„ grandis 766
Opalina 558
„ caudata 563
„ dimidiata 561
Opalina discoglossi 571
Opalina intestinalis 562
Opalina lineata 564
„ *lumbrici* 565, 571
„ *mytili* 565
„ *naidos* 563
Opalina obtrigona 562
Opalina planariarum 569
„ *polymorpha* 569
„ *prolifera* 564
Opalina ranarum 559
Opalina recurva 573
„ *similis* 563
„ *uncinata* 571
Opalinidæ 476, 481, 556
Opalinopsis octopi 860
„ sepiolæ 860
Opercularia 710
„ arenicola 861
„ articulata 711
„ berberina 711
„ cylindrata 713
„ hospes 714
„ Lichtensteinii 712
„ microstoma 713
„ nutans 710
„ stenostoma 712
Ophidomonas 244
„ jenensis 244
„ sanguinea 244
Ophionella 734
„ picta 734

PAGE

Ophrydina 734
Ophrydium 735
Ophrydium Ædæ 738
Ophrydium Eichornii 737
Ophrydium longipes 737
Ophrydium sessile 738
„ versatile 735
Ophryodendridæ 849
Ophryodendron 849
„ abietinum 850
„ Belgicum 853
„ multicapitatum 854
„ pedicellatum 852
Ophryodendron pedunculatum 853
Ophryodendron porcellanum 852
„ sertulariæ 851
Ophryoglena 532
„ atra 532
„ acuminata 532
„ cæca 533
Ophryoglena citreum 535
„ *flavicans* 534
„ *griseo-virens* 533
Ophryoglena oblonga 533
„ Wrzesniowskii 533
Ophryoglenidæ 531
Ophryoscolecidæ 652
Ophryoscolex 653
„ inermis 653
„ Purkynjei 653
Opisthodon 749
„ niemeccensis 750
Opisthotricha 785
„ parallela 785
„ similis 785
Organization of Infusoria 49–117
Orthonectida 480
Otostoma 500
„ Carteri 500
Oxyrrhis 427
„ marina 427
Oxytricha 786
„ æruginosa 787
Oxytricha affinis 772
„ *auricularis* 773
„ *caudata* 780
„ *crassa* 768
Oxytricha fallax 787
„ ferruginea 786
Oxytricha flava 770
„ *fusca* 765
„ *gibba* 780
„ *Kessleri* 769
Oxytricha macrostyla 788
„ micans 787
Oxytricha multipes 765
„ *mystacea* 769
„ *parallela* 785
Oxytricha pellionella 786
Oxytricha pernix 768
Oxytricha platystoma 787
Oxytricha retractilis 774
„ *rubra* 770
Oxytricha scutellum 788
„ sordida 788

PAGE

Oxytricha strenua 771
„ *tubicola* 789
„ *urostyla* 765
„ *velox* 768
Oxytrichidæ 759

Pachytrocha 729
„ cothurnoides 729
Panophrys 533
„ chrysalis 534
Panophrys chrysalis 496
„ *conspicua* 534
„ *farcta* 534
Panophrys flava 534
„ flavicans 534
Panophrys griseola 534
„ *paramecioides* 534
„ *rubra* 496, 534
„ *sordida* 534
„ *zonalis* 534
Pantostomata 35
Pantostomata-Dimastiga 262
„ -Monomastiga 232
„ -Polymastiga 305
Pantotrichum lagenula 505
Paramæcidæ 483
Paramæcium 483
„ aurelia 483
„ bursaria 486
Paramæcium caudatum 486
„ *chrysalis* 488, 542
„ *coli* 578
„ *colpoda* 488
„ *compressum* 583
„ *cucullus* 538
Paramæcium glaucum 488
Paramæcium inversum 488
„ *kolpoda* 537
Paramæcium marinum 488
Paramæcium microstomum 488
„ *nucleus* 577
„ *ovale* 488
Paramæcium putrinum 488
Paramæcium stomioptycha 540
Paramonadidæ 367
Paramonas 370
„ deses 371
„ globosa 370
„ ovum 370
„ stellata 370
Peranema globulosa 225, 431
„ *protracta* 375
Peridiniidæ 441
Peridinium 447
„ æquale 451
„ apiculatum 449
Peridinium arcticum 454
„ *Carolinianum* 462
Peridinium chilophænum 450
Peridinium cinctum 446
„ *cornutum* 462
„ *corpusculum* 443
„ *cypripedium* 618
„ *depressum* 453
„ *divergens* 453

