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The Asian Weaver Birds: Problems of co-existence and evolution with particular reference to Behaviour

BY

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*(With two plates, five text-figures, and three
diagrammatic schemes)*

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I. INTRODUCTION

a. Aim

In many parts of tropical Asia two or more weaver species (Ploceinae), often apparently very closely related indeed, may be found side by side in a common, usually fairly homogeneous, environment. The question is at once posed as to how reproductive isolation is maintained between them and whether they compete with one another for certain biological necessities¹. In recent years the ecology and behaviour of the commonest species, the Baya *Ploceus philippinus*, has been much studied (Ali 1931, Ali & Ambedkar 1956, 1957, Ambedkar 1958 and in preparation, Crook 1960c), and in 1959 a start was made on the other Indian species about which, apart from notes in Jerdon (1877), Oates (1883), Hume (1890), and Stuart Baker (1926, 1934), the standard works on Indian ornithology, and a short study by Spennemann (1926), very little was known. The area chosen for a comparative field study was the Kumaon tarai for this was known to be one of the localities where extensive sympatry of at least three species occurred.

During the visit the elusive Finn's Baya (*Ploceus megarhynchus* Hume), for long one of the mysteries of Indian ornithology, was rediscovered (Ali & Crook 1959) so that a total of four species was kept under observation throughout the same period. The enquiry was of necessity exploratory and consisted mainly in recording hitherto unknown details of the ecology and reproductive behaviour of *Ploceus manyar*, *P. benghalensis*, and *P. megarhynchus*, details which were quantified whenever possible. The observations on *P. megarhynchus* have already been published (Ali & Crook 1959) and the aim of this paper is, firstly to present the new data on *P. manyar* and *P. benghalensis* and, after comparisons with other Asian weavers, to review briefly the problems presented by the extensive sympatry of the group. As the paper goes to press the ecological work is being continued in Kumaon by Dr. Sálím Ali and Shri Vijaykumar Ambedkar.

b. Study area—the Kumaon tarai

Below the Himalayan foothills the Kumaon area consists of a northern tract of forested country known as 'bhabar' and, to the south of this, a

¹ Modern theory assumes that species originate in the following way. The appearance of geographical barriers between local populations of a species prevents gene exchange between them. In isolation the adaptive differentiation of the separated populations continues leading to regional contrasts in physical, physiological, and behavioural characters which may prevent inter-breeding if and when an overlap in distribution occurs. If reproductive isolation is complete when this occurs the sibling populations are considered distinct species (Dobzhansky 1941, Huxley 1942, Mayr 1942, Lack 1944). The contrasts of particular importance in preventing inter-breeding are differences in courtship and mating behaviour and in habitat and food preferences (Hinde 1959). Furthermore the co-existence of sibling or closely related species in the same general environment depends also on the absence of ecological competition between them (Gause 1934, Crombie 1947).

flat largely treeless and often flooded stretch of grassland known as the 'tarai'. This type of country extends parallel to the bhabar for most of the length of the Himalayas north of the Ganges plain and reaches southwards to the river. The contrast between the forested bhabar and the swampy tarai depends on the fact that the drainage water from the Himalayas runs very deeply below the surface in bhabar, necessitating the construction of concrete surface runs from the hills and deep wells, whereas it emerges on the surface of the plain in the tarai and moves slowly along meandering streams and rivers down to the Ganges. In the monsoon season the tarai is subject to extensive flooding.

The four weaver species occur almost exclusively in the tarai, only the Common Baya having colonies in the agricultural lands in cleared bhabar. In the Rudrapur area of Nainital district colonies of all four species were observed; those of *P. philippinus* in bushy trees over ditches, streams, and rivers, *P. megarhynchus* mainly in *Salmalia* trees (Ali & Crook loc. cit.), *P. benghalensis* in grassland near flood pools and fish tanks, and *P. manyar* in reed and rush beds over swampy pools and in rushes over flood water. Mixed colonies of *P. benghalensis* and *P. manyar* occur both in rushes in swamps and in grass near flood pools, normally with one of the two species predominating. Thus, while differences in colony siting are apparent, the overall environment of the species is the same. All species are gregarious and it is probable that in winter, when the males lose the bright nuptial dress, the three smaller species flock together in search of food. *Ploceus megarhynchus*, much larger and with a massive bill, probably moves separately, and certainly exploits different food supplies although the degree of overlap in preferences remains unknown. All these birds are seed eaters, the smaller three in particular being granivores. In the monsoon season there is a fairly clear concentration of each species around their nesting colonies and this tends to promote some degree of ecological segregation. Females of *P. philippinus* have, however, been seen visiting colonies of both *P. benghalensis* and *P. manyar*, and the country is in general so homogeneous and the individual nesting habitats so interlaced that there is ample opportunity for interspecies communication. There are considerable differences in both nest form and site between the species. The Baya suspends its nests with long tubular entrances from the twigs of trees and bushes. *P. benghalensis* fixes its tubed nest to a wad of rushes passing through the fabric at the upper end of the structure. *P. manyar* builds a similar nest supported by the long leaves of rushes (*Typha*), which are often bent down and woven into the structure for the purpose. *P. megarhynchus* usually places its vast globular nest, with an entrance at the side near the top, in the terminal twigs of tree-tops but sometimes among reeds (*Phragmites*) standing in water.

c. Field methods

The party consisted of Dr. Sálím Ali, Mrs. Eirene Harvalias Crook, the author and, for much of the time, Shri S. S. Bahadur, Wild Life Warden, Western Circle, U.P. We began work on July 10th 1959 and left the area on August 8th. Dr. Sálím Ali had to leave on July 23rd by which time the pattern of investigation had been well established. The original base of operations was Fatehpur (an excellent rest-house some 10 miles from Haldwani) and from here preliminary surveys were made. The later more detailed study, particularly of behaviour, was based on the Forest Rest House at Lalkua. The country was toured by car with additional trips into the forests on elephant back arranged by Shri Bahadur.

The colonies were studied from very close quarters, and the detailed movements of the birds observed with $\times 8$ binoculars and when necessary with a $\times 21$ telescope. The data recorded in the diagrams were taken down directly on tape using an EMI field tape recorder.

II. NEW OBSERVATIONS ON TWO WEAVER SPECIES IN INDIA

a. *Ploceus benghalensis*

Geographical distribution. The species, of which only the nominate race has been described, is restricted to the northern regions of the Indian sub-continent from the East Punjab and Sind to eastern Assam, Sylhet, and Manipur. In western India it is found as far south as Baroda and there is a record from near Bombay (Hume 1890), but it is most common in the flat low-lying country of Bengal, Bihar, and the Ganges plain. It has not been seen in Burma. In most of its range it is local and capricious (Stuart Baker 1926).

Ecology. *Ploceus benghalensis* is essentially a bird of the plains and lower hills though it has been recorded breeding in a tea estate at 4000 feet (Baker 1926). Its common habitat is open country, grass covered and liable to monsoon flooding. The breeding colonies are placed in elephant grass or 'moonj' (*Saccharum munja*), often close to or standing in flood water. The colony studied most closely in Kumaon was built in tall grass on a bank overlooking a fish culture tank, some of the nests leaning out over the water itself. All were easily approached along the bank by passing carefully through the high grass that hid the colony from view on the landward side. On July 21st 1959, there were eight territories each with several nests, but later the number increased. At another colony there were seven nests in a patch of moonj reeds standing in a shallow pool. At a further colony some birds were nesting in rushes and grasses over water in association with *P. manyar*. Two

records from Bengal describe nests in low bushes over water on river or stream banks.

Nests, sex ratio in the colony, eggs and clutch size. The nests are finely woven unlined structures extremely similar to those of *P. philippinus* (Ali 1931, Ali & Ambedkar 1957, Crook 1960c). The fabric is identical except that it is not thickened to so great an extent by repetitive weaving. The structures are attached to upright grass stems woven tightly together by much stitching and entwining to form the wad base of the nest. The top of the nest is flat or dome-like, unlike the long thin supporting 'neck' of the Baya's structure. The male alone weaves and the entrance tubes may vary greatly in length, many being over a foot long. The nests are grouped into twos and threes at different stages of construction and each group is the work of a single male. When first observed (July 21st), the colony consisted of eight territories containing helmet stage nests, completed nests, and several ruined nests some partially constructed. All the old ruins had been abandoned and presumably represented an earlier attempt at breeding during one of the brief rainy spells that precede the monsoon proper. By July 25th each territory held several new structures many only a foot apart. While males were interested primarily in the latest nest they also maintained the earlier structures by 'titivating' them and, while primarily courting females near the latest structure, they also welcomed with greeting postures females already established. Polygamy was confirmed; several males having two nests occupied by females in their respective territories. As in the Common Baya the number of nests available for occupation is greater than the number occupied, and the number of females to a male perhaps varies from individual to individual and from year to year.

The eggs were white and their measures all fell within the range given by Stuart Baker (1926). Of 21 clutches examined in Kumaon in 1959 4 were c/5, 2—c/4, 12—c/3, 2—c/2, and one c/1. The mean thus is 3.25 eggs per clutch for the sample.

Territorial Behaviour. Three types of territorial defence were observed: supplanting attacks, head forward threats, and singing. Males move about the colonies outside their own territories a great deal particularly when following prospecting females, which fly from one territory to another on their visits. As soon as a territorial boundary is infringed the owner supplants the intruder and chases it away. Sometimes supplants lead to brief aerial combats. When two males are near one another between their respective nest groups 'head forward threats' occur. The birds flick their wings, turn towards one another with lowered heads and beaks pointing at the opponent, and hop about eyeing one another. These encounters are, however, brief and do not culminate

in protracted 'threatening matches', 'aggressive dances', or 'song bowing' encounters such as have been described for some African ploceines (Crook 1959, 1962, in press). Female intruders are usually courted, but may be threatened or supplanted, particularly if another male intrudes at the same time. The males frequently perch upright on grass stems near their nests and sing. The song is however so soft that it is almost inaudible to the human observer only a few yards away.

Courtship. The male *P. benghalensis* leave the dry season flocks before the females and establish nests and territories in the colony. They continue to forage and to roost with the females, and retain intact the flocking responses of the breeding season. There is evidence to suggest that, as for *P. philippinus* in the Bombay-Poona area, several false starts are made at breeding as soon as the rain falls at the onset of the monsoon. Breeding activity slows down and stops if the rainfall is not maintained, and only develops fully when the rains are well under way. Thus half constructed nests and abortive courtships are seen at a few localities where, a few days later, the nests are abandoned. Later still, renewed activity at the same spot culminates in breeding.

At the start of breeding the males keep strictly to their territories, building nests and supplanting intruding neighbours. The females fly into the colony, usually singly but occasionally in small groups, and proceed to hop through the territories and to approach the various nests. Should the male be absent a female will alight in his nest, examine it, titivate upon it, and then hop on into the next territory. As soon as a male observes an approaching female he leaves his nest and flies towards her, often leaving his territory, alights close beside her, and gives an intense wing beating display during which he moves along the grass stem towards her. Most of these displays occur on tall grass stems overhanging water which usually bend to a horizontal position under the weight of the performing birds (Fig. 1). The posture of the male in this 'Upright Wings Beating Display' (UWBD) has the following components:

- i. Wings beaten vigorously (mean speed 10 beats in 1.7 seconds $n=21$, Table I) fully elevated and extended above the back up to about 10 degrees from the dorso-ventral line of the body.
- ii. Body plumage sleeked except for some fluffing of the nape feathers.
- iii. Body crouched, oriented towards female.
- iv. Tail straight, rarely raised, often fanned.
- v. Beak turned down vertically so that the yellow crown faces the female.
- vi. Song.

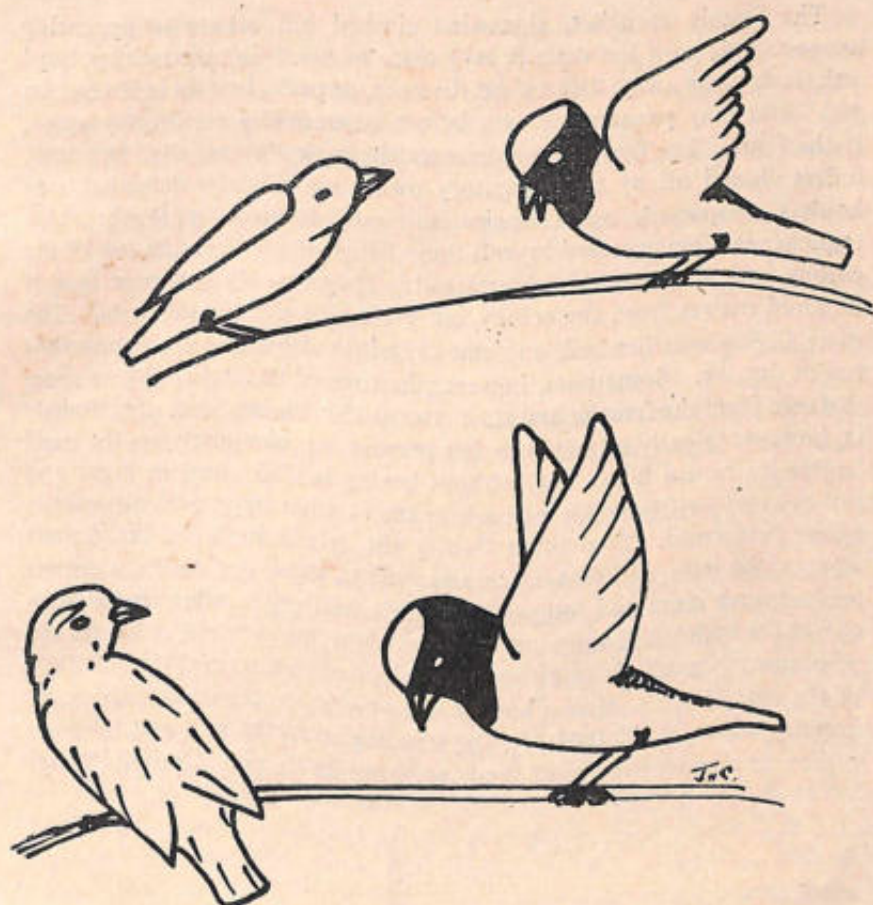


Fig. 1. Upright Wings Beating Display of male *Ploceus benghalensis*. Male on grass stem following close approach to female. Two field sketches.

TABLE I

Wing beating speeds of *P. benghalensis* and *P. manyar* during Upright Wing Beating Displays. Stopwatch accurate to 0.1 seconds

Time in seconds for 10 wing beats	<i>P. benghalensis</i> (n=21)	<i>P. manyar</i> (n=7)
2.0-2.1 seconds	4	5
1.8-1.9 "	4	2
1.6-1.7 "	9	—
1.4-1.5 "	3	—
1.2-1.3 "	1	—
Mean time for 10 beats	1.7 secs.	2.0 secs.

N.B.: The mean time for *P. philippinus* is 10 beats every 1.8 seconds (Crook 1960c) (n=25).

The female crouches, somewhat sleeked but otherwise appearing unconcerned, until the male is very close to her. She then either hops a short distance away, flies a short distance, or pecks fiercely at her suitor. The latter may pause a moment before commencing his display again. If the female has flown some distance the male flutters after her, and, unless chased off by some territory owner upon whose defended area he has trespassed, again begins the wing-beating approach. This sequence is often repeated several times before the female flies out of the colony with the male in swift pursuit. They may fly for more than a hundred metres from the colony but eventually the female lands. The male alights near her and, on some occasions at least, again approaches her in display. Sometimes, however, he tires of the chase, alights some distance from the female, and then returns alone to his nest. The female is, however, clearly attracted by her pursuer for, commonly, as the male begins his return flight, she, without having landed, turns in flight and follows him swiftly to his nest where the familiar approach sequence is again performed. Sometimes during the return flight, if the female wavers, the male will turn again and start to chase her until she swings around once more and follows him to his territory. After several such chases the male often wing-quivers intensely in the presence of the female who now repeatedly hops on to the developing 'initial ring' (Skead 1947) of the nest. Often, after a bout of wing-beating approaches and mutual hopping about in the territory, the female goes to the nest and the male rushes to the nest entrance and performs an intense Upright Wings



Fig. 2. Upright Wings Rigid Display of *Ploceus benghalensis*. Wings outstretched at side of body in the plane of the back and held motionless. Tail extremely fanned. Bird facing female in or near nest.

Beating Display just outside. At moments of high intensity the wing-beating changes to 'wings rigid', recalling similar changes in the composition of the Advertisement displays of *P. cucullatus* and *P. philippinus* (Crook 1960c, and in press).

The 'Upright Wings Rigid Display' (UWRD) has the following composition :

- i. Wings fully spread and stretched out to full extent on either side of the body (at 90 degrees to the dorso-ventral line). They are quite still and have an appearance of rigidity.
- ii. Body plumage sleeked.
- iii. Body not crouched, bird usually hopping about.
- iv. Tail widely fanned and straight.
- v. Beak not turned down, usually oriented to female, but the head is not retracted into shoulders as in preparatory movements of lunging.

As the female leaves the nest the male commonly hops about the territory in this posture with her.

The female solicits the male either in the nest entrance or in the grasses below the nest. Her posture is a simple crouching accompanied by tail vibration in the vertical plane and wing-quivering. The male normally mounts at once. Frequently, however, in the course of these sequences the female attacks the male, particularly after he has made a close approach in the Upright Wings Beating Display posture. No pseudo-female solicitation has been recorded for the male.

A total of 71 courtship sequences were closely observed and recorded in detail on tape. These are presented in Diagram A which thus summarises the data and shows the frequency with which the various responses occurred. Altogether only 11.2% of all sequences included copulations or attempted copulations, whereas 32.3% included aggression from one sex or the other. In one case only did the male succeed in copulating when the female had previously lunged at him in the same sequence. Normally, only those sequences in which neither sex showed aggression ended in copulation. Most of the attacks were made on the male by the female (18/23 of sequences containing aggression) usually following the close approach of the former. Only 6 actual attacks on females by males were seen. Copulation normally followed intense wing-quivering which in all weavers indicates a strong tendency to respond sexually (Crook 1960b, c, and in press). In only 2/8 copulations did the response follow the Upright Wings Beating Display directly without an interim period of wing-quivering usually performed mutually. There was one anomalous response in which the male both sang at the female and wing-quivered to her. These data may be compared with those of *P. manyar* in Diagrams B and C and those of *P. philippinus* in Crook 1960c (Table V).

Vocalisation. Soft *chit chit* calls are given by birds flying into the colony. These appear to help in the orientation of the female to the male during the return flight to the nest. The soft, barely audible song *tsi tsi tsisik tsisik tsik tsik* 'like the chirp of a cricket or the subdued short squeaks of an unoiled bicycle wheel' (Sâlim Ali, in litt.) is given during the UWB approaches to the female and also by males sitting solitarily within their territories. The extreme softness of the song, an anomaly among Ploceines, correlates with its utterance from a mere inch or so from the female to which it is given. The function appears to be courtship rather than advertisement (cf. *P. manyar*). In the alert 'song posture' when the male sings solitarily in his small territory there may be some advertisement significance for the neighbouring males close by. It is clear, however, that the contrast in loudness of song between this species and *P. philippinus* and *manyar* is due to its production at close quarters to the female [cf. Estrildid song (Hall 1962)].

b. *Ploceus manyar*

Geographical distribution. Three races of *P. manyar* are accepted at the present time. The nominate, *manyar*, extends throughout the islands of Java, Bali, and Bawean, *P. m. peguensis* occurs from Annam, Yunnan, Siam, Burma, and Assam into the Ganges Valley; while *P. m. striatus* (with which the former race *flavipes* is now merged) is found from NW. India through S. India to Ceylon. The distribution of the species is thus not only as great as that of the Common Baya, *P. philippinus*, but regional differentiation into races has similarly occurred. The range of the two races in northern India overlaps that of *P. benghalensis* the two species being, so far as is known, entirely sympatric within the range of the latter.

Ecology. *Ploceus manyar* inhabits flat swampy and rain-flooded lands in India and SE. Asia. In north India it shows a preference for swampy areas covered by rushes or reeds over standing water and colonies are normally so situated. In this it contrasts with *P. benghalensis* in the same area which tends to occupy grassland alongside flood water. *P. manyar* is locally distributed in most of peninsular India and Burma being limited to sizeable areas of swamp country. In the Ganges Valley and in Bengal colonies of some 40-50 pairs are usual, but in Sind and Punjab, where suitable tracts of reed-covered swamp are more restricted, it often breeds in very large colonies and Hume once found about 100 nests on a small bulrush island not twenty yards in diameter. Occasionally the species has been seen breeding in thorny bushes overhanging water (Hume 1890). Spennemann (1926) and Delacour (1947) write that in Java the nominate race nests in large colonies in bushes, trees, or palms, often near houses and usually over water, and it is common

in a variety of terrain including reed beds, open grassy country, rice fields, and lowland gardens.

In Kumaon, colonies were situated in reeds or rushes over muddy pools in the tarai grassland, all in close proximity to colonies of *P. benghalensis*, *P. philippinus*, and *P. megarhynchus*. The colonies varied in size from 3-4 nests up to about 30. Three particular sites were watched during the visit.

Nests, sex ratio in the colony, eggs and clutch size. The nests of *P. manyar* are normally suspended from the tips of rushes or reeds usually bent down and incorporated into the wall of the structure (Fig. 4). The nests are 2-3 yards apart, at the closest one yard and in the most dispersed colonies about 6 yards. The structures are more coarsely woven than the nests of either *P. benghalensis* or *P. philippinus* and the top of the nest is rounded and not extended into flanges of weaving along the supporting reeds. The coarseness of the fabric is due to the use of strips of greater width for building than in the other two species. The tubular nest entrance is rarely developed much beyond the level of the bottom of the egg chamber floor in Kumaon, but in Java Delacour (1947) states that long tubes are made. This correlates evidently with siting in trees there.

The species is commonly monogamous. In one colony in Kumaon in 1959, groups of 5 and 3 nests respectively were closely observed and each nest was found to belong to a single male. This condition remained unchanged throughout the period of observation. In a large colony of 30 nests male *manyar* were never observed to visit more than a single structure except during occasional attempts to steal material. In no case was a male observed constructing a series of nests in the manner of *P. benghalensis* or *P. philippinus* in the same area. In addition in two nests males were seen incubating, an activity not recorded from polygamous male weavers and, in a mixed colony with *P. benghalensis*, males of the latter species continued courting and chasing females long after the male *manyar* had ceased to do so—although the nests of both species had been established at the same period. There are suggestions, however, that sometimes the species may breed polygamously. Thus, although Spennemann (1926) described monogamy in Java, Delacour (1947) says the species is polygamous there. In addition Sálím Ali (personal communication) saw a single male with three nests at different stages all being maintained at once at Shamshabad in the Deccan in 1952, and in Kumaon he recorded two cases of males building a couple of nests each with courtship occurring at both structures.

The eggs are white. Some measurements exceed those of Stuart Baker (1926) made in south India (maximum length 21.6 mm., minimum 19.2, maximum breadth 15.1, minimum 13.1). The maximum length of

Kumaon sample of 16 eggs was 22.6 mm. with a minimum of 20.2, maximum breadth 15.5 with minimum 14 mm.

Of 7 clutches examined in Kumaon in 1959 1 was c/4, 4—c/3, 2—c/2, and none c/1. Ali (in litt.) in Travancore in 1933 recorded 1—c/3, 3—c/2, and 1—c/1. From these 12 clutches therefore the mean clutch size for the species is 2.85 eggs. Further figures may substantiate the slightly larger clutch size from the more northern population.

Territorial behaviour. The only aggressive behaviour observed between the males was an occasional supplant easily dodged by the offender. Trespassers over territorial boundaries were treated in this way but, compared with *P. benghalensis*, there was much less territorial infringement and this correlated with the different mode of pair formation of the latter in which the males fly out at females, and thereby enter other territories, much more frequently.

The males further advertise their territories by a loud and remarkably attractive song given when sitting solitarily on a conspicuous perch near or on the nest. This song undoubtedly emphasises territorial claims. Further, when females begin to arrive, the males perform Upright Wing Beating Displays near their nests often in social facilitation with one another. These mass performances undoubtedly make clear the position of defended areas to other males as well as the sites of potential nests to females.

Courtship. As in other Ploceines the males leave the flocks before the females and establish nests in territories in their colony sites. Flocking responses likewise are retained away from the colony itself. As soon as the nest sites are established the males respond to the arrival of other individuals, male or female, with dramatic Upright Wing Beating Displays. These are, moreover, given at the nests and do not follow a flight towards the female during her approach as in *P. benghalensis*. Approaching birds can be heard for a considerable distance and emit loud *chirt chirt chirt* calls continuously over a distance of at least 100 yards as they fly into the colony. This appears to alert the colony and coincides with the start of display by some of the males, display rapidly taken up by others through social facilitation. As soon as the females enter the colony they pass rapidly to the nests or territories of displaying males. The Upright Wing Beating Display, performed either on the nest or, more frequently, on rushes near it, has the following composition :

- i. Wings fully raised above the back at about 45 degrees to the dorso-ventral line of the body and beaten vigorously (mean speed 10 beats in 2 seconds, $n=7$, Table I).
- ii. Body plumage normal, not markedly sleeked.

- iii. Body upright, usually oriented to approaching birds or the female.
- iv. Tail straight, sometimes a little fanned.
- v. Beak neither turned down over chest nor pointed at female aggressively.
- vi. The bird calls *tre tre cherrer cherrer* repeatedly when performing in unison with other males, but in courtship to the female he sings a slightly curtailed version of the song.

