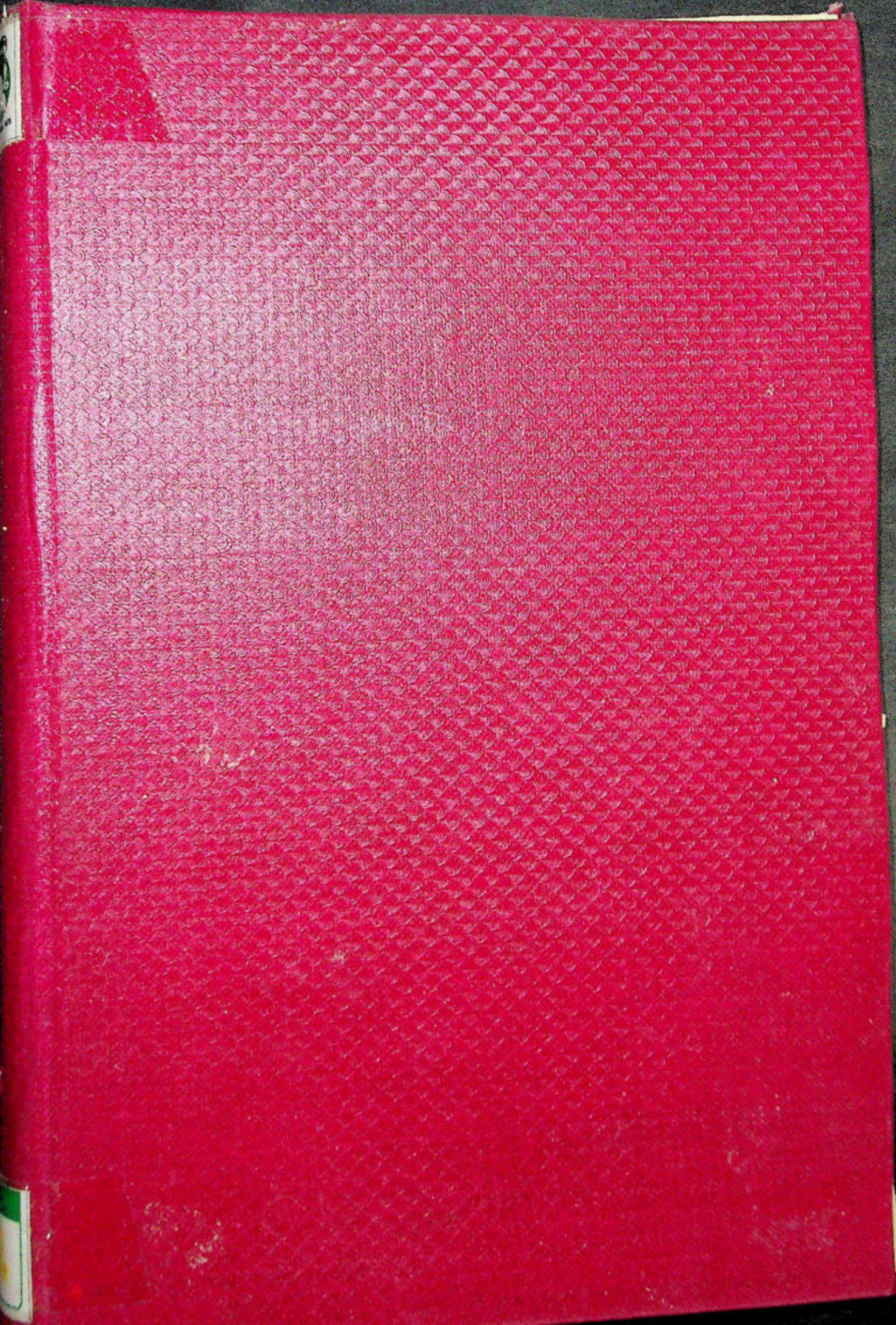




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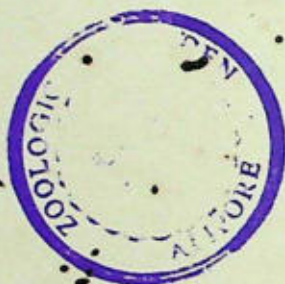
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CONTENTS.

PART I. Published 26th February, 1916.

	Page
On some undescribed Aphides from the collection of the Indian Museum	1
On some Indian Cestoda, Pt. II.	5
Notes on Oriental Dragonflies in the Indian Museum, No. 4	21
Report on a collection of Mollusca from the Cochin and Ennur backwaters	27
V. Four new species of <i>Anlacobolus</i> Poc. (Diplopoda: Spirobolidae) from India	41
VI. On the Hydrozoon <i>Campanulina ceylonensis</i> (Browne)	49

PART II. Published 28th March, 1916.

VII. The Evolution and Distribution of the Indo-Australian Thelyphonidae, with notes on the distinctive characters of various species	59
VIII. Report on a small collection of Marine Mollusca dredged in shallow water in the Andaman Islands	87

PART III. Published 19th May, 1916.

IX. A new <i>Chlamys</i> from Calcutta	101
X. Description of two new Fish from the Chilka Lake	105
XI. Description de la larve de <i>Lasiodactylus chevrolati</i> , Reitt (Coleoptera, Nitidulidae)	109
XII. Contributions to a knowledge of the Terrestrial Isopoda of India, Pt. II	115

PART IV. Published 31st August, 1916.

XIII. Notes on Indian Odonata	129
XIV. Some Lignicolous Beetle-Larvae from India and Borneo	137

PART V. Published 27th September, 1916.

XV. Notes on the Ciliate Protozoa of Lahore	177
XVI. The Cephalopoda of the Indian Museum	185

PART VI. *Published 31st October, 1916.*

	<i>Page</i>
XVII. Notes on the Freshwater Fish of Madras ..	249
XVIII. Studies in Indian Helminthology, No. III ..	295

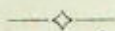
PART VII. *Published 16th November, 1916.*

XIX. On a collection of Oligochaeta belonging to the Indian Museum ..	
---	--

PART VIII. *Published 18th December, 1916.*

XX. } Notes on Crustacea, Decapoda in the Indian Museum	
XXI. }	
VI.—Indian Crangonidae ..	
VII.—Further Notes on Hippolytidae ..	

LIST OF PLATES.



	<i>Follow page</i>
Plates I—IV (Thelyphonidae)	86
Plates V—VII (Hydrozoa)	58
Plate VIII (Crustacea Decapoda)	384
Plates IX—XIX (Isopoda)	128
Plates XX—XXII (Beetle-Larvæ)	176
Plates XXIII—XXIV (Cephalopoda)	248
Plates XXV—XXIX (Fish)	294
Plates XXX—XXXIII (Oligochaeta)	354
Plates XXXIV—XXXV (Cestoda)	298
Plate XXXVI (Crustacea Decapoda)	406

LIST OF AUTHORS.

	Page
ANNANDALE, N., D.Sc.	
On the Hydrozoon <i>Campanulina ceylonensis</i> (Browne). I.—	
The Systematic Position and Synonymy of the species ..	49
BHATIA, B. L., M.Sc.	
Notes on the Ciliate Protozoa of Lahore ..	177
CHAUDHURI, B. L., D.Sc.	
Descriptions of two new Fish from the Chilka Lake ..	185
COLLINGE, W. E., M.Sc.	
Contributions to a knowledge of the Terrestrial Isopoda of India, Pt. II ..	115
GOOT, P. van der.	
On some undescribed Aphides from the collection of the Indian Museum. ..	I
GRAVELY, F. H., M.Sc.	
The Evolution and Distribution of the Indo-Australian Thelyphonidae, with notes on the distinctive characters of various species ..	59
Some Lignicolous Beetle-Larvae from India and Borneo ..	137
KEMP, S., B.A.	
Notes on Crustacea Decapoda in the Indian Museum:—	
VI.—Indian Crangonidae ..	355
VII.—Further Notes on Hippolytidae ..	385
LAIDLAW, F. F.	
Notes on Oriental Dragonflies in the Indian Museum, No. 4 ..	21
Notes on Indian Odonata ..	129
LLOYD, R. E., M.B., D.Sc.	
On the Hydrozoon <i>Campanulina ceylonensis</i> (Browne). II.—	
Life History of the Hydroid and Medusa ..	52
MASSY, ANNE L.	
The Cephalopoda of the Indian Museum ..	185
MAULIK, S., B.A.	
A new <i>Chlamys</i> from Calcutta ..	101
PEYERIMHOFF, P. de.	
Description de la larve de <i>Lasiodactylus chevrolati</i> , Reitt. (Coleoptera, Nitidulidae) ..	109

	<i>Page</i>
PRESTON, H. B., F.Z.S.	
Report on a collection of Mollusca from the Cochin and Ponnur backwaters	27
Report on a small collection of Marine Mollusca dredged in shallow water in the Andaman Islands	87
SILVESTRI, F.	
Four new species of <i>Aulacobolus</i> Poc. (Diplopoda: Spiro- bolidae) from India	41
SOUTHWELL, T. A.R.C.Sc., F.Z.S., F.L.S.	
On some Indian Cestoda, Pt. II	5
STEPHENSON, J., M.B., D.Sc.	
On a collection of Oligochaeta belonging to the Indian Museum	200
STEWART, F. H., D.Sc.	
Studies on Indian Helminthology, No. III	205
SUNDARA RAJ, B., M.A.	
Notes on the Freshwater Fish of Madras	249

INDEX.

N.B.—An asterisk (*) preceding a line denotes a new variety or subspecies; a dagger (†) indicates a new species; a double dagger (‡) a new genus or subgenus: synonyms are printed in italics.

A		Page
Abalius ..	62, 62, 77, 78, 82	
manilanus ..	78, 81	
nasutus ..	81	
ohdei ..	78, 81	
samoanu ..	78, 81	
willeyi ..	78, 81	
Abothrium crassum ..	6	
fragile ..	6	
rugosum ..	6	
Abralia andamanica ..	239	
trigonura ..	240	
Acanthocirrus macropeos ..	13	
macrostratus ..	13	
Acanthosepion hasselti ..	223	
Aceraius ..	139	
grandis hirsutus ..	142, 143	
helferi ..	143	
kuwertii ..	142	
pilifer ..	143	
Acmaeodera adpersula ..	152	
Aegeon ..	355, 374, 375, 383	
<i>affine</i> ..	376	
andamanense ..	375, 379	
bengalense ..	375, 379	
cataphractus ..	375, 376, 378	
habererii ..	374, 375	
lacazei ..	374, 375	
medium ..	376, 377, 378	
obsoletum ..	376, 377	
orientalis ..	374, 375, 378	
pennata ..	375, 376, 377	
propensalata ..	375, 376, 377	
Aegeon (Parapontocaris) anda-		
manense ..	379	
bengalense ..	379	
Aegus ..	150	
roepstorffii ..	147, 149, 150	
Aesalus scarabaeoides ..	147	
Agrilus anxius ..	155	
auricollis ..	155	
granulatus ..	155	
ruficollis ..	155	
Agrioninae ..	21, 129	
Akidinae ..	158	
Akis bacanozzo ..	158	
punctata ..	158	
reflexa ..	158	
Alaba rectangulata ..	30	
Albula conorhynchus ..	253	
vulpes ..	253	
Alectrion unicolorata ..	28	
Aleochara bilineata ..	150	
Alope ..	387	
Alphitobius diaperinus ..	168	
<i>fagi</i> ..	169	
<i>mauritanicus</i> ..	169	
<i>piceus</i> ..	169	
Alphitophagus bitasciatus ..	167	
Ambassia ambassia ..	251, 279	
<i>commersoni</i> ..	279	
<i>miops</i> ..	251, 279	
<i>myops</i> ..	279	
<i>ranga</i> ..	251, 278	
Amblypharyngodon ..	259	
<i>microlepis</i> ..	251, 260	
<i>mola</i> ..	251, 260	
Amia calva ..	15	
Amphibia ..	14	
Amphicotylinae ..	5, 6	
<i>Amphilephus fasciola</i> ..	181	
Amphiprion percula ..	390	
<i>Amphiprion elegans</i> ..	7	
Anabantidae ..	251	
Anabas scandens ..	250, 251, 276, 277, 278	
Anaitis calophylla ..	95	
Anatinacea ..	39, 99	
Ancyllocaris ..	390	
<i>aberrans</i> ..	389, 390	
<i>Ancyllocheira douei</i> ..	153	
<i>Angasia armata</i> ..	399	
Anguilla ..	265	
<i>australis</i> ..	251, 266	
<i>bengalensis</i> ..	265	
<i>bicolor</i> ..	266	
<i>elphinstonei</i> ..	251, 265, 266	
Anguillidae ..	251	
Anomalocardia squamosa ..	36	
Anomia ..	35	
Anoplocephalinae ..	18	
<i>Anthaxia inculta</i> ..	154	
<i>umbellatulum</i> ..	154	
Aphanisticus consanguineus ..	155	
<i>krugeri</i> ..	155	
Aphididae ..	1	
Aplocheili ..	270	
<i>Aplocheilus melanostigma</i> ..	294	
<i>panchax</i> ..	294	
<i>rubrostigma</i> ..	268	
Aplustridae ..	93	
Arachnida ..	84	
Arca ..	93	

[illegible]

	Page
Cheraphilus ..	355
Chiffiera ..	182
Chione imbricata ..	36
marmorata ..	36
Chiroteuthidae ..	243
Chiroteuthis (Chirothauma) im- rator ..	243
Chlamydinæ ..	101
Chlamydodonta ..	182
Chlamys ..	101
†gravelyi ..	101, 102
Chrysobothris affinis ..	154
dentipes ..	154
femorata ..	154
Chrysoceroa (Megaloxantha) bi- color gigantea ..	152
Chrysomelidae ..	101
Chrysophlegma flavinucha ..	11
Cichlidae ..	251
Ciliata ..	177
Cirrhinia reba ..	251, 254
Cirroteuthidae ..	186
Cirroteuthis grimaldii ..	186, 247
macrope ..	187
meangensis ..	186
Cistopus bursarius ..	204
indicus ..	204, 205
Clarius batrachus ..	256, 262
magur ..	262
Clupea finta ..	6
ilisha ..	252
Clupeidae ..	251
Cobitidae ..	251
Codokia fischeriana ..	37
Coelenterata ..	56
Coenagrioninae ..	129
Coleoptera ..	59, 109
Colepina ..	180
Coleps hirtus ..	180
Colpoda cucullus ..	182
Conchacea ..	35, 94
†Conradia cancellata ..	30
Coraebus bifasciatus ..	154
Corallioeraugon ..	384
†Corbicula cochlinensis ..	36
Corvus macrorhynchus ..	8, 9, 16
splendens ..	9
Cotugnia ..	8
digonopora ..	8
Cranchiidae ..	245
Crangon ..	355, 379, 383, 384
affinis ..	380
cassiope ..	380
consobrinus ..	380
crangon ..	379, 380, 381
hakodatei ..	380
propinquus ..	380
Crangonidae ..	355, 383, 384
Cricelomys gambianus ..	18
Cristovomer namaycush ..	15
Crustacea Decapoda ..	355, 385
Crypticinae ..	164
Crypticus glaber ..	164
quisquilius ..	164
Cryptocheles ..	392
Cubaridae ..	126
Cubaris ..	115, 117, 119, 123, 126
falbolateralis ..	115, 125

		Page
†Cubaris brunneo caudatus	115,	121, 123
†cavernosus	..	115, 123
†chiltoni	..	115, 122, 123
†dilectum	..	115, 120
†expansus	..	115, 119
†gravelii	..	115, 118
†lobatus	..	115, 124, 125
†pusillus	..	115, 120
solidulus	..	122
Cucujidae	..	150
Cultellus subellipticus	..	37
Cuspidaria annandalei	..	39
†cochlinensis	..	39
Cuspidariidae	..	39, 9
Cyclodina	..	180
Cyclostrema micans	..	33
Cyclostrematidae	..	33
Cylindna cylindracea	..	92
†Cylindrella syngenes	..	92
Cyprinidae	..	251, 278
Cyprinodontidae	..	251
Cyrenidae	..	36
Cysticercus cellulosae	..	16
fasciolaris	..	16, 17
pisiformis	..	16

D

<i>Davainea</i> ..	..	7, 8
<i>cecticillus</i> ..	..	9
<i>corvina</i> ..	..	9
<i>echinobothrida</i> ..	..	9
<i>Davainea friedbergieri</i> ..	..	8
<i>polycalcaria</i> ..	..	9
<i>proglottina</i> ..	..	8
<i>Davaineidae</i> ..	..	5, 7
<i>Davaineinae</i> ..	..	7, 8
<i>Davidius</i> ..	135,	136
<i>aberrans</i> ..	..	135
<i>davidi</i> ..	..	135
<i>*davidi assamensis</i> ..	135,	136
<i>zalorensis</i> ..	..	135
<i>Dendrocitta</i> ..	..	13
<i>Dendroctonus</i> ..	..	111
<i>Diaperinae</i> ..	..	166
<i>Diaperis aenea</i> ..	..	169
<i>boleti</i> ..	..	166
<i>Dibothrium longicollis</i> ..	..	8
<i>Dibrauchia</i> ..	..	37, 95
<i>Dicercia</i> ..	..	157
<i>divaricata</i> ..	..	153
<i>Dichogaster</i> ..	299,	346
<i>affinis</i> ..	..	348
<i>Dichogaster bolauii palmicola</i> ..	300,	348
<i>malayana</i> ..	349,	348
<i>Dicranotaenia</i> ..	..	10
<i>Didinium nasutum</i> ..	..	180
<i>Diorechis acuminata</i> ..	..	12
<i>americana</i> ..	..	13
<i>Diplocanthus</i> ..	..	10
<i>Diplopoda</i> ..	..	41
<i>Dipylidiinae</i> ..	..	13
<i>Discosoma</i> ..	385, 387, 389,	390
<i>Dorcus</i> ..	..	49, 150
<i>parallelipodus</i> ..	146, 147, 148,	149
<i>Doryichthys</i> ..	269,	270
<i>bleekeri</i> ..	..	269
<i>cunicalus</i> ..	..	270

	Page
Dorythamphus ..	269, 270
<i>laevis</i> ..	250, 251, 269, 270
<i>cuneatus</i> ..	251, 270
Dosinia laminata ..	94
Drawida ..	299, 307
<i>ghatensis</i> ..	309
<i>jalpaigurensis</i> ..	307
<i>robusta typica</i> ..	309
<i>travancorensis</i> ..	309
Drepanidotaenia ..	10, 11
<i>gracilis</i> ..	12
<i>lanceolata</i> ..	12

E

<i>Echinocotyle</i> ..	10
<i>Echocerus cornutus</i> ..	167
<i>Egeon orientalis</i> ..	379
<i>Eichhornia</i> ..	183
<i>Eirene</i> ..	50
<i>Eledona agaricicola</i> ..	165
<i>agaricola</i> ..	165
Eledonella ..	214
<i>diaphana</i> ..	213, 214, 215
<i>heathi</i> ..	214
Elenophorinae ..	157
Elenophorus collaris ..	157
Eleodes ..	161
<i>dentipes</i> ..	160, 161
<i>gigantea</i> ..	161
<i>opaca</i> ..	161
Eleodini ..	161
Eleodinae ..	160
Eleotia fusca ..	251, 286, 287
Elodea ..	250
Elopidae ..	251
<i>Elops apalike</i> ..	253
<i>hawaicensis</i> ..	251
<i>indicus</i> ..	251, 252
<i>lacerta</i> ..	252
<i>machnata</i> ..	251
<i>saurus</i> ..	251
Enallagma parvum ..	131
Enchelina ..	178
Enchelys arcuata ..	179
Engraulis purava ..	251, 253
Enoplateuthidae ..	239
Episphenus indicus ..	141, 142, 143
<i>neelgherriensis</i> ..	139, 141
Epitonium robillardi ..	91
Ethalia capillata ..	87, 92
Etioplus ..	285, 286
<i>maculatus</i> ..	251, 282, 285
<i>suratensis</i> ..	251, 285, 286
Eucentrobolus ..	41
Endichogaster ..	299, 344, 345
<i>bengalensis</i> ..	344
Eulima oxytata ..	87, 91
<i>rossinsulae</i> ..	91
Eulimidae ..	91
Euprymna morsei ..	216
Eutyphoeus ..	299, 342
<i>annandalei fulgidus</i> ..	342
<i>bastianus</i> ..	342
<i>incommodus</i> ..	342
<i>picholsoni</i> ..	342
<i>waltoni</i> ..	342

<i>Exhippolysmata</i> ..	385, 401, 402
<i>tufelae</i> ..	402

F

Figulinae ..	149
Figulus striatus ..	146, 149
Folliculina ..	54
Fossaridae ..	30
Fulvia papyracea ..	94

G

Gallus bankiva ..	9, 14
<i>gallus</i> ..	8
Gastropoda ..	27, 87
Gelastocaris paronae ..	401
Glossoscolecidae ..	299, 349
Glossoscolecinae ..	299
Glyphidrilus ..	299, 300, 349
<i>annandalei</i> ..	349
<i>stuhlmanni</i> ..	300
<i>tuberosus</i> ..	300, 349
Gnathocera (Cerandria) cornuta ..	167
Gnathocerus cornutus ..	167
Gobiidae ..	251
Gobius giuris kokius ..	288
<i>postreicola</i> ..	105
<i>setosus</i> ..	287
<i>striatus</i> ..	250
Gobius (Acetrogobius) acutipin-	
<i>nis</i> ..	251, 287, 288
<i>neilli</i> ..	251, 287
Gobius (Glossogobius) giuris ..	251, 288, 289
Gobius (Oxyurichthys) striatus ..	251, 289
Gomphiinae ..	135
Gonocephalum intermedium ..	162
<i>micans</i> ..	163
Gonocephalum pusillum ..	163
<i>pygmaeum</i> ..	163
<i>simplex</i> ..	163
Greenidea ..	3
Gryporhynchus pusillus ..	13
Gryporhynchus (Acanthochirus)	
<i>macropeus</i> ..	13

H

Hagenius aberrans ..	135
Halammobia pellucida ..	164
Halysis gracilis ..	12
Haplochilus ..	270, 291, 292, 293, 294
<i>dayi</i> ..	291
<i>melanostigma</i> ..	251, 266, 268, 269, 291, 293
<i>melastigma</i> ..	266
<i>panchax</i> ..	269
<i>rubrostigma</i> ..	268, 291
Hectarthrum ..	150
<i>tfiginum</i> ..	150, 151
Heliopathes abbreviatus ..	161, 162
<i>gibbus</i> ..	162
<i>ibericus</i> ..	161
Heliophilus ibericus ..	161
Helodrilus ..	299, 352
Helodrilus (Bimastus) constrictus ..	352
<i>eiseni</i> ..	352
<i>parvus</i> ..	352

	Page
<i>Helodrilus</i> (<i>Eisenia</i>) <i>foetida</i> ..	352
<i>Helopinae</i> ..	172
<i>Helops</i> <i>agonus</i> ..	172
<i>angustatus</i> ..	172
<i>assimilis</i> ..	172
<i>cerberus</i> ..	173
<i>coeruleus</i> ..	172
<i>ecoffeti</i> ..	172
<i>laevioctostriatus</i> ..	172
<i>lanipes</i> ..	173
<i>laticollis</i> ..	173
<i>pellucidus</i> ..	173
<i>pyrenaeus</i> ..	173
<i>striatus</i> ..	172
<i>Heterophaga</i> <i>opatroides</i> ..	168
<i>Hippocampi</i> ..	270
<i>Hippolysmata</i> .. 385, 401, 402	
<i>dentata</i> ..	402, 405
<i>ensirostris</i> .. 385, 401, 402,	
403	
<i>ensirostris punctata</i> ..	403
<i>vittata</i> .. 402, 404, 405	
<i>Hippolysmata</i> (<i>Lysmatella</i>) <i>prima</i> ..	404
<i>Hippolyte</i> .. 387, 391, 392	
<i>ventricosus</i> ..	391
<i>Hippolytidae</i> ..	385, 402
<i>Hispinae</i> ..	101
<i>Histioteuthidae</i> ..	242
<i>Holocrates</i> <i>gibbus</i> ..	162
<i>Holophrya</i> .. 178, 179	
<i>coleps</i> ..	179
<i>indica</i> .. 178, 179, 180	
<i>simplex</i> ..	179
<i>Holophryina</i> ..	178
<i>Hoplocephala</i> <i>haemorrhoidalis</i> ..	166
<i>Hydrobiidae</i> ..	31
<i>Hydromedion</i> <i>nitidum</i> ..	173
<i>sparsutum</i> ..	173
<i>Hymenolepididae</i> ..	5, 9, 14
<i>Hymenolepidinae</i> ..	9, 10, 12
<i>Hymenolepidinae</i> ..	9
<i>Hymenolepis</i> .. 9, 10, 11, 12, 19,	
298	
<i>capillarioides</i> ..	10
<i>diminuta</i> ..	10
<i>flavopunctata</i> ..	10
<i>murina</i> .. 16, 295, 296	
<i>nana</i> .. 295, 296	
<i>Hypoetonus</i> .. 60, 61, 62, 63, 67, 69, 73,	
79, 80, 81, 83	
<i>binghami</i> ..	68
<i>birmanicus</i> ..	68
† <i>carmichaeli</i> ..	67
<i>formosus</i> ..	68
<i>formosus insularis</i> ..	68
<i>granosus</i> ..	69
<i>oatesi</i> .. 61, 66, 67, 68	
<i>rangunensis</i> ..	68
<i>saxatilis</i> ..	69
<i>stoliczkae</i> .. 60, 69	
<i>sylvaticus</i> ..	69
<i>wood-masoni</i> ..	69
<i>Hypophloeus</i> <i>bicolor</i> ..	169
<i>fasciatus</i> ..	169
<i>ferrugineus</i> ..	169
<i>linearis</i> ..	169
<i>pini</i> ..	169
<i>unicolor</i> ..	169

	Page
<i>Ichthyotaenia</i> .. 5, 16, 18	
<i>Ichthyotaenia</i> (<i>Acanthotaenia</i>)	
<i>nilotica</i> ..	15
<i>Ichthyotaenia</i> (<i>Proteocephalus</i>)	
<i>ambloplitis</i> ..	45
<i>pusilus</i> ..	15
<i>Ichthyotaeniidae</i> ..	15
<i>Idotea</i> ..	401
<i>Infusoria</i> ..	183
<i>Inioteuthis</i> <i>japonica</i> ..	215, 216
<i>maculosa</i> ..	215, 216
<i>morsei</i> ..	216
<i>Iphidionus</i> <i>italicus</i> ..	169
† <i>Iravadia</i> <i>annandalei</i> ..	31
† <i>ennurensis</i> ..	31
† <i>funerea</i> ..	36
<i>Irene</i> <i>ceylonensis</i> ..	49, 51, 52
<i>palkensis</i> ..	51
<i>Ischnura</i> ..	129
<i>aurora</i> ..	130, 131
<i>delicata</i> ..	131
<i>forcipata</i> ..	129
<i>gangetica</i> ..	129, 130
<i>immsi</i> ..	131
<i>inamata</i> ..	130, 131
<i>nursei</i> ..	131
<i>rufostigma</i> ..	130, 131
<i>senegalensis</i> ..	23, 129, 130
<i>Isocerus</i> <i>purpurascens</i> ..	161
<i>Isopoda</i> ..	115, 126, 127

J

<i>Japatella</i> <i>diaphana</i> ..	213
<i>Julodis</i> <i>albopilosa</i> ..	152
<i>onopordi</i> ..	152

L

<i>Labeo</i> ..	253
<i>calbasu</i> ..	251, 253, 255
<i>Labochirus</i> .. 60, 61, 62, 63, 64, 67, 79,	
80, 82, 83	
<i>africanus</i> ..	64
<i>andersoni</i> ..	66, 83
<i>browni</i> ..	66
<i>cervinus</i> ..	65
<i>dawnae</i> ..	66, 67
<i>ellisi</i> ..	67, 83
<i>gastrostictus</i> ..	65
<i>kraepelini</i> ..	65
<i>proboscideus</i> ..	64
<i>tauricornis</i> ..	65
<i>Lacrymaria</i> <i>vermicularis</i> ..	180
<i>Lamellibranchiata</i> ..	33
<i>Lampito</i> .. 299, 315, 317, 327	
† <i>dubius</i> ..	316
<i>mauritii</i> ..	315
<i>Lamprea</i> <i>rotilans</i> ..	153
<i>solieri</i> ..	153
<i>Lasiodactylus</i> ..	112
<i>caliginosus</i> ..	113
<i>chevrolati</i> .. 109, 110, 111, 112	
<i>pictus</i> ..	112
<i>Lates</i> <i>calcarifer</i> ..	251, 278
<i>Latreutes</i> .. 392, 396, 398, 399, 402	

	Page
<i>Latreutes anoplonyx</i> ..	399
<i>anurostris</i> ..	399
<i>mucronatus</i> ..	396, 397, 398
<i>plairostris</i> ..	396, 397
<i>planus</i> ..	399
<i>porcinus</i> ..	397, 398
<i>pygmaeus</i> ..	396, 398
<i>unidentatus</i> ..	399
<i>Lepidocephalichthys thermalis</i> ..	251, 261
<i>Lepidotrias</i> ..	10
<i>Leptaulax bicolor</i> ..	139, 140, 144
<i>bicolor vicinus</i> ..	140, 145
<i>dentatus</i> ..	144
<i>Limnodrilus</i> ..	299, 307
<i>Lionotus</i> ..	182
<i>Liosiphon strombii</i> ..	182
<i>Litiopidae</i> ..	30
<i>Litonotus</i> ..	182
<i>fasciola</i> ..	181, 182
<i>varsaviensis</i> ..	181, 182
<i>Littorina arboricola</i> ..	30
<i>Littorinidae</i> ..	30
<i>Loliginidae</i> ..	218
<i>Loligo</i> ..	204, 222
<i>indica</i> ..	185, 218, 221, 222
<i>pealii</i> ..	221
<i>spectrum</i> ..	221
<i>Loliolus investigatoris</i> ..	222
<i>Lordites</i> ..	113
<i>glabricula</i> ..	112
<i>Loxophyllum</i> ..	181, 182
<i>fasciola</i> ..	181, 182
<i>fasciola punjabensis</i> ..	181, 182
<i>Lucanidae</i> ..	145
<i>Lucanus</i> ..	145
<i>alces</i> ..	145
<i>cervus</i> ..	145, 148
<i>saiga</i> ..	146
<i>Lucina semperiana</i> ..	95
<i>Lucinacea</i> ..	37, 95
<i>Lucinidae</i> ..	37, 95
<i>Lumbricidae</i> ..	299, 352
<i>Lyphia ficiola</i> ..	168
<i>tetraphylla</i> ..	168
<i>Lysmata</i> ..	402, 404
<i>Lysmatella</i> ..	385, 402
<i>prina</i> ..	385, 402, 404

M

Macrolinus	..	..	139
andamanensis	..	..	143
Macrones	..	..	205
cavasius	..	251, 264	
keletius	..	251, 265	
vittatus	..	250, 251, 265	
Macropodus	..	251, 281, 282	
viridiauratus	..	..	282
Mangilia gracilentia	..	..	87
Mastacembelidae	..	..	251
Mastacembelus armatus	..	251, 290	
pancalus	..	250, 251, 290	
Mastigoproctus	..	62, 63, 83	
Mecistocerus	..	150, 151	
corticeus	..	..	150
Megalops	..	..	253
cyprinoides	..	251, 252, 253	
kundaga	..	..	252

	Page
Megascolecidae ..	299, 311
Megascolecinae ..	299, 327
Megascolex ..	299, 327
cingulatus ..	329
insignis ..	329
konkanensis ..	328
†pentagonalis ..	331
†pumilio ..	333
ratus ..	327
travancorensis ..	333
†trivandranus ..	330
Megascolides ..	299, 300, 311, 327
*onelli monarcus ..	313
*teumalai karakulamensis ..	311
Megeletes sequoiarum ..	165
Melanimon tibiale ..	162
Melanophila ..	154
Melia azadirachta ..	109
Melobasis cupriceps ..	154
iridescens ..	154
Menephilus cylindricus ..	170
Menephilus (<i>Tenebrio</i>) <i>curvipes</i> ..	170
Meracantha contracta ..	173
Meracanthinae ..	173
Meretrix casta ..	35
ovum ..	35
zonaria ..	35
Meselia ..	32
Metroliasthes lucida ..	14
Microchaetinae ..	299
Micromelo undatum ..	93
Micronympha aurora ..	131
rufostigma ..	130
senegalensis ..	129
Microphus ..	270
Microzoum tibiale ..	162
Mimoscorpius ..	62, 63, 71, 80, 83
pugnator ..	71
Mitophyllus irroratus ..	147
Modiola taprobanensis ..	35
Mollusca ..	27, 87
Molurinae ..	158
Moniligaster deshayesi graveli ..	309
grandis ..	353
Moniligastridae ..	299, 307
Mormula ..	32
Muricidae ..	29
Mus decumanus ..	16, 295
decumanus albino ..	296
rattus ..	16, 17
Mytilacea ..	35, 93
Mytilidae ..	35, 93
Mytilus curvatus ..	9

N

Naididae ..	299, 300
<i>Naidium tentaculatum</i> ..	304
Nais ..	301, 302
Naididae ..	251
<i>Nandus marmoratus</i> ..	278
<i>nandus</i> ..	251, 278
Nassa ..	89
<i>denegabilis</i> ..	28
<i>†kempi</i> ..	88
<i>kieneri</i> ..	28
<i>•orissaensis ennurensis</i> ..	28
<i>†phoenicensis</i> ..	88, 89

	Page
<i>Nassa</i> (<i>Alectrion</i>) <i>unicolor</i> ..	90
<i>Nassa</i> (<i>Arcularia</i>) <i>cancellata</i> ..	89
<i>globosa</i> ..	89
<i>Nassa</i> (<i>Hima</i>) <i>tindalli</i> ..	89
<i>Nassa</i> (<i>Niotha</i>) <i>livescens</i> ..	89
<i>Nassidae</i> ..	28, 88
<i>Nassodonta</i> ..	28
† <i>gravelyi</i> ..	29
<i>insignis</i> ..	28, 29
<i>Nassula stromphii</i> ..	182
† <i>Natica kemp</i> ..	38, 90
<i>marochiensis</i> ..	32
<i>Naticidae</i> ..	32, 90
<i>Nautilus</i> ..	185
<i>Neacra</i> ..	38, 33
<i>Nectocrangon</i> ..	383
<i>Nematotaenia dispar</i> ..	14
<i>Neritidae</i> ..	32, 92
<i>Neritina</i> ..	92
<i>Nigidius dawnae</i> ..	148, 149, 150
<i>impressicollis</i> ..	149
<i>Nitidulidae</i> ..	109, 112
<i>Notopteridae</i> ..	251
<i>Notopterus kapirat</i> ..	253
<i>notopterus</i> ..	251, 253
<i>Notoscolax</i> ..	299, 325, 327
† <i>gravelyi</i> ..	325
<i>sarasinorum</i> ..	327
<i>Nucula bengalensis</i> ..	94
† <i>semiramisensis</i> ..	93, 94
<i>Nuculidae</i> ..	93
<i>Nuria danrica</i> ..	251, 259

O

<i>Obeliscus</i> ..	32
<i>Ochtochaetinae</i> ..	299
<i>Ocnerodrilinae</i> ..	299
<i>Ocnerodrilus</i> ..	299, 348
<i>Ocnerodrilus</i> (<i>Ocnerodrilus</i>) <i>occidentalis</i> ..	348
<i>Octochaetus</i> ..	299, 338
† <i>baikudensi</i> ..	340
<i>fermori</i> ..	338
<i>surensi</i> ..	338
<i>Octopus</i> ..	204
<i>aculeatus</i> ..	191
<i>areolatus</i> ..	193, 194
<i>bandensis</i> ..	201
<i>boscii pallida</i> ..	189
<i>brocki</i> ..	193
<i>cuvieri</i> ..	192
<i>cyanea</i> ..	195
<i>DeFilippe</i> ..	196
<i>Defilippi</i> ..	196
<i>defilippi</i> ..	196
<i>de-filippi</i> ..	196
<i>fusiformis</i> ..	203
<i>globosus</i> ..	202
<i>granulatus</i> ..	189, 190
<i>hongkongensis</i> ..	197
<i>januarii</i> ..	199
<i>kagoshimensis</i> ..	189
<i>levis</i> ..	198
<i>macropus</i> ..	192
<i>microphthalmus</i> ..	205
<i>ocellatus</i> ..	193, 194
<i>pisiformis</i> ..	203

Page

<i>Octopus polyzenia</i> ..	189
<i>punctatus</i> ..	197
<i>rugosus</i> ..	189, 202
<i>longanus</i> ..	200
<i>Odonata</i> ..	23, 24, 25, 129
<i>Oligochaeta</i> ..	299
<i>Onchorynchus tshawytscha</i> ..	210
<i>Oniscidae</i> ..	117
<i>Oniscinae</i> ..	117
<i>Onicoidea</i> ..	117
<i>Opatrinae</i> ..	162
<i>Opatrum intermedium</i> ..	162
<i>psillum</i> ..	163
<i>sabulosum</i> ..	163
<i>tibiale</i> ..	162
<i>verrucosum</i> ..	162, 163
<i>Opatrum (Microzoum) tibiale</i> ..	162
<i>Ophiocephali</i> ..	271
<i>Ophiocephalidae</i> ..	251
<i>Ophiocephalus</i> ..	271, 276, 280
<i>gachua</i> ..	251, 275
<i>punctatus</i> ..	251, 273, 275, 276, 284
<i>striatus</i> ..	249, 251, 270, 271, 272, 273, 274, 275
<i>Ophrygonius cantori conoexifrons</i> ..	141
<i>Opisthocaulichia</i> ..	92
<i>Opisthobranchiata</i> ..	27
<i>Osphromenidae</i> ..	251
<i>Osphromenus gourami</i> ..	251, 279
<i>olfax</i> ..	279
<i>Ostracea</i> ..	33
<i>Ostrea canadensis</i> ..	33
† <i>madrasensis</i> ..	33, 34
<i>virginica</i> ..	33
<i>Ostreidae</i> ..	33

P

<i>Pachychile servillei</i> ..	157
<i>Pachyschelus</i> ..	155
<i>Palorus depressus</i> ..	168
<i>Panchax</i> ..	270, 291, 292, 293, 294
<i>dayi</i> ..	291, 292, 293, 294
<i>lineatum</i> ..	291, 292, 293, 294
<i>panchax</i> ..	291, 292, 293, 294
† <i>parvus</i> ..	250, 251, 268, 269, 291, 292, 293
<i>rubrostigma</i> ..	268, 291, 292, 293
<i>Panicum jumentorum</i> ..	281
<i>Paracephala cyaneipennis</i> ..	155
<i>Paracracon</i> ..	383
<i>Paramacchia</i> ..	183
<i>Paramaecium</i> ..	183
<i>caudatum</i> ..	177, 183
<i>putrinum</i> ..	177
<i>Paraperiscyphis</i> ..	115, 116
<i>gigas</i> ..	115, 116
† <i>pulcher</i> ..	115, 116, 117
† <i>scabrus</i> ..	115, 117
<i>stebbingi</i> ..	115, 116
<i>Parapontocaris</i> ..	375, 378
<i>Paratelphusa</i> ..	288
<i>Paruterina</i> ..	14
<i>Paruterinae</i> ..	14
<i>Paruterinidae</i> ..	14
<i>Passalidae</i> ..	137
<i>Passalus</i> ..	138, 139
<i>cornutus</i> ..	138, 139, 140

	Page		Page
<i>Passalus distinctus</i> ..	13	<i>Placuna placenta</i> ..	35
<i>interruptus</i> ..	138	<i>Plagiomina</i> ..	183
<i>punctiger</i> ..	138	<i>Platybema pristi</i> ..	392
<i>Pavo nigripennis</i> ..	8	<i>rugosum</i> ..	392
<i>Pectinula panchiata</i> ..	28	<i>Platycerus caraboides</i> ..	146, 148, 149
<i>Pedininae</i> ..	161	<i>Platyedema ellipticum</i> ..	166
<i>Pedinus femoralis</i> ..	162, 163	<i>europaea</i> ..	166
<i>Pelecypoda</i> ..	93	<i>europaeum</i> ..	166
<i>Pentaphyllus testaceus</i> ..	167	<i>palliditarse</i> ..	167
<i>Pericephalus</i> ..	117	<i>violacea</i> ..	167
<i>Periclimenes hermitensis</i> ..	389	<i>violaceum</i> ..	167
<i>Perilampus atpur</i> ..	261	<i>Platyscelinae</i> ..	161
<i>cachius</i> ..	251, 261	<i>Platyscelis gages</i> ..	161
<i>Perimylops antarcticus</i> ..	123	<i>Pleurarius</i> ..	139
<i>Perionychella</i> ..	327	<i>brachyphyllus</i> ..	140, 141
<i>Perionyx</i> 299, 300, 317, 323, ..	327	<i>Pleurotoma fusca</i> ..	87
<i>aborensis</i> ..	320	<i>Pleurotomidae</i> ..	87
<i>annulatus</i> ..	327	<i>Poecilonota solieri</i> ..	153
<i>ceylonensis</i> ..	325	<i>Polyacanthus cupanus</i> ..	281
<i>excavatus</i> ..	317	<i>Polycesta californica</i> ..	152
<i>fulvus</i> ..	322	<i>elata</i> ..	152
<i>finornatus</i> ..	320	<i>Polypodidae</i> ..	189
<i>parvulus</i> ..	321	<i>Polypus</i> .. 185, 209, 210, 211, ..	212
<i>pincerna</i> ..	319	<i>aculeatus</i> ..	191
<i>pulvinatus</i> ..	317	<i>aranea</i> ..	197
<i>Periscyphis gigas</i> ..	110	<i>arborescens</i> ..	207
<i>Petrosia testudinaria</i> ..	401	<i>areolatus</i> ..	193
† <i>Petroscirtes bhattacharyae</i> ..	107	<i>australis</i> ..	210
<i>Phaleria bimaculata</i> ..	164	<i>bandensis</i> ..	201
<i>cadaverina</i> ..	164	<i>cyanea</i> ..	195
<i>hemisphaerica</i> ..	164	<i>defilippi</i> ..	196, 197
<i>Phaleriinae</i> ..	164	<i>elegans</i> ..	205
<i>Phenicopterus roseus</i> ..	12	<i>fontanianus</i> ..	297
<i>Pheretima</i> 299, 300, 318, 321, 327, 331, ..	334, 335	<i>fusiformis</i> ..	203, 205
<i>bicincta</i> ..	335	<i>globosus</i> ..	202
<i>feae</i> ..	335	<i>herdmani</i> ..	206
<i>hawayana typica</i> ..	334	<i>hongkongensis</i> ..	197, 198
<i>heterochaeta</i> ..	327, 334	<i>hoylei</i> ..	207
<i>houletti</i> ..	334	<i>januarii</i> ..	199
<i>kuchingensis</i> ..	337	<i>levis</i> ..	198
<i>lignicola</i> ..	335	<i>macropus</i> ..	192
<i>posthuma</i> ..	334, 344	<i>microphthalmus</i> ..	205
<i>trivandrana</i> ..	335	<i>pictus</i> ..	197
<i>Phialina vermicularis</i> ..	180	<i>polyzona-granulatus</i> ..	190
<i>Philocheras</i> ..	355	<i>pricei</i> ..	205, 209
<i>megalochair</i> ..	372	<i>punctatus</i> ..	198
<i>Philoscia</i> ..	127	<i>rugosus</i> ..	89, 211, 213
<i>coeca</i> ..	126	<i>tonganus</i> ..	200
<i>Phortis</i> ..	50, 51	<i>vulgaris</i> ..	211
<i>gibbosa</i> ..	54	<i>Pontocaris</i> ..	374
<i>Phthora crenata</i> ..	168	<i>media</i> ..	378
† <i>Phycocaris</i> .. 385, 391, 392, 395 ..	391, 392, 393	<i>pennata</i> ..	376, 377
<i>simulans</i> ..	391, 392, 393	<i>propensalata</i> ..	377, 378
<i>Phylan abbreviatus</i> ..	161	<i>Pontodrilus</i> ..	299, 311
<i>gibbus</i> ..	162	<i>bermudensis ephippiger</i> ..	311
<i>Phylax littoralis</i> ..	162	<i>Pontophilus</i> .. 355, 356, 381, 383, ..	384
<i>picipes</i> ..	162	<i>abyssi</i> ..	356, 357, 381
<i>Phylethus quadripustulatus</i> ..	167	<i>australis</i> ..	384
<i>Pica rustica</i> ..	9	<i>bidentatus</i> ..	364
<i>Pimelia bipunctata</i> ..	159	<i>bispinosus</i> ..	382
<i>boyeri</i> ..	159	<i>brevirostris</i> ..	381
<i>grossa</i> ..	159	† <i>candidus</i> 356, 357, 365, 366, 371, ..	382
<i>inflata</i> ..	159	<i>chiltoni</i> ..	381
<i>pilifera</i> ..	159	<i>echinulatus</i> ..	382
<i>sardea</i> ..	159	<i>gracilis</i> ..	356, 357, 381
<i>Pimeliinae</i> ..	159	<i>hendersoni</i> ..	357, 368, 372, 382
<i>Pitaria</i> ..	94		

	Page
† <i>Pontophilus incisus</i>	356, 357, 358, 360, 361, 363, 364, 367, 371, 381
<i>japonicus</i>	364
<i>flowisi</i> 356, 361 , 362, 364, 367, 382	
<i>norvegicus</i>	381
<i>occidentalis</i>	381
† <i>parvirostris</i> 357, 369, 372 , 373, 374, 382	
† <i>pilosus</i> 357, 367 , 368, 369, 382	
† <i>plebs</i>	357, 370 , 382
<i>sabsechota</i>	356, 364, 382
<i>sculptus</i> 356, 359, 369, 361, 363, 381	
<i>spinosus</i>	381
<i>trispinosus</i>	382
<i>victoriensis</i>	382
<i>Pontosclex</i>	299, 349
<i>corethrurus</i>	349
<i>Potamides</i> (<i>Tympanotonos</i>) <i>fluvialis</i>	29
<i>Prionocrangon</i> 355, 379, 383, 384	
<i>ommastotes</i>	379
<i>Prionocelis serrata</i>	171
<i>Pristina</i>	299, 304
<i>aquiseta</i>	304
<i>longiseta</i>	301, 304
<i>tentaculata</i>	304
<i>Prosobranchia</i>	87
<i>Prosobranchiata</i>	28
<i>Proteocephalidae</i>	19
<i>Proteocephalus</i>	16, 18, 19
<i>gallardi</i>	19
<i>proteocotyle</i>	7
<i>Protozoa</i>	177, 183
<i>Psammodes reichei</i>	158
<i>Pseudagrion</i>	21, 24, 134
<i>aureofrons</i>	21
<i>australasiae</i>	21, 22, 23
<i>azureum</i>	22, 23
<i>bidentatum</i>	21, 22, 25
<i>decorum</i>	21, 22, 24
<i>hypermelas</i>	21, 22, 25
<i>microcephalum</i> 21, 22, 23, 24, 25	
<i>rubriceps</i>	22, 24
<i>Pseudotropius atherinoides</i> 251, 264	
<i>Pterochlorus</i>	4
† <i>tropicalis</i>	3, 40
<i>Ptychobothriidae</i>	5
<i>Ptychobothriinae</i>	5
<i>Pycnocerinae</i>	171
<i>Pyramidella</i> (<i>Mormula</i>)	32
<i>Pyrgulina humilis</i>	32
<i>humilis chilkaensis</i>	32
<i>Pyrrhosoma tenellum</i>	131

R

<i>Rasbora buechanani</i>	259
<i>daniconius</i>	251, 259
<i>rasbora</i>	259
† <i>Retusa ennurensis</i>	27
<i>estriata</i>	27
<i>Rhinoceros sondaicus</i>	18
<i>Rhipidandrinae</i>	165
† <i>Rhopalosiphum ipadicum</i>	1, 2
<i>Rhyncobdella aculeata</i> 251, 289, 290	
<i>Rissoidae</i>	30

S

	Page
<i>Sabinea</i>	383, 384
<i>Saccobranchius rossilis</i> 251, 262, 263	
<i>singio</i>	262, 263
<i>Salmo sebago</i>	6
<i>Saron</i>	385, 387
<i>marmoratus</i>	385
<i>Scalaria</i>	91
<i>Scalidae</i>	91
<i>Scaphandridae</i>	92
<i>Scaphidema aeneum</i>	166
<i>metalicum</i>	166
<i>Scauridae</i>	159
<i>Scaurus agratus</i>	159
<i>tristis</i>	159
<i>Schistoccephalus</i>	272
<i>Sclerocrangon</i>	382
<i>Scombresocidae</i>	251
<i>Serobulariidae</i>	38, 99
<i>Sepia</i> 185, 228, 229, 231, 236, 237	
<i>aculeata</i>	223, 226
<i>arabica</i>	228
<i>blainvillei</i>	224
<i>elliptica</i>	226
<i>esculenta</i>	225, 226, 231
<i>indica</i>	224
<i>microcheirus</i>	231
<i>plangon</i>	225
<i>rouxii</i>	227, 228
<i>rugosa</i>	189
<i>sinensis</i>	231
<i>singalensis</i>	227, 228
<i>singaporensis</i>	225
<i>Sepia</i> (<i>Doratosepio</i>) <i>audreana</i>	229
<i>oides</i>	230
<i>kobianis</i>	230
<i>Sepiella</i>	231, 236, 237
<i>curta</i>	232, 234
<i>inermis</i> 185, 231, 232, 234, 235	
<i>ocellata</i>	232, 234
<i>ornata</i>	234, 235, 236
<i>Sepiidae</i>	223, 237
<i>Sepiola bursa</i>	216
<i>Sepiolidae</i>	215, 217
<i>Sepioteuthidae</i>	237
<i>Sepioteuthis arctipinnis</i>	237
<i>Septaria crepidularia</i>	33
<i>Serranidae</i>	251
† <i>Sigaretus</i> (<i>Eunaticina</i>) <i>calaraphe</i> 90, 91	
<i>Siluridae</i>	251
<i>Silvanus sultinensis</i>	150
<i>Sinodendron</i>	147, 149
<i>cylindricum</i>	147, 149
<i>Sinochilus colliardi</i>	163
<i>Slavina</i>	299, 301, 302
<i>appendiculata</i>	302
<i>punjabensis</i>	302
† <i>Solaria deliciosa</i>	33
<i>Solen</i>	95
<i>fonesi</i>	37
<i>Solenidae</i>	37, 95
<i>Solifugae</i>	84
<i>Sphenoptera arachidis</i>	153
<i>gossypii</i>	153, 155
<i>lamellata</i>	153
<i>neglecta</i>	153
<i>Spinoniformia</i>	54

	Page		Page
Spirobolidae	41	Tenebrio picipes	171
<i>Spirobolus thurstoni</i>	41	<i>transversalis</i>	171
<i>urceus</i>	41, 42	Tenebrionidae	157, 158, 164, 174
Spirogyra	250, 283	Tenebrioninae	157
Spirontocaris	386, 387, 402	Tentyria mucronata	157
pandaloides	386	interrupta	157
rectirostris	386	Tentyriinae	157
Spirostomum ambiguum minor	183	Terebra	32
†Stenothyra perpumila	31	Tetrabalius	62, 63, 78, 82
Stenotrachelus aeneus	169	nasutus	79, 81
Sterna bergii	7	seticauda	79, 81
Stigmatoteuthis	243	Tetrabothriidae	5, 7
japonica	242	Tetrabothrius erestris	7
Stigmodera rufipennis	154	Tetrabranhia	93
Stilesia	14	Tetrabranchiata	33
Strongyliinae	174	Tetracotylus	16
Strongylium sobrinum	174	Tetradrachnum trimaculatum	390
tenuicolle	174	Tetraphyllidae	15
Stylaria	299, 301, 303	Teuthowenia (Hensenioteuthis)	
†kempi	303	joubini	245
lacustris	303, 304	Thais carinifera	29
lomondi	304	Thelyphonellus	61, 63, 83
Swietenia	156	Thelyphonidae	59, 62, 63, 65, 80, 82, 84
Syngnathidae	251	Thelyphonus	62, 63, 73, 75, 77, 78, 80, 81, 82, 83, 84
Syngnathus	270	angustus	63
Syniola attenuata	32	anthracinus	75, 76, 81
		asperatus	78, 81
		assamensis	71
		bonensis	76, 81
		burchardi	77, 81
		caudatus	75, 81
		celebensis	76, 81
		cristatus	73, 74
		doriae	77, 81
		doriae hosei	77
		hanseni	78, 81
		insulanus	77, 81
		klugi	76, 81
		leucurus	78, 81
		linganus	75, 76, 81
		lucanoides	63
		manilanus	74, 81
		manilanus halimae	74
		nigrescens	73
		pococki	77, 81
		schimke-witschi	72, 77, 78, 81
		schnehageni	74, 82
		semperi	77, 81
		sepiaris	60, 73, 74, 82
		sepiaris indicus	74
		sepiaris muricola	74
		seticauda	63
		spinimanus	63
		sucki	77, 81
		sumatranus	78, 81
		wayi	75
		Theodoxus ovalanensis	92
		sowerbyana	32
		†Theora hindsiana	98, 99
		iridescens	39
		opalina	38, 99
		†translucens	39
		Thor	387, 392, 394
		†discosomatis	385, 387, 388, 389, 390
		maldivensis	385, 387, 391
		paschalis	387, 388, 389

T

<i>Taenia agama</i>	8
<i>cesticillus phasianorum</i>	8
<i>collo-langissimo</i>	12
<i>crassicollis</i>	17
<i>digonopora</i>	8
<i>dispar</i>	14
<i>ectinodothrida</i>	9
<i>erosiris</i>	7
<i>fosteri</i>	7
<i>fröderbergi</i>	8
<i>gracilis</i>	12
<i>immersina</i>	7
<i>infundibuliformis</i>	9
<i>infundibuliformis phasianorum</i>	8
<i>macropeos</i>	13
<i>murina</i>	297
<i>nana</i>	297, 298
<i>solum</i>	16
Tapes tatrix	95
turgida	36
Tectibranchiata	27
†Tellina bertiniana	95, 96
†brunneo-flavida	38
†ennurensis	38
†innocens	96
micans	96
†persimplex	96
†pervitrea	96, 97
†phoenicensis	97
†soror	97
†unguis	97, 98
†vadorum	98
vestalis	98
viator	90, 99
Tellinacea	38, 95
Tellinidae	38, 95
Tenebrio molitor	170, 171
obscurus	171
opacus	171

	Page
Thysanosoma ..	17, 18
actinioides ..	17, 18
gambianum ..	17, 18
giardii ..	17
Tiara (Platia) scabra ..	29
Tiaridae ..	29
Tima ..	50
Tornatina ..	27
Tornatinidae ..	27
Tozeuma ..	399, 400
armatum ..	398, 399, 400, 401
Trachelina ..	481
Trachycaris ..	392
rugosus ..	392, 398
Tribolium castaneum ..	168
confusum ..	168
ferrugineum ..	168
Trichoda pura ..	182
Trichoniscidae ..	126
Trichosiphum ..	3
†minutum ..	2
Trigastriinae ..	299
Triorchis ..	10
Trochidae ..	33, 92
Tubificidae ..	299, 307
Turritellidae ..	32
Typopeltis ..	62, 63, 70, 80, 82, 83, 85
amurensis ..	70, 80
crucifer ..	71
dalyi ..	70
harmandi ..	71
kasnakowi ..	70
niger ..	70
stimpsoni ..	71
tarnani ..	70

U

	Page
Uleiota indica ..	150
Uloma culinaris ..	168
perroudi ..	168
Ulominae ..	167
Upis ceramboides ..	169
Urogonoporus ..	19
Uroproctus ..	60, 62, 68, 71, 78, 79, 81, 82, 83
assanensis ..	66, 71, 72, 74, 75, 82
Urotricha globosa ..	179

V

Vallisneria ..	250
Vanesia rambhaensis ..	32
Varanus bengalensis ..	15
†Velorita delicatula ..	37
Veneridae ..	35, 94
Venus ..	35, 36, 94, 95
excavata ..	94
Vercoria ..	384

W

Wallago attu ..	251, 263
Woodwardia ..	327

Y

Yoldia tenella ..	94
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Z

Ziziphus jujuba ..	101, 102
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I. ON SOME UNDESCRIBED APHIDES FROM
THE COLLECTION OF THE INDIAN
MUSEUM.

By P. VAN DER GOOT, *Salatiga, Java.*

During the course of the years 1913 to 1915, Mr. F. H. Gravely had the kindness to submit to me for investigation and determination some 60 tubes of Aphididae from the collections of the Indian Museum. Some of the specimens contained therein had already been determined by Mr. Buckton; many others proved to be well-known species, already described either from Europe or from other tropical countries. Three of them however, appeared to me to be new to science. With the kind permission of the Superintendent of the Indian Museum I am giving here the descriptions of these new species.

Rhopalosiphum indicum, sp. nov.

Apterous viviparous female.

Measurements.

Length of body	4.40 mm.
Breadth of body	2.70 "
Length of antennae	4.30 "
Length of siphunculi	1.03 "
Length of cauda	0.47 "

Colour.—Body light reddish-brown. Eyes black. Antennae black. Legs brownish-black, the base of the femur more yellowish. Siphunculi dark brown. Cauda light reddish-brown.

*Morphological characters*¹.—Body ovate, slightly arched; dorsum with only a few very short hairs, integument with distinct reticulation.

Antennae nearly as long as the body, with a few short hairs; relative lengths of the last antennal joints about as: 70. 45. 34. 12. 58. The third antennal joint bears at its base some 5 small circular sensoriae. Frontal tubercles fairly large, distinctly protruding and rounded on the inner side.

Rostrum reaching to the second pair of coxae.

Siphunculi relatively short, only slightly swollen, considerably constricted near the tip, with a fine reticulation only at the

¹ Notes from specimen in alcohol.

Acc. No. P702
Dt. 15/5/17



extreme top-end. Cauda short, club-shaped, about half as long as the cornicles.

Legs fairly long, with a few short hairs.

Biology.—Collected in large numbers on the shoots of an unknown plant. Only wingless females and numerous larvae were captured.

Locality.—Kurseong, Darjeeling (4700 feet), 24-xi-1910.

Types in the collection of the Indian Museum, Calcutta; labelled no. 9602/19.

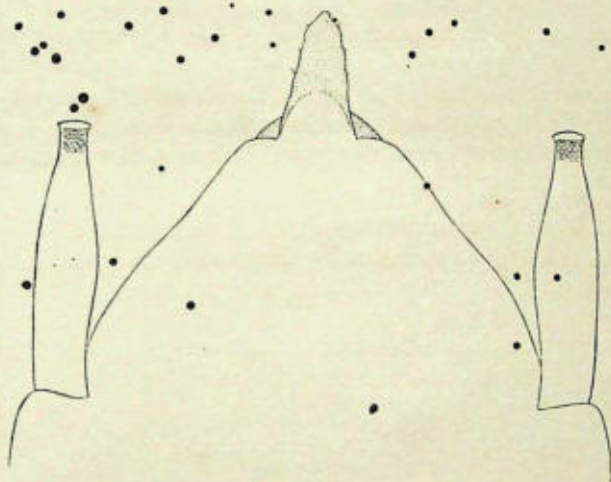


FIG. 1.—*Rhopalosiphum indicum*, sp. nov.
Hind part of body of apterous female (dorsal view) $\times 50$.

Trichosiphum minutum, sp. nov.

Alate viviparous female.

Measurements.

Length of body	..	2.07 mm.
Breadth of body	..	0.86 "
Length of antennae	..	1.98 "
Length of siphunculi	..	1.53 "
Expanse of wings	..	7.70 "

Colour.—Head and thorax brown, abdomen brownish-yellow. Eyes red. Antennae black. Legs yellowish. Siphunculi yellowish-brown. Wings hyaline.

*Morphological characters*¹.—Body elongate, with the forehead, the prothorax and the sides of the body clothed with long bristles.

Antennae nearly as long as the body, with numerous bristles, seven-jointed; relative lengths of the five last antennal joints about as: 40. 13. 15. 12. 16. The third antennal joint bears on

¹ Notes from specimen in alcohol.

its whole length about 20 sensoriae; these are broadly oval and occupy nearly half of the antennal circumference.

Rostrum slender, reaching to the third pair of coxae.

Siphunculi very long, about $\frac{1}{3}$ of the whole length of the body, cylindrical, thin, with numerous fine bristles. Cauda obsolete, the last abdominal segment broadly rounded, without a small point at the apex. Rudimentary gonapophyses apparently 3.

Wings with the same venation as in the genus *Greenidea*, with the *media* II curved. Hooking-hairs 2.

Biology.—The aphids described above were collected on a jungle creeper. Only a number of nymphs and a few winged individuals were caught.

Locality.—Kurseong, Darjeeling (4700 feet).

Types in the collection of the Indian Museum, Calcutta; labelled no. 9620/19.

NOTE.

In the genus *Trichosiphum* (Perg.), v. d. G. I include those species that differ from *Greenidea*, Schout., in having the caudal segment broadly rounded, not protruding into a small point like the species of the genus *Greenidea*.

Pterochlorus tropicalis, sp. nov.

Apterous viviparous female.

Measurements.

Length of body	.. 5.40 mm.
Breadth of body	.. 2.90 ,,
Length of antennae	.. 2.70 ,,
Siphunculi (diam.)	.. 0.14 ,,

Colour.—Head and prothorax brownish-black; the rest of the body greyish, with four longitudinal rows of minute black dots on the dorsum. Eyes, antennae and legs black. Siphunculi surrounded by a broad black ring; caudal segment brownish-black.

*Morphological characters*¹.—Body broadly oval, slightly arched, clothed with numerous fine, short hairs.

Antennae half as long as the body, six-jointed, with numerous short hairs; relative lengths of the last four joints about as: 55. 23. 18. 11.

Distribution of sensoriae on the different joints mostly as follows: III₉ IV₅ V₁ VI₁ (+). The secondary sensoriae are round and small. *Processus terminalis* fairly long, about $\frac{1}{3}$ of the length of the entire sixth joint.

Rostrum long, nearly reaching halfway to the ventral part of the abdomen.

Siphunculi only very slightly protruding, nearly reduced to pores. Caudal segment not constricted at the base, nearly obsolete. Rudimentary gonapophyses 3.

¹ Notes from specimen in alcohol.

Legs long, especially the hind shins, with numerous short fine hairs.

Alate viviparous female.

Measurements.

Length of body	..	5.05 mm.
Breadth of body	..	2.07 "
Length of antennae	..	2.52 "
Siphunculi (diam.)	..	0.13 "
Expanse of wings	..	12.70 "

Colour.—Head light brownish, thorax black, abdomen greyish. Eyes black. Antennae and legs black. Siphunculi surrounded by a broad dark ring; caudal segment black.

Forewings beautifully tinged with brown; the following parts only are hyaline: the basal part of the radial cell, a small stretch from the base of the *media* I to the first furcation, a larger one from the first furcation point of the *media* I to the top of the

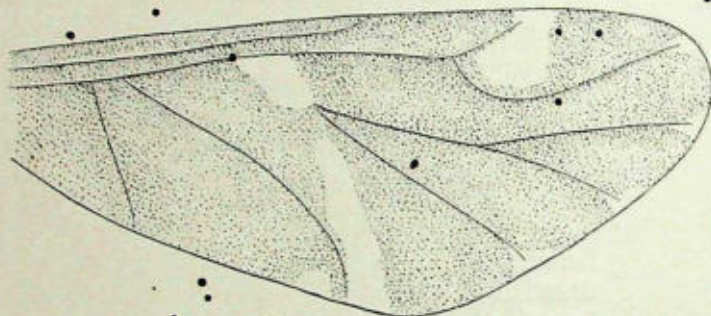


FIG. 2.—*Pterochlorus tropicalis*, sp. nov.
Forewing of alate female, $\times 60$.

media II, the tips of all veins except the *cubitus* and the base of the forewing itself. The hind wings are uniformly light brownish.

*Morphological characters*¹.—Body clothed with numerous fine, short hairs.

Antennae about half as long as the body; relative lengths of the four last antennal joints about as: 50. 25. 24. 15. The distribution of sensoriae on the different joints is as follows: III 12-16 IV 5-7 V 1 VI 1 (+6). The secondary sensoriae are circular and moderately small.

Rostrum, siphunculi, etc. as in the apterous female.

Wings with the normal *Pterochlorus*-venation, the *media* II distinctly curved. Hooking-hairs 6 in number.

Foodplant.—Unknown.

Locality.—Dibrugarh, N.-E. Assam (Abor Exped.), 20-xi-1911.

Types in the collection of the Indian Museum, Calcutta; labelled no. 4695/20.

¹ Notes from specimen in alcohol.

II. ON SOME INDIAN CESTODA.

PART II.

By T. SOUTHWELL, A.R.C.Sc. (Lond.), F.L.S., F.Z.S., Dy. Director
of Fisheries, Bengal, Bihar and Orissa; Honorary
Assistant, Indian Museum, Calcutta.

The object of the present paper is merely to record a number of parasites for the most part found commonly in certain Indian birds. The characters given for the members of the family Ptychobothridae are after Lühe. Those of the families Tetrabothridae, Davaineidae and Hymenolepidae are after Ransom. The writer hopes in succeeding papers to confine his attention to the anatomical details of a series of families.

Family PTYCHOBOTHRIDAE, Lühe, 1910.

Scolex unarmed, or rarely armed, and always with two separate, more or less perfectly developed suckers, which may exceptionally be replaced by a pseudo-scolex. Neck absent. Outer differentiation of segments always present, but very often imperfect, or partly obliterated by secondary formation of folds. Genital organs numerous, but single in each proglottid. Genital apertures single. Cirrus devoid of spines, but with a striated cuticle. Apertures of the cirrus and vagina behind that of the uterus, arranged on the surface, or on the edge. In the first instance, the openings of the cirrus and vagina are on the opposite surface to that of the uterus, and are approximately median. No muscular bulbus in connection with the inner extremity of the cirrus sac. Usually, the receptaculum seminis is missing, but, if present, it has the shape of a small caecum, placed internal to, and in close connection with, the vagina. Ovary and shell-gland median; testes in two side fields. Uterus never takes the shape of a rosette, but usually exists as a wide, uniform cavity. Eggs with a thin shell, without operculum; embryonic development takes place in the uterus, and, on account of the cessation of the egg-production, all the eggs of the tapeworm are ultimately in the same stage of development. The cessation of egg-production however, appears, in some species, to have a relation to the season of the year. Mature in the intestine of fish. Development of larva unknown. There are two sub-families.

CHARACTERS OF THE SUB-FAMILIES.

- | | |
|--|-------------------------|
| (1) Apertures of cirrus and vagina arranged on the surface | Ptychobothriinae |
| (2) Apertures of cirrus and vagina arranged on the edges | Amplicotyliinae. |

Sub-family AMPHICOTYLINAE, Lühe, 1910.

Scolex unarmed. Mouth of cirrus and vagina marginal, irregularly alternate, with a more or less strongly pronounced partiality for being unilateral. The deferens strongly coiled. Mouth of uterus median; aperture of uterus large. In the intestines of fishes. In fresh water there are two genera.

CHARACTERS OF THE GENERA.

- (1) Yolk-gland follicles numerous, irregularly formed, in loose coils, and situated, at least partly, between the muscle bundles ... *Abothrium*.
- (2) Yolk-gland follicles in small numbers, on each side, pressed together very closely, on the outer edge of the nerve strands, between the main longitudinal nerves and the muscles ... *Bathybothrium*.

Abothrium (Van Ben.), 1871.

Scolex unarmed, not very long, with two strong (but not specially deep) suckers. Segmentation of the posterior part of the strobila is often indistinct on account of the superficial wrinkling of the skin. The ripe segments are considerably wider than long. Nerve strands lateral, dorsal to the cirrus sac and vagina. Vesicula seminis lies exclusively between the two nerve strands, in the two lateral fields. Yolk-glands irregular in shape, in two broad lateral fields, situated partly between the bundles of the longitudinal muscles. The yolk-glands of each proglottid do not appear to be distinctly separated. Ovary somewhat bean or kidney-shaped, median, and situated, along with the aperture of the uterus, ventrally. Shell-gland dorsal to ovary. Aperture of uterus, in mature proglottides, is a uniform sac, almost filling the whole of the nerve areas.

The uterine apertures appear as a more or less distinctly marked median, longitudinal, furrow, running the length of the proglottides. There are three species.

CHARACTERS OF THE SPECIES.

- (1) Yolk-glands partly internal to the longitudinal muscles.
Parasitic in Gadoid fishes ... *A. rugosum*.
- (2) Yolk-glands only between the longitudinal muscles.
Parasitic in Salmonidae ... *A. crassum*.
- (3) Yolk-glands partly external to the longitudinal muscles.
Parasitic in *Clupea finla* (Cuvier) ... *A. fragile*
(After Lühe)

Abothrium crassum (Bloch, 1779) Lühe, 1910.

ZEV 5433 Pyloric caeca of Sebago Lake, H. B. Ward.
Salmo sebago. Maine, U.S.A.

One specimen named and presented by Professor H. B. Ward of the University of Illinois.

Literature:—Lühe, 1910.

Family TETRABOTHRIIDAE, Linton, 1891.

= Tetrabothridae, Diesing, 1850 (in part).

Family diagnosis:—Taeniidea. Scolex unarmed, without rostellum. Suckers with an outwardly projecting auricular appendage on the anterior border. Neck short. Segments of the strobila, with the exception of the hindermost segments, always much broader than long. A single set of reproductive organs in each segment. Genital pores unilateral. Genital cloaca deep. Cirrus pouch small, and nearly spherical, united with the genital cloaca by a muscular cloacal canal. Yolk-gland in front of ovary. Eggs with three transparent envelopes. Adult in birds and mammals.

Type-genus:—*Tetrabothrius*, Rudolphi, 1819.

Genus *Tetrabothrius*, Rudolphi, 1819.

= *Amphotercoyle*, Diesing, 1863 (type, *A. elegans*, Diesing, 1863).

= *Prosthecocoyle*, Monticelli, 1892 (type, *Taenia fosteri*, Kreff, 1871).

= *Bothridiotaenia*, Lonnberg, 1896 (type, *Taenia erostris*, Lonn., 1889).

Generic diagnosis:—Tetrabothriidae. With the characters of the family.

Type-species:—*Bothriocephalus macrocephalus*, Rudolphi, 1810.

Tetrabothrius erostris, Lonnberg, 1889.

ZEN 6917 *Sterna bergii*. Tamblegam, T. Southwell. Ten specimens.
(Tern). Ceylon.

This parasite has previously been recorded from Ceylon by Shipley.

Synonym:—*Taenia immerina*, Abildg., 1790.

Literature:—Shipley, 1903; Johnston, 1912; Ransom, 1909; Fuhrmann, 1908; Monticelli, 1892.

Family DAVAINIIDAE, Fuhrmann, 1907.

(See *Rec. Ind. Mus.*, Vol. IX, Part V, Dec. 1913).

Sub-family DAVAINIINAE, Braun, 1900.

Sub-family diagnosis:—Davainiidae. Suckers armed around periphery with several rings of hooklets which are unstable or persistent. Uterus breaks down into numerous egg capsules, each containing one or more eggs. Para-uterine organs not present. Adult in mammals and birds.

Type-genus:—*Davainea*, Blanchard and Railliet, 1891.

Genus *Cotugnia*, Diamare, 1893.

Generic diagnosis:—Davainiinae. Segments broader than long. Several layers of longitudinal muscles, alternating with layers of transverse muscle fibres. A double set of reproductive

organs in each segment, close to the longitudinal excretory canals. Genital canals pass dorsal of longitudinal excretory vessels and nerve. Testicles numerous, filling the median fields, and extending dorsal of the female organs and excretory vessels to the extreme edge of the medullary parenchyma. Uterus breaks down and the eggs become enclosed singly in egg capsules. Adult in birds.

Type-species:—*Cotugnia digonopora* (Pasquale 1890) Diamare, 1893.

Cotugnia digonopora (Pasquale, 1890) Diamare, 1893.

ZEV 6293. *Corvus macrorhynchus*. Calcutta. T. Southwell. Two specimens.
(Crow).

ZEV 6293. *Gallus gallus*? Berhampur, Major Lane, I.M.S. Five specimens.
(Hen). Bengal.

Length 70 mm. Greatest breadth 6 mm. Length of last segment 12 mm. Head 14 mm. broad. Suckers 45 mm. broad, globular and prominent. Spines on rostellum exceedingly minute. Neck absent. Genital pores double and situated about the middle of the segment. Calcareous corpuscles large.

Synonym:—*Taenia digonopora*, Pasquale, 1890.

Literature:—Pasquale, 1890; Diamare, 1893; Stiles and Hassall, 1896; Ransom, 1909.

Genus *Davainea*, Blanchard and Railliet, 1891.

= *Bothriotaenia*, Railliet, 1892,
(type, *Dibothrium longicolle*, Molin, 1858).

Generic diagnosis:—*Davaineinae*. A single set of reproductive organs in each segment. Genital pores unilateral or occasionally irregularly alternate. Uterus breaks down into egg capsules each containing one or several eggs. Adult in mammals and birds.

Type-species:—*Davainea proglottina* (Davaine 1860) Blanchard, 1891.

Davainea friedbergeri (Von Linstow, 1878) R. Blanchard, 1891.

ZEV 6293. *Pavo nigripennis*. Berhampur, Major Lane, I.M.S. One specimen.
(Black shouldered peacock). Bengal.

I very doubtfully refer a single damaged specimen to the above species. It measured 140 mm. long and the greatest breadth was 5 mm. The genital pores were unilateral.

Synonyms:—*Taenia friedbergeri*, Von Linstow, 1878.

Taenia agama, Megnin, 1878.

Taenia infundibuliformis var. *phasianorum*, Megnin, 1878.

Taenia cesticillus var. *phasianorum*, Neumann, 1878.

Literature:—Stiles and Hassall, 1896.

Davainea echinobothrida (Megnin, 1881) R. Blanchard, 1891.

ZEV 6175 *Gallus bankiva*. Berhampur, Major Lane, I.M.S. Over thirty specimens.
(Hen). Bopal.

Synonyms:—*Taenia infundibuliformis*, Megnin (part.), 1880.

Taenia echinobothrida, Megnin, 1880.

Literature:—Stiles and Hassall, 1896; Ransom, 1905.

Davainea corvina, Fühmann, 1905.

ZEV 6146 *Pica rustica*. Zoological Gardens. Two specimens.
(Magpie.) Calcutta.

Our specimens agree exactly with the description given by Fühmann.

Synonym:—*Davainea polycalcaria*, von Linstow, 1906.

Literature:—Fühmann, 1905; von Linstow, 1906.

Examples of this parasite were also obtained as under:—

Nine specimens, *Corvus macrorhynchus*. Chilka Lake, Orissa. T. Southwell.

Twenty-one „ *Corvus macrorhynchus* and *Corvus splendens*. Sabour, Bihar. T. Southwell.

Twelve „ *Corvus splendens*. Calcutta. T. Southwell.

Six „ *Corvus macrorhynchus* and *Corvus splendens*. Colombo, Ceylon. T. Southwell.

Davainea cesticillus (Molin, 1858) R. Blanchard, 1891.

ZEV 6135 Small intestine of chick. ? H. B. Ward.

One specimen named and presented by Professor H. B. Ward of the University of Illinois. The locality is not given; presumably it is from the United States (Nebraska?).

Literature:—Molin, 1858; R. Blanchard, 1891.

Family HYMENOLEPIDIDAE, Railliet and Henry, 1909.

For characters of family see *Rec. Ind. Mus.*, Vol. IX, Pt. V, December 1913.

Sub-family HYMENOLEPIDINAE, Ransom, 1909.

= Hymenolepinae, Perrier, 1897.

Sub-family diagnosis:—Hymenolepididae. Rostellum armed with a single crown of hooks, or more rarely rudimentary and unarmed. Segments always broader than long. Longitudinal muscles in two layers. A single set of reproductive organs in each segment. Genital pores unilateral. Genital canals pass on the dorsal side of the longitudinal excretory vessels and nerve. Vas deferens always short, with seminal vesicle. Uterus persistent, sac-like. Eggs with three transparent shells. Adult in mammals and birds.

Type-genus:—*Hymenolepis*, Weinland, 1858.

Genus *Hymenolepis*, Weinland, 1858.

= *Diplocañthus*, Weinland, 1858; = *Lepidotrias*, Weinland, 1858; = *Drepanidotaenia*, Railliet, 1892; = *Dicranotaenia*, Railliet, 1892; = *Echinocotyle*, Blanchard, 1891; = *Triorchis*, Clerc, 1903.

Generic diagnosis:—*Hymenolepidinae*. Rostellum generally well developed, and armed with a single crown of hooks, or more rarely, rudimentary and unarmed. Suckers in adult rarely armed with hooklets of fine spines; are generally unarmed. Testicles three in each segment. Vas deferens with internal (*i.e.* inside the cirrus pouch) as well as external seminal vesicle (outside the cirrus pouch). Sacculus accessorius generally absent. Adult in mammals and birds.

Type-species:—*Hymenolepis flavopunctata*, Weinland, 1858.

= *Hymenolepis diminuta* (Rudolphi, 1819) Blanchard, 1891.

Sub-genus *Hymenolepis*, Weinland, 1858.

Sub-generic diagnosis:—*Hymenolepis*. Rostellum generally well developed, and armed with a single crown of hooks, or more rarely rudimentary and unarmed. Suckers in adults generally unarmed, or, rarely, their entire surface may be covered with rudimentary spines. Sacculus accessorius generally absent. Adult in mammals and birds.

Type-species:—*Hymenolepis flavopunctata*, Weinland, 1858.

= *Hymenolepis diminuta* (Rud., 1819) Blanchard, 1891.

Hymenolepis capillaroides? Fühmann, 1906.

ZEV 9381 *Corvus macrorhynchus*. Calcutta. T. Southwell. Twenty-eight specimens.
(Crow).

The specimens under consideration are placed in the above species with a little uncertainty. The rostellum in every specimen was slightly damaged and the exact size and number of spines could not be determined. If not absolutely identical, our specimens are closely related to *Hymenolepis capillaroides*, Fühmann.

The specimens measured 25 to 30 mm. long. The last segments were 22 mm. long, 22 mm. broad, and the edges were slightly salient. In one specimen, only, which was more mature than the rest, and which had contracted to a greater degree, the greatest breadth was 58 mm. The head is 14 mm. long, and 2 mm. broad. As far as could be ascertained, there was a single row of 10 hooks, 0.21 mm. long, on the rostellum. The suckers were 0.98 mm. in diameter. Neck 4 mm. long. The genital pores unilateral. The testes are three in number, and have a diameter of 0.6 mm. Two were situated posteriorly, one on each side, and the third was lateral and somewhat anterior. The variable disposition of the testes noted by Fühmann (1906) was not seen in our specimens. The cirrus bulb measured 12 mm. long, and was situated anteriorly. The internal extremity abutted on the posterior edge of the preceding segment. It will be noted

that the last segments in our specimens are square. The segments figured by Fühmann for this species are broader than long, but possibly those figured were not the posterior gravid segments.

Literature:—Fühmann, 1906.

Hymenolepis sp.

ZEV ⁰⁰⁵⁰ *Chenopus atrata*. Berhampur, Major Lane, I.M.S. Numerous
(Black Australian Bengal. specimens.
swan).

Our specimens are without heads and were badly preserved. They measured 17 mm. long and 6 mm. broad. The segments are all much longer than broad, the genital pores are all on one side and are situated anteriorly. The cirrus pouch is enormous. It is placed at the anterior end and lies transversely across two-thirds of the segment. It is one-third the length of the segment. The penis is also very long and covered with exceedingly minute spines. As far as could be ascertained, the testes were three in number, and posterior and median in situation. Near them, and on the side opposite to that on which the genital pore occurs, was a darkish mass, which appeared to be the ovary. No further anatomical details could be determined.

Hymenolepis sp.

Two specimens from *Chrysophlegma flavinucha* (woodpecker), Zoological Gardens, Calcutta. The specimens, which have been permanently stained and mounted, were so badly preserved that, although they appear to be new species, I have been obliged to defer a careful description until more material can be collected. They measure 25 mm. long and are thin and filamentous. The last few segments were gravid. The rostellum is comparatively long, and, owing to contraction, appears wrinkled. There appears to be a single row of ten hooks. Suckers unarmed. There is no neck. The first segments are much broader than long and the last few are slightly longer (26 mm.) than broad (19 mm.). The reproductive apertures are almost, but not quite, unilateral. The testes are very large and are three in number, two being posterior, (one on each side of the middle line) and the third being anterior to one of the former. The genital cloaca is large, and the cirrus small. The ovary and vittellarium appear to be situated between, and anterior to the two posterior testes. The receptaculum seminis (?) was enormous, and situated anteriorly, in the middle of the segment. The uterus occupied the whole of the last segments, and appeared to be divided into two, by a dorso-ventral septum running from the anterior to the posterior end of the segment.

Sub-genus *Drepanidotaenia*, Railliet, 1892.

Head provided with a single row of uniform hooks, few (8-20) in number, with dorsal root much longer than ventral root,

the latter always small, with prong directed posteriorly when the rostellum contracts.

Type-species:—*Drepanidotaenia lanceolata* (Bloch, 1782) Railliet, 1892.

Larval stages have been found in small crustaceans.

This genus does not appear to differ from *Hymenolepis*, Weinland, 1858.

Drepanidotaenia gracilis (?) Zeder, 1803) Krabbe, 1869, Railliet, 1892.

ZEV 894. *Phenicopterus* Zoological Gardens, T. Southwell. About two
rosens. (Flamingo). Calcutta. hundred specimens.

Synonyms:—*Taenia collo-longissimo*, Bloch, 1782?

Taenia gracilis (Zeder) Rudolphi, 1810?

Halysis gracilis, Zeder, 1803?

Literature:—Stiles and Hassall, 1896; Führmann, 1908.

Stiles gives the following description of this worm:—

"About 270 mm. long, by 1.5 to 2 mm. broad. Head sub-globular. Rostellum cylindrical, obtuse, armed with a simple crown of 8 hooks, 77-80 μ long. Neck very short, genital pores unilateral. Receptaculum pyriform; penis unarmed. Genital sinus provided with large spines." Our specimens, although extremely small, undoubtedly are of the same species. They measured only 3 mm. long and .5 mm. broad. The posterior segments measured 15 mm. long and .6 mm. broad, and were not fully mature. They showed a tendency to become square. The genital pores are unilateral. The rostellum is cylindrical and measures .3 mm. long. It is marked by transverse wrinkles. The hooks are eight in number and they measure .08 mm. long. These hooks are attached to the extreme end of the rostellum. There is no neck. The testes are three in number, and are situated posteriorly, two being lateral and one median. The vas deferens runs nearly straight to the anterior aporose corner of the segments and swells into a very large vesicula seminalis. The cirrus is long. The penis was not observed. Unfortunately the female reproductive organs did not appear to be sufficiently developed to admit of description.

For notes on the systematic position of this genus see Führmann, 1908.

Genus *Diorchis*, Clerc, 1903.

Generic diagnosis:—Hymenolepidinae. Rostellum with a single crown of ten hooks with long dorsal and short ventral roots, or exceptionally, with very short dorsal root and with ventral root nearly as long as the blade. Surface of the suckers may be armed with minute spines. Inner longitudinal muscular layer consisting of 8 bundles, 4 dorsal and 4 ventral. Two testicles in each segment. Adult in birds.

Type-species:—*Diorchis acuminata* (Clerc 1902) Clerc, 1903.

Diorchis americana, Ransom, 1909.

ZEV ²²³³ *Dendrocitta* sp. Zoological Gardens. T. Southwell. Eighteen specimens.
(Tree pie). Calcutta.

In our specimens the surface of the suckers was armed with very minute spines, but the longitudinal bands of muscles were not well defined. The segments were mature, but not gravid, and were extremely short. Three fairly well defined sizes were noticed, for which the following are the dimensions:—

	I.	II.	III.
Length of specimens	9 mm.	12 mm.	16 mm.
Extreme breadth	7 mm.	5 mm.	9 mm.
Breadth of head	1 mm.	1 mm.	1 mm.

Literature:—Ransom, 1909.

Sub-family *DIPYLIDIINAE*, Stiles, 1896.Genus *Gryporhynchus*, Nordman, 1832.

= *Acanthocirrus*, Fühmann, 1907.

(type, *Acanthocirrus macrostratus*, Fühmann, 1907).

Generic diagnosis:—Dipylidiinae. Rostellum armed. Genital pores unilateral. Genital canals pass between the longitudinal excretory vessels. Root of cirrus with one or two pairs of powerful spines lying in special pockets. Testicles few (6-8). Uterus sac-like. Adult in birds.

Type-species:—*Gryporhynchus pusillus*, Nordman, 1832.

= larva of *Acanthocirrus macropeos* (Wedl, 1856).

Gryporhynchus (*Acanthocirrus*) *macropeos*, Wedl, 1855.

ZEV ²¹⁶¹ *Ardeola grayi*. Zoological Gardens. T. Southwell. Over one hundred specimens.
(Pond heron). Calcutta.

Our specimens measured 4 mm. long, and each consisted of about 30 segments. The last segments measured 3 mm. long, and 3 mm. broad. The peck is 1 mm. long. The number of hooks could not be satisfactorily counted as many of them were missing. They measured 03 mm. long. The genital pores are unilateral, and are situated in the anterior $\frac{1}{4}$ of the segment. The penis is 13 mm. long, 018 mm. broad, and covered with exceedingly minute spines. There are six testes. The cirrus sac is situated transversely at the anterior and extends two-thirds the distance across the segment. The uterus, in gravid segments, consisted of two circular sacs, one on each side, which appeared to communicate with each other.

Synonyms:—*Taenia macropeos*, Wedl, 1856.

Acanthocirrus macropeos, Fühmann, 1908.

Literature:—Fühmann, 1907; Fühmann, 1908; Ransom, 1909; Lühe, 1910.

For a discussion of the synonymy of this species the reader is referred to Ransom and Fühmann (above).

Sub-family *PARUTERININAE*, Ransom, 1909.

= *Paruterinae*, Fühmann, 1907.

Sub-family diagnosis:—*Hymenolepididae*. Scolex usually armed, rarely without rostellum. A single (double in *Stilesia* provisionally placed in the sub-family) set of reproductive organs in each segment. Uterus simple or double, with a single para-uterine organ, or multiple with several para-uterine organs, into which the eggs pass in the final stage of development of the segment. Adult in birds and Amphibia. (*Stilesia* in mammals).

Type genus:—*Paruterina*, Fühmann, 1906.

Genus *Metroliasthes*, Ransom, 1900.

Generic diagnosis:—*Paruterininae*. Scolex unarmed, without rostellum. Genital pores irregularly alternate. Genital canals pass between dorsal and ventral longitudinal excretory vessels and dorsal of the nerve. Testicles rather numerous (20 to 40) in posterior portion of segment. Uterus single in origin and consisting, when fully developed, of two spherical sacs touching in the median line and more or less fused with one another. A para-uterine organ, developing in front of the uterus, and into which the eggs pass, becomes transformed finally into a spherical egg capsule. Adult in birds.

Type-species:—*Metroliasthes lucida*, Ransom, 1900.

Metroliasthes lucida, Ransom, 1900.

• ZEV 237.0 *Gallus bankiva*? Angul, Orissa Vety. Asstt., Twenty-one
(Hen). Angul, Orissa. specimens.

Our specimens measured 12 cms. long and 1.7 mm. broad.

Literature:—Ransom, 1905.

Genus *Nematotaenia*, Lühe, 1899.

Generic diagnosis:—*Paruterininae*. Scolex unarmed, without rostellum. Segmentation of strobila distinct only at posterior end. Strobila circular in cross section. Genital pores alternate. Genital canals pass dorsal of longitudinal excretory vessels and nerves. Uterus horse-shoe shaped, disappears early. Eggs, through the action of numerous para-uterine organs, become inclosed in egg capsules, 3 or 4 in each capsule. Adult in Amphibia.

Type-species:—*Tacnia dispar*, Goeze, 1782.

Nematotaenia dispar (Goeze 1782) Lühe, 1910.

• ZEV 237.0 *Dufa* sp. Lucknow. Capt. F. H. Stewart, I.M.S.
(Toad).

A few fragments are referred to this species with some hesitation. Only one damaged scolex was available. The anterior extremity was unsegmented, and the worm was circular in cross section. Segmentation was distinct only towards the posterior extremity. The fragments in no case measured more than 7 mm.

Literature:—Lühe, 1910; Ransom, 1909.

Family ICHTHYOTAENIIDAE, Ariola, 1899.

Head with four unarmed suckers. Genitalia as in other Tetraphyllidae. The uterus does not open to the exterior by a pore. The openings of the cirrus and vagina are situated at the side. Yolk-glands double, situated laterally and consisting of numerous follicles. Ovary situated behind the shell gland. Adult in reptiles and birds.

Genus *Ichthyotaenia*, Lonn., 1894.

Scotex armed with four suckers and often a fifth apical sucker. Genital pores marginal, irregularly alternate. Testes numerous. The vagina forms coils at the posterior margin of the proglottides in the middle, which replace a receptaculum seminis. Parasitic in fishes, birds and reptiles.

Ichthyotaenia (Acanthotaenia) nilotica, Beddard, 1913.

ZEV 5045 *Varanus bengalensis*. Balugaon, T. Southwell. Numerous specimens.
Orissa.

Our specimens agree in every detail with the excellent description given by Beddard of this species in the P.Z.S., London, March 1913, and to this paper the reader is referred for a discussion of the relationship of the genus.

The lizard was caught near a small freshwater ditch 8 miles north of Balugaon, and about 3 miles from the west shore of the Chilka lake.

Ichthyotaenia (Proteocephalus) pusillus, Ward, 1910.

ZEV 5327 *Cristovomer namaycush*. Lake Temnogami, H. B. Ward.
Ontario, Canada.

One specimen named and presented by Professor H. B. Ward of the University of Illinois.

Literature:—Benedict, 1900; George La Rue, 1909; George La Rue, 1911; Johnstone, 1911; Beddard, 1913.

Ichthyotaenia (Proteocephalus) ambloplitis (Leidy, 1887)

Benedict, 1900.

ZEV 6329. Stomach of *Amia calva*. Put-in-Bay, Ohio, H. B. Ward.
U.S.A.

Two specimens, named and presented by Professor H. B. Ward of the University of Illinois.

Literature:—Benedict, 1900; George La Rue, 1909; George La Rue, 1911; Johnstone, 1911; Beddard, 1913.

Considerable confusion exists with reference to many of the genera included in the family Ichthyotaeniidae, Ariola, 1899. It is not proposed in the present paper attempting to review the anatomical relationships of the various genera in question. Details relating thereto are given in the papers cited. La Rue

(1911), as a result of a prolonged investigation of the three genera *Proteocephalus*, Weinland, *Ichthyotaenia*, Lonnberg, and *Tetacetylus*, Monticelli, stated that "the genera *Proteocephalus*, Weinland, and *Ichthyotaenia*, Lonnberg, are synonymous. The name *Proteocephalus*, being the older should be retained to designate the species".

Unfortunately I have not the material before me for the proper discussion of the question, and I have therefore left the species in the nominal genus to which they were referred by their authors.

ADDENDUM.

Professor Albert Hassall of the United States Department of Agriculture (Bureau of Animal Industry) has called my attention to certain remarks I made in my report "On some Indian Cestoda, Part I" (*Rec. Ind. Mus.*, Vol. IX, Part V, December, 1913) regarding the occurrence of certain cestode parasites in particular hosts.

As a result, I have examined the material again and now wish to make the following remarks and corrections.

Cysticercus cellulosae (pp. 292 and 293 of above paper).

I remarked upon the fact that it was unusual to find this larva in the muscles of *Bos taurus*. The armature on the head led me to the above identification. Professor Hassall, referring to this identification remarks that "we have been in the habit of determining the armed larval form in the sheep as a larval stage of *Taenia solium* (i.e. as *C. cellulosae*), but on closer examination Dr. Ransom determined that it was an entirely different form, and experiment proved this to be a fact. Perhaps you may find that these forms represent new species."

Unfortunately, I have been unable to obtain a copy of Dr. Ransom's paper (Occurrence of *Cysticercus* of *Taenia solium* in sheep. *Amer. Ass. Adv. Sc. N.Y.*, U.S. (703), June 19, 1908). My material consists of three cysts only. The further elucidation of the exact nature of these larval forms will depend on my being able to obtain more and fresh material.

I was in error with regard to the identification of *Cysticercus fasciolaris* and *C. pisiformis* (page 292). The data with reference to the above species should read as follows:—

Hymenolepis murina (Duj., 1845) R. Blanchard, 1891.

ZEV 3362	<i>Mus decumanus</i> ^{mus.}	Calcutta?	Col. A. Alcock, I.M.S.
ZEV 3672	<i>Mus rattus</i> ?	Lahore, Punjab.	Punjab Civil Vety. Dept.
ZEV 3673	No history.		
ZEV 3146	<i>Mus rattus</i> ?	Berhampur, Bengal.	Major Clayton Lane, I.M.S.
ZEV 1037	<i>Mus rattus</i> ?	Calcutta.	Major R. Milne, I.M.S.

Cysticercus fasciolaris, Rudolphi, 1808.(Larval form of *Taenia crassicollis*, Rudolphi, 1810).ZEV 18725 Liver of *Mus* Amritsar, Capt. G. I. Davis, I.M.S.
rattus, Punjab.

Large numbers of larval forms of *C. fasciolaris* were removed from their cysts. The error arose in consequence of the above two forms being mixed in the same bottle.

Thysanosoma sp., Diesing, 1835.

The specimens referred to *T. actinioides* on page 286 were two in number. One specimen consisted of a scolex and about 12 segments only; the other was a mature worm. The measurements of the latter were as follows:—

Entire length of worm	...	...	...	90 mm.
Greatest breadth	...	...	...	13 mm.
Length of longest segment	...	...	...	1 mm.
Breadth of head	...	...	...	19 mm.

Scolex unarmed. Rostellum absent. There was no neck. The suckers are four in number and symmetrical. They face slightly forward. Proglottides numerous and always much broader than long throughout the entire length of the worm. The posterior flap of each segment markedly overhangs the succeeding segment both dorsally and ventrally. As I had only one complete specimen, sections were not prepared, but I concluded from an examination of the external character that the specimen was *Thysanosoma actinioides*.

A more careful examination which I have just made has, however, conclusively proved that the specimen, although probably belonging to the genus *Thysanosoma*, does not agree with any known species of that genus.

The following details have been definitely established:—

The head is unarmed. There are four symmetrical suckers directed slightly forward. There is no unsegmented portion succeeding the head, but the neck portion is flattened dorso-ventrally. The posterior edge of each segment very markedly overlaps the succeeding segment both dorsally and ventrally, but the free edge of this flap is puckered or frilled and *not* broken up into fimbriae. The gonads appear in the 11th segment, on one side only, and the genital pores are absolutely unilateral. Details with reference to the reproductive organs could not be made out satisfactorily as the material was badly preserved, but sections of the terminal segment led me to the definite conclusion that many para-uterine organs were present surrounding small clusters of embryos.

It is clear that these characters distinguish this worm both from *T. actinioides* and from *T. giardii*. The only other known species of this genus is *T. gambianum*, Beddard (Contributions to the anatomy and systematic arrangement of the *Cestodea*, by

F. E. Beddard, F.R.S., P.Z.S., September 1911, London). Our specimens agree with *T. gambianum* in all the anatomical details which I have been able to elucidate, particularly with reference to the unilateral genital pores, the probable presence of numerous para-uterine organs, the absence of armature on the head and the absence of a "neck." At the same time, judging from Beddard's figures, I am of opinion that our specimens are not *T. gambianum*.

Beddard's specimens were from the Gambian Pouched Rat (*Cricetomys gambianus*). Our specimens are recorded as being obtained from *Rhinoceros sondaicus*, but no locality or date is given, nor is the name of the collector known. The absence of armature on the head, the absence of a neck, together with unilateral genital pores and the presence of para-uterine organs leads me to place our specimens in the genus *Thysanosoma*. A determination of the species will not be possible until more material is available.

In view of the preceding facts, the details given on page 286 of my report (*vide ante*) under "*Thysanosoma actinioides*, Diesing, 1895" should read as follows:—

Thysanosoma sp.

ZEV ²⁹⁸⁵⁰ *Rhinoceros sondaicus*. ?

Literature:—Beddard, 1911.

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III. NOTES ON ORIENTAL DRAGONFLIES IN THE INDIAN MUSEUM.

No. 4.—THE GENUS *PSEUDAGRION*.

By F. F. LAIDLAW.

Genus *Pseudagrion*, de Selys.

A genus showing the essential features of the dominant section of the Agrioninae both as regards venation and in other respects. It ranges from S. Africa through the tropical regions of the old world to Australia (I can find no record for Ceylon). It is characterized especially by the following characters:—

- (i) Extent of petiolation of the wing. This ceases at the level of the basal post-costal nerve; this latter lies at a level between the first and second antenodal nerves.
- (ii) Presence of post-ocular spots, and by certain sexual characters:—
 - (a) Pterostigmata of all four wings of males alike.
 - (b) Shape of superior anal appendages of males.
 - (c) Structure of hind margin of prothorax of female.
 - (d) Absence of a spine on the ventral surface of the eighth abdominal segment of the female.

Morton has published admirable figures of the anal appendages of three species, viz. *P. decorum* (Ramb.), *P. hypermelas*, Selys, and of *P. bidentatum*, Morton (*Trans. Ent. Soc. London*, 1907, pl. xxiv). Tillyard has figured the anal appendages of a male *P. australasiae*, Selys, from Queensland, the base of the wing of the same species, and the prothorax of the female of an allied form *P. aureofrons*, Tillyard, the latter exhibiting the characteristic generic features (*Proc. Linn. Soc. N.S. Wales*, XXXVII, 3, pls. xlviii, xlix). The anal appendages of *P. microcephalum* (Ramb.) have been figured by myself in a recent paper (*Mem. Ind. Mus.*, V, p. 179). In the Museum collection examples of four Indian species are preserved.

I give below a table which will, I hope, be of service in facilitating the recognition of the Indian species.

CHARACTERS OF MALES.

A. Abdominal segments 1-7 with black or bronze black markings.

i. Segments 8, 9, 10 black.

a. Thorax black with olive-coloured antehumeral band, superior anal appendage bifurcate in profile, with a single large internal tooth ...

P. hypermelas, Selys.

- b. Thorax blue with a black line on either side of carina. Superior anal appendage ciliate in profile with a large internal two-pointed tooth ... *P. bidentatum*, Morton.
- ii. Segments 8-9 blue,¹ 10 black dorsally.
- c. Dorsum of thorax with three narrow black stripes. Superior anal appendages as long as segment 10; marked with white internally ... *P. microcephalum* (Ramb.).
- d. Dorsum of thorax with three broad black bands. Superior anal appendages only half as long as segment 10 ... *P. australasiae*, Selys.
- iii. Segments 8, 9, 10 blue.¹
- e. Upper lip and head largely blue, anal border of segment 10 moderately excavate, spines on border very small. Superior anal appendages unequally bifurcate in profile, black above, whitish below; lower pair truncate, much shorter than upper pair ... *P. decorum* (Ramb.).
- f. Upper lip and head largely orange-brown; anal border of segment 10 deeply excavate, beset with strong black spines. Upper anal appendages not bifurcate in profile. Lower pair nearly as long, pointed ... *P. rubriceps*, Selys.
- B. Abdominal segments all blue except 9, which is black above ... *P. azureum*, Selys.

To supply any key for discrimination between the females of these species is a much more difficult matter.

In the first place the Museum material includes female specimens of two species only, viz. of *P. microcephalum* in some abundance, and a solitary female of *P. decorum*. Secondly the females of *P. hypermelis* and of *P. bidentatum* are quite unknown and thirdly it is evident that characters which can be used for purposes of identification are much harder to find than in the case of the males.

In a general way the female of *P. azureum* can be contrasted with those of the other species that have been described by the absence in it of any black markings on the abdomen, which according to Selys is bluish (bleuâtre) in colour, paler beneath.

The remaining species of which any account is available all have black markings on the abdomen on segments 1-9.

P. microcephalum has the post-ocular spots of a fairly bright blue colour with blue on the thorax. *P. decorum*, which is a rather larger insect, has green post-ocular spots and the ground colour of the thorax is distinctly green. That of *P. australasiae* is also larger than *P. microcephalum* and according to Selys the black marks on segments 8 and 9 are more extensive than in the smaller species.

Lastly *P. rubriceps* is described as having the upper lip of an orange colour, the rest of the head yellowish with blue post-ocular spots, the thorax orange yellow.

¹ The sutures of these segments are ringed with black.

P. australasiae, Selys.

P. australasiae, Kirby, *Cat. Odonata*, p. 183; Tillyard, *Proc. Linn. Soc. N. S. Wales*, XXXVII, 3, p. 469, pl. xlviii, figs. 23-24; pl. xlix, fig. 15.

Range.—India to Australia.

Recorded Stations.—Pulo Besaor (*Selys*), Queensland (*Selys*), Cape York to National Park, N.S.W. (*Tillyard*).

The males of this species are exceedingly like those of *P. microcephalum*. The build is a trifle more robust than in that species, and the three black bands of the thorax are much broader, whilst the black marking on segment 10 of the abdomen is more extensive. Examination of the anal appendages of the males will facilitate the distinction of the two species.

I believe the Calcutta specimens can be further differentiated from Australian forms by the characters of the anal appendages, but have no specimens for comparison. Tillyard, *loc. cit.*, describes the superior anal appendages as having the upper lobe shorter than the lower; in the Calcutta specimens both lobes appear equal in length, whilst the lower appendages in the latter seem to me to be rather more conical and tapering. The specimens are, however, not in the best of condition and study of further material is necessary for a satisfactory determination of possible differences. *A priori* I am inclined to expect the two forms to be moderately distinct.

The Museum collection contains an old specimen of the male labelled by Selys. I have found also a single male from Calcutta, amongst specimens of *Ischnura senegalensis*.

Approximate dimensions:

♂ abdomen 31-32 mm., hind-wing 21 mm.
♀ „ 29-30 mm., „ 21 mm.

P. microcephalum (Rambur).

P. microcephalum, Kirby, *Cat. Odonata*, p. 153; Selys, *Ann. Mus. Genova*, (2) X, p. 83 (1891); Martin, *Mission Pavie* (sep.), p. 18; Ris, *Archiv. f. Naturgesch.*, 1900, p. 198.

Range.—India, Burma, Tonkin, Malaya to the Bismark Archipelago.

I have recently dealt with this species in an account of Odonata found about Lake Chilka in Orissa (*Mem. Ind. Mus.*, V, p. 178, 1915). In the accompanying diagrammatic text-figure I show the colour pattern of the thorax of the female viewed from above. The dotted areas are brown in colour, the unshaded spaces blue. The immature male has the same colouring; in mature males the brown is entirely replaced by black on the three stripes.

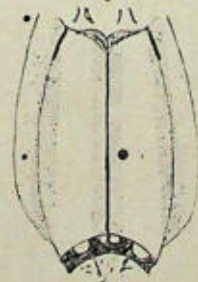


FIG. 1.—Dorsum of thorax of *P. microcephalum* ♀.

P. microcephalum is evidently one of the commonest of dragonflies in the low-lying parts of Bengal.

Approximate dimensions:

♂ abdomen 27-29 mm., hind-wing 17-18 mm.
♀ „ 27-28 mm., „ 18-19 mm.

P. decorum (Ramb.).

P. decorum, Kirby, *Cat. Odonata*, p. 153; Kruger, *Stettin Ent. Zeit.*, 1898, p. 119; Morton, *Trans. Ent. Soc. London*, 1907, p. 307, pl. xxiv, figs. 7, 8.

2 ♂♂ Calcutta, 4-6-15 (²³³/₁₁).

1 ♂ Calcutta (²³³/₁₁). Labelled by de Selys.

1 ♂ Sar Lake, Puri District, Orissa, 9-iv-13 (¹¹⁶/₁₁).

Range:—Peninsular India, Sumatra.

Recorded Stations:—Bombay (Rambur), Deesa (Morton), Soekranda, Sumatra (Kruger).

The adult male closely resembles the newly-emerged male of the closely allied *P. microcephalum* in colour, so far as the thoracic pattern is concerned.

Approximate dimensions:

♂ abdomen 28-30 mm., hind-wing 19 mm.
♀ „ 25-27 mm., „ 18 mm.

P. rubriceps, Selys.

P. rubriceps, Kirby, *Cat. Odonata*, p. 183; Selys, *Ann. Mus. Genova*, (2) X, p. 83 (1891).

1 ♂ immature, with larval skin. Museum Tank, Calcutta (⁶⁶⁹⁷/₂₀).

Range:—India, Burma, Java.

Recorded Stations:—Palon (Selys), "India" (Selys), "Java" (Selys).

The specimen was preserved shortly after emerging, consequently it is not possible to make any examination of the wing characters.

Fortunately the anal appendages are well shown. The colouring of the thorax resembles closely that of an immature

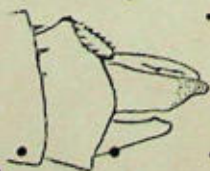


FIG. 2.—Apex of abdomen of *P. rubriceps* seen from the side obliquely.

P. decorum. In general the insect both as regards colour and the structure of the anal appendages is a typical *Pseudagrion*. Segments 9, 10 of the abdomen are (apparently) blue; 8 would appear to have a longitudinal bronze band dorsally, narrowing in front. The upper pair of anal appendages are tinged with brown, the lower pair are white. The curious series of spines developed along the border of the excavation of segment 10 are black (see text-fig 2).

Selys' accounts of the colouring of the abdomen are contradictory. In the synopsis he states that segment 10 is black

above; in the "*Odonates de Birmanie*" that segments 8-10 are light blue. The present specimen is too young to show colours satisfactorily, but so far as one can judge segment 10 is blue.

The larval skin, which is lacking the gill lamellae, shows a close general resemblance to that of *P. microcephalum* described by me.

Approximate dimensions:

♂ abdomen 29 mm., hind-wing 18-20 mm.

♀ ,, 27-29 mm., ,, 19-20 mm.

P. bidentatum, Morton.

P. bidentatum, Morton, *Trans. Ent. Soc. London*, 1907, p. 308, pl. xxiv, figs. 11-12.

Recorded Stations:—Deesa, Gujerat.

Dimensions: ♂ abdomen 23.75 mm., hind-wing 16.5 mm.

P. hypermelas, Selys.

P. hypermelas, Kirby, *Cat. Odonata*, p. 183; Kruger, *Stettin Ent. Zeit.*, 1898, p. 119; Morton, *Trans. Ent. Soc. London*, 1907, p. 307, pl. xxiv, figs. 9-10.

Range:—India, Sumatra.

Recorded Stations:—Deesa (Morton), Sambong, Sumatra (Kruger).

Approximate dimensions: ♂ abdomen 15-18 mm., hind-wing 24-26 mm.

P. azureum, Selys.

P. azureum, Selys, *Ann. Mus. Genova*, (2) X, pp. 81-83 (1891).

Range:—Burma.

Recorded Stations:—Karin Hills in June; Cobapo in September (Selys).

Dimensions: ♂ abdomen 30-36 mm., hind-wing 21-23 mm.

♀ ,, 36 mm., ,, 23 mm.



IV. REPORT ON A COLLECTION OF
MOLLUSCA FROM THE COCHIN AND
ENNUR BACKWATERS.

By H. B. PRESTON, F.Z.S.

Class GASTROPODA.

Order OPISTHOBRANCHIATA.

Suborder TECTIBRANCHIATA.

Family TORNATINIDAE.

Retusa estriata (Preston).

Rec. Ind. Mus. X, 1914, p. 303 (as *Tornatina*).

Cochin backwater, near Ernakulam (F. H. Gravely).

Mr. T. Iredale having pointed out to the author that the name "*Tornatina*" is antedated by *Retusa*, the latter must take precedence.

Retusa ennurensis, sp. n.

Shell cylindrical, whitish in the median part, painted with a broad pale red band above, and having the base also painted red, but of a deeper hue than that on the upper part of the shell, sculptured throughout with fine, closely set, revolving striae which the microscope reveals to be also of a reddish colour, transversely marked with microscopic growth striae; apex deeply sunken; columella margin white, polished, calloused, sloping, scarcely curved; labrum acute, slightly inwardly bent over the aperture in the lower median part; aperture narrow, straightish, broadening above and especially below; interior of shell tinged with lilac.

Alt. 5.5, diam. 2.25 mm.

Hab.—Ennur backwater, Madras.

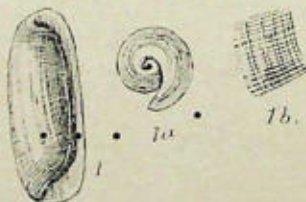


FIG. 1. 1a. — *Retusa ennurensis*,
sp. n. $\times 4$.

FIG. 1b. — do., sculpture,
 $\times 8$.

Order PROSOBRANCHIATA.

Suborder PECTINIBRANCHIATA.

Family NASSIDAE.

Nassa denegabilis, Preston.*Rec. Ind. Mus.* X, 1914, pp. 297-298.

Ennur backwater, Madras; Cochin backwater, near Ernakulam.

Nassa kieneri, Desh.*Moll. H. Bourbon*, 1863, p. 129.

Cochin backwater, near Ernakulam; a single young specimen (F. H. Gravely).

Nassa orissaensis,¹ Preston var. *ennurensis*, var. n.

- Shell differing from the type in its much larger size, it having 6 whorls, and in its more exaggeratedly fusiform shape, moreover both the canal and aperture are narrower.



Alt. 10.25, diam. maj. 4.5, diam. min. 4 mm.

Aperture: alt. 4.25, diam. 2 mm.

Hab. — Ennur backwater, Madras (*Type*); Canal near Chingrihatta, outskirts of Calcutta (a single specimen only).FIG. 2.—*Nassa orissaensis* var. *ennurensis*, var. n. $\times 3$.FIG. 2a.—*do.*, sculpture, $\times 6$.*Alectrion unicolorata*, Kiener.*Monog. Buccinum*, p. 60, pl. xix, fig. 69.

Cochin backwater, near Ernakulam; a single young specimen (F. H. Gravely).

Nassodonta insignis, H. Ad.*Proc. Zool. Soc. London*, 1866, p. 445.

Cochin backwater, near Ernakulam (F. H. Gravely).

In the *Proc. Malac. Soc. London*, vol. I, 1895, pp. 257-258, Mr Edgar A. Smith doubted the validity of the genus *Nassodonta*, this view however the author is unable to accept, hence its reinstatement in the present paper.

¹ *Rec. Ind. Mus.* X, p. 299.

Nassodonta gravelyi, sp. n.

Shell allied to *N. insignis*, H. Ad., with which it occurs, but differing from that species in its narrower form, external dark blackish brown colour and internal dark livid violet tinge.

Alt. 7.5, diam. maj. 4.25, diam. min. 3.5 mm.

Aperture: alt. 3.5, diam. 1.5 mm.

Hab.—Cochin backwater, near Ernakulam; *Type* (F. H. Gravely); Ennur backwater, Madras.

At first sight this might be taken for a variety of *N. insignis*, the author has, however, been able to examine a fairly large series of both forms, and as they never seem to blend he is of opinion that the one above described is quite worthy of specific rank.



FIG. 3.—*Nassodonta gravelyi*, sp. n. × 4.

Family MURICIDAE.

Thais carinifera, Lamark.

Anim. sans Vertébres, VII, 1822, p. 241.

Cochin backwater, near Ernakulam; a single very immature specimen (F. H. Gravely).

Family CERITHIIDAE.

Bittium gravelyi, sp. n.

Shell minute, fusiform, purplish-brown, encircled by a spiral band of a darker colour; whorls 6, spirally lirate, not convex; suture impressed; columella margin curved; labrum acute, yellowish; aperture sub-circular.

Alt. 2.25, diam. maj. 1.25 (nearly) mm.

Hab.—Cochin backwater, near Ernakulam (F. H. Gravely).



FIG. 4.—*Bittium gravelyi*, sp. n. × 8.
FIG. 4a.—*do.*, sculpture, × 16.

Potamides (Tympantonus) fluviatilis, Pot. and Mich.

Cat. Moll. de Douai, p. 363, pl. xxi, figs. 19-20.

Cochin backwater, near Ernakulam (F. H. Gravely).

Family TIARIDAE.

Tiara (Platia) scabra (Müller).

Hist. Verm. II, p. 136 (as *Buccinum*).

Ennur backwater, Madras.

Family LITTORINIDAE.

Littorina arboricola, Reeve,*Conch. Icon.* pl. vi, figs. 27, *a* and *b*.

Ennur backwater, Madras.

Family FOSSARIDAE.

Conradia cancellata, sp. n.

Shell perforate, small, turbinate, in dead condition whitish; whorls 4, the first two smooth, the remainder cancellately sculptured with spiral lirae crossed by slightly oblique, transverse riblets, the last whorl convex; suture impressed; perforation narrow, smooth within; columella margin descending in a curve, labrum continuous; aperture rather oblique, ovate.

FIG. 5.—*Conradia cancellata*, sp. n. $\times 6$.FIG. 5a.—*do.*, sculpture, $\times 12$.

Alt. 3, diam. maj. 2.5, diam. min. 1.75 mm.

Aperture: alt. 1.25, diam. 1 mm.

Hab.—Ennur backwater, Madras.

Family LITIOPIDAE.

Alaba rectangulata, Craven.*Ann. Soc. Mal. Belg.* XVI, 1880.

Ennur backwater, Madras.

Family RISSOIDAE.

Iravadia funerea, sp. n.

Shell small, ovately fusiform, covered with a grayish-black periostracum; remaining whorls 3, sculptured with coarse, spiral lirae and showing traces of transverse striation; suture impressed; columella margin vertically descending, diffused above into a very restricted, well defined, parietal callus which joins it with the upper margin of the labrum; labrum acute, angled by the terminations of the spiral lirae; aperture slightly oblique, elliptical.

FIG. 6.—*Iravadia funerea*, sp. n. $\times 8$.FIG. 6a.—*do.*, sculpture, $\times 16$.

Alt. 2.75, diam. maj. 2, diam. min. 1.25 mm.

Hab.—Cochin backwater, near Ernakulam

Iravadia ennurensis, sp. n.

Shell imperforate, small, cylindrically fusiform, in dead condition yellowish-white; whorls 5, sculptured with regular, revolving lirae crossed by fine, transverse striae; suture impressed, finely lirate above; columella margin slightly oblique, diffused above into a thick, restricted and well defined, parietal callus which unites it with the upper margin of the labrum; labrum varicosely thickened behind, outwardly bevelled, angled at each point of termination of the revolving lirae; aperture rather oblique, ovate.

Alt. 4, diam. maj. 1.75, diam. min. 1.5 mm.

Aperture: alt. 1, diam. .75 mm.

Hab.—Ennur backwater, Madras.



FIG. 7.—*Iravadia ennurensis*,

sp. n. $\times 6$.

FIG. 7a.—do., sculpture, $\times 18$.

Iravadia annandalei, sp. n.

Shell allied to *T. ennurensis*, but differing from that species in its more slender form, more acute lirations and obsolete, transverse striae, these latter being only indistinctly visible with the aid of the microscope; the aperture moreover is much smaller than in that species and the labrum is quite continuous, while it is possessed of an extra whorl, making 6 in all.

Alt. 3.75, diam. maj. 1.5, diam. min. 1.5 mm.

Aperture: alt. 1, diam. .5 mm.

Hab.—Ennur backwater, Madras

(Type); Cochin backwater, near Ernakulam (F. H. Gravely).



FIG. 8.—*Iravadia annandalei*,

sp. n. $\times 6$.

FIG. 8a.—do., sculpture, $\times 18$.

Family HYDROBIIDAE.

Stenothyra perpumila, sp. n.

Shell perforate, minute, shortly fusiform, semi-transparent, polished, shining, milky white; whorls 4, the last convex; suture well impressed; umbilicus narrow; labrum continuous, opaque white, a little projecting in front; aperture almost circular.

Alt. 1.5, diam. .75 mm.

Hab.—Cochin backwater, near Ernakulam (F. H. Gravely).



FIG. 9.—*Stenothyra perpumila*,
sp. n. $\times 10$.

• Family NATICIDAE.

• *Natica marochiensis*, Gmelin.• *Syst. Nat.*, p. 3675, No. 15.

• Cochin backwater, near Ernakulam (F. H. Gravely); Ennur backwater, Madras (a single young and dead specimen from each locality).

• Family TURRITELLIDAE.

• *Vanesia rambhaensis* (Preston).• *Rec. Ind. Mus.* X, 1914, p. 297 (as *Terebra*).

• Cochin backwater, near Ernakulam; a single specimen only (F. H. Gravely).

The author is again indebted to Mr. T. Iredale for the above generic rectification; the genus *Vanesia* was described by A. Adams in the *Annals and Magazine of Natural History*, ser. 3, vol. VIII, 1851, p. 242, in whose opinion it might be allied to *Mesalia* and here the present writer is inclined to leave it; it certainly is far removed from the *Opisthobranch* genera among which it has found a resting place in the British Museum collection.

• *Syrnola attenuata* (A. Ad.).• Sowerby, *Thes. Conch.*, II, p. 811, pl. clxxi, fig. 22, 1855 (as *Obeliscus*).

• Cochin backwater, near Ernakulam: a single dead and worn specimen (F. H. Gravely).

• *Pyrgulina humilis* (Preston).• *Journ. Malac.* XII, 1905, p. 6, pl. ii, fig. 27 (as *Pyramidella* (*Mormula*)).
• *Rec. Ind. Mus.* XI, 1915, pp. 294-295 (as *Mormula*).

• Cochin backwater, near Ernakulam (F. H. Gravely).

Mr. T. Iredale has again kindly assisted the author to a correction of former errors, he having very rightly pointed out that the present species should not remain in the genus *Mormula* but should be removed to *Pyrgulina*.

• var. *chilkaensis* (Preston).• *Rec. Ind. Mus.* XI, 1915, p. 295 (as *Mormula*).

• Cochin backwater, near Ernakulam; found with the type from (F. H. Gravely).

• Family NERITIDAE.

• *Theodoxus sowerbyana* (Recluz).• *Proc. Zool. Soc. London*, 1842, p. 174.

• Ennur backwater, Madras.

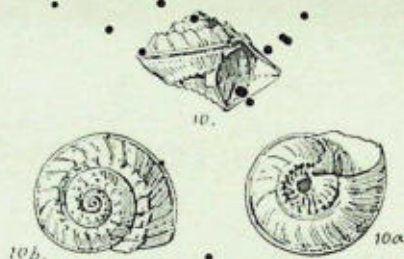
Septaria crepidularia, Lamarck.*Anim. s. Vert.*, VI, 2, 1822.

Cochin backwater, near Ernakulam (F. H. Gravely).

Family TROCHIDAE.

Solariella deliciosa, sp. n.

Shell small, rather depressedly conic, pale brownish-green, somewhat iridescent above, highly so on the base; whorls 4, carinately angled above, the last volution also strongly carinate at the periphery, the upper carination being tubercled throughout, sculptured with very minute and closely-set microscopic, oblique, transverse striae; suture impressed; umbilicus ornamented round its margin with a broad ridge crossed by regular transverse costulae, moderately wide; columella margin rather sharply curved, outwardly expanded above into a white wing-like projection; labrum acute, sharply angled at the base and at the point of termination of the peripheral carina; aperture depressedly diamond shaped.

FIGS. 10, 10a, 10b.—*Solariella deliciosa*, sp. n. $\times 6$.

Alt 1.5, diam. maj. 3.25, diam. min. 2.75 mm.

Aperture: alt. 1.25, diam. 1 mm.

Hab.—Ennur backwater, Madras.

Family CYCLOSTREMATIDAE.

Cyclostrema micans, A. Ad.*Proc. Zool. Soc. London*, 1850, p. 44.

Ennur backwater, Madras.

Class LAMELLIBRANCHIATA.

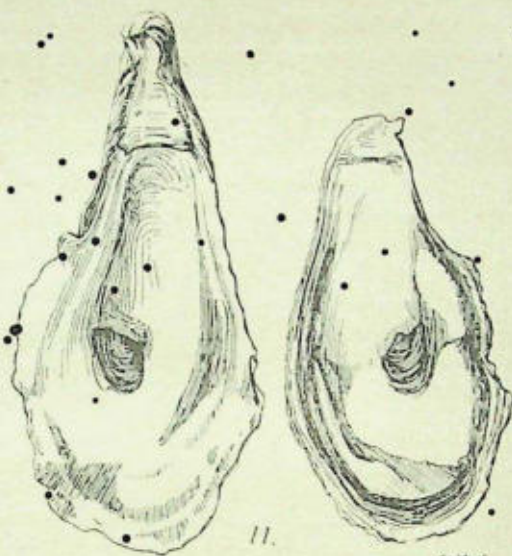
Order TETRABRANCHIATA.

Suborder OSTRACEA.

Family OSTREIDAE.

Ostrea madrasensis, sp. n.

This species may be compared to *O. virginica*, Gmel. (= *O. canadensis*, Lk.) from the E Coast of N. America, it is however of a straighter form and thinner texture and is much more foliaceous externally, the left valve is more concave and the



FIGS. II, IIa, IIb.—*Ostrea madrasensis*, sp. n. $\frac{1}{2}$ nat. size.

inner margins of both valves, as well as the muscular scars, are of a deep purplish-black colour.

Long. 140, lat. 56.5 mm.

Hab.—Ennur backwater, Madras.

Placuna placenta, Linnaeus.

Syst. Nat. ed. 12, p. 1154 (as *Anomia*).

Ennur backwater, Madras (a single very juvenile specimen).

Suborder MYTILACEA.

Family MYTILIDAE.

Modiola taprobanensis, Preston.

Ann. Mag. Nat. Hist. ser. 8, XVI, p. 84.

Ennur backwater, Madras.

Suborder ARCACEA.

Family ARCIDAE.

Arca granosa, Lin.

Syst. Nat. ed. 12, p. 1142.

Ennur backwater, Madras.

Arca (Fossularca) lactea, Lin.

Syst. Nat. ed. 12, p. 1141.

Ennur backwater, Madras.

Suborder CONCHACEA.

Family VENERIDAE.

Meretrix casta, Chem.

Conch. Cab. VI, p. 349, pl. xxxiii, fig. 346 (as *Venus*).

Ennur backwater, Madras; Cochin backwater, near Ennakulam; juvenile specimens (*F. H. Gravely*).

Meretrix ovum, Hanley.

Proc. Zool. Soc. London, 1845, p. 21.

Cochin backwater, near Ennakulam.

Meretrix zonaria, Lamk.

Anim. s. Vert. VI, p. 299.

Ennur backwater, Madras; Cochin backwater, near Ennakulam (young specimens only from both localities).

Chione imbricata, Sow.*Thes. Conch.* II, 1855, p. 715, pl. clvi, figs. 81, 82.

Eunur backwater, Madras.

Chione marmorata, Lamarck.*Anim. s. Vert.* VI, p. 261 (as *Venus*).

Cochin backwater, near Ernakulam.

Anomalocardia squambsa, Lin.*Syst. Nat.* ed. 12, p. 1133.

Eunur backwater, Madras (young specimens only).

Tapes turgida, Lamk.*Anim. s. Vert.* VI, p. 353 (as *Venus*).

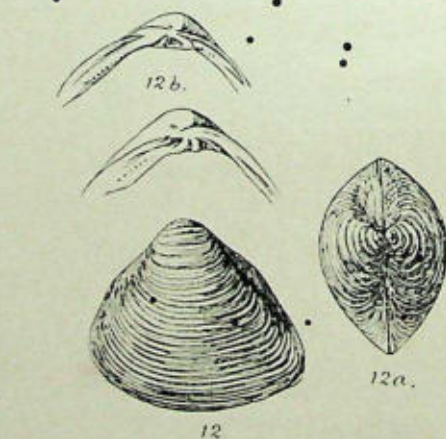
Cochin backwater, near Ernakulam.

Family CYRENIDAE.

Corbicula cochinensis, sp. n.

Shell small, trigonal, covered generally and in type specimen

with a dark olive periostracum and showing traces of radiate painting; umbones not very prominent; both valves somewhat contracted in the posterior median part and coarsely and somewhat distantly, concentrically ridged towards the umbonal region, the ridges becoming suddenly finer and more closely-set and continuing thus to the margin; dorsal margin narrowly and strongly arched; ventral margin gently, anteriorly rounded, elongated and very slightly contracted posteriorly; posterior side steeply sloping

FIG. 12. 12a.—*Corbicula cochinensis* sp. n.

× 6.

FIG. 12b.—

do.,

hinge, × 9.

above, rounded below; anterior side also sloping above, rostrate below; interior of shell dark livid brownish-violet.

Long. 4, lat. 4.5 mm.

Hab.—Cochin backwater, near Ernakulam.

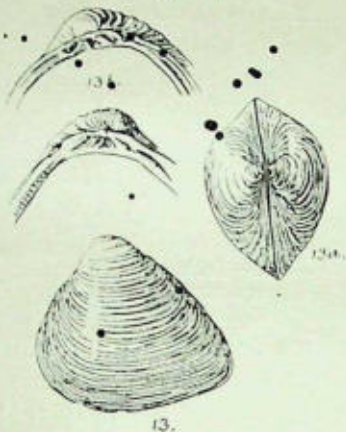
The colour of the shell varies from pale yellowish-green in certain specimens to the dark olive of the type, the paler specimens showing a number of narrow, transverse, radiate, reddish or purple bands.

Velorita delicatula, sp. n.

Shell small, trigonal, dark olive gray; both valves sculptured in the umbonal region with fine, distant, concentric ridges which suddenly become much more serried and numerous, continuing thus throughout the remainder of the shell; umbones small, inwardly bent; dorsal margin sharply arched; ventral margin slightly rounded, a little contracted posteriorly; anterior side rather sharply rounded; posterior side sloping above, angularly rounded and a little rostrate below.

Long. 5, lat. 6 mm.

Hab.—Cochin backwater, near Ernakulam (*F. H. Gravely*).



FIGS. 13, 13a.—*Velorita delicatula*,
sp. n. $\times 4$.

FIG. 13b.—do., hinge, $\times 8$.

Family SOLENIDAE.

Cultellus subellipticus, Dunk.

Proc. Zool. Soc. London, 1861, p. 421.

Ennur backwater, Madras (two young specimens).

Solen fonesi, Dunk.

Proc. Zool. Soc. London, 1861, p. 419.

Cochin backwater, near Ernakulam (*F. H. Gravely*).

Order DIBRANCHIA.

Suborder LUCINACEA.

Family LUCINIDAE.

Codokia fischeriana, Issel.

Mal. del Mar. Rosso, 1869, p. 83.

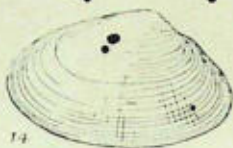
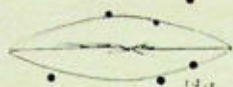
Ennur backwater, Madras.

Suborder TELLINACEA.

Family TELLINIDAE.

Tellina ennurensis, sp. n.

Shell small, ovate, whitish, faintly tinged with pink, iridescent, polished, shining, marked with fine, concentric growth lines and indistinct, closely-set, transverse striae, these latter being only visible with the aid of the microscope; umbones small, not prominent; dorsal margin gently sloping anteriorly, rather steeply sloping posteriorly; ventral margin anteriorly, and in the median part, gently rounded, a little contracted posteriorly; anterior side rounded, somewhat produced;



FIGS. 14, 14a.—*Tellina ennurensis*,
sp. n. $\times 4$.

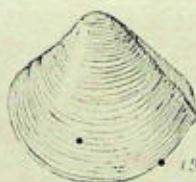
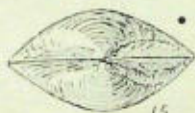
posterior side shortly and bluntly rostrate.

Long. 4.75, lat. 7.25 mm.

Hab.—Ennur backwater, Madras.

Tellina brunneo-flavida, sp. n.

Shell convex, rather small, thin, roundly trigonal, pale yellowish-brown; both valves sculptured with slightly distant, concentric striae; umbones small, not very prominent; dorsal margin strongly arched, steeply descending on both sides; ventral margin rounded, posteriorly excavated; anterior side rounded; posterior side bluntly and abruptly rostrate, angled from the umbone downward.



FIGS. 15, 15a.—*Tellina brunneo-flavida*, sp. n. $\times 3$.

Long. 7, lat. 7.5 mm.

Hab.—Ennur backwater,
Madras.

Family SCROBICULARIIDAE.

Theora opalina (Hinds).

Proc. Zool. Soc. London, 1843, p. 78 (as *Neaera*).

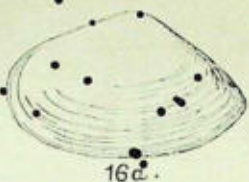
Ennur backwater, Madras; Cochin backwater, near Ernakulam (F. H. Gravely).

Theora translucens, sp. n.

Shell allied to *T. iridescens* (Hinds)¹ from the Philippines, but much smaller and of a transparent yellowish-white colour, it having none of the milky semi-opaque appearance of that species; it also differs in the somewhat more prominent concentric lines and in being of a generally more regularly oval form, lacking as it does, the posterior ventral excavation and both the anterior and posterior dorsal curves of *T. iridescens*.

Long. 5, Lat. 8.25 mm.

Hab.—Ennur backwater, Madras.



FIGS. 16, 16a.—*Theora translucens*, sp. n. $\times 4$.

Suborder ANATINACEA

Family CUSPIDARIIDAE.

Cuspidaria annandalei, Preston.

Rec. Ind. Mus. XI, 1915, p. 308.

Ennur backwater, Madras; Cochin backwater, near Ernakulam (*F. H. Gravely*).

Cuspidaria cochinensis, sp. n.

Shell small, thin, oblong, grayish-white, inequivalve, the left valve being slightly the smaller, both valves finely concentrically striate; umbones small, rather prominent; dorsal margin sloping anteriorly in a very slight curve and rather strongly curved and elongate posteriorly; ventral margin very gently and elongately rounded; anterior side sharply rounded; posterior side produced, strongly angled from the umbone downwards, very abruptly and squarely truncate.

Long. 1.5, lat. 3 mm.

Hab.—Cochin backwater, near Ernakulam (*F. H. Gravely*).



FIGS. 17, 17a.—*Cuspidaria cochinensis*, sp. n. $\times 8$.

¹ *Proc. Zool. Soc. London*, 1843, p. 78 (as *Neaera*).

V. FOUR NEW SPECIES OF *AULACOBOLUS*
POC. (DIPLOPODA: SPIROBOLIDAE)
FROM INDIA.

By F. SILVESTRI.

The genus *Aulacobolus* was proposed by Pocock¹ for *Spirobolus uroceros*, Poc., from Madras and up to the present comprises in addition only *Spirobolus thurstoni*, Poc., also from Madras. Mr. F. H. Gravely has sent me specimens of two species collected at Kavalai and Mr. L. Newton specimens of two more collected on the Pulney Hills. Examination of this material has shown that the four species received by me are distinct among themselves and from the species named by Pocock, they are therefore described here as new.

It is worthy of record that the species of *Aulacobolus* are all from Madras and South India, as are also the two species of *Eucentrobolus*, Poc., a genus distinguished from *Aulacobolus* only by the very strange sculpture of the body.

Aulacobolus excellens, sp. n.

♀ Corpus niger capite, antennis pedibusque rubro-testaceis, vel testaceo-latericiis.

Caput sulco mediano in fronte, inter antennas, interrupto instructum, sublaevigatum, striis tantum nonnullis transversis per faciem inferiorem exaratum, clypei depressione laterali sat profunda; oculi subrotundi, ocellis c. 38 compositi; antennae (fig. I, 3) accommodatae mandibularum stipites haud superantes. Column (fig. I, 1) margine antico ad oculorum latum externum rotundatum vix productum, lateribus sat angustatis trunci segmenti primi latera brevi spatio haud attingentibus, angulo antico acuto, rotundato, angulo postico exciso, obtuso, late rotundato, superficie sublaevigata.