PAGE

Peridinium furca 455
„ *fuscum* 443
„ *fusus* 456
„ *inæquale* 444
„ *inerme* 444
„ *lineatum* 455
„ *macroceros* 454
„ *monadicum* 442
„ *monas* 444
„ *pulvisculus* 442
Peridinium reticulatum 449
„ sanguineum 450
„ spiniferum 449
„ splendor-maris 449
„ tabulatum 448
Peridinium uberrimum 445
„ *vorticella* 444
Perispira 511
„ ovum 511
Peritricha 620
Peritromidæ 758
Peritromus 759
„ Emmæ 759
Peronospora infestans 293
Petalomonas 371
„ abscissa 371
„ ervilia 372
„ irregularis 373
„ mediocanellata 371
„ sinuata 372
Petalotricha 627
„ ampulla 627
„ spiralis 629
Phacus 386
„ longicaudus 387
„ pleuronectes 386
„ pyrum 387
„ triqueter 387
Phalansteriidæ 361
Phalansterium 361
„ consociatum 362
„ digitatum 362
Phalansterium intestinum 287, 361
Phascolodon 745
„ vorticella 746
Phialina 519
„ vermicularis 519
„ viridis 519
Phialonema 373
„ cyclostomum 373
Phyllomitus 299
„ undulans 299
Physarum tussilaginis 470
Physemaria 162
Physomonas 263
„ marina 264
„ socialis 263
Pinacocoleps 506
Placus 489
„ striatus 490
Plagiomastix 424
Plagiopogon 508
„ coleps 508
Plagiopyla 538
„ Carteri 538

	PAGE
Plagiopyla fusca	539
„ nasuta	538
Plagiotoma	583
Plagiotoma acuminata	490
„ *blattarum*	580
„ *lateritia*	585
Plagiotoma lumbrici	583
Plagiotricha	771
„ affinis	772
„ strenua	772
Planicola	715
„ *ingenita*	717
Platycola	731
„ decumbens	731
„ dilatata	731
„ gracilis	732
„ longicollis	732
„ mollis	731
„ regularis	731
„ striata	732
„ truncata	732
Platytheca	262
„ micropora	262
Pleurochilidium	540
„ strigilatum	541
Pleuromonadidæ	249
Pleuromonas	248
„ jaculans	249, 270
Pleuronema	542
„ chrysalis	543
Pleuronema citrellus	545
Pleuronema coronata	544
Pleuronema crassa	543
„ *cyclidium*	545
Pleuronema marina	543
„ natans	543
Pleuronemidæ	542
Pleurotricha	782
„ echinata	783
„ grandis	782
„ lanceolata	783
Pleurotricha setifera	784
Plœotia vitrea	317
Plœsconia affinis	800
„ *charon*	800
„ *longiremis*	800
„ *radiosa*	800
„ *scutum*	797, 800
„ *subrotunda*	800
Podocyathus	827
„ diadema	827
Podophrya	813
„ astaci	819
„ Buckei	822
„ carchesii	818
„ conipes	815
„ cothurnata	815
Podophrya crustaceorum	826
Podophrya cyclopum	818
„ cylindrica	814
„ elongata	820
„ ferrum-equinum	813
„ fixa	813
Podophrya gemmipara	823
Podophrya infundibulifera	816
Podophrya infusionum	819
„ Leichtensteinii	818
„ libera	814
„ limbata	816
„ Lyngbyi	815
„ mollis	821
„ phryganidarum	818
Podophrya pusilla	826, 827
Podophrya pyrum	819
„ quadripartita	820
„ Steinii	815
Podophrya Trold	847
„ *truncata*	825
„ Wrzesniowskii	817
Podostoma	224
„ filigerum	225
Polykrikos	508
„ auricularia	859
„ Schwartzii	508, 860
Polyœca	360
„ dichotoma	360
Polystomata	35
Polytoma	301
Polytoma ocellata	304
Polytoma uvella	302
Polytoma virens	304
Polytomidæ	301
Poteriodendron petiolatum	278
Preservative Fluid for Infusoria, &c.	863
Proaulax	463
Proboscella	549
„ vermina	549
Prorocentrum	461
„ lima	462
„ micans	461
Prorocentrum viridis	462
Prorodon	491
„ armatus	492
„ edentatus	493
„ griseus	492
„ margaritifer	493
„ marinus	493
„ niveus	492
„ teres	492
Prorodontidæ	491
Proterospongia	858
Proteus tenax	418
PROTISTA	44
Protoceratium	859
„ aceros	859
Protococcus chalybius	381
„ *turgidus*	381
Protomyxomyces coprinarius	472
Protoperidinium	859
„ pellucidum	859
Protospongia	363
„ Haeckeli	363
Protozoa	31
Pseudospora	304
Pseudospora nitellarum	237, 304
„ *parasitica*	236, 304
„ *volvocis*	304
Pseudosporidæ	304
Psilotricha	762
„ acuminata	762