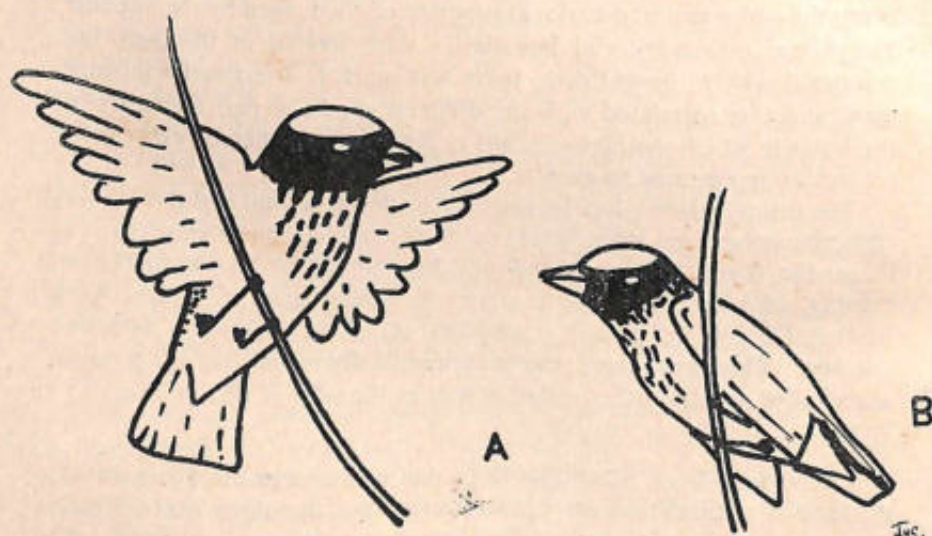


Fig. 3. A. Upright Wings Beating Display of male *Ploceus manyar*. B. Wing quivering of male *Ploceus manyar* to female in or near nest.

If a female enters the colony unnoticed she slips quietly into the territory of her choice, where the male greets her by going to the nest structure and performing the Upright Wings Beating Display. Often, however, the male supplants the female and chases her out of the colony. In the territory the female moves about into and around the nest in a 'sleeked' nervous posture while the male hops about in the display posture frequently singing, especially when she has entered the nest. Sometimes the male's display assumes the form of an Upright Wings Rigid posture with the wings held out on either side at about 90 degrees to the dorso-ventral line and quite still and rigid. He then sings loudly to the female who is usually in or emerging from the nest. When the female leaves the territory the male pursues her well beyond the colony following her flight manoeuvres closely. When she alights he comes down near her and quivers his wings in continued courtship after which he leads her back in swift flight to his territory turning to follow her at

once should she diverge from the flight line. On arrival he at once goes to his nest, perches in the initial ring, and, as the female arrives in the

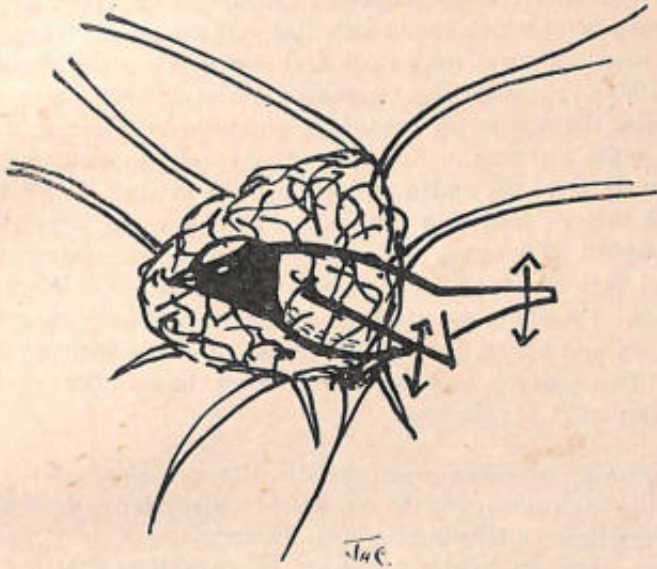


Fig. 4. Male *Ploceus manyar* giving pseudo-female solicitation in nest entrance of fresh incompleting structure.

territory behind him, he gives an intense 'pseudo-female solicitation' display with body crouched, wings drooped and tremored, and tail tremoring at high speed in the vertical plane (Fig. 4). The female then hops into the nest, the male emerges and usually attempts to mount her. At this she frequently flees and a further long chase follows until both return again calling the loud *chirt chirt* approach cry as they come in. When the female is receptive she solicits copulation, often as soon as she has arrived at the nest, in a crouched posture with quivering wings. Copulation occurs in the nest entrance or in vegetation near or below the nest.

During pursuit flights several males may join in the chase and, in general, competition between males for females is very considerable. Males sometimes zip into another's territory and attempt a stolen copulation as soon as the rightful male dismounts—a particularly fine piece of timing it would appear. Dr. Ali has also seen neighbouring males copulating, apparently successfully, with a single female during her visit to the colony.

In Diagram B, 19 sequences of early courtship during the first approaches of females to territories are shown. These are marked by displays near the nest and, if the female is receptive, attempts at copulation. In Diagram C, 26 later sequences depicting events following sex

chases away from the colony are shown. Here the male performs pseudo-female solicitation and attempts copulation when the female has perched in the nest entrance. In 5 sequences (heading B) he sang aggressively at the female after which she usually fled. If the female leaves the nest the male usually returns to it again and performs further pseudo-solicitation. 10/16 copulations in Diagram C occurred in the nest entrance, others below the nest in the reeds. Copulations in Diagram B likewise occurred in the nest ring. Only 29% of all sequences contained marked aggression while 47.1% ended in copulatory behaviour (Table IV). It is concluded that in courtship the species is much less aggressive than *P. benghalensis*. There are no records of female *P. manyar* attacking males and this clearly correlates with the absence of Wing Beating approaches. Finally pseudo-female solicitation indicates a conflict state in which sex and escape tendencies are active rather than the tendency to attack. This posture, common in *P. manyar*, has not been seen during the courtship of *P. benghalensis*.

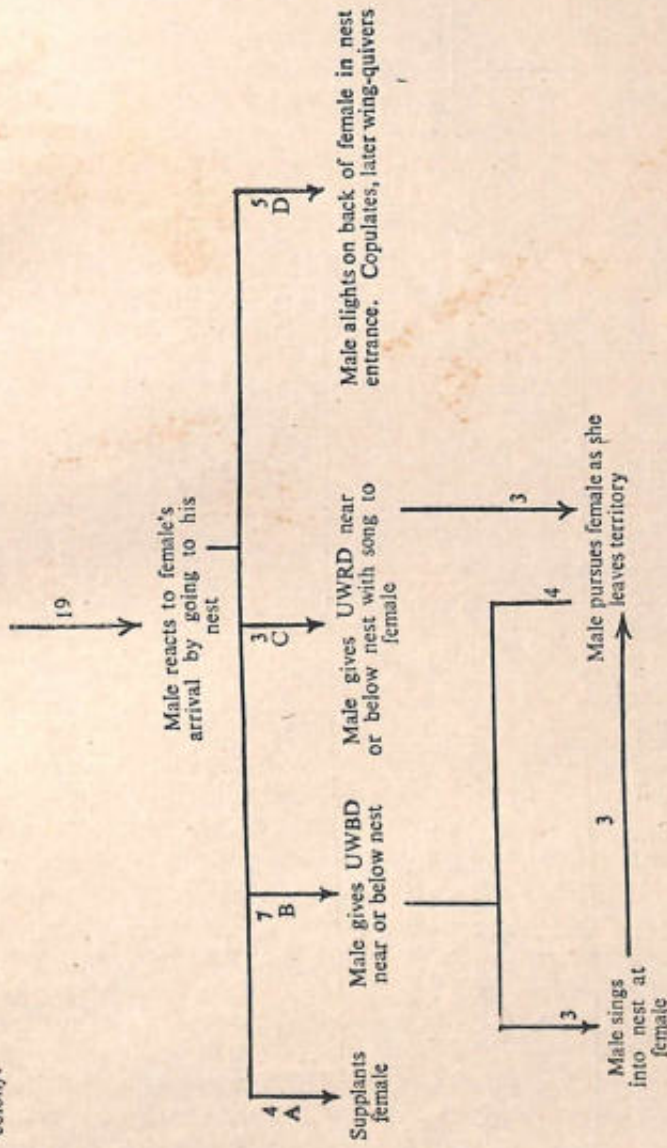
Vocalisation. Vocalisations include: (i) the *chirt chirt* cries on approaching the colony, (ii) the *tre tre cherrer cherrer* calls in repetition during Wing Beating Display, and (iii) the song.

All these cries are louder and more emphatic than similar cries produced by *P. benghalensis*. The song is clearly aggressive though the tendency to attack is balanced by conflicting tendencies to retreat, remain near the nest, or to behave sexually, depending on context. Often, in company with the female, wing-quivering occurs with song indicating a strong sexual tendency. Even when song is clearly threatening, the female rarely abandons the territory completely but merely flies away and later returns with the male which has pursued her. Both the threatening and the chasing are probably highly stimulating to the female (Hinde 1953) and are an integral part of courtship although the initial chases are clearly more in the nature of supplanting attacks than sexual pursuits. Again copulatory behaviour commonly follows the return from a pursuit. The song which is charmingly musical, contains a long trill of about six notes (*tsi tsi* etc.) culminating in a long drawn wheeze. It is apparently not sung in choruses like the baya. It may be rendered *Tzrr we tsee tsee tsi tsi tser cheeze we*. It is often shorter when given to the female in courtship.

At times the males give a variety of chirring sounds particularly as a party arrives in the colony and each bird separates to his nest. The cry is apparently aggressive.

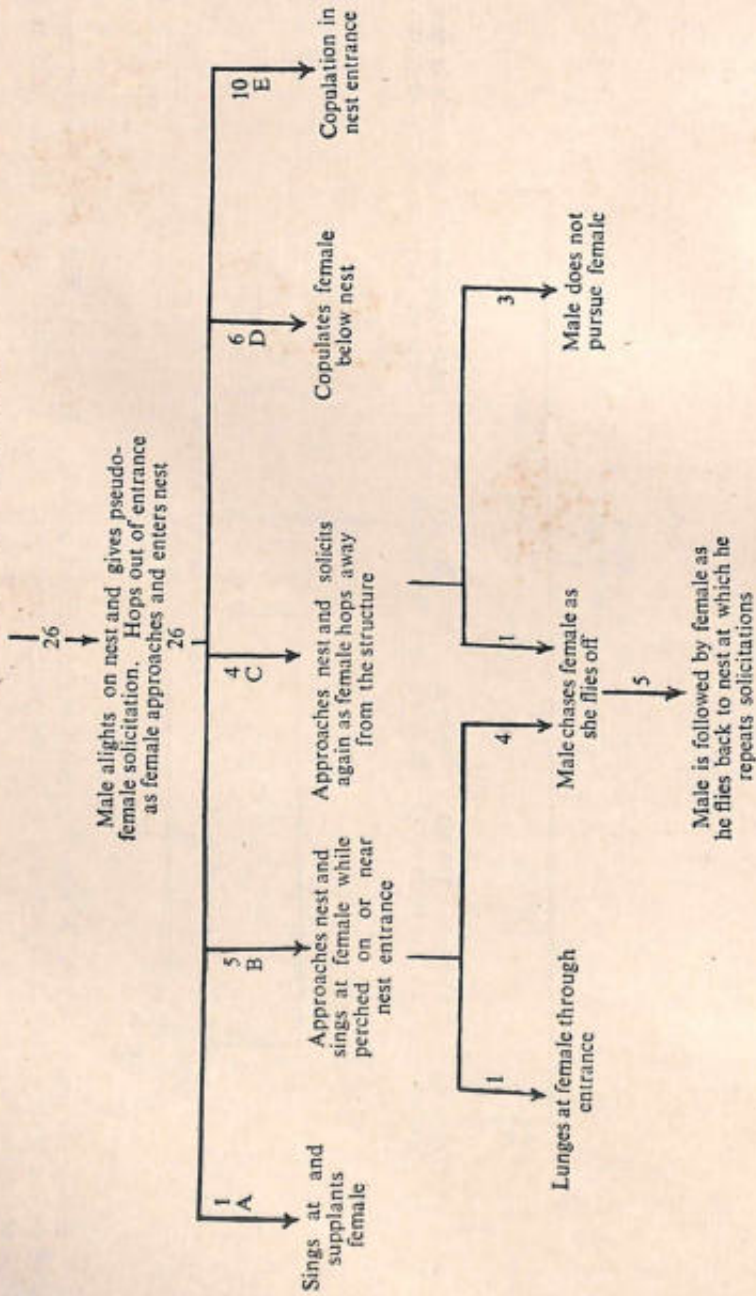
During mounting attempts the male flutters about after the female calling *chewe chewe chewe* repeatedly. When the female is soliciting she gives a very thin repeated piping call.

DIAGRAM B. Behaviour sequences of male *Ploceus manyar* in the territory following the arrival of a female on the nest either after her solitary entrance to the territory or after a pursuit flight. These sequences occur during the initial visits of females to the colony.



Female responses. In A, B, and C female remains sleeked, nervous. Finally she flies from the nest usually pursued by the male. Only in D does she solicit or permit mounting. Here the male does not display prior to an attempt at copulation.

DIAGRAM C. Behaviour sequences of male *Ploceus manyar* on arrival at the nest followed by the female. These sequences usually occur later in courtship than those shown in Diagram B.



Female responses. She follows the male into the territory, perches near nest and wing-quivers. She then approaches it and sits in entrance. If male performs A or B she flees but may return if male pursues and leads her back to the territory. After C she hops away and returns as male solicits; she then flies off. In cases D and E she solicits the male while he is likewise soliciting or wing-quivering. Copulation then follows.

III. PROBLEMS OF PLOCEINE SYMPATRY IN ASIA, WITH PARTICULAR REFERENCE TO THE TARAI

Evaluation of the extent of competition and reproductive isolation between closely related species in the same area depends upon a detailed knowledge of the relevant ecological and behavioural variables. The existing information may be summarised under headings : (i) habitat selection, (ii) food selection, and (iii) mate selection. Differences in habitat and food preferences clearly reduce the likelihood of competition while in addition the habitat contrasts reduce the frequency with which species encounter one another in the breeding season and thus reduce the likelihood of attempted hybridisation. Contrasts in behaviour occurring in mate selection tend to inhibit pairing and prevent hybridisation.

Throughout the discussion it will be clear that differences in size, colour, beak proportions, and behaviour set *P. megarhynchus* apart from the other Indian weavers. Only *Ploceus hypoxanthus*, for which there is regrettably little information, appears to have some significant resemblances to *P. megarhynchus*. A general comparative summary of the relevant characteristics is provided in Tables II and III.

a. Habitat Selection

Differences in habitat preference are important in reducing ecological competition and the frequency of opportunities for hybridisation. In general *P. philippinus* is found in drier areas than either *P. benghalensis* or *P. manyar* and shows a strong preference for agricultural land rather than extensive grasslands or swamps. Furthermore, it requires trees, commonly in protective sites near water or around habitation, in which to construct its nests. Even in the arid Deccan the species appears locally wherever agriculture is permitted by the presence of seasonal streams or wells, over which the nests are commonly built. The nature of the bird's habitat suggests that prior to the establishment of widespread farming in India the bird was an inhabitant of damp 'savannah', nesting in colonies in trees over water. By contrast *P. manyar* requires extensive swampy areas and *P. benghalensis* the wet often seasonally flooded grasslands of the tarai. Both species place their nests low down in rushes (see further below) and grass respectively, and not in trees. At higher elevations only *P. philippinus* occurs; for instance it is the only weaver in the Valley of Nepal.

In the tarai all three habitats, agricultural land with streams and a sprinkling of trees, patches of swamps, and extensive grass plains interdigitate tightly within the same general environment and the three species breed in adjacent, occasionally mixed (*P. manyar* and *P. benghalensis*), colonies in which, however, one species is normally in the majority. In



TABLE II
SUMMARY OF GENERAL CHARACTERISTICS OF ASIAN WEAVERS

	<i>Ploceus philippinus</i>	<i>Ploceus manyar</i>	<i>Ploceus benghalensis</i>	<i>Ploceus megarhynchus</i>	<i>P. hypoxanthus</i>
Number of races	3	3	1	2	1
Habitat	Open country with agriculture and irrigation. Not in arid areas	Swamps, flood plains, etc. in Java	Grassy flood plains	Grassy flood plains with trees	Swamps, flood plains, Rangoon gardens
Colony site	Trees over water, vegetation over wells, palms, bungalow verandahs	Reeds, rushes, grass. Trees in Java	Grass beds, rushes	Tops of tall trees	Bushes in swamps etc.
Nest shape	Retort shape. Suspended or pendant	Retort shape. No neck. Short tube longer in Java. Suspended	Retort shape. No neck. Suspended	Globular. Supported	Globular. Supported
Nest fabric, lining ¹	Fine weave. No lining. Mud blobs	Less fine weaving. No lining. Mud layer in some nests	Fine weave. No lining. Mud layer in some nests	Coarse weave. Lining. Mud blobs	Coarse weave. Mud etc.? Lining?
Pair formation	Inverted advertisement on nest precedes sex chasing	Upright WB near nest precedes sex chasing	Sex chasing with WB approach precedes visit to nest with female	Elaborate advertisement display positions. No sex chasing. Courtship entirely within territory	

Notes: (a) All Asian weavers are seed eaters, primarily granivorous, taking insects in the breeding season to feed young. Diet of *P. hypoxanthus* presumed the same. All are gregarious, colonial, sexually dimorphic and in the male seasonally dimorphic (female *megarhynchus* too apparently). All except perhaps *Kumamon manyar* population are polygamous.

(b) The southern races of *P. philippinus* and *P. manyar*, i.e. those of evergreen environments, have richer, darker coloration than those of the more arid monsoon areas in northern India. Abdulali (1961) describes the colour differences between *P. megarhynchus* and *P. megarhynchus* races—the birds from Assam being more yellow on underparts etc.

¹ A very small amount of soft material is brought in by the female and placed on the floor of the egg chamber. Only in *P. megarhynchus* is the male known to line extensively.



Swampy grassfield nests of *Ploceus benghalensis*



Treetop nests of *Ploceus megarhynchus*

Photos : Dr. Sâlim Ali

peninsular India both *P. philippinus* and *P. manyar* are widely, though often locally, distributed but only where extensive swampy places are found in river valleys or coastal plains are the two species likely to occur together. Both are found again in Ceylon with the same habitat preferences.

In south-east Asia there is a more complex picture. In Burma and Thailand *P. philippinus* and *P. manyar* occupy habitats apparently identical to those in India. In Malaya only *P. philippinus* occurs and this is restricted to gaps in the prevailing forests and to farming areas. *P. hypoxanthus* also occurs with *P. philippinus* locally in Sumatra but the latter is the commoner. In Java, where *P. manyar* reappears, *P. philippinus* again appears the commoner in coastal areas. *P. manyar* now occupies a habitat around farmed areas and plantations nesting in trees and bushes (Spennemann 1926, Delacour 1947) and thereby differing considerably from other populations elsewhere. It is commonly found at higher elevations than *philippinus* though there seems to be considerable overlap in altitudinal range. Hoogerwerf (1947), in a survey of the birds of contrasting localities in Java, found it not only at sea-level but also up to 1500 feet in the area of Buitenzorg (Bandung) while he records *P. philippinus* only between sea-level and 800 feet. Delacour (loc. cit.) furthermore reports that the *manyar* nests in trees have long tubular entrances. Thus, in Java, far from being a swamp dweller, *P. manyar* seems to inhabit precisely the same niche as *P. philippinus* but primarily at a higher altitude. In addition Spennemann (loc. cit.) describes a difference in breeding season between the two species.

P. megarhynchus occurs in the tarai and usually nests in the tops of trees near canals or roads. It is sympatric with the other three Indian species and ranges widely though patchily over their breeding areas. In Burma and Thailand *P. hypoxanthus* occurs in swampy marshy areas often together with other species, and reappears apparently very locally (it seems to turn up only rarely in bird lists) in Sumatra and Java, again in similar habitats.

There are of course profound differences in the vegetation of India and south-east Asia, for whereas the former suffers a monsoon climate with an alternation of wet and dry seasons, in Malaya, Sumatra, Borneo, parts of Burma, and Thailand climatic conditions change little throughout the year and much of the land is covered with vast expanses of tropical rain forest in which Asian weavers are never found. In Java there is a monsoon season and a widespread deciduous forest, the rain forest being limited to favoured areas (Richards 1952). In India the plains of the tarai in winter are bare and dry and limited observations suggest that at this time the habitat preferences of the weavers break down entirely and the three smaller species then flock together in a mutual search for food. In addition they probably undergo migrations along the Ganges



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Treetop nests of *Ploceus megarhynchus*

Photos : Dr. Salim Ali

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Valley. It is thus likely that the habitat contrasts in the northern areas are only operative during the breeding season. In more constant climates (Ceylon, Burma, Sumatra) breeding and habitat differences are maintained for much of the year. In Java nothing seems to have been recorded of seasonal changes in bird activity.

b. Food Preferences

While it is generally agreed that the Asian Ploceines are all seed eaters to date no critical study of the subject has been made. In Poona *P. philippinus* takes a variety of seeds during the dry season mostly from the ground around farms and, in the breeding season, in addition to attacking ripening crops of jowar (*Sorghum*), bajra (*Pennisetum*), and maize (*Zea*), it brings insect food in the beak for the young in the nest. Similarly *P. megarhynchus* brings insects in the beak for its young but otherwise takes seeds. Nothing is known of its food outside the breeding season. The massive bills of both *P. megarhynchus* and *P. hypoxanthus* suggest food supplies differing from those of other weavers.

The beak sizes of *P. philippinus*, *P. manyar*, and *P. benghalensis* are similar and this, together with similarities in body size and gregarious habits, suggests that they take similar foods (Kear 1962). In order to evaluate more precisely the similarities in beak sizes, measurements were made on samples of British Museum material and analysed statistically (Appendix). The results show: 1) the beak lengths of *P. manyar*, *P. benghalensis*, and *P. philippinus* do not differ significantly. 2) The beak depths of the same three species do not differ significantly. 3) The beak lengths and depths of *P. hypoxanthus* differ significantly from those of the other three species. 4) A consistent difference in bill length was found between the sexes of each species, those of the males being the larger. This sex effect appears to be the same for all four species. 5) A similar sex effect was found in the beak depths but here the difference between the sexes for *P. benghalensis* was much greater than for the other three species (see Appendix). 6) The sex effect is presumably due to secondary sexual changes in the beak of the breeding male and is probably not sufficient to have any differential effect on the food taken by the two sexes. The larger beak of the male may be of survival value in nest building.

These facts suggest that, unless the responsiveness to food objects differs between the three species, they must take seeds and perhaps insects of the same size range whenever they feed together in the same area. In the breeding season such habitat contrasts as exist in Kumaon will tend to aggregate the species in differing areas so that local supplies will, to some extent at least, be utilised by different species. If, as seems possible, the flocks join up in winter then the conclusion that they take

the same food is inescapable. If this is so when the food supplies are insufficient to support the whole population competition between the individual members of the flock for the diminishing supply must occur. In such competition any individuals which through dominance or any other characteristic (such as faster 'follow up' responses ensuring quicker arrival at limited food supplies found by the group) have an advantage over their fellows will tend to survive at their expense and ultimately replace them throughout the area. The result of such a process has been expressed in Gause's Law (Gause 1934).

There are, however, certain conditions under which sympatric species in the same niche can maintain their numbers in a balanced population. Such conditions are those of food 'superabundance' (Lack 1954). Moreau (1948) has in fact suggested that competition between the species members of mixed flocks of weavers in Africa is prevented by the overwhelming quantity of grass seed in the savannah areas at the end of the rainy season and that the birds move from one rich food area to another as the supplies are exhausted. Alternatively, factors other than density-dependent mortality through food shortage may control the absolute and relative numbers of birds present (i.e. see Wynne Edwards 1959, Ripley 1959a). If this were so and the numbers maintained at such a level that food supplies were never limiting, clearly competition would not occur. In the Ganges Valley 'superabundance' of food is most likely at the start of the dry period but it seems improbable that this should outlast the season. Competition, it seems, must occur at some times and in some localities in every year, but its extent and duration remains an open problem. One method of study would be to weigh samples of natural populations throughout the dry season.

c. Mate Selection

As all the weavers breed in the monsoon real possibilities of cross breeding exist in nature. Only in two cases are there differences in breeding season between sympatric species. In the Kumaon *P. megarhynchus* breeds earlier than *P. manyar*, *P. benghalensis* and *P. philippinus* though there is some overlap in timing. Similarly in Java Spennemann (1926) states that while *P. philippinus* starts breeding in early February *P. manyar* does not begin until middle or late March. As these two species are so similar in their habitat preferences in Java this contrast is likely to have considerable significance in preventing hybridisation.