Truncus. Segmentum primum lateribus quam colli latera deorsum aliquantum magis productis, carinam longitudinalem angulo antico acuto antorsum aliquantum vergente, postico obtuso, margine infero integro formantibus; segmenti secundi latera ad segmenti praecedentis carinae libellam margine postico incrassato et retrorsum paullum productum; segmenta cetera cylindracea. Segmentorum omnium praezona sublaevigata, vix coriaria tantum subtus et postice sub poris striis nonnullis instructa,

¹ Ann. Mag. Nat. Hist., (7) XII (1903).

metazona gradatim magis elevata ita ut segmentorum margo posticus supra segmenti sequentis praezonam aliquantum altior sit, parum coriaria et longe sub poris longitudinaliter striata; sutura, ut linea tenuis, supra poros evanescens, manifesta est; pori magni; sterna transverse et profunde striata. Segmentum praeanales (fig. I, 2) in processum longum, gradatim attenuatum, aliquantum arcuatum (convexitate supra), acutum, valvulas anales spatio longo superantem productum. Lamina infraanalis lata, brevis. Valvulae anales marginibus bene compressis, depressione praemarginali parva.

Pedes (fig. I, 5-7) sat longi et crassiusculi, ungue terminali longo.

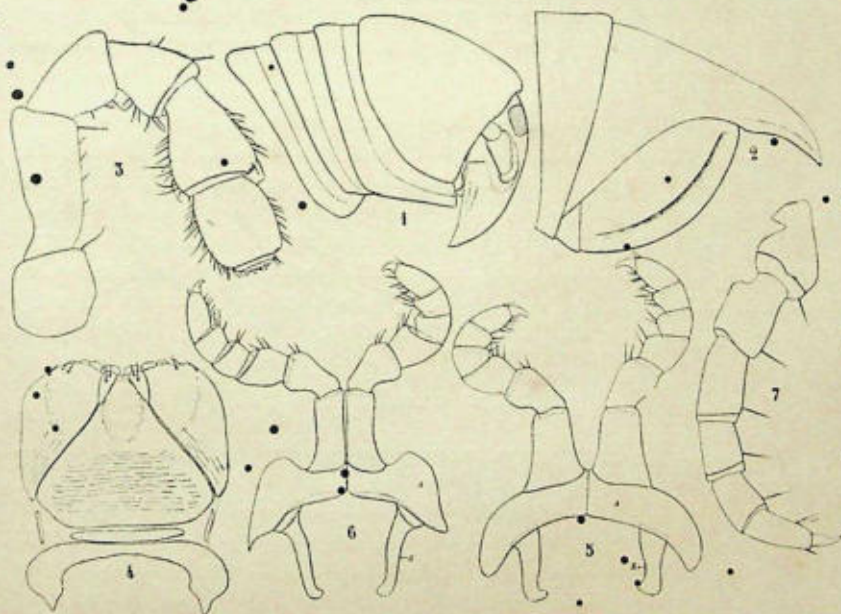


FIG. 1.—*Aulacobolus excellens*: 1. corporis pars antica lateraliter inspecta; 2. ejusdem pars postica; 3. antenna; 4. hypostoma; 5. pedes primi paris; 6. pedes secundi paris; 7. pes segmenti decimi; A. lamina ventralis; S. pera stigmatica.

Segmentorum numerus 51-54.

Long. corp. 160 mm., lat. 12, long. antennarum 8, pedum paris decimi 9.

♂ Corpus quam idem feminae parum magis attenuatum, pedibus parum longioribus et crassioribus et articulo sexto soleato.

Organum copulativum vide fig. II.

Habitat.—Cochin State: Kavalai, 1300-3000 ft. (F. H. Gravely legit).

Observatio.—Species haec caudae forma ad *Aulac. uroceros* (Poc.) proxima est, sed magnitudine, sculptura et metazonarum forma, facillime distinguenda.

Aulacobolus gravelyi, sp. n.

♀ Corpus niger. capite, antennis pedibusque rubro-testaceis vel latericiis.

Caput laevigatum, medium sulco subcontinuo (tantum inter antennis subevanescente exaratum), clypei depressione laterali

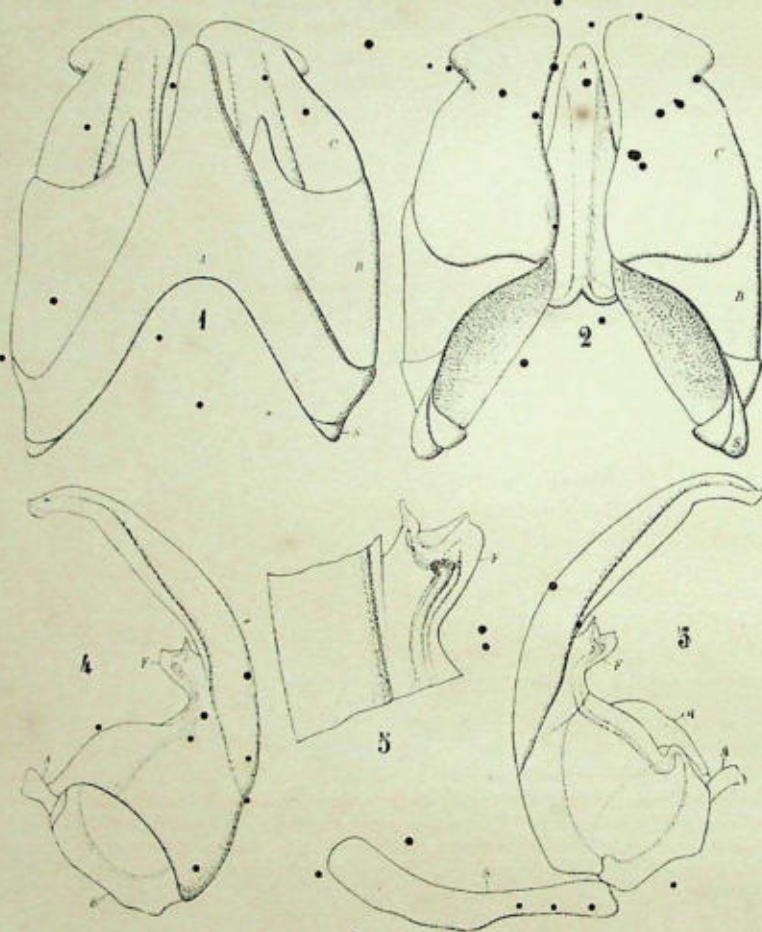


FIG. 11.—*Aulacobolus excellens*: 1. organi copulativi par anticum antice inspectum; 2. idem postice inspectum; 3. organi copulativi paris postici dimidia pars a latere externo inspecta; 4. eadem a latere interno inspecta; 5. ejusdem pars cum pseudoflagello magis ampliata: A. lamina ventralis; B. podum arculus basis; C. articulus secundus; F. pseudoflagellum; S. pera stigmatica.

parva; oculi ocellis c. 32, longitudinaliter 7-seriatis compositi; antennae (fig. III, 3) breves, accomodatae stipitum mandibularum apicem haud superantes. Collum (fig. III, 1) margine antico ad oculorum latera externa paullum convexo, lateribus trunci segmenti primi latera brevi spatio haud attingentibus, angustatis

et postice aliquantum magis quam antice rotundatis, superficie laevigata.

Truncus. Segmentum primum lateribus quam colli latera deorsum aliquantum magis productis, carinam longitudinalem margine integro formantibus, angulo antico acuto, antrorsum et deorsum aliquantum producto; segmenti secundi latera ad segmenti praecedentis carinae libellam incrassata et retrorsum paulum producta; segmenta cetera cylindracea. Segmentorum omnium praezona supra pororum libellam longitudinaliter et creberrime striata, sub pororum libella vix coriaria, mesozona supra poros punctis parvis impressa, sub poris oblique striata, metazona laevigata, pone poros vix striata, longe sub poris longitudinaliter

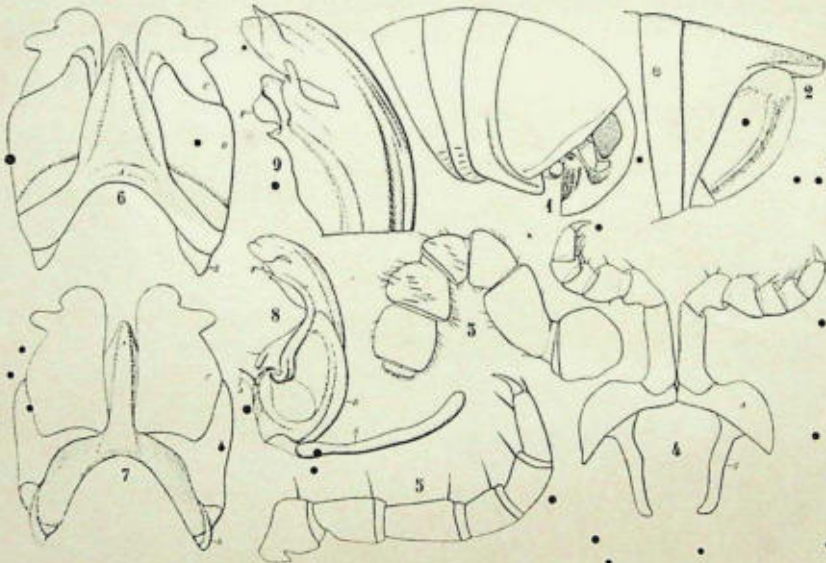


FIG. III.—*Aulacobolus graveyi*: 1. corporis pars antica lateraliter inspecta; 2. ejusdem pars postica; 3. antenna; 4. pedes secundi paris; 5. pes segmenti decimi; 6. organi copulativi par anticum antice inspectum; 7. idem postice inspectum; 8. organi copulativi par postici dimidia pars a latere externo inspecta; 9. ejusdem pars apicalis magis ampliata: litterae ut in fig. II.

striata; pori magni; sterna transverse et profunde striata. Segmentum praeanales (fig. III, 2) in processum sat longum, subrectum, crassum, parum attenuatum, in apice obtusum productum, valvulas anales spatio sat longo superans. Lamina infraanalis brevis, lata, postice vix arcuata. Valvulae anales marginibus compressis praesertim postice, depressione praemarginali sat evoluta.

Pedes (fig. III, 4, 5) breves, parum crassi.

Segmentorum numerus 51.

Long. corp. 120 mm., lat. 11, long. antennarum 6, pedum paris decimi 6.5.

♂ Corpus quam idem feminae parum magis attenuatum; pedes aliquantum crassiores, articulo sexto soleato.

Organum copulativum vide fig. III. 6-9.

Habitat.—Cochin State: Kavalai, 1300-3000 ft. (F. H. Gravelly, cui species grato animo dicata est, legit).

Observatio.—Species haec a ceteris omnibus mihi notis segmentorum numero, metazonis haud elevatis, laevigatis, organi copulativi forma distinctissima est.

Aulacobolus newtoni, sp. n.

♀ Corpus nigrescens capite et antennis latericiis, pedibus rufescentibus vel fulvo-ferrugineis.

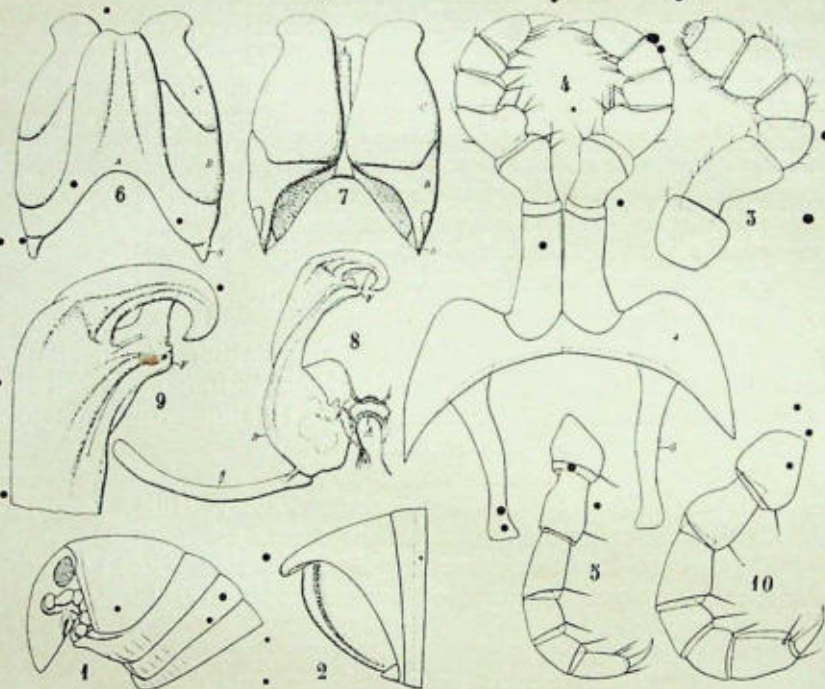


FIG. IV.—*Aulacobolus newtoni*: 1. corporis pars antica lateraliter inspecta; 2. ejusdem pars postica; 3. antenna; 4. pedes secundi paris; 5. pes paris decimi; 6. organi copulativi pars anticum antice inspectum; 7. idem postice inspectum; 8. organi copulativi paris postici dimidia pars a latere externo inspecta; 9. ejusdem pars apicalis magis amplata; 10. maris pes segmenti decimi: litterae ut in fig. II.

Caput totum minute et sat crebre punctatum, per faciem mediam ab antennarum libella ad labrum sulcatum et transverse striatum, vertice sulco sat profundo; clypei depressione laterali parum profunda; oculi ocellis c. 35, longitudinaliter 7-seriatis, instructi; antennae (fig. IV, 3) breviores, accomodatae apicem mandibularum stipitum haud superantes. Collum (fig. IV, 1) pone oculorum marginem externum paullum emarginatum et ab hoc puncto usque ad angulum externum linea postmarginali

perparva instructum, angulis lateralibus postice quam antice magis excisis et rotundatis, superficie leviter coriaria.

• *Truncus.* Segmentum primum lateribus quam colli latera deorsum aliquantum magis productis, carinam longitudinalem formantibus angulo antico acuto antrorsum et deorsum aliquantum producto; segmenti secundi latera ad segmenti praecedentis carinae libellam deorsum et retrorsum vix producta, segmenta cetera cylindracea; segmentorum omnium praezona supra pororum libellam longitudinaliter striata, sub pororum libella sublaevigata, vix oblique striata, mesozona punctato rugosa, sub poris gradatim magis distincte oblique striata, metazona quam mesozona paululum magis elevata coriaria pone poros longitudinaliter sulcata et longe sub pororum libellam longitudinaliter striata; pori magni; sterna transverse striata. Segmentum praeanales (fig. IV, 2) in processum sat longum, crassiusculum, paululum arcuatum (convexitate supera), in apice obtusum, valvulas anales spatio parvo superantem productum. Lamina infraanalis brevis, lata, postice subrecte truncata. Valvulae anales sat longae, marginibus, postice quam antice magis compressis, depressione praemarginali sat magna.

Pedes (fig. IV, 5) breves, sat tenues, ungue longo.

Segmentorum numerus 49.

Long. corp. 80 mm., lat. 7.6, long. antennarum 3.80, pedum segmenti decimi 4.70.

♂ Corpus quam idem feminae aliquantum longius (ad 90 mm.) et angustius (ad 7.2 mm.) metazonis parum magis elevatis et sutura profundiore. Pedes (fig. IV, 1) aliquantum longiores et crassiores, articulo sexto bene soleato.

• Organum copulativum vide fig. IV, 6-9.

Habitat.—Vicinity of Kodaikanal, Pulney Hills, 5000-7000 ft. (L. Newton, cui species grato animo dicata est, legit).

Observatio.—Species haec ad *Aul. thurstoni* (Poc.) proxima est, sed corporis sculptura et organi copulativi forma saltem distincta est.

Aulacobolus variolosus, sp. n.

♀ Corpus nigro-castaneum capite et antennis latericiis, pedibus rubrotestaceis.

Caput ver idem sub collo obtecto, faciei superficie coriaria et media parum longe ab antennarum libella ad labrum sulco gradatim magis manifesto sulcata, verticis sulco sat profundo, clypei depressione laterali sat profunda; oculi sat magni, subovales, ocellis c. 30, longitudinaliter 7-seriatis, compositi; antennae (fig. V, 3) breviores, accommodatae mandibularum stipitum apicem haud superantes. Collum (fig. V, 1) magnum, lateraliter inspectum mandibularum stipites omnino obtegens, margine antico pone oculos parum sinuato, margine antico laterali quam postico laterali multo magis exciso, rotundato, angulo laterali acuto, rotundato, trunci segmenti primi marginem inferum parvo spatio haud attingente, superficie tota punctata et parum rugosa.

Truncus. Segmentum primum lateribus latis quam colli latera deorsum parum magis productis, carinam longitudinale formantibus angulo antico acuto antrorsum et deorsum aliquantum producto, margine infero obtuse 3-5 dentato; segmenti secundi latera ad segmenti praecedentis carinae libellam deorsum et retrorsum vix producta; segmenta cetera cylindracea. Segmentorum omnium praezona leviter striata, mesozona supra poros coriaria-reticulata, sub poros oblique striulata; metazona quam mesozona aliquantum magis elevata, variolosa, pone poros pro-



FIG. V.—*Aulacobolus variolus*: 1. corporis pars antica lateraliter inspecta; 2. ejusdem pars postica; 3. antenna; 4. pedes paris secundi; 5. pes paris decimi; 6. organi copulativi par anticum antice inspectum; 7. idem postice inspectum; 8. organi copulativi paris postici dimidia pars ex latere externo inspecta; 9. ejusdem pars distalis magis ampliata: litterae ut in fig. II.

funde sulcata et longe sub poris longitudinaliter profunde striata; pori magni, sterna segmenti secundi (fig. V, 4) infra triangulariter producta, sterna coalita transverse striata. Segmentum praeanae (fig. V, 2) in processum sat longum, crassum, paullum arcuatum (convexitate supra), in apice obtusum valvulae anales spatio parvo superantem, productum. Lamina infraanalis brevis, lata, postice subrecte truncata. Valvulae anales punctatae, marginibus partem posticam versus gradatim magis compressis et depressione praemarginali bene evoluta.

Pedes (fig. V, 4-5) breves, sat tenues.

Segmentorum numerus 45.

Long. corp. 85 mm., lat. 9, long. antennarum 4.30, pedum segmenti decimi 25.

♂ Corpus quam idem feminae paullo angustius pedibus aliquantum robustioribus et longioribus, articulo sexto soleato.

Organum copulativum vide fig. V, 6-9.

Habitat.—Vicinity of Kodaikanal, Pulney Hills, 5000-7000 ft. (L. Newton legit).

Observatio.—Species haec ad *A. newtoni*, Silv. proxima est, sed colli forma, corporis sculptura et segmentorum numero, cauda crassiore, nec non organi copulativi forma facile distinguenda est.

VI. ON THE HYDROZOON CAMPANULINA CEYLONENSIS (BROWNE).

By R. E. LLOYD, M.B., D.Sc., Major, I.M.S., Professor of Biology,
Medical College, Bengal, and N. ANNANDALE, D.Sc., F.A.S.B.,
Superintendent, Indian Museum.

I.—THE SYSTEMATIC POSITION AND SYNONYMS OF THE SPECIES.

By N. ANNANDALE.

The medusa of this species was described by Browne¹ in 1905 under the name *Irene ceylonensis*, while the hydroid was discovered by myself² in 1906. In a recent paper³ I have referred the species to the genus *Campanulina*, van Beneden, and this attribution is fully borne out by a detailed examination since made of the living hydranth.

Medusae that agree, so far as structure is concerned, in every respect with Browne's figures and description of *I. ceylonensis* have made their appearance in great numbers in a canal of brackish water in Calcutta in July, 1915, the water having, at the place and time at which specimens were taken, a specific gravity of 1.0085 (the reading corrected to a standard temperature of 15°C.), and no great difficulty has been experienced in rearing young colonies of hydroids in a bell-jar. The development is rapid. Medusae were placed in the bell-jar, which was filled with water from the canal, on July 5th; on July 7th numerous planulae and single minute hydranths, many of which had attached themselves to the cast skins of Copepods, were found, with intervening stages; while two days later young colonies were observed with a single perfect hydranth and a short rhizome bearing at least two hydranth-buds. The buds had the capitate form of those of *C. acuminata* (Alder) as figured by Hincks.⁴ The hydranth figured here was sketched from life on July 10th, by Babu D. N. Bagchi; only the part exerted from the hydrotheca is shown. The column was capable of great elongation, but the tentacles seemed to be less extensible than in the adult and the whole organism was less sensitive.

¹ In Herdman's *Rep. Ceylon Pearl Fish.*, IV, p. 140, pl. iii, figs. 9-11 (1905).

² *Rec. Ind. Mus.*, I, p. 142, fig. 4 (1907).

³ *Mem. Ind. Mus.*, V, p. 105 (1915).

⁴ *Brit. Marine Hydroid Zoophytes*, pl. xxxvii (1868).

This hydranth, though immature in several respects, already exhibits the generic characters of that of *Campanulina*, being webbed at the base of the tentacles, which are surrounded by regular circles of nematocysts, and having a short conical hypostome. The hydrothecae of the adult hydroid only differ from those of more robust species of the genus in that each grows on a short stalk that arises directly from an adherent stolon while the gonothecae closely resemble those of *C. repens*, Allman, in outline. Major Lloyd¹ tells me that a short stem bearing a gonotheca as well as a hydranth is sometimes produced and that more than one medusa is often produced in a single gonotheca.

If it is necessary to place the medusa as distinct from the hydroid in a recognized genus, greater difficulty is experienced. It agrees with *Phortis*, McCrady, and differs from *Eirene* and *Tima*, Eschscholtz, in not possessing marginal cirri, but the ten-

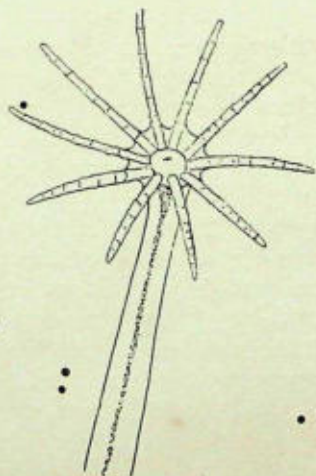


FIG. 1.—Young hydranth of *Campanulina ceylonensis* (highly magnified).

tacles have a narrow longitudinal band of muscle on the velar surface and the gonads are less restricted in position than in most species of *Phortis*, though they do not until very fully ripe extend along the manubrial peduncle as in *Tima*. On the whole, therefore, the medusa may be said to occupy a position intermediate between *Tima* and *Phortis*, but to be nearer the authentic species of the latter, to which it should probably be assigned, as Meyer² suggests.

The name *Campanulina* (1847) has priority over *Phortis* (1857) by ten years.

¹ I regret that, as I am about to leave India for some months, I have not been able to read Major Lloyd's paper printed below. He has, however, kindly informed me as to the results of his observations, and shown me his preparations.

² *Medusae of the World*, II, p. 309 (1910).

The only species of *Phortis*, that has been traced to its hydroid, if we except "*Irene ceylonensis*," is *P. gibbosa* (McCrary), the life-cycle of which was worked out by Brooks¹ in North America. His description, which is brief and unaccompanied by figures, does not conform to *Campanulina* in that it makes no mention of an operculum to the hydrotheca or of a webbing of the tentacles, but both these points are difficult to detect unless attention is specially directed to them and the general conformation of the colony is not unlike that of the species found in the Gangetic delta.

Some of the medusae from Calcutta lived in captivity for a week, though all of them had apparently shed their gonads at least three days earlier. Those that remained alive at the end of the week were, as was shown by the asymmetrical form of their bells and their feeble and irregular pulsations, in a degenerate condition. They had, moreover, assumed completely the peculiarities regarded by Browne (*op. cit.*, p. 141, pl. iii, figs. 12-16) as diagnostic of his *Irene palkensis*. When the gonads first reach or approach maturity the tentacles alternate with sense-organs round the margin of the bell; the former are capable of great elongation and all are complete in structure; the otocysts are small and each contains a single otolith or sometimes a pair of otoliths. The shedding of the sexual products apparently takes some days. When it commences the gonads do not extend down the manubrial peduncle, but as it proceeds and approaches completion they do so to some extent. Meanwhile considerable changes take place on the margin of the bell. Numerous additional tentacles begin to bud out, but as a rule only the basal bulb is completed and the filamentous part is altogether abortive. At the same time the otocysts increase greatly in size, becoming three or four times as large as hitherto; the otoliths multiply, so that there may be as many as eight in a single sense-organ, and finally the whole structure divides into two otocysts. Details as to the process of division have not yet been worked out either in the cysts or in their contained concretions.

These changes in the tentacles and sense-organs prove that Browne's two species, *Irene ceylonensis* and *Irene palkensis*, are identical, or rather that the latter represents merely a degenerating phase of the former.

Before the sexual products are completely shed the upper part of the bell often becomes constricted, the constriction involving not only the jelly but also the upper part of the subumbrellar cavity. The tentacles then degenerate, and finally both they and the sense-organs disappear. The bell shrinks to a half or a third, and finally to about a sixth of its original size and at last ceases to pulsate. The manubrium, however, though also shrunken, still exhibits languid movements, which persist for some days after the complete disappearance of the marginal structures and even

¹ *Stud. Biol. Lab. John Hopkins Univ.*, II, p. 470 (1883).

of the radial canals. Death is thus extremely gradual. All these points are clearly important in considering the systematic position of any medusa that exhibits the slightest signs of degeneracy.

II.—LIFE HISTORY OF THE HYDROID AND MEDUSA.

By R. E. LLOYD.

In July 1915, Dr. Annandale informed me of the occurrence of the Medusa, *Irene ceylonensis* (Browne), in the brackish water of a canal in the neighbourhood of Calcutta and suggested that I should enquire into its life-history as his own observations on the subject had to be discontinued. He also kindly lent me a stained permanent preparation showing several planulae, some with budding hydroids and stolons. This preparation was made by Mr. F. H. Gravely from material gathered from the bottom of a glass bowl in which a number of the medusae with ripe gonads had been confined for observation.

About the middle of July, the medusae were plentiful throughout the canal so that I was able to obtain a large number, varying in diameter from about 2.5 mm. to 2.5 cm. By the end of the month however none were to be found. No doubt they were killed by the heavy monsoon rain, which greatly diminishes the salinity of the water.

I was unsuccessful in again raising the planulae in captivity, but was fortunate in obtaining some colonies of the hydroid growing in the canal attached to stones. Some were kept alive for ten days, affording good opportunity for observation. Several gonosomes were obtained from these colonies. These were stained and mounted in Canada balsam. They show certain stages in the development of the medusa, especially the early and late stages, in a satisfactory manner.

The Hydroid Colony.

The hydroid was defined by Dr. Annandale from material taken in brackish water at Port Canning, but as I had the opportunity of examining the living animal from day to day in the laboratory a few further remarks on its structure will be made.

The hydroid varies considerably in size. Only the larger and older individuals can be discerned by the naked eye. The colony as a whole is much less conspicuous than most hydroid colonies. The stolon seldom divides, so that it is easy to strip off as much as an inch from the substratum without meeting any outgrowths except the hydrothecae. The stolon however does occasionally branch, the growing point dividing in a simple dichotomous manner.

The coenosarc of the stolon has a different appearance from the coenosarc of the hydroid; due principally to the fact that the endoderm cells of the stolon are granular and opaque while those of the hydroid are clear, vacuolated and much larger. The hy-

hydroid is not set directly upon the stolon but upon short intermediate branches which have the same structure as the stolon. The line of attachment of the hydroid to these intermediate branches is most conspicuous when the hydroid is contracted, but it is visible at all times as a sudden change in the character of the endoderm cells.

The intermediate branch as well as the hydroid lies in the hydrothecae.

The Hydrotheca.

As a rule the hydrothecae arise directly from the perisarc of the stolon. Occasionally, however, they arise from short lateral branches which are common to them and to a gonotheca. They measure .45 mm. by .15 mm. (*Annandale*). They terminate in a conical pointed operculum consisting of a number of acute converging projections of the perisarc which together closely resemble the peristome of a moss capsule. The number of these processes is about twelve but they are difficult to count owing to their transparent delicacy.

The method of the opening and closing of the hydrotheca is simple and effective, depending as it does upon the elasticity of the marginal projections and upon a slight upturning of their points. Because of their elasticity they tend to converge so that they are always in contact with the stalk of the hydroid even when it is fully extended. At first sight it seems that in this condition the converging points would hinder the withdrawal of the hydroid by catching in rugosities projecting from the surface of the stalk during contraction, and it also seems likely that the points would strangle the neck and so prevent the entry of the head into the theca. Such possibilities are prevented by the slight upturning of the points. The act of withdrawal is not easy to observe. Low degrees of magnification are insufficient for the purpose, but when using the high power it is of course necessary to cover the object which causes immediate and lasting contraction of the hydroid. The difficulty was overcome by using an ocular of very high power with a low power lens. Ocular No. 18 such as is supplied with Zeiss' oil immersion lens combined with an objective $\frac{2}{3}$ in. focus gave good results. A portion of a colony living undisturbed in a capsule of water was thus magnified about 200 times so that the act of withdrawal could be observed.

The Hydroid.

The principal features of the hydroid are well known. The web or membrane uniting the bases of the tentacles being the chief characteristic. The fully extended stalk of a large individual measures about 2 mm. in length by .06 mm. in thickness. In the living animal the ectoderm of the stalk is a very thin layer devoid of cell outlines or nematocysts. The outlines of the endoderm cells on the other hand are plainly visible even under the low power of the microscope. In the expanded state each endoderm

cell appears to contain a single vacuole, so large that the protoplasm is reduced to a delicate peripheral layer in which nuclei are scarcely visible. Except for the granular contents of the gut cavity the stalk is transparent. The appearance of transverse lines in it is due to protoplasmic septa composed of the peripheral layers of adjacent endoderm cells which separate the vacuoles.

Since the diameter of the hydrotheca is not much more than twice the diameter of the extended stalk, it is evident that the cubic content of the stalk must be very much reduced before it can be accommodated by the hydrotheca during contraction. This reduction must be brought about by evacuation of fluid from the vacuoles of the endoderm cells. The process however was not observed. As mentioned before, the endoderm cells of the stalk present a very different appearance from those of the stolon and intermediate branches, the latter being granular and not vacuolated. The transition from the one to the other is sudden. When extended the stalk is straight and stiff. It usually appears to be motionless but on attempting to draw the outline with the Camera lucida, it becomes evident that the animal is seldom quite motionless. In the largest individuals the tentacles are constantly sixteen in number. When extended they measure about .5 mm. in length and they are usually held in two series, eight of them springing from the base of the hypostome at an angle somewhat less than a right angle, while the other eight which alternate with them project more downwards. When the tentacles are in this position the margin of the web forms a characteristic zig-zag outline. The web measures about .06 mm. from its margin to the angle between adjacent tentacles. The tentacles are as usual, in the Calyptoplastica devoid of a central cavity, the outline between the endoderm cells being plainly visible, in the living animal. That part of the base of the tentacles which lies in the web usually includes three endoderm cells and bears a few scattered nematocysts. Throughout the length of the tentacles the nematocysts are disposed somewhat irregularly in rings, one ring corresponding roughly to each endoderm cell.

Habits.

The hydroid first found at Port Canning was living in association with the protozoon *Forficulina* and this organism also occurred among the colonies taken from the canal. A species of small Polychaet worm (*Spioniformia*), however, was found more plentifully in association with the hydroid at Calcutta. The delicate sandy tube of the Polychaet was frequently interwoven with the stolon of the hydroid. On one occasion I was able to observe the hydroid preying upon the worm. Three fully expanded hydroids which happened to be adjacent were under observation in a capsule of water. An immature worm measuring about a millimetre in length came within reach of their tentacles and was soon fast entangled and paralysed. One hydroid attached itself to the mouth of the worm another to the anus, while the third which

apparently obtained no nourishment helped to subdue the struggles of the victim. A yellowish granular stream, the blood and coelomic fluid of the worm was seen pouring slowly into the two hydroids which were attached terminally. The enteron of the hydroids became considerably expanded for a short distance below the tentacles and this expansion was no doubt the means of suction. A lesser expansion at this point is frequently visible even in the resting condition (plate v, fig. 1). The nourishment was not retained by the hydroids but passed on rapidly into the general coenosarc of the colony. Within five minutes from the commencement of the operations, the stems of the hydroids which remained extended throughout had regained their usual glassy appearance. The body of the worm, motionless and shrunken, was released in less than five minutes after capture.

The Gonosome.

The gonosome was found in various stages of development (plate vi). Although the series illustrated is not complete the earliest and later stages are well represented. In the latest the young medusa can be seen lying within the gonotheca provided with tentacles and sense vesicles. Although the manubrium is still imperforate, the medusa is evidently almost ready to be liberated. As estimated from the drawing to scale, the convexity of the bell of the medusa lying within the gonotheca measures about 7 mm. in the specimen figured. The diameter of the bell in the smallest medusa caught swimming freely was at least 2 mm. There is therefore an interval in the life-history including the liberation of the medusa and the first part of its free life which was not observed.

There are usually two medusae in each gonosome, a proximal and a distal, the latter being always the more developed. Sometimes only one medusa occurs which probably represents the proximal member of the pair after the liberation of the distal member. About 1 in 5 of the mature gonosomes were in this condition.

The gonosome of *Campanulina* was described by Hincks as growing from the stolon and containing one medusa. In this species, however, the gonosome usually grows from the base of a hydrosome and contains two medusoid buds.

In its earliest phase the gonosome appears as a tubular outgrowth from the coenosarc which sometimes arises from the main stolon but more often from the intermediate branches near the base of the hydrosome. This tubular outgrowth is a blastostyle which gives rise to the two medusae by budding. Before any buds have appeared upon it, the blastostyle has a characteristic appearance. It is, we have seen, a tubular outgrowth of the coenosarc and throughout most of its length it appears to have the same structure as the coenosarc of the stolon, the cells of both ectoderm and endoderm being opaque and finely granular. Close to the extremity, however, the cells have a different appearance,

being translucent and vacuolated, having indeed the same appearance as the cells of the hydrosome. It has been mentioned that the change in the appearance of the cells at the base of the hydrosome is characteristic and sudden. The junction between the translucent end of the blastostyle and the opaque proximal portion has exactly the same appearance (plate vi, fig. 1). The translucent end of the blastostyle therefore perhaps represents a reduced hydrosome. Be that as it may, it is a conspicuous feature of the gonosome visible from first to last, forming in the later stages a kind of lid closing in the gonotheca. It may be referred to as the operculum.

The medusae arise from buds which spring from the stem of the blastostyle below the operculum. They appear to arise in the usual manner by the sinking in of an entocodon. A conspicuous feature of the development is the early formation of four large lappets, placed radially on the margin of the bell. Upon these the tentacles appear at a later stage.

At the time when the first bud appears upon the blastostyle, it is evident that the cavity of the operculum is in open communication with the cavity of the cylindrical stem. But later when the development of the medusae is more advanced, the stem of the blastostyle becomes flattened out and can scarcely be traced. But even at a comparatively late stage the endodermal cavity of the two growing medusae may be seen communicating with one another through the cavity of the blastostyle. One specimen shows a similar communication between the cavity of a medusa and that of the operculum. Though much compressed and rendered inconspicuous by the growing medusae, it is probable that the stem of the blastostyle preserves its status until the end. Thus, in the oldest gonosome met with, the stem of the blastostyle can plainly be seen between the two medusae, and its communication with the cavity of the operculum may be inferred owing to an interesting circumstance. The cavity of the stem of the blastostyle contains a number of irregular nucleated cells which have much the appearance of phagocytes and the same kind of cells are to be seen in the cavity of the operculum. This fact indicates that the communication between the stem of the blastostyle and the operculum persists to a late stage. Little seems to be known of phagocytosis among the Coelenterata but it is unlikely that a process so general in the animal kingdom should not occur in this group. It is possible that the presence of these cells, which, as I have said, have the appearance of phagocytes, indicate the approaching dissolution of the distal part of the gonosome and the liberation of the mature medusa.

The Gonotheca.

In the early stages of its development the gonosome is completely enclosed by a delicate perisarc. The later history of this layer, as to how and when it allows the liberation of the medusae, was not ascertained.

The Free Medusa.

The medusa was described by Browne from specimens taken in the sea off Ceylon, and its systematic position has been discussed by Dr. Annandale in the first part of this paper. It is therefore unnecessary to say much more beyond reference to the peculiar condition under which the organism was found in Calcutta. The unusual and sudden appearance of a swarm of medusae in a brackish canal—far removed from the sea though connected at one point with the tidal waters of the Hooghly—make it most likely that the medusae were all of one species. An examination showed beyond doubt that the many hundreds of specimens taken by the tow-net were indeed of one species though varying very much in appearance according to age and state of activity. Plate vii, fig. 1 gives some idea of the appearance presented by a number of the medusae at the time of capture. At first sight one might suppose that they included several distinct species. The largest, bearing ripe gonads, measured about 2.5 cm. in diameter, the height of the bell during relaxation being about two-thirds of the diameter, but specimens preserved in formalin are usually flatter than this. Half-grown specimens, especially when swimming actively, appear higher than they are broad and in this condition the tentacles may stream out to a length two or three times greater than the height of the bell. When resting they assume a flatter shape and the tentacles are considerably contracted. In this condition the peduncle and manubrium together can often be seen revolving about the fixed base. While so engaged the mouth and lips appear to clean the tentacles and search the groove between the velum and inner wall of the bell for adherent food particles.

The smallest specimens, measuring 2-3 mm., show certain differences from the mature form. The peduncles of the manubrium, which is a characteristic feature of the adult, is scarcely represented. The sense vesicles are less numerous than the tentacles, nor are they so regularly disposed in alternation with the tentacles as in the adult; but this is only to be expected at a time when the tentacles are rapidly increasing in number. Plate vii, fig. 4 shows a young medusa with eight tentacles, six sense vesicles and a number of tentacular buds. At this time the primitive germ cells are distinctly visible and they can be seen even before the medusa has left the gonosome.

In the mature condition the generative cells are disposed along the radial canals from the base of the peduncle to the margin of the bell. They form prominent ridges with a somewhat contorted edge which projects from the lower surface of the bell. A section across one of these ridges shows the radial canal lined by attenuated columnar cells between which and the very delicate ectoderm the generative cells lie.



VII. THE EVOLUTION AND DISTRIBUTION
OF THE INDO-AUSTRALIAN THELYPHONI-
DAE, WITH NOTES ON THE DIS-
TINCTIVE CHARACTERS OF
VARIOUS SPECIES..

By F. H. GRAVELY, M.Sc., Assistant Superintendent, Indian
Museum.

(Plates I—IV.)

It has recently been shown (*J.A.S.B.* [n.s.] X, 1914, pp. 201-210, pl. xxiv) that in several groups of animals the extraordinarily rich fauna of the Malay Archipelago is composed of highly specialized species, whose more primitive ancestors are represented by species found at the present day mainly in the surrounding countries. And it has been suggested that this is due to the conditions found in the Archipelago favouring the rapid evolution of highly specialized species, these replacing the less specialized, and tending to force them outwards towards, or even beyond, the borders of the combined Oriental and Australian Regions. In this way it is possible to explain the fact that primitive species found in Ceylon are sometimes more closely related to species found in Australia than to their allies found in the intervening countries.

The groups specially referred to were Passalid Coleoptera, Crinoids, and Thelyphonids. But the reference to Thelyphonids was based only on a short preliminary note published in the *Proceedings of the Asiatic Society of Bengal* for August 1911. The object of the present paper is to supplement this note by gathering together all available information bearing on the subject.

An excellent account of the Thelyphonidae was written by Kraepelin and published in "*Das Tierreich*" in 1899. Although several new species have since been described a complete synonymic revision of the group is as yet uncalled for, and would be largely a repetition of Kraepelin's work.

In many species, however, the distinctive characters are most difficult to describe with precision and determinations have to be based largely on comparison with authentically named specimens or accurate figures. Opportunity has therefore been taken of publishing with this paper a number of figures which seem to be required.

The numerous specimens of certain of the commoner species of Thelyphonidae possessed by the Indian Museum have shown that the characters supposed to be distinctive of different species

are sometimes variable within the limits of a single species, and have enabled me to obtain some idea of the extent of this variation.

The number of teeth on the trochanter of the arm is one such character, and it sometimes happens that the variation is not uniform on the two sides of the body (see text-figs. 1-4, pp. 64, 72, 74 and 76).

The structure of the modified joints of the antenniform legs of the females of certain species, which Kraepelin has found to afford useful specific characters, is almost certainly connected with the mating habits of the group (Gravely 1915b, p. 522, pl. xxiv, figs. 25-26); and I have reason to think that it may possibly vary, not only according to the degree of maturity of a specimen, but also according to the proximity of the mating period. As, however, none of the species in which the structure in question is developed occur in the Indian Empire, I have been unable to make special collections bearing on this point, and the material at present in the Indian Museum is insufficient for its settlement.

Iwakawa (1908, pp. 287-291, pl. xi, figs. 1-4B) has shown that the form of the genital segment may vary considerably according to age, even when adult characteristics appear to be present.

Kraepelin's classification is based mainly on the presence or absence of a keel between the median and lateral eyes and of a tooth on the inner side of the gnathobase of the arm, the number of vitreous spots ("ommatoids") on the third caudal segment, and the form of the tibial apophysis of the male. It is now known, however (Gravely, 1912a, pp. 101 and 106), that the keel between the lateral and median eyes, and the tooth on the gnathobase of the arm, may either of them be present in the genus *Hypoctonus*, which Kraepelin believed to be characterized mainly by the absence of both. In this connection it is perhaps noteworthy that *Hypoctonus stoliczkae*, the only known species of the genus as hitherto defined in which there is a tooth on the gnathobase of the arm, occurs in the excessively damp region at the base of the Darjeeling hills together with the genus *Uroproctus*, which is also characterized by the possession of such a tooth; and that the remaining genus *Labochirus*, which is similarly characterized, is found in the excessively damp jungles of the Western Ghats and of the hills of Ceylon.¹ There seems, therefore, to be some connection, at present unaccountable, between the presence of this tooth and the degree of moisture characteristic of the natural habitat of the species possessing it; and its value as an indication of phylogeny is unlikely to be great.

¹ That the S. Indian species inhabit excessively damp jungles is an assumption based on the habits of the Ceylon species. I failed to find any *Thelyphonids* in the damp jungles of Cochin. In Cochin, as in Ceylon, *Thelyphonus sepiaris* lives in comparatively hot dry places. Places suited to the existence of both forms are often found in close proximity to one another.

In my preliminary note on the evolution and distribution of the Thelyphonidae it was suggested that the distinction between the genera with and without keels between the median and lateral eyes was extremely ancient, and consequently of fundamental importance. The discovery of species, clearly allied not to the keeled but to the keelless group, in which this ridge, though not very strong, is quite distinct, renders this hypothesis less probable than it previously appeared. The fact, however, that the species of the keelless group which have the tibial apophysis of the male least specialized appear, so far as is known, to agree in having tibial spurs on the fourth pair of legs only, no matter from what part of the world they come, seems to imply that the group may really be an old one which once had a more continuously extensive distribution than it has at present. The only known exceptions to this rule are *Hypoctonus oatesi* and one or two other species leading up to the most specialized section of the latter group—a section confined to the neighbourhood of Burma and Assam. Nothing is, however, known of the male of the single African keelless species hitherto recorded; nor is anything known of the tibial spurs of the American keelless genus *Thelyphonellus*, in which the male appears to have retained its primitive form more nearly than has that of any Oriental species yet described.

The distinction between the keeled and keelless groups may therefore be accepted as being in all probability of fundamental importance, with the reservation that weak keels may occasionally be developed in species whose other characters, especially the form of the tibial apophysis of the male, show them to belong to the latter and not to the former group.

The keelless group is at present divided into an Indian genus *Labochirus*, in which a tooth is present on the inner margin of the gnathobase of the arm, and a (mainly) Burmese genus *Hypoctonus*, which is ordinarily without this tooth. But in view of the fact that the tooth is now known to be present in at least one species whose other characters show it to be a member of the latter genus, a revised definition seems necessary.

The number of legs bearing tibial spurs, a character which is correlated with the form of the tibial apophysis of the male¹, supplies an excellent basis for this definition. It is probable, however, that as yet the group is very imperfectly known. For it inhabits country which has for the most part been very imperfectly explored zoologically, and the range of most at least of its species seems to be somewhat circumscribed. For the present, therefore, it will probably be best to transfer to the genus *Labochirus*, hitherto restricted to Indian species, the African and Burmese species in which only the fourth legs bear tibial spurs, although it is

¹ The tibial apophysis of the male has much the same form in the simpler members of both groups defined according to the presence or absence of tibial spurs on the third pair of legs; but in the more specialized species without these spurs the upper ridge of the tip of the apophysis is most strongly developed, while in those with these spurs the lower ridge is larger.

by no means unlikely that ultimately these African and Burmese forms will have to be separated under distinct generic names. It may be pointed out here that no two species, either of *Hypoctonus* or *Labochirus* as redefined, have ever been found together; but that several localities are known in which both genera are represented by a single species.

The keeled group can be split into three sections:—one in which the tibial apophysis of the male is strongly modified as in the Oriental species of the keelless group, one in which the hand is strongly modified, and one in which both tibial apophysis and hand are unmodified in the male and resemble more or less closely those of the female. The first, which includes only one genus, *Typopeltis*, may conceivably have been derived from the keelless group by the development of keels, and not from genera with keels and with the tibial apophysis of the male unmodified, as is here assumed. No proof is available for either hypotheses. All species of the genus *Typopeltis*, however, are stated by Kraepelin to have tibial spurs on all three pairs of walking legs, not on the last one or two pairs only as in the keelless genera. The spurs of *Mimoscaprius*, the only genus in which the hand is strongly modified, have not yet been described. In the larger genera, at least, of the section of the keeled group with unmodified or almost unmodified hands and tibial apophyses in the male, the number of legs with tibial spurs is variable.

The most primitive genus of the last-mentioned section of the keeled group appears to be the American *Mastigoproctus*, in which, according to Kraepelin, the sexes are scarcely distinguishable superficially. In all Oriental genera, except *Uroproctus*, the genital sternum of the male has a strong median groove, and the posterior margin of the following segment bears a strong median tubercle. *Uroproctus* differs, however, from *Mastigoproctus* in having the tibial apophysis of the male markedly slenderer than that of the female, and differs from this and from all other genera of the group in the presence of a tooth on the inner side of the gnathobase of the arm. The three remaining genera, *Thelyphonus*, *Abalius* and *Tetralalius*, are distinguished from one another solely by the number of vitreous spots on the third caudal segment. Nothing whatever is known as to the function of these spots¹; and their taxonomic significance appears to me to be equally uncertain. Provisionally, however, the distinctions which they afford may continue to be regarded as generic.

The genera of Thelyphonidae may now be redefined thus:—

- | | | | |
|-----|---|---|----|
| I. | { | Keels between median and lateral eyes almost | 2. |
| | | always absent, never very strong; tibial apophysis of male strongly modified in Oriental genera | |
| II. | { | Well developed keels always present between | 4. |
| | | median and lateral eyes; tibial apophysis of male often unmodified | |

¹ See Börner, 1904, pp. 25-26. Concerning improbability of their being urinous organs see Gravely, 1915b, p. 523.

2. { Third caudal segment without vitreous spots;
tibial apophysis of male slender, but otherwise
not very different from that of female ... *Thelyphonellus* (American).
Third caudal segment with the usual vitreous spot
on either side; tibial apophysis of male more
strongly modified ... 3.
3. { Tibial spurs confined to the fourth pair of legs;
tibial apophysis of male strongly modified ... *Labochirus*, p. 64.
Tibial spurs present on (and confined to) the
third and fourth pairs of legs; tibial apophysis
of male often still more strongly modified ... *Hypoctonus*, p. 67.
4. { Tibial apophysis strongly modified in male; modi-
fication of tarsus of antenniform legs of female,
when present, affecting one or both of the eighth
and ninth (terminal) joints ... *Typopeltis*, p. 70.
Tibial apophysis of male not strongly modified;
modification of tarsus of antenniform legs of fe-
male, when present, affecting the seventh joint
with or without one or more joints on one or
both sides of it ... 5.
5. { Genital sternum of male without median groove,
posterior margin of following sternum without
median tubercle ... 6.
Genital sternum of male with strong median groove,
posterior margin of following sternum with me-
dian tubercle ... 8.
6. { Hand flat, twice as broad as the long slender
femur; unjointed finger strongly curved at apex ... *Mimoscorpis*, p. 71.
Hand normal ... 7.
7. { Tibial apophysis of male like that of female; no
tooth on inner side of gnathobase of arm ... *Mastigoproctus* (American).
Tibial apophysis of male much slenderer than that
of female; a tooth on inner side of gnathobase
of arm in both sexes ... *Uroproctus*, p. 71.
8. { Third caudal segment with the usual single vitreous
spot on each side ... *Thelyphonus*, p. 73.
Third caudal segment without or with two such
spots on each side ... 9.
9. { Third caudal segment without vitreous spots ... *Abalius*, p. 78.
Third caudal segment with two vitreous spots on
each side, one above the other ... *Tetrabalius*, p. 78.

Before considering the connection between the phylogeny of different forms of Indo-Australian Thelyphonidae with their distribution, it is necessary to summarize the zoogeographical information with regard to the family at present available.

In addition to the species mentioned in the summary of this information given below, "*Thelyphonus*" *spinimanus*, Lucas, *angustus*, Lucas and *lucanoides*, Butler, from unknown localities, appear to belong to Indo-Australian genera. The identity of the first two appears to have been lost beyond recall.¹ The third is stated by Butler (1872, p. 205) to be closely related to "*Thelyphonus*" *seticauda*, Doleschall. The latter species has now, however, been made the type of a distinct genus (*Tetrabalius*), to which,

¹ Lucas states that the types were in the Natural History Museum in Paris; but there is no mention of them in Kraepelin's catalogue of the Pedipalpi of that collection (1901).

according to Pocock (1894, pp. 122-3), the former does not belong. The type is in the British Museum and must be redescribed before the species can be recognized. Pocock believes it to have come from Borneo.

Localities mentioned below are marked with an asterisk (*) when represented in the Indian Museum collection. References to descriptions are only given in the case of species not mentioned by Kraepelin in "*Das Tierreich*," where descriptions of and references to other species will be found.

Genus *Labochirus*, Pocock.

This genus is found in western Africa, western India, Ceylon, Burma and the north of the Malay Peninsula; perhaps also Borneo.

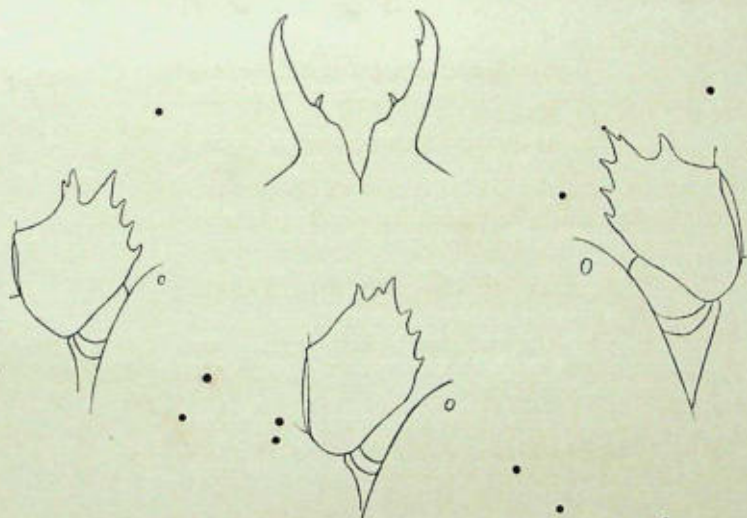


FIG. 1.—Abnormalities in the gnathobase and trochanter of the arm of *Labochirus proboscideus*, $\times 4$.

Labochirus africanus (Hentschel).

Western Africa: Senegal.

? Northern Africa: Algeria.

This species was described by Hentschel from female specimens only in 1899. It was unknown to Kraepelin when the family was revised in "*Das Tierreich*."

Labochirus proboscideus (Butler).

(Pl. i, figs. 1-4.)

Ceylon: Central Province—*Kandy, 1500-2000 ft.; *Peradeniya, 1600-1800 ft.; Haragama, ca. 1200-1400 ft.; *Galagedara, ca. 800-2000 ft.; *Nalanda, ca. 900-1000 ft.; Matale; *? Sigiri.

? Western Province—Kalutara.

The Kalutara record is based on a young and indeterminable specimen in the Colombo Museum. The Sigiri specimens, which are also young, have remarkably red fore-arms and hands.

In young specimens of this, as of other species of Thelyphonidae, the abdominal sterna are all much alike. The genital sternum begins, however, to extend backwards at a very early stage. Unfortunately the material at my disposal does not show all stages of its development. Two early stages, and the final stage in both sexes, are figured (pl. i, figs. 1-4).

Among the five males and three females of this species in the Indian Museum collection one male bears an extra tooth on the gnathobase of the left arm, and three females show abnormalities in the armature of the trochanter of one arm. These abnormalities are illustrated in text-fig. 1. Among three young specimens one shows a slight abnormality in the trochanter.

Labochirus tauricornis, Pocock.

South India: Kanara.

Malabar—Mahé.

By an oversight this species was given the same name as the next when originally described (Pocock, 1899a, p. 745).

Labochirus cervinus, Pocock.

South India: South Kanara—Mangalore.

Described by Pocock in 1899, and not included in "*Das Tierreich*."

Labochirus gastrostictus (Kraepelin).

(Pl. i, fig. 5.)

? Borneo.

This species is known only from a single female in the Vienna Museum. A figure of its anterior abdominal sterna, kindly supplied to me by Dr. Penther, is reproduced on pl. i, fig. 5.

Labochirus kraepelini (Simon).

(Pl. i, fig. 6; pl. ii, fig. 14.)

Malay Peninsula: *Lankawi Island.

Perak—*Grik.

E. Siamese Malay States—Biserat in Jalor; Bukit Grah in Nawng-Chik.

The anterior abdominal sterna of the female are shown in pl. i, fig. 6, a figure prepared from the type from Bukit Grah, kindly lent me by the Zoological Museum of Cambridge University. The "*Tierreich*" revision does not include this species, which was described by Simon from the female sex only in 1901.

Mr. B. H. Buxton recently presented specimens of both sexes to the Indian Museum. The male, which was previously unknown, may be described as follows:—Length of carapace 8·7-10·0 mm.; maximum breadth of same 5·0-5·8 mm. Closely allied to *L. dawnae*, from which it differs only in the following particulars:—the distance between the median eyes is perhaps scarcely as great; the ridge in front of the lateral eyes is indistinct; the coarser granules on the carapace are somewhat more clearly defined and more regularly rounded; the arm and hand show more frequently a slight rugosity; the spine on the lower surface of femur of the arm is sometimes obsolete; the tibia and hand are somewhat slenderer; the tibial apophysis (pl. ii, fig. 14) is slenderer and is not expanded distally—from above it seems no more strongly modified than that of *Uroproctus assamensis*, but it is triangular in section with the side nearest the hand strongly grooved.

Labochirus dawnae (Gravely).

(Pl. i, fig. 7; pl. ii, fig. 15.)

Lower Burma: Amherst District—*Dawna Hills, from Misty Hollow near top of western slope (ca. 2200 ft.) to Thingannyinaung at base of eastern slope (ca. 900 ft.).

This species was described in 1912, and is not included in Kræpelin's revision. The tibial apophysis of the male (pl. ii, fig. 15) is shorter than in the preceding species, but is of the same general form. In both these species this apophysis is very like that of the Ceylonese (?) and Indian species of the present genus, and like that of *Hypoctonus oatesi*, which appears to be the least highly specialized form yet known in the next genus.

Labochirus browni (Gravely).

(Pl. i, fig. 8.)

Upper Burma: Hsipaw (N. Shan) State—*Parni near Mong-long.

Also described in 1912. Only the female is known.

Labochirus andersoni (Oates).

(Pl. ii, fig. 16.)

Upper Burma: Bhamo District—*Second Defile of Irrawady.
?•Ruby Mines District—*Pudupyu Mountain.

The latter record is that of a mutilated and immature specimen that Oates described as the female of this species.

The tibial apophysis of the male (pl. ii, fig. 16) is somewhat highly modified, as in the following species.

Labochirus ellisi (Gravely).

(Pl. i, fig. 9; pl. ii, fig. 17.)

Lower Burma: Tharawady District—*Zigon Division.

Described with *L. dawnae*, etc., after the appearance of "*Das Tierreich*."

Labochirus spp. juv.

S. India: Mysore—*Koppe.

Upper Burma: *Pum-Ga-Taung, 13 miles east of Wanh-saung, 3600 ft. (half way between Sadon and Myitkyina).

Genus Hypoctonus, Thorell.

The genus *Hypoctonus*, as here restricted, is found mainly in Burma, but is known to extend to Penang, Western Siam and Southern China, and through Chittagong and Western Assam to the base of the Darjeeling hills.

Hypoctonus oatesi, Pocock.

(Pl. ii, fig. 18.)

Assam: Sylhet—*Shamshernager, ca. 100 ft.

The male was first described in the Arachnid volume of the "*Fauna of British India*" series (1900). The female was described in 1912 (a).

The tibial apophysis of the male is very like that of the simpler members of the preceding genus. There is no lamina either on the upper or the lower border of the grooved surface, but the apical angle of the latter is somewhat swollen.

The genital sternum of the female has the same form as in the preceding genus, instead of being strongly produced backwards in the middle as it is in most species of *Hypoctonus*.

Hypoctonus carmichaeli, n. sp.

(Pl. ii, fig. 19.)

Chittagong: *Rangamati.

Three specimens, all mature males, were obtained by the Museum collector who accompanied H.E. Lord Carmichael to Rangamati in July of last year.

The species is closely allied to *H. oatesi*, from which it differs only in its smoother and much slenderer arms, and in its more highly modified tibial apophysis, which arises before the distal end of the joint, is strongly curved at the base and has the apical angle of the lower border of the grooved surface produced into a large and lightly curved triangular papilla (pl. ii, fig. 19).

Hypoctonus birmanicus, Hirst.

Lower Burma: Pegu.

Only the male is known. It was described in 1911. It is said to be closely related to *H. binghami*.

Hypoctonus binghami (Oates).

Lower Burma: Tavoy—*Reef Island at mouth of Tavoy River.

Megui—Owen Island.

In this species also the genital sternum of the female is not extended backwards in the middle. The male is unknown to me, but appears from descriptions to have a somewhat more strongly modified tibial apophysis than has that of *H. oatesi*.

Hypoctonus formosus (Butler).

(Pl. ii, fig. 20.)

Lower Burma: Amherst District—*Moulmein (*H. formosus*, s. str.); *Double Island (*H. formosus*, subsp. *insularis*).

Also recorded from Taoo, a place whose whereabouts is unknown to me.

Thorell gives a number of additional localities, this being the only form without keels between the median and lateral eyes that was recognized when he wrote. His records probably refer to several distinct species. Simon's specimens from Tavoy, similarly, were no doubt *H. binghami* as already suggested by Oates (1889, p. 16).

In this, as in all the following species of the genus, the lower ridge of the grooved surface of the tibial apophysis of the male (pl. ii, fig. 20) is strongly developed near the tip, and the genital sternum of the female is produced backwards in the middle.

Hypoctonus rangunensis (Oates).

(Pl. ii, fig. 21.)

Lower Burma: *Rangoon; ? *Arakan.

Also recorded from Palon, of whose whereabouts I am uncertain.

The Arakan specimen is a female with all the characters of the Rangoon species.

Deep grooves are present between the paired cavities and posterior margin of the genital sternum of all females of this species that I have seen.

Hypoctonus sylvaticus (Oates).

(Pl. i, fig. 10; pl. ii, fig. 23.)

Lower Burma: Tharawadi—*Zigon; Minhla.

The female of this species was first described in 1912 (a).

Hypoctonus saxatilis (Oates).

(Pl. i, fig. 11; pl. ii, fig. 22.)

Lower Burma: *Thayetmyo. . .

Hypoctonus wood-masoni (Oates).

(Pl. i, fig. 12; pl. ii, fig. 24.)

Lower Burma: Amherst District—*Dhammathat, Gyaing River a few miles from Moulmein (sea level); *Sukli, E. side of Dawna Hills, ca. 2100 ft.; *Myawadi, Burmo-Siamese frontier, ca. 900 ft.; *near Mulaiyit Mountain; *Meetan (? Mita of Imperial Gazetteer) in the Haung-tharaw Valley.

This appears to be a somewhat widely distributed species; but many of the above records are based on females only.

The figure of the genital sternum of the female (pl. i, fig. 12) has been prepared from Oates' specimen. Since it was prepared specimens have been added to our collection which indicate that this one is scarcely fully mature. In these the posterior median expansion of the genital sternum is even narrower in proportion to its length and more abrupt, and its posterior margin may be lightly cleft in the middle line.

Hypoctonus stoliczkae, Gravelly.

(Pl. ii, fig. 25.)

E. Himalayas: Darjeeling District—*Punkabari.

Described in 1912. The lamina developed from the lower ridge of the grooved surface of the tibial apophysis is exceptionally large in this species.

Hypoctonus granosus, Pocock.

China: Yunnan.

Only the female is known. Pocock, who described it in 1900 (a), states that it is recognizable from all previously described species by the coarse granulation on the upper side of the hand.

Hypoctonus spp.

China: Yunnan—*Lo-po-ssu-Chuan.

Siam: *Meetaw forest, Raheng, 2000 ft.

Upper Burma: *On high ridge (ca 1000 ft.) at source of Kyathe, Myaung, Bawbin forest reserve; *Pyinmanna, Yamethin, Meiktila; Bhamo; Mandalay; Thigyam.

Lower Burma: Prome; *Farm Caves near Moulmein; Kathistan, ca. 900 ft., and Western slopes of Pegu Yomas, 1000-1100 ft., Thayetmyo District; Thagata-Juva in Mulaiyit Mountain.

Malay Peninsula: Penang Island.

Genus *Typopeltis*, Pocock.

This genus is confined to far eastern Asia from Cochin China to Siberia and Hong Kong to Japan. Since the publication of the Revision in "*Das Tierreich*" Pocock (1900a, p. 298) and Tarnani (1901, p. 214) have published keys for the determination of species.

Typopeltis amurensis (Tarnani)¹.

E. Siberia: between Olga Bay and the Amur River.

China: Canton—Sikiang.

Annam.

Also recorded from Haut Song Chai and Moïs Balnar, whose whereabouts I have been unable to trace.

The tarsi of the antenniform legs of the female are unmodified.

Typopeltis kasnakowi, Tarnani.

Siam: Arran Kull; Ta-ta-kham (? or -khaw); Watanaa.

This species was described by Tarnani in 1901 from male specimens only.

Typopeltis niger (Tarnani).

China.

Also known from the male only.

Typopeltis tarnani, Pocock.

N. Siam: Lampun.

This species was described from the male only in 1902.

Typopeltis dalyi, Pocock.

Siam: Lampun; Lacan via Raheng.

This species was described in 1900 (a); it does not appear in the "*Tierreich*" revision.

¹ See below, p. 80, footnote.

The tarsi of the antenniform legs are modified in the female of this and all the remaining species of the genus.

Typopeltis stimpsoni (Wood).

—Incl. *T. crucifer*, Pocock.

(Pl. i, fig. 13.)

Japan: Yokohama.

Loochoo Islands: Oö-Sima.

Formosa: Tam-sui on the Keelung River; Kushaku Mountain; *Takao

Hong Kong.

This appears to be a most variable species. Iwakawa (1908) has shown that *T. crucifer* cannot be separated from *T. stimpsoni*. This author does not appear to have been aware that Schwangart (1906) had suggested splitting the former species into two subspecies, a proceeding whose validity now seems very doubtful.

Among other characters, the armature of the lower side of the trochanter of the arm seems to be very variable (compare pl. i, fig. 13 of the present paper with pl. i, fig. 15 of Kraepelin, 1897).

Typopeltis harmandi, Kraepelin.

Cochin China.

This species was described by Kraepelin in 1900. It does not appear in his revision in "*Das Tierreich*." Only the female is known.

Genus *Mimoscorpius*, Pocock.

Mimoscorpius pugnator, Butler.

Philippine Islands.

Only the male is known.

Genus *Uroproctus*, Pocock.

Uroproctus assamensis, Stoliczka.

(Pl. iii, figs. 26, 27; pl. iv, figs. 35, 36.)

E. Himalayas: Darjeeling District—*Punkabari and *Sevoke (both near base of hills); *Ghumti Tea Estate, 2500 ft.; Pedong; Maria Basti¹; *Dafila Hills.

Abor Country—*Kobo, 400 ft.; *banks of Siyom River below Damda, 1300 ft.; *beside stream below Balek; *Rotung, 1300 ft.;

¹ Dr. Suherland informs me that Maria Basti is the same place as that called Kaggia Monastery on the Survey of India map of the Darjeeling District.

- Assam: *Upper Rotung ca. 2000 ft.; *between lat. 28°45 and 29°, ca. 4000 ft.
- *Goalpara District.
- Darrang District—*Assam-Bhutan frontier north of Mangaldai, ca. 300 ft.; *Kowpati; *Tezpur; Burroi¹; *Harmutti¹.
- Lakhimpur District—*Dikrang Valley; Sadiya.
- *Sibsagar District—*Dumar Dulong, Moran P.O.
- *Garo Hills
- Khasi Hills—*Cherra Punji.
- Sylhet—*Shamshernager, ca. 100 ft.; *Langla, ca. 100 ft.
- Cachar—*Silcuri forests.

In addition to the above localities "*Thelyphonus assamensis*" was recorded by Simon in 1885 (p. 452) from the Malay Peninsula and Indo-China. In 1896 he again recorded the species from Indo-China, this time from Pavie's collection. In his full report upon

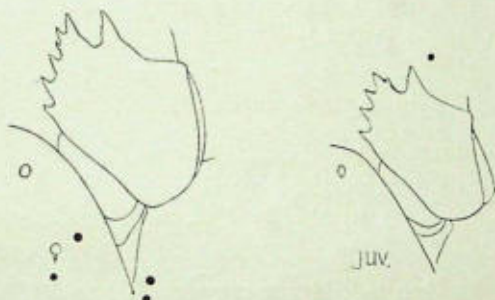


FIG. 2.—Abnormalities in the trochanter of the arm of *Uroproctus assamensis*, $\times 4$.

that collection, however, he records *Thelyphonus schimkewitschi* instead (1904, p. 293). *Uroproctus assamensis* is not otherwise recorded either south or east of Assam, and there can be no doubt, I think, that the record from the Malay Peninsula as well as that from Indo-China was based upon an incorrect determination. Kraepelin records the species from Calcutta; but this record probably refers not to the original place of capture, but to the place of dispatch; for there do not appear to be any Thelyphonids in the Gangetic Plain or Delta.

Uroproctus assamensis is an extremely constant species, in spite of its abundance and wide distribution. Even abnormalities in the teeth on the trochanters of the arms, such as are shown in text-fig. 2, are very rare, occurring only in two or three out of over fifty specimens examined.

¹ According to the labels these two localities are situated at the base of the Daffa Hills. They must therefore be in or near the Darrang District. I cannot locate them with greater precision than this.

The genital sternum is very little modified in adults of either sex (see pl iii, figs. 26 and 27). In the female especially it remains throughout life very like that of immature specimens of all forms of Thelyphonidae.

Genus *Thelyphonus*, Latreille.

This genus occurs throughout the Oriental Region, with the exception of Burma where it is largely, if not entirely, replaced by *Hypoctonus*; and it extends far eastwards among the Polynesian islands.

Thelyphonus sepiaris, Butler.

Incl. *T. cristatus*, Pocock.

* "Western Bengal" (probably Chota Nagpur, which is no longer included in Bengal).

Orissa : *Balasore ; *Barkul on the Chilka Lake, 0-1000 ft.

South India : Ganjam District—*Gopkuda Island, Chilka Lake ; foot of Mohiri Hills, 3 or 4 miles from Berhampur¹.

Karnul District—*Nandyal.

Chengalpat District—*Poonamallee ; *Tiruvallur.

Coromandel coast—Pondicherri ; Genji.

Salem District—*Yercaud in the Shevaroy Hills.

Coimbatore District—*Ootacamund in the Nilgiri Hills ; foot of Anamalai Hills.

Mysore—Bangalore ; ca. 3000 ft. ; French Rocks.

Cochin—Trichur.

Travancore—Trivandrum ; Athengil² ; Aramboly².

Ceylon : North-Central Province—*Anuradhapura ; *Minneriya ; *Polonuruwa.

Central Province—*Sigiri ; *Nalanda.

Thelyphonus sepiaris was originally described by Butler (1873, p. 131) from "Tongoo" (? = Taung-ngu) in Burma and from Ceylon; and Pocock (1894, p. 134) states that the type of Butler's *T. nigrescens* from Tenasserim is identical with *T. sepiaris*. But no original records from outside the Indian Peninsula appear to have been made since. Pocock (1900 b, p. 105, foot-note) regards the locality recorded for *T. nigrescens* as probably incorrect; and in this he is doubtless right.

The Tongoo cotypes of *T. sepiaris* were only lent to Butler and seem now to have disappeared—possibly they may have

¹ Mr. Fischer tells me that his observations on the courtship of the species (1911) were made at this place.

² Specimens in the Trivandrum Museum.

been *T. schnehageni*, Kraepelin. Altogether it seems most unlikely that *T. sepiaris* really occurs in Burma at all.

Butler does not say whether his figure of *T. sepiaris* (1873, pl. v. fig. 6) was taken from one of his Burmese or Ceylonese specimens. It differs from specimens of *T. sepiaris* from India and Ceylon in having the tibia of the arm slightly broader instead of narrower than it is long. I have no knowledge of the shape of the tibia of the arm of *T. schnehageni*.

Thelyphonus sepiaris is a much more variable species than *Uroproctus assamensis*. The range of variation in the teeth of the trochanters of the arms is indicated in text fig. 3. One male of *T. sepiaris* in the Indian Museum collection has the hand relatively narrow as in the female. The shape of the fingers is somewhat variable in both sexes.

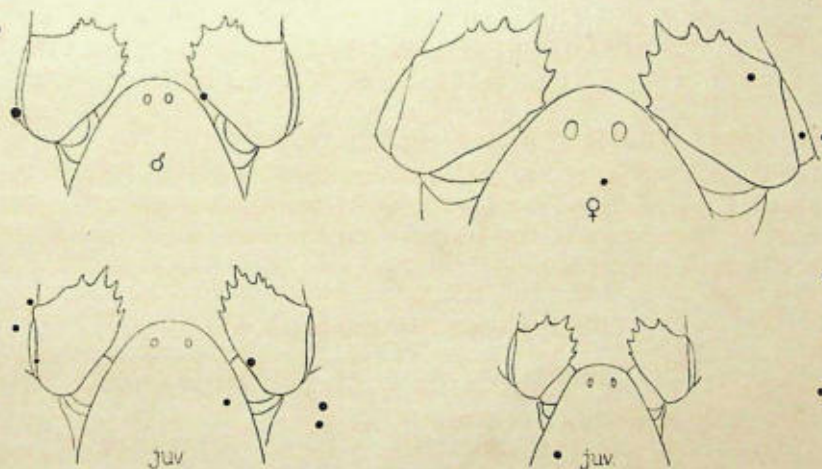


FIG. 3.—Abnormalities in the trochanter of the arm of *Thelyphonus sepiaris*, $\times 4$.

Specimens answering to Pocock's descriptions of the subspecies *indicus* and *muricola*, and to that of the form which he regarded as a distinct species *cristatus*, occur with various intermediate forms in various places, and I am unable to regard any of them as in any way distinct.

Thelyphonus schnehageni, Kraepelin.

Burma: Rangoon.

Only the female is known.

Thelyphonus manilanus, Koch.

Philippine Islands: Manila.

Moluccas: Halmaheira (subsp. *halmaheirae*, Kraepelin).

New Guinea (introduced).

***Thelyphonus wayi*, Pocock.**

Siam : Bathambang.

Described from a single female in 1900(a).

In this species and the next the tarsal joints of the antenniform legs, though long as in *Uroproctus assamensis* and the preceding species of *Thelyphonus*, are modified in mature females as in the remaining species of *Thelyphonus*.

***Thelyphonus anthracinus* (Pocock).**

Borneo: Batu Song in Eastern Sarawak.

The antenniform legs of the female are of the same transitional type as in the preceding species. The male has probably been described by Thorell (see below, p. 76).

***Thelyphonus caudatus* (Linnaeus).**

(Pl. iii, figs. 28, 29; pl. iv, figs. 37, 38.)

• • Java; Batavia; *Buitenzorg; *West Java.

Pocock (1834, p. 122) gives Hong Kong as well as Java. As, however, there are no records from intervening countries the occurrence of the species in the former locality needs confirmation before it can be accepted.

***Thelyphonus linganus*, Koch.**

(Pl. iii, figs. 30, 31; pl. iv, figs. 39, 40.)

Malay Peninsula: Penang.

• Perak—Ulu Selama; *Grik; *Lenggong Cave; ? Larut Hills, 3400 ft.

Kelantan—Kuala Aring.

*Johore—Johore Bahru; up to about 500 ft. on Gunong Pulai.

*Singapore.

Sumatran Islands: Sumatra; *Linga; *Sinkep.

The specimens from Perak differ from those from further south in that the tarsi of the antenniform legs are less distinctly modified, being of more uniform thickness and lacking the grooves on the sixth and seventh segments and the hook on the seventh. In a series of specimens from Johore and Sinkep Island the grooves are, however, usually absent from the sixth segment and often from the seventh, while the tooth is not always well developed. Probably, therefore, the differences are not specific.

Tarnani (1895) records this species from Batavia; but his description is inadequate, and his figure of the tarsus of the antenniform leg indicates a mistaken identification, the eighth joint being, for instance, shorter instead of longer than the seventh, and the third longer instead of shorter than broad.

Thorell (1888, pp. 390-395) records a male from Borneo; but from his description of the tarsus of the antenniform legs it is clear that the identification is at fault. Kraepelin (1897, pp. 32-3) believes this specimen to be the male of *T. anthracinus*, Pocock.

In Kraepelin's key for the identification of species the presence of a longitudinal groove in the last sternum is mentioned as one of the principal characteristics of both sexes of *T. linganus*. In the female, however, this is not so well developed as in the male, and in some specimens it is absent.

In a series of 27 specimens of *T. linganus* from Johore, eight show abnormalities of some kind in the armature of the trochanter. Five of these are shown in text-fig. 4. There are no such ab-

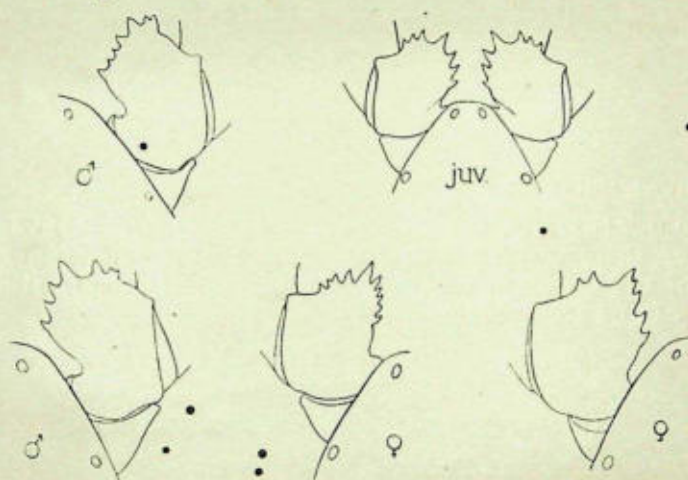


FIG. 4.—Abnormalities in the trochanter of the arm of *Thelyphonus linganus*, $\times 4$.

normalities among our eleven specimens from Perak, ten from Sinkep Island, and two from Singapore.

Thelyphonus borneensis, Kraepelin.

Borneo.

Only the female is known.

Thelyphonus klugi, Kraepelin.

Sumatra.

Celebes.

Thelyphonus celebensis, Kraepelin.

Celebes.

Only the female is known.

Thelyphonus doriae, Thorell.

(Pl. iv, figs. 34, 41.)

Malay Peninsula: Singapore.

Sumatran Islands: Billiton Island, half way between Sumatra and Borneo.

Java.

Borneo: Sarawak—*Kuching; Mt. Dulit (var. *hosei*).

West Borneo (var. *hosei*)—Pontianak.

Central Borneo.

Thelyphonus sucki, Kraepelin.

(Pl. iii, fig. 32; pl. iv, fig. 42.)

South-East Borneo: Tandjong; *Bendjermasin.

Thelyphonus semperi, Kraepelin.

Philippine Islands: Mindanao—Zamboanga, the Western extremity of the Island.

Thelyphonus pococki, Tarnani.

Celebes.

This species has been described (Tarnani, 1900, p. 482) since the revision of the family in "*Das Tierreich*." Only the female is known. It appears to be closely related to *T. semperi*.

Thelyphonus schimkewitschi, Tarnani.

(Pl. iii, fig. 33; pl. iv, fig. 43.)

Siam: *Pitsahuloke, *Bangkok; Koh Si Chang (Island); Chantaboon.

Laos: Luang Prabang.

Cambodia.

Cochin China: Saigon.

Thelyphonus burchardi, Kraepelin.

East Sumatra: Sungei Lalah.

This species has been described from female specimens only (Kraepelin, 1910, pp. 99-100, pl. i, figs. 1a-c) since the revision of the family in "*Das Tierreich*."

Thelyphonus insulanus, Keyserling.

New Hebrides.

Fiji Islands: Viti—Kandanavu.

Pocock (1899b, p. 98) says that this is a true *Thelyphonus*, not an *Abalius* as suggested by Kraepelin (1897, p. 17). Kraepelin

(1899, p. 322) finally suggests affinities with *T. schimkewitschi*. I have not seen a description of the species.

Thelyphonus hanseni, Kraepelin.

Philippine Islands: Mindanao.

Thelyphonus asperatus, Thorell.

Java.

Amboina.

Thelyphonus leucurus, Pocock.

Solomon Islands: New Georgia—Narowal; Rubiana.

Thelyphonus sumatranus, Kraepelin.

Sumatra.

Described from the male only.

Genus *Abalius*, Kraepelin.

In one species of this genus (*A. rohdei*) the tarsi of the antenniform legs are long as in *Uroproctus*, and are not modified in the female. In the rest they are short, and are modified in the female as in the more highly specialized species of *Thelyphonus*.

Abalius rohdei, Kraepelin.

New Guinea.

Abalius samoanus, Kraepelin.

Samoa: Upolu.

Male unknown.

Abalius willeyi, Pocock.

New Britain.

Male unknown.

Abalius manilanus, Kraepelin.

Philippine Islands: Manila.

This species has been described from a female specimen (Kraepelin, 1900, p. 7, text-fig. 2) since the revision of the family in "*Das Tierreich*."

Genus *Tetrabalius*, Thorell.

This genus occurs in the Moluccas and Borneo.

The tarsi of the antenniform legs are moderately short and are slightly modified in the female of the only species in which they have been examined.

Tetrabalius seticauda (Doleschall).

Moluccas : Halmaheira ; Amboina ; Ternate ; Batjan ; Ceram.

Tetrabalius nasutus, Thorell.

Borneo.

Only one specimen is known. It is said to be a female, but both antenniform legs are damaged.

It will be seen from the foregoing pages that among the Thelyphonidae evolution has chiefly affected three organs—the tibial apophyses of the male, the tarsi of the antenniform legs of the female, and the genital sternum of both sexes.

The modification of the tarsi of the antenniform legs of the female occurs at about the place at which the male holds them, between his chelicerae during courtship (see Gravelly, 1915*b*, p. 52-2, pl. xxiv, fig. 25) and there can be little doubt that it implies a specialization connected with this process. Species in which these tarsi are modified must therefore be regarded as higher in the evolutionary scale than allied species in which they are unmodified.

Nothing definite is known as to the uses of the modified tibial apophyses of males; but since this modification is also confined to one sex it is presumably also connected in some way with sexual processes. In any case, since the tibial apophyses of both sexes of some genera, and of females of all, are alike simply conical, those species must clearly be regarded as most highly specialized in the males of which these apophyses are most widely removed from this fundamental form.

With regard to the genital sterna, those species in which these plates undergo the greatest change when maturity is reached must similarly be regarded as the most highly specialized.

Specialization of the genital sterna appears to be roughly correlated with specialization in other parts. Thus in the keelless genera, in which the antenniform legs are never modified, it is not known to occur in the genus *Labochirus*, very few members of which have the tibial apophysis as highly modified as is usual in the genus *Hypoctonus*; and in the genus *Hypoctonus* it appears to be confined to the most specialized species—i.e. to those in which the tibial apophyses of the male bear a distinct lamina on the lower border of the grooved surface. Similarly in the keeled group it appears to be least marked, among Indo-Australian forms, in the genus *Uroproctus*, in which the tibial apophyses of the male are scarcely, and the antenniform legs of the female not at all, modified. Specialization of the genital sternum appears, moreover, often to be more marked in males than in females in genera in which the antenniform legs of the latter are more strongly modified than the tibial apophyses of the former, and *vice versa*. It seems impossible to say more at present with reference to modifications of the genital sternum.

The genera characterized by the specialization of the tibial apophyses of males are three in number—*Labochirus*, *Hypoctonus* and *Typopeltis*.

The distribution of the genus *Labochirus*, as already pointed out (above, p. 61), suggests that this genus, which contains almost all the most primitive representatives of the keelless group in the Indo-Australian area, once had a more continuously wide distribution than is at present the case. Its most highly specialized species appear to be confined to Burma, in and around which country and nowhere else the remaining Indo-Australian genus of the keelless group—*Hypoctonus*—is found. The more primitive species of this genus closely resemble those of the last, proving a common origin for the two; but the proportion of highly specialized species is much greater. I have already alluded to the concentration of this highly specialized genus in Burma as evidence that the conditions found among the secluded valleys of this country have acted as a stimulus to evolution in the same sort of way as the conditions found among the islands of the East Indian Archipelago, a conclusion which finds support in other groups (see Gravelly, 1915a, p. 416).

The genus *Hypoctonus* appears to be dominant over the whole of Burma, and its range extends beyond the Siamese frontier almost to Raheng in the Me Ping Valley, an immature specimen having been sent to us by Mr. C. S. Barton from laterite jungle in the forest surrounding the Metaw River, a river which joins the Me Ping from the west close to Raheng. From open ground in this forest Mr. Barton has also sent us an immature specimen of the genus *Thelyphonus*, a genus which appears to be widely distributed in Siam and Indo-China. It is difficult to determine, from the evidence at present available, whether *Thelyphonus* or *Typopeltis* is the dominant genus of the two last named countries, or whether both are equally common.

Typopeltis extends northwards to Japan and Siberia. It resembles the keelless genera already dealt with in having the tibial apophyses of males strongly modified, though perhaps in general a little less strongly. In addition, however, the tarsi of the antenniform legs of females—though always long—are often somewhat modified, a thing which is unknown in the keelless genera. It is impossible in the present state of our knowledge to locate the evolutionary centre of this genus, but it is noteworthy that the only species in which the antenniform legs of the female are known to be unmodified is *Typopeltis amurensis*¹ from Siberia on the periphery of the range of the genus.

Omitting the genus *Mimoscorpius* (from the Philippines), of which scarcely anything is known, the keeled genera with unmodi-

¹ The type specimen is a female from Siberia. Kraepelin (1897, p. 13) identifies with this a male from Canton. In view of the limited range of most species of Thelyphonidae the correctness of this identification can scarcely be considered certain. Unfortunately nothing is known of the sex of the Indo-Chinese specimens in the Paris Museum.

fied or almost unmodified male tibial apophyses remain for consideration. Of these the genus *Uroproctus*, whose unmodified genital sternum indicates its primitive character, contains only one species, a species the females of which have the tarsi of their antenniform legs long and unmodified. In two at least of the other three genera the females of some species have the tarsi of their antenniform legs long and unmodified, while those of most have them short and modified, two species of *Thelyphonus* being transitional in so far as these tarsi are long although modified. The phylogenetic value of the distinctions between these genera is very doubtful, and they may be treated here as together forming a single unit.

The species found in the Malay Peninsula and Archipelago and the Polynesian Islands are as follows:—

<i>Thelyphonus manilanus</i> ,	<i>Thelyphonus insulanus</i> ,
" <i>anthracinus</i> ,	" <i>hanseni</i> ,
" <i>caudatus</i> ,	" <i>asperatus</i> ,
" <i>linganus</i> ,	" <i>leucurus</i> ,
" <i>borneensis</i> ,	" <i>sumatranus</i> ,
" <i>klugi</i> ,	<i>Abalius rohdei</i> ,
" <i>celebensis</i> ,	" <i>samoanus</i> ,
" <i>loriae</i> ,	" <i>willeyi</i> ,
" <i>sucki</i> ,	" <i>manilanus</i> ,
" <i>semperi</i> ,	<i>Tetrabalius seticauda</i> ,
" <i>pococki</i> ,	" <i>nasutus</i> .
" <i>burchardi</i> ,	

In two of these—*Thelyphonus sumatranus* from Sumatra and *Abalius nasutus* from Borneo—the structure of the antenniform legs of the female is not definitely known.¹ But the tarsi of these legs are short in the male of the former species, and as shortening appears to follow modification it may be assumed that they are modified in the female. In the only known specimen of the latter species they are damaged.

In all the others, except *Thelyphonus anthracinus* from Borneo, *Thelyphonus manilanus* from the Philippines and Moluccas, and *Abalius rohdei* from New Guinea, they are both modified and short. In the first of these three exceptional species they are modified but long; in the other two they are both long and unmodified.

In Continental Asia (excluding the Malay Peninsula and including Ceylon) on the other hand, only two out of five species belonging to the keeled group have the antenniform tarsi modified, and in one of these they are long. Both species are, moreover, confined to Siam and Indo-China, i.e. they are the nearest of all to the Archipelago.

The country west of Siam and more directly north of the Malay Peninsula is occupied by the keelless genera *Hypoctonus*

¹ I have not seen a description of *T. insulanus*. If it is allied to *T. schimkewitchi* as Kraepelin suggests it must have the antenniform legs of the female modified.

and *Labochirus*. Only one species of *Thelyphonus*—*T. schneehageni* from Rangoon—has been recorded from this country. Throughout Assam and the Eastern Himalayas the present group of genera is represented by *Uroproctus assamensis*; and throughout the Indian Peninsula and Ceylon by *Thelyphonus sepiaris*. In all of these three species the tarsi of the antenniform legs of the female are long and unmodified.

It is clear, therefore, that species of this group are more numerous and as a rule more highly specialized in the Archipelago than in Continental Asia.

SUMMARY OF CONCLUSIONS.

1. The degree to which different species of Thelyphonidae have been affected by the process of evolution can best be seen in the genital sternum of both sexes, the antenniform legs of the female, and the tibial apophyses of the male (p. 79).
2. The modifications seen in the genital sternum are not sufficiently definite or varied to be of much use for the purposes of this paper. Broadly speaking, however, they are correlated with the modifications seen in the other two structures mentioned (p. 79).
3. One of these two structures is affected in some genera, and the other in the rest. Only in the genus *Typopeltis* are both affected together. The relationships of this genus are rendered obscure by the fact that it differs from other genera with modified male tibial apophyses in having keels between the median and lateral eyes, and that it differs from other genera with modified female antenniform legs in having a different (more nearly terminal) series of joints affected by the modification (pp. 62 and 80).
4. The genera *Uroproctus*, *Thelyphonus*, *Abalius* and *Tetralalius* are closely related. Except in so far as the structure of the genital sternum of *Uroproctus* indicates the primitive character of this genus, they are separated by characters of doubtful phylogenetic significance and they are best treated together as a unit group for the purposes of this paper. In all species the tibial apophysis of the male is simply conical, though often slenderer than that of the female; in the more highly specialized species the antenniform legs of the female are modified (pp. 62 and 81).
5. Twenty-three of the twenty-eight species belonging to these four genera are found in and confined to the Malay Peninsula, the Malay Archipelago and the Polynesian Islands. Of these the females of only two have unmodified antenniform legs; one of the remaining twenty-one has the tarsi of these legs unshortened although they are modified (p. 81). Of the two species which inhabit Siam and Indo-China one has these tarsi shortened and the other unshortened; both have them modified (p. 81). One species has been recorded from Burma, where the keelless genera with modified male tibial apophyses are dominant. Like the two species occurring (and dominant) in Assam and in the Indian Peninsula (with Ceylon) respectively it has the antenniform legs of the female unmodified

(pp. 81-82). Species found in and near the Archipelago are evidently, then, more highly specialized and much more numerous than those in Burma, Assam and the Indian Peninsula.

6. The keelless genera may for the present be regarded as two in number; but it has been necessary to redefine them (pp. 61-63). The genus *Labochirus* as redefined occurs in Africa, in South India and Ceylon, in Burma and the north of the Malay Peninsula, and perhaps in Borneo (pp. 64-67). It is composed almost entirely of relatively primitive forms which presumably had at one time a more continuously wide distribution than at present. Two species (*L. andersoni* and *L. ellisi*), however, show a specialization of the male tibial apophysis similar to that found in the higher members of the genus *Hypoctonus*, but affecting the upper instead of the lower border of the grooved surface. Both these species are confined to Burma (pp. 64 and 80). The genus *Hypoctonus*, which consists chiefly of the more highly specialized species of the group, is also confined to Burma, whose secluded valleys presumably form the main evolutionary centre of the group. The fauna of these valleys is very imperfectly known, and the species of this group have for the most part very restricted ranges. Probably, therefore, there is still much to be learnt with regard to them (pp. 61 and 80).

7. In the genus *Typopeltis* the number of records, especially from Continental Asia, is exceptionally small in comparison with the range of the genus, which indicates that here too there is still much to be found out. For the present the most that can be said is that the evolutionary centre is presumably somewhere in the tropics, that the genus does not extend south of Indo-China, and that the only species in which the female is known to have unmodified antenniform legs occurs in Siberia on the northern periphery of the range of the genus (p. 80).

8. Nothing can be said of the genus *Mimoscorpius* from the Philippines, as next to nothing is known about it.

9. Before concluding it may be well to note that the two American genera, which do not properly come within the scope of this paper, are both extremely primitive. *Thelyphonellus* has the male tibial apophysis less modified than any of its Oriental keelless allies; and *Mastigoproctus* has the genital sternum as little modified as the allied and primitive Oriental *Uroproctus*, and the tibial apophyses alike in the two sexes.

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VIII. REPORT ON A SMALL COLLECTION
OF MARINE MOLLUSCA DREDGED IN
SHALLOW WATER IN THE
ANDAMAN ISLANDS.

By H. B. PRESTON, F.Z.S.

In dealing with the present small collection the exceedingly rich nature of the Andaman Islands Molluscan fauna is once more emphasized, several large collections, notably those of Nevill, Bouley, Wilmer and Warneford, made during more or less recent years having seemingly failed to exhaust it and there is little doubt that were systematic dredging, especially in from two to twenty fathoms, carried on at every available point round the islands large numbers of forms hitherto unknown to science would be revealed.

In the present paper the author is able to diagnose and figure seventeen species which appear to have up to now escaped notice, and also to place on record the occurrence of several quite unlooked for forms, thus very considerably extending their known range, while the material collected has, in addition, enabled him to provide drawings of two species (*Ethalia capillata*, Gould and *Eulima oxytata*, Watson) which, though duly described, have not before been figured.

Class GASTROPODA.

Order PROSOBRANCHIA.

Family PLEUROTOMIDÆ.

Pleurotoma fusca, Hombron and Jacquinot.

Voy. Sud. Pole. Zool., Vol. V. p. 111, pl. xxv, figs. 19-20.

Brigade Creek, in 2-5 fathoms, on a bottom composed of decaying vegetation; Port Blair.

Mangilia gracilentia, Reeve.

Proc. Zool. Soc., 1843, p. 184; Tryon, *Man. Conch.*, Vol. VI, p. 251, pl. xxiii, figs. 98, 88; pl. xvii, fig. 11.

Port Blair.

Family NASSIDAE.

Nassa kempī, sp. n.

(Figs. 1, 1a.)

Shell small, ovately fusiform, whitish, shading on the last whorl to pale yellowish-brown, painted with two spiral bands of pale reddish-chestnut which increase to three on the last whorl; whorls 5, the first two smooth, polished, the last three sculptured with rather closely-set, transverse costulae; base of shell finely spirally sulcate; suture impressed, crenellated by the terminations of the

FIG. 1.—*Nassa kempī*, sp. n. $\times 6$... 1a.—do., sculpture, $\times 8$.FIG. 2.—*Nassa phoenicēnsis*, sp. n. $\times 4$... 2a.—do., sculpture, $\times 4$.FIG. 3. 3a.—*Natica kempī*, sp. n. $\times 3$... 3b.—do., operculum $\times 3$.

transverse costulae; columella obliquely descending, narrowly and restrictedly outwardly calloused, the callus extending upward across the parietal region to meet the upper margin of the labrum and bearing eight denticle-like plaits of which the uppermost and the three basal ones are the coarsest; labrum white, acute, varicosely thickened behind, slightly projecting in front and somewhat sharply contracted near the base, bearing seven small, regular denticles just within the aperture; aperture ovate; canal short, rather broad.

Alt. 4.5, diam. maj. 2.5, diam. min. 2.25 mm.

Aperture: alt. 1.5, diam. .5 mm.

Hqb.—Semiramis Bay, Andaman Islands, in 2-6 fathoms, on a bottom of fine mud (*S. Kemp*).

***Nassa phoenicensis*, sp. n.**

(Figs. 2, 2a, p. 88.)

Shell rather small, shortly fusiform, reddish-brown, painted with spiral bands of dark chocolate; whorls 6, flattish, regularly increasing, the last long, sculptured with slightly oblique, transverse costulae, crossed by fine, spiral lirae and a single groove a little below the sutural region, which transforms the terminations of the transverse costulae into a row of nodules; suture impressed; columella margin obliquely descending, bearing four plait-like denticles, livid whitish in colour, restricted and rather erectly calloused and extending above into a well defined, parietal callus which reaches to the upper margin of the labrum; labrum varicosely thickened with narrowly reflexed margin, obliquely backwardly sloping and sharply contracted to form a notch near its base, bearing seven denticles just within; aperture irregularly ovate, canal short.

Alt. 7, diam. maj. 3.75, diam. min. 3.25 mm.

Aperture: alt. 2.25, diam. 1 mm.

Hab.—Phoenix Bay, Andaman Islands, in 1-3 fathoms, on a bottom of muddy sand (*S. Kemp*).

***Nassa (Hima) tindalli*, Melvill.**

Proc. Malac. Soc. London, Vol. VII, 1907, p. 29 (fig. in text).

Port Blair.

A single small and damaged specimen which the author refers with some hesitation to the above quoted species originally described from Baticaloa, Ceylon.

***Nassa (Niotha) livescens*, Phil.**

Zeitschr. für Malak., 1848, p. 135 (as *Nassa*): Tryon, *Man. Conch.*, Ser. 1, Vol. IV, p. 54, pl. xvi, fig. 304.

Semiramis Bay, 2-6 fathoms, in fine mud.

A single dead and immature specimen.

***Nassa (Arcularia) globosa* (Quoy).**

Quoy and Gaimard, *Zool. Voy. Astrolabe*, II, p. 448, pl. xxxii, figs. 25, 27 (as *Buccinum*).

Phoenix Bay, in 1-3 fathoms, in muddy sand.

***Nassa (Arcularia) cancellata*, Adams.**

Proc. Zool. Soc., 1851, p. 99; Tryon, *Man. Conch.*, Ser. 1, Vol. IV, p. 26, pl. viii, fig. 35.

Bamboo Flat Bay, 1-4 fathoms, in muddy sand.

Nassa (*Alectrion*) *unicolor*, Hombron and Jacquinot.

Voy. Astrol. et Zél., 1853, V, p. 76, pl. xxi, figs. 13-15.

Semiramis Bay, 2-6 fathoms, in fine mud; Port Blair.

A single juvenile example from each locality.

Family CAPULIDAE.

Calyptraea pellucida, Reeve.

Coch. Icon. (Trochita), sp. 2, pl. i, figs. 2a-b.

A single specimen on the inner side of a valve of *Tellina viator*, Preston, from Port Blair.

Family NATICIDAE.

*Natica kemp*i, sp. n.

(Figs. 3, 3a, 3b, p. 88.)

Shell small, solid, ovate, of a yellowish ground colour, painted with rather fine, closely-set, transverse, zig-zag, chestnut markings and irregularly, broadly, spirally banded with pale reddish-chestnut; whorls 4, the first three small, the last large, convex, finely, transversely striate; sutures so lightly impressed as to be almost linear; umbilicus deep, sealed, but for a comparatively narrow opening, by a heavy convex callus which is stained with dark livid purple; columella margin obliquely descending, spreading above into a well defined, parietal callus which is so thickened as to take on almost the appearance of a nodule near its junction with the upper margin of the labrum; labrum sub-acute above and in front where it is stained with a livid tinge, slightly dilated below and considerably thickened where it merges into the base of the columella margin; aperture ovate; operculum thick, shelly, polished shining, semi-transparent, but marked with opaque, radiating bands of milk white, two-whorled, with eccentric nucleus and strongly spirally striate.

Alt. 7.5, diam. maj. 5.75, diam. min. 4.75 mm.

Aperture: alt. 4, diam. 2.25 mm.

Hab.—Port Blair, Andaman Islands (*S. Kemp*).

Sigaretus (*Eunaticina*) *calaraphe*, sp. n.

(Figs. 4, 4a.)

Shell small, moderately solid, yellowish-white; whorls 4, the first two small, the last two rapidly increasing, the last large, long, sculptured with fine, but rather irregular, slightly wavy, incised spiral striae; suture canaliculate; umbilicus moderately narrow, deep, partly concealed by the outward expansion of the calloused columella margin; columella margin obliquely descending, curved below, outwardly expanded, the expansion appearing as a wing-

like projection above and much contracted in the median part; labrum continuous with the columella callus, acute, somewhat projecting in front; aperture pyriform; interior of shell white, porcellaneous.

Alt. 8.5, diam. maj. 5.5, diam. min. 4.25 mm.

Aperture: alt. 6, diam. 3 mm.

Hab.—Semiramis Bay, Andaman Is., in 2-6 fathoms, on a bottom of fine sand (*S. Kemp*).

Family SCALIDAE.

Epitonium robillardi (Sowerby).

Proc. Malac. Soc., London, 1, p. 42, pl. iv, fig. 5 (as *Scaltria*).

Bamboo Flat Bay, 1-4 fathoms, in muddy sand.

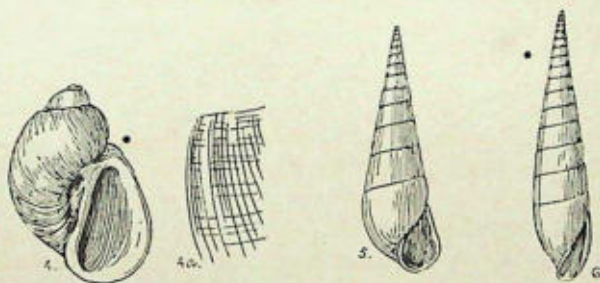


FIG. 4.—*Sigaretus (Eunaticina) calaraphe*, sp. n. $\times 4$.

.. 4a.—do. sculpture, $\times 4$.

.. 5.—*Eulima oxytata*, Watson $\times 4$.

.. 6.—*Eulima rossinsulæ*, sp. n. $\times 3$.

Family EULIMIDAE.

Eulima oxytata, Watson.

(Fig. 5.)

J. Linn. Soc., 1883, Vol. XVII, p. 117 (unfigured).

Bamboo Flat Bay, 1-4 fathoms, in muddy sand.

The author has been unable to trace the existence of any figure of this pretty little species, hence the figure now given.

Eulima rossinsulæ, sp. n.

(Fig. 6.)

Shell elongately subulate, semi-opaque, white; whorls 17, flattened, not convex, smooth, polished, shining; suture linear; columella margin oblique; labrum acute, slightly bent inwards over the aperture; aperture slightly oblique, narrowly and somewhat elongately triangular.

Alt. 11, diam. maj. 2.25 mm.

Aperture: alt. 1.5, diam. .75 mm.

Hab.—Off Ross Island, Andaman Is., 2-10 fathoms, on a bottom of sand, stones and coral (S. Kemp).

Family NERITIDAE.

Theodoxus oualanensis, Lesson.

Lesson in Duperoy, *Voy. Coquilte, Zool.*, Vol. II, 1830, p. 379.

Beeve, *Conch. Icon.*, sp. 166, pl. xxxvi, fig. 168 (as *Neritina*).

Bamboo Flat Bay, 1-4 fathoms, in muddy sand.

A single small specimen; the species though originally described from the Pacific appears to have a very wide range, the author having taken quite typical specimens some years ago at Baticaloa on the east coast of Ceylon.

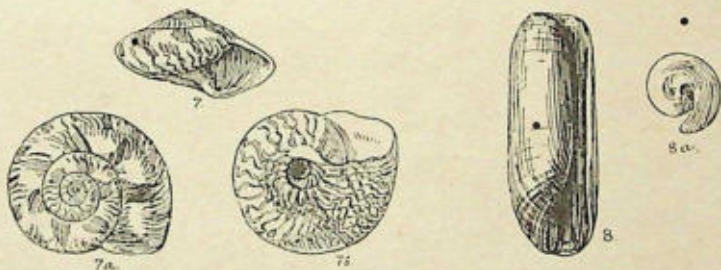


FIG. 7a, 7b.—*Ethalia capillata*, Gould, $\times 4$.
8, 8a.—*Cylichnella syngenes*, sp. n. $\times 8$.

Family TROCHIDAE.

Ethalia capillata, Gould.

(Figs. 7, 7a, 7b.)

Proc. Bost. Soc. Nat. Hist., 1861, Vol. VIII, p. 17.

Off Ross I., in 2-10 fathoms, on a bottom of sand, stones and coral.

A very beautiful species which appears hitherto to have escaped being figured.

Order OPISTHOBRANCHIA.

Family SCAPHANDRIDAE.

Cylichnella syngenes, sp. n.

(Figs. 8, 8a.)

Shell allied to *Cylichna cylindracea*¹ Pennant, a common European form, but differing from that species in the wider apical

¹ *Brit. Zool.*, Ed. 4, Vol. IV, p. 117, pl. lxx, fig. 35 (as *Bulla*).

umbilicus, in its coarser revolving striae and more cylindrical and truncate form.

Alt. 5.25, diam. 2 mm.

Aperture: alt. 5.25, diam. .25 mm.

Hab.—Port Blair, Andaman Is. (*S. Kemp*).

Family APLUSTRIDAE.

Micromelo undatum (Bruguère).

Brug., Encycl. Méth., 1, p. 380 (as *Bulla*); *Tryon, Man. Conch.*, Vol. XV, p. 392, pl. lix, figs. 20-24.

Off Ross I., in 2-10 fathoms, on a bottom of sand, stones and coral.

A single very brightly coloured example which is inseparable from the West Indian shells in the British Museum.

Class PELECYPODA.

Order TETRABRANCHIA.

Sub-order MYTILACEA.

Family MYTILIDAE.

Mytilus curvatus, Dunker.

Proc. Zool. Soc., 1856, p. 361; *Reeve, Conch. Icon.*, sp. 53, pl. xi, fig. 53.

Brigade Creek, in 2-5 fathoms, on a bottom composed of decaying vegetation.

Sub-order ARCACEA.

Family ARCIDAE.

Arca (*Anadena*) *holoserica*, Reeve.

Proc. Zool. Soc., 1844, p. 39 (as *Arca*); *Reeve, Conch. Icon.*, sp. 11, pl. ii.

A young specimen from Semiramis Bay, in 2-6 fathoms, in fine mud.

Family NUCULIDAE.

Nucula semiramisensis, sp. n.

(Figs. 9, 9a, 9b.)

• Shell tumid, ovately rhomboidal, covered with a thin, pale reddish-brown periostracum, polished, shining, minutely, obsoletely, transversely striate, and marked with concentric growth lines; umbones pearly, not prominent; dorsal margin arched in the median part, anteriorly sinuous, posteriorly bulging; ventral margin rounded; anterior side sharply angled above, obliquely sloping below; posterior side rather slightly produced, sharply rounded; hinge plate bearing on right valve five erect, sharp-pointed,

anterior and sixteen posterior lateral teeth, and on the left valve

six anterior and seven-
teen posterior lateral
teeth. Interior of shell
pale bluish, nacreous.

Long. 7.75, lat. 11.75
mm.

Hab.—Semiramis
Bay, Andaman Is., in
2-6 fathoms, in fine
mud (*S. Kemp*).

Allied to *N. bengal-
ensis*, Smith¹, from deep
water in the Bay of Ben-
gal. The present species

is however of smaller dimensions and greater convexity for its size,
the anterior side is also much more angular than is the case in
that species.

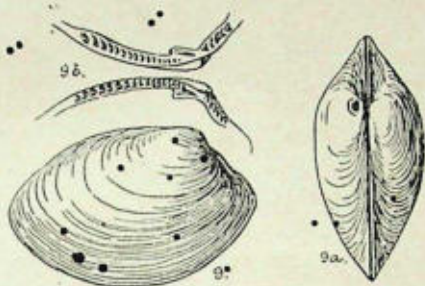


FIG. 9, 9a.—*Nacula semiramisensis*, sp. n. $\times 3$.
" 9b.— do., hinge, $\times 3$.

Yoldia tenella, Hinds.

Proc. Zool. Soc., 1843, p. 99; Reeve, *Conch. Icon.*, sp. 2, pl. ii.

Semiramis Bay, in 2-6 fathoms, in fine mud; Port Blair.

Sub-order *CARDIACEA*.

Family *CARDIDAE*.

Fulvia papyracea, Chem.

Conch., Cab., Vol. VI, p. 190, pl. xviii, fig. 184; Sowerby, *Conch. Illust.*,
fig. 56 (non fig. 55); Reeve, *Conch. Icon.*, sp. 9, pl. ii (as *Cardium*).

Bamboo Flat Bay, in 1-4 fathoms, on a bottom of muddy
sand (young specimens only).

Sub-order *CONCHACEA*.

Family *VENERIDAE*.

Dosinia laminata, Reeve.

Venus, No. 34 Schröter, *Einleit.*, iii, p. 167, pl. x, fig. 3?; *V. excavata*,
Gmel. *Syst.*, p. 3269, No. 83?; cf. Römer, *Krit. Unters.*, p. 26; Reeve, *Conch.
Icon.*, sp. 41, pl. vii.

Port Blair.

A number of small specimens measuring about 13 millimetres
in height and breadth.

Pitaria sp.? Juv.

Phoenix Bay, in 1-3 fathoms, on a bottom of muddy sand;
Port Blair.

¹ *Ann. Mag. Nat. Hist.*, Ser. 6, Vol. XVI, 1895, p. 257, pl. ii, fig. 9.

Anaitis calophylla, Hanley.

Cat. Rec. Biv. Shells, Appendix, p. 361, pl. xvi, fig. 26 (as *Venus*).
Port Blair.

Anaitis sp.? Juv.

Semiramis Bay, 2-6 fathoms, in fine mud.

A single very beautiful specimen, which the author has been unable to satisfactorily determine, it is obviously in a very youthful state.

Tapes textrix, Chem.

Coch. Cab., VII, p. 48, pl. xlii, fig. 442 (as *Venus*).
Port Blair. Two young examples.

Family SOLENIDAE.

Solen sp.? Juv.

Bamboo Flat Bay, 1-4 fathoms, in muddy sand; only extremely juvenile specimens obtained.

Order DIBRANCHIA

Sub-order LUCINACEA.

Family LUCINIDAE.

Lucina semperiana, Issel.

Savigny, *Descript. de l'Egypte Coq.*, pl. viii, fig. 12, Issel, *Mal. del Mar. Rosso*, 1869, p. 82.

Semiramis Bay, 2-6 fathoms, in fine mud.

Sub-order TELLINACEA.

Family TELLINIDAE.

Tellina bertiniana, sp. n.

(Figs. 10, 10a, p. 96.)

Shell trigonally ovate; somewhat convex, white, opaque, slightly polished, smooth but for concentric growth lines which are more closely-set and more apparent near the margins; umbones moderately small and inwardly curved, marked with rather distant growth ridges; dorsal margin arched; ventral margin gently rounded, very slightly contracted posteriorly; anterior side rounded; posterior side angularly rounded.

Long. 7.5, lat. 9.25 mm.

Hab.—Bamboo Flat Bay, Andaman Islands, in 1-4 fathoms, on a bottom of muddy sand (*S. Kemp*).

Dedicated to M. Victor Bertin in recognition of assistance received from his valuable work on the Tellinidae.¹

¹ *Nouv. Arch. Mus. Paris*, 2nd Ser., I, pp. 202-361, pls. viii, ix.

Tellina innocens, sp. n.

(Fig. 11.)

Shell small, ovately and broadly auriform, thin, semi-transparent, white, both valves finely concentrically striate; umbones small, a little prominent; dorsal margin anteriorly sloping, posteriorly sharply sloping and a little excavated; ventral margin rounded; anterior side also rounded; posterior side shortly and obtusely rostrate, abruptly rounded at its extremity.

Long. 4, lat. 5 mm.

Hab.—Phoenix Bay, Andaman Is., in 1-3 fathoms, on a bottom of muddy sand (*S. Kemp*).

Tellina micans, Hanley.

Proc. Zool. Soc., 1844, p. 72; *Sowerby, Thes. Conch.*, fig. 106.

Port Blair (several specimens).

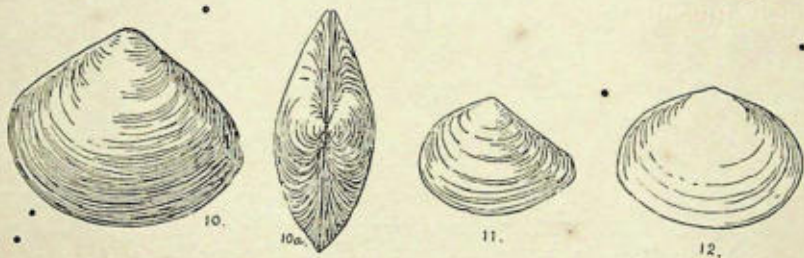


FIG. 10, 10a.—*Tellina bertiniana*, sp. n. $\times 3$.
 " 11.—*Tellina innocens*, sp. n. $\times 4$.
 " 12.—*Tellina persimplex*, sp. n. $\times 3$.

Tellina persimplex, sp. n.

(Fig. 12.)

Shell oval, thin, semi-transparent, whitish, both valves having the upper portion smooth, while the lower portions are marked with fine, concentric ridges which become coarser on the posterior side; umbones small, not prominent; dorsal margin gently sloping both anteriorly and posteriorly; ventral margin rounded; anterior and posterior sides bluntly rounded.

Long. 6, lat. 8 mm.

Hab.—Port Blair, Andaman Is. (*S. Kemp*).

Tellina pervitrea, sp. n.

(Fig. 13.)

Shell small, ovately cuneiform, exceedingly thin and almost transparent, smooth, polished, shining, marked only with fine, concentric growth lines; umbones small, not prominent; dorsal

margin anteriorly gently arched, markedly excavated in the ligamental region and sloping posteriorly; ventral margin scarcely rounded; anterior side rounded; posterior side comparatively short, abruptly descending, rounded below.

Long. 4.75, lat. 8.25 mm.

Hab.—Semiramis Bay, Andaman Is., in 2-6 fathoms, on a bottom of fine mud (*S. Kemp*).

Tellina phoenicensis, sp. n.

(Figs. 14, 14a.)

Shell small, ovately cuneiform, milk white, both valves sculptured with moderately fine, concentric ridges which stand out somewhat along the upper portion of the posterior, dorsal margin, the interstices being occupied by very fine, microscopic, concentric striae; umbones small, rather prominent; dorsal margin

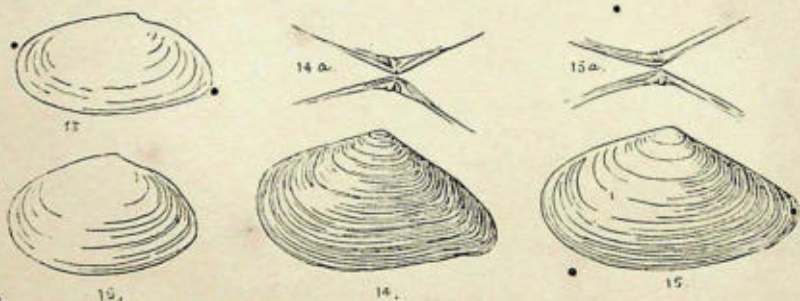


FIG. 13.—*Tellina pervitrea*, sp. n. $\times 3$.
 „ 14.—*Tellina phoenicensis*, sp. n. $\times 4$.
 „ 14a.—do., hinge, $\times 4$.

FIG. 15.—*Tellina soror*, sp. n. $\times 3$.
 „ 15a.—do., hinge, $\times 3$.
 „ 16.—*Tellina unguis*, sp. n. $\times 4$.

anteriorly, very slightly sloping, posteriorly sloping, faintly excavated above then a little bulging; ventral margin rounded anteriorly, contracted posteriorly, anterior side bluntly rounded; posterior side produced, subrostrate, sharply rounded.

Long. 5, lat. 8.5 mm.

Hab.—Phoenix Bay, Andaman Islands, in 1-3 fathoms, on a muddy bottom (*S. Kemp*).

Tellina soror, sp. n.

(Figs. 15, 15a.)

Shell allied to *T. phoenicensis* but larger and of a thinner and semi-transparent texture, the concentric ridges are lacking and are replaced by very fine and closely-set striae only; the ventral margin is not posteriorly contracted; the anterior side is still more obtusely rounded, and the posterior side is neither unduly produced nor rostrate.

Long. 6.75, lat. 21.25 mm.

Hab.—Port Blair, Andaman Islands (S. Kemp).

Tellina unguis, sp. n.

(Fig. 16, p. 97.)

Shell rather elongately ovate, thin, transparent, yellowish-white, shining, polished, smooth but for exceedingly fine growth lines; umbones small, scarcely prominent; dorsal margin arched, posteriorly excavated for a short distance; ventral margin very gently rounded; anterior side produced, rounded; posterior side obliquely sloping above, very obtusely rostrate below.

Long. 4.75, lat. 7.25 mm.

Hab.—Bamboo Flat Bay, Andaman Is., in 1-4 fathoms, on a bottom of muddy sand (S. Kemp).

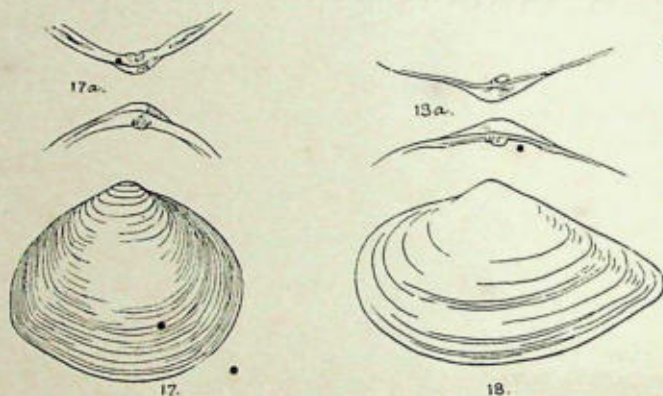


FIG. 17.—*Tellina vadorum*, sp. n. $\times 4$. FIG. 18.—*Theora hindiana*, sp. n. $\times 3$.
 „ 17a.—do., hinge, $\times 4$. „ 18a.—do., hinge, $\times 3$.

Tellina vadorum, sp. n.

(Figs. 17, 17a.)

Shell rather roundly ovate, thin, white, both valves sculptured with fine, regular, concentric ridges which become more closely crowded towards the ventral, anterior and posterior margins; umbones small, a little prominent; dorsal margin arched; ventral margin rounded; anterior side also rounded; posterior side very obtusely and roundedly rostrate.

Long. 6.5, lat. 8 mm.

Hab.—Bamboo Flat Bay, Andaman Islands in 1-4 fathoms, on a bottom of muddy sand (S. Kemp).

Tellina vestalis, Hanley.

Proc. Zool. Soc., 1844, p. 141 Reeve, *Conch. Icon.*, sp. 230, pl. xl.

Port Blair (young only).

Tellina viator, Preston.*Ann. Mag. Nat. Hist.*, Ser. 8, Vol. XVI, 1915, p. 84, fig. in text.

Port Blair.

A number of specimens of this very delicate species which are inseparable from the type which is of New Caledonian origin.

Family SCROBICULARIIDAE.

Theora hindsiana, sp. n.

(Figs. 18, 18a, p. 98.)

Shell allied to *T. opalina*, Hinds¹, but differing from that species in its more tumid form, anteriorly excavated and posteriorly sloping dorsal margin, broader and more obtusely rounded anterior side and more rostrate posterior side.

Long. 8.25, lat. 13 mm.

Hab.—Phoenix Bay, Andaman Islands, in 1-3 fathoms, on a bottom of muddy sand.

Named in honour of the late Mr. R. B. Hinds, to whose researches are due a large proportion of the known members of the group.

Sub-order ANATINACEA.

Family CUSPIDARIIDAE.

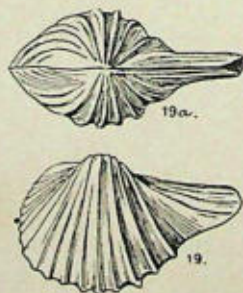
Cardiomya andamanica, sp. n.

(Figs. 19, 19a.)

Shell small, convex, pyriform, pure white, sculptured with seven minute anterior, eleven coarse median, and three fine posterior radiate riblets, a considerable smooth gap intervening between the two last; umbones small, not prominent; dorsal margin anteriorly sloping towards the umbones, posteriorly gently curving upwards towards the posterior side; ventral margin rounded, posteriorly contracted; anterior side steeply sloping above, rounded below; posterior side produced, rostrate, sharply rounded at its extremity.

Long. 3, lat. 5 (nearly) mm.

Hab.—Semiramis Bay, Andaman Is., in 2-6 fathoms, on a bottom of fine mud (*S. Kemp*).

FIG. 19, 19a.—*Cardiomya andamanica*, sp. n. $\times 6$.¹ *Proc. Zool. Soc.*, 1843, p. 28.

IX. A NEW *CHLAMYS* FROM CALCUTTA.

By S. MAULIK, B.A. (Cantab), F.E.S.,
Imperial College of Science and Technology, London.

Among the Hispinae and Cassidinae sent to me by Mr. Gravely from the Indian Museum, there occurs an interesting insect, belonging to the division Camptosomes of the family Chrysomelidae. It is necessary to describe it as a new species, it being the fourteenth *Chlamys* recorded from the Indian region. I name it after Mr. Gravely who found it on *Ziziphus jujuba* at Calcutta and tells me that in life it closely resembles a piece of caterpillar excrement. I thank Dr. Gahan for allowing me to see the types in the collection of the British Museum, and Mr. Andrewes for letting me examine the types in his collection.

Family CHRYSOMELIDAE.

Division CAMPTOSOMATA.

Sub-family CHLAMYDINAE.

Genus *Chlamys*, Knoch.

Chlamys gravelyi, n. sp.

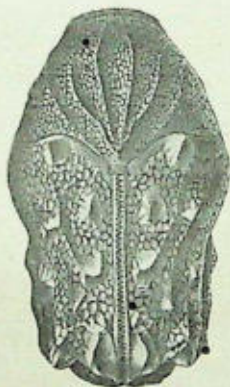
Sub-quadrate, broadest at the middle, narrowed anteriorly and posteriorly, black, five basal joints of antennae fulvous, the remaining six joints very dark brown. The insect is completely covered with coarse and shallow punctures, in some parts the punctures are shallower and in others they are deeper. The elevated surface of the prothorax with four ridges and without any tubercles, each elytron with ten sharp tubercles. Length 2.5 mm.

Head with the vertex coarsely punctate, shallowly depressed in the middle; eyes oval, convex, triangulately notched on the inner side; basal joint of the antenna thickest, longest, and curved to fit into the grooves round the eyes, 2nd joint small and rounded, 3rd-5th joints small and equal to one another in length, 6th joint transverse but smaller than the following joints, 7th-11th joints large and transverse, apex of 11th joint rounded. When the antennae are extended forwards the lateral expansions of the apical 6 joints are on the outer side, in repose they lie closely pressed to the sides of the prosternum, the tips reaching up to its constricted portion, and the lateral expansions being on the inner side. It is difficult to examine the antennae properly unless they are dissected off and a balsam mount made of them.

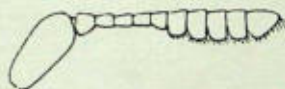
Prothorax bisinuate on either side at base which is as broad as that of the elytra; narrowed in front, anterior margin circular, the head fits in well into this circular front of the prothorax; lateral margins oblique and straight; the disc in the middle is triangularly and considerably elevated, the apex of the triangle being towards the scutellum, on this elevated portion there are two strong ridges running parallel down the middle, and from near the bases of these middle ridges two other sinuous ridges branch off, all of these ridges scarcely reach the anterior margin, they become feebler towards the margin.

Scutellum about twice as broad as long, the two apical outer angles produced, surface rough.

Elytra broadest at base, constricted at the middle; coarsely and deeply punctate; suture serrate throughout; humeral callus raised, rounded, surface finely strigose. Each elytron has ten



1.



1a.

FIG. 1.—*Chlamys graveleyi*, n. sp. from above; 1a. antenna.

sharp tubercles disposed as follows:—in a longitudinal line parallel to the suture there are four tubercles, the third being smaller and more towards the suture, along the median longitudinal line three, and finally there are three along the lateral marginal line, the second of these tubercles being deviated more towards the median line; the fourth tubercle of the sutural line, third of the median line and the second of the lateral marginal line being close together form a group. The surface of the elytra is rough being raised in places, particularly between the tubercles.

Underside.—Prosternum widened anteriorly and greatly constricted towards the posterior extremity. Last abdominal sternite with a depression in the middle. Pygidium with three ridges and four deep furrows.

Localities:—Calcutta, 3-iv-1915, 25 and 30-v-1915, 8-vii-1912, 27-ix-1915, 2-x-1915, "on *Ziziphus jujuba*" (F. H. Graveley); Pares-

1916.]

S. MAULIK: *A new Chlamys*.

103

nath, W. Bengal, 4000-4400 ft., 10-iv-1909, "on various shrubs".
(*Annandale*).

Described from 14 examples.

Type in the Indian Museum, Calcutta; 2 co-types in the
British Museum.

X. DESCRIPTIONS OF TWO NEW FISH FROM THE CHILKA LAKE.

By B. L. CHAUDHURI, D.Sc. (Edin.), F.R.S.E., F.L.S.,
Assistant Superintendent, Indian Museum.

Descriptions of two new species in the Chilka Survey collection are now published in advance of the report on the fish which is under preparation, in order to avoid the detention of a paper on the larval stages by Professor D. R. Bhattacharya, which will be issued shortly in vol. V of our *Memoirs*.

Gobius ostreicola, sp. nov.

The height of the body is 22.2% of the total length without the caudal fin, the length of the head is 35.5%, the least depth of the caudal peduncle is 15.5%, the diameter of the eye is 9%, the height of the first dorsal fin is 22.2%, the length of the pectoral fin is 33.3%, the length of the ventral fin is 26.6%, the base of the anal fin is 20%, the base of the second dorsal is 26.5%, the length of the caudal fin is 26.6% in the total length without the caudal fin.¹

The body is elongate and compressed. The caudal peduncle is very much compressed. The dorsal profile slopes downwards from the nape towards the caudal peduncle as well as towards the snout; the ventral profile is almost a straight line.

The head is large and broad and is very much depressed, its breadth being shorter than its length by the length of its snout. The part of the head on each side in front of the opercle and behind the eye protrudes above and is inflated sideways with a pore behind. There is a median longitudinal groove from the occiput to the back of the eye. The interorbital space is saddle-shaped with a slight bridge-like elevation in the middle and is equal to the length of the snout. There are a series of minute pores—openings of muciferous glands—arranged in patterns round the eyes, the nasal area and other parts of the head. The nasal area has two fleshy tubular protuberances with two valvular openings behind each in front of the eyes. The eyes are rather large, and are not lateral but wholly superior, and project beyond the dorsal profile. The snout is short and is less than the diameter of the eye in length.

The mouth is horizontal, the jaws are subequal, the lower jaw being slightly the longer, the angle of the jaws is vertically below the middle of the eye. The teeth are villiform and are in several

¹ Measurements are in hundreds of length without the caudal fin.

rows in each jaw, those of the upper jaw being smaller and less numerous than those of the lower. The teeth in the upper jaw are in two series: the outer series consists of two or three rows of teeth larger anteriorly but becoming smaller laterally; the inner (posterior) series forms a cluster of smaller teeth several rows deep but not spreading laterally. In the lower jaw there are broad bands of teeth several rows thick which continue to the angle of the mouth in almost equal thickness; the outer ones of this set are slightly larger than those behind.

The gill openings are lateral and they do not continue forward beneath. The isthmus is broad, the width being contained three times in the length of the head. Pseudo-branchiae are present.

There are two dorsal fins, entirely separated from each other, the first one has six spines and the second has ten rays; the anterior end of the first dorsal is considerably behind the base of the pectoral fin, the third to fifth spines are the longest but they do not reach beyond the third ray of the second dorsal fin when lying horizontal. The second dorsal fin begins a little forward of the tip of the pectoral fin; the posterior rays of this fin are slightly longer than the anterior ones and the last of these rays almost reaches the base of the caudal fin.

The anal fin has nine rays the first of which is undivided; it is inserted a little behind the origin of the second dorsal fin and is somewhat similar in shape to that fin. Its posterior rays are longer and are long enough to reach some of the rays of the caudal fin that are attached to the ventral side of the base of that fin.

Six specimens—one type and five co-types—have the dorsal and anal fin rays as follows:—

	Dorsal spines.		Dorsal rays.		Anal rays.	
	VI.	VII.	10	11	•	10
Specimens	5	1	5	1	4	2

The pectoral fin has sixteen rays, some of which are thin and silky; the fin is somewhat low down, rather broad, and has a rounded margin.

The tip of the united ventral fin reaches the vent. The anal papilla is prominent, long and muscular. The caudal fin is broadly rounded.

The scales are small and are mostly ctenoid, except a few very small scales embedded in the occipital region of the head which is otherwise naked; the isthmus and chest are also scaleless. There are a few embedded scales in front of the vent and the part of the abdomen above the joined-ventral fin is scaleless. The number of scales in the lateral line is thirty-seven and in the lateral transverse fourteen.

The colour of the body (in spirit) is mottled dark brown, the ventral side and the sides of the abdomen being slightly lighter; the fins are dull white and the two dorsal, anal and caudal fins are banded by series of black spots in the spines and rays; in the first dorsal fin there are four such series of black dots, in the rest it varies from two to three.

The fish was found breeding among the oyster beds near Manikpatna in the Satpara peninsula.

The type specimen, measuring 45 mm. without the caudal fin and 57 mm. with it, was collected in the beginning of the month of December, 1914 near Manikpatna among the oyster beds.

There are altogether five co-types, two of which, measuring 48 mm. and 49 mm., were collected along with the type specimen near the same spot. The other three co-types measuring 39 mm. to 41 mm. were collected on the 5th of September, 1914 near the same locality.

Petrosciartes bhattacharyae, sp. nov.

The height of the body is 18% of the total length without the caudal fin, the length of the head is 25%, the least depth of the caudal peduncle is 11.5%, the diameter of the eye is 7%, the length of the snout is 9%, the length of the pectoral fin is 18%, the length of the ventral fin is 14%, the length of the caudal fin is 16%, the base of the dorsal fin is 72%, and the base of anal fin is 22% in the total length without the caudal fin.

The body is moderately elongate, round and naked. The snout is rounded and short; the mouth is sub-inferior and terminal; the cleft of the mouth is narrow. There are two small tentacles about the middle of the snout in front of the nasal openings.

There are long incisiform teeth in a single row in each jaw, and a pair of canine teeth at each angle of the jaws. The upper canine teeth are very much bent and recurved, the lower ones are longer and stouter and not curved. The number of incisor teeth in the upper jaw is 18 and that in the lower 16. There is a considerable alveolar space between the upper canine and the last (outermost) incisor of the upper jaw in each side—in which space the lower canine is lodged when the mouth remains shut.

The fins are thin, the spines and rays are hyaline and the interstices are membranous. There is a single dorsal fin with thirty-one spines commencing slightly in front of the gill-openings and ending near the base of the caudal fin; the posterior spines of the dorsal fin are higher than the anterior ones, some of the long posterior spines being almost double the length of the anterior short ones. The anal fin has twenty-one rays, the last rays almost touch the lower caudal rays. The caudal fin is fan-shaped, it appears to be somewhat truncated and has rounded sides. The ventral fin consists of two fleshy round rays united at the base and free at the end, the free portion of the outer ray is nearly double that of the inner free end. The pectoral fin is

rounded and has a somewhat muscular base. It is considerably posterior to the origin of the ventral fin. There is an anal papilla equidistant from the end of the snout and the base of the caudal fin, it is also in the middle of the vent and the anterior origin of the anal fin.

The ground colour of the head and of the body is dull brown with a lighter shade in the abdominal region. On each side of the head there are four broad transverse bands, black in colour, with interspaces equally broad but white; on the upper part of the head there is one white horse-shoe-shaped loop commencing behind the eyes and reaching round the occiput. On the side of the body there are eight or nine very faint but darkish transverse bands—broader than those on the sides of the head, with interspaces equally broad; along the middle line on each side of the body—on each of these dark faint bands—there are altogether eight or nine round black blotches. Looking from above the lighter interspaces, that pass through the base of the dorsal fin from side to side, appear as many white blotches. The fins are diaphanous and slightly darkish, the anal fin being darker than the rest. The dorsal and the anal fins are edged with bright white points and the base line of the caudal fin has a white band posterior to a dark band. There is a transverse broad black band low down on the anterior side of the base of the pectoral fin. The terminal edge of the opercular membrane is white.

The type specimen, measuring 44 mm. without the caudal fin and 51 mm. with that fin, was obtained at Barkul Point on the 2nd March, 1914. There are altogether eleven co-types.

Habitat.—The species is a permanent inhabitant of the lake, both in the Main Area and in the outer channel, breeding in the lake.

XI. DESCRIPTION DE LA LARVE DE
LASIODACTYLUS CHEVROLATI,
REITT.

[COLEOPTERA, NITIDULIDAE].

Par P. DE PEYERIMHOFF.

Matériel étudié: Nombreuses larves de tous âges, conservées dans l'alcool faible, recueillies avec l'imago.

Provenance: Barkuda I., Chilka L. (Ganjam, Madras, Indes Anglaises), dans des fruits tombés et fermentés de *Melia azadirachta* (Neem ou Nim tree). Coll. Chilka Survey.

Longueur des plus grands spécimens: 7 mm.—Largeur: 1.5 mm.

Corps éruciforme, assez convexe, d'un jaune orangé; tête plus foncée; pronotum chargé de deux plaques cornées brunes; contours des mandibules, taches rétinienne, stigmata, quatre taches cornées sur le mésonotum et le métanotum, deux taches analogues sur les 9 tergites abdominaux, extrémité des prolongements du dernier segment et trochantins, d'un brun clair. Téguments mats, sauf sur la tête et sur les taches cornées. Pilosité presque nulle, au moins chez les individus âgés.

Tête dégagée chez les individus jeunes, légèrement engagée dans le prothorax chez les individus âgés, atténuée en avant à partir de la moitié, arrondie en arrière, portant une forte impression en U superposée aux sutures de l'aire frontale, ornée de quelques soies, claviformes en dessus, simples en dessous. Clypeus transversal, fortement tuméfié de chaque côté, sans suture nette. Labre bien détaché, encore plus transversal, portant six soies sur le pourtour et des papilles au bord antérieur.

Antennes ayant à peu près la longueur de l'épistome et du labre pris ensemble, basées sur une large membrane cupiliforme, de 3 articles décroissant en largeur, le 1^o carré, plus ou moins enchâssé dans la membrane basilaire, le 2^o allongé, légèrement fusiforme, le dernier très petit, subulé, terminé par une soie et accolé à un cône sensitif interne moindre de moitié.

Ocelles latéraux, au nombre de 4, sous forme de cornées saillantes disposées au-dessus d'une tache rétinienne foncée.

Mandibules courtes, à peu près symétriques, cachées sous l'épistome et le labre, peu chitinisées, sauf sur les bords et sur les condyles, fortement anguleuses au côté externe, composées d'une pointe cornée au sommet bifide, portant 4 ou 5 dents au bord interne,—d'une lacinia formée de lanières multifides réunies en frange,—d'une mola finement striée, semblant évidée en dessous et un peu davantage à droite qu'à gauche.

Trou occipital inféro-postérieur; trou maxillaire vaguement

rectangulaire; tous deux communiquant entre les pleures, dont les ailes sont distantes du dixième environ de la largeur de la tête. *Pièces labio-maxillaires* en partie membraneuses, peu saillantes en dessous.