	PAGE
Ptychostomum	541
„ paludinarum	541
„ sænuridis	541
Pulsatella convolutæ	861
Pycnobryon socialis	272
Pyramimonas descissus	314
„ *rostrata*	313
Pyrocystis fusiformis	399
Pyrocystis pseudonoctiluca	399
Pyronema	375
Pyrsonema	554
„ vertens	554
Pyxicola	725
„ affinis	727
„ Carteri	729
„ furcifer	727
„ operculigera	725
„ pusilla	726
„ pyxidiformis	726
„ socialis	728
Pyxidium	666
„ cothurnoides	667
„ inclinans	667
Radio-Flagellata	225
Radiolaria	40
Raphidomonas	391
„ semen	392
Reptomonas	223
„ caudata	223
Rhabdostyla	664
„ brevipes	665
„ longipes	666
„ nebulifera	665
„ ovum	664
„ ringens	666
„ sertularium	665
„ sphæroides	666
Rhipidodendron	285
„ Huxleyi	286
„ splendidum	285
Rhizo-Flagellata	220
Rhizomonas	224
„ verrucosa	224
Rhodæssa grimselina	412
Rhopalura	481
Rhyncheta	806
„ cyclopum	806
Salpingœca	343
„ amphora	347
„ amphoridium	343
„ ampulla	349
„ Boltoni	259
„ campanula	357
„ Carteri	348
„ Clarkii	358
Salpingœca Clarkii	346
Salpingœca convallaria	357
„ cornuta	350
„ curvipes	355
„ cylindrica	348
„ fusiformis	346
„ gracilis	351
„ infusionum	356
Salpingœca inquillata	354
„ longipes	353
„ marina	352
„ minuta	347
„ napiformis	355
„ oblonga	358
„ petiolata	349
„ pyxidium	347
„ ringens	354
„ Steinii	346
„ teres	353
„ tintinnabulum	354
„ tuba	351
„ urceolata	353
„ Wallichi	348
Salpingœcidæ	342
Salpistes	590
„ *castaneus*	595
Scaphidiodon	750
„ navicula	750
Schizopus norvegicus	800
Schizosiphon	778
„ socialis	778
Scyphidia	658
„ Fromentellii	659
„ inclinans	659
Scyphidia inclinans	667
Scyphidia limacina	658
„ physarum	658
„ rugosa	659
Scytomonas	241
„ pusilla	241
Sisyridion cochliostoma	501
Solenophrya	828
„ crassa	828
Sparotricha vexillifer	861
Sphærophrya	808
„ hydrostatica	811
„ magna	808
Sphærophrya paramæciorum	810
Sphærophrya pusilla	808
„ sol	810
„ stentorea	810
„ stylonychiæ	810
„ urostylæ	809
Sphenomonas	438
„ octocostata	439
„ quadrangularis	439
Spirillum	244
Spirochona	660
„ gemmipara	660
„ Scheutenii	661
„ tintinnabulum	661
Spiromonas	297
„ angustata	298
„ distorta	298
„ volubilis	298
Spirostomidæ	583
Spirostomum	586
„ ambiguum	586
„ teres	586
Spirostomum filum	587
„ *virens*	587
„ *virescens*	587
Spongasteriscus	229