Factors reducing the chances of interspecies mating in these weavers are contrasts in: (i) coloration, in particular the nuptial dress of the male, (ii) the sequence of events in courtship, (iii) the postures of advertisement and courtship display, their orientation and accompanying vocalisation, (iv) nest site, (v) nest form and fabric, and (vi) habitat. The relative importance of these factors is undetermined, but present

observations suggest that i-iv are of particular significance with other factors playing a contributory role. Mate selection, which is performed by the female, is probably a response to the summation of the effects of numerous mutually reinforcing stimuli from the male, his nest, and the context of the whole behaviour. If any factors have negative valence they will play the part of 'inhibitors' (Marshall 1959) the summation of which may prevent breeding.

i. *Coloration.* The coloration of male weavers is species-specific and minor contrasts also exist between the females. In parti-

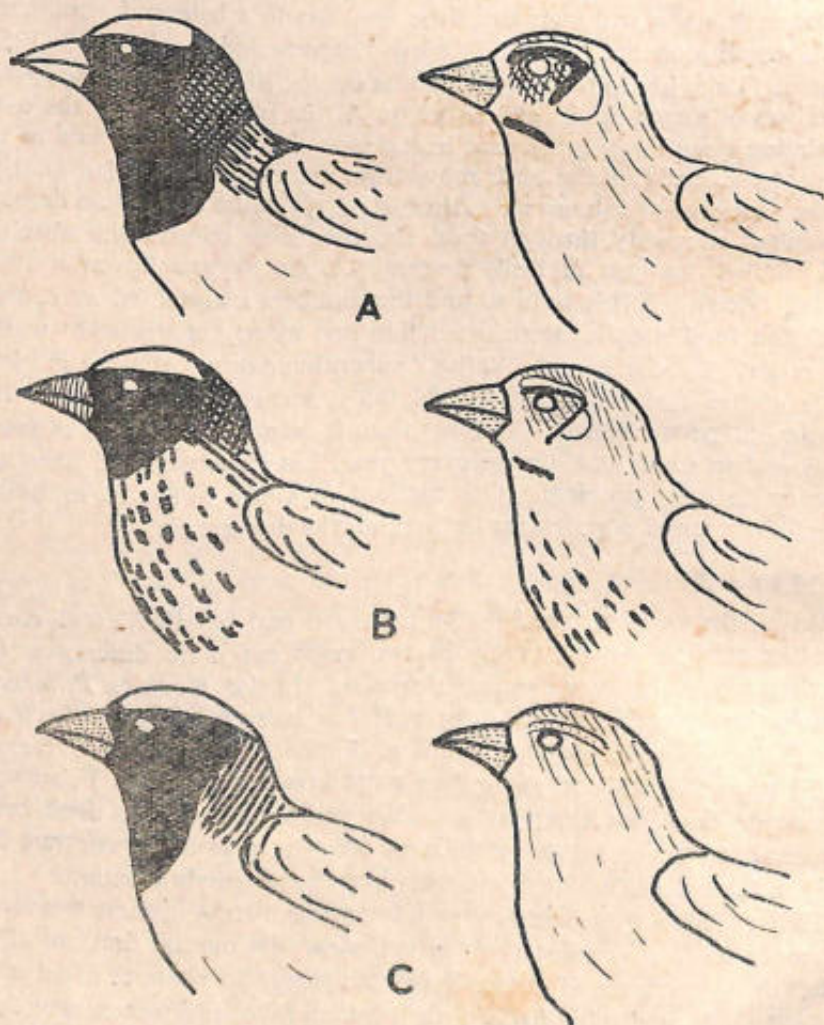


Fig. 5. Heads of male and female weavers. A. *Ploceus benghalensis*. B. *Ploceus manyar*. C. *Ploceus philippinus*.

EXPLANATION TO FIGURE 5

MALES	A. <i>P. benghalensis</i>	B. <i>P. manyar</i>	C. <i>P. philippinus</i>
Beak	Blue	Black	Dark brown horn
Crown	Orange-yellow	Golden yellow	Golden yellow
Face	Black with dark brown nape	Black with brown striated nape	Black with brown nape
Breast	Black	Striated	Upper black ; lower yellow
Underparts	White	Striated ; white on belly	Yellow ; white on belly

NOTE : In the field male *P. manyar* often showed striated nape running up as a cleft for a short distance into yellow of crown. Yellow ends in straight line in *benghalensis*.

FEMALES	A. <i>P. benghalensis</i>	B. <i>P. manyar</i>	C. <i>P. philippinus</i>
Beak	All females have beak of horn brown colour.		
Superciliary stripe	Yellow above thick black line	Pale yellow above thin dark brown line	Pale fawn
Cheeks	Grey	Fawn	Dark fawn
Ear coverts	Large yellow patch behind black line	Small pale yellow patch behind brown line	Dark fawn ; no yellow
Chin	Yellowish white	White	White
Moustachial streak	Black	Dark brown	None
Breast	Pale fawn	Striated	Pale fawn

All the characters listed are those observed through $\times 8$ binoculars in the field and found useful for identification of females in the colonies.

cular the yellow heads and bodies, including the rump, of both *P. megarhynchus* and *P. hypoxanthus* males set these species apart from the others. *P. philippinus*, *P. benghalensis*, and *P. manyar* are alike in colour patterning, the main contrasts being the black chest in *P. benghalensis*, streaked in *P. manyar*, and yellow in *P. philippinus*. Further, while the bills of breeding male *P. philippinus* and *P. manyar* are dark brown-black, those of *P. benghalensis* are pale blue (see details—Fig. 5).

ii. *Sequence of events in reproductive behaviour.* Here again the behaviour of *P. megarhynchus* contrasts sharply with the other Indian species ; in particular courtship is restricted to the territory and no

sexual chasing occurs (Ali & Crook 1959). Nothing is known of the courtship of *P. hypoxanthus*.

In general the events and postures in the reproductive behaviour of *P. philippinus*, *P. manyar*, and *P. benghalensis* are remarkably alike. There are however important contrasts in the sequence in which these events occur and in the precise context in which the Wing Beating Displays are given. This contrast in context also involves a shift in the function of the display. In Table III the sequences of events for the three species are summarised. Thus in *P. philippinus* the timing of events goes : (a) Nest Advertisement (i.e. invitation) and acceptance ; (b) Courtship in the territory with sex chasing outside it ; (c) Mating in the territory. In *P. manyar* it is : (a) Advertisement Display in the territory ; (b) Sex chasing and courtship, the latter both within and without the territory ; (c) Nest invitation by pseudo-female solicitation by the male, and mating. In *P. benghalensis* : (a) Courtship approaches to female with WBD and sex chasing ; (b) Flight to the nest, female following and entering with male WBD outside ; (c) Nest acceptance and mating. Thus whereas in *P. philippinus* and *P. manyar* advertisement precedes courtship, in *P. benghalensis* courtship comes first and nest visiting second. In all three species, however, unlike *P. megarhynchus*, sex chasing is an important element in courtship.

iii. *The postures of Advertisement and Courtship and contrasts in motivation.* The main contrasts here are :

(a) The WBDs of *P. philippinus* are usually inverted below the nest while those of *P. manyar* are upright and given in the territory usually near the nest rather than upon it. The WBD of *P. benghalensis* is given without reference to the nest and is exclusively oriented to the female. Thus, while the displays of the first two species have advertisement function in attracting females to nest and territory, that of *P. benghalensis* is essentially a courtship posture. The extreme similarity of these displays indicates their homology.

The compositions of the ritualised WBDs are remarkably alike. The wing beating speeds differ but little (Table I) and tail elevation varies only in the greater frequency of depression in *P. philippinus*. There are, however, differences in wing arc, the elevation of *P. manyar* and *P. benghalensis* being greater than that of *P. philippinus*. Again while the beaks of *P. benghalensis* and *P. philippinus* are normally turned down during display (Fig. 1) that of *P. manyar* (Fig. 3) is not. *P. benghalensis* gives a short soft song during display while *P. manyar* gives a curtailed song phrase, and *P. philippinus* a special cry (Crook 1960c). All these contrasts probably originated through differential sexual selection of displays in isolated populations, but the tail and beak differences originally probably expressed motivational contrasts in courtship prior to posture ritualisa-

TABLE III
SEQUENCES OF EVENTS IN THE REPRODUCTIVE BEHAVIOUR OF *PLOCEUS PHILIPPINUS*, *P. MANYAR*, AND *P. BENGHALENSIS*

<i>Ploceus philippinus</i>	<i>Ploceus manyar</i>	<i>Ploceus benghalensis</i>
I. Females approach established colonies.	I. Females approach established colonies.	I. Females approach established colonies.
II. Males give inverted WBD in Advertisement on nest with a special cry. Social facilitation between males occurs.	II. Males give UWBD on rushes etc. in their territories as an Advertisement Display. Social facilitation sometimes occurs.	II. Males approach females often outside the territory and give UWBD with depressed beak and song. This is the initial courtship posture. No social facilitation between males.
III. Females enter nests.	III. Female enters territory and may go to the nest. Finally flees with male in a sex-chase.	III. Female follows male to territory and either goes to nest or flies away again. Sex-chases follow.
IV. Male gives a WR posture and bows with a song into the nest. If female flees nest he pursues her in sex-chase, if she stays in territory courtship occurs.	IV. Female follows returning male to territory. Male performs pseudo-female solicitation in the nest entrance.	IV. Female follows male to territory and goes to the nest. Male displays UWBD or often UWRD outside nest entrance.
V. Mutual adjustments, male chases female aggressively from territory many times. Sex-chases lead to renewed courtship.	V. Female enters nest and male at once attempts copulation. Female may flee but commonly accepts.	V. Mutual adjustments. Female commonly attacks the male as he approaches her in display. Sex-chase often repeated.
VI. Female solicits in nest ring. Copulation.	VI. Copulations in nest entrance etc.	VI. Copulation in nest entrance etc.

tion. Thus tail depression, otherwise common in threat, suggests that prior to ritualisation the tendency to attack was strong during the relevant phase of *P. philippinus* courtship. Similarly beak depression suggests a tendency to escape in conflict with attack (Crook in press, in preparation). Such contrasts are supported by an analysis of the motivation of contemporary unritualised posturings in the courtship of the three species.

(b) The 'pseudo-female solicitation' posture occurs in *P. philippinus* (Crook 1960c) and in *P. manyar* but not in *P. benghalensis*. In *P. manyar* it is most marked and plays a special role in enticing the female to the nest and in initiating copulatory behaviour (Fig. 4).

Contrasts in behaviour sequences and postures express differences in motivation. Analysis is based on the methods of Tinbergen 1959, Hinde 1953, 1955, 1956, Morris 1956, Andrew 1961 and follows analyses of other Ploceinae (Crook 1962 etc.) in which the rationale is given in detail. In brief, the reproductive behaviour of the weavers is determined by the interaction of attack, escape, and sexual responses in conflict. The relative strengths of these tendencies in courtship vary between related species and produce contrasting behaviour patterns. In addition the strength of attachment to nest during courtship varies between the species. The number of sequences containing attack (and threat) is particularly high in *P. philippinus*, high in *P. benghalensis*, but low in *P. manyar* (see Table IV). In correlation with this a particularly high percentage of sequences ends in copulatory behaviour in *P. manyar* while *P. philippinus* and *P. benghalensis* show low percentages. In the latter species this is probably due to the fact that 18/23 recorded sequences containing aggression involved attacks by females on approaching males. The giving of aggressive responses in a sequence clearly reduces greatly the chance of a copulation in that visit, aggression inhibiting sexual behaviour. By contrast in *P. manyar* the high rate of copulatory activity correlates with a high frequency of male behaviour patterns expressing sex and escape tendencies in conflict (the 'pseudo-female postures' see Morris 1952, Hinde 1955, 1956, Crook 1960b).

These comparisons suggest: (i) The threshold for attack on females entering a territory is low throughout the early courtship of *P. philippinus* and is only gradually raised as the sexual tendency increases in strength during courtship. The tendency to remain at the nest is strong until the female has actually entered the structure after which chases occur. (ii) In *P. benghalensis* the male has a low threshold for sexual behaviour and the tendency to remain at the nest is weak. Thus on the approach of a female he flies out and approaches her. The nearer he gets the stronger becomes his tendency to escape. The female at first responds to these approaches, often within her individual distance, with attack. Only after many sequences does her threshold for attack rise as she begins to respond sexually to the male's approaches. (iii) The male *P. manyar*, shows

particularly strong tendencies to behave sexually and to flee from the approaching female. This is associated with relatively strong nest attachment and a high threshold for attack.

It follows that while aggressiveness inhibits the early expression of sexual behaviour in the sequences of *P. philippinus* and *P. benghalensis*, in the former case this is due to the male's tendency to attack approaching females near his nest, and in the latter to the female's aggressive response to the approach of courting males. In *P. manyar* courtship attempts by the male are frequently frustrated by the female's lack of responsiveness rather than by aggression by either sex.

To summarise: the displays and postures of the three species are homologous. The WBD clearly plays an important role in mate selection, and females probably react specifically to the posture composition (and coloration) and also to the display orientation. The major contrasts concern orientation—whether the display is given to the female away from or at the nest, and whether it is upright or inverted. Such contrasts undoubtedly enhance the likelihood of reproductive isolation, particularly since they are maintained when two species are breeding in mixed colonies (*P. manyar* and *P. benghalensis*) in the same habitat. Both the contrasts in behaviour sequences and in postures depend largely on differences in motivation between the species.

TABLE IV
COMPARISON BETWEEN THE BEHAVIOUR SEQUENCES OF THREE ASIAN
WEAVERS DURING PAIR FORMATION

Species	No. of sequences containing attack or threat upon sex partner	No. of sequences ending in copulation or attempted copulation	Other sequences ending inconclusively in the departure of the female	Total of sequences
<i>Ploceus manyar</i> (Diagrams B and C)	13 (28.8%)	21 (46.7%)	11 (24.4%)	45
<i>Ploceus benghalensis</i> (Diagram A)	23 (32.3%)	8 (11.2%)	40 (56.4%)	71
<i>Ploceus philippinus</i> (Schemes B and C in Crook 1960c)	31 (65.9%)	13 (27.6%)	3 (6.5%)	47

NOTES: (a) In *P. benghalensis* 18/23 aggressive sequences were initiated by the females as against 7/31 in *P. philippinus* and zero incidence of female attack on males in *P. manyar*. Other attack sequences were initiated by territorial males. Discussion in text.

(b) Statistics: An overall χ^2 test gives the significance of the differences between the proportions for the three species at the 0.001 level and similar tests, taking the species in pairs, give in each case significance at the same level. Real behaviour differences are thus considered established.

iv. *Nest site.* It is uncertain how far differences in nest site as such are of direct significance to the female. For instance in Kumaon *P. philippinus* females visit *P. manyar* colonies in reeds and hop about actually visiting their nests in the absence of the males. It seems probable also that female *P. manyar* and *P. benghalensis*, not easy to distinguish quickly in the field, may also visit each other's untenanted nests particularly in mixed colonies. No *P. manyar* or *P. benghalensis* females have been recorded in the tree sites of *P. philippinus*, however, and although *P. megarhynchus* often build nests (in Kumaon) in rushes they have not visited structures of *P. manyar* when perching in their colonies.

v. *Nest form and fabric.* The fact that female weavers spend much time examining and adjusting the fabric of the nests they visit suggests that differences in nest form and the manner of construction might inhibit acceptance of a nest not built by a male of the species. The globular structures of *P. megarhynchus* and *P. hypoxanthus* are of course quite different from those of the other species, and where *P. hypoxanthus* and *P. manyar* are sympatric this may be a factor preventing female interest in each other's colonies or nests. Nests of *P. benghalensis* and *P. philippinus* are particularly alike both in form and in the fineness of the materials used although mud is plastered more extensively in the interiors of some *P. benghalensis* nests than has ever been recorded for *P. philippinus*. *P. manyar* nests are rough, rather 'angular' balls made of coarser materials and have a shorter tube (in Kumaon), and mud is often plastered fairly extensively in the egg chamber. Nonetheless female *P. philippinus* visiting *P. manyar* colonies not only enter the nests but mandibulate the fabric extensively suggesting little appreciation of these differences. Spennemann (1926) considered nest construction important in pairing and showed that male *P. manyar* destroy nests not accepted by a courted female and build another in the same or a near-by site. Sálím Ali (1931) has also recorded the destruction of unaccepted nests by the male *P. philippinus*.

vi. *Breeding habitat.* Specific preferences for certain habitats undoubtedly play a major role in ensuring reproductive isolation. Where, however, the preferred habitats are dovetailed in an intricate fashion as in the Kumaon area, direct segregation of the species is very much reduced and the factor of less significance.

Observed attempts at cross-mating

So far no direct evidence for hybridisation between any Asian weaver species in the wild has been obtained, and in captivity there are only two records of possible hybrids between *P. manyar* and *P. philippinus* (Gray 1958). There are, however, some observations showing that male

P. benghalensis do occasionally chase and mount female *P. manyar* in mixed colonies. In a particular case recorded by Sálím Ali (in litt.) the female was already mated and in possession of a nest of its own species.

Such cases are probably due to the relative inability of males to distinguish quickly their own mates and females of their own species. Since, however, it is the female which ultimately chooses her mate and nest, and which therefore plays the fundamental role in mate selection (as in the American Grackles, Selander & Giller 1961), it follows that only observations showing females to have chosen mates and nest of a species other than their own can be considered evidence for hybridisation of any biological significance. No such cases have yet been recorded.

d. Conclusions

The above discussion allows the following conclusions regarding the extent of competition and the maintenance of reproductive isolation between sympatric Asian weavers.

Competition

(a) *Ploceus megarhynchus* probably has quite different food preferences from those of the smaller species in Kumaon. In SE. Asia *P. hypoxanthus*, probably also takes different food from the three smaller weavers.

(b) *P. philippinus*, *P. manyar*, and *P. benghalensis* probably take similar or identical foods and must compete for nourishment in environments where they are sympatric if food supplies are limiting. Differences in habitat preference in the breeding season and food 'superabundance' for at least part of the dry season probably reduce the extent of competition considerably. Exact measures are required. In Java contrasts in breeding season and altitudinal range between *P. philippinus* and *P. manyar*, the nest siting of which is identical there, have been noted.

Reproductive isolation

(a) Differences between the species in six sets of variables influence to varying extents the likelihood of matings between the closely related species. Matings between *P. philippinus*, *P. manyar*, and *P. benghalensis* are possible, especially between the last two in north India and the first two in Java where ecological similarities are particularly apparent. In the latter case, however, contrasts particularly in the timing of the breeding season reduce the likelihood of hybridisation.

(b) Of the variables discussed, contrasts in the coloration of the males, in the sequences of events in courtship, in posture composition, and in song are likely to play a direct role in inhibiting cross-matings. Contrasts in the behavioural context, orientation, and form of the ritualised

Wing Beating Displays are probably especially significant as the latter function as signals in the initial communication between the sexes at the onset of pairing. The contrasts in orientation are particularly important and are closely linked with the differences in nest site. Differences in the conflict motivation shown by each species in the behaviour sequences are apparent, and might involve incompatibilities in any attempted hybridisation in addition to the effects described above.

(c) The close contiguity of breeding colonies of *P. manyar* and *P. benghalensis* allows males to attempt copulations with females of species other than their own. Females have, however, never been seen choosing mates and nests of another species.

These results suggest that some degree of competition may exist in India particularly between *P. manyar* and *P. benghalensis* and in Java between *P. manyar* and *P. philippinus* although in both cases this must occur only for limited periods and only in the few localities where extensive sympatry occurs. Inter-breeding between the species is prevented by a number of species-specific characters.

IV. THE EVOLUTION OF THE ASIAN WEAVERS

a. The African origin of the Asian weavers

The weavers (Ploceinae) are found throughout Africa and tropical Asia but not in the desert areas of the Sahara and the Middle-East. Most of the 95 species occur in Africa and only 5 are known in Asia. In Africa all biomes have weaver representatives: rain forest, montane forest, humid and dry savannah, lakeside, and grass. The Asian species, however, are restricted to savannah, grassland, and swampy country.

In spite of the absence of a fossil record a coherent evolutionary picture of a bird family can be built up from two sorts of evidence: firstly, a precise knowledge of comparative anatomy and behaviour together with an understanding of the functional significance of these characteristics in relation to species ecology, and, secondly, a knowledge of the ecological changes dependent upon climate, which have occurred within the geographical range of the group during the relevant period of time. While at present this latter type of evidence is meagre there is sufficient to construct an hypothesis which represents in outline the likely course of events. The picture will become clearer not only through further study of the birds themselves but through an improved understanding of the phyto-geographical changes in Asia since the Pliocene.

The following points suggest that the ancestors of the Asian weavers invaded Asia from Africa at a time, or at times, when a suitable tract of country connected the two continents.

(a) Prior to the Miocene unbroken evergreen forest is believed to have stretched from West Africa to eastern tropical Asia. As the weavers are not represented in the Asian forests they could not have been part of the widespread pan-Afro-Asian avifauna of that time. They must have invaded African evergreen forests after the biome had split.

(b) The great majority of weaver species occur in Africa which has been the main centre of radiation of the group.

(c) The weavers appear to have originated as savannah species and to have entered forest secondarily (Chapin 1923, Crook in preparation). Their spread northwards and eastwards into Asia was dependent upon the existence of a suitable tract of open country in those areas.

(d) The Asian weavers are few, all are open country birds of general similarity to African savannah species but showing signs of long isolation and parallel evolution. Typical African grassland weavers (i.e. *Euplectes* spp., *Quelea* spp., etc.) and insectivorous weavers (i.e. *Malimbus* spp., *Ploceus bicolor*, etc.) are not represented in Asia suggesting that only the most adaptable seed eating species of the genus *Ploceus* reached a latitude sufficiently northerly to turn the Arabian Gulf and spread into Asia.

The suggestion that Asian weavers came from a stock of savannah adaptation is supported by their nest structure. The tubed nests (retort shape B, Crook 1960a, and in preparation) of *P. philippinus*, *P. manyar*, and *P. benghalensis* are characteristic of weaver construction in trees when fine terminal twigs are used for suspension. In Africa such nests occur in both forest and savannah. In swamp, grass, or scrub, however, African weavers have globular nests supported from below rather than above. Now, in spite of major contrasts in nest site, *P. manyar* and *P. benghalensis* retain the same basic tubed nest as *P. philippinus*, and all are suspended from their upper parts. This indicates that the Asian grassland and swamp species are derived secondarily from a tree-nesting stock, to which *P. philippinus* is presumably very similar, and that in the absence of selection to the contrary they have retained the tubular entrance to the suspended nest. Only in *P. manyar* is there a noticeable shortening of the tube. Since there are no forest weavers in Asia the tree-dwelling ancestors must have lived in savannah.

The nests of *P. megarhynchus* and *P. hypoxanthus* are globular but, while that of the latter is only sited in bushes in swamps (etc.), the former places its nest both in a curious tree-top site (Ali & Crook 1959) and in reeds. This major contrast with the *P. philippinus* species group, taken together with other anomalous characteristics, suggests that *P. megarhynchus* and *P. hypoxanthus* come from a separate stock. The nest construction and siting suggest that these birds built globular nests in dense scrub or marsh in the manner of *Quelea quelea* (Morel, Morel & Bourliere 1957) in Africa today. Once in Asia, they became specialised to their particular sites and ways of life in different areas.

(e) As no Asian weaver lives in particularly arid areas, except where watercourses, wells, and agriculture provide tolerable conditions for *P. philippinus*, it can be assumed now that their ancestors belonged to the relatively humid African savannah contribution to the Indian avifauna rather than to the Somali-Arid element (Chapin 1923, Hussain 1958, cf. Ripley 1959a).

Only two Asian weavers are widespread over the whole area (*P. philippinus* and *P. manyar*), and only *P. philippinus* can be considered a very common bird. *P. benghalensis*, *P. megarhynchus* and *P. hypoxanthus* all have small ranges and those of the latter two species are much subdivided. This suggests that, while the weavers spread widely in Asia on their arrival and underwent adaptive radiation, obscuring any close relationship with African forms, later phyto-geographical changes brought about restrictions in range for all except the two species able to take active advantage of them (*P. philippinus* and *P. manyar*). Thus, while *P. benghalensis*, *P. megarhynchus*, and *P. hypoxanthus* are essentially relict populations, *P. manyar* and especially *P. philippinus* are dynamic and expanding stocks (see Darlington 1957).

Although a general similarity between the African and Asian weaver faunas persists, certain details of weaver life in Asia are peculiar to that area. These features are : (i) the development of colonial life in areas of short rainy seasons without reduction of courtship activity outside the territory (*P. megarhynchus* excepted) ; (ii) the development in *P. philippinus* of elaborate nest repair behaviour ; (iii) the use of mud in nest construction (*P. hypoxanthus* ?). These points refer particularly to *P. philippinus*, *P. manyar*, and *P. benghalensis* and are probably all correlated closely in relation to the survival value of the particular type of nest constructed by them. *P. philippinus* resembles closely many colonial species of relatively dry areas in Africa, but unlike them does not show reduction in the amount of sex chasing beyond the limits of the territory. In African species such as *P. cucullatus* the survival value of this limitation is held to be that it reduces the frequency of nest robbing attacks by neighbouring males by increasing the amount of time spent in active occupation of the territory. Nest robbing is known to delay nest completion appreciably and, in a short breeding season, this reduces the chances of a male acquiring a maximum number of females for his nests and of having young in them during the period of optimum food availability. Furthermore, females will only accept properly completed nest baskets with at least a fine floor to the egg chamber. In *philippinus*, by contrast, the male is often absent from his nest and sex chasing and nest robbing then occurs without hindrance. Any damage done is, however, repaired with a speed and agility not seen so far in tests on African species. In addition the male brings several strands of material to the nest on each visit and the method of construction is such that it encourages rapid

repair and constant fabric maintenance. Female *P. philippinus* accept nests in the 'Helmet stage' when the floor of the egg chamber is not yet finished. The males await acceptance before completing the structure. Furthermore, *P. philippinus* maintains the nest by constant attention throughout its occupation. These features of construction, together with the use of mud, appear originally to have been adaptations to rain-shedding, thereby keeping the young from chilling. Additionally they permit rapid nest repair thereby eliminating the necessity of a courtship restricted to the nest area (Crook in press). *P. benghalensis* and *P. manyar* have not yet been tested for their repair abilities. Some observations suggest that the constant padding of the fabric, typical of *P. philippinus*, is absent. The nest sites in thick vegetation with a reduced visibility between nests may entail a reduced frequency of nest robbing compared with the tree site and hence less need for repair. Furthermore, the nests may be better protected from rain. In conclusion the contrasts between *P. philippinus* and similar African species are interpreted as different adaptations to identical selection pressures occasioned by high seasonal rainfall and nest robbing by other males.

b. Dispersal and adaptive radiation

The dispersal of weavers through Asia depended upon the provision of suitable climatic and vegetational conditions. It is therefore essential to determine, so far as possible, the nature of the phyto-geographical changes that occurred within the relevant time period. Recent studies suggest that the age of the Oscines is very much less than had previously been suspected—their radiation probably occurring primarily in the Miocene (Darlington 1957). Furthermore, while Brodtkorb (1960) puts the average longevity of pleistocene birds at about $\frac{1}{2}$ million years and the top longevity at one million, Moreau (in press) points out that the fossil evidence is mostly non-passerine. He considers that for passerines the figures are likely to be very much lower even for the oldest species. This suggests that, at most, the present Asian weavers could only have seen two glaciations and have undergone their radiation entirely within the Pleistocene.