Maxilles formées d'un *stipe* deux fois plus long que large, à contours externes flexueux basé sur un *cardo* très peu coudé, et au sommet, séparé du lobe par une suture très nette. *Lobe maxillaire* oblong, couvert au sommet de papilles et de soies sensibles et portant à la base, sur la face dorsale, un fascicule de 4 dents aigues, dont deux beaucoup plus développées, dépassant le bord interne. *Membrane articulaire* à peine chitinisée sur son bord interne. *Palpes maxillaires* épais, le palpigère complètement détaché, corné à la base et simulant un premier article; l'orange paraît ainsi composé de quatre segments.

Labium composé d'avant en arrière: d'un *palpigère* cordiforme portant une paire de palpes *uniarticulés* recouverts d'une *langue* arrondie, obtuse, non sétuleuse, — d'un *menton* également cordiforme, pourvu de deux soies, membraneux au sommet, où il peut enchaîner une partie du palpigère, — d'un *sous-menton* très allongé, dont le tégu-

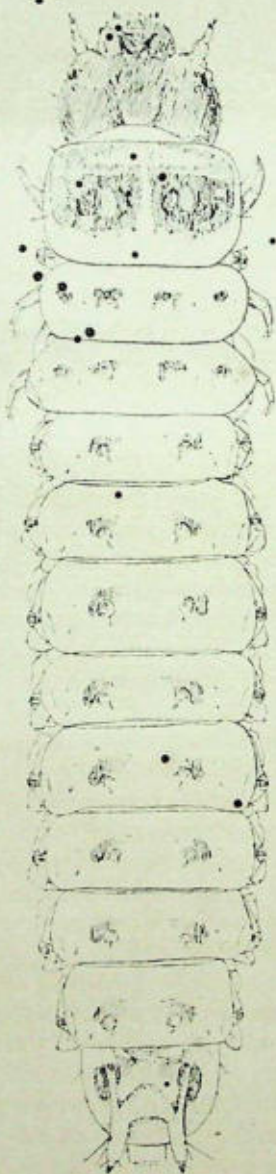


FIG. 1.—Larve de *Lasiodactylus chevrolati*.
Specimen âgé.

ment luisant contrasta avec la matité de la membrane articulaire, — d'une *gula* membraneuse (à peu près invisible sans dissection) et située exactement entre les deux sommets cornés des pleures.

Pronotum beaucoup plus développé que tout autre segment, transversal à côtés arrondis, orné sur ses deux tiers antérieurs de

deux plaques cornées et luisantes, presque contigues; chacune d'elles porte quelques courtes soies claviformes et quatre impressions, une médiane et trois latérales, à fond plus clair.

Mésanotum et *métanotum* identiques, presque de moitié plus courts que le pronotum, portant quatre plaques luisantes bien moins étendues, les médianes plus développées, terminées en arrière par un tubercule charnu couronné de trois soies claviformes,—les latérales munies de deux soies seulement; de chaque côté en outre, deux papilles et une soie claviforme.

Segments abdominaux ornés sur les 8 premiers de deux plaques seulement, de plus en plus étendues et à tubercule sétigère de plus en plus isolé et saillant d'avant en arrière,—portant en outre une papille et une soie discales de chaque côté. Neuvième segment

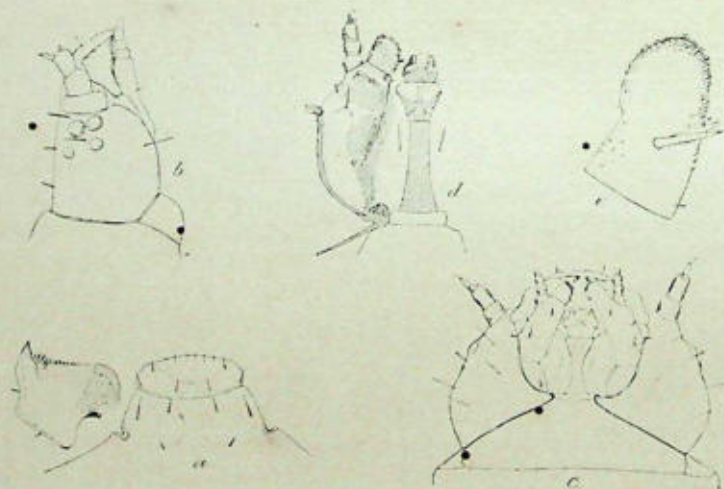


FIG. 2.—Larve de *Lasiodactylus chevrolati*.

a. Clypeus, libre et mandibule (légèrement détachée), face dorsale: b. Tête vue latéralement: c. Face ventrale de la tête: d. Maxillaire et labium vus par la face ventrale: e. Lobe maxillaire vu par la face dorsale.

sensiblement plus étroit, en trapèze renversé, tuméfié vers le sommet, d'où partent deux paires d'appendices à sommet chitineux, les antérieurs courts, les postérieurs allongés, sétigères.

Dessous membraneux et mou. *Prosternum* relié à la tête par un goître transversal très développé. *Pleurites* thoraciques et abdominaux composés de toutes les pièces indiquées par Hopkins¹, savoir l'épipleuré, l'hypopleuré, le sternum (silloné longitudinalement), le sternum et le poststernellum (fig. 3a). L'épipleuré, de plus en plus saillante d'avant en arrière, se termine latéralement par un tubercule charnu, orné d'une papille antéapicale. *Anus* tronconique, à extrémité orné de 6 soies; maqueuse érectile quadrilobée.

¹ "The genus *Dendroctonus*". Washington, 1909, p. 62, fig. 39.

Stigmates en nombre normal, la 1^{re} paire inféro-latérale, située à la marge antérieure du métathorax, les 8 autres dorso-latérales, de plus en plus rapprochées, d'avant en arrière, du bord postérieur des segments. Ils sont très saillants, en forme de boutons foncés, et constitués par un élément de trachée très élargi, très chitinisé, recouvert d'une sorte de cloche également chitineuse, percée au sommet par le pérित्रème, qui est légèrement réniforme.

Pattes très écartées, et de plus en plus de la 1^{re} à la 3^e paire, rattachées à un *trochantin* bien visible, composées d'une *hanche* globuleuse semée de papilles microscopiques, sauf sur la partie centrale qui s'affaisse en contraction pour recevoir une partie des segments suivants, — d'un *trochanter* égal à la moitié du fémur, — d'un *fémur* deux fois plus long que large, — d'un *tibia* égal en longueur au fémur, mais deux fois plus mince, — d'un *tarse* formé d'un ongle à base membraneuse portant une soie en-dessous.

Chez les larves de plus en plus jeunes, la tête est de plus en plus grosse par rapport au prothorax, les tubercules sétigères sont de plus en plus saillants, et les soies elles-mêmes, simples ou clavi-

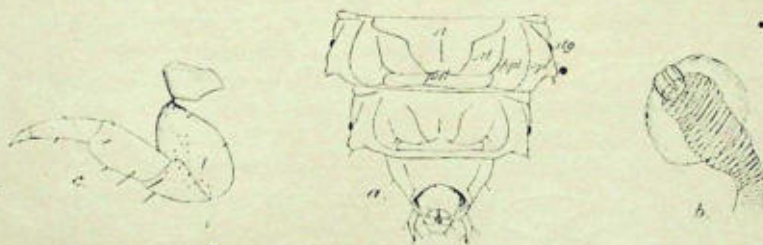


FIG. 3.—Larve de *Lasiodactylus chevrolati*.

a. Face ventrale des derniers segments; b. Extrémité d'un tronc trachéen et stigmate; c. Patte postérieure droite, vue de dessous (avec le trochantin précédant la hanche).

formes, de plus en plus longues; les papilles deviennent également sétifères, notamment celles qui terminent le processus latéral des pleures. Les soies inférieures participent au même développement.

Larve de Nitidulide typique, à structure très différenciée et à adaptation nettement saprophage. La discussion de ses caractères et leur comparaison avec ceux des autres types seront faites ultérieurement. D'ailleurs, le petit nombre de Nitidulidae connus à ce point de vue et l'insuffisance de la plupart des descriptions, rendraient actuellement cet examen comparatif aussi incomplet que difficile.

Deux larves de *Lasiodactylus* ont été déjà décrites:

1. Celle de *L. pictus*, Mac-Leay (E. Candèze, Histoire des métamorphoses de quelques Coléoptères exotiques, Liège, 1861, p. 16, pl. iii, fig. 6 [sub "*Lordites glabricula*, Murray i. litt.]).—Quoi que très succincte, cette description permet de constater que la larve de *L. pictus* (de Ceylan) diffère peu de celle de *L. chevrolati*. Elle n'aurait toutefois que deux taches cornées au lieu de 4, sur le

mésnotum et le métanotum, et ces taches, comme celles des segments de l'abdomen, seraient surmontées d'épines au lieu de soies claviformes.

2. Celle de *L. caliginosus* Reitt. [d'après une communication *in litteris* de M. le Dr. Sicard, qui a récolté cette larve et l'a communiquée à l'auteur de la description]—Capt. Xamheu, Larves de Madagascar, 14^e Mémoire, sep. 1905, p. 16—17 [sub "*Lordites species*"].—Cette larve n'a que deux ocelles, et le mésnotum, le métanotum et les segments abdominaux sont dépourvus de plaques ou taches cornées. Différences relativement importantes, et qui laisseraient supposer une erreur d'attribution ou de détermination.

XII. CONTRIBUTIONS TO A KNOWLEDGE
OF THE TERRESTRIAL ISOPODA
OF INDIA.

Part II.—SOME NEW SPECIES OF *PARAPERISCYPHIS*,
CUBARIS, etc.

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(Plates IX—XIX.)

The present contribution deals mainly with new species of the genus *Cubaris*, Brandt, amongst which is an interesting one from caves near Cherrapunji, Assam. Two new species of *Paraperiscyphis*, Stebbing, are described from single specimens from Ceylon, but their characters are so distinct from any known forms, that I offer no excuse for departing from a rule not to describe from single examples. It is interesting to be able to record a new species of *Burmoniscus*, Cllge., also from a cave near Cherrapunji. The complete list is as follows:

- Paraperiscyphis stebbingi*, Cllge.
- „ *pulcher*, n. sp.
- „ *scabrus*, n. sp.
- Cubaris gravelii*, n. sp.
- „ *expansus*, n. sp.
- „ *dilectum*, n. sp.
- „ *pusillus*, n. sp.
- „ *brunneocaudatus*, n. sp.
- „ *chiltoni*, n. sp.
- „ *cavernosus*, n. sp.
- „ *lobatus*, n. sp.
- „ *albolateralis*, n. sp.
- Burmoniscus kempi*, n. sp.

Genus *Paraperiscyphis*, Stebbing.

1911. *Paraperiscyphis* Stebbing, *Rec. Ind. Mus.*, vol. VI, p. 184.

Paraperiscyphis stebbingi, Cllge.

1914. *Paraperiscyphis stebbingi*, Collinge, *Rec. Ind. Mus.*, vol. X, p. 207,
pl. xxiv, figs. 1-10.

Habitat.—Kavalai, 1300-3000 ft., Cochin State, 24-27-ix-1914.
No. 838 (F. H. Gravelly).

This is an additional record for this interesting species.

I find that in describing this species I made a most unfortunate slip in the diagnosis wherein it was stated (p. 207) "2-jointed flagellum, the first joint longer than the second," and again on p. 208 the error was repeated. In *P. stebbingi* the first joint of the flagellum is *not longer than the second*, but as correctly figured (cf. pl. xxix, figs. 1 and 2).

Paraperiscyphis gigas (Collge.).

1915. *Periscyphis gigas*, Collinge, *Rec. Ind. Mus.*, vol. XI, p. 148, pl. ix, figs. 1-10.

The form of the uropoda, which is a character of the very greatest importance in the classification of this and allied genera, will necessitate the removal of this species to the genus *Paraperiscyphis*.

Paraperiscyphis pulcher, n. sp.

(Pl. ix, figs. 1-5).

Body oblong oval, dorsal face strongly convex, surface irregular but smooth. Cephalon (fig. 1) small, flanked by the lateral plates of the first segment of the mesosome, lateral lobes well developed, median lobe represented by slight median expansion of the anterior margin; epistoma carinate. Eyes subdorsal. Antennulae (fig. 2) small, 3-jointed, distal joint with terminal style and indented on the inner side. Antennae (fig. 3) moderately stout, joints 2-4 subequal, 5th joint the longest; flagellum 2-jointed, with the first joint shorter than the second which has a fine terminal style. Uropoda (fig. 4) extending beyond the telson, basal plate short and stout with antero-dorsal surface expanded, convex dorsally, concave ventrally; exopodite and endopodite extending beyond the basal plate, both articulating on the inner margin, exopodite flat and blade-like, endopodite three-sided. Telson (fig. 5) obtusely triangular, dorsal surface convex, irregular and smooth. Length 14.5 mm. $\times$ 7 mm. Colour (in alcohol) greyish-green ground colour with small irregular blackish spots on the posterior border of each mesosomatic segment, in the median line on each mesosomatic and metasomatic segment is a yellowish spot, lateral to this an irregular yellowish marking, and still more laterally another spot, which together give the appearance of five broken lines.

Habitat.—Peradeniya, Ceylon, 28-v-1910. No. ²⁶⁹³₁₆ (F. H. Gravely).

Type.—In the collection of the Indian Museum.

The form of the cephalon, antennae and uropoda separate this handsome species from any other member of the genus. There being only a single example, I have not attempted any examination of the mouth-parts.

Paraperiscyphis scabrūs, n. sp.

(Pl. ix, figs. 6—10).

Body oblong oval, dorsal face strongly convex, richly tuberculated. Cephalon (fig. 6) small, flanked by the 1st segment of the mesosome, lateral lobes well developed, median lobe small and confluent with carina of epistoma. Eyes subdorsal. Antennulae (fig. 7) small, 3-jointed, distal joint terminating as a cone. Antennae (fig. 8) with joints 2 and 3 subequal, 4th joint nearly twice as long and 5th nearly three times as long; flagellum 2-jointed, with the first joint shorter than the second which has a fine terminal style. Whole of appendage sparsely covered with short bluntly ending setae. Uropoda (fig. 9) extending beyond the telson, basal plate short and stout, with antero-dorsal surface expanded, convex dorsally with thickened antero-dorsal margin bounding the antero-dorsal surface, concave ventrally with groove; exopodite and endopodite both extending beyond the basal plate and articulating on the inner margin. Telson (fig. 10) obtusely triangular, dorsal surface convex, tuberculated. Length 11.5×6 mm. Colour (in alcohol) greenish-brown with yellowish mottling.

Habitat.—Peradeniya, Ceylon. No. 2333 (F. H. Gravely).

Type.—In the collection of the Indian Museum.

In the form of the telson and uropoda this species shows a relationship to *P. pulcher*, but is separated by the striking difference in the shape and development of the lateral and median lobes of the cephalon, there are also well-marked differences in the form of the antennulae and antennae.

Genus *Cubaris*, Brandt.

The widely conflicting opinions held as to the position of this genus afford a typical instance of the very unsatisfactory state of the classification of the Terrestrial Isopoda.

Brandt's description¹, though brief, is quite clear, and the slight modifications suggested by Miers² in 1877 scarcely affect it. Budde-Lund³ in his 'Revision' p. 36, under the Family Oniscidae, subfamily 7 Oniscinae, Tribe 1 Armadilloidea, cites the genus *Armadillo*, Dum., and under Tribe 2 Oniscoidea, the genus *Armadillidium*, Brandt, and from the later text we gather that the genus *Cubaris* is sunk as a synonym of *Armadillo*. In 1910⁴ (p. 9) the genus is recognized and appears between *Armadillo*, Dum., and *Pericephalus*, B.-L., whilst in 1912⁵ it is regarded by him as a subgenus only, in the subfamily Oniscinae.

¹ Bull. Nat. Hist. Soc. Moscow, 1833.

² Proc. Zool. Soc. Lond., 1877.

³ Rev. Crust. Isop. Terr., 1904.

⁴ Sjöstedts Kilimandjaro-Meru Exped. 21 Crust. 2 Isop., 1910.

⁵ Trans. Linn. Soc. Lond. (Zool.), 1912.

This author's attempts at classification were frequently unfortunate, as in the present instance. He approached more closely to a sound classification perhaps in 1910 than in any of his previous or later writings, but did not seem able to decide upon any system or parts, other than the oral appendages, which frequently misled him.

I hope at a later date, when more of the Indian and Asiatic species have been worked out, to submit a revision of the Family Armadillidiidae founded upon structural characters, in the meantime I am provisionally placing all the Indian forms in the one genus.

Cubaris gravelii, n. sp.

(Pl. x, figs. I—II).

Body oblong oval, slightly convex, smooth. Cephalon (figs. 1 and 2) small, strongly marginate anteriorly and posteriorly, lateral lobes small, median lobes absent; epistoma vertical with triangular-shaped depression in the medio-anterior line. Antennulae (fig. 3) small, 3-jointed, terminal joint pointed with number of fine setae laterally, proximal joints globose, distal joint attenuated. Antennae (fig. 4) short, sparsely setaceous, joints 3—5 slightly grooved on their outer side; flagellum 2-jointed, the distal joint being the longer. First maxillae (fig. 5), outer lobe terminating in four stout incurved spines and four smaller inner ones. Second maxillae (fig. 6) thin and plate-like, terminating distally in a bilobed manner, the outer lobe is fringed with setae, and those on the inner one form a brush-like lobe. Segments of the mesosome convex, lateral plates of 2nd to 4th segments slightly excavate, remainder truncate, posterior angles only slightly produced backwards. Segments 1 and 2 with notch and groove on their lower inner margins for reception of succeeding segments (fig. 7). Maxillipedes (fig. 8), outer palp terminates in a multispinous process on the outer side, with a very small spine and then two larger ones below it, from the base of the outer palp are three large spines, the inner palp is very broad and has two spines with wide bases, and one short, blunt, tooth-like one on the innermost border and a longer pointed one on the lower margin. Uropoda (figs. 9 and 10) not extending beyond the telson, basal plate narrow posteriorly, thickened and convex dorsally, antero-dorsal surface prominent; exopodite articulating in deep groove on the inner border of the basal plate, which here is slightly excavate, endopodite setaceous, with two long whip-like setae terminally. Telson (fig. 11) longer than the breadth at the posterior margin which is slightly curved, expanded anteriorly, somewhat flattened. Length 12 mm. Colour (in alcohol) dark horny-brown with few lighter lateral flecks on the mesosomatic segments.

Habitat.—Pass. between Chaibassa and Chakardharpur, Chota Nagpur, 24-iii-13. No. $\frac{2601}{10}$ (F. H. Gravelly).

Type.—In the collection of the Indian Museum.

The species is named in compliment to Mr. F. H. Gravely.

The antennules here differ strikingly from any other species of *Cubaris* I know of. The mouth-parts are typical of the genus. The tooth on the underside of the lateral plate of the first mesosomatic segment is small, being just large enough to overlap the anterior wall of the groove on the second segment. The uropoda have a prominent antero-dorsal surface on the basal plate and the postero-dorsal portion is strongly convex, ventrally the plate is almost flat. Below the point of articulation of the exopodite is a small groove, and the inner border of the basal plate is slightly excavate. The length of the telson is greater than the breadth of the posterior margin.

Cubaris expansus, n. sp.

(Pl. xi, figs. 1—10).

Body broadly oval, strongly convex, almost smooth. Cephalon (figs. 1 and 2) small, marginate anteriorly, lateral lobes very small, median lobes absent; epistoma almost vertical. Eyes situated dorso-laterally. Antennulae (fig. 3) small, 3-jointed, terminal joint pointed with eight blunt setae, proximal joint the smallest. Antennae (fig. 4) short, covered with fine setae, 2nd to 4th joints grooved on their outer side; flagellum 2-jointed, distal joint nearly twice as long as the proximal one. First maxillae (fig. 5), outer lobe terminates in four stout incurved spines and six smaller ones; inner lobe terminally rounded, with two setose spines. Segments of the mesosome strongly convex, lateral plates of 2nd and 3rd segments slightly excavate, remainder truncate, posterior angles very slightly produced backwards. Segments 1 and 2 with notch and groove on their lower inner margins for reception of succeeding segments (fig. 6). Maxillipedes (fig. 7), the outer palp terminates in a multispinous process on the outer side, with two prominent spines below it, the inner palp possesses two spines with wide bases, then a fine marginal spine and one short blunt tooth-like one on the innermost border. Uropoda (figs. 8 and 9) not extending beyond the telson, basal plate narrower posteriorly than anteriorly, posterior margin almost straight, dorso-antero-lateral surface prominent; exopodite small, articulating on the inner border of the basal plate, which is here raised in a boss, endopodite setaceous, two and a half times the length of the exopodite, articulating at the top of the inner border of the basal plate. Telson (fig. 10) longer than the breadth at posterior margin which is almost straight, expanded anteriorly with slight concavity in the median line. Length 13.5×6.5 mm. Colour (in alcohol) horny-brown with lighter lateral flecks on the mesosomatic segments.

Habitat.—Barkuda I., Chilka L., Ganjam Dist., Madras Pres., 16-vii-14. No. 813.

Type.—In the collection of the Indian Museum.

C. expansus is characterized by the broadly oval body, the series of eight blunt setae on the inner border of the distal joint of

the antennulae and the form of the uropoda. The tooth on the underside of the lateral plate of the first mesosomatic segment is fairly long and pointed and overlaps the anterior wall of the somewhat flattened groove of the second segment.

Cubaris dilectum, n. sp.

(Pl. xii, figs. 1—9).

Body oblong oval, convex, finely tuberculate. Cephalon (figs. 1 and 2) small, strongly marginate anteriorly and posteriorly, lateral lobes small, median lobes absent; epistoma almost vertical, slightly depressed laterally. Antennae (fig. 3) situated rather low on the epistoma, sparsely setaceous, somewhat attenuate; flagellum 2-jointed, the distal joint being the longer. First maxillae (fig. 4), outer lobe terminating in four stout incurved spines and six smaller inner ones. Segments of the mesosome convex, lateral plates of 2nd to 5th segments slightly excavate, remainder truncate, posterior angles only slightly produced backwards. Segments 1 and 2 with notch and groove on their inner margins for reception of succeeding segments (fig. 5). Maxillipedes (fig. 6), outer palp terminates in a broad multispinous process on the outer side and a single large pointed one below it, from the base of the outer palp are two large spines, the inner palp is broad and has three pointed marginal spines and one short, blunt, tooth-like spine on the innermost border. Uropoda (figs. 7 and 8) extend very slightly beyond the telson, basal plate narrow posteriorly, thickened and strongly raised, convex dorso-laterally, antero-dorsal surface expanded, strongly marginate; exopodite large and extends slightly beyond the basal plate, endopodite setaceous, broad and slightly flattened, with three long whip-like setae terminally. Telson (fig. 9) longer than the breadth at the posterior margin which is slightly curved, sides only very slightly incurved, expanded anteriorly. Length 8 mm. Colour (in alcohol) fawn with irregular light and dark brown mottling.

Habitat.—Kalimpong, Darjiling District, E. Himalayas, 600—4500 ft. No. 9187 (F. H. Gravely).

Type.—In the collection of the Indian Museum.

This beautifully marked species differs from any other described form in a number of important characters. The tooth on the underside of the lateral plate of the first mesosomatic segment is large and truncate, and works in a slight groove in the anterior wall of the groove of the second segment. The exopodites of the uropoda extend beyond the telson and the antero-dorsal surface is unusually deep.

Cubaris pusillus, n. sp.

(Pl. xiii, figs. 1—10).

Body oblong oval, strongly convex, smooth. Cephalon (figs. 1 and 2) small, but rather long, strongly marginate, lateral lobes

small, median lobes absent; epistoma vertical. Eyes prominent, situated dorso-laterally. Antennae (fig. 3) sparsely setaceous, 2nd to 5th joints deeply grooved on their outer sides; flagellum 2-jointed, the distal joint being twice the length of the proximal one. First maxillae (fig. 4), outer lobe terminating in four stout incurved spines and five smaller ones; inner lobe terminally rounded with two large setose spines. Second maxillae (fig. 5) thin and plate-like, terminating distally in an inner setaceous lobe and an outer tooth-like plate with three ridges of setae. Segments of the mesosome convex, with posterior margins prominent, lateral plates of 2nd to 5th segments slightly excavate, remainder truncate, posterior angles very faintly developed. Segments 1 and 2 with notch and groove on their inner margins for reception of succeeding segments (fig. 6). Maxillipedes (fig. 7), outer palp elongated, terminating in a multispinous process with three longer spines on the outer side and three on the inner side, inner palp also elongated, with three marginal spines and one blunt tooth-like spine on the innermost border. Uropoda (figs. 8 and 9) not extending beyond the telson, basal plate narrow posteriorly, thickened, convex dorso-laterally, antero-dorsal surface expanded, concave, strongly marginate; exopodite small and bluntly pointed, endopodite setaceous, also bluntly pointed. Telson (fig. 10) longer than broad at the posterior margin which is very slightly curved, sides faintly incurved, expanded anteriorly. Length 5.5 mm. Colour (in alcohol) variable, bluish-black to a horny-brown.

Habitat.—Kas, Satara Dist., Bombay Pres., 3700 ft., 23–24. iv-1912. No. 8939 (*F. H. Gravely*).

Type.—In the collection of the Indian Museum.

This is a very distinct species and the type of an interesting group. The head is longer than in most species. The antennae are characterized by the unusually deep grooves on the inner sides of joints 2, 3 and 4. The second maxillae are quite unlike those of any other described member of the genus. The tooth on the underside of the lateral plate of the first mesosomatic segment is small, but stands out some little distance, overlapping the groove of the second segment. The uropoda have a deep antero-dorsal surface and small exopodite.

Cubaris brunneocaudatus, n. sp.

(Pl. xiv, figs. 1–10).

Body oblong oval, strongly convex. Cephalon (figs. 1 and 2) small with posterior margin slightly raised, lateral lobes small, median lobe absent; epistoma vertical. Eyes fairly large, situated dorso-laterally. Antennulae (fig. 3) small, 3-jointed, with few stout setae on the terminal joint. Antennae (fig. 4) deeply grooved on the outer side of joints 3–5; flagellum 2-jointed, distal joint two and a half times as long as the proximal one. First maxillae (fig. 5), outer lobe terminates in four stout incurved spines

and six smaller ones. Segments of the mesosome strongly arched, lateral plates of 2nd to 5th segments slightly excavate, remainder truncate, posterior angles only slightly developed. Segments 1 and 2 with notch and groove on their inner margins for reception of succeeding segments (fig. 6). Maxillipedes (fig. 7), the outer palp terminates in a multispinous process on the outer side with two large spines at its base, internal to the process are three pointed spines, the inner palp appears to be thrown into three folds with a marginal tooth-like spine on the outer border of each and a longer spine on the inner border of the most dorsal fold. Uropoda (figs. 8 and 9) not extending beyond the telson, basal plate narrow posteriorly, thickened, convex dorso-laterally, antero-dorsal surface expanded, concave with raised margin ventrally, the anterior margin forms a deep fold which is continued laterally on the outer border; exopodite small, not more than half the length of the endopodite, terminating in a finely pointed style, endopodite bluntly pointed, with three whip-like setae terminally. Telson (fig. 10), posterior margin broader than the length, sides faintly curved, expanded anteriorly. Length 10.5 mm. Colour (in alcohol) dark grey with the telson and uropoda a reddish-brown.

Habitat.—Tatkon, Burma, 6-ix-1914. No. 9151 (T. B. Fletcher).

Type.—In the collection of the Indian Museum.

This species in the form of the cephalon and uropoda exhibits a slight relationship with *C. solidulus*, Clge., but differs from that species in the form of the antennulae, antennae, and maxillipedes and the strongly arched body. There are also well marked differences in the shape of the tooth and groove on the under side of segments 1 and 2.

Cubaris chiltoni, n. sp.

(Pl. xv, figs. 1—11).

Body oblong oval, slightly convex, finely punctulated. Cephalon (figs. 1 and 2) small with posterior margin slightly raised, lateral lobes distinct, median lobe absent; epistoma medianally convex. Antennae (figs. 3 and 4) with the outer side of the joints 2—5 almost flat; flagellum 2-jointed, distal joint two and a half times as long as the proximal one. First maxillae (fig. 5), outer lobe terminates in four stout incurved spines and six rather long thin ones; inner lobe short, rounded terminally, with two setaceous spines. Second maxillae (fig. 6) thin, plate-like, terminating distally in an inner lobe with short stout setae on the inner side and long fine setae on the outer side, and an outer tooth-like plate. Segments of the mesosome slightly convex, lateral plates of 2nd to 5th segments slightly excavate, remainder truncate, posterior angles produced backwards. Segments 1 and 2 with notch and groove on their inner margins for reception of succeeding segments (fig. 7). Maxillipedes (fig. 8), the outer palp terminates in a multispinous process on the outer side external to which is a small spine and two internal to it and a further two at the inner border, the inner

palp shows three folds with two curved spines on the outer border of the ventral one and a longer spine on the margin of the most dorsal fold. Uropoda (figs. 9 and 10) not extending beyond the telson, basal plate narrow posteriorly, thickened and slightly convex dorso-laterally, antero-dorsal surface expanded, ventrally almost flat; exopodite small, half the length of the endopodite, terminating bluntly, no style, endopodite bluntly pointed with whip-like setae. Telson (fig. 11), posterior margin almost straight and shorter than the length, sides curved, anterior portion expanded, and convex dorsally. Length 9 mm. Colour (in alcohol) blackish-brown with lighter irregular markings laterally and as a broken median line on the mesosome.

Habitat.—Puenjikara I., nr. Ernakulam, Cochin State, ix-1914. No. 808 (F. H. Gravely).

Type.—In the collection of the Indian Museum.

C. chiltoni is allied to *C. brunneocaudatus*, agreeing with this last mentioned species in the form of the mouth-parts and in a lesser degree the uropoda. It differs, however, in the shape of the cephalon, antennae, maxillipedes, uropoda, and telson, as also in the more depressed form of the body and in the form of the notch and groove on the underside of segments 1 and 2. Most species of *Cubaris* show the peduncular joints of the antennae grooved on the outer side, but in *C. chiltoni* these grooves have become widely expanded, so that the outer side of the joints 2—5 are almost flat, in section exhibiting a form as shown in figure 4 (pl. xv):

I have much pleasure in associating with this interesting species the name of Professor Charles Chilton, to whom we are indebted for his valuable work on the Isopoda and other Crustacea of New Zealand.

Cubaris cavernosus, n. sp.

(Pl. xvi, figs. 1—9).

Body oblong oval, convex dorsally with faintly rugose lateral patches on the mesosomatic segments. Cephalon (figs. 1 and 2) small, lateral lobes fairly well developed, median lobe absent; epistoma depressed laterally and in the medio-dorsal portion. Eyes very small, occasionally one or both imperfect. Antennules (fig. 3) 3-jointed, with lateral setae on the distal joint. Antennae (fig. 4) rather slender, joints 2—5 slightly grooved, setae small and fine; flagellum 2 jointed. First maxillae (fig. 5), outer lobe terminates in five stout curved spines and four smaller ones, inner lobe truncate terminally with two short setose spines. Segments of the mesosome convex, lateral plates of 2nd to 5th segments excavate, 6th and 7th very slightly so, posterior angles of 2nd—5th segments only very faintly developed. Segments 1 and 2 with notch and groove on their inner margins for reception of succeeding segments (fig. 6). Maxillipedes (fig. 7), the outer palp terminates in a multispinous process on the outer side, at its base is a small upright

spine and three directed outwards, still more internally there are three fine spines; the inner palp has a single long marginal spine and two blunt tooth-like ones. Uropoda (fig. 8) not extending beyond the telson, basal plate narrow posteriorly, thickened and slightly convex dorso-laterally, antero-dorsal surface expanded obliquely; exopodite extending to the end of the basal plate, terminally truncate with short style, endopodite large, with two long whip-like setae terminally and numerous long setae elsewhere. Telson (fig. 9) slightly longer than the breadth of the posterior margin, which is almost straight, sides faintly curved. Length 10.5×5.5 . Colour (in alcohol) tawny-yellow.

Habitat.—Caves near Cherrapunji, Assam, ca. 4000 ft., 31-X-1914. No. 8933 (R. Friel).

Type.—In the collection of the Indian Museum.

The eyes in this species are present in varying degrees of complexity. Sometimes they are represented by two or three pigmented facets with others in which there is no pigment, in other cases the facets are imperfect, the eye being represented by irregular-shaped pigment spots.

Cubaris lobatus, n. sp.

(Pl. xvii, figs. 1—11).

Body oblong oval, strongly convex, anterior margin deflected backwards. Cephalon (figs. 1 and 2) small, lateral lobes well developed, median lobe absent; epistoma sunken laterally with raised medium portion. Eyes large, situated dorso-laterally. Antennulae (fig. 3) longer than usual, 3-jointed, the terminal joint has a number of lateral setae and the 2nd joint a short spine on the inner side. Antennae (fig. 4) rather longer than usual, joints 2—5 grooved on their outer sides; flagellum 2-jointed, distal joint nearly three times as long as the proximal one, terminally there is a style. First maxillae (fig. 5), outer lobe terminates in four stout incurved spines and six smaller ones, inner lobe terminally rounded, with two setose spines. Second maxillae (fig. 6) thin and plate-like, outer lobe tooth-like, inner lobe terminating in a dense mass of fine setae. Segments of the mesosome strongly convex, lateral plates of 2nd to 5th segments excavate, remainder truncate, posterior angles very faintly developed. Segments 1 and 2 with notch and groove on their lower inner margins for reception of succeeding segments (fig. 7). Maxillipedes (fig. 8), outer lobe terminating in a multispinous process, external to this is a small curved spine and one large one and four short ones internally, on the ventral side a very large spine arises from the base of the lobe, the inner lobe has two stout curved tooth-like spines and a single fine one; arising from the basal segment are two long stout spines. Uropoda (figs. 9 and 10) not extending beyond the telson, basal plate narrow posteriorly, thickened, convex dorso-laterally, antero-dorsal surface expanded, oblique, with raised margin ven-

trally; exopodite small, articulating slightly away from the inner margin, endopodite stout, setose, terminating in three stout whip-like setae, which exhibit a series of spiral markings. Telson (fig. 11), posterior margin slightly broader than the length, sides faintly curved, expanded anteriorly, slightly raised in the median line. Length 9 mm. Colour (in alcohol) brown with light broken median line and yellowish mottling laterally.

Habitat.—Parambikulam, 1700—3200 ft., Cochin State, 16—24-ix-1914. No. 2382 (F. H. Gravely).

Type.—In the collection of the Indian Museum.

Cubaris lobatus exhibits a number of features not found in the majority of known species of the genus, thus the lateral lobes of the cephalon are well developed, the antennulae and antennae are longer than usual, and the maxillipedes differ markedly in detail.

Cubaris albolateralis, n. sp.

(Pl. xviii, figs. 1—12).

Body oblong oval, strongly convex, smooth, with a small lateral indentation on each side of all of the mesosomatic segments. Cephalon (figs. 1 and 2) small, with posterior margin raised, lateral lobes feebly developed, median lobe absent, dorsal surface with raised lateral lines; epistoma dorsally sloping backwardly, otherwise almost vertical. Eyes dorsal. Antennulae (fig. 3) 3-jointed, proximal joint attenuated at its base, distal joint with number of lateral setae on the inner border. Antennae (fig. 4) short and stout, 2nd to 5th joints deeply grooved on their outer sides; flagellum 2-jointed, distal joint three times the length of the proximal one, terminally there is a short style. First maxillae (fig. 5), outer lobe terminates in four stout curved spines and six smaller ones, inner lobe rounded terminally with two long curved setose spines. Second maxillae (fig. 6) thin and plate-like, terminating distally in an inner setaceous lobe and an outer tooth-like plate. Segments of the mesosome strongly convex, each has laterally a small indentation (fig. 7), lateral plates of 2nd to 4th segments slightly excavate, remainder truncate or almost so, posterior angles only slightly produced backwards. Segments 1 and 2 with notch and groove on their inner margins for reception of succeeding segments (fig. 8). Maxillipedes (fig. 9), outer lobe terminates in a multispinous process and four inner fine pointed spines, the inner lobe has a tooth-shaped spine on its outer and inner border and two longer pointed spines. Uropoda (figs. 10 and 11) not extending beyond the telson, basal plate narrow posteriorly, terminally blade-like, thickened and slightly convex dorso-laterally, antero-dorsal surface expanded, ventrally the outer border shows a flattened rim and blade-like posterior margin; exopodite small with terminal style, situated on the inner lateral margin of the basal plate, which is obliquely flattened, endopodite large, with two long whip-like setae terminally, setose elsewhere, in section triangular.

Telson (fig. 12), posterior margin almost straight and broader than the length, sides curved, anterior portion expanded, convex dorsally. Length 8 mm. Colour (in alcohol) greyish-green, dorsally with few lateral irregular yellowish markings, yellowish below the indentations.

Habitat.—Under stones, Kamalapuram, S. India, 6-ix-1912. No. 2111 (T. B. Fletcher).

Type.—In the collection of the Indian Museum.

There are a number of important characters in this species by which it differs from any other members of the genus, amongst these may be mentioned the dorsal position of the eyes and the very feeble development of the lateral lobes of the cephalon, the short, thick-jointed antennae, the broad maxillipedes, the truncate lateral plates of the 5th—7th mesosomatic segments, and the form of the uropoda.

Genus *Burmoniscus*, Cllge.

Hitherto this genus has been known only from the two examples of *B. moulmeinensis*, Cllge.,¹ obtained by Mr. F. H. Gravely, from the Farm Caves, near Moulmein.

With so limited a supply of material the description of the genus was perforce somewhat imperfect, and I am now able to give a fuller diagnosis, and at the same time add an additional species to the genus.

B. moulmeinensis, and *Philoscia coeca*, Budde-Lund², have hitherto been the only cavernicolous species of Terrestrial Isopoda known from India, indeed only very few have been described from Asia. Ridley³ mentions *Armadillo intermixtus*, Budde-Lund, as being common on the walls of caves in the Malay Peninsula, and Budde-Lund⁴ describes with that species *A. nigromarginatus* from the same locality. He has also described⁵ an *Armadillo infuscatus* from the same source.

In all probability there are a considerable number of species awaiting discovery, especially belonging to the genus *Cubaris*. Just as in Europe we have a large Isopodean cave fauna⁶ belonging to the Trichoniscidae, so, I think, we shall find a similar one in India referable to the Cubaridae.

Burmoniscus, Cllge.

1914. *Burmoniscus*, Collinge, *Rec. Ind. Mus.*, vol. VIII, p. 406, pl. xxxi.

Body oblong oval, dorsal surface strongly convex, perfectly smooth and shiny. Cephalon small, emarginate, median and lateral lobes absent. Eyes absent, may be represented by pigmented

¹ *Rec. Ind. Mus.*, 1914, vol. VIII, p. 466.

² *An. Mus. Civ. Stor. Nat. Genova*, 1894, s. 2, vol. XIV, p. 617.

³ *Brit. Assocn. Rpt.*, 1898, p. 581.

⁴ *Rev. Crust. Terr. Isop.*, 1899, pp. 126, 127.

⁵ *Proc. Zool. Soc. Lond.*, 1902, p. 380.

⁶ Racovitz, *Arch. Zool. exp. e. gén.*, 1907, t. 7 and 1909, t. 9.

areas. Antennae slender, elongated, joints grooved on their outer sides, with 3-jointed flagellum. First maxillae, outer lobe terminates in four stout curved spines and four finer inner ones which latter have bifurcated ends. Second maxillae thin and plate-like, the inner one terminating in a brush of fine setose spines. Segments of the mesosome strongly convex, the lateral plates of 1 to 4 slightly overlap one another posteriorly, whilst those of 5 and 7 are produced backwardly, especially the 7th. Maxillipedes poorly developed, with the inner lobe the larger. Metasome narrow, lateral plates small and slightly incurved. Uropoda with elongated, somewhat flattened basal plate, which extends beyond the telson; exopodite long and pointed, endopodite elongated. Telson very short and broad, terminally rounded or pointed.

Although I have carefully examined a number of specimens I have not so far been able to find any antennules. Apart from the maxillae, the mouth parts are of little value here for purposes of generic distinction.

Respecting the affinities of this genus it is not possible to say much, as our knowledge of the Indian and Asiatic Terrestrial Isopoda is, as yet, so fragmentary. In the form of the cephalon, the mesosome, and metasome and the uropoda, *Burmoniscus* undoubtedly shows a remote relationship with *Philoscia*, at least the Asiatic *Philoscias*, although these also are, as yet only imperfectly understood.

Burmoniscus kempfi, n. sp.

(Pl. xix, figs. 1—8).

Body oblong oval, dorsal surface convex, smooth and shiny. Cephalon (figs. 1 and 2) larger than in *B. moulmeinensis*, Clig., and partly flanked by the lateral plates of the 1st segment of the mesosome, emarginate, median and lateral lobes absent; epistoma almost vertical. Eyes absent. Antennae (fig. 3) slender and elongated, especially the 4th and 5th joints, peduncular and flagellar joints grooved on their outer sides, flagellum 3-jointed, terminal joint with long fine style. First maxillae (fig. 4), outer lobe terminates in four stout curved spines and four inner ones deeply bifurcated, inner lobe rounded terminally with two setose spines. Second maxillae (fig. 5) thin and flexible, somewhat thicker on the inner side, on the outer side it is produced into a thin plate with radiating thickened arms, anteriorly terminating as a flattened tooth, and a smaller one on the inner side, between the two the inner lobe forms a brush-like mass of setae. Maxillipedes (fig. 6) poorly developed, the inner lobe the larger. Uropoda (fig. 7) with elongated, somewhat flattened basal plate which extends beyond the telson, grooved dorsally between points of articulation of exopodite and endopodite; exopodite long, stout, and slightly ridged dorsally on the outer side, endopodite elongated, and comparatively not so stout. Telson (fig. 8) short with the posterior

margin rounded. Length 7.5 mm. Colour (in alcohol) light brown with darker pigmented network.

• *Habitat*.—Maosmai Cave, Cherrapunji, Assam, ca. 4000 ft., x-1914. No. 8913 (S. W. Kemp). Living in total darkness.

Type.—In the collection of the Indian Museum.

B. kempi differs from *B. moulmeinensis* in having a larger cephalon, in the more elongated form of the spines of the outer lobe of the 1st maxillae and in the form of the inner lobe also. The 2nd maxilla is quite unlike that in *B. moulmeinensis*, and the basal plate of the uropoda is narrower and more elongated, there is also a lateral ridge on the outside of the exopodite. The telson is very different, being shorter and rounded posteriorly.

This species is named in compliment to Mr. S. W. Kemp, by whom it was discovered, and whose work has added so largely to our knowledge of the Decapod and other Crustacea of India.

ERRATA.

In the previous "Contribution", *Rec. Ind. Mus.*, 1915. Vol. XI, Pt. II, No. 6, on pages 144, 149 and 151 under the descriptions of the antennae, the word *inner* should read *outer*.

XIII. NOTES ON INDIAN ODONATA.

By F. F. LAIDLAW.

Subfamily AGRIONINAE, Selys.

(= *Coenagrioninae*, Kirby).

Genus *Ischnura*, Charp.

Represented in the Indian Empire so far as is known by six species; one of these is possibly to be referred to a distinct genus when better known. Two species are of a wide distribution, the remainder probably have a restricted habitat.

The genus itself is a dominant member of the Agrionine group, and the Indian area therefore shows a high percentage of endemic species. *Ischnura* is one of the genera which appears to be poorly represented in equatorial regions, having a richer representation in tropical and especially N. temperate countries.

Ischnura senegalensis (Ramb.).

Micronympha senegalensis, Kirby, *Cat. Odonata*, p. 141 (1890).

Ischnura senegalensis, Ris, *Katalog des Odonata von Südafrika*, in L. Schultze, *Forschungseise im west. u. zent. Südafrika*, Jena 1908, p. 310.

" " Martin, *Mem. Soc. Zool. de France*, 1901, p. 246.

" " Tillyard, *Proc. Linn. Soc. N. S. Wales*, 1912, XXXVII, 3, p. 451.

34 ♂♂; 10 ♀♀ (isochromatic); 12 ♀♀ (heterochromatic), No. 237.

The isochromatic females were all taken in Calcutta on July 27th, 1914. They can be distinguished from the males only by careful scrutiny. Eighteen males were taken with them.

2 ♂♂, 4 ♀♀ are from the salt lake below Chingrighatta, Calcutta, 12-ii-15 (*F. H. Gravely*), No. ¹⁰⁹/_{H.T.}. 1 ♂ 1 ♀ Rangoon, No. ²⁴⁵/_{H.T.}. The remainder from Orissa, Puri District, Nos. ⁸²¹³/₂₀, ⁸²⁵¹/₂₀, ¹²⁹/_{H.T.}; Sar Lake, No. ¹¹⁶/_{H.T.}.

The species breeds in the Museum tank in Calcutta, and probably in Lake Chilka. The African and Oriental representative of a group of closely allied species whose distribution is well-nigh cosmopolitan.

Ischnura forcipata, Morton.

I. forcipata, Morton, *Trans. Ent. Soc. Lond.*, 1907, p. 306, pl. xxiv, figs. 1, 2, 3.

I. gangetica, Laidlaw, *The Entomologist*, Aug. 1913, p. 235, text-fig.

Not represented in the Museum collection.

A green (or blue) and black species readily distinguished from the other similarly coloured Indian species (*I. senegalensis*) by the pterostigma of the fore-wing which is much narrower in front than behind and has its hinder margin very strongly convex. In this respect it resembles *I. aurora*.

The female remains unknown. Length of abdomen ♂ 24 mm., hind-wing 15 mm. Recorded from Quetta (Morton) and Kumaon (Laidlaw).

Range probably restricted to the foot hills of the west and central Himalaya.

The type male of *I. gangetica* is in the British Museum.

Ischnura rufostigma, Selys.

Micronympha rufostigma, Kirby, Cat. Odonata, p. 143 (1890).

Ischnura rufostigma, Morton, Trans. Ent. Soc. Lond., 1907, p. 307 (?).

" " Laidlaw, Rec. Ind. Mus., VIII, 4, p. 344, pl. xvi, fig. 5.

2♂♂, 2♀♀, Calcutta, 4-i-15, No. ⁸⁵²⁹/₂₀.

The female has not been described (see note under *I. inarmata*). Pterostigma dull gray.

Head, prothorax and thorax as in the male, but with a duller ground colour.

Abdomen rather stouter than in the male. Ground colour pale yellowish-brown, with a metallic black line on the dorsum of each of the segments, this line is moderately broad, pointed in front, and widening a little at the apex of each segment.

Range: Bengal, Assam, and doubtfully Kashmir (see note under *I. inarmata*, Calvert).

Ischnura inarmata, Calvert.

Ischnura inarmata, Calvert, Proc. Acad. Nat. Sci. Philadelphia, 1898, pp. 147-148, text-figs. 1, 2.

2♂♂, 1♀?, Kashmir, 1915 (H. T. Pease).

The female appears to have been taken at the same time and place with the males, and is in all probability con-specific.

It seems also to belong to the same species as 3♀♀ recorded by Morton from Kashmir (Trans. Ent. Soc. London, 1907, p. 307).

These specimens were however regarded by him as being possibly examples of *I. rufostigma*, Selys.

Against this view is the fact that the undoubted examples of females of *I. rufostigma* described in this paper are quite different in their colour characters, and also the probability that *I. rufostigma* has a more easterly distribution.

On the other hand Calvert describes a female specimen regarded by him as the female of *I. inarmata*, which also is quite distinct in colouring from the specimen before me, whilst it does not agree with Morton's specimens; it may be added that his account of the

female is very incomplete, no mention is made of the thoracic colouring.

Possibly the species has dimorphic females. In the absence of clearer evidence I propose to take this view. But of course *I. rufostigma* may have dimorphic females. I tabulate these female forms below:—

A. 1 ♀. Indian Museum.

Head as in male *I. inarmata*, but ground colour orange instead of blue.

Prothorax orange, with small paired black spots.

Thorax orange.

Abdomen, segments 1—3 orange, apex of 3 marked with black, remaining segments metallic black above.

B. 3 ♀♀. (Morton's specimens). "Like *Pyrrhosoma tenellum* (Villers), but thorax paler" (identical with A.?).

C. 3 ♀♀. (Calvert's specimens). Head coloured as in males. Dorsum of abdominal segments 1—10 dark metallic green, the articulations with narrow, yellow, transverse rings.

This species is recorded from Kashmir only.

Ischnura aurora, Brauer.

Micronympha aurora, Kirby, *Cat. Odonata*, p. 143 (1890).

Ischnura delicata, Martin, *Mem. Soc. Zool. de France*, 1901, p. 246.

" " Tillyard, *Proc. Linn. Soc. N. S. Wales*, 1907, XXXII (2), p. 384 seq.

2 ♂♂ 1 ♀, Nagpur, C. P., 1000 ft., Oct. 1914 (*E. D'Abreu*). In bad condition.

Range: India to Ceylon; Australia, not recorded from intermediate territory so far as I know.

Apparently not very common though widely distributed in India.

Ischnura ? nursei, Morton.

Ischnura ? nursei, Morton, *Trans. Ent. Soc. Lond.*, 1907, p. 306, pl. xiv, figs. 4, 5, 6.

A red and black species, unknown to me. The abdomen is described as being short and stout relative to that of other males of the genus; "segments 1—4 carmine, 5 lemon yellow, 6 yellowish in anterior half, remainder of abdomen metallic violet, posterior part of 10 and appendages reddish." The species differs from other *Ischnuras* in the absence of post-ocular spots and is referred by Morton to this genus with doubt. The pterostigma of the fore wing is diamond-shaped, bright carmine inwardly, paler exter-

Ischnura immsi, Laidlaw, *The Entomologist*, Aug. 1913, p. 236. Mr. Morton has pointed out to me (*in litt.*) that this species is identical with *Enallagma ? parvum*, Selys. My name is therefore merely a synonym of Selys' species to which I hope to refer in a later note.

nally, that of the hind wings small, yellow. Length of hind-wing 12 mm., of abdomen 16½ mm.

- Recorded from Deesa, Gujerat.

It is to be hoped that more examples of this very interesting species will be forthcoming before long.

Genus *Ceriagrion*, Selys.

Ceriagrion coromandelianum (Fabr.)

- Ceriagrion coromandelianum*, Kirby, *Cat. Odonata*, p. 154.
 " " " " Martin, *Odonot. Mission Pavie* (sep.), p. 18.
 " " " " Ris, *Abhandl. d. Senckenberg. Naturf. Gesellsch.*, XXXIX, p. 519.
 " " " " Morton, *Trans. Ent. Soc. London*, 1907, p. 308.
 " " " " Laidlaw, *Rec. Ind. Mus.*, VIII, p. 345, pl. xvi, figs. 8, 8a.

Many specimens, ♂ ♀. Kierpur, Purneah District, Bihar, 7—9-X-15
 (C. Paiva). No. ⁸⁵¹ H.J.

Many specimens, ♂ ♀. Maidan, Calcutta.

♂ ♀. Ernakulam, Cochin State, 11—14-X-14
 (F. H. Gravely). No. ⁴²²⁹ 20.

♂ ♀. Calcutta. Nos. ^{3150, 3350} 8, 20. } Labelled
 ♂ ♀. Sibsagar, Assam. Nos. ^{6325, 6326} 20, 20. } by de
 Selys.

Range: Ceylon, India, Burma, Indo-China (Sunda Islands, Celebes are also given as included in the range of the species by Martin, *loc. cit.*).

My figures of the anal appendages of the male are not satisfactory. They were drawn from a shrivelled specimen. Normally the inferior pair project directly backwards and slightly exceed the upper pair in length. Each member of a pair is curved inwards at its free extremity, the upper pair actually meeting in the middle line. The lower appendage has its free extremity more finely pointed than in the figure and tipped with black. Also when viewed directly from above the extremities of the lower pair can be seen projecting beyond the upper pair.

Ceriagrion rubiae, sp. nov.

2 ♂ ♂, 1 ♀. Chalakudi, Cochin State, 14-ix-14 (F. H. Gravely).
 No. ⁸²¹⁵ 20.

Length of abdomen: ♂ 26 mm., ♀ 27 mm.

hind-wing: ♂ 18 mm., ♀ 18.5 mm.

A small species in which the wing is petiolated to the level of the basal post-costal nerve; the wings are uncoloured, and the excision on the hinder margin of segment 10 of the male abdomen is small and rather bluntly angular.

Description: Post-costal nerves 10.

♂ Head rusty yellow, paler beneath; upper half of the eyes greenish-brown, lower half yellow.

Prothorax and thorax rusty yellow above, fading to pale yellow at the sides and underneath.

Abdomen entirely reddish-orange above and at the sides, yellow ventrally.

Legs yellow with black spines.

Anal appendages dark reddish-brown in colour, black at extremities. The upper pair are distant to each other and parallel, seen in profile they are a little narrowed basally so as to be somewhat club-shaped, each carries a fine black point distally, which is directed downwards. The lower pairs are larger, directed upwards and taper regularly to their apices. They lie internally to the upper pair. The excision on segment 10 is small and shallow, bluntly angular; barely one third as deep as the segment. The floor of the excision is formed by a shelf-like ridge which in the middle line has a small tongue-like projection directed backwards.

♀. Head greenish-brown above, paler below, eyes similarly coloured but of a greener tone.

Prothorax and thorax gray-green above, yellowish-white below.

Abdomen dull, greenish-brown above, paler below.

The species differs from the closely allied *C. erubescens*, Selys, chiefly as follows:—in colour; it is smaller, and the excision on segment 10 of the abdomen is bluntly angular, narrow, and its floor has the curious little tongue-like projection noted above. The anal appendages of the males of the two species differ in detail.

C. erubescens appears to be a more eastern species and I cannot find that it has been recorded from India. (See Ris, *Abhandl. d. Senckenberg. Naturf. Gesellsch.*, Bd. XXXIV, p. 519, taf. xxiii, figs. 13, 14).

The holotypes ♂ ♀ will be returned to the Indian Museum; paratype ♂ in my collection.

Ceriagrion olivaceum, Laidlaw.

Ceriagrion olivaceum, Laidlaw, *Rec. Ind. Mus.*, VIII, 1914, p. 345
pl. xvi, fig. 9.

This is the largest of the four species recorded from the Indian Empire. It appears to be confined to Upper Burma and Assam.

A female specimen from Nurbong, Assam, sent to me by Mr. Stevens, has only 12 post-nodal nerves on the fore-wings.

Like the other Indian species it has the wings petiolated to the level of the basal post-costal nerve.

Ceriagrion cerinorubellum (Brauer).

Ceriagrion cerinorubellum, Kirby, *Cat. Odonata*, p. 154.
" " " " Krüger, *Stettin Entomol. Zeit.*, 1898, p. 119.
" " " " Ris, *loc. cit.*, p. 519.

9 ♂♂. Kierpur, Purneah District, Bihar, 19-ix-15 (*C. Paiva*)
"resting on weed in stream." Nos. ⁸⁶²H.T., ⁸⁶²H.T.

The description given by de Selys of this insect scarcely does justice to its beautiful colouring which is well preserved in spirit specimens. The head, prothorax and thorax are a rich dark olive green above, passing on the sides to a beautiful shade of blue.

The first three segments of the abdomen and the last three are of a beautiful cherry red colour, the intermediate segments being intense black.

Range: Ceylon, India, Burma, Malay States, Sumatra, Borneo.

A number of the larvae of *C. coromandelianum* (Fabr.) were taken in the Museum tank, and were hatched out in the Museum (No. 1188). The larva shows, especially in the structure of the anal lamellae, considerable differences from the larva of such a genus as *Pseudagrion*. The following is a brief account:—

Body sandy yellow or brown in colour. Total length about 20 mm. including the anal lamellae.

Head broad, flat. I can find no indication of the transverse frontal ridge of the adult.

Mask when folded just reaching base of second pair of legs. Its outer margin carries about 6 or 7 short stout spines along its



distal half. On either side of the middle line is an oblique row of 5 setae, diverging distally; the outermost being by far the largest. Anterior margin of mask bluntly angular. The palpi each bear 7 long setae in addition to the moveable hook (see fig. 1). The length of each of the middle pair of legs is about 7 mm.

FIG. 1.—Mask of larval form of *Ceragrion coromandelianum* (Fabr.).

The abdomen is cylindrical and tapers very gradually backwards. Each of the segments has a ring of short blunt setae set around its hinder margin, and each of the last five segments has in addition a pair of similar setae dorsally, one on either side of the middle line near the end of the segment. The pair on segment 10 are much more remote from each other than those on the other segments.

The anal lamellae (gills) are leaf-like, ob-lanceolate; 4—5 mm. long, 1.5 mm. wide, in one or two individuals acuminate but more often irregularly rounded at the apex. They are not jointed nor marked with a transverse fold, but the basal half is stouter and more strongly chitinized than the apical part.

Each has two stout, main tracheal tubes forming as it were a mid-rib from which a large number of branches run outwards increasing the resemblance to a leaf.

In the lateral pair of lamellae the mid-rib lies nearer to the ventral than to the dorsal margin, in the central lamellae the reverse condition obtains.

In each lateral lamella the basal two-fifths of the mid-rib bears a row of chitinous teeth on its outer side. In the central

lamella there is a similar row of equal extent on both sides of the mid-rib.

Lastly, on the ventral margin of the outer pair, and on the dorsal margin of the central lamella there lies another row of teeth also extending from the base for about two-fifths of the total length of the lamella.

Subfamily *GOMPHINAE*, Rambur.

Genus *Davidius*, Selys.

Davidius aberrans (Selys).

Hagenius (?) aberrans, Selys, *Bull. Acad. Belg.*, (2) XXXVI, p. 506 (1873); Kirby, *Cat. Odonata*, p. 75.

Davidius ? zallorensis, Selys, *l.c.*, (2) XLVI, p. 667 (1878); Kirby, *l.c.*, p. 75.

Davidius aberrans, *D. zallorensis*, Williamson, *Proc. U. S. Nat. Mus.*, XXXIII, 1907, pp. 286-287.

See also Selys, *Ann. de la Soc. Entom. de Belgique*, XXXVIII, 1894, p. 175.

1 ♀. Binyar, Kumaon, 7700 ft., 24-V-1912. (A. D. Imms)
For. Zool. Mus.

I have compared this specimen with the descriptions of *D. aberrans* and of *D. zallorensis* and can find no grounds for separating the two species. In the specimen before me the triangle of the left fore-wing is free, that of the right is crossed by a single nerve. Both hind-wings have the triangle crossed.

Davidius davidii, Selys, subsp. *assamensis*, nov.

Davidius davidii, Selys, *Bull. Acad. Belg.*, (2) XLVI, 1878, p. 671.

1 ♂, 2 ♀♀. Gopal, Assam, 1914 (H. Stevens).

Length of abdomen ♂ 31 mm., ♀ 28 mm.

hind-wing ♂ 26 mm., ♀ 28.5 mm.

Distinguished from the type by its smaller size (*D. davidii* type: abdomen ♀ 34.35 mm., hind-wing 32.33 mm. Selys, *loc. cit.*), and absence of isolated superior antehumeral spots of cuneiform shape which occur in the type. The basal black band on the frons is not large.

The male differs from the female so far as colouring goes chiefly in having only the lower third of the mid-dorsal carina of the thorax coloured, and in having lateral spots on the first three segments only of the abdomen.

Anal appendages of male: Upper pair slender and rather horn-like, each with a stout downwardly curved, rounded, hook-like process projecting from near its base, scarcely visible in profile. The appendage itself is longer than the tenth segment. The lower appendage is shorter than the upper pair, triangular and deeply cleft in the middle line (see fig. 2a).

The male has the triangle of the left hind-wing crossed, the remaining triangle free.

The females have the triangles of the hind-wing crossed in every case. Those of the front wing free except in the case of the left fore-wing of the paratype where the triangle is crossed. The

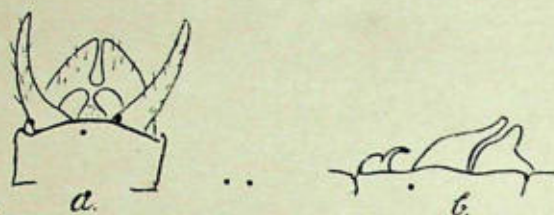


FIG. 2.—*Davidius davidi assamensis*, subsp. nov.

a. Anal appendages ♂ : b. Lateral view of genital structures on abdominal segment, 2 ♂.

genus *Davidius* ranges from China and Japan to N. India, Assam and Tonkin. The two species noted above are the only forms recorded from the Indian Empire.

The holotypes ♂ & ♀ will be deposited in the Indian Museum.

XIV. SOME LIGNICOLOUS BEETLE- LARVAE FROM INDIA AND BORNEO.

By F. H. GRAVELY, D.Sc., Asst. Superintendent, Zoological Survey
of India.

(Plates XX—XXII.)

While hunting for insects in dead wood my attention has from time to time been attracted by stages in the life histories of various beetles. Often the determination of the adult form into which a particular kind of larva will develop is a matter only to be determined by breeding. At other times the association of larvae, possessing definite family characteristics, with adults of the same family all belonging to one species, indicates the identity of the larvae with a high degree of probability. And when larvae and adults are associated with pupae, shown by their accompanying exuviae to have been derived from the former and by their form to be about to give rise to the latter, the probability becomes a certainty.

By one or other of the above means, the identity of various beetle larvae recently added to the Indian Museum collection has been established. The Bornean Passalid larvae described below were collected by Mr. J. C. Moulton, many of the South Indian Passalid larvae by Mr. T. Bainbrigge Fletcher, the Andaman Passalid larvae by Mr. M. C. Bonig and Mr. S. W. Kemp, and two species of the Lucanid larvae by Mr. S. W. Kemp. The rest were collected by myself. Whenever possible the specimens have been hardened before being placed in spirit by immersion either for a few minutes in boiling water, or (better) for an hour or two in Carnoy's fluid¹, as this helps to prevent blackening and collapse of the tissues.

I have thought it best to refrain at present from attempting to prepare an account of the Longicorn larvae, since I have as yet been unable to consult the part of Xamheu's "*Moeurs et Métamorphoses d'Insectes*" dealing with this group.²

PASSALIDAE.

The collection of material for the study of the development of Passalid beetles is rendered particularly simple by the close association which appears to exist between adults and their young. This association has been investigated in the case of American forms by Ohaus (*Stett. Ent. Zeit.*, Jahrg. LXI, 1900, pp. 164-172

¹ Absolute alcohol 6 parts, chloroform 3 parts, glacial acetic acid 1 part.

² Published as a Supplement to "*Echange*". (Lyon, 1892-1897).

and Jahrg. LXX, 1909, pp. 23-25 and 29-32). It is doubtful whether the association is quite so close in Indian forms as in American ones (Gravely, *Rec. Ind. Mus.*, XI, 1915, p. 496), although the structure of the mandibles is the same as in American larvæ, and seems equally unsuited for the mastication of unprepared wood; but it is sufficient to allow of the collection of whole groups of insects in various stages all belonging to one species. Larvæ of the following species have already been described¹ :—

"*Passalus*" ? *punctiger*, Lepeletier and Serville.²

1835. Percheron, A. "*Monographie des Passales*" (Paris, 1835), pp. 17-18, pl. i, figs 13-14.

"*Passalus*" *cornutus*, Fabricius.

1847. Burmeister, H. "*Handbuch der Entomologie*", V (Berlin, 1847), pp. 454-459.
 1872. Riley, C. V. "*The Horned Passalus*." *Ann. Rep. Ins. Missouri*, IV, 1872, pp. 139-141, text-fig. 62 a-d.
 1874. Schiødte, J. C. "*De metamorphosi Eleutheratorum observationes: Bidrag til Insekternes Udviklingshistorie*." *Naturhist. Tids.*, XI, 1874 ("*Passalus*," pp. 356-359, pl. xv, fig 16; pl. xviii, figs. 12-19; pl. xix, fig 17).

"*Passalus*" *distinctus*, Weber.

1853. Chapuis, F. and Candèze, E. "*Catalogue des Larves des Coléoptères connues jusqu'à ce jour avec la description de plusieurs espèces nouvelles*," pp. 343-653, 9 pls. *Mem. Soc. R. Sci. Liège*, VIII, 1853 ("*Passalus*," pp. 467-468, pl. iv, figs. 5-5c).
 1861. Candèze, E. "*Histoire des Métamorphoses de quelques Coléoptères exotiques*." *Mem. Soc. R. Sci. Liège*, XVI, 1861 ("*Passalus*," pp. 343-344).

Aulacocyclus kaupi, MacLeay.

1893. Froggatt, W. W. "*On the Life-Histories of Australian Coleoptera I*." *Proc. Linn. Soc. N. S. Wales*, VIII, 1894 (*Aulacocyclus*, p. 41).

¹ The synonymy of the American genera, to which most of these belong, is at present so confused that it seems best to refer to all under the single generic name "*Passalus*" which is applied to them by the authors here referred to. Only in the case of Indo-Australian species is the genus given according to modern definitions. Madam Mérian's larva can no longer be regarded as a Passalid.

² The plate bears the legend "*P. interruptus*"; but this does not apply to the larva and pupa figured which are probably, according to Percheron, those of *P. punctiger*.

Leptaulax bicolor (Fabricius).

1861. Candèze, E. "Histoire des Métamorphoses de quelques Coléoptères exotiques." *Mem. Soc. R. Sci. Liège*, XVI, 1861 ("Passalus," pp. 343-344).

Passalid larvae are all much alike, and Schipdte's elaborate description of the larva of "*Passalus cornutus*" will probably be found to apply to all so far as general structure is concerned. Only specific differences, therefore, will be described here. Candèze was unable to detect any definite differences between the species before him, beyond slight ones in the position of the stigmata.

In Oriental forms specific differences are found in the arrangement and nature of the large hairs, and in the manner in which, if at all, pile is developed on the body.

Among the larvae I have examined all those with definite pile belong to the *Pleurarius*, *Aceraius* and *Macrolinus* groups, and in the first of these it is confined to the later stages while in the second it is absent in one species. Probably, therefore, the development of pile is a departure from the primitive type of larva. In this connection it is noteworthy that the larva of the *Aceraius* group from which it is absent—*Episphenus neelgherriensis*—is that of the most primitive beetle of this group whose larva I have seen; also that the larvae of the two Bornean species of *Aceraius* examined have the pile better developed than those of the two from continental Asia, although one of the latter is the northern race of the highly specialized dominant species of the genus (compare *Journ. As. Soc. Bengal*, [n.s.] X, pp. 201-210, pl. xxiv; or *Mem. Ind. Mus.* III, pp. 311-313, text-fig. 7, p. 314).

The manner in which the larger hairs are distributed appears to be derived by the suppression or multiplication of particular hairs from the following generalized plan.¹ A short row (usually five) behind each antenna on the head; a short row (usually three including the lateral hair) bordering each of the anterior angles of the first thoracic segment; one pair of dorsal hairs on each segment in front of the tenth abdominal; one pair of lateral hairs situated obliquely above and behind the stigmata, and directly below but somewhat further away from the dorsal pair of hairs on each of these segments; one pair of ventral hairs in the same vertical plane but situated obliquely behind and below the stigmata on each of these segments after the first two thoracic, and especially on the ninth abdominal; a circumanal ring, usually of about seven pairs of hairs, on the tenth abdominal segment.

It is noteworthy that, in these characters also, *Episphenus neelgherriensis* approaches the generalized type more nearly than do any of the more highly specialized members of the *Aceraius* group that I have examined; and that in this and some other species

¹ Only in certain species of the highly specialized genus *Aceraius* are hairs produced in an entirely fresh place, namely on the frons.

this generalized type is approached more closely by young than by old larvae. Only in *Leptaulax bicolor* is the reverse the case, and here only as regards the small dorsal thoracic hairs which do not develop at all in *L. bicolor* var. *vicinus*.

Passalid pupae all appear to resemble in general form that of "*Passalus*" *cornutus* figured by Riley (*loc. cit.*), differing mainly in the structure of the head, which reveals more or less distinctly the characteristic features of the head of the developing beetle. They will not be further described here.

Pleurarius brachyphyllus, Stoliczka.

(Pl. xx, figs. 1-3.)

Localities.—Cochin State: 10th-14th mile of State Forest Tramway, ca. 0-300 ft; Kavalai, ca. 1300-3000 ft.

Larvae of this species are remarkable for the change which takes place in the structure of their hairs when the insects are about 25 mm. long. In young larvae these hairs are all long, tapering and filiform as in other species. In old ones only those on the head (missing in all our full grown specimens, but present in a number somewhat more than 25 mm. long), the ventral pair on the ninth abdominal segment, and the circumanal ring on the tenth retain this form, the rest being short, stout and clavate.

Full grown larvae may be at least 50 mm. in length. In the Indian Museum collection there are several of about this size, and a large number of from about 14-30 mm. long. Unfortunately there are none between 30 and 50 mm.

The head would apparently be covered all over with fine hair was it not worn down to the roots in places—e.g., on the dorsal surface—till only the points of origin remain. Two long hairs are present behind the antennae. Of these the dorsal is the stouter and may be more or less ribbon-like. Three hairs are present in the anterior angles of the first thoracic segment of larvae not old enough to have developed clavate hairs. In others, on this as on other segments up to the second abdominal, only the single lateral pair of hairs is present. A single pair of dorsal hairs is present in addition on the next seven segments. On the last of these (the ninth abdominal) the ventral pair is also present. The tenth abdominal segment bears the usual circumanal ring of hairs.

In larvae which are not old enough to have developed clavate hairs the general surface of the body is smooth, apart from scattered specks which appear to represent sparse and undeveloped pile. In older larvae there are tufts of pile above each leg, one in front and one behind, and tufts on the lateral margins of each tergum. The tergal tufts are united by dorsal bands on the first and second thoracic segments, and on the posterior border of the ninth and the whole of the tenth abdominal segments.

***Episphenus neelgherriensis* (Percheron).**

Localities.—Nilgiri Hills : Ootacamund, 7500 ft.

Mysore Bababudin Hills, 4000-5000 ft.

Cochin State : Kavalai, *ca.* 1300-3000 ft.

The lengths of the various larvae in the collection vary from 11-35 mm.

The head is almost devoid of any indication of hairs on the dorsal surface except for about 5-7 long ones in a row behind each antenna, 5 being apparently the normal number.

The arrangement of the hairs on the thorax and abdomen seems to be less constant than is usual. The tenth abdominal segment always bears a circumanal ring. In the smallest specimens each segment in front of it bears dorsal and lateral pairs of hairs, of which the former are much the strongest; and the first thoracic segment bears in addition a line of about three hairs in each anterior angle. All these hairs may be retained in large larvae; but more usually the first thoracic segment bears only two hairs situated laterally side by side, being without dorsal hairs, the second thoracic segment bears none at all, the third thoracic and first abdominal segments each bear the dorsal pair only, and the second to ninth abdominal segments bear both dorsal and lateral pairs. The whole body is smooth as in young larvae of the preceding species.

***Episphenus indicus* (Stoliczka).**

Localities.—Mysore : Bababudin Hills, 4000-5000 ft.

Anamalai Hills, 5000 ft.,

Cochin State : Kavalai, *ca.* 1300-3000 ft.

The lengths of all the larvae of this species that I have before me are about 35-50 mm. There are no really small specimens among them. The head is more uniformly covered with fine hair than is that of the preceding species, which it resembles as regards the hairs behind the antennae. The thorax and abdomen are more or less covered with moderately long pile, especially laterally; but there are no definite tufts as in large larvae of *Pleurarius brachyphyllus*. The thorax is without prominent hairs. The first seven abdominal segments each bear two hairs (abnormally one or three) situated dorsally rather close together one below the other. The eighth and ninth abdominal segments bear none. The tenth bears the usual circumanal ring.

***Ophrygonius cantori*, Percheron, subsp. *convexifrons*, Zang.**

Locality.—Assam : Shillong, Khasi Hills, 5500-6400 ft.

Four specimens, all about 22 mm. long. Both head and body are covered, except near the mid-ventral line of most of the abdominal segments, with somewhat thickly scattered coarse hairs, but there is no true pile. Longer and thicker hairs are present on the head in a row behind the antennae in the lateral angles of the frons. On

the first thoracic segment such hairs form a row behind the anterior margin, one or two similar dorsal and one lateral hair being present on each side behind them. On the second and third thoracic segments there are two dorsal and two lateral hairs on each side, the dorsal ones being situated as usual one on the outer side of the other, and the lateral ones one behind the other. There are moderately long hairs above the legs on all segments, and a ventral pair of hairs between them; on the third segment there are about three very long hairs, resembling in size and position the ventral hairs of the abdominal segments. On the first seven abdominal segments there are two pairs of dorsal hairs, one pair of lateral hairs, two or one pairs of ventral hairs, and one pair of weaker hairs nearer the middle of the ventral surface than the last named. The hairs on the eighth and ninth abdominal segments resemble those on the segments in front of them, except that there are three instead of two dorsal ones. The tenth abdominal segment bears the usual circumanal ring, and has short hairs scattered all across the ventral surface instead of having a mid-ventral hairless band like the preceding segments.

Aceraius grandis, Burmeister, subsp. *hirsutus*, Kuwert.

Locality.—Darjiling District: Pashok, ca. 2000 ft.

The lengths of the larvae before me vary from 38-50 mm. The largest larvae have jaws and labrum of about the same size as those of cast larval skins belonging to pupae found with these larvae, so presumably they are full grown. The beetles found with them are all about 40 mm. long. Doubtless the size of full-grown larvae varies like that of the adult beetles. The head resembles that of *Episphenus indicus*, except for the presence of a group of two or three well marked hairs in the lateral angles of the frons. The body is covered with pile as in that species, but this is inclined to be densest mid-dorsally instead of laterally. The thorax is without special hairs as a rule, but one or two pairs of rather small dorsal ones are present on the third segment in some specimens; these and the three pairs which are present on each of the first six abdominal segments, form a series of transverse dorsal lines. The seventh, eighth and ninth abdominal segments are without hairs. The tenth bears the usual circumanal ring.

Aceraius kuwertii, Zang.

(Pl. xx, fig. 4.)

Locality.—Sarawak: Kinabalu, 4500 ft.

Two specimens 46 and 68 mm. long respectively. The head resembles that of the preceding species except that the long hairs are more numerous, both in the lateral angles of the clypeus and behind the antennae. In the larger of the two specimens there are also a few long hairs among the shorter ones that border the frons and fill its posterior angle. The thoracic and first seven abdominal segments each bears a transverse dorsal line of 5-7

hairs, which are weakest and least numerous in the first and last segments, the seventh (counting from the middle line) being identical, at least in position, with the lateral hairs of other species. On the eighth and ninth abdominal segments these hairs are all so small as to be scarcely noticeable among the well-developed pile with which the body is covered. The pile is associated with minute spinules, of which one is situated immediately in front of the base of each of the fine hairs of which the pile is composed. In front of the lateral ends of each line of long hairs the pile is less dense and the spines are relatively large and sharply pointed. In the smaller of the two specimens part of this area is entirely without hairs and spines. The tenth abdominal segment bears the usual circumanal ring.

Aceraius pilifer (Percheron).

Locality.—Sarawak: Kinabalu, 4500 ft.

Two specimens 30 and 37 mm. long respectively. The head resembles that of the larger of the two specimens of the preceding species. The pile on the thorax and abdomen is much longer than in that species, and is accompanied by somewhat finer spinules; otherwise the thorax and abdomen resemble those of that species.

Aceraius helferi, Kuwert.

Locality.—Tenasserim: Misty Hollow to Sukli, Dawna Hills, ca. 2100-2500 ft.

Four specimens, each about 38 mm. long. The head resembles that of *A. grandis* subsp. *hirsutus*. The pairs of dorsal hairs are three in number as in that species, but are present on the thoracic as well as on the abdominal segments, and are accompanied on each of these segments by a pair of lateral hairs. On the first thoracic segment they are also accompanied by a few long hairs in the anterior angles, and on the ninth abdominal by a pair of well developed ventral hairs. The tenth abdominal segment bears the usual circumanal ring. The pile is short as in *A. grandis* subsp. *hirsutus*.

Macrolinus andamanensis (Stoliczka).

Localities.—Andamans: Port Blair; Bom lungta (from Popita tree).

Four specimens, all about 30-32 mm. long. The head is covered with fine hair, but bears no long hairs either behind the antennae or elsewhere. The body is covered somewhat closely with short pile. The thoracic and seventh to ninth abdominal segments are without hairs. The first six abdominal segments have two pairs of dorsal hairs as in *Episphenus indicus*, from which species the present one may be distinguished by the

absence of hairs behind the antennae and by the somewhat shorter pile on the body. There are no lateral hairs. The tenth abdominal segment bears the usual circumanal ring.

Leptaulax dentatus (Fabricius).

Localities.—Abor Country: Rotung, 1300 ft.

Tenasserim: Kawkareik, Amherst District.

Four specimens, 18-25 mm. long. The head is practically hairless above, and is entirely without long hairs. The body is practically without pile and has only a single pair of dorsal hairs on the first eight (? sometimes six or seven only) abdominal segments.

Leptaulax bicolor (Fabricius).

The two somewhat imperfectly separated varieties into which, at most, the adults of this species seem at present to be divisible, are associated in the single collection of each before me with slightly different larvae. Although it is impossible to be certain, from these two collections only, that this implies that the separation referred to has been on right lines, it will be convenient to accept this hypothesis in describing them.

I. L. BICOLOR (Fabricius) *s. str.*

Locality.—Cochin State: Kavalai, ca. 2000-2500 ft.

Several specimens varying from 12-31 mm. in length. The adults with which they are associated are about 29 mm. in length. The whole larva is practically without pile. In the smallest specimens there is a single long hair in a row of small ones behind the antennae; but this disappears later, apparently when the larva is about 15 mm. long. In the smallest larvae the thorax bears three long hairs in the anterior angles of the first segment, a cluster of much shorter ones above the base of each of the first two pairs of legs, and a single pair of ventral hairs behind the third pair of legs. In a specimen a little over 15 mm. the hairs above the legs are quite weak, and a single pair of rather small dorsal hairs has appeared on each thoracic segment. In larger larvae the hairs above the legs completely disappear. Each of the first nine segments of the abdomen bears two pairs of well developed dorsal hairs, and one pair of much smaller dorsally directed ventral hairs; on the ninth segment there is in addition a pair of ventrally directed ventral hairs resembling those which are dorsally directed and situated slightly below them; the ventral hairs on the eighth and ninth segments are duplicated in one very small specimen; the ventral hairs are easily seen in very small specimens but are quite small in large ones. The tenth abdominal segment bears the usual circumanal ring of hairs.

2. L. BICOLOR var. VICINUS (Percheron).

Locality.—Andamans: Port Blair.

Several specimens, varying from about 14-28 mm. in length.

The smallest specimen resembles the smallest of the preceding form, except that the single long hair behind each antennae is much shorter, though relatively stout, and is associated with a cluster of small spinules or bacilli. Large larvae differ from this specimen only in the loss of the hairs above the two front pairs of legs (though these do not appear to be lost so quickly as in the preceding form), and in the replacement of the pair of hairs behind the last pair of legs and of all the ventral pairs of hairs on the abdomen by short bacilli. The hairs and groups of spinules behind the antennae are not lost, and the dorsal pairs of hairs on the thoracic segments are not developed.

LUCANIDAE.

Several descriptions of Lucanid larvae have appeared since the publication of Chapuis and Candèze's catalogue (*Mem. Soc. R. Sci. Liège*, VIII, 1853, Lucanidae, pp. 468-470). In the following list of the references I have been able to trace those not available in Calcutta are marked with an asterisk (*), as I have not been able to use them.

Lucanus cervus, Linnaeus.

- ? *Albrecht. *Acta Acad. nat. Cur.* (series ?) IV, pl. 5.
 1746. *Rossel von Rosenhof, A. J. *Ins. Belust.*, II (1), 1746, pl. iv, fig 3.
 1790. *Herbst, J. F. W. "Natursystem aller bekannten in- und ausländischen Insekten," III (Berlin, 1790), p. 289, pl. F, figs 1-6.
 1804. *Posselt, C. F. "Beyträge zur Anatomie der Insekten", etc., (Tübingen, 1804), pl. ii, fig 1.
 1823. *Blot. *Mem. Soc. Linn. Calvados*, I, 1823.
 1839. Ratzeburg, J. T. C. "Die Forst-Insecten," 2nd. ed., I (Berlin, 1839), pp. 105-106.
 Westwood, J. O. "Introduction to the Modern Classification of Insects," I (London, 1839), pp. 187-188.
 1848. *Erichson, W. F. "Naturgeschichte der Insekten Deutschlands," (Berlin, 1848), p. 938.
 1874. Schiødte, J. C. "De metamorphosi Eleutheratorum observationes: Bidrag til Insekternes Udviklingshistorie." *Naturhist. Tids.*, IX, 1874 (*Lucanus*, pp. 341-345, pl. xviii, figs. 12-19, pl. xix, fig. 17).

"Lucanus" alces.

1836. *Haan, W. de. "Mémoires sur les Métamorphoses des Coléoptères," I (Paris, 1836), p. 25, pl. iii, fig. 6.

"Lucanus" saiga.

1836. *Haan, W. de. "Mémoires sur les Métamorphoses des Coléoptères," I (Paris, 1836), p. 24, pl. iii; fig. 7.

Dorcus parallelipedus, Linnaeus.

1833. Bree, C. R. "Remarks on the Fall of an aged Ash Tree." *Mag. Nat. Hist.*, VI, 1833, pp. 327-335, text-figs. 43-44.
1839. Ratzeburg, J. T. C. "Die Forst-Insecten." 2nd ed., I (Berlin, 1839), pp. 105-106, pl. iii, fig. 19.
1842. *Dufour, L. "Histoire comparative des métamorphoses et de l'anatomie des *Cetonia turata* et *Dorcus parallelipedus*." *Ann. Sci. Nat.*, (2) XVIII, 1842, pp. 162-181, pl. iv-v.
- *Mulsant, M. E. and Rey, C. "Histoire Naturelle des Coléoptères de France, Lamellicornes." (Paris and Lyon, 1842), p. 281, pl. i, figs. 18a-c.
1848. *Erichson, W. F. "Naturgeschichte der Insekten Deutschlands." (Berlin, 1848), p. 491.
1874. Schiodte, J. C. "De metamorphosi Eleutheratorum observationes: Bidrag til Insekternes Udviklingshistorie." *Naturhist. Tids.*, IX, 1874 (*Dorcus*, pp. 345-349, pl. xvii, figs. 1-10, pl. xix, figs. 14-15).
1890. *Planet, L. *Naturaliste*, XII, 1890, p. 156

Platycerus caraboides, Linnaeus.

1842. *Mulsant, M. E. and Rey, C. "Histoire Naturelle des Coléoptères de France, Lamellicornes." (Paris and Lyon, 1842), p. 597.
1874. Schiodte, J. C. "De metamorphosi Eleutheratorum observationes: Bidrag til Insekternes Udviklingshistorie." *Naturhist. Tids.*, IX, 1874 (*Platycerus*, pp. 349-352, pl. xvii, figs. 11-21).

Figulus striatus, Fabricius.

1845. *Blanchard, C. E. "Histoire des Insectes," I, 1845 p. 268, pl. viii, figs. 2-3.

Ceruchus tarandus, Panzer.

1842. *Mulsant, M. E. and Rey, C. "Histoire Naturelle des Coléoptères de France, Lamellicornes." (Paris and Lyon, 1842), p. 593, pl. iii, figs. 6a-c.

Ceratognathus froggatti, Blackburn.

1894. *Froggatt, W. W. "On the Life-Histories of Australian Coleoptera," II. *Proc. Linn. Soc. N. S. Wales*, (2) IX, 1894 (1894-5), pp. 120-121.

Mitophyllus irroratus, Parry.

1881. Brown, T. "On the Larva and Pupa of *Cerdognathys irroratus*." *Trans. N. Z. Inst.*, XIII, 1880 (1881), pp. 230-231.

Aesalus scarabaeoides, Fabricius.

1842. *Mulsant, M. E. and Rey, C. "Histoire Naturelle des Coléoptères de France, Lamellicornes." (Paris and Lyon, 1842), p. 604.

Sinodendron cylindricum, Linnaeus.

1839. Westwood, J. O. "Introduction to the Modern Classification of Insects," I (London, 1839), p. 189, text-fig. 18 (p. 185), 11-13.
1842. *Mulsant, M. E. and Rey, C. "Histoire Naturelle des Coléoptères de France, Lamellicornes." (Paris and Lyon, 1842), p. 600, pl. iii, figs. 10a-b.
1874. Schiødte, J. C. "De metamorphosi Eleutheratorum observationes: Bidrag til Insekternes Udviklingshistorie." *Naturhist. Tids.*, IX, 1874 (*Sinodendron*, pp. 352-356, pl. xviii, figs. 1-10, pl. xix, fig. 16).

The Lucanid larvae described below were found in wood together with adults of the species to which I have referred them. In no case were any pupae found.

Aegus roepstorffi, Waterhouse.

(Pl. xxi, figs. 8-11.)

Locality.—Andamans: Port Blair (in rotten wood).

Two larvae about 25 and 30 mm. long respectively, accompanied by two mesodont males of slightly dissimilar development. The larvae are of the usual curved clavate form.

The head is polished and obscurely rugose. It bears a few long slender hairs in a line behind the clypeo-frontal suture and the antennae, as in *Dorcus parallelipedus*. The sutures bounding the frons latero-posteriorly, though distinct, are very weak. The clypeus is somewhat or much broader than long in front; behind it is quite twice as broad as long. The labrum is about twice as broad as long behind, and somewhat broader in front; its anterior margin and angles are rounded; it is lightly elevated in the middle line in front, between a pair of marginal or submarginal depressions.

The antennae resemble those of *Dorcus parallelipedus*, but have the last of the two long joints scarcely longer than the first. I would regard these antennae, and those of other Lucanids; as apparently 5-jointed and really 4-jointed; not apparently 4-jointed and really 3-jointed as does Schiødte. Both mandibles have three teeth at the apex, of which the ventral is situated in front of the middle one, and the middle one in front of the dorsal. In the right

mandible there is one and in the left there are two smaller teeth on the dorsal margin behind these, as in *Lucanus cervus*¹ and *Dorcus parallelipedus*. The molar tooth of the right mandible consists of a low anterior transverse ridge followed by a somewhat higher hollowed L-shaped cusp; that of the left mandible consists of a very strongly elevated anterior transverse ridge, longitudinally grooved in front and more elaborately marked behind, followed by a low hollowed cusp of considerable size. The maxillae resemble those of *Dorcus parallelipedus*. As with the antennae I would regard the basal piece ("stipes palpiger" of Schiødte) as a basal joint. The labial palps are 2-jointed, the proximal joint being about as long as broad, and the distal about three times as long as broad and about twice as long as the proximal.

The legs resemble those of *Dorcus parallelipedus* in structure and proportions except that each joint—judging from Schiødte's figure of the third leg of that species—is slenderer, and that the stridulating joint of the third leg is more sharply pointed distally as in *Platycerus caraboides*. The stridulating surface on the middle leg resembles that of the former species; the tubercles are very fine and closely set. The second, third and fourth joints of all legs, when not modified for stridulation, are thickened ventrally near the distal end. The projections thus formed bear clusters of stout spiniferous tubercles and are strongest on the third joint of each, and especially of the second, leg.

Only the thoracic and first two abdominal segments are distinctly divided transversely by a groove above. All segments as far as the sixth abdominal are sparsely covered above with short hairs, and have a posterior line of long hairs. Further back the short hairs disappear, and from about this point backwards long hairs are found on the anterior as well as the posterior parts of each segment. Each segment up to and including the ninth abdominal bears a large tubercle on each side in the posterior angles of the tergum. The terminal segment resembles that of *Dorcus parallelipedus*, as do also the stigmata.

The larva of this species closely resembles that of its ally *Dorcus parallelipedus*, the chief differences being found in the structure of the molar teeth and the greater slenderness of the legs.

Nigidius dawnae, Gravely.

(Pl. xxi, figs. 12-13.)

Locality.—Tenasserim: near Sukli, eastern side of Dawna Hills, Amherst District, ca. 2200 ft. (in hard dry wood).

Several larvae about 20-35 mm long (all but one of about the latter size) were found in association with the well developed

¹ Schiødte speaks of the right mandible as tridentate only in these species, but the extra denticle is clearly shown in the right mandible of the latter species, which he figures (*loc. cit.*, pl. xvii, figs. 3 and 4).

males and females which formed part of the material from which the species was originally described (*Rec. Ind. Mus.*, XI, pp. 427-429, pl. xxix, fig. 7). They are curved and more or less clavate, but are slenderer than the larvae of the preceding species.

The head closely resembles that of the preceding species but bears fewer hairs, and has a somewhat narrower clypeus and a labrum with less distinct anterior marginal depressions.

The second of the two long joints of the antennae is somewhat shorter than in the preceding species; it is much, instead of scarcely, shorter than the first. The right mandible has only two terminal teeth as in *Platycerus caraboides* and *Sinodendron cylindricum*, the ventral being much the larger of the two; but beneath these a rudiment of the third terminal tooth is recognizable. The left mandible has three large teeth arranged like the apical teeth of *Dorcus parallelopipedus*, with a small denticle a little behind each of the two outermost of the three. Except for the presence of the small dorsal denticle the termination of this mandible is also very like that of *Sinodendron cylindricum*. The molar teeth of both mandibles closely resemble those of this species. The maxillae and labium resemble those of *Aegus roepstorffi*—the former at least are very like those of *Dorcus* and *Sinodendron*. The legs resemble those of *Aegus roepstorffi* in general structure, but are without the ventral projections and spiniferous tubercles found on the second, third and fourth joints in that species. The stridulatory tubercles on the coxae of the second legs are all small and scattered. The corresponding ridges on the second joint of the third legs are weak.

The stigmata and the integuments of the thorax and abdomen resemble those of the preceding species.

The only larva previously described belonging to the subfamily Figulinae is that of *Figulus striatus*. Unfortunately I have not been able to refer to this description. Of the larvae described by Schiodte, the nearest to that of *Nigidius dawnae* appears to be *Sinodendron cylindricum*, but the latter has not got transversely striate stigmata like those of *Dorcus*, etc., in general form it is not even faintly clavate, and its stridulating organs appear to be slightly different.

Nigidius impressicollis, Boileau.

(Pl. xxi, figs. 14-17.)

Locality.—Assam: Maflong, Khasi Hills, 5900 ft. (in damp and thoroughly decayed wood).

Two larvae, about 27 and 31 mm. long respectively, found in association with adults of various sizes. They are scarcely as slender as larvae of *N. dawnae*, but are much slenderer than larvae of *Aegus roepstorffi*.

The head is very like that of *A. roepstorffi* but has a somewhat shorter clypeus and less distinct anterior marginal depressions. The antennae resemble those of *N. dawnae*. The man-

dibles resemble those of *N. dawnae*, except that the right one is distinctly tridentate at its apex, the lowest terminal tooth being, however, a little weaker than the uppermost; the middle terminal tooth is the strongest of the three.

The maxillae and labium resemble those of *N. dawnae*. The legs resemble those of *N. dawnae*, except in the structure of the stridulating organ, which is transitional between those found in *A. roepstorffi* and *N. dawnae*. The ridges on the second joint of the third leg are weak as in the latter species; but there is a row of special tubercles, as in the former, on the basal joint of the second leg. Similar but stronger tubercles are found in *Aegus roepstorffi*, but they are absent in *Nigidius dawnae*. Small tubercles are present on both sides of them in the present species, however, and on one side of them only in *Aegus roepstorffi*. The stigmata and integuments of the thorax and abdomen resemble those of *N. dawnae* and *A. roepstorffi*.

This larva is not unlike the last—the only larva of its genus known—but the stridulating organ is more highly specialized along the same lines as, but to a less extent than, the stridulating organs of *Dorcus*, *Aegus*, etc.

CUCUJIDAE.

A list of the Cucujid larvae hitherto described will be found at the end of the account of the development of *Uleiota indica*, Arrow (*Rec. Ind. Mus.*, XI, pp. 353-358, pl. xxi, figs. 13-19).¹ None of these larvae bear any resemblance to the larva of *Hectarthrum trigeminum* now to be described. The larvae of *Hectarthrum* were found in decaying wood with all stages of a weevil belonging to the genus *Mecistocerus*.² Often they were found in a cavity of the wood with a larva or pupa of this insect, and sometimes with the remains of such. Other Cucujid larvae, although found under the bark of trees, have the appearance of actively predaceous insects. These have rather the appearance of lignophagous larvae. But in view of the circumstances under which they were found, and of the structure of their mandibles, there can, I think, be little doubt that the reduction of legs and mouthparts which gives rise to this appearance is due not to their having adapted themselves to a diet of wood, but to their having become parasitic rather than predaceous.³ They must, however, move about in search of their victims, for the weevil larvae and pupae are not much larger than they are when full grown, and it cannot be supposed that one weevil larva affords all the food needed for complete development.

¹ To this list may now be added Herrick's account of the habits and development of *Silvanus surinamensis* in "Insects Injurious to the Household and Annoying to Man" (New York, 1914), pp. 236-239, text-figs. 70-71.

² Mr. G. A. K. Marshall, to whom I am indebted for this identification, informs me that this weevil is near and perhaps identical with *M. corticeus*, Faust.

³ Compare Wadsworth's figures of the mouthparts of the endoparasitic Staphylinid larva, *Aleochara bilineata*, *Journ. Ec. Biol.* X, pl. ii, figs. 14-18.

***Hectarthrum trigeminum*, Newman.¹**

(Pl. xxii, figs. 18-22.)

Locality.—E. Himalayas: Kalimpong, ca. 2500 ft., Darjiling District (in decaying wood with all stages of *Mecistocerus* sp.).

Several larvae and pupae, the former 4.0-15.6 mm. long, the latter 9.0-12.0 mm., found together with adults. The pupae and adults clearly belong to one and the same species; a cast larval skin secured with one of the pupae establishes the identity of the latter with the larvae, while in the largest of these larvae the skin is wrinkled and the spines of the pupa are clearly visible beneath it dorsally and laterally.

The larva is a white fleshy and almost hairless grub. Its abdomen is somewhat barrel-shaped, being thickest at about the fourth segment. The thorax is conical, and slenderer than the abdomen, tapering away to the base of the small semicircular head, which bears a few minute hairs on its dorsal surface.

The form of the head is shown in figs. 18 and 21 (pl. xxii). Each antenna arises from a low lateral convexity just behind the mandible; it is unjointed but is biramous, a small pointed branch being situated immediately below a stouter and slightly longer rounded one (pl. xxii, fig. 20). The mandibles are small and concave; they do not appear suitable for grinding fragments of wood. Their outer surface is whitish near the base, but they are narrowly bordered and extensively tipped with dark brown. They are tridentate at the tip (pl. xxii, figs. 19 and 21), the middle one of the three teeth being much longer than the other two, of which the dorsal is much broader than the ventral; there are no other teeth on the dorsal margin of the mandible, but the ventral terminal tooth is followed by another tooth of about the same shape and size, and this is followed by a strong convexity of the raised margin (pl. xxii, fig. 19). The maxillae and labium (pl. xxi, fig. 22) are rudimentary like the antennae. The blade and palp of the maxillae are imperfectly separated; the former is broader but no longer than the latter, and each is tipped with a cluster of small spines. The labium is a bilobed structure, with a papilla mounted on each lobe, tipped with small spines and doubtless representing a palp.

The legs are short, stout and conical; they have two well-marked white fleshy joints and a stout terminal claw; as seen from the outer side there appears to be a third joint at the base, but it is not clearly marked off from the body on the inner side. The second thoracic segment, and each abdominal segment except the ninth (anal), bears a pair of circular stigmata a little behind the anterior margin; but the last pair is much smaller than the others. The anal segment bears a pair of black forwardly curved hooks on the posterior margin of its dorsal surface.

¹ I am indebted to M. A. Grouvelle for this identification.

BUPRESTIDAE.

The habits and metamorphoses of Buprestid beetles form the subject of a monograph published by Xamheu in 1892-3 ("Moeurs et Métamorphoses d'Insectes III—Buprestides." *Rev. d'Ent.* XI, 1892, pp. 202-252; XII, 1893, pp. 54-126). This work contains an excellent bibliography which may now, however, be supplemented. In the following list of supplementary references the species are arranged in the order adopted by Kerremans in the *Genera Insectorum*.

Julodis onopordi, Fabricius.

Julodis albopilosa, Chevrolat.

1893. Herculais, J. Künckel d'. *Bull. Soc. ent. France*, 1893, pp. cxii-cxv, 7 figs.

1898. Lesne, P. "Description de la larve adulte du *Julodis albopilosa*, Chevr., et remarques sur divers caractères des larves de Buprestides." *Bull. Soc. ent. France*, 1898, pp. 69-75, 7 text-figs.

Polycesta californica, Leconte.

Polycesta elata, Leconte.

1891. Angell, G. W. J. "Larva of *Polycesta elata*, Lec." *Ent. News*, 1891, pp. 106-107, text-figs.

Acmaeodera adpersula, Illiger.

1900. Seurat, L. G. "Observations biologiques sur les parasites des chênes de la Tunisie." *Ann. Sci. Nat., Zool.* (8) XI, 1900, pp. 1-34, 10 text-figs. (*Acmaeodera*, pp. 22-26, text-figs. 9-10).

Chrysochroa (*Megaloxantha* nec *Catoxantha*) *bicolor*,

Fabricius, var. *gigantea*, Shallern.

1901. Zehntner, L. *Bull. Proefstation voor Cacao te Salatiga*. No. 1, 10 pp.

Chalcophora ? *virginiensis*, Drury.

Chalcophora virginiaca, Gmelin.

1883. Packard, A. S. "Descriptions of the Larvae of Injurious Forest Insects." *Rep. U. S. Ent. Comm.*, III, pp. 252-262, pl. vi-xv (*Chalcophora* ? *virginiensis*, pp. 252-253, pl. vi, fig. 1).

Sphenoptera lamellata.

1880. Lamey. *Nouv. et Faits*, II, p. 113.

Sphenoptera ? neglecta, Klug.

? *Sphenoptera gossypii*, Cotes.

1911. King, Harold H. "The Cotton Stem-borer." *Rep. Wellcome Trop. Res. Labs.*, IV, pp. 134-137, pl. vii, figs. 1-6.

Sphenoptera gossypii, Cotes.

1906. Lefroy, H. M. "Indian Insect Pests" (Calcutta, 1906), pp. 100-103, text-figs. 114-119.
1909. Lefroy, H. M. "Indian Insect Life" (Calcutta, 1909), pl. xx. (No description).
1914. Fletcher, T. B. "Some South Indian Insects" (Madras, 1914), p. 298, pl. viii.

Sphenoptera arachidis, Fletcher.

1914. Fletcher, T. B. "Some South Indian Insects" (Madras, 1914), pp. 298-299, text-figs. 141-142.

Dicerca divaricata, Say.

1881. Packard, A. S. "Insects injurious to Forest and Shade Trees." *Bull. U. S. Ent. Comm.*, no. 7, 275 pp., 100 text-figs. (*Dicerca divaricata*, p. 108).
1883. Packard, A. S. "Descriptions of the Larvae of Injurious Forest Insects" *Rep. U. S. Ent. Comm.*, III, pp. 251-262, pl. vi-xv (*Dicerca divaricata*, p. 255, pl. vi, fig. 2).

Lampra solieri, Castelnau and Gory.

Poecilnota solieri, Castelnau and Gory.

1908. Escalera, M. de la. "Observaciones sobre la ninfosis de *Poecilnota solieri*, Cast." *Boll. Soc. Esp. Hist. Nat.*, 1908, pp. 269-271.

Lampra rutilans, Fabricius.

1881. Altum, B. "Forstzoologie, III (1) Allgemeines und Käfer" (Berlin, 1881), pp. 1-380 (*Lampra rutilans*, pp. 121-123, text-fig. 7).

Buprestis douei, Lucas.

Ancylocheira douei, Lucas.

1896. Xamheu. "Moeurs et Métamorphoses d'Insectes V." *Ann. Soc. Linn. Lyon*, XLII, pp. 53-100 and 123-188 (*Ancylocheira douei*, p. 83).

Melobasis cupriceps, Kirby.

• *Melobasis iridescens*, Castelnau and Gory.

1895. Froggatt, W. W. "Life-Histories of Australian Coleoptera III." *Proc. Linn. Soc. N. W. Wales*, (2) X, 1895 (1895-6), pp. 325-336 (*Melobasis*, pp. 332-333).

Melanophila sp.

1883. Packard, A. S. "Descriptions of the Larvae of Injurious Forest Insects." *Rep. U. S. Ent. Comm.*, III, pp. 252-262, pl. vi-xv (*Melanophila* sp., pp. 253-354, pl. vi, fig. 4, pl. xii, fig. 1).

Anthaxia umbellatarum, Fabricius.

Anthaxia inculta, Germar.

1895. Xamheu. "Moeurs et Métamorphoses d'Insectes VI." *Echange*, 1895, supplement (*Anthaxia inculta*, p. 84).

Chrysobothris dentipes, Germar.

1881. Packard, A. S. "Insects Injurious to Forest and Shade Trees." *Bull. U. S. Ent. Comm.*, No. 7, 275 pp., 100 text-figs. (*Chrysobothris dentipes*, pp. 12-15, fig. 1).

Chrysobothris femorata, Olivier.

1881. Packard, A. S. "Insects Injurious to Forest and Shade Trees." *Bull. U. S. Ent. Comm.*, No. 7, 275 pp., 100 text-figs. (*Chrysobothris femorata*, pp. 16-20, figs 2-3).
1883. Packard, A. S. "Descriptions of the Larvae of Injurious Forest Insects." *Rep. U. S. Ent. Comm.*, III, pp. 251-262 (*Chrysobothris femorata*, pp. 251-252).

Chrysobothris affinis, Fabricius.

1881. Altum, B. "Forstzoologie, III (1) Allgemeines und Käfer" (Berlin, 1881), 380 pp., 55 text-figs. (*Chrysobothris affinis*, pp. 124-128, text-fig. 8).

Stigmodera rufipennis, Kirby.

1893. Froggatt, W. W. "On the Life-Histories of Australian Coleoptera I." *Proc. Linn. Soc. N. S. Wales*, (2) VIII, 1893 (1893-4), pp. 27-42 (*Stigmodera rufipennis*, p. 36).

Coraebus bifasciatus, Olivier.

1881. Altum, B. "Forstzoologie, III (1) Allgemeines und Käfer" (Berlin, 1881), 380 pp., 55 text-figs. (*Coraebus bifasciatus*, pp. 128-130, text-fig. 9).

1910.] F. H. GRAVELY: *Lignicolous Beetle-Larvae*. 155

Agrilus ruficollis, Fabricius.

1870. Wielandy. *Amer. Ent.*, II, pp. 128 and 133, figs. 68, 69 and 90.

Agrilus granulatus, Say.

1884. Burrill. *Rep. Ins. Illinois*, XII, pp. 121-122.

Agrilus anxius, Gory.

1898. Chittenden, F. H. "A destructive Borer Enemy of Birch Trees, with Notes on Related Species." *Bull. U. S. Dept. Agric. Div. Ent.*, (n. s.) No. 18, pp. 14-51, text-figs. 15-17.

Agrilus auricollis, Kiesenwetter.

1888. Wachtl, F. A. "Ein Lindenverwüster." *Wien. Ent. Zeit.*, VII, 1888, pp. 293-297, pl. iii.

Paracephala cyaneipennis, Blackburn.

1894. Froggatt, W. W. "On the Life-Histories of Australian Coleoptera." *Proc. Linn. Soc. N. S. Wales*, IX, 1894 (1894-5), pp. 113-125 (*Paracephala cyaneipennis*, p. 122).

Aphanisticus krugeri, Ritsema.

1889. Ritsema. *Tijdschr. Ent.*, XXXIII, 1889-90, pp. xxii-xxiii, 1 text-fig.

1897. Zehntner, L. "De Mineerlarven van het Suikerriet op Java II-III." *Med. Proefstation Ost Java*, (n. s.) No. 42, 1897, 14 pp., 1 pl.

Aphanisticus consanguineus, Ritsema.

1897. Zehntner, L. "De Mineerlarven van het Suikerriet op Java II-III." *Med. Proefstation Ost Java*, (n. s.) No. 42, 1897, 14 pp., 1 pl.

Pachyschelus sp.

1908. Friebrig, K. "Eine Schaum bildende Käferlarve." *Zeitschr. wiss. Insektenbiol.*, IV, 1908, pp. 333-339 and 353-363.

Brachys aeruginosa, Gory.

1881. Packard, A. S. "Insects Injurious to Forest and Shade Trees." *Bull. U. S. Ent. Comm.*, No. 7, 275 pp., 100 text-figs. (*Brachys aeruginosa*, p. 130, fig. 60½).

The Indian Museum collection contains larvae of *Sphenoptera gossypii* from the material from which this species was originally

described, and larvae found with pupae and adults in a tree probably belonging to the genus *Swietenia* on the Calcutta Maidan. There can be little doubt, from the state of the tree when it was cut down, that these larvae, together with many others of the same species, were responsible for its death. The adults agree closely with Théry's description of *Cardiaspis pisciformis* from Mysore (*Bull. Soc. ent. France*, 1904, pp. 73-74, text-fig. 2), the only apparent differences being that the sides of the pronotum are practically parallel in their latter half, and that the posterior tibiae are straight except in one specimen and are almost imperceptibly curved in this. Equally great differences exist, however, between Théry's figure of *C. mouhoti*, Saunders, and our specimens of this species, and I have no hesitation in referring the specimens from ? *Swietenia* to Théry's species. Their larvae may now be described.

Cardiaspis pisciformis, Théry.

(Pl. xxii, figs. 23-28.)

Locality.—Calcutta (? in *Swietenia* sp.).

Four specimens varying in length from 23-33 mm.

The clypeus is about 5 times as wide as long and bears a small but deep and clearly defined puncture on either side of the middle line, which is more or less faintly keeled between and behind them. The anterior margin is lightly concave and the anterior border strongly depressed laterally, the depressions being bounded behind by keels.

The labrum is mounted on a membranous peduncle. The labrum and peduncle are each fully as wide as the clypeus is long, and are together fully as long as wide, the labrum being about twice as long as the peduncle. The anterior and lateral margins of the labrum are lightly convex, the angles are rounded; the surface is grooved in the middle line in front, this groove being surrounded by a semicircular or more or less V-shaped groove which crosses the middle line behind it. The peduncle is depressed or grooved in the middle line.

The antennae are three-jointed. The basal joint is large and fleshy, almost white in colour. The second joint is smaller and harder, much yellower in colour, obliquely truncate and fringed with short close hair distally, the truncation facing downwards. The terminal joint is much smaller still, the distal fringe being indeed its most conspicuous part; as it is set on the oblique distal face of the second joint it is directed downwards. A (? sensory) hair arises dorsally at the base of the terminal joint; whether this hair arises from the middle or terminal joint I have been unable to determine. The mandibles are small, tridentate distally, and very hard. The maxillae are weak; the blade of each is cylindrical, and is rounded and unarmed distally; the palp is two-jointed, the basal joint is as large as the blade and not unlike it in shape, the terminal joint conical, slightly longer than it is broad at the base and scarcely half as long as the basal joint. The labium is even less

well developed than are the maxillae. It consists of a pair of whitish pilose fleshy convex lobes, each about twice as long as broad, with a pair of brown rudimentary palps, the former being fused with, and the latter closely apposed to, the surface of the highly polished, densely fringed but otherwise hairless hypopharynx, which fills up the space between the maxillae. The strongly chitinized ventral plate behind the mouth parts is much shorter than the clypeus; it bears a pair of longitudinal grooves close to the middle-line, and its anterior margin is lightly concave as a whole.

Both the dorsal and ventral plates of the prothorax are dull as a whole, owing to an even and almost microscopically fine granulation; but the median ventral groove with a strongly fan-shaped area in front of it, and the dorsal V with a less expanded area in front of it, are polished. The rest of the body is dull except for the posterior end which is polished.

This larva closely resembles larvae of the allied genus *Dicerca*, as these are defined in Xamheu's key to the genera of Buprestid larvae.

TENEBRIONIDAE.

A key to the genera of Tenebrionid larvae was published by Schiødte (*Nat. Tidsskr.*, XI, 1877-1878, pp. 491-522). This has been republished by Kiesenwetter and Seidlitz, who also give a new key (*Naturg. Ins. Deutschl.*, Coleoptera V [1], pp. 210-216).

The following is a list of the references I have been able to find to descriptions of Tenebrionid larvae. Those not available in Calcutta are marked with an asterisk.

TENTYRIINAE.

Pachychile servillei, Soc.

1898. *Xamheu. "Moeurs et Métamorphoses des Insectes VII (1)." *Ann. Soc. Linn. Lyon*, XLV, pp. 9-66 (? 197).

Tentyria interrupta.

1877. Perris, E. "Larves de Coléoptères" (Paris, 1877), 590 pp., 14 pl. (*T. interrupta*, pp. 253-255), reprinted from *Ann. Soc. Linn. Lyon*, (n. s.) XXIII, pp. 1-430 (*T. interrupta*, p. 94).

Tentyria mucronata, Steven.

1877. Perris, E. *Loc. cit.*, p. 255.

ELENOPHORINAE.

Elenophorus collaris, L.

1856. Mulsant, E. and Mulsant, V. "Description de la larve de l'*Elenophorus collaris*, coléoptère de la tribu Latigènes."

Opusc. Ent., VII, 1856, pp. 133-134 (? reprinted from *Ann. Soc. Linn. Lyon*, 1856, II, 3, p. 133).

ASIDINAE.

Asida corsica, Cast.

1877. Perris, E. *Loc. cit.*, pp. 256-57 and 96 respectively.

Asida dejeani, Sol.

1887. *Rey, C. "Essai d'études sur certaines larves de Coléoptères et descriptions de quelques espèces inédites ou peu connus." *Ann. Soc. Linn. Lyon*, (n. s.) XXXIII, pp. 231-259, pls. i and ii (*Asida dejeani*, p. 223, pl. ii, fig. 23).

Asida jurinei, Sol.

Asida bigorrensis, Sol.

1877. Perris, E. *Loc. cit.*, pp. 257 and 97 respectively.

1893. *Xamheu. "Mœurs et métamorphoses d'insectes." *Ann. Soc. Linn. Lyon*, XL, 1893, pp. 1-52, and 101-185 (*Asida jurinei*, p. 28).

Asida sericea, Ol.

1887. *Rey, C. "Essai d'études sur certaines larves de Coléoptères et descriptions de quelques espèces inédites ou peu connus." *Ann. Soc. Linn. Lyon*, (n. s.) XXXIII, pp. 131-259, pls. i and ii (*Asida sericea*, p. 224).

MOLURINAE.

Psammodes reichei, Sol.

1909. *Mally, C. W. "The Tok-Tokje (*Psammodes*) as a grain pest." *Cape Town Agricull. J.*, 1909, text-figs.

AKIDINAE.

Akis bacarozzo, Schrank.

Akis reflexa, Ol.

Akis punctata, Thunb.

1844. *Mulsant, E. *Mem. Soc. Linn. Lyon*, I, 1844.

1877-8. Schødte, J. C. "Le metamorphosi Eleutheratorum observationes." *Natur. Tidsskr.*, XI, pp. 479-598 (*Akis bacarozzo*, pp. 507, 508, 529-531, pl. v, figs. 12-21).

1898. Kiesenwetter, H. v., and Seidlitz, G. "Tenebrionidae." *Naturg. Ins. Deutschl.* (Berlin, 1898), V, p. 213 (foot note).

SCAURINAE.

Scaurus atratus, F.

1877-8. Schiødte, J. C. *Loc. cit.*, pp. 526-29, pl. vi, figs. 14-20.

? *Scaurus tristis*, Ol.

1854. *Mulsant, E. "Histoire naturelle des Coléoptères de France, Latigenes," (Paris & Lyon, 1854), pp. x, 396 (*Scaurus tristis*, p. 51). See also Perris, 1877, *loc. cit.*, p. 252.

PIMELIINAE.

Pimelia bipunctata, F.

1877. Perris, E. *Loc. cit.*, p. 259.

Pimelia boyeri, Sol.

1898. *Xamheu. "Mœurs et métamorphoses des Insectes" VII (1). *Ann. Soc. Linn. Lyon*, XLV, pp. 9-66 (*Pimelia boyeri*, p. 59).

Pimelia grossa, F.*Pimelia inflata*, Herbst.

1877-8. Schiødte, J. C. *Loc. cit.*, p. 523, pl. v, figs. I-II.

Pimelia pilifera, Sén.

1898. *Xamheu. "Mœurs et métamorphoses des Insectes" VII (1). *Ann. Soc. Linn. Lyon*, XLV, pp. 9-66 (*Pimelia pilifera*, p. 57).

Pimelia sardea, Sol.

1877. Perris, E. *Loc. cit.*, pp. 258 and 98 respectively.

BLAPTINAE.

Blaps gigas, Linn.

1872. *Mulsant. *Mem. Acad. Lyon*, XIX, 1872, pp. 340-342.

1873. Mulsant, E., and Mayet, V. "Histoire des métamorphoses de diverses espèces de Coléoptères." *Opusc. Ent.*, XIV, 1873, pp. 65-100 (*Blaps gigas*, pp. 92-96).

1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, pp. 245, 246.

Blaps lethifera, Marsh.*Blaps fatidica*, Sturm.1843. *Letzner. *Uebers. Schles.*, 1843, p. 4.1852. Perris, E. "Histoire des métamorphoses du *Blaps producta* Dej.? et *Blaps fatidica*, Sturm." *Ann. Soc. Ent. France* (2) X, 1852, pp. 603-612, pl. xv (*Blaps fatidica*, pp. 609-612, pl. xv, figs. 20-21).1877-8. Schipfde, J. C. *Loc. cit.*, p. 532, pl. vi, figs. 1-13.**Blaps ldsitanica**, Herbst.*Blaps producta*, Cast.1852. Perris, E. "Histoire des métamorphoses du *Blaps producta*, Dej.? et *Blaps fatidica*, St." *Ann. Soc. Ent. France*, (2) X, 1852, pp. 603-612, pl. xv (*Blaps producta*, pp. 606-608, pl. xv, figs. 13-18).1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 246.**Blaps mucronata**, Latr.*Blaps chevrolati*, Sol.*Blaps mortisaga*, Ol.*Blaps obtusa*, Sturm1838. Patterson, R. and Haliday, A. H. "Note respecting the larva of *Blaps mortisaga*, Ol., with a description of the larva by A. H. Haliday." *Trans. Ent. Soc. London*, 1838, II, pp. 99-102, pl. xi, figs. 1-19.1839. Westwood, J. O. "An Introduction to the Modern Classification of Insects" I (London 1839), pp. 1-462 (*B. mortisaga*, p. 321, text-fig. 39, 11).1853. Chapuis, F. and Candèze, E. A. C. "Catalogue des larves des coléoptères, connues jusqu'à ce jour avec la description de plusieurs espèces nouvelles," pp. 343-653, 9 pls. *Mem. Soc. Roy. Sci. Liège*, VIII, 1853 (*Blaps obtusa*, p. 515, pl. vi, fig. 5).1893. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 246.**Blaps plana**, Sol.1893. *Xambou. "Mœurs et métamorphoses des Insectes." *Echange*, 1893 (*Blaps plana*, p. 49).

ELEODINAE.

Eleodes dentipes, Eschsch.1878-9. *Gissler, C. F. *Bull. Brooklyn Ent. Soc.*, I, 1878-79, p. 19, figs. 4-5.

1909. Blaisdell, F. E. "A monographic revision of the Coleoptera belonging to the Tenebrionide tribe Eleodini, etc." *Bull. U. S. Nat. Mus.*, LXIII, 1909, pp. 1-524, pls. i-xiii (*Eleodes denipes*, pp. 496, 497-499, pl. xiii, figs. 4-14).

Eleodes gigantea, Mannerh.

- 1878-9. *Gissler, C. F. *Bull. Brooklyn Ent. Soc.*, I, 1878-79, p. 19, figs. 4-5.
1909. Blaisdell, F. E. "A monographic revision of the Coleoptera belonging to the Tenebrionide tribe Eleodini, etc." *Bull. U. S. Nat. Mus.*, LXIII, 1909, pp. 1-524, pls. i-xiii (*Eleodes gigantea*, p. 496).

Eleodes opaca, Say.

1909. *Swenk, M. H. "*Eleodes* as an enemy of planted grain." *J. Econ. Ent. Concord N. H.*, 2, 1909, pp. 332-336, pls. ix-x.

PLATYSCELINAE.

Platyscelis gages, Fisch.

1888. *Lindeman, K. "Die schädlichsten Insekten des Tabak in Bessarabien." *Bull. Mosc.*, 1888, pp. 10-77 (*Platyscelis gages*, pp. 56-57).
1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 340.

PEDININAE.

Isocerus purpurascens, Herbst.

1898. *? Xamheu. "Moeurs et métamorphoses des Insectes, VII (1)." *Ann. Soc. Linn. Lyon*, XLV, pp. 9-66 (*Isocerus purpurascens*, p. 63).

Heliophilus ibericus, Muls.

Heliopathes ibericus, Muls.

1877. Perris, E. *Loc. cit.*, p. 263 and 103 respectively.

Phylan abbreviatus, Ol.

Heliopathes abbreviatus, Ol.

1887. *Rey, C. "Essai d'études sur certaines larves de Coléoptères et descriptions de quelques espèces inédites ou peu connus." *Ann. Soc. Linn. Lyon*, (n. s.) XXXIII, pp. 131-259, pls. i-ii (*Heliopathes abbreviatus*, p. 224).
1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 403.

1901. Xamheu. "Moeurs et métamorphoses des Insectes, IX (3)." *Rev. d'Entom.*, XX, pp. 7-68 (*Heliopathes abbreviatus*, pp. 21-23).

Phylan gibbus, F.

Holocrates gibbus, F.

1877. Perris, E. *Loc. cit.*, pp. 261-63 and 101 respectively.
 1877-8. Schiodte, J. C. *Loc. cit.*, pp. 538-540, pl. vii, figs. 7-14.
 1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 403.
 1895. Judeich, J. and Nitsche, H. "Die übrigen forstschädlichen Familien der Pentameren und Heteromeren." *Lehrbuch Mitt. Forstins.*, II (Wein, 1895), pp. 1299-1303 (*Heliopathes gibbus*, p. 1301).

Pedinus femoralis, L.

1887. Lindeman, K. "*Opatrum verrucosum* und *Pedinus femoralis* als Schädiger des Tabak in Bessarabien." *Entom. Nachr.*, XIII, pp. 241-244 (*Pedinus femoralis*, p. 244).
 1888. *Lindeman, K. "Die schädlichsten Insekten des Tabak in Bessarabien." *Bull. Mosc.*, 1888, pp. 10-77 (*Pedinus femoralis*, pp. 50-56).
 1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 362.

• *OPATRINAE*.

• *Phylax picipes*, Ol.

Phylax littoralis, Mulsant.

1873. Mulsant, E. and Mayet, V., "Histoire des métamorphoses de diverses espèces de Coléoptères." *Opusc. Ent.*, XIV, 1873, pp. 65-100 (*Phylax littoralis*, p. 90). See also Perris, 1877, *loc. cit.*, p. 263.

Melanimon tibiale, F.

Microzoum tibiale, F.

Opatrum tibiale, F.

1877. Perris, E. *Loc. cit.*, pp. 264 and 104 respectively.
 1895. Judeich, J. and Nitsche, H. "Die übrigen forstschädlichen Familien der Pentameren und Heteromeren" *Lehrbuch Mitt. Forstins.*, II (Wein, 1895), pp. 1299-1303 (*Opatrum* [*Microzoum*] *tibiale*, p. 1302).

Gonocephalum intermedium, Fisch.

1888. *Lindeman, K. "Die schädlichsten Insekten des Tabak Bessarabien." *Bull. Mosc.*, 1888, pp. 10-77 (*Opatrum intermedium*, pp. 19-49).

Gonocephalum pusillum, F.

1888. *Lindeman, K. "Die schädlichsten Insekten des Tabak in Bessarabien." *Bull. Mosc.*, 1888, pp. 10-77 (*Opatrum pusillum*, p. 58).

Gonocephalum pygmaeum, Stev.

1839. Westwood, J. O. *Loc. cit.*, p. 319, text-fig. 39, 6.

Gonocephalum simplex, F.*Gonocephalum micans*, Germ.

1902. *Xamheu. "Mœurs et métamorphoses des Insectes." *Ann. Soc. Linn. Lyon*, 1902, XLIX, pp. 1-53 and 95-160 (*Gonocephalum micans*, p. 122).

Opatrum sabulosum, L.

1870. Lucas, M. H. *Bull. Soc. Ent. France*, 1870, pp. lxxxii-lxxxiii.
 1871. Lucas, M. H. "Note sur la vie évolutive de l'*Opatrum sabulosum*." *Ann. Soc. Ent. France*, 1871, pp. 452-460, pl. 7, figs. 9-17.
 1877-8. Schiødte, J. C. *Loc. cit.*, pp. 541-543, 585, pl. vii, figs. 15-19.
 1895. Judeich, J. and Nitsche, H. "Die übrigen forstschädlichen Familien der Pentameren und Heteromeren." *Lehrbuch Mitt. Forstins.*, II (Wien, 1895), pp. 1299-1303 (*Opatrum sabulosum*, pp. 1301-1302).
 1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 422.

Opatrum verrucosum, Germ.

1888. *Lindeman, K. "Die schädlichsten Insekten des Tabak in Bessarabien." *Bull. Mosc.*, 1888, pp. 10-77 (*Opatrum verrucosum*, p. 43).
 1887. Lindeman, K. "*Opatrum verrucosum* und *Pedinus femoralis* als Schädiger des Tabak in Bessarabien." *Entom. Nachr.*, XIII, pp. 241-244 (*Opatrum verrucosum*, pp. 242-43).

Sinorus colliardi, Fairm.

1877. Perris, E. *Loc. cit.*, pp. 263-264 and 103 respectively.

Bycra villosa Pasc.

1885. Duges, E. "Métamorphoses de la *Bycra villosa*, Pasc." *Ann. Soc. Ent. Belgique*, XXIX (2), 1885, pp. 51-55, pl. iv, figs. 1-25.

PHALERIINAE.

Phaleria bimaculata,¹ L.*Phaleria cadaverina*, Latr. nec *cadaverina*, F.

1865. Fairmaire, L. "Note explicative des figures 1 à 9 de la planche 11 au sujet de la larve de la *Phaleria cadaverina*." *Ann. Soc. Ent. France*, (4) V, 1865, p. 657, pl. xi, figs. 1-9.
1877. Perris, E. *Loc. cit.*, pp. 269-271, fig. 277 and p. 109, fig. 277 respectively.
1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 478.

Phaleria cadaverina, F.

1889. Fowler, W. "Description of the larva of *Phaleria cadaverina*, F." *Ent. Mo. Mag.*, XXV, pp. 304-305.

Halammobia pellucida, Herbst.*Phaleria hemisphaerica*, Kust.

1877. Perris, E. *Loc. cit.*, p. 272, fig. 278 and p. 112, fig. 278 respectively.
1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 478.

CRYPTICINAE.

Crypticus quisquilius, L.*Crypticus glaber*, Dej.

1834. *Bouché, P. F. "Naturgeschichte der Insekten, besonders in Hinsicht ihrer ersten Zustände als Larven und Puppen" (Berlin, 1834), pp. v, 216, 10 pls. (*Crypticus glaber*, p. 191).
1839. Westwood, J. O. *Loc. cit.*, p. 319.
1877. Perris, E. *Loc. cit.*, pp. 259-261 and 99 respectively.
- 1877-8. Schiødte, J. C. *Loc. cit.*, pp. 535-538, pl. vii, figs. 1-4.

BOLITOPHAGINAE.

Bolitotherus cornutus, Panz.

1861. Candèze, E. C. A. "Histoire des métamorphoses de quelques Coléoptères exotiques." *Mem. Soc. R. Sci. Liège*, XVI, pp. 325-408 (*Bolitotherus cornutus*, p. 365, pl. iii, fig. 9).

¹ Gebien (Junk's *Coleopterorum Catalogus*, Tenebrionidae, p. 346) refers this description to *Phaleria cadaverina*, Latr., which is synonymous with *P. bimaculata*, L., and not to *P. cadaverina*, Fab., under which name Perris described the larva.

***Bolitophagus armatus*, Panz.**

1877. Perris, E. *Loc. cit.*, pp. 276-278, figs. 288-89 and p. 116, figs. 288-89 respectively.
1877-8. Schöpfde, J. C. *Loc. cit.*, p. 546, pl. ix, figs. 1-4.
1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, pp. 493, 494.

***Bolitophagus reticulatus*, Linn.**

1854. Curtis, J. "Descriptions of some Colcopterous Larvae, etc." *Trans. Ent. Soc. London*, (n. s.) III, 1854, pp. 33-40 (*Bolitophagus reticulatus*, p. 36, pl. v, figs. 13-22).
1859. Kraatz, G. "Ueber die ersten Stände einiger Coleopteren." *Berlin Ent. Zeits.*, III, 1859, pp. 304-312 (*Bolitophagus reticulatus*, pp. 309-310, pl. iv, fig. 5).
1877. Perris, E. *Loc. cit.*, pp. 273-275, figs. 279-287 and p. 113, figs. 279-287 respectively.
1877-8. Schöpfde, J. C. *Loc. cit.*, pp. 544-546, pl. viii, figs. 1-7.

***Bolitonaeus quadridentatus*, Cand.**

1861. Candèze, E. C. A. "Histoire des métamorphoses de quelques Coléoptères exotiques." *Mem. Soc. R. Sci. Liège*, XVI, pp. 325-408 (*Bolitothorus quadridentatus*, p. 368).

***Megeleates sequoiarum*, Cas.**

1896. *Wickham, H. F. "Descriptions of the larvae of some Heteromerous and Rhynchophorous beetles." *J. New York Ent. Soc.*, IV, pp. 118-124, pl. iv (*Megeleates sequoiarum*, p. 118).

RHIPIDANDRINAE.***Eledona agaricola*, Hbst.*****Bolitophagus agaricola*, F.*****Boletophagus agricola*.*****Eledona agaricicola*, Latr.**

1834. *Bouché, P. F. "Naturgeschichte der Insekten besonders in Hinsicht ihrer ersten Zustände als Larven und Puppen" (Berlin, 1834), pp. v, 216, 10 pls. (*Bolitophagus agaricola*, p. 191, pl. ix, fig. 7).
1839. Westwood, J. O. *Loc. cit.*, p. 315, text-fig. 38, 4.
1842. Erichson, W. F. "Zur systematischen Kenntniss der Insectenlarven." *Arch. für Naturg.*, VIII (1), pp. 363-379 (*Bolitophagus agricola*, p. 366).
1843. Dufour, M. L. "Histoire des métamorphoses de l' *Eledona agaricicola*, Latr." *Ann. Sci. Nat.*, (2) XX, 1843, pp. 284-289, pl. xii B, figs. 1-7.

1867. Frauenfeld, G. von. "Zoologische Miscellen, XII." *Verh. zool.-bot. Ges. in Wien*, XVII, pp. 775-804 (*Bolitophagus agaricola*, p. 780).
 1877-8. Schipdte, J. C. *Loc. cit.*, p. 547.
 1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 502.

DIAPERINAE.

Diaperis boleti, L.

1795. Olivier, M. *Entomologie*, III, 1795, No. 55.
 1832. *Hamerschmidt, C. E. "De ins. agric. damn." 1832, pl. i.
 1843. Dufour, M. L. "Histoire des métamorphoses du *Diaperis boleti*." *Ann. Sci. Nat.*, (2) XX, 1843, pp. 290-291, pl. xii B, figs. 10-14.
 1867. Frauenfeld, G. von. "Zoologische Miscellen, XII." *Verh. zool.-bot. Ges. in Wien*, XVII, pp. 775-804 (*Diaperis boleti*, p. 780).
 1877-8. Schipdte, J. C. *Loc. cit.*, pp. 547-49, pl. viii, figs. 14-22.
 1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 513.

Hoplocephala haemorrhoidalis, F.

1869. Gernet, C. v. "Beiträge zur Käferlarvenkunde." *Horae Soc. Entom. Ross.*, VI, 1869, pp. 3-16 (*Hoplocephala haemorrhoidalis*, p. 8, pl. ii, fig. 9).
 1877. Perris, E. *Loc. cit.*, pp. 280-81, figs. 297-299 and p. 120, figs. 297-299 respectively.

Scaphidema metallicum, F.*Diaperis aenea*, Panz.*Scaphidema aeneum*, Panz.

1839. Westwood, J. O. *Loc. cit.*, p. 314, text-fig. 37, 11-19.
 1877-8. Schipdte, J. C. *Loc. cit.*, pp. 552-54, pl. ix, figs. 10-16.

Platydema ellipticum, F.

1861. *Candèze, E. C. A. "Histoire des métamorphoses de quelques Coléoptères exotiques." *Mem. Soc. R. Sci. Liège*, XVI, pp. 325-408 (*Platydema ellipticum*, p. 370).

Platydema europaeum, Cast. et Brll.

1857. Perris, E. "Histoire des Insectes du Pin Maritime." *Ann. Soc. Ent. France*, (3) V, pp. 341-395, pls. viii-ix (*Platydema europaea*, pp. 343-45, pl. viii, figs. 401-412).

Platydemia palliditarse, Cast. et Brll.

1904. *Xamheu. "Moeurs et métamorphoses des insectes XIV." *Ann. Soc. Linn. Lyon*, LI, 1904, pp. 67-154 (*Platydemia palliditarse*, p. 123).

Platydemia violaceum, F.

1857. Perris, E. "Histoire des Insectes du Pin Maritime." *Ann. Soc. Ent. France*, (3) V, pp. 341-395 (*Platydemia violacea*, p. 346).
 1877. Perris, E. *Loc. cit.*, pp. 278-80, figs. 290-296 and p. 118, figs. 290-296 respectively.
 1877-8. Schiødte, J. C. *Loc. cit.*, pp. 550-52, pl. viii, figs. 25-29.

Alphitophagus bifasciatus, Say.

Phylethus quadripustulatus, Step.

- 1877-8. Schiødte, J. C. *Loc. cit.*, p. 555, pl. vi, figs. 17-27.

Ceropria subocellata, Cast. et Brll.

1861. *Candèze, E. C. A. "Histoire des métamorphoses de quelques Coléoptères exotiques." *Mem. Soc. R. Sci. Liège*, XVI, pp. 325-408 (*Ceropria subocellata*, p. 369).

Pentaphyllus testaceus, Hellw.

1842. Erichson, W. F. "Zur systematischen Kenntniss der Insectenlarven." *Arch. für Naturg.*, VIII (1), pp. 363-379 (*Pentaphyllus testaceus*, p. 366).
 1877. Perris, E. *Loc. cit.*, pp. 281-283, figs. 300-303 and p. 121, figs. 300-303 respectively.
 1877-8. Schiødte, J. C. *Loc. cit.*, pp. 557-559, pl. x, figs. 1-5.

ULOMINAE.

Gnathocerus cornutus, F.

Cerandria cornuta, F.

Echocerus cornutus, F.

1854. Motschulsky, V. de. "Sur la larve et chrysalide de la *Cerandria cornuta*." *Etud. Entom.*, III (Helsingfors, 1854), pp. 67-68.
 1869. Gernet, C. v. "Beiträge zur Käferlarvenkunde." *Horae Soc. Ent. Ross.*, VI, 1869, pp. 3-16 (*Gnathocera* [*Cerandria*] *cornuta*, pp. 11-15, pl. ii, fig. 10).
 1907. *Reineck, G. "Neue Beobachtungen über *Echocerus cornutus*, F." *Zeitschr. wiss. Insektenbiol.*, III, pp. 128-129.

***Lyphia tetrphylla*, Fairm.**

Lyphia ficicola, Muls. et Rey.

1877. Perris, E. *Loc. cit.*, pp. 283-285, figs. 304-309 and p. 123, figs. 304-309 respectively.

***Tribolium confusum*, Jacq du Val.**

1901. Xamheu. "Mœurs et métamorphoses des Insects, IX (3)" *Rev. d'Entom.*, XX, pp. 7-68 (*Tribolium confusum*, p. 63).

***Tribolium ferrugineum*, F.**

Tribolium castaneum, Herbst.

1839. Westwood, J. O. *Loc. cit.*, p. 319, text-fig. 39, 2-3.
1855. Lucas, M. H. "Observations sur les métamorphoses du *Tribolium castaneum*, Herbst., coléoptère hétéromère de la tribu des Diapériens." *Ann. Soc. Ent. France*, (3) III, pp. 249-259, pl. xiii, no. iii.
1877-8. Schiødte, J. C. *Loc. cit.*, pp. 563-565, pl. x, figs. 18-20.
1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 579.