	PAGE
Plagiopyla fusca	539
„ nasuta	538
Plagiotoma	583
Plagiotoma acuminata	490
„ *blattarum*	580
„ *lateritia*	585
Plagiotoma lumbrici	583
Plagiotricha	771
„ affinis	772
„ strenua	772
Planicola	715
„ *ingenita*	717
Platycola	731
„ decumbens	731
„ dilatata	731
„ gracilis	732
„ longicollis	732
„ mollis	731
„ regularis	731
„ striata	732
„ truncata	732
Platytheca	262
„ micropora	262
Pleurochilidium	540
„ strigilatum	541
Pleuromonadidæ	249
Pleuromonas	248
„ jaculans	249, 270
Pleuronema	542
„ chrysalis	543
Pleuronema citrellus	545
Pleuronema coronata	544
Pleuronema crassa	543
„ *cyclidium*	545
Pleuronema marina	543
„ natans	543
Pleuronemidæ	542
Pleurotricha	782
„ echinata	783
„ grandis	782
„ lanceolata	783
Pleurotricha setifera	784
Plœotia vitrea	317
Plæsconia affinis	800
„ *charon*	800
„ *longiremis*	800
„ *radiosa*	800
„ *scutum*	797, 800
„ *subrotunda*	800
Podocyathus	827
„ diadema	827
Podophrya	813
„ astaci	819
„ Buckei	822
„ carchesii	818
„ conipes	815
„ cothurnata	815
Podophrya crustaceorum	826
Podophrya cyclopum	818
„ cylindrica	814
„ elongata	820
„ ferrum-equinum	813
„ fixa	813
Podophrya gemmipara	823
Podophrya infundibulifera	816
Podophrya infusionum	819
„ Leichtensteinii	818
„ libera	814
„ limbata	816
„ Lyngbyi	815
„ mollis	821
„ phryganidarum	818
Podophrya pusilla	826, 827
Podophrya pyrum	819
„ quadripartita	820
„ Steinii	815
Podophrya Trold	847
„ *truncata*	825
„ Wrzesniowskii	817
Podostoma	224
„ filigerum	225
Polykrikos	508
„ auricularia	859
„ Schwartzii	508, 860
Polyœca	360
„ dichotoma	360
Polystomata	35
Polytoma	301
Polytoma ocellata	304
Polytoma uvella	302
Polytoma virens	304
Polytomidæ	301
Poteriodendron petiolatum	278
Preservative Fluid for Infusoria, &c.	863
Proaulax	463
Proboscella	549
„ vermina	549
Prorocentrum	461
„ lima	462
„ micans	461
Prorocentrum viridis	462
Prorodon	491
„ armatus	492
„ edentatus	493
„ griseus	492
„ margaritifer	493
„ marinus	493
„ niveus	492
„ teres	492
Prorodontidæ	491
Proterospongia	858
Proteus tenax	418
PROTISTA	44
Protoceratium	859
„ aceros	859
Protococcus chalybius	381
„ *turgidus*	381
Protomyxomyces coprinarius	472
Protoperidinium	859
„ pellucidum	859
Protospongia	363
„ Haeckeli	363
Protozoa	31
Pseudospora	304
Pseudospora nitellarum	237, 304
„ *parasitica*	236, 304
„ *volvocis*	304
Pseudosporidæ	304
Psilotricha	762
„ acuminata	762

	PAGE
Ptychostomum	541
„ paludinarum	541
„ sænuridis	541
Pulsatella convolutæ	861
Pycnobryon socialis	272
Pyramimonas descissus	314
„ *rostrata*	313
Pyrocystis fusiformis	399
Pyrocystis pseudonoctiluca	399
Pyronema	375
Pyrsonema	554
„ vertens	554
Pyxicola	725
„ affinis	727
„ Carteri	729
„ furcifer	727
„ operculigera	725
„ pusilla	726
„ pyxidiformis	726
„ socialis	728
Pyxidium	666
„ cothurnoides	667
„ inclinans	667
Radio-Flagellata	225
Radiolaria	40
Raphidomonas	391
„ semen	392
Reptomonas	223
„ caudata	223
Rhabdostyla	664
„ brevipes	665
„ longipes	666
„ nebulifera	665
„ ovum	664
„ ringens	666
„ sertularium	665
„ sphæroides	666
Rhipidodendron	285
„ Huxleyi	286
„ splendidum	285
Rhizo-Flagellata	220
Rhizomonas	224
„ verrucosa	224
Rhodæssa grimselina	412
Rhopalura	481
Rhyncheta	806
„ cyclopum	806
Salpingœca	343
„ amphora	347
„ amphoridium	343
„ ampulla	349
„ Boltoni	259
„ campanula	357
„ Carteri	348
„ Clarkii	358
Salpingœca Clarkii	346
Salpingœca convallaria	357
„ cornuta	350
„ curvipes	355
„ cylindrica	348
„ fusiformis	346
„ gracilis	351
„ infusionum	356
Salpingœca inquillata	354
„ longipes	353
„ marina	352
„ minuta	347
„ napiformis	355
„ oblonga	358
„ petiolata	349
„ pyxidium	347
„ ringens	354
„ Steinii	346
„ teres	353
„ tintinnabulum	354
„ tuba	351
„ urceolata	353
„ Wallichi	348
Salpingœcidæ	342
Salpistes	590
„ *castaneus*	595
Scaphidiodon	750
„ navicula	750
Schizopus norvegicus	800
Schizosiphon	778
„ socialis	778
Scyphidia	658
„ Fromentellii	659
„ inclinans	659
Scyphidia inclinans	667
Scyphidia limacina	658
„ physarum	658
„ rugosa	659
Scytomonas	241
„ pusilla	241
Sisyridion cochliostoma	501
Solenophrya	828
„ crassa	828
Sparotricha vexillifer	861
Sphærophrya	808
„ hydrostatica	811
„ magna	808
Sphærophrya paramæciorum	810
Sphærophrya pusilla	808
„ sol	810
„ stentorea	810
„ stylonychiæ	810
„ urostylæ	809
Sphenomonas	438
„ octocostata	439
„ quadrangularis	439
Spirillum	244
Spirochona	660
„ gemmipara	660
„ Scheutenii	661
„ tintinnabulum	661
Spiromonas	297
„ angustata	298
„ distorta	298
„ volubilis	298
Spirostomidæ	583
Spirostomum	586
„ ambiguum	586
„ teres	586
Spirostomum filum	587
„ *virens*	587
„ *virescens*	587
Spongasteriscus	229