Moreau (in press) has recently completed a re-evaluation of the ecological history of Africa since the Pliocene based upon new geological evidence obtained since his earlier account (1952). During the Pleistocene three glacial periods occurred of which the last continued for at least 50,000 years prior to 18,000 years ago. During this period the temperature of Africa must have been some 5°C. lower than at present at the glacial maximum, and a corresponding reduction in evaporation would have increased the effectiveness of the rainfall. The reduction in temperature would have extended the area of the montane biome down to

between 500 and 1000 metres greatly restricting the lowland biota except in the areas to the west of the Cameroons. The montane avifauna, at present restricted to small isolated areas, would have ranged from the Cameroon Highlands to Abyssinia and to South Africa. Such extension in range must have occurred at each glaciation to be followed by recession and local isolation. In addition sub-regional geological changes, the dating and relationship of which to the glacial changes are not yet understood, occurred. The most significant to the present discussion are the extensions of the Sahael (Sudanese climatic belt) to at least 300 miles north of the present position (on the last occasion only about 7000 years ago) and the southward movement of the palaeartic fauna at least 400 miles into the Sahara.

Changes similar to these must have occurred in both the Arabian and the Indian areas. It seems likely that during each glaciation unbroken palaeartic conditions must have reached southward deeply into Arabia and Persia, in the latter, due to the elevation of the land, penetrating to the coastal strip. In India the whole of the elevated Deccan Plateau was much cooler and more humid and, except where edaphic factors were unsuitable, a Himalayan type of flora and fauna similar to those at present restricted to the Nilgiri Hills, parts of the Western Ghats, the hills of Assam, and the Himalayan foothills (Ali 1949) must have been widespread throughout. Following the glacial maxima the montane biota would have receded giving place to tropical forest in the wetter areas and savannah in the drier or poorer soils (i.e. in Rajasthan and the Deccan traps). At this time a savannah vegetation probably linked Africa through Arabia to India along a rather narrow coastal strip of Persia. The Indo-Gangetic plain was covered by flat land of high water table and presumably flooded for long periods each year. Such seasonal flooding prevents the establishment of a climax swamp forest and great areas of marsh and wet grassland, similar to the uncultivated tarai of today, probably existed.

Archaeological evidence from the Harappa culture (3250-2750 B.C.) and records in stone and literature from Buddhist and ancient Hindu sources (around 2000 years ago) allow a limited reconstruction of the flora (Randhawa 1945, Law 1954). The forests stretched from west to east along the Satpura-Vindhya range (furthest west at Aravalli Hills) and south to the Ajanta area (Hora 1949, Ali 1949, Ripley 1949, 1959a, Dilger 1952) while some probably persisted for a long time in the Indus basin. The forests of the Western Ghats, north central India, and Burma thus formed an unbroken area bordering swamps and grassland in the wet Ganges Valley and savannah in both Rajasthan and to the south in the area of the Deccan traps. Within these forests there must have been sub-divisions into the flora of the cooler more elevated regions, then diminishing in extent, and those of the lower altitudes. Other contrasts

due to the differential distribution of the monsoon rainfall over the area must also have occurred.

The above picture represents a stage in the progressive desiccation which has been going on since the last Ice Age (d' Aubreville 1949, Moreau 1952, Ripley 1959a). The forests of central India have now disappeared and only groves remain (Randhawa 1949). Much of the Ganges Valley is very arid in the dry season.

Similar changes must have occurred in SE. Asia with a major expansion southward of cool climate biota over higher ground at the glacial maxima followed by a recovery of vast tropical forests. In southern Burma, Thailand, and south Indochina the climax forest development was probably prevented over wide areas by prolonged seasonal floods resulting in a grass vegetation (Suvatabandhu 1958, Stamp 1959). During the Ice Ages the islands of Borneo, Java, and Sumatra were connected together with Malaya and Indochina to form the vast continental area of Sundaland. Changes in that land area have been extremely complex (Umbgrove 1949, Beaufort 1951, Dammerman 1929) but most of it must have been covered by rain forest (Richards 1952). In the huge river system draining north over the low-lying land between Malaya and Borneo there were probably patches of open grass-*scrub* and palms and occasional extensive areas of swamp or grassland maintained on a heavily waterlogged soil. Such areas are more likely than swamp forest because when Sundaland was undivided the climate in the rain shadow to the north of the Sumatra-Javan mountains was probably very much drier than at present with a seasonal rainy period. It follows that, as on the Amazon, the upper reaches of the great northward flowing river contained much swamp grassland rather than the forest that is all to be seen today. Following the Ice Ages the low-lying areas between the present islands were gradually submerged.

The dispersion of the weavers was probably affected by these changes in the following way :

(i) The main eastward movements of the birds probably correlated with the recessions of the last two Ice Ages. During glaciation movement must have been prevented by the southward penetration of the palaeartic biota into Arabia and Persia as well as the expansion of the 'montane' floras of Africa and Asia. The ensuing savannah conditions in the Middle East must have been ideal for dispersal of seed-eating weavers. During the arid interglacial period, however, desert regions must have constituted a barrier as at present.

(ii) Entry to India would have been much hindered by forest barriers. As these broke up under increasing desiccation the eastward movements, particularly into the Deccan, continued.

(iii) Since only the last two glaciations are considered, it follows that the weavers could have reached Asia following either the last or the

penultimate Ice Age. The Red Sea and Persian Gulf do not appear to have constituted effective barriers. The relict distributions and characteristics (such as the nest form) of *P. megarhynchus* and *P. hypoxanthus* set these species apart from the other Asian birds. They probably represent a distinct and phylogenetically primitive group within the genus, which entered India at the earlier glaciation to be followed later by the more advanced birds of *P. philippinus* type when conditions again became suitable for movement.

Both *P. megarhynchus* and *P. hypoxanthus* are marshland birds and the savannah ancestor is no longer extant. The size contrast is unlikely to be completely explained as an example of Bergmann's Law although *P. megarhynchus* undoubtedly lives in the cooler climate, at least in winter. The upright stance in display and the nest form of *P. megarhynchus* suggest that the use of the tree-top nesting sites is recent following the reduction of swampy marshland.

(iv) The ancestors of *P. philippinus*, *P. manyar*, and *P. benghalensis* presumably spread first into savannah country around the Indus Valley and in Rajasthan. Forest belts doubtless still existed in the Indus basin together with large swamps along the river. The opportunity thus existed for a population to colonise the marshland. A similar region in the Ganges Valley was more certainly cut off from savannah by forests in the Delhi area and to the south. Once weavers had reached the area adaptation to the prevailing marshland would have followed rapidly. Thus at an early date opportunities existed for the development of two marshland populations in the eastern and western limbs of the Indo-Gangetic plain. The relatively greater contrast between *P. benghalensis* and *P. philippinus*, together with the restricted range of the former, suggests that *P. benghalensis* was the first to diverge, probably in the Indus basin. The *P. manyar* stock from the Ganges Valley could have spread eastwards later to colonize the highly suitable marshland areas in SE. Asia by moving along the coasts. It also proved more adaptable than *P. benghalensis* and spread widely over India and Ceylon wherever suitable marshy areas existed.

There are of course several possible alternative explanations. *P. manyar* may have arisen in SE. Asia from a stock ancestral both to it and *P. benghalensis*, or it may represent a second invasion of the Ganges swamp-land at a later date from *P. benghalensis*, when the two had diverged sufficiently for reproductive isolation to have developed. Be this as it may, the main point here is that the local conditions in north India and parts of SE. Asia, in which large swampy basins lay surrounded by forests and at periods effectively isolated from savannah on higher, drier, or poorer land, provided the local isolation during which marshland populations could diverge from the parental savannah stock.

The savannah birds persisted in suitable areas as the ancestors of

P. philippinus. Furthermore, as drier conditions developed and savannah spread, the birds ranged widely over India especially in the Deccan.

(v) Prior to the dissolution of Sundaland SE. Asia appears to have contained widely dispersed populations of both *P. hypoxanthus* and *P. manyar*. Later the flooding of the low-lying land between Sumatra, Java, and Borneo seems to have entailed the virtual extinction of most of the weaver populations that lived there. The vast unbroken forests of Malaya, Sumatra, and Borneo would not support a relict population but on drier Java, with its Monsoon climate, a small population of *P. manyar* survived (presumably at first only on the northern alluvial plain), and eventually adapted to the absence of extensive swamps by moving in on a tree nesting site. *P. hypoxanthus* also survived locally on Sumatra and Java.

(vi) The spread of the adaptable and vigorous *P. philippinus* through the forests of SE. Asia seems to be a recent event occasioned by the felling of forests and the opening up of areas to agriculture. It is found now irregularly throughout Malaya (which has no other weavers), Sumatra, and Java, but has not yet reached Borneo where the almost unbroken forests would probably effectively prevent colonisation. In Java *P. manyar* and *P. philippinus* probably compete (see above); the result seems to be the present contrast in altitudinal range and breeding season.

In spite of obvious weaknesses and the paucity of information the above argument does account in general for the facts available and explains the origin of the extant Asian weaver species. During isolation the populations diverged sufficiently in habitat preferences and in reproductive behaviour, so that now that the forest barriers have largely disappeared sympatry occurs without extensive hybridisation. The specific ranking of the birds is certainly justified even though the precise extent of their ecological and behavioural interaction remains to be determined. The degree of competition that occurs is an expression of the continuing unstable relations between the species and their environment.

c. The origin and nature of the behavioural differences

The differences between the Asian weavers concern primarily the coloration of the males, habitat preferences, nest sites, and the methods of communication between the sexes by display and voice during pair formation. In particular, contrasts in the orientation of the WBDs and their context within the courtship sequences have been shown to correlate with different motivation in the species concerned. All these contrasting features are fundamentally directed to the guiding of the female to the nest. It is thus the nest site and the nature of the environ-

ment around it which comprise the ultimate factors determining the behaviour shown.

In the tarai contrasts in nest site and communication behaviour are maintained in sympatry in an area of complex interdigitation of species habitats, and it appears that they are genetically controlled and hence innate. However, nest site selection is by no means invariably fixed¹ and, in particular, the contrasts in site between *P. manyar* races on Java and elsewhere suggest that here the factors determining site selection may be sufficiently labile to allow the choice of trees in one locality and rushes in another. The convergence of *P. manyar* in nest site, and probably in courtship, to *P. philippinus* on Java may thus depend on the relative absence of swamp there and the choice of tree sites for nests. Here then the whole shift from the characteristic marshland behaviour of the species could have been due to a direct reaction to the environment. Whether at present the site selection of the Javan population is environmentally or genetically controlled will require much further analysis but the point raises wide issues.

'Genetical systems do not directly and rigidly determine the characteristics of organisms but set up reaction ranges within which those characters develop' (Simpson 1953). Within the labile reaction range the particular character depends upon interaction with the environment. It thus seems probable that the initial adaptation to the grass nest site in a recently invaded (or rapidly changing) environment was due to the differential survival of those members of a population whose site preferences were sufficiently labile to allow the choice of a site, abnormal for the species, but of adaptive significance. Such 'facultative adaptations' dependent upon particular environmental circumstances may be distinguished from 'fixed innate adaptations' determined genetically independently of the environment (Underwood 1954). Furthermore, the learning of the species nest site by the young occupants (i.e. nest site imprinting) may result in the perpetuation of the preference in succeeding generations and the establishment of a tradition (Thorpe 1945, Klopfer 1961). The establishment of such a tradition may allow the selection of genetic changes such that eventually the site preference becomes incorporated into the genotype (i.e. the 'Baldwin effect', Thorpe 1945, Mayr

¹ Note the variation of nest sites chosen by *P. philippinus* in different parts of its range: tall palmyra and date palms near Bombay, vegetation over or hanging within wells near Poona and in the Deccan, trees on canal and stream banks in the tarai, and bungalow verandahs in eastern India and Burma. Even within a given area different sites are chosen in different localities (Crook 1960c, Table I) but the species has never been recorded nesting in rushes or reeds. Similarly occasional records (Hume 1890) describe *P. manyar* and *P. benghalensis* nesting in atypical sites such as low bushes over water rather than in reeds and grass but never in palms or tall trees. In addition Ali (in litt.) informs me that *P. megarhynchus* breeds both in tree-tops and in reed-beds in the same area of the tarai. In this case the preferences cannot be controlled by genetic contrasts as the populations must intermingle in feeding flocks and probably visit both types of site when selecting building places.

1947, Waddington 1953, Simpson 1953, Hinde 1959, Underwood 1954), the behaviour thus becoming 'innate'. This, however, is not essential for the perpetuation of the behavioural change once the tradition is established.

The contrasts in nest site between these three weavers correlate with major differences in the conditions of cover affecting the visibility of the Advertisement displays attracting females to the nest. Thus if a male with a nest hidden in grass continued to display upon it not only would the likelihood of a female seeing him be reduced but the male, often unable to spot the approach of females, might be inhibited frequently from display.

In such a context however the likelihood of neighbouring males seeing one another frequently on their nests is less and the tendency to visit neighbouring nests to steal materials is probably reduced. A reduced frequency of observation of his fellow males is likely to lower the aggressiveness of a territory owner so that the threshold for attack behaviour would rise. This would correlate with a reduced tendency to stay constantly beside the nest and a lowered threshold for approach to females. Displays would thus soon become orientated towards approaching females away from the nest rather than upon or very close to the structure. This could be a simple phenotypic effect of reduced visibility and less territorial trespassing. Furthermore, since the male's display is rarely released without the sight (or sound) of other males in display, and since the performance of display is probably rewarding, particularly if it ends in sex chasing and especially in copulation, the birds may learn to give their displays on grass tops etc. rather than upon the nest, so that a tradition may develop through some such process as 'local enhancement'. Certainly the *P. philippinus* data (Crook 1960c) showing that males sometimes leave their nests on the approach of a female and display upright on twigs indicate that the display orientation is sufficiently labile to allow the development of a facultative adaptation here. Further shifts in orientation so that the display comes to be given following an approach flight to the female could develop in the same way.

This approach could account for the present differences in pair formation behaviour between *P. philippinus*, *P. manyar*, and *P. benghalensis*. *P. philippinus*, a highly successful dry country stock responding fully to the climate changes favourable to it in the present epoch, retains the original inverted nest-oriented type of advertisement at the tree nest-site. In *P. manyar*, nesting in rushes and reed-beds scattered over swamps, the relatively loose character of the vegetation appears to have permitted the retention of display near the nest so that it still functions as a territorial proclamation. The dense grass in which *P. benghalensis* places its nest makes approach to the female a necessity if initial contact between the sexes is to be established. The display here becomes purely of courtship

function and in correlation with this the song is much subdued. Furthermore the motivational contrasts between the three species in the tarai (pp. 26-29) are also explained.

In Java the local race of *P. manyar* places its nests in trees with good visibility all around. As a result the behaviour of the bird probably resembles that of *P. philippinus* extremely closely.

The important question then is to determine the limits of lability of nest site selection in each species for it is this that very largely determines the types of pair formation behaviour (Crook 1962). Thus, while *P. philippinus* chooses a wide range of sites in different localities, the conditions of visibility around the nests remain about the same and the communication system between the sexes in reproductive behaviour is not affected as it would be if a local population suddenly took to the reeds. In the case of the Java population of *P. manyar* the change does involve a major increase in visibility which probably has affected the signal system. Here then the lability of site selection appears to have been larger than for *P. philippinus* and has probably had more severe consequences. In the Kumaon tarai, in spite of the mixture of habitats, each species shows clear nest-site preferences suggesting that the range is fairly tightly controlled. There is, however, probably sufficient lability to allow quite a drastic change of site should the birds be confined to a habitat radically different to the preferred one. The effect of such a change, which might be arranged experimentally, on the orientation of the WBD would be extremely interesting to observe.

Finally, while the stereotyped appearance of the ritualised displays (Tinbergen 1952, Blest 1961, Crook 1962) in advertisement must be the result of sexual selection, differences in the posture material, upon which selection has worked in producing the signal, may well have been determined initially by shifts in the strengths of tendencies to remain at the nest and to approach the female of the type described above.

Thus while characters such as plumage coloration, body size, beak proportions, nest structure, and ritualised wing beating displays have narrow reaction ranges, other characteristics such as nest-site selection, the orientation of the displays, and the sequence of events in courtship are probably more labile and, through their adaptability, allow rapid phenotypic adaptation to invaded or changing environments. It follows that some 'fixed adaptations', such as the ritualised displays, may be dependent for their orientation and function on facultative adaptations perhaps maintained by local or specific traditions.

d. Species grouping

Moreau (1960) placed the Asian Ploceines in two separate species groups of the genus *Ploceus*, the first consisting of *P. manyar*, *P. philippinus*, *P. benghalensis*, and *P. megarhynchus* and the second of *P. hypoxan-*

thus together with the African species *Ploceus (Pachyphantes) superciliosus*. This latter group was established mainly upon supposed similarities in nest structure, which a close reading of the literature taken in conjunction with new observations in Africa on the nest form and construction of *P. superciliosus* (Crook in preparation) now show to be invalid. Since Moreau's account the new data on *P. megarhynchus* has also become available. In the above survey it is shown that while *P. philippinus*, *P. manyar*, and *P. benghalensis* are extremely similar to one another, *P. megarhynchus* and *P. hypoxanthus* resemble one another much more than either resembles the *manyar* group. It is thus considered that the two species groups of the genus *Ploceus* found in Asia be composed as follows: (1) *Ploceus megarhynchus* and *P. hypoxanthus*, (2) *Ploceus manyar*, *P. philippinus*, and *P. benghalensis*. Neither appears to have any close relationship with any well-studied African species group.

V. SUMMARY

(i) In many areas of tropical Asia several closely related Ploceine species show sympatric distributions. The problems of reproductive isolation and competition posed by these species are discussed. New field data on *Ploceus benghalensis* and *Ploceus manyar* observed in the Kumaon tarai 1959 are provided, and the characteristics of these and other Asian weavers are summarised in Tables II and III.

(ii) The available data suggest:

(a) *Ploceus megarhynchus* and *P. hypoxanthus*, which differ greatly in body size, bill proportions, coloration, nest form and site, and behaviour (still unknown for *hypoxanthus*) from other Asian weavers, are only distantly related to them and would under no circumstances in the wild interbreed or compete with them.

(b) *P. philippinus*, *P. manyar*, and *P. benghalensis*, probably take similar or identical foods and compete for nourishment in areas of sympatry under conditions of food shortage. Differences between the species in habitat preferences in the breeding season and 'superabundance' of food in at least part of the dry season probably limits the frequency and duration of periods of competition. Actual measures are required.

(c) The six contrasting variables likely to play a role in ensuring reproductive isolation between *P. philippinus*, *P. manyar*, and *P. benghalensis* are: (i) coloration of nuptial males, (ii) sequence of events in courtship, (iii) postures, orientation and vocalisation during Wing Beating Display, (iv) nest site, (v) nest form and fabric, and (vi) habitat. The first four are the more important—in particular the orientation of WB display postures, which is closely correlated with differences in nest sites. The females perform mate selection so that attempts by males in mixed colonies to mount females other than those of their own species are not, by themselves, of much biological significance. Deliberate female

choice of male, nest, and site of a species other than her own has yet to be recorded.

(iii) The ancestors of the Asian weavers entered Asia from Africa as savannah-adapted birds. Radiation into swamp and grassland species has occurred in isolation within Asia. Evidence from nest structures and sites, comparative behaviour, and, in particular, the few available studies of vegetation changes in Asia since the Pliocene, is used to produce a hypothesis for the radiation and speciation of the birds. The relative importance of 'innate' and 'traditional' behaviour in the maintenance of specific characters is briefly discussed.

The Asian weavers are listed in two groups : (a) *Ploceus megarhynchus* and *P. hypoxanthus* ; (b) *P. philippinus*, *P. manyar*, and *P. benghalensis*. Neither appears to have any particularly close relationship with any existing African species group of the genus.

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APPENDIX

STATISTICAL ANALYSIS OF BILL MEASUREMENTS ON SAMPLES OF PLOCEINE MATERIAL FROM THE BRITISH MUSEUM

The table below gives the mean beak lengths and beak depths (from top to bottom of bill at its base when closed) for male (\bar{x}) and females (\bar{y}) of each of the four species: (A) *Ploceus manyar* ($n_{\sigma}=12$, $n_{\varphi}=6$), (B) *P. benghalensis* ($n_{\sigma}=2$, $n_{\varphi}=10$), (C) *P. philippinus* ($n_{\sigma}=11$, $n_{\varphi}=6$), and (D) *P. hypoxanthus* ($n_{\sigma}=5$, $n_{\varphi}=4$). Also it shows the sums and differences $\bar{x}+\bar{y}$ and $\bar{x}-\bar{y}$ together with their estimated standard errors. Tabulating $\bar{x}+\bar{y}$ rather than of $\frac{1}{2}(\bar{x}+\bar{y})$ makes only one standard error necessary for each species since $s.e.(\bar{x}-\bar{y})=s.e.(\bar{x}+\bar{y})$. These estimated standard errors are calculated on the assumption that the variance of beak length or depth is the same for all the eight groups, so that a fairly precise estimate of this can be obtained by pooling the estimates for the separate groups. The differences between the estimates for the separate groups are in reasonable agreement with this assumption, which enables one to include all the groups in the analysis and not just those that are fairly well represented (thus B σ has not been omitted).

Species	Beak length				Beak width					
	$\bar{x}(\sigma)$	$\bar{y}(\varphi)$	$\bar{x}-\bar{y}$	$\bar{x}+\bar{y}$	S.e. of $\bar{x}-\bar{y}$	\bar{x}	\bar{y}	$\bar{x}-\bar{y}$	$\bar{x}+\bar{y}$	S.e. of $\bar{x}-\bar{y}$
A	1.690	1.667	0.023	3.357	0.027	1.201	1.188	0.013	2.389	0.026
B	1.685	1.642	0.043	3.327	0.043	1.255	1.145	0.110	2.400	0.040
C	1.727	1.690	0.037	3.417	0.028	1.188	1.215	0.027	2.403	0.026
D	1.562	1.495	0.067	3.057	0.037	1.304	1.270	0.034	2.574	0.035

(a) Beak lengths

Although none of the differences $\bar{x}-\bar{y}$ exceeds twice its estimated standard error, they all have the same sign, which suggests a systematic sex effect. If there were no sex effect each difference would have the same chance of being positive or negative, and the probability that all 4 differences have the same sign is only $\frac{1}{8}$. In fact the average difference $\frac{1}{4}(0.023+0.043+0.037+0.067)=0.0425$ is significant at the 5% level (its estimated standard error is only 0.0172).

Moreover the 4 values of $\bar{x}-\bar{y}$ do not differ significantly from one another at the 5% level, so that the data may be considered consistent with the hypothesis that the sex effect is the same for all 4 species. On this hypothesis the best estimate of the sex effect, obtained by taking a weighted mean of the 4 values (the weight being proportional to the estimated variances of $\bar{x}-\bar{y}$) is 0.0388 (with standard error 0.0161). However, it is perhaps doubtful whether this hypothesis is meaningful as D

is clearly different from A, B, C (if D is omitted, the weight mean becomes 0.0323, which is not significantly different from zero at the 5% level, being only about 1.8 times its estimated standard error 0.0178).

The values of $\bar{x} + \bar{y}$ for A, B, C do not differ significantly at the 5% level (this is almost obvious from the magnitudes of the estimated standard errors), while the difference between $\bar{x} + \bar{y}$ for D and these are very highly significant.

(b) Beak widths

The situation here is less clear. For the values of $\bar{x} + \bar{y}$ we reach the same conclusion as in (a), those for A, B, C not differing significantly at the 5% level and the difference between them and $\bar{x} + \bar{y}$ for D being very highly significant. But the behaviour of the values of $\bar{x} - \bar{y}$ is rather puzzling. The differences between them are quite large compared with their standard errors and, if we test the hypothesis that the sex effect is the same for all 4 species, we obtain a result that is just significant at the 5% level. In view of this, averaging the 4 values is not very appropriate. Omitting D does not alter the result, which is due to the value of $\bar{x} - \bar{y}$ for B being much greater than the rest; in fact B is the only species for which $\bar{x} - \bar{y}$ is quite highly significant. (B ♂ has only two members, but that does not affect the argument, as the small size of this group is properly allowed for in the formula for the standard error. Certainly it might not be legitimate to treat the 2 members as a random sample from the species but this is an objection that may be applied to any of the groups regardless of their size).