***Phthora crenata*, Muls.**

1857. Perris, E. "Histoire des insectes du Pin Maritime." *Ann. Soc. Ent. France*, (3) V, pp. 341-359 (*Phthora crenata*, pp. 351-52, pl. viii, figs. 421-429).

***Palorus depressus*, F.**

- 1877-8. Schiødte, J. C. *Loc. cit.*, pp. 561-63, pl. x, figs. 12-15.

***Uloma culinaris*, L.**

1877. Perris, E. *Loc. cit.*, pp. 265-267 and 105 respectively.

***Uloma perroudi*, Muls. et Guilleb.**

1857. Perris, E. "Histoire des insectes du Pin Maritime." *Ann. Soc. Ent. France*, (3) V, pp. 341-395 (*Uloma perroudi*, pp. 347-49, pl. viii, figs. 413-420).

***Alphitobius diaperinus*, Panz.**

Heterophaga opatroides, Brll.

1848. Lucas, M. H. *Bull. Soc. Entom. France*, 1848, (2) VI
(*Heterophaga opatroides*, p. xiii).
1877-8. Schiødte, J. C. *Loc. cit.*, pp. 565-68, pl. xi, figs. 1-3.
1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 601.

Alphitobius piceus*, Ol.Alphitobius fagi*, Curt.*Alphitobius mauritanicus*, L.

1839. Westwood, J. O. *Loc. cit.*, p. 319, fig. 38, 20.
 1857. Lucas, M. H. "Note sur les métamorphoses de l'*Alphitobius mauritanicus*, Linné." *Ann. Soc. Ent. France*, (3) V, pp. 71-84, pl. iv, no. iii.
 1877-8. Schipdte, J. C. *Loc. cit.*, p. 568, pl. xi, figs. 4, 5.
 1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 602.

***Hypophloeus bicolor*, Ol.**

1839. Westwood, J. O. *Loc. cit.*, p. 315, fig. 38, 6.
 1877-8. Schipdte, J. C. *Loc. cit.*, pp. 559-561, pl. x, figs. 8-11.
 1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 551.

***Hypophloeus fasciatus*, F.**

1877. Perris, E. *Loc. cit.*, pp. 287-88 and 127 respectively.
 1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 551.

***Hypophloeus linearis*, F.**

1857. Perris, E. "Histoire des insectes du Pin Maritime." *Ann. Soc. Ent. France*, (3) V, pp. 341-395 (*Hypophloeus linearis*, pp. 358-360, pl. viii, figs. 439-443).
 1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 551.

? *Hypophloeus pini*, Panz.*Hypophloeus ferrugineus*, Crtz.

1857. Perris, E. "Histoire des insectes du Pin Maritime." *Ann. Soc. Ent. France*, (3) V, pp. 341-395 (*Hypophloeus ferrugineus*, Creutz., pp. 354-356, pl. viii, figs. 430-438).

***Hypophloeus unicolor*, Pill. et Mitterp.**

1877. Perris, E. *Loc. cit.*, pp. 285-287 and 125 respectively.
 1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 551.

TENEBRIONINAE.***Iphthimus italicus*, Truqui.**

1859. Mulsant, E., and Revielère, E. "Notes pour servir à l'histoire de quelques Coléoptères." *Opusc. Ent.*, XI, pp. 63-68 (*Iphthimus italicus*, p. 63-65).

***Upis ceramboides*, L.**

- 2-3. *Saalas, U. "Die Larven der *Stenotrachelus aeneus*, Payk. und *Upis ceramboides*, L., sowie die Puppe der

letzteren." *Helsingfors Acta Soc. Fauna et Fl. Fenn.*, XXXVII, No. 8, 1912-13, 12 pp., 2 pls.

***Menophilus cylindricus*, Herbst.**

Menophilus (Tenebrio) curvipes, Fab.

1857. Perris, E. "Histoire des insectes du Pin Maritime." *Ann. Soc. Ent. France*, (3) V, pp. 341-395 (*Menophilus [Tenebrio] curvipes*, Fab., pp. 361-364, pl. viii, figs. 444-457).

***Tenebrio molitor*, L.**

1721. Frisch, J. L. ("Von dem gelben meel-wurm und dem Schwarzen kefer, so daraus wird," pp. 1-3, pl. i, figs. 1-6). *Beschreibung von allerley Insecten in Deutschland, nebst nützlichen Anmerkungen*, III. (Berlin, 1721).
1775. De Geer, C. *Mem. Hist. Ins.*, V (Stockholm, 1775) (*Tenebrio molitor*, pp. 35-37, pl. ii, figs. 6-11).
- 1788-93. Gmelin, J. F. In C. a Linné "Systema Naturae", Ed. 13, I (*Tenebrio molitor*, p. 1995).
1795. Olivier, M. *Entomologie*, 1795, IV, No. 57.
- 1802-5. Latreille, P. A. *Hist. nat. des. Crust. et Insectes*, X, pp. 289-292.
1804. *Posselt, C. F. *Beyträge zur Anat. der Insekt.* (Tubingen, 1804), 36 pp., 3 pls. (*Tenebrio molitor*, p. 25, pl. iii, figs. 1-14).
1807. *Sturm. *Deutsch. Insekt.*, 1807, II, p. 214, pl. xlvi.
1817. Cuvier, G. *Regne Animal, Les Insectes*, pt. I (*Tenebrio molitor*, p. 371).
1839. Westwood, J. O. *Loc. cit.*, p. 317, text-fig. 38, 14-16.
1853. Chapuis, F. and Candèze, E. A. C. "Catalogue des larves Coléoptères connues jusqu'à ce jour avec la description de plusieurs espèces nouvelles," pp. 343-653, 9 pls. *Mem. Soc. R. Sci. Liège*, VIII, 1853 (*Tenebrio molitor*, p. 176).
- 1877-8. Schiødte, J. C. *Loc. cit.*, pp. 568-571, pl. xi, figs. 6-11.
1893. Lintner, J. A. "Eighth report on the injurious and other Insects of the state of New York for the year 1891." (Albany, 1893). (*Tenebrio molitor*, p. 177, text-fig. 29a.)
1896. Chittenden, F. H. "The principal Household Insects of the United States. Insects affecting cereals and other dry vegetable foods." *Bull. U. S. Dept. Agri. Ent.*, IV (Washington, 1896), 130 pp., 64 text-figs. (*Tenebrio molitor*, p. 116, text-fig. 54a).
1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 630.
- ? 1901. *Manger, K. "Einiges über die Entwicklung von *Tenebrio molitor*." *Soc. Ent.* (Zurich), XVI, pp. 73, 74.
1908. *Lindner, A. "Schwarze Mehlwürmer." *Gefied. W.* (Magdeburg, 1908), XXXVII, pp. 92-93.

1918.] F. H. GRAVELY : *Lignicolous Beetle-Larvae*. 171

1914. Herrick, G. W. *Insects injurious to the Household*. (New York, 1914), 470 pp., 152 text-figs., 8 pls. (*Tenebrio molitor*, p. 229).

Tenebrio obscurus, F.

1839. Westwood, J. O. *Loc. cit.*, p. 318, text-fig. 38, 17.
1893. Lintner, J. A. "Ninth report on the injurious and other Insects of the state of New York for the year 1892". (Albany, 1893). (*Tenebrio obscurus*, p. 307, text-fig. 5a.)
1896. Chittenden, F. H. "The principal Household Insects of the United States. Insects affecting cereals and other dry vegetable foods." *Bull. U. S. Dept. Agr. Ent.*, IV (Washington, 1896), 130 pp., 64 text-figs. (*Tenebrio obscurus*, pp. 117-118).
1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 630.
1914. Herrick, G. W. *Insects injurious to the Household*. (New York, 1914), 470 pp., 152 text-figs., 8 pls. (*Tenebrio obscurus*, p. 227-229, pl. iii).

Tenebrio opacus, Duft.

1855. Mulsant, E. and Guillebeau. "Notes pour servir a l'histoire des Tenebrions." *Opusc. Ent.*, VI, 1855, pp. 9-13 (*Tenebrio opacus*, pp. 9-11) ? reprinted from *Ann. Soc. Linn. Lyon*, I, 1855. See also Perris, 1877, *loc. cit.*, p. 290.
1877-8. Schiødte, J. C. *Loc. cit.*, p. 571.
1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 630.

Tenebrio picipes, Herbst.

Tenebrio transversalis, Duft.

1839. Westwood, J. O. *Loc. cit.*, p. 317, text-fig. 38, 14-16.
1855. Mulsant, E. and Guillebeau. "Notes pour servir a l'histoire des Tenebrions." *Opus Ent.*, VI, 1855, pp. 9-13 (*Tenebrio transversalis*, pp. 11-13) ? reprinted from *Ann. Soc. Linn. Lyon*, I, 1855, p. 11.
1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 630.

Catapiestus indicus, Fairm.

1915. Gravelly, F. H. "The larvae and pupae of some beetles from Cochín." *Rec. Ind. Mus.*, XI, pp. 353-366, pls. xx-xxi (*Catapiestus indicus*, pp. 363-365, pl. xxi, figs. 20-21).

PYCNO CERINAE.

Prioscelis serrata, F.

1897. *Kolbe, H. J. "Coleopteren (Käfer und Netzflugler)." *Deutsch. Ostafr.*, IV (Lief vi, vii, viii), 364 pp., 3 pls. (*Prioscelis serrata*, p. 244, pl. iii, fig. 25).

HELOPINAE.

Helops angustatus, Luc.*Helops agonus*, Muls.

1887. *Rey, C. "Essai d'études sur certaines larves de coléoptères et descriptions de quelques espèces inédites ou peu connus." *Ann. Soc. Linn. Lyon*, (n. s.) XXXIII, pp. 131-259, pls. i-ii (*Helops agonus*, p. 225).

Helops assimilis, Kust.

1877. Perris, E. *Loc. cit.*, pp. 292-293 and 132 respectively.

Helops coeruleus, L.

1836. Waterhouse, G. R. "Descriptions of the Larvae and Pupae of various species of Coleopterous Insects." *Trans. Ent. Soc. London*, I, 1836, pp. 27-33, pls. iv-v (*Helops coeruleus*, p. 29, pl. iv, fig. 3).
 1839. Westwood, J. O. *Loc. cit.*, p. 312, text-fig. 36, 20-25.
 1840. Perris, M. E. "Observations sur quelques Larves Xylophages." *Ann. Sci. Nat.*, (2) XIV, pp. 81-96, pl. iiiA (*Helops coeruleus*, pp. 81-83, pl. iiiA, figs. 1-5).
 1877. Perris, E. *Loc. cit.*, pp. 290-291, fig. 310 and p. 131, fig. 310 respectively.
 1877-8. Schöpfte, J. G. *Loc. cit.*, pp. 571-574, pl. xi, figs. 15-22.
 1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 687.

Helops ecoffeti, Kust.

1887. *Rey, C. "Essai d'études sur certaines larves de coléoptères et descriptions de quelques espèces inédites ou peu connus." *Ann. Soc. Linn. Lyon*, (n. s.) XXXIII, pp. 131-259, pls. i. and ii (*Helops ecoffeti*, p. 224).
 ? 1896. *Xamheu. "Mœurs et métamorphoses d'insectes, V." *Ann. Soc. Linn. Lyon*, XLIII, pp. 53-100 and 123-188 (*Helops ecoffeti*, p. 128).

Helops laevioctostriatus, Goeze.*Helops striatus*, Geoffr.

1857. Perris, E. "Histoire des Insectes du Pin Maritime." *Ann. Soc. Ent. France*, (3) V, pp. 341-395 (*Helops striatus*, p. 367, figs. 458-465).
 ? 1890. *Planet, L. *Le Naturaliste* (Paris, 1890), XII (*Helops striatus*, p. 17).
 1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 688.

Helops lanipes, L.

1837. Blanchard, E. "*Helops lanipes*, Fab." *Mag. Zool.*, 1837, class IX, pl. 175, figs. 1-2.

Helops laticollis, Kust.

Helops cerberus, Muls.

1892. Xamheu. "Mœurs et métamorphoses d'insectes (II)." *Echange*, suppl. (Lyon, 1892), pp. 1-46 (*Helops cerberus*, p. 11).

Helops pellucidus, Muls. et Rey.

1877. Perris, E. *Loc. cit.*, pp. 293-294 and 133 respectively.
1898. Kiesenwetter, H. v., and Seidlitz, G. *Loc. cit.*, p. 687.

Helops pyrenaeus, Muls.

- 1890.*Xamheu. *Le Naturaliste* (Paris, 1890), XII (*Helops pyrenaeus*, p. 279).
1893.*Xamheu. "Mœurs et métamorphoses d'insectes." *Ann. Soc. Linn. Lyon*, XL, pp. 1-52 (*Helops pyrenaeus*, p. 30).

Hydromedion nitidum, Mjöberg.

1906. Mjöberg, E. "Zur Kenntnis der Insektenfauna von Süd-Georgien." *Ark. f. Zool.*, III (13), pp. 1-14 (*Hydromedion nitidum*, p. 10, pl. i, fig. 4).

Hydromedion sparsutum, Müll.

1906. Mjöberg, E. "Zur Kenntnis der Insektenfauna von Süd-Georgien." *Ark. f. Zool.*, III (13), pp. 1-14 (*Hydromedion sparsutum*, pp. 6-7, text-fig. 4a-e, pl. i, fig. 2).

Perimylops antarcticus, Müll.

1906. Mjöberg, E. "Zur Kenntnis der Insektenfauna von Süd-Georgien." *Ark. f. Zool.*, III (13), pp. 1-14 (*Perimylops antarcticus*, pp. 11-14, text-figs. 5a-d, pl. i, fig. 5).

MERACANTHINAE.

Meracantha contracta, Beauv.

- 1896.*Wickham, H. F. "Descriptions of the larvae of some Heteromorous and Rhynchophorous beetles." *Journ. New York Ent. Soc.*, IV, pp. 118-124 (*Meracantha contracta*, p. 119, pl. v, fig. 2).
1915.*Hyslop. "Observations on the life-history of *Meracantha contracta*, Beauv." *Psyche*, XXII, pp. 44-48, pl. xxii.

STRONGYLIINAE.

? *Strongylium tenuicolle*, Say.

1874. Riley, C. A. "Sixth annual report on the noxious, beneficial and other Insects of the State of Missouri." 1874, pp. 117-118, text-fig. 32.

The Indian Museum collection of Tenebrionidae includes larvae of *Catapiestus indicus* and a cast larval skin of *Strongylium sobrinum*. The larvae of *Catapiestus indicus* have already been described (*loc. cit.*); but as the characteristic structures of the posterior end of the abdomen do not show well in the plate I take this opportunity of figuring them on a larger scale (pl. xx, fig. 5).

The cast larval skin of *Strongylium sobrinum* was found with a newly emerged adult in rotten wood. The adult was soft and quite white, but quickly hardened and assumed the characteristic dark olive colour when put alive into a tube with some of the wood from which it was taken. The larva of this species is as yet unknown. Many of its characters can, however, be determined from the skin, and these may now be described. It is unfortunate that the general form of the body cannot be determined. It seems unlikely, however, that the anus protruded in the living larva to anything like the extent that it does in the larva believed by Packard to be that of *Strongylium tenuicolle*, Say.

Strongylium sobrinum, Dohrn.

(Pl. xx, figs. 6-7.)

Locality.--Darjeeling District: Kalimpong, ca. 2000 ft. (in rotten wood).

The head bears a number of very large spines which appear to have had a definite arrangement. What this arrangement was, however, is not clear in the somewhat contorted state of the exuvium.

The labrum is more or less oval, and quite twice as broad as long. The antennae appear to be two-jointed, the basal joint being both shorter and broader than the other, which is about twice as long as broad and bears a few spines distally; but it is possible that they are incomplete. The mandibles are massive; they are much worn, but each appears to have had three terminal teeth and one large molar tooth. The blades of the maxillae are fringed with very strong spines; there are a number of finer spines behind the margin at the tip, and a few very long slender ones behind these. The maxillary palps are three-jointed, and are a little shorter than the blades; the first joint is about twice as broad as long; the second is scarcely as long as the first is broad, and scarcely as broad as long; the third is about as long as the second is broad and nearly twice as long as broad. The labrum is squarish

with almost straight sides. Its palps are two-jointed; the basal joint is stout, but scarcely as broad as long; the distal joint is only about half as broad as the basal, and is distinctly longer than broad.

The legs appear to have been soft and fleshy, but are each tipped with a strong claw.

All segments of the body except the anal are much shrivelled. There is a row of about eight¹ strong hairs in front of the anus, and a pair of smaller hairs a little in front of these on the same segment. On the ventral margin of the flattened posterior surface of the anal segment is a pair of large upwardly curved horns near the middle line, with a pair of strong hairs between them. Ten similar hairs are arranged on each side of the segment (pl. xx, fig. 7). The dorsal margin is thickly dentate, and there is a pair of transverse fossae situated laterally on the posterior surface immediately above a small tooth (see pl. xx, fig. 6).

¹ Four on one side, three and a small one a little out of the row on the other.

XV. NOTES ON THE CILIATE PROTOZOA OF LAHORE.

By B. L. BHATIA, M.Sc., Assistant Professor of Zoology,
Government College, Lahore.

I. ON THE OCCURRENCE OF THREE CONTRACTILE VACUOLES IN SPECIMENS OF *PARAMAECIUM CAUDATUM*.

Paramaecium caudatum, Ehrbg., is found in large numbers both in infusions and in stagnant water in Lahore and is studied as a type by the students. Recently (June, 1916) when my B.Sc. class were examining this animal, my attention was drawn by two students, Mr. Sham Nath and Mr. Prashar, to the existence of a third contractile vacuole in the specimen which was being studied by each. None of the other specimens from the same tube showed this peculiarity. The water had been collected from a ditch outside the laboratory compound.

In both these specimens the two normal vacuoles, each with its own system of radiating canals, were situated at about one-fourth of the length of the animal from either end, as is usually the case. The third contractile vacuole was situated nearer to the posterior vacuole at one-fourth of the distance between the two vacuoles in one specimen, and midway between the two vacuoles in the other. In both specimens the third vacuole had its own system of radiating canals and showed its systole and diastole independently of the other two, the three contracting regularly one after the other.

So far as I am aware, this occurrence of a third contractile vacuole has not been observed in this species before though it was observed by Bütschli in *P. patrinum*, as recorded in the following extract from Bronn's *Thier-Reichs* (I, p. 1417):—

“Erhöhung der vacuolenzahl ist nur von *Paramaecium* und *Ophryoglena* bekannt. Bei ersterer Gattung scheint die Zweizahl Regel zu sein (3 beobachtete Bütschli zuweilen bei *P. patrinum* 1876, p. 88); beide Vacuolen liegen ungefähr auf den Grenzen des 1 und 2 sowie des 3 und 4 Körperviertel hintereinander.”

II. RECORDS AND DESCRIPTIONS OF SPECIES.

The object of this paper is to record and describe a number of the more striking Ciliata that the writer has come across during the last two years in the water collected at various times from ditches, ponds, etc., in and about Lahore. The list represents

only a very small proportion of the Ciliate fauna of this place, and it is hoped to add to it occasionally in future communications.

Family ENCHELINA.

Subfamily HOLOPHRYINA.

Genus *Holophrya*, Ehrbg.

Holophrya indica, sp. nov.

Body evenly elliptical, a little more than one and a half times as long as broad; cuticular surface presenting distinct alternating longitudinal striae and furrows, ciliation uniform, cilia fairly long and distinct, disposed along the longitudinal striae; colourless;

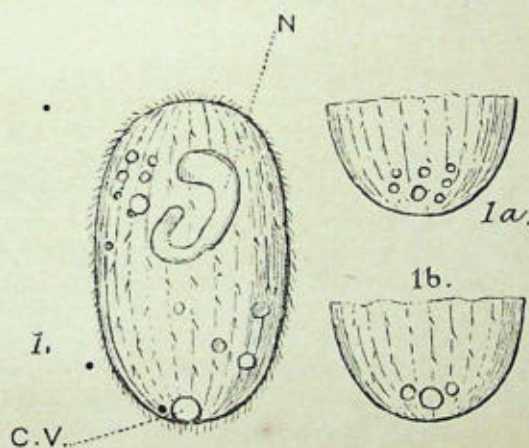


FIG. 1.—*Holophrya indica*, sp. nov., 1a. posterior end showing one principal and six subsidiary vacuoles; 1b. posterior end showing one principal and two subsidiary vacuoles.

(N. macronucleus; C. V. contractile vacuole or vacuoles.)

border of the oral aperture not projecting, pharynx absent; contractile vacuole single, spherical, postero-terminal, with a number of small circular feeding vacuoles in its neighbourhood which are not arranged in longitudinal rows; macronucleus large, band-shaped, curved in a horseshoe-shaped manner, situated in the anterior half of the body. Length 105μ , width 63μ . Habitat, stagnant water.

A few specimens of a new species of *Holophrya*, as defined above, were found in a temporary collection of water in a ditch on the roadside in front of the College compound in March, 1914. The body showed only a slight degree of flexibility, and was almost equally rounded at the anterior and posterior ends. On the surface presented to view, thirteen longitudinal striae, along which the cilia were disposed, were distinctly made out. So the animal

presented, both in its form and in its ciliary arrangement, a close resemblance to the theoretical diagram in Bronn's *Thier-Reichs*, fig. 17 a. The single spherical contractile vacuole situated near the posterior pole was seen to be surrounded by 5 to 7 small feeding vacuoles at the commencement of its diastolic phase. These were seen to contract and there would remain 3 only, the central one considerably larger than the 2 subsidiary ones now left. This main contractile vacuole then contracted and disappeared, the others following almost simultaneously and contributing to the formation of the vacuole afresh, the neighbouring subsidiary ones soon making their appearance again (figs. 1, 1a, 1b).

Of the several existing species of *Holophrya*, it shows some resemblance to *H. simplex* in the absence of trichocysts and pharynx, but differs considerably from it in the size of the body and the form of the macronucleus, specimens of that species being only about 35μ in size and the macronucleus globular. The only other species possessing a band-like nucleus is *H. coleps*, Ehrbg., in which, however, it is curved in a spiral and the subsidiary vacuoles arranged in an elongated row. So the form described belongs to a new species, for which the name *H. indica* is suggested.

Genus *Urotricha*, Clap. u. L.

Urotricha globosa, Schewiakoff.

Forms belonging to this species were found in the same locality as *H. indica* in April, 1914, and resembled closely the description given in Eyferth (3, p. 392); body egg-shaped with an anterior terminal mouth, and a posterior springing bristle elongated in the direction of the long axis of the body. A few points of difference were however observed. The macronucleus, which is spherical, is proportionately larger in size than there figured (tafel xii, 2), the contractile vacuole is placed in the median line near the posterior end and not on one side, and there are cilia on the posterior part of the body in the neighbourhood of the springing bristle also.

Genus *Enchelys*, Hill.

Enchelys arcuata, Clap. u. L.

Members of this species were found in an infusion of dry leaves in September, 1915, the dry leaves having been steeped in a dish of water about 10 days previously. Body rounded posteriorly, attenuated anteriorly. Length 80μ , maximum width 30μ . The animal is broadest at one-fourth of the length of the body from the posterior end, and begins to taper rapidly in the anterior fourth. Anterior end truncate, occupied by the mouth. Cilia covering the whole body, but very fine, rather longer ones at the oral end. Contractile vacuoles several, arranged in an arch along the margin of the body.

Genus *Lacrymaria*, Ehrbg.*Lacrymaria vermicularis* (Ehrbg.).(Syn. *Phialina vermicularis*, Ehrbg., Cl. u. L., and Kent.)

This animal was found in the same locality as *H. indica* in March, 1914. Body sub-cylindrical, or bottle-shaped if the apical lobe is taken into consideration, flexible and contractile, two and a half times as long as broad (Kent, 4, p. 519) appears to refer to the contracted state of the animal; in the fully extended condition in which I was able to observe it, it was 4 to 6 times as long as broad (figs. 2, 2a, 2b). Length about $104\ \mu$. Apical portion in advance of the annular furrow short and cylindrical, anterior margin of the body truncate and bearing a single circlet of cilia

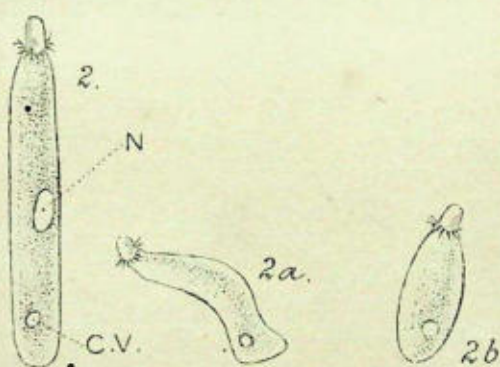


FIG. 2.—*Lacrymaria vermicularis* (Ehrbg.), fully extended, 2a, moderately extended; 2b, fully contracted.

(N, macronucleus; C. V., contractile vacuole or vacuoles.)

which are directed backwards, the rest of the body appeared, however, to be glabrous. The nucleus was seen to be oval in outline, and the single contractile vacuole situated near the posterior end.

Subfamily *COLEPINA*.Genus *Coleps*, Nitzsch.*Coleps hirtus*, O. F. Müll.

From a pond near Chota Ravi. Size $40\ \mu \times 20\ \mu$.

Subfamily *CYCLODININA*.Genus *Didinium*, Stein.•*Didinium nasutum*, St.

From the pond in front of the Municipal Office. Size $123\ \mu \times 64\ \mu$.

Family TRACHELINA.

Genus *Loxophyllum*, Duj.*Loxophyllum fasciola* (Ehrbg.), Cl. u. L.

(Syn. *Amphilephus fasciola*, Ehr., *Litonotus fasciola*, Kent.,
Litonotus varsaviensis, Wrz.)

subsp. *punjabensis*, subsp. nov.

Body elongate, transparent, flexible but scarcely contractile, three and a half times as long as broad, pointed posteriorly but not prolonged into a distinct tail-like portion, tapering gradually towards the anterior extremity which is curved towards the right;

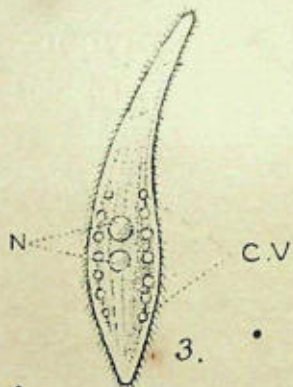


FIG. 3.—*Loxophyllum fasciola punjabensis*, subsp. nov.

(N. macronucleus; C.V. contractile vacuole or vacuoles.)

oral aperture nearly median; cuticular surface striate longitudinally; cilia on the neck region most conspicuous; contractile vacuoles arranged in two rows, seven along each border; macronuclei two in number, not united by a filament, spheroidal, sub-central. Length about 100 μ . Habitat, stagnant water.

A single specimen of this form, from water from the ditch in front of the College compound, came under my observation in March, 1914. The animal showed slow locomotion, now moving forwards, then suddenly in a backward direction. The length of the specimen was 147 μ and the maximum width 42 μ . The form showed closest resemblance to *Litonotus varsaviensis*, Wrz. (Kent, p. 744, pl. xlii, fig. 4), from which, however, it differed in the absence of trichocysts, number of contractile vacuoles, and their arrangement in two longitudinal rows instead of one containing five contractile vacuoles only (fig. 3). In the footnote Kent

observes as follows: "The large number of contractile vesicles serve to distinguish this species from *L. fasciola*, which in other respects it closely resembles." On this consideration there would be abundant justification for the erection of a new species for the present form, but by later writers *L. varsaviensis*, Wrz., does not appear to have been considered as specifically distinct from *L. fasciola*, which it closely resembles and in which there is only one contractile vacuole. I should think that *L. varsaviensis*, Wrz., and the form under consideration are sufficiently distinct to rank as subspecies. *Lionotus fasciola* has however since been separated from the genus *Lionotus* (falschlich zuerst *Lionotus* genannt—Bronn), which is reserved for species with a very long neck (in some being even longer than the body) and placed again under *Loxophyllum*, to which indeed it originally belonged (Clap. u. L.). So the form described above may be identified with *Loxophyllum fasciola*, and the name *punjabensis* given to the subspecies to indicate its special peculiarities.

Family CHLAMYDODONTA.

Genus *Nassula*, Ehrbg.

Nassula stromphii (Ehrbg.)

(Syn. *Liosiphon stromphii* Ehrbg.).

Found in water from a ditch on the roadside outside the College compound in March, 1914. The animals examined are referable to *Nassula stromphii* (Ehrbg.) as described in Kent (p. 496), but the description given there is inadequate, and so the following description is appended:—

Body ovate, with a distinct large prolongation of the anterior region beyond the oral aperture, anterior portion flexible; length 57μ , width 36μ ; colour green owing to the ingestion of algae as food particles; cilia uniform; pharynx armed, tubular, with a cylindrical fascicle of rod-like teeth; contractile vacuole large, posteriorly situated, with pinkish contents, with two or more smaller vacuoles irregularly distributed; macronucleus oval, sub-central and eccentric.

Family CHILIFERA.

Genus *Trichoda*, O. F. Müll.

Trichoda pura, Ehrbg.

In infusions of dry leaves.

Genus *Colpoda*, Müll.

Colpoda cucullus, Ehrbg.

In infusions of hay.

Family PARAMAECINA.

Genus *Paramaecium*, Hill.*Paramaecium caudatum*, Ehrbg.

In pond water and infusions of dry leaves.

Family PLAGIOTOMINA.

Genus *Spirostomum*, Ehrbg.*Spirostomum ambiguum*, Ehrbg., var. *minor*, Eyf.

In large numbers among the roots of *Eichhornia* growing in an aquarium. Length about 765 μ .

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3. Eyferth, B. . . Einfachste Lebensformen der Tier- und Pflanzenreiches. Vierte Auflage von W. Schoenichen und A. Kalberlah. (Braunschweig: 1909.)
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In addition to the works cited above, current literature in *Archiv für Protistenkunde*, *Journal of the Royal Microscopical Society*, etc., have also been consulted.

XVI. THE CEPHALOPODA OF THE INDIAN MUSEUM.

By ANNE L. MASSY.

(Plates XXIII—XXIV.)

The collection described in this paper includes all the specimens of Cephalopoda (except shells of *Nautilus*) that have accumulated in the Indian Museum in the course of the last 20 years, since Mr. Goodrich published his "Report on the collection of Cephalopods in the Indian Museum" in the "*Transactions of the Linnean Society*" in 1896.

The Cephalopods in the present list have been taken in most instances by the 'Investigator' off the Indian and Burmese coasts at depths varying from 5 to 947 fathoms, and in one instance a haul was made at 2000 fathoms. Reference to the text will show that many specimens were also collected on shore, and that the area covered extends from the Persian Gulf to China and Japan, and southwards to the Andaman Islands. It will be noted that many interesting specimens owe their capture to the energy of private collectors. Over four hundred specimens are enumerated, consisting of sixteen genera and forty-three species, only one of which, a small *Sepia*, appears to have been hitherto undescribed. There are also some specimens which are too young or in too bad a state of preservation for specific identification. Over half the collection is comprised of individuals of *Loligo indica*, Pfeffer, and *Sepiella inermis* (van Hasselt), in about equal numbers. Goodrich (1896) enumerates fifteen genera and twenty-eight species, five genera and twelve species of which are absent from the present list, but the results of both collections produce a total of twenty-one genera and fifty-five species.

Of these genera *Polypus* comes first with twenty species, and it may be thought that the eighteen members of this genus noted in the present paper have been described at undue length, but anyone who has made a study of these creatures is aware of the difficulties lying in the path to correct identification and will not, I think, regret having as many details as possible, especially as it seems probable that future research may reduce the number of species ascribed to this genus. The *Sepia* family comes next with nine species. In this family so many differences occur in colour, surface and shape, from individual variation, and different modes of preservation, that in many cases specimens very unlike each other have proved to be the same species when the shell was examined. Measurements of a number of shells will be found in

the text showing that the index is longest in young shells (at which period it is natural to expect that growth would be more rapid) and becomes shorter with age.

I have to thank Mr. Robson of the British Museum, and Mr. Nichols of the Dublin Museum, for giving me every facility to examine eastern Cephalopods in their charge.

I am indebted to M. Edouard Lamy for taking much trouble to find a number of specimens in the Paris Museum, and to my colleague Mr. Farran for much help and advice. Mrs. Russell is responsible for the illustrations. The three parts of Dr. Hoyle's "Catalogue of Recent Cephalopoda" have of course been invaluable, as they must always be to anyone working out a large collection of Cephalopoda. All the specimens except where otherwise stated have been preserved in alcohol.

Family CIRROTEUTHIDAE.

Cirroteuthis grimaldii, Joubin.

Cirroteuthis grimaldii. Joubin, *Bull. L'Inst. Océan.*, No. 226, pp. 1-13, figs. 1-7 (1912).

M²⁴³ 'Investigator' station 233: 6-xii-1897, Andaman Sea, 13° 17' 15" N., 93° 10' 25" E., 185 fathoms—One.

M^{327.1} 'Investigator' station 332: 12-iv-1904, Andaman Sea, 10° 21' N., 92° 46' 15" E., 279 fathoms—One.

M^{328.3} 'Investigator' station 333: 19-iv-1904, S.W. of Ceylon, 6° 31' N., 79° 38' 45" E., 401 fathoms—One.

M^{33.92} 'Investigator' station 361: 24-iii-1906, Arabian Sea, 13° 9' 27" N., 46° 45' 15" E., 540 fathoms—One.

M^{31.33} 'Investigator' station 381: 28-ii-1908, off Akyab, Burma, 18° 8' N., 93° 40' E., 298 fathoms—One.

These are all in very bad condition but appear to be of the same species. The two last-named and specimen M²⁴³ are in sufficiently good condition to show that their general contour bears a strong resemblance to the photographs of *C. grimaldii*, Joubin, which is characterized by its egg-shaped body, enormous eyes, and small fins set in a line with the posterior end of the body. Specimens M^{327.1} and M^{328.3} are much larger than the others and are in fragmentary condition. The dorsal cartilages of M^{328.3} and M²⁴³ were examined as they were protruding from the integument, and resemble fairly well the scheme of Joubin (*l.c.*, fig. 7) designed after feeling the cartilage through the skin.

The dorsal cartilage of the other specimens, felt through the skin, seems to be of the same shape.

It is very like that of *C. meangensis*, Hoyle (1886, fig. 5) except that the outer curves of the "horse-shoe" are less angular.

The fin cartilage resembles that of *C. grimaldii*. All the specimens agree with the type in the arrangement of the single row of arm suckers. The three or four next the mouth are very minute, and are suddenly succeeded by very large ones until

¹ *Proc. Royal Phys. Soc. Edinburgh*, 1886, 1897 and 1909.

about the seventh or eighth sucker, after which they become much smaller and continue gradually diminishing in size until the tip is reached. The cirri commence at about the second or third sucker. Specimen M ³¹²⁷ has enormously enlarged suckers on the ventral arms at the edge of umbrella. One of the arms is mutilated and only shows one large sucker, the other has five. Probably these enlarged suckers are connected with a hectocotylus but as the specimen is the best in the collection I have not dissected it. Specimen M ³²⁵³ which has lost almost all of its internal organs has three very large suckers at the edge of umbrella on four of the arms. The fragments of mantle remaining are so twisted that it is impossible to say if these are the four ventral arms.

With regard to measurements M. Joubin has already pointed out the difficulty of obtaining accurate figures from placing a compass on such soft tissues. A few approximate measurements and the number of suckers on some of the arms may be of use.

Eighty-six suckers were found on the type specimen on an arm of 214 mm. Specimen M ³²⁷³ possesses fifty-six suckers on the second left arm of 126 mm. less tip, seventy-two on the first right arm of 140 mm., and seventy-six on the third left of 130 mm.; specimen M ³²⁵³ has eighty-six suckers on the first right arm of 163 mm., seventy-one on the second left arm of 147 mm. less tip, and ninety on the fourth left of 150 mm. less tip. The proportionately larger number of suckers on the arms of the present specimens is probably due to the arm lengths being contracted from preservation in alcohol.

All the specimens have the surface inside the umbrella of a deep chocolate colour and the outer surface and fins much paler.

Specimen number	M ⁷⁴⁵	M ³²⁷³	M ³²⁵³	M ³¹²⁷	M ³¹³³
	mm.	mm.	mm.	mm.	mm.
End of body to dorsal edge of umbrella	61	...	...	61	51
Breadth of body	21	...	...	33	22
.. across eyes	22	...	...	45	25
Diameter of eye measured through skin	10	18	17	12	12
Fin length, insertion to tip	21	48	...	20	17
.. .. anterior to posterior margin	5	12	...	10	9
Diameter of ordinary largest sucker	2	5	3	3	50
.. .. enlarged sucker	...	...	6	5	...

Distribution.—Azores, 1900 m. (Joubin, 1912).

Cirroteuthis macrope, Berry.

Cirroteuthis macrope, Berry, *Bull. Bur. Fish.*, XXX, pp. 273-4, pl. 32, figs. 1-3 (1912).

M ³²⁵³ 'Investigator' station 109; 25-x-1890, S. of Cape Cormorin, 7° 41' N., 78° 21' E., 738 fathoms—One.

This is a damaged specimen intermediate in size between the two examples described by Berry. It is in sufficiently good condition to show clearly the wide mantle-opening, oar-like fins,

and large fused siphon with organ of two small oval pads on either side of dorsal wall near apex. The umbrella, which is very delicate and possibly mutilated, extends for about two-thirds of the length of the arms. The latter have lost almost all their suckers and only doubtful traces of cirri are present. Both eyes seem to measure about the same diameter. In the type specimens the left eye is much larger than the right. The inside of umbrella, and any patches of epidermis remaining on other parts of the body, are dark purple-brown.

Some approximate measurements are appended:—

	mm.
Total length	50
End of body to mantle-opening	15
Width of body	13
From point to insertion of fin	12
Breadth of fin at insertion	4
Width between eyes	16
Length of siphon	9

Type.—In U. S. National Museum.

Type locality.—Vicinity of San Diego, California, 2113-2259 fathoms, bottom of soft gray mud. Two specimens (Berry, 1912).

Family ARGONAUTIDAE.

Argonauta böttgeri, Maltzan.

Argonauta böttgeri, Maltzan, *Fourn. de Couch.*, XXIX, p. 163, pl. 9, fig. 7 (1881); Hidalgo, *Rev. Real. Acad. Cien.*, p. 9 (1905); *Argonauta böttgeri*, Dall, *Bull. Mus. Comp. Zool.*, XLIII, pp. 226, 229 (1908); *Argonauta böttgeri*, Smith, *Ann. Mag. Nat. Hist.*, XXI, p. 409, pl. 17, figs. 1-6 (1887); Berry, *Bull. Bur. Fish.*, XXXII, pp. 277-280, pl. 48, fig. 5, text-figures 3-7 (1914).

M³³⁸ 'Investigator,' Andamans, Marine Survey of India—One ♀.

This is in very soft condition and the mantle is denuded of epidermis. The dorsal surface of the head and upper arms is buff, spotted with small bluish-black chromatophores. The expanded portions of the first pair of arms are about 5 mm. in diameter. The arm suckers, except on the expanded portions, are very prominent. The web is about equal on all the arms and does not extend higher than the third sucker anywhere. The beak appears to be black when seen with the naked eye, and dark brown when viewed through a lens. The mantle-opening extends to the dorsal margin of each eye. The funnel is very long and its organ is similar to that figured by Berry (1914, text-fig. 5). The branches of the median pad measure 4.50 mm. in length and the lateral pads are 4 mm. in length. The end of the mantle is broken, disclosing the gonad with ova. The principal measurements are appended:—

	mm.
End of body to dorsal mantle-margin	14
" " " " eye	16
Breadth of body	7
" " " head	7

	mm.
Length of funnel	8
Diameter of eye	4
" " largest sucker	1
1st right arm to expanded portion	12
2nd " "	18
3rd " "	15
4th " "	15
1st left " to expanded portion	12
2nd " "	19
3rd " "	16
4th " "	14

Distribution.—Mauritius and Chagos Islands (Smith); Masbate, Philippines (Smith, Hidalgo); China Sea and Australia (Smith); Hawaiian Islands (Berry).

Family POLYPODIDAE.

Polypus rugosus (Bosc) d'Orbigny.

Sepia rugosa, Bosc, *Actes Soc. d'histoire nat. Paris*, p. 24, pl. 5, figs 1, 2 (1792); *Octopus rugosus*, d'Orbigny, *Céphalopodes acétabulifères*, p. 45, pls. 6, 23, fig. 2 (1835); Brock, *Zool. Jahrb.*, II, pp. 501-614, taf. 16, figs. 1-4, Jena (1887); Joubin, *Bull. Soc. Zool. France*, XXII, p. 99 (1897); *Octopus granulatus*, Lamarck, *Mém. Soc. d'histoire nat. Paris*, p. 20 (1799); Hoyle, 'Challenger' Rep. XVI (Cephalopoda), pp. 80-81 (1886); Goodrich, *Trans. Linn. Soc. Zool.*, VII, p. 19 (1896); Wülker, *Abh. d. II. Kl. d. k. Ak. d. Wiss.*, III Suppl.-Bd., I Abh., pp. 5, 6 (1910); *Octopus boscii* var. *pallida*, Hoyle, *l.c.*, pp. 81-83, pl. 1, pl. 3, fig. 2; *Octopus polyzenia*, Gray, *British Museum Catalogue*, p. 13 (1849); E. A. Smith, *Rep. Zool. Coll. Indo-Pacific Ocean during voyage H.M.S. 'Alert'*, p. 34, pl. 4, fig. A (1884); (?) *Octopus kagoshimensis*, Ortmann, *Zool. Jahrb.*, V, p. 644, pl. 21, fig. 2 (1888).

- M ¹⁷⁹² 'Investigator,' Palk St., Ceylon, Marine Survey of India—One ♀.
M ¹⁸³⁵ 'Investigator' station 267: 0-iv-1930, W. of Ceylon, 7° 2' 30" N., 79° 36' E., 457-589 fathoms—One ♀.
M ¹⁸⁹⁷ Persian Gulf (Townsend)—One ♀.
M ¹⁸⁸⁴ Off Santapilly, Madras Presidency, x-1900, trawler 'Golden Crown,' Bengal Fish. Dept.—One ♂.
M ¹⁹¹⁴ Persian Gulf, 19-v-1914, R. I. M. S. 'Palaurus'—One ♂.

These possess a round body with ventral furrow, a narrower head, and robust arms tapering to fine points, and measuring about two and a half times the length of the ventral mantle.

The umbrella, which is about one-quarter the length of the arms, and extends on their outer margins nearly to the tip, is lowest dorsally and about equal on the other arms. It is tubercled and covered with chromatophores inside and outside between the dorsal pair, and smooth and colourless elsewhere.

The mantle opens just below the eye and about half way between eye and siphon. Siphon conical, free for half its length and extending to, or above, the level of the eyes, and less than half way to umbrella margin; funnel organ W-formed and composed of narrow bands. Hectocotylized arm with well-marked sperm canal and very small terminal organ. Some suckers are enlarged on the lateral arms of both male specimens. In colour, all show

the very pronounced difference commented upon by Brock between the dorsal and ventral surface, the scoop out of the umbrella between the dorsal arms being also very marked. The Santapily specimen is of a reddish-purple colour above with an immense number of tubercles and oblong ridges, and a large cirrus at the posterior dorsal edge of eye. The examples M ^{327.0}₁, M ^{105.5}₁ and M ^{83.2.5}₂ resemble each other very closely in size and appearance, and are dark grey above with no oblong ridges, but with a great number of round tubercles regularly disposed, and surrounded and intersected by small dark chromatophores, arranged sometimes in masses which causes a handsome appearance like black veins all over the dorsal surface of head, mantle and arms. A trace of this marbling occurs on one side of the Santapily specimen. Ocular cirri are present on specimen M ^{105.5}₁ and faintly visible on M ^{83.2.5}₂ and suppressed entirely on M ^{327.0}₁. All four specimens possess a smooth ventral surface scattered thinly with reddish or brown chromatophores on a pale ground. The young specimen M ^{22.1}₁ is obviously the same species as the three just mentioned, but is without the dark veinings, and shows two rows of large dark chromatophores on the upper arms, in addition to the small chromatophores. Ocular cirri are present, and there are close-set tubercles on the dorsal surface of head and umbrella, but the mantle is nearly smooth. Specimen M ^{105.5}₁ closely resembled two specimens in the British Museum, one of which labelled "*O. granulatus*," came from the Cape, and the other labelled "*P. polyzenia-granulatus*," came from Thursday Island, Torres Straits.

Many arms are in course of regeneration in M ^{83.2.5}₂. The principal measurements of the other specimens are appended:—

Specimen number	M ^{327.0} ₁	M ^{105.5} ₁	M ^{22.1} ₁	M ^{83.2.5} ₂
	mm.	mm.	mm.	mm.
End of body to mantle-margin	26	25	39	8
" " " " eye	35	30	52	10
Eye to umbrella	19	19	29	6
Breadth of body	28	28	39	8
" " " head	18	18	30	7
1st right arm ¹	ca. 66	70	117	15
2nd " "	62	81	123	17
3rd " "	80	83	102	18
4th " "	81	87	159	18
1st left " "	mutilated.	mutilated.	116	15
2nd " "	77	80	119	16
3rd " "	75	less tip. 86	146	mutilated.
4th " "	77	72	142	17
Hectocotylus	...	...	3	...
Length of funnel	12	10	15	2.50
Diameter of largest sucker	4	3	6	ca. .75

Distribution—Africa, west and south, Peru, Indo-Malayan Region, Japan, Australia.

¹ Arms much curled up.

Polypus aculeatus (d'Orbigny).

Octopus aculeatus, d'Orbigny, *Céphalopodes acétabulifères*, p. 53, pl. 7, figs. 1, 2 (1825); pl. 8, fig. 1, pl. 23, figs. 3, 4 (1838).

M⁸¹⁰¹ Investigator, 25-viii-1911, Byikhwaaw Bay, Burma, Marine Survey of India—One ♂.

M⁸²⁴³⁻²⁴ (7) Burma (W. T. Blanford) from coral reef—Five ♂.

These are characterized by a short body, narrower head, and arms about seven times the length of the mantle. The umbrella is highest laterally, attains from one-eighth to one-tenth of the length of the arms, and continues on their outer margins almost to the tip, forming wide membranous expansions. The mantle opens midway between the eye and the siphon, and on a line with the base of the eye. Siphon conical, with a narrow opening, free for about half its length, and reaching above the level of the eyes; funnel organ, in the only specimen examined, W-shaped, and dark red on a pale ground; hectocotylized arm relatively long, with a wide membranous sperm canal; terminal organ small, narrow, with crenulated edges folded over the transversely-grooved inner channel. Some suckers on the lateral arms are moderately enlarged.

One specimen has had four of its arms mutilated near the base, a sharply-projecting point indicating the commencement of a new limb in each case. Very large cirri occur on the head and near the eyes in all the specimens, and are dispersed also on the dorsal surface of the mantle and umbrella and on the proximal parts of the arms. Some cirri measure as much as 2 mm. in length. In two of the specimens the surface between the large cirri is almost smooth, in others it is very rugose. All have the ventral surface smooth. Colour dull lilac, heavily marked on the dorsal surface with minute purple-black chromatophores. The specimen M⁸²⁴³ was compared with the type in the Paris Museum and appeared to resemble it very closely.

The latter was carefully set up in such a manner that a good comparison could be made. The Indian Museum specimens are, perhaps, a little more purple than the type but nevertheless the colouring and sculpture are very like.

The umbrella in the type is very short and much continued up the arms, and the tip of the hectocotylized arm is very minute. Enlarged suckers are present on the second and third arms, the largest being just above the umbrella.

The principal measurements of three specimens are appended:—

Specimen number	M ⁸¹⁰¹	M ⁸²⁴³	M ⁸²⁴⁴
	mm.	mm.	mm.
End of body to mantle-margin	11	17	22
.. .. eye	18	31	32
Eye to umbrella	12	22	24
Breadth of body	14	21	24
.. .. head	16	15	20

Specimen number	M ⁵¹⁰¹	M ⁵²¹³	M ⁵³¹¹
	mm.	mm.	mm.
1st right arm	57	110 ¹	157
2nd ..	80 less tip.	141	184
3rd ..	80	127	150
4th ..	mutilated.	137	172
1st left ..	63	130	150
2nd ..	98	147	210
3rd ..	62 less tip.	168	223
4th ..	82	163	182
Hectocotylus	125	250	225
Length of funnel	6	12	15
Diameter of largest sucker	650	4	5

Distribution.—Indo-Malayan and Insular Pacific Regions.

Type.—In Paris Museum, a male from Manila.

Polypus macropus (Risso).

Octopus macropus, Risso, *Hist. nat. Europ. méditerr.*, p. 3, pl. iv (1826); Hoyle, 'Challenger' Rep. XVI (Cephalopoda), p. 95 (1880); Ortmann, *Zool. Jahrb.*, III, p. 643, pl. 21 (1888); Jatta, *I Cefalopodi viventi nel Golfo di Napoli*, p. 117, pls. 6, 23, 24 (1896); Jouin, *Bull. Soc. Zool. France*, XXI, p. 93 (1897); *Octopus cuvieri*, d'Orbigny-Férussac, *Céphalopodes acétabulifères*, p. 18, pls. 1, 4, 24, 27 (1838); Appellöf, *K. Svensk. Vetensk. Akad. Handl.*, XXI, p. 6, pl. i (1886); *Polypus macropus*, Hoyle, *Bull. Mus. Comp. Zool.*, XI, III, p. 195 (1904); (?) Hoyle, *Trans. Linn. Soc. Zool.*, XXXI, pp. 36-37 (1907); Wülker, *Abh. d. H. Kl. d. k. Ak. d. Wiss.*, III Suppl.-Bd., 1 Abh., p. 6 (1910); Berry, *Proc. Acad. Nat. Sci. Phil.*, pp. 389-90 (1912a).

M ⁶⁰³ Indian Seas (Dr. Armstrong)—One ♂.

M ⁵²²⁰ Persian Gulf (R. Hugh Butler)—One ♂.

M ¹⁰²⁹⁸ Singgora, Talé Sap, Gulf of Siam, i-ii-1916 (N. Annandale)—One ♀.

Specimen M ⁶⁰³ agrees closely with a male example from Naples Bay, purchased by the Dublin Museum from the Zoological Station at Naples. The loose skin, which forms many thick rolls on the nuchal region is a remarkable feature, and both specimens have a closely noded surface with minute chromatophores, and a long funnel indented laterally at the apex so as to produce a lip on the dorsal and ventral walls. The example M ⁶⁰³ has a ventral median groove of which there is no trace in the Naples specimen. The main characters of M ⁶⁰³ are, briefly, arms about seven times the length of the mantle; the first pair the thickest and longest, and the only arms with enlarged suckers; umbrella about one-fifth of the arms and continued on their outer margins, highest dorsally; mantle-opening 6 mm. behind the eye and on a level with its lower edge; siphon long, two-thirds of it above the level of the eye, and reaching to within 3 mm. of the edge of umbrella; sperm canal striated faintly in proximal part, smooth elsewhere; terminal organ of hectocotylized arm very small², and narrower than the part of arm immediately preceding it; surface more or less

¹ In course of regeneration.

² In the Naples specimen, the terminal organ measures 6.50 mm. on an arm of 140 mm.

closely granulated all over, including inside of arms and umbrella; colour buff with minute dark chromatophores on dorsal surface of mantle and head. Specimen M ⁸⁹²⁰₁ is a dried-up sand-coated specimen, but closely resembles a female from Yokohama in the British Museum which was got by the 'Challenger' Expedition. It differs a good deal from specimen M ⁶⁹³₁, but like it, has the first pair of arms the longest and thickest. Enlarged suckers are present on the four upper arms. The sperm canal is not striated. The hectocotylus is mutilated, but was probably very small and narrower than the part of arm immediately preceding it. The funnel is indented at the apex but does not extend so far as in specimen M ⁶⁹³₁. The umbrella is about one-seventh the length of the arms and is much higher dorsally than ventrally. It does not seem to extend up the arms, which are, however, much shrivelled and each possesses a remarkable dark line on the dorsal surface. A distinct trace of this line occurs in the Yokohama specimen, but it is absent in specimen M ⁶⁹³₁.

The principal measurements are appended:—

Specimen number ...	M ⁶⁹³ ₁ mm.	M ⁸⁹²⁰ ₁ mm.
End of body to mantle-margin ...	19	32
" " " " eye ...	28	43
Eye to umbrella ...	27	27
Breadth of body ...	26	23
" " head ...	21	20
1st right arm ...	137	mutilated.
2nd " " ...	133	170
3rd " " ...	62	83
4th " " ...	90	137
1st left " " ...	145	196
2nd " " ...	128	146 less tip.
3rd " " ...	105	153
4th " " ...	87	148
Hectocotylus ...	3	mutilated.
Length of funnel ...	17	15
Diameter of largest sucker ...	3	5

The female from the Gulf of Siam, which was received too late to incorporate full particulars, has the mantle 44 mm. long.

Distribution.—Mediterranean, Azores, Canary Islands, Red Sea, Indo-Malayan Region, Japan, Pacific Ocean.

Polypus areolatus (de Haan).

Octopus areolatus, de Haan MS., 1835 (*fide* d'Orbigny); d'Orbigny and Férussac, *Céphalopodes acétabulifères*, p. 65 (1838), p. 186 (1845); Hoyle, 'Challenger' Rep. XVI (Cephalopoda), pp. 86-88, pl. 3, figs. 6, 7 (1886); Brock, *Zool. Jahrb.*, II, pp. 610-611 (1887); Ortman, *Zool. Jahrb.*, III, p. 662 (1888); Joubin, *Revue Suisse Zool.*, II, p. 28 (1894); *Notes Leyden Mus.*, XX, p. 22 (1898); *Octopus ocellatus*, Gray, *Cat. Moll. B.M.*, part 1, p. 15 (1849); Appellöf, *K. Svensk. Vetensk. Akad. Handl.*, XXI, p. 8, pl. i, figs. 1, 3 (1886); *Octopus brocki*, Ortman, *Zool. Jahrb.*, V, p. 645 (1888); *Polypus areolatus*, Hoyle, *Bull. Mus. Comp. Zool.*, XLIII, p. 16 (1904); Wülker, *Abh. d. II. Kl. d. k. Ak. d. Wiss.*, III Supple.-Bd., I Abh., p. 6 (1910); Berry, *Proc. Acad. Nat. Sci. Phil.*, pp. 393-396, text-fig. 1 (1912).

M. 1922 "Investigator" station 328: 7-III-1904. Gulf of Martaban, 14° 40' N., 95° 52' E., 61 fathoms—One ♂.

Brock objects to Hoyle's view that the *O. ocellatus* of Appellöf is the same species as *O. arcolatus*, and states that the umbrella in Appellöf's species is weakly developed and that the ocellus is placed close to its edge. A glance at Appellöf's fig. 2 of pl. 1 shows, however, that he placed the ocellus at fully 8 mm. from the edge of the umbrella, and in his description he states that the umbrella is "well developed" (Väl utvecklad) and describes the situation of the ocellus as being "between the base of the second and third arm pair." Appellöf's description and illustration of the terminal organ of the hectocotylized arm, and the widely developed membranous sperm canal with its transverse grooves, closely agrees with the form of hectocotylus in the present specimen, which is, however, characterized by a somewhat shorter body than that of the example figured by Appellöf. It has the mantle widest posteriorly and with a conspicuous ventral furrow. Arms two and a half to three times the length of the body and with prominent suckers, some of which are enlarged on the lateral arms. Umbrella extending to about one-third of the length of the arms, thin, smooth and membranous, except between the dorsal pair, where it is much shorter, thick and tubercled. Umbrella continued on outer margin of arms for more than two-thirds of their length. Ocelli placed midway between eye and edge of umbrella, each consisting of a dark core surrounded by a white ring, and succeeded by a dark outer ring. Mantle opening placed a little below and behind eye, and on a line with ocellus, visible from above. Funnel free for half its length and reaching considerably above level of eye. Funnel organ more like the typical printer's W than Berry's illustration (1912a, fig. 1). Dorsal surface of head and mantle closely set with round tubercles; traces of cirri on dorsal edge of eye. The space between each tubercle is covered with minute dark chromatophores which are thinly scattered on the ventral surface, causing the colour to appear grey above and buff beneath. Hoyle (1886, p. 87) remarks that "on the outer surface of each of the four ventral arms are two rows of dark elongated spots." All the arms of the present specimen are thus adorned.

The principal measurements are appended:—

	mm.
End of body to mantle-margin	20
" " " " eye	25
Eye to umbrella	11
Breadth of body	10
" " head	13
1st right arm	44
2nd " "	49
3rd " "	45
4th " "	61
1st left " "	39
2nd " "	52
3rd " "	58
4th " "	56
Hectocotylus	6

	mm.
Length of funnel	8
Diameter of largest sucker	2
" " eye opening	2
Ocellus	5

Distribution.—Japan (Wülker, Ortmann, Appellöf, Berry); Hong Kong and south of Papua (Hoyle).

Polypus cyanea (Gray).

Octopus cyanea, Gray, *Brit. Mus. Cat.*, p. 15 (1840); Brazier, *Aus. Mus. Cat. Sydney*, p. 7 (1892).

M²⁵³ Akyab, Burma (J. H. Burkill)—One ♀.

This has an elongate body, widest at centre, and quite smooth except for a few very minute tubercles on dorsal mantle and arms. Eyes not prominent and without cirri. Mantle-opening placed just behind eye but much below it. Apex of siphon about on level with eyes and reaching nearly half way to umbrella. Siphon free for almost half its length and appearing to be without a funnel organ. Arms about four and a half times the length of the body and head, and six times the length of the body alone, very robust and long in proportion to size of body; semi-equal, the second and third being the longest, and the fourth a little longer than the first. Suckers very prominent and not very close; in two alternate rows except at the base where a few are placed singly. About the eleventh sucker from the base is very large and has eighteen to twenty radial grooves. The umbrella attains one-third to one-quarter the length of the arms, and is highest laterally, and considerably higher dorsally than ventrally. Colour pale lilac, produced by a sprinkling of minute black or purple dots on a buff ground; ventral surface paler with brownish and purple-red dots. A male specimen in the British Museum, labelled "*Octopus cyanea*, Gray, Moreton Bay, between tide marks, Queensland Museum," very closely resembles this in general appearance, as well as in the absence of ocular cirri, the almost smooth body, the position of the mantle-opening, the shape of the siphon, the order and length of arms and the prominence of the suckers. The colouring of the Australian specimen is a little darker and the chromatophores on the arms are sometimes arranged in circles which is not the case with specimen M²⁵³. It may be useful to add that the hectocotylized arm of the Australian specimen has a minute terminal organ measuring only 2 mm. on an arm of 3.40 mm. The sperm canal is unusually broad and its clear buff colour is sharply defined from the mottled oral and dorsal surface. Some suckers at the margin of the umbrella are much enlarged on the second and third arms. The principal measurements of specimen M²⁵³ are appended:—

	mm.
End of body to mantle-margin	108
" " " " eye	125
Eye to umbrella	106

	mm.
Breadth of body (flattened)	78
Breadth of head	46
1st right arm	342
2nd " "	455
3rd " "	427
4th " "	422
Umbrella between dorsal arms	98
" " ventral "	73
" " " 1st and 2nd left arms	128
Diameter of largest sucker	10
" " eye-opening	7
Length of funnel	32
Breadth of funnel at apex	15

Distribution.—New South Wales, Queensland, Solomon Islands (Brazier, 1892).

Polypus defilippi (Verany).

Octopus defilippi, Verany, *Céphalopodes de la Méditerranée*, p. 30, pl. xi, figs. d. l. (1851); Hoyle, 'Challenger' Rep., XVI (Cephalopoda), p. 8 (1886); Jatta, *I Cefalopodi viventi nel Golfo di Napoli*, pp. 221-224, pl. 4, fig. 2; pl. 24, figs. 4-13; pl. 25, fig. 1 (1896); *Octopus De Filippi*, Targioni-Tozzetti, *Commentario sui Cefalopodi mediterranei del R. Museo di Firenze*, p. 20 (1869); Tiberi, *Bull. Soc. Mal. Ital.*, V, p. 2 (1880); Carus, *Prodromus Faunae Mediterraneae*, etc., II, Cephalopoda, p. 460 (1890); *Octopus Defilippi*, Tryon, *Manual of Conchology*, I, Cephalopoda, p. 3 (1879); *Octopus de-filippi*, Bergmann, *Sitz.-Ber. Ges. Nat. Freunde Berlin*, pp. 104-109, 3 figs. [*Receptaculum seminis*] (1903).

M. 5133. Investigator's station 503; 25-1-1913, Mergui Archipelago, shore collecting, Marine Survey of India—One ♂.

Except that it is a little smaller, this specimen exactly resembles the illustration of Jatta (*l.c.*, tav. 4, fig. 2) having the same long narrow body, prominent eyes, and pale greenish-yellow colouring with delicate slightly-defined dark reticulations. The fourth arms are much the longest and thickest, being six or seven times the length of the mantle, while the dorsal pair is only about three times of this length. None of the suckers is specially enlarged. Umbrella attaining about one-eighth of the length of the arms, widest ventrally, and extending prominently on the upper part of arms forming large crests. The mantle opens a little below and at the ventral edge of eye. Funnel small and extending about half way to the margin of umbrella. Two ocular cirri are present over each eye and a few tubercles are scattered on the dorsal surface of the head and mantle. Ventral surface smooth except for a faintly-indicated median groove. The striated sperm canal and small terminal organ of the hectocotylized arm agree with Jatta's description. A Bay of Naples specimen, purchased from the Zoological Station of Naples by the Dublin Museum, has the typical round body represented by Verany, and by Jatta on pl. 24, figs. 10, 12. Jatta mentions that this is due to the mantle of specimens in alcohol becoming contracted, and, therefore, swollen in the middle, restricted at each end, and furnished with a median ventral groove. He describes the surface as being perfectly smooth

except for two ocular cirri. The Dublin Museum specimen is however, much tubercled, even on the ventral surface, where there is also a strong median groove, and in the centre of the posterior end of the mantle there is a slight projection surrounded by a ring of tubercles.¹ The specimen is of a pale purple-gray tint, but agrees with the example M⁵¹⁵³ in having the first four suckers placed singly on all the arms, and also in the width of the mantle-opening, the size of the funnel, and its distance from the umbrella-margin, as also in the size of umbrella and the conspicuous development of the white transparent portion of it between the ventral arms. Tryon remarks that this species is certainly very near *P. aranea*, d'Orb., and I thought at first that the example M⁵¹⁵³ would probably prove to be it, particularly as *P. defilippi* had not been observed outside the Mediterranean. On comparing M⁵¹⁵³, however, with the type of d'Orbigny in the Paris Museum, I found that the umbrella in *P. aranea* is lower ventrally than dorsally and does not appear to be continued on the arms, which are much slighter in proportion to the size of the body than in *P. defilippi*; the body also is quite round, but that, as in *P. defilippi*, may be due to contraction. *P. aranea* has a very smooth surface and a pale body with very minute round red-brown chromatophores. In the specimen M⁵¹⁵³ the chromatophores are minute, oblong and almost black. The principal measurements are appended:—

	mm.
End of body to mantle-margin	23
" " " " eye	32
Eye to umbrella	14
Breadth of body	15
" " head	11
1st right arm	82
2nd " "	135
3rd " "	46
4th " "	157 ²
1st left " "	80
2nd " "	115
3rd " "	107
4th " "	138 ²
Hectocotylus	150
Diameter of largest sucker	3

Distribution.—Mediterranean.

Polypus hongkongensis (Hoyle).

(?) *Octopus punctatus*, Gabb, *Proc. Calif. Acad. Nat. Sci.*, II, p. 170 (1862); Dall, *Ibid.*, III, p. 243, fig. 27 (1866); Verrill, 'Blake', *Suppl.*, p. 117, pls. 4, 5, fig. 2 (1883); *Octopus hongkongensis*, Hoyle, *Diagnoses* I, p. 224; *Prelim. Rep.*, I, p. 99 (1885); *Octopus punctatus*, Hoyle, 'Challenger' *Rep.*, XVI (Cephalopoda), p. 100, pl. 5 (1886); Ortmann, *Zool. Jahrb.*, III, p. 662 (1888); Joubin, *Mém. Soc. Zool. France*, X, p. 110, pl. 9 (1897); *Bull. Soc. Zool. France*,

¹ This would appear to be an abnormality common to several species. It is noted by Hoyle (1886, p. 93) for *Polypus pictus* (Brock), and is figured by Joubin (1903, pl. 1, figs. 7 and 8) for *P. fontanianus*, d'Orb.

² Less tip.

XXII, p. 98 (1897); *Polypus punctatus*, Wülker, *Abh. d. H. Kl. d. k. Ak. d. Wiss.* III Suppl.-Bd., 1 Abh., p. 7 (1910); *Polypus hongkongensis*, Berry, *Bull. Bur. Fish.*, XXX, pp. 280-4, pls. 35, fig. 3; 36, fig. 1; 39, figs. 3-4; 40, fig. 1 (1912); *Proc. Acad. Nat. Sci. Phil.*, p. 391 (1912).

M ³¹¹² 'Investigator' station 237: 13-iv-1898, Andaman Sea, 13° 17' N., 93° 7' E., 90 fathoms—One ♂.

M ³¹¹⁷ 'Investigator' station 465: 22-iv-1912, S. of Ceylon, 5° 56' N., 81° 24' E., 109-132 fathoms—One ♀.

Specimen M ³¹¹² agrees exactly with the 'Challenger' example in the British Museum in shape of body and general appearance, distribution of web, brown coloured chromatophores, round tubercles and large cirri under eyes.

The funnel organ was apparently W-shaped but the lateral pads have become very indistinct.

Specimen M ³¹¹⁷ is darker, being of a reddish-brown mottled with black on the upper surface. The web is highest laterally but the ventral arms and web are longer than the dorsal. The entire surface, including inside of web, is tubercled, and there are also oblong wart-like folds on the dorsal surface of the body and arms. Funnel organ W-shaped.

The principal dimensions are appended:—

Specimen number	M ³¹¹²	M ³¹¹⁷
	mm.	mm.
End of body to mantle-margin	14	54
" " " " eye	16	63
Breadth of body	12	51
" " " " head	9	32
Eye to umbrella	15	51
1st right arm	70	140
2nd " "	62 less tip.	170
3rd " "	38	190
4th " "	mutilated.	170
1st left " "	70	150
2nd " "	60 less tip.	172
3rd " "	79	187
4th " "	67	133 less tip.
Diameter of largest sucker	1	6
Hectocotylus	3 less tip.	

Distribution.—Indo-Malayan Region, Japan, Alaska, British Columbia, California.

Type.—A male in the British Museum.

Type locality.—Off Ino Sima Island, Japan, 345 fathoms.

Polypus levis, Hoyle.

Octopus levis, Hoyle, *Diagnoses* I, p. 229; *Prelim. Rep.*, I, p. 104 (1885); 'Challenger' *Rep.*, XVI (Cephalopoda), pp. 98-99, pl. 2, figs. 1-4, pl. 3, fig. 1 (1886).

M ⁴⁷⁶⁸ 'Investigator,' Indian seas, Marine Survey of India—One ♀.

Compared with the large type male this has the same shaped head and body, and wide web not attaining much development on

the arms. The large type specimen shows no colour but a smaller example exhibits the same peculiar large chocolate coloured chromatophores distinguishing *M. ^{11,98}*, which is further characterized by a hard dried-up body with ventral furrow, narrow mantle opening, and siphon extending one-third of the distance to margin of web between ventral arms and having its apex above the line of the eyes. Surface smooth, colour slate-blue¹ above with large chromatophores at sides, paler beneath and freckled with minute dots and paler large chromatophores. Funnel organ W-shaped.

Principal measurements :—

	mm.
End of body to eye	30
Eye to umbrella	21
Breadth of body	20
" " head	17
End of body to ventral mantle	24
1st right arm	59
2nd " "	60
3rd " "	57
4th " "	56
1st left " "	60
2nd " "	62
3rd " "	56
4th " "	57
Diameter of largest sucker	2

Distribution.— $52^{\circ} 59' 30''$ S., $73^{\circ} 33' 30''$ W., 75 fathoms.

Type.—In British Museum, two males (one immature) and two immature females.

Polypus januarii (Steenstrup).

Octopus januarii: "Steenstrup, MS." Hoyle, *Diagnoses* I, p. 229; *Prelim. Rep.*, p. 105 (1885); *Challenger Rep.*, XVI (Cephalopoda), pp. 97-98, pl. 7, figs. 1-4 (1886); *Octopus januarii*, Goodrich, *Trans. Linn. Soc. Zool.*, 2, VII, part 1, p. 10 (1896); *Polypus januarii*, Hoyle, *Bull. Mus. Comp. Zool.*, XLIII, p. 18, pl. 5, fig. 2 (1904a); Berry, *Proc. Acad. Nat. Sci. Phil.*, p. 392 (1912).

M ^{31,5} 'Investigator' station 222: 21-xii-1896, Andaman Sea, $13^{\circ} 27'$ N., $93^{\circ} 14' 30''$ E., 405 fathoms—One ♀.

M ^{31,11} 'Investigator' station 332: 12-iv-1904, $10^{\circ} 21'$ N., $92^{\circ} 46' 15''$ E., 279 fathoms—One ♀.

M ^{32,13} 'Investigator' station 207: 13-iv-1902, Gulf of Oman, $25^{\circ} 11' 30''$ N., $57^{\circ} 15'$ E., 689-700 fathoms—One ♂.

M ^{33,18} 'Investigator' station 343: 19-x-1904, Gulf of Oman, $23^{\circ} 46' 15''$ N., $58^{\circ} 31' 50''$ E., 609 fathoms—One ♀.

These are all characterized by a round body of very soft consistency, enormous eyes, and arms of from three and a half to five times the length of the ventral mantle. The arms are not so long in proportion to the body as in Hoyle's description, but this is a character depending much on preservation. The first and second pairs seem to be always longer than the others, and slightly thicker

¹ This tint seems like a deposit over a reddish-brown colour.

than the ventral pair. The suckers are small, prominent and far apart; none are enlarged in the male. The umbrella attains to one-third or one-fourth of the arms, is lowest ventrally and about equal elsewhere. It is continued on the outer margins of the arms, but not remarkably so except in the largest specimen. The mantle-opening is placed just below the eye. The funnel is much fused to the head and reaches to about one-third of the distance to the umbrella margin. Two specimens were examined with regard to the funnel organ. One is in too bad condition; but the other, M ²¹¹¹, possesses an oval, somewhat shield-like median pad, and two oblong lateral pads of about half the width of the median one. It is possible that these may have been joined to the median pad at the posterior end. The tip of the hectocotylized arm resembles that figured by Hoyle (1886, pl. 7, fig. 2) except that, as in the examples recorded by Goodrich, the ridges are more marked. All the examples are quite smooth and pinkish in colour. The chromatophores are very minute, and of various tints from yellow-brown to purple-red. The principal measurements are appended:—

Specimen number	M ²¹¹¹	M ⁸¹¹¹	M ¹⁵¹¹	M ³⁸¹⁸
	mm.	mm.	mm.	mm.
End of body to mantle-margin	24	25	37	42
Eye to umbrella	29	31	54	60
Breadth of body	24	21	30	40
head	18	20	18 ¹	26 ¹
1st right arm	118 ²	96	140	182
2nd ..	115 ²	90	136	201
3rd ..	112	mutilated.	65	201
4th ..	115	..	117	192
1st left ..	135	93	mutilated.	185
2nd ..	130	85 ²	124	168
3rd ..	122	84	114	172
4th ..	76 ³	75	122	180
Hectocotylus	..	..	13	..
Diameter of largest sucker	1.50	2	1.50	3

Distribution.—Off Barra Grande, Brazil (type locality); Rio de Janeiro, Brazil, and North Pacific, east of Japan (Hoyle); Bay of Bengal and Andaman Sea (Goodrich); Off the Cocos Islands (Hoyle).

Polypus tonganus, Hoyle.

Octopus tonganus, Hoyle, *Diagnoses* 1, p. 225 (1885); *Prelim. Rep.*, p. 100 (1885); *Challenger Rep.*, XVI (Cephalopoda), pp. 83-84, pl. 8, figs. 1, 2 (1886); Hedley, *Mem. Austr. Mus. Sydney*, III, pp. 520, 550 (1899); *Polypus tonganus*, Hoyle, *Bull. Mus. Comp. Zool.*, XLIII, no. 1, p. 17 (1904); *Fauna and Geogr. Maldive Laccadive Archip.*, II, suppl. 1, p. 978 (1905).

M ⁷⁹⁶. Investigator's station 242: 2-x-1898, Arabian Sea, 17° 27' N., 71° 41' E., 56-58 fathoms—One ♂

¹ In bad condition.

² Less tip.

³ In course of regeneration.

This resembles the type male in the British Museum very closely but is a little lighter in colour on the lower surface.

The hectocotylus is exactly like that of the type. It will be remembered that the latter has four enlarged suckers on each lateral arm; the present specimen does not show these probably because the arms are in course of regeneration. The first and third pairs are the most slender at the base and the second and fourth the strongest and thickest.

The web is very short, highest laterally and lowest ventrally. The funnel organ appears to be W-shaped but is not in good condition. A few very small tubercles are present on the head and dorsal mantle. Colour buff densely covered above with very minute dark brown chromatophores, paler beneath. The dark dorsal surface of arms presents a strong contrast to the flesh-coloured ventral surface.

The principal measurements are appended:—

	mm.
End of body to mantle-margin	31
" " " " eye	38
Eye to umbrella	16
Breadth of body	22
1st right arm ¹	92
2nd " "	148
3rd " "	73
4th " "	200
1st left " "	86
2nd " "	145
3rd " "	69
4th " "	72
Hectocotylus	ca. 1
Diameter of largest sucker	3

Distribution.—Pacific Insular Region; Indian Ocean.

Type.—In British Museum, one male, two females.

Polypus bandensis (Hoyle).

Octopus bandensis, Hoyle, *Diagnoses* 1, p. 227; *Prelim. Rep.*, 1, p. 109 (1885); *'Challenger' Rep.*, XVI (Cephalopoda), p. 96, pl. 7, figs. 2 and 10 (1886); Appellöf, *Abh. d. Senckenb. naturf. Ges.*, XXIV, p. 566 (1898).

M⁸¹⁹⁹ 'Investigator' station 152; 12-xii-1893, 11½ miles S. 83° W. of Colombo Lt., 26½ fathoms—One ♀.

The extreme length of the third arms is the most important character of this species.

The present example has a roundish body separated from the head by a constriction, and the head is wider than the body owing to the large prominent eyes. The third arms are about six times the length of the mantle and nearly twice as long as any of the other arms. Umbrella very short and membranous, about equal all round, continued on the outer surface of the arms, and forming

¹ A study of the base of the arms shows that the short ones are evidently in course of regeneration.

large webs on the third pair. Siphon pointed, and reaching halfway between the mantle and margin of umbrella. Prominent tubercles surround the eyes and a few are scattered on the dorsal surface of the mantle. The ventral mantle has a median furrow, and eight little pits arranged in a row of four pairs at 1 mm. from the posterior end. As indications of similar pits appear elsewhere, I believe them to be surface indentations due to accidental pressure sustained in transit¹.

Colour buff with reddish-brown chromatophores, usually thinly distributed, but forming definite patches below each eye on the constriction between head and body, and also on each side of the mantle at about half way between the first patch and the end of the body. The arms show dark patches on their outer surface arranged either in pairs or in single bars.

The principal measurements are appended:—

	mm.
End of body to mantle-margin	6
" " " eye	7
Eye to umbrella	6.50
Breadth of body	5.50
" " head	6.50
1st right arm	26
2nd " "	27
3rd " "	46 less tip.
4th " "	34
1st left " "	39
2nd " "	36
3rd " "	59
4th " "	35
Diameter of largest sucker	ca. 50

Distribution.—Banda Ternate.

Type.—In British Museum, one young specimen.

Polypus globosus (Appellöf).

Octopus globosus, Appellöf, *K. Svensk. Vetensk. Akad. Handl.*, XXI, pp. 7, 8, pl. 1, figs. 4, 5 (1886); Ortmann, *Zool. Jahrb.*, III, p. 662 (1888); *Octopus rugosus* (pars), Ortmann, *Zool. Jahrb.*, V, p. 669 (1891); *Octopus globosus*, Goodrich, *Trans. Linn. Soc.*, VII, p. 19, pl. 5, fig. 81 (1896); Joubin, *Bull. Soc. Zool. France*, XXII, p. 98 (1897); Appellöf, *Abh. d. Senckenb. naturf. Ges.*, XXIV, pp. 365, 366 (1898); *Polypus globosus*, Hoyle, *Proc. Roy. Phys. Soc. Edinburgh*, XVII, p. 259 (no description) (1909); Berry, *Proc. Acad. Nat. Sci. Phil.*, p. 388 (1912a).

M ²⁵⁸ Bombay—One ♂.

M ^{227.5} Off Gopalpore, 25-28 fms., Sept., 1909, trawler 'Golden Crown', Bengal Fish. Dept.—One ♂.

M ²²⁵⁰ Bandra, near Bombay (J. W. Caunter)—One ♂.

The globular body, small mantle-opening, ventral furrow, order of arms, and the colouring and sculpture of these three little specimens closely agrees with the description of the type. The umbrella, which is about one quarter the length of the arms,

¹ All the specimens were wrapped in muslin and closely packed in soldered in boxes, and a few specimens had metal labels.

and about equal all round, is so membranous as to be almost transparent, while that of the type is described as "quite thick", but the much smaller size of the present examples may account for the difference. It is continued up the arms, as in Appellöf's (1886, p. 8) description, "in the form of two keels on their outer sides." The terminal organ of the hectocotylized arm resembles Goodrich's illustration, and appears to have no striae in the concave part; the sperm canal, on the contrary, is transversely striate throughout. In the two largest specimens the arms are bent back over the head, and one or two suckers are markedly enlarged on the lateral arms. In the specimen M ²²⁷⁸ the arms are only partially bent over the head, the terminal organ of the hectocotylized arm is very short, and looks as if it was only in process of formation, and no suckers appear to be enlarged on the lateral arms; two rows of large dark chromatophores are present on all the arms, and on the dorsal mantle a few large, almost black, chromatophores are interspersed with small brown ones, while on the ventral mantle the large dark spots only are present, being placed about 1 mm. apart. The specimen M ²²⁷⁹ was found in a hole in a rock at low tide.

The principal measurements are appended:—

Specimen number ...	M ²²⁷⁸	M ²²⁷⁹	M ²²⁸⁰
	mm.	mm.	mm.
End of body to mantle-margin	12	13	6
" " " eye	17	15	9
Breadth of body	14	14	7
" " head	12	12	8
1st right arm	64	43	19 less tip.
2nd " "	72	50	24
3rd " "	59	44	20
4th " "	60	48	22
1st left " "	60	44	20
2nd " "	71	53	22 less tip.
3rd " "	68	51	22
4th " "	62	44	22
Hectocotylus	4	ca. 3	ca. 25
Length of funnel	5	ca. 5	2.50
Diameter of largest sucker	3	2	1

Distribution.—Japan (*Appellöf*, *Joubin*); Straits of Malacca, Kabusa Islands, Nicobar Islands, Bombay, Ceylon (*Goodrich*).

Type.—In Zoological Museum, Upsala University, two females.

Polypus fusiformis (Brock).

Octopus fusiformis, Brock, *Zool. Jahrb.*, V, p. 601, pl. 10, figs. 1 and 2 (1887); *Octopus pisiformis*, Hoyle, *Proc. Royal Phys. Soc. Edinburgh*, p. 5 (merely listed) (1897).

M ²²⁸²:2 Palk Straits, south of India—Two ♀.

These are characterized by a very long narrow body with extremely narrow neck and prominent eyes; mantle-opening so wide that it is visible from above; arms of about five times the length of the body and tapering to very fine points; umbrella

extending about one-fifth of the length of the arms, and with indications showing that it was continued on their outer margins; funnel long, conical, and adherent for two-thirds of its length; funnel organ in bad condition in both specimens; surface smooth, except for a few small tubercles, chiefly on the dorsal surface of the mantle, head and umbrella; no cirri; colour brownish above, paler below; dorsal surface with very many minute dark chromatophores, which are fewer, and of a reddish-brown colour, ventrally. These seem to agree with Brock's description very closely, except that he describes the umbrella in his specimen to be highest ventrally, and prolonged in a well developed swimming membrane to the points of the arms. In the largest of the present specimens the umbrella is slightly highest dorsally, and in the other example it is about equally developed all round. Brock remarks that this species "is excellently characterized by the long spindle-shaped body, which is completely like a *Loligo* without fins", and that no species already described resembles it.

An example of *Cistiopus indicus*, Gray, in the British Museum, bears, however, a strong superficial resemblance in colour and form, but possesses arms seven or eight times the length of the body, and an umbrella about one-eighth of the arms. As, however, a careful examination fails to reveal any trace of pouches between the arms in the present specimens, I have no doubt that they belong to the form described by Brock. Steenstrup is very doubtful whether d'Orbigny's two figures of *Cistiopus indicus* represent the same species. "He is disposed to regard the type of Rapp's species as having been a true *Octopus* and for the form with "pouches between the arms he has adopted the name *Cistiopus bursarius*" (Hoyle 1886a., p. 19). It seems, therefore, possible that Brock's form may be identical with the type of Rapp's species.

The principal measurements of the present examples are appended:—

Specimen number	...	M 8232	M 8233
		mm.	mm.
End of body to mantle-margin	...	43	43
" " " " eye	...	67	60
Eye to umbrella at left side	...	50	36
" " " " right "	...	35	36
Breadth of body	...	24	21
" " head	...	22	16
" " neck	...	15	9
1st right arm	...	200	155
2nd " "	...	185	143
3rd " "	...	128	156
4th " "	...	135	143
1st left arm	...	162	151
2nd " "	...	167	160
3rd " "	...	135	137
4th " "	...	125	110
Length of funnel	...	22	16
Diameter of largest sucker	...	6	3

Distribution.—Amboina, a male presented by the natives.

***Polypus microphthalmus* (Goodrich).**

Octopus microphthalmus, Goodrich, *Trans. Linn. Soc.*, VII, p. 20, pl. 5, figs. 83, 84 (1896).

10972-8 Karnaphuli River, Chittagong, Dec., 1914 (A. C. Chowdhury)
— Two ♀.

These have a long narrow body with a yet narrower head, wide mantle-opening placed a little below and in line with the eye,¹ visible from above; eyes small; siphon with broad apex extending above the eyes and half-way to umbrella margin; free for half its length; no trace of funnel organ in either, although the specimens are in very good condition; arms not very tapering at the tips, and about two and a half times the length of the body. Web lowest ventrally, and highest in both at the right side, extending to about one-third of the length of the arms but not continued up them. Suckers small and much elevated, very like Goodrich's illustration (pl. 5, fig. 83). Surface quite smooth everywhere. Colour white, speckled with minute, dark-grey or purple-black, round chromatophores, which are most numerous on the dorsal surface of head and mantle where they form occasionally elongate grey smears. Larger chromatophores, measuring about 50 mm., are also present on the mantle and form two rows up each arm, each spot being placed about 3 mm. apart. These rows are very ornamental, and are especially distinct on the umbrella region. The inner surface of web and oral aspect of arms is sparsely sprinkled with small dots. There is a tendency, especially in the smaller specimen, to form pockets in the umbrella. These are not to be compared to the aquiferous pouches of *Cistopus indicus*, Gray, as they are merely transverse or oblique folds of the web extending from one arm to the next at about the middle of umbrella. They are not confined to any particular pair of arms but are most developed between the laterals, where the umbrella is widest, and are scarcely indicated between the ventral pair.

This delicately-pretty species seems to differ from the other more or less pale and smooth-skinned Polyps of this region chiefly by its small eyes, wide mantle-opening, and short arms possessing very prominent suckers and with web not continued up them. *Polypus elegans* (Brock), *P. fusiformis* (Brock) and *P. pricei* (Berry), are perhaps the nearest to it.

P. elegans has, however, very prominent eyes, a pointed funnel, much longer arms, and chromatophores which "almost vanish in alcohol." *P. fusiformis* has a narrower body and head, and longer arms and web, and *P. pricei* is of much more delicate consistency with huge eyes and a longer web.

The principal dimensions are given below : —

¹ One specimen has the mantle-opening at one side placed as in the type, e.g., at "rather more than halfway from the siphon to the eye."

Specimen number	M 1977	M 1978
	mm.	mm.
End of body to mantle-margin	20	31
Breadth of body	20	22
" " head	15	14
Eye to umbrella	20	23
Length of funnel	11	13
1st right arm	65	67
2nd " "	64	75
3rd " "	83	81
4th " "	82	76
Diameter of largest sucker	1.75	1.75

Distribution.—Port Blair, Andaman Islands.

Type.—In Indian Museum, Calcutta, a female.

Polypus herdmani, Hoyle.

Polypus herdmani, Hoyle, *Rep. Pearl Oyster Fish. Gulf of Mannar*, p. 187, pl. 1 (1904); Hoyle, *Proc. Zool. Soc. London*, p. 454 (1907).

M 1973 Pearl Banks, Ceylon (T. Southwell)—One ♀.

This has a round body with a median ventral groove; mantle-opening placed a short distance below and behind the eyes, and extending a little less than half round the body; arms stout and nearly four times the length of the mantle; suckers apparently ceasing at a short distance from the tip of each arm; umbrella extending about one-fourth of the length of the arms, continuing moderately on their outer margins, lowest dorsally and highest between the two ventral pairs; siphon small, not passing the level of the eye, and reaching nearly half way to the edge of umbrella; ocellar spots (each consisting of a dark oval patch surrounded by a narrow lighter coloured ring) placed about half way between the eye and the edge of umbrella; numerous elongated warts and tubercles placed chiefly round eyes and on dorsal surface of head and umbrella; inside of umbrella wrinkled but not tubercled. Colour greyish-brown, produced by minute brown chromatophores on a buff ground; ventral surface paler and browner. It will be seen from the above notes that this specimen seems to differ from the description of the type only in having a somewhat smaller mantle-opening, and that the ocellar spots are placed a little nearer the umbrella. The latter difference may be accounted for by contraction, many nuchal wrinkles being present.

The principal measurements are appended:—

	mm.
End of body to mantle-margin	8
" " " eye	12
Eye to umbrella	8.50
Breadth of body	8
" " head	6
1st right arm	25 ¹
2nd " "	mutilated.
3rd " "	31

¹ All the arms are much curled up, so that measurements can only be regarded as approximate.

	mm.
4th right arm	28
1st left arm	26
2nd	28
3rd	32
4th	mutilated.
Length of funnel	3.50
Diameter of largest sucker	1
.. eye-opening	1
Ocellus	2

Distribution.—Ceylon (type locality); Zanzibar (Hoyle).

Polypus arborescens, Hoyle.

Polypus arborescens, Hoyle, *Rep. Pearl Oyster Fish. Gulf of Manar*, p. 189, pl. 2, figs. 8, 9, 12; pl. 3 (1904); *Fauna and Geogr. Maldives Laccadive Archip.*, II, suppl. 1, p. 979 (1905); *Proc. Zool. Soc. London*, p. 454 (1907).

M⁸²⁵¹ Pearl Banks, Ceylon (T. Southwell)—One ♂.

This possesses a round body with a constriction at the neck, and a mantle-opening placed about halfway between the eye and an unusually broad siphon; the latter has a blunt apex, and reaches nearly halfway to the margin of umbrella. The arms are about three times the length of the mantle, and are bent back over the body revealing that the first four suckers on each arm are placed singly, and that all have the eighth, ninth and tenth suckers enlarged. Umbrella lowest dorsally, extending about one-third of the length of the arms, and continued on their outer margins. Terminal organ of hectocotylized arm very small. Colour of body grey with dark lines; arms reddish with light coloured patches, each of which is the seat of a cirrus. Cirri very numerous even on the ventral surface, many being much branched and measuring 2 mm. in length.

The principal measurements are appended:—

	mm.
End of body to mantle-margin	6
.. .. eye	8
Breadth of body	5
.. .. head	7
1st right arm	18
2nd	20
3rd	19
4th	22
1st left	mutilated.
2nd	10
3rd	21
4th	21
Hectocotylus	50

Distribution.—Indian Ocean; Zanzibar.

Polypus hoylei, Berry.

Polypus hoylei Berry, *Proc. U. S. Nat. Mus.*, XXXVII, pp. 407-8, text-fig. 1 (1909); *Bull. Bur. Fish. U. S. A.*, XXXII, pp. 296-298, text-fig. 15, pl. 48, figs. 2-4, pl. 55, fig. 1 (1914).

M ⁸¹²³ 'Investigator' station 379: 8-x-1905, Persian Gulf, 28° 59' N., 50° 3' E., 25 fathoms—One ♂.

M ⁸¹²³⁻² 'Investigator' station 380: 20-xii-1905, Arabian Sea, 13° 36' N., 47° 32' E., 130 fathoms—Two ♂.

M ⁸¹⁴³ 'Investigator' station 464: 22-iv-1912, S. of Ceylon, 6° 2' 30" N., 81° 29' E., 52-68 fathoms—One ♀.

These agree very closely with Berry's full description and excellent figures. All are characterized by a soft body; very large eyes with small openings, stout arms of about two and a half times the length of the mantle: a semitransparent umbrella extending about equally (slightly less between ventral pair) on all the arms for from one-third to nearly one half of their length, and continued along their outer margins in membranous expansions; a very small mantle-opening; and funnel organ of two V-shaped pads.

The tip of the hectocotylized arm is stout and broad, and the usual transverse grooves are very obscure in two examples, and absent in the third.

The male specimens show no special enlargement of the suckers. The ventral mantle is divided by an incipient groove in one specimen only.

In three examples the funnel is free for the anterior third, or less, of its length, in the other it is totally fused to the head. The latter specimen is from comparatively shallow water, but the fused funnel, when opened, disclosed the same peculiar type of organ and the specimen did not appear to differ from the rest in any other character. Two examples exhibit clearly two cirri near each eye, one being placed above and the other below its dorsal edge. The sculpture and colouring are very striking; each of the numerous tubercles is surrounded by a dotted circle of minute reddish-brown chromatophores, producing a somewhat star-like, or white-spotted pattern. The tubercles are sometimes continued on the ventral surface, and a few may be observed on the inner dorsal surface of the umbrella. In two specimens the dorsal chromatophores are so dense as to present a purple-red tone, and the lower surface appear much paler by contrast.

Three of Berry's specimens were taken at 257-460 fathoms, and the remaining one off the Hawaiian Islands, depth unknown. The present examples show that the species does not restrict its range to deep water.

The principal measurements are appended:—

Specimen number	M ⁸¹²³	M ⁸¹²³⁻²	M ⁸¹²³⁻²	M ⁸¹⁴³
	mm.	mm.	mm.	mm.
End of body to mantle-margin	31	32	25	30
" " " eye	40	49	38	48
Eye to umbrella	30	42	22	31
Breadth of body	28	30	26	38
" " head	29	29	22	29
1st right arm	65	1	67	96
2nd " "	75	1	75	92
3rd " "	47	60	45	1

¹ In course of regeneration.

Specimen number	M 81323 mm.	M 81325 mm.	M 81326 mm.	M 81344 mm.
1st left arm	1	82	69	91
2nd " "	80	1	65	100
3rd " "	1	1	1	93
4th " "	1	85	1	93
Hectocotylus	6	7	5	...
Diameter of largest sucker	2	2	1.50	2

Distribution.—In the archibenthal region of the Hawaiian Islands.

Type.—In U. S. National Museum, an adult male.

Polypus pricei, Berry.

(Pl. XXIII, figs. 7-8).

Polypus pricei, Berry, *Proc. Acad. Nat. Sci. Phil.*, pp. 73-5 (1913);
Polypus juv., Berry, *University of California Publications in Zool.*,
VIII, p. 303, 304 (1911).

M 81322-31. Investigator's station 366: 10-iv-1906, Arabian Sea, 24° 45' N., 63° 50' 15" E., 544 fathoms—Three ♂.

This species possesses the delicate and fragile appearance of a pelagic organism, and is so transparent that the venous system can be distinctly traced, without a lens, all about the head and up each arm. The body is soft and elongate, and the head is occupied by large prominent eyes. The arms are two and a half times the length of the body, and have small but very prominent suckers placed rather far apart; none are specially enlarged. The hyaline umbrella attains more than one-third of the length of the arms, continues a little on their outer margins, and is slightly less between the ventral pair. Berry describes the umbrella as extending about equally between all the arms for "perhaps a twelfth of their length." His specimens were, however, all taken from the stomach of a salmon and it seems reasonable to suppose that the fragile membrane constituting the umbrella might easily suffer injury under such conditions. The mantle opens just below the eye. The funnel has an unusually broad apex, and the funnel organ is so peculiar that two specimens were examined, and both were found to agree exactly. The median organ consists of two very small, oblong, widely-spaced pads, placed rather near the anterior margin of the funnel, and single lateral pads of similar shape and size are also present. In the smallest specimen the median pads measure about 1.50 mm. in length, and the space between them is about 3 mm. Owing to the condition of Berry's specimens, he was unable to give a drawing of the funnel organs which is therefore given here (pl. xxiii, fig. 8). The hectocotylus (not observed in the type) is also figured (pl. xxiii, fig. 7). The terminal organ is small, and the usual transverse furrows are faintly marked in the largest specimen, and almost invisible in the others;

¹ In course of regeneration.

the sperm canal is moderately defined. All the examples have a perfectly smooth surface and are pale buff in colour with minute yellow-brown chromatophores, interspersed with a few larger ones. "The two alternating longitudinal rows of large light-coloured chromatophores" described by Berry as decorating the outer surface of each arm are very conspicuous in the present specimens in parts where the outer skin has been rubbed off.

Some measurements of the largest and smallest examples are appended:—

Specimen number	M ⁸¹²⁸ mm.	M ⁸¹²³ mm.
End of body to mantle-margin	26	20
" " " " eye	34	27
Eye to umbrella	28	13
Breadth of body	20	13
" " head	14	10
1st right arm	70	54
2nd " "	64	53
3rd " "	41	30
4th " "	71	47
1st left " "	70	48 less tip.
2nd " "	72	49
3rd " "	70	mutilated.
4th " "	68	47
Hectocotylus	2'50	1'75
Length of funnel	14	12
Diameter of largest sucker	1	75
Diameter of eye	7	5

Distribution.—Off Point Pinos, Monterey Bay, California; four specimens from the stomach of a salmon (*Onchorhynchus tshawytscha*). Santa Catalina Island, California.

Type.—In the Stanford University Collections, four female specimens.

Polypus sp.

M ⁸²²⁵. Locality lost—One ♀.

This would appear to have been preserved in alcohol for a long period, all trace of chromatophores having faded, leaving the specimen of a uniform dull pale-green colour. Body ovoid, firm, much wrinkled, but appearing to possess many tubercles on the dorsal surface and to be smooth below. A narrow fold of skin, more developed laterally than posteriorly, divides the dorsal from the ventral region. Hoyle (1886, p. 89) says with regard to a similar character in *P. australis*: "It is doubtful what value is to be attached to the raised ridge mentioned above; it is to be seen in other species under certain conditions, possibly due either to different modes of preservation or to varying states of contraction; nevertheless, in the majority of forms it is never observed, and I am therefore inclined to attribute to it a certain systematic importance."

This example does not, however, agree with any of the species hitherto described as possessing a carinated membrane. The head is a little narrower than the body and there is a large

conical cirrus on the posterior dorsal edge of each eye, with a smaller cirrus at the anterior dorsal edge. No nuchal constriction; eyes not prominent. Arms about twice the length of the body, thick and muscular, tapering to fine points. Umbrella highest laterally, extending nearly one-third of the length of the arms, measuring 80 mm. between the dorsal and 70 mm. between the ventral pair; continued on outer margins of arms. Mantle-opening placed nearly at the ventral edge of eye and but little below it. Siphon conical, about half of its length projecting above level of eyes; funnel organ W-shaped, the median pads being very wide and touching one another throughout most of their length; the lines forming the commencement and end of the "W" meet in a point and all the other angles are rounded.

In the short arms, ocular cirri, and the deep scoop out occurring on the umbrella margin between dorsal arms, this resembles *P. rugosus*. It differs, however, in the long narrow body and the broad funnel organ to the specimens referred to *P. rugosus* in the present paper. Compared with an example of *P. vulgaris* from Plymouth¹, this has a longer and narrower body; a wider mantle-opening, larger suckers, a higher umbrella dorsally, and a blunter apex to the siphon; the latter also reaches higher above the eye than in *P. vulgaris*. The ventral mantle in the Plymouth specimen measures 85 mm. in length and 84 mm. in breadth, and the distance from the end of the body to the eye is 100 mm.

The principal measurements of the specimen M ⁸²⁵⁸ are, as follows:—

	mm.
End of body to mantle-margin	128
" " " " eye	146
Eye to umbrella	88
Breadth of body	89
" " head	67
1st right arm	mutilated.
2nd " "	287
3rd " "	270
4th " "	278
1st left " "	mutilated.
2nd " "	"
3rd " "	"
4th " "	277
Diameter of largest sucker	16
" " eye-opening	9
Length of funnel	55
Breadth of funnel at apex	15

Polypus sp.

M ⁸²⁵² Kilakarai, Ramnad District, Gulf of Manar, South India, from coral reefs, Feb. 1913 (S. W. Kemp)—One ♀.

This is too small to determine with certainty. It is characterized by an oblong body; very prominent eyes, each having a

¹ Kindly forwarded by the Marine Biological Laboratory, Plymouth, May 1914.

large four-lobed cirrus at the centre of its dorsal edge; arms about three times the length of the mantle; umbrella about a quarter the length of the arms, a little higher laterally, about equal elsewhere, not continued on outer margins of arms; mantle-opening placed just behind, and on a level with, the posterior end of the eye; siphon reaching about half way to the edge of umbrella. Colour above greyish, produced by minute red-brown chromatophores closely sprinkled on a buff ground; paler below, with fewer and larger chromatophores. On the outer surface of each arm there is a row of four to six large dark chromatophores which cease at about the edge of the umbrella, or, more rarely, a little above it. Numerous small pointed tubercles are scattered over the dorsal surface. The ventral mantle is smooth except for a median groove. Compared with the descriptions of Hoyle, Wülker and Berry of young specimens of this genus, the present example seems to be nearest to *Polypus* H. (Hoyle, 1904, p. 197) and *Polypus* M. (Hoyle, 1907, p. 455).

The principal measurements are appended:—

	mm.
End of body to mantle-margin ...	5
" " " " eye ...	6
Eye to umbrella ...	4
Breadth of body ...	4
" " head ...	5
1st right arm ...	19
2nd " " ...	mutilated.
3rd " " ...	17
4th " " ...	18
1st left " ...	17
2nd " " ...	20
3rd " " ...	17
4th " " ...	14

Polypus sp.

M 8994 'Investigator' station 557: 1-xi-1913, Port Maria, Elphinstone I., 12° 23' 15" N., 93° 2' 00" E., shore collecting—One ♀.

This young example does not seem to agree with the characters of any of the described species, and the comparison is rendered more difficult by the mutilation of the ventral arms which are represented only by stumps with the first two suckers, and as a consequence of this much of the umbrella is also absent. The principal characters are: elongate body; prominent eyes; arms two and a half times the length of the mantle, with large suckers, the first four being placed singly; umbrella (where present) about one-fifth the length of the arms, continued conspicuously on the outer margins of the arms almost to the extremity; mantle-opening at ventral edge of eye; siphon somewhat pointed and reaching above arm roots, siphonal organ probably W-shaped but is not in good condition; dorsal surface, and inside of umbrella between dorsal arms, much wrinkled and with many small tubercles, the latter becoming less numerous on the mantle which has a smooth ventral surface without a median groove, only a few elongate

wrinkles being present. Ocular cirri not apparent. Colour buff with numerous minute dark chromatophores which are equally small, but much fewer, ventrally. This approaches *P. rugosus* more than any other species in the collection, but the eye, in the examples which have been referred in the present list to that species is lower in regard to the position of the siphon than it is in *M. egnas*, and this would seem to be a character less dependent on modes of preservation than such differences as the elongate shape of the body and the absence of ocular cirri.

The principal measurements are appended :—

	mm.
End of body to mantle-margin	19
" " " " eye	25
Eye to umbrella	10
Breadth of body	12
" " head	12
1st right arm	39
2nd " "	46
3rd " "	47
4th " "	mutilated.
1st left arm	38
2nd " "	45
3rd " "	50
4th " "	mutilated.
Length of funnel	6
Diameter of largest sucker	2

Eledonella diaphana (Hoyle).

Fapetella diaphana, Hoyle, *Diagnoses*, 1, p. 232; *Prelim. Rep.*, 1, p. 108 (1885); *Eledonella diaphana*, Hoyle, 'Challenger' *Rep.*, XVI (Cephalopoda), pp. 187-8, pl. 9, figs. 3-6 (1886); *Bull. Mus. Comp. Zool.*, XLIII, No. 1, p. 22, pl. 5, fig. 11 (1904); Joubin, *Res. Camp. Sci. Monaco*, XVII, pp. 37-39, pl. 2, figs. 5-7 (1901); *C. R. Acad. Paris*, XXXVI, p. 101 (1903).

*M*¹²¹¹ 'Investigator' station 273 : 27-xii-1900, Laccadive Sea, 12° 47' N., 73° 44' 45" E., 823-870 fathoms—One.

*M*¹⁴³¹ 'Investigator' station 315 : 12-iv-1903, S. of Andaman Islands, 10° 6' N., 92° 29' E., 705 fathoms—One.

Specimen *M*¹²¹¹ agrees closely with Hoyle's description of the type and it is interesting to note that some of the suckers have a circular opening and others the quadrangular or triangular form which Hoyle thought was probably due to shrinking. The siphon extends two-thirds of the distance to the umbrella margin and its organ is a Λ -shaped pad. The third arms are nearly as long as the mantle. Colour pale with red-brown spots.

Specimen *M*¹⁴³¹ differs a little from the type but agrees very closely with the illustrations and measurements of an almost similar sized specimen referred by Joubin (1901) to this species. The arms and siphon are shorter and the umbrella higher than in the type. The latter is highest between the dorsal arms, extending to two-thirds of their length, and attains about half the length of the other arms. The mantle extends 6 mm. below and 7 mm. at either side of the visceral sac. About eighteen suckers are

present on the longest arm. Neither specimen shows any trace of a hectocotylus.

The principal measurements are appended:—

Specimen number	M ¹³¹¹ ₁ mm.	M ³³³¹ ₁ mm.
End of body to dorsal mantle-margin	33	23
" " " " eye	39	27
Eye to umbrella	7	6
Breadth of body	22	20
" " head	12	12
Length of eye	7	6
" " siphon	10	5
1st right arm	mutilated.	ca. 7
2nd " "	19 ¹	ca. 11
3rd " "	29 ¹	mutilated
4th " "	22	9
1st left " "	20	9
2nd " "	22	mutilated.
3rd " "	31 ¹	14
4th " "	21	10

Distribution.—North of Papua (Hoyle, 1886); Between Madeira and Morocco (Joubin, 1901); Tropical Pacific (Hoyle, 1904); Off Cape Verde (Joubin, 1903).

Eledonella sp.

M ²¹¹⁰ Arabian Sea, 947 fathoms—One.

M ²¹³² 'Investigator' station 393: 21-x-1911, Bay of Bengal, 7° 21' 6" N., 85° 7' 15" E., net at 400 fathoms, soundings 2000 fathoms—One.

M ²¹³² 'Investigator' station 462a: 20-iv-1912, Bay of Bengal, 9° 8' N., 87° 25' E., 475 fathoms—One.

Specimen M ²¹¹⁰ consists of fragments of a very large example. The siphon, which has a Λ -shaped organ, measures 15 mm. in length and 6 mm. at the apex which is flattened. None of the arms shows any sign of a hectocotylus, and as they are all detached from the body their order cannot be ascertained. The shortest measures 100 mm. in length and possesses thirteen suckers arranged singly, but unequal gaps and fibres of muscle show that many suckers are missing. The six largest are placed on the distal half and measure nearly 5 mm. in diameter by 5 mm. in height; the most distal sucker measures 1.25 mm. in diameter and the final 8 mm. of arm is devoid of suckers. All are shaped as described by Hoyle for *E. diaphana* and have a quadrangular opening caused by four rounded lips folded towards each other as in Berry's figure of a single sucker of *E. heathi*, Berry (1912, pl. 33, fig. 3). The longest arm measures 171 mm. and has eleven suckers, the largest measuring 7 mm. in diameter at the base. The other arms measure 166 mm., 167 mm., 135 mm., 130 mm., 125 mm., and 110 mm. in length. The mantle is denuded of epidermis, but the arms are pale buff with brown spots, and such of the animal as is present possesses the delicate hyaline consi-

¹ Less tip.

tency of the specimens referred to *E. diaphana*. Specimen M ²¹³³¹ is very young having a mantle-length of only 5 mm., the pallial opening is very wide and the eyes large: the siphon extends half way to the umbrella margin. The arms are all mutilated. The umbrella reaches to about the third sucker on the dorsal arms and is much shorter ventrally. Colour pale with a few reddish-brown chromatophores. This and the following have been preserved in formalin. Specimen M ²¹³³¹ has a mantle of 8 mm. The third arms are the longest, and the siphon extends two-thirds of the distance to the umbrella margin. Colour as in specimen M ²¹³³⁷. Probably these specimens are referable to *E. diaphana*.

Family SEPIOLIDAE.

Inioteuthis japonica, Verrill.

Inioteuthis japonica, Verrill, *Rep. U. S. Fish. Comm.*, p. 417, footnote (1881); Joubin, *Bull. Soc. Zool. France*, XXII, p. 101 (1897); Berry, *Proc. Acad. Nat. Sci. Phil.*, pp. 405-8, pl. 5, fig. 5 (1912a).

M ¹⁰⁰⁷⁵⁻⁶ Port Blair, Andaman Islands (S. W. Kemp)—Two ♀, one young.

The two smallest of these specimens have a mantle-length of 5 and 9 mm.

The largest female, compared with a male of *I. maculosa*, Goodrich, of similar mantle-length, shows that *I. japonica* has the nuchal commissure narrower than the length of the fin at insertion, while in *I. maculosa* these measurements are about equal.

The latter has a uniformly narrower body, shorter, rounder fins, and larger siphon than *I. japonica*. The bell-shaped mantle of the latter is very marked in the large female, when viewed ventrally.

In *I. maculosa* the chromatophores form large, dark-brown spots and blotches all over the body and arms, except the siphon and lower surface of fins.

In *I. japonica* they form very minute bluish-red dots which become larger on the head, and the ventral surface of the fins and siphon is freckled with orange dots. A note on the label states that the specimens were bright yellow when alive. These three specimens of *I. japonica* are all a little contracted, and seem to have a thicker skin and harder body than *I. maculosa*, but these differences may be due to varying modes of preservation.

The valve in the siphon is much longer in the example examined than in that of *I. maculosa*.

The measurements of this large female are appended:—

Specimen number	M ¹⁰⁰⁷⁵
	mm.
End of body to mantle-margin	13
Breadth of body	12
" head	10
Nuchal commissure	5
Fin length at insertion	6

Specimen number	M 1007
	mm.
1st right arm	8
2nd "	8
3rd "	9
4th "	8
Tentacle	18
Club	4

Distribution.—Japan.

Type.—Cat. No. 9,639 (part) Yale University Museum, a male.

Inioteuthis maculosa, Goodrich.

Inioteuthis maculosa, Goodrich, *Trans. Linn. Soc.*, VII, pp. 2-3, pl. 1, figs. 1-3 (1896).

M 8211 Puri Beach, Orissa Coast (*R. E. Lloyd*)—One ♂.

M 8203 'Investigator' station 556; off Burma Coast, Marine Survey of India—One ♀.

The hectocotylus in the male specimen closely resembles Joubin's (1897, p. 101) description of the modified arm in *I. japonica*, VII., e.g., "Une membrane demi-circulaire, en forme de 'C', entoure un tubercule median."

Such of the tentacular rings as are in a favourable position for examination show ten or eleven blunt teeth which seem to extend round the entire ring. What appear to be papillae are also present in the guise of small, pointed between-teeth.

Some of the differences between this species and the last mentioned have been already pointed out.

The principal measurements are appended:—

Specimen number	M 8211	M 8203
	mm.	mm.
End of body to mantle-margin	13	8
Breadth of body	10	7
" " head	9	6
Nuchal commissure	3.50	3
Length of fin at insertion	3.50	2.50
Breadth across fins	15	10
1st right arm	12	5
2nd "	13	7
3rd "	15	7
4th "	12	ca. 6
Tentacle	20	12
Club	7	3

Distribution.—Andamans; Persian Gulf.

Type.—In Indian Museum, Calcutta, two females.

Euprymna morsei (Verrill), Steenstrup.

Inioteuthis morsei, Verrill, *Rep. U. S. Fish Comm.*, p. 417, footnote (1881); Joubin, *Bull. Soc. Zool. France*, XXII, p. 102 (1897); ? *Sepioida bursa*, Pfeffer, *Abh. Naturw. Ver. Hamburg*, VII, p. 6, fig. 6 (1884); *Euprymna morsei*, Steenstrup, *Overs. K. D. Vidensk. Selsk. Forh.*, p. 66 (1887); Hoyle, *Bull. Mus. Comp. Zool.*, XLIII, p. 26 (1904); Wülker, *Abh. d. II. Kl. d. k. Ak. Wiss.*, III Suppl.-Bd., 1 Abh., pp. 9

etc., pl. 1, fig. 9; pl. 3, figs. 23, 24; pl. 4, fig. 40 (1910); Berry, *Proc. Acad. Nat. Sci. Phil.*, pp. 408-14, pl. 6, fig. 1 (1912a).

M ⁸⁰⁹² Nyanbyini Bay, Burma: 28-viii-1911, 5 fathoms—One ♀.

M ⁸¹⁰⁰ Andamans—One ♂. 1899.

M ⁸²²⁴ Persian Gulf (*Townsend*)—One ♀.

M ⁸⁴⁶² Hongkong (*R. Hungerford*)—One ♂.

Berry states that the umbrella is "lacking or at best rudimentary between the dorsal arms." In the present specimens a delicate web extends to the third or fifth sucker between these arms. The hectocotylus in both males agrees with Berry's description. In specimen M ⁸¹⁰⁰ enlarged suckers appear on the third and fourth right arms, and in specimen M ⁸⁴⁶² on the third right and fourth left. Many suckers are missing from the other arms of both specimens. The enlarged suckers occur on the two ventral rows as noted by Berry. The principal measurements are appended:—

Specimen number	M ⁸⁰⁹²	M ⁸¹⁰⁰	M ⁸²²⁴	M ⁸⁴⁶²
	mm.	mm.	mm.	mm.
End of body to web between dorsal arms	24	24	22	28
" " " " mantle-margin	16	18	15	14
Breadth of body	15	12	12	11.50
" " nuchal commissure	8	7	8	6
" " head	12	11	11	9
" " fins	24	22	22	21
1st right arm	mutilated.	15	mutilated.	14
2nd " "	17	19	"	15
3rd " "	15	17	"	16
4th " "	14	16	"	14
1st left " "	12	12	"	11
2nd " "	16	17	"	mutilated.
3rd " "	14	16	"	16
4th " "	13	15	"	12
Tentacle	15	14	"	27
Club	6	ca. 5	"	5

Distribution.—Japan, Philippines (*Joubin*), Formosa, Hong Kong, Andamans, Gulf of Manaar, Maldive Archipelago.

Type.—Cat. No. 9,638, Yale University Museum, a female.

Family SEPIOLIDAE.

M ⁸³³⁴ 'Investigator' station 383: 23-xi-1908, off Burma, 17° 18' N., 94° 8' E., 517 fathoms—One ♀.

This is in such bad condition that it is not possible to say if a nuchal commissure was present or if the species was provided with a pen.

The mantle is bell shaped, and the lacerated fins appear to have been attached at about the middle portion. The funnel is long and its organ consists of two elongate somewhat pyriform pads, the narrowest part in each being placed anteriorly. Each pad is 10 mm. by 4 mm. in breadth. Eyes very large. First pair of arms the shortest, the others semi-equal. The suckers are missing but their bases show that they were placed in two rows.

The club suckers are very minute and possess a smooth ring; they are placed in about eight rows at the centre of the club. The epidermis is wanting in many parts but the colour seems to have been buff covered very densely with purple or black chromatophores, which are present on both sides of the fins also. Such of the surface as is entire seems to be smooth.

The principal measurements are given below:—

	mm.
End of body to ventral mantle-margin	35
Breadth of body	ca. 22
Length of fin	21
Breadth "	16
Diameter of eye	8
" eye-opening	5
1st right arm	30
2nd " "	34
3rd " "	37
4th " "	33
1st left " "	29
2nd " "	21
3rd " "	33
4th " "	32 ¹
Tentacle	59
Club	15

Family LOLIGINIDAE.

Loligo indica, Pfeffer.

(Pl. XXIII, fig. 9; pl. XXIV, fig. 11.)

Loligo indica, Pfeffer, *Abh. Naturw. Ver. Hamburg*, VIII, p. 4, figs. 3, 3a (1884); Hoyle, 'Challenger' Rep., XVI (Cephalopoda), pp. 156-7, pl. 26, figs. 1-10 (1886); Goodrich, *Trans. Linn. Soc.* VII p. 7, pl. 2, figs. 20-28 (1896).

	mm.
M ³⁰⁷ ₁ Cochin (F. Day): 26-vi-1877—One ♀ Mantle-length	95
M ⁶²⁴ ₁ Penang, Malay Peninsula (Dr. Stoliczka)	
—One ♂	73
M ⁶²⁸ ₁ Akyab, Burma (W. Dodgson)—One ♂	82
M ⁸²⁴ ₁ Puri, Orissa Coast (S. W. Kemp)—	
One ♀	22
M ⁸⁴² ₁ Off Puri Coast, 1908, trawler 'Golden Crown', Bengal Fish. Dept. —Three ♂	83-187
M ⁸⁰⁸ ₁ Cochin (F. Day): 26-vi-1877—Two ♂	65-77
One ♀	69
M ⁸⁰¹ ₁ Akyab, Burma (W. Dodgson)—One ♀	74
M ⁸⁰² ₁ Madras, purchased —Three ♂	68-94
Three ♀	45-83
M ⁸¹⁴ ₁ Investigator station 481: 25-26-xii-1912, Mergui Harbour, 7 fathoms—Two ♂	53-71
One ♀	58
M ⁸¹⁵ ₁ Investigator station 522: 2-iii-1913, Mergui Archipelago, 12° 35' 15" N., 98° 16' E., 5 fathoms —One ♀	44
A ⁸¹⁶ ₁ Ardlamans (J. Wood Mason)—Two ♂	72-77
Two ♀	72-80

Less tip.

	mm.
5124-23 Puri Beach (?)—Eighteen young Mantle-length 12-26	
M 5122-25 Puri, Orissa Coast (N. A. and R. E. L.)	
—Five ♂	32-49
—Four ♀	47-98
M 5200-10 Puri Beach (F. H. Gravely)—	
—Three ♂	36-77
—Two ♀	64-75
M 5213-12 Puri Beach (C. Paiva), 23-iii-1908	
—One ♂	92
—One ♀	110
M 5215 Puri Beach, Orissa Coast (J. Caunter)	
31-i-1909 —One ♂	43
M 5219-12 Varkulay, Travancore (N. Annandale): 10-xi-1900	
—One ♂	220
—Two ♀	93-114
M 5219 Karachi (W. D. Cumming)—One ♂	75
M 5225 Gangaram, Vizagapatam District, Madras Coast (Moti Ram)	
—One ♀	91
• ? Small specimen in bad condition.	
M 5222 Akyab, Burma (J. H. Burkill)—One ♀	72
M 5224 Off Gopalpore, trawler 'Golden Crown', Bengal Fish. Dept., 23-27-ix-1909—	
—Three ♀	78
	120
	34
M 5280-1 Off Eastern Channel, m. of R. Hughli, trawler 'Golden Crown', xi-1909, Bengal Fish. Dept.	
—Two ♂	97-148
M 5295-2002 Investigator's station 565 and 567: 13-21-xi-1913, 11° 54' 00" N., 98° 19' 00" E., 6-7 fathoms	
—Five ♂	25-85
—Two ♀	33-42
(?) Three young	10-12
M 5007-12 Investigator's station 575: 20-xii-1912, Off entrance to Mergui Harbour, S. Burma, 7-fathoms	
(?) Six young	8-0
M 5217-12 Investigator's station 590: 8-9-i-1913, Mergui Archipelago, 13° 5' 15" N., 97° 53' E., about 30 fathoms	
—One ♂	17
—Two ♀	72-80
M 5030-2002 Investigator's station 569: 29-30-xi-1913, 11° 52' 10" N., 98° 18' 40" E., 5 fathoms	
—Thirty-six ♂	10-81
—Thirty-two ♀	10-102
M 5225 Off Gopalpore, 30-38 fathoms, Bay of Bengal, trawler 'Golden Crown', Bengal Fish. Dept., Dec., 1909	
—One ♀	110

• These twenty-five records of seventy males and sixty-two females show that the present species occurs all round the coast of India from Karachi to the mouth of the River Hughli, and also off the Burmese coast and Andaman Islands. The length and breadth of the fins with regard to the length of the mantle exhibits a certain amount of individual variation, but, except in the case of several small females in the haul M 5030-2002, which showed much wider fins than males of the same size, there seems to be no

marked difference as regards this between the sexes. The small specimens M ⁸¹⁷⁴⁻⁹¹ possess a fin measuring one-third of the length of the mantle and resemble the useful illustration of Hoyle (*l. c.*, p. 156, text-fig.). Sixteen males from various hauls, with mantle-length of 21-97 mm., possess a fin measuring about half the length of the mantle, and the same proportion is shown by eleven females with mantle of 16-120 mm. In three females with mantle of 63-75 mm. the fin does not attain quite half the length of the mantle, and in two others with mantle of 30-42 mm. the fin measures two-thirds of the mantle. The largest sized specimens of both sexes possess a fin measuring more than half and less than one-third of the mantle.

The rings of the arm suckers in the young specimens M ⁸¹⁷⁴⁻⁹¹ show five to eight teeth, and some large tentacle rings possess sixteen to nineteen teeth round the ring; suckers occur on the buccal membrane but there is no trace of a hectocotylus.

Large males, frequently, but not always, have the largest rings of the lateral arms larger than the largest rings of the club. In females these rings are almost always either slightly or much smaller than the largest rings of the club, and as a consequence of this they have fewer teeth on the lateral arm rings than the male owing to the smaller size of the ring. Thus a male with mantle of 75 mm. possesses ten or eleven teeth on the lateral rings, and not more than six on the dorsal and ventral arms, and a female with mantle of 72 mm. does not possess more than six teeth on the largest arm suckers. The number of teeth on the largest tentacle rings does not appear to increase after a certain mantle-length has been attained. Thus a male and female with mantle-length of 77 mm. possess seventeen to twenty teeth on the largest rings, and the same number is shown by two females with mantle of 120-134 mm.

The number of suckers on the different angles of the buccal membrane varies from one or two to three, four or six. Five to nine blunt teeth are present on the ring, part of which is always smooth. In large females a tubercle is placed at the base between the ventral angles. In the small specimens M ⁸⁰³⁰⁻⁹⁰⁹⁷ the nidamental glands are barely perceptible in females with a mantle-length of 10-15 mm. The smallest sexually distinct males have a mantle of 16 mm. Young specimens of both sexes have much fewer chromatophores, but examples with a mantle-length up to about 37 mm. seem always to show two very conspicuous clusters of dark chromatophores on the dorsal surface of the head, giving each little creature a superficial appearance of having two eyes on the back of its head as well as the real laterally-placed eyes.

As regards anatomy the specimens M ⁸²¹³⁻¹⁴ were examined and nothing was discovered that is not usual in the genus. The female specimen had the ovary tightly packed with eggs—the bilobed nidamental gland measured 24 × 11 mm. The radula

(pl. xxiv, fig. 11) closely resembles that of *L. pealii*, Verrill (1882, pl. xxviii, figs. 6-8). The frontal lamina of the upper mandible (pl. xxiii, fig. 9) curves more upwards than in that species and the posterior end of the palatine lamina has a median indentation. The lower mandible (pl. xxiii, fig. 9) has the notch near the rostrum less marked than in *L. pealii* and the lower edge of the gular lamina is indented.

Distribution.—Indo-Malayan Region.

Type.—In Hamburg Museum.

Loligo spectrum, Pfeffer.

Loligo spectrum, Pfeffer, *Abh. Naturw. Ver. Hamburg*, VIII, pp. 5-6, figs. 5, 5a (1884).

M²²⁴³ Arakan coast, trawler 'Golden Crown', Bengal Fish. Dept.,—One ♂.

The long, slender body readily distinguishes this species from *L. indica*. Order of arms 3, 4, 2, 1. Rings of arm suckers usually with eight teeth (sometimes seven or nine) on the distal margin, and the rest of ring smooth. At the base and distal portion of each arm the teeth are short, broad and blunt, elsewhere they are rather narrow, pointed and slightly curved. Distal rings often have only four to six teeth, and a sucker at the base of the fourth right arm has eleven teeth. Sixteen rows of suckers occur on the proximal part of the hectocotylyzed arm, the two pairs immediately preceding the papillae being placed on long stalks. Pfeffer describes the tentacular rings as possessing forty teeth. Thirty-one is the largest number I could find on any tentacular ring, but this specimen is considerably smaller than the type which has a mantle-length of 284 mm. A marginal sucker, intermediate in size between the large and the distal club suckers, possesses eight pointed teeth separated by the width of the base of a tooth, and covering the distal half of the ring. Suckers are present on the buccal membrane which is seven-angled.

The principal measurements are appended:—

	mm.
End of body to dorsal mantle-margin	155
Length of fin	100
Breadth of fins	62
1st right arm	28
2nd " "	30
3rd " "	mutilated.
4th " "	45
1st left " "	33
2nd " "	38
3rd " "	45
4th " "	42
Length of tentacle	103
" " club	33
Diameter of largest tentacular ring	2.50
" " " arm "	2

Distribution.—Marquesas.

Type.—In Hamburg Museum, three males.

Loligo sp.

	mm.
M ⁸⁷⁰ ₁ and M ⁸²² ₁ Madras, purchased, 30-iv-1877 —Two ♂ Mantle-length	120-135
M ⁸²³ ₁ Pamban, Ramnad District, Gulf of Manaar, from weeds, 0.2 fathoms, 24-iii-1913 (S. W. Kemp) —Two	4
M ⁸²³ ₂ Kilakarai, Ramnad District, South India, from weeds, 0.2 fathoms, 16-ii-1913 (S. W. Kemp) —One	7
M ⁸²³ ₃ 'Investigator' station 565: 13-xi- 1913, 11° 57' 30" N., 98° 19' 00" E., 7 fathoms —One	8

Specimens M ⁸⁷⁰₁ and M ⁸²²₁ resemble *L. indica* in their shape and colour, and in the size and arrangement of the suckers on club, arms and buccal membrane; as, however, the horny rings of all the suckers are missing it is not possible to determine the species with certainty.

Loliolus investigatoris, Goodrich.

Loliolus investigatoris, Goodrich, *Trans. Linn. Soc.*, VII, pp. 8-9, pl. 2, figs. 29-37 (1896).

	mm.
M ⁸⁷³ ₁ Penang (<i>Dr. Stoliczka</i>) —One ♀ Mantle-length	43
M ⁸²⁹ ₁ Sandheads, River Hughli (<i>G. Lord</i>)— One ♀	53
M ⁸⁴⁴ ₁ Puri, Orissa Coast (<i>S. W. Kemp</i>)— Two ♂	35-39
M ⁸⁰⁰ ₁ 'Investigator', Mouth of Tavoy River, 28-viii-1911 —One ♂	25
M ⁸¹⁰ ₁ E. S. E. of S. Moscos L. Marine Sur- vey of India —One ♂	26
M ⁸¹⁵ ₁ 'Investigator' station 481: 25-26-xii- 1912, Mergui Harbour, 7 fathoms— One ♀	30
M ⁸¹⁵ ₂ Mouth of River Hughli (<i>Capt. R. Munro</i>) —Four ♂	31-38
One ♂	34
M ⁸¹⁷ ₁ Puri Beach, 1-2-ii-1900 (<i>N. Annandale</i>) —One ♂	34
M ⁸²⁰ ₁ Puri, Orissa Coast, 18-19-i-1908 (<i>N. A. and R. E. L.</i>) —One ♀	26
M ⁸²³ ₁ 10 miles N. E. of Devi river, Orissa Coast —One ♀	31
M ⁸²⁶ ₁ Shrimp-trawler off Frazergunge, Sunderbuds —One ♂	35
M ⁸²⁸ ₁ 'Investigator' station 402: 15-16-xi- 1911, Mergui Archipelago, 13° 2' N., 98° 25' E., 5 fathoms —One mutilated	27
M ¹⁰⁰⁷ ₁ Karnaphuli River, Chittagong (<i>A. C. Chowdhury</i>) December, 1914 —Two ♂	32-37
Three ♀	2-42
M ¹⁰⁰⁷ ₂ Near Mud Point, River Hughli, D. net used as townet, S. L. Kitty (<i>T. Southwell</i>) 13-ii-1915 —One ♂	28
One ♀	37

A marked sexual difference is apparent in the specimens .
M ⁸¹⁵₂. The male with a mantle-length of 31 mm. has much

Found in a hole near a rock at low tide.

longer lateral arms with much larger suckers than the female with a mantle-length of 34 mm.

Distribution.—Indo-Malayan Region.

Type.—In Indian Museum, Calcutta.

Family SEPIIDAE.

Sepia aculeata, Van Hasselt MS., in d'Orbigny.

Sepia aculeata, Van Hasselt MS., in d'Orbigny and Férussac, *Hist. Nat. Céph. acét.*, p. 287, pls. 5, 25 (1834); Steenstrup, *Vidensk. Selsk. Skr.* 5th R., Bd. 10. VII (1876); Tryon, *Man. Conch.*, (1) 1, p. 169, pl. 90, fig. 415; pl. 91, figs. 416, 417 (after d'Orbigny) (1879); Goodrich, *Trans. Linn. Soc.*, VII, p. 3 (1896); Joubin, *Notes Leyden Mus.*, XX, p. 25 (1898); Wülker, *Abh. d. II. Kl. K. Ak. d. Wiss.*, III Suppl.-Bd., 1 Abh., p. 11 (1910); Berry, *Proc. Acad. Nat. Sci. Phil.*, p. 418 (1912a); *Acanthosepion Hasselti*, de Rochebrune, *Bull. Soc. Phil. Paris*, (7), VIII, p. 101 (1884).

M ^{81.2} Akyab, Burma (W. Dodgson)—One ♀.

M ^{7.2} Sandheads, River Hughli (F. Milner)—One ♂.

M ^{81.2.2} 'Investigator' station 519: 1-iii-1913, Mergui Archipelago, Elphinstone I., Port Maria, shore collecting—One ♀.

M ^{82.2.2} Palk Straits, South of India—One ♀.

M ^{82.2.1} Akyab, Burma (J. H. Burkill)—One ♂.

M ^{82.2.2} Bay of Bengal, trawler 'Golden Crown', Bengal Fish. Dept.,—One ♀.

M ^{82.2.2.2} Bay of Bengal, trawler 'Golden Crown', Bengal Fish. Dept.,—One ♂, one ♀.

M ^{82.2.2} Balasore Bay, Orissa Coast, viii-1908, trawler 'Golden Crown', Bengal Fish. Dept.,—One ♀.

M ^{29.2.1} 'Investigator' station 557: off Burma Coast, Marine Survey of India—One ♂.

These all agree in the presence of suckers on the buccal membrane and in having the tentacle suckers all of small size and semi-equal, and armed with acute teeth all round the ring, the largest being on the distal half of the circumference. Very prominent papillae are also apparent in the best-preserved specimens. Specimen M ^{82.2.2} possesses what appear to be clubs in process of repair at the end of each tentacle stem. They are much narrower than the stems and end acutely, and possess a very rudimentary fin only visible with a lens; minute pointed papillae, which would seem to be the base of suckers (as occasionally fibres of muscle project from them), are present on either side of a median line.

The arm suckers are arranged in four rows and their rings are usually armed with many teeth on the distal half of the ring. They vary greatly in number and appearance; often two are welded together or they may be somewhat widely spaced; eighteen to thirty are present on many rings but those placed on the proximal or distal portions are usually (but by no means invariably) smooth. An idea of the variation in dentition is afforded by specimen M ^{82.2.2}. Fifty-six teeth surround a sucker ring on the middle of the first right arm, the distal teeth being the longest; a sucker on the distal half of the third left arm shows a ring with about forty teeth; twenty-one teeth are present on a sucker ring on the distal half of the fourth right arm, and are placed on the distal margin, the rest of the ring being smooth. All the proximal rings examined in this

specimen are smooth. Some suckers from the buccal membrane show smooth rings, others have notches or short blunt teeth.

The hectocotylus is placed on the proximal half of the left ventral arm. The first three or four rows of suckers are normal, and are followed by about six pairs of very minute suckers on the ventral margin, about four pairs being placed on an excavation on the corresponding part of the dorsal margin of the arm. In the smallest male, M ⁸²⁶³, this excavation is slight, but a deep round cavity is formed on the older specimens. The spermathecal pad is broad and very papillate. Colour, slate above and buff-pink below; the chromatophores are all small and usually dark; a few look like white spots but are pale blue when examined with a lens; although very dense on the dorsal mantle they form no bands or other definite markings. The fins, which have fewer chromatophores on their ventral surface, are usually broad and thick but are sometimes closely adherent to the mantle. The surface is generally smooth but often about six crescent-shaped wrinkles occur at the base of the fins along either side of the dorsal mantle. The cuttle bones of seven specimens examined all show a callosity on the inner cone, and their form agrees closely with the illustration of d'Orbigny (pl. 25, fig. 4), and also closely resembles that of the shell of *S. indica*, d'Orb., which Joubin (*l.c.*, pp. 21-28) thinks is very likely identical with the present species. Hoyle has pointed out that *S. indica* is called *S. blainvillei* in d'Orbigny's illustration (pl. 21, figs. 1, 3, 4). The specimens M ⁸¹³⁵ and M ⁸²²², with mantle-lengths of 44-59 mm., have both much smaller spermathecal pads, and in the shell the callosity of the inner cone is only partly developed. The smallest has thinner fins than the others; probably this may be attributed to its youth. Measurements of some of the specimens are appended:—

Specimen number	M ⁷²²⁸ mm.	M ⁸²²⁷ mm.	M ⁸²⁶⁸ mm.	M ⁸²⁶⁹ mm.
Dorsal mantle-length	105	109	125	170
Ventral mantle-breadth	54	60	70	ca. 62
Fin maximum	11	11	7	18
Breadth of head	37	41	44	60
1st right arm	43	mutilated.	50	61
2nd " "	43	50	45	55
3rd " "	49	60	49	59
4th " "	48	65	57	60
Tentacle	110	191	...	128
Club	25	33	...	...

Sepiostaire:—

Specimen number	M ⁸¹³⁵ mm.	M ⁸²²² mm.	M ⁸²⁵¹ mm.	M ⁸²⁶³ mm.	M ⁸²⁶⁷ mm.	M ⁸²⁶⁸ mm.	M ⁸²⁶⁹ mm.	M ⁸²⁷⁴ mm.
Total length	42	58	80	110	110	173	112	112
Breadth	17	23	25	35	35	60	36	36
Length of spine	ca. 3				4			
Index ¹	40	40	25	ca. 27	22	23	18	

Distribution.—Japan, Java, Indian Ocean.

¹ The index is the relation of the last loculus plus the total length of the shell when divided into one hundred parts. See Hoyle, 'Challenger' Rep., XVI (Cephalopoda), p. 123.

Sepia singaporensis, Pfeffer.

Sepia singaporensis, Pfeffer, *Abh. Naturw. Ver. Hamburg*, VIII, pp. 10-11, figs. 13, 13a (1884); Hoyle, *Proc. Roy. Phys. Soc. Edinburgh*, p. 27 (1886); Goodrich, *Trans. Linn. Soc.*, VII, p. 3 (1896).

M ⁸¹³⁹ Investigator's station 387: 16-xi-1909, off C. Negrais, Burma, 15° 25' N., 93° 45' E., 40-49 fathoms—One ♂.

This has lost the tentacles but in all other respects seems to agree closely with Pfeffer's description. Fourteen to thirty-three teeth were counted on different arm sucker rings.

On the fourth left arm about six rows of suckers, on the proximal half are appreciably smaller than those immediately preceding and following them, the two dorsal suckers in each row being the smallest; the surface of this modified portion appears to be slightly excavated.