	PAGE
Plagiopyla fusca	539
„ nasuta	538
Plagiotoma	583
Plagiotoma acuminata	490
„ *blattarum*	580
„ *lateritia*	585
Plagiotoma lumbrici	583
Plagiotricha	771
„ affinis	772
„ strenua	772
Planicola	715
„ *ingenita*	717
Platycola	731
„ decumbens	731
„ dilatata	731
„ gracilis	732
„ longicollis	732
„ mollis	731
„ regularis	731
„ striata	732
„ truncata	732
Platytheca	262
„ micropora	262
Pleurochilidium	540
„ strigilatum	541
Pleuromonadidæ	249
Pleuromonas	248
„ jaculans	249, 270
Pleuronema	542
„ chrysalis	543
Pleuronema citrellus	545
Pleuronema coronata	544
Pleuronema crassa	543
„ *cyclidium*	545
Pleuronema marina	543
„ natans	543
Pleuronemidæ	542
Pleurotricha	782
„ echinata	783
„ grandis	782
„ lanceolata	783
Pleurotricha setifera	784
Plœotia vitrea	317
Plæsconia affinis	800
„ *charon*	800
„ *longiremis*	800
„ *radiosa*	800
„ *scutum*	797, 800
„ *subrotunda*	800
Podocyathus	827
„ diadema	827
Podophrya	813
„ astaci	819
„ Buckei	822
„ carchesii	818
„ conipes	815
„ cothurnata	815
Podophrya crustaceorum	826
Podophrya cyclopum	818
„ cylindrica	814
„ elongata	820
„ ferrum-equinum	813
„ fixa	813
Podophrya gemmipara	823
Podophrya infundibulifera	816
Podophrya infusionum	819
„ Leichtensteinii	818
„ libera	814
„ limbata	816
„ Lyngbyi	815
„ mollis	821
„ phryganidarum	818
Podophrya pusilla	826, 827
Podophrya pyrum	819
„ quadripartita	820
„ Steinii	815
Podophrya Trold	847
„ *truncata*	825
„ Wrzesniowskii	817
Podostoma	224
„ filigerum	225
Polykrikos	508
„ auricularia	859
„ Schwartzii	508, 860
Polyœca	360
„ dichotoma	360
Polystomata	35
Polytoma	301
Polytoma ocellata	304
Polytoma uvella	302
Polytoma virens	304
Polytomidæ	301
Poteriodendron petiolatum	278
Preservative Fluid for Infusoria, &c.	863
Proaulax	463
Proboscella	549
„ vermina	549
Prorocentrum	461
„ lima	462
„ micans	461
Prorocentrum viridis	462
Prorodon	491
„ armatus	492
„ edentatus	493
„ griseus	492
„ margaritifer	493
„ marinus	493
„ niveus	492
„ teres	492
Prorodontidæ	491
Proterospongia	858
Proteus tenax	418
PROTISTA	44
Protoceratium	859
„ aceros	859
Protococcus chalybius	381
„ *turgidus*	381
Protomyxomyces coprinarius	472
Protoperidinium	859
„ pellucidum	859
Protospongia	363
„ Haeckeli	363
Protozoa	31
Pseudospora	304
Pseudospora nitellarum	237, 304
„ *parasitica*	236, 304
„ *volvocis*	304
Pseudosporidæ	304
Psilotricha	762
„ acuminata	762