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Chapters on the History of Botany in India

VI. THE PUBLICATION OF HOOKER'S *FLORA OF BRITISH INDIA* AND WHAT ITS PUBLICATION RELEASED

BY

I. H. BURKILL

[Continued from Vol. 59 (3) : 777]

1. THE PUBLICATION OF HOOKER'S *FLORA OF BRITISH INDIA* RELEASES *FLORAS* OF DIVISIONAL OR SUB-SUB-AREAS

Sir Joseph Hooker described his *FLORA OF BRITISH INDIA* as 'an attempt to sweep together and systematise a century of hitherto undigested materials scattered through a library of botanical books and monographs, in vast public and private herbaria and a "pioneer work"'. It was a large undertaking; its seven volumes together weigh so much that a botanist cannot conveniently take them into the field; the work is for the study. In a valedictory preface to the last volume he expressed a wish that 'it would facilitate the preparation of local floras'. That it did. By the time that others were in a position to guess the date of its conclusion some of them were engaged on writing their own local *Flora*. So much the better. Hooker himself set the example by taking up at once the completion of Trimen's *HANDBOOK TO THE FLORA OF CEYLON*; and he had vol. 4 out in 1898 and vol. 5 in 1900. But the reader is entitled to comment—5 is not a great reduction on 7. The next author in time was Theodore Cooke with the first part of his *FLORA OF THE BOMBAY PRESIDENCY* who reduced the number of volumes to 2, albeit bulky. Theodore Cooke (1836-1910) had gone to India in 1860 to build railways; Botany became a hobby, ability brought him to the position of Principal of the Poona Civil Engineering College and it was from it that he organized both teaching and a field study of Botany. When the Forest Service wanted to start training Forest Rangers (see chapter V, section 11) he came forward with proposals to have Botany taught at Poona. The proposal was not accepted. But when King advised the formation of the Botanical Survey (see chapter V, section 12) Cooke organized (1891) a Bombay section complete with a Presidency Director and collectors and within the College buildings a herbarium which remained under his direction until he retired (1893).

From 1866 **George Marshall Woodrow** (1846-1911) had been in charge of the Ganeshkhind Experimental Garden—in 1872 his charge was extended over all the official gardens in Poona ; in 1879 he became lecturer in the College ; and in 1893 when Cooke retired the directorship of the local Botanical Survey passed to him. He held it until 1899, when his retirement came and it was passed to **George Gammie**. The Survey originated a method of collecting by caravan. This team was well calculated to advance available knowledge of the Bombay flora. Cooke determined to write a Flora for which purpose he moved to Kew on retirement. He had divided a personal herbarium into two parts, one to retain, the other for the Herbarium in the College. Cooke contrived to get a volume of his FLORA completed by 1901. Later, when an unfortunate fire destroyed the Herbarium that he had so enriched, he gave in replacement the half that he had kept. He continued his work, completing it by a second volume (1908).

It will conduce to clarity if I assemble the dates here: Ceylon, recognizing that the first essential rested in a Flora, began the preparation of that for the island with Trimen's appointment to the post of Director of the Peradeniya Garden (1879) ; Bengal held itself ready at the publication of Hooker's FLORA OF BRITISH INDIA (1897) and was prompt (1903) with one ; Upper India held itself entitled to begin one (1903) ; Bombay and Madras were left behind ; Bombay took the help that Kew was able to offer and Cooke did his work there ; the means of Bombay had not been developed adequately. Later Madras needed similar help. As the Government of India had turned a nearly deaf ear to King's suggestions for linking the botanical work of the different parts of India together, the efforts were independent, save that the Saharanpur and Calcutta gardens kept in rather close touch.

When Cooke commenced making his collections he was so domiciled as to be able to explore rather more freely that part of the Presidency where Bombay City and Poona are than the southern parts of the Presidency ; these were then getting the attention of **Alexander Talbot** and **A. P. Young**. The considerable collections of the latter were sent to the British Museum (Natural History) in 1884.

The next Flora to reach printing was **Kanji Lal's** FOREST FLORA OF THE SCHOOL CIRCLE, i.e. of Dehra Dun. It was out as a whole in 1901, the year of Cooke's first volume and much before Cooke's second. It was followed in the next year by two other Floras, Sir **David Prain's** BENGAL PLANTS and Sir **Henry Collett's** FLORA SIMLENSIS; and these were followed one year later by the first part of **Duthie's** FLORA OF THE UPPER GANGETIC PLAIN AND THE ADJACENT SIWALIK AND SUB-HIMALAYAN TRACTS. With this sequence of dates before him my reader sees how real was the release. Beyond all doubt, each of the five authors felt the need of keeping down the size of his volume or volumes ; but they reacted in very different

ways. Prain took the most original line. Writing actually for the students that he taught in the Medical College and well aware that the common garden plants of Bengal were on the whole better known to them than the country's wild plants, he inserted these, getting room to do so by excluding descriptions in favour of keys. Brandis, who had retired to his native town in Germany at some date in the early nineties, returned to taxonomic work; and, restricting himself as he had done before to woody plants, started to write his *INDIAN TREES*. In 1899 he moved to Kew that the work might be checked there. The book has great value, but is of course not a geographic section cut out of the *FLORA OF BRITISH INDIA*. It was not published until 1906. Another forest Flora which must have been well in preparation before 1900, but not published until 1909 (with a second in 1911) was Talbot's *FOREST FLORA OF THE BOMBAY PRESIDENCY AND SIND*.

Duthie's *FLORA* is deserving of great praise, but progressed so slowly that he himself did not complete it.

Prain, while engaged on writing his *BENGAL PLANTS* prepared a working list for the use of the dweller in Calcutta—a list of the plants of the three districts that surround the city—Howrah, Hughli, and the Twenty-four Parganas. It was printed in the third volume of the *Records of the Botanical Survey*. The nearer these publications were to the date of the *FLORA OF BRITISH INDIA* the more faithfully do they follow its taxonomy. Does my reader at times give thought to the 'species' as a conception that has grown up very much without challenge but with universal consent? That consent is basic in the biological sciences, and the species concept is unavoidable. But the individual taxonomist, except, it seems, a Russian school, forms his own concept of the range of variation which he should allow. That being so, it was vastly to the advantage of India that one man, namely Sir Joseph Hooker, should be allowed to impress his estimate of specific range on the whole phanerogamic flora of the sub-continent.

To a small extent Dalgado's *FLORA OF GOA* escapes Hooker's influence in that *Celasio Dalgado*, the author, though a correspondent, was not more closely associated with Kew. He had been born in Goa, had qualified in Medicine, and became the Civil Surgeon of the little State of Sawantwadi. Goa and Sawantwadi are outside the area of Malabar whence Rheede drew his information; but it was the *HORTUS MALABARICUS* that drew Dalgado to his study of the simples. The *FLORA* was published in 1898; and later its author lived in Lisbon.

While Prain was at work on his *Flora*, the surgeon John Justus Wood of the Madras Medical Service retiring, moved to Chota Nagpur and collected compiling a list of the *PLANTS OF CHUTIA NAGPUR* published in the *Records of the Botanical Survey* in 1902, and two missionaries Father *Cardon* and the Rev. *Campbell* of Pokhuria collected. Further the

Hieronymite missionary, Father **Rastier**, collected at Bettiah in the unworked district of Champaran.

The following information may be inserted here. A list of Simla plants was printed privately by Mr. **H. B. Smith** and Lady **E. Smith**; and some years after 1900 Miss **Emilia Frances Noel** published an enumeration of plants that she had found in various parts of Kashmir.

Right in the extreme south of India **Emile Deschamps** and **Francis Wilms** collected. The first mostly in the French Settlements of either coast and in Ceylon; the second in Kerala. Wilms's specimens were given to Kew.

2. COOPER'S HILL AND A MORE FAVOURABLE OUTLOOK IN INDIA TOWARDS BOTANY

Towards the end of section 11 of chapter V the reader was made aware how it came about that teaching was provided at Dehra Dun for Forest Rangers and told that, though Brandis was still in India when events led up to it, the moving spirit was Schlich's.

Schlich was Inspector-General of Forests for less than five years, as in 1885 he left for Britain to organize another teaching centre—the Forestry College as part of the Imperial Engineering College at Cooper's Hill (some 20 miles west of London) where Foresters for India were to have the advantage of learning their technology through the medium of their own tongue and under a specially appointed staff.

I have called the Botanists who entered the Forest Service under Brandis, Brandis's front line. Those who followed them, and had had a different training make the second line. They had for a teacher Marshall Ward who was appointed to the Professorship of Botany (1886).

Harry Marshall Ward (1854-1906) was contemplating a career as a teacher of the Natural Sciences when at the age of 20 he attended evening classes taught by the most inspiring teachers in London, and then went to Cambridge where he passed botanically under Vines. With a degree gained, he was chosen to go to Ceylon with an appointment of two years in which he was to find if possible a way of suppressing the coffee-leaf disease. That experience over he taught Botany in the University of Manchester until chosen for Cooper's Hill.

His suitability for the post was undoubted, his experience of tropical vegetation a recommendation, and he taught for 10 years. I put before my readers the names of a few of his pupils who made their mark on the Botany of India with the dates of entering India: **H. H. Haines** (1888), **C. G. Rogers** (1888), **R. L. Heinig** (1895), **C. E. C. Fischer** (1895), and **R. S. Hole** (1896). Marshall Ward left Cooper's Hill in that year, before the following two new pupils could finish their courses: **B. B. Osmaston** (1896) and **R. S. Troup** (1897).

Cooper's Hill is near enough to Kew, for Ward to bring over his students week by week in summer to see live plants falling within their interest.

The reader perhaps comments that the botanical maturity of these officers came one or two decades after 1900 at which my chapter is expected to end. That is so. I break bounds as without looking forward the shaping of the end of my period will become uninformative and ragged as regards Troup's most valuable work.

Henry Haselfoot Haines (1867-1943) reached India at the very end of the year 1888. He had passed out of Cooper's Hill at the head of the list and it was to be his to serve in northern Bengal forests which Schlich himself had organized excellently; he was in these forests until 1899 when he was moved to Singbhum, south of the Ganges, where working plans for forest management were in hand. Haines collected, but had not at first the idea of writing on that flora. The idea came in a further spell of service in the same part of India which enlarged his opportunities. It may be said that he was fortunate in regard to them. He escaped the very great transfers which have broken into the experiences of so many of the botanists of the Forest Service—interruptions through wide experiences are pleasant if time is given for digesting them. He became Divisional Forest Officer for Chota Nagpur and when he could obtain leave tramped through four of the districts of Chota Nagpur to extend his knowledge. Being appointed to the new post of Imperial Forest Botanist at Dehra Dun (1905) he had the time and the means of working out his collections. The working out was finished next at Kew. On his return to India his results to date were embodied in his *FOREST FLORA OF CHOTA NAGPUR INCLUDING GANGPUR AND THE SONTAL PERGUNNAHS* (1910).

Chota Nagpur had of course come within the area that Prain covered in his *BENGAL PLANTS*, but that in no way lessened the value of Haines's *FLORA*, for Haines wrote for an entirely different assembly of readers, and moreover his descriptions were original. We do not need to follow Haines's successive appointments; it suffices to record that in 1914 he became Conservator of Forests, Bihar and Orissa, and that the gradual extension of the interest of the Forest Service over forests in which grazing was encouraged had meanwhile increased the responsibilities and directed attention to the carpet of herbs on the soil. Now at last a complete flora had the right which Haines gave to it. Haines had collected as he could; then again he used his own time to work the plants out in the Calcutta Garden and at Kew.

How far Haines's opportunities were officially designed to lead to a complete *FLORA* can only be ascertained from official records. One would like to think that they were; whether it was so or was not, the curating and naming cost Haines most of his leisure. He gave the collections to Kew when his book had appeared.

The next name on the list is that of **Charles Gilbert Rogers** (1864-1937). Like Haines he had his early service in northern Bengal; thereafter he was posted to widely scattered parts—the Andaman Islands, Berar, and Pegu, so scattered that the learning of each flora involved a step back at each transfer. This and a catholicity in interests made him a collector for others; but he did much to promote their work.

The third name on the list is that of **Robert Lawrence Heinig**. He had service in the Andaman Islands, Chittagong, and the Sundarbans. He compiled a *FOREST MANUAL OF THE ANDAMANS* which was published in 1900; and he collected a large part of the information required for working plans for the forests of the Sundarbans whence Calcutta so extensively gets its fire-wood. He compiled a *LIST OF PLANTS OF THE CHITTAGONG COLLECTORATE AND HILL TRACTS* (1925) and supplied to Prain much information for his *FLORA OF THE SUNDARBANS* (*Rec. Bot. Survey Ind.*, 1903).

The fourth name on the list is that of **Cecil Ernest Claude Fischer** (1874-1950). He had had part of his technical training at Nancy and part at Cooper's Hill. Arriving in India in 1895, he was sent to Madras and did the whole of his service in that Presidency except a short spell of teaching at Dehra Dun. He sent collections to the Calcutta Garden and, when stationed at Coimbatore from 1911 forward, was able to give time to the flora of the Anamalai Hills and with the help of collections in the possession of the Agricultural College to produce his 'Survey of the Flora of the Annamalai Hills' (*Rec. Bot. Survey Ind.* 9, No. 1; 1921). After retirement he became Assistant for India in the Kew Herbarium (1925-1937) and did most valuable work including the completion of Gamble's unfinished *FLORA OF MADRAS*.

Robert Selby Hole (1874-1938) arrived in India in 1896. He had passed out of Cooper's Hill at the head of the list. His first service in India was in the Central Provinces; then he was sent to Dehra Dun as Instructor in the College; following this he was promoted Imperial Forest Botanist in succession to Haines (1906), teaching and investigating forest composition and chiefly the make-up of the ground covering, seeking the relation between it and the canopy. Hole was indeed a pioneer. In 1909 he was instructed to prepare a text book for the student. This, his *MANUAL OF BOTANY FOR INDIAN FOREST STUDENTS*, has for us the great interest of exposing what was taught.

Bertram Beresford Osmaston was an earlier Instructor in the College, then did service in various parts of northern India, and was again on the College staff, sending collections to the Calcutta Garden.

The last name on this list is that of **Robert Scott Troup** (1874-1939). He reached India in 1897, already a marked man; and was sent to the Tharrawadi teak forests of Burma, whence 9 years later he was called to the establishment at Dehra Dun; and at Dehra Dun he completed his

service in India in 1920, returning to Britain to succeed Schlich at Oxford as Professor of Forestry.

Troup comments in one place that the Service in India had not the ability—one may say had not the experience—for drawing up working plans until after the days of Brandis. Genuine plans came later and were gradually improved as experience was gathered. Then came the concentration of the minds who did the actual planning at Dehra Dun, and after that the establishment of a Research unit—the Research Institute with five divisions, one of them for working plans. Troup being at Dehra Dun, when the Institute actually came into being, was at first given the Division of Utilisation, but was soon turned over to the Division of Working Plans. The transfer gave him charge of a vast store of data on tree behaviour which he digested into his masterly *SILVICULTURE OF INDIAN TREES*.

In the year after Troup, **Sir Ralph Pearson** went out to India in the Forest Service. It suffices to add his name as being that of one of the men who put Botany forward. He was not of Marshall Ward's teaching.

I have sought in this section to convey to the reader how greatly Schlich's educational policy was calculated to increase the efficiency of the botanically minded who reached India, and that the needs of the Service were segregating specialists and, again, what the delegation of work to Dehra Dun has meant.

At the same time a voice whispers—Dehra Dun is far from central.

3 VASCULAR CRYPTOGAMS OVER THE HALF CENTURY

No one can complain that ferns do not get the attention of botanists. Because they are of a size similar to herbaceous flowering plants, they get the same attention. They even get rather more, for there are many of those who specialize. The mosses get the attention of collectors of mosses.

This section is a continuation of the record brought to 1850 on p. 84 of the second chapter. Soon after that year two botanists whose interests were wide, cleared a way for the fern specialist; they were **R. H. Beddome** and **C. B. Clarke**. Beddome published in 1863-1864 his *FERNS OF SOUTHERN INDIA: BEING DESCRIPTIONS AND PLATES OF THE FERNS OF THE MADRAS PRESIDENCY*, following it in 1865-1870 by his *FERNS OF BRITISH INDIA: BEING FIGURES AND DESCRIPTIONS OF FERNS FROM ALL PARTS OF BRITISH INDIA*. Later (1883) came his *HANDBOOK OF THE FERNS OF BRITISH INDIA, CEYLON AND THE MALAY PENINSULA*.

C. B. Clarke had slightly anticipated the last by publishing in 1880 his paper—'A Review of the Ferns of Northern India' (1880). **Henry Francis Blandford** followed in 1888 with his *FERNS OF SIMLA*.

Very striking indeed is the relative abundance of ferns in different parts of India, so striking as to set the mind wondering on what limiting factor Nature failed to evolve ferns more freely for generally unsuitable areas. The local poverty is illustrated by what Prain records in his *BENGAL PLANTS*. His area is divided by him into 10 sub-areas: Tirhut, Bihar, Chota Nagpur, North Bengal, Central Bengal, West Bengal, Orissa, East Bengal, Tippera, and Chittagong. He names 112 species, of which 88 are found in Chittagong, 53 being only in Chittagong. Chittagong therefore for a collector of ferns is a paradise. After Chittagong Chota Nagpur is favourable, for it has 12 that are unrecorded for other sub-areas of Bengal and 5 more in common with Chittagong, but not beyond these two sub-areas. The rest of Bengal is strikingly poor, so poor as to handicap the Botanical teaching in Calcutta by making material for illustration difficult to get, save from the Botanic Garden; and of the Garden it may be recalled Griffith discovered his fern material deficient (see p. 66 of the second chapter).

It is evident that the fern specialist who is not free to travel may be area-limited.

Of fern-lovers connected with India Sir **William Norris** may have been among the first; if not, it would be because he was not collecting during his earlier years in Ceylon: he collected vigorously after his transfer to Penang as Recorder for the Straits Settlements. Lady Dalhousie was at the time in Penang and an enthusiastic companion in the field. Sir William Norris went back to Ceylon as Chief Justice (1847), and on retirement took his collections to Britain and they were given to Kew. He has already been mentioned in chapter II as climbing Mount Ophir with Griffith.

Ceylon is a paradise for the botanist seeking ferns. **William Ferguson** (1820-1887), a Surveyor who reached the island in 1839 and was there until his death, collected ferns during part of his long career, and in 1880 published an account of them. There were three other collectors in the island about that time—**George Wall**, a merchant of Colombo, **W. Thomas Naylor Beckett**, a coffee-planter, and **Frederick J. Hutchinson**, an army officer. They rivalled each other in collecting and helped each other. Hutchinson collected also in the Nilgiri Hills. After his service in the East he was stationed in Plymouth and, when he died, he left a beautifully mounted and cared-for collection. A contemporary, collecting in northern India, was **Charles William Webley Hope** (1832-1904), a Civil Engineer who had reached India in 1859 and had adopted fern collecting as a pastime. His *FERNS OF NORTH-WESTERN INDIA* was published by the Bombay Natural History Society in 1899-1903. One of Hope's interests was to connect the epiphytic ferns with the most favourable support, a line of study which belongs to ecology. **Harry Corbyn Levinge** (1831-1896), of the Bengal Public Works Department, collected ferns in the

Sikkim and Kashmir Himalaya and in the Nilgiri Hills ; and **J. Munro**, a tea-planter, collected in Sikkim. It happened that Britain was leading Europe in attention to ferns ; and, by British workers of the time in India, the knowledge of the ferns was brought to a very dependable level.

Not so the Mosses; specialists interested in them were few, and their study more difficult.

The study of the Mosses of India may be said to have commenced when the road to Nepal was opened ; but it was not long before the southern parts of the Peninsula also received attention. **Francis Buchanan**, the first (1802) to collect in Nepal these small but most attractive plants, had collected mosses to good effect in Scotland before he went to India (see Prain, *LIFE OF FRANCIS BUCHANAN* p. vi footnote). The first close attention to the southern mosses came from some of the earliest to settle in the Nilgiri Hills and also when collecting in Ceylon followed. Sir Joseph Hooker, when he searched for geographic data for his *SKETCH OF THE FLORA OF BRITISH INDIA*, was compelled to admit that in 1900 data which would serve him did not exist. Nor did they for yet another 30 years—that is until the publication of a list compiled by Professor **J. P. Brühl** (*Rec. Bot. Survey Ind.* 13, pp. 15-120 ; 1931). The list suggests a great abundance among them in all the wettest parts of India proper, not only of species of mosses but also of endemics. This great endemism is doubtless exaggerated and will be reduced by further study as exploration is continued. Many of the Ceylon species not recorded as occurring in the mountains of southern India will be found to have been overlooked ; and a considerable number now known from the Nilgiri or Palni Hills will be found in the Western Ghats or elsewhere outside their known range. As for the species of Burma the knowledge that we have is very meagre.

Among the collectors of mosses in India, the only taxonomist so advanced as to make determinations had been **Griffith**.

In my second chapter I referred to Mitten's *CONSPECTUS* of the mosses that he knew to occur, and I got together the names of the collectors to his year of publishing (1869). At that date Thwaites was collecting as opportunities came to him, and Mitten (1873) reported on Thwaites's specimens including what W. T. Naylor Beckett obtained for Thwaites. In 1872 **Odoardo Beccari** left Italy on his great travels in Malaysia, and halted in Ceylon for a short time. His mosses, then collected, were determined later by Hampe (1872). Activity increased towards the end of the century. J. F. Duthie collected vigorously when touring in the north-western Himalaya, and Brotherus reported on the results. He reported also on mosses collected in Coorg by Dr. **T. L. Walker**. Mrs. **May Bradford** collected in the Sikkim Himalaya ; **J. H. Darrell** and **C. E. C. Fischer** in southern India, **H. N. Dixon** reporting on these.

A. W. Fraser, an officer in the Royal Engineers, collected in northern Burma.

The Hepaticae drew very little attention until 1893, in which year **Victor Felix Schiffner**, at the time a lecturer in Prague, was commissioned to write up this group for Engler's PFLANZENFAMILIEN, and to get material travelled in Bombay, Ceylon, and forward to Malaysia, collecting in large quantities.

4. THE MICROSCOPE IS GREATLY IMPROVED AND BOTANY PROFITS IN UNDERSTANDING THE LOWER PLANTS : EFFECTIVE COLLECTING OF THEM BEGINS IN CEYLON

The great improvements referred to in this section were made in Europe, where every branch of Botany profited, perhaps most of all the understanding of sex in the higher plants, which, as it involved understanding sex in the plants at large, intensified the interest in the Algae and Fungi. The first Botanist to make any systematic attempt at collecting these in our area was **George Gardner** who in 1844 reached Ceylon as Superintendent of the Peradeniya Botanic Garden. During the short time before his death in 1848 he sent herbarium specimens to his former teacher, Sir William Hooker, and by the services of the artist Harmanis De Alwis preserved records of fleshy Agarics in coloured drawings. But Gardner's time was short ; and it was not much that he could do.

William Henry Harvey (1811-1860) as a school boy made all the use that he could of holidays at the sea-side to satisfy a tremendous inquisitiveness into the life that was there, and again as a young man in business used the opportunities of holidays. Among diverse interests he found his greatest in collecting the sea-weeds of the British Isles. Then came to him some years of employment at the Cape of Good Hope where he made acquaintance with a different algal flora. A return to Ireland was followed by appointment as Keeper of the Herbarium of the Dublin University. He had made a friendship with Sir William Hooker as far back as 1829 ; now University vacations allowed Harvey personal contact with him in work at Kew. Publication on British sea-weeds commenced. Harvey was next enabled to visit the east coast of North America. In 1853 he executed the largest collecting trip of his life. He sailed for Egypt, proceeded via Aden to Ceylon, then went to Singapore, Australia, the Central Pacific, the west coast of South America, and returned to Dublin carrying back very extensive material ; and in Dublin was elected a Professor (1848). His collection had numbered 5000 specimens before Australia was reached.

The reader realises how advantageous it was that so great an authority should name up the Ceylon sea-weeds.

Next as to Fungi :

Thwaites, as the reader will have realized, was at Peradeniya at the

time of Harvey's visit. He had been in Ceylon for 2½ years, finding his feet, enquiring what the obscure as well as the obvious plants were. Like Harvey he had been in business and his knowledge was that which a naturalist gets by contact with living things.

He was soon sending specimens which he could not name to Sir William Hooker at Kew and leaving to his discretion the manner of handling them. Hooker from 1828 had had the friendship and co-operation in work of the mycologist, M. J. Berkeley, and all the fungi received from Thwaites were sent to Berkeley.

Miles Joseph Berkeley (1803-1889) was already a naturalist before he went as a student to Cambridge. There he came into the company of J. S. Henslow, not as yet the Professor of Botany but sufficient of a leader to have been elected Secretary of the Cambridge Philosophical Society.

Berkeley left Cambridge for a curacy at Margate on the Kent coast, where he was able to give his leisure to studying the life of the sea-shore, just as Harvey was doing on an Irish coast of very different aspect. Berkeley's first publications were on animals; the next (1833) were on Algae. Fungi later usurped the first place, partly because Berkeley by moving inland lost touch with the sea-weeds and partly because he found his energy satisfied when Hooker persuaded him to undertake the elaboration of the Fungi for his edition of Smith & Sowerby's *BRITISH FLORA*. Later the interest became world wide and a very fruitful association commenced between Berkeley and **Christopher Edmund Broome** (1812-1886) which carried the study of Ceylon fungi so far that before Broome's death they had described more than 1200 species. Broome was by profession a lawyer, but leisured and had had the friendship of Thwaites in Bristol.