Hoyle (1886, p. 128) thinks that it is quite possible that this species may be identical with *S. plangon*, Gray. The shell of specimen M ⁸¹³⁹ measures 63 mm. by 18 mm., and has an index of 31. The end of the spine is broken but the portion remaining does not show the keel on the ventral edge present in the shell of *S. plangon*.

The principal measurements are appended:—

	mm.
Dorsal mantle-length	62
Breadth of body	29
" " head	22
Fin maximum	ca. 4
1st right arm	25
2nd " "	... mutilated.
3rd " "	28
4th " "	31
1st left " "	26
2nd " "	... *mutilated.
3rd " "	24
4th " "	25

Distribution.—Singapore (Pfeffer and Goodrich).

Type.—In Hamburg Museum.

Sepia esculenta, Hoyle.

Sepia esculenta, Hoyle, *Diagnoses*, II, p. 188; *Prelim. Rep.*, II, p. 291 (1885); *'Challenger' Rep.*, XVI (Cephalopoda), pp. 129-31, pl. 17, figs. 1-5; pl. 18, figs. 1-6 (1886); Appellöf, *K. Svensk. Vetensk. Akad. Handl.*, XXI, p. 28, pl. 3, figs. 1-6, 24 (1886); Ortmann, *Zool. Jahrb.*, III, pp. 649-665 (1888); Pilsbry, *Nautilus*, VII, p. 144 (1894); Joubin, *Bull. Soc. Zool. France*, XXII, pp. 102-103 (1897); Hedley, *Proc. Linn. Soc. N. S. W.*, XXXI, p. 463 (1906); Berry, *Proc. Acad. Nat. Sci. Phil.*, pp. 418-19 (1912a).

M ⁸²⁸⁶ Moji, Japan, 1-vii-1913 (J. D. Cooper)—One ♀.

Owing to its large size this specimen was not taken to be compared with the type. A vivid recollection of its appearance, and a subsequent glance at the type male in the British Museum has, however, quite satisfied me that it is rightly referred here.

It agrees with Appellöf's description as regards the presence of notches, in some cases amounting to teeth, on the rings of the arm suckers.

The median tentacular suckers are a little larger than those at the margin (as observed by Joubin), and there are two larger than the rest at the tip of the club. Thirty to forty teeth are present on some of the tentacular rings.

The crescent-shaped folds, or wrinkles on the dorsal skin, which frequently occur along the origin of the fin in this genus, are well-marked. The shell agrees closely with Hoyle's description except that the last loculus is shorter. The horny brown mass noticed by Joubin between the spine and inner cone is distinct. Berry has remarked that this species is very nearly allied to *S. aculeata*, van Hasselt, in spite of the absence of suckers on the buccal membrane and that the shell is without the callosity of the inner cone. Besides these two important differences, it may be noted that the parallel lines of the striated area of the shell are always more or less evenly rounded in *S. aculeata* and never form the acute angle present in *S. esculenta*, and the fins, buccal membrane and sperm pad are all much thicker and narrower in *S. aculeata*. A number of sperms are adhering to the sperm pad in the present specimen.

The principal measurements are appended:—

	mm.
Dorsal mantle-length	108
Breadth of body	75
" " head	58
Fin maximum	20
1st right arm	72
2nd " "	77
3rd " "	90
4th " "	100

Sepiostaire:—

Length	156
Breadth	57.50
Spine (end broken)	5
Index	13

Distribution.—Japan; Queensland.

Type.—In British Museum, a male and female.

Sepia elliptica, Hoyle.

Sepia elliptica, Hoyle, *Diagnoses*, II, p. 189; *Prelim. Rep.*, II, p. 293 (1885); 'Challenger' *Rep.*, XVI (Cephalopoda), pp. 131-3, pl. 19, figs. 14-24 (1886); Wülker, *Abh. d. H. Kl. d. k. Ak. d. Wiss.*, 411 Supl.-Bd., I Abh., pp. 11-12 (1910).

M²¹⁰⁸ 'Investigator' station 90: 17-21-ii-1890, 8 miles E. S. E. of Kalingapatam Lt., Ganjam Coast, 28-30 fathoms—One ♀.

M²²⁸³ 'Investigator' station 366: 10-iv-1906, Arabian Sea, 24° 45' N., 63° 50' 15" E., 544 fathoms—One ♂.

These two specimens differ a good deal outwardly, the small female being of a greenish tint and the male of a beautiful purple-

brown mottled with buff. The shells of both are, however, alike, and that of the male was compared with the shell of a type male in the British Museum and found to be exactly similar. This shell measures about 58 mm. in length by 25 mm. in breadth, and has an index of about 30; the spine is broken. Both specimens exhibit irregular teeth or notches on the distal surface of some of the arm rings, while other rings are quite smooth. M⁸¹⁰⁸ possesses from 8-10 teeth, and M⁸²⁸³ 11-18. The hectocotylized arm of the latter specimen has five normal rows of suckers proximally, followed by seven rows of modified suckers.

The principal measurements are appended:—

Specimen number	...	M ⁸¹⁰⁸ mm.	M ⁸²⁸³ mm.
End of body to dorsal mantle-margin	...	27	63
Breadth of body	...	18.50	33
" " head	...	13	25
Fin maximum	...	3	11
1st right arm	...	10	mutilated.
2nd " "	...	9	"
3rd " "	...	8	22
4th " "	...	10	mutilated.
Tentacle	...	35	missing.
Club	...	4	

Distribution.—Misaki, Sagami (Wülker); Arafura Sea, south of Papua, 28-49 fathoms (type locality).

Type.—In British Museum, two males, six females.

Sepia singalensis, Goodrich.

Sepia singalensis, Goodrich, *Trans. Linn. Soc.*, VII, pp. 3-5, pl. 1, figs. 4-8 (1896); Hoyle, *Rep. Pearl Oyster Fish. Gulf of Manaar*, p. 198 (1904).

M⁸²⁷¹ 'Investigator', Indian Seas, Marine Survey of India—One ♂.

M⁸²⁸³ Arakan Coast, 3-i-1909, trawler 'Golden Crown', Bengal Fish. Dept.—Two ♂.

M⁸²⁷² Off Gopalpore, Ganjam Coast, 25-28 fathoms, 23-ix-1909, trawler 'Golden Crown', Bengal Fish. Dept.—One ♂.

M⁸²⁸² 'Investigator' station 366: 10-iv-1906, 24° 45' N., 63° 50' 15" E. 544 fathoms—One ♂.

M⁸²⁷³ Port Blair, Andamans (G. H. Booley)—One ♂ (dorsal-mantle 155 mm.).

These are "conspicuously striped with broad dark bands on the upper surface of the mantle, head and arms" as described by Goodrich. The form of the hectocotylus and the arrangement of the teeth on the arm and tentacular sucker rings agrees with the type except for an interesting deviation as regards the large tentacular rings of specimen M⁸²⁸³. Goodrich has pointed out that the largest tentacular rings in this species are smooth and the others are denticulate, and that this is one of the characters separating it from the nearly allied species *S. rouxii*, d'Orb., which has all the tentacular rings denticulate. Specimen M⁸²⁸³, which is the smallest of the above, has the largest tentacular suckers of 2 mm. in diameter with denticulate rings like the small suckers.

The specimen next in size (M ²⁷⁸⁶₁) has the two largest tentacular suckers, of 3 mm. in diameter, with smooth rings and the remaining suckers of the club denticulate. All the other specimens show a number of large smooth rings on each club; specimen M ²⁹⁷⁷₁ for instance possesses ten smooth rings (some much larger than the others) on one club. As far as can be judged from the present material of a few male specimens, it would appear that the number of smooth rings on the club depends on the age of the specimen, and that in youth all the tentacular suckers are denticulate. The shell of specimen M ²⁹⁶³₁ was examined and measures about 107 mm. by 37 mm., and has an index of 28. The wide flattened inner cone with an oval prominence in the centre is very like Goodrich's figure. The chitinous margins measure in some parts as much as 8 mm.

The spine (broken in the type) measures 4 mm. and curves slightly backwards. Hoyle (1905, p. 981) has referred a *Sepia* to *S. rouxii*, d'Orb. with some hesitation, adding that it possessed teeth on the rings of the large tentacular suckers, but that in certain respects it seemed to be intermediate between *S. rouxii* and *S. singalensis*.

Some measurements of the specimens are appended:—

Specimen number	...	M ²⁷⁷¹ ₁	M ²⁹⁶³ ₁	M ²⁹⁶⁶ ₁	M ²⁹⁷⁷ ₁	M ²⁹⁸² ₁
		mm.	mm.	mm.	mm.	mm.
End of body to dorsal mantle-margin	...	180	111	125	173	151
Breadth of mantle	...	76	53	55	70	68
" " fin	...	25	15	17	ca. 20	19
1st right arm	...	mutilated.	44	50	68	52 ¹
2nd " "	...	69 ¹	46	47	83	55
3rd " "	...	59	48	45	90	65
4th " "	...	69	58	57	96	73
Tentacle	...	41	113	106	148	51
Club	...	33	27	26	36	30

Distribution.—Ceylon and Gulf of Manaar (Goodrich and Hoyle); Suez, Zanzibar (Hoyle).

Sepia arabica, sp. n.

(Plate xxiii, figs. 1-5; pl. xxiv, fig. 10.)

M ²³¹³₁ 'Investigator' station 246: 15-x-1898, Laccadive Sea, 11° 14' 30" N., 74° 57' 15" E., 68-148 fathoms—One ♀.

M ²³²³₁ 'Investigator' station 292: 2-xi-1901, Persian Gulf, 26° 20' N. 53° 54' E., 53 fathoms—One ♀.

Body broad in proportion to length, fins narrow, dorsal mantle-margin not much produced in centre. Head broad and flattened. Eyes large. Buccal membrane without suckers. Sperm pad not developed, perhaps owing to youth. Funnel with broad apex not reaching to fork between ventral arms. Umbrella well developed between the dorsal arms, lower laterally, and absent between the ventral pair. Fourth arms the longest, the rest

¹ Less tip.

subequal, and about one-third the length of the body. Suckers usually arranged in a slanting series of four in a row, except the proximal two rows which generally consist of two and three suckers each. The rings are usually smooth, but a few irregular notches are present on the rings of some distal suckers in specimen M⁸¹¹³. Tentacles not extending below mantle. Club small with moderate fin. Tentacular suckers subequal and placed about five in a row. The rings possess a few minute widely-spaced teeth, some blunt, others pointed. Six were observed on one ring. Surface smooth except for a few tubercles on the dorsal mantle, and oblong folds or wrinkles along the origin of the fin.

Specimen M⁸¹¹³ has also two curious ear-shaped folds on the head behind each eye, but these appear to be accidental. Colour pinkish-buff sprinkled with reddish-brown or grey-blue chromatophores which are less numerous ventrally. The shell appears to be unusually narrow in proportion to the width of the body, but this seems to be due in part to the chitinous margin having unfortunately decayed away in both specimens, the inner cone being also absent. Enough of the shell remains, however, to show the most important character of this species, *viz.*, the form followed by the lines composing the striated area.

The parallel lines are at first almost transverse, gradually a median indentation which rapidly deepens makes its appearance, so that the posterior margin of the last loculus is bounded by two V-shaped lines apparently quite unlike that of any *Sepia* hitherto described. Both shells are alike in this respect. The smooth, polished dorsal surface of the shell is only interrupted by a moderate median ridge and the divisions between the loculi. The ventral surface is slightly elevated and marked by a narrow, shallow, median groove. Judging the length of the shell from the impression of the mantle cavity the index in specimen M⁸¹¹³ would appear to be about 55 and that of M⁸¹²² about 40.

Some measurements are appended:—

Specimen number	M ⁸¹¹³ mm.	M ⁸¹²² mm.
Dorsal mantle-length	29	28
Breadth of body	16	16
" " head	11	13
Fin maximum	2	3
1st right arm	10	mutilated.
2nd " "	9	8
3rd " "	10	9
4th " "	12	11
1st left " "	9	8
2nd " "	7	mutilated.
3rd " "	8	9
4th " "	12	11
Tentacle	38	31
Club	3	ca. 5

Sepia (Doratosepion) andreanoides, Hoyle.

Sepia andreanoides, Hoyle, *Diagnoses*, II, p. 193; *Prelim. Rep.*, II, p. 297 (1885); *Challenger Rep.*, XVI (Cephalopoda), pp. 139, etc., pl. 21,

figs. 11-19; pl. 22, fig. 11 (1886); Ortmann, *Zool. Jahrb.*, III, pp. 653, 665 (1888); Wülker, *Abh. d. II. Kl. d. k. Ak. d. Wiss.*, III Suppl.-Bd., I Abh., pp. 19, 22, 24 (1910); Berry, *Proc. Acad. Nat. Sci. Phil.*, p. 423 (merely listed) (1912a).

M ²⁹⁷₁ 'Investigator' station 246: 15-x-1898, Laccadive Sea, 11° 14' 30" N., 74° 57' 15" E., 68-148 fathoms—One ♂.

M ²⁹⁸₁ 'Investigator' station 36a: 20-xii-1905, 13° 36' N., 47° 32' E., 130 fathoms—One ♀.

M ²⁹⁹₁ 'Investigator' station 464: 22-iv-1912, S. of Ceylon, 6° 2' 30" N., 81° 29' E., 52-68 fathoms—One ♀.

These all have smooth rings to the arm suckers, and teeth on the distal border of the tentacular suckers. Specimens M ²⁹⁷₁ and ²⁹⁸₁ have dorsal mantle-lengths of only 20-21 mm., and possess three to five teeth on the tentacular rings.

Specimen M ²⁹⁹₁ is much larger and has eight to seventeen teeth on the tentacular rings, and about twelve of the club suckers are as large as those of the arms. The hectocotylus and shell agree with the description of the type.

The principal measurements of this specimen are appended:—

	mm.
Dorsal mantle-length	48
Breadth of body	19
" " head	15
Fin maximum	ca. 6
1st right arm	20
2nd " "	19
3rd " "	19
4th " "	17
Tentacle	51
Club	6

Sepiostaire:—

Length	47
Breadth	9.50
Index	32

Distribution.—Bay of Tokio (Ortmann); Yokohama market (Hoyle).

Type.—In British Museum, one male, two females.

Sepia (Doratosepion) *kobiensis*, Hoyle.

Sepia kobiensis, Hoyle, *Diagnoses*, II, p. 195; *Prelim. Rep.*, II, p. 300 (1885); 'Challenger' *Rep.*, XVI (Cephalopoda), p. 142, pl. 18, figs. 7-14 (1886); Appellöf, *K. Svensk. Vetensk. Akad. Handl.*, XXI, p. 20, pl. 3, fig. 7 (1886); Ortmann, *Zool. Jahrb.*, III, pp. 654, 665 (1888); Wülker, *Abh. d. II. Kl. d. k. Ak. d. Wiss.*, III Suppl.-Bd., I Abh., pp. 16, 20, 24 (1910); Berry, *Proc. Acad. Nat. Sci. Phil.*, p. 423 (1912a).

M ³¹¹₁₋₁₂ 'Investigator' station 246: 15-x-1898, Laccadive Sea, 11° 14' 30" N., 74° 57' 15" E., 68-148 fathoms—Four ♀, two young.

M ³¹²₁₋₂₃ 'Investigator' station 292: 2-xi-1901, Persian Gulf, 26° 20' N., 53° 54' E., 53 fathoms—One ♀, one ♂.

M ³¹³₁₋₅ 'Investigator' station 383: 22-ii-1909, off C. Negrais, Burma, 16° 0' N., 93° 37' E., 40 fathoms—One ♂.

M ³¹⁴₁₋₅ 'Investigator' station 464: 22-iv-1912, S. of Ceylon, 6° 2' 30" N., 81° 29' E., 52-68 fathoms—One ♀.

The outline of the striated area of the shell seems a little different in these specimens to the description of the type and to the illustration of Appellöf (1886, pl. 3, fig. 7a). The present examples have no median indentation in the curved line which more resembles that of the shell of *S. esculenta*, Hoyle. The line is, however, somewhat irregular, especially in the earlier stages, and in all other respects there is no deviation from the description of the type.

The smallest female examined has a mantle-length of 22 mm. and nidamental glands measuring 1.25 mm. in length. Measurements of three of the largest specimens are appended, also measurements of four shells:—

Specimen number	M $\frac{2120}{1}$ ♂ mm.	M $\frac{2121}{1}$ ♀ mm.	M $\frac{2133}{1}$ ♀ mm.
Dorsal mantle-length	55	40	37
Breadth of body	22	19	17
.. .. head	16	16	14
1st right arm	16	13	14
2nd	15	12	11
3rd	12	11	10
4th	15	14	12
Tentacle	missing.	41	34
Club	..	ca. 6	5

Sepiostaire:—

Specimen number	M $\frac{2121}{1}$ ♀ mm.	M $\frac{2125}{1}$ ♂ mm.	M $\frac{2133}{1}$ ♀ mm.	M $\frac{2136}{1}$ ♀ mm.
Length	39	26	35	27
Breadth	10	6	8.50	8
Spine	ca. 2	1		1.75
Index	30	32	30	32

Distribution.—Japan; Indo-Malayan Region; Pacific Region.

Type.—In British Museum, one female.

Sepia sp.

M $\frac{2222}{1}$ Persian Gulf (Townsend)—Two young.

These have a broad body, and dorsal mantle-length of about 10 mm. The arm suckers are placed four in a row and have eight or nine teeth. The proximal tentacular suckers are placed two or three in a row. Suckers in the central part of the club have ten teeth and are twice the size of those at the outer edge. The ventral mantle-margin shows a marked indentation below the siphon. Colour greyish-brown above, lighter beneath.

Genus Sepiella, Gray.

Sepiella inermis (van Hasselt, MS.), Steenstrup.

(Plate xxiii, fig. 6; pl. xxiv, figs. 1-9.)

Sepia inermis, d'Orbigny, *Cephalopodes acetabuliferae*, p. 226, pl. 6, bis; pl. 20, figs. 1-9 (1839); Steenstrup, *K. d. Vid Selsk. Skr.* (5) VII, p. 478, pl. 2, fig. 3 (1875); *Sepia sinensis*, d'Orbigny, *op. cit.*, p. 289, pl. 9, figs. 1, 2 (*fide* Gray) (1839); *Sepia microcheirus*, Gray,

British Museum Catalogue, p. 107 (1849); *Sepiella inermis*, Steenstrup, *Vid. Meddel. Nat. Foren. Kjöbenhavn*, pp. 347-356, figs. 1-8 (1880); Goodrich, *Trans. Linn. Soc.*, VII, p. 5 (1896); Joubin, *Bull. Soc. Zool. France*, XXII, p. 103 (1897); Joubin, *Notes Leyden Mus.*, XX, p. 25 (1898); Hoyle, *Fauna and Geogr. Maldives-Laccadive Archip.*, II, suppl., p. 982, fig. 152 (1905); *Sepiella curta*, Pfeffer, *Abh. Naturw. Ver. Hamburg*, VIII, p. 13, fig. 16 (1884); *Sepiella ocellata*, Pfeffer, *op. cit.*, p. 13, fig. 17 (1884).

			mm.
M 21 ⁹	Sandheads, River Hughli (J. Barnett)		
	—One ♀	dorsal mantle-length	61
M 61 ¹	Galle, Ceylon (Dr. Anderson)	—One ♂	68
M 61 ⁴	Indian Seas (Dr. Armstrong, 1875)		
	—One ♀	" "	58
M 61 ⁶	Loc. ? Asiatic Soc. Bengal	—One ♂	55
M 61 ⁹	Penang (Dr. Stoliczka)	—One ♂	45
M 72 ⁷	Sandheads, River Hughli (Milner)		
	—One ♀	" "	68
M 327 ³	'Investigator' station 332 : 12-iv-1904, Andaman Sea, 10° 21' N., 92° 46' 15" E., 279 fathoms.	—One ♂	59
M 327 ⁷⁻⁹	Mutlah River, surface	—One ♂, Two ♀	26-60
M 327 ²⁻⁴	Indian Seas, Marine Survey of India	—One ♂, two ♀	47-64
M 333 ⁹⁻⁶¹	Off Puri, Orissa Coast, trawler 'Golden Crown', Bengal Fish. Dept.	—One ♂, two ♀	46-7
M 305 ²	Sandheads, River Hughli, 20-iv-1870 (G. Lord)	—One ♂	323
M 310 ⁹	Hainze Basin, Burma, Marine Survey of India	—One ♀	50
M 310 ⁶	'Investigator' station 70 : 9-i-1890, Off Chilka L., Orissa Coast, 11 fathoms	—One ♀	28
M 310 ⁷	'Investigator' station 83 : 28-i-1890, 9 miles S. W. of Bawanapadu Beacon, Ganjam Coast, 13 fathoms	—One ♂	45
M 314 ²⁻³	'Investigator' station 463a : 21-iv-1912, Bay of Bengal, 7° 37' N., 84° 19' E., 400 fathoms	—Two ♂	39-53
M 315 ²⁻³	'Investigator' station 481 : 25-26-xii-1912, Mergui Harbour, 7 fathoms	—One ♂, One ♀	36-47
M 316 ²	Mouth of River Hughli (Capt. T. Munro)	—One ♀	77
M 317 ⁰	Puri Beach (N. Annandale), 20-22-iii-1906	—One ♂	66
M 317 ¹⁻²	Puri Beach, Orissa Coast (N. Annandale), 1-2-ii-1909	—Two ♀	79-84
M 320 ²⁻⁰⁵	Puri Beach, Orissa Coast, 18-19-1-1908 (Capt. R. E. Lloyd)	—One ♂, Three ♀	53-71
M 321 ¹	(a, b, c, d) Puri Beach, Orissa Coast (F. H. Gravely)	—Three ♂, One ♀	25-79
M 321 ²	Puri Beach, Orissa Coast (C. Paiza)	—One ♀	70
M 321 ⁹	Persian Gulf (R. Hugh Butler)	—One ♂	46
M 322 ⁰⁻²¹	Palk Straits, S. of India	—Two, ♂, One ♀	36-52

	mm.
M 8250 Akyab, Burma. (I. H. Burkill)	
—One ♀ dorsal mantle-length	40
M 8251 10 m. N. E. of Devi River, Orissa Coast. 8 fathoms. 24-xii-1888—Three ♂, One ♀	21-31
M 8252 Puri Beach, Bengal Fish. Dept. —One ♂, Two ♀	57-73
M 8270-71 Balasore Bay, Orissa Coast, trawler 'Golden Crown', Bengal Fish. Dept. —Two ♀	62-63
M 8272-23 Balasore Bay, Orissa Coast, trawler 'Golden Crown', Bengal Fish. Dept. —Two ♀	62-65
M 9013-20 'Investigator' station 565 and 567: 13-20-xi-1913. 11° 57' 30" N., 98° 19' 00" E., 6-7 fathoms —Fourteen ♂, Three ♀	26-37 40-47
M 9018-2120 'Investigator' station 569: 29-30-xi-1913. 11° 52' 10" N., 98° 18' 4" E., 5 fathoms —Forty-three ♂, Nineteen ♀	20-40 15-40

These eighty-one males and fifty-one females taken either by shore collecting, or at a few fathoms to four hundred fathoms' depth, chiefly come from the Bay of Bengal region, and southwards to the Andamans and Ceylon. The Persian Gulf and Malay Peninsula are also represented.

All agree in having an oblong body, the breadth of which is two-thirds of the mantle-length, except in the case of large females (mantle 63-79 mm.), when the breadth is a little more than half the length.

The fins usually begin at a short distance from the mantle-margin and are generally formed anteriorly like a roll, and become wider posteriorly. The deep water specimens, and many collected on shore or at a few fathoms, have very wide fins throughout their entire length.

Head very broad. Umbrella highest laterally, and absent between the ventral arms. Arms short and keeled, the fourth pair strongly, the first and second very slightly. All with strong protective membranes and suckers in four rows. The suckers have meridional grooves and distal notches. In male specimens the rings of the arm suckers possess eight to fourteen long, pointed, closely-placed teeth on the distal margin, the rest of the ring being smooth. The number of teeth is largest in suckers from the centre of an arm, although the proximal suckers may equal them in size. A specimen with mantle-length of 36 mm. possesses eight teeth on the proximal and distal suckers and ten on those from the centre of an arm.

The female specimens have arm suckers with smooth rings; occasionally the horny ring shows indications of ten to eleven long, pointed teeth on the distal portion but the margin is un-split. In some cases it is notched but not deeply enough to form teeth. Wülker (*op. cit.*, p. 20) refers two females to *Sepiella*

curta, Pfeffer, and describes them as having arm rings quite wanting in teeth and yet not completely smooth. He expresses doubt as to whether the species should not be united with *S. inermis*, as the only difference rests on whether the arm rings are smooth or dentate. The type specimens of *S. curta* are two in number, and one is described as having a hectocotylized arm. The other is presumably a female, and if the description of the arm rings was taken from it, and not from the male, it would naturally seem to be a different species to *S. inermis*, which is figured by d'Orbigny as possessing sharp teeth on the upper edge of the ring. The exceptional advantage I have enjoyed in having such a large collection of both sexes of various sizes to examine has convinced me that both *S. curta* and *S. ocellata*, Pfeffer are the same species as *S. inermis*, and although *S. ornata* (Rang) has only been recorded from the west African region, I think it may eventually prove to be also this species, in which case Rang's name would have the priority. The hectocotylus has been figured by Hoyle (1905, fig. 152). It affects the proximal part of the fourth left arm, extending over more than half its length in small specimens, and less than half the length in larger examples. The modified suckers are very minute and in four rows, each row having a pair of suckers placed close together at either side of the arm, those on the ventral border being larger and placed closer together. Transverse folds on the modified portion of the arm are very distinct in well preserved specimens. The tentacle stems are flattened on the inner surface. The club is very long and possesses a moderate fin and slight protective membrane, and a width at the centre of about twice that of the stem.

The very numerous and minute club suckers are distributed in no particular order. Two much larger than the rest are placed at the tip of the club. The rings of the tentacular suckers possess blunt teeth on the distal margin, the remainder of the ring being smooth. The teeth are very little wider at the base than at the top and are generally separated by about the width of their base. The number varies according to the size of the specimen, and individual variation plays a part. Thus a male with mantle-length of 33 mm. possesses three to four teeth, and a female specimen with mantle-length of 30 mm. possesses three to six teeth. A male with mantle of 48 mm. possesses nine to eleven teeth, and a female of 52 mm. mantle-length has five to seven. Females with mantle-length of 61-79 mm. show nine to thirteen teeth. If one of the minute club suckers is placed on its side the papillae cause the ring to appear to be dentate all round.

Two females from Puri Beach (M ⁵¹⁷¹²₁) showed either no teeth, or a very feeble development of them on the rings of the only tentacle present, but in general appearance, funnel organ and shell, they agreed perfectly with other specimen of *S. inermis*. Buccal membrane seven-angled and minus suckers. A large spermatheca is developed in the female. Funnel organ: a Λ -shaped median pad and pear-shaped lateral pads, widest posteri-

only. Sculpture: a few papillae are usually present on the dorsal surface of the mantle, and sometimes extend to the head, but never to the fins or ventral surface. Colour in alcohol, buff with a variety of bluish-slate and purple-pink markings. The innumerable chromatophores are very small and dark on the dorsal surface and are usually reddish ventrally. Very few chromatophores occur on the ventral surface of the fins. The row of dark ornamental spots or ocelli along the base of the fin shown in the illustration of d'Orbigny (pl. 20) is present only in males of a certain size. Among the specimens M $\frac{9013-29}{2}$, eight males with mantle-length of 26-35 mm. show no ocelli, which are, however, distinctly marked on four males with mantle-length of 32-37 mm. As regards the specimens M $\frac{9098-9150}{2}$, thirty-one males with mantles of 33-40 mm. show the ocelli and the remaining twelve males, which are without them, have a mantle-length of only 20-32 mm. The ocelli are always largest at the posterior end of the mantle, and in very small males appear first at this end. They are usually pear-shaped with the pointed end innermost, and may be 7 mm. by 2 mm. in large specimens. Anteriorly they become rounder. A male with mantle-length of 36 mm. shows five ocelli on each side, one with mantle-length of 46 mm. has seven on each side, and one with mantle of 53 mm. has nine on each side. The Penang specimen (M $\frac{616}{1}$) shows a deviation from this rule by exhibiting eleven strongly-marked ocelli on either side of a mantle of 43 mm. in length. The ocelli, which show no iridescence, are situated in the skin beneath the outside layer, and do not penetrate to the muscular layer. If a portion of epidermis is examined with a high power, the ocelli appear as opaque, white, oblong masses, and are thus in sharp distinction to the round dark chromatophores none of which approach them in size. In light coloured specimens the ocelli are pinkish¹, and small dark chromatophores are sprinkled over their surface as elsewhere. In the female the ocelli are always absent, and they are also wanting in a few males large enough to possess them (M $\frac{614}{1}$, M $\frac{1772}{2}$ and M $\frac{8219}{2}$), but these latter are either faded or in bad condition as regards the epidermis. Many of the specimens in the collection possess no date of capture, but there is evidence to show that examples with ocelli were taken in the months of January (1890 and 1908, in both hauls ocelli barely visible); March (1900, very distinct); April (1870, faint, 1904 and 1912, very distinct); November (1913, very distinct); and December (1912, well-marked).² A male *S. ornata* in the Paris Museum exhibits ocelli along the sides closely resembling those of male *S. incermis*. A female *S. ornata* in the same collection has unfortunately become suffused with black so that it is not possible to see if the ocelli are absent.

Eight males (M $\frac{9013-29}{2}$) with mantle-length of 30-37 mm. and six males and one female (M $\frac{9098-9150}{2}$) also small, exhibit a beauti-

¹ It is often necessary to hold a specimen up to the light, or allow it to become dry, in order to discover the ocelli.

² A specimen taken in December, 1888 shows no ocelli.

ful iridescent patch on the dorsal surface at the posterior end of the body. The pore, situated at the ventral posterior end of the body in the present genus, leads into a gland the function of which has never been made clear. This gland is covered by a muscular coat under and amongst which lies (in the present specimens) a thin iridescent layer which does not extend to the many-furrowed inner wall, and only traces of iridescence were observed outside the lower surface of the gland. Besides the above-mentioned female, two others (M⁰⁰¹³²⁹), showing no external iridescence, displayed, when the skin was removed, flashes of golden-green and pink. In one of these females the gland was pale purple and the pore had a purple tinge, but on being opened no trace of purple fluid could be seen. Wülker, *op. cit.* p. 32, has remarked on the existence of a purple gland in this part of the body in *Sepiella*, discovered by Appellöf. He alludes also to the striking coloured appearance figured by d'Orbigny and Férussac for *S. ornata* (Rang) at the dorsal posterior end of the body, and suggests that if a living example could be examined a luminous organ might be found in this situation. The adornment figured by d'Orbigny is, however, probably similar to the iridescent patch described above, which would seem, moreover, to be evanescent in alcohol, no specimens exhibiting it excepting those which had been preserved for less than a year when examined. Steenstrup has remarked with regard to the shell in *Sepia* that the proportion which the last loculus bears to the area of the shell varies according to the season of the year. Jatta says with regard to this "while the sepium increases in volume "and therefore augments the number of lamelli, the striated area "becomes larger while the smooth area diminishes: as a consequence of which in the same species there may be found "according to the stage of growth of the bone, and the greater "or less activity in the formation of lamelli, and, therefore, "perhaps also according to the seasons, the two areas now equal "and now one prevailing above another." The shells of sixteen males and twenty females from the present collection were examined. The limited amount of evidence thus available seems to show that the limbs of the inner cone become accentuated with age and are then widest in the female, and, also, that individual variation exists as to their thickness and height. It will be observed in the specimens figured (pl. xxiv, figs. 1-8) that the striated area comprises more than half of the length of the shell in youthful specimens, and that the shell of a very young female is not broader in proportion to its length than that of a male. The shells of older specimens usually have the last loculus occupying about two-thirds of the length of the shell. The curvature of the parallel lines formed by the margin of the striated area varies occasionally, as is seen in the shell of the largest male figured, the other specimens exhibiting what appears to be the usual form. The dorsal surface is coarsely granulated and the shell beneath it is striated longitudinally. This can be seen in young specimens

in which the granulation is not much developed, and in most other examples at the commencement of the chitinous margin of the last locus. An examination of the arrangement of the various internal organs showed, that, as Wülker (*op. cit.*, p. 31) has already pointed out, this genus and *Sepia* resemble each other almost exactly as regards the anatomy.

The radula and mandibles are shown on pl. xxiii, fig. 6 and pl. xxiv, fig. 9.

The principal measurements of a male and female are appended.

Specimen number	...	M ⁸²³⁰ ♂	M ⁸²¹² ♀
		mm.	mm.
End of body to dorsal mantle-margin		43	62
Breadth of body	...	29	42
" " head	...	20	26
1st right arm	...	15	20
2nd " "	...	16	21
3rd " "	...	21	25
4th " "	...	23	32
Tentacle	...	56	76
Club	...	13	ca. 18
Fin maximum	...	6	6
" minimum	...	2	3

Distribution.—Indo-Malayan Region; Timor, Japan (*Joubin*).

Sepiella sp.

M ⁸²³⁰ Kilakarai, Ramnad District, South India, 0-2 fathoms, ii-1913 (*S. W. Kemp*)—One.

The above is too young to determine with certainty as it has a mantle-length of only 13 mm. Wülker regards *Sepia* specimens with mantle of 27-40 mm. as too young to determine specifically. If, however, a number of specimens of large and small size occur together it seems possible to assign them specifically at a much earlier age.

Family SEPIIDAE.

M ⁸¹⁹⁵³ 'Investigator' station 80: 17-i-1890, 4 miles S.E. of Sonapur Beacon, Ganjam Coast, 24 fathoms—Two immature.

These have a mantle-length of 6 mm. The fins commence at 2 mm. from the mantle-margin and are most developed posteriorly. Fourth arms the largest and with keels; suckers of arms in two rows. Tentacles missing except for a retracted one which can be observed coiled round beneath the skin on the ventral surface. Colour buff, closely freckled with small purple, brown chromatophores, which are thickest on the median dorsal surface of the mantle and head.

Family SEPIOTEUTHIDAE.

Sepioteuthis arctipinnis, Gould.

Sepioteuthis arctipinnis, Gould, *U. S. Exploring Exp.*, XII, p. 479, fig. 93 (1852); Wülker, *Abh. Senckenb. Nat. Gesell.*, XXXIV, pp. 452-

475, 482 (1913); Berry, *Bull. Sur. Fish.*, XXXII, pp. 308-9, figs. 9-22 (1914).

M ⁵¹³²₁ 'Investigator', N. Andaman Island, littoral, Marine Survey of India—One ♂, one ♀.

M ⁵¹⁰³₁ 'Investigator', E.S.E. of S. Moscos Island, Marine Survey of India—One ♀.

M ^{5103:1} Andamans (F. Wood-Mason)—One ♂, one ♀.

The above all agree in the shape of the pen and in having the greatest width of the fin at the posterior third of the body. The pen has a hollow midrib with broad marginal thickenings, and is covered by a transparent and very delicate horny plate with a broadly rounded anterior margin. The median mantle-margin in order to correspond with the shape of the pen is, therefore, very obtuse and evenly rounded. The funnel organ was examined in specimens M ⁵¹⁰⁴₁ and M ⁵¹⁰³₁. It is A-shaped, with smaller, oblong, lateral pads. Order of arms 3, 4, 2, 1; protective membranes to all, especially developed on third pair; suckers in two rows. Specimens M ^{5103:1}₁ are in good condition, and their largest arm suckers have rings armed with nineteen or twenty teeth all round the ring, five or six on the distal margin being larger than the rest. The space between each tooth is about the width of the base of two teeth and this space is equal to the length of a tooth. The teeth are incurved and resemble short, broad claws. A distal sucker shows twenty teeth, eight of which are larger than the rest. The tentacle suckers are in four rows, those of the middle third of the club being much larger than the rest. The suckers of the inner rows here are larger than the marginal ones. The rings of the tentacular suckers also have teeth on the entire circumference, five, or sometimes more, claw-like teeth larger than the rest being placed on the distal margin.

The space between each of these is about equal to the width of three teeth and corresponds with the length of each. The proximal suckers show less space between the teeth. Both specimens have a spoon-shaped expansion with small flat suckers at the tip of the club. The hectocotylized arm of specimen M ⁵¹⁰³₁ has twenty rows of ordinary suckers followed by a few small suckers on long pedicels; these are succeeded by papillae surmounted by extremely minute suckers which persist either as complete suckers, or in rudimentary form, to the tip of the arm. The ventral papillae are smaller than those of the dorsal margin. Buccal membrane seven-angled and with suckers with toothed rings. As many as five suckers may be present on an angle. Colour pinkish-buff with large brownish-red chromatophores or small, almost black, ones.

Ventral fin surface without chromatophores. Specimens M ⁵¹³⁻⁴₁ are in bad condition and much contracted. Their characters seem to agree with the foregoing except that their colour is much darker, viz., ground colour gray, with very dark blotches covering much of the ventral as well as the dorsal surface. The ink sac is ruptured in one of the specimens which may account for the dark ground colour.

Specimen M ⁸¹⁰⁵ seems to have a somewhat wider and rounder head, and arms shorter in proportion to the length of the mantle than the other specimens, but these differences may be accounted for by its being at a younger stage of growth or by varying modes of preservation. The tentacle stems are evidently partly withdrawn. The arm rings of this little specimen are armed with fourteen to twenty-four teeth surrounding the entire ring, about five on the distal margin being stouter and longer than the rest. A large median tentacular sucker shows eleven long teeth on the distal portion and the rest of the ring possesses much smaller teeth. Conical papillae are present and those near the ring sometimes look like small between teeth. The teeth are longer in proportion to the size of the ring than in the older specimens.

Colour pinkish-brown with many dark blotches and spots, head so densely mottled as to be almost black.

No chromatophores on ventral surface of fins.

The principal measurements in mm. are appended:—

Specimen number ..	M ⁸¹⁰⁵ ♂	M ⁸¹⁰⁶ ♀	M ⁸¹⁰⁷ ♀	M ⁸¹⁰⁸ ♂	M ⁸¹⁰⁹ ♀
End of body to dorsal mantle-margin	60	52	34	95	129
Breadth of mantle	28	22	12	34	43
" " head...	16	20	11.50	27	35
Greatest width of fins	39	32	22	58	85
1st right arm	15	ca. 13	ca. 8	28 ¹	45
2nd " "	22	ca. 22	10	38 ¹	54
3rd " "	24	ca. 24	17	51	67
4th " "	24	ca. 23	13	49	69
Tentacle	ca. 63	57	23	98	133
Club	23	22	13	37	58
Diameter of largest sucker of sessile arm	75		50	150	ca. 175
Diameter of largest sucker of tentacle.	1		75	2	2

Distribution.—Island of Maui (type locality); Honolulu, Oahu, Bertrand Island, North Coast of Papua? (*Wülker*).

Family ENOPLOTEUTHIDÆ

Abralia andamanica, Goodrich.

Abralia andamanica, Goodrich, *Trans. Linn. Soc.*, VII, p. 9, pl. 2, figs. 38-45 (1896); *Asteroteuthis andamanica*, Pfeffer, *Plankton Exp.*, (Oegopsida) p. 137 (1912).

M ⁸²⁰⁰ 'Investigator' station 224: 23-ii-1897, 14° 54' 30" N., 96° 13' E., 55 fathoms—One ♀.

M ^{8202, 8203} 'Investigator' station 590: Mergui Archipelago, Marine Survey of India—One ♀ and one (?) ♂.

Specimen M ⁸²⁰⁰ is not in very good condition and it is difficult to discover more than about three rows of transverse luminous

¹ Less tip.

organs on the ventral surface of the mantle. A few organs are visible on the siphon and they form nine rows on the ventral surface of the head. Three rows are present on the ventral arms and a single organ is visible on the third left arm. About thirty surround one eye, those on the ventral surface being most conspicuous. The first right arm possesses eleven hooks and twelve suckers, and the fourth has sixteen hooks and the same number of suckers. The rings of the arm suckers have twelve to fourteen blunt and rather long teeth, separated by about the width of their base on the distal edge of the ring. Goodrich (1896, pl. 2, fig. 42) represents the ring as being toothed all round. Pfeffer (*l.c.*, p. 137) has, however, suggested that Goodrich may have mistaken some papillae for teeth as it is frequently very difficult to distinguish them unless the horny ring is isolated from the sucker. This specimen has more tentacular hooks and suckers than the type, but the fact that these vary on the different clubs shows that no hard and fast rules can be laid down as regards this. One tentacle has a connective apparatus of five suckers and six papillae, and along the ventral margin of the club are three much-curved hooks and the sockets of two others, the central hook being the largest. Nine large suckers occur near the hooks, each having a horny ring with about thirty teeth (separated by about the width of their base) on its circumference. The distal part of the club has fifteen or sixteen rows of very small suckers placed four in a row and becoming very minute towards the tip, their rings being armed with many teeth. The other tentacle has a connective apparatus of four suckers and eight papillae, and the club shows five hooks and the socket of a sixth, as well as eight large suckers, and fifteen or sixteen rows of minute suckers on the distal portion.

Specimen M ²³²⁰₂ has five hooks on the only club present. The ventral surface of the mantle shows many luminous organs on the median line, and elsewhere, but they are not arranged in any definite order, and a few trespass a little on the dorsal surface. Besides the three rows on the ventral arms, a single row ornaments each of the third arms. The eight-angled buccal membrane is pale and dotted with red chromatophores. The funnel organ closely resembles that of *A. trigonura*, Berry (1914, p. 329, text-fig. 33), and consists of a median Λ -shaped dorsal pad and broad ovate ventro-lateral pads, a small valve being also present. The luminous organs on the funnel fail, however, to show the triangular arrangement described by Berry. The small specimen M ²³²¹₁ seems to be a male, but it is not in very good condition, and there is no trace of a hectocotylus. Four hooks are present on one club and five on the other. Luminous organs are visible on the third as well as on the fourth arms, and are very distinct round each eye-opening, but the eyes, as is the case with the other specimens, are injured.

The principal dimensions in mm. are given below

Specimen number	M ⁸¹³⁸ ₁	M ⁸¹³⁹ ₂	M ⁸¹⁴¹ ₃
End of body to dorsal mantle-margin	40	35	24
Mantle-margin fork between dorsal arms	12	13	9
Breadth of mantle	12	10	10
" across fins	30	25	15
Length of fin	22	20	11
1st right arm	20	20	14
2nd " "	25	21	18
3rd " "	22	20	17
4th " "	22	22	14
Tentacle	45	35	33
Club	10	9	5

Distribution.—Andaman Sea, 188-320 fathoms.

Type.—In Indian Museum, Calcutta, three specimens, male and female.

Family BATHYTEUTHIDAE.

Bathyteuthis abyssicola, Hoyle.

Bathyteuthis abyssicola, Hoyle, *Narr. Chall. Exp.*, I, p. 272, fig. 108 (1885); 'Challenger' *Rep.*, XVI (Cephalopoda), pp. 168-169, pl. 29, figs. 1-7 (1886); Pfeffer, *Synopsis Oegopsid. Ceph.*, pp. 172-3 (1900); Hoyle, *Bull. Mus. Comp. Zool.*, XLIII, no. 1, p. 33, pl. 1, fig. 2 (1904); *Trans. Royal Soc. Edin.*, XLVIII, part II, no. 14, pp. 282-283 (1912); *Benthoteuthis megalops*, Verrill, *Trans. Connect. Acad., Third Catalogue* (Cephalopoda), p. 401, pl. 44, fig. 1 (1885); Chun, *Valdivia Exp.*, (Oegopsida) p. 185, pls. 24-27 (1910); Pfeffer, *Plankton Exp.*, (Oegopsida) pp. 325-331, pl. 40, figs. 12-16 (1912).

M⁸¹³⁸₁ 'Investigator' station 393: 21-x-1911, Bay of Bengal, 7° 21' 6" N., 85° 7' 15" E., 2000 fathoms—One.

M⁸¹³⁹₂ 'Investigator' station 462a: 20-iv-1912, Bay of Bengal, 9° 8' N., 87° 25' E., 475 fathoms—One.

In specimen M⁸¹³⁹₂ the suckers of the ventral arms are in two rows throughout, and on the other arms they are proximally in two rows and distally in three or four irregular rows. The rings of the arm suckers have five to six teeth.

The tentacles are very long which is perhaps due to the specimen having been preserved in formalin. The suckers of the club begin proximally by a single sucker, followed by three in a row, and gradually increasing to about six in a row. A few rings of the club suckers appear to have about four blunt rather widely separated teeth on the distal margin and the rest of the ring smooth. Their position on the ring, and their blunt ends, seems to point to their being teeth and not papillae. Other rings seemed to be smooth. Hoyle describes the tentacular rings to be smooth, and Verrill does not mention their condition which would seem to imply that he had not observed any teeth.

The horny rings of both tentacular and arm suckers are very dark. The luminous organs of the arms are about 50 mm. in length. The chromatophores are darkest on the dorsal surface of the head. Specimen M⁸¹³⁸₁, from the great depth of 2000 fathoms, is very young, and the mantle is much crumpled and denuded of its epidermis. The luminous organs at the base of the arms are clearly perceptible. The arm suckers are in two rows, and their largest rings show four to five teeth. The ten-

tacles are only represented by portions of stems. The arms are about 2 mm. in length, and the distance from the dorsal mantle-margin to the fork between the dorsal pair is 2 mm. The breadth of the head across the eyes is about 2.50 mm. The specimen has been preserved in formalin.

The following are the principal measurements of specimen M ⁸¹³⁰₁ :—

	mm.
End of body to dorsal mantle-margin ...	12
Breadth of mantle ...	4
" head across eyes ...	6
1st right arm ...	3.50
2nd " " ...	4
3rd " " ...	4
4th " " ...	5
Length of tentacle ...	22
" club ...	2.50

Distribution.—North Atlantic (Verrill, 1885); Indian Ocean (Chun); between Marion Island and the Crozets (Hoyle, 1886); North Pacific (Hoyle, 1904); Antarctic (Hoyle, 1912).

Vertical Range.—437-1600 fathoms (Pfeffer, 1912).

Family HISTIOTEUTHIDAE.

Stigmatoteuthis japonica, Pfeffer.

Stigmatoteuthis japonica, Pfeffer, *Plankton Exp.*, (Oegopsida) pp. 284-5 (1912); *Calliteuthis reversa*, Hoyle, 'Challenger' Rep., XVI (Cephalopoda), pp. 183-4, pl. 33, figs. 12-15 (1886).

M ⁸¹³²₁ 'Investigator' station 374: 2-iv-1907, Andaman Sea, 11° 37' N., 95° 57' E., 28 fathoms—One.

The first three pairs of arms have a row of luminous organs on the ventral margin of their dorsal surface. Of these there are eight on the first arm, eleven to twelve on the second, and nine on the third. On the latter pair a short, strong keel attaining 3 mm. in width, is developed on the central third of the arm along the line of the luminous organs. The fourth arms possess three rows of luminous organs for more than half their length, two of which persist towards the tip where a single row containing four terminates the series. About twenty-nine organs are present on one of these arms. Seventeen luminous organs surround the right eye-opening. The left eye has only six organs. The mantle-margin has a well-defined row of organs all round its circumference, except on the median dorsal surface, where a space of 11 mm. is ornamented by a solitary organ in the exact median line. On the ventral mantle there are about sixteen transverse rows of organs, and about six similar rows occur on the ventral surface of the head; eight organs form a low arch above the siphon. Very few luminous organs are present on the dorsal surface of the head and mantle. The arms have slight protective membranes and their suckers are furnished with smooth rings, except at the distal portion of each arm, where the rings have five to eight

blunt rather closely-set teeth on the distal margin, the rest of the ring being smooth. The tentacle stem is flattened and its inner surface is marked with a groove. At 16 mm. from the base of the club the connective apparatus, consisting of eight suckers and four papillae, commences. These suckers have a papillary area and smooth ring. Six or seven suckers are placed in a row on the proximal two-thirds of the club, about ten being larger than the rest; the distal third has very small suckers, the last six rows containing only two apiece. Protective membranes are moderately developed, and there is a slight dorsal keel. The rings of the large tentacular suckers have twenty-two to twenty-five pointed teeth all round their circumference. Smaller suckers may have as many as thirty-six teeth. None of the suckers has accessory chitinous formations.

Colour reddish-purple, fins paler and their ventral surface sprinkled with chromatophores on the part next the mantle. Pfeffer (*l.c.*, p. 249) has shown that the genus *Calliteuthis* is defined by having smooth rings to arm and tentacle suckers, and that the latter are furnished with accessory chitinous formations which are wanting in the genus *Stigmatoteuthis* which has denticulate rings to arm and tentacle suckers.

The principal measurements are as follows:—

	mm.
End of body to dorsal mantle-margin	56
Breadth of mantle	23
Breadth across fins	37
" of fin	29
1st right arm	52
2nd " "	62
3rd " "	56
4th " "	52 ¹
Tentacle	125
Club	19

Distribution.—Japan, 345 fathoms (*Hoyle*). One specimen.

Family CHIOTEUTHIDAE.

Chiroteuthis (*Chirothauma*) *imperator*, Chun.

Chiroteuthis (*Chirothauma*) *imperator*, Chun, *Valdivia Exp.*, (Oegopsida) p. 241, pls. 38, 39, 40, 41, 42, 43, 44 (1910); Pfeffer, *Plankton Exp.*, (Oegopsida) p. 581 (1912).

- M¹²⁵⁰₁ 'Investigator' station 281: 20-iii-1901, Bay of Bengal, 11° 15' 15" N., 8° 7' E., 300 fathoms.—One ♀.
 M¹³⁵⁰₁ 'Investigator' station 297: 13-iv-1902, Gulf of Oman, 25° 11' 30" N., 57° 15' E., 700-689 fathoms.—One.
 M¹³²⁸₁ 'Investigator' station 366: 10-iv-1906, Arabian Sea, 24° 45' N., 63° 50' 15" E., 544 fathoms.—One ♀, and arms of another specimen.

The specimen M¹²⁵⁰₁ resembles in colour Chun's illustration (pl. 38, figs. 1 and 2). The ventral luminous organs measure about

¹ Less tip.

3 mm. in length and 2.50 mm. in breadth. The nidamental glands measure nearly 1.50 mm. in length. The olfactory papillae measure about 2 mm. in length and are situated at about 3 mm. below the posterior end of the eyes. The ventral arms have the margins mutilated in many parts so that only a few luminous organs are present, *viz.*, 9 on one arm and 3 on the other. The tentacles have lost their clubs.

The example M ¹³⁸⁰₁ is much damaged but in spite of its mutilated condition it has been easy to identify it with certainty from Chun's magnificent illustrations. One of the tentacles possesses a club, and the stalks of its suckers are furnished with the wing-like membrane described by Chun (p. 247), and in other details the club suckers and those of the arms resemble completely Chun's description and figures. About fifty luminous organs are present on the fourth right arm and forty-six on the fourth left arm. Nothing resembling a hectocotylus appears on any of the arms. The eyes have the three longitudinal rows of luminous organs which Chun describes as "sparkling like a chain of jewels." Twenty-two are present on one eye. The fins, siphon, and much of the ventral region have been torn away.

The dorsal mantle-margin has the attachment exactly as in Chun's illustration (pl. 39, fig. 1).

The tentacles are furnished at the base with membranes which are widest at the dorsal side.

The dorsal mantle region is much darker in tone than the illustration of Chun (pl. 38, figs. 1 and 2), who, however, mentions (*l.c.*, p. 251) "auch hebt sich bei einzelnen Exemplaren die Rückenregion im Bereiche des Gladius durch etwas intensivere Pigmentierung ab."

The specimen M ⁸¹²⁸₁ is also in very bad condition, and is accompanied by the arms of another large specimen M ^{8128a}₁ and a loose tentacle which presumably belongs to one of them. The club of the latter measures 140 mm. Approximate measurements of the different specimens are given below:—

Specimen number	...	M ¹³⁸⁰ ₁ mm.	M ¹³⁸⁰ mm.	M ⁸¹²⁸ mm.	M ^{8128a} mm.
Dorsal mantle-margin to commencement of fins	...	26	...	74	...
Breadth of body at mantle-margin	...	15	...	45	...
" of head	...	11	45	ca. 28	...
" of fins	...	30	...	82	...
1st right arm	...	25	214	83	101
2nd " "	...	38	mutilated.	112	122
3rd " "	...	45	203	128	140
4th " "	...	92	337	200	202
Length of tentacle	...	106 ¹	1098	mutilated.	mutilated.
" " club	...	...	167	...	...

Distribution.—0° 15' N., 98° 8' E., trawl 614 m. ('*Valdivia*' *Exp.*) Sagami Bay, Japan, from the collection of Haberer and Doflein (Chun, 1910).

¹ Mutilated.

Family CRANCHIIDAE.

Teuthowenia (Hensenioteuthis) joubini, Pfeffer.

Teuthowenia (Hensenioteuthis) joubini, Pfeffer, *Plankton Exp.*, (Oegopsida) pp. 747-8, pl. 48, figs. 12-16 (1912).

M⁸¹³⁰ 'Investigator' station 462a: 20-iv-1912, Bay of Bengal, 9° 8' N., 87° 25' E., 475 fathoms—One.

This is considerably larger than the type, and unfortunately resembles it in having the tentacles represented only by mutilated stems. There is a slight groove on the inner surface of the stem, and at about 3 mm. from the mouth there seemed to be two minute suckers, which, however, may have been only abrasions on the stem surface. A very delicate membrane unites the first and second pairs of arms extending to about the first sucker, but is very slight between the second and third pair and absent between the ventral arms. This membrane had probably been torn away from the type. Only the rings on the distal half of the third arms could be examined without injuring the specimen. The suckers in this region have four or five short, widely-spaced teeth on the distal margin, the rest of the ring being smooth. Colour dull white sprinkled on both sides of the mantle with small dark chromatophores, arranged in about twenty-eight irregular transverse rows. When not contracted the chromatophores are reddish-brown and oblong. They are dark and narrow and placed transversely on the dorsal surface of the arms and are sometimes scattered amongst the suckers. They are present on the siphon but absent from the fins. The extraordinary eyes make this a species easy to identify.

The following are the principal measurements:—

	mm.
End of body to dorsal mantle-margin	... 14
Breadth of mantle	... 9
" head and eyes	... 5
Length of fin	... 1
Breadth of fins	... 4
1st right arm	... ca. 2
3rd " "	... 4
Mutilated tentacle stems	... 10

Distribution.—31° 7' N., 43° 6' W., 0-400 m., Sargasso Sea, type specimen (Pfeffer, 1912).

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XVII. NOTES ON THE FRESHWATER FISH OF MADRAS.

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(Plates XXV—XXIX.)

INTRODUCTION.

The following notes, necessarily imperfect, on the habits, spawning season and early stages of some of the Madras freshwater fish, are based mainly on investigations made during 1910-11, the results of which were embodied in a dissertation which was submitted to the University of Madras in 1912. The enquiry, however, was continued in subsequent years amidst other work, and consequently the original paper has been considerably modified as the result of additions and corrections made in the light of further research and study.

Though a number of notes on the habits of Indian freshwater fish have appeared from very early times, they are comparatively few and most of them are at best random observations. In the following pages an attempt has been made to combine all that is known regarding the habits and early stages of the fish in question (by a fairly exhaustive though by no means complete reference to previous literature) with facts personally observed and recorded for the first time in this paper. Only such observations from previously published accounts as are likely to be of general interest have been included and duly acknowledged. They have been gathered for the most part from the writings of Hamilton Buchanan, Sir E. Tennent, Cantor, Jerdon, Day, Thomas and especially Dr. Willey, whose observations on the breeding habits of *Ophiocephalus striatus* and accounts of the nests, eggs and fry of some other species in his report on the inland fisheries of Ceylon are substantial contributions to our knowledge of the spawning habits of Indian freshwater fish.

The local limits of my collection and observation are defined by the title of this paper, my examination being confined to the rivers Cooum and Adyar and to the ponds within the municipal limits of the city of Madras, and in a few cases being extended to some large outlying tanks such as Sembarambakkam and Red Hills. The Red Hills, some seven miles west of Madras, is a large perennial tank, while Sembarambakkam, about ten miles from the city, is the largest irrigation tank in this neighbourhood, but runs dry during the hot weather. The ponds within the city limits are of the usual type and require no special consideration; nearly all of

them contain fresh water excepting a few on the sea-coast in which the water is brackish. The rivers Cooum and Adyar, like most rivers of the Coromandel coast, are almost dry for several months of the year: the season of their chief flow is usually during the N. E. monsoon (November and December). When in flood they are raging torrents and the water is brick-red owing to the admixture of a red deposit of light specific gravity: at other times the water is clear and collects in pools on the bed. Near the mouth for a distance of over two miles from the sea both rivers form extensive estuaries, and the embouchures of both are encumbered by natural bars. Since the construction of the Buckingham Canal it has been found necessary to keep the mouths of both the rivers closed throughout the year in order to regulate and confine their spill so as to contract the waterway for boat traffic: in the case of the Cooum a high level in the estuary is further necessary for sanitary purposes, in order to keep submerged its sewage-laden banks and shoals. Hence the estuary is not subject to tidal action and the percentage of salt is not very variable. A sample of water obtained from the Cooum estuary in August, when the river was at its lowest, had 3.576 per cent of dissolved salts and a specific gravity of 1.0164.¹

The Cooum estuary is always highly contaminated with sewage except during the freshets.

The flora of the ponds and the rivers in Madras is more or less the same and consists chiefly of many filamentous and unicellular algae notably species of *Chara* and *Spirogyra*; the former abounds in brackish water. A few species of Phanerogams, principally *Elodea* and *Vallisneria*, occur; the former is the commonest and the most abundant water-weed in Madras, while the latter is found in clumps in a few places in the rivers.

Of the 57 species of fish recorded, one (*Panchax parvus*) is described as new to science; in the case of at least three species, viz. *Catla catla*, *Doryrhamphus brachyurus* and *Mastacembelus pancalus*, the geographical distribution has been extended; in two species, *Anabas scandens* and *Macrones vittatus*, albinism has been noted and for more than a dozen, information regarding breeding habits has been furnished. Notes regarding growth and colouration of fry are based mainly on observations conducted in aquaria. However, I have been able to verify the results of such experiments in most cases by obtaining identical stages direct from nature.

I am indebted to Drs. J. R. Henderson and N. Annandale for many references and much help; and to Dr. B. L. Chaudhuri for kindly confirming my identifications in a few doubtful cases. My thanks are due to Mr. H. C. Wilson of the Madras Fisheries for permitting me to publish his figures of the eggs and larvae of *Gobius striatus* and for valuable information that he has kindly given me regarding the habits of some of the species.

¹ I am indebted to Mr. Ramaswami, B.A., of the Madras Fisheries, for this information.

SYSTEMATIC INDEX OF SPECIES.

	Page		Page
Family Elopidae.		Family Cyprinodontidae.	
<i>Elops indicus</i> ...	251	<i>Haplochilus melanostigma</i> ...	266
<i>Megalops cyprinoides</i> ...	252	<i>Panchax parvus</i> ...	268
Family Notopteridae.		Family Syngnathidae.	
<i>Notopterus notopterus</i> ...	253	<i>Doryrhamphus brachyurus</i> ...	269
Family Clupeidae.		<i>Doryrhamphus cyclicus</i> ...	270
<i>Engraulis purava</i> ...	253	Family Scombresocidae.	
Family Cyprinidae.		<i>Belone cancula</i> ...	270
<i>Labeo calbasu</i> ...	253	Family Ophiocephalidae.	
<i>Cirrhina rebe</i> ...	254	<i>Ophiocephalus striatus</i> ...	270
<i>Catla catla</i> ...	254	<i>Ophiocephalus punctatus</i> ...	273
<i>Barbus chrysopoma</i> ...	254	<i>Ophiocephalus gachua</i> ...	275
<i>Barbus amphibius</i> ...	255	Family Anabantidae.	
<i>Barbus dorsalis</i> ...	255	<i>Anabas scandens</i> ...	276
<i>Barbus sophore</i> ...	256	Family Nandidae.	
<i>Barbus filamentosus</i> ...	258	<i>Nandus nandus</i> ...	278
<i>Barbus mahacola</i> ...	258	Family Serranidae.	
<i>Barbus vittatus</i> ...	258	<i>Lates calcarifer</i> ...	278
<i>Rasbora daniconius</i> ...	259	<i>Ambassis rangi</i> ...	278
<i>Nu·ia daurica</i> ...	259	<i>Ambassis ambassis</i> ...	279
<i>Amblypharyngodon microlepis</i> ...	260	<i>Ambassis utiops</i> ...	279
<i>Amblypharyngodon mola</i> ...	260	Family Osphromenidae.	
<i>Chela clupeoides</i> ...	260	<i>Osphromenus gourami</i> ...	279
<i>Perilampus cachius</i> ...	261	<i>Macropodus cupanus</i> ...	281
Family Cobitidae.		Family Cichlidae.	
<i>Lepidocephalichthys thermalis</i> ...	261	<i>Etroplus maculatus</i> ...	282
Family Siluridae.		<i>Etroplus suratensis</i> ...	283
<i>Clarius batrachus</i> ...	262	Family Gobiidae.	
<i>Saccobranchius fossilis</i> ...	262	<i>Eleotris fusca</i> ...	286
<i>Wallago attu</i> ...	263	<i>Gobius (Acentrogobius) neilli</i> ...	287
<i>Pseudentropius atherinoides</i> ...	264	<i>Gobius (Acentrogobius) acutipin-</i>	
<i>Arius falcarius</i> ...	264	<i>nis</i> ...	287
<i>Macrones cavasius</i> ...	264	<i>Gobius (Glossogobius) giuris</i> ...	288
<i>Macrones vittatus</i> ...	265	<i>Gobius (Oxyurichthys) striatus</i> ...	289
<i>Macrones keletius</i> ...	265	Family Mastacembelidae.	
Family Anguillidae.		<i>Rhyncobdella aculeata</i> ...	289
<i>Anguilla elphinstonei</i> ...	265	<i>Mastacembelus panculus</i> ...	290
<i>Anguilla australis</i> ...	266	<i>Mastacembelus armatus</i> ...	290

Elops indicus, Swainson.¹

(Elops saurus of the Fauna of Brit. India.)

Tamil—*Ālātti*.

Habitat and Habits.—Day mentions tropical and subtropical seas as the habitat of this fish, while Drs. Max Weber and De Beaufort regard *E. hawaiiensis* and *E. machnata* as sea fish.² The Madras species, however, appears to be essentially an estuarine fish, which

¹ Dr. B. L. Chaudhuri has discussed the Indian species of this genus in detail in his report on the fish of the Chilka Lake, in vol. V of the *Memoirs of the Indian Museum*, pp. 413-416. He concludes that the species that occurs commonly at Madras should be called *Elops indicus*, Swainson.

² *Fishes of the Indo-Australian Archipelago*, II, p. 4.

easily acclimatises itself to fresh water. Large numbers are caught in the river Cooum within tidal influence, and in brackish ponds near the coast.¹ During the floods young fish are common in the Cooum above tidal influence, while adult fish occur in the Madras Fort ditch² and in tanks in the Government House gardens, both of which have had no access to the sea for years. The above facts seem to show that this fish breeds in fresh water. A congener, *E. lacerta* of Africa, is known to enter rivers.³

E. indicus appears to breed during the cold weather. The fry of this genus, like those of the other members of the family, are said to be ribbon-shaped.⁴

Megalops cyprinoides (Broussonet).

Tamil—*Morān Kendai*.

All the specimens examined, ranging from a length of 6 inches to 20 inches, are referable in most respects to Bleeker's *M. kundinga*, but the head is slightly smaller and there are a greater number of anal and dorsal rays.

Habitat and Habits.—*M. cyprinoides* is an estuarine fish frequently entering fresh water and easily accommodating itself to it. The larvae and young are common in the Cooum river, within and above tidal influence and in pools near the coast; but the largest specimens I have seen, about a foot and a half in length, are from ponds in the city. According to Thomas they acclimatise very readily to fresh water and grow fast and are said to breed in fresh water.⁵ In support of the last statement, I may state that I have obtained the species in various sizes from a pond about 4 miles from the sea which has no communication with river or backwater. I have not seen it in the Red Hills tank or in any of the larger lakes further inland.

M. cyprinoides is an active and powerful fish, predaceous in habits, subsisting mainly on the smaller Cyprinidae in ponds. In an aquarium young specimens are attractive, but their growth in such surroundings is not rapid. At frequent intervals they rise slowly till they are quite near the surface, when they make a sudden dash to the surface and descend down in a moment having swallowed air, which escapes through the opercular cleft. This habit is natural to the fish, as it often rises to the surface in ponds and the act is accompanied by a characteristic splash of water and the escape of air bubbles. According to "Skeen Dhu" they rise to the surface only between 5 and 6 p.m.⁶ Connected with this habit is the fact observed by Dr. Willey that this species lives

¹ At the lower anicut on the Col river, Tanjore district, specimens over a foot and a half in length are frequently captured with Hilsa (*Clupea ilisha*) during the floods in July and August.

² Thomas, *Tank Angling*, p. 168 (1887).

³ and ⁴ *Cambridge Nat. Hist.*, VII, *Fishes*, p. 547.

⁵ Thomas, *Fish in India*, p. 214.

⁶ Skeen Dhu, *The Mighty Mahseer*, p. 49.

for many hours out of water, rather an exceptional feature in the herring family to which *Megalops* belongs.¹

M. cyprinoides breeds during the cold weather. Thomas, however, in his *Report on Pisciculture in South Canara* states that *E. apalike*, Day (= *M. cyprinoides*) is said to breed from May to June. The larvae are common in the river Cooum in October and November in fresh water. As in *Albula vulpes* (*A. conorhynchus* of the "Fauna") the young pass through a characteristic larval stage analogous to that of the eel.²

Notopterus notopterus (Pallas).³

(*Notopterus kaporat* of the *Fauna of Brit. India*.)

Tamil—*Chotta Vālai*.

Habitat and Habits.—Day records this species from fresh and brackish waters. In Madras, however, it is confined to the former and appears to thrive best in the stationary water of ponds and lakes; Hamilton-Buchanan, however, obtained his largest specimens (3 feet in length) from rivers.⁴

Uses.—Though the species is said to attain to 3 feet, I have not seen it above a foot and a half in length. It is esteemed as food.

Engraulis purava (H. B.)

Tamil—*Ven Kannu*.

Young fish of *E. purava* occur in the river Cooum in fresh water during October and November, which appears to be the breeding season. It is an estuarine fish which ascends rivers when young. In 1910 a specimen was collected as far inland as Tirhoot in Bengal.⁵

Labeo calbasu (H. B.)

Tamil—*Sēl Kendai*.

Habitat and Habits.—This species abounds in large tanks in the neighbourhood of Madras and in rivers above tidal influence. It also occurs in a few small tanks within the city. Like the other species of *Labeo*, it feeds on vegetable matter and minute crustacea and is essentially a bottom-feeder.⁶ *L. calbasu* breeds during the cold weather. Immature fish are common in the river Cooum in fresh water in January. Young fish of about 6 inches in length are silvery white in colour, the scarlet spots being entirely absent.

¹ *Spolia Zeylanica*, VII, p. 98.

² van Kampen, *Larvae of Megalops cyprinoides*: Bull. Dept. Agri. des Ind. Néer. Buitenzorg, 1908 (10-12).

³ Max Weber and De Beaufort, *Fishes of the Indo-Australian Archipelago*, II, p. 9. (Pallas, *Spicil. Zool.*, VII, p. 40.)

⁴ Hamilton-Buchanan, *Fishes of the Ganges*, p. 235.

⁵ *Journ. Bombay Nat. Hist. Soc.*, XX, p. 432.

⁶ Thomas, *Rep. Pisciculture S. Canara*, p. 70.

Uses.—This is a large fish, growing to about 3 feet in length, which is much esteemed as food.

Cirrhitina reba (H. B.)

Tamil—*Arinjal* or *Arinjal Kendai*.

This is a common species in large tanks in the neighbourhood of Madras; it however does not seem to occur within the city or in brackish water.

Uses.—It is a small fish growing to about 9 inches in length, and not much in demand as food.

Catla catla (H. B.)

(*C. buchanaani* of the *Fauna of Brit. India*.)

On 10th June, 1912 I obtained a fresh specimen in the Chintadripet Market, Madras which is preserved in the Madras Museum. This is apparently the first record of this species south of the Kistna. Mr. Wilson informs me that since the introduction of this species into the Cuddapah-Kurnool canal by the Fisheries Department, it has found its way into the Pennar river and some of the large tanks of the Nellore District. Some tanks further south are shortly to be stocked by the Fisheries Department.

It is a valuable food fish attaining to 6 feet and more in length and an inhabitant of fresh and brackish waters. "It is a very strong and active animal and often leaps over the seine of the fisherman . . ." (H. B.). Growth is said to be very rapid in this species. Mr. Mitchell's specimens, which were only $\frac{1}{2}$ to 1 inch in length when introduced into his tank, had attained a length of 11 inches in the course of five months (*Nature*, 1875, XIII, p. 107). In the Godavari river, where this fish is quite common, it breeds about August. Young specimens from 2 to 3 inches in length are common in that river in January.

Barbus chrysopoma, C. and V.

Tamil—*Panjela*, also *Shani Kendai*.

I have referred to this species¹ a common tank *Barbus* in Madras, though it does not exactly agree with Day's description of the species. The original description by Cuvier and Valenciennes is very defective.²

In Madras specimens usually there are 3 or 4 anterior unbranched rays in the dorsal fin, the pectoral has 15 rays, the number of perforated scales on the lateral line varies from 29 to 32, the diameter of the eye varies from 4 to $4\frac{1}{2}$ in the length of the head, there are 10 to 12 rows of scales in front of the dorsal fin,

¹ Jerdon (*Madras Journ. Lit. Sc.*, 1849, p. 314). Thomas (*Tank Angling*, pp. 96-97) and Skeen Dhu (*Mighty Mahseer*, pp. 6 and 62) record this species from Madras.

² Cuvier, *B. M. Catalogue*, VII, p. 113 (syn.).

the rostral pair of barbels are one-half longer than the orbit and the dark lateral blotch anterior to the base of the caudal fin may be present or absent.

The above particulars show that Madras examples combine the characters of the three species, *B. sarana*, H. B., *B. chrysopoma*, C. and V., *B. pinnauratus*, Day, all of which according to the *Fauna of British India* may occur in Madras. Day himself doubted the validity of his species *B. pinnauratus*, which he thought may be a variety of *B. chrysopoma*, while *B. sarana* is closely related to these.¹ The series examined, however, is entirely too limited to decide whether these three species are really distinct.

This fish is common in ponds in and around Madras and does not appear to occur in rivers. The breeding season seems to be about December, as the young are very common in January and February. In the young the eyes are comparatively large.² When they are an inch long, there are 4 undivided anterior rays in the dorsal fin. All the fins and the opercles are suffused with orange, the body is bright silvery and the dark lateral spot at the root of the caudal fin is very distinct.

Uses.—Much valued as food.

Barbus amphibius (C. and V.)

Tamil—*Numbriki Kendai*.

Both in the *Fishes of India* and in the *Fauna of India* Day gives the number of undivided anterior rays in the anal fin as 2, while in his *Fishes of Malabar* he mentions 3 such rays; in Madras specimens the latter number usually occurs.

Habitat and Habits.—Though not uncommon it does not appear to be very numerous except in some tanks. In the river Cooum it occurs within tidal influence. It is a shallow-water species subsisting on a mixed diet composed of aquatic weeds, worms, flies, etc. *B. amphibius* breeds during October, November and December and also according to Thomas during June and July.³

Description of young.

"When young the summit of the head is golden green, and a yellow streak runs from opposite the centre of the eye to the centre of the tail. When about two inches in length the black spot on the side of the tail commences to appear, and by degrees the golden streak along the side disappears."⁴

Uses.—It is a small fish not much in demand as food.

Barbus dorsalis (Jerdon).

Tamil—*Mukanang Kendai*. "*Saal Candee*" (Day) is the name given to *Labeo calbasu* in Madras.

Habitat and Habits.—*B. dorsalis* occurs in ponds and rivers, but nowhere abundantly. It is rare in tanks within city limits.

¹ Day *Fishes of India*, p. 562.

² *Ibid.*, p. 561.

³ *Report Pisciculture S. Canara*, p. 72.

⁴ Day, *Fishes of Malabar*, p. 214.

The spawning season is said to extend from August to October. Dr. Willey observes :

"On August 31st a half-spent spawning (*Barbus dorsalis*) accompanied by a batch of adhesive eggs was brought from the Colombo lake. The eggs measured 0.75 mm. in diameter with a pale grayish transparent yolk nearly uniformly granulous. The eggs had been caught in the act of being laid and were apparently unfertilized."

Uses.—This species attains to at least eight inches in length and is fairly good as food.

Barbus sophore (H. B.)¹

(*B. stigma* of the Fauna of Brit. India.)

Tamil—*Kulla kendai*.

In June, 1910 I obtained a dozen specimens of this species from a pond behind the Madras Museum, some of which possess a pair of small maxillary barbels. The chief characters of examples of the two kinds obtained simultaneously from the above pond are detailed below to obviate all possible doubt as to their identification—

I. SPECIMENS WITH A PAIR OF MAXILLARY BARBELS.

1. A specimen 3 in. in length.

D. 3/8. A. 3/5. V. 2/7. LL. 26.

A dark lateral blotch on scales 22 and 23 of the lateral line.
Three rows of scales between the LL. and the ventral fin.
Length of head 5 in total length.
Nine scales before the dorsal fin.
A scarlet lateral band.

2. A specimen 4 in. in length.

D. 3/8. A. 3/5. V. 2/7. LL. 26.

A dark lateral blotch on scales 22, 23 and 24 of the LL.
Three rows of scales between the LL. and the ventral fin.
A scarlet lateral band present.
Ten scales before the origin of the dorsal fin.

3. A specimen 4½ in. in length.

D. 3/8. A. 3/6. M. 2/7. LL. 26.

A scarlet lateral band.
A dark lateral blotch on scales 22, 23 and 24 of the LL.
Three rows of scales between the LL. and the ventral fin.
Length of head 4½, height of body 3½ in total length.
The diameter of the eye 3½ in the length of the head.
Ten scales before the dorsal fin.

¹ *Spolia Zeylanica*, VII, p. 103.

² Chaudhuri, *Mem. Ind. Mus.*, V, p. 436 (1916).

II. SPECIMENS WITHOUT BARBELS.

1. A specimen $3\frac{1}{2}$ in. in length.D. $\frac{3}{8}$. A. $\frac{3}{5}$. V. $\frac{2}{7}$. LL. 25.

A dark lateral blotch on scales 22 and 23 of the LL.
Three rows of scales between the LL. and the ventral fin.
Length of head $4\frac{1}{2}$ in total length.
Nine rows of scales before the dorsal fin.
A scarlet lateral band.

2. A specimen 4 in. in length.

D. $\frac{3}{8}$. A. $\frac{3}{5}$. V. $\frac{2}{7}$. LL. 25.

A dark lateral blotch on scales 22 and 23 of the lateral line.
Three rows of scales between the LL. and the ventral fin.
Length of head 5, height of body $3\frac{3}{4}$ in total length.
The diameter of the eye $3\frac{1}{2}$ in length of head.
Nine scales before the dorsal fin.
A scarlet lateral band.

In all the specimens the eyes are $1\frac{1}{2}$ diameters apart, the first dorsal ray is osseous and entire, the dorsal fin commences rather in advance of the ventral fin, midway between the end of the snout and the base of the caudal fin. The lateral line sense organs exist in all the specimens only on 25 scales, the 26th scale is a small scale, when present, without a perforation. In all, there are only 3 rows of scales between the LL. and the base of the ventral fin. A dark blotch on the mid-dorsal rays is present in all.

The only fish with which a possible confusion could arise is *B. amphibius*, which has a maxillary pair of barbels; but in all the specimens described above, there are 3 rows of scales between the LL. and the origin of the ventral fin. This character apart from others, such as the greater breadth of the body in *B. sophore*, is sufficient to distinguish it from *B. amphibius*, which has only two such rows of scales.

From the above statements it will be seen that maxillary barbels, while absent in most specimens, are present in some. If my observations are correct, the presence or absence of barbels is evidently variable and so cannot serve as a safe criterion for classifying species of *Barbus*. Day also doubted if the two species *B. mahecola* and *B. filamentosus*, distinguished by the presence of a small pair of maxillary barbels in the former, were really distinct.¹

From the history of *B. sophore* it is seen that till 1869 *B. stigma* (C & V.) destitute of barbels was considered identical with *B. sophore* (H. B.), and the mention of 4 barbels by the latter author in his description, as they were not shown in his figure, was considered a mistake. In 1869, Day discovered a form with 4 barbels in the Khasi Hills for which he adopted the name *B. sophore*, *B. stigma* being retained by him for the common form without barbels.²

¹ Day, *Fishes of India*, p. 556; *Fauna Brit. Ind.*, I, pp. 293 and 294.

² Day, *l. c.*, p. 566; *Proc. Zool. Soc.*, 1869, p. 376.

Though I have not seen the form with 4 barbels, it seems likely that these three forms—the common form destitute of barbels, the Madras one recorded in this paper with a pair of maxillary barbels, and the kind from the Khasi Hills with 4 barbels—represent phases of a very variable species which according to time or locality may possess four, two or no barbels.

Habitat and Habits.—*B. sophore* is one of the commonest species in Madras, occurring in abundance in the shallows of ponds and rivers. In the Cooum it is found within tidal influence in brackish water. It breeds during the cold weather; Day records finding 1850 mature eggs in a female at Madras in January.¹ The young, which are common in November and December, closely resemble the adult, except in their paired fins, which are comparatively long; the pectorals reach the ventrals and the latter the origin of the anal fin. The lateral scarlet band, frequently seen in the adult, is often present in the young also.

Uses.—A small species, reaching a maximum length of about 5 inches, not much in demand as food. Its flesh is bitter and is supposed to be medicinal. It is a valuable mosquito larvicide.

Barbus filamentosus (C. & V.)

Tamil—*Sevāli* (red tail) or *Retha kendai*.

It is very doubtful if the present species is really distinct from *B. mahecola* (C. & V.).² Both forms, those with a pair of minute maxillary barbels (*B. mahecola*) and those without them (*B. filamentosus*), occur in Madras and are identical in all other characters.

This handsome fish frequents streams in small shoals.

Barbus mahecola (C. & V.)

Occurs in a few tanks in the neighbourhood of Madras.

Barbus vittatus (Day).

Tamil—*Sinna kulla kendai*.

Colour.—In Madras examples there are only three characteristic black spots, one on the dorsal fin; another at the root of the caudal and a third in front of the anal fin; the last though fairly constant appears to be caused by faecal matter.

"In the immature the colours vary: when the fish is about 8/10ths of an inch long, a vertical stripe begins to show itself in the posterior third of the dorsal fin, the summit of which also becomes edged with black, whilst there are some irregular orange markings; in very young specimens the line of demarcation between the green of the back and the silvery abdomen appears like a white band running from the eye to the middle of the tail." (Day).³

¹ Day, *Fishes of India*, p. 579.

² Day, *Fishes of India*, p. 556. Day combines the two species in his *Fishes of Malabar*, p. 215.

³ *Fishes of Malabar*, p. 215; *Fishes of India*, p. 582; *Fauna Brit. Ind.*, p. 333.

Habitat and Habits.—Very common in several ponds in and around Madras and in rivers in fresh water. After a heavy shower this is one of the foremost fish to enter drains and gutters in the city.

Uses.—Its small size, hardihood and the ease with which it could be kept alive for years in small aquaria make it one of the most valuable mosquito larvicides.

Rasbora daniconius (H. B.)

Tamil—*Ovari* or *Paravū*.

In Madras specimens, two complete horizontal rows of scales do not exist between the L. line and the root of the ventral fin as stated by Day,¹ there being only one and a half rows as correctly shown by his figures²; the number of rows in front of the dorsal fin varies from 14 to 16.

Habitat and Habits.—*R. daniconius* abounds in all the rivers and tanks in Madras in fresh water. It is a shallow-water species and feeds on both animal and vegetable matter.³ This species breeds during the rains in September and October in Madras, while its congener *R. rasbora* (*R. buchanani* of the 'Fauna') is said to breed on the West Coast in June and July.⁴ The fry, which are very common during the breeding season, enter drains and are frequently caught there with the young of species of *Amblypharyngodon*, *Nuria danrica* and *Barbus vittatus*, the other common tank-fish of Madras. They are easily distinguished from the fry of *Amblypharyngodon* by the absence of both the orange colour and the convex dorsal profile so characteristic of the latter; but are not easily separable from the fry of *N. danrica* before the barbels appear in them, and the fry of *B. vittatus*.

Uses.—Conflicting opinions exist as to their usefulness as mosquito-destroyers; my experiments show them to be at least as useful as *N. danrica* in this respect.

Nuria danrica (H. B.)

Tamil—*Paravū*.

The height of body in some large examples is 5 in total length and the eyes are usually $1\frac{1}{2}$ diameters apart.

Habitat and Habits.—*N. danrica* is very common in ponds and not uncommon in rivers. The breeding season extends from October to December, when many adults have the caudal portion

¹ Day, *Fishes of India*, p. 584; *Fauna Brit. Ind.*, p. 337.

² Day, *Fishes of India*, pl. cxlvi, figs. 2 and 3.

³ Jerdon, *Madras Journ. Lit. Sc.*, xv, p. 320. The statement of Messrs. Chaudhuri and Sewell in their *Ind. Fish of Proved Utility as Mosquito Destroyers*, that this species is a pure vegetarian is contradicted by Mr. H. C. Wilson in his "Notes on larvicides and natural enemies of mosquitoes in South India," *Proc. Gen. Mal. Commit.*, 2nd meeting, Madras, 1912.

⁴ Thomas, *Rep. on Pesci, South Canara*, p. 72.

of their bodies with the caudal fin stained crimson; which is supposed by fishermen in Madras to indicate good rains. The fry are very common in November, when they frequently enter drains in the city after a heavy shower. Till they attain a length of 19 mm. the barbels are undeveloped and the scales are indistinct; when 25 mm. long, the maxillary barbels reach the eye, the colour is greyish white, a faint yellow band extends along the sides and some dark pigment spots are present at the root of the caudal fin.

Uses.—This is a small species which is said to reach a maximum length of 5 inches. Being a surface feeder it is valuable as a mosquito-destroyer.¹

Amblypharyngodon microlepis (Bleeker).

Tamil—*Puli Elai Kendai* or *Pacha Thalai Kendai*; both names refer to the metallic green colour of the back.

The rows of scales between the L. line and the base of the ventral fin is usually 6 and even 7; only occasionally is it 5 as stated by Day.

Habitat and Habits.—*A. microlepis* is one of the commonest tank-fish in Madras. It inhabits shallow water and is among the first to migrate from ponds with the shallowest of overflows, in which act it is frequently caught in drains after a heavy shower.

The breeding season extends from October to December, when the fry are extremely common.

Description of Fry.—There are usually 9 rays in the dorsal and 8 in the anal fin. When less than 2 centimeters long the scales are indistinct, the body translucent and bright orange in colour, except the abdomen, which is silvery; the dorsal profile is very convex; a dark green crescent mark on the head behind the line of the eyes is very distinct in preserved specimens; the pectoral fins reach the ventral, which reach the anal.

Uses.—A small species not more than 3 or 4 inches in maximum length, which enters largely into the diet of the poorer classes in consequence of its abundance. Experiments prove it to be a valuable mosquito-destroyer.

Amblypharyngodon mola (H. B.)

Not so common as *A. microlepis* in Madras.

Chela clupeoides (Bloch).

Tamil—*Vellichi*.

C. clupeoides is found chiefly in ponds and only occasionally in rivers. Though not uncommon it is rarely abundant in any single locality. It is an active fish and a fast swimmer and in-

¹ Sewell and Chaudhuri, *Ind. Fish of Proved Utility as Mosquito-destroyers*, p. 17.

habits clear water. Being a surface-feeder it is frequently seen near the surface of the water.

"The chelas are remarkably active in the early mornings and evenings, which means that they are thoroughly on the feed then. During the middle of the day they seem to favour the deeper waters and become less active, occasional rises being seen in the centre or deep parts of the pool, but not feeding regularly."¹

In sport or when chased they shoot into the air; more frequently they expose their silvery sides at the surface of the water in bright sunshine.

Uses.—This species attains a maximum length of six inches and is esteemed as food. The doubt cast on the usefulness of species of *Chela* in destroying mosquitoes by some writers,² has been criticised by Mr. H. C. Wilson.³ My own experiments show that *C. clupeoides* readily eats mosquito larvae at any rate in captivity. Possibly *C. argentea* differs from the present species in this respect.

Perilampus cachius (H. B.)

(*P. atpur* of the *Fauna of British India*.)

Tamil—*Salvāi*.

Cachius being the first of the two specific names (*cachius* and *atpur*), used for this species by Hamilton-Buchanan⁴, has to be adopted according to the law of priority.

In Madras specimens the anal fin has only 20 to 22 rays, the number of longitudinal rows of scales between the L. line and the base of the ventral fin is frequently only $3\frac{1}{2}$, and the number of perforated scales on the L. line usually only 50. I have not seen this species more than an inch and a half in length, though it is said to grow to a maximum length of 4 inches.

It is a rare fish in Madras. I have met with it very occasionally in the Cooum river and in the Sembarambakkam tank.

Uses.—Messrs. Sewell and Chaudhuri mention it as a mosquito-destroyer.⁵

Lepidocephalichthys thermalis (C. and V.)

Tamil—*Asarāi*.

This common species abounds in the rivers where the bottom is sandy, and in ponds.

Habits.—*L. thermalis* inhabits the bottom mud or sand of rivers and ponds, where it usually lies buried during the day, venturing out to feed at night. The burrowing in mud or sand does not appear to be a laborious process. In an aquarium, when

¹ Wilson, Some notes on larvicides and natural enemies of Mosquitoes in South India. *Proceedings Third General Malaria Committee, Madras* (November 18th, 19th and 20th, 1912).

² Bentley, 2nd Rev. *Wellcome Laboratory*, p. 418; Sewell and Chaudhuri, *Ind. Fish of Proved Utility as Mosquito-destroyers*, p. 19.

³ H. C. Wilson, *l. c.*

⁴ Hamilton-Buchanan, *Fishes of the Ganges*, pp. 258 and 259.

⁵ *Ind. Fish of Proved Utility as Mosquito-destroyers*, p. 19.

disturbed, it rapidly darts about and suddenly strikes the bottom sand head-forwards, diving into it by sheer force. A favourite position for the fish is to lie buried with just the snout and the tail above the surface of the sand; often the latter is also concealed and the snout is withdrawn at the approach of danger, only to reappear almost immediately.

Branchial respiration appears to be insufficient in this loach. In an aquarium it grows restless at varying intervals, and rises to the surface to take air, which is apparently swallowed; consequently it lives for a long time out of water.

The erectile sub-orbital spine appears to be an organ of defence; when the fish is seized by the tail it rapidly swings round and dashes its head against the hand, when the prick of the erected spine is felt.

The breeding season extends from October to January, when the young, which resemble the adult, are quite common everywhere in shallow collections of rain-water.

Uses.—Though small it is considered very nourishing.

Clarius batrachus (Lin.)¹

(*Clarius magur* (H. B.) of the Fauna of British India.)

Tamil.—*Karuppu thēli* (*thēli*=scorpion, has reference to the poisonous pectoral spines).

Habitat and Habits.—*C. batrachus* is rare in Madras. It inhabits fresh and brackish water.

Like most Silurids it is sluggish and prefers muddy to clear water. It lives and feeds at the bottom of ponds and rivers, and in the mud sometimes lies concealed for hours, with no movements save those of respiration and the constant lashing of its barbels, which appear to be its chief organs of perception. Experiments in an aquarium seem to prove that this fish is practically blind to objects beyond the reach of its barbels. The colour is eminently protective and effectively conceals the fish in dark muddy surroundings.

As is well known *C. batrachus* is amphibious, possessing an accessory breathing organ; it lives a considerable time out of water.

The pectoral spines in this species are not dreaded.

Uses.—*C. batrachus* reaches a length of a foot and a half and is considered as wholesome and nourishing food. The air-bladder yields a coarse isinglass.²

Saccobranchus fossilis (Bloch).

Tamil—*Thēli*.

Cuvier and Valenciennes in 1840 identified *S. fossilis* (Bloch) with *S. singio* (H. B.).³ Gunther in 1864 held the two to be dis-

¹ Max Weber and De Beaufort, *Indo-Australian Fishes*, II, p. 190. (Linné, *Syst. Nat.*, 1758, p. 305).

² Day, *Fishes of India*, p. 485. ³ *Hist. Nat. des Pois.*, XV, p. 297.

inct species.¹ Again Day united the two in 1878.² Since then, *S. singio* (H. B.) has been ranked as a synonym of *S. fossilis* (Bl.) by most systematists. Recent anatomical research, however, appears to show that the two are probably distinct species. Hyrtle³ (1853), followed by Hubrecht and Day (1877)⁴, states that in *S. singio* the right accessory air-sac is supplied with blood by the first afferent branchial artery, the left on the contrary being supplied by the fourth afferent artery. Burne in 1894 found that in *S. fossilis* both air-sacs are supplied by the fourth afferent arteries.⁵

Habitat and Habits.—Quite common in ponds and ditches, where it frequents the muddy bottom. Its distribution does not appear to be limited to fresh water as on the west coast (Cochin); it is said to occur in backwaters where the fishermen catch it at night with a torch, the light of which attracts it. *S. fossilis* is amphibious and consequently lives for a long time out of water. "Wounds from the pectoral spines of this fish are dreaded in India as they are reputed to be very poisonous."⁶

The breeding season extends from September to December; during the rains the fish deposit their eggs in irrigated fields, where the young, which are copper-red in colour, are frequently caught for stocking tanks.

Uses.—*S. fossilis* attains a length of a foot and a quarter when full grown and is highly esteemed as food by Indians.⁷

Wallago attu (Bl. and Schn.)

Tamil—*Vālai*, *Āthu Vālai*.

Habitat and Habits.—The "freshwater shark" inhabits lakes and rivers. Col. Tickell⁸ states that it occurs sometimes within tidal influence: this is probably the case when it is carried down by floods, as the least salinity seems to disagree with this fish and to cause death.

W. attu is a large and powerful fish and predaceous in habits. It feeds on both vegetable and animal matter, preferably on the latter, and is said to destroy fry and large numbers of smaller fish in ponds. It is sluggish in its movements and lives for the most part at the bottom. Thomas attributes the frequent slowness of this fish to discover the presence of food to deficient sight. The statement that it feeds mostly at night⁹ appears to be incorrect, as I have seen it very active and freely take a bait by day. It is usually caught in large nets and when handled it makes fierce attempts to bite.

¹ *Brit. Mus. Cat. Fishes*, V, pp. 30 and 31.

² *Fishes of India*, p. 486.

³ *Akad. Wiss. Wien*, XI, p. 302 (1853).

⁴ *Four. Lin. Soc. Zool.*, XIII, p. 198 (1877).

⁵ *Loc. cit.*, XV, p. 48 (1894).

⁶ and 7 Day, *Fishes of India*, p. 487.

⁷ *Rod in India*, 1881, p. 168.

⁸ Day, *Fauna of Brit. India, Fishes*, I, p. 127.

Uses.—This is a large fish which is said to reach a maximum length of six feet though specimens above four feet are very rare. It is esteemed as food and salts well.¹

***Pseudentropius atherinoides* (Bloch).**

Tamil—*Nā Keliti* (the epithet *na* = dog and hence an inferior kind).

The "three or four bands along the sides formed by black spots" (Day)² are not found in Madras specimens and the pectoral spines usually have about twelve denticulations.

Habitat and Habits.—*P. atherinoides* inhabits lakes and ponds in the neighbourhood of Madras and is rarer than most other Silurids.

***Arius falcarius*, Richardson.**

Tamil—*Uppu Kali Keliti*.

In most Madras specimens the pectoral fin does not reach the ventral nor does the ventral the anal.

Habitat and Habits.—A common estuarine species which occasionally ascends rivers and comes into fresh water.

The interesting breeding habits of species of *Arius* are well known.³ The breeding season in Madras extends from September to November, when large numbers congregate in estuaries to deposit their spawn. One of the breeding grounds for this species in Madras is the mouth of the River Adyar. The eggs, which are large and yolky measuring .5 to .6 inches in diameter, are probably deposited in batches by the female. The male takes up the eggs—usually about eight—into his mouth and keeps them there for many days till they hatch out as fry. They are retained by the male till the yolk is absorbed. During the whole of this period, the ovigerous male never feeds. During the breeding season the males frequently have the caudal, anal and part of the dorsal fins stained red.

Uses.—*A. falcarius* attains a maximum length of two feet, and, being common, enters largely into the diet of the poorer classes.

***Macrones cavasius* (H. B.)**

Tamil—*Sōlai Keliti*.

It is common in lakes and rivers at a distance from the sea; while it is common in Sembadambakkam and Red Hills tanks, it is not known to occur within city limits.

In habits it closely resembles other Silurids. The pectoral spines cause painful wounds. Though it does not breathe air direct, it lives for a long time out of its native element.

Uses.—It is said to attain a maximum length of eighteen inches and is esteemed as food by Indians.

¹ Day, *Fishes of Malabar*, p. 193.

² *Fishes of India*, p. 475; *Fauna Brit. Ind.*, I, p. 141.

³ *Spolia Zeylanica*, VII, p. 97 (1911); Day, *Fishes of India*, p. 457; *Fauna Brit. Ind.*, p. 169.

Macrones vittatus (Bloch).

Tamil—*Nāttu Keliti*.

Habitat and Habits.—This is the commonest species of *Macrones* in fresh water in Madras. In the Cooum and Adyar rivers it frequently occurs within tidal influence.

In habits it closely resembles the previous species; Day¹ observes:—

"This fish is termed 'the fiddler' in Mysore; I touched one which was on the wet ground, at which it appeared to become very irate, erecting its dorsal fin and making a noise resembling the buzzing of a bee, evidently a sign of anger. When I put some small carp into an aquarium containing one of these fish it rushed at a small example, seized it by the middle of its back and shook it like a dog killing a rat."

In April, 1911 I obtained from a ditch near Chetput, which contained large numbers of this fish, two albino specimens perfectly pigmentless; they were translucent white, showing the surface blood vessels of the skin, and were less active and more sensitive to light than pigmented ones.

In March I found a female with eggs.

Uses.—Though small, it is very common, and is eaten by the poor.

Macrones keletius (C. and V.)

Comparatively rare in Madras; I have met with it only in one or two ponds in the city and in the Red Hills tank.

Anguilla elphinstonei, Sykes.

(*Anguilla bengalensis* (Gray) of the *Fauna of Brit. India*.)

Tamil—*Velangu*.

Dr. Max Weber, in his recent revision of the species of *Anguilla* of the Indo-Pacific region, considers the earlier name *A. bengalensis* (Gray) invalid, as the figure published by Gray and Hardwicke is altogether inadequate to identify the species.²

Habitat and Habits.—This is by far the commoner of the two species of *Anguilla* in Madras, and is abundant in ponds and rivers. It is carnivorous and is very voracious, hiding in the bottom mud during the day and emerging out to feed at night; hence it is mostly captured at night. Indian fishermen have an easy way of taking it "they leave small-mouthed earthen pots with a bit of sheep skin in each overnight, and draw them up in the morning, with their fish lying coiled up most comfortably in them."³ It is very tenacious of life and survives most adverse conditions such as drought and starvation. Like most eels, it lives for a long time out of water and leaving its native waters

¹ *Fauna of Brit. Ind.*, p. 158; *Fishes of India*, p. 449.

² Max Weber, Revision der Indo-Pacifischen *Anguilla*-Arten, *Zool. Jahrb.*, Sup. 15, Band I, p. 578 (1912).

³ Thomas, *Tank Angling*, p. 100 (1887).

migrates considerable distances overland in search of ponds and streams, when desirous of a change. "It is an irritable creature, swelling its head whenever angered; and constantly, when it can, buries itself in putrescent carcases."¹

Every year a large number of elvers, measuring two or three inches in length and perfectly transparent in colour, ascend the rivers Cooum and Adyar about November.

Uses.—Though good to eat there is little demand for this eel. It is consumed chiefly by Mahomedans. *A. elphinstonei* attains a large size; a specimen in the Madras Museum measures 4½ feet in length.

Anguilla australis, Richardson.²

(*A. bicolor*, McClelland, of the *Fauna of Brit. India*.)

A rarer species than *A. elphinstonei* in Madras but resembles it in habits. It is a smaller species, attaining a maximum length of about two feet.

Haplochilus melanostigma, McClelland.

(Pl. xxv, figs. 1, 3, 4, 10; pl. xxvi, figs. 12-16).

Tamil—*Munda Kanni* (=big eye).

McClelland's specific name *melastigma* (Gr. = black spot) has been corrected in the *Fauna of British India* into *melanostigma*, which is the correct etymological rendering of the word.

The caudal fin is truncated and not rounded in Madras specimens.

In the adult male, which is larger than the female, the anal fin has most of its rays prolonged in a filiform manner beyond the membrane, and each præmaxilla has about four coarse 'teeth' at the angle of the mouth: whereas in the female the anal rays are not prolonged and the præmaxilla is drawn out into a bifid 'tooth' at the angle of the mouth.

Habitat and Habits.—This very common species abounds in ponds and rivers in both fresh and brackish water; in the latter it seems to thrive best, as the largest specimens in my collection are from the Cooum within tidal influence. It inhabits the shallows of ponds and rivers, where it affects the surface and swims very close to it frequently with its mouth touching it. "When swimming in their natural surroundings, the surface of the head is kept almost on a level with the plane of water."³ The flat head and the transverse mouth are adaptations to surface feeding and the species is well-known as an effective mosquito-destroyer. The habit of inhaling the oxygenated surface water enables it to

¹ Hamilton-Buchanan, *Fishes of the Ganges*, p. 22.

² Max Weber, Revision der Indo-Pacifischen Anguillidae. *Zool. Jahrb.*, Sup. 15, Band I (1912).

³ Sewell and Chaudhuri, *Ind. Fish of Proved Utility as Mosquito Destroyers*, p. 3.

withstand to a considerable extent foul water full of organic impurities detrimental to most fish : in the city it frequently occurs in gutters and sewage-farms.

Being a surface fish it is diaphanous, but possesses a remarkable capacity to change colour in accordance with its environment. Fish inhabiting the Cooum river often, within a distance of a few yards, show variations in colour ; those among green weeds are greenish, those in dirty water correspondingly brown and those in clear water translucent white ; while I have caught specimens reddish in colour during the floods, when the water is brick-red owing to the admixture of clay.

The breeding season extends chiefly from September to February or even later, but is certainly not limited to these months. In the Cooum the earliest specimens with eggs are found in brackish-water and only later in fresh water higher up. The peculiar breeding habits were first observed by Dr. Jenkins.¹ During the spawning season the dorsal, caudal and anal fins in both sexes usually acquire a bright golden-yellow edge. The eggs after extrusion are attached in two rounded clusters, one on each side, to the genital opening of the female. In the natural surroundings the eggs are probably carried till they are hatched, a condition highly favourable for their protection and aeration ; but in an aquarium they are sooner or later cast and, being demersal, sink to the bottom. Gobies and carp attack the fish when it is carrying eggs and feed on the latter. On an average from 20 to 40 eggs are carried by a female at a time.

Description of egg.—The eggs are transparent and large, about 1 mm.² in diameter. Under the microscope the outer egg-membrane is seen to give off externally numerous short adhesive threads, by means of which the eggs adhere to one another or to foreign objects (figs. 12-14). From a certain area on each egg a group of very long filamentous threads arise, and these from different eggs are twisted together to form a common cord which protrudes from the genital opening of the female (fig. 12). In the yolk there is a small oil globule, not large enough to make the egg float. The embryo is clearly seen within the egg-membrane in all stages of development (figs. 13 and 14). In an advance stage dark pigment cells appear on the body of the developing embryo and the egg looks dark in colour.

Distinguishing characters of the fry.—I succeeded in hatching some eggs in an aquarium. The fry when hatched measure 4 mm. in length and possess the pectoral fins and a single median fin starting dorsally about the middle of the back, and continued round the tail up to the remains of the yolk-sac on the ventral surface. They are easily identified from the fry of other fish by the characteristic arrangement of dark stellate pigment-spots. On the head and snout a few large scattered spots occur ; immediately behind

¹ Jenkins, *Rec. Ind. Mus.*, V, p. 137, pl. vi, figs 7 and 7a.

² Jenkins, *l. c.* (His measurement of the egg "about a centimeter" is obviously wrong).

the root of the pectoral fins, dorsally, is a semi-circular patch of close-set small spots: on the body and tail there are five longitudinal rows of spots, one mid-dorsal, two lateral and two ventral rows, one on either side of the mid-ventral line of the body (figs. 15 and 16).

During growth the following changes occur: the dorsal, caudal and anal fins become distinct in about 3 weeks; the pigment spots slowly disappear, except the lateral row which is retained in most adults as a faint black streak. The eyes acquire a glittering azure-blue colour and a pearly white speck is developed on the head—two unmistakable features of the immature *H. melanostigma*.

Uses.—A valuable mosquito-destroyer.

Panchax parvus, sp. nov.¹

(Pl. xxv, figs. 2, 8; pl. xxvi, fig. 11).

Tamil—*Pachai Munda kanni*.

Br. VI. D. 2-3/5. A. 3/11-12. C. 24. V. 6. P. 12. Vertebrae 26.

The length of the head is $3\frac{1}{2}$ to $3\frac{1}{2}$ times, and the depth of the body 4 to $4\frac{1}{2}$ times in the total length (exclusive of the caudal fin). The snout is longer than the diameter of the eye, which latter is $3\frac{3}{8}$ to $3\frac{1}{2}$ in the length of the head, and nearly half the interorbital width; the lower jaw is slightly projecting. *Teeth* are present in bands on both the jaws, some three vestigial ones on the anterior edge of the vomer. *Fins*—the pectorals reach considerably beyond the root of the ventrals which reach the anal. In the male, the 4th or 5th dorsal ray and the 11th and 12th anal rays are prolonged and both the fins reach the caudal; in the female these fins are rounded and do not reach the caudal. *Scales* possess both concentric and radiating seriations. The lateral line is absent; there are 26 to 27 scales along the mid-lateral line of the body counted from the top of the branchial aperture to the root of the caudal fin (scales on the caudal fin are not included). Seven longitudinal rows of complete scales exist between the root of the dorsal fin and that of the anal.

Colour.—Males are larger and are more brightly coloured than females. In both during life a metallic green spot exists on every scale of the back and upper half of the body, and on alternate scales of the mid-lateral row and a few horizontal rows below it. In this latter portion light Italian pink dots alternate with

¹ Day appears to have described this species from Madras under the name *Panchax rubrostigma* (Proc. Zool. Soc. London, 1867, p. 706) in the idea that it was identical with Jerdon's *Aplocheilichthys rubrostigma*. Later, in 1878, in his *Fishes of India* the description of *Haplocheilichthys rubrostigma* is identical with that of Jerdon, and obviously he has mixed up the two species. *P. rubrostigma* differs from the present species chiefly (1) in size, as it reaches nearly 3 inches in length, (2) in having the second ray of the ventral fin elongated. *P. parvus* reaches only a maximum length of $1\frac{1}{2}$ inches and never has the rays of the ventral fin elongated.

the above-mentioned green dots. The ventral surface is more or less translucent in life, and the scales possess a purplish gloss. The usual pearly white speck is present on the head. An ocellus, with a black centre and light margin, is usually present at the root of some of the anterior rays of the dorsal fin, most distinct in female and immature examples. In the males, the longitudinal rows of alternating green and pink dots extend over the proximal half of the caudal, dorsal and anal fins; in the two latter fins the spots gradually increase posteriorly so as to completely cover the posterior half of the dorsal and a third of the anal fin. In the female the above-mentioned fins are unspotted and of a light orange colour. These brilliant colours disappear more or less completely in spirit.

Type-specimen.—In the Indian Museum.

Habitat and Habits.—*P. parvus* is found only in fresh water and confined, so far as I am aware, to the tanks and rivers in and around Madras city. It is somewhat local in distribution and inhabits stationary and sheltered waters of tanks and rivers overgrown with vegetation.

The breeding season appears to be January and February. The eggs are demersal and adhesive and are not carried in clusters by the female after extrusion. Thomas remarks:

"*H. panchax*" (I have no doubt he means this species) "extrudes one egg at a time and that disproportionately large, as big as its own eye. This keeps hanging to the vent as the fish is moving and feeding till it is cast and adheres; and so single eggs are laid and distributed."¹

Description of egg (pl. xxvi, fig. 11).—The egg of *P. parvus* closely resembles that of *H. melanostigma* but is slightly larger, the adhesive threads of the outer membrane are thinner, longer and more numerous. The chief difference, however, is the absence of the tuft of long processes by which the eggs of *H. melanostigma* are held together and are suspended from the genital opening of the female. This is obviously due to the fact that the eggs in this species are not carried about by the female.

Uses.—A small species (adult male about 42 mm. and adult female about 28 mm.) which is valuable as a mosquito larvicide.

***Doryrhamphus*² *brachyurus* (Bleeker).**

(*Doryichthys bleekeri* of the *Fauna of Brit. India*.)

In a recent paper³ George Duncker has united *D. brachyurus* (Bleeker) with *D. bleekeri* (Day). The only appreciable difference between the two, as would appear from descriptions, was in the number of the rays of the dorsal fin, there being 40-45 rays in *D. bleekeri* and only 36-37 in *D. brachyurus*; from an examination

¹ Thomas, *Tank Angling*, p. 112 (1887).

² The name *Doryrhamphus* has priority over *Doryichthys*. Max Weber, *Fish. Siboga-Expedition*, 1913, p. 116.

³ Duncker, *Syngnathids from Ceylon. Spol. Zeylan.*, VII. pt. 25, p. 26 (1910).

of a large number of Ceylon examples Duncker has now shown the number to vary from 37 to 43. In an adult Madras example I found 41 rays in the dorsal fin.

For want of material (ovigerous males), I have placed this species as usual in Kaup's genus *Doryrhamphus* (= *Doryichthys*) and not in Duncker's new genus *Microphis*.

Habitat and Habits.—Rare in Madras, a few occur in the Cooum River just above tidal influence in November. *D. brachyurus* is usually sluggish in its movements and keeps close to the banks of the river amidst grassy weeds; when frightened, however, it swims very rapidly and skilfully after the manner of eels. According to most writers¹ the Pipe-fishes swim in a vertical position like *Hippocampi*. *D. brachyurus*, *D. cuncalus* and at least one species of *Syngnathus*, which I have had the opportunity of observing in their natural surroundings, swim in the normal horizontal position, flush with the surface of the water.

The males are known to take charge of the eggs after extrusion, in a brood-pouch on the abdomen. Such males were found in summer by George Duncker in Ceylon in 1909. "The eggs were small, in 4—13 longitudinal and 60—110 transverse rows."²

Doryrhamphus cuncalus (H. B.)

(*Doryichthys cuncalus* of the Fauna of Brit. India.)

Tamil—*Usi kolachi* (=needle fish).

A few occur in the Cooum during November and December.

In habits it closely resembles *D. brachyurus*, in whose company it frequently occurs.

Belone cancila (H. B.)

Tamil—*Kolachi*, "*Pissu kolah*" (Day).

In Madras this species appears to be confined to freshwater ponds and lakes. Though common it is never abundant in any one locality. According to Jerdon "It is very voracious and devours large quantities of the little *Aplocheili*" (*Haplochilus* and *Panchax*).

Ophiocephalus striatus, Bloch.

Tamil—*Verāhl*.

Habitat and Habits.—Common everywhere in ponds, ditches and rivers. In the Cooum it occasionally occurs within tidal influence. In its natural surroundings *O. striatus* often resorts to the margin of the water overgrown with weeds. It frequents shallow water probably because air is easy of access and so suits its amphibious habits. The air-breathing habit of this fish is well-known: in consequence it lives hours, sometimes days, out of

¹ *Fauna of Brit. India, Fishes*, II, p. 460.

² G. Duncker, *Syngnathids from Ceylon. Spol. Zeylan.*, VII, p. 26.

Days after hatching.	Total length.	Principal events.
12-15	6.75 mm.	Posterior end of notochord bends up.
28	8 to 10 mm.	Caudal rays jointed and articulated with the basal cartilages. Larvæ rise to surface to take air.
37	10 mm.	Primordia of dorsal and anal rays.
40	10.25 to 13 mm.	Rudiments of ventral fins appear. Dorsal and anal fins separating from caudal. End of larval development.
63	17 mm. }	Fry now hide in the mud.
73	25 mm. }	

*Characteristic colour of the Larvæ.*¹—On either side of the body there is a broad reddish-orange band occupying almost the entire height of the myotomes, commencing from the eye on each side, and ending behind with a rounded edge at the base of the caudal fins. The iris is golden with a red flush; there is a bright golden occipital point, and the base of the anal and dorsal fins is black along their whole length. This characteristic livery is retained by the fry till they reach a length of about 40 mm. (nearly for 3 months after hatching); after which period the definitive markings begin to appear, in the form of 9 dark vertical half-stripes on either side descending from the base of the dorsal fin.

Growth.—From the fifth day after hatching, when the larvæ begin to feed independently, the daily growth begins to vary. Some young *O. striatus* kept by Dr. Willey in Colombo had an average total length of about 35 mm. in February 1908, 45 mm. in July 1908, 96 mm. in April 1909; the series last measured consisted of six individuals ranging from 85 mm. to 115 mm. The average measurements of a brood hatched in the central pond of the Marine Aquarium, Madras, was as follows:—

April 1913	..	..	hatched from eggs.
„ 1914	..	..	6 inches.
„ 1915	..	..	over a foot in length.

In nature growth is even more rapid and the young under favourable conditions begin to breed in about two years.

Uses.—*O. striatus* is one of the largest and most valuable food fishes of our inland waters. Being an air-breather it is transported with ease²; and is admirably adapted for pisciculture. Care, however, should be exercised in introducing it into preserved waters³ as it is very voracious and destructive to fry. The young are susceptible to attacks from internal parasites (? *Schistocephalus* larvæ).⁴

¹ Willey, *Spol. Zeylan.*, V, p. 145 (1908); VII, p. 116 (1910).

² Day, *Rep. Freshwater Fish and Fisheries Ind. and Bur.*, p. 25 (1873).

³ Thomas, *Rod in India*, p. 234 (1897); Willey, *Spol. Zeylan.*, V, p. 146 (1908).

⁴ Willey, *l.c.*

Ophiocephalus punctatus, Bloch.

(Pl. xxvii, figs. 17—22).

Tamil—*Maniāṅ koravai* (*Para korava* (Day) is the name of *O. gachua* in Madras).

Habitat and Habits.—A very common species in ponds, ditches and rivers. In the last it is known to occur in brackish water when it is said to acquire a purplish colour.¹ It is a mud-burrowing fish² and prefers stagnant and muddy to running water.³ It is one of the fish Day saw exhumed from the mud of a dried-up tank.⁴

The breeding habits are very similar to those of *O. striatus*. *O. punctatus* is monogamous, and breeds twice in the year, about January and February and again about July and August; occasionally nests are met with at other times.⁵ At these seasons the fish come together in pairs and construct a nest among the rushes in the shallows of ponds and rivers. I have never seen the nest in water deeper than a foot and a half, as a rule it is built in water only a foot in depth. The nest is the usual roundish clearing measuring 8 or 9 inches in diameter. The nests of *O. striatus* differ in being larger (about 12 to 14 inches in diameter) and are found in water at least 2 feet, frequently 3 or 4 feet deep. At the surface the nests of both species appear as circular areas of clear water with the eggs floating in the centre. Both parents tend the nest; while the male keeps a vigorous guard, aggressively protecting the spawn from intruders, the female is found in the neighbourhood.

Eggs.—Oviposition usually takes place at night; a few thousand eggs⁶ are deposited by the female in a single night. The eggs measure about 1.25 mm. in diameter and are of a pale amber colour. In size and appearance they are hardly to be distinguished from those of *O. striatus* and like the latter contain a large oil-globule and float flush with the surface of the water⁷ (figs. 17 and 18).

The rapidity of the embryonic development seems to depend on the strength of the sun. On all occasions when I obtained collections of eggs they invariably hatched during the night following, i.e., on the average in 24 hours after procuring them. This corroborates the statement of fishermen that the eggs of *O. punctatus* usually hatch on the night following that on which they are laid.

¹ Day, *Fishes of India*, p. 368.

² Willey, *Spol. Zeylan.*, V, p. 149.

³ Day, *Fishes of India*, p. 368; *Fauna of Brit. India* II, p. 365.

⁴ Day, *Freshwater Fish and Fisheries of India and Burma*, p. 28 (1873).

⁵ Willey records finding a nest in October. *Spol. Zeylan.*, VII, p. 101 (1911), and I have seen nests in the Cooum in December.

⁶ Day, *Fishes of India*, p. 318 (records finding 4702 eggs in a female in February).

⁷ Willey, *Spol. Zeylan.*, VII, p. 101.

The embryonic and larval development of this species closely resembles that of *O. striatus*,¹ but is more rapid. In fresh eggs the outline of the embryo encircling the yolk becomes evident in about 8 hours; the eyes and auditory sacs are developed in 16 hours; and the heart begins to beat and the curious yolk-sac circulation also starts soon after this (figs. 19 and 20). At the time of hatching the embryo violently twitches its tail, which is now free of the yolk-sac, and performs rotations within the egg-membrane.

On hatching the fry measure 3.25 mm. in length and are almost identical in general appearance with the first day hatchlings of *O. striatus* (fig. 21). They, however, do not remain at the surface for 3 days like the latter fry but begin to descend down even at the close of the first day, though this is accomplished with considerable effort.

On the second day, the pigment cells are well developed, the eyes being quite black; the length increases to 4½ mm.; the mouth opens and respiratory movements begin; and the pectoral fins develop. The larvæ move in unison and effect their descent from the surface in a long procession, swimming slowly close to the bottom sand of the aquarium. Most of the above changes are those of the 3rd day in the development of *O. striatus*.

On the third day, the fry swim at all levels with ease. On the sides of the body the mid-lateral line is clear of pigment, but pigment is intense along the root of the dorsal and ventral portions of the median embryonic fin. During the second and third days the capillary network formed by the caudal vein in joining the subintestinal vein, and the "marvellous yolk-sac circulation" described by Dr. Willey, arise in the same way as in *O. striatus*.

On the fourth day (fig. 22), the length is 5 mm. The characteristic black and yellow colour of the fry, which distinguishes it from the brown and pink fry of *O. striatus*, now begins to appear.

It will be seen from the above observations that the larval development in this species, while it closely resembles that of *O. striatus*, goes forward more rapidly. This is true of most of the subsequent stages, such as the formation of the network of vessels at the root of the caudal fin (which happens about the eighth or ninth day instead of on the twelfth as in *O. striatus*²); the deflection of the end of the notochord, the commencement of aerial respiration, etc.

*Characteristic colour of the young*³ (fig. 22).—The characteristic larval colouration begins to appear as early as the fourth day after hatching. On the sides of the body, as noticed above, pigment is intense along the root of the dorsal and ventral por-

¹ Willey, "Nests, eggs and larvæ of *Ophiocephalus striatus*," *Spol. Zeylan.*, VI, pp. 108-118 (1909).

² Willey, *Spol. Zeylan.*, VI, p. 112 (1909).

³ Willey, *Spol. Zeylan.*, V, p. 150; VI, p. 116.

tions of the median embryonic fin, but the mid-lateral line is free of pigment and is consequently traversed by a pale longitudinal band, which later on acquires a bright golden-yellow hue. There is also a more or less uninterrupted pale longitudinal band in the mid-dorsal line of the head and fore-body.

The larval colours when fully assumed are as follows:—The body is dark olive along the back and sides, becoming slightly pale or whitish along the abdomen. This dark ground colour is resolvable into close-set longitudinal stripes along the scales, clearly seen in specimens preserved in spirit. Three longitudinal golden-yellow bands pass from the snout to the caudal fin; a mid-lateral band on each side which becomes narrow as it passes over the opercle and the upper portion of the eye to meet its fellow on the tip of the snout, and a narrow median dorsal band extending from the junction of the above two bands on the tip of the snout, along the base of the dorsal fin to the root of the caudal. These three bands are of a brilliant golden-yellow colour and stand out clearly on the dark ground colour; while the two lateral bands extend on the caudal fin to the extent of nearly one-third the length of that fin; the dorsal band, which is comparatively narrow and is more distinct in younger than in older stages, has two spindle-shaped enlargements in front of the dorsal fin (fig. 22). Thus the fry of *O. punctatus* are easily distinguished from the fry of *O. striatus* after they assume their characteristic larval colour.

In growth the dorsal median band is the first to disappear. In specimens above two inches in length the dark olive brown of the back and sides changes to a dirty brown, and a double row of ill-defined brown blotches appear on either side of the body one above the other, the blotches of the upper row alternating with those of the lower. These blotches encroach on the lateral golden bands and disfigure and destroy it in growth; the three golden bands are, however, retained for some considerable time on the head.

The parents guard the young till they reach two inches in length, *i.e.*, till they lose their larval colours. It is quite a sight to see the parents leading their brood of brightly coloured fry in bright sunlight in shallow water in fields,¹ where they usually come out to feed.

Uses.—*O. punctatus* is extensively eaten.

Ophiocephalus gachua, H. B.

(Pl. xxvii, fig. 23).

Tamil—*Para koravai*.

Habitat and Habits.—This very common species is found in ponds but much more abundantly in rivers, where it often frequents brackish water within tidal influence.

¹ Willey, *Spol. Zeylan.* V, p. 149.

In habits it closely resembles *O. punctatus*. The breeding season is December and January in Madras (June and July in South Canara).¹ I have not seen the nest of this species; from the accounts of fishermen it does not appear to be among weeds but in sheltered crevices in the bank. A brood of young with the parents were brought to me on the 15th February, 1911, from the river Cooum near Chetput. The adults refused to feed and died after a few days, but the fry continued to live. In habits and appearance the fry were very different to those of the previous two species. The entire brood consisted of some 300 individuals, a comparatively small number.

Description of Fry (fig. 23).—The average length of the young was 7 mm.; traces of the yolk-sac and the continuous embryonic median fin devoid of fin-rays were present. The colour was dark brown, due to a very considerable development of pigment cells, which were arranged on the sides of the body chiefly in two horizontal rows, one dorsal and one ventral, with a more or less unpigmented area between them along the mid-lateral line. Of the two the ventral band was the more conspicuous, being very broad on the abdomen and tapering gradually into a streak posteriorly. A number of pigment spots are also found on the head: a concentration of them occurs behind each eye. Scattered spots are found on the continuous median fin.

Later on, some much older fry were brought to me from the same locality. These measured on an average 48 mm. long and had the following characteristic colour. The body was of a pale olive-brown, and the sides were crossed by ten or twelve <-shaped light bands with their apices on the lateral line pointing forwards. I have not seen the large ocellus on the dorsal fin mentioned by Day² and doubt if it ever occurs in this species. It is frequently present in the young of some larger species of *Ophiocephalus*.

Uses.—A small fish not much in demand as food.

Anabas scandens (Daldorff).

Tamil—*Panai ēri kendai* (=fish that climbs palmyra-trees).

Habitat and Habits.—"Estuaries and freshwaters³ most numerous in maritime provinces and the deltas of the larger rivers" observes Day.⁴ In Madras I have not seen it in estuaries or in rivers; Hamilton-Buchanan, Jerdon⁵ and Thomas⁶ record it only from ponds and ditches.

This species is the well-known "Climbing perch." Though I have never witnessed a display of the extraordinary scansorial powers attributed to it by Daldorff⁷ and John, and wholly

¹ Thomas, *Rep. Pisc. South Canara*, p. 74 (1870).

² Day, *Fishes of India*, p. 368.

³ Day, *Fishes of India*, p. 370; *Fauna of Brit. India*, II, p. 367.

⁴ Day, *l. c.*, p. 369.

⁵ *Madras Journ. Lit. Sc.*, XV, p. 144.

⁶ *Tank Angling*, p. 99.

⁷ Daldorff, *Trans. Linn. Soc.*, III, p. 62, 1797.

discredited by most subsequent writers, I have no doubt it sometimes takes place. Gill records Mr. Rengaswamy Mudaliar's and Capt. J. Mitchell's (once Superintendent, Govt. Museum, Madras) experiments which show the reliability of the early reports.¹ Mr. Wilson of the Madras Fisheries tells me that he once trained a few of these fish to climb up a nearly vertical sheet of cloth, when held over the water in the aquarium in which he kept them. The highly mobile sub-operculum and its spines are the chief organs of climbing.²

Many records exist of these fish leaving their native waters and migrating long distances on land to other ponds, and of their aestivating during the hot months.³ Day describes how they progress on land⁴ either by lying flat on one side or by keeping their erect position. The power that the fish possesses of erecting its fins, scales and opercles assists it to move on land.

The air-breathing habit of *A. scandens* is well-known, and its great tenacity of life enables it to live out of its native element, as Hamilton-Buchanan observes, even for six days.

The breeding season extends from May to July.⁵ On the 20th of May, 1915 a brood of very young fry were obtained from a pond. On the average they measured 17 mm. in length. They were of a light olive-brown colour above, becoming pale white below. On the sides there were eight (somewhat indistinct in live but quite distinct in preserved specimens) dark vertical bands extending from the pectoral to the root of the caudal fin. A dark terminal band was found at the free edge of the dorsal and anal fins. A very distinct ocellus, consisting of a black central spot surrounded by white, was present at the root of the caudal fin on either side. The iris was red.

By the 25th of July they had grown to 25 mm. in length; the anterior vertical bands were fading away, while the posterior ones were still clear; the ocellus continued to be quite distinct. A dark band was observed to pass from the corner of the mouth backwards and downwards, and another parallel to it below: the upper and lower lips were silvery.

By November the fish had attained a length of over 8 cm. and had lost all traces of the vertical bands; the ocellus, however, remained as a black round dot.

The young of *A. scandens* grow up rapidly; the fry in the marine aquarium, spoken of above, have grown to 80 mm., i.e., more than four times their original length (17 mm.) in the course of six months (May to November). Dr. Willey records a much

¹ Jordan, *Guide to the Study of Fishes*, II, pp. 367 and 368.

² Jordan, *l. c.*, pp. 366-368.

³ Tennent, *Nat. Hist. Ceylon*, p. 354, 1861 (speaks of a specimen dug out from a depth of a foot and a half in the bottom mud of a dried-up tank).

⁴ Day, *Fishes of Malabar*, p. 133.

⁵ According to Day the breeding season is June and July (*Fishes of India*, p. 370). I have seen them breed in May while Willey found a female egg-laden female in January in Ceylon. *Spol. Zeylan.*, VII, p. 92.

slower growth in the case of half a dozen young which he kept under observation at Colombo.¹

I have recently obtained two albino specimens.

Uses.—*A. scandens* is a small fish attaining a maximum length of 9 inches. It is highly esteemed as food. It bears transport well and is employed for stocking tanks.

Nandus nandus (H. B.)

(*Nandus marmoratus* of the Fauna of British India.)

Tamil—*Mapanji*, or *Seepu-meen* (=comb-fish).

Habitat and Habits.—A comparatively rare species which inhabits a few freshwater tanks in the interior. It is never abundant in any locality, feeds voraciously on small Cyprinidae and, as observed by Buchanan, is very tenacious of life.²

According to Thomas the breeding season is May and June and again in December and January³, when this "fish builds nests among the rushes at the margin of the water, deposits its eggs therein and keeps guard over them like a stickle-back."⁴

Lates calcarifer (Bloch).

Tamil—*Koduwa*.

Habitat and Habits.—A common estuarine species which ascends rivers and is frequently captured in fresh water. Immature specimens are met with in the Cooum river far above tidal influence; Day records the capture of one at Mandalay in Upper Burma about 680 miles from the sea.⁵ While it is common at the mouths of rivers and in backwaters, its occurrence at sea appears to be very scarce and occasional; thus Willey records the remarkable fact that statistical reports show that this fish is never captured out at sea at Kalutara (Ceylon), where it is very common.⁶

Pertwee⁷ observes that *L. calcarifer* breeds in backwaters and lagoons generally about January and February, but the breeding season is known to vary; some spawn as late as March.

Uses.—A highly esteemed food fish which attains a large size.

Ambassis ranga (H. B.)

Tamil—*Sennel* or *Kaka Sennel*.

A. ranga appears to be very local in its distribution; while it abounds in some freshwater ponds and ditches in the vicinity of

¹ Willey, *Spol. Zeylan.*, VI, p. 120.

² Hamilton-Buchanan, *Fishes of the Ganges*, p. 97.

³ Thomas, *Rep. Pisc. South Canara*, p. 73 (1876).

⁴ Thomas, *l. c.*, p. 57.

⁵ Day, *Freshwater Fish and Fisheries Ind. and Burma*, para. XXVIII.

⁶ *Spol. Zeylan.*, VII, p. 100 (1911).

⁷ A. H. Pertwee, Notes on the Freshwater Fish of Ceylon, *Spol. Zeylan.*, VIII, p. 246.

Madras, it is entirely absent from others. "It breeds everywhere during the rains and has in some instances been found breeding as early as March."¹

Uses.—A small species which is said to be an effective mosquito-destroyer.²

Ambassis ambassis (Lacepede).

(*A. commersoni* of the *Fauna of Brit. India*.)

Tamil.—*Aunē Kakachi*.

The occurrence of this species in fresh water is very rare and occasional.

Ambassis miops, Gunther.

(Pl. xxviii, figs. 24, 25).

(*Ambassis myops* of the *Fauna of Brit. India*.)

A very common estuarine fish in Madras which ascends rivers when young and comes into fresh water.

Fry almost certainly of this species swarm the river Cooum in November and December, which appears to be the breeding season.

Characters of Fry.—D. 9/10. A. 10 (2/8). The fry measured from 12 to 14 mm. in length when captured. The scales were undeveloped. The body was diaphanous, of a translucent yellow colour, except the abdomen and opercles which were bright silvery; the upper two-thirds of the first dorsal fin black; a beautiful arrangement of dark stellate pigment-spots occur in clusters along the back. The shape of the body was similar to the adult (figs. 24 and 25).

Osphromenus gourami, Lacep.³

(*O. olfax* of the *Fauna of Brit. India*.)

Tamil—*Sangarā*.

The gourami is a large freshwater fish of the Malay Archipelago⁴ which has been introduced into Europe, Mauritius, Cayenne, Australia (1864), Madras (1866), Ceylon (1909)⁵ and other places as a valuable food fish.

Sir William Denison⁶, when Governor of Madras, imported them from Mauritius about 1865. The fish arrived in the early part of Lord Napier's stay and were introduced into the Govt.

¹ and ² Chaudhuri and Sewell, *Ind. Fish of Proved Utility as Mosquito-Destroyers*, p. 10.

³ Tate Regan, *Asiatic Fishes of the Family Anabantidae*. *Proc. Zool. Soc.*, 1909, II, p. 774.

⁴ The locality China (Richardson and Day) has been omitted by most authorities such as Gunther (*Brit. Mus. Cat.*, III, p. 382); Boulenger (*Cambridge Nat. Hist., Fishes*, p. 669).

⁵ *Spol. Zeylan.*, VII, pp. 95, 96, 210 and 221.

⁶ *Red in India*, 1881, pp. 279 and 280; *La Pisciculture et la Pêche en Chine*, 1872.

House ponds at Guindy and Madras, while a few were taken to the Nilgiris. In 1874 eight young fish are on record as having been caught in the ponds at Madras; about 1883 they must have been breeding in Madras as Gilbert¹ mentions obtaining a supply of fry from Thomas for the Ana Sagar tank that year. Dr. Henderson informs me that a few years ago they existed in two ponds close to the Madras Museum, from one of which he once took a four-pounder. One of these tanks has since been filled up and the other is at present low and said to contain no gourami. Mr. Wilson of the Madras Fisheries, in connection with his proposal to re-introduce this fish into Madras, examined the ponds at Guindy and Madras about April 1915², with the result that he found only a few in the ponds at Madras and none at Guindy.

In May, 1911 I obtained from the Red Hills tank, seven miles from the city, two full-grown specimens. The larger was a female measuring 48 cm. in length and contained numerous small eggs of a bright orange colour. I am certain that the fish were breeding in the tank at the time, as later on, in July, I obtained a young one about 10 cm. in length.

The above facts prove that the introduction of the gourami into Madras is not a failure, and the fact that they have done very well and were numerous and of fair size till lately in the Govt. House ponds, combined with their character as a non-predaceous and herbivorous species, show that they are well fitted for the waters of India.

Gourami inhabit ponds and rivers and in the latter some have been found within tidal influence in brackish water³; they however prefer stationary waters and thrive best in the shallows of large weedy ponds and lakes. In Java, according to M. Dabry de Thiersant⁴, they thrive in ponds not more than three feet in depth; survive with difficulty at 2800 ft. elevation and die promptly at any higher altitude. Its sensitiveness to cold is further shown by the fact that in spite of the numerous attempts to introduce it into France, the fish have never been successfully acclimatized in the Republic.

The gourami though essentially a vegetarian, being fond of several araceous plants⁵ and of water-lilies in India, is omnivorous and feeds at times on flesh, fish, insects, etc. Among themselves they are said to be pugnacious.⁶ They are able to respire air direct and possess an accessory super-branchial organ; but, according to Gilbert, this is done only when the water is foul.⁷ I doubt the accuracy of the latter statement. In a pond in the old Powder Factory grounds in Madras where some 200 gourami recently received from Mauritius and Java are kept under observa-

¹ *Journ. Bombay Nat. Hist. Soc.*, VIII, p. 436.

² G. O. No. 632, 10th March, 1915. Govt. Madras, Revenue Department.

³ Jordan, *Guide to the Study of Fishes*, II, p. 369. (Quotes from Gill.)

⁴ *La Pisciculture et la Pêche en Chine*, 1872.

⁵ Jordan, *l. c.*

⁶ Cantor, *Cat. Mal. Fish.* *Journ. As. Soc. Bengal*, XVIII, p. 1071 (1849).

⁷ *Journ. Bombay Nat. Hist. Soc.*, VIII, p. 436.

tion, they are seen to come up at all hours and take air though the water is beautifully clear.

The breeding season in Java is March¹ and in Madras about May. "The fish is assiduous in the care of its young" and constructs complex nests for the reception of its eggs. General Hardwicke² has described the interesting breeding habits of this fish in Mauritius, while Gilbert gives an account of its breeding in an aquarium.³ The nest is of a nearly spherical form composed of plants, preferably tufts of a peculiar grass (*Panicum jumentorum*) which grows on the surface of the water, and considerably resembles a bird's in form. It is usually attached to plants or weeds growing at the edge of the pond and the bottom selected is muddy while the depth varies.⁴ According to Gilbert, whose observations were on aquarium fish, the gourami assume a jet black colour and flashing red eyes during this season and become highly pugnacious. The female emits a stream of 15 to 20 eggs which (in the aquarium) adhered to the undersurface of a rock, and are aerated by the female frequently rising to the surface and bringing down a mouthful of air which she lets go against the underside of the rock. In its natural surroundings the eggs are attached to water plants.⁵ The eggs hatch in about a month.⁶ The fry on hatching are transparent and possess a yolk-sac. "When I had had them about two months" observes Gilbert "they were perfectly formed and very handsome but alas they were only two inches long at the outside."

The rate of growth appears to be rapid if conditions are favourable; "the gourami is known to attain a length of about 4 inches in the first year, 7 or 8 in the second and 10 or 11 in the third";⁷ "the young has black bands across the body and also a blackish spot at the base of the pectoral fin."⁸ In captivity they are fed on bran and oil cakes.

Uses.—The gourami is well-known and highly prized as an article of food. It attains a large size (nearly 2 feet in length) and bears transport and acclimatization well. It is one of the few fish well adapted for pisciculture.

***Macropodus cupanus* (C. and V.).⁹**

(*Polyacanthus cupanus* of the *Fauna of Brit. India*.)

Tamil—*Punnah, Panni* (Day).

Habitat and Habits.—A rare species in Madras occurring in a few small ponds in the city.

¹ Dabry de Thiersant, *La Pisciculture et la Pêche en Chine*, 1872.

² *Zool. Journ.*, IV, p. 309.

³ *Journ. Bombay Nat. Hist. Soc.*, VIII, p. 436.

⁴ Jordan, *Guide to the Study of Fishes*, II, pp. 166-167.