	PAGE
Ptychostomum	541
„ paludinarum	541
„ sænuridis	541
Pulsatella convolutæ	861
Pycnobryon socialis	272
Pyramimonas descissus	314
„ *rostrata*	313
Pyrocystis fusiformis	399
Pyrocystis pseudonoctiluca	399
Pyronema	375
Pyrsonema	554
„ vertens	554
Pyxicola	725
„ affinis	727
„ Carteri	729
„ furcifer	727
„ operculigera	725
„ pusilla	726
„ pyxidiformis	726
„ socialis	728
Pyxidium	666
„ cothurnoides	667
„ inclinans	667
Radio-Flagellata	225
Radiolaria	40
Raphidomonas	391
„ semen	392
Reptomonas	223
„ caudata	223
Rhabdostyla	664
„ brevipes	665
„ longipes	666
„ nebulifera	665
„ ovum	664
„ ringens	666
„ sertularium	665
„ sphæroides	666
Rhipidodendron	285
„ Huxleyi	286
„ splendidum	285
Rhizo-Flagellata	220
Rhizomonas	224
„ verrucosa	224
Rhodæssa grimselina	412
Rhopalura	481
Rhyncheta	806
„ cyclopum	806
Salpingœca	343
„ amphora	347
„ amphoridium	343
„ ampulla	349
„ Boltoni	259
„ campanula	357
„ Carteri	348
„ Clarkii	358
Salpingœca Clarkii	346
Salpingœca convallaria	357
„ cornuta	350
„ curvipes	355
„ cylindrica	348
„ fusiformis	346
„ gracilis	351
„ infusionum	356
Salpingœca inquillata	354
„ longipes	353
„ marina	352
„ minuta	347
„ napiformis	355
„ oblonga	358
„ petiolata	349
„ pyxidium	347
„ ringens	354
„ Steinii	346
„ teres	353
„ tintinnabulum	354
„ tuba	351
„ urceolata	353
„ Wallichi	348
Salpingœcidæ	342
Salpistes	590
„ *castaneus*	595
Scaphidiodon	750
„ navicula	750
Schizopus norvegicus	800
Schizosiphon	778
„ socialis	778
Scyphidia	658
„ Fromentellii	659
„ inclinans	659
Scyphidia inclinans	667
Scyphidia limacina	658
„ physarum	658
„ rugosa	659
Scytomonas	241
„ pusilla	241
Sisyridion cochliostoma	501
Solenophrya	828
„ crassa	828
Sparotricha vexillifer	861
Sphærophrya	808
„ hydrostatica	811
„ magna	808
Sphærophrya paramæciorum	810
Sphærophrya pusilla	808
„ sol	810
„ stentorea	810
„ stylonychiæ	810
„ urostylæ	809
Sphenomonas	438
„ octocostata	439
„ quadrangularis	439
Spirillum	244
Spirochona	660
„ gemmipara	660
„ Scheutenii	661
„ tintinnabulum	661
Spiromonas	297
„ angustata	298
„ distorta	298
„ volubilis	298
Spirostomidæ	583
Spirostomum	586
„ ambiguum	586
„ teres	586
Spirostomum filum	587
„ *virens*	587
„ *virescens*	587
Spongasteriscus	229

PAGE

Spongasteriscus quadricornis 229
„ tetraceras 229
Sponges, Nature and Affinities .. 143–194
Spongida 365
Spongocyclia 228
„ charybdæa 229
„ cycloides 229
„ elliptica 229
„ orthogona 229
„ scyllæa 229
Spongomonadidæ 284
Spongomonas 286
„ discus 287
„ intestinalis 287
„ sacculus 288
„ uvella 288
Spontaneous Generation 118–142
Spumella 305
„ guttula 305
Spumella neglecta 305
„ *termo* 305
Spumella vivipara 306
Spumella vulgaris 305
Spumellidæ 305
Squamulina scopula 160
Steinia ferruginea 787
„ *platystoma* 787
Stentor 588
Stentor albus 596
Stentor amethystinus 861
Stentor anceps 596
Stentor auricula 595
„ Barretti 593
Stentor cucullus 596
Stentor cæruleus 593
Stentor deformis 596
„ *elegans* 596
„ *fimbriatus* 596
„ *fuscus* 596
Stentor igneus 594
Stentor Mülleri 590
Stentor multiformis 595
Stentor nanus 596
Stentor niger 594
„ pediculatus 596
„ polymorphus 590
Stentor pygmæus 407
Stentor Rœselii 591
Stentor roseus 596
Stentoridæ 588
Stephanomonadidæ 465
Stephanomonas 466
„ locellus 466
Sterromonas 420
„ Bütschlii 421
„ formicina 420
Stichochæta 775
Stichochæta cornuta 776
„ pediculiformis 775
Stichotricha 775
„ aculeata 777
„ cornuta 776
„ marina 778
„ remex 777
„ secunda 776