The coffee-leaf disease, *Hemileia vastatrix*, got its condemnatory name from them in 1871; but it had not deserved the epithet *vastatrix* had not intense cultivation, by offering unbroken stretches of planted coffee, invited its riotous spread.

Wallich's son **George Charles Wallich**, born in the Calcutta Garden in 1818, after taking the degree of doctor of medicine in Edinburgh had entered the service of the East India Company. In Calcutta he became a specialist in the Diatoms of Lower Bengal and of the Bay of Bengal and listed them. Later when the great undertaking came of connecting the coasts of Britain and North America by a submarine cable (1860) he was drawn from India to study the life on the floor of the Atlantic.

The algae of the Indian fresh waters, swamps, rice fields, and rivers got little attention; and it was their smallness that led to this.

In 1888 an ingenious botanist, Professor **G. von Lagerheim**, observing in the Copenhagen Museum much debris attached to the roots of a specimen of a *Myriophyllum* collected by Hooker in the Bengal plains, soaked

off the adherent material, and identified 52 species of algae in it. Then he treated specimens of *Utricularia* similarly.

Professor **George Dickie** (1813-1882), at one time of Aberdeen and then of Belfast, in the last paper that he wrote describes algae that he had received from the Himalaya (1881).

William Joshua (1828-1898) described (1886) Desmidiaceae of a considerable collection that Dr. Robert Romanis had sent to him from Rangoon. William Barwell Turner's FRESH WATER ALGAE, principally Desmids of India, appeared in Stockholm in 1892. Professor **Antonin Hansgirg** collected in the Bombay Ghats; and his collection was worked through by **Wilhelm Schmilde** (1900). In 1896-1897 **William G. Freeman** took rather extensive samples from various places in western Ceylon and from under various conditions. Freeman's sampling, probably the best sampling made before the century ended, was reported on fully by the two Wests, **William West** (1848-1914) of Bristol and his son Professor **George Stephen West** of the Mason College, Birmingham. The Wests' report on the Ceylon Algae was followed by reports on Algae from various parts of India both by the Wests and by Dr. **Nellie Carter**. But right up to the early years of the 20th Century the Indian freshwater Algae were very inadequately collected.

Some collecting of fungi in Ceylon was done by **Odoardo Beccari**. He (1843-1920), as soon as he had finished his University studies (1864), began to plan jointly with Marquis **Giacomo Doria** the first of his collecting expeditions to the Malay Archipelago. Together they set out in the next year and there was a halt in Ceylon when a small collection of fungi was made.

The reader will find more details regarding fungi than are given here in a paper by Sir Edwin Butler and Dr. Bisby in the first of the Science Monographs of the Imperial Council of Agricultural Research, 1931.

5. A GREAT STEP FORWARD IN THE BOTANIC LABORATORY : THOUGH VERY HESITATINGLY TAKEN

Laboratories are of many kinds; but our interest is in none until dedicated temporarily or otherwise to botanic work.

The word 'laboratory' had obtained recognition as meaning a work-room for chemical investigations and other work requiring apparatus. What was new in the use of it in India was not the holding of apparatus, but the idea of needing a building to hold apparatus for the purposes of Botany. The medical schools, powder factories, museum of the Asiatic Society, etc. had had need of a room set apart; Jacquemont describes a chemical lecture given in Calcutta in 1829 which implied a chemical laboratory. Without Mycology the appearing of the botanical laboratory in India would have been even later than it was.

David Douglas Cunningham (1832-1914) entered the Indian Medical Service in 1868. He and another entrant, T. G. Lewis, were not forthwith sent out to India in the usual way, but were marked off for a little further learning; they were sent to Berkeley to see him at work and then sent to Germany to see Professor Anton De Bary at work. We have seen Berkeley at his life-work—the taxonomy of the Fungi. Why were these two entrants to the Indian Medical Service sent to Berkeley?

De Bary had published two years earlier one of his books—his *MORPHOLOGY AND PHYSIOLOGY OF THE FUNGI, LICHENS AND MYXOMYCETES*, a book which he himself said had been well received and had paved the way for further advances. De Bary was a master of method of laboratory study of the Fungi and other Lower Plants; Cunningham would be able to see life-histories under investigation in the most fertile conditions.

The two entrants into the Medical Service were sent to other centres of research also. They went to India in 1869; doubtless the better for what they had seen; though their delegation might be taken for an intention to promote a study of the fungi, their careers were not directed towards that. Cunningham's first laboratory in India was pathological and only mycological in an incidental way. In 1885 there was a redistribution of work which affected both. Lewis was called to the India Office in London and Cunningham nominated Professor of Physiology in the Medical College, Calcutta. He controlled a laboratory of course; and in that laboratory carried out some very interesting mycological investigations. Sir David Prain, who saw Cunningham's work in progress, classes his mycological writings as recreations of an active mind, 'either questions which attracted his attention as a teacher of Physiology or subjects in which his interest was the outcome of his early friendship with Berkeley and De Bary.' The reader doubtless appreciates that whatever were the thoughts of the Government that sent him to see these two, there was no official dedication of him to Mycology; but he kept his laboratory in part mycological. King had asked that a Mycologist be added to his staff; but had not received one. Cunningham was a good friend who could and would do work for him at times, but his health broke down in 1897 and he was invalided out of India. In 1880 he had acted as Superintendent of the Calcutta Garden.

Four years after Cunningham had been attached to the Calcutta Medical College **Arthur Barclay** (1852-1891) entered the same service and was appointed Professor of Pathology in the College. He, too, commanded a laboratory which though dedicated to a different purpose, provided him with room for mycological work.

Barclay specialized on the Rusts of Wheat. He died in India in 1891, having been the Professor of Physiology in the Calcutta Medical College from 1874.

Two years after Cunningham's arrival in India, and the same before Barclay's, a parasitic fungus had appeared on the coffee bushes in Ceylon; and this, *Hemileia vastatrix*, was destined to bring another mycologist eastwards. The mycologist was **Harry Marshall Ward** whose career as a teacher of Botany brought mention of him into section 2 (see p. 52). The rapid spreading of *Hemileia* had been alarming; it girdled the World in 25 years—whence its sudden vigour is not clear. At length (1880) the Ceylon Government determined to find funds for an investigation in Ceylon. Now (1880) for the first time a laboratory was set aside in the East completely but temporarily dedicated to Botany. In it Marshall Ward did superb work on three or four different fungi and a lichen; but the coffee-disease had gone beyond control, as every villager's garden was full of it.

He returned to Britain and held among various professorial posts that of Professor of Botany at Cooper's Hill. Marshall Ward's work drove into the minds of the least philosophical of administrators and planters this—that there may be circumstances when a botanical laboratory has an overruling value. In 1897 the planters of Cacao in Ceylon, troubled as to their crops, engaged the mycologist **John Bennett Carruthers**, which meant providing the service of a laboratory, and in the same year the tea-planters in Assam engaged Dr. **Harold H. Mann** for their crops for work, at first conjointly with Sir George Watt, on pests and then with a laboratory for whatever he saw needed attention. In 1900 Dr. **John Christopher Willis** (1868-1957), who had succeeded Trimen in 1896 as Director of Peradeniya, sought to make mycological work at Peradeniya permanent by the appointment of J. B. Carruthers as Assistant Director and Mycologist.

The Botanical Laboratory with this began to be a mark of advance at large characterizing colleges as well as research institutions.

The indigo-planters later, but too late, engaged experts of their own.

6. BY WHOSE BOTANIZING CAME THE RECOGNITION OF AN UNLIKE FLORA TOWARDS THE PERSIAN GULF

An observant traveller from Gujarat to Sind is readily aware of passing into an altered vegetation. This altered vegetation is Persian. Botanizing in Sind was impossible before 1838; but in that year **Vicary** was sent thither with his regiment; and **Griffith**, deputed from Calcutta, entered the northern edge, later to be the Upper Sind Frontier. Griffith was not again in Sind; but Vicary was, and he wrote three papers on the vegetation. Next **Ritchie** visited Sind; then **Stocks**.

John Ellerton Stocks (1822-1854) had been a pupil of Lindley in London and went to Bombay in 1847, where he was employed as a vaccinator in Sind. In 1848 starting from Hyderabad (Sind), where he

verified the Assyrian method of pollinating dates, he ventured into the Las-Bela District of Baluchistan. Two years later, ascending the Indus to the Upper Sind Frontier District, he passed through Nushki and Kalat to Quetta (Shawalkot). He wrote to Sir William Hooker that he had collected 300 plants new to him. He explains further that in traversing the Zawa pass and returning through Zehri he saw change in the vegetation. Both places are to the south of Kalat. What this implies is that Stocks had detected the passing over of the flora of Persian type which occupies southern Baluchistan and Sind into that of Afghanistan.

Stocks took his collections to Kew in 1855 where Bentham was prepared to work them out with him; but he died in the next year. Sir Joseph Hooker has said of Stocks that he was a collector so observant that he scarcely missed anything.

During the seventies two other men collected to good effect in Sind; and the collections that they made were given to Kew in the year 1877. One was Captain **William Stackhouse Church Pinwill** (1835-1920) whose regiment was stationed there. At the time he was an indefatigable collector, not only of plants but of animals of various groups. He collected also in Malacca. He left the army, inheriting property in the extreme south-west of Britain and the enthusiastic collecting was redirected into an equally enthusiastic accumulation of growing plants; he indeed became a great horticulturist.

The second was his brother-in-law, Archdeacon **Stead** of Bombay.

Two very highly placed administrators, both Commissioners in their time, were among the next collectors of plants of the Sind flora—Sir **Bartle Frere** and Sir **Henry Evan Murchison James**.

Many of the plants that occur retain their positions by means of water which rivers bring to them and their drought-resistance is very interesting. So too is the fight of the field weeds to keep a place. I would call my reader's attention to the collecting along the rivers by Father **E. Blatter** and **T. S. Sabnis** in order that more may be done in this ecological line.

After the year 1900 this intrusive flora of Persian type was studied as it occurs in southern Baluchistan.

7. BEHIND THE PERSIAN FLORA IS THE AFGHAN FLORA

The Afghan flora has attracted considerable attention. The first to collect in Afghanistan was **John Martin Honigberger**, a man to whom adventure seemed irresistible. He was born in Kronstadt, Transylvania; and in 1815 left his home to practise medicine and surgery for various periods in Constantinople, Cairo, and elsewhere and continued, until in 1833, he found himself on the Indus at Dera Ghazi Khan where he joined a caravan starting for Kabul. The caravan took him north to

the Kurram and thence to Ghazni and Kabul. He collected a little, but the weather was at its hottest and conditions unfavourable. His few specimens he took at a later date to Vienna and Endlicher described them in his *SERTUM CABULICUM*.

A second period in India followed, during which he studied the Indian *Materia Medica* extensively, and, employing an artist, figured the plants in his *THIRTY-FIVE YEARS IN THE EAST*; but it was no longer Afghanistan in which he worked, but chiefly Kashmir.

The next botanist was **Griffith**, who reached Quetta by the Bolan pass in the spring of 1840. He was at Kandahar on the first of May and then passed by Ghazni to northern Afghanistan to spend the rest of that year and the next year collecting diligently, getting aid from friends and employing local men. There was a trip to Bamean and a trip to Saighan and a trip up the Kuner Valley. In fact Griffith would have allowed little to escape him in the latitude of Kabul. As to the south he had friends there too, who collected for him and added to what he himself had obtained of the spring flowers. But the botanist of that part of the Afghan flora was J. E. T. Aitchison.

James Edward Tierney Aitchison (1838-1898), with a degree in medicine, had entered the service of the East India Company in 1858 and was sent to the Punjab where he started studying the plants at once. In 1865 he published a list of what he had observed in the Jhelum District, Thomas Thomson helping him to name them. Six years later he published a list of what he had found in the Hoshiarpur District, followed by a list of the plants of the Punjab and Sind. He returned to the Jhelum District and to Rawalpindi, but was soon sent to Leh in the Upper Indus Valley on an economic mission which resulted in his *HANDBOOK OF THE TRADE PRODUCTS OF LEH* (1874); then he had a short time in Hazara. These many charges with their considerable experience ended now in a permanent dedication to the eastern and south-eastern margins of Afghanistan. The collections that he made then were worked up at Kew, conjointly with Dr. W. B. Hemsley, into a valuable report.

In the year 1876 Quetta became the centre of civil administration, There was a collecting of plants also by two medical officers, **Oliver T. Duke** and **H. Hamilton**, who sent what they collected to the Calcutta Garden. Duke collected as far south as Kalat. In 1877 Colonel **J. W. Johnstone** collected a little at Kandahar and Kalat-i-Gilzai. By 1884 it had become possible to put the fuel and timber supplies under control; and **John Henry Lace** was appointed Deputy Conservator. He made considerable collections in the area under him until 1888, and an account of them was published for him by the Linnean Society. In 1888 Sir Robert Sandeman had straightened out the affairs of the area of the Zhob river, east and north-east of Quetta, and Duthie, who had paid a visit to Quetta, was able to send his collector Harsukh into that part of

Baluchistan. In 1896 there was another Boundary Delimitation Commission on which Surgeon-Captain **Frederick P. Maynard** collected along the border west of Quetta. He in conjunction with David Prain reported on the collection. Maynard's work had extended towards Persia. After 1900 Baluchistan in general was collected over by Mr. R. **Hughes-Buller** and Rai Bahadur Diwan **Jamiat Rai**, and their results were incorporated by the writer into an enumeration of the Baluchistan flora published as a supplement to the Baluchistan Gazetteer. The southern Afghan flora appeared now to be fairly well-known; to the names of collectors of it are to be added those of two more army officers, **Henry Appleton** and **Edwin Pierce**.

8. ASCERTAINING WHAT THE HIMALAYA SHUTS OUT FROM INDIA

The abruptness of the Himalaya brings the flora of the upper or gritty Tibetan plateau to a position against the real Himalayan flora; but in Kashmir the long range of snowy peaks on the north of the Vale has been interjected and is like a parting fence. It is interesting historically that botanical investigation should have found so much favour behind the fence.

The reader will recall that in 1812 the Government's veterinary officer, **William Moorcroft** made a dash through the Himalaya of Kumaon to procure shawl-wool goats (see p. 869 of chapter I). In 1819 he endeavoured to reach Turkestan that he might procure horses. On this occasion he was not on an expedition with a directing official but, on his own responsibility and for rather obscure reasons, he began by proceeding through Kulu to the Upper Indus, where he lingered. A little bundle of dried plants sent to the Calcutta Garden was the result of the lingering—plants which would seem to have been to Moorcroft curios. Among them was *Gentiana moorcroftiana* from Dras, which village he would pass through when in 1822 he left the Upper Indus to reappear in the Vale of Kashmir. The date was 10 years before **Jacquemont** botanized in the Vale; it was the year of the building of the first permanent house at Simla and two years before the Garden at Saharanpur was reconstructed. Only when those 10 years were over was further botanising to be done. Jacquemont did not penetrate as deeply; he entered the Vale via Punch and Baramula, collected through the summer, and left by Jammu when the winter came. **Godfrey Vigne** obtained entry into Kashmir in 1834. He was a leisured traveller who claimed to carry a plant press on his journeys, but probably used it only on a few occasions. He had entered the Vale by Jammu and thence crossed the Snowy range to the Upper Indus; he was in Srinagar again in 1835 where he met **von Hügel** who likewise had reached the Vale by Jammu. The two left together by Baramula and Hazara, after a little exploration

near Srinagar undertaken while von Hügel was packing and sending to Bombay collections which would seem to have held little botanical. Vigne went back to Kashmir and again into the rift of the Upper Indus, and there he met Falconer who had entered the Vale from Hazara (1836), had wintered there, and had taken the road northwards through Tragbol. Falconer, as one knows, collected in that year diligently; and Vigne, then or afterwards collected in Astor. Falconer's plants would represent the first serious botanizing in the Rift of the Upper Indus; they were fated to be kept for working out until Falconer could take them to London and after that to lie in the store of the India House until 1865 when Sir Joseph Hooker succeeded in getting them out, somewhat the worse for the passing of time. Vigne's plants were taken to Royle in England, the worse for not having been well collected or from rough handling.

Simla was becoming an attractive base from which to go into the Himalaya to its north. Edgeworth did so, collecting in Kulu and Chamba; his friends Lance went to Ladak and Lord William Hay went to Lahoul.

James Edward Winterbottom visited Kashmir at the time when Thomas Thomson was there. It was a short visit and not quite along the Rift; but to Astor where the upper Indus wriggles out of its confinement.

A few words may be said here regarding the juxtaposition of the exit of the Indus to the peaks of Nanga Purbat. It has been pointed out that such juxtaposition is to be expected for the supply of snow which the peaks secure, and therefore the supply of water to be run off, intensifies the grinding power of the streams it feeds. It is therefore not to be thought that the appearance which the Indus has of cutting the corner comes from some remote period of greater volume in the river above the corner, but can be explained without supposing that. There are three kinds of plants among these peaks: the melt-water species whose vegetative season climbs the hill-side behind the thaw of the winter snow, the short-lived annuals which are followers of man, and the xerophytes. The earlier collectors scarcely appreciated this; but Thomson did point out what melt-water meant in the maintenance of flowering plants on stream sides.

Thomson went north from Leh to the Shyok Valley and the Nubra Valley, reaching the passes of the Karakoram. He was followed (1854) into these desolate regions by the brothers Schlagintweit. These three brothers, Hermann, Adolph, and Robert, were financed by the King of Prussia and their occupation was chiefly physical geography; but they collected plants also, though their collections not being in the first line only very tardily received attention in Europe. Adolph was seized and killed by a rascal in rebellion at Kashgar. The other two worked on until 1858, their area of work the upper parts of the rivers of the

Punjab, the Tibetan plateau to Gartok, and the Karakoram. The next interest in the area came after an interval of 10 years. The Chinese had lost their overlordship of Kashgaria and their traders had been driven away. This produced a great shortage of such things as tea which had been coming to these parts from China. But it could also come from the new industry of the lower Himalaya by caravans trading from Kashgar to the Punjab in increasing numbers. For their convenience a market had been established at Palanpur, north of Amritsar. Contact with these traders caused a Kangra tea planter, **R. B. Shaw**, to adventure back with some of them to Yarkand. A request for official contact followed. Two embassies were sent, the first in 1870, the second in 1874, both under Sir Douglas Forsyth. Each embassy had a Surgeon-naturalist and the second had other scientific officers. The embassies went through the Vale of Kashmir, over the Zozi pass, up the Indus to Leh, and then over the Karakoram, varying the way a little after reaching the Tibetan plateau. As surgeon-naturalist on the first was **George Henderson** (1836-1929); we hear of him later as acting Superintendent of the Calcutta Garden. As surgeon-naturalist on the second was **Henry Walter Bellew** (? -1892) who had seen service on several political missions around the eastern frontiers of India. **Ferdinand Stoliczka**, the geologist, who reached India in 1862 and died in 1874, was on the second; he was taken ill in Tibet, and he died two marches short of Leh, to the great loss of Geology, for he had made himself an authority on the structure of the Himalaya. While attached to the mission he had made several side trips as for instance to Wakhan. The missions were so timed that, by crossing Kashmir when the passes were free, they left Tibet soon after the entry of spring—too early for a part of the flowers. The reader understands that the stationing of Aitchison at Leh, summer and winter, in 1874 was connected with the consent to send these missions. After all, the tea which Kangra produced was not liked in Kashgar and the trade in Chinese tea slowly came back. Bellew was observant enough to comment on the change in the vegetation at the Zozi pass; already he knew the flora of the Vale from previous residence in it. The Vale had become a popular hot weather resort and now and then among the visitors would be someone who found an interest in the plants. Such was **W. S. Atkinson**, the entomologist, who collected at various places round the Vale shortly before his death in 1878 or 1879.

C. B. Clarke's longest collecting trip was through Kashmir in 1876. He had entered the mountains in 1874 from Kangra, 2 years earlier, going forward to Dalhousie; but the journey of 1876 was much longer. Entering Kashmir at its eastern end he travelled through the Vale, then took the Tragbol route by Astor to the Upper Indus, across the Indus he visited Askole and then the Karakoram. From these journeys he took to Britain in the next year vast collections.

Forsyth's two Yarkand Missions were preludes to collecting in Tibet with Leh a centre from which the explorers set out or to which they came on returning. In June 1890 Captain **N. H. P. Deasy** and **Arnold Pike** crossing the Lanak pass went over the gravel plateau as far eastwards as the Choral Cho, which lake is roughly north of the Manasarovar lakes, and returned. In 1891 Captain (later Major-General Sir) **Hamilton Bower** and Surgeon Captain **W. G. Thorold** crossed Tibet from the Lanak pass eastwards well to the north of Lhasa and so into China, descending into the lower plateau at the position where the Brahmaputra leaves Tibet. In 1895 Sir **Martin Conway** explored the Karakoram defiles north of the Lanak pass. In October of the same year Mr. and Mrs. **St. George Littledale**, who had crossed the Thian Shan in February of that year, completed the arduous part of their journey at Leh. In 1896 Captain **M. S. Welby** and Lieutenant **Neill Malcolm** left Leh on a route parallel to that of Deasy and Pike, crossed the whole upper plateau, and descended on to the lower plateau, where there was a carpet 'everywhere of good grass, flowers and wild onions, rhubarb and game', in the month of August. These expeditions and the plants that were collected on them are very fully discussed by Hemsley in a paper published by the Linnean Society in 1902 (*Journal* 35, pp. 120) to which the reader is referred. What I wish to do here is to take these statements from Dr. Hemsley's paper: Above 16,000 feet 282 flowering plants and one fern are reported to grow, of which 53 belong to the Compositae, 30 to the Gramineae, 23 to the Cruciferae, 19 to the Ranunculaceae, 18 to the Leguminosae, 11 to the Caryophyllaceae, and 10 to each of these—the Crassulaceae, Gentianaceae, and Labiatae, also 9 to Polygonaceae, and 8 to the Cyperaceae. Bulbous species are few in number but as there is a part of eastern Tibet where *Allium* is so common that the country is called 'the onion country', there seems nothing against the bulb as a way of survival.

Hemsley, having called attention to the Compositae being present in more species than any other family, showed that this is so for the floras of the Karakoram, of Gilgit, and of the Yatung in the back of the eastern Himalaya.

While the adventurous explorers, who have been named, were exploring Tibet, certain botanists were paying attention to the flora where the Indus bends southwards. Collections made in Baltistan by Captain **Hunter Weston** and by Dr. **A. Neve** (1895) reached Kew in 1890 and 1898 respectively; and the first named was in touch with Duthie in Saharanpur. Gilgit to this time had attracted other collectors; **C. B. Clarke** visited the Gilgit Valley in the very long tour that he made in 1876. Colonel **H. C. B. Tanner** did so in 1880; Dr. **G. M. J. Giles** went there for a long stay in 1886; **J. F. Duthie** paid a visit in 1892, and so did Professor **Paulus Johannes Brühl** of the Shibpur Civil Engineering

College. Colonel Tanner's and Dr. Giles's collections were large, and the latter who was able to make excursions beyond the Gilgit Valley had reached Wakhan. In 1895 there was an expedition to meet the Russians in the Pamirs, on which Captain **Alfred William Alcock** went as surgeon-naturalist.

Though the phyto-geography of the western end of the Himalaya needs much study yet, it is convenient to recognize as the Trans-Indus Himalaya an approximately rectangular block with the Indus on the east, the Kabul river on the south, and Russian Turkestan completing the other two sides. Chitral is towards the back of this rectangle. In the last years of my period the rectangle had needed military occupation along with parts of the mountains of Afghanistan, and it is interesting to record to what a large measure officers whose duty kept them in these wild mountains found the collecting of plants a relief from the tedium of their watch and ward. The names of the following can be found on herbarium sheets of these years :

Field Marshals **Lord Roberts** and **Sir Arthur A. Barrett**, **Sir Francis Younghusband**, **Sir Henry Collett**, and **Sir William Gatacre**, Colonels **Henry Halcro Johnston**, **Davidson**, **Mainwaring**, **H. H. Rich**, and **Wingate**, Captains **Hare**, **Harriss**, **Marsh**, **Milne**, **Pirie**, **Skey**, and **Wright**, and Lieutenant **Sidney Miles Toppin**.

Six of these, **Sir William Gatacre**, Colonels **Rich** and **H. Johnston**, Captains **Harriss** and **Wright**, and Lieutenant **Toppin**, collected also on other occasions, and Colonel **Johnston** (1856-1930) possessed a herbarium of his own which, after his death, was given to the Garden in Edinburgh.

The Afghan flora laps round the end of the inner north-west Himalayan flora and then appears to have its own end tucked into it. But there is a great deal of disentangling to do towards sorting out the components of the vegetation. Duthie's collector **Inayat** by visits to the district of Hazara made extensive collections there. **James Ramsay Drummond** (1851-1921) collected largely in the submontane districts and gave his collections to Kew.

The following comment may be made here. The geologists have shown that there have been descents in the mountains of glaciers to 4000 feet below present altitudes and therefore periods of increased cold ; and **G. S. Puri** has discovered plant impressions in Kashmir of living species which at one time grew at greater elevations than they now do. Thus we have in considering distribution evidence of changes of the climate in both directions. Perhaps a few northern species were enabled to reach the Deccan by the lowering across the plains.

9. THE FLORAS OF FURTHER INDIA AND THE WAY IN WHICH A KNOWLEDGE OF THEM GREW

In the last three sections we have seen the way in which knowledge grew of a Persian flora that extended into India, a flora characterizing Afghanistan, and of the flora of the upper or gritty plateau of Tibet. It is time to do the same for the opposite or Assam corner.