⁵ Dabry de Thiersant, *l. c.*

⁶ Hardwicke, *Zool. Journ.*, VI, p. 309. ⁷ Willey, *Spol. Zeylan.*, VI, p. 120.

⁸ Jordan, *Guide to the Study of Fishes*, II, p. 368.

⁹ Tate Regan, *Asiatic Fishes of the Family Anabantidae*. *Proc. Zool. Soc.*, 1909, II, pp. 769 and 775.

"It lurks under stones or amongst weeds" observes Day, but so far as I have observed, it appears to be a gregarious surface fish. In an aquarium, however, it at times settles on the bottom, when the prolonged ventral rays are stuck perpendicularly into the sand to support the forepart of the body. They are pugnacious and often fight and chase each other; the immature fish are afraid of the adults. According to Jerdon¹ "it must be handled with caution, for the spines inflict a most severe burning pain which lasts a few hours." They are air-breathers and in an aquarium they mount up to the surface every 2 or 3 minutes to take air, but unlike most other fish which respire air, the act is not usually accompanied by the escape of air-bubbles. *M. cupanus* is essentially a vegetable-feeder and in captivity eats crumbs of bread, but feeds also on insects and insect larvae. Ground-feeding is not natural to this fish, as it does so with deliberation and effort, and in an aquarium I have often seen it fail to pick up the particle of food on the bottom in spite of repeated efforts: the mouth is dorsal in position and in order to feed on the bottom it has to stand almost vertically upside down.

The breeding season has been ascertained to be May and June.² *M. cupanus* probably builds a nest like its congener *M. viridiauratus*.³

Uses.—According to Mr. Wilson it is an effective mosquito-destroyer.

Etroplus maculatus (Bloch).

(Pl. xxviii, figs. 26—30).

Tamil—*Burakāsu*.

Habitat and Habits.—This pretty little fish is abundant all over Madras in ponds, ditches and rivers; in the last many habitually live and breed within tidal influence in brackish water.

E. maculatus frequents the weedy shallows of ponds and streams and feeds for the most part on aquatic vegetation and partly on worms and insects. It is highly pugnacious in disposition and at times, as observed by Day⁴, turns almost black with passion. "This species does not live long after its removal from water" observes Day⁵; but on the contrary its tenacity of life has frequently surprised me. It is one of the few fish that is occasionally brought to the market alive; out of water it sometimes makes, at regular intervals, a peculiar ticking noise by the sudden closing and opening of its mouth.

The spawning season extends from January to April: most fish breed during February and March. The only account of the nidification was published in 1848 by Jerdon in his paper "On the

¹ Day, *Fishes of India*, p. 371.

² Thomas, *Rep. Pisc. South Canara*, p. 72.

³ Gill, Parental care among F. W. Fishes. *Ann. Rep. Smith. Inst.*, 1905.

p. 529.

⁴ and ⁵ *Fishes of India*, p. 415.

Freshwater Fishes of South India" in the *Madras Jour. of Lit. and Science*, Vol. XV, p. 143. He observes that

"At the season of spawning the fish (both male and female I believe though I am not quite certain of this) assumes a brighter livery than at other times; the yellow of its lower surface deepens, and the one dark spot on its side is accompanied by several others so much so as to give it a marbled appearance, which however is somewhat transient. The eggs are not very numerous, and are deposited in the mud at the bottom of the stream, and when hatched, both parents guard their young for many days, vigorously attacking any large fish that pass near them. I have had an opportunity of observing this, as well among fish in confinement as in the streams."

The colours are very variable, but usually become very vivid and bright during the breeding season. The whole fish becomes orange, especially the ventral half of the body, the ventral fins turn jet black, and a broad terminal band of the same colour extends along the margin of the anal covering nearly $\frac{3}{4}$ ths of that fin. The eyes are red, and shining metallic blue lines appear below them and on the opercles.

During the breeding season the fish are found in pairs and several pairs build their nests close together in the same locality. Early in February, 1910 I had the opportunity of observing several such nests in an inundated paddy-field in Puruswakam, Madras. They contained eggs and fry in various stages of development, with the parents guarding them. The nest is a shallow cup-shaped pit, roughly an inch deep at the centre and about 3 to 4 inches in diameter, scooped in the bottom debris and lined with the silky fibres of the common freshwater alga (*Spirogyra*).¹ All the nests were in very shallow water, the depth varying from 4 to 9 inches. The eggs are not very numerous (in a nest recently obtained there were 266) and are demersal and adhesive in character. They are oval, about $1\frac{1}{2}$ by 1 mm. each, and of a dark brown colour. They were deposited in the centre of the nest and each egg was found adhering to a plant-fibre, being attached at one end by a short thick stalk. The yolk is dark brown and contains a large oil globule (fig. 26). I have not been able to ascertain the interval between oviposition and hatching. The eggs hatch by the top of the egg-membrane lifting off like a lid. The shallow water which becomes tepid during the day no doubt helps to develop the eggs. The parents keep a vigorous guard and every now and then the male or female is seen to stoop over the nest and scrutinise the eggs.

Description of fry.—A few eggs obtained from one of the above nests hatched in the aquarium. On the first day the fry measure $4\frac{1}{2}$ mm. in length (fig. 27), the eyes are pigmentless, the yolk-sac is large, the median fins are continuous and there is no trace of the paired fins. The larvae rest on the bottom with the ventral surface uppermost. There are two cement organs on the head, one above the other, by which they adhere to the bottom debris. Once

¹ Recently in South Arcot I saw a nest which was a mere pit in the sand and the eggs were attached to a submerged rock.

the larvae are hatched they are restless; an incessant vibration of their bodies continues day and night.

On the second day the length increases to 5 mm. (fig. 28), pigment appears in the eyes and in the form of stellate cells on the yolk-sac, the pectoral fins appear as buds. The habits are the same as on the first day.

In a few days the mouth and anus are formed, the fry assume their normal position, *i.e.* have their backs directed upwards, and the yolk-sac is considerably reduced.

In a fortnight the yolk-sac becomes completely absorbed, only two clusters of pigment spots are now seen, one on the head and the other on the nape: the embryonic median fin still persists, and the fry still adhere to the bottom and oscillate their bodies (fig. 29).

So long as the fry keep to the nest the parents guard it and, in the natural surroundings, I have noticed that one of them, the female probably, is engaged in the task of what appears to be feeding the fry. She is seen constantly to go to a selected spot in the neighbourhood, usually only a few feet from the nest, and there dig with her mouth at the root of an aquatic plant and bring up a mouthful of dark sediment which she ejects into the nest. If the nest is attacked she leaves her task and joins the male in defence.

As soon as the young are able to swim freely the parents and their brood desert the nest and a life of wandering in quest of food commences. In such rambles, the mother occupies generally the centre of the family group and the male takes charge of the circumference. When thus engaged the adults are highly pugnacious and vigorously attack any large fish that pass near them: on one occasion I saw an adult *O. punctatus* chased for several yards by one of these fish.

As the body of the adult is much compressed and elevated, there is a curious disproportion at various stages of growth in the relative length and height of the body, as will be seen from the table below:—

Length	9—12	—16	—18	—19—30 mm.
Height	3—4½	—4½	—7½	—8—14 mm.

In a specimen 9 mm. long the back is green or olive, a well-marked white band is found across the nape and the body is elongated (fig. 30). In young 19 mm. long there is a considerable increase in height so that the body is oval in shape, the back is olive and has 6 broad transverse bands descending half way on the sides and the ventral surface is dirty white. In the adult fish these bands disappear and the lower ends of 3 of them alone are retained as the characteristic 3 spots on either side of the body. When the young are about an inch long they are abandoned by the parents.

Etroplus suratensis (Bloch).

Tamil—*Pani shettai*, *Setha kendai*.

Habitat and Habits.—Fairly common in fresh and brackish water, both in ponds and rivers. Salinity does not appear to affect this fish, while it lives and breeds in the Red Hills in absolute fresh water. I have obtained adult fish on at least two different occasions from the sea opposite the mouth of the river Adyar. In the Madras marine aquarium specimens captured in the backwater live in sea water with marine fish. Saltwater specimens are much more vividly coloured than freshwater ones.

"*Etroplus* greatly affect the shallows of a tank or river and congregate near rocks and stones, and if there are wooden palings going into the water, they are often to be found round about them, probably for the sake of the moss and weeds."¹

It is essentially a vegetable-feeder but takes worms and insects also, and according to Thomas ejects the cuticle. It is said to be a very powerful fish for its size, but very sluggish.

"On hot days the *Etroplus* may be seen basking in large shoals on the surface. They take best from about five o'clock until dusk; the larger fish especially seem very particular as to the time of day they feed."²

Day's statement that this fish buries itself in the mud³ has not been confirmed by other observers. Recently, while engaged in stocking operations when hundreds of *E. suratensis* had to be captured, I have observed that it has the peculiar habit of lying flat on the bottom of ponds and rivers to escape drag nets. It occurs almost entirely in the maritime districts and hence is probably unsuitable for stocking waters far inland; the experiment however is being made by the Madras Fisheries.

The only published account of the breeding habits is that of Dr. Willey,⁴ who describes the nest, eggs and young of this species in his preliminary account of the Inland Fisheries of Ceylon, (Reports of 1908 and 1909); from which the following extracts are taken:—

The breeding habits are very similar to those of *E. maculatus*.

"The eggs . . . are attached to the lower surfaces of stones and logs and are watched over by the male. On May 21, 1909, a Koraliya (*E. suratensis*) nest was found . . . I went there about 11-30 A.M. and saw the adults, both male and female keeping guard. When the man who was with me advanced his hand to the small stone projecting from the bank of the canal under which the eggs were attached, the smaller, male, . . . approached and pecked at the man's fingers. The large, female, kept a little in the background in deeper water. . . . The eggs were attached contiguously in a single layer on the underside of the stone, which was partially imbedded in the earth at the base of the bank of the canal. Some of the eggs were white, indicating failure and death. The living eggs were in an advanced stage of development, the embryo being formed and the yolk pigmented. The yolk is yellow opaque, and

¹ Thomas, *Tank Angling*, p. 91 (quotes from "*Fleur de Lys*").

² Thomas, *l. c.*, p. 92.

³ Day, *Fishes of Malabar*, p. 162; *Fishes of India*, p. 416.

⁴ Notes on the Freshwater Fisheries of Ceylon, *Spol. Zeylan.*, VII, p. 102 (1911).

darkly pigmented, but no pigment was present in the eye. The circulation of the blood is active, and the embryo can change its position within the egg membrane. . . . The surface of the egg appeared minutely rugulose. The length of the egg, without the short stalk, is 2 mm., the width 1 mm., slightly narrower at the free end. Within 24 hours after finding the nest one of the eggs hatched out, the top of the egg membrane lifting up like a lid; there is still no pigment in the eyes, and no mouth; length 5 mm. On the second day after hatching pigment begins to appear in the eyes, and on the third day, when the larva is 6 mm. long, the mouth opens and respiratory movements commence; foreign particles were noted adhering to what looked like a cement organ at the front of the head. The eggs of Koraliya are very difficult to rear when removed from their proper habitat. On May 23, and again on June 1, more eggs were found attached to cocoanut husks, branches, and stones at Hunapitiya, Colombo. . . . On October 28, 1909, another series of Koraliya eggs containing formed embryos . . . was found . . . attached to the outer surface of a short length of water-logged bamboo stem. This species is therefore a perennial spawner."

According to Thomas ¹ *E. suratensis* breeds twice in the year in S. Canara, in May and June and again in December and January. In Madras the specimens in the Red Hills tank build their nests in the open canal in which water is brought to the city, during April and May.

Of the later changes which the fry undergo in growth nothing is known, except that "very young fish have a large black ocellus surrounded by a white margin extending from the fourth to the tenth soft ray of the dorsal fin." ²

Uses.—*E. suratensis* attains a large size, more than a foot in length, and is a highly esteemed food fish. Its non-predaceous and vegetarian habits make it a very suitable fish for stocking tanks.

Eleotris fusca (Bl. and Schn.).

Tamil—*Mussoorie* (Day), in Madras *Kul Uluway*.

Habitat and Habits.—*E. fusca* is common in fresh and brackish waters, occurring in ponds, ditches, rivers, and more abundantly in the backwater.

It is apparently nocturnal in habits. During the day it is very slow in its movements, "concealing under stones and among weeds, and remaining for hours motionless." ³ In an aquarium it becomes very active by night and frequently jumps out of the vessel if uncovered; and as Jerdon has observed "it is very fond of fixing itself vertically to the side of a tub or vase (in which it may be confined) with its head downwards." Experiments with a specimen in confinement tend to show that the sense of sight in this species is very poor, at least by day. It is said that black fish appear pale white in colour at night; and according to Jerdon "it has the faculty of changing its colour, at times becoming nearly black, at other times marbled; and usually with a strong line of demarcation between the tint of the back and sides." It is tenacious of life and lives a fairly long time out of water. It is carnivorous and a bottom-feeder.

¹ *Rep. Pisc. S. Canara*, p. 73 (1870). ² Day, *Fishes of Malabar*, p. 162.

³ Jerdon, *Madras Journ. Lit. Sci.*, XV, p. 149.

E. fusca breeds during the cold weather in Madras, but in S. Canara, as ascertained by Thomas¹, in June and July and again in January and February. I have not seen young below 2 cm. in length, and when of that size they are easily distinguished from other young fish by their distinctive colour. A broad black lateral band, very conspicuous and sharply distinguished from the pale colour of the back and abdomen, extends from the snout to the caudal fin, while the summit of the head and the portions of the body above and below this band is pale gray. The younger the specimens the more sharply contrasted are the two colours.

Gobius (Acentrogobius) neilli, Day.

This small species abounds in shallow pools in the bed of the Cooum and Adyar rivers both in fresh and brackish water. Though essentially a backwater fish, I have kept it living for months in fresh water.

It is a bottom-feeder with limited powers of swimming; when resting on the bottom it spreads out its ventral sucker as a support and by means of this organ often adheres to stones and in the aquarium to the glass, and climbs aquatic weeds on the leaves of which it frequently rests. In its natural surroundings it delights to bask in the sun, coming up close to the margin of the water, receding at the least sign of danger and raising a cloud of mud under cover of which it escapes.

G. neilli seems to be a perennial spawner as I have seen young ones throughout the year, but it is specially prolific about March and April. It is evidently monogamous and during the breeding season each pair inhabit a horizontal burrow excavated in the mud.

Gobius (Acentrogobius) acutipinnis, C. and V.

Tamil—*Nation pulowe* (C. and V.).

Cuvier and Valenciennes describe this species under the two names *G. acutipinnis* (from Malabar) and *G. setosus* (from Pondicherry); the chief differences between the two being:—(1) the length of the head is 6 in the total length in the former while it is only 5 in the latter; (2) spots and blotches occur on the body of the former whereas they are absent in the latter. There is no constant difference in the relative lengths of the head between the blotched and unblotched forms, and the difference in colour between the two forms appears to be due to the difference in sex; the males, having their bodies spotted and blotched, represent *G. acutipinnis* and the females, being destitute of such spots, correspond to *G. setosus*.

Habitat and Habits.—Not uncommon in pools within tidal influence, in the Adyar and Cooum rivers where the bottom is muddy; occasionally ascending into fresh water higher up.

¹ *Rep. Pisc. S. Canara*, p. 73.

Like most of its congeners *G. acutipinnis* is a bottom-feeder with limited powers of swimming. It habitually inhabits horizontal burrows, which it excavates in the soft mud full of organic debris. These tunnels, which are nearly straight, measure on an average 4 inches in length and half an inch in diameter and are provided with two orifices, one at each end, hidden under some aquatic plant. A pair inhabit a burrow. The two entrances are a repetition of the usual device employed by shallow-water forms; if danger threatens at one end, the fish escape by the other, causing a cloud of mud which effectually hides the animal and its burrow. *G. acutipinnis* breeds about February when the females contain ova.

Gobius (Glossogobius) giuris,¹ H. B.

(Pl. xxviii, fig. 31; pl. xxix, figs. 32—36).

Tamil—*Uluway* or *Nallatanni uluway*.

The term *uluway* appears to have been derived from a Tamil word which means to plough, and is appropriate to a fish which is a bottom-feeder and a burrower.

Habitat and Habits.—One of the most common and best known freshwater fish of Madras, occurring everywhere in ponds, ditches and rivers, in abundance. While the typical *G. giuris* is an exclusively freshwater form, the variety *kokiis* is confined to backwaters and the sea.

In habits *G. giuris* closely resembles other gobies. It is voracious and lives for a considerable time out of water, dying with its opercles dilated. The colour of this fish is well adapted to its muddy surroundings.

The breeding season extends from October to December in Madras, while it is said to be May to July in Ceylon.² The fish deposit their eggs as a rule in shallow water, in crevices and burrows, usually not of their own construction. The nests have been found under submerged rocks and tiles, in demersed pieces of iron piping, bamboo and cocoanut shells, and more frequently in the deserted burrows of such aquatic animals as crabs (*Paratelphusa* sp.).

The eggs are very numerous and of a pale greenish-yellow colour and are attached in contiguous clusters (fig. 31) to the roof of the burrow. The egg-membrane is in the form of an elongated tube 3 to 6 mm. long and about $\frac{1}{4}$ to $\frac{1}{2}$ mm. in diameter and holds the egg at the slightly swollen distal free end. It is attached at the other end by means of a short stalk to a shapeless basal stolon which adheres to the substratum (fig. 32). The parent remains on guard in the burrow and by the movements of its pectoral fins promotes the aëration of the eggs.

In the early stages of development the embryo faces the attached end, with its tail coiled up in a spiral behind (figs. 33 and

¹ Max Weber, *Die Fische der Siboga-Expedition*, p. 468 (1915).

² Willey, *Spol. Zeylan.*, VII, pp. 102-103.

34); but when the tail is detached from the yolk-sac the embryo changes its orientation by the agitation of its tail (fig. 35). The fry on hatching (fig. 36) measure about 2.25 mm. long and are not quite so helpless as the larvae of *Ophiocephalus*, *Etroplus*, etc., but are able to feed and swim. The parents do not appear to guard them after hatching. The eggs and fry of this species are very difficult to rear when removed from their natural surroundings.

Uses.—*G. giuris* grows to a foot and a half in length and fetches a high price in the local market when large.

*Gobius (Oxyurichthys)*¹ *striatus* (Day).

(Pl. xxix, figs. 37, 38).

Tamil—*Kundalam*.

Habitat and Habits.—Not uncommon in ponds, rivers and in the backwater.

It is a sluggish fish, chiefly nocturnal in habits, and frequents sandy shallows, where it is fond of lying half buried during the day time. Its movements are for the most part confined to the bottom, but it swims occasionally in a feeble clumsy manner, swaying and rolling irregularly.

This species breeds from October to November. Mr. Wilson of the Madras Fisheries obtained a nest of this fish with eggs in an advanced condition. Figs. 37 and 38 are copies of his figures reproduced by kind permission. The eggs closely resemble those of *G. giuris* and like them are attached to the under surface of demersed stones, tiles, etc., by means of a gelatinous stolon.

Rhynceobdella aculeata (Bloch).

Tamil—*Ārāl*.

Fairly common in fresh and brackish water.

In an aquarium *R. aculeata* habitually conceals itself by day in the bottom sand or mud, with just the snout and at times the whole head projecting above the sand for respiration; even this is withdrawn at the least disturbance. At night however it emerges to feed. The pointed snout, the weak sight, the conical head, the absence of the ventral and the poorly developed pectoral fins are obvious adaptations to the burrowing habits of this fish. The dorsal spines are organs of defence, while the trilobed proboscis is evidently an organ of touch. The fish lives a long time out of water, and is known to withstand periods of drought by burrowing in the bottom mud of ponds and streams.² "It becomes drowned in water if unable to reach the surface, as it apparently requires to respire air directly."³

Uses.—It is moderately esteemed as food.

¹ Max Weber, *Die Fische der Siboga-Expedition*, p. 475.

² Day, *Freshwater Fishes and Fisheries of India and Burma*, p. 28 (1873).

³ *Fauna of Brit. India. Fishes*, II, p. 332.

Mastacembelus pancalus (H. B.).

Tamil—*Pil Ārāl*.

Colour.—In Madras examples the vertical stripes are as a rule absent in adults and the pectoral fins are unspotted.

Habitat and Habits.—*M. pancalus* abounds in tanks all over Madras and in the Cooum, usually above tidal influence. Day is obviously in error in stating "I have taken this species in the Ganges but have not seen it in the Coromandel coast south of the Kistna", as the fish is too common on the Madras coast to escape notice. Its habits are those of the genus. It is a much smaller species than *M. armatus*, and in its natural haunts it frequents the soft loose mud close to the margin of the water. One of the easiest ways to capture this fish is to draw ashore a portion of the weeds growing in the water and to search for it in the loose mud that is thus brought ashore.

M. pancalus breeds during the cold weather. Early in February I obtained the young of this fish in a shallow pool in the Spur tank, Egmore; they measured on an average 30 mm. in length.

Description of the immature fish. D. 24/31. A. 3/35.

Shape of body same as that of the adult.

Colour.—Pale olive along the back and sides, whitish beneath, iris red. A dark band from the tip of the proboscis to the eye and extending behind that organ over the opercles. About 31 dark transverse stripes at regular intervals on the sides of the body from behind the opercles to the root of the caudal fin. The spinous portion of the dorsal fin is placed in a yellowish groove on the back.

Uses.—A small species attaining a maximum length of seven inches and of no market value.

Mastacembelus armatus (Lacep.).

Tamil—*Kal Ārāl*.

Though it is said to occur in brackish water elsewhere in India¹, in Madras it is not known to frequent estuaries or rivers within tidal influence. *M. armatus* appears to prefer stationary to running water, and is fairly common in large tanks, where it is said to affect the neighbourhood of demersed rocks and stones. Early in February, 1910 I found mature ova in a female.

Uses.—This species attains a much larger size than *R. aculeata* which it resembles, and is highly esteemed as food.

¹ Day, *Fauna of Brit. India, Fishes*, II, p. 334.

APPENDIX.

REMARKS ON THE GENUS *HAPLOCHILUS*.

Tate Regan¹ has recently suggested a division of the genus *Haplochilus* into two genera, viz. the genus *Haplochilus* proper, represented in India by the single species *melanostigma*, and the genus *Panchax*, to include the remaining species *panchax*, *lineatum*, *rubrostigma*, *dayi* and *parvus*. He has stated the differences as follows:—

"In the one (*Panchax*) the premaxillaries are flattish and somewhat produced, protractile, the cleft of the mouth is rather wide, horizontal, almost semi-circular, the teeth are in bands, with an outer and a more or less distinct inner series of enlarged teeth, vomerine teeth and pseudobranchiae are present, the gill-membranes are not united, and the pectoral fins are placed low. In the other (*Haplochilus*) the mouth is small, transverse, not protractile, with the teeth in a single series, sometimes followed by a second series of minute teeth; there are no vomerine teeth or pseudobranchiae, the gill-membranes are broadly united, and the pectoral fins are placed high."

This division of the old genus *Haplochilus* has not been generally adopted in India and further research was desired on the subject.² At the instance of Dr. Annandale I have recently examined all the Indian species save *H. rubrostigma* and *H. dayi*³ of Ceylon, with special reference to the differences between the two proposed genera, with the result that I accept Tate Regan's division of the genus but modify some of the differences he has pointed out between the two. In addition I have stated other differences, notably in the structure of the scales and in the habits of the two genera.

The premaxilla.—The shape of this bone differs considerably in the two genera (pl. xxv, figs. 3, 4 and 5). In *Panchax*, towards the mid-dorsal line of the body where the two premaxillae meet, each gives off posteriorly a flat triangular process of considerable length; the rest of the bone is narrow, elongate and bent backwards and downwards, tapering to a spine at the extreme corner of the mouth. In *Haplochilus* the triangular process is feebly represented by a rounded extension, the rest of the bone is short and of uniform breadth, ending in two or more coarse teeth in the corner of the mouth, according to the sex.

The mouth.—The cleft of the mouth in *Panchax* is wide but in *Haplochilus* it is small: beyond this there is very little to be said by way of a difference. If it is semicircular in *Panchax*, in *Haplochilus melanostigma* too it is so to a slight degree, and as to its being horizontal in *Panchax* and transverse in *Haplochilus* the distinction to a large extent depends on the proportionate lengths

¹ Tate Regan, *Ann. Mag. Nat. Hist.* (8), VII, p. 324.

² Sewell and Chaudhuri, *Ind. Fish of Proved Utility as Mosquito Destroyers*,

p. 2.

³ Steindachner, *Denkschriften der kais. Akad. Wein*, LIX, pp. 376-377 (1892).

of the two jaws. In *lineatum* the upper jaw is longer, in *panchax* the two jaws are equal, in *parvus* the lower jaw is distinctly longer and the direction of the mouth-cleft in the normal unprotruded condition is very similar to that in *melanostigma* (pl. xxv, figs. 1 and 2).

The upper jaw is protractile in *Panchax* and in the normal unprotruded condition a deep transverse fold is formed across the snout (pl. xxv, fig. 2). In *Haplochilus* the upper jaw is not protractile and there is no fold.

Teeth.—Tate Regan lays special emphasis on the difference in teeth, which he believes are present in a band in *Panchax*, while they occur in a single series sometimes followed by a second series of minute teeth in *Haplochilus*. A microscopical examination of the isolated praemaxilla and mandible of *H. melanostigma* reveals the presence of a band of teeth hardly distinguishable from that in species of *Panchax* (pl. xxv, figs. 3 and 4).

Vomerine teeth (pl. xxv, figs. 6, 7 and 8).—These are invariably present in all the known Indian species of *Panchax*, in *lineatum* as a narrow band composed of three or four rows of teeth, in *panchax* in a single or occasionally double row; in *parvus* about three vestigial teeth are borne by the vomers at their extreme anterior end, and in *rubrostigma* and *dayi* also they are said to occur. It is quite likely that all species of *Panchax* possess these teeth in various degrees of development. While they are present as a prominent band in *lineatum*, the presence of the three teeth in *parvus* can only be detected by a microscopical examination of the vomer. At least so far as Indian species are concerned, their presence or absence constitutes a safe criterion of classification.

The *pseudobranchiae* are glandular, richly supplied with blood during life, and covered by a highly pigmented mucous membrane. They are present in all the three species of *panchax* examined and probably in *rubrostigma* and *dayi*, while they are absent in *H. melanostigma*.

Gill-membranes.—These are broadly united with one another in *H. melanostigma*, while they are not united, but cleft to the chin in *lineatum*, *panchax*, *parvus* and probably in the other two Indian species of *Panchax*.

Position of pectoral fins.—In *melanostigma* these are placed high, i.e. nearer the mid-dorsal line of the body than the mid-ventral, whereas in species of *Panchax* they are placed low (pl. xxv, figs. 1 and 2).

Scales.—In *melanostigma* the scales possess only concentric (circular) striations, but in the three species examined and probably in all other species of *Panchax* radiating striae (basal radii) are present in addition to the concentric rings in the imbedded part of the scale (pl. xxv, figs. 9 and 10).

Vertebrae.—Their number in the various species are as follows: in *melanostigma* 29, in *lineatum* 32, in *panchax* 29, in *parvus* 26. Tate Regan seems to have supposed that the number 29 in the species *panchax* obtains in all the species of the genus *Panchax*.

Breeding Habits.—There is a wide difference between the Indian representatives of the two genera in spawning habits. *H. melanostigma* as stated above has the remarkable habit of carrying the extruded cluster of eggs suspended from a cord attached to the genital opening of the female, probably till they are hatched. Species of *Panchax* however show no such parental care, and according to the only observer Thomas,¹ who has recorded oviposition in this genus, *Panchax* (*parvus*?) extrudes a single egg at a time which is soon deposited. The eggs of both genera, however, are adhesive and demersal and are very similar in structure.

In addition there are a number of minor differences which separate *H. melanostigma* from species of *Panchax*. From all this it is clear that Tate Regan's division of the genus *Haplochilus* of Günther and Day is amply justified and quite natural and necessary. The diagnostic characters of the two genera and a key to the Indian species may be drawn up as follows:—

Genus Panchax.

Praemaxillae flat, elongate and protractile, a deep transverse fold on the snout, mouth wide, vomerine teeth and pseudobranchiae present, gill-membranes not united, pectoral fins placed low, and scales with concentric and radiating striae.

- | | |
|---|--------------------------|
| A. With a prolonged ventral ray— | |
| Spotted with red | ... <i>rubrostigma</i> . |
| Body with vertical dark bands or blotches— | |
| 32 to 34 scales on L. line | ... <i>lineatum</i> . |
| 29 to 30 scales on L. line | ... <i>dayi</i> . |
| B. No prolonged ventral ray— | |
| Numerous vomerine teeth; greenish or olive in colour; size large (3" to 3½") | |
| 3 vomerine teeth; body greenish, with peacock-blue and sometimes Italian pink dots; size small (1½" to 1¾") | ... <i>parvus</i> . |

Genus Haplochilus.

Mouth small, not protractile, no fold on the snout, neither vomerine teeth nor pseudobranchiae present, gill-membranes broadly united, pectoral fins placed high, and scales with concentric striations only. A single species, *H. melanostigma*.

I have classed *P. dayi* as a distinct species from *P. lineatum*, only provisionally, as it is very likely that further research will prove them to be conspecific. Steindachner in his description distinguishes *dayi* from *lineatum* by the intense sexual dimorphism of the former, the most conspicuous differences between the sexes in *dayi* consisting chiefly in the dark vertical bands of the female and in the elongation of the anal rays of the male. From an examination of a large collection of *P. lineatum* from Coorg and Cochin, I venture to state that the above-mentioned sexual dimorphism is exhibited by this species also, though Day fails to record it.²

¹ Thomas, *Tank Angling*, p. 112 (1887).

² In his *Fishes of Malabar*, p. 222, Day states that the colours vary according to the sex and that the vertical black stripes are absent in some specimens.

Apart from sexual dimorphism no salient anatomical feature has been stated in the description of *P. dayi* save the reduced number of scales on the lateral line mentioned in the above key to the species.

History.—McClelland in 1839 founded the genus *Aplocheilus*, in which he included the two Indian species *melanostigma* and *panchax*. In 1846 Valenciennes made *Panchax* a generic name and included under it the species *panchax* and *lineatum*. Later Bleeker distinguished the two genera, restricting the genus *Panchax* to those species possessing vomerine teeth and the genus *Aplocheilus* to those destitute of them. Günther protested against this differentiation and included all the known species under the genus *Haplochilus*, on the ground that "the vomerine teeth of *panchax* are minute and rudimental, not offering a character on which a genus may be founded. In one out of three specimens they are entirely absent." Day stated that the latter statement was not true of his numerous specimens. No such variation is shown by the species I have examined. Tate Regan in the paper cited above remarks that vomerine teeth are not invariably present in *Panchax*, probably on the authority of Günther. At least so far as Indian species are concerned, vomerine teeth are always present.

XVIII. STUDIES IN INDIAN HELMINTHOLOGY.

No. III.

ON AN UNSUCCESSFUL ATTEMPT TO INFECT *MUS DECUMANUS*
WITH *HYMENOLEPIS NANA*, SIEBOLD, AND ON THE
SECTIONAL ANATOMY OF THAT PARASITE.

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(Plates XXXIV—XXXV).

The question of the specific identity or distinctness of *Hymenolepis nana*, Siebold, and *H. murina*, Duj., is a matter of practical as well as of scientific interest. Grassi, Calandruccio, and Rovelli (1, 2 and 3) consider that the two species are identical and that *H. nana* is only a dwarfed variety of *H. murina*. Moniez (7) and Linstow (5) have maintained on anatomical grounds that they are two valid species. Grassi and Rovelli (3) state that on feeding rats aged between one and three months with ripe proglottides of *H. murina* the contained onchospheres developed to cysticercoids in the intestinal villi of the rat, and further that the cysticercoids ultimately rupture into the lumen of the intestine and there become adult. They apparently did not attempt to infect man with the tapeworm from the rat or to perform the reverse experiment. Grassi (1) had previously administered to a boy ripe proglottides of *H. nana* and had found proof of the subsequent existence of the parasite in the bowel. He did not, however, consider this to be conclusive proof of direct transmission from man to man as *Hymenolepis nana* is very frequent in the district where the experiment took place.

If the two species are identical and if the development in the rat is direct as described by Grassi and Rovelli, it is clear that infection in man will as a rule be due to contamination of food by rats. To prove or disprove the transmissibility of *H. murina* to man or of *H. nana* to the rat would therefore be of considerable practical importance. It is also clear that when such eminent zoologists differ on anatomical grounds as to whether the species are one or two, the scientific question can only be decided by feeding experiments.

The experiment which the present paper records could unfortunately be conducted on a small scale only and as it proved negative would require to be repeated on a larger scale to be

conclusive. It is, however, of considerable value in consideration of the statement of Grassi and Rovelli that they obtained infection in every rat employed which was between the ages of one and three months.

On the 19th of January two young white rats (*Mus decumanus albino*) were obtained which were stated to be twenty days old and which appeared to be about that age. Their faeces were examined and no eggs of parasites found. On the 10th of February they were presumably 42 days old. Five specimens of *H. nana* were obtained on that day from an Indian soldier after the administration of *Ol. Chenopodii*. One specimen was stained and mounted and proved to contain onchospheres. The remaining four were given, two each, to the two young rats and were actually swallowed by them. On the 10th of March and 5th of April the faeces of these animals were examined and found not to contain any ova. One rat died on the 12th of April, the second was killed on the 17th. No tapeworms were found in their intestines.

The experiment¹ therefore tends to prove that *Hymenolepis nana* and *H. murina* are two distinct species and that the rat is not the source of infection of man.

ON THE SECTIONAL ANATOMY OF *HYMENOLEPIS NANA*, SIEB.

The anatomy of *Hymenolepis nana*, Sieb., has been described by Leuckart (4, pp. 832, 995), Linstow (5), Miura and Yamasaki (6), Railliet (9), and other authors. A full account of the literature is given by Ransom (10). None of the authors mentioned above have illustrated their papers with figures of sections except diagrammatic figures. The present writer therefore considers it desirable to publish drawings of the actual sections together with some pictures of the undissected animal and a short account of the anatomy of the reproductive system.

The female reproductive organs are fully developed from the 50th segment; fertilisation takes place between the 62nd and 66th (fig. 12). It takes place abruptly; thus in the 61st segment all the eggs are unsegmented; in the 62nd, if this is the first fertilised segment, the left lateral and ventral half of the egg-mass is segmented, the right lateral and dorsal half unsegmented; in the 63rd segment all the eggs with the exception of one or two near the yolk-gland are segmented. Fig. 12 shows this transition between the 62nd and 63rd segments, it also shows the commencing atrophy of the yolk-gland in the fertilised segments and the testes, seminal vesicle and cirrus sac.

Figs. 1-5 are drawn from sections of the 60th segment. They show the yolk-gland, the bilobed ovary, the receptaculo-ovarian duct, the receptaculum seminis and vagina. The receptaculo-ovarian duct has not been described previously in this species. It leads from the receptaculum in the direction of the ovary, but its

¹ I understand that the experiment was carried out at Hong Kong.—Ed.]

exact lower connection cannot be determined. A uterus is not recognisable apart from the cavity of the ovary. The tissues of the animal are, however, so loose that it is impossible either to prove or to disprove the homology of some of the spaces with the uterus of larger forms. On passing from the unfertilised to the fertilised segments (fig. 12) the egg-mass broadens out. This may be due to a change of situation of the eggs or merely to an increase in size.

The present writer has not been able to recognise a shell-gland.

The yolk-gland atrophies at the 65th segment, having decreased in size from the 63rd.

Development of the ova.—The ova in the 50th segment have no cell outlines, the nuclei being embedded in a syncytium (fig. 6). At the 53rd segment irregular cell outlines appear (fig. 7). In the 54th segment yolk granules occur in the protoplasm (fig. 8), which increase markedly in size up to the 60th segment (fig. 9). Fig. 10 shows the segmented egg of the 62nd segment. The embryos develop double-contoured shells in the 90th segment and embryonic hooks in the 91st.

Male reproductive organs in the 60th segment.—The three testes lie near the posterior margin of the segment close to the dorsal surface (fig. 1). The vas deferens (figs. 2 and 3) leads forward to the base of the seminal vesicle. The seminal vesicle (fig. 4), a sausage-shaped thin-walled structure, runs from the midline toward the left side to become continuous with the cirrus pouch. The walls of the latter (fig. 5) are markedly thicker than those of the former and contain muscle fibres. A definite cirrus has not been recognised by the present writer.

The seminal vesicle can first be observed to contain spermatozoa in the 44th segment. The testes are progressively compressed behind the 63rd segment and disappear about the 67th or 68th.

Fig. 11 represents the 57th segment of an undissected preparation seen from the ventral surface. It shows the three testes, the vas deferens and seminal vesicle, the ovary, yolk-gland and receptaculum seminis.

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XIX. ON A COLLECTION OF OLIGOCHAETA BELONGING TO THE INDIAN MUSEUM.

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(Plates XXX—XXXIII).

CONTENTS.

	Page		Page
INTRODUCTION ...	299	Gen. <i>Megascolex</i> ...	327
Fam. Naididae ...	300	„ <i>Pheretima</i> ...	334
Gne. <i>Stavina</i> ...	301	Subfam. Octochaetinae	
„ <i>Stylaria</i> ...	303	Gen. <i>Octochaetus</i> ...	338
„ <i>Pristina</i> ...	304	„ <i>Eutyphoeus</i> ...	342
„ <i>Aulophorus</i> ...	304	Subfam. Trigasterinae	
Fam. Tubificidae ...	307	Gen. <i>Eudichogaster</i> ...	344
Gen. <i>Limnodrilus</i> ...	307	„ <i>Dichogaster</i> ...	346
Fam. Moniligastridae ...	307	Subfam. Ocnodrilinae	
Gen. <i>Drawida</i> ...	307	Gen. <i>Ocnodrilus</i> ...	348
Fam. Megascolecidae ...	311	Fam. Glossoscolecidae ...	349
Subfam. Megascolecinae		Subfam. Glossoscolecinae	
Gen. <i>Pontodrilus</i> ...	311	Gen. <i>Pontoscolex</i> ...	349
„ <i>Megascolides</i> ...	311	Subfam. Microchaetinae	
„ <i>Lampito</i> ...	315	Gen. <i>Glyphidrilus</i> ...	349
„ <i>Perionyx</i> ...	317	Fam. Lumbricidae ...	352
„ <i>Notoscolex</i> ...	325	Gen. <i>Helodrilus</i> ...	352

INTRODUCTION.

The following paper describes a collection of Oligochaeta belonging to the Indian Museum, which has been accumulating for some time. Contained in the collection were a number of worms from Trivandrum and places in the vicinity, handed over to the Indian Museum by the authorities of the Trivandrum Museum. I have also added a few records of worms that have come into my hands from other sources during the preparation of the paper.

Nineteen forms are described as new, either species or varieties; and one or two more, which I have not named, may be so also. In addition I have given fairly complete descriptions of a few forms which have only been recorded and described once, and that, perhaps, some time ago.

There is no addition of importance to our knowledge of the distribution of Indian earthworms; indeed this is hardly to be

expected, at any rate from regions represented in the present collection. The genus *Megascolides* appears again in its double distribution, on the one hand S. India, and on the other the E. Himalayas (cf. Stephenson, 23). The record of an apparently endemic species of *Pheretima* in S. India represents an extension of the proper range of the genus beyond the limits that have hitherto been assigned to it. New species of *Perionyx* from the E. Himalayas are in accordance with what was to be expected.

The *Glyphidrilus* described below (*G. tuberosus*) is an interesting novelty; the genus has, however, previously been recorded in India, and its bearing commented on by Michaelsen (14). The new species belongs distinctly to the Further India group, and is not in any way closely related to the African *G. stuhlmanni*.

Artificial introduction must account for the presence of *Dichogaster bolau* (Mehlsn.) subsp. *palmicola* (Eisen), described by Eisen from the Pacific Coast of America, in the compound of the Museum.

An interesting series of specimens of *Aulophorus* necessitates the fusion of two species, and it is possible that another will sooner or later have to be merged in *A. furcatus*. Some of the specimens were sexually mature, and I give below an account of the appearances; so far as I know there has hitherto been no description of the genital organs of any species of *Aulophorus*.

My best thanks are due to Dr. Annandale for kindly allowing me the opportunity of examining this extensive collection.

Fam. NAIDIDAE.

The determination, from preserved material, of species belonging to the Naididae is liable to be very unsatisfactory. Though the family is particularly fascinating to study in the living condition, spirit specimens are extraordinarily troublesome; and this is due to several causes. In the first place the setae, on the minute description of which so much depends, cannot be seen as a rule in their whole extent nor in one plane. One can easily, simply by allowing the water to evaporate, cause the coverslip to exercise sufficient pressure on a fresh specimen to flatten it completely; but this does not answer with preserved material. The only way is to soften the specimen by treatment for some time with solution of potash; and I once thought that this would prove a method of some value. But I now find that the potash distorts the setae; and the more, the longer the specimens remain in the solution. According to my observations the setae may actually swell from a thickness of 3μ to as much as 7μ ; and although the length, position of nodulus, and even the general curve of the shaft are more or less maintained, the shape of the terminal prongs is quite unreliable in specimens so treated.

Secondly, the preservation of the setae often leaves much to be desired. It may happen that throughout the whole length of a

specimen not a single dorsal seta is found perfect. In some cases nearly the whole of the dorsal setae may actually be broken off level with the body-wall, scarcely one being left projecting; so that I was for a time misled, in the examination of one of the present specimens, into thinking that I had before me one of the genera which are without dorsal setae. But even where the ends of the setae of one single segment are alone damaged, it may be difficult or impossible to discriminate, for example, such forms as *Pristina longiseta* from the other species of its genus.

Thirdly, there is frequently more than one species represented in a limited amount of material; and there is naturally the liability to confusion, especially if some of the specimens are fragmentary. Confusion may easily result if, in order to get a complete description, one specimen is used for the dorsal, another for the anterior ventral, and a third for the posterior ventral setae, according as they happen to be well shown in one or other specimen; additional specimens have frequently to be taken for a description of the process of budding, or perhaps for the internal organs. It is practically impossible ever to write a complete description from a single specimen.

I thus spent much time over a tube of eight small worms from Bhim Tal. Besides two specimens that I can say nothing definite about, there was one specimen of a *Nais* without eyes; three of a *Slavina* which I describe shortly below, but which I do not feel justified in naming; and two of a *Stylaria* which seems to me to require specific distinction.

Gen. *Slavina*.

Slavina sp

(Plate xxx, fig. 1).

Bhim Tal, 4450 ft., Kumaon, W. Himalayas, 2-10-V-1911 (*S. W. Kemp*).
Three specimens, one considerably damaged.

Length 5.5 mm., diameter about .25 mm. Segments 47 or 48, with a small undifferentiated zone at the hinder end. No zone of budding. A considerable amount of debris adherent to the surface. Prostomium blunt. No eyespots.

The anterior ventral setae are in length 135μ , in thickness 3μ . The proximal prong of the fork is almost equal in length to the distal, but is twice as thick, and this on the whole is much the more massive of the two; the distal prong is slightly claw-like. The curve of the shaft at its proximal end is slight; the nodule is proximal to the middle point of the shaft, the relation between the segments of the shaft proximal and distal to the nodule respectively being 2 : 3 or 3 : 5. There may be up to four setae per bundle (fig. 1).

Behind the first few segments the ventral setae are not very different from those just described. The length is rather less, 125μ ,

and the number in a bundle does not exceed three; but I could not be certain of any other constant distinction.

The dorsal setae begin in segment vi, and the bundles consist of one hair-seta and one needle. The hairs are equal to the diameter of the body in length, that is about 250μ , and taper finely towards the tip; none are specially lengthened, the one on segment vi being in fact rather shorter than that of vii. The needles are straight or perhaps slightly curved at the tip (this last character was only noted in a potash preparation), which is simple; they taper to a point distally, and in length are from 50 to nearly 60μ .

The bodywall contains pigment grains.

Chloragogen cells begin in segment vi; there was a stomachal dilatation in vii in one specimen, but none in another.

The sensory papillae characteristic of *S. appendiculata* are present. They are flat-topped, of some considerable height, often higher than broad, truncated or cylindrical. They are segmentally arranged, several in each segment rather behind its middle, often about at the level of the setal bundles.

Remarks.—If I could be certain that no specially elongated setae had dropped out from segment vi, this would be an extremely well-defined species (I say 'dropped out' because so far as I could see there were no broken stumps on segment vi). It would, I think, be necessary to enlarge the scope of the genus *Slavina*, defining it by the sensory papillae and covering of foreign particles, without reference to the elongated dorsal setae of vi. The papillae and the foreign particles are such peculiar characters that I cannot doubt the close relationship of this form to *S. appendiculata*; and it would be pedantry to remove it to another genus (e.g. *Nais*) or to form a separate genus for its reception, merely because of the absence of specially long setae in a particular segment.

Whether such setae have fallen out or not, I think these specimens are specifically distinct from *S. appendiculata*. Eyespots, which are absent here, are present in *S. appendiculata*, as a rule, at any rate, though perhaps not constantly ["Augenflecke meist vorhanden" Michaelsen, 13; "meist mit 2 Augen," Michaelsen (1); though Piguet (19) apparently allows no exception]. Is it not possible that where eyespots are not present in *S. appendiculata* it is because the individual—on this supposition the former posterior component of a chain—has separated before complete differentiation of the head region?

The stomachal dilatation, here in vii, is in viii in *S. appendiculata* according to Piguet, and it is in viii also in the specimens which I previously distinguished as *S. punjabensis* (20), but which Michaelsen (15) thinks are to be included under *S. appendiculata*. The point of the dorsal needles is expanded at the tip in *S. appendiculata* (Piguet, 17).

I think Michaelsen's statement (13) that the nodulus is distal in the ventral setae of *S. appendiculata* is probably a slip.

Gen. *Stylaria*.*Stylaria kempi*, sp. nov.

(Plate xxx, fig. 2).

Bhim Tal, 4450 ft., Kumaon, W. Himalayas, 2-10-V-1911 (S. H. Kemp). Two specimens.

Length 2.25-4 mm. No eyes. The prostomium forms a long narrow proboscis, in length equal to three times the diameter of the body. $n=25$.

The anterior ventral setae (fig. 2) (segments ii-v) are 120μ in length; the terminal prongs are very unequal, the distal being large, the proximal very short. The nodulus is markedly proximal, the relation between proximal and distal portions of the shaft being 1 : 2. The distal curve of the seta is slight, the shaft being straight almost to its end; there is a slight bending forwards (in the direction towards which the prongs point) of the shaft at the nodulus. The number in a bundle is six or fewer.

The posterior ventral setae (vi backwards) are $96-100\mu$ in length. The proximal prong is perhaps even more rudimentary than in the more anterior setae. The nodulus is still proximal, but not so markedly, the relation of the two parts of the shaft being 2 : 3. There is a slight 'kinking' of the shaft at the nodulus here also. The number in a bundle is six or seven.

The dorsal setae begin in segment vi. In each bundle there is a long hair $450-600\mu$, i.e. twice, three times, or even more than three times as long as the diameter of the body. In addition to the long hair there are others, shorter, equal in length to the diameter of the body or less, 200μ down to 120μ or less, even 80μ . A third component of the dorsal bundles exists in the form of two or three short, fine, and sharp needles, 40μ in length; these do not appear to differ (except in length) from the shortest of the hairs, and may be merely a younger stage of the latter. It is possible also that the shorter hairs are merely a stage in the growth of the long hair; certainly they are much thinner, but then they naturally would be thinner if they represent only the distal portion of the fully formed long seta. There is apparently however only one long hair per bundle, which seems to mark it out as a special structure.

There are no septal glands. The gut may show either a sudden and considerable widening, or only a slight dilatation, in segments viii and ix, taking up both these segments.

Remarks.—The chief difference between this species and the common *S. lacustris* is the absence of eyes in the present case. This would seem to be an absolute distinction, since Piguet (17) states that he has seen hundreds of specimens of *S. lacustris*, but none without eyes.

Piguet also describes a pigmented band encircling the gut (not always marked) in each segment after the sixth in *S. lacustris*; I did not observe this in the present specimens. Michaelsen (13)

would limit the length of the hair setae of *S. lacustris* to, at most, a little more than the diameter of the body.

The present specimens have no resemblance to *S. lomondi*, Martin (8).

Gen. *Pristina*.

Pristina longiseta, Ehrbg.

Aquarium, Elphinstone College, Bombay, 26-ii-1913 (*S. P. Agharkar*).

A few small specimens, along with some examples of *Aulophorus* (*v. inf.*).

Pristina aquiseta, Bourne.

Allahabad, Jumna River, 10-i-1909 (*A. D. Imms*). A number of specimens.

The specimens correspond with the *Naidium tentaculatum* of Piguet (17). This author has however (18) more lately united the Swiss species with the *Pristina aquiseta* of Bourne (3). This is not accepted as beyond doubt by Michaelsen (13), who denotes Piguet's species as "*P. tentaculata*, Piguet (? < *P. aquiseta*, Bourne)."

Gen. *Aulophorus*.

The collection under review contains specimens of *Aulophorus* from two localities,—a hot spring at Khed, and an aquarium in Elphinstone College, Bombay. Before assigning them to their position in the genus, I wish to make a few remarks on them, and to indicate the conclusions which it is possible to draw.

In the specimens from Khed, besides the palps, there were three pairs of gills, all about the same size, arising from within the margin of the funnel; the dorsal margin of the funnel projected backwards slightly as an indented prominence, which was apparently not gill-like (pl. xxx, fig. 3). In one specimen examined, however, the dorsalmost of the three gills, though of large size, seemed to be continuous with the margin of the funnel,—to be itself the folded margin, in fact. It may be noted also that in the specimen from which the figure is taken the anterior gill on the right side is almost completely continuous with the margin of the funnel.

In the specimens from Bombay, there are three pairs of gills, decreasing in size anteriorly, all separate from and within the margin of the anal funnel. The dorsal margin of the funnel has the form of a straight edge, without projections, and is not gill-like (this was confirmed by sections). In one specimen however the dorsal lip projects slightly,—according to my original notes, not unlike what is described for *A. stephensoni*, Mehlsn., where there is a gill-like projection on each side (*v. inf.*).

Now let us consider the following series of forms:—

- (1) *Aulophorus furcatus*.—Two pairs of gills, with one pair of accessory gills, the latter being the dorso-lateral projecting margin of the funnel; when the funnel is fully

expanded these appear merely as a fold of the margin (cf. Stephenson, 24).

- (2) The single specimen from Khed, referred to above, in which the anterior of the three pairs of gills are continuous with the margin of the funnel.
- (3) The specimen figured (fig. 3), where one of this pair is well within the margin.
- (4) The bulk of the specimens from Khed, with three pairs of true gills (i.e. all separate from and within the margin).
- (5) The Bombay specimens, similar to the last, the dorsal margin of the funnel not gill-like.
- (6) The single specimen from Bombay, with three pairs of gills, and projections of the dorsal margin of the funnel.
- (7) *Aulophorus stephensoni*, described as having four pairs of gills, the anterior being the smallest, and forming only small projections on the margin; using the recognized terms, there are three pairs of true and one pair accessory gills.
- (8) *Aulophorus palustris*, Mehlis. (11, 22) possessing four pairs of gills, all within the margin of the funnels.

The series is not in absolute strictness one of increasing complexity throughout, since the Khed specimens (2, 3 and 4) have a somewhat projecting and indented dorsal margin, while this is quite straight in 5. But it does show in a striking manner the evolution of successive pairs of gills as differentiations of the margin of the anal funnel.

I think it will be admitted that, with the exception of number 8, the difference between the arrangements of the gills in successive terms is nowhere sufficient to allow us to separate the successive terms as different species or even varieties. No. 6 is almost identical with 7; so is 5 with 6, and moreover comes from the same limited batch of material; both 5 and 6 must therefore be united with 7. The same reasoning obliges us to unite 2, 3 and 4 with 1. But 5 is identical with 4, or even slightly less differentiated, since it wants the slight bifid projection of the dorsal margin of the funnel. From a consideration of the characters of the gills, then, we must conclude that *Aulophorus furcatus*, *A. stephensoni*, and all intermediate forms constitute a single species.

I have said "from a consideration of the characters of the gills." The case would be different if we could differentiate the terms of the series by means of other structures, —for example the setae. I do not think we can. There is a considerable amount of variation to be met with amongst these forms. Recent descriptions of *A. furcatus* have been given by Piguet (19) and myself (24); Piguet finds a stomachal dilatation of the gut in segm. viii, which was absent in my specimens, and there are slight differences in the accounts of the setae. I found that in the Bombay specimens the prongs of the posterior ventral setae were as a rule equal in length, and the distal was about two-thirds as thick as the proximal;

but sometimes the distal was shorter than the proximal, and very fine. The position of the nodulus is known to vary in setae of the same bundle in *A. stephensoni* (21), as well as in *A. furcatus* (24).

I have made a careful comparison of the setal and other characters of all the forms tabulated above; and I have come to the conclusion that the differences, such as they are, cannot be used for purposes of discrimination between them. They are of the same order as the differences of which examples have just been given, and therefore fall within the limits of individual variability.

As to the outlying term of the series, *A. palustris*, the setal and other characters here also allow of no distinction. The gap between it and its next neighbour, in regard to the gills, is however fairly well marked, and it may therefore be allowed for the present to retain the distinction of a separate specific name. *A. stephensoni*, however, must disappear, and it is probable that *A. palustris* will eventually have to follow it.

Aulophorus furcatus (Oken).

(Plate xxx, fig. 3).

Aquarium, Elphinstone College, Bombay, 26-ii-1913 (*S. P. Agharkar*). Several specimens.

Hot spring at Khed, Poona Dist., 31-x-1912 (*S. P. Agharkar*). Numerous specimens.

Some of the specimens from Bombay were sexual, though perhaps not quite fully mature (apparent absence of female funnels). However, the individuals which were examined by sections had already copulated (presence of spermatozoa in the spermathecae).

The clitellum extends from the anterior end of segment v back to the middle of vii ($=2\frac{1}{2}$). This region is not thickened, and is not distinguishable except in sections. I would not say that I definitely identified the testes and ovaries in segments v and vi respectively; there may have been some confusion with the ganglion cells of the ventral nerve cord.

Many developing spermatozoa were free in v. The spermsac, as usual a backwardly directed diverticulum of septum 5/6, extends back to the hinder end of vii.

The male funnels are cup-shaped, near the middle line, close together, indeed apparently continuous with each other. They look upwards and backwards, and are placed in the mouth of the spermsac; thus, though morphologically in v, they appear at first sight to be in vi. The vas deferens runs on septum 5/6 downwards for a short distance, and enters the anterior face of the atrium.

The atrium, in segment vi, is small, subspherical, and in the specimens examined contained ripe spermatozoa. Its wall is comparatively thin; its lining epithelium is cubical, and there is no covering of prominent peritoneal cells. The ejaculatory duct is short and somewhat invaginated upwards into the atrium; a thick cluster of cells surrounds it. The aperture is on segment vi.

The ovisac extends backwards into segment ix; as usual it encloses the spermsac. It was mostly occupied, in the specimens examined, by discrete yolk granules; a cluster of young ova was seen in segment viii, neither at the anterior nor the posterior end of the sac. The female funnel, oviduct, and aperture were not identified.

The spermathecae are ovoid sacs, confined to segment v; their long axis is mainly longitudinal, but directed somewhat downwards as well as backwards; they take up nearly the whole length of the segment in a longitudinal direction. They are thin-walled and, in the examples investigated, contained spermatozoa and granular matter. There is no prominent peritoneal investment. The duct leaves the ventral surface of the ampulla; it is narrow, straight, and as long as the ampulla is high. Its lining epithelium is cubical. The aperture is near the anterior border of segment v.

Fam. TUBIFICIDAE.

Gen. *Limnodrilus*.

Limnodrilus sp.

Sona Sar Lake, Kashmir, 12500 ft., no date (*H. S. Bion*). A number of specimens.

The worms showed the first stages in the development of the genital organs. Testes and ovaries were present, but the male ducts and spermathecae were very incomplete. The diagnosis of the genus is suggested by the fact that the dorsal setae are of the same type as the ventral.

Fam. MONILIGASTRIDAE.

Gen. *Drawida*.

Drawida jalpaigurensis, sp. nov.

(Plate xxx, figs. 4, 5).

Mud at edge of R. Tista, Jalpaiguri, base of E. Himalayas, 3-vi-1911 (*N. Annandale* and *S. W. Kemp*). A single specimen, in a poor state of preservation.

External Characters.—Length about 23 mm. (the specimen was much curled up); diameter 2 mm. Colour dark grey, blotchy (? due to state of preservation), the same on both surfaces; the anterior end much lighter, almost white. Segments 106.

Prostomium? prolobous, relatively large; first segment very short.

Dorsal pores absent.

Setae small very closely paired; $aa < bc$, $dd = \frac{1}{2}$ circumference

Clitellum not certainly distinguishable, perhaps x-xiv = 5.

The male apertures are on prominent oval papillae, with their long axis transversely disposed in furrow 10/11. The papillae obliterate the furrow where they lie, and extend in a transverse direction inwards to the line of setae *b*, outwards not much more than halfway from *b* to *c*; in a longitudinal direction they take up half the length of segment xi, and nearly half of x. The apertures themselves lie between the lines *b* and *c*, but nearer to *b*.

The female apertures were not seen.

The spermathecal apertures are in furrow 7/8, between *b* and *c*, but nearer to *c*.

There is a pair of genital papillae anteriorly on segment vii. These are flat-topped and circular, with their anterior margin touching furrow 6/7, they are rather internal to the spermathecal apertures, and therefore their centres are about midway between *b* and *c*.

Internal Anatomy.—Septa 5/6, 6/7, 7/8, 8/9 are all considerably thickened, 9/10 is very thin, and so are the rest. Septa 10/11 and 11/12, in fact, seemed to be defective; no ovarian chamber had been formed and these septa were not recognizable at all dorsal to the gut. But they seem to be present in the ventral part of their segments, and a fringe on one of them perhaps represents the ovary.

The gizzards are four in number, in segments xii-xv, that in xii being smaller than the rest. These gizzards are bands of muscular gut which are separated from each other by thinner and quite soft bands of gut-wall; the bands of one kind are about equal in breadth (antero-posteriorly) to those of the other kind.

The last heart is in segment ix.

The testis-sacs are large, subovoid in shape, attached to septum 9/10, but wholly dependent into segment x, being attached indeed only by a slender neck. The sac of the right side was much posterior to that of the left, being displaced backwards by a bulging of the alimentary tube on that side. The vas deferens runs from the lower and anterior end of the testis-sac downwards, and joins the anterior end of the prostate a little to the inner side of its longitudinal axis; its course is relatively short, since though wavy it is otherwise straight.

The prostate of the right side, in the single specimen which came under examination, was vertically flattened, with a generally circular outline and small marginal lobulation. On the left side it was much more elongated, and bent on itself with the convexity looking outwards; the ental (remote from external aperture) end was posterior, thicker than the ectal portion, and markedly lobulated,—more so than the ectal part of the gland; the vas deferens here passes from the anterior end along the outer border to end at the middle of the outer surface (fig. 4).

All that can be said of the ovaries and ovarian chamber has been noted when describing the septa.

The spermathecae, in segment vii, are large ovoid sacs full of white flocculent matter, which touch each other in the middle line.

The duct passes downwards behind septum 7/8, and in its course presents a number of coils; it then pierces the septum close to the bodywall, and immediately joins the posterior face of the atrium. The atrium here appears as a simple projection, sessile on the bodywall; but from it, rather towards its inner side, there arises a stalked sac, in shape a much elongated ovoid, which rises vertically upwards. The stalk of the sac is about half as thick and half to a third as long as the sac proper. Both atrial swelling and stalked sac are completely contained within segment vii (fig. 5).

Remarks.—In the presence of the free sac just described the present species resembles *D. travancorensis*, Mehlsn. (14); from which however it is distinguished by the setal relations, the characters of the male apertures, the situation of the spermathecal apertures, and the relation of the testis-sac to the septum.

Drawida robusta (Bourne) f. *typica*.

Jungle, Coonoor 6000 ft., Nilgiris, June, 1912 (Capt. Seymour Sewell, I.M.S.). A single specimen.

External Characters.—Length 136 mm.; diameter 6 mm. Colour a blotchy brownish grey, lighter at both ends. Body dorso-ventrally depressed behind the anterior region; there are indications of the demarcation of dorsal, ventral, and lateral areas, as in a number of other Moniligastrids (e.g. *Drawida ghatensis*, *Moniligastraster deshayesi* var. *gravelyi*, cf. 25). Segments 176.

Prostomium prolobous; segments i and ii very narrow.

Dorsal pores absent.

On segments iii-xviii there are a number of minute white papillae arranged in a ring round the segment, and looking like the papillae on which setae are implanted in Perichaetine forms, though they are not quite as regular as these. They are situated in line with the setae in each segment; they may be met with also behind segment xviii. Similar papillae occur in other Moniligastrids also (cf. description of the two species just mentioned), and it would be worth while investigating them histologically in a well preserved specimen; they are not improbably sensory in nature.

The setae are very minute, and very closely paired; $aa > bc$; dd is distinctly more than half the circumference. No ventral setae are distinguishable in segment ii; lateral setae in this segment could be seen only on the right side.

Nephridiopores are in the line cd ; there is no alternation in position.

No clitellum was distinguishable.

The male apertures are conspicuous slits with tumid lips in furrow 10/11; the middle point of each aperture is between the lines of the ventral and lateral setae, slightly nearer the latter.

The female apertures were doubtfully identified as a slight whitening of furrow 11/12, in the lines of the ventral setae.

The spermathecal apertures appear on separating the lips of furrow 7/8 as slits a little below the level of setae *e*.

Internal Anatomy.—Septum 5/6 (the first) is slightly, 6/7 moderately, 7/8 and 8/9 considerably thickened.

There are four gizzards, in segments xii-xv.

The last heart is in segment ix.

The meganephridia are of the usual type in the family.

The testis-sacs are large, subovoid, asymmetrical. The left projected into both ix and x, but more forwards into ix, where in this specimen it reached septum 8/9; it is not constricted by the septum 9/10 on which it is suspended. The right projected backwards only, reaching and bulging back septum 10/11.

The vas deferens forms a closely packed coil in front of 9/10; if unravelled it would form a tube of considerable length. Its first portion is very fine.

On opening the testis-sac and shelling out the contents the thin transparent sac-wall shows a slight but well-defined circular opacity around the commencement of the vas deferens; this thickening represents the funnel. The testis is a small round mass attached to the wall of the sac just in front of the funnel. Both funnel and testis were anterior in position to the septum on the left side (this sac being the one opened).

The prostate, in x, is a white ovoid mass attached to the parietes by a narrower base. The junction of the vas deferens was not seen distinctly; but the vas seems to go under the peritoneum and some muscular strands in the last part of its course, and to join the base of the prostate at the outer and anterior side of the gland. Exceptionally numerous and definite muscular bands radiate outwards and backwards from the base of the prostate to the bodywall.

The ovarian chamber, limited as usual by septa 10/11 and 11/12, remains unopened in the dissection for opening and displaying the worm, *i.e.* these septa meet and fuse some distance beneath their combined attachment to the dorsal parietes. The chamber contains the nephridia, ovaries and oviducal funnels. The ovaries, not fully developed in the present specimen, appear each as a fringe on the anterior wall of the chamber, and arch upwards on each side towards the middle dorsal line. No egg-sacs were developed in the present specimen.

The spermathecae present a pear-shaped ampulla, which narrows at its outer and lower end to form the duct. This latter forms a long coiled tube in segment viii, which passes downwards behind 7/8 to the junction of the septum with the parietes. Here it joins the atrium, which is partly buried in the bodywall, but when freed forms a finger-like, somewhat curved projecting lobe on each side of the septum.

Remarks.—The original account of this species is by Bourne (2,4). The above description is fairly complete, and adds a considerable number of details.

Fam. MEGASCOLECIDAE.

Gen: *Pontodrilus*.*Pontodrilus bermudensis*, Bedd. f. *ephippiger* (Rosa).

From a rotten palm tree lying in the water, Pamban, Raminad Dist.,
21-ii-1903 (S. W. Kemp). Several specimens.

Gen. *Megascolides*.*Megascolides tenmalai*, Mehlsn. var. *karakulamensis*, var. nov.

(Plate xxx, figs. 6, 7).

Karakulam. 17-x-1911. Two specimens, both incomplete posteriorly.

External Characters.—Length 70 mm. +; breadth 1-1½ mm. Colour a nondescript medium grey, clitellum brownish yellow. Segments 93 +.

Prostomium absent (or invisible).

Dorsal pores small, the first in groove 4/5 (?).

Setae in front of clitellum have the following relations:—taking the interval *ab* as the standard, *aa* = 2*ab* (= 2½*ab* near anterior end), *bc* = 2*ab*, *cd* = 1½*ab*. Behind the clitellum *aa* = 2-2½*ab*, *bc* = 2*ab*, *cd* = 1½*ab* or less. The seta *d* is above the lateral line of the body, *dd* being about ½ of the circumference.

The clitellum extends ventrally from xiv-½xvii = 3½, dorsally xiv-xvi = 3. A faint annulation is visible; ventral setae are not discoverable on these segments.

The male pores, on segment xviii, are associated with a pair of irregularly ovoid elevations, longitudinally placed with the anterior ends slightly converging. The posterior ends of these elevations are narrower than the anterior; the male apertures are possibly on the inner margin of the elevation, in a slight indentation where the narrower passes into the broader part; if so, they would be in line with seta *a*. The anterior slightly converging ends of the elevations are thus within *a*; in length the elevations take up about the length of the segment, but slightly transgress groove 17/18 in front and fall short of 18/19 behind (fig. 6).

The female pore or pores are contained within a circular whitish patch on xiv, just behind the groove 13/14. The extent of the patch is less than the interval *aa*.

The spermathecal apertures, small, in 7/8 and 8/9, are in line with *b*.

Internal Anatomy.—Septum 4/5 is very thin, 5/6 thin, 6/7 somewhat thickened, 7/8-10/11 moderately thickened, 11/12 onwards somewhat thickened even as far as 18/19.

The gizzard is in segment v, of moderate size, and rather soft. There are no calcareous glands. The intestine begins in xvii.

The last heart is in xiii.

Beginning from the hinder end of the pharynx, the micro-nephridia form large tufts in each segment, but there are none on

the bodywall in front of the clitellum,—none visible, at any rate. Behind the clitellum the disposition is quite different; the micro-nephridia, few and relatively large, are attached to the bodywall; towards the posterior end of the (incomplete) specimen there were about half a dozen nephridia of moderate size on each side in each segment, but no meganephridium.

Testes and funnels are free, in segments x and xi. The vesiculæ seminales are two pairs, in xi and xii, on the anterior wall of each segment. Those in xi are very small, those in xii of moderate size.

The prostates are one pair, long, flat and strap-like, with slightly lobed margins, and extending backwards to segment xxi; they look at first sight like small flattened masses of coagulum on the bodywall. The portions of the gland in successive segments are connected only by narrow necks; but each of the quadrangular expansions which occupy the individual segments appeared to be lobular in constitution, and the margins are slightly indented. One gland was sectioned; not more than one duct was visible, which was seen to give off, in one section, a small side branch; but even the single central duct becomes difficult or impossible of distinction some distance down the series.

The prostatic duct begins near the anterior inner angle of the gland, and forms an oval loop, passing first inwards and backwards, then curving round outwards and forwards; it is of equal diameter throughout and is confined to segment xviii. No penial setae were discovered.

Ovaries were present in xiii; funnels were not identified. A couple of small structures in xiv may perhaps represent ovisacs; but the specimen was too small to allow a definite determination of their nature.

The spermathecae (fig. 7) are pyriform sacs, narrowing to form a duct which is not marked off in any way from the lower part of the ampulla. A single diverticulum arises from the middle of the length of the duct; it is narrow and club-shaped, with a simple cavity, and in length is about two-fifths as long as duct and ampulla together. No spermatophores were seen; and there were no glandular appendages round the duct.

Remarks.—The differences of the above specimens from the typical form (Michaelsen, 14) entitle it to rank as a variety. The distinguishing marks are the prostomium, the setal intervals, the smaller extent of the clitellum, the position of the gizzard (here in v), and the absence of glands round the spermatheca. I think the nephridia are also likely to form a distinction; Michaelsen could not see any; they must therefore be very small in the typical form, or else Michaelsen's specimens must have been in a very bad state of preservation,—which however is not stated to have been the case. Even in a badly preserved specimen I think nephridia of the size of those I found would probably have been visible. Michaelsen puts the male pores on the swellings in xviii; they seemed to

me to be probably at the inner margin, but I will not say that they might not be at the outer margin with almost equal probability.

Megascolides oneilli, Stephenson var. **monorchis**, var. nov.

Darjiling to Soom 7000-5000 ft., E. Himalayas, 14-vi-1914 (*F. H. Gravely*). A single specimen.

External Characters.—Length 115 mm., maximum breadth 5 mm. Colour pale buff, somewhat mottled on dorsal surface and towards posterior end. Segments 188; segments iv, v biannular, the rest triannular as far as some distance behind the male pores.

Prostomium prololobous.

Dorsal pores very obvious, from groove 9/10 onwards.

Setae very small paired. Behind the clitellum the relations, expressed in terms of the distance ab , are:— $aa = 3-4ab$, bc is rather less than aa and $= 3ab$, $cd = 2ab$ or rather less further back. In front of the clitellum aa is rather less, $>$ or $= 2ab$, $bc =$ or $< 3ab$, cd as before $= 2ab$. The interval $dd = \frac{2}{3}$ circumference, or nearly.

The clitellum was indistinguishable.

The male pores are on segment xvii. Ventrally this segment presents a somewhat thickened pad, extending laterally rather beyond c , and taking up the whole length of the segment in an antero posterior direction. The apertures are minute, between the lines of setae a and b . Secondary furrows are present in front of and behind the apertures, somewhat as in the typical form. Setae cd of xvii are present, but ab are absent. The anterior two-thirds of the ventral surface of xviii is also thickened, and the ventral setae are absent.

The female apertures are not visible.

The spermathecal apertures are in line with a , in grooves 6/7 and 7/8.

Internal Anatomy.—Septum 5/6 is thin, 6/7-9/10 are much strengthened, 10/11 and 11/12 somewhat strengthened, and the next few decreasingly thinner.

The gizzard is large and barrel-shaped, in segment vi, and is preceded by a soft dilated crop-like portion of the oesophagus. Well-marked calcareous glands are present in segments viii-xii; each is kidney-shaped, well set off from the gut, and contained within the curve of the corresponding heart. The intestine begins in xiv; there is a conspicuous typhlosole of a curious appearance, characterized by possessing numerous closely set transverse folds along each side.

The last heart is in xii.

There are large tufts of micronephridia by the side of the crop, but in general the nephridia in the anterior part of the body are minute and scattered. At the posterior end of the body the arrangement is different; meganephridia are present in addition to micronephridia, as very slender and much elongated loops. The meganephridia are not seen in any number on the bodywall on pinning out the animal, since for the most part they remain

attached to the intestine. They have an attachment dorsally to the dorsal vessel, by a connective tissue strand, at about the middle of each segment, and extend downwards nearly as far as the level of seta *b*.

Testes and funnels are free in segment ix, and in this segment only. Vesiculae seminales are present in segments x, xi and xii, on the anterior wall of each segment; those of x were of moderate size, those of xi and xii were small and obviously not fully developed,—indeed the one on the left side of xii was wanting.

The prostate, in the single specimen, was small, tongue-like, and contained mostly in segment xix; passing forwards it becomes the considerably coiled duct, which remains soft and non-muscular, and, keeping the same diameter all the way, ends in segment xvii. The vas deferens joins the gland at its base, where it passes into the duct. From the number of strands which radiate from the neighbourhood of the male aperture to the bodywall this region appears to be very retractile.

Small ovaries were present on both sides.

The spermathecae were small and not fully developed. They were situated in segments vii and viii, opening in 6/7 and 7/8, near the middle line, and appeared as small ovoid sacs, narrowing to a duct, which is scarcely separately distinguishable; there is a single diverticulum which arises from the base of the ampulla, is cylindrical in shape, and about half to two-thirds as long as the ampulla.

No penial setae were discoverable.

Remarks.—The remarkable shifting forwards of the organs in the anterior part of the body occurs here as in the type form (23). The chief differences which mark the present example as distinct are the extra pair of calcareous glands in segment viii, and of seminal vesicles in xii, and especially the presence of only a single pair of testes and funnels. Less important are the differences in the setal arrangement, and in the extent of the dorsal pores.

Through the kindness of Dr. Annandale I was able to re-examine the type form of the species, in order to compare the condition of the nephridia in the hinder part of the body. Here also I found meganephridia of considerable size, which lie, in the dissection, not on the bodywall but on the intestine; the nephridia are attached to the intestine in the immediate neighbourhood of the dorsal vessel; each consists of a series of loops, of which the dorsal are the largest; and thus each nephridium as a whole is stouter dorsally and thins towards its ventral end.

I also took the opportunity of re-examining the type form as regards the prostates. I found that they were much lobulated, indeed cut up to an extreme degree, and nothing could be further from the tubular type. The condition is illustrated in pl. xxx, fig. 8. The difference between the variety and the type form is probably due to the earlier stage of development of the latter.

Gen. *Lampito*.*Lampito mauritii*, Kinb.

Trivandrum : numerous specimens taken on a number of occasions.

Cape Comorin, 7-xi-1911. Several specimens.

Under stones by tank, Museum compound, Calcutta, 9 and 11-iv-1910 (F. H. Gravely).

In mud in flower-pots, Ross I., Andamans, 26-iii-1911 (C. Paiva). A single specimen.

Siliguri, base of E. Himalayas, 3-4-vi-1911 (N. Annandale and S. W. Kemp). Three specimens.

Lampito dubius, sp. nov.

(Plate xxxi, fig. 9).

Kurseong, E. Himalayas, 4700 ft., 14-17-iv-1911 (N. Annandale). A single specimen.

External Characters.—Length 106 mm., but originally more, as the hinder end was regenerated. Breadth 6 mm. Colour slate blue, slightly lighter on the ventral surface. Segments 94 plus 40 regenerated, and in addition a small undifferentiated zone.

Prostomium epilobous $\frac{1}{2}$; the sides of the tongue, wide apart anteriorly, almost meet behind at an obtuse angle.

Dorsal pores from 6/7.

The setae are disposed in rings, the dorsal break being small, about equal to $2\frac{1}{2}$, irregular, or sometimes absent. There is no ventral break, and the ventral setae are smaller and closer together than the dorsal. The numbers counted were as follows:—91/v, 88/ix, 69/xii, ca. 81/xix, 82/xxvi.

No clitellum was visible.

The male pores are on segment xviii. The midventral portion of the segment is pale in colour and presents a short transverse groove just behind the line of the setae, the setae being on the sloping anterior wall of the groove. In the groove are two small slits, the male pores, close to the midventral line. A few setae in the neighbourhood of the slits appeared to be lost, but none seemed to be transformed.

The female aperture is represented by a slight transverse depression midventrally on xiv, a little in front of the line of the setae, but no opening was distinctly visible.

The spermathecal apertures were indistinct, close together, but slightly wider apart than the male pores, in 7/8 and 8/9. They seemed not to have pierced through to the exterior.

Internal Anatomy.—Septum 4/5 is present, but thin; 5/6, 6/7 and 7/8 are slightly strengthened, 8/9 is moderately thickened, and all succeeding septa down to 15/16 are considerably strengthened. After this the thickness gradually diminishes, but some strengthening is visible as far as 28/29.

The gizzard is large and firm, and takes up two segments, v and vi. There are firm lateral swellings of the oesophagus in segments x to xiii, which when opened present on their inner walls

very numerous and closely set villous processes; the swelling and the processes are both less marked in xiv, but there seems to be no definite posterior limit to this portion of the canal. The intestine begins in xix; the typhlosole in the middle of the body is low, and presents a number of parallel transverse folds.

The last heart is in xiii.

The condition of the nephridia is interesting. On the body-wall, in each of the most anterior segments, are a number of tufts, one on each side, each component of a tuft being a fairly stout coiled micronephridial tube; there are about half a dozen such tubes in each tuft, and all these loops or coils converge and are united at the base of the tuft into what may be compared to the main trunk of a bush. In segment vi, on the right side, the tuft is large, and two loops are considerably longer than the others; in vii the five loops or coils are of various sizes, from long to short; in viii and ix two are much longer than the rest; but this is not so noticeable in the immediately succeeding segments. In xii, of three coils, two are long and one short; in xiii there is a diminishing series of four. After this there is constantly one long loop stretching outwards on the bodywall. In addition, there are a large number of very minute micronephridia scattered further out on the bodywall; but not in the most anterior segments,—that is not in front of about segment x.

In the middle region of the body there is a large meganephridium and a number of small micronephridia on each side in each segment. The latter form a transverse line about the middle of each segment. Each meganephridium (fig. 9) begins as a cluster of funnels, about half a dozen in number, underneath the intestine; they are situated just in front of the posterior septum of the segment. The tubes leading from the funnels pierce the septum in a bunch, and become continuous with the main portion of the nephridium, which is situated as usual in the segment behind the funnels. This portion presents, besides a mass of coiled tubes, the course of which I did not minutely investigate, two considerable loops, which stretch outwards on the bodywall; one stout and conspicuous, and another, which at first escaped my observation, inconspicuous and very thin, but very long; the parallel limbs of which this longer loop is constituted extend very far out on the bodywall, almost to the mid-dorsal line.

The funnels, examined microscopically, show a deeply indented lip on one side of the margin; cilia were seen in various parts of the tube, but I could not distinguish any on the funnel; a mass of disintegrating cells was seen to surround the apertures of the funnels.

Testes and funnels are free in segments x and xi.

Vesiculæ seminales are present in segments xi and xii. In xi there is a single sac, attached to the anterior septum of the segment, large, flocculent looking and not lobed, extending quite undivided across the middle line. In xii the sac is small, similar in position, and also continuous across the middle line.

The prostate, situated posterior to the nephridium in xviii, is extraordinarily small. It appears as a small white mass frayed out into a number of finger-like processes laterally; it is almost sessile on the bodywall, and no separate duct is visible.

Ovaries and funnels are present in the usual situation. A curved ridge on each side on the posterior face of 13/14, embracing with its fellow the alimentary tube, may possibly represent an ovisac.

No trace of spermathecae was visible internally.

Remarks.—There is a possibility that the specimen is immature. The absence of spermathecae (though there is an indication of their apertures), small size of prostate, and absence of clitellum seem to point to this; the rest of the sexual apparatus however is well developed, and small size or absence of prostate is not very infrequent (e.g. the common *Pheretima heterochaeta*, Michlsn.). The condition of the nephridia however decided me to describe the specimen; one might say that the meganephridia are here caught in the act of dividing up. The mixed mega- and micronephridial condition which results is certainly not that of the known species of *Lampito* however, and the systematic position of the specimen is a little puzzling.

Gen. *Perionyx*.

Perionyx excavatus, E. Perrier.

Almora, 5500 ft., Kumaon, 16-ix-1911 (*C. Paiva*). Several specimens. Under stones or mud by tank, Museum compound, Calcutta, 8-iv-1910 (*F. H. Gravely*). Three specimens. In leaves of water plants, Sahasr Dhara, near Dehra Dun, 6-iv-1914 (*Prof. S. R. Kashyap*). A single specimen. Painsur, above Lohba, 8000 ft., 23-iv-1914 (*Col. Tytler*). Several specimens. (Doubtful, immature).

Perionyx pulvinatus, sp. nov.

(Plate xxxi, figs. 10, 11).

Near Ghoom, 7000 ft., E. Himalayas, 16-iv-1911 (*N. Annandale*). Six specimens.

External Characters.—Length 57 mm., maximum breadth 3.5 mm. Dorsally the colour is in general a deep brown with darker median stripe, but is lighter over and in front of the genital region; ventral surface pale. Body dorso-ventrally compressed, except the most anterior segments; ventral surface flat, indeed rather concave; posterior end tapering. Segments 126.

Prostomium well-marked, epilobous $\frac{1}{2}$, tongue delimited by a groove behind; prostomium and first two segments marked by a median dorsal groove.

Dorsal pores exist from furrow 5/6.

The setal ring shows a small and irregular dorsal break; $22 = 2-3yz$. The neighbouring intersetal distances are also irregular. The ring is unbroken ventrally; and the setae are much closer ventrally than dorsally. All the setae are small and difficult to count. The following numbers were met with: 56/vi, 54/ix, 50/xii,

48/xix; but these figures must not be considered as anything more than approximate.

The clitellum covers xiii— $\frac{1}{2}$ xix = 6 $\frac{1}{2}$. It is rather indefinite, and setae and dorsal pores are present.

A conspicuous depression on the ventral surface, rectangular with rounded corners, takes up the whole length of segment xviii and neighbouring parts of xvii and xix; the breadth of the depression is slightly greater than its length. Within this depression are two large oval cushions, touching each other in the middle line, and taking up nearly the whole of the depression,—but in such a way as to leave deep transverse hollows in front and behind, while laterally their margins merge into the margin of the general depression. The apertures are anterior and internal to the middle point of each cushion, and hence are in front of the line of setae of the segment (fig. 10). In one specimen the cushions were not situated in a depression; in another the cushions were fused with each other in the middle line, and there was considerable tumidity around the apertures.

The female aperture is single, and is situated on segment xiv between the line of the setae and the anterior limiting furrow.

The spermathecal apertures are large, in 7/8 and 8/9, about one-half of the circumference apart, and opposite the tenth seta on each side.

Internal Anatomy.—No septa are notably thickened; 7/8 is perhaps slightly so.

There is a very rudimentary gizzard in segment vi; its walls are soft and not much thickened. The oesophagus is rather bulged, and its walls have apparently a lamellate structure, in segments ix and x. The intestine begins in xv.

The last heart is in xii.

The excretory system is meganephric.

Testes and funnels are free in segments x and xi.

The seminal vesicle in segment xi is a single large lobed mass in the middle line. The second vesicle is double in segment xii, but the pair of which it is composed fuse together incompletely in xiii, and completely in xiv and xv, so that in these segments there is a single median vesicle only.

The prostates are of moderate size, lobed, of the *Pheretima* type, and occupying on each side segments xviii and xix. The duct is stout, and beginning at the middle of the gland forms a loop with its convexity forwards. The duct is bound down to the bodywall by a number of muscular bands; its first part is the broadest.

The ovaries and funnels have the usual situation.

The spermathecae (fig. 11) present an irregularly shaped ampulla with a nodular surface; its form might very roughly be called pyramidal. The duct is extraordinarily wide,—almost as wide as the ampulla; in length it is also equal to the ampulla. There is no diverticulum.

There are no penial setae.

***Perionyx pincerna*, sp. nov.**

(Plate xxxi, figs. 12, 13).

Near Ghoom, 7000 ft., E. Himalayas, 16-iv-1911 (*N. Annandale*). A single specimen.

External Characters.—Length 45 mm.; breadth 3 mm. Colour a light brownish grey. Body cylindrical, not flattened; posterior end blunt and squarish, so much so as to give the idea of mutilation without time for subsequent repair. Segments 88.

The prostomium is epilobous $\frac{1}{2}$, the short tongue being broad and delimited by a groove behind.

The first dorsal pore is in furrow 4/5.

The setae are in rings; the dorsal break is small and irregular,—on the average less than 25%. In front of the clitellum the ventral break is absent, or small and irregular; behind the clitellum it is small and variable. The setae are set closer together ventrally than dorsally, but there is no apparent difference in the size of the ventral and dorsal setae, nor any marked difference in different parts of the body. The numbers counted were: 47/v, 57/ix, 60/xii, 50/xx.

No clitellum was distinguishable.

On segment xviii is a transversely elongated oval ventral depression, the margin of which being more sunk than the centre constitutes a moat around the central area; surrounding the whole is a very thick whitish lip, which, though not much raised above the general surface, extends as far as to embrace the posterior half of xvii and the anterior half of xix. The actual apertures are scarcely visible, but may be in line with setae *c* or *d*. A few penial setae are visible as blackened points in the neighbourhood of the male pores (fig. 12).

The female aperture is not visible.

The spermathecal apertures are small slits near the middle line, about one-tenth of the circumference apart, in furrows 6/7 and 7/8.

Internal Anatomy.—Septa 5/6 to 9/10 are slightly thickened.

The gizzard, in segment v, is in some degree rudimentary; it is of moderate size, but its walls are quite soft and thin. The intestine begins in xviii.

The last heart is in segment xii.

The meganephridia show no alternation in the position of their pores.

Testes and funnels are free in segments x and xi.

The vesiculae seminales, in xi and xii, are single in each segment, situated in the middle line, semicircular in shape, and arching over the dorsal vessel and intestine. They are attached to the anterior septum of the respective segments.

The prostates are small lobed masses confined to segment xviii. The duct is narrow, of the same diameter throughout, not shining nor resistant, and passes, with a slight wavy course, almost directly inwards.

The ovaries and their funnels have the usual position.

The spermathecae, in vii and viii, are simple oval sacs sessile by one of their extremities on the bodywall, and without distinguishable duct.

The penial setae (fig. 13) are of very simple form. The tip is blunt and very slightly curved, and the proximal end of the shaft is bent at an obtuse angle; otherwise the shaft is straight. There are faint sculpturings near the tip,—fine points, forming irregular and much broken circles round the terminal portion of the shaft; there are about a dozen such circles in all. In length the setae are 63 mm., and in diameter at the middle of the shaft 24 μ .

Remarks.—The species which the present form most resembles is *Perionyx aborensis*, Stephenson (23). Besides minor differences, the fusion of the vesiculae seminales, and the presence of penial setae in the present specimen, suffice to distinguish the two.

Perionyx inornatus, sp. nov.

(Plate xxxi, fig. 14).

Sandakphu, Darjiling district, 12000 ft., E. Himalayas, 14-iv-1910 (C. W. Beebe). A single specimen.

External Characters.—Length 96 mm.; breadth 5 mm. Colour yellowish brown. Segments 124. The specimen was not easy to examine, owing perhaps to the method of preservation, which besides contracting it had rendered it hard and brittle.

Prostomium apparently proepilobous.

Dorsal pores from furrow 6/7.

The setal rings show no ventral break, nor any dorsal break in front of the genital region; behind this, however, there is a small and irregular dorsal break. The setae are set closer together ventrally than dorsally. The following numbers were counted:—56/v, 70/ix, 75/xii, 83/xix.

No clitellum was distinguishable.

There is no apparent modification of the skin over the region of the male apertures. On segment xviii there is present a median shallow depression, with shelving sides, oval in shape with its long axis transverse. The whole extent of the depression is about one-ninth of the circumference, and the small male apertures are on its sides, about in line with the setal interval *de*.

The female apertures were not seen.

The spermathecal pores are near the middle line in furrows 6/7 and 7/8; the distance between them is about equal to that between the male pores.

Internal Anatomy.—Septum 5/6 is thin, 6/7 and 7/8 slightly, 8/9 and 9/10 moderately thickened, 10/11, 11/12, and 12/13 again slightly thickened.

The gizzard is, in segment v, of squarish outline and considerable size, but soft and with comparatively thin walls, *i.e.* in some degree rudimentary. The intestine begins in xiv.

The last hearts are in xii.

The excretory system is meganephric.

Testes and funnels are free in segments x and xi.

The vesiculae seminales, in xi and xii, are single in each segment, large and conspicuous, placed dorsally over the alimentary tube and dorsal vessel.

The prostate, small and confined to segment xviii, is of the *Pheretima* type. The duct is soft, white, comparatively narrow and of the same diameter throughout; it has a straight course, passing transversely inwards.

Ovaries and funnels have the usual situation.

The spermathecae, in segments vii and viii, are simple small sacs of ovoid form. The duct is short and stout and not marked off from the ampulla. There is no diverticulum.

The penial setae (fig. 14) are in length 92 μ m., in thickness at the middle of the shaft 30 μ . The point is blunt, the shaft is straight and without any proximal bend; the tip is ornamented with about fourteen rows of very minute sculpturings.

Remarks.—The present species shows a certain amount of similarity to the last, from which however it is distinguished by its greater size, more numerous setae, and the characters of the male genital area. The paucity of external markings is remarkable.

Perionyx parvulus, sp. nov.

(Plate xxxi, fig. 15).

Near Ghoom, E. Himalayas, ca. 7000 ft., 10-IV-1911 (N. Annandale).

A single specimen.

External Characters.—Length 23 mm., maximum breadth 2 mm. Colour dorsally a light brown with slight purplish tinge, clitellum rather paler; ventrally a pale grey. Segments 75.

Prostomium relatively large and prominent, epilobous $\frac{2}{3}$.

Dorsal pores from furrow 4/5.

The setal rings show a small dorsal break, equal to or less than 2v2. The ventral break is very small,—little more than the ordinary distance between two setae. No setae are specially enlarged, and there are no considerable differences among the intersetal intervals. Near the middle of the body the number is about 40 per segment.

The clitellum, distinguishable only by its colour and only on the dorsal surface, extends over xiv—xvii. There is some modification of segment xiii also.

The male apertures, transverse and slit-like, are on segment xviii, with their centres opposite the interval *cd*. The lips of the apertures have a slightly whiter appearance. The interval between the slits is rather greater than the length of each slit. The setae of xviii begin with *f* or *g* outside the region of the slits.

The female aperture is single, between the setal row and the anterior margin of segment xiv.

The spermathecal apertures are small, in 7/8 and 8/9; six setae intervene, so that the distance between them is about equal to that between the male pores.

Internal Anatomy.—No septa are notably thickened.

A soft, small and very rudimentary gizzard is present in segment vi. The sides of the oesophagus are much swollen out in xiii, and to a less degree in xii; the swellings are not set off from the alimentary tube, and their cavity is in free communication with the lumen. The intestine begins in xv.

The last heart is in segment xii.

The excretory system is meganephric.

The male funnels are present in segments x and xi; testes, present in xi, were not certainly identified in x. The vesiculæ seminales depend from the anterior wall of their segments into xi and xii. They are large flocculent-looking masses, squarish and not lobed, each meeting its fellow dorsally in the middle line, but not fusing there.

The prostate is a compact-looking mass, confined to segment xviii and causing septum 17/18 to bulge forwards. Its inner face can be separated into lobes. The duct arises in a hilus, forms a small loop with its convexity upwards (in the position of the dissection), and then passes inwards to its aperture; it is of the same diameter throughout and rather soft.

The ovaries and their funnels have the usual situation.

The spermathecae, lying in segments viii and ix, are small and extremely simple in form; they are cylindrical with a rounded internal end, without any distinct duct, and without diverticulum.

The penial setae (fig. 15) are small, in length .525 mm., and in breadth at the middle of the shaft .14 μ . The shaft is straight and tapers towards the tip; the tip itself however is blunt and squarish. Near the tip are a number of relatively stout short spines, arranged in rings, of which there are about five.

Perionyx fulvus, sp. nov.

(Plate xxxi, fig. 16).

Calcutta, 3-viii-1910 (*R. D. Banerjee*). A single specimen, incomplete posteriorly.

External Characters.—Length 106 mm. (+), diameter 3.75 mm. Colour yellowish brown, almost unpigmented, anterior segments with a darker, slightly bluish tinge dorsally; a median dark dorsal stripe along whole length. Segments 139 (+).

Prostomium epilobous $\frac{1}{2}$, tongue partly cut off behind by an inturning of the sides.

Dorsal pores from groove 4/5; an indication of a rudimentary pore in 3/4.

The setal ring presents a small and rather irregular dorsal break, on an average less than 2yz. There is an irregular small ventral break in the anterior part of the body (less than 2ab), but none at all posteriorly. The setae are closer together ventrally than dorsally. The following numbers were counted:—48/v, 55/ix, 52/xii, 53/xix, 55/xxv.

The clitellum, not very distinct, extends over xiii-xvii = 5; the body is rather narrower here.

The male apertures, not very close together on segment xviii, are situated on small porophores which are slightly depressed and turned inwards towards each other, so that the apertures point (in the normal position) inwards as well as downwards. The papillae are separated from each other by a small median groove, and are bounded in front and behind by transverse grooves, but are not delimited from the general surface at their outer border.

The female pore is a conspicuous round aperture on segment xiv, midway between the row of setae and the anterior border of the segment.

The spermathecal apertures, in furrows 7/8 and 8/9, are close together near the middle line. The grooves are obliterated at the situation of the pores, which are level with the general surface.

Internal Anatomy.—Septum 4/5 is extremely thin, 5/6 and 6/7 are thin, 7/8 and 8/9 slightly thickened, and the rest thin.

The gizzard, in segment vi, is small, rather square in shape, soft, and rudimentary. Moderately large kidney-shaped calcareous glands are present in xiii, in xi and xii there are lateral enlargements of the oesophagus which are not set off from the tube. The intestine begins in xvi.

The last heart is in xii.

The excretory system consists of meganephridia, the openings of which do not alternate.

Testes and large male funnels are free in segments x and xi. Vesiculae seminales are present in xi and xii; the sacs in xi are large and meet dorsally but do not unite; those in xii are united and prolonged backwards through xiii.

The prostates, in segment xviii, are rather small, compact and squarish masses, not cut up into lobes. The soft short duct lies curled up in a hollow on the inner and under side of the gland; it becomes broader towards its ectal end.

The ovaries and funnels occupy the usual situation.

The spermathecae are considerable sacs, of an irregular ovoid shape, with, in cases, small wart-like projections. The duct is short and stout, and there is no diverticulum.

The penial setae (fig. 16) are in length .83 mm., in breadth 20μ at the middle of the shaft, and 18μ nearer the distal end. The shaft is almost straight, the tip slightly curved and pointed. The distal end is ornamented with about twelve rings of narrow, comparatively long spines.

Perionyx sp.

(Plate xxxi, figs. 17, 18).

Peradeniya, Ceylon, 26-vi-1910 (*E. S. J.*). A single specimen.

External Characters.—Length 8 mm., maximum diameter 1 mm. According to a note in the tube, the ground colour of the living worm was whitish, and each segment was girdled with a broad

dark reddish-brown and black band. In the preserved condition the ground colour was still whitish, and the bands were of a dark purple; in width the bands were the equivalent of more than the middle third of each segment; they were less distinct ventrally, especially behind the genital region. The setae were indicated by whitish points in the dark rings. Segments 30, but the specimen had previously been mutilated at the hinder end.

Prostomium epilobous $\frac{1}{2}$, with curved posterior border.

The dorsal pores begin from furrow 4/5.

The setae are in unbroken rings; I was unable to count them, but found them set closer together ventrally than dorsally.

No cliellum was visible, nor was it, later, distinguishable in sections.

The male genital area, on segment xviii, is a clean-cut oval with its longer axis transverse, which occupies the whole length of the segment. The apertures appear as black points on considerable rounded papillae which project upwards slightly from the floor of the oval depression; these papillae are almost confluent, being divided from each other only by a slight longitudinal depression in the middle line. The depth of the oval is therefore greatest in two transverse lines within its anterior and posterior boundaries respectively (fig. 17).

The female aperture was not distinguishable.

Spermathecal apertures were made out near the middle line as minute white points in the furrows from 5/6 to 8/9; but sections subsequently showed them to be seven pairs in all, beginning in 2/3.

Internal Anatomy.—This was investigated by means of sections.

The pigment of the bodywall appears as an opaque darkish green in the stained sections; it is disposed as a ring in each segment in the deeper portion of the circular muscular coat, and altogether superficial to the longitudinal fibres.

The first septum is 4/5; that and the following one are thin; the rest are all of the same thickness, none being specially thickened.

The septal gland cells extend back into segment vii.

There is no trace of a gizzard. The oesophagus extends from the pharynx to the intestine as a straight, almost perfectly cylindrical tube, without segmental swellings, widening very gently however in xii, xiii, and xiv before suddenly dilating to form the intestine in segment xv. The internal surface of the oesophagus is somewhat more papillose in xiv than elsewhere, without however forming lamelliform folds or calcareous glands.

The last heart is in xii.

The excretory system is meganephridial.

Testes and funnels are free in segments x and xi, enveloped in masses of developing spermatozoa which fill up the whole of the two segments.

The vesiculae seminales, in xii, attached to the posterior face of septum 11/12, are paired, and come near but do not touch each other in the middorsal line.

The prostates, compact in form, are confined to xviii. The duct is stout and very muscular, and passes from the middle of the gland downwards and then inwards.

The ovaries and their funnels have the usual position.

The spermathecae are seven pairs, the first opening in furrow 2/3 and the last in 8/9. The ampulla is ovoid, the first of the series is .2 mm. long, and some subsequent ones .25 mm. The duct is short and comparatively stout,—half the length and half the thickness of the ampulla. The diverticula are either one or two in number, globular, in diameter .06 to .12 mm., and attached by short stalks to the junction of ampulla and duct.

The penial setae (fig. 18), in length .27 mm. or possibly as much as .3 mm., and in breadth 7μ near the base, are absolutely straight and rod-like; and taper very gradually along the shaft, more suddenly at the tip, which is bluntly pointed. There is an ornamentation of fine spines at the distal end.

Remarks.—This is a particularly well-marked species, by reason of the bands of pigment and the extraordinarily large number of spermathecae. It is possible however that it has already been described. Michaelsen (10) has given an account of a form which he has named *P. ceylonensis*, also from Peradeniya in Ceylon. Unfortunately I am for the present unable to obtain his paper, so that I am quite in the dark as to whether this species is or is not the same as his. Should it ultimately turn out to be the same, a second and independent description of this interesting little worm will perhaps not be altogether without value.

Gen. *Notoscolex*.

Notoscolex gravelyi, sp. nov.

(Plate xxxi, fig. 19; pl. xxxii, fig. 20).

Lady Blake's Drive, Kandy, Ceylon, 22-v-1915 (*F. H. Gravely*). A single specimen.

External Characters.—Length 29 mm., maximum breadth 1.75 mm. Colour a dirty brown (white in life according to a note accompanying the specimen). Segments 110.

Prostomium epilobous $\frac{1}{2}$, tongue broad, cut off behind.

The first dorsal pore apparently in furrow 9/10.

The setae are widely paired. In the anterior part of the body $ab = \frac{2}{3}aa = \frac{2}{3}bc = cd$, and dd is equal to half the circumference. Posteriorly ab and cd are a little greater relatively to aa and bc , and cd may be rather greater than ab . At the hinder end $aa = bc = cd$ or almost so (*i.e.* the lateral setae are no longer paired); ab is about $\frac{2}{3}aa$, and dd considerably less than half the circumference.

The clitellum extends over xiv-xvi = 3.

The male apertures are situated on segment xviii in line with setae b , on slightly raised transversely oval areas which extend

inwards to *a*, but not outwards to a corresponding distance outside *b*.

The female apertures are apparently paired, in a minute whitish groove equal in length to the interval *aa* and situated just in front of the level of the setae.

The spermathecal apertures were not seen externally. From the dissection they were found to lie in furrows 7/8 and 8/9, a little ventral to the line of setae *c*.

A pair of small papillae on segment xvii in front of the male pores may quite possibly be artefacts.

Internal Anatomy.—Septum 5/6 is apparently present, but very thin; 6/7 is very thin; 7/8 is still thin, though thicker; 8/9 is slightly strengthened, 9/10 moderately so; a number of succeeding segments are moderately or slightly strengthened, as far as 13/14, but it is difficult to be precise as regards these degrees in so small a worm.

The gizzard, in segment vi, is large, barrel-shaped, and firm. The oesophagus is much bulged laterally in xv and xvi, but there are no separate calcareous glands. The intestine begins in xix.

The last hearts are in xiii.

The excretory system shows a mixed condition. In and in front of the prostatic segment, as far as segment x, bushy tufts of micronephridia, of relatively considerable length, are implanted ventrally in each segment, one on each side by the side of the alimentary canal; in ix the tuft is implanted on the anterior face of 9/10 or at least is adherent to it; in viii none were seen; but there are very large tufts on each side behind the pharynx, on a level with the anterior end of the gizzard.

Behind the prostate mega- and micronephridia coexist. The first meganephridium is in xx; thence backwards the meganephridia are prominent structures, appearing as elongated loops in each segment, and so continue through and behind the middle of the body. Towards the posterior end they become less conspicuous, and the micronephridia, which have accompanied them throughout, become more numerous and relatively more prominent. About twenty segments from the end the meganephridium becomes indistinguishable, or only doubtfully distinguishable, from the micronephridia. The nephridia cover the bodywall on each side from the level of *b* to above *d*, or rather more than one-third of the half-circumference.

The small testes and moderate-sized funnels are free in segments x and xi.

The vesiculae seminales are small, racemose in form, and situated on the anterior septa of segments xi and xii.

The prostate is small and confined to segment xviii; it is compact in form and only slightly lobed on the surface; possibly, in the single specimen available, it is not fully developed. The duct begins in the middle of the gland as from a hilus; it is comparatively long, shining, with a rather bent or wavy course, and passes transversely inwards.

The ovaries are large, in xiii. A pair of relatively considerable ovisacs are present in xiv, attached to septum 13/14 along a curved line on each side of the alimentary canal.

The spermathecae (fig. 19) are two pairs, which pierce the bodywall in a rather lateral position in 7/8 and 8/9. The ampulla is elongated, of a rather irregular ovoid shape, and narrowing without any distinct demarcation to become the duct, half as long and half as wide as the ampulla itself. The diverticulum is implanted at the junction of ampulla and duct, and has the form of an ovoid sac with a stalk as long as itself. The whole diverticulum including the stalk is about one-third the length of the main ampulla.

The penial setae (fig. 20) are in length .9 mm., and in thickness 7 μ ; thus they are relatively very narrow. They have a gently undulating shape, but the proximal half is fairly straight, the curves being mainly in the distal portion. The tip is pointed; the end may taper gradually, or there may be a slight bulbous swelling just above the extreme point. There is no ornamentation, but there is a curious series of minor irregularities all along the distal portion of the shaft, which are illustrated in fig. 20.

Remarks.—*Notoscolex* is a micronephridial genus; the presence of a species with a mixture of mega- and micronephridia is however perhaps not more anomalous than the presence of similar species in the genus *Megascolex* (cf. descriptions of several such species in Stephenson, 25). *Perionyx* also, a typically meganephridial genus, contains a species with the mixed condition (*P. annulatus*, Stephenson, 23). The present species is near *N. sarasinorum*, of which it may even be the direct ancestor. I at first thought of putting it in *Woodwardia*,—a genus with perichaetine setae, meganephridia, and *Pheretima* prostates; and it may indeed represent a connecting link between the two genera. It is usual, however, to derive *Notoscolex* from *Megascolides* by increased breaking up of the nephridia and development of a lobed prostate (*Pheretima*-prostate) out of the tubular prostate of the latter genus. But there is no reason, as far as I can see, why some of the genera of *Megascolecinae* should not be polyphyletic;—e.g. *Megascolex* itself may be derived both from *Notoscolex* by the multiplication of setae, and from *Lampito* (and so ultimately, perhaps, from the *Perionychella* forms of *Perionyx*) by the breaking up of the nephridia; such a double origin appears to be hinted at by Michaelsen (12).

It may be remarked that if *Lampito* is a valid genus, separated from its allies on account of the mixed mega- and micronephridial condition, the present species might also lay some claim to generic distinction.

Gen. *Megascolex*.

Megascolex ratus, Cogn.

Trivandrum, 1911. A number of specimens on several different occasions.

A few notes may be added to supplement the original description (5)

The prostomium was proepilobous in some specimens.

In front of the clitellum the ventral break in the setal ring was small, equal to $2ab$ or $3ab$, and the ventral setae were numerous and closely set at slightly irregular intervals; the dorsal break was irregular, and both it and the intersetal distances on the dorsal side were greater than the corresponding intervals on the ventral side. Behind the clitellum aa is very regular, and equal approximately to $2ab$; the dorsal break is about the same size as the ventral, and is also pretty regular.

The clitellum includes $\frac{1}{3}$ of $xiii$ and $\frac{2}{3}$ of $xix = 6$. Dorsally the greater part of $xiii$ is discoloured, and xix is not included ventrally,—indeed in the midventral region $xvii$ and $xviii$ also want the purple colour which distinguishes the clitellum in general. Setae are distinguishable ventrally in xvi , $xvii$ and xix , and less easily in xv and xiv ; there are two or three on $xviii$ between the male pores.

The most conspicuous genital markings were a pair of concave sucker-like discs, circular and sharply delimited, in $16/17$, the interval between them being equal to the diameter of one of the discs. In addition there were smaller eye-like markings in $19/20$, $20/21$ and $21/22$, circular, flat, not raised, with dark centre and lighter periphery; they may be surrounded by a slight groove. The interval between those of a pair is small, = aa only; in an antero-posterior direction they take up the posterior and anterior thirds of the segments bordering the grooves on which they lie. In some specimens these markings were only present on $19/20$ and $20/21$. In one specimen there were similar markings on $14/15$ and $15/16$ also.

The large firm barrel-shaped gizzard I find to be in segment v , though the septa in this region are not easy to distinguish. The first well-marked septum is $4/5$, a stout sheet of tissue behind the pharynx, convex backwards; $7/8$ is also thickened; and between the two there is certainly one extremely tenuous septum ($6/7$), as well as, in front of this, an extremely fine membrane around the gizzard,—a delicate bag in which the gizzard is contained, which is probably septum $5/6$.

Megascolex konkanensis, Fedarb.

Trivandrum, 1911; numerous specimens taken on several occasions.

Out of a large number of examples a very few showed the full development of the male genital field. This I should describe as follows:—

On the flattened ventral surface of segment $xviii$ are two large shallow depressions, oval in shape, with clean-cut margins and slightly prominent lips; the lips approach each other in the midventral line, where they are separated only by a median groove. The breadth of segment $xviii$ is increased by the presence of these depressions; they encroach slightly on xix , and more on $xvii$; the axis of the oval is a little oblique, being directed forwards and

inwards. Across each oval passes a transverse ridge, at a level between a third and a quarter of the length of the oval from its posterior margin; the floor of the oval is thus formed of two declivities, an anterior longer and gently sloping, and a posterior shorter and steeper. The male aperture is probably on the ridge.

Megascolex cingulatus (Schmarda).

(Plate xxxii, fig. 21).

Lady Blake's Drive, Kandy, Ceylon, 29-V-1910 (*F. H. Gravely*). A single specimen.

In length the specimen was 53 mm., originally more, the hinder end having been mutilated and showing signs of commencing regeneration; the diameter was 3 mm.

Calcareous glands were present in segments x—xiii.

Seminal vesicles were present in segments x, xi and xii; there were none in xiii, and those in xii were not grape-like.

The spermathecae (fig. 21) are characteristic. The ampulla is soft, slightly lobed and somewhat pyramidal in shape. The duct consists of two portions, an ectal (nearer the external aperture) which is exceptionally stout, flattened, and slightly constricted below its middle; and an ental, a shining cylindrical tube, lying underneath the ampulla in the natural position of the parts; it begins at the rounded apex of the ampulla, after emerging from underneath which it dilates to form the much stouter ectal portion already mentioned. There is a single diverticulum, implanted above the constriction in the ectal portion of the tube; this is elongated, pear-shaped or club-shaped, and extends from its attachment to the base of the ampulla, against which it rests; the diverticulum, like the duct, is firm, shining and muscular. From it near its attachment originate two small stalked secondary diverticula, with one, three or four minute grape-like chambers each.

Megascolex insignis, Mchlsn.

(Plate xxxii, fig. 22).

Karakulam, 17-X-1911. Several specimens.

The dorsal pores begin from furrow 5/6 or 6/7.

The ventral break in the setal ring was found to be equal to 3ab. The number of setae counted was:—ca. 34/vi, ca. 34/viii, 38/xii, 34/xix, 29/xxii.

The male apertures are contained in a pair of slightly sunken darker coloured conical depressions; surrounding the depressions on the outer sides are a pair of slightly raised whitish semicircular curved lines.

The gizzard appeared to me to be in segment vi.

Ovisacs were present in segment xiv.

The spermatheca (fig. 22) differs in some respects from the original description by Michaelsen (14); a comparison of the figures will render description unnecessary.

Megascolex trivandranus, sp. nov.

(Plate xxxii, figs. 25, 26).

Trivandrum, 1911. Two specimens, taken at different times.

External Characters.—Length 72 mm., diameter 2 mm. Colour in general an equable grey, with darker middorsal line; clitellum a reddish brown. Segments 136.

Prostomium epilobous $\frac{1}{2}$ to $\frac{1}{3}$.

Dorsal pores from furrow $\frac{5}{6}$.

The dorsal break in the setal rings is equal to 2-3yz. Ventrally $aa=3ab$, or it may be $4ab$ behind the clitellum. The inter-setal distances increase towards the sides, ab being distinctly the smallest. The numbers were:—36/v, 43/ix, 41/xii, 34/xix, and 29 in the middle of the body.

The clitellum extends over approximately xiv—xvii = 4, or ventrally $\frac{1}{2}$ xiii— $\frac{1}{2}$ xvii. Setae are easily distinguishable and dorsal pores are well marked.

The male apertures are borne on small porophores on segment xviii; these are situated in bc or c , at the ends of a transversely elongated depression, which, deepest at its ends, is slightly curved with its convexity forwards. The depression is surrounded by a well marked whitish lip all round; in longitudinal extent the depression with its lips takes up the whole of segment xviii (fig. 25). In the second specimen the transverse depression was practically divided into two, its median portion being but little below the level of the general surface.

The female area is a white oval patch on xiv, in which the actual apertures could not be discriminated. In breadth it extends over the interval bb , in length it takes up not quite the whole of the length of the segment.

The spermathecal apertures, in furrows $\frac{7}{8}$ and $\frac{8}{9}$, are situated on minute papillae just external to the line of setae b .

Internal Anatomy.—Septa $\frac{4}{5}$, $\frac{5}{6}$, $\frac{6}{7}$ are very thin; $\frac{7}{8}$ is slightly thickened, the succeeding ones up to $\frac{11}{12}$ moderately, thence up to $\frac{15}{16}$ progressively less so.

The gizzard, of which one-third is contained in segment v and the rest in vi, is subspherical with a flattened anterior end. The oesophagus is segmentally swollen and dark in colour (*i.e.* vascular) in segments ix-xiv. The intestine begins in xvi.

The last heart is in xiii.

Behind the clitellum the micronephridia are arranged in a transverse row or band, just behind the septum in each segment, which does not attain the middorsal region. In segments xiv to xvi the arrangement is similar, but the individual nephridia are very considerably larger, with much more numerous coils; in

xii the row is very short and consists of one or two large tufts only. In front of the clitellum there are no nephridia on the body-wall; but in each segment by the side of the alimentary canal there is a considerable stalked tuft with numerous branches. The first tuft of the series is a large one connected with the hinder angle of the pharynx.

The male funnels are free in segments x and xi; testes were not identified.

The seminal vesicles depend from septa 10/11 and 11/12 into segments xi and xii. They are racemose and not large; those in xii however are larger than the anterior pair.

The prostates, small and confined to segment xviii, are of the *Pheretima*-type, and are made up of small closely compacted lobules. The relatively stout duct passes transversely inwards; it is thinner at its ental end and gradually widens.

The ovaries are in xiii, and in xiv there are small structures which may be minute ovisacs, or possibly only nephridial tufts.

The spermathecal ampulla is smooth, regularly ovoid, and of an opaque white colour. The duct is relatively stout, half as broad and two-thirds as long as the ampulla. There is a very long diverticulum, two-thirds as long as ampulla and duct combined: it is a coiled and twisted tube which takes origin from the termination of the duct and at its free end is dilated into a small spherical chamber with a simple cavity (fig. 26).

There are no penial setae.

***Megascolex pentagonalis*, sp. nov.**

(Plate xxxii, figs. 23, 24).

Trivandrum, 24-vi-1911. A single specimen, incomplete posteriorly.

External Characters.—Length 108 mm.+, diameter 3 mm. Colour a uniform medium grey. Segments 94+; vii, viii and ix with three or four secondary annuli.

The anterior end of the animal is truncated, not tapering; the prostomium is seen on looking at the animal from the front; it is small and triangular, the pointed posterior angle being directed upwards.

The first dorsal pore is in furrow 5/6.

The ventral setal interval is equal to $2ab$ (in front of the clitellum), or $2\frac{1}{2}ab$ (behind it). The ventral setae are in fairly definite longitudinal lines; those on viii and ix are remarkably small. The dorsal setae are not in definite lines, and the dorsal break is large; thus it is $4-5yz$ in front of the clitellum, $6yz$ or even $8yz$ posteriorly. The numbers were:—14/v, 16/x, 6+8/xii, 7+6/xix, 9+10/xxii, further back 10+10 or 10+12; at the posterior end of the (incomplete) specimen there were 32, all setae were at irregular intervals, and the dorsal break was much smaller, $=2yz$ only.

The clitellum is not definitely limited; it appears to extend over xiv— $\frac{1}{2}$ xvii= $3\frac{1}{4}$.

On segment xviii is a thickened area, of the shape of an irregular pentagon with its base forwards and its lateral angles produced outwards. This area is surrounded by a moat-like channel, deepest posteriorly where the margin of the pentagon overhangs; the pentagon itself is marked by a $\perp$ -shaped depression. The male apertures are under the overhanging posterior borders of the area, near its lateral angles, and in line with setae *b*. The transverse extent of the thickened area with the surrounding moat is equal to the interval *cc*; in a longitudinal direction it occupies the anterior two-thirds of segment xviii (fig. 23).

The female apertures are perhaps represented by two small whitish dots in line with the setae of xiv in such a position that $a\varnothing = \varnothing\varnothing = \varnothing a$.

The spermathecal apertures, in 7/8 and 8/9, are small pores in line with setae *b*.

Internal Anatomy.—The first distinguishable septum is 5/6, which is thin; septa 6/7—10/11 are considerably thickened, the next few moderately so, after which they are diminishingly thickened as far back as 16/17: the rest are thin.

The gizzard, in segment v, is of fair size, firm and barrel-shaped. There are no calcareous glands. The intestine begins in xvi.

The last heart is in segment xiii.

The micronephridia are present as large tufts in the anterior segments from v to the clitellum, especially in from v to ix; there are few or none on the bodywall in front of the clitellum, but the inner surface of the parietes in segments xiv, xv, xvi and part of xvii is thickly covered with micronephridia ventrally and laterally. They are scattered and fairly numerous on the bodywall behind the prostate.

Testes and funnels are free in x and xi.

Vesiculae seminales are attached to the anterior walls of segments xi and xii. Those in xi are small, those in xii moderate in size; all are much cut up into small lobes.

The prostates, long, flat and much divided up, lie on the bodywall in segments xvii to xx. The duct, with a sinuous or curled course, passes backwards and inwards from its origin on the inner margin of the gland at about the level of septum 17/18; its first part is the thinnest.

The ovaries and their funnels have the usual situation.

The spermathecae (fig. 24) are of a general sausage-shaped form, bent inwards towards their free (posterior) end, and slightly dilated at the extremity. The duct is short and moderately stout, half as thick as the ampulla. There is a single diverticulum, which arises from the duct close to its junction with the ampulla; it is of an elongated club shape, and more than half as long as the ampulla, reaching about as far as the bend in the latter.

There are no penial setae.

Remarks.—The present species seems to be related to *M. travancorensis*, Mehlsn. (14). But though the characters of the male area in the latter are variable, it does not seem possible to reduce the condition in the present specimen to the same type. One has here, as so often, to regret that the form is represented by only a single specimen.

***Megascolex pumilio*, sp. nov.**

Trivandrum, 11-ii-1911. Two mature specimens, one immature, and one fragment.

External Characters.—Length 54 mm., maximum diameter $1\frac{1}{2}$ mm. Colour an equable grey, clitellum a marked reddish brown. Segments 109.

Prostomium epilobous $\frac{1}{2}$, tongue not delimited behind.

Dorsal pores begin from furrow 5/6.

For the greater part of the body there are twelve setae per segment. In front of the clitellum these are arranged in three pairs, the intervals *bc* and *de* being rather greater than *ab*, *cd* and *ef*. The setae *a* are in regular rows, one on each side, and the same is the case with *e*; the setae *b* form regular rows for the greater part of the length of the body, but *c* does so only in the anterior part; the row *y* is irregular. The dorsal interval is considerable; in front of the clitellum *zz* (or *ff*) is equal to about 4yz (or *ef*), behind the clitellum to about 3yz.

The number twelve persists till near the hinder end of the body; but there 16, 17 and 18 are found, irregularly arranged and not in pairs.

The clitellum extends over segments xiv—xvi=3; the situation of the setae is shown by white dots on the brown-red background.

The ventral surface of segment xviii shows a transversely elongated thickened patch, extending from beyond the line *b* on the one side to a corresponding point on the other. The male apertures are only faintly indicated in or just outside *b*.

A small white patch, circular and midventral, in the line of the setae of xiv, represents the female aperture.

The spermathecal apertures are faintly indicated in the furrows 7/8 and 8/9, in line with setae *b*.

Internal Anatomy.—The anterior portion of the animal was cut into sections of 12μ diameter.

Septum 4/5 is very thin, 5/6 thin, 6/7 somewhat thickened, 7/8, 8/9 and 9/10 considerably so; from 10/11 to 14/15 they become progressively thinner again.

The gizzard, in segment v, is of moderate size and thick-walled. The oesophagus, narrow in segment vi, is bulged segmentally from vii to xiv; there are no separate calcareous glands, but the epithelium is raised into villous processes or folds which extend inwards towards the centre of the lumen. The intestine begins in xv.

The last heart is apparently in xiii.

The excretory system is micronephridial; the very large tufts in segment v, by the side of the anterior end of the gizzard, are a conspicuous feature.

Testes and funnels are free in x and xi. Seminal vesicles are present in ix and xii.

The prostates, of the *Pheretima*-type, are relatively large, occupying segments xviii to xxi. They are most bulky in xviii and xix, thinner and dorsally situated in xx and xxi. The duct is relatively stout and sharply curved.

The ovaries and their funnels are in segment xiii; the oviducts unite before debouching externally.

The spermathecae, in segments viii and ix, have an ovoid ampulla of relatively considerable size. The duct is not sharply demarcated; it is as long as and nearly half as thick as the ampulla, and has a slightly curved course, forwards or forwards and then downwards to the exterior. The single diverticulum is club-shaped; it originates from the upper end of the duct just below the ampulla; it is about half as broad as the ampulla, and reaches dorsalwards nearly as far as the latter.

Gen. *Pheretima*.

Pheretima posthuma (L. Vaill.).

Lucknow, 15-x-1910 (*Md. Mohsin Khan*). Several specimens.

Same place, 1916 (*L. Harnarajan Das*). Several specimens.

Kalka, base of Simla Hills, 2400 ft., 19-vii-1911 (*Museum Collector*). Several specimens.

Under stones or mud by tank, Museum compound, Calcutta, 8-iv-1910 (*F. H. Gravely*). A single specimen.

Pheretima heterochaeta (Mchlsn.).

Darjiling district, 1000-3000 ft., v-vi-1912. A number of specimens. (*Carmichael Collection*).

Darjiling, ca. 6000 ft., iv-1914. Several specimens (*Same Collection*).

Singla, Darjiling district, 1500 ft., v-1914. Three specimens. (*Same Collection*).

Darjiling, ca. 7000 ft., 12-vi-1914 (*F. H. Gravely*). A single specimen.

Soom, Darjiling district, 4000-5000 ft., 16-vi-1914 (*F. H. Gravely*). Three specimens.

Kurseong, 4700 ft., E. Himalayas, 25-iii-1910 (*F. H. Gravely*). A single specimen.

Same place, 14-17-iv-1911 (*N. Annandale*). Two specimens.

Pheretima hawayana (Rosa) f. *typica*.

Kurseong, 4500 ft., E. Himalayas, 26-iii-1910 (*F. H. Gravely*). Two specimens.

Pheretima houlleti (E. Perr.).

Rawal Pindi, N. Punjab, xii-1915 (*I. Raghunath Sahai*). Two specimens.

Pheretima bicincta (E. Perr.).

Trivandrum, i-vii-1911. A single specimen.

Pheretima feae (Rosa).

Kawkareik, Amherst District, Lower Burma, 19—20-xi-1911 (F. H. Gravely). A single specimen.

A glandular collar has previously been described round the oesophagus in segment x. This was seen to be a flange-like structure behind the gizzard, against which it rests; since the flange is set rather obliquely, the appearance is not unlike that of a cup and saucer. Microscopically the collar was found to be composed of follicles of blood-glands like those described by Beddard (1) behind the pharynx in certain species of *Pheretima* and other genera.

Pheretima lignicola, Stephenson.

Thingannyinaung to Myawadi, Lower Burma, ca. 900 ft., 24—26-xi-1911 (F. H. Gravely). A single specimen.

Here also in segment x, behind the pharynx, there was found a ring-like or collar-like thickening of the oesophageal wall, soft and of an opaque yellow colour. On teasing a small portion and examining it microscopically this was, as in *P. feae*, found to consist of follicles of blood-glands.

Pheretima trivandranæ, sp. nov.

(Plate xxxii, fig. 27; pl. xxxiii, figs. 28, 29).

Trivandrum, 23-vi-1911. A single specimen.

External Characters.—Length 70 mm., maximum diameter 3 mm. Colour an equable grey. Segments 100.

Prostomium epilobous $\frac{1}{2}$, tongue broad, not delimited behind. The first dorsal pore is in furrow 8/9.

In the first ten segments there is no dorsal break in the continuity of the setal rings, but behind this there is a small interruption ($zz = 2yz$). The ventral break is also small ($aa = ca. 1\frac{1}{2}ab$), and in some of the anterior segments, v to vii, is altogether absent. The setae of segments ii-ix are rather enlarged, those on x rather small. The following numbers were counted:—28/v, 46/ix, 52/xii, 52/xix, and 54 in the middle of the body.

The clitellum was not distinguishable, except perhaps by the smaller size of the setae of segments xiv-xvi.

The male apertures, on segment xviii, are fairly conspicuous pores in line with setae g. They are situated towards the inner side of, but well within, a pair of circular thickened areas, somewhat raised in their centres. The pores are slightly more than a quarter of the circumference apart, and four (right side) or five setae (left side) intervene between the pore and the midventral line.

The female apertures were just indicated, situated in a pair of slight whitish thickenings immediately internal to setae *a* of segment xiv.

The spermathecal apertures are three pairs, in furrows 6/7, 7/8, and 8/9, situated well to the sides, about two-fifths of the circumference apart. The last is about opposite seta *i* or *h* of ix, the first opposite seta *e* of vi.

Internal Anatomy.—Segment x is remarkably smooth on the inside; the bodywall is thinner here, and without nephridia.

Septum 4/5 is thin, 5/6 somewhat thickened, 6/7 and 7/8 moderately so; 8/9 and 9/10 are absent; 10/11, 11/12 and 12/13 are moderately thickened, 13/14 and 14/15 slightly so.

The blood-glands in segment vi are very conspicuous. The gizzard, ovoid and well developed, is in the middle of the space between septa 7/8 and 10/11. The oesophagus is bulged laterally behind the gizzard in the portion corresponding to segment x, and also in segments xi, xii and xiii. The intestine begins in xv. Intestinal diverticula, originating in xxvii, extend forwards through xxvi and xxv.

The last heart is in segment xiii.

The excretory system is micronephridial; there are the usual large tufts by the side of and behind the pharynx in segments v and vi.

The testes and funnels are contained in testis-sacs in segments x and xi, which probably communicate with their fellows across the middle line.

The seminal vesicles are attached to the anterior walls of segments xi and xii respectively; they are lobed masses which do not meet dorsally over the intestine.

The prostates (fig. 27), small glands in xvii and xviii, are cut up into numerous small lobules. The duct begins as a small soft tube which immediately swells and becomes firm and shining; it takes a much curved course, describing almost a complete circle, and increasing in diameter as it does so; at its broad ectal end it joins the outer margin of a soft white cushion on which it lies.

The female organs have the usual situation.

The laterally situated spermathecae (fig. 28) have a characteristic form. The ampulla is relatively small, ovoid or pear-shaped. The duct is extremely stout, much longer than the ampulla and almost straight. The diverticula are of two kinds. One is thin and finger-like, originating from the extreme base, or perhaps more properly from the bodywall close to the base of the duct, and approximately half the length of the duct. The second kind arises from the middle of the length of the duct; it consists of an irregular pear-shaped chamber presenting about five lobules, and a stalk which is half as stout as the main duct; the whole, stalk and chamber together, are nearly as long as the main ampulla and duct above the point where the stalk of the diverticulum is attached. Lastly, in one out of the six spermathecae another diverticulum, of the second kind, but much smaller than the one

just described, was present; its termination presented only two lobules and it was inserted into the main duct just below the ampulla. Microscopically, after clearing, the first kind of diverticulum was found to be a simple tube, with the cavity wider at the free end. The second kind consists of several (three or four) elongated and irregular chambers, tightly bound together by connective tissue (fig. 29).

***Pheretima kuchingensis*, sp. nov.**

(Plate xxxiii, fig. 30).

Kuching, Sarawak, 29-vii-1910 (*C. W. Beebe*). Two specimens, in bad condition.

External Characters.—Length 136 mm., diameter 4.5 mm. It is impossible to say what the original colour may have been; the clitellum is a medium brown. It would be impossible to estimate the segments without stripping off the whole of the cuticle and counting the setal rings.

Prostomium?

- Dorsal pores begin from furrow 12/13.

The dorsal break in the setal rings is equal to about 2yz anteriorly and $1\frac{1}{2}yz$ behind the clitellum. The ventral break is practically absent,—not more than $1\frac{1}{2}ab$. The setae of segments iv to ix are enlarged, especially those of v, vi and vii. Ventrally the setae are closer set than laterally and dorsally. The numbers counted were:—35/v, 42/ix, 40/xii, 46/xix, 46/xxvi.

The clitellum extends over segments xiv—xvi=3. It is smooth, without visible setae or dorsal pores.

The male apertures are situated in the setal ring of segment xviii, on moderately large round dark-coloured papillae. They are in line with setae *h* of the adjoining segments, and ten setae intervene between the pores.

There appears to be a single female pore in the setal ring of xiv.

The spermathecal apertures are four pairs, small, in grooves 5/6—8/9; they are about the same distance apart as the male pores, and are in line with the setal interval *fg*.

Internal Anatomy.—Septum 4/5 is somewhat thickened, 5/6, 6/7 and 7/8 apparently considerably strengthened, 8/9 is thin and 9/10 absent; 10/11—13/14 are all somewhat thickened.

The gizzard, large and barrel-shaped, is in segment viii. The intestine begins in xv. Elongated diverticula originate in xxvii; tapering and showing a few constrictions, they reach forwards to xxiv.

The last heart is in xiii.

The micronephridia were mostly indistinguishable, but a dense fur was present on the inner side of the bodywall in segments xv, xvi and part of xiv.

Ovoid testis-sacs are present in segments x and xi, smaller in the former, larger in the latter. Those of the same segment appear

to be separate from each other,—at least the opaque masses within them are separate, but the walls of the sacs are too delicate and transparent to be followed in the present specimen.

The seminal vesicles, three pairs in segments xi, xii and xiii, are attached to the anterior walls of the segments. Those in xi are deeply incised, and have an appendage, separate from the rest of the sac, which extends nearly to the middorsal line; those in xii, also incised, extend nearly to the middorsal line by a narrow and tapering dorsal lobe; those in xiii are quite small.

The prostates are rather small, occupying segment xviii only (right side) or xviii and xvii (left side). They are made up of small and closely adpressed lobules. The duct is short and almost straight; there is no copulatory pouch,—at least none is distinguishable in the present specimen, though it is possible that one might have been visible in a fresh or a well-preserved specimen.

The spermathecal ampulla is pear-shaped, and becomes continuous with the duct at its broader end. The duct is half the length of the ampulla, and is half as broad also,—rather narrower where it pierces the bodywall; it appears broader than it is however, since it is covered with a considerable fur of micronephridia. The single diverticulum is tubular with a spherical or ovoid dilatation at its free extremity; it is half the length of the ampulla, and is attached to the upper end of the duct near the base of the ampulla; in one case there was present a small excrescence at the base of the terminal dilatation, where the latter passes into the stalk (fig. 30).

Gen. *Octochaetus*.

Octochaetus fermori, Mchlsn.

Karakulam, 17-x-1911. A number of specimens.

In a previous paper I recorded the presence of a second pair of ovaries in this species (24); I even went so far as to state that microscopic examination confirmed the ovarian nature of the structures. After an examination of a specimen of the present batch of material, however, I believe the structures to be ovisacs; no doubt, in my previous examples, they contained ova, and not being on the look-out for ovisacs in a species belonging to the present genus, I interpreted the mass of ova wrongly.

Octochaetus surensi, Mchlsn.

(Plate xxxiii, fig. 31).

Barkul, 0-1000 ft., Orissa, 1-3-viii-1914 (*F. H. Gravely*). Two specimens, one injured anteriorly.

I give a description of some of the features of the present specimens, in order to supplement Michaelsen's account (14).

External Characters.—Length 90 mm., diameter 3.5 mm. Colour dark purplish brown along a middorsal strip, rapidly fading off laterally, so that the sides as well as the ventral surface are unpig-

mented,—over the greater part of the body at least; the clitellum is brown all round; and in front of the clitellum also the pigmentation extends on to the lateral aspects of the body. A slightly lighter band, very narrow, at the middle of each segment, corresponds to the zone of the setae.

Segments 171; vii to x more or less distinctly triannular, xi and xii quadriannular dorsally.

Prostomium epilobous $\frac{1}{2}$, the sides of the tongue parallel, the tongue not cut off behind.

No dorsal pores are to be seen in front of the anterior border of the clitellum; the first one seems to be in this situation, *i.e.* in 12/13, but all are small.

The ventral setae are paired, the dorsal less closely so. The ratios between the various intervals may be expressed as follows:—in front of the clitellum $ab = \frac{2}{3}aa = \frac{1}{2}$ to $\frac{2}{3}bc =$ approximately $\frac{1}{2}cd$; behind the clitellum $ab = \frac{2}{3}aa$ approximately, $= \frac{2}{3}bc = \frac{1}{2}cd$; in the middle of the body $ab = \frac{1}{3}aa =$ rather more than $\frac{1}{2}bc =$ nearly $\frac{1}{2}cd$. The interval dd is about $\frac{1}{7}$ of the circumference.

The clitellum extends over xiii— $\frac{1}{2}$ xvii = $4\frac{1}{2}$ above, but apparently only to $\frac{1}{2}$ xvi = $3\frac{1}{2}$ below.

A male area is distinguishable, constituted by the flattened ventral surface of segments xvii—xx, quadrilateral in shape with rounded corners. The prostatic pores, on xvii and xix, are small, with slightly tumid margins; they are united on each side by straight, very narrow,—indeed linear grooves, and across the middle line by broad grooves with shelving anterior and posterior walls; these transverse grooves are continued outwards in a more or less definite manner beyond the situation of the prostatic pores for a short distance. In the second specimen the longitudinal seminal grooves are rather bowed outwards. The male pores are not visible. The situation of the grooves and prostatic pores is between *a* and *b*.

The female apertures, on the anterior part of segment xiv, are paired, and contained in a small transverse groove surrounded by a whiter area. The pores themselves are slightly internal to the line *a*.

The ventral surface of segments viii and ix is rather irregularly thickened and glandular in appearance. No setae are visible, but corresponding to the position of setae *a* or between *a* and *b* there are small white and slightly elevated points, the spermathecal apertures.

Internal Anatomy.—Only a few points need be noticed. The first septum is 5/6, which is moderately thickened; the next is 8/9, thin and displaced backwards to about the position of furrow 9/10, septum 9/10 itself, moderately thickened, is midway between furrows 9/10 and 10/11; the remaining septa are in the normal positions, 10/11 being moderately thickened, 11/12 considerably thickened and 12/3 slightly so; the rest are thin.

The gizzard is large, between septa 5/6 and 8/9; morphologically it is in segment vii, since the two vascular commissures close

together behind it are those corresponding to vii and viii, and the one at its anterior end belongs to segment vi. Its walls show a curious condition; the whole of its anterior end is thick and very firm, and so is its ventral wall, but the rest of its dorsal and lateral walls and its posterior end are thin, soft and slightly baggy; the same condition was found to be present in a second specimen also.

The spermathecae (fig. 31) are mushroom-like, or somewhat pyramidal with much rounded angles. The duct is very broad at its origin,—about one-third as broad as the ampulla,—but becomes much narrower at its ectal opening; it is rather shorter than the ampulla. The diverticulum arises from the uppermost portion of the duct by a short and narrow stalk, which bears a rounded cauliflower-like mass, composed of a large number of indistinct chambers; the breadth of the mass is about equal to that of the upper end of the duct.