PAGE

Stichotricha socialis 778
Strombidinopsis 613
„ gyrans 614
Strombidium 633
„ acuminatum 634
„ Bütschlii 634
„ caudatum 635
„ Claparedi 634
„ globosum 635
Strombidium polymorphum 582
Strombidium sulcatum 633
„ turbo 634
„ urceolare 634
„ viride 635
Strongylidium 779
„ crassum 779
Stylobryon 278
„ epistyloides 279
Stylobryon insignis 278
Stylobryon petiolatum 278
Stylochona 662
„ coronata 663
„ nebalina 662
Stylochrysalis 405
„ parasita 405
Stylocola 730
„ ampulla 730
„ striata 730
Stylonethes 782
„ tardus 782
Stylonychia 790
Stylonychia appendiculatus 800
„ *echinata* 783
Stylonychia fissiseta 791
Stylonychia histrio 789
„ *lanceolata* 783
Stylonychia macrostyla 791
„ mytilus 790
„ pustulata 791
Styloplotes 800
„ appendiculatus 800
Sub-kingdom Protozoa 31–48
Sycandra raphanus 180, 181
Sycon ciliatum 173
Syncrypta 413
„ volvox 413
Synura 411
„ uvella 412

Telotrochidium 478, 643
„ crateriforme 643
Tentaculifera 40, 801
„ -Actinaria 846
„ -Suctoria 806
Tetramitidæ 312
Tetramitus 313
„ descissus 314
„ rostratus 313
„ sulcatus 314
Tetraselmis 315
„ cordiformis 315
Thuricola 718
„ folliculata 718
„ operculata 719
„ valvata 718

	PAGE
Tillina	513
„ magna	514
Tintinnidium	611
„ fluviatile	611
„ marinum	611
„ semiciliatum	612
Tintinnodæ	603
Tintinnopsis	617
„ beroidea	617
Tintinnus	603
„ acuminatus	606
„ amphora	606
Tintinnus ampulla	610, 627
Tintinnus annulatus	609
„ campanula	617, 609
„ cinctus	616, 608
„ cothurnia	608
„ denticulatus	607
„ Ehrenbergii	607
Tintinnus fluviatilis	611
Tintinnus helix	608
„ inquilinus	604
„ lagenula	608
„ mediterraneus	610
„ mucicola	605
„ obliquus	606
„ quadrilineatus	607
Tintinnus spiralis	610, 627
Tintinnus Steenstrupii	606
„ subulatus	605
„ urnula	609
„ Ussowi	609
„ ventricosus	609
Torquatella	621
„ typica	621
Torquatellidæ	621
Tracheliidæ	522
Trachelius	522
Trachelius anas	525
„ *apiculatum*	502
„ *dendrophilus*	378, 523
„ *falx*	527
„ *globulifer*	431
„ *lamella*	529
„ *meleagris*	526
Trachelius ovum	522
Trachelius pusillus	503
„ *striatus*	522
„ *stricta*	529
„ *teres*	521
„ *trichophora*	376, 523
Trachelocerca	514
Trachelocerca biceps	515
„ *linguifera*	515
Trachelocerca olor	515
„ phœnicopterus	516
Trachelocerca sagitta	516
Trachelocerca tenuicollis	517
„ versatilis	516
Trachelocerca viridis	515
Trachelocercidæ	514
Trachelomonas	388
„ acuminata	391
Trachelomonas areolata	391
Trachelomonas armata	390
Trachelomonas aspera	391
Trachelomonas bulla	391
„ caudata	391
„ cylindrica	390
„ curystoma	390
„ hispida	390
„ lagenella	389
Trachelomonas nigricans	390
Trachelomonas rugulosa	389
„ volvocina	389
Trachelophyllidæ	502
Trachelophyllum	502
„ apiculatum	502
„ pusillum	503
Tremella pruniformis	736
Trepomonadidæ	300
Trepomonas	300
„ agilis	248, 300
Trichoda	535
Trichoda æthiopica	536
„ *ambigua*	519
„ *anas*	525
„ *angulata*	536
„ *asiatica*	536
Trichoda carnium	536
Trichoda charon	800
Trichoda cimex	800
„ *fixa*	813
„ *fœta*	767
„ *gibba*	767
„ *grandinella*	632
„ *index*	525
„ *inquilinus*	603
„ *nasamomum*	536
„ *navicula*	751
„ *patula*	587
„ *paxillus*	511
„ *pellionella*	786
Trichoda pirum	536
Trichoda piscis	780
Trichoda pura	535
Trichoda transfuga	797
„ *versatilis*	516
Trichodina	645
„ baltica	649
„ digitodiscus	649
Trichodina grandinella	632
Trichodina pediculus	646
„ scorpæna	649
„ Steinii	648
Trichodina tentaculata	640
„ *volvox*	632
„ *vorax*	746
Trichodinopsidæ	614
Trichodinopsis	614
„ paradoxa	614
Trichogaster	764
„ pilosus	764
Trichomonas	308
„ batrachorum	308
Trichomonas hirsuta	466
Trichomonas limacis	309
Trichomonas locellus	466
„ *minima*	466
Trichomonas vaginalis	309