India proper is rather symmetrical in the way it spreads as an isosceles triangle with the long angle pointing south, almost reaching the equator, and with the Himalaya from west to east in the north. Warm seas make the southern complete boundary ; frosty and very high mountains make the less incisive but yet incisive northern boundary ; and there can be a great range in climate on the score of temperature, which is mixed with room for a like range in humidity. Under the Himalaya at either corner the isolation of India is modified by continuous land, a consociation of lowland and mountain which has allowed plant migration through it to a degree which must interest a phyto-geographer. The passage way towards the west is half as wide again as the passage way towards the east, the addition of width being towards the north. Favoured by the width, passage towards the west would seem to have been more penetrable during climatic change than the passage towards the east, but climate rules.

Of the two floras which today plug the passage towards the west, the Afghan flora is montane and the Persian lowland ; but in the passage towards the east there is less difference due to elevation. Exactly what this amounts to is a matter for future work ; and therefore let us assess the incompleteness of our knowledge of the botany from the eastern Himalayas to the isthmus of Kra.

The first botanical specimens which reached any scientific destination were sent from Siriam in the delta of the Irrawaddy by **Edward Bulkley** to the East India Company in London. Siriam faces the site on which Rangoon was to be built some 50 years later. And after that a century passed before there was a fresh and better opening. Then (1793) **Francis Buchanan**, newly arrived in India, was attached to Captain Michael Symes's mission to the Burmese court at Ava. He collected in the Irrawaddy delta in the hot weather and ascended the river in the rains, returning in the cold weather.

After that he was stationed on medical service at Noakhali and gradually worked out his collections in correspondence with Roxburgh. From Noakhali he had a brief deputation to Chittagong and then a move to Baruiipur, which to his satisfaction brought him within a day's journey of the books of the Calcutta Garden. In 1809 the missionary **Felix Carey** sent to the Garden dried plants 'from the neighbourhood of

Rangoon. In 1826 Wallich made the journey that Buchanan had made 22 years earlier ; he did yet more, for after descending the Irrawaddy he went to Moulmein and up the Salween as far as the East India Company's authority ran, and up the Ataran river to its teak forests. A very few years later the missionary **Francis Mason** arrived and was at first at Tavoy, then at Moulmein. There was in him that thirst for knowledge that characterized and drove forward the Serampore missionary Carey. Next **Griffith** arrived ; stationed at Mergui, Moulmein was within reach and he actually was there, for according to Griffith his collections ran to 400 species. A year after Griffith had been called away to join the Assam Delegation, **Helfer** and his wife arrived—energetic and diligent collectors. Helfer went to the Andaman Islands and lost his life in an attack on his party by a band of Andamanese (1840). His wife apparently returned to Bohemia. (See Kerr in *Journ. Thail. Res. Soc., Nat. Hist. Suppl.*, 12 p. 9.) In 1849 **Falconer** was sent to Moulmein to report on the teak forests. In 1857 **McClelland** was sent to Pegu to take charge of the forests ; and these in 1856 passed into the charge of Sir **Dietrich Brandis**, who in 1857 was also given charge of the Moulmein forests. About four years earlier **Charles Samuel Pollock Parish** had been appointed chaplain at Moulmein and he remained there until 1878, collecting and sending dried plants to Kew.

Before this activity, Griffith had made (1838) his journey down the Irrawaddy. The colony at Rangoon had been growing, looking after its own affairs and reached the state of maintaining a horticultural establishment.

Chittagong as to its flora is Burmese. Mention has been made of Buchanan's visit of a month's duration in 1798. Roxburgh had arranged also the visits of his sons William and John as he well knew the interest of the plants there. Later Wallich sent his collector, Henry Bruce, to Chittagong. But none of these contrived to explore in the interior. However a door was found further north and in this again water-carriage had a great influence — the way by water from the mart of Bengal into Sylhet was so convenient and useful. Along it the first botanical exploitation was made ; and we find in Roxburgh's day the magistrate **M. R. Smith** residing at Pundua (16 miles from Sylhet village) to which the hillmen would come to barter. It is evident that his dealings with the hillmen extended to getting plants for his own garden, some of which he would send as gifts to Roxburgh. He died in 1819. To Pundua Wallich sent a collector, **Francis de Sylva**, who living on a boat could carry on collecting in a most convenient way. In 1826, the missionary teacher of Serampore, Professor **John Mack** (see Chapter II, Vol. 54, p. 45) visited the stations of the mission to the Khasis, presumably via Pundua, and he and his wife prepared a collection of dried plants which was a beginning. Sir Alexander Mackenzie records that 1826 was the year of the first poli-

tical approach to the Khasis. **David Scott**, who has been mentioned as sending a scrap of a *Camellia* to Wallich in 1826 enquiring if he had in it the tea plant, was at the time the Governor-General's Agent on the north-eastern frontier, and in 1829 he suggested to the hillmen the convenience of a bridle-path down from the neighbourhood of Cherrapunji and at the further end down to Gauhati. Scott constructed for himself a house at Cherrapunji and the path was made. With the trouble that followed its completion we are not concerned, save to mention that the police officer Captain **Lister**, who had the business of restoring order, later did a little plant collecting. Scott died in 1832 and after a short break **Francis Jenkins** succeeded him (1834) operating from Gauhati. He was there when at the end of that year Wallich received through him a twig and admitted it to be the tea plant, an admission that caused the Assam Delegation to be planned, Jenkins taking a leading part. Of the alternative ways of reaching Gauhati, the river for the whole way or the river to Sylhet and David Scott's path through the Khasia Hills, the former wasted an opportunity of seeking the tea bush in accessible parts, and so Jenkins would have the Delegation cross the Hills; from Gauhati there was no alternative but the river. Perhaps Wallich would have preferred to use the river all the way; Griffith certainly did not. And so the plateau received its first visit from a professional botanist. Griffith was destined to cross the plateau again and able slightly to vary his route. **Masters** must have used the road, for he travelled not a little when in charge of half the Company's patches of tea and he certainly collected as far away as Sadiya and in a journey into the country of the Angami Nagas. Griffith kept a paid collector in the Khasia Hills.

In 1851 **Hooker** and **Thomas Thomson** spent the months from May to November collecting in the Khasia Hills with great vigour and, when they left, Falconer had collectors there; the Kew Collector **Richard Oldham** made a short visit in 1861, the geologist **Thomas Oldham**, the zoologist **H. H. Godwin-Austen**, and the physician Sir **Joseph Fayrer** as occasion offered would collect. **C. B. Clarke** was appointed Inspector of Schools, Assam, in 1883 and that connected him with Shillong until his retirement in 1887. Sir **George Watt** visited the Hills at the beginning of Clarke's years in Assam. The hills then and continuously afterwards served as a base for botany deeper in the Province. The tea industry brought fresh workers into it. Wild tea had been found in Cachar in 1855 and planting followed. Among the early planters was **Richard L. Keenan** who left Kew, where he had been training, in 1867, to become a tea-planter, and carrying with him his interest in Botany sent a consignment of dried plants to Kew in 1874. There is a reported abundance of wild tea on the Manipur-Burma boundary, where Watt later collected, but the difficulty of communications beyond Cachar arrested planting towards it. Few tea planters collected in the Brahmaputra Valley. One who did

was S. E. Peal of Sibsagar. Further collecting was a little here and a little there, but nothing consecutive. Early in the time when any collecting was possible Griffith had gone some 80 miles into Bhutan on Pemberton's mission—the season : late rains to the return of the rains—when he collected nearly 1600 numbers. On his short journey among the Mishmis in mid-October he collected nearly 1200 numbers. Smaller collections resulted from Booth's journey for rhododendron plants into the mountains just beyond Bhutan, ascending to 7000 ft. ; Colonel Lister's gathering from the edge of the mountains when occupied in a bloodless blockade of the Daphlas of the Dukrung Valley ; a little material from the zoologist Godwin-Austen, Griffith's collection from the more eastern Naga country ; Collett's visit to Kohima in 1891 ; Prain's collections a year in the hills of the Angami Nagas ; J. Rollo's collecting of Bamboos, and the Calcutta Garden's collecting from the trace of the railway through the hills ; Griffith's rains and cold weather collecting about Sadiya and George Gammie's collecting there in 1894.

The collectors of plants for growing : Thomas Lobb was hunting for them on the Khasia Hills when Hooker was collecting. Booth soon afterwards came to hunt for handsome rhododendrons on the other side of the Brahmaputra Valley. Others followed.

10. SIR JOSEPH HOOKER EXPOSES IN A NEW WAY SOME OF THE PHYTO-GEOGRAPHIC PAST OF INDIA

When the FLORA OF BRITISH INDIA was done Sir Joseph Hooker was asked if he would prepare a review for the IMPERIAL GAZETTEER then in preparation, and he consented. No one living could have done it better than he. He recognized and admitted that what he had written in 1855, conjointly with Thomson, was now quite out-of-date. The two of them had then suggested 64 areas each characterized floristically, and these they had called 'provinces' ; Hooker makes it quite clear in the new *Sketch* that he put them aside though suggestive. He now made a different approach ; he reduced the number of 'provinces' to 9, as parts of three divisions of political India which he calls regions.

At the time when Hooker was commencing to write his *Sketch*, C. B. Clarke had prepared a paper on the geographic dispersal of the Cyperaceae in British India, and had read it to the Linnean Society as his presidential address (1898). His approach was through an Indo-Chinese area cut out of Asia, of which British India became a sub-area ; and the sub-area he divided into 11 sub-sub-areas. They had a close

resemblance to Hooker's 9 provinces as the adjoining table shows :

HOOKER'S PROVINCES		CLARKE'S SUB-SUB-AREAS	
Himalayan Region	Eastern Himalaya	Eastern Himalaya	} British Indian Sub-area of Indo-Chinese Area of Asia
	Western Himalaya	Western Himalaya	
Western Region of India	Indus plains	India deserta	
	Gangetic plains	Gangetic plains	
	Malabar	Malabar	
	Deccan	Coromandel	
Eastern Region of India	Ceylon	Ceylon	
	Burma	Assam	
		Ava	
	Malaya	Pegu	
		Malay Peninsula	

Differences not obvious on the Table need not be detailed here : Hooker and Clarke had discussed them. Clarke excluded from his paper any botanic defining of areas and sub-areas, as being to his purpose no more than links with Geography.

The agreement between Hooker and Clarke is important as far as it means that both of them regarded sub-sub-areas as having dimensions appropriate for discussion, Hooker judging by the whole vegetation, Clarke by the family Cyperaceae which he had recently worked up for Hooker's FLORA. They may assuredly be accepted. Clarke's nomenclature is better than Hooker's in avoiding the word 'province', which word from its very origin has belonged to political geography. But the term 'region' is as elastic as 'area' and is without political implications ; there is no objection to recognizing 'regions', 'sub-regions', and 'sub-sub-regions' as in the following pages, should 'region' suit the context better than 'area'. The two authors diverge widely in dividing or not dividing Hooker's Eastern Region and in the ways of dividing the Peninsula of India.

Hooker put an enormous amount of work into the collection of the data that he used. He would have liked a large number of plant-lists and had to compile many for his purpose. Having provided himself with lists, he scored them by the ten families with most species proved present.

A few pages back I have had cause to quote Hemsley on the flora of the upper Tibetan plateau in which Compositae come first and the families follow it in this order : Gramineae, Cruciferae, Ranunculaceae, Leguminosae, Caryophyllaceae, Crassulaceae, Gentianaceae, Labiatae, and Polygonaceae. Hooker's first 10 in all cases differ from the sequence of

high altitudes in Tibet. I do not wish to quote all ; but I wish to indicate what a striking result can be reached, and in the following table quote eight lists :

	Ceylon, as a whole	Western Peninsula	Gangetic Plains	Indus Plains	W. Himalaya	E. Himalaya	Burma	Malaya of Hooker
Acanthaceae	7	3	7	..	..	..	6	..
Annonaceae	..	..	..	..	..	..	..	5
Asclepiadaceae	..	10	..	..	..	..	..	..
Boraginaceae	..	..	..	7	..	..	..	..
Compositae	8	8	4	5	2	4	9	..
Convolvulaceae	..	..	9	10	..	..	..	..
Cruciferae	..	..	..	..	8	..	..	..
Cyperaceae	4	5	3	4	4	5	7	9
Euphorbiaceae	6	6	8	9	..	10	5	3
Gramineae	1	1	1	1	1	2	3	6
Labiatae	..	9	..	6	5	..	..	..
Leguminosae	2	2	2	2	3	3	2	2
Malvaceae	..	..	6	6	..	..	..	..
Melastomaceae	10	..	..	..	..	..	..	8
Orchidaceae	3	4	..	..	7	1	1	1
Ranunculaceae	..	..	..	..	6	..	..	..
Rosaceae	..	..	..	..	9	8	..	..
Rubiaceae	5	7	..	..	..	9	4	4
Scitamineae	..	..	..	..	..	..	10	7
Scrophulariaceae	..	..	5	5	10	7	..	..
Urticaceae	9	..	10	..	..	6	8	10

The 8 columns carry the names of 21 families of flowering plants : of them 3, being Gramineae, Cyperaceae, and Leguminosae, occur in all the columns ; Compositae and Euphorbiaceae in 9 ; Orchidaceae and Rubiaceae in 8. I have arranged the columns to show that the families

in which turf-making herbs abound are on the left and those in which epiphytes abound are on the right. In brief the table exposes the fact that the turf-herbs belong to the west side of India and the epiphytes to the east side. Why?—climatic. Hooker was endeavouring to read back from present dispersal into geological time. Furthermore he had called attention to the existence of a Cupuliferous boundary line which runs along the base of the western Himalaya and at Bhutan turns south to the Bay of Bengal; and now his new figures suggest another line, say from southern Gujarat to the Nepal Himalaya sagging southward in the centre—a line that under increasing dryness might sag right to the south of India, restricting without driving out the flora which Hooker calls 'Malayan', or putting an end to the evolution of the seasonal Podostemaceae of the Western Ghats.

If that line at one time sagged enough on the map for this—and the patanas of Ceylon suggest that it did—it has retreated as well as advanced. The line anyhow is something that must be considered in discussions on that drying of India which certain other features demonstrate.

Hooker published further decads which do not illustrate climatic change at all, usually because the collections had not been spread over the whole year. If two lists be prepared and compared, one from Griffith's intense collecting when he spent 24 months in the Afghan area and the other from list of Aitchison's Kurram Valley collection, the first has the Acanthaceae in the sixth place and the second has Scrophulariaceae in the fifth place, neither getting into the decad of the other. And in regard to this the reader needs to be told that military exigences kept Aitchison out of his area in the spring, causing the periods to disagree. If Hooker's method is to be used, the periods and area must agree. The use of Hooker's device is most certainly recommendable but with considerable caution.

There is another confusion possible. It is obvious that genera such as *Impatiens*, *Pedicularis*, and showplant *Rhododendron* must greatly disturb the sequences in some areas. In their case evolution seems recently explosive so that their species have not the specific value safe to associate with evolution.

Clarke postulated a land-bridge from the Malay islands to Ceylon to account for the presence in both areas of certain sedges; he did not bring to notice the alternative of a route round the Bay of Bengal.

I would that the reader should realize the tremendous but complicated interest of Hooker's line of investigation.

The *Sketch* was put into print in 1903 for the convenience of obtaining criticism; then in 1907 it was published in the appropriate volume of the IMPERIAL GAZETTEER.

In 1903 Sir David Prain's BENGAL PLANTS appeared. He applied a terminology of his own to geographic areas in relation to Bengal. He

accepted *India deserta* for the dry north-west, *India diluvia* for the Gangetic plains, *India aquosa* for the western coastal strip which the south-west monsoon soaks, *India vera* for the plateau east of it, *India subaquosa* for Coromandel which the dying monsoon saturates, and *India littorea* for the great Ganges delta and the lesser deltas of India's outline. Prain's terminology is climatic saving the last name. Professor Troup later gave another set of names which, though their date is 1921, I mention here lest they be overlooked.

Robert Scott Troup (1874-1939) entered the Indian Forest Service in 1897 and had had 9 years of experience in the best teak forests of Burma when (1905) he was transferred to the forest central station at Dehra Dun.

The Forest Service as far back as 1872 had taken to Dehra Dun their survey work. Already three years earlier Brandis had pointed out that the Service would need to teach at least its Forest Rangers and, when teaching began, the experiment was tried of giving it to apprentices sent to the Engineering College. Schlich, who had suggested this, was soon to come into contact with the result and found himself constrained to report that the new Forest Rangers back from the Roorkee College had acquired there much useful knowledge, but not in Botany. The upshot was that teaching was established by the side of the Forest Survey work and a large area of forest attached to the School, where, as recorded, J. F. Duthie would teach the young men to know their trees.

The Forest Service was irregular, experimenting with its working plans until 1880; then by way of improving work their preparation began to be regularized; and the process led to specialization ending in transfer of the final and decisive stages to Dehra Dun. The next step was the setting up of a department for Research, and Troup, though he was not at first in charge of working plans, soon found his day to day work in them. The Forest Service had collected large quantities of data. Troup with these wrote his excellent *SILVICULTURE OF INDIAN TREES*. He had commenced it in 1916; he was called to Oxford in 1920 to the post of Professor of Forestry; and the three volumes were published in the next year. The date of course is far beyond the end of my period, but to proceed without a reference would suggest that the work of Hooker, C. B. Clarke, and Prain had a sort of finality.

Troup's phyto-geography, founded only on the growth of forest trees—there are a little over 700 referred to or dealt with in great detail, led to suggesting these 'regions':

(i) Western Himalaya; (ii) Eastern Himalaya; (iii) The Trans-Indus; (iv) the North-Eastern Dry Region; (v) the Gangetic Plain; (vi) the West Coast Region; (vii) the Central Indian Region; (viii) the Deccan along with the Carnatic; (ix) Assam; (x) Burma; and (xi) the Andaman Islands. Like the sub-regions or sub-sub-areas there is as much

definition in them from geography as from botany, or perhaps even more.

It is desirable that the nomenclature should come under criticism, and that botanists now in India should shape it, and that they co-operate with the climatologists for they have put forward classifications of India's surface that, differing in detail, should not be neglected. They suggest improvements : for instance, they take note of the equatorial air-regime by which there is rain twice in the year as the sun is twice at its remotest from the equator. Of this the phyto-geographers up to 1900 have taken no notice, although Ceylon and Kerala show its effects ; phyto-geographers, furthermore, before 1900 had not thought it proper to divide Ceylon into its dry and humid parts. Other improvements originating with them are recognition of a sub-Himalayan belt on the north-west of India, and a closer union between the Santal Hills and the Gangetic deltaic plains than had been conceded.

11. PLANNING IN CEYLON

John Christopher Willis (1869-1958) succeeded Trimen as Director of the Peradeniya Garden in 1896. Trimen, who had become a very sick man, was endeavouring in spite of his difficulties to complete his *HANDBOOK OF THE FLOWERING PLANTS OF CEYLON* ; and Hooker, his own *FLORA OF BRITISH INDIA* completed, had promised to see Trimen's *HANDBOOK* out. The situation suggested the end of a chapter to any involved in it, and of course particularly to the new Director with whom lay planning for the future. The Government of the island accepted his views.

The taxonomic work of the Garden was to be intensified as to the lower plants, and particularly towards the fungi for economic reasons : the disaster of the coffee-leaf disease impressed that. Further, for the security of existing crops provision for the entertainment of an entomologist was made ; and for miscellaneous enquiries needing the attention of a biologist the entertainment of one who acted as an assistant to the Director and, as the occasions for requiring his research could not be predicted, was to be as it were on post-graduate research within a period of three years.

The three, a mycologist who was to be at the same time Assistant Director, the entomologist, and the post-graduate engaged on research were laboratory workers whose results depended on development of buildings in the Peradeniya Garden.

I have called my reader's attention to the creation of a high level plantation in 1860 when the introduction of *Cinchona* was contemplated. This, the Hakgala Garden, preserved also a sample of the vegetation characteristic of its zone on the mountains. In 1876 another plantation was required, a hot humid one for the accommodation of the rubber

tree, *Hevea brasiliensis*, from the Amazon ; this, the Heneratgoda Plantation, also held a sample of the local jungle. Naturally these were used for lesser experiments—the way plants unsuited for Peradeniya would behave in the climates of these plantations. They are called gardens officially, and botanical work was theirs in this geographic way. About 1880 the whole of Peradeniya was landscape-gardened. In 1886 another plantation was established, that of Badulla, hot and relatively dry, with a dry season between July and September instead of that between January and March of the Colombo side of the island. Yet another plantation was made, that in the dry north at Anahadrapura.

This useful dispersal of trial grounds was to be somewhat increased. There was a small school of Agriculture in Colombo and proposals came forward to close it in favour of something more ambitious on the Gangaruwa estate alongside Peradeniya. The estate had been owned by the Governor Barnes who, having opened the way for the coffee-planters into the hills by making the Colombo-Kandy road, had grown coffee, indigo, and sugar-cane on his estate. It was now to hold demonstration plots, and agricultural practice regarding them was to be taught by the officers of the Garden staff. The illiterate peasant, it was hoped, would learn new ways through those who had learned them at Gangaruwa. Meanwhile he was to learn through school gardens and then a teacher using a vernacular language of the island was chosen as a demonstrator for the schools.

There was a planters' magazine in the island ; this, taken over and entrusted to Willis as editor, sufficed along with Circulars to keep the literate in touch with the progress of the Gardens. As an outlet for the Gardens for scientific research, Willis arranged for the publication of a journal in pure science—the *Annals of the Royal Botanic Gardens, Peradeniya* ; and the first part appeared in June, 1901. In it he gave an account of his planning to that date. When later the duty of education was entrusted to him, he began to call his charge a department of Agriculture. Then someone else planned, seeking to place Agriculture over Botany ; this came after Willis's department had been growing for a decade and so was outside my period but I have to refer to the way in which it broke up Willis's planning, leading him to retire.

The speed of a convoy is that of the slowest unit in it ; the slowest speed of Willis's convoy was that of the unit of the peasant's education.

Ceylon is on one of the busiest of ships' highways and for some time before Willis's appointment botanists of various nations had, as it were, looked in if they had the opportunity. Some of them were on their way to the Netherlands Indies to undertake research, and the Dutch provided facilities for their work. Willis, taking a lead from this, planned to do the same at Peradeniya. He wrote : ' it would be difficult to exaggerate the

value of travel in other countries to the working botanist, especially if his work lie in the departments of systematic botany, geographical distribution, ecology, morphology or economic botany, whilst to the physiological or anatomical worker there are also innumerable problems which can only be solved by research in tropical countries.' He sought to make it easy for students new from British centres of teaching, and their teachers too, to visit Ceylon as others were visiting Java, to learn how the plant lives in the tropics—a knowledge which really is essential—and got sanction for an extension of his laboratory facilities to make work easy. It had been necessary to create working room for Marshall Ward when the coffee-leaf disease needed investigation; Willis would have the working room ready in advance. But visitors from Britain had come without waiting, some with grants for travel.

Willis assembled his staff. But on the horticultural side the two chief men were already there—(i) **William Nock** who had been acting Director from the date of Trimen's retirement and who on Willis's arrival went back to his substantive post at Hakgala, and (ii) **Hugh Fraser Macmillan** who had been sent out from Kew in 1895. H. F. Macmillan (1869-1948) took charge of the horticulture of Peradeniya when Nock went back to Hakgala. From that year until 1912 he held this position; but in 1912 with the passing of Peradeniya under a Director of Agriculture he was given charge of all the Department's horticulture and had the title of Superintendent of Gardens. His 30 years in Ceylon enabled him to write his *TROPICAL GARDENING* (1912). **John Parkin** had arrived in Ceylon by an understanding with Trimen; and to him was given the new three-year post of Assistant to Director. A disease of Cacao had alarmed the planters of that crop and they had invited **John Bennett Carruthers** (1869-1910) in 1891 to Ceylon to seek for remedies. The Government accepted him as their Mycologist, coupling with that post the post of Assistant Director of the Garden. **Ernest E. Green** was in the island investigating insects, chiefly pests, and was attached to the staff. The research work of these three was such as would be done in a laboratory, and so was also the work that the Director expected to do apart from administrative duties; and so Willis planned to facilitate the research of visitors by providing laboratory accommodation for them too. Willis went on to get chemists attached to the Garden. The plans for the education in agriculture took time to shape and, except that the Garden's officers were to teach, could have been separate.

Parkin joined the Director for work on the bleeding of rubber trees and joined Pearson in research on the plants of the patanas. At the end of his period he gave place in 1900 to **Herbert Wright** (1874-1940, knighted in 1930) whose future economic interests were shaped in Ceylon, partly as the Assistant to Willis and then as Controller of the Peradeniya Experimental Station (1904-1907).

Carruthers left Ceylon for Malaya in 1905, T. Petch succeeding him as Mycologist and remaining until 1906. So far the intensification of the taxonomic work of the Garden towards the fungi has had a favourable development.

Willis entertained no doubt as to the nature of the department entrusted to him ; it was to be brought into line with such departments as that of the Dutch in Java and reflect the thought of lively European universities as far as possible. The island could teach many lessons in the way that tropical life moves.