Testis-sacs are present, as Michaelsen (14) suspected, but they are of peculiar form; they are constituted by an extremely delicate membrane, which covers in the whole of the contents of the respective segments,—stretching from one septum to the next and including dorsal vessel and alimentary canal as well as sperm masses and the male organs. I did not see the testes in segment xi, and the funnels of xi appeared to be distinctly smaller than those of x.

Octochaetus barkudensis, sp. nov.

(Plate xxxiii, figs. 32, 33).

Barkuda Island, Chilka Lake, Ganjam District, Madras Pres., 17-vii-1914. (*Chilka Survey*). Two specimens, one not fully mature.

External Characters.—Length 43 mm., diameter 1.5 mm. Colour brown. Segments 140, the last few very short.

In one specimen the prostomium was tanylobous; in the other epilobous $\frac{1}{2}$, pointed behind, the angle being continued as a median groove back to the first furrow ($1/2$).

I could not see any dorsal pores in front of the clitellum.

The setae are paired; their relations may be expressed as follows:—behind the clitellum $ab = \frac{1}{4}aa, = \frac{1}{3}bc, = \frac{1}{2}cd$ or nearly; near the posterior end $ab = \frac{1}{3}aa, = \frac{1}{2}bc$, and is somewhat less than cd . In front of the clitellum the setae are difficult to see, but the relations appear to be much as they are near the posterior end. The seta d is a little below the lateral line of the body.

The clitellum includes two-thirds of xiii and two-thirds of xvii, $= 4\frac{1}{3}$; it is smoother than the neighbouring segments, but there is little difference of tint.

On segment xviii are two approximately rectangular cushions which take up the whole length of the segment, and meet in the middle line where they are separated by a slight groove. The seminal grooves cross the somewhat indefinitely limited outer ends of the cushions, passing between the prostatic apertures on xvii and xix, in line with setae b .

The female apertures appear to be indicated by a transverse depression on the anterior part of segment xiv, which is bounded along its anterior margin by furrow 13/14.

The spermathecal apertures are apparently indicated by slight whitish marks on segments viii and ix, in front of and between *a* and *b*.

Internal Anatomy.—The first septum appears to be 4/5, which is somewhat thickened: no more are visible till 8/9, which is slightly thickened; 9/10, 10/11 and 11/12 are considerably, 12/13 somewhat and 13/14 slightly thickened.

The gizzard, in front of septum 8/9, is subspherical, firm and well-developed. A single pair of calcareous glands is present, taking up segments xv and xvi; they are thus of considerable size. The intestine begins in xvii.

The last heart is in xii.

The excretory system is micronephridial.

Testes and funnels are free, embedded in sperm masses in segments x and xi; the funnels appear to be of relatively large size.

The vesiculae seminales are two pairs. Those in segment ix, attached to septum 9/10, are flattened, with their edges cut up into lobes; those in xii, depending from septum 11/12, are of considerable size.

The prostates, in xvii and xix, are tubular, the tube forming only a few coils and maintaining the same appearance and diameter throughout.

The ovaries are situated in segment xiii; there is a pair of ovisacs in xiv.

The spermathecae are two pairs, one opening at the level of septum 8/9, the other opposite the middle of the gizzard, and so probably at the level of the absent septum 7/8. The ampulla is of moderate size, and very irregular, more or less ovoid in shape; a prolongation of one end forms a short and narrow stalk. A small stalked rounded diverticulum arises (in three out of the four) from the middle part or from the lower end of the duct; in one case it seemed to be a mere bulging of one side of the duct.

The penial setae are in length .58 mm., in breadth 10μ at the middle, 12μ nearer the base. The shaft is slightly curved, the distal end has a somewhat sinuous outline, and the tip is pointed. The ornamentation consists of a number of relatively large spines near but not extending quite to the tip (fig. 32).

The copulatory setae (fig. 33) in segment viii (no sacs or setae were seen in segment ix) are .52 mm. long and 17μ broad. They are not much modified; the shaft is slightly curved along most of its extent, more so at its proximal end than elsewhere. The distal end is pointed, and slightly bulbous close to the tip; above (proximal to) the bulbous portion the lateral aspects of the seta are marked by a number,—more than a dozen,—of serrations; the appearance is that of a lateral flange or seam cut up into teeth.

Gen. *Eutyphoeus*.*Eutyphoeus nicholsoni* (Bedd.).

Mowae, Bara Banki, United Provinces, 11-iv-1910 (*Mohd. Mohsin Khan*).
Four specimens.

Same place and collector, 11-12-x-1910. A number of specimens.

Eutyphoeus bastianus, Mchlsn.

Mowae, Bara Banki, United Provinces, 15-iv-1910 (*Mohd. Mohsin Khan*). A number of specimens.

Same place and collector, 11-12-x-1910. A number of specimens.

Dehra Dun, in a tank, under water, no date (*S. Maulik*). A single specimen.

Eutyphoeus waltoni, Mchlsn.

Tollygunge, nr. Calcutta, 30-vii-1912 (*N. Annandale and F. H. Gravely*).
Two specimens.

Siripur, Saran, Bihar, 27-ix-1910 (*R. Hodgart*). Three specimens.

Eutyphoeus incommodus, (Bedd.)

Rawal Pindi, N. Punjab, Dec. 1915 (*L. Raghunath Sahai*). Four specimens.

Eutyphoeus annandalei, Mchlsn. var. *fulgidus*, var. nov.

(Plate xxxiii, fig. 34).

Anwarganj, Cawnpore District, 1-13-x-1911 (*J. W. Caunter*). Nine specimens, one being immature.

External Characters.—Length 56 mm., maximum diameter 4 mm. Unpigmented, clitellum a light brownish grey. Segments 164; a number of preclitellar segments multiannulate.

Prostomium taulylobous, the tongue narrow with parallel sides. There is also a transverse groove which cuts off the main portion of the prostomium from the tongue.

The first dorsal pore is in groove 11/12.

The setae are paired. In front of the clitellum *ab* is equal to *cd*, and is equal to $\frac{2}{3}aa$ and to $\frac{1}{2}$ or $\frac{2}{3}bc$; behind the clitellum *ab* is rather less than *cd*, and equal to $\frac{2}{3}aa$ and nearly $\frac{1}{2}bc$.

The clitellum is saddle-shaped, or at least much less marked over a longitudinal midventral strip. It includes two-thirds of segment xiii and one third of xviii, or five segments in all.

The male apertures are situated on conical and extremely prominent porophores; these almost penis-like projections take up the length of segment xvii. The orifice forms a transverse slit on the summit, with its centre in the line *b* or opposite the interval *ab*.

The female apertures are small, each situated in front of one of the setae *a* of segment xiv; they are thus separated from each other by a moderate interval.

The spermathecal apertures are one pair, in furrow 7/8, between *b* and *c* though rather nearer to *b*.

Genital markings are present in or rather just in front of furrows 13/14, 14/15, and 15/16; in some cases there was an additional pair in relation to furrow 16/17. These are small, oval or almost circular slightly raised areas, with a somewhat darker centre. They take up approximately a space corresponding to the interval *ab*, but may slightly overstep these limits on one or other side.

Internal Anatomy.—Septum 4/5 is thin, 5/6 is moderately thickened; then two septa are missing; 8/9 is thin, 9/10 and 10/11 considerably thickened, and the following ones thin. Septa 9/10—11/12 are crowded together.

The gizzard, subspherical and moderately firm, is in the interval between septa 5/6 and 8/9. Calcareous glands, in segment xii, are not separated off, and are only discovered on opening the oesophagus; the oesophagus is also slightly swollen in segment xiv. The intestine begins in xv.

The last heart is in xiii. The dorsal vessel is continued forwards over the gizzard to the pharynx; the hearts of segments vii and viii are close together behind the gizzard and in front of septum 8/9; the next commissure is at the anterior end of the gizzard, and the next after that in front of 5/6. The missing septa and the exact morphological position of the gizzard can thus be established.

The excretory system is micronephridial. Behind and on the clitellum there is a single row of relatively large tufts, about seven in number on each side, transversely disposed in each segment; these are set closer together ventrally than on the other regions of the bodywall. On some of the anteclitellar segments the tufts are more numerous; and in segment iii the bodywall is densely covered with micronephridial tubules; there are however no large tufts such as are commonly met with by the side of the pharynx and gizzard.

Testes and funnels are present in segments x and xi; there appears to be no marked difference in size between those of the two segments; those in x are not rudimentary, as they were in Michaelsen's specimens of the type form and would have been passed without comment if met with elsewhere.

Vesiculae seminales are present in segments ix and xii; those of ix are soft lobulated masses of moderate size, those of xii are large, and on one side extend back through segments xiii and xiv, though on the other they merely cause a considerable bulging back of septum 12/13. The conditions in this region are primitive as compared with most species of the genus; septum 11/12 is not absent, and the corresponding heart is not bound down to the alimentary canal by dense connective tissue.

The prostates and their ducts form a continuous tube on each side, beginning behind in segment xix; each tube is of the same diameter throughout, the glandular part being soft and white, the terminal portion more glistening. The vas deferens passes back on the outer side of the termination of the prostatic duct, and then swells into a pouch behind it.

The spermathecae are one pair. The ampulla is large, globular, and sessile on the bodywall, without duct. A complete circle of relatively large, round, oval, or somewhat irregular diverticula surround the base of the ampulla; in one specimen these were eight in number on either side and each was attached by a stalk to the base of the ampulla; in another the diverticula, fifteen in number, were not separable, being bound together by fibrous tissue at their contiguous margins, and so appearing as a continuous ring lobed peripherally.

The penial setae (fig. 34) are 9 mm. long and 17μ broad at the middle of the shaft. The shaft shows a slight curvature, rather more marked towards the free end; the tip is bluntly pointed. The ornamentation consists of a number of extremely fine sculpturings, — short transverse rows of fine points, near the tip and over the distal part of the shaft.

Remarks.—The variety may be distinguished from the typical form by the greater number of the genital markings, the much shorter prostates, and especially the complete ring of diverticula at the base of the spermathecal ampulla. The penial setae are not known in the typical form.

Gen. *Eudichogaster*.

Eudichogaster bengalensis, Mchlsn.

Bed of the Chitartala (branch of the Mahanadi), near Kenduapatna, Cuttack, 25-iii-1910 (B. L. Chaudhuri). A number of specimens.

I subjoin a few notes in order to supplement the original description by Michaelsen (14).

The first dorsal pore I found to be in furrow 11/12.

The penial setae, in length 7 to 8 mm., and in diameter 16μ , have a slightly bowed shaft and a tapering, rather more strongly curved blunt tip; the extremity is blunt. Near the distal end are a number of fine spines, rather irregularly arranged in about half a dozen transverse rows, and scattered spines are continued for some little distance along the shaft. The end could not be described as claw-like; all the spines are very small, and there was no circle of larger spines round the tip, as is described and figured by Michaelsen.

The spermathecal duct was not sharply set off from the ampulla, and the ducts of the two diverticula did not, in the specimen examined, join together before entering the main duct.

The calcareous glands are of interest in connection with the definition and position of the genus. The bulgings of the oesophagus in segments x—xiii are thin-walled and not at all set off from the lateral walls of the oesophagus; they are not calcareous glands any more than the similar part of the tube in, for example, *Pheretima posthuma* is a series of calcareous glands. On opening this part of the tube through its whole length all four segments,

were seen to present low lamellar transverse folds projecting into the lumen from the ventral wall, the dorsal half of the wall being almost or quite smooth, and in the two hinder segments (xii and xiii) slightly constricted off from the ventral by a lateral fold. Along all four segments there is a large and very conspicuous longitudinal midventral projection into the lumen; in a transverse section this would appear bilobed, spreading out on each side of a narrow median attachment, as if it were a ventrally situated typhlosole. The annular intersegmental constrictions of the oesophagus are thickened, as seen from the inside, and present a number of nodular projections.

The nephridia have a similar interest. In the anterior segments these are present as villous tufts, or as an aggregate of three or four coils, within the cone-like septa. On passing back, larger nephridia soon make their appearance, more laterally placed in the segment; the first of these occurs in segment xiii, and is not of any considerable size. From here onwards the more ventral nephridia, covered by the intestine in the normal condition, appear as two compact coils; the dorsal nephridia, of considerable size behind the prostate, are thin and flat, and occupy the lateral third of the bodywall on each side; there are also a few smaller coils near the middorsal line (? normally one per segment).

In the posterior third of the body, about 30 to 40 segments from the hinder end, there are two considerable nephridia on each side per segment; the dorsal of the two seems to be usually the longer, the ventral the more bushy; there is also on the bodywall a fur of very minute micronephridia. Between the thirtieth and twentieth segment from the end these minute nephridia become fewer, and after the twentieth they have almost gone. The dorsal nephridium has become relatively smaller, and the ventral larger; the latter is now a stoutish tube which forms only one or a few twisted loops; its calibre is much greater than that of the dorsal nephridium. The smaller nephridia could not be distinguished.

I succeeded in finding a funnel on one of these stout ventral nephridia (from the twenty-second segment, counting from the posterior end); it was formed of a rosette of cells, all the same size, evenly surrounding a small circular aperture; a narrow but quite short portion of the tube succeeds, which soon widens to form the stout tube of which nearly the whole nephridium consists. I did not find funnels in the nephridia from the region behind the clitellum.

Eudichogaster sp.

From base of leaves of tall palm tree, Museum compound, Calcutta, 28-vii-1909. A single specimen.

The condition of the worm did not permit of a satisfactory examination, and mention is made of it only because of its peculiar habitat.

Gen. *Dichogaster*.*Dichogaster malayana* (Horst).

(Plate xxxiii, figs. 35, 36).

Neyyatinkara, Travancore, 28-vi-1911. Two specimens.

Since the original description (7) of this species is short, and indeed omits mention of some organs or systems altogether, I give an account of the specimens in the present collection.

External Characters.—Length 30 mm., maximum diameter 1.5 mm. Colour grey with dark clitellum. Segments 92.

Prostomium proepilobous, hinder margin projecting backwards as an angular process into segment I; segment I partly divided in the midventral line by a median fissure leading backwards from the margin of the mouth.

The dorsal pores begin from furrow 5/6.

The setae are closely paired and all ventrally situated. The relations may be expressed thus:— $aa = bc = 3ab = 3cd$.

The clitellum extends from segments xiii to xx inclusive. It is brown in colour, lighter along a midventral strip, and sharply marked off by a constriction at both ends.

The prostatic apertures, on segments xvii and xix, are minute dots between the lines of setae *a* and *b* (? in line with *a*). The seminal grooves are straight, with only a slightly wavy course. The male pores were not visible. There are indications of slight transverse grooves between the prostatic pores of the same segment, and thus a rectangular figure is outlined on the male area.

The female aperture is perhaps in line with the setae of segment xiv, single and midventral (?).

The spermathecal apertures are in furrows 7/8 and 8/9, opposite the interval *ab*.

Internal Anatomy.—One specimen was dissected and the other sectioned.

The first septum probably represents 4/5; it is attached at the level of groove 4/5 below, but at that of 3/4 above. The next is septum 7/8, which envelopes the gizzard. Septa 10/11 to 12/13 are slightly thickened.

The oesophagus is bulged in an annular fashion in front of the gizzards. The gizzards, in segments vi and vii, are not well divided from each other; no septum is attached between them, and the separation is evidenced (apart from the examination of longitudinal sections) only by the wall of the thickened tube yielding under manipulation at a level corresponding to the line between the two. In sections however the muscular coat is easily seen to be interrupted for a narrow space. The oesophagus is continued, straight and fairly narrow, scarcely bulging at all, as far as segment xv, where it dilates somewhat. Calcareous glands, all of about the same size, are present in xv, xvi and xvii.

The micronephridia are present behind the clitellum in four rows on each side; each is a flat plate-like organ, subcircular in shape or rectangular with rounded corners. The rows nearly touch each other, and each organ being in longitudinal extent equal to about the length of a segment, the bodywall is pretty completely lined by them,—probably entirely so in the natural condition of the parts. The lowest row on each side is smaller than the others, and there is occasionally a fifth, still more ventral; if so it is also small.

In the clitellar region the nephridia have more the ordinary form of twisted tubes. More anteriorly some are seen in the neighbourhood of the spermathecae, but none are visible, in the dissection, on the bodywall; they may be seen in sections in the male genital segments.

Testes and funnels are free in segments x and xi.

The seminal vesicles are in segments x and xi; in the dissected specimen none were present in xii. In the sectioned specimen a vesicle was present on the right side in xii; it was of racemose form, composed of small rounded masses, each stalked and attached to a stem which in turn was implanted on septum 11/12; the whole, though not of large size (smaller than those in the segments in front), was still a conspicuous feature in the anatomy.

The prostates are tubular, in segments xvii and xix. That in xvii lies behind the calcareous gland, that in xix behind the bulging of the intestine, in the respective segments. They are vertically placed by the side of the alimentary tube, and the muscular duct is directed inwards from the lower end of the gland.

The spermathecae (fig. 35) are contained in segments vii and viii. The ampulla is rather small, ovoid in shape, and divided from the duct by a marked constriction. The duct is at least of the same size as the ampulla, pear-shaped and narrowing gradually to the aperture; the interior of the duct is occupied by a gelatinous-looking non-staining mass. A minute tag-like diverticulum is present in some, but not, apparently, in all; it arises from the duct on its anterior face at about the middle of its length.

The penial setae (fig. 36) are of several types. (1) A slender form 3.5 μ in thickness, with straight shaft and thin flattened oar-like extremity; the width of the flattened end is 6 μ . (2) A form which also presents a narrow shaft and expanded tip; but the expanded portion is one-sided only; length .28 mm., thickness at middle of shaft 4 μ . (3) A stout variety, breadth 7 μ , shaft straight in its proximal, gently curved in its distal portion; the distal end presents a few blunt projections on its sides and on the concavity of the curve. (4) A mixed type combining the tip of the second and the stout shaft of the third variety; the shaft shows a gentle, almost even curve, and tapers towards its free end; the extreme point is furnished with a wing-like expansion on one side only; length across the bend .3 mm., thickness at middle 6 μ , at proximal end 7 μ .

Dichogaster affinis (Mchlsn.)

Trivandrum, 20-vi-1911. Several specimens.

The species has previously been recorded by me from Ceylon (22). I stated that in the single specimen available for examination the organs of the anterior part of the body were displaced one segment forwards as compared with the normal condition. It is possible however that this may have been apparent only, and due to the small size and retraction of the first segment.

Dichogaster bolau (Mchlsn.) subsp. *palmicola* (Eisen).

Datar Hill, nr. Junagadh, Kathiawar, 1-xii-1912 (S. P. Agharkar). A single specimen.

From base of leaves of tall palm tree, Museum compound, Calcutta, 28-vii-1908. Two specimens.

From crown of palm tree, same place, 4-i-1911. Two specimens.

From base of leaf found on so-called Sago palm, Museum compound, Calcutta, 9-vii-1914. Several specimens.

It is interesting to find this Pacific subspecies in Calcutta, where it is also "palmicolous." The specimens show a few departures from the condition as originally described.

The size is one of the most marked of these differences, Eisen (6) attributing to this form a length of 55—60 mm., while the present specimens varied only between 16 and 21 mm.

The dorsal pores began in all in furrow 5/6.

The two gizzards are in segments vii and viii; but as in *D. malayana* septum 7/8 is absent.

The nephridia are in four rows.

The penial setae are of two types :—(1) Length .34 mm., diameter 7μ ; the shaft has a very slight $\int$ -shaped curve, and the tip is tapering, sharp and hooked. A few spines, not always confined to the concave side, stand off from the surface near the tip; these spines were about eight in number in one of the Kathiawar specimens, but were few (only about four) or entirely absent in one from Calcutta. (2) Length .32 mm., thickness near base 6μ , near tip only about 2.5μ ; the shaft shows a slight $\int$ -shaped curve; the tip is expanded to form a flat oval spatula- or oar-like blade about 4.5μ wide. There was no hint of a forking such as stated by Eisen for his specimens.

Gen. *Ocnerodrilus*.*Ocnerodrilus* (*Ocnerodrilus*) *occidentalis*, Eisen.

Under flower-pots, Ross I., Andamans, 26-iii-1911 (C. Parva). A number of specimens.

Fam. GLOSSOSCOLECIDAE.

Gen. *Pontoscolex*.*Pontoscolex corethrurus* (Fr. Müll.)

Trivandrum. Several occasions in 1911. Numerous specimens.

Vellany, 8-vi-1911. Numerous specimens.

Neyyatinkara, Travancore, 7-vii-1911 (*Shunker Narayan*). A number of specimens.

In mud in flower-pots, Ross I., Andamans, 26-iii-1911 (*C. Paiva*). Several specimens.

Gen. *Glyphidrilus*.*Glyphidrilus annandalei*, Mchlsn.

Trivandrum, 23-ix-1901. Numerous specimens.

Jaithy Field, Trivandrum, 5-ix-1906. Numerous specimens.

Trivandrum, 6-iii-1911. Numerous specimens.

Vellany, 29-ii-1911. Numerous specimens, but only one mature.

Neyyatinkara, Travancore, 7-vii-1911 (*Shunker Narayan*). Numerous specimens.

The limits of the clitellum are indefinite; taking it as marked out by the brick-red colour, it extends from xiii to xxxix in one specimen of which a complete examination was made.

There appeared to be an ovisac in segment xiv.

The setae are widely paired; the relations are simple:— $ab = cd = \frac{1}{2}aa$; bc is rather greater than aa ; $dd = aa$, and both c and d are on the dorsal surface. Towards the posterior end the setae of a pair are closer together:— $ab = cd = \frac{2}{3}aa = \frac{1}{3}bc$; $dd = 4cd$ and so is considerably greater than aa .

Glyphidrilus tuberosus, sp. nov.

(Plate xxxiii, fig. 37).

Kenduapatna Canal, Cuttack, 24-iii-1910 (*B. L. Chaudhuri*). Two specimens.

Ponds at Pubhans, Cuttack, 28-iii-1910 (*B. L. Chaudhuri*). Several specimens.

Mud at edge of River Tista, Jalpaiguri, 3-vi-1911 (*N. Annandale* and *S. W. Kemp*). Two specimens, immature.

External Characters.—Length estimated at 60 mm.; the specimen, which was considerably curled, broke on the first slight effort at straightening it. Breadth 2.5 mm. average, 3 mm. maximum. Colour a light brown, rather blotchy. Segments 221, all very short behind the clitellum. Behind the clitellum the dorsal surface is concave, and the ventral surface also flat or concave; hence a transverse section would be four-sided,—more especially towards the hinder end of the body, where all four surfaces are flat or concave. At the posterior end the dorsal surface is the most extensive, and is considerably broader than the ventral, so that the sides converge downwards. The anus is dorso-terminal.

The prostomium is prolobous or ? zygolobous. The demarcation between the prostomium and the first segment is a shallow transverse valley rather than a definite fissure or groove.

In front of the clitellum the setae are widely paired and rather irregular; *ab* is approximately equal to *cd*, and is half *aa* or less; *aa* is rather less than *bc*; *d* is dorsally situated, and *dd* is greater than either *aa* or *bc*. Behind the clitellum the setae are more regular, and are set at the angles of the transverse section; $aa = bc = 2ab = 2cd$; *dd* is the greatest interval, and is equal to $3cd$ or nearly so.

The clitellum extends from segment xiv, xv or xvi to xxviii or xxix (or xxx dorsally).

The genital markings are of two kinds, a series of small papillae, and certain cauliflower-like excrescences.

The papillae occur in three sets,—an anterior, on segments x to xii, a middle, on segments xvii to xix or on xviii and xix, and a posterior, on xxiv to xxviii. They are small, white, rounded elevations on the hinder parts of the segments to which they belong; sometimes, where the segments are short and swollen, they appear on the anterior wall of the intersegmental groove,—they may indeed be almost hidden in the groove.

In the anterior set, there is a single midventral papilla on segment x, a midventral and others more laterally placed on xi and xii. The full number of the lateral papillae here appears to be two on each side, symmetrically placed, one between *a* and *b*, the other outside *b*; some may be less definite than others, or one may be missing.

The middle series of papillae (fig. 37) consists of a pair on segment xvii,—one on each side near the middle line, internal to *a*; a similar pair, with or without one more laterally placed (outside *b*), on xviii; and six on xix, *viz.*, a pair near the middle line, as above, one on each side between *a* and *b*, and one on each side outside *b*. There may be no papillae on xvii.

In the posterior group also six, in the positions just described, appears to be the full number; but any one or more may be absent in one or other segment, so that the number may dwindle to one only (*e.g.* in segment xxviii in fig. 37, where the single papilla is one of the median pair).

The cauliflower-like outgrowths (fig. 37) are also variable; they may be described in a specimen in which they were well-marked. Extending ventro-laterally on the left side over segments xx to xxiii and partly on to xxiv also is a longitudinal crest or ridge, narrow from side to side, uneven, folded and notched; this ridge is well-marked only in the extent indicated, but it is continued forwards very faintly, inclining slightly dorsalwards, as far as xv or xiv. On the right side the ridge in segments xx to xxiii has grown out into a foliating tumour-like mass of numerous soft irregular closely apposed papillae; the ventral surface of the mass is flat and of triangular shape, the apex of the triangle extending inwards to the line *a*; as seen from the dorsal surface the mass is also triangu-

lar and similar in appearance to what has just been described, but the separate papillae are not so well marked. Another papillose excrescence occurs dorsally on the left side on segment xxiv; this is a similar patch of soft closely set papillae, taking up the length of the segment, but much broader in a transverse direction, extending indeed from the middorsal line nearly to the lateral line of the body. Some of the specimens, perhaps not fully mature, showed the lateral ridges but no cauliflower-like excrescences.

Internal Anatomy.—Septum 4/5 is thin, 5/6 slightly and 6/7 somewhat thickened; 7/8 is moderately thickened, and is the strongest of the series; 8/9 to 11/12 are less thickened again, and 12/13 only slightly so.

The degree of development of the gizzard varies in the two or three specimens dissected. In the first, though of moderate size, it was soft, thin-walled and vertically flattened,—i.e. in considerable degree rudimentary; in a second the wall was of moderate thickness, though the organ was still flattened dorso-ventrally; in a third the gizzard was well developed and fairly firm, and cylindrical in shape. The last-mentioned specimen would have been passed without comment in an ordinary way; but the firmness of the gizzard was in part deceptive, as on opening it it was found to be full of earth. The gizzard is contained in segment vii; in the last instance it extended also into the hinder part of vi.

There are no calcareous glands. The intestine begins in segment xv.

The last heart is in xi.

Testes and funnels are present in segments x and xi (testes not identified in xi).

The vesiculae seminales are four pairs, in segments ix to xii. Those in ix, on the anterior face of septum 9/10, are large and smooth; those in x, on the anterior face of 10/11 are smaller, and only slightly cut up into lobes; those in xi, on the posterior face of 10/11, are of the same size as the last, regularly ovoid and not lobed; the last pair, attached to the posterior surface of 11/12, are large, lobed and meet each other dorsally above the alimentary canal.

The ovaries occupy their usual position. Ovisacs are present in segment xiv; they were much flattened against the posterior face of septum 13/14 (being empty), but were of considerable vertical and transverse extent.

The spermathecae are situated in segments xiv and xv. They are small subspherical or somewhat irregular sacs, each with a short thin duct as a stalk, and without diverticula. The duct runs forwards towards the anterior boundary of the segment, and therefore debouches into the groove 13/14 or 14/15 as the case may be; at least the attachment to the parietes is nearer the anterior than the posterior septum of the segment. In number there are either three or four on each side in each segment,—three in both segments on the right side, four in the anterior and three in the posterior on the left side. The two externally placed sacs are in line

with setae *a* and *b*, the third is between *b* and *c*, and the fourth in line with *c*. Each spermatheca is about large enough to fill out the longitudinal extent of a segment.

Fam. LUMBRICIDAE.

Gen. *Helodrilus*.

Helodrilus (*Bimastus*) *parvus* (Eisen).

Edge of small stream, Barogh, Simla Hills, 5000 ft., 10-v-1910 (*N. Annandale*). Two specimens.
Kasauli, Simla Hills, 6000 ft., Aug. and Sept., 1915 (*Baini Prashad*). Numerous specimens.

Helodrilus (*Bimastus*) *constrictus* (Rosa).

Darjiling, ca. 6000 ft., April 1914 (*Carmichael collection*). Three specimens, one immature.

The clitellum begins on segment xxvi, but it extends behind so as to include xxxii,—the whole of it dorsally, and a half and two-thirds of it ventrally.

Pigmentation is wanting; and there are no papillae in the regions of setae *ab* of xvi.

The agreement is therefore not very close, but it hardly seems worth while making a new species or variety for these specimens.

Helodrilus (*Bimastus*) *eiseni* (Levins.)

Painsur, above Lohba, 8000 ft., 23-iv-1914 (*Col. Tytler*). A single specimen, not fully mature.

The identification is not absolutely certain; the species has been recorded from Kumaon district.

Helodrilus (*Eisenia*) *foetida* (Sav.)

Simla, W. Himalayas, 7000 ft., 9-v-1910 (*N. Annandale*). Four specimens.
Same place and collector. 12-13-v-1913. A single specimen.

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XX. NOTES ON CRUSTACEA DECAPODA IN THE INDIAN MUSEUM.

VI. INDIAN CRANGONIDAE.

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of India.

(Plate VIII.)

The number of Crangonidae known from Indian seas has been considerably increased by recent work in shallow water on various parts of the coast. In dealing with the additional material that has come to hand I have thought it useful to include references to all the known Indian forms and to construct keys to facilitate the identification of the species of *Pontophilus* and *Aegeon*.

Six species hitherto unknown are described, all belonging to the genus *Pontophilus*, while, thanks to the assistance of Dr. W. T. Calman, I have been able to rectify certain errors in the nomenclature of two species of *Aegeon*.

In a previous paper in this series¹ I expressed the view that *Philocheras*, Stebbing (= *Cheraphilus*, Kinahan, *partim*) could not be sustained as a distinct genus, but must be merged in *Pontophilus*. In examining the new forms of this genus a point hitherto overlooked has come to light, namely, that in certain species there are considerable differences between the sexes in the form of the pleopods. The modifications of these appendages are not only of interest as evidence of the affinities of the different species, they also, as it appears to me, afford a valuable clue to the origin of the various genera of the family and point to lines of descent very different from those suggested by Ortmann in 1890. I have thought it best to discuss the structure of these appendages and the phylogenetic conclusions which may be derived from them under a separate heading at the end of the paper.

In all eighteen species of Crangonidae are now known from Indian waters, ten belonging to the genus *Pontophilus*, six to *Aegeon*, and one each to *Prionocrangon* and *Crangon*.

Genus *Pontophilus*, Leach.

The six undescribed Indian species of this genus were obtained, two from Kilakarai at the northern end of the Gulf of Mannar

¹ *Rec. Ind. Mus.*, VI, p. 5 (1911).

and four from Port Blair in the Andamans. One of the new forms, *P. incisus*, is a very close ally of the Atlantic and Mediterranean *P. sculptus*, the remainder are sharply distinguished from all species previously described by well-marked characters found in the sculpture of the carapace and abdomen and in the form of the rostrum, lateral process of the antennule, antennal scale and first two pairs of legs.

In some of the species there are considerable differences between the sexes in the form of the last four pairs of pleopods, a feature discussed in detail on p. 381, and other sexual distinctions of an unusual nature are met with in *P. lowisi* and *P. candidus*. In the former the antennal scale, which is remarkable for the possession in both male and female of a series of spinules on its outer margin, shows wide differences in form in the two sexes. In the latter a conspicuous spine in the mid-dorsal line of the carapace is present in the male and absent in the female, a remarkable distinction when the great constancy of the armature of the carapace in other species is remembered.

The ten Indian species of *Pontophilus* may be distinguished thus:—

I.—First peraeopods with rudimentary exopod; second peraeopods very short, not reaching distal end of merus of first pair, their chela well formed with curved fingers; lateral process of antennular peduncle styliform, much longer than broad.

- A. Median carina of carapace with two spines ... *gracilis*, Smith.
- B. Median carina of carapace with three spines ... *abyssi*, Smith.

II.—First peraeopods without exopod; second peraeopods longer, reaching beyond carpus of first pair, their chela ill-formed with parallel fingers; lateral process of antennular peduncle not styliform, usually subquadrate and broader than long.

- A. A median longitudinal carina on carapace and on 3rd, 4th and 5th abdominal somites [rostrum broad distally, anterior margin squarely truncate or concave].

- 1. Outer margin of antennal scale armed with a spine or a series of spinules in addition to a terminal spine.

- a. Carapace with five carinae bearing spines; a single additional spine on outer margin of antennal scale, placed near base; merus of first peraeopods with a single spine at distal end of outer margin; first four abdominal somites with strong lateral sculpture ... *incisus*, sp. nov.

- b. Carapace without spines and without lateral carinae; a series of spinules on outer margin of antennal scale; merus of first peraeopods with three spines at distal end of outer margin; lateral sculpture of first four abdominal somites feeble ... *lowisi*, sp. nov.

- 2. Antennal scale without additional spines on outer margin; [carapace with spines and lateral carinae; first four abdominal somites with strong lateral sculpture.] ... *sabsechota*, Kemp.

- B. No median longitudinal carinae on carapace or abdomen.

1. Lateral margins of rostrum anteriorly divergent, apex broad, squarely truncate [carapace with one mid-dorsal spine in male only; two pairs of lateral spines in both sexes] ... *candidus*, sp. nov.
2. Lateral margins of rostrum anteriorly convergent, apex narrow, rounded or pointed.
 - a. Rostrum of good size, separating the eyes; carapace with one or more teeth in median line; dactylus of second peraeopods not narrower than fixed finger.
 - i. Carapace pubescent with three teeth in mid-dorsal line [four pairs of lateral teeth on carapace; lateral process of antennular peduncle anteriorly spinose] ... *pilosus*, sp. nov.
 - ii. Carapace not pubescent with only a single tooth in mid-dorsal line.
 8. Three pairs of lateral teeth on carapace; lateral process of antennular peduncle anteriorly pointed; "thumb" of subchela formed of a single articulated tooth ... *plebs*, sp. nov.
 8. No lateral teeth on carapace; lateral process of antennular peduncle anteriorly truncate; "thumb" of subchela formed of two teeth, closely juxtaposed and not articulated ... *hendersoni*, Kemp.
 - b. Rostrum exceedingly small, eyes contiguous; carapace without teeth in median line; dactylus of second peraeopods very slender, less than half the breadth of fixed finger ... *parvirostris*, sp. nov.

Pontophilus gracilis, Smith.

1901. *Pontophilus gracilis*, Alcock, *Cat. Indian deep-sea Crust. Macrura and Anomala*, p. 115.
 1905. *Pontophilus gracilis*, Stebbing, *Marine Invest. S. Africa*, IV, p. 49, pl. xxv.

Pontophilus abyssii, Smith.

1901. *Pontophilus abyssii*, Alcock, *Cat. Indian deep-sea Crust. Macrura and Anomala*, p. 116.

Pontophilus incisus, sp. nov.

(Plate viii, fig. 1.)

The rostrum is longitudinally channelled; its sides are almost parallel and its distal border, in dorsal view, is strongly concave. The actual apex is rounded, but is abruptly deflexed at a right angle and can therefore be seen only from in front. The sides of the rostrum and the orbital margins are clothed with long hairs which partially conceal the eyes.

On the carapace a shallow groove extends transversely across the base of the rostrum. In the mid-dorsal line there is a rather obscure interrupted carina composed of four short ridges. The first of these ridges ends anteriorly in a conspicuous tooth just behind the transverse groove mentioned above; the second, which is very feebly developed, usually terminates in a minute denticle; the third is

well elevated and its margin in lateral view is a little uneven; the fourth is distinct and ends abruptly. The first lateral carinae are not parallel, but converge anteriorly. Each is composed of a number of short ridges ending anteriorly in denticles. The foremost ridge is short and terminates in a comparatively large tooth placed a little behind the first of those in the median line. The small teeth or denticles on the two ridges posterior to it are also well formed, while the remainder are minute and can only be seen with difficulty. At the posterior end of the carapace there are a few additional short ridges, some bearing denticles, between the median and the first lateral carinae. The second lateral carina is also

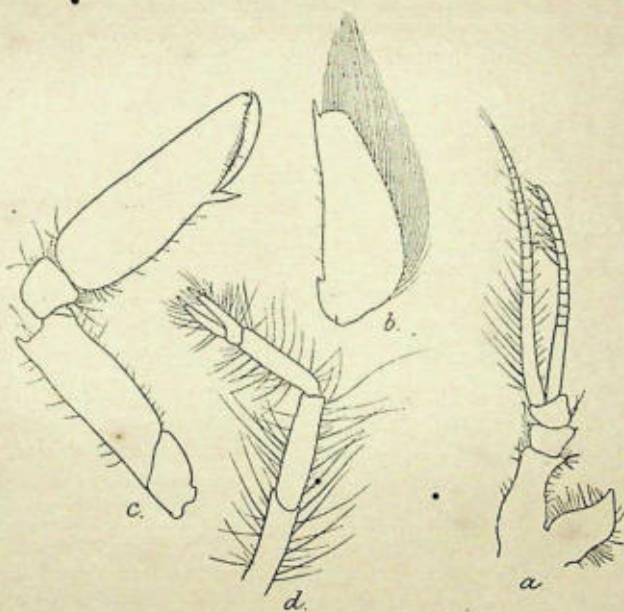


FIG. 1.—*Pontophilus incisus*, sp. nov.

a. Antennule.

b. Antennal scale.

c. First peraeopod.

d. Second peraeopod.

composed of interrupted ridges, the foremost ending in a stout hepatic tooth situated in advance of the primary median tooth. The ridge flanking the hepatic tooth is comparatively long and is succeeded by another, also of considerable length, which ends in a conspicuous tooth; the remaining ridges, three or four in number, are short and each may or may not bear a small denticle. There are sharp orbital and branchiostegal spines, the latter being the longer and extending beyond the level of the rostral apex. Except for the ridges, the entire carapace is covered with a fine pubescence and also, in many cases, bears several upstanding tufts of long setae.

The corneal portion of the eye is reniform in outline. The basal segment of the antennular peduncle (text-fig. 1a) is longitudinally keeled below and usually bears a small tooth near its proximal end. Its lateral process is transversely oblong with the outer distal angle somewhat drawn out and projecting forwards. The second and third segments of the peduncle are extremely short, the two combined being scarcely half the length of the first.

The antennal scale (text-fig. 1b) is broadest near the base and is narrowed strongly towards the apex. It is about three times as long as broad and the short spine which terminates its outer margin extends by almost its whole length beyond the apex of the lamella. On the outer margin, at the end of the proximal quarter is a single stout tooth, recalling that found in *P. sculptus*, but placed much nearer the base. The margin behind this tooth is strongly convex and that in front of it slightly concave.

The outer maxillipedes reach beyond the tip of the antennal scale by almost the entire length of the ultimate segment.

The first peraeopods (text-fig. 1c) are a little shorter than the outer maxillipedes and do not possess exopods. The spine on the outer margin of the merus is strong and, as in *P. sculptus*, is terminal in position. On the distal margin of the carpus there are two external spines. The propodus is nearly three and a half times as long as wide and the "thumb" of the subchela is exceptionally large and strong. At their base the first peraeopods are separated, in both sexes, by a sharp forwardly directed sternal tooth.

The second peraeopods (text fig. 1d) are clothed with long hairs and reach beyond the end of the carpus of the first pair by almost the entire length of the chela. The carpus is about one fifth shorter than the merus and nearly one fifth longer than the chela. The chela, as in allied species, is weakly constructed, without incurved claws at the apex. The fingers are of equal breadth and length and the palm is exceptionally short, occupying only about one fifth the length of the chela.

The slender third peraeopods reach beyond the tip of the antennal scale by the two terminal segments and by one third the length of the carpus. The latter segment is nearly one and a half times the length of the merus, twice the length of the ischium and one and a half times the length of the propodus and dactylus combined. The propodus is equal in length with the ischium and is two and a half times as long as the dactylus.

In the last two peraeopods, which are similar, the four distal segments are practically glabrous; those of the fourth pair reach beyond the antennal scale by the length of the dactylus. The merus in this pair is a trifle longer than the dactylus, four fifths the length of the propodus and nearly twice as long as the carpus. The dactylus is almost three quarters the length of the propodus.

The abdominal segments are deeply grooved and incised, much as in *P. sculptus*, the depressed portions being pubescent and the raised portions glabrous. On the first five somites the sculpture is

transverse for the most part; but there is a sharp longitudinal mid-dorsal carina in the posterior three-quarters of the third somite, a pair of juxtaposed carinae, fused posteriorly, in the same position on the fourth somite and a similar pair of carinae, slightly divergent posteriorly, on the fifth. On the sixth somite the only sculpture consists of a pair of longitudinal carinae separated by a broad flat interspace. The pleura of the first four somites are pointed below, bluntly in the female, rather more sharply in the male.

The pleopods show marked sexual differences. In the male the endopod of the last four pairs is comparatively well developed and possesses an appendix interna. In the female the endopod is reduced in size and is extremely small in the case of the last pleopod: the appendix interna is present in the second pair, but is much smaller than in the male; in the third and fourth pairs it is quite rudimentary and from the fifth it is entirely absent.

The outer uropod is shorter than the inner and is very slender, nearly four times as long as broad. The telson is scarcely longer than the inner uropod and is also very slender. It is sulcate above and bears two pairs of small dorso-lateral spinules. The lower edges are fringed with long setae and distally it terminates in a sharp point, flanked by a pair of short spinules and bearing two pairs of long finely plumose setae.

Large females reach a length of 18 mm.; the males are smaller, not exceeding 15 mm., and are apparently much less abundant. The eggs are about 0.4×0.3 mm. in longer and shorter diameter.

Pontophilus incisus is a remarkably close ally of *P. sculptus*, Bell, a species known from the Mediterranean and from the French and British coasts.¹ In all conspicuous characters there is a very close similarity between the two forms, but differences in detail are sufficiently numerous to justify their specific separation. In *P. incisus* there is only one strong tooth in the mid-dorsal line of the carapace, whereas in *P. sculptus* there are almost invariably two. In *P. incisus*, also, the antennal scale is narrower and the tooth on its outer margin is placed near the base instead of in the middle. In both species the spine on the outer margin of the merus of the first peraeopods is terminal and not sub-terminal as in some other species of the genus; in *P. incisus*, however, the anterior edge of the merus between this spine and the articulation of the carpus is entire, bearing only a few hairs, whereas in *P. sculptus* two or three additional spines are found in this position. In *P. incisus*, moreover, the lateral process of the antennular peduncle is more pointed distally, the subchela is more slender, the palm of the second peraeopods shorter and the dactyli of the last two peraeopods comparatively longer.

In a previous paper² I have remarked on the presence of the appendix interna in *P. sculptus*; but I failed to notice that in the

¹ I have compared the Indian species with specimens of *P. sculptus* from the Irish Sea.

² Kemp, *Rec. Ind. Mus.*, VI, p. 10 (1911).

development of this appendage there were marked sexual differences. The condition in *P. sculptus* is, in fact, precisely the same, as has been described above in the case of the related Indian form.

As regards the characteristic tooth on the outer edge of the antennal scale, I noted, in the paper cited above, that it was apparently absent in a single Mediterranean example of *P. sculptus* preserved in the Indian Museum. Further examination of this individual shows that the tooth is indeed present, but situated at the proximal end of the scale. The specimen is, in fact, in all points identical with the types of *P. incisus* and differs from *P. sculptus* in the characters noted above. It is labelled "Mediterranean" without more precise locality and is said to have been received from E. Cornalia, from whom Wood-Mason obtained a large number of Mediterranean Decapoda. From Heller's description,¹ however, it seems clear that the true *P. sculptus* occurs in the Mediterranean, for in his description of the antennal scale he says "am Seitenraude ausser dem endständigen stachel mit einem zweiten beiläufig in der Mitte." It is probable therefore that some mistake has arisen and that the specimen, said to have been found in the Mediterranean, was in reality obtained in Indian waters.

In life *Pontophilus incisus* is closely mottled with dark grey and brown, the colouration being apparently protective.

All the specimens in the collection are from the Andaman Is.—

2927	Andamans, 20 fms.	'Investigator.'	1, 10 mm.
9070-2	Port Blair, Andamans,	S. Kemp.	41, 7-18 mm.
10	2-12 fms.		

The specimens from Port Blair, among which the types of the species (9070/10) are included, were obtained in the channel off Ross I. on a rough bottom composed of sand, stones, shells and coral.

Pontophilus lowisi, sp. nov.

(Plate viii, fig. 2.)

The rostrum is longitudinally channelled above; its lateral margins are curved and strongly divergent distally. The anterior margin is very broad and, in dorsal view, a little concave. The true apex is sharply deflexed; it has a rounded margin and is visible only from in front.

On the carapace there is no trace of the transverse groove behind the rostrum which occurs in most species. In the mid-dorsal line there is a longitudinal carina which extends close up to the base of the rostrum. Throughout the greater part of its length, this carina is obscure; but for a short distance just behind the middle of the carapace it is sharp and well defined and owing to its greater elevation is distinct in lateral view. A feeble groove runs obliquely forwards and downwards on either side of the cara-

¹ Heller, *Crust. südlich. Europa*, p. 228 (1863).

pace terminating just above the sharp branchiostegal spine. This spine reaches to the level of the rostral apex and extends far in advance of that which defines the outer orbital angle. Except for those on its frontal margin the carapace is entirely devoid of spines and, except for that in the mid-dorsal line, it is without carinae. The carapace does not appear to be pubescent.

The basal segment of the antennular peduncle is about one and a half times the length of the second and third combined; its lateral process is oval (text-fig. 2a).

The antennal scale differs notably in the two sexes. In the female (text-fig. 2b') it is scarcely more than twice as long as broad

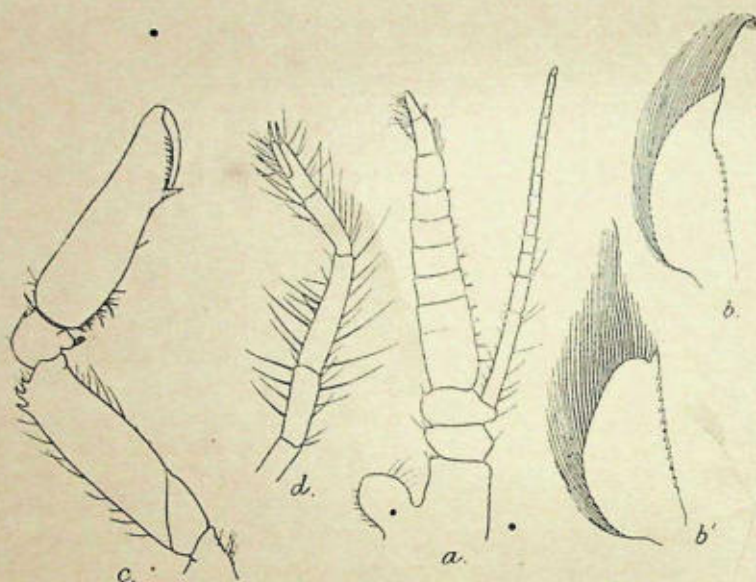


FIG. 2.—*Pontophilus lowisi*, sp. nov.

- | | |
|----------------------------|-------------------------------|
| a. Antennule. | b'. Antennal scale of female. |
| b. Antennal scale of male. | c. First peraeopod. |
| d. Second peraeopod. | |

and the lamella, though narrowed, is of considerable breadth at its distal end. In the male (text-fig. 2b), it is almost three times as long as broad and the lamella slopes sharply away from the base of the distal tooth. The outer margin in both sexes bears numerous spines, in this respect differing from all known species of the genus. In the female the margin is straight or very slightly concave and bears some 12 or 13 spines which increase in size from behind forwards. In the male the margin is strongly sinuous, convex in the middle and concave towards the distal end. It bears from 9 to 11 spines, similar to those of the female, but they are restricted to the basal convex portion of the margin and do not extend on to the concave part nearer the apex.

The third maxillipedes reach almost or quite to the end of the antennal scale. The combined length of the two subequal distal segments is not greater than that of the antepenultimate. The latter segment bears a few small spinules at the distal end of its lower margin and the exopod, when naturally flexed, reaches but little beyond the middle of its length.

The first peraeopods (text-fig. 2c) reach a little further than the third maxillipedes. The merus at its outer distal angle bears three stout curved spines and there is a single external spine near the distal end of the carpus. The subchela is a little more than three times as long as broad; the "thumb" is large and sharp as in *P. incisus*. The first legs are separated at their base by a large forwardly directed sternal tooth.

The second peraeopods (text-fig. 2d) are clothed with long hairs and reach beyond the carpus of the first pair; the merus is as long as the carpus and chela combined, the carpus is one and a third times the length of the chela and the fingers are a little less than one and a half times as long as the palm. Each finger bears a slender spine at its apex, but the spines are not curved and the claw is apparently without cutting edges. The fixed finger is a little broader than the dactylus.

The third peraeopods reach beyond the antennal scale by the length of the two ultimate segments. The proportions are much the same as in *P. incisus*, but the propodus and dactylus are comparatively a trifle longer, their combined lengths being almost three quarters that of the carpus.

The fourth and fifth pairs bear scattered setae on the propodus. The fifth reach beyond the scale by about half the length of the dactylus. The propodus in this limb is two and a half times the length of the carpus and is a quarter longer than the subequal merus and dactylus. Seen under a high power of the microscope the anterior margins of the merus and carpus have a roughened appearance, as though they were studded with small tubercles.

The abdomen in a dried specimen shows faint indications of sculpture, very shallow transverse grooves and elevations being visible on the first four segments. In the posterior half of the second somite and over the greater part of the third and fourth there are sharp longitudinal mid-dorsal carinae. Those on the second and third somites are simple, but that on the fourth is longitudinally grooved in the middle and thus has the appearance of a double carina fused at either end. There are two short dorsal carinae on the fifth somite and a pair of similar widely-separated carinae, which are exceedingly obscure, on the sixth. The pleura are not pointed inferiorly.

The pleopods of the male resemble those of *P. incisus*, the endopod of the last four pairs is well developed and carries an appendix interna. In the female, as in *P. incisus* and *P. sculptus*, the endopod is greatly reduced and the appendix interna, found in those species in a rudimentary condition on the second, third and fourth pairs, is entirely suppressed.

The outer uropod is a little shorter than the inner and bears long setae on its outer, as well as on its inner margin; it is a little more than three times as long as broad. The telson reaches about to the apex of the inner uropod; it is deeply sulcate above with two pairs of dorso-lateral spinules and in the form of its apex resembles *P. incisus*.

This species is, I believe, the smallest known Macruran. It is smaller even than *P. sabsechota*, Kemp, the largest individual in the collection, an ovigerous female, being slightly less than 7.5 mm. in total length. The eggs are comparatively large for such a small species; when not eyed and to all appearances freshly extruded they are about 0.34×0.27 mm. in longer and shorter diameter; when fully eyed and ready to hatch they measure about 0.48×0.36 mm.

Pontophilus lowisi is perhaps distantly related to *P. bidentatus*, de Haan¹, and *P. japonicus*, Doflein², but from both these species it differs conspicuously in the form of the carapace and in the presence of a series of spines on the outer edge of the antennal scale.

The colouring of the species differed considerably in specimens from different localities. Individuals found on a muddy bottom were for the most part densely pigmented with grey and brown, the last abdominal somite and tail-fan being colourless except for a dark transverse band on the latter. Specimens from sandy ground were much lighter in colour, often quite pale and sometimes with one or two transverse brown bands. In one example from this type of bottom the pigmentation is very peculiar, the carapace being deep amber brown, the abdomen white with transverse bars of brown on the fifth somite and tail-fan and the antennules bright red.

^{0.02 1.2 2.1}
1.0 Port Blair, Andamans, 3-12 fms. S. Kemp. 69, 4.5-7.5 mm.

Specimens were found off Ross I. and in various other parts of the harbour, but were most abundant at the inner end on a muddy bottom. The types of the species are numbered 9074/10 in the Indian Museum register.

With this species I have associated the name of Mr. R. F. Lewis, Deputy Superintendent of Port Blair, to whom I am much indebted for assistance during my visit to the Andamans.

Pontophilus sabsechota, Kemp.

1911. *Pontophilus sabsechota*, Kemp, *Rec. Ind. Mus.*, VI, p. 6, pl. ii, figs. 11-14.

A male from Port Blair, only 8 mm. in length, agrees in most particulars with the type, a female. The distal margin of the

¹ De Haan, in Siebold's *Fauna Japonica*, p. 183, pl. xlv, fig. 14 (1849) and Balss, *Abhandl. math.-phys. Klasse K. Bayer. Akad. Wiss. München*, Suppl. Bd. II, p. 68, text-fig. 41 (1914).

² Doflein, *Abhandl. math.-phys. Klasse K. Bayer. Akad. Wiss. München*, XXI, p. 621, pl. iii, fig. 6, and text-fig. p. 622 (1902).

rostrum is, however, more definitely concave in dorsal view and the anterior tooth of the second lateral carina of the carapace is less acute. The outer margin of the merus of the first legs terminates in a small spine and two similar spines exist between it and the articulation of the carpus: these spines do not exist in the type. The dactylus of the second legs is proportionately shorter than in the female, less than twice the length of the palm. The dorsal carina of the fourth abdominal somite is feebly channelled longitudinally; that of the fifth is similar in its anterior half, but posteriorly it is split into two divergent branches. On either side of the median line in the third, fourth and fifth somites are short but well defined carinae, which are transverse on the third but take a more oblique direction on the two succeeding somites. In the type specimen these lateral carinae are obsolete and the median keel of the fourth somite does not appear to be bifurcated posteriorly. In the pleopods there is a wide difference between the sexes. The endopod of the last four pairs is well developed in the female; but in the male is exceedingly small in the second, third and fourth pairs and is entirely absent from the fifth.

In life the male was almost pure white in colour with a black spot in front of the median tooth of the carapace, a pair of similar spots on either side between the first and second lateral carinae and a pair near the posterior margin. There were transverse bars of black pigment on the fourth abdominal somite and on the tail-fan, a black band near the distal end of the subchela and three similar bands on the fourth leg, situated on the ischium, merus and propodus.

1908.5
10 Port Blair, Andamans, 6 fms.

S. Kemp.

1 ♂, 8 mm.

Pontophilus candidus, sp. nov.

(Plate viii, fig. 3.)

The rostrum is flat and not channelled longitudinally; its lateral margins are curved, convergent from the base to the middle and divergent from the middle onwards. The distal end, seen in dorsal view, is abruptly and squarely truncate. The true apex of the rostrum is sharply deflexed; it is visible only from in front and has a broadly convex margin.

The carapace is entirely devoid of carinae; its surface, though smooth to the naked eye, is microscopically scabrous. The transverse depression usually found behind the rostrum is obsolete. The spinulation shows a remarkable difference in the two sexes. In the male there is a sharp spine in the median line a little behind the base of the rostrum, but of this in the female there is no trace. In both sexes there is a sharp hepatic spine, situated about on the same level as the dorsal spine of the male, and below and in advance of it is another conspicuous spine situated behind the branchiostegal angle. In the male there is a short longitudinal groove above the hepatic spine and another beneath it, shallower

and considerably longer, extending almost to the posterior margin of the carapace. The branchiostegal angle is sharp and reaches the level of the fostral apex. On the margin immediately beneath it is a small spinule.

The basal segment of the antennular peduncle (text-fig. 3a) is broad, its outer distal angle is bluntly produced. The lateral process is transversely oval with a straight posterior margin and a sharp point at its antero-external angle. The antennal scale (text-fig. 3b) is broad, not more than two and a third times as long as wide; the outer margin is a trifle sinuous and terminates in a sharp spine which does not reach nearly as far forwards as the distal end of the lamella.

The third maxillipedes reach a little beyond the end of the

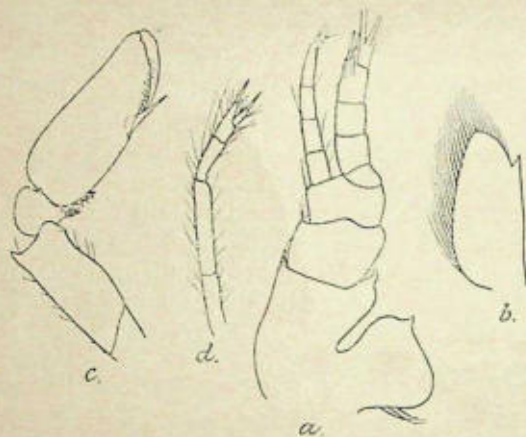


FIG. 3.—*Pontophilus candidus*, sp. nov.

a. Antennule.

b. Antennal scale.

c. First peraeopod.

d. Second peraeopod.

antennal scale; the ultimate segment is decidedly longer than the antepenultimate.

The first peraeopods (text-fig. 3c) reach a little beyond the third maxillipede and do not possess an exopod. The outer edge of the merus terminates in a single stout tooth and the margin between this tooth and the carpal articulation is entire. The carpus bears two spines on its outer distal margin. The subchela is little more than two and a half times as long as wide; the cutting margin is strongly oblique and the spine which forms the 'thumb' is extremely long and slender and is remarkable in that it is articulated and movable. The first legs are not separated at their base by the forwardly directed sternal tooth found in some other species of the genus.

The second peraeopods (text-fig. 3d) reach beyond the carpus of the first pair and are lightly clothed with hair. The merus is

long, more than twice the length of the carpus; the chela is a little shorter than the carpus. The fingers are a trifle shorter than the palm; they are of equal breadth, without definite cutting margins, and each bears at its apex a single stout seta serrated on the inner side.

The third pereopods reach beyond the end of the first by the two ultimate segments. The carpus is one third the length of the merus and is a little shorter than the propodus and dactylus combined. In the fourth pair the propodus is the longest segment, nearly a quarter longer than the merus, a trifle longer than the carpus, and about 1.7 times the length of the dactylus.

The abdomen is quite smooth, without trace of sculpture; the lower margins of the pleura are rounded. The pleopods resemble those of *P. lowisi*. The endopod of the last four pairs in the female is greatly reduced and shows no trace of an appendix interna. In the male the endopod is better developed and in all four pairs is provided with a well formed appendix.

The outer uropod is shorter than the inner and is about three times as long as broad; its external margin is without setae, except for a few at the distal end. The telson reaches about as far as the outer uropod and is not sulcate above. It bears two pairs of dorso-lateral spinules and the apex is similar to that of *P. incisus*.

Living specimens were as a rule almost pure white with a narrow transverse brown band on the tail-fan.

^{9082:4}₁₀ Port Blair, Andamans. S. Kemp. 2 ♂, 4 ♀, 7-10 mm.

The type specimens bear the number 9082/10.

Pontophilus pilosus, sp. nov.

(Plate viii, fig. 4.)

The rostrum is well developed and reaches almost to the end of the eyestalks. It is deeply hollowed longitudinally and tapers to a narrow rounded apex. On its ventral side there is a deep vertical keel, extending downwards between the eyestalks. The keel ends abruptly a little behind the apex where it bears a tuft of long setae.

The carapace is everywhere clothed with a fine pubescence, which, over the greater part of the surface, is comparatively short, but becomes more conspicuous laterally and on the antero-lateral portions takes the form of long silky hairs. There are three procurved teeth in the mid-dorsal line, but no carina. The first two of these teeth are placed rather close together in the anterior half of the carapace, while the third is in the middle of the posterior half. Behind the antennal spine, which reaches almost as far forward as the rostrum, there are two small teeth placed one behind the other in the latitude of the first tooth of the mid-dorsal series. Below these there is a stout hepatic tooth which overhangs a deep sulcus—the lateral continuation of the transverse post-rostral

groove, especially well marked in this portion of the carapace. The branchiostegal spine is strong and extends forwards beyond the level of the eyestalks. Behind it is another small tooth, placed further forward than any others of the dorsal series. Exclusive of the spines on its frontal margin, there are in all eleven teeth on the carapace: none of these teeth form the terminations of carinae.

In the male each of the last three thoracic sterna bears a median keel, which ends anteriorly in a small tooth: these keels are absent in the female. The first and second pairs of legs are adjacent at the base in the male and are not separated by the antorse spine found in *P. hendersoni*.

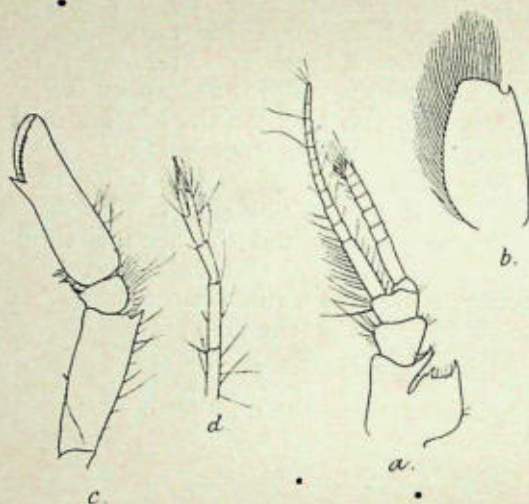


FIG. 4.—*Pontophilus pilosus*, sp. nov.

a. Antennule.

b. Antennal scale.

c. First peraeopod.

d. Second peraeopod.

The eyes are stout and short. In both sexes the distal margin of the stalk, on its upper and inner side, is produced beyond the cornea to a small but conspicuous papilla.

The basal segment of the antennular peduncle (text-fig. 4a) bears a stout ventral spine and another at the distal end of its outer margin. The lateral process is peculiar in form. It is fully as long as broad and is furnished anteriorly with two spines, the outermost the largest and the inner bearing a small internal spinule. The outer flagellum does not appear to be appreciably stouter in the male than in the female and is shorter than the peduncle.

The antennal scale (text-fig. 4b) is broad, its breadth in a large female being more than half its length. The outer margin is convex and terminates in a spine which does not reach as far forward as the lamella and is separated from it by a broad U-shaped gap.

The outer maxillipedes are clothed with long setae and reach beyond the end of the antennal scale by almost the entire length of the ultimate segment.

The first peraeopods (text-fig. 4c) are a little shorter than the outer maxillipedes and are not provided with exopods. The spine on the outer margin of the merus is terminal and on the anterior margin between it and the articulation of the carpus there is another smaller spine. The carpus is short; the inner margin is lobed and bears coarse setae, while on the outer margin are two spines. The breadth of the hand, measured near its base, is about one third its entire length.

The second peraeopods (text-fig. 4d) reach to the carpus of the first pair. The carpus is two thirds the length of the merus and is as long as the palm and half the length of the fingers. In the chela, which as in the preceding species is weakly constructed and without cutting margins or terminal claws, the palm is about one seventh longer than the dactylus. The fixed finger is noticeably shorter than the dactylus and both fingers bear long setae.

The slender third peraeopods reach beyond the antennal scale by about the length of the two ultimate segments. The merus is a little shorter than the ischium and a little longer than the propodus. The carpus is one and two thirds the length of the merus and is one fifth longer than the propodus and dactylus combined. The fourth and fifth legs are rather densely clothed with hairs. The merus, carpus and propodus are subequal and the dactylus is a little more than half their length.

The abdominal somites are quite smooth and are covered with a fine pubescence similar to that on the carapace; the margins of the pleura are rounded. The inner ramus of the last four pairs of pleopods is comparatively well developed in the male and carries an appendix interna; in the female it is reduced and no trace of this appendage is to be found. The outer uropod is shorter than the inner and is nearly three times as long as broad. The telson is one and a half times the length of the last abdominal somite; it is provided with two pairs of dorso lateral spinules and its lower margins are ciliated. The apex is similar to that of *P. parvirostris*.

Pontophilus pilosus is sometimes conspicuously banded in life with dark brown. In examples from very shallow water there is a narrow transverse band at the posterior end of the carapace and others, rather broader, on the second and fourth abdominal somites and across the middle of the telson and uropods. Individuals obtained at a depth of two fathoms were marbled with brown pigment mixed with a certain amount of pure white, the carapace being sometimes of a dull reddish-brown. In all the specimens there was a dark spot at the distal end of the subchela.

The specimens were obtained at the northern end of the Gulf of Mannar.—

⁸⁹⁷⁹₁₀ Kilakarai, Ramnad
dist., S. India.

S. Kemp.

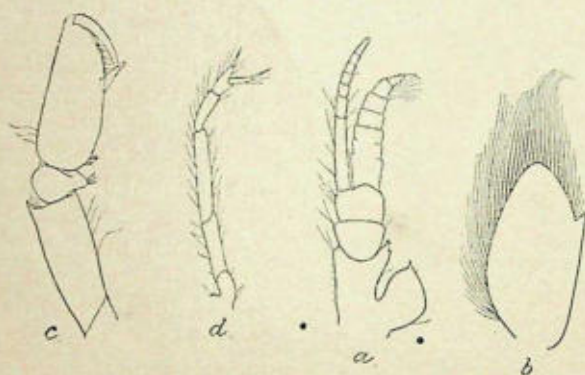
2 juv., 3 ♂, 4 ♀,
5.5-13 mm. TYPES.

Pontophilus plebs, sp. nov.

(Plate viii, fig. 5.)

The rostrum is longitudinally channelled; its lateral margins are convergent and meet in a narrowly rounded apex. The carapace is devoid of pubescence and is not carinated. It bears seven teeth, one situated mid-dorsally, close behind the rostrum and separated from it by a shallow transverse groove, and three pairs on either side. The latter comprise a stout hepatic tooth, on a level with that in the middle line, and two small teeth, both in advance of the hepatic, placed close together behind the sharp spinous branchiostegal angle. In the anterior half of the carapace there are obscure longitudinal furrows above and below the hepatic tooth.

The basal segment of the antennular peduncle (text-fig 5a) is longer than the two following combined, externally the distal

FIG. 5.—*Pontophilus plebs*, sp. nov.

a. Antennule.

b. Antennal scale.

c. First peraeopod.

d. Second peraeopod.

margin is produced to an acute tooth. The lateral process is more or less oval in shape, longer than broad, and is anteriorly pointed. The second and third segments are broader than long. The antennal scale (text-fig. 5b) is only twice as long as broad; the outer margin is straight and terminates in a tooth which is far exceeded by the distal end of the lamella.

The third maxillipedes reach beyond the scale by about half the length of the ultimate segment. The first peraeopods (text-fig. 5c) are scarcely shorter. The outer edge of the merus terminates in a large tooth and the margin between this tooth and the articulation of the carpus is unarmed. The carpus bears a stout external tooth. The hand is about two and a half times as long as wide and the single tooth which forms the 'thumb' of the sub-

chela is articulated, as in *P. candidus*, and not fixed as in most species of the genus.

The second peraeopods (text-fig. 5d) reach little beyond the end of the merus of the first pair. The merus is one third longer than the ischium and more than twice the length of the carpus. The dactylus is longer than the palm and conspicuously longer than the fixed finger, the fingers are of equal breadth and each bears a single stout seta at its apex. The whole limb is rather thickly clothed with hairs.

The slender third peraeopods reach beyond the end of the antennal scale. The carpus is a little longer than the merus and as long as the propodus and dactylus combined. The fourth and fifth peraeopods are shorter than the third. In the fifth pair the dactylus and propodus are subequal; the carpus is a little longer than the propodus and a little shorter than the merus.

In the male the last three segments of the thoracic sternum are carinate, the carina of each ending anteriorly in a small tooth. These carinae and teeth do not appear to exist in the female and in neither sex is there a sternal spine extending between the bases of the third legs.

The abdominal somites are smooth, without sculpture or pubescence; their pleura are rounded inferiorly. In the male the endopod of each of the last four pairs of pleopods is comparatively well developed and possesses an appendix interna. In the female there is no appendix interna and the endopod is very small in the second and third pairs, quite rudimentary on the fourth and absent from the fifth.

The telson, including the terminal spines, reaches a little beyond the end of the inner uropod. It is not sulcate above and bears two pairs of lateral spinules between which are two rows of exceedingly minute denticles. These denticles can only be seen if the telson is viewed obliquely from the side under a microscope; they extend from the base almost to the distal end and may be as many as sixteen in number. The apex is closely similar to that of *P. incisus*.

The outer uropod is shorter than the inner. It bears setae on its external margin and is fully three and a half times as long as broad.

The largest of the nine specimens obtained is only 6 mm. in length. No ovigerous females were found and it is possible, therefore, that all are immature. The characters are, however, quite distinctive and experience with other species leads me to believe that they would not change appreciably with further growth. The specimens were pale in life with sparse black dendritic chromatophores.

⁹¹⁵⁸₁₀ Port Blair, Andamans, 2 fms. S. Kemp. ♀ 4½-6 mm. TYPES.

The specimens were all found together in Phoenix Bay on a bottom of muddy sand.

Pontophilus hendersoni, Kemp.

1915. *Pontophilus hendersoni*, Kemp, *Mem. Ind. Mus.*, V, p. 261, pl. xiii, fig. 8.

The characters given in the key on pp. 356 and 357 will suffice to distinguish this species from all other Indian representatives of the genus.

P. hendersoni is very closely allied to *P. megalochair* (Stebbing)¹, obtained at depths of 25 and 37 fathoms on the coast of S. Africa. The African form agrees in nearly all respects with that from the Indian coast; in particular, there is (as shown in Stebbing's figures) an almost complete identity of form in the structure of the subchela, the 'thumb' being composed of two closely juxtaposed spines instead of the single one found in all other species of the genus.

There are, however, certain discrepancies between Stebbing's account and my own, which, if substantiated, are sufficient to justify the separation of the two forms. The apex of the lamella of the antennal scale is, for instance, much more acute in *P. megalochair* than in *P. hendersoni*, extending much further beyond the apex of the spine that terminates the outer margin (cf. Stebbing's pl. lxxix, fig. a.i. and my text-fig. 25a). Stebbing also has made no mention of the small tubercle found in *P. hendersoni* on the dorsum of the third abdominal somite and the armature of the telson is totally different. In *P. megalochair* the telson is furnished at its apex with a long and slender tooth, flanked by a pair of plumose setae (v. Stebbing, pl. lxxix, fig. T). In *P. hendersoni* the apex consists of a triangular plate with a minute spinule on either side and with two pairs of plumose setae arising from beneath it (v. Kemp, text-figs. 25 g, g').

Since the original account of *P. hendersoni* was published, additional specimens have been taken in the open sea on the Orissa Coast, a circumstance which tends to confirm the view that the occurrence of the species in the outer channel of the Chilka Lake was purely accidental and that it is not normally an inhabitant of brackish water.

²⁵⁵⁶₁₀ Puri, Orissa coast, 4-4½ fms.

S. Kemp.

3, 6½-9 mm.

Pontophilus parvirostris, sp. nov.

(Plate viii, fig. 6.)

The rostrum is extremely small, far less conspicuous than in any other species of the genus. It recalls that found in many Pagurids and consists merely of a small flat triangular prolongation of the median part of the carapace. The apex is acute and does not reach further than to one third the length of the eyestalks.

The antennal spine is sharp and extends far beyond the level of the rostral apex; the branchiostegal spine is long and reaches

¹ *Philocheras megalochair*, Stebbing, *Ann. S. African Mus.*, XV, p. 71, pl. lxxix (1915). This work was not received in Calcutta in sufficient time to enable me to refer to it in my account of the Decapods of the Chilka Lake.

almost as far forwards as the ends of the eyestalks. The latter spine is flanked by a short carina which runs obliquely downwards and backwards and, above its posterior termination, in the anterior quarter of the carapace, there is another well marked spine. Except for this spine and for the carina mentioned above the entire surface of the carapace is smooth, save for a feeble transverse depression behind the frontal margin. On the sides of the carapace, most numerous below the branchiostegal carina, are some long silky hairs.

The thoracic sterna of the female are not carinate.

The eyes are elongate and their inner margins are contiguous; the cornea is well pigmented and its length in dorsal view is about equal to that of the stalk.

The basal segment of the antennular peduncle (text-fig. 6a) bears two stout teeth, one situated ventrally and one externally

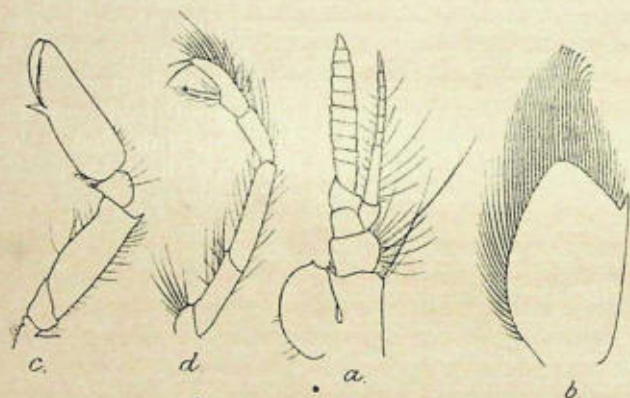


FIG. 6.—*Pontophilus parvirostris*, sp. nov.

a. Antennule.

b. Antennal scale.

c. First pereopod.

d. Second pereopod.

at its distal end. The lateral process is elongate oval and is furnished with a minute point anteriorly. The second and third segments are about equal in length and the outer flagellum in the female is about as long as the peduncle.

The antennal scale (text-fig. 6b) is about one and two thirds as long as broad; the outer margin is very slightly convex and terminates in a stout tooth which does not reach nearly as far forwards as the apex of the lamella.

The outer maxillipedes reach beyond the apex of the scale by more than half the length of the ultimate segment.

The first pereopods (text-fig. 6c) reach as far forwards as the third maxillipedes and do not possess exopods. The merus bears a terminal (not sub-terminal) spine at the distal end of its outer margin. On the outer and inferior aspect of the carpus there is a sharp spine; the inner angle is produced and is provided with a

tuft of coarse setae. The basal breadth of the hand is little more than one third its entire length. The "thumb" of the subchela is stout and strongly deflected outwards. On the inner surface near the base of the propodus there is the usual tuft of coarse setae.

The second peraeopods (text-fig. 6d) reach about to the end of the merus of the first pair. The chela is a trifle longer than the carpus and is remarkable in that the dactylus is extremely slender, less than half the thickness of the fixed finger. As in allied forms the chela is very weakly constructed and is without terminal claws or definite cutting edges. The palm is about two thirds the length of the fingers and the propodus on its outer margin is densely fringed with long setae.

The slender third peraeopods reach beyond the scale by the whole length of the two ultimate segments. The merus is a little longer than the ischium and a little shorter than the propodus and dactylus combined. The carpus is twice the length of the ischium.

The fourth and fifth peraeopods are similar and stouter than the third. The merus is a little longer than the subequal carpus and propodus and about three times the length of the dactylus. The segments are rather densely clothed with hairs.

The abdominal somites are quite smooth, without carinae or grooves, and the margins of the pleura are rounded below. The sixth somite is about equal in length with the telson. The inner ramus of the last four pairs of pleopods is very short and does not possess an appendix interna. The uropods are half as long again as the telson and the exopod is nearly four times as long as broad.

The telson is rather broad at the base, but much narrowed at the apex. The margins are setose and there are two pairs of dorso-lateral spinules. The tip is triangular and sharply acute; beneath it three pairs of spinules arise, the innermost two thirds the length of the intermediate pair and two and a half times as long as the outer.

The colour in life of *Pontophilus parvirostris* was pale, mottled and spotted with dark umber, tending to maroon at the sides and on the appendages and forming distinct blotches on the pleura of the first, fourth and sixth abdominal somites.

The specimens are registered thus,—

*₁₀⁸⁸⁰ Kilakarai, Ramnad dist., S. India. S. Kemp. 4 ♀, 9-14 mm.
TYPES.

Genus *Aegeon*, Guérin Méneville.

1888. *Pontocaris*, Bate, Rep. 'Challenger' *Macrura*, p. 495.

1900. *Aegeon*, Stebbing, *Marine Invest. S. Africa*, I, p. 50.

1901. *Aegeon*, Alcock, *Cat. Indian deep-sea Crust. Macrura and Anomala*, p. 117 (including subgenus *Parapontocaris* p. 120).

All the described forms of this genus are represented in the collection of the Indian Museum. Three of them, *Aegeon orientalis*, Henderson, *A. habereri*, Doflein, and *A. lacazei*, Gourret, are intermediate in character between the more typical species of the genus and those which Alcock referred to the subgenus *Parapont-*

tocaris; the latter term should therefore lapse. *Aegeon orientalis* agrees with *Parapontocaris* in the complete absence of the hepatic groove and in the arrangement of the carinae on the first and second abdominal somites and resembles typical *Aegeon* in the very broad antennal scale and in the possession of strong median spines on the abdominal sterna. *Aegeon habereri* and *lacazei* are closely allied forms: in most respects they agree closely with typical species of the genus, but they resemble *Parapontocaris* in the sculpture of the first two abdominal somites and in the elongate form of the antennal scale.

In all six species of *Aegeon* are known from Indian waters; they may be distinguished by the following key:—

- I. Second lateral carina of carapace interrupted anteriorly by a well defined hepatic groove; lateral parts of 1st and 2nd abdominal somites irregularly lobed, without sharp longitudinal keels continuous with those on carapace.
 - A. Median carina of carapace with 4 teeth; two or three tubercles, forming an oblique transverse row, between median and 1st lateral carinae ... *cataphractus* (Olivi).
 - B. Median carina of carapace with 8 or 9 teeth or serrations; surface between carinae of carapace smooth, without tubercles.
 1. Marginal carina of carapace smooth; two lobules separated by a vertical furrow on either side of median carina of 2nd abdominal somite ... *pennata*, Bate.
 2. Marginal carina of carapace serrulate; a sinuous longitudinal ridge, entire and not divided by a furrow, on either side of median carina of 2nd abdominal somite ... *propensalata*, Bate.
- II. Second lateral carina of carapace not interrupted, hepatic groove absent; lateral parts of 1st and 2nd abdominal somites with sharp longitudinal keels continuous with those on carapace.
 - A. 1st and 2nd lateral carinae of carapace with 7 teeth, marginal with 7 to 9; antennal scale as broad as long ... *orientalis*, Henderson.
 - B. 1st lateral carina of carapace with 4 teeth, 2nd lateral with 3 to 6, marginal with 2 or 3; antennal scale much longer than broad.
 1. 2nd lateral carina of carapace with 5 or 6 teeth, marginal with 3; median carina of 2nd abdominal tergum bispinous ... *andamanense* (Wood-Mason).
 2. 2nd lateral carina of carapace with 3 teeth, marginal with 2; median carina of 2nd abdominal tergum unispinous ... *bengalense* (Wood-Mason).

Aegeon cataphractus (Olivi).

1900. *Aegeon cataphractus*, Stebbing, *Marine Invest. S. Africa*, I, p. 50 (*ubi syn.*).
1905. *Aegeon cataphractus*, Pearson, *Ceylon Pearl Oyster Fish., Macrura*, p. 89.

Except that the teeth on the carapace are blunter and that the abdominal sculpture is a little less sharply defined, I can find no difference between the two Indian specimens and others of similar size from the Mediterranean.

Characteristic of *A. cataphractus* are the supernumerary tubercles between the longitudinal carinae of the carapace. Between the median and uppermost carinae are two or three tubercles arranged to form an oblique transverse row, which commences in the middle of the carapace and extends forwards and outwards on either side. Between the first and second lateral carinae there is a single tubercle placed on the posterior edge of the hepatic groove. Though both the Indian examples are small these tubercles are clearly visible.

The occurrence of this species in India is interesting, for very few sub-littoral Decapoda are common to the Mediterranean and to Indian waters. Miers, however, states that the species probably occurs at Senegambia, while Stebbing records it from the Cape of Good Hope, so that there is reason to believe that the distribution is continuous round the African coasts.

In Indian waters *A. cataphractus* appears to be very scarce. Pearson has recorded it from the Ceylon Pearl Banks and there are two specimens in the Indian Museum, both obtained on the west coast of the peninsula:—

- 2244 26 mi. W.S.W. of Honawar, N. 'Investigator.' 1♀, 15 mm.
 Kanara dist., Bombay Pres., 28 fms.
 2453 Karachi. W. T. Blanford. 1♂, 23 mm.

Aegeon pennata (Bate).

1888. *Pontocaris pennata*, Bate, Rep. 'Challenger' Macrura, p. 449, pl. xci.
 1895. *Pontocaris pennata*, Ortmann, Proc. Acad. Sci. Philadelphia, p. 175.
 1901. *Aegeon affine*, Alcock, Cat. Indian deep-sea Crust. Macrura and Anomala, p. 188, and Illust. Zool. 'Investigator,' pl. li, figs. 3, 4.
 1914. *Aegeon obsoletum*, Balss, Abh. math.-phys. Klasse Bayer. Akad. Wiss. München, Suppl. Bd. II, p. 70, pl. i, figs. 3.

Alcock, when describing *Aegeon affine*, suggested that the species might prove to be identical with Bate's *Pontocaris pennata*. The description and figures of the latter species being inadequate, the point could only be determined by actual comparison of specimens. In order to settle the question I sent co-types of *A. affine* to Dr. Calman, who, with his usual kindness, readily undertook to give me an opinion. He informs me that Alcock's suggestion is correct and that there is no doubt that the two forms are specifically identical.

An example of *Aegeon obsoletum*, determined by Balss, has been received in exchange from the Munich Museum; it was obtained in Sagami Bay, Japan, at a depth of 50-100 m. The individual agrees precisely with Indian specimens of *A. pennata*.

In addition to the characters noted by Alcock for the separation of this species from *A. medium* (= *A. propensalata*, Bate),

there is a marked difference between the two in the sculpture of the second abdominal somite. In *A. propensalata*, on either side of the middle line, there is a broad sinuous ridge which extends obliquely throughout the length of the somite. In *A. pennata* this ridge is broken in two by a deep vertical furrow.

Dr. Calman has kindly sent me the following notes regarding the types obtained by the 'Challenger'—"The three specimens of *P. pennata* differ among themselves in the form of the rostrum and other characters. In two specimens the rostrum is relatively short, bifid at tip, and with the lateral spines as large as in *A. medium*. In the third specimen the rostrum is longer, sharp-pointed, and with very small lateral spines. In this last specimen also there is a tendency towards a softening of the inequalities of the general surface, i.e. the keels and ridges are not so prominent. In particular the two lobules on either side of the median carina of the second abdominal somite are not sharply defined, although the vertical furrow separating them is distinct."

The following records of occurrence in Indian waters may be added to those given by Alcock:—

1911	Persian Gulf, 26°20'30" N., 54°52'30" E., 35 fms.	'Investigator'	Five.
1909	Persian Gulf, 26°33' N., 52°23' E., 40 fms.	"	One.
1911	Arabian Sea, 24°26'50" N., 66°35'50" E., 35 fms.	"	Seven.
1917	Coromandel coast, 14°25' N., 80°15'45" E., 12 fms.	"	Two.
1907-8, 1907-9	Ganjam coast, 26-93 fms.	"	Twenty-two.
1905-1906, 1907-9	28 mi. S.W. of Puri, Orissa, 25 fms.	"	Three.
1902-3	Off Gangetic delta, 20°18' N., 90°50' E., 65 fms.	"	One.
1912	Off Tennasserim coast, 13°27'30" N., 97°37' E., 50 fms.	"	Two.
1900	Off Cheduba, Arakan coast, 20 fms.	"	One.

According to the labels the individual from the neighbourhood of the Gangetic delta was, "grey, touched with dark brown and green marks", while some of those from the Ganjam coast were irregularly banded with lichen green and mottled pink.

On the Indian coasts *A. pennata* is evidently common; it has been found at depths ranging from 12 to 93 fathoms. The type specimens were obtained by the 'Challenger' in the Arafura Sea, south of New Guinea, 8°56'S., 136°5'E., at a depth of 49 fathoms. Balss, under the name *A. obsoletum*, records numerous specimens from Japan from depths of 80 to 150 metres. The species is apparently one of wide Indo-Pacific distribution.

Aegeon propensalata (Bate).

1888. *Pontocaris propensalata*, Bate, Rep. 'Challenger' Macrura, p. 46, pl. xc, figs. 2, 3; pl. lxxxv, fig. 5.
1895. *Pontocaris propensalata*, Ortmann, Proc. Acad. Sci. Philadelphia, p. 175.

1899. *Pontecaris media*, Alcock and Anderson, *Ann. Mag. Nat. Hist.* (7), III, p. 282.
 1900. *Pontecaris propensalata*, Whitelegge, *Mem. Australian Mus.*, IV, p. 198.
 1901. *Aegeon medium*, Alcock, *Cat. Indian deep-sea Crust. Macrura and Anomala*, p. 120, and *Illust. Zool. 'Investigator'*, pl. xli, fig. 6.

In this case also I am indebted to Dr. Calman for the elucidation of the synonymy. Dr. Calman has kindly compared co-types of *A. medium* with the type of Bate's *P. propensalata* and has sent me the following note on the subject.—"I cannot find any difference between the type of *P. propensalata* and *A. medium*. The sculpturing of the abdominal somites is less sharp in the former and the serration of the supramarginal carina of the carapace is very obscure—as it tends to be in the smaller of the two specimens of *A. medium* that I have examined."

The only specimens in the Indian Museum are those described by Alcock from the Andaman Sea, 55-66 fathoms. Bate's type specimen was obtained off the Ki Is., south of New Guinea, 5° 49' 15" S., 132° 14' 15" E., at a depth of 140 fathoms, and Whitelegge has recorded the species from 50 fathoms in Botany Bay.

Aegeon orientalis, Henderson.

1893. *Aegeon orientalis*, Henderson, *Trans. Linn. Soc., Zool.* (2), V, p. 446, pl. xl, figs. 16, 17.

Three specimens in rather poor condition from the Persian Gulf and the Andamans evidently belong to this species, which does not appear to have been recognised since it was first described more than twenty years ago.

The spinulation of the carapace agrees exactly with Henderson's description except that the serrations on the marginal carina vary in number from 7 to 9. The abdominal sculpture also agrees with the original description; but there are two longitudinal carinae on either side of the second abdominal somite, and the five carinae on the first somite, as well as the median carina on the second, end anteriorly in sharp spines. These spines were perhaps worn away in the type, which is larger than any of the three specimens here recorded.

Although, as Henderson has remarked, the species bears a rather marked resemblance to *A. calaphractus*, it is not in reality a very close ally of that species. As has already been pointed out it is intermediate in character between the more typical species and those that Alcock referred to the subgenus *Parapontecaris*. Pearson's suggestion that *A. orientalis* is merely an extreme variation of *A. calaphractus*¹ is certainly incorrect. *A. orientalis* may readily be distinguished (i) by the complete absence of the hepatic groove, (ii) by the smaller number of serrations on the marginal carina of the carapace, (iii) by the sharp longitudinal lateral carinae of the first two abdominal somites and (iv) by the presence of only a

¹ Pearson, *Ceylon Pearl Oyster Fisheries, Macrura*, p. 89 (1905).

single retrorse spine behind the middle point of each of the submedian carinae of the last abdominal somite. The spines on the first two abdominal somites, if their presence proves to be constant, will also serve to distinguish the two forms.

I think it improbable that the specimens from deep water off the Hawaiian Is., recorded by Miss Rathbun as *Egeon orientalis*¹, are correctly referred to this species. In the examples in the Indian Museum the middle tooth of the median carina of the carapace is not smaller than the rest and the denticulation of the second lateral and marginal carinae is also different. Moreover, the third and fourth abdominal somites though strongly sculptured, only bear a single lateral longitudinal carina. These carinae, which are submedian in position and are clearly shown in Henderson's figure, are sinuous and towards the hinder end of the somite are directed obliquely outwards; that on the third is entire, while that on the fourth is interrupted in the middle. There are certainly not two lateral carinae on the third and three on the fourth as in Miss Rathbun's description.

The specimens examined are registered as follows:—

1151	Persian Gulf, 26°22' N., 56°10' E., 48-49 fms.	'Investigator.'	1 ♂, 18 mm.
			1 ♀, 15 mm.
1152	Port Blair, Andamans.	J. Wood-Mason.	1 ♂, 14 mm.

The type and only other known example of the species is recorded by Henderson from the Gulf of Martaban.

Aegeon andamanense (Wood-Mason).

1901. *Aegeon* (*Parapontocaris*) *andamanense*, Alcock, *Cat. Indian deep-sea Crust. Macrura and Anomala*, p. 121, and *Illust. Zool. 'Investigator,' Crust.*, pl. ix, fig. 2.

Aegeon bengalense (Wood-Mason).

1901. *Aegeon* (*Parapontocaris*) *bengalense*, Alcock, *Cat. Indian deep-sea Crust. Macrura and Anomala*, p. 122, and *Illust. Zool. 'Investigator,' Crust.*, pl. ix, fig. 1.
1912. *Aegeon* (*Parapontocaris*) *bengalense*, Kemp and Sewell, *Rec. Ind. Mus.*, VII, p. 22.

Genus *Prionocrangon*, Wood-Mason.

Prionocrangon ommatosteres, Wood-Mason.

1901. *Prionocrangon ommatosteres*, Alcock, *Cat. Indian deep-sea Crust. Macrura and Anomala*, p. 123, and *Illust. Zool. 'Investigator,' Crust.*, pl. ix, fig. 4.

Genus *Crangon*, Fabricius.

Crangon crangon (Linnaeus).

I have compared the Indian specimens with examples from Plymouth and the only appreciable distinctions that I can find are

¹ Rathbun, *Bull. U.S. Fish Comm.* for 1903, p. 911 (1906).

that in the Indian form the rostrum is narrower and distinctly longer, reaching almost to the end of the eyes (cf. text-figs. 7a, b) and that the sixth abdominal somite is less distinctly grooved inferiorly. There is the closest resemblance between the two groups of specimens in the form of the subchela and antennal scale.

The characters yielded by the rostrum and last abdominal somite may ultimately afford grounds for the recognition of the Indian form as a distinct subspecies, but in my opinion are insufficient for specific distinction.

A number of forms very closely allied to the common European species have been recorded from Japan; Miss Rathbun¹, indeed, has reported the presence of *C. crangon* itself at Rikuoku (Rikuchu) and Hokkaido. Balss², the most recent author to discuss the Japanese forms, notes that Brashnikow³ (writing in Russian) has established the fact that *C. crangon crangon* does not occur in

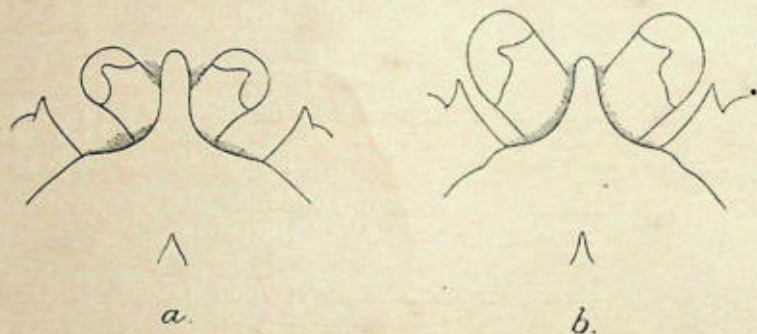


FIG. 7.—*Crangon crangon* (Linn.).

Anterior portion of carapace, rostrum and eyes: (a) of an Indian specimen: (b) of a specimen from Plymouth.

Japanese waters. He, however, gives a summary of the characters of *C. affinis*, de Haan, *C. propinquus*, Stimpson, *C. hakodatei*, Rathbun, *C. consobrinus*, de Man, and *C. cassiope*, de Man, and remarks that in the collections that he himself has examined these characters are inconstant, even in specimens from a single gathering. He regards the last four of the names just mentioned as synonyms of *C. affinis*, a form which he apparently considers to be merely a subspecies of *C. crangon*.

If Balss is correct, the retention of a distinct subspecific name for the Japanese form seems to have little to recommend it. The characters of *C. crangon*, if tabulated on Balss's plan, will evidently fall within the range of variation of the single Japanese

¹ Rathbun, *Proc. U.S. Nat. Mus.*, XXVI, p. 42 (1902).

² Balss, *Abhandl. math.-phys. Klasse K. Bayer. Akad. Wiss. München*, Suppl.-Bd. II, p. 62 (1914).

³ Brashnikow, *Mém. Acad. Imp. Sci. Nat. St. Pétersburg*, (8), XX, p. 84 (1907).

race that he recognises, the difference between the European and Japanese races consisting solely in the greater variability exhibited by the latter.

The Indian specimens do not show any marked variation, but the series is small. And even should their form prove constant, it is useless to speculate on the precise status of the different races until some general consensus of opinion on the Japanese forms has been reached.

Crangon crangon appears to be very rare on the Indian coasts; the only specimens in the Museum are the following :—

Akyab, Arakan coast. F. Stoliczka. 5. 35.52 mm.

THE STRUCTURE OF THE PLEOPODS IN *PONTOPHILUS*.

The recognition of the fact that in certain species of *Pontophilus* there are often marked differences between the sexes in the form of the pleopods, and that the species themselves also differ to a great extent in the development of these appendages, has led me to re-examine the material available in the Museum collection. In the Indian Museum twenty-one species of the genus are represented, a very considerable proportion of those that are known; but, unfortunately, in the case of thirteen only do we possess examples of both sexes.

Although in the development of the pleopods there is a certain amount of intergradation, it is possible roughly to classify the species according to the development of these appendages into five groups :—

Group I.

<i>P. norvegicus</i> , M. Sars	{	Endopod of last four pairs of pleopods well developed in both sexes, with conspicuous appendix interna.
<i>P. gracilis</i> , Smith		
<i>P. brevirostris</i> , Smith		

P. spinosus, Leach, *P. abyssii*, Smith, and *P. occidentalis*, Faxon, represented in the collection by female specimens only, doubtless also belong to this group.

Group II.

<i>P. sculptus</i> (Bell)	{	Endopod of last four pairs of pleopods comparatively well developed in male, reduced in female. Appendix interna present in male on all four pairs, but somewhat rudimentary on the last; in female present on 2nd and 3rd pairs, rudimentary on 4th and absent from 5th.
<i>P. incisus</i> , sp. nov.		
<i>P. australis</i> , Thomson		

P. chiltoni, Kemp, known from female specimens only, also in all probability belongs to this group.

Group III.

- | | | |
|-------------------------------|---|--|
| <i>P. lowisi</i> , sp. nov. | { | Endopod of last four pairs of pleopods comparatively well developed in male, reduced in female. Appendix interna present on all four pairs in male, but entirely absent in female. |
| <i>P. pilosus</i> , sp. nov. | | |
| <i>P. candidus</i> , sp. nov. | | |
| <i>P. plebs</i> , sp. nov. | | |

Group IV.

- | | | |
|-----------------------------|---|--|
| <i>P. sabsechota</i> , Kemp | { | Endopod of last four pairs of pleopods large and well developed in female, quite rudimentary in male. Appendix interna absent in both sexes. |
| | | |
| | | |

Group V.

- | | | |
|--|---|---|
| <i>P. bispinosus</i> , Hailstone and Westwood. | { | Endopod of last four pairs of pleopods much reduced in both sexes. Appendix interna absent in both sexes. |
| <i>P. trispinosus</i> , Hailstone. | | |

P. echinulatus (M. Sars), *P. victoriensis*, Fulton and Grant, *P. hendersoni*, Kemp, and *P. parvirostris*, sp. nov., represented in the Museum collection by examples of one sex only, also in all probability belong to this group.

In Group I the appendix interna is usually tipped with a series of small coupling hooks, which are ill-developed or absent in other groups that possess this appendage. In Group V the separation of a distinct segment at the base of the endopod is clearly marked, whereas in Group I the division is obscurely indicated.¹

P. sabsechota, the sole species comprised in Group IV, is apparently an abnormal form, the distinction between the sexes in the size of the endopod being the reverse of that found in any other species which in this respect exhibits sexual differences. The remaining groups clearly form a morphological series characterised by the progressive reduction of the endopod and by the reduction and suppression of the appendix interna. Group I in which the pleopods have retained their full development is clearly the most primitive, while Group V in which they are more reduced than in any other is the most specialised. It is noteworthy that Group I includes all the deep-water forms in the collection.

The facts are not only of interest in the light they throw on the development of the species within the genus; they also, as it appears to me, form a valuable clue to the evolution of the family as a whole, for the other genera can be divided into two sections agreeing, respectively, in the development of their pleopods with

¹ Cf. Wollebaek, *Bergens Museums Aarbog*, 1908, no. 12, p. 44, text-fig. 2.

Groups I and V of *Pontophilus*. Ortmann¹ in 1890 published a genealogical tree of the five genera known to him; but the evidence afforded by the pleopods leads to results directly at variance with those which he obtained and it will be well therefore to discuss the matter briefly.

The two most primitive groups of species in the family are in all probability *Aegeon* and *Pontophilus*, Group I. They possess—most of them at any rate—a rudimentary exopod on the first legs, the number of branchiae is at least as great as that in any other genus and the endopod of the last four pairs of pleopods is well developed and possesses an appendix interna. In *Aegeon* the second leg is larger than in *Pontophilus*, Group I, agreeing more nearly with that of Group V, and the former genus also possesses a rather larger number of branchiae than the latter. In this last feature it appears to be the more primitive of the two, but in the curious C-shaped form of its gills it presents a character not known in any other genus of Caridea. *Aegeon*, in my opinion, must be regarded as an offshoot of the original stock from which the other genera are descended.

The evolution of the remaining genera of Crangonidae can, I think, be traced back to *Pontophilus*, from which there have been two main lines of descent, originating respectively in Group I and in Group V.

In Group I of *Pontophilus*, as has already been noted, the second leg is shorter than in the other groups and it is not difficult to understand how *Sabinea*, Owen, and *Paracrangon*, Dana, have arisen from it by successive steps. In *Sabinea* the pleopods are as well developed as in any species of Group I and possess a conspicuous appendix interna; the second leg has, however, undergone further reduction; it is smaller than in any species of *Pontophilus* and terminates simply, the chela being altogether suppressed. *Paracrangon* is apparently a further development on the same line. The second legs are entirely absent and the endopod in the last four pairs of pleopods, though large and well-formed, is without appendix interna.

The other line of development has apparently arisen through forms similar to those of Group V and terminates in four branches, representing respectively the genera *Crangon*, L., *Sclerocrangon*, Sars, *Argis*, Kröyer (= *Nectocrangon*, Brandt) and *Prionocrangon*, Wood-Mason. In all these genera the endopod of the last four pleopods is greatly reduced, possesses a well marked basal segment, and is devoid of appendix interna.

The evidence afforded by the development of the second leg is, in this case, rather difficult to interpret. In all the four genera named above it has a proportionately greater length than in any species of *Pontophilus*; in *Prionocrangon*, evidently a very highly specialised form, it terminates simply, while in the other three it is chelate. But it must be presumed that all Crangonidae have

¹ Ortmann, *Zool. Jahrb., Syst.*, V, p. 530 (1890).

primarily arisen from a form in which this limb was well developed and *a priori* it was not to be expected that the four genera had passed through a stage in which it was to some extent reduced.

It is, however, difficult to see how it could have been otherwise. *Crangon* and its allied genera might, indeed, have arisen independently from an ancestor of *Pontophilus*, that is to say from a form differing from Group I of that genus only in the possession of long second legs. In this case the pleopods must have evolved separately in the two instances; with the result that their identity of structure, as we see it to-day in *Crangon* and the related genera on the one hand and in *Pontophilus*, Group V, on the other, is an example of convergence.

I am inclined to think that this conclusion is erroneous. The tendency that clearly exists towards the reduction or suppression of the second pair of legs shows that these appendages are unusually plastic in Crangonidae: the monodactylous condition of these limbs in *Sabinea* and *Prionocrangon* is evidently an instance of convergence and affords no evidence of real affinity. The structure of the pleopods is more likely to yield a trustworthy estimate of relationship.

Of the genera *Vercoia*, Baker¹, and *Coralliocrangon*, Nobili², I have seen no examples. In the former, according to a sketch kindly sent me by Mr. Baker, the endopod of the last four pleopods is comparatively large, but without appendix interna. The genus has perhaps arisen separately from forms similar to those in Group III of *Pontophilus*; it differs from all species of the latter in the monodactylous character of the second legs. Owing to lack of information regarding the pleopods, it is impossible to make any suggestion regarding the relationships of *Coralliocrangon*. This is particularly unfortunate, for the persistence in the genus of the linea thalassinica points to its being a survival of some very primitive form.

¹ Baker, *Trans. Roy. Soc. S. Australia*, XXVIII, p. 158 (1904).

² Nobili, *Ann. Sci. Nat. Zool. Paris*, (9), IV, p. 82 (1906).

XXI. NOTES ON CRUSTACEA DECAPODA
IN THE INDIAN MUSEUM.

VII. FURTHER NOTES ON HIPPOLYTIDAE.

By STANLEY KEMP, B.A., Superintendent, Zoological Survey
of India.

(Plate XXXVI).

Although only two years have elapsed since my previous paper on the Indian Hippolytidae was published, a number of interesting forms have come to light, obtained partly during the recent cruises of the 'Investigator' by Capt. R. B. Seymour Sewell, I.M.S., partly by Dr. Annandale in Japan, and partly by myself during a short visit to Port Blair in the Andamans.

The Hippolytid fauna of Port Blair is one of great richness. During three weeks' collecting, fully half the known Indian species of the family were met with, enabling me to obtain notes on the natural colouration of several forms hitherto unknown in this respect. In addition, three forms were found that had not previously been recognised, one representing a new generic type. Of these, *Thor discosomatis* is of particular interest owing to the fact that it lives commensally with a large anemone of the genus *Discosoma*, and is most peculiar in its colouration; the species of *Phycocaris*, gen. nov., is extremely grotesque in appearance and closely mimics the weed among which it lives.

Borradaile, in a recent paper,¹ has briefly described a genus and three new species of Hippolytidae from the Maldives, the Seychelles and other localities. If my identification is correct, two of these, *Thor maldivensis* and *Lysmatella prima* (the latter the type of the new genus), occur in the Andamans; but I am inclined to think that *Lysmatella* should at most be distinguished only subgenerically from the closely allied *Hippolysmata*. *Exhippolysmata*, recently proposed by Stebbing² to include *Hippolysmata ensirostris* and a nearly related form from S. Africa, does not appear to differ sufficiently to warrant either generic or subgeneric separation.

Genus Saron, Thallwitz.

Saron marmoratus (Olivier).

1914. *Saron marmoratus*, Kemp, *Rec. Ind. Mus.*, X, p. 84.

A number of specimens of this well-known species were obtained at Port Blair; the majority were found under stones left

¹ Borradaile, *Ann. Mag. Nat. Hist.*, (8), XV, pp. 206, 208 (1915).

² Stebbing, *Ann. S. African Mus.*, XV, p. 94 (1915).

bare at low water, but one individual was dredged at a depth of two fathoms.

There are tufts of setae on the carapace and abdomen of all the specimens; the males are small and do not possess the enlarged third maxillipedes and first peraeopods characteristic of well-grown examples of their sex.

On close inspection the colouration of living specimens is very wonderful, resembling that of a rich Turkey carpet. At a casual glance, however, the animal is dull in tone and it is clear that the vivid tints blend and cause it to harmonise with its surroundings, just in the same way that the splashes of bright colour on gun-mountings are effective in rendering them inconspicuous.

On the carapace and abdomen are numerous large ocellar spots of an irregular shape; in the centre these spots are buff, dotted with red and circumscribed with white and reddish orange. Between the spots are patches, irregularly lobulate in form, but symmetrical on either side of the animal. They are of a deep reddish brown colour with numerous large bright blue spots. Each patch is sharply defined, its sinuous margin being outlined with black and pale grey. At the antero-lateral angle of the carapace there is a dull red spot. The rostrum, antennules and antennal scales are pale buff, barred with dark brown, the brown bearing numerous white flecks. The anterior two pairs of legs are reddish at the base; their distal segments and all segments of the last three pairs are pale yellowish green broadly barred with black. The tail-fan is obscurely mottled with brown and buff.

The largest specimen, an ovigerous female, is only 36 mm. in total length.

²³⁸⁹₁₀ Port Blair, Andamans.

S. Kemp.

Eleven.

Genus *Spirontocaris*, Bate.

Spirontocaris pandaloides (Stimpson).

1907. *Spirontocaris pandaloides*, de Man, *Trans. Linn. Soc., Zool.*, (2), IX, p. 418, pl. xxxii, figs. 47, 48.

A number of examples of this species were obtained by Dr. Annandale during his recent visit to Japan from Mr. Kuma Aoki. The teeth on the rostrum vary from 8 to 10 on the upper border and from 10 to 13 on the lower.

²⁵⁶¹₁₀ Misaki, Japan.

Kuma Aoki.

Fourteen,
46-49 mm.

Spirontocaris rectirostris (Stimpson).

1907. *Spirontocaris rectirostris*, de Man, *Trans. Linn. Soc., Zool.*, (2), IX, p. 411, pl. xxxii, figs. 31-34.

Two fine specimens in Dr. Annandale's Japanese collection (presented by Dr. S. Yoshida) agree very closely with de Man's description of the male of this species. Both individuals have only 5 teeth on the upper border of the rostrum; on the lower

border there are 2 in one specimen and 3 in the other. The telson in one case bears four pairs of dorsal spinules, in the other five.

De Man has drawn attention to the great development of the third maxillipedes and first peraeopods in the male. In the two specimens obtained by Dr. Annandale this character is well shown, the proportions of the limbs agreeing precisely with de Man's description. The enlargement of these appendages in the adult male is a feature of considerable interest, for though apparently rare in the genus *Spirontocaris*, an almost precisely similar phenomenon is met with in the genera *Alope* and *Saron*.

1912 Tanabe, Kii prov., Japan.

S. Yoshida.

Two, 34, 36 mm.

The third maxillipedes in the larger specimen are 30 mm. in length; in the smaller they are 26 mm.

Genus *Thor*, Kingsley.

The definition of this genus requires modification in order to include *T. maldivensis*, Borradaile, in which supraorbital spine are found on the carapace. In addition to the greater number of segments in the carpus of the second peraeopods and the presence of a movable plate at the distal end of the antennular peduncle—characters by which the genus is readily distinguished from *Hippolyte*—the outer antennular flagellum, in *Thor*, is greatly swollen in both sexes.

An interesting species, hitherto undescribed, was obtained at Port Blair; it lives commensally with giant sea-anemones of the genus *Discosoma* and is very peculiar in its pigmentation.

The three known species of *Thor*, all of which have been found in the Andamans, may be distinguished as follows:—

- | | |
|--|-------------------------------------|
| I. Rostrum with two or more dorsal teeth;
supraorbital spines absent. | |
| A. Apex of rostrum bifid; lateral process
of antennule without a tooth at its
proximal end | <i>T. paschalis</i> (Heller). |
| B. Apex of rostrum simply pointed;
lateral process of antennule with a
small upstanding tooth at its prox-
imal end | <i>T. discosomatis</i> , sp. nov. |
| II. Rostrum with only a single dorsal tooth;
supraorbital spines present | <i>T. maldivensis</i> , Borradaile. |

Thor paschalis (Heller).

1914. *Thor paschalis*, Kemp, *Rec. Ind. Mus.*, X, p. 94, pl. i, figs. 6-10.

Additional specimens are from Singapore and from Port Blair in the Andamans. The species was found on several occasions in the latter locality, living among weeds at depths of from 2 to 5 fathoms in the neighbourhood of Ross I. The specimens are smaller than the majority of those obtained in the Gulf of Manaar; the largest is only 8 mm. in length and ovigerous females sometimes do not exceed 6.5 mm. The single individual from Singapore, a male, was obtained at low water under a block of coral.

9563
9564
10
Port Blair, Andamans,
Tanah Merah Besar,
Singapore I.

S. Kemp.
N. Annandale.

Ten.
One.

Thor discosomatis, sp. nov.

(Plate xxxvi, fig. 1).

Thor discosomatis is a very close ally of *T. paschalis* and agrees with that species in the great majority of its structural features. It differs, however, in the following points:—

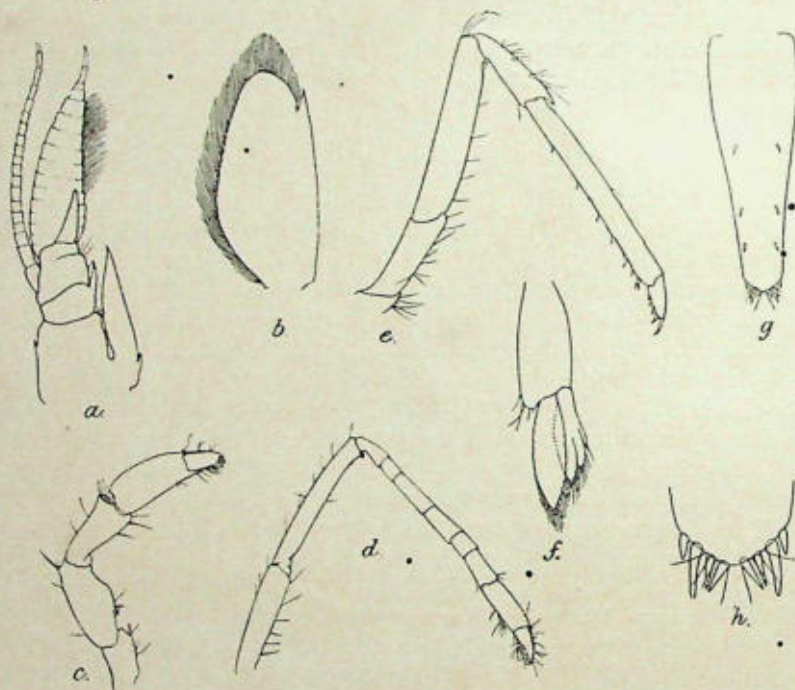


FIG. 1.—*Thor discosomatis*, sp. nov.

- | | |
|----------------------|----------------------------|
| a. Antennule. | e. Third peracopod. |
| b. Antennal scale. | f. Second pleopod of male. |
| c. First peracopod. | g. Telson. |
| d. Second peracopod. | h. Apex of telson. |

The rostrum is a little shorter; at its apex it is sharply pointed, not bifid, and on its upper margin it bears only two or three teeth. These teeth are larger and all of them are situated on the rostrum in front of the hinder limit of the orbit. The basal segment of the antennular peduncle (text-fig. 1a) bears a spine on its infero-internal aspect, as in *T. paschalis*; but the lateral process, though variable in length, is usually longer than in that species, often reaching the end of the third segment. The process bears, near the proximal end of its outer margin, a sharp upstanding tooth of which no trace exists in the allied species.

The peraeopods closely resemble those of *T. paschalis*. The carpus of the second pair (text-fig. 1d) is composed of six sub-segments the proportional lengths of which are much the same as in *T. paschalis*, except that the third is comparatively a little shorter. There is practically no difference between males and females in the length of the third pair of legs (text-fig. 1e). On the lower border of the merus of the third and fourth pairs there is a small subterminal spine. This spine is present on all the last three pairs in *T. paschalis*,¹ whereas in *T. discosomatis* it is absent from the last pair.

On the telson (text-fig. 1g) as in *T. paschalis* there are three or four pairs of dorso-lateral spinules. At the apex, however, there are four pairs of spines, the outermost the shortest, the second the longest and the two inner pairs sub-equal (text-fig. 1h). In *T. paschalis* there are only three pairs of terminal spines.

In the shape of the antennal scale (text-fig. 1b) and in all other features, *T. discosomatis* seems to bear the closest resemblance to *T. paschalis*.

The largest specimen obtained, an ovigerous female, is 13 mm. in length.

The colouration of living specimens was very remarkable, the animal being of a deep reddish brown tint, semitransparent, with very large spots and patches of pale greenish yellow. On the carapace are two such spots, round and confluent in the mid-dorsal line; there is one on either side of the second abdominal somite, a broad transverse band on the fourth somite with a small spot on each side below it, a ventral transverse bar on the fifth somite and a patch, forming a complete ring, on the sixth somite. Each of these spots or patches is very pale green in the centre, with a broad margin of bright yellow, the whole being narrowly circumscribed by blue. The central portions are traversed by streaks of yellow extending inwards from the margin. The apex of the telson is greenish yellow and there is a circumscribed spot in the middle of each uropod. On the upper side of the eyestalk there is a greenish yellow patch; all the other appendages are reddish brown.

The specimens of *Thor discosomatis* were found along with a Palaemonid in the immediate vicinity of large anemones of the genus *Discosoma*. Two very small individuals were obtained in the dredge, but it is probable that on this occasion the net was drawn over an anemone in the course of its passage along the bottom.

The Palaemonid has been described by Nobili under the name *Ancyllocaris aberrans*,² and of this species Miss Rathbun's *Periclimenes hermitensis*³ is apparently a synonym. Coutière,⁴ who

¹ These spines are omitted in the figure given in pl. i, fig. 6, *op. cit.*, 1914.

² Nobili, *Bull. sci. France Belgique*, XL, p. 52, pl. iv, figs. 9-9b (1906).

³ Rathbun, *Proc. Zool. Soc. London*, 1914, p. 655, pl. i, figs. 1-3.

⁴ Coutière, *Bull. Mus. d'Hist. nat., Paris*, IV, p. 198 (1898).

refers to the same form as a species of *Bithynis*, has given the following account of its habits.—“ Un Palémonidé du genre *Bithynis* Dana mérite une mention spéciale par son habitat et sa coloration. Il est absolument transparent, mais se signale par quelques anneaux d'un violet pâle sur les appendices et l'abdomen, et surtout par des taches d'un blanc nacré éclatant, occupant la région stomacale tout entière, le coude de l'abdomen, l'extrémité des rames caudales et les épimères du deuxième segment. Ce magnifique Crustacé se tient obstinément dans la zone de protection que circonscrit une grande Actinie assez commune dans les flaques profondes qui séparent les Madrépores. Étale sur le sable, le disque oral de l'Actinie de couleur blanchâtre, armé d'un très grand nombre de courts tentacules urticants, atteint souvent 0 m. 30 de diamètre. *Bithynis* se tient dans ce cercle, nageant à peu de distance au-dessus, souvent par couples, et se laisse assez aisément capturer à l'aide d'une éprouvette pleine d'eau que l'on descend doucement sur l'animal.”

The anemone at Port Blair was one with greenish tentacles, not whitish as in Coutière's description. It was not uncommon at low water on the foreshore at “Aberdeen” and was sometimes left high and dry by the tide. On anemones from which the water had completely retreated we failed to find any shrimps, even though the whole specimen was dug up and most carefully examined. On the other hand the shrimps were seldom absent from anemones living in a few inches of water, and were easily caught in a tube full of water as described by Coutière. The *Ancyllocaris*¹ was found swimming and crawling on the column of the anemone beneath the fringe of tentacles and wandering occasionally on to the disc. *Thor discosomatis* had similar habits, but seemed to wander further afield and rarely ventured among the tentacles.

The curious feature of the shrimps is that in both species the pigmentation takes the form of very large spots almost pure white in colour. This, too, is a characteristic of certain fish, *Amphiprion percula* (Lacép.) and *Tetradrachmum trimaculatum* (Rüpp.),² which also appear to live commensally with the *Discosoma*; the latter was found beneath the fringe of tentacles and was black with a broad transverse band of white at the back of the head, extending downwards to the eye, and a large white spot below the dorsal fin; the former, which was commonly found swimming among the tentacles, was bright orange with three broad bands of white tinged with green and narrowly margined with black. The presence of white patches in all four commensal species is a most curious

¹ Coutière, in this brief description, has scarcely done justice to the marvellous colouration of *Ancyllocaris aberrans*; the large white patches are frequently circumscribed by red or orange pigment and on the tail-fan are eye-spots with reddish centres. A complete account of the colouration of this Palaemonid would be out of place in the present paper, but it may be mentioned that the pigmentation varies somewhat in the two sexes and alters considerably with age. The colouration of *Thor discosomatis*, on the other hand, is apparently constant throughout life.

² I am indebted to Dr. B. L. Chaudhuri for these determinations.

feature and one of which it is impossible to offer an explanation.

$\frac{9261+4}{10}$ Port Blair, Andamans. S. Kemp. Fourteen.

The types bear the number 9261/10.

Thor maldivensis, Borradaile.

1915. *Thor maldivensis*, Borradaile, Ann. Mag. Nat. Hist., (8), XV, p. 268.

A single ovigerous female, about 9 mm. in length, doubtless belongs to this species. It differs, however, from Borradaile's brief description in possessing six distinct segments in the carpus of the second peraeopods. The presence of strong supraorbital spines and the very short rostrum, armed with only a single dorsal tooth are characters which readily distinguish it from the two preceding species. According to Borradaile the first leg is enlarged in adult males.

$\frac{9251}{10}$ Port Blair, Andamans. S. Kemp. One.

The specimen was found at low water on the coral reef in North Bay and was, when living, rather conspicuously mottled.

Thor maldivensis was described from Minikoi, the Maldives and Salomon Atoll.

Genus *Hippolyte*, Leach.

Hippolyte ventricosus, Milne-Edwards.

1914. *Hippolyte ventricosus*, Kemp, Rec. Ind. Mus., X, p. 96, pl. ii, figs. 1-3.

This species is not very abundant in Port Blair harbour. The majority of the specimens obtained were taken at Corbyn's Cove North, not far from the entrance to the harbour, living in a fucoid weed washed by the waves. All the individuals taken in this situation were of a dull olive-brown colour closely resembling that of the sea-weed.

The collection includes many ovigerous females, an unusually large specimen being 21 mm. in length.

$\frac{2217}{10}$ Port Blair, Andamans. S. Kemp. Many.

Genus *Phycocaris*, nov.

Carapace with supraorbital and antennal spines; antero-lateral (pterygostomian) spine absent. Lateral process of antennular peduncle spiniform; upper flagellum uniramous. Mandible with incisor-process, but without palp. Third maxillipede with exopod. Neither epipods nor arthrobranchs at base of first four peraeopods. Carpus of second peraeopods composed of two segments. Endopods of second to fifth pleopods very large in female, small and slender in male.

Type and only species, *Phycocaris simulans*, sp. nov.

This genus is formed for the reception of a small and peculiar Hippolytid of the most grotesque appearance, that lives on weeds in the vicinity of Port Blair. On its appendages, including the eyestalks, are long straggling hairs and these, in conjunction with its colour and the unusual attitude it adopts, combine to give it a most extraordinarily close resemblance to small tufts of algae.

In most of the characters mentioned above the genus agrees with Calman's *Trachycaris*,¹ though in outward appearance there is the widest possible difference between them. The type and only known species of *Trachycaris*² is that described by Spence Bate from the West Indies under the name *Platybema rugosum*. It agrees with *Phycocaris* in having only two segments in the carpus of the second pereopods and in the great size of the endopods of the second to fifth pairs of pleopods. The latter character, though given without qualification in Calman's diagnosis, is probably found only in females.

Phycocaris differs from *Trachycaris* in the absence of the antero-lateral spine of the carapace and in the presence of an incisor-process on the mandible.³ The latter feature is of considerable importance and indicates that the genus is in reality allied to *Thor* and *Hippolyte* rather than to *Trachycaris* and other genera of the Latreutid section of the family. From *Thor*, *Hippolyte* and the peculiar N. Atlantic genus *Cryptocheles*, it is easily distinguished by the number of segments in the second legs.

Phycocaris simulans, sp. nov.

(Plate xxxvi, fig. 2).

The carapace is arched above and is produced anteriorly to a short and simple rostrum that reaches only a little beyond the end of the basal antennular segment. On the frontal margin above the eye there is, on either side, a short and stout supraorbital spine. The antero-lateral (pterygostomial) spine is absent, but there is a small spine at the base of the antenna; the antero-inferior angle is rounded. The carapace is not carinate in the middle line and bears a few long scattered hairs.

The eyes are comparatively long and slender. In dorsal view the cornea is not broader than the stalk and is about half its length. There is no ocellus; but at the junction of the cornea and stalk there is a circlet of long hairs, a remarkable feature not known in any other Hippolytid.

The basal segment of the antennular peduncle (text-fig. 2a) is fully as long as the two following combined; its lateral process is

¹ Calman, *Ann. Mag. Nat. Hist.*, (7), XVII, p. 33 (1906).

² *Platybema pristis*, Nobili, (*Ann. Mus. civ. Genova*, (2), XX, p. 233 (1899)) should doubtless be referred to the genus *Latreutes*.

³ The statement that the mandible in *Trachycaris* is without incisor-process is given by Calman on the authority of Spence Bate. I have examined a specimen of *T. rugosum* and am able to confirm the accuracy of the observation.

slender, incurved and spine-like, extending a little beyond the end of the segment and bearing a few hairs externally. The second and third segments are nearly equal in length, each bearing near its distal end one or two very long plumose setae. The outer flagellum is longer and stouter in the male than in the female. In the former sex the thickened portion is composed of some seven segments and is longer than the peduncle; in the latter it is shorter than the peduncle and consists only of five more slender segments.

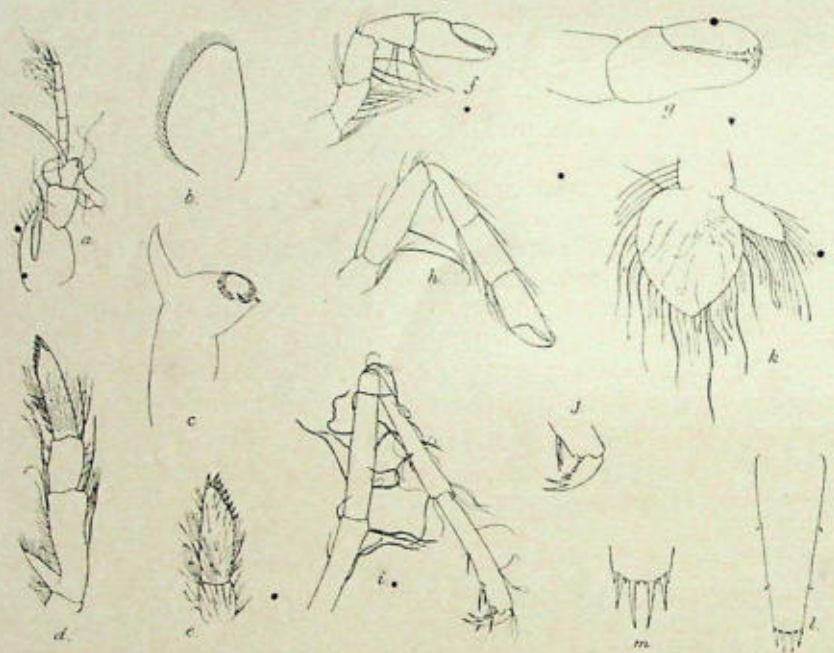


FIG. 2.—*Phycocaris simulans*, gen. et sp. nov.

- | | |
|--|---------------------------------|
| a. Antennule. | g. Chela of first peracopod. |
| b. Antennal scale. | h. Second peracopod. |
| c. Mandible. | i. Third peracopod. |
| d. Third maxillipede, the distal segment seen obliquely. | j. Dactylus of third peracopod. |
| e. Distal segment of third maxillipede. | k. Second pleopod of female. |
| f. First peracopod. | l. Telson. |
| | m. Apex of telson. |

The inner flagellum is short and is usually carried reflected backwards.

The antennal scale (text-fig. 2b), which reaches a little beyond the antennular peduncle, is broadest near the base and is less than twice as long as wide; the outer margin is convex, terminating in a spine that reaches as far forwards as the apex of the lamella. The peduncular segments bear long setae similar to those on the antennule.

The mandible resembles that found in the genus *Thor*; the incisor-process is well developed and is furnished with about seven teeth at the apex. The palp is entirely absent and the molar process is cleft and furnished with slender spines, many of which are serrate.

The second maxilla is normally developed; the distal endite of the endopod is divided into two parts of equal breadth. The first and second maxillipedes possess epipods, that of the former being emarginate distally, while that of the latter is deeply bilobed. The ultimate segment of the endopod of the second maxillipede is placed terminally at the end of that which precedes it and is not applied as a strip along the outer margin of the latter as in the great majority of the Caridea. The third maxillipede (text-fig. 2d) does not possess an epipod; the exopod is small but foliaceous, reaching about to the middle of the antepenultimate segment. The ultimate segment (text-fig. 2e) is less than twice the length of the penultimate and is not three times as long as broad; in addition to numerous hairs it bears a series of nine or ten sharp spinules in its distal half.

The first pereopods (text-fig. 2f) are stout, but very short; the ischium and merus and carpus are sub-equal, a little shorter than the chela. The segments bear long setae but are otherwise unarmed. The chela (text-fig. 2g) is rather more than twice as long as broad and the fingers are distinctly longer than the palm. On the internal surface of the chela the fingers are deeply hollowed or spooned near the cutting margin, while externally each forms a thin blade with a saw-like edge, the two meeting throughout their length when the claw is closed. At the extreme tip each finger is provided with three large teeth.

The second pereopods (text-fig. 2h) are much longer, reaching nearly to the tip of the antennal scale. The carpus is almost as long as the ischium and merus combined and consists of two segments, the second a little shorter than the first and about twice as long as broad. The chela is almost two-thirds the length of the carpus and nearly two and a half times as long as wide, the fingers being about one-third shorter than the palm. When the claw is closed the fingers meet only at the tips where they cross each other.

The last three pairs of pereopods (text-fig. 2i) are similar and show no sexual differences. The carpus is scarcely shorter than the merus and is a trifle longer than the propodus. The propodus is armed beneath with five or six spines, two pairs towards the distal end and one or two others, which are smaller, near the middle. When the dactylus is folded inwards it lies between the two spines constituting the distal pair and thus forms a poorly developed grasping organ. The dactylus (text-fig. 2j) is short, spines included about two-fifths the length of the propodus; on its inferior edge it bears a series of seven or eight spinules which increase in size distally, the two terminal ones being large spines. All the legs bear very long plumose setae, especially conspicuous on the ischium, merus and carpus.

The abdominal somites are not carinate dorsally. The third is very strongly humped and the sixth, which is but little longer than the fifth, is produced to a rounded prominence in the middle of its posterior margin. The endopod of the last four pairs of pleopods bears an appendix interna and is enormously expanded in the female (text-fig. 2*k*); in the male it is not broader than the exopod. The margins of both rami bear long setae.

The telson (text-fig. 2*l*) is nearly twice the length of the sixth somite and is feebly sulcate above. It bears two or three pairs of small dorso-lateral spines and terminates in a broad, almost truncate apex (text-fig. 2*m*) armed with three pairs of spines, the innermost the longest, about equal to the breadth of the apex, and the outermost much the shortest. Between the innermost pair of spines are two minute spinules, while a similar spinule occurs on either side between the bases of these spines and those of the intermediate pair. The outer uropods do not reach the apex of the telson; they are shorter than those of the inner pairs and are rather more than two and a half times as long as wide.

The long setae that have been described above as plumose differ considerably from those to which this term is generally applied, for the plumes have not the form of very fine microscopic hairs, but are comparatively short and blunt processes from the main axis of the seta.

The largest specimen obtained, an egg-bearing female, is barely 9 mm. in total length; other ovigerous individuals do not exceed 7 mm.

This curious little species was found at Port Blair near Ross I., living among weeds in water from 2 to 4 fathoms in depth. We found it impossible to obtain specimens at all freely by the usual methods, but if the contents of the net were immediately transferred to a bucket of sea-water, individuals were sometimes found swimming at the surface and alighting on floating fragments of weed.

The illustration on Plate xxxvi, which is based on sketches made from living specimens, will give an idea of the peculiar attitude that the species adopts. The abdomen is strongly flexed near its junction with the cephalothorax, so much so that the third segment as a rule almost touches the carapace, and the antennules are bent upwards and backwards. In this attitude, and with the help of the long plumose setae that the species possesses,¹ *Phycocaris* bears the most extraordinarily close resemblance to small tufts of algae that are plentiful on the weeds: it was only after considerable experience that we were able to distinguish the one from the other. The resemblance, which is undoubtedly protective, is further enhanced by the colour. The tufts of algae vary in shade and are sometimes dull olive-yellow and sometimes almost black. Two colour varieties of the prawn, corresponding

¹ These setae are very easily broken off in preserved specimens and are in life more numerous and longer than is shown in the figure.

exactly with these tints, were obtained and a few specimens of a bright red tone were also caught on occasions in which much red alga was brought up in the net.

⁹²⁵⁵⁻⁶₁₀ Port Blair, Andamans. S. Kemp. Twenty-four.

The type specimens bear the numbers 9255-6/10 in the Indian Museum register.

• Genus *Latreutes*, Stimpson.

Latreutes pygmaeus, Nobili.

1924. *Latreutes pygmaeus*, Kemp, *Rec. Ind. Mus.*, X, p. 99, pl. ii, figs. 7, 8; pl. iii, figs. 1-7.

The species was very common in the vicinity of Ross I., living among weeds. Most of the females were ovigerous.

⁹²⁷⁶₁₀ Port Blair, Andamans. S. Kemp. Many.

Latreutes planirostris (de Haan).

1907. *Latreutes planirostris*, de Man, *Trans. Linn. Soc., Zool.*, (2), IX, p. 421.

1914. *Latreutes planirostris*, Balss, *Abhandl. math.-phys. Klasse K. Bayer. Akad. Wiss.*, Suppl. Bd. II, abh. 10, p. 46.

This species is represented in the Museum collection by two female specimens, in both of which, as in those examined by Miss Rathbun,¹ the median spine in the posterior third of the carapace, figured by de Haan, is obsolete.

Miss Rathbun cites *L. mucronatus* as a synonym of *L. planirostris*, but this view is not held by Balss. *L. planirostris* is a larger species, with even more perfectly orbicular rostrum than in any examples of *L. mucronatus* that I have seen; the carapace, moreover, is carinate in the mid-dorsal line almost up to the posterior margin.

⁹²⁸⁰₁₀ Sagami Bay, Japan. Munich Mus. One, 25 mm.
⁹³⁶⁷₁₀ Misaki, Japan. Kuma Aoki. One, 28 mm.

Latreutes mucronatus (Stimpson).

1914. *Latreutes mucronatus*, Kemp, *Rec. Ind. Mus.*, X, p. 101, pl. iii, figs. 8-15; pl. iv, figs. 1, 2.

1914. *Latreutes mucronatus*, Balss, *Abhandl. math.-phys. Klasse K. Bayer. Akad. Wiss.*, Suppl. Bd. II, abh. 10, p. 47, fig. 27.

The additional specimens agree with those recorded from Kilakarai and Pamban in S. India, but are rather smaller; the largest is only 10.5 mm. long and one of the five ovigerous females is less than 8 mm. in length. The remarkable sexual differences noted in the case of the S. Indian specimens are clearly shown in the Andaman series, the females have the carapace more strongly arched and the rostrum more orbicular than in the males. Out of a total of thirty individuals only five, all males, possess more than a single tooth on the carapace behind the orbit; in three specimens

¹ Rathbun, *Proc. U.S. Nat. Mus.*, XXVI, p. 46 (1902).

there are 2 teeth and in two specimens 3 teeth in this position. In no case is there a tooth in the posterior third of the carapace, as in de Haan's figure of *L. planirostris*. The teeth on the upper edge of the rostrum in the male may be as many as 10.

Living specimens were as a rule inconspicuously mottled; two examples were, however, found in which the carapace and the greater part of the abdomen were of a uniform rich red-brown, the tail-fan and the posterior half of the last abdominal somite being pure white.

Balss, who has recently recorded this species (*l.c. supra*) from Sagami Bay in Japan, from the Gulf of Siam and from Chemulpo in Korea, notes that the specimens recorded by Doflein in 1902 as *L. mucronatus* are in reality examples of *L. planirostris*, de Haan.

¹¹³⁹⁵₃₀ Port Blair, Andamans, 2-6 fms. S. Kemp. Thirty.

Most of the specimens were obtained among weeds in the channel off Ross I.; a few were found in Brigade Creek.

Latreutes porcinus, sp. nov.

(Plate xxxvi, fig. 3).

In general form there is very little difference between the sexes; in both the carapace is sharply carinate dorsally, the carina being very high and abruptly declivous in its anterior third. The carina is armed with rather irregular procurved teeth, 6 to 12 in number (usually 9 to 11 in large specimens). The series begins behind the middle point of the carapace and the foremost 3 or 4 are usually in advance of the orbit, though separated, in the majority of the specimens, by an unarmed interval from the teeth on the rostrum proper. The antennal spine is present and there are 7 or 8 spinules on the antero-lateral margin.

The rostrum resembles that found in female *L. mucronatus*, being semiorbicular and rounded anteriorly or broadly lanceolate and more or less pointed at the apex. The teeth are on the whole less numerous than in the allied species; the dorsal series consists of from 4 to 8 and the ventral of from 3 to 8; in most specimens there are from 5 to 7 on each margin. In two out of the fifteen specimens examined there are three minute teeth in the interval between the upper rostral teeth and the series on the carapace.

The antennule (text-fig. 3a) is more slender than in *L. mucronatus*; the antennal scale (text-fig. 3b) is closely similar in form. The second peraeopods (text-fig. 3c) are a trifle more slender and of the three segments of which the carpus is composed the second is proportionately longer, exceeding the length of the first and third combined. The last three peraeopods are similar to those of *L. mucronatus*, but the terminal spine of the dactylus is usually more slender than the next of the series. In a few individuals two spines are to be found at the distal end of the lower margin of the merus of the third pair (text-fig. 3f); in most cases, however, as in *L. mucronatus*, single spines occur in this position.