PAGE

Trichonema 469
„ hirsuta 469
Trichonemidæ 468
Trichonympha 552
„ agilis 552
Trichonymphidæ 551
Trichophrya 811
„ digitata 812
„ epistylidis 811
Trichophrya Ophrydii 813
Trichopus 758
„ dysteria 758
Trimastigidæ 307
Trimastix 312
„ marinus 312
Trochilia 756
„ marina 757
„ palustris 757
„ polonica 757
„ sigmoides 757
Tropidocyathus octocostatus 439
Tropidocyphus 438
Trypanosoma 218
„ Eberthi 219
„ sanguinis 219
Trypanosomata 218

Undulina ranarum 219
Urceolaria 649
„ mitra 650
Urceolariidæ 645
Urceolus Alenizini 857
Urnula 807
„ epistylidis 807
Urocentrum 641
„ turbo 476, 641
Uroglena 414
„ volvox 414
Uroleptus 779
„ agilis 781
„ gibbus 780
„ mobilis 781
„ musculus 779
„ piscis 780
„ rattulus 780
„ violaceus 781
Uronema 546
„ marinum 546
Uronychia 797
„ transfuga 797
Urostyla 764
„ flavicans 766
„ grandis 765
„ viridis 765
„ Weissii 764
Urotricha 504
„ farcta 505
„ lagenula 505
Uvella 406
Uvella chamæmorus 267
„ *disjuncta* 341
„ *uva* 267
„ *virescens* 412

Vaginicola 714

PAGE

Vaginicola attenuata 717
„ crystallina 715
Vaginicola decumbens 731
Vaginicola gigantea 716
„ globosa 716
„ grandis 716
„ inclinata 717
„ ingenita 717
„ tincta 716
Vaginicola valvata 718
Vaginicola vestita 717
Vaginicolina 714
Vasicola 613
„ ciliata 613
Vibrio 244
Vibrio cygnus 515
„ *olor* 515
„ *proteus* 515
„ *verminus* 548, 550
Volvox vegetans 267
Vorticella 667
„ alba 676
Vorticella ampulla 598
„ *anastatica* 701
„ *annularis* 689
Vorticella aperta 680
„ appuncta 688
Vorticella berberina 712
Vorticella brevistyla 675
„ campanula 678
„ chlorostigma 686
„ citrina 678
„ communis 681
„ constricta 682
„ convallaria 686
„ crassicaulis 676
„ cratera 679
Vorticella crateriformis 644
Vorticella cucullus 677
Vorticella cyathina 689
Vorticella dilatata 681
„ dubia 676
„ elongata 686
„ fasciculata 681
„ fluvialis 676
Vorticella folliculata 719
„ *gemella* 680
Vorticella globularia 681
„ gracilis 675
„ hamata 678
Vorticella hians 690
„ *inclinans* 557, 659
„ *infusionum* 684
Vorticella longifilum 677
„ mamillata 682
„ margaritifera 682
Vorticella margaritata 688
Vorticella marina 685
„ microscopica 688
„ microstoma 683
„ monilata 688
Vorticella multangula 686
„ *multiformis* 595
„ *nasuta* 639
Vorticella nebulifera 673

	PAGE
Vorticella nutans	679
„ patellina	679
„ picta	675
Vorticella polymorphus	591
„ *polypina*	691
Vorticella procumbens	680
„ putrinum	684
Vorticella pyriformis	659
„ *pyrum*	685
Vorticella quadrangularis	685
Vorticella ringens	659
Vorticella spectabilis	687
„ sphærica	681
„ striata	684
„ telescopica	677
Vorticella vaginata	605
„ *versatilis*	736
Vorticellidæ	654
Vorticellina	657
Wagnerella cylindroconica	639
Zoothamnium	693
Zoothamnium affine	698
„ alternans	695
„ arbuscula	694
„ aselli	698
„ carcini	700
„ Cienkowskii	696
„ dichotomum	697
„ elegans	699
„ gleniscum	697
„ macrostylum	699
„ marinum	700
„ niveum	694
„ nutans	698
„ parasita	698
„ pictum	699
Zoothamnium plumosum	695
Zoothamnium simplex	700
Zoothamnium spirale	695
Zygoselmidæ	416
Zygoselmis	417
„ inæqualis	417
„ nebulosa	417

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