The third abdominal somite is distinctly carinate in its posterior half. The telson and uropods (text-figs. 3g, h) are not greatly dissimilar from those of *L. mucronatus*.

The largest specimen, an ovigerous female, is about 15.5 mm. in length.

In general appearance this species bears some resemblance to *Trachycaris rugosus*, a West Indian form with which it has, of course, no real affinity. From all species of *Latreutes* hitherto

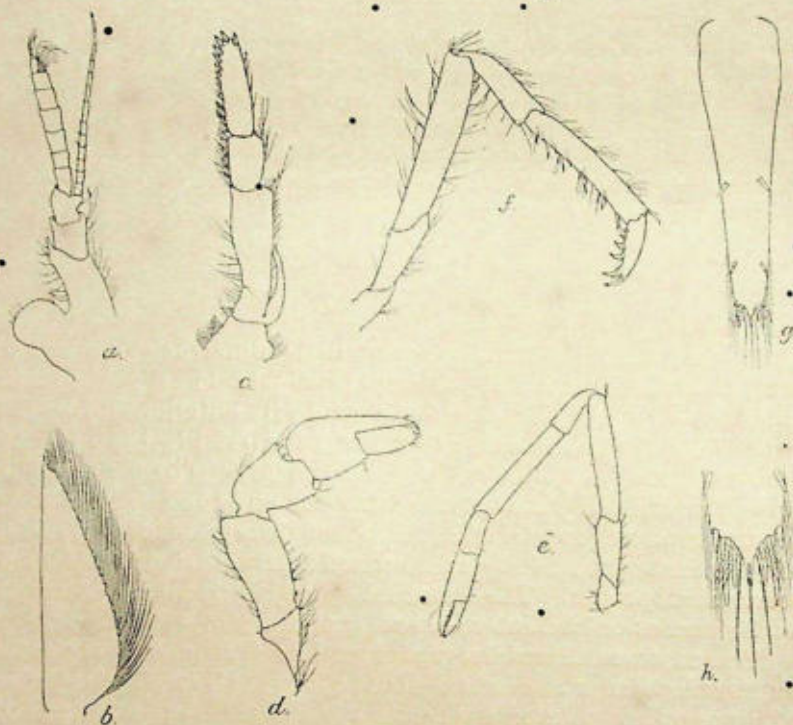


FIG. 3.—*Patreutes porcinus*, sp. nov.

- | | |
|----------------------|---------------------|
| a. Antennule. | e. Second pereopod. |
| b. Antennal scale. | f. Third pereopod. |
| c. Third maxilliped. | g. Telson. |
| d. First pereopod. | h. Apex of telson. |

known it is at once distinguished by the great number of teeth on the carapace.

Living specimens were variously banded and mottled, sometimes with pure white on a ground colour of reddish brown; one individual was pale pink throughout.

9269-71
10

Port Blair, Andamans.

S. Kemp.

Fifteen.

The specimens were all obtained off the jetty on Ross I., living among weed in company with *Latreutes pygmaeus*, *L. mucronatus* and *Tozeuma armatum*. The types bear the number 9269/10.

Latreutes anoplonyx, Kemp.

1914. *Latreutes anoplonyx*, Kemp, *Rec. Ind. Mus.*, X, p. 104, pl. iv, figs. 3-5.

Numerous additional specimens of this species have recently been obtained by the 'Investigator' off the Burma coast; they agree closely with the type. The rostrum is rather unusually constant in form, being always narrowly triangular in shape and extending, in all except extremely young specimens, well beyond the apex of the antennal scale. The dorsal margin is, however, straight in some examples, markedly concave in others. The number of teeth is variable; there are from 7 to 15 on the upper margin and from 6 to 11 on the lower. As was pointed out in the original description, *L. anoplonyx* differs from all other Indian species of the genus in that the dactyli of the last three legs are unarmed except for a few microscopic spinules.

The largest individual, an ovigerous female, is only 28 mm. in length, and is thus considerably smaller than the type.

335 Bombay.

H. P. le Mesurier.

One.

$\frac{287.8-2}{1.0}$ Burma coast, 7-8½ fms.

'Investigator.'

Many.

The only other known example was found at Bombay.

When describing this species I remarked that its nearest ally appeared to be Ortmann's *L. laminirostris*. It is perhaps at least as nearly related to *L. unidentatus*, Bate,¹ imperfectly described from a single specimen only 5.5 mm. in length obtained off Samboangan in the Philippine Is. Very young examples of *L. anoplonyx* do not differ greatly from Bate's figure; but in the description it is stated that the last three legs agree with those of *L. planus* in which, according to the figure, the dactylus is biunguiculate. Neither *L. planus* nor *L. unidentatus* have been recognised since they were first described and it seems likely that their identification will remain uncertain until the Hippolytid fauna of the Philippine Is. is investigated in detail; it is not even certain that they are correctly referred to the genus *Latreutes*.

Genus Tozeuma, Stimpson.**Tozeuma armatum, Paulson.**

1914. *Tozeuma armatum*, Kemp, *Rec. Ind. Mus.*, X, p. 106.

1914. *Angasia armata*, Balss, *Abhandl. math.-phys. Klasse K. Bayer. Akad. Wiss.*, Suppl. Bd. II, abh. 10, p. 48.

The additional specimens of this species, though a number of them are ovigerous females, are much smaller than those previously recorded from the Indian coast, a feature correlated perhaps with the shallower water in which they were obtained. The largest individual is only 43 mm. in length.

The number of teeth on the lower margin of the rostrum is variable and in one example is as high as 39. This specimen, obtained by Mr. Hornell in S. India, also possesses the additional

¹ Bate, *Rep. Challenger Macrura*, p. 584, pl. lxxix, fig. 5.

spine near the postero-inferior angle of the fifth abdominal somite, noticed in one of the examples previously recorded. In the latter, however, the number of rostral teeth is not abnormal.

A remarkable larval Carid found by the 'Investigator' in the Mergui Archipelago almost certainly belongs to this species (text-fig. 4). Although the rostral apex is broken the specimen is no less than 31 mm. in length. On the carapace are two large supra-orbital spines (which are absent in the adult) and the spines on the lower edge of the rostrum are represented merely by fine spinules. The legs are imperfectly formed, the first being chelate and the second simple with unsegmented carpus; attached to the first three pairs are long exopods. The hook-like projection on the dorsum of the third abdominal somite, a characteristic feature of adults of this species of *Tozeuma*, is represented by an enormously long, flattened, outstanding process, the tip of which is sickle-shaped and curved forwards. The sixth abdominal somite is proportionately much longer than in adults, while the telson

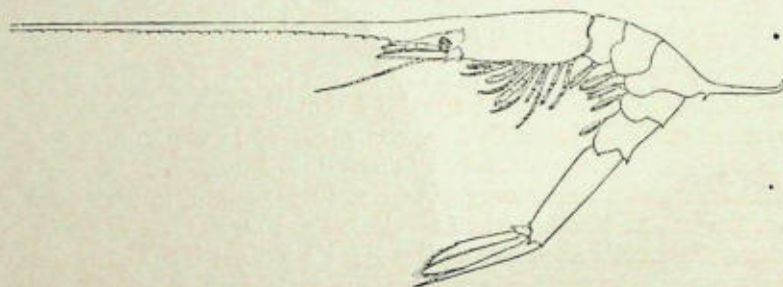


Fig. 4.—*Tozeuma armatum*, Paulson.
Late larval stage.

exceeds the tips of the uropods and is deeply bifurcate at its apex. Apart from its structure this post-larval specimen is remarkable for its great size. It is probable that (as is known to be the case with some other Caridea) there is an actual shrinkage in length at the final moult of the larval metamorphosis; other specimens in the collection, possessing all the adult characters, are 1 or 2 mm. shorter than the post-larval individual.

The colouration of living individuals, as observed in the Andamans, is peculiar. The specimens were deeply mottled with closely aggregated dark red chromatophores, slightly paler dorsally and especially dark on the lower portion of the rostrum which was fringed with bright red hairs. On the second and fifth abdominal pleura there were large eye-spots, each being deep blue in the centre, surrounded with concentric rings of black, pale yellow and red, in the order named. Just beyond its middle each of the inner uropods bore half a similar eye-spot, the two uropods, when juxtaposed, presenting a single perfect spot when seen from below. In dorsal view the spot is partially covered by the telson which is

not marked correspondingly. The inferior portions of the sixth somite were tinged with blue and there were pale pink chromatophores on the hook-like process on the third somite. The outer maxillipede was dark red, the first legs tinged with red and the remainder transparent.

Not infrequently specimens of a uniform bright green colour were met with. In these the rostral setae were also bright red, but the eye-spots were merely of a darker green surrounded by narrow bands of black and white. In the weed among which it is found *T. armatum* is very inconspicuous, extending its body almost perfectly straight and holding tightly to the stem.

²⁷⁶² / ₁₀	Mandapam, Ramnad Dist., S. India, 3 fms.	J. Hornell.	One.
²⁷⁶³ / ₁₀	Port Blair, Andamans; 2-5 fms.	S. Kemp.	Nineteen.
²⁷⁶⁸ / ₁₀	Burma coast, 8 fms.	Investigator.	One, larval.

Balss (*loc. cit. supra*) has recently recorded this species from Japan, thereby making a considerable increase in its known geographical range.

Genus *Gelastocaris*, Kemp.

Gelastocaris paronae (Nobili).

1914. *Gelastocaris paronae*, Kemp. *Rec. Ind. Mus.*, X, p. 107, pl. v, figs. 1-11.

An additional specimen of this curious species was obtained at Port Blair. It was dredged in 5 fathoms of water along with the sponge *Petrosia testudinaria*, Lamarck.¹ When alive the individual was remarkable for its strangely depressed form, the carapace and abdomen being so much flattened that it resembled an Isopod of the genus *Idotea*. In colour the specimen was pale pink throughout with a speckling of darker pink chromatophores on the antennal scale and tail-fan and at the sides of the carapace and abdomen. The *Petrosia* was of a similar pink shade and the colouration is doubtless protective.

The specimen is a male, about 10 mm. in length, and, except for the thickened outer antennular flagellum, differs little from the two females previously recorded; in lateral view, however, the carapace is less strongly arched anteriorly.

²⁷⁶⁸ / ₁₀	Port Blair, Andamans, 5 fms.	S. Kemp.	One.
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Genus *Hippolysmata*, Stimpson.

1914. *Hippolysmata*, Kemp. *Rec. Ind. Mus.*, X, p. 112.

1915. *Exhippolysmata*, Stebbing, *Ann. S. African Mus.*, XV, p. 94.

Stebbing has recently proposed to separate *Hippolysmata ensirostris*, along with a closely allied S. African form, as a distinct genus under the name *Exhippolysmata*. The characters employed

¹ I am indebted to Dr. Annandale for this determination. Mr. Southwell informs me that the specimen from the Ceylon Pearl banks, recorded in the paper cited above, was also found on this sponge.

are those made use of in my key to the Indian species (*loc. cit.*, p. 113): the rostrum is longer than in other species of the genus and is provided with an elevated dentate basal crest; the telson is lanceolate, with the apex acute and unarmed.

These characters appear to me to be altogether unsuitable for generic definition and are clearly of far less morphological value than those hitherto employed in the generic subdivision of the family. In young specimens of *H. ensirostris* there is a pair of long spines at the tip of the telson, reaching far beyond the produced median point and these may still be seen in a reduced condition, even in individuals 40 mm. in length. Stebbing also, when describing *Exhippolysmata tugelar*, notes the presence of a very small spine on either side of the telson tip. The claims of *Exhippolysmata* to generic rank rest therefore on the rostral characters and in the fact that the telson has a median point instead of being rounded. If it be retained, its recognition requires to be balanced by the institution of a considerable number of other "new genera," a procedure which seems unlikely to serve any useful purpose, while tending to confuse the natural affinities of the component species of the family.

Lysmatella, recently instituted by Borradaile for a species from the Maldives, is based on surer structural differences, but is none the less very closely allied to *Hippolysmata*. In the very brief preliminary diagnosis that Borradaile has given,¹ it is merely described as "related to *Lysmata*, but without mastigobranchs on the legs." The type species of the genus, *Lysmatella prima*, is described in the same paper.

Three specimens, recently obtained in the Andamans, agree in every particular with the generic and specific descriptions that Borradaile has given; but, unfortunately, the information is so meagre that it is impossible to be certain of their identity. The Andaman specimens are, however, clearly related in a very close manner with the species of *Hippolysmata* belonging to the *vittata* group, the affinity being shown not only by the almost exact correspondence in all structural details (except for the absence of epipods), but also in colour, the specimens when alive exhibiting the brilliant longitudinal red streaks that characterise *H. vittata* and *H. dentata*.

If my identification of the Andaman specimens is correct it appears to me unwise, in the present state of our knowledge, to recognise *Lysmatella* in full generic significance. The presence or absence of epipods is in many cases a valuable aid to generic diagnosis in the Hippolytidae, but the number of these structures is variable in the genera *Spirontocaris* and *Latreutes* and in *Hippolysmata ensirostris* the entire series is rudimentary. In many species referred to *Hippolysmata* the epipods have not been examined and, on analogy with other genera, it would occasion no surprise if some were found to possess a reduced number.

¹ Borradaile, *Ann. Mag. Nat. Hist.*, (8), XV, p. 206 (1915).

Hippolysmata ensirostris, Kemp.

1914. *Hippolysmata ensirostris*, Kemp, *Rec. Ind. Mus.*, X, p. 118, pl. vii, figs. 1-4.

A number of very interesting larval and post-larval specimens belonging to this species have recently been found off the Orissa coast. The post-larval specimens are about 14 to 16 mm. in length and in most of their characters agree closely with adults. The rostrum, however, is much shorter, usually not reaching the end of the antennal scale, and the peraeopods, though well-formed, with perfect chelae, and with apparently the full number of sub-segments in the carpus of the second, possess rudimentary exopods on all pairs except the last. The apex of the telson is compara-

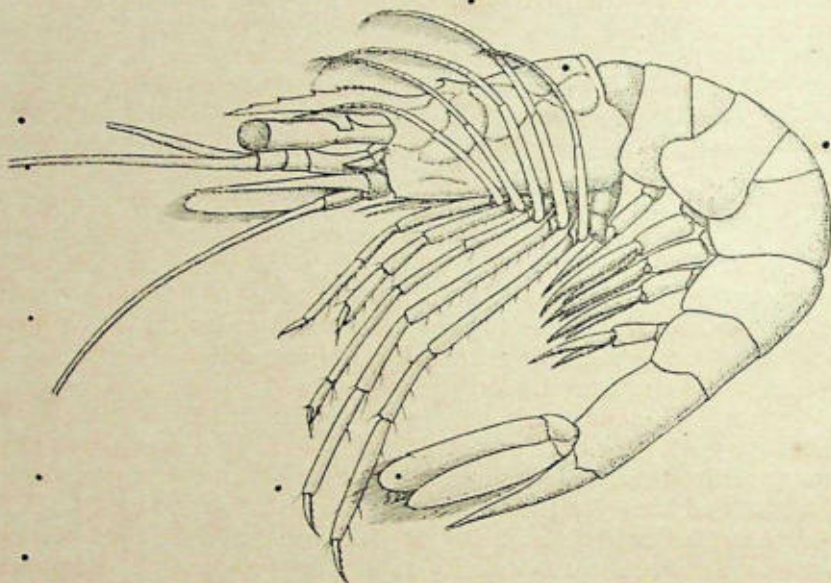


FIG. 5.—*Hippolysmata ensirostris*, Kemp.
Late larval stage.

tively broad, with a pair of long spines that extend beyond the small median point by more than half their length. These spines appear to dwindle slowly in the course of further development and, though not mentioned in my original description, traces of them may still be found in specimens 40 mm. in length.

Judging by the number of teeth on the basal crest of the rostrum, these post-larval specimens belong to *H. ensirostris* rather than to its variety *punctata*.

Other specimens, found with the above, almost certainly represent the same species in its last larval stage, but show remarkable differences in structure (text-fig. 5). The rostrum is short, dorsally convex and bears teeth only on its dorsal margin and that on the carapace, which is deeply grooved on either side

of the mid-dorsal line, is large and procurved. The eye is exceedingly long, reaching beyond the end of the antennular peduncle; it is composed of two distinct segments, the proximal and more slender of the two bearing a conspicuous dorsal spine. The antennules and antennae are normally developed, except that the lateral process on the basal segment of the former is rudimentary. The third maxillipedes and all the pereopods except the last bear very long exopods. The chelae of the first and second pairs are more rudimentary. The full series of gills appears to be present but there is no trace of epipods. The pleopods and uropods are well formed and the apex of the telson resembles that of the post-larval specimens, but possesses a pair of setae near the middle.

So far as I am able to discover the larva differs from that of all other Carids hitherto described in the possession of a large spine on the eyestalk.

$\frac{0.58 \pm 0.1}{1.0}$	Off Puri, Orissa coast,	S. Kemp.	Fourteen, post-larval
	4-4½ fms.		five, larval.

Hippolysmata (Lysmatella) prima (Borradaile).

1915. *Lysmatella prima*, Borradaile, *Ann. Mag. Nat. Hist.*, (8), XV, p. 209.

Borradaile's description of this species runs as follows:—
 "Rostrum $\frac{5.11}{5.0}$, straight but upcurved at end, outreaching antennular stalk. Third maxilliped as stout as first leg, in which hand and arm are subequal, wrist a little shorter. Second wrist has 20-22 joints, the last the longest. Maldives Is."

The Andaman specimens agree well with this description as far as it goes. The rostrum reaches beyond the end of the antennular peduncle and is almost or quite as long as the carapace; it is furnished with 9 or 10 teeth above and with 5, 6 or 7 below. The posterior tooth of the dorsal series is situated a little in front of the middle of the carapace and is separated by a marked interval from the rest; the latter are rather crowded posteriorly but more distantly spaced on the rostral blade; two of them (that is to say three teeth in all) are situated on the carapace behind the orbital notch. The teeth on the lower margin are as large as those on the upper. There is a large antennal spine on the carapace and another, which is smaller, at the pterygostomian angle.

The lateral process of the basal segment of the antennular peduncle is short, not reaching to half the length of the segment; its outer margin is strongly convex. The outer antennular flagellum is thickened at the base, but is devoid of the accessory ramus found in species of *Lysmata*. The antennal scale is narrow, scarcely broader behind than in front, and four times as long as wide. The outer margin is conspicuously concave and terminates in a sharp spine that reaches beyond the distal end of the lamella. The mouth-parts closely resemble those of *H. vittata*. All three maxillipedes bear epipods; the exopod of the last pair reaches beyond the middle of the antepenultimate segment.

The first peraeopods are as described by Borradaile; the chela resembles that of *H. vittata*, the fingers being shorter than the palm and meeting only at the tips when the claw is closed. The second legs are very slender, reaching beyond the antennal scale by nearly two-thirds the length of the carpus; the merus is indistinctly divided into 13 or more segments, while the carpus is composed of from 21 to 24 segments. The last carpal segment is the longest, about equal in length with the palm and one and a half times as long as the fingers.

Of the remaining pairs of the peraeopods the third is the longest reaching beyond the antennal scale by almost the entire length of the propodus. In each pair the merus bears conspicuous teeth externally near the lower border: 5 in the third pair, 5 or 6 in the fourth and 3 or 4 in the fifth. The posterior edge of the propodus is set with fine setae and some seven or eight very slender spinules. The toothing of the dactylus is characteristic. As in *H. vittata* it bears 3 or 4 teeth on its posterior margin which increase in size distally; the actual apex of the dactylus does not, however, take the form of a tooth, comparable to the others, but is extremely slender and, at the base, less than half the breadth of the adjacent tooth of the marginal series.

The abdomen, telson and uropods do not appear to differ in any marked degree from those of *H. vittata*.

The three specimens obtained are all ovigerous females; the largest is about 21 mm. in length.

The colouration of living specimens is striking, the entire carapace and abdomen being marked with longitudinal stripes composed of small bright red chromatophores. On the carapace at the base of the rostrum the first three pairs of lateral stripes meet in the middle line. The three succeeding pairs are strictly longitudinal, but beneath them the striping on the carapace is oblique. In the middle of the abdomen there are about twenty longitudinal stripes. The eyestalks are heavily blotched with red; the antennules and antennae are transparent with a faint yellowish tinge; the third maxillipedes and all the legs, except the second pair, are conspicuously banded with red. The tail-fan is dotted with red and the eggs are sage green. In colour, therefore, the species bears a striking resemblance to *Hippolysmata vittata* and *H. dentata*, but lacks the transverse bands on the abdomen that are found in the former of these species.

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Port Blair, Andamans, 8 fms.

S. Kemp.

Three.

The three specimens were all obtained in a single haul of the net on rough ground in the southern entrance to the channel off Ross I.

EXPLANATION OF PLATE I.

- FIG. 1.—Anterior abdominal sterna of *Labochirus proboscideus*, very young, $\times 4$.
- „ 2.—Anterior abdominal sterna of *Labochirus proboscideus*, young, $\times 4$.
- „ 3.—Anterior abdominal sterna of *Labochirus proboscideus*, ♀ $\times 4$.
- „ 4.—Anterior abdominal sterna of *Labochirus proboscideus*, ♂ $\times 4$.
- „ 5.—Anterior abdominal sterna of *Labochirus gastrostictus*, ♀ $\times 4$.
- „ 6.—Anterior abdominal sterna of *Labochirus kraepelini*, ♀ $\times 4$.
- „ 7.—Anterior abdominal sterna of *Labochirus dawnae*, ♀ $\times 4$.
- „ 8.—Anterior abdominal sterna of *Labochirus browni*, ♀ $\times 4$.
- „ 9.—Anterior abdominal sterna of *Labochirus ellisi*, ♀ $\times 4$.
- „ 10.—Anterior abdominal sterna of *Hypoctonus sylvaticus*, ♀ $\times 4$.
- „ 11.—Anterior abdominal sterna of *Hypoctonus saxatilis*, ♀ $\times 4$.
- „ 12.—Anterior abdominal sterna of *Hypoctonus wood-masoni*, ♀ $\times 4$.
- „ 13.—Lower surface of left trochanter of *Typopeltis simpsoni*, ♂ $\times 4$.



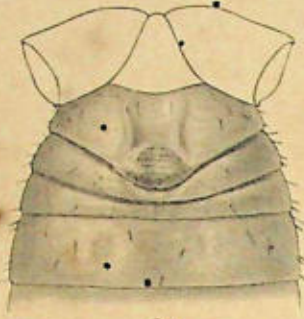
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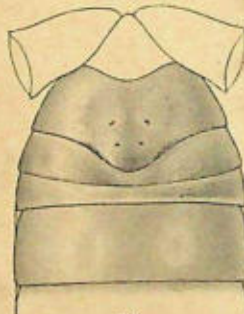
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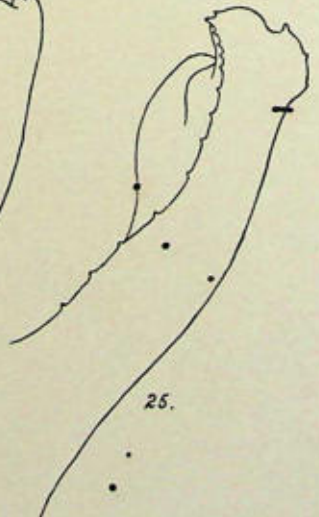
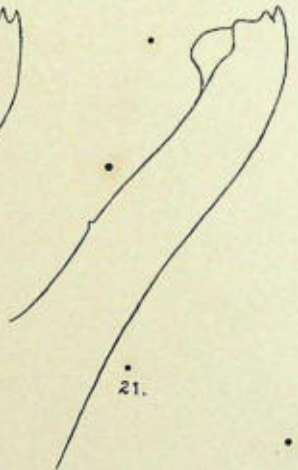
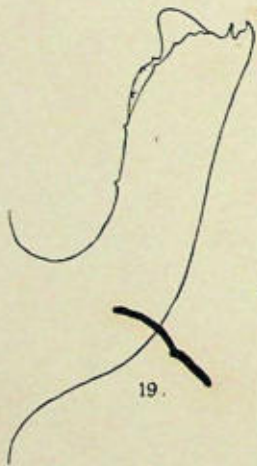
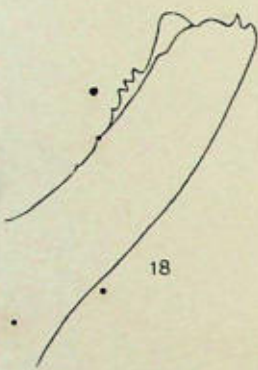
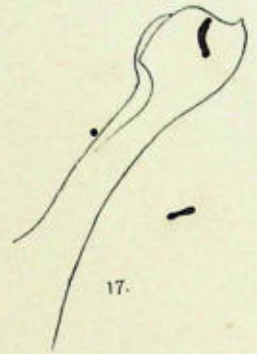
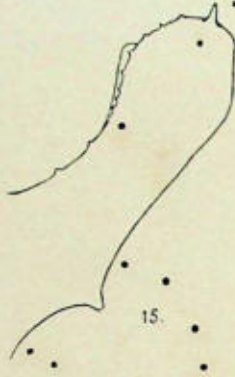
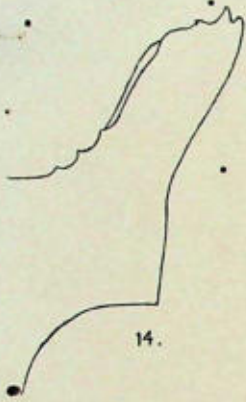
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D. N. Bagehu, del.

Seneca, Cal., Derby

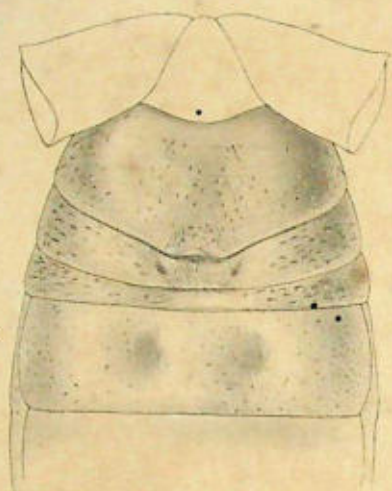
EXPLANATION OF PLATE II.

FIG. 14.—	Tibial apophysis of	<i>Labochirus kraepelini</i> ,	♂.
15.—	"	"	<i>dawnae</i> , ♂.
16.—	"	"	<i>andersoni</i> , ♂.
17.—	"	"	<i>ellisi</i> , ♂.
18.—	"	<i>Hypoctonus</i>	<i>oatesi</i> , ♂.
19.—	"	"	<i>carmichaeli</i> , ♂.
20.—	"	"	<i>formosus</i> , ♂.
21.—	"	"	<i>rangunensis</i> , ♂.
22.—	"	"	<i>saxatilis</i> , ♂.
23.—	"	"	<i>sylvaticus</i> , ♂.
24.—	"	"	<i>wood-masoni</i> , ♂.
25.—	"	"	<i>stoliczkae</i> , ♂.

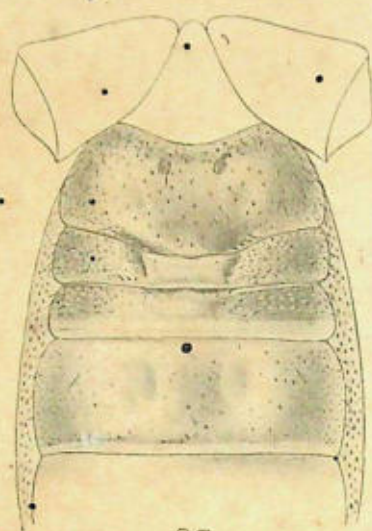


EXPLANATION OF PLATE III.

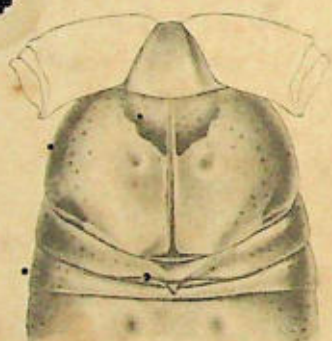
- FIG. 26.—Anterior abdominal sterna of *Uroproctus assamensis*, ♂
× 4.
,, 27.—Anterior abdominal sterna of *Uroproctus assamensis*, ♀
× 4.
,, 28.—Anterior abdominal sterna of *Thelyphonus caudatus*, ♂
× 4.
,, 29.—Anterior abdominal sterna of *Thelyphonus caudatus*, ♀
× 4.
,, 30.—Anterior abdominal sterna of *Thelyphonus linganus*, ♂
× 4.
,, 31.—Anterior abdominal sterna of *Thelyphonus linganus*, ♀
× 4.
,, 32.—Anterior abdominal sterna of *Thelyphonus sucki*, ♂ × 4.
,, 33.—Anterior abdominal sterna of *Thelyphonus schimkewitschi*,
♂ × 4.



26.



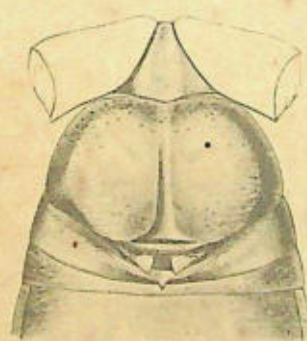
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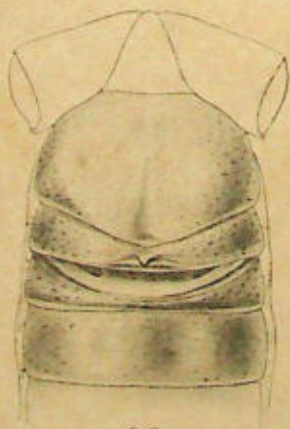
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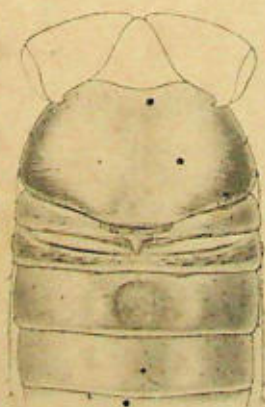
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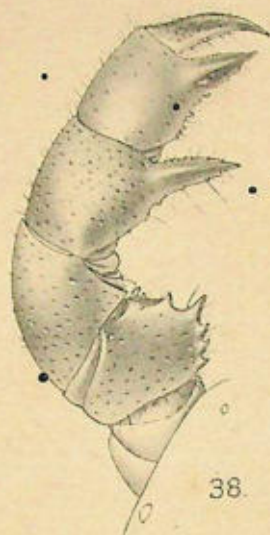
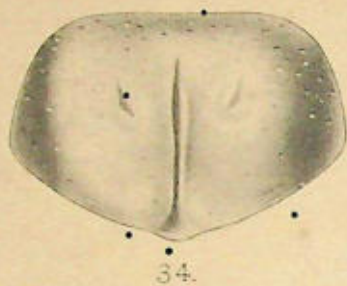
33.

J. N. Bagchi, del.

Bonross Coll. Derby

EXPLANATION OF PLATE IV.

- FIG. 34.—Genital sternum of *Thelyphonus doriae*, ♂ × 4.
 „ 35.—Tibial apophysis of *Uroproctus assamensis*, ♂ × 4.
 „ 36.— „ „ „ „ „ „ ♀ × 4.
 „ 37.—Arm and hand of *Thelyphonus caudatus*, ♂ × 4.
 „ 38.— „ „ „ „ „ „ „ ♀ × 4.
 „ 39.— „ „ „ „ „ „ „ *linganus*, ♂ × 4.
 „ 40.— „ „ „ „ „ „ „ ♀ × 4.
 „ 41.— „ „ „ „ „ „ „ *doriae*, ♂ × 4.
 „ 42.— „ „ „ „ „ „ „ *sucki*, ♂ × 4.
 „ 43.— „ „ „ „ „ „ „ *schimkewitschi*, ♂ × 4.



EXPLANATION OF PLATE V.

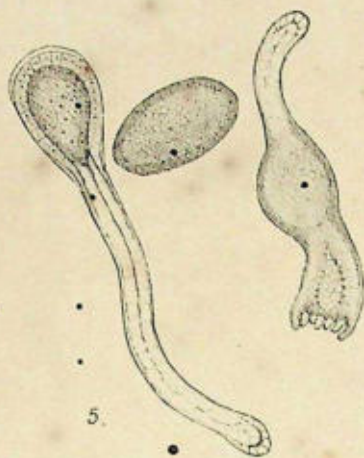
Campanulina ceylonensis (Browne).

- FIG. 1.—A portion of the stolon bearing three hydrosomes in different states, expanded, retracted and retracting, the last bearing a gonosome.
- „ 2.—A very young hydrosome attached to the cast skin of a Copepod (drawn from a preparation by Mr. F. H. Gravely).
- „ 3.—Optical section of a portion of the stem of a fully expanded hydrosome, protruding from the perisarc, showing the everted points of the marginal processes of the hydrotheca.
- „ 4.—A portion of the living hydroid showing the web.
- „ 5.—Three planulae reared in captivity, one with a stolon, another with a hydrosome and stolon (preparation by Mr. F. H. Gravely).

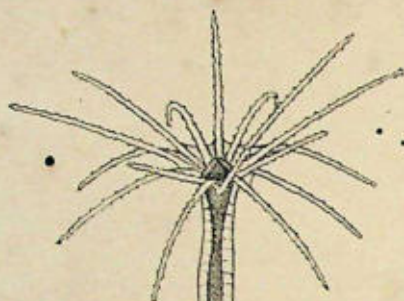
All figures drawn to scale with the Camera lucida.



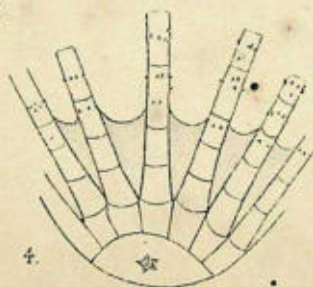
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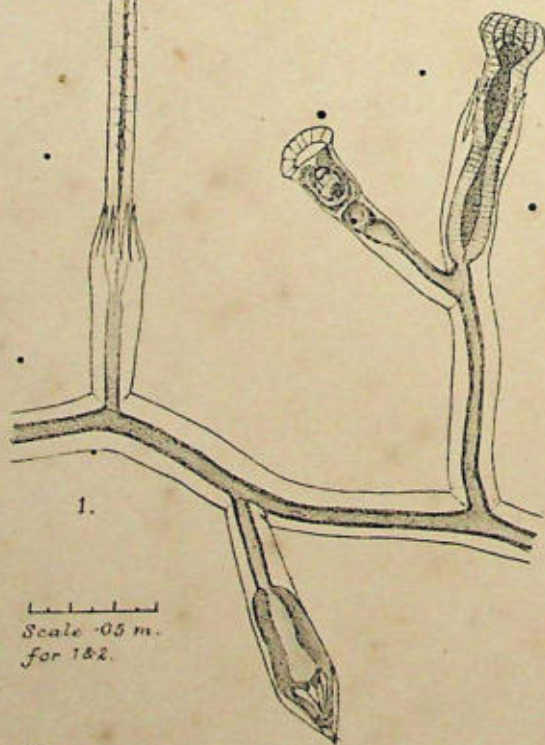
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Scale .05 m.
for 1 & 2.

Scale .01 m.
for 3, 4 & 5.

R. E. Lloyd, del.

A. C. Chowdhury, lith.

CAMPANULINA CEYLONENSIS (Browne).

EXPLANATION OF PLATE VI.

Campanulina ceylonensis (Browne).

FIG. 1.—Optical section of the young gonosome growing from the base of a hydrosome, before the formation of any medusoid buds.

FIGS. 2, 3, 4.—Similar views of gonosomes at somewhat later stages showing the early formation of the first bud.

FIG. 5.—A gonosome with one medusoid.

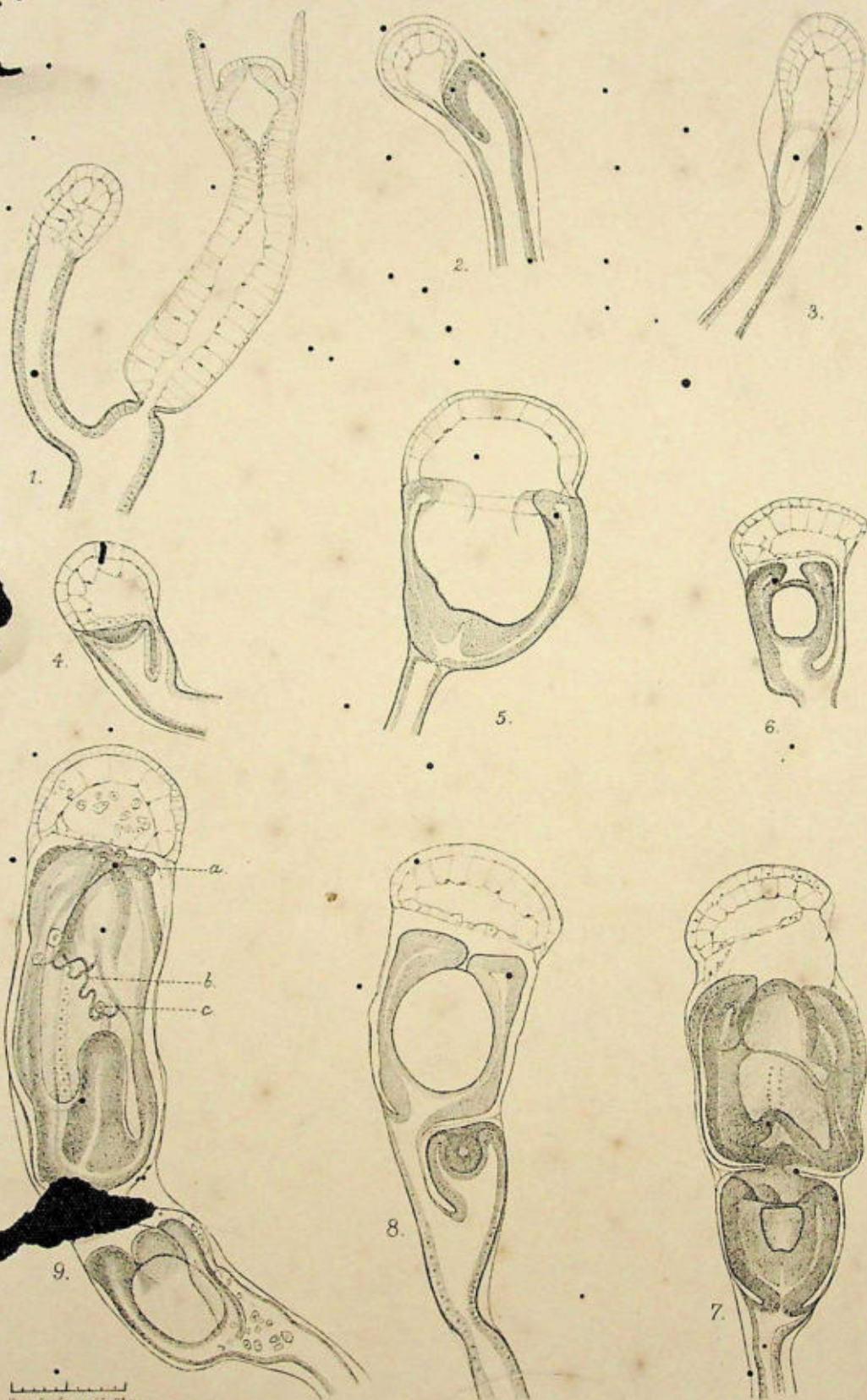
„ 6.—Upper part of a gonosome showing communication between the cavity of the operculum and the enteron of the medusoid.

„ 7.—Gonosome at a later stage, showing the marginal lappets.

„ 8.—Gonosome at a slightly earlier stage than fig. 7, in optical section.

„ 9.—Gonosome, probably mature: *a*, marginal tentacles; *b*, velum; *c*, sense vesicle. Cells resembling phagocytes can be seen in the operculum and in the lower part of the blastostyle.

All figures drawn to scale with the Camera lucida from stained preparations.



Scale for all of m.

R.E. Lloyd, del.

A.C. Chowdhary, lith.

CAMPANULINA CEYLONENSIS (Browne).

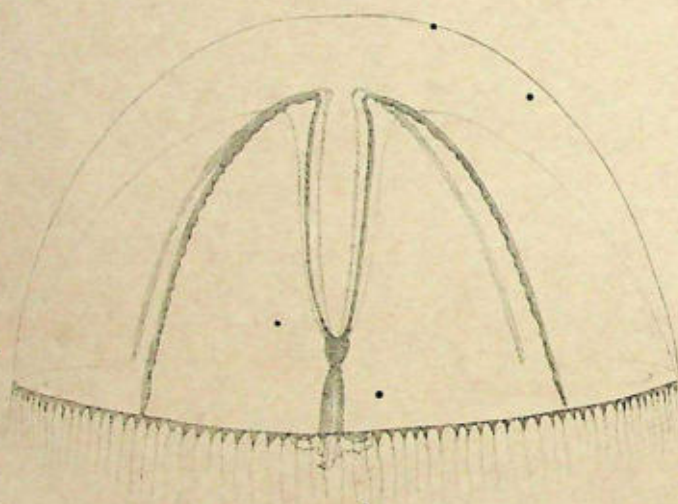
EXPLANATION OF PLATE VII.

Campanulina ceylonensis (Browne).

- FIG. 1.—Medusae of different ages in different attitudes, from life, natural size.
- „ 2.—The mature medusa, from life; $\times 5$. The sense vesicles are not shown. The marginal lappets are somewhat exaggerated in this figure.
- „ 3.—Section of the generative ridge of a ripe female medusa.
- „ 4.—Young medusa, found swimming freely. From a stained preparation, $\times$ about 35.



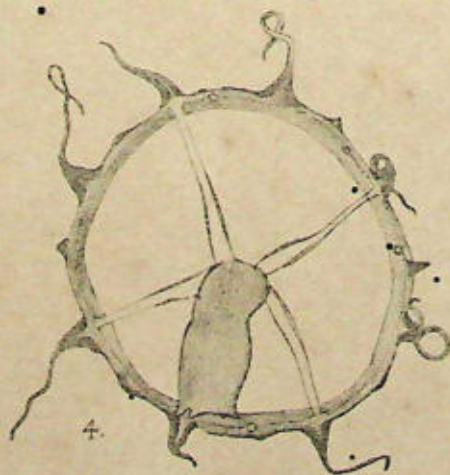
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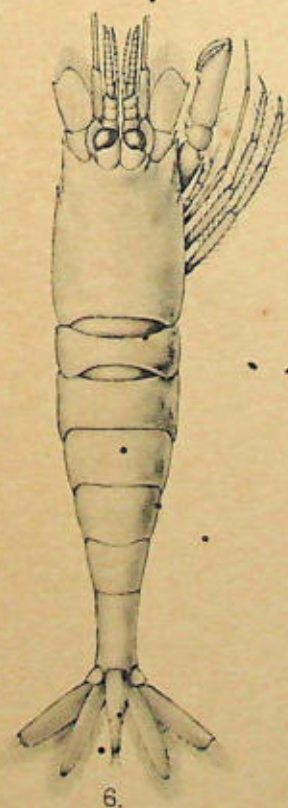
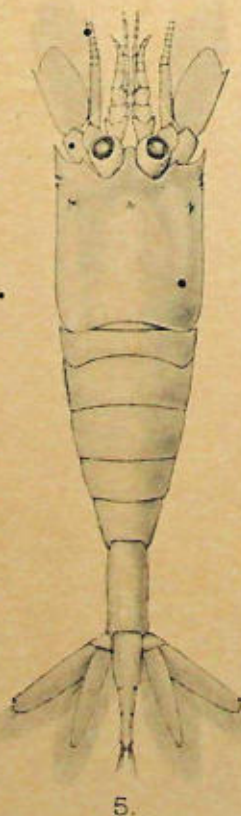
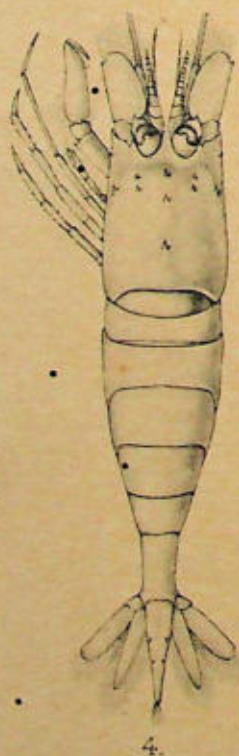
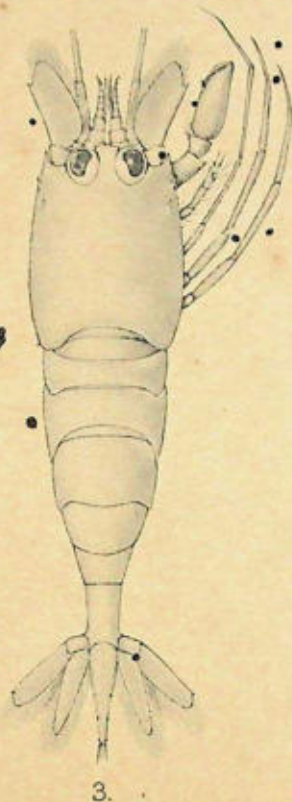
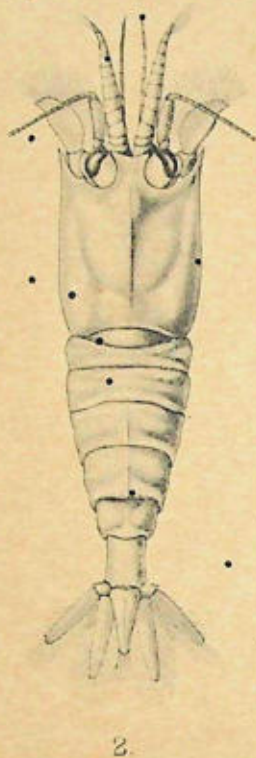
R. H. Lloyd, del.

A. C. Chowdhary, lith.

CAMPANULINA CEYLONENSIS (Browne).

EXPLANATION OF PLATE VIII.

- FIG. 1.—*Pontophilus incisus*, sp. nov.
,, 2.—*Pontophilus lowisi*, sp. nov.
,, 3.—*Pontophilus candidus*, sp. nov.
,, 4.—*Pontophilus pilosus*, sp. nov.
,, 5.—*Pontophilus plebs*, sp. nov.
,, 6.—*Pontophilus parvirostris*, sp. nov.



A.C. Chowdhary, del.

NEW INDIAN SPECIES OF PONTOPHILUS.

Bennett, Colls, Derby

EXPLANATION OF PLATE IX.

Paraperiscyphis pulcher, n. sp.

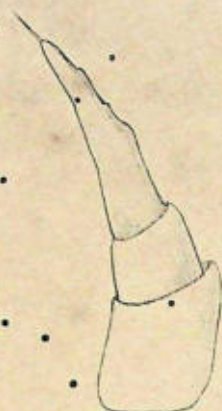
- FIG. 1.—Dorsal view of the cephalon.
,, 2.—Right antennule.
,, 3.—Right antenna.
,, 4.—Right uropod, dorsal view.
,, 5.—Telson and uropoda.

Paraperscyphis scabrus, n. sp.

- FIG. 6.—Dorsal view of the cephalon.
,, 7.—Left antennule.
,, 8.—Right antenna.
,, 9.—Right uropod, dorsal view.
,, 10.—Telson and uropoda.



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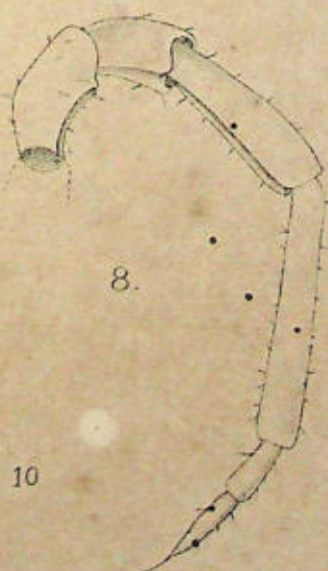
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9.



10.

H.G.K. del.

A. Chowdhary, lith.

1-5. PARAPERISCYPHIS PULCHER, n. sp.
6-10. PARAPERISCYPHIS SCABRUS, n. sp.

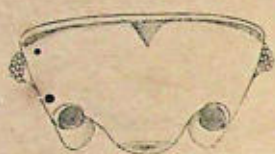
EXPLANATION OF PLATE X.

Cubaris gravelii, n. sp.

- FIG. 1.—Dorsal view of the cephalon.
,, 2.—Anterior view of the cephalon.
,, 3.—Antennule.
,, 4.—Right antenna.
,, 5.—First maxilla, outer lobe.
,, 6.—Second maxilla.
,, 7.—Lateral portions of 1st and 2nd mesosomatic segments,
showing notch and groove on the inner border of the
under side.
,, 8.—Maxillipede, terminal portion.
,, 9.—Right uropod, dorsal view.
,, 10.—Right uropod, ventral view.
,, 11.—Last metasomatic segment, uropoda, and telson.



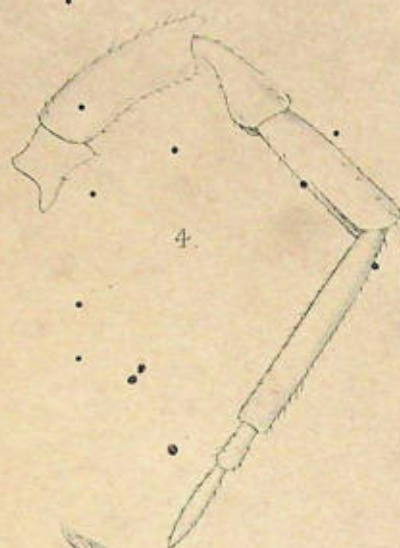
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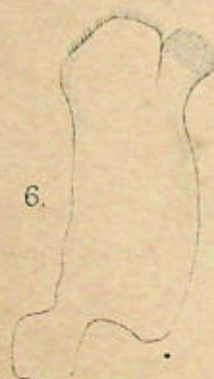
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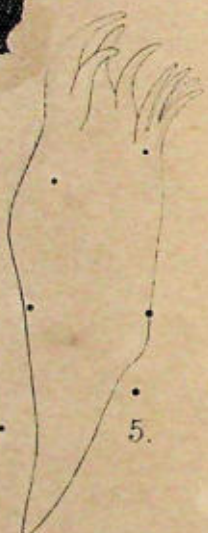
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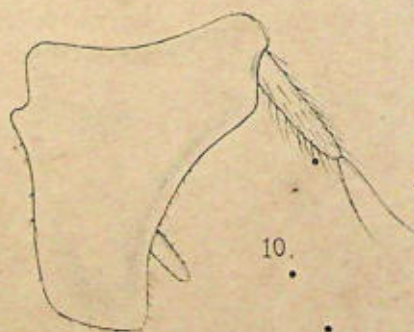
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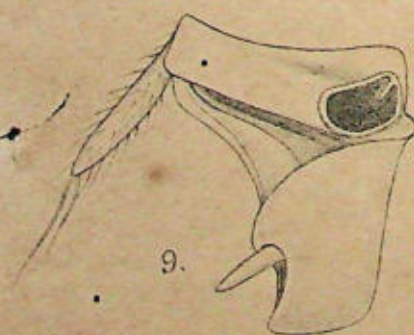
7.



8.



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10.



11.

H. G. K. del.

CUBARIS GRAVELII, n. sp.

A. Chowdhary, lith.

EXPLANATION OF PLATE XI.

Cubaris expansus, n. sp.

- FIG. 1.—Dorsal view of the cephalon.
,, 2.—Anterior view of the cephalon.
,, 3.—Antennule.
,, 4.—Right-antenna.
,, 5.—First-maxilla, terminal portion of outer lobe.
,, 6.—Lateral portions of 1st and 2nd mesosomatic segments, showing notch and groove on the inner border of the under side.
,, 7.—Maxillipede, terminal portion.
,, 8.—Right uropod, dorsal view.
,, 9.—Right uropod, ventral view.
,, 10.—Last metasomatic segment, uropoda, and telson.



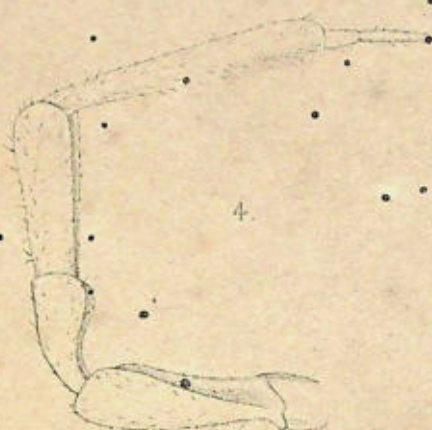
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• T. G. K. del.

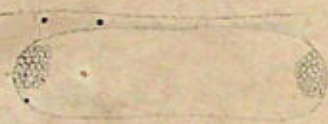
CUBARIS EXPANSUS, n. sp.

A. Chowdhury, lith.

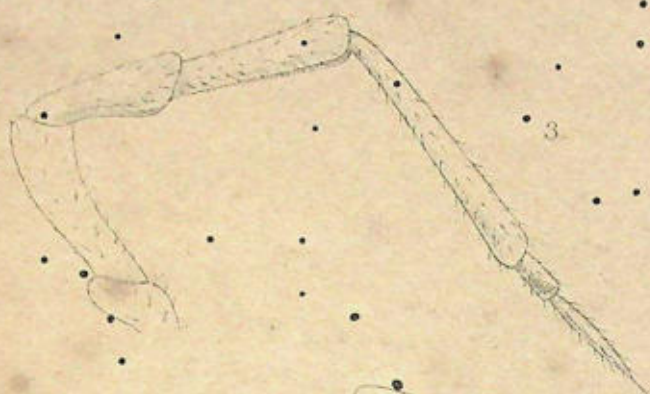
EXPLANATION OF PLATE XII.

Cubaris dilectum, n. sp.

- FIG. 1.—Dorsal view of the cephalon.
" 2.—Anterior view of the cephalon.
" 3.—Right antenna.
" 4.—First maxilla, terminal portion of outer lobe.
" 5.—Lateral portions of 1st and 2nd mesosomatic segments.
showing notch and groove on the inner border of the
under side.
" 6.—Maxillipede, terminal portion.
" 7.—Right uropod, dorsal view.
" 8.—Right uropod, ventral view.
" 9.—Last metasomatic segment, uropod and telson.



1



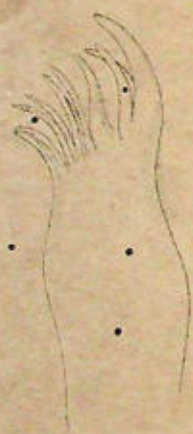
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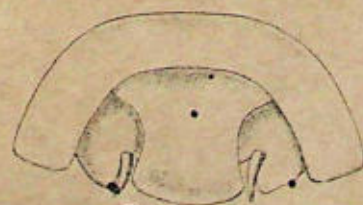
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6



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9

G. K. del.

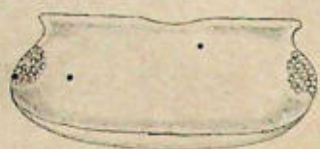
CUBARIS DILECTUM, n. sp.

A. Chowdhary, lith.

EXPLANATION OF PLATE XIII.

Cubaris pusillus, n. sp.

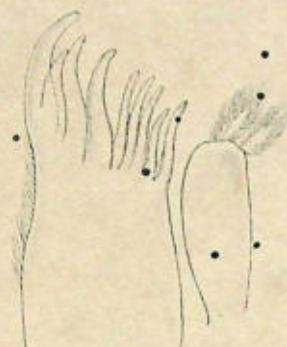
- FIG. 1.—Dorsal view of the cephalon.
,, 2.—Anterior view of the cephalon.
,, 3.—Right antenna.
,, 4.—First maxilla, terminal portions of inner and outer lobes.
,, 5.—Second maxilla, terminal portion.
,, 6.—Lateral portions of 1st and 2nd mesosomatic segments,
showing notch and groove on the inner border of the
under side.
,, 7.—Maxillipede, terminal portion.
,, 8.—Right uropod, dorsal view.
,, 9.—Right uropod, ventral view.
,, 10.—Last metasomatic segment, uropod and telson.



1.



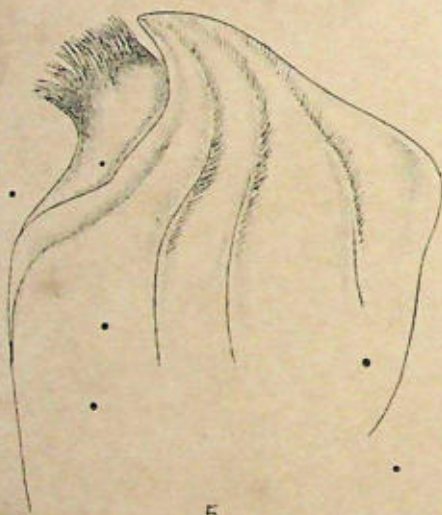
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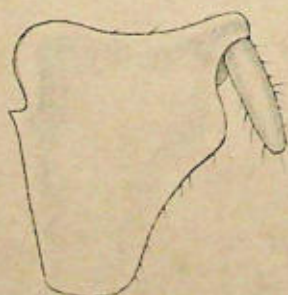
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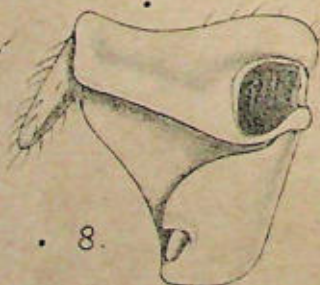
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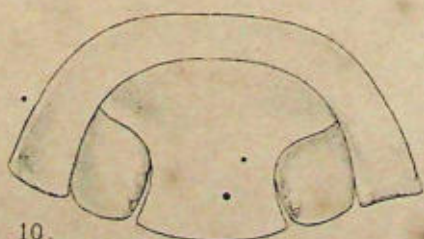
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H.G.K. del.

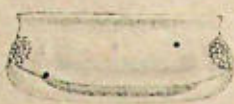
CUBARIS PUSILLUS, n. sp.

A. Chowdhary, lith.

EXPLANATION OF PLATE XIV.

Cubaris brunneocaudatus, n. sp.

- FIG. 1.—Dorsal view of the cephalon.
,, 2.—Anterior view of the cephalon.
,, 3.—Right antennule.
,, 4.—Right antenna.
,, 5.—First maxilla, terminal portion of outer lobe.
,, 6.—Lateral portions of 1st and 2nd mesosomatic segments,
showing notch and groove on the inner border of the
under side.
,, 7.—Maxillipede, terminal portion.
,, 8.—Right uropod, dorsal view.
,, 9.—Right uropod, ventral view.
,, 10.—Last metasomatic segment, uropoda and telson.



1.



3.



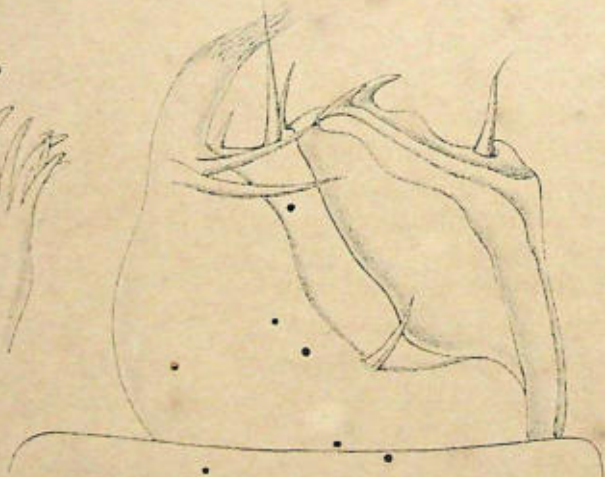
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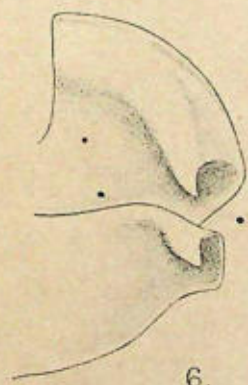
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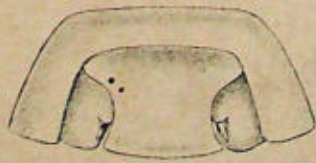
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H. G. K. del.

CUBARIS BRUNNEOCAUDATUS, n. sp.

A Chowdhary, lith.

EXPLANATION OF PLATE XV.

Cubaris chiltoni, n. sp.

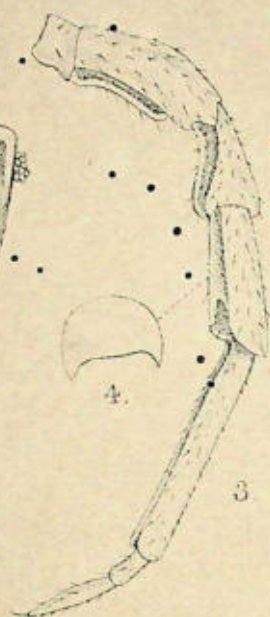
- FIG. 1.—Dorsal view of the cephalon.
,, 2.—Anterior view of the cephalon.
,, 3.—Right antenna.
,, 4.—Semi-diagrammatic section of the 4th joint of the antenna.
,, 5.—First maxilla, terminal portions of inner and outer lobes.
,, 6.—Second maxilla, terminal portion.
,, 7.—Lateral portions of 1st and 2nd mesosomatic segments, showing notch and groove on the inner border of the under side.
,, 8.—Maxillipede, terminal portion.
,, 9.—Right uropod, dorsal view.
,, 10.—Right uropod, ventral view.
,, 11.—Last metasomatic segment, uropoda and telson.



1.



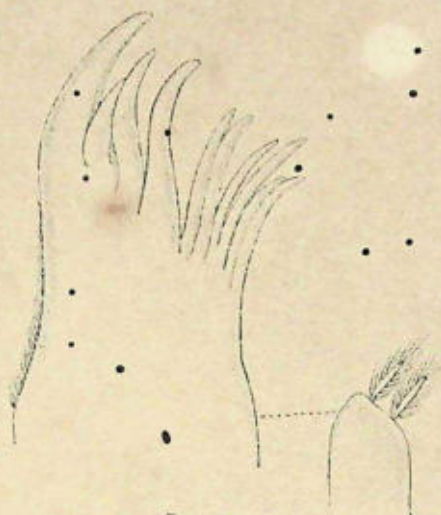
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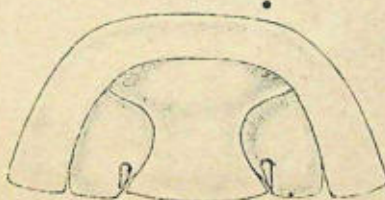
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11.



7.



10.



9.



8.

H.G.K. del.

CUBARIS CHILTONI, n. sp.

A. Chowdhary, lith.

EXPLANATION OF PLATE XVI.

Cubaris cavernosus, n. sp.

- FIG. 1.—Dorsal view of the cephalon.
,, 2.—Anterior view of the cephalon.
,, 3.—Antennule
,, 4.—Right antenna.
,, 5.—First maxilla, terminal portions of inner and outer lobes.
,, 6.—Lateral portions of 1st and 2nd mesosomatic segments,
showing notch and groove on the inner border of the
under side.
,, 7.—Maxillipede, terminal portion.
,, 8.—Right uropod, dorsal view.
,, 9.—Last metasomatic segment, uropoda and telson.



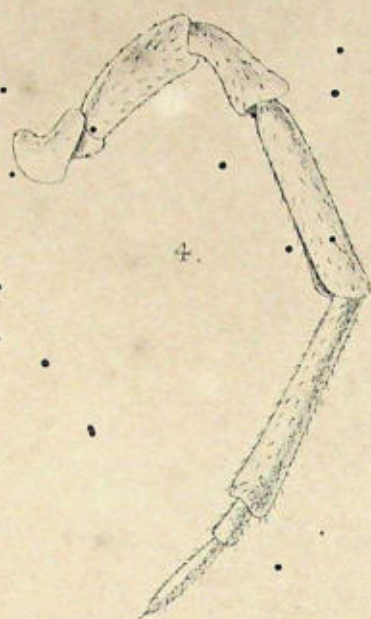
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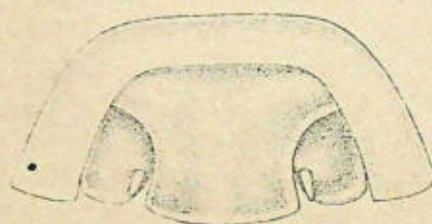
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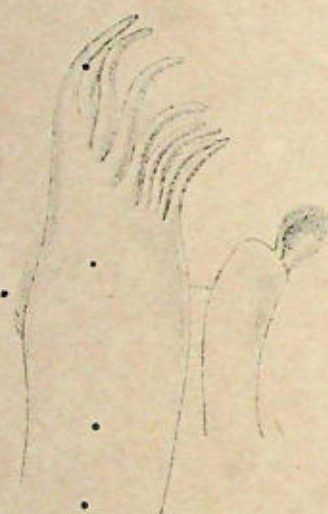
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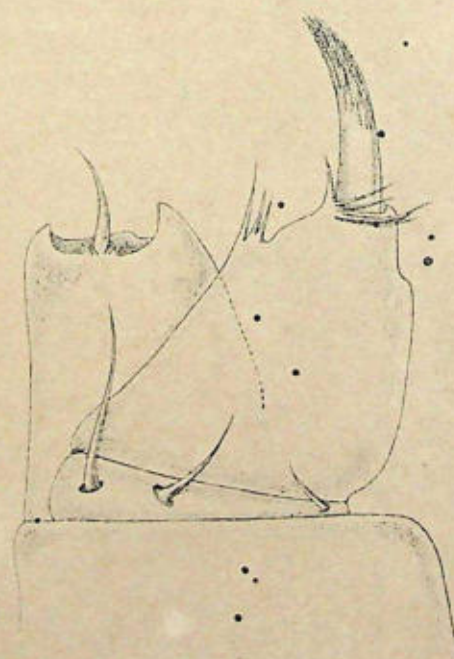
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H.G. K. del.

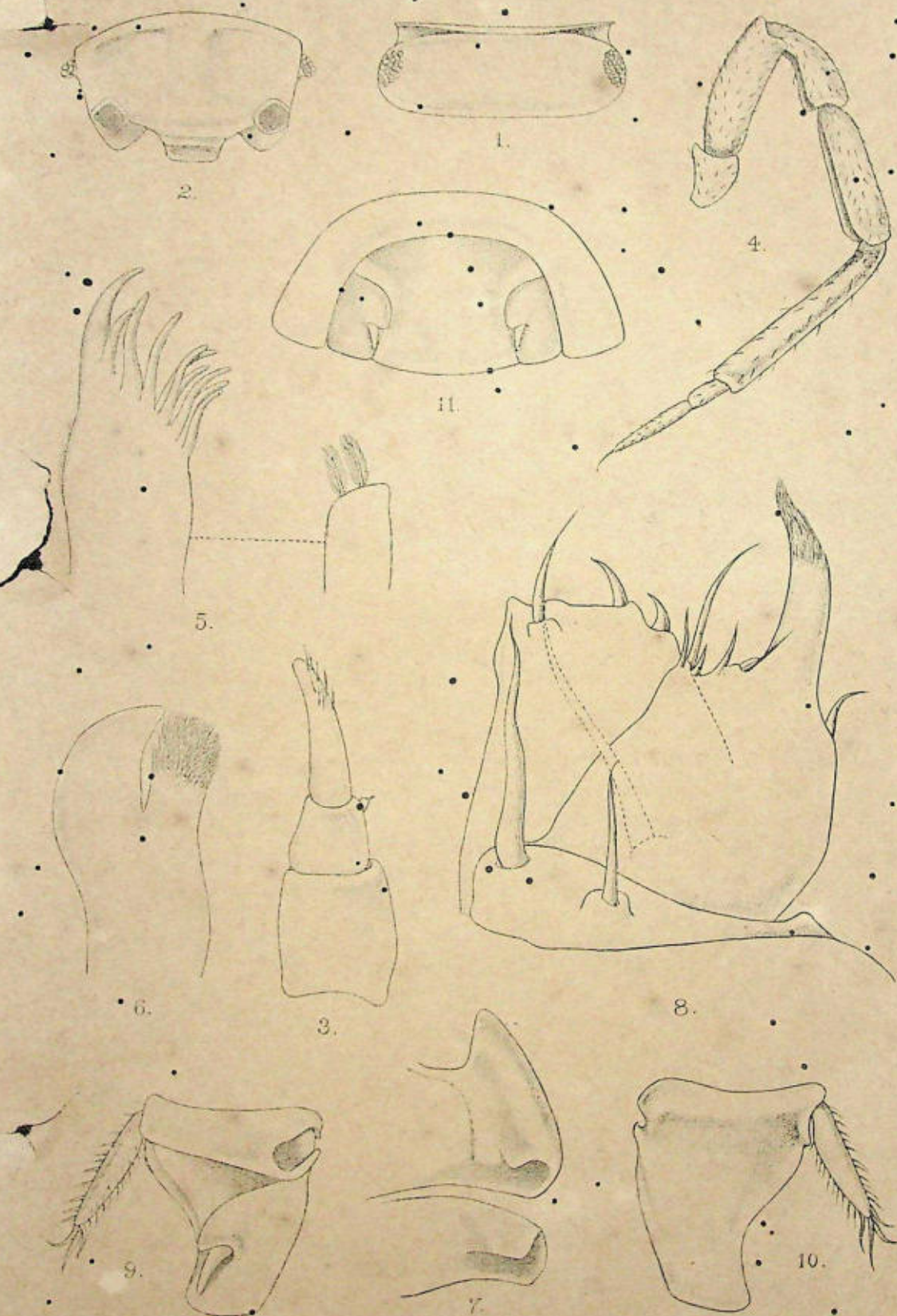
A. Chowdhary, lith.

CUBARIS CAVERNOSUS, n. sp.

EXPLANATION OF PLATE XVII.

Cubaris lobatus, n. sp.

- FIG. 1.—Dorsal view of the cephalon.
,, 2.—Anterior view of the cephalon.
,, 3.—Antennule.
,, 4.—Right antenna.
,, 5.—First maxilla, terminal portions of outer and inner lobes.
,, 6.—Second maxilla, terminal portion.
,, 7.—Lateral portions of 1st and 2nd mesosomatic segments,
showing notch and groove on the inner border of the
under side.
,, 8.—Maxillipede, terminal portion.
,, 9.—Right uropod, dorsal view.
,, 10.—Right uropod, ventral view.
,, 11.—Last metasomatic segment, uropoda and telson.



M.G.K. del.

CUBARIS LOBATUS, n.sp.

A. Chowdhary, lith.

EXPLANATION OF PLATE XVIII

Cubaris albolateralis, n. sp.

- FIG. 1.—Dorsal view of the cephalon.
,, 2.—Anterior view of the cephalon.
,, 3.—Antennule.
,, 4.—Right antenna.
,, 5.—First maxilla, terminal portion.
,, 6.—Second maxilla, terminal portion.
,, 7.—Lateral portions of mesosomatic segments, showing form of the lateral plates and indentations on the segments.
,, 8.—Lateral portions of 1st and 2nd mesosomatic segments, showing notch and groove on the inner border of the under side.
,, 9.—Maxillipede, terminal portion.
,, 10.—Right uropod, dorsal view.
,, 11.—Right uropod, ventral view.
,, 12.—Last metasomatic segment, uropoda and telson.



W.E.C. & H.G.K. del.

A. Chowdhary, lith.

CUBARIS ALBOLATERALIS, n.sp.

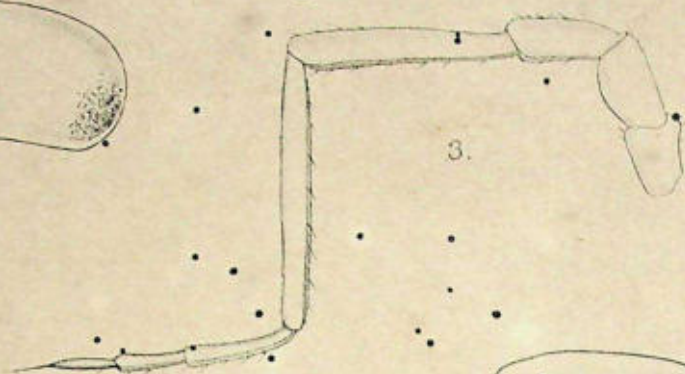
EXPLANATION OF PLATE XIX.

Burmoniscus kempi, n. sp.

- FIG. 1.—Dorsal view of the cephalon.
,, 2.—Anterior view of the cephalon.
,, 3.—Left antenna.
,, 4.—First maxilla, terminal portions of outer and inner lobes.
,, 5.—Second maxilla, terminal portion.
,, 6.—Maxillipede, terminal portion.
,, 7.—Right uropod, dorsal view.
,, 8.—Last metasomatic segment, telson and basal plates of the uropoda.



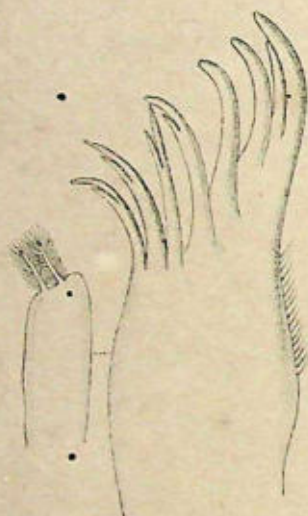
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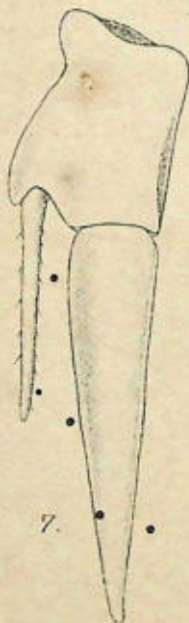
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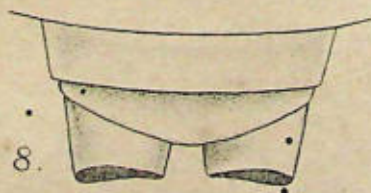
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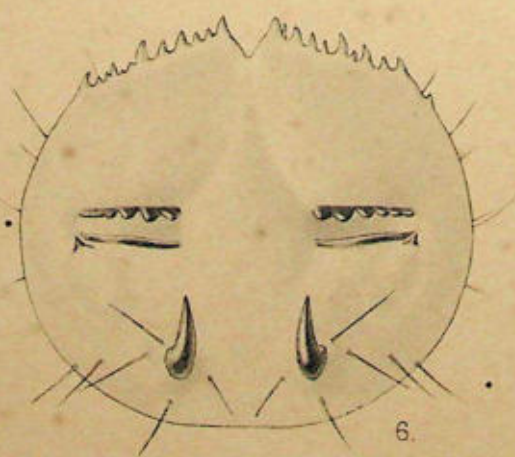
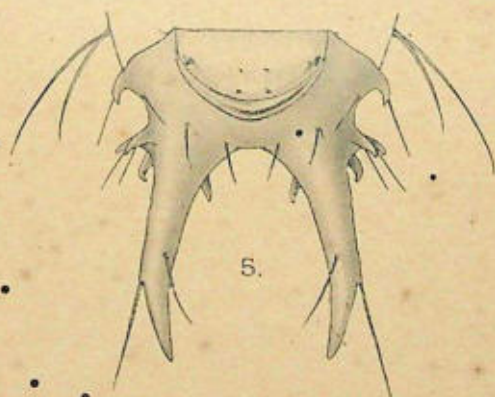
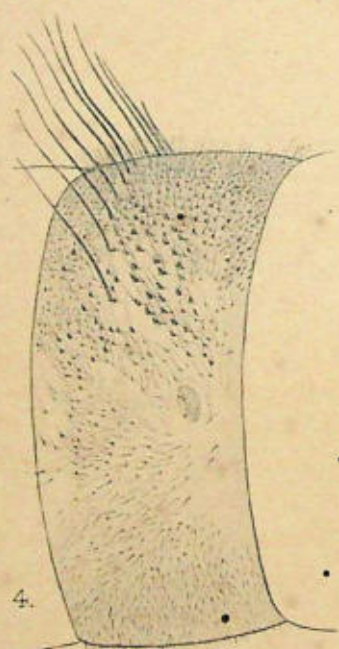
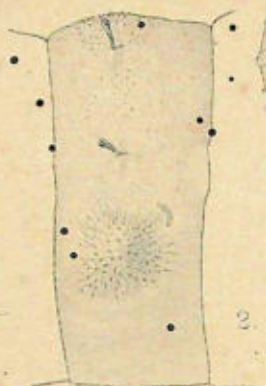
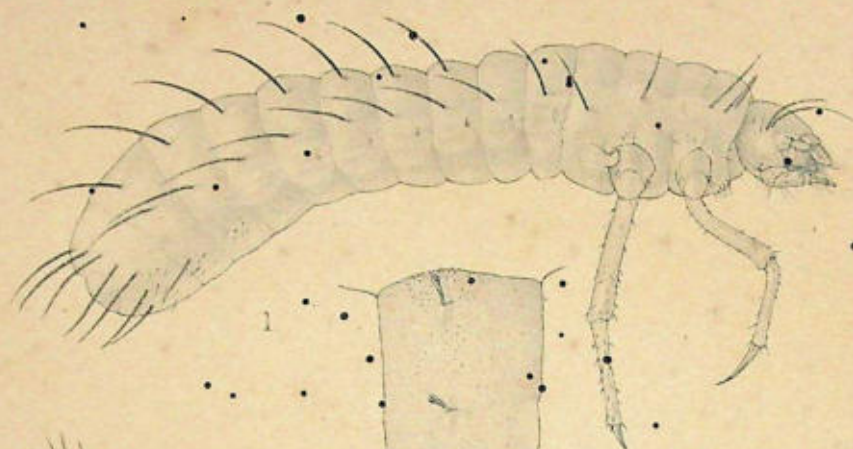
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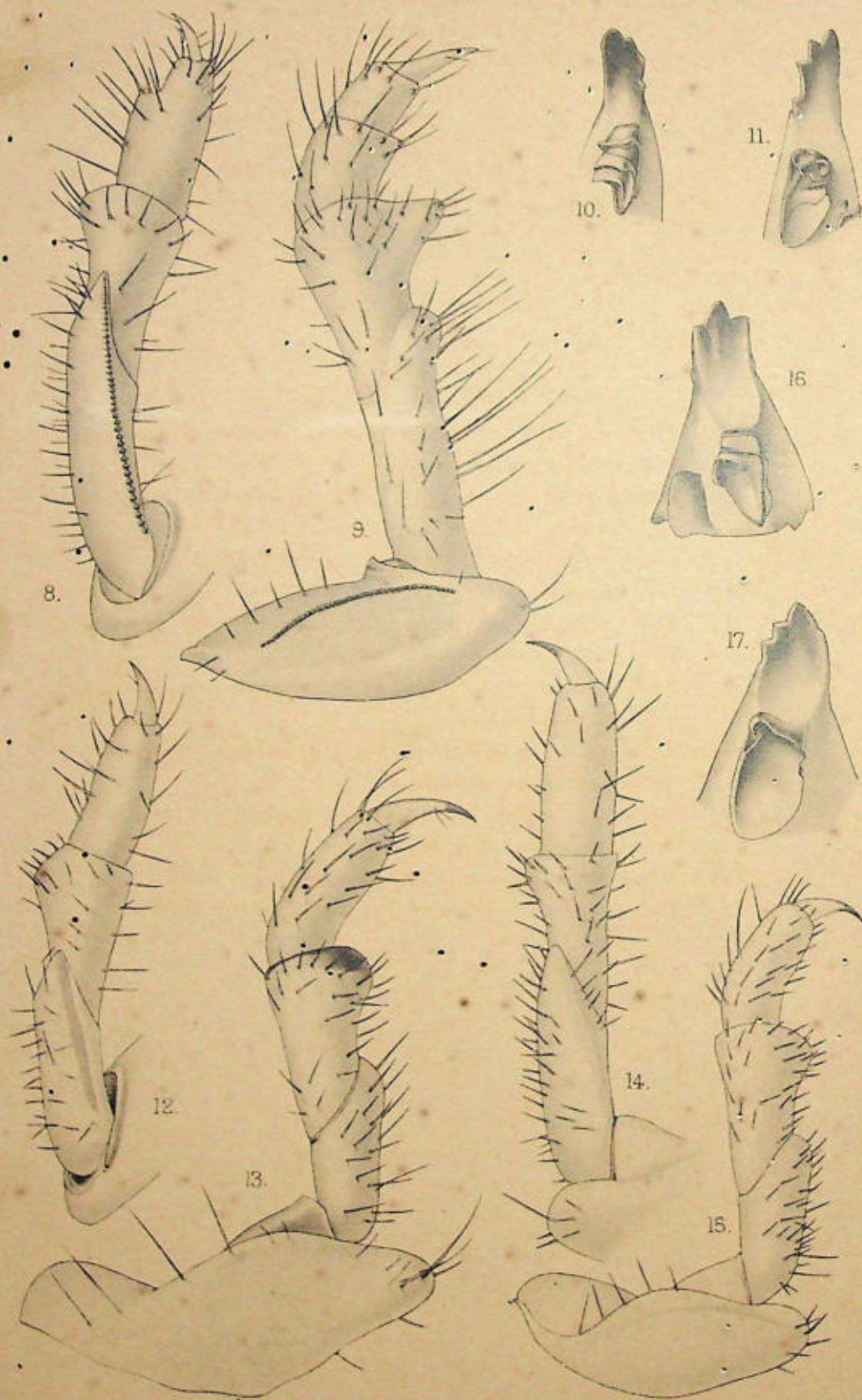
EXPLANATION OF PLATE XX.

- FIG. 1. Larva of *Pleurarius brachyphyllus*, towards the end of the stage with spiniform bristles. $\times 5$.
- „ 2. Fourth segment of fully developed larva of *Pleurarius brachyphyllus*. $\times 5$.
- „ 3. Claviform bristle of same larva more highly magnified.
- „ 4. Fourth segment of larva of *Acceraius kuwerti*. $\times 5$.
- „ 5. Anal segment of larva of *Catapiestus indicus* from below. $\times 12$.
- „ 6. Anal segment of last larval exuvium of *Strongylium sobrinum*, cleared and viewed as a transparency, from behind.
- „ 7. The same from the side.



EXPLANATION OF PLATE XXI.

- FIG. 8. Third right leg of larva of *Aegus roepstorffi*, showing stridulating surface.
- „ 9. Second right leg of larva of *Aegus roepstorffi*, showing stridulating surface.
- „ 10. Right mandible of larva of *Aegus roepstorffi*.
- „ 11. Left mandible of larva of *Aegus roepstorffi*.
- „ 12. Third right leg of larva of *Nigidius dawnae*, showing stridulating surface.
- „ 13. Second right leg of larva of *Nigidius dawnae*, showing stridulating surface.
- „ 14. Third right leg of larva of *Nigidius impressicollis*, showing stridulating surface.
- „ 15. Second right leg of larva of *Nigidius impressicollis*, showing stridulating surface.
- „ 16. Right mandible of larva of *Nigidius impressicollis*.
- „ 17. Left mandible of larva of *Nigidius impressicollis*.



LUCANIDAE.

Germine, Coll. Derby

EXPLANATION OF PLATE XXII.

- FIG. 18 Larva of *Hectarthrum trigeminum*.
,, 19. Mandible of same larva.
,, 20. Antenna of same larva.
,, 21. Head of same larva from front.
,, 22. Maxillae and labium of same larva.
,, 23. Larva of *Cardiaspis pisciformis* from below.
,, 24. Anterior part of head of same larva from below.
,, 25. Anterior part of head of same larva from above.
,, 26. Pupa of same species from below.
,, 27. Adult of same species from below.
,, 28. Adult of same species from above.



19.



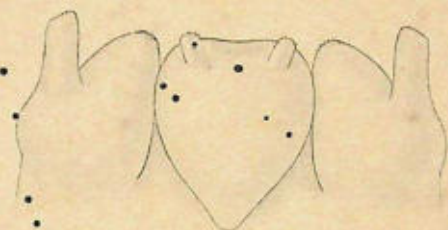
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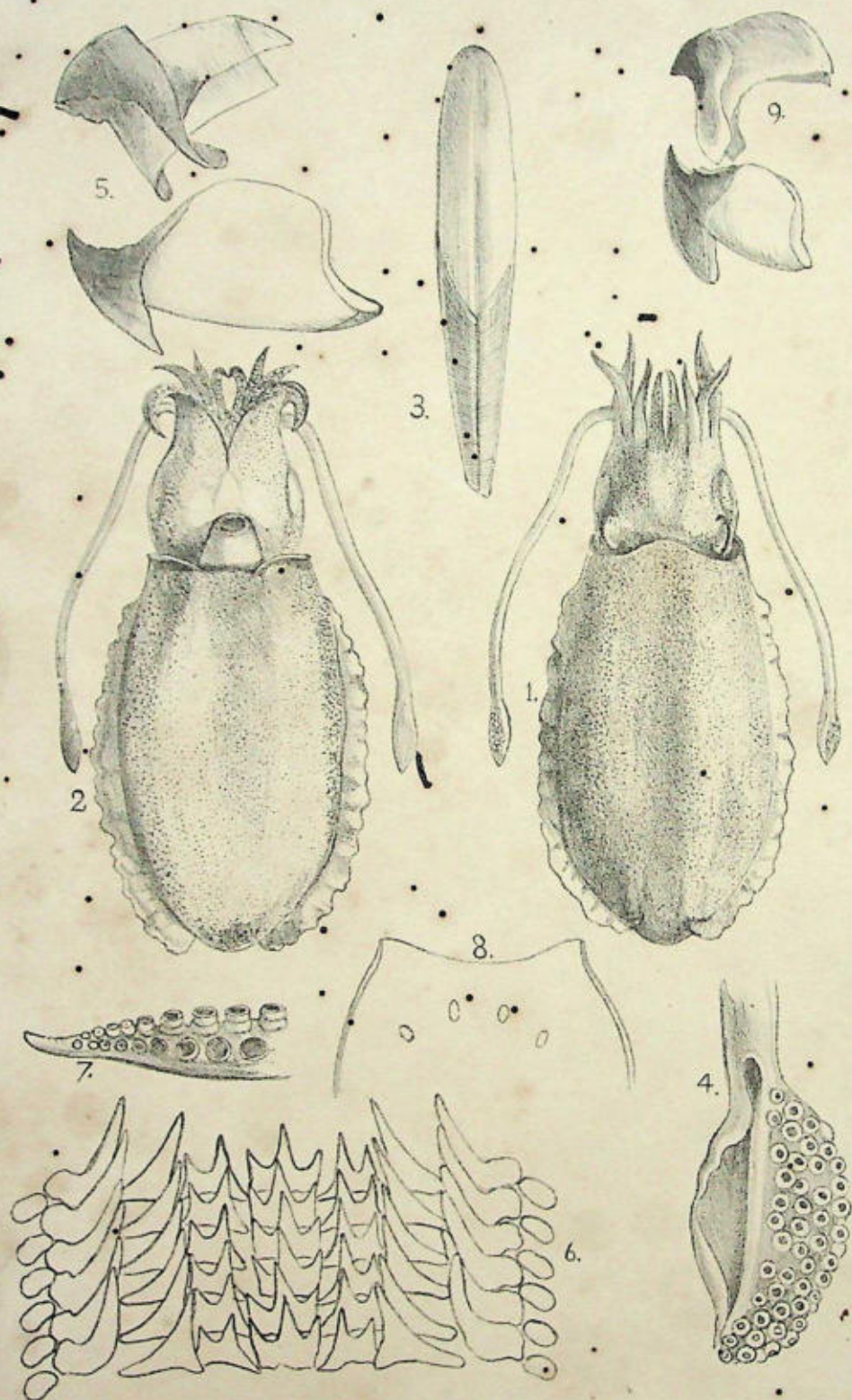
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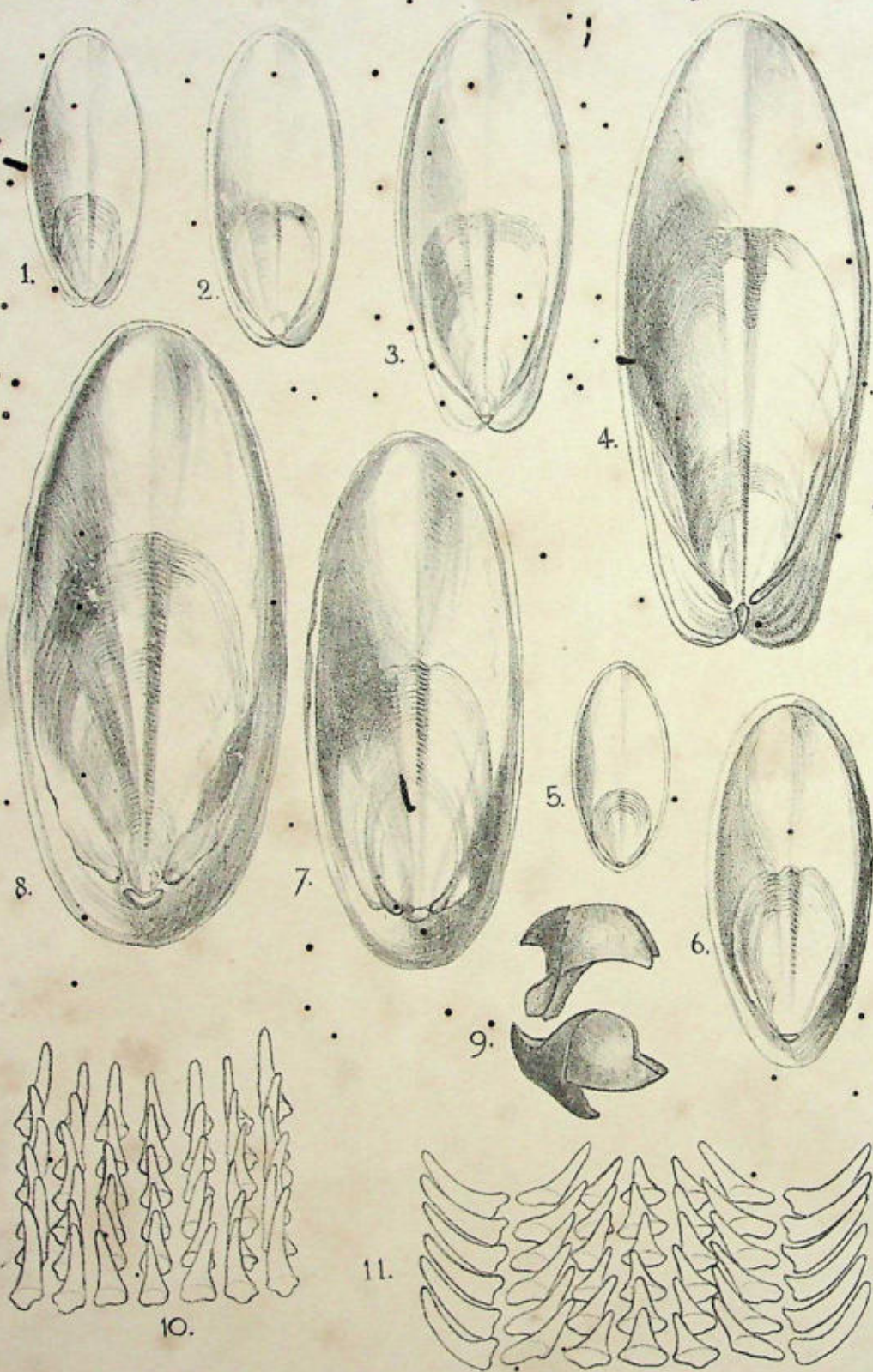
EXPLANATION OF PLATE XXIII.

- FIG. 1.—*Sepia arabica*, sp. n., dorsal view.
 „ 2.— „ „ ventral „
 „ 3.— „ „ sepiostaire.
 „ 4.— „ „ club.
 „ 5.— „ „ mandibles.
 „ 6.—*Sepiclla inermis* (van Hasselt, MS.) Steenstrup, radula.
 „ 7.—*Polypus pricei*, Berry, hectocotylized arm.
 „ 8.— „ „ „ funnel organ.
 „ 9.—*Loligo indica*, Pfeffer, mandibles.



EXPLANATION OF PLATE XXIV.

- FIG. 1.—*Sepiella inermis* (van Hasselt, MS.) Steenstrup,
 sepiostaire M $\frac{82110}{1}$ ♂
 " 2.— " " " " " " M $\frac{82116}{1}$ ♂
 " 3.— " " " " " " M $\frac{8142}{1}$ ♂
 " 4.— " " " " " " M $\frac{8143}{1}$ ♂
 " 5.— " " " " " " M $\frac{8648}{1}$ ♀
 " 6.— " " " " " " M $\frac{8250}{1}$ ♀
 " 7.— " " " " " " M $\frac{8260}{1}$ ♀
 " 8.— " " " " " " M $\frac{8261}{1}$ ♀
 " 9.— " " " " " " mandibles.
 " 10.—*Sepia arabica*, sp. n., radula.
 " 11.—*Loligo indica*, Pfeffer, radula.



EXPLANATION OF PLATE XXV.

Structural differences between the genera *Haplochilus* and *Panchax*.

FIGS. 1 and 2.—Heads of *Haplochilus melanostigma*, McClelland and *Panchax parvus*, sp. nov., showing the position of the mouth and pectoral fin. Note the fold over the snout of the latter.

FIG. 3.—Right premaxilla of a female *H. melanostigma*, McClelland.

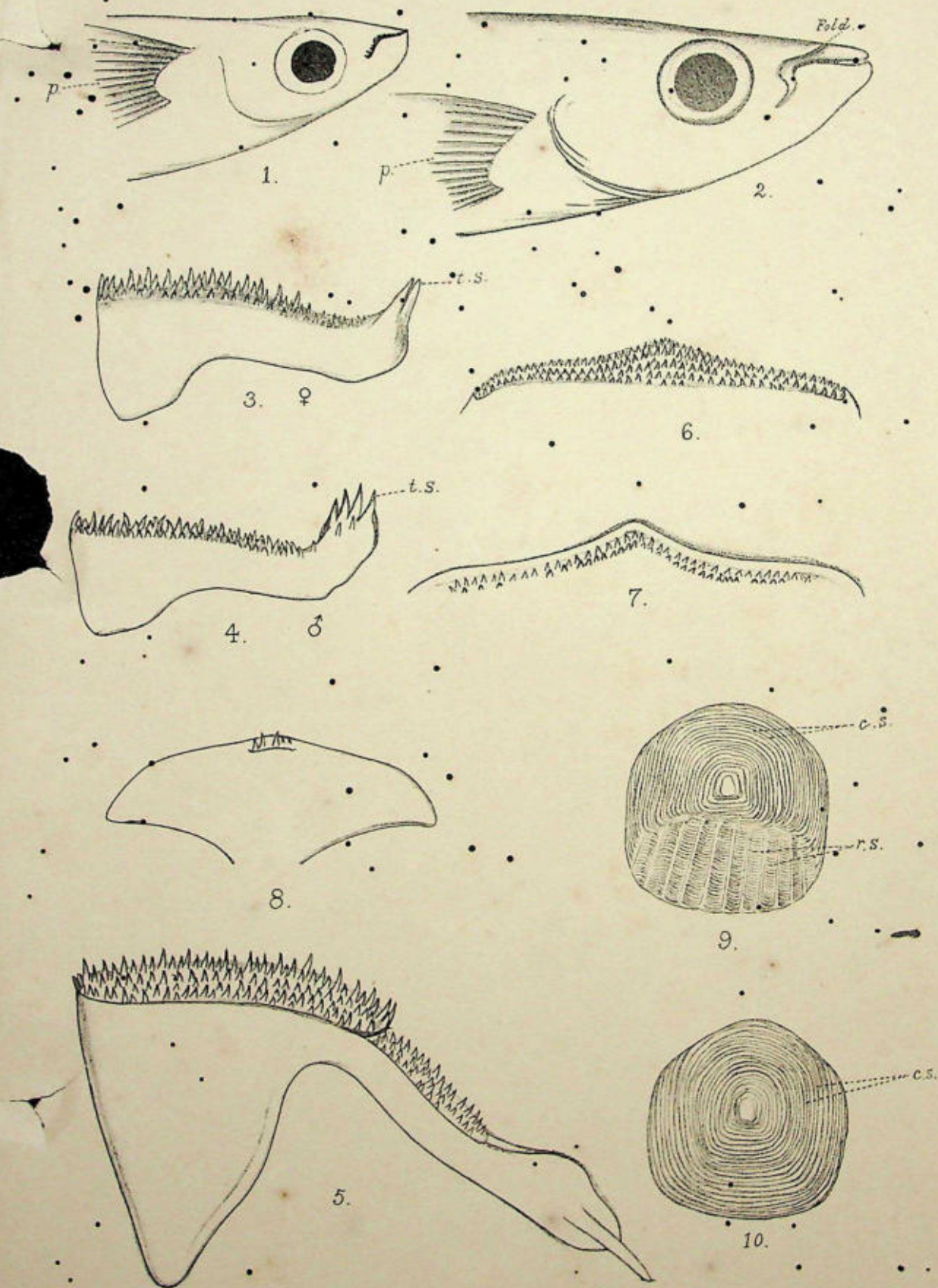
„ 4— „ „ „ male „ „

„ 5— „ „ of *Panchax lineatum*, C.V.

FIGS. 6, 7 and 8.—Vomerine teeth of *Panchax lineatum*, C.V., *P. panchax* (H. B.) and *P. parvus*, sp. nov.

„ 9 and 10.—Scales of *Panchax panchax* (H. B.) and *Haplochilus melanostigma*, McClelland.

C. S. = circular striations; P. = pectoral fin; R.S. = radiating striations; T.S. = terminal spines ("teeth").



B. Sundara Raj, del.

A. Chowdhary, lith.

EXPLANATION OF PLATE XXVI.

FIG. 11.—Ovum of *Panchax parvus*, sp. nov.

Haplochilus melanostigma, McClelland.

FIG. 12.—A cluster of eggs with their long filaments twisted together.

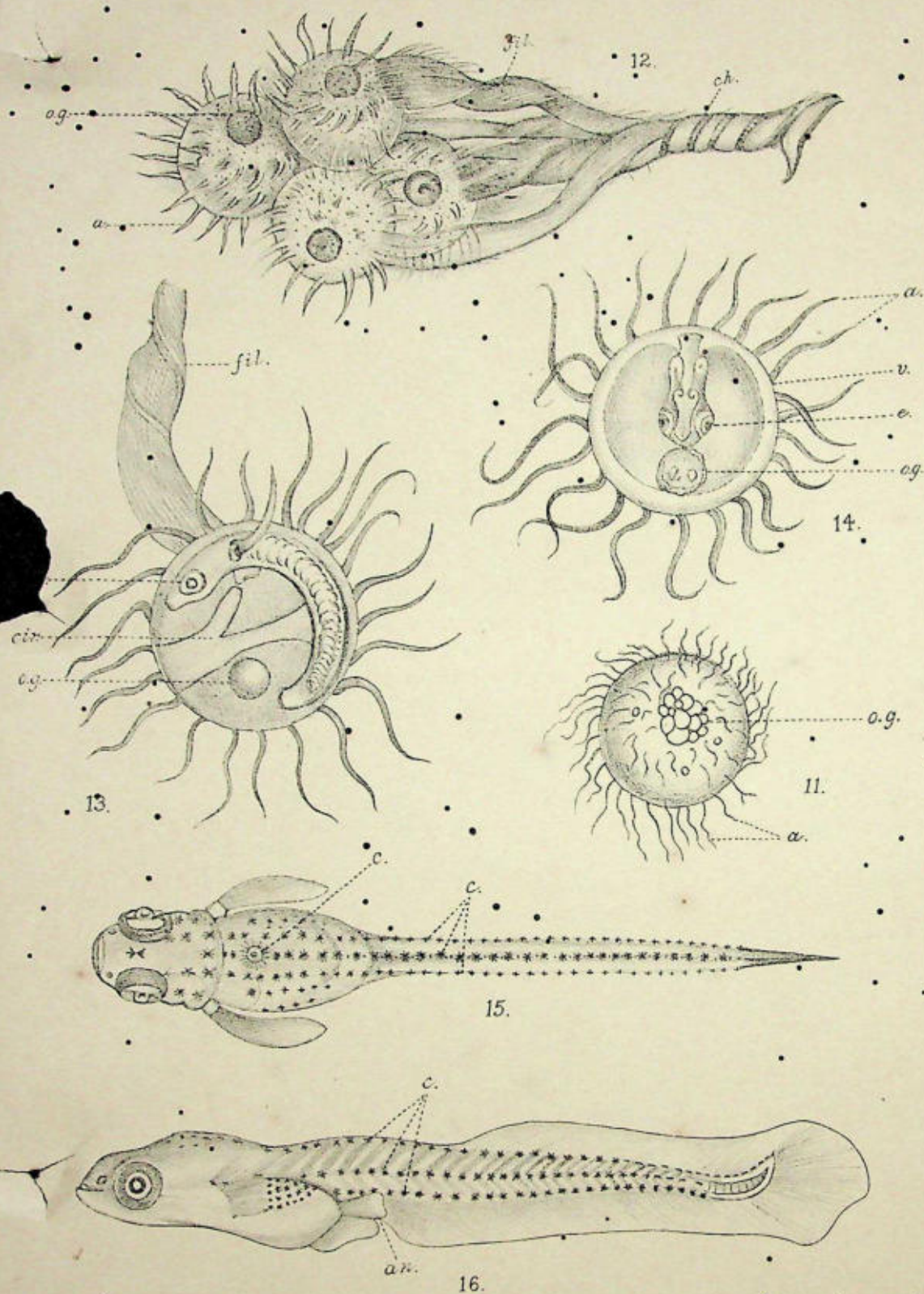
„ 13.—Lateral view of embryo inside the egg-membrane.

„ 14.—Dorsal view of embryo inside the egg-membrane.

„ 15.—Larva just hatched from the egg (dorsal view).

„ 16.— „ „ „ (lateral view).

A. = adhesive threads; An. = anus; C. = pigment cells (chromatophores);
Ch. = cord formed by twisted filaments from eggs; Cir. = circulation in the
yolk-sac; E. = eye; Fil. = filaments; O. G. = oil globule; V. = egg-membrane.



EXPLANATION OF PLATE XXVII.

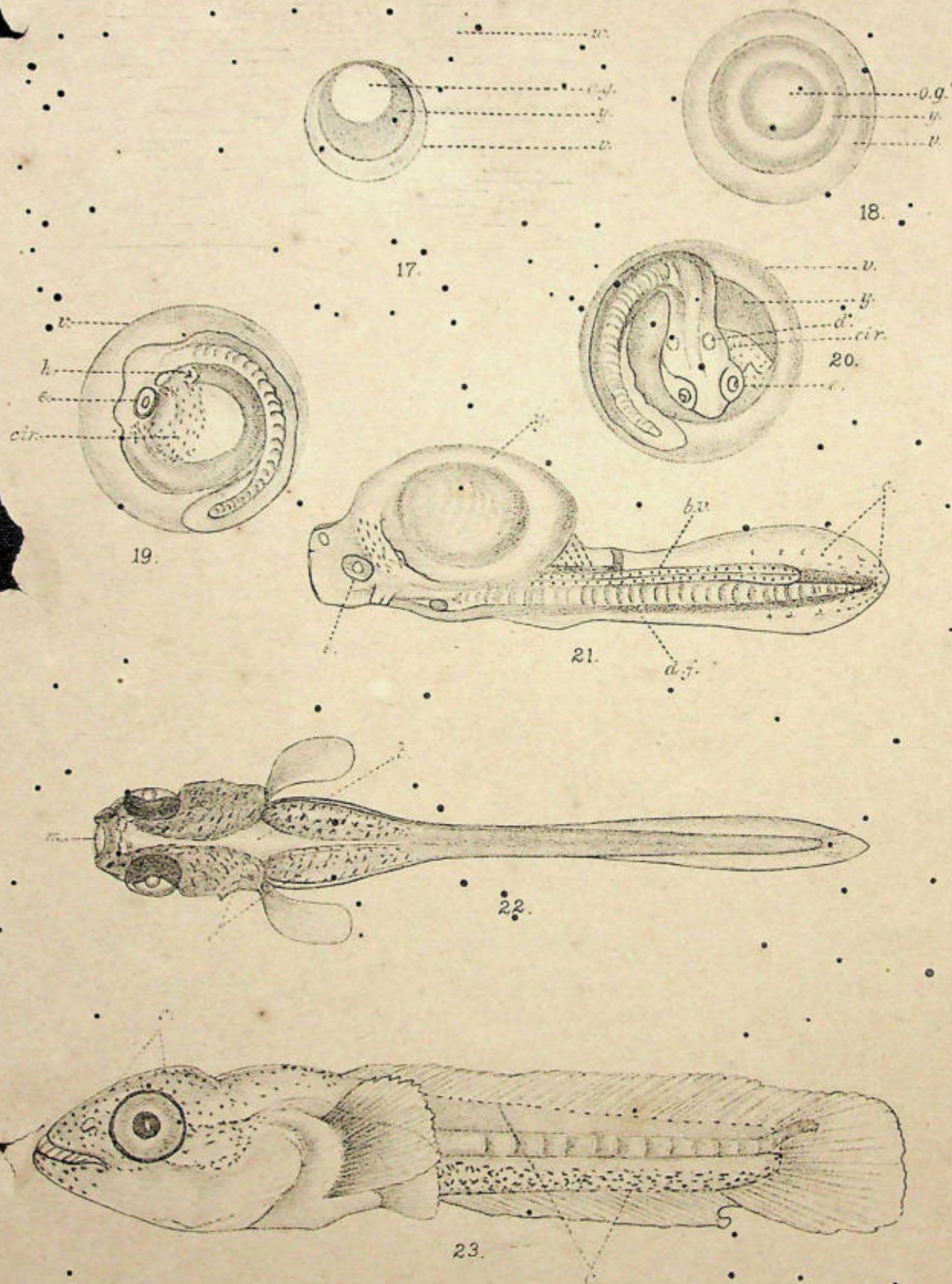
Ophiocephalus punctatus, Bloch.

- FIG. 17.—Egg floating in water.
,, 18.—Enlarged view of an egg.
,, 19.—Lateral view of embryo inside the egg-membrane.
,, 20.—Dorsal view of embryo inside the egg-membrane.
,, 21.—Larva just hatched from the egg.
,, 22.—Larva 5 mm. long. Note the first appearance of the mid-dorsal streak (*b*) with its two spindle-shaped enlargements.

Ophiocephalus gachua, H. B.

- FIG. 23.—Larva 7 mm. long.

B. = mid-dorsal band; B. V. = blood vessel; C. = chromatophores; Cir. = circulation in the yolk-sac; D. = ear; D. F. = dorsal fin; E. = eye; H. = heart; O.G. = oil globule; V. = egg-membrane; W. = water; Y. = yolk.



EXPLANATION OF PLATE XXVIII.

Ambassis (miops?), Gunther.

FIG. 24.—Lateral view of a young fish.

„ 25.—Dorsal view of the same.

Etroplus maculatus (Bloch).

FIG. 26.—Egg attached to a plant filament.

„ 27.—Larva just hatched from the egg, $4\frac{1}{2}$ mm. long.

„ 28.—Larva on the second day, 5 mm. long.

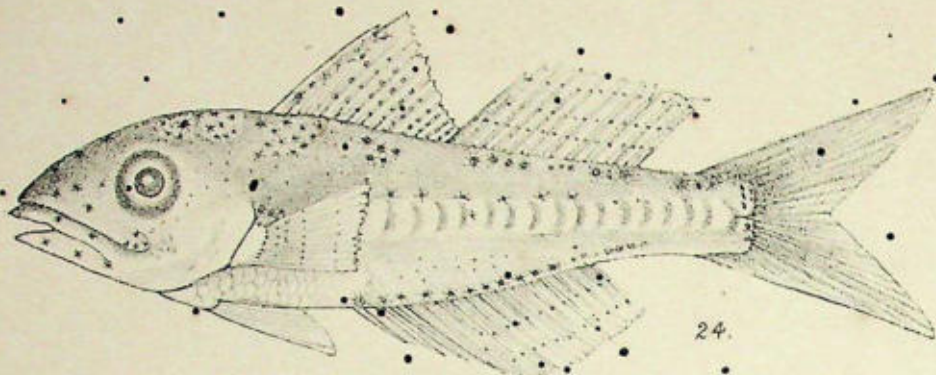
„ 29.—Larva a fortnight old.

„ 30.—Young fish 9 mm. long.

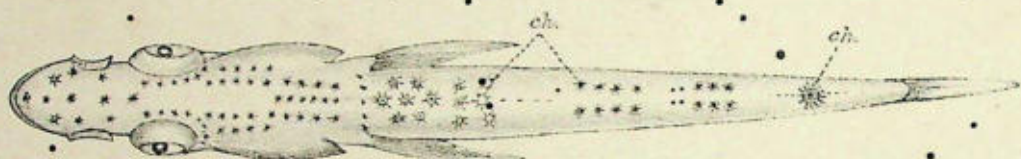
Gobius (Glossogobius) giuris, H. B.

FIG. 31.—Two clusters of eggs attached to the root of a plant.

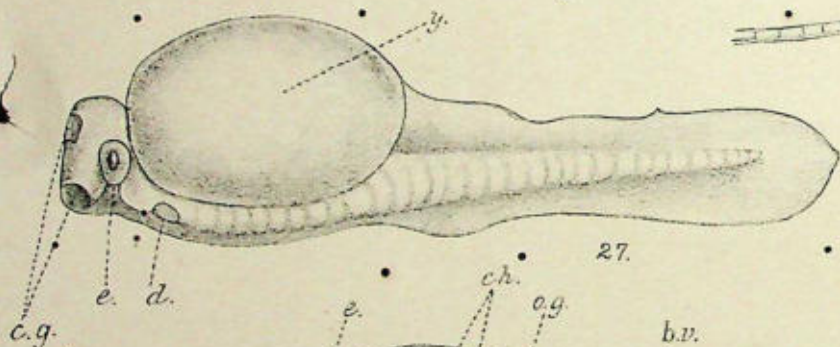
An. = anus; B. = white band on the nape; B.V. = blood vessel; Ch. = chromatophores; C.g. = cement organs; C. E. = cluster of eggs; D. = ear; E. = eye; H. = heart; O. G. = oil globule; P. = stalk; P.F. = plant filament; V. = egg-membrane; Y. = yolk.



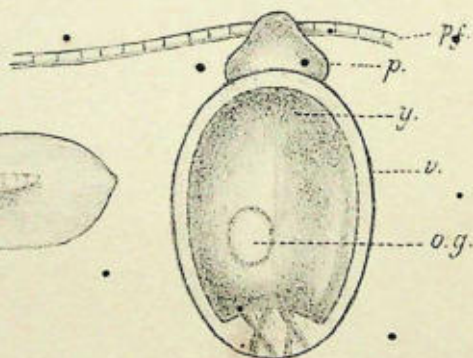
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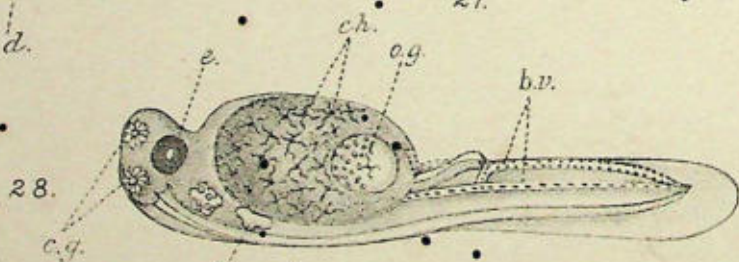
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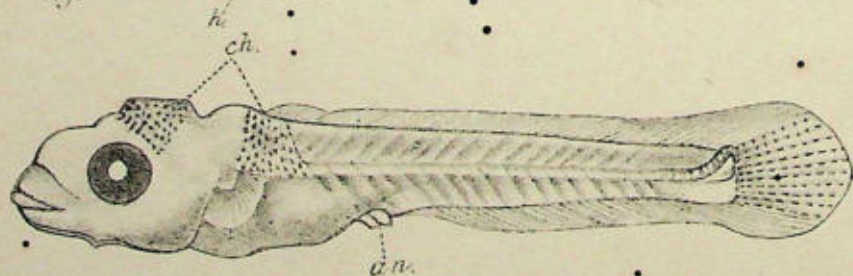
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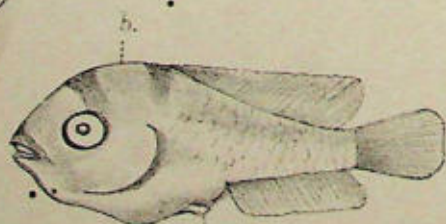
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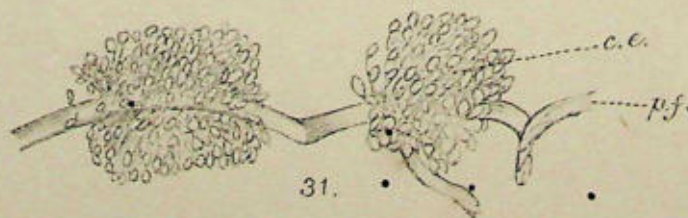
28.



29.



30.



31.

B. Sundara Raj, del.

A. Chowdhary, lith.

EXPLANATION OF PLATE XXIX.

Gobius (Glossogobius) giuris, H. B.

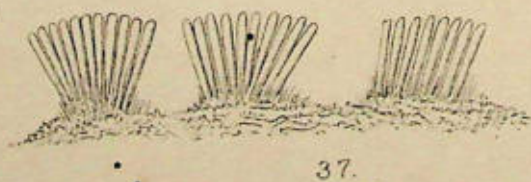
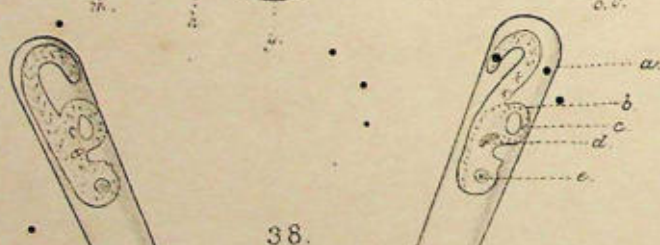
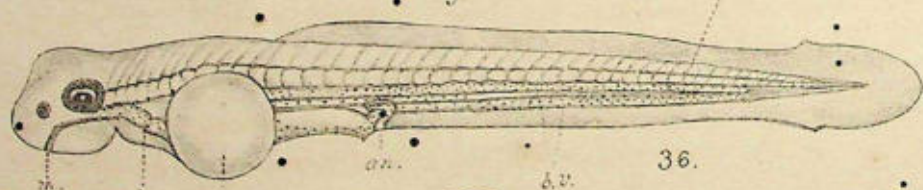
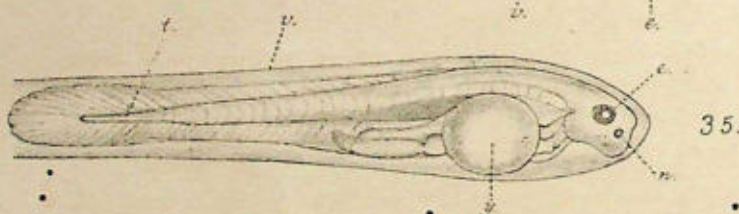
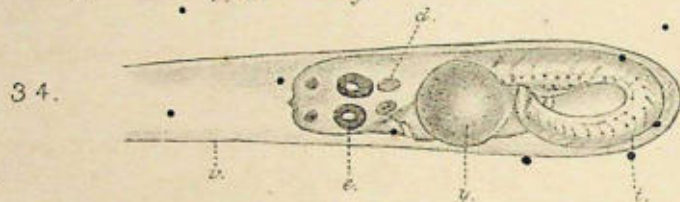
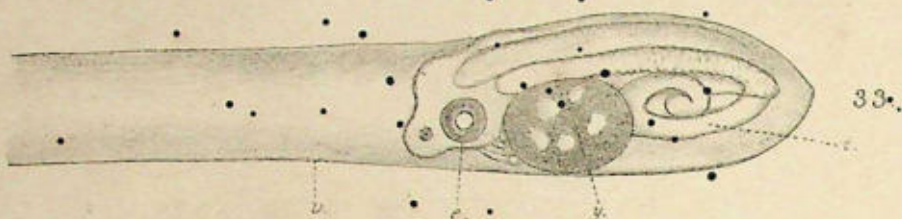
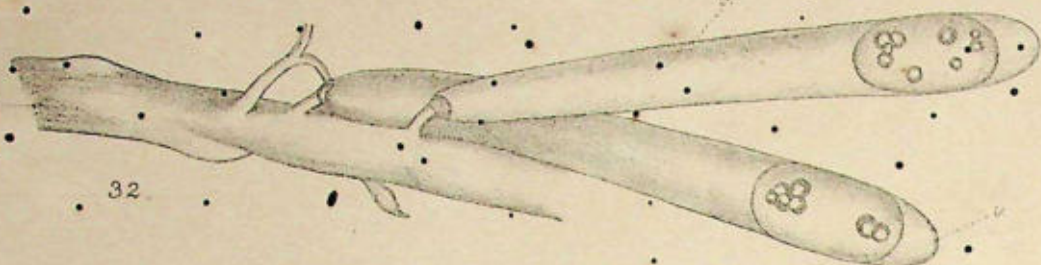
- FIG. 32.—Enlarged view of two eggs attached to a root.
„ 33.—Lateral view of embryo within the egg-membrane.
„ 34.—Dorsal view of the same.
„ 35.—Lateral view of a more advanced embryo still within the egg-membrane. The tail is uncoiled and the embryo now faces the free distal end of the egg.
„ 36.—Larva just hatched from the egg, 2.25 mm. long.

An. = anus; B. V. = blood vessel; D. = ear; E. = eye; H. = heart; M. = mouth; N. = nasal organ; T. = tail; V. = egg-membrane; Y. = yolk.

Gobius (Oxyurichthys) striatus (Day).

- FIG. 37.—Outline of three clusters of eggs attached to a rock.
„ 38.—Enlarged view of two eggs with embryos in an advanced stage of development.

a. = egg-membrane; b. = yolk; g. = oil globule; hl. = heart; e. = eye.



EXPLANATION OF PLATE XXX.

- FIG. 1.—Ventral seta of *Slavina* sp. $\times 500$.
,, 2.—Ventral seta from second segment of *Stylaria kempi*;
 $\times 540$.
,, 3.—Hinder end of *Aulophorus furcatus* (specimen from
Khed).
,, 4.—*Drawida jalpaigurensis*; prostate of left side.
,, 5.—The same; diagrammatic sketch to show relation of
parts near spermathecal aperture; *a.*, atrium; *at. s.*,
atrial sac; *d.*, spermathecal duct; *s.*, septum 7/8.
,, 6.—*Megascolides tenmalai* var. *karakulamensis*; male area.
,, 7.—The same; spermatheca.
,, 8.—*Megascolides oneilli* f. *typica*; prostate.



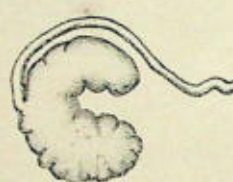
1.



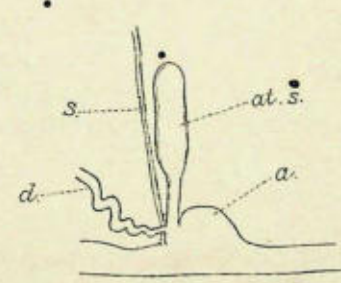
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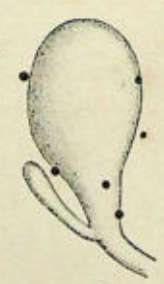
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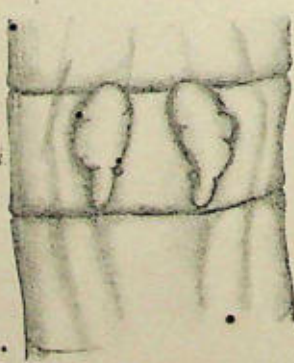
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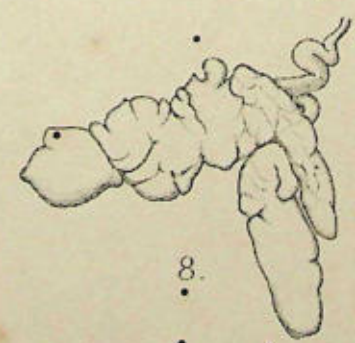
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7.



6.



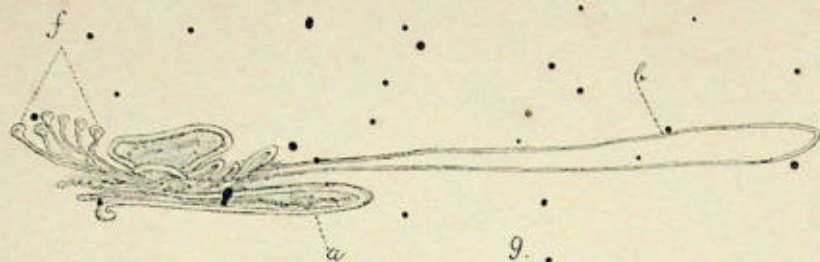
8.

J S del.

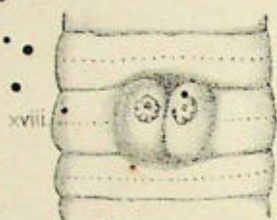
A. Chowdhary, lith.

EXPLANATION OF PLATE XXXI.

- FIG. 9.—*Lamipito dubius*; meganephridium from middle of body, to show the general relations of the parts, the funnels, stout and slender loops; *a.*, stout loop; *b.*, slender loop; *f.*, funnels.
- „ 10.—*Perionyx pulvinatus*; region of male pores.
- „ 11.—The same; spermatheca.
- „ 12.—*Perionyx pincerna*; region of male pores.
- „ 13.—The same; penial seta.
- „ 14.—*Perionyx inornatus*; penial seta.
- „ 15.—*Perionyx parvulus*; penial seta.
- „ 16.—*Perionyx fulvus*; penial seta.
- „ 17.—*Perionyx* sp.; male genital area.
- „ 18.—The same; penial seta.
- „ 19.—*Notoscolex graveleyi*; spermatheca.



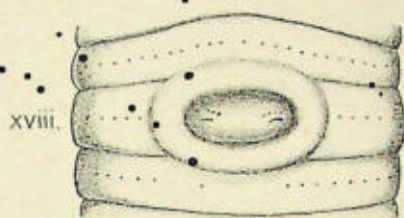
9.



10.



11.



12.



13.



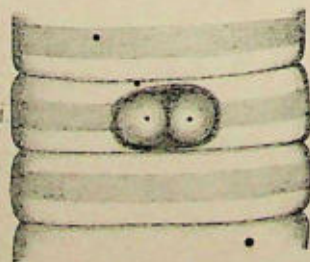
14.



15.



16.



17.



18.



19.

J S del

A. Chowdhury, lith

EXPLANATION OF PLATE XXXII.

FIG. 20.—*Notoscolex graveleyi*; penial seta. *a*, slightly magnified, to show the general form; *b*, highly magnified, the distal end only.

„ 21.—*Megascolex cingulatus*; spermatheca. *a*, the whole spermatheca, the dotted lines showing the course of the duct behind the ampulla; *b*, diverticulum only, from another organ, showing a different condition of the secondary diverticula, rather more highly magnified.

„ 22.—*Megascolex insignis*; spermatheca.

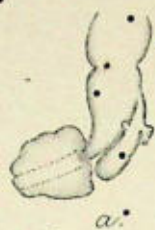
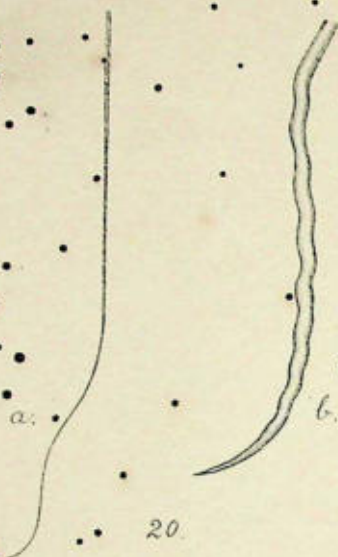
„ 23.—*Megascolex pentagonalis*; male genital area. σ points to position of male aperture.

„ 24.—The same; spermatheca.

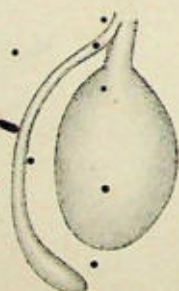
„ 25.—*Megascolex trivandranus*; male genital area.

„ 26.—The same; spermatheca.

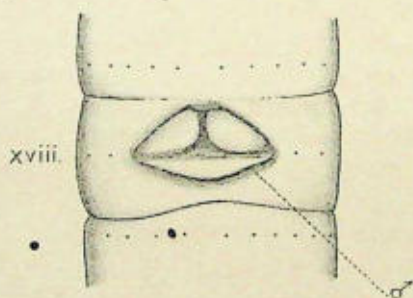
„ 27.—*Pheretima trivandranus*; prostate.



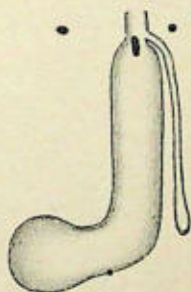
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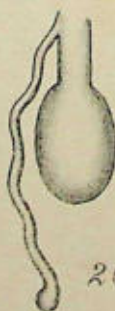
22.



23.



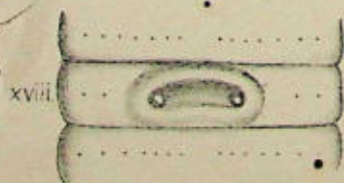
24.



26.



27.



25.

J.S. del.

INDIAN OLIGOCHAETA.

A. Chowdhary, lith.

EXPLANATION OF PLATE XXXIII.

FIG. 28.—*Pheretima trivandranq*; spermatheca.

„ 29.—The same; spermatheca viewed under the low power after clearing, to show the chambers in the diverticulum.

„ 30.—*Pheretima kuchingensis*; spermatheca. *a*, the whole organ, showing the micronephridia covering the duct; *b*, diverticulum of another organ, showing a small secondary diverticulum.

„ 31.—*Octochaetus surensis*; spermatheca.

„ 32.—*Octochaetus barkudensis*; penial seta.

„ 33.—The same; copulatory seta.

„ 34.—*Eutyphoeus annandalei* var. *fulgidus*; penial seta.

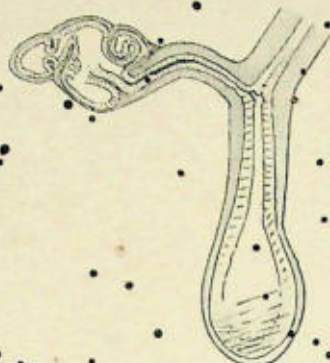
„ 35.—*Dichogaster malayana*; spermatheca seen by transparency after clearing.

„ 36.—The same; penial setae. *a*, *b*, the two types numbered 1 and 3 in the text; *c* (2 in text) resembles *a* except that the thin expansion is one-sided only.

„ 37. *Glyphidrilus tuberosus*; segments xviii to xxviii from the ventral surface, showing the papillae in this region, with the ventro-lateral ridge on one side and the cauliflower-like excrescence on the other.



28.



29.

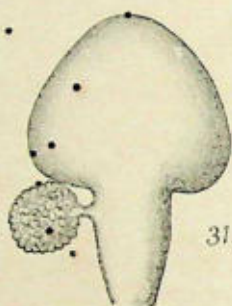


a.

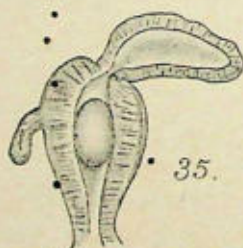


b.

30.



31.



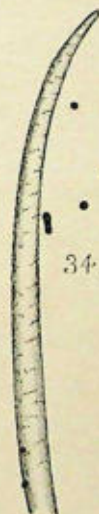
32.



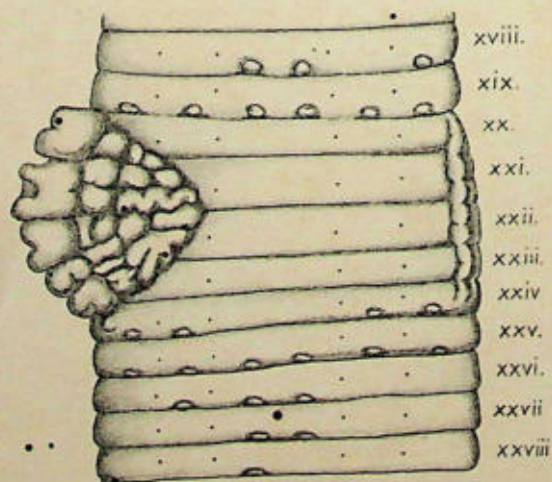
33.



34.



35.



xviii.

xix.

xx.

xxi.

xxii.

xxiii.

xxiv.

xxv.

xxvi.

xxvii.

xxviii.

36.



a.



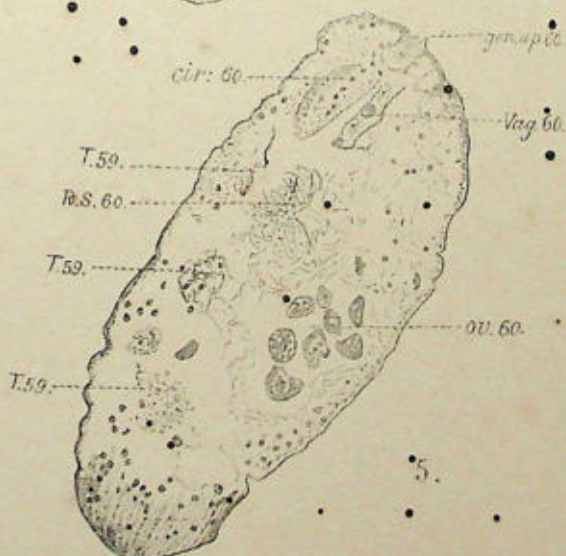
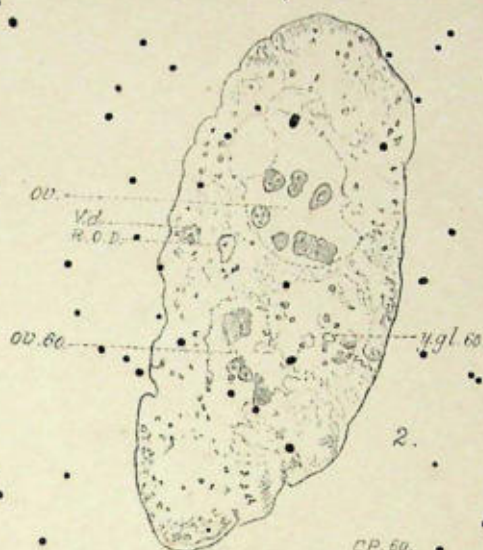
b.

37.

EXPLANATION OF PLATE XXXIV.

Hymenolepis nana, Siebold.

- FIG. 1.—Transverse section through the posterior end of the 60th segment. $\times 400$.
- „ 2.—Transverse section 24 microns anterior to the above. $\times 400$.
- „ 3.—Part of a transverse section 20 microns in front of section 2. $\times 1050$.
- „ 4.—Transverse section 8 microns anterior to section 3. $\times 400$.
- „ 5.—Transverse section microns anterior to section 4. $\times 400$.
- „ 6.—Section of the ovary of the 50th segment. $\times 1360$.



EXPLANATION OF PLATE XXXV.

Hymenolepis nana, Siebold.

- FIG. 7.—Section of the ovary of the 53rd segment. $\times 1360$.
,, 8.—Section of the ovary of the 54th segment. $\times 1360$.
,, 9.—Section of the ovary of the 60th segment. $\times 1360$.
,, 10.—Section of an embryo in the 62nd segment. $\times 1360$.
,, 11.—The 57th segment, stained with borax-carmin. $\times 680$.
,, 12.—The 62nd and 63rd segments, stained with haematoxylin.
 $\times 680$.

Reference letters.—cir. p. = cirrus pouch; emb. = embryo; gen. ap. = genital aperture; l.c. = longitudinal canal; n. = nucleus; ov. = ovary; r.o.d. = receptaculo-ovarian duct; r.s. = receptaculum seminis; s.v. = seminal vesicle; t. = testis; vag. = vagina; v.d. = vas deferens; y.g. = yolk-gland; y.gr. = yolk-granule.



EXPLANATION OF PLATE XXXVI.

- FIG. 1.—*Thor discosomatis*, sp. nov., $\times 8\frac{1}{2}$.
,, 2.—*Phycocaris simulans*, gen. et sp. nov., $\times 11$.
,, 3.—*Latreules porcinus*, sp. nov., $\times 8\frac{1}{2}$.