Here is a list of eminent botanists whose visits proved this awareness :

Karl I. E. Goebel, Assistant Professor at Strasburg, visited Ceylon in 1886 ; Michael C. Potter, when teaching in Cambridge, in 1888 ; Wilhelm O. A. Tschirch, a professor of Berlin, in 1888 ; John Bretland Farmer from London in 1891 ; Frederick W. Keeble, a post-graduate student of Cambridge in 1893 ; Carl Holtermann from Berlin in 1895 ; Hans Molisch, a professor from Prague, in 1897 ; Henry H. W. Pearson, a post-graduate student of Cambridge, in 1899 ; J. Stanley Gardener also from Cambridge in 1899 ; Andreas F. W. Schimper from Basel in 1899 ; K. Giesenhagen from Marburg in 1899 ; Arthur George Tansley and Felix E. Fritsch together, from London, in 1902. The list might be made longer ; but from it the reader understands that botanists of the new school were very well aware that to visit the tropics was expedient. I have excluded from it others who came to collect as Otto Warburg (1881), Wenzel Svoboda (1886), and Gustav F. Radde (1890). The first visited many parts of India collecting economic plants. Willis embarked on a morphological and taxonomic study of the Podostemaceae, for which he had excellent material in the river Mahaweliganga close at hand and for the furtherance of which he made two journeys in India, one to the Bombay Ghats and the other to the Khasia Hills. The value of his work was great ; as to the geographic dispersal in the East which the work detailed, there was a connection with that of Hooker which I have pointed out in section 10 (see p. 74) and which did not emerge at the time.

The conditions under which Podostemaceae can grow are limited by their seasonal need of torrents ; therefore their dispersal proves a past climate of contrasted seasons dry and wet in alternation for ages long enough for their establishment. Applying what this shows to the knowledge that climates within the peninsula of India have oscillated, we have it clear before us that the margin of the Peninsula has never failed, since Gondwanaland went to pieces, to retain its wet seasons while the inner parts went dry.

Willis did not succeed in finding Podostemaceae in Sikkim, but they are now known to occur in at least one part.

What was the dying condition of Gondwanaland when the condition of India, bordered by deluge-monsoon-needing Podostemaceae, took its origin ?

In 1907 a serious accident terminated Willis's field work. His administrative planning, than which there was nothing more advanced in India, had made its mark and it is for another to assess the effect of the counter planning to which I have alluded.

When Willis was appointed to Ceylon, the Forests were in charge of A. F. Brown, who had written an account of the forests as an appendix to Trimen's *HANDBOOK*. He was followed by Frederick Lewis, who, like Bourdillon in Travancore, had been a planter at one time. A planter with a botanical interest, who was in Ceylon at the time, was John Foot Jowett. Passing mention is due to J. Miguel Silva, plant collector at Peradeniya under Trimen and for twenty years after Trimen's death. His name becomes familiar to any botanist interested in Ceylon collections.

12. A GREAT STRIDE FORWARD COMES THROUGH THE UNIVERSITIES

At the end of section 5 attention was called to the setting up in India of laboratories to aid or guide certain large industries. It had seemed, when Dr. D. D. Cunningham was sent to see Miles Berkeley at work and to visit various teaching institutions in Germany where the study of Fungi was active, as if he was to link his work with the greatest industry in the country, namely the raising of food crops ; but that was not to be ; Sir David Prain, a most intimate friend, states that Cunningham's work with fungi, when it came, originated without attachment to economy. In 1878 he was publishing on the way in which a living organism, whether animal or plant, meets starvation. This was followed by other work as purely scientific, which gave to Cunningham the place of a pioneer. The next pioneer after him was Marshall Ward, who went to Ceylon in 1882 on a two years' agreement originating in a definitely economic enquiry, but which gave him the opportunity of making investigations of great general import in pure science. Marshall Ward left Ceylon in 1885 when his mission was finished ; Cunningham left India in 1897, broken in health.

It was shortly after this that Professor Jagadis Chunder Bose (knighted later) turned his attention to the perceptions of plants. He had been led into making observations by physical work which at first he had in hand in London ; and then he took the prosecution of it to his University laboratory in Calcutta.

The reader sees that the entry of the botanical research laboratory into India, which ensued through the three old Universities, was at the very end of my period. That being so, I shall not follow its course

more than to refer the reader to a publication by Professor P. Maheshwari and R. N. Kapil (*Journ. Univ. Gauhati* 9 (2), 1958) in which are named the Universities and University Colleges whereat courses in the Science of Botany are given. My chapters are not for the scholars of these teaching establishments but for the botanists engaged in taxonomic research ; and the proper place for them is not the class-room but the herbarium work-tables, as four-fifths of the names in them are the names of men who collected plants and by their collecting not only established the make-up of the flora of India but got together also a fair amount of information on plant-geography. I began a card-index when engaged on herbarium work in India and it ultimately became a foundation for these chapters. As to completeness I think very few names can have been omitted. The chapters could have been headed 'A record of the growth of systematized knowledge of the plants of India'.

I had not in my mind, when determining that my narrative should end at 1900, the fact that Reynold Green's HISTORY OF BOTANY IN THE UNITED KINGDOM ends at the same date. But so much the better, for my chapters become a chronicle that can be read along with that excellent book.

(To be continued)

A small collection of earthworms from Nepal (Megascolecidae : Oligochaeta)

BY

R. W. SIMS

British Museum (Natural History)

(With a plate)

During October and November 1961, and March 1962, Dr. W. G. Inglis and Mr. K. H. Hyatt made a small collection of Megascolecid earthworms when in Nepal as members of the British Museum Nepal Expedition 1961-1962. Although only a few specimens were collected they were found to include some which are rarely recorded. It seems useful, therefore, to report on this collection particularly as it was made in an area from which material is seldom obtained. All of the worms were collected in the vicinity of Maewa Khola, Sanghu, Nepal (27° 21' N., 87° 33' E.). I would like to express my gratitude to Dr. Inglis and Mr. Hyatt for providing me with the material.

Pheretima campanulata (Rosa)

Perichaeta campanulata Rosa, 1890, *Ann. Mus. Genova* 30, p. 115. Palon, Burma.

Under a damp stone, Maewa Khola, Sanghu, 6500 ft. 14 November, 1961, K. H. Hyatt. 1 clitellate specimen.

External Characters. Length 108 mm. Diameter 4 mm. Number of segments 110. The specimen which is preserved in alcohol, is a dark greyish brown colour. Prostomium $\frac{1}{2}$ epilobous. The first dorsal pore is in intersegmental furrow 11/12. The clitellum is annular and extends over three segments, *xiv-xvi*; the intersegmental furrows and the dorsal pores in this region are missing, also the setae except for a few in *xiv*. The setal areas on the ventral surface of the preclitellar region are raised giving a triannulate appearance. Generally the setal rings are broken irregularly on the ventral surface. The number of spermathecal setae on *vii* is 11, *viii* 17; penial setae

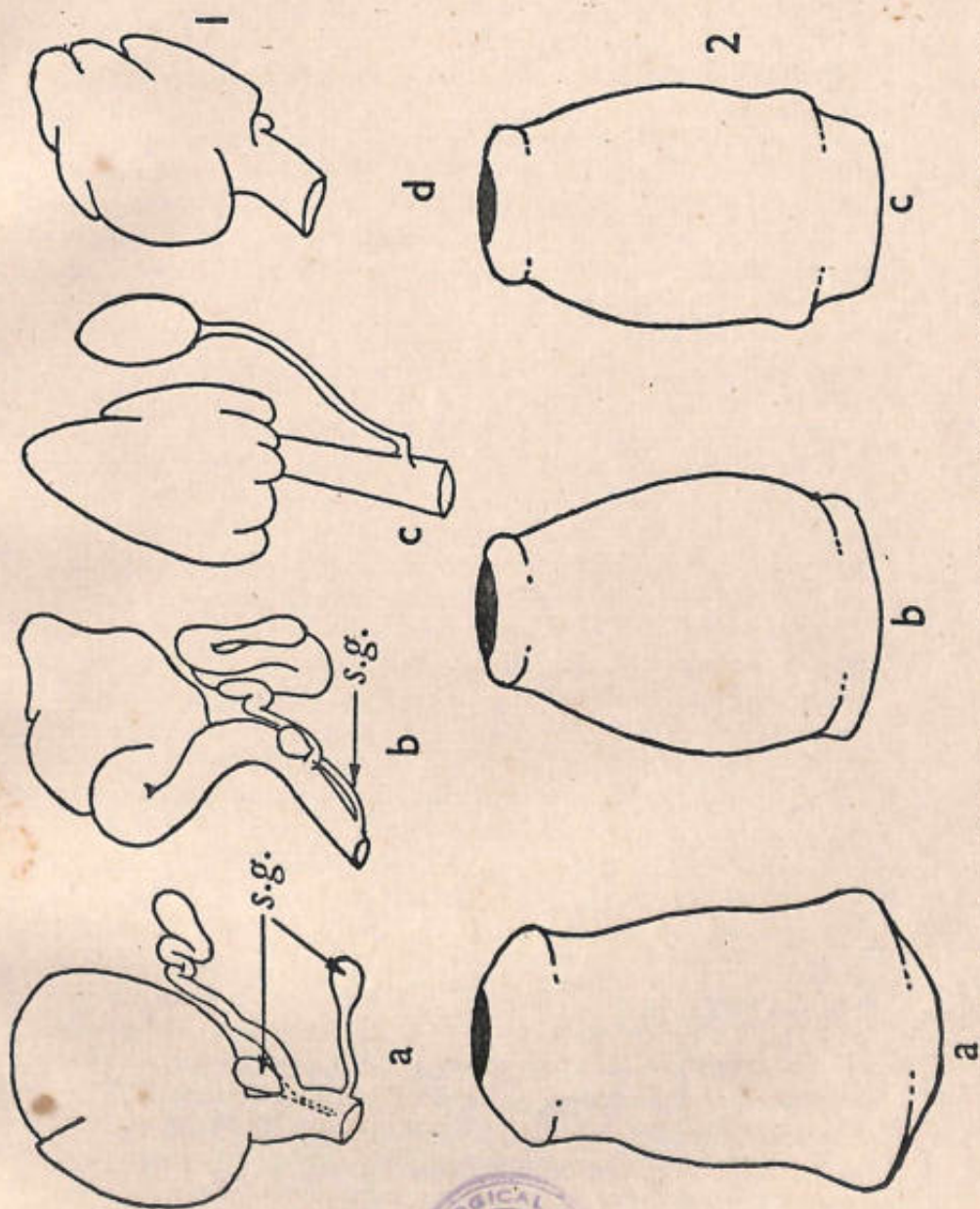


Fig. 1. Spermathecae (anterior view): (a) *Pheretima campanulata*, (b) *P. houletti*, (c) *P. diffringens*, (d) *Perionyx foveatus*.
 Fig. 2. Gizzards (dorsal view): (a) *Pheretima campanulata*, (b) *P. houletti*, (c) *P. diffringens*
 s.g., stalked gland.

xviii 11; setae *xx* 52. There is a single, median female pore on *xiv*. The male pores are paired and each lies within a copulatory chamber in *xviii*, the chambers are in the setal ring and each is closed by a medially directed tongue-like lateral lobe. The spermathecal pores are three pairs, 6/7, 7/8, 8/9. They are minute on the right side but larger on the left. The areas surrounding the pores on the left are swollen as transversely ellipsoidal mounds extending to the setal rings. No genital markings were seen.

Internal Characters. Septa 5/6-7/8 and 10/11-13/14 are thickened, septa 8/9 and 9/10 are represented by ventral rudiments only; in 8/9 extending laterally only to the spermathecae. The gizzard is somewhat bell-shaped (Fig. 2 *a*) with the anterior diameter only slightly less than the posterior. The intestinal caeca are simple extending anteriorly from *xvii* to *xxiii* where they flex ventrally into *xxii*. The caeca are almost imperceptibly constricted by the septa through which they pass but the constrictions are more evident at 22/23. The intestine begins in *xv*. Lateral hearts are present in *ix-xiii* passing into the ventral vessel. The right heart in *ix* is rudimentary, its diameter being about one-quarter of the left heart. A single median testis sac is present in both *x* and *xi*; laterally each sac curves gently anteriorly, the antero-lateral margins being bilobed. The seminal vesicles are fairly well developed in *xi* and *xii* being about the same height as the oesophagus. They are a somewhat depressed heart-shape each with a small ampulla arising from the dorsal cleft. The ampullae are of a slightly finer texture and in size each is about one-quarter of that of the seminal vesicle from which it arises. The prostates extend from *xvi-xxi*, they comprise two closely associated anterior and posterior groups of three lobes, each lobe itself being lobulated. As usual the paired prostatic ducts are situated in *xviii*, each forms a single loop with the ental end lying immediately dorsal to the ectal end above the copulatory chamber. The dorsal (coelomic) surfaces of the paired copulatory chambers are smooth and penial setae are apparently absent from inside. Anterior to each copulatory chamber there is an ovoid mass consisting of three small stalked glands which pass into the anterior wall of the chamber, posterior to the chamber is a smaller mass containing one stalked gland which passes into the posterior wall. The spermathecae are paired and lie in segments *vii*, *viii*, *ix*. Each is flattened and leaf-like, the length of the duct is about equal to the length of the main body. The diverticulum arises from midway along the mesial surface of the spermathecal duct, it consists of a narrow stalk reaching to nearly the equator of the spermatheca where it becomes slightly convoluted, the

loops which remain in the same plane are contained by connective tissue (Fig. 1 *a*). Where the spermathecal duct passes into the parietes two small stalked glands enter into the duct, one into the anterior surface the other into the posterior surface.

Remarks. This species is the only Indian *Pheretima* with spermathecal pores in intersegmental furrows 6/7, 7/8, 8/9 and possessing both an anterior and a posterior stalked gland arising towards the ectal end of each spermathecal duct (see *Remarks* under *P. houletti* below, and Gates, 1937 : 197, for other characters). Gates (1931 : 435) separated the subspecies *penetrans* on a series from near Darjeeling in which he found that on the posterior face of each copulatory chamber there were two ovoid glandular masses instead of the usual one; also the seminal vesicle in *xi* curled upwards and around to cover the dorsal blood vessel (this latter difference could be due to age or season, see *P. houletti* below). These characters were not seen in the specimen reported here which resembles the Siamese subspecies *meridiana* Gates (1932 : 457) in lacking penial setae inside the copulatory chambers. In view of these discrepancies in subspecific characters and the fact that I have only one specimen before me, I do not propose to identify it subspecifically.

Pheretima diffringens (Baird)

Megascolex diffringens Baird, 1869, *Proc. zool. Soc. London*, 1869, p. 40. Plas Machynlleth, Montgomeryshire, Great Britain.

Under a damp stone in forest, Maewa Khola, Sanghu, 6500 ft. 29 October, 1961. K. H. Hyatt. 1 clitellate specimen.

Under a rock by a river, (very active when exposed to light), Maewa Khola, Sanghu, 5500 ft. 12 November, 1961. K. H. Hyatt. 1 clitellate specimen.

Under a rock by a river, Maewa Khola, Sanghu, 5500 ft. 15 November, 1961. K. H. Hyatt. 1 clitellate specimen.

On the banks of a stream after heavy rain, Maewa Khola, Sanghu, 6500 ft. 2 March, 1962. W. G. Inglis. 69 specimens.

External Characters. Gates (1931 : 387; 1936 : 412; 1937 : 198) gave details of variation in the external characters of this fairly well-known species. In the present series differences in the external anatomy are well within the limits which Gates recorded. It is interesting to note that these worms agree with his series from near Kathmandu and differ from most from elsewhere in that the clitellum extends beyond intersegmental furrows 13/14 to 16/17. It begins in the posterior quarter of *xiii*, midway between the setal ring and

furrow 13/14, and finishes in the anterior quarter of *xviii*, midway between furrow 16/17 and the setal ring; the furrows being almost obliterated by the clitellum. The same agreement is not to be found, however, in the genital markings. In the Sanghu specimens there are the usual paired presetal genital markings on *vii*, *viii*, *ix* at *cd* but the larger worms have small, paired postsetal genital markings on *vi*, *vii*, *viii* abutting on the anterior or antero-dorsal borders of the spermathecal pores, also on *v* (eight specimens).

Internal Characters. (Three specimens dissected.) Septa 5/6-7/8, 10/11, 11/12 are thickened also 12/13 to a lesser extent; septa 8/9, 9/10 are missing. The gizzard is somewhat barrel-shaped but the diameter of the anterior end is less than that of the posterior (Fig. 2 *c*). The intestinal caeca arise in *xxvi* and pass forwards as far as *xxiii*, they are simple and only slightly constricted by the septa. Paired lateral hearts are present in *xi*, *xii*, *xiii*, passing into the ventral vessel. The testes sacs in *x* are joined medially and are almost dumb-bell shaped with the contents aggregated laterally. There is only one median sac in *xi*, resulting probably from fusion similar to that in *x* but it is more complete and the contents are more uniformly distributed. The seminal vesicles are paired in *xi* and *xii*, each is bilobular with a large ampulla arising from the dorsal cleft between the lobes, each ampulla is at least half of the size of one lobe. The prostates are variable differing in size from two fragile flattened lobes of the same width as the duct to massive, rather globular glands extending from *xvi* to *xix*. The right prostate of one specimen is well developed whereas the left, both gland and duct, are rudimentary. The prostatic duct forms a simple loop, like a closed U, with the open side directed postero-laterally. The spermathecae are paired and lie in segments *vi*, *vii*, *viii*, *ix*. Each is a slightly compressed cone slightly longer than the duct. The diverticulum arises from the antero-mesial surface of the spermathecal duct near where it passes into the parietes. It is directed posteriorly either curving gently or with a sharp flexure near its site of origin (Fig. 1 *c*). The ampulla is ellipsoidal and pure white in colour in contrast to the creamy colour of the diverticulum and spermathecal duct of these alcohol preserved specimens.

Pheretima houlleti (Perrier)

Perichaeta houlleti Perrier, 1872, *N. Arch. Mus. Paris* 8, p. 99. Calcutta.

From soil in banks of river terrace, Maewa Khola, Sanghu, 6500 ft. 18 November, 1961. K. H. Hyatt. 2. clitellate specimens.

External Characters. Length 64, 65 mm. Diameter 3 mm. Number of segments 62, 75. The colour of one specimen is a greyish brown, the other is a greenish grey-brown; both are preserved in alcohol. The first dorsal pore occurs in intersegmental furrow 10/11. The clitellum extends over *xiv*, *xv*, *xvi*, in one specimen to $\frac{1}{2}$ *xvii*. The setal rings are raised on the ventral surface in the pre-clitellar region giving a triannulate appearance. Posteriorly, the setal areas in the last seven or so segments are considerably raised. Setae are present throughout the clitellum.

Number of setae

<i>vii</i> ¹	<i>viii</i> ¹	<i>xviii</i> ²	<i>xx</i>
11	18	9	51
12	17	9	52

The spermathecal pores are minute in furrows 6/7, 7/8, 8/9. The paired male pores are situated $\frac{1}{2}$ circumference apart in *xviii* where they may be seen as indistinctly paler coloured areas in the setal ring. The single median female in *xiv* is situated anteriorly to the setal ring at a distance equal to *ab*. The pore is in the centre of a small papilla surrounded by a paler coloured area.

Internal Characters. Septa 5/6-7/8, 10/11-12/13 thickened. Septum 8/9 is rudimentary and is represented only ventrally as a narrow strip, septum 9/10 is thin and appears to be applied peripherally to 10/11. The gizzard is rather pitcher-shaped with the anterior diameter considerably less than the posterior (Fig. 2 *b*). The intestine begins in *xv*. The paired intestinal caeca are simple, they arise in *xxvii* and extend forwards only to *xxiv*. They are constricted where they pass through the septa, the constriction at 24/25 is particularly marked and the distal end of each caecum is devoid of gut content and appears as a semi-transparent ampulla. The lateral hearts pass into the ventral vessel, the last pair being in *xiii*. In one specimen the right heart in *xi* and the left heart in *xii* are rudimentary. The testes sacs are joined ventrally in both *x* and *xi* but their contents are concentrated laterally and each pair appears to be dumb-bell shaped, they are somewhat transparent but laterally they are whiter and more opaque. One specimen has a pair of small vertical seminal vesicles in *xi* and *xii*, each individual vesicle being surmounted by a primary ampulla of similar diameter. The other specimen which is sexually riper, has a pair of large seminal vesicles in *xi* each with a mid-dorsal cleft from which a small primary ampulla extends (the ampullae are the same size as those of the first specimen but the seminal vesicles

¹ Between the spermathecal pores
² Between the male pores

are much larger). The seminal vesicles in *xii* unite dorsally above the dorsal blood vessel and the ampullae were not seen. The prostates extend from *xvii-xx* in one specimen and *xvii- $\frac{1}{2}$ xix* in the other; in both they consist of several slightly depressed lobes. Each prostatic duct forms a simple loop like a constricted U and lies on the dorsal (coelomic) surface of the copulatory chamber with the open end of the U directed mesially. On the anterior wall of each copulatory chamber there are two stalked glands and on the posterior wall one. The surface of each copulatory chamber is smooth indicating the absence of setae from within. The spermathecae are paired in *vii*, *viii*, *ix*. They are variable in shape, the first pair are rounded sacs about half the size of the last pair which are more leaf-like; all are distally transparent. The spermathecae and their ducts are about equal in length, the duct being flexed through nearly 180° where it issues from the spermatheca. The diverticulum arises from the antero-mesial surface of the spermathecal duct at one-third of the distance from the ectal end. The duct is convoluted with five or six folds lying in the same plane and its diameter gradually increasing until it swells finally into a small ampulla (Fig. 1 *b*). The total area of the convoluted diverticulum is nearly equal to two-thirds of that of the spermatheca. A small stalked gland is closely associated with each diverticulum, its fine duct passes forwards to join the antero-mesial surface of the spermathecal duct as the latter passes into the parietes.

Remarks. For many years *P. campanulata* was confused with this species until Gates (1932 : 462) recognized the taxonomic importance of the stalked glands of the spermathecae and of the copulatory chambers as means of distinguishing between the two taxa. The spermathecal ducts of *P. campanulata* have both anterior and posterior stalked glands compared with only an anterior gland in *P. houletti*; further, there are three stalked glands on the anterior walls of the copulatory chambers of *P. campanulata* compared with two in *P. houletti*. Gates examined longer series than reported here and referred to other specific characters. In the Sanghu material of *houletti* and *campanulata* additional interspecific differences are readily evident. The gizzard of *houletti* is pitcher-shaped whereas the gizzard of *campanulata* is bell-shaped, also the spermathecal diverticulum of *houletti* has five or six large loops in contrast to the diverticulum of *campanulata* which has only two small loops (Fig. 2).

Perionyx foveatus Stephenson

Perionyx foveatus Stephenson, 1914, *Rec. Indian Mus.* 8, p. 396. Rotung, Abor Country, eastern Himalayas.

Under a stone by a river, Maewa Khola, Sanghu, 6500 ft. 23 October, 1961. K. H. Hyatt. 1 acitellate specimen.

On vegetation beside a river, Maewa Khola, Sanghu, 5500 ft. 12 November, 1961. K. H. Hyatt. 1 acitellate specimen.

On the banks of a stream, Maewa Khola, Sanghu, 6500 ft. 2 March, 1962. W. G. Inglis. 1 clitellate specimen.

External Characters (Clitellate specimen). Length 56 mm. Diameter 2 mm. anteriorly, tapering to 1 mm. posteriorly. Number of segments 138. The ventral surface of the worm is slightly concave along most of its length. The specimen is preserved in alcohol, dorsally it is a uniform dark purple, ventrally a light straw colour; apart from a median ventral, oval brownish area, the clitellum is paler. The first dorsal pore is in intersegmental furrow 4/5. The prostomium is $\frac{1}{2}$ epilobous and closed posteriorly; furrow 1/2 is missing so that the first apparent segment, i.e. *i* and *ii*, seems to be conical and twice the length of other anterior segments. The clitellum is annular and extends from midway between the setal ring in *xiii* and furrow 13/14 to slightly posterior to furrow 16/17. The setal rings are closed ventrally but dorsally $zz = 1\frac{1}{2}zy$, the number of setae at *x* being 52; penial setae are absent. The female pores are closely paired immediately posterior to furrow 13/14. The male pores are paired and situated in a narrow transverse pit in *xviii*. A single, median tuberculum pubertatis is present on the ventral surface of *xvii*. The spermathecal pores are small circular papillae in furrows 6/7, 7/8, 8/9, they are closely paired each being about one-third of the distance from the lateral margin of the ventral surface to the mid-ventral line.

Internal Characters. The first septum is 5/6, no septa are thickened. The gizzard is absent but the intestine is slightly swollen in *ix*, *x*, $\frac{1}{2}xi$. The last lateral hearts are in *xiii*. The ovaries are in *xiii*, the funnels small and circular. The testes in *x* and *xi* are free on the posterior wall of septa 9/10 and 10/11; large, transversely situated fimbriated funnels lie freely in *x* and *xi*, they have oval apertures with the length equal to twice the width. The seminal vesicles in *xi* and *xii* extend dorsally and around the dorsal blood vessel to meet mesially. The prostates are paired, they are large in *xvii* and small in *xviii*. A short prostatic duct leads from the hilus of each gland with only slight convolutions. Paired spermathecae

present in *vii*, *viii*, *ix* of varying size, the series on the right is larger, the largest spermatheca is the right in *viii*. The spermathecal ducts are rounded and half the diameter of the glands. At the ental end of each spermathecal duct there is a rudimentary diverticulum represented by a minute protuberance (Fig. 1 *d*). The excretory system is meganephridial, the nephridia which lack terminal reservoirs, 'end-bladders', are arranged in a single row along each side.

Remarks. The specimens collected at Sanghu appear to be the first recorded since Stephenson described the species nearly fifty years ago. *P. foveatus* approaches the description of *P. hingstoni* Stephenson, 1925, but among other characters it would seem to be a more slender worm tapering from the clitellum to the posterior end with a concave ventral surface which is markedly different to the convex ventral surface of the stouter *hingstoni*, moreover the female pores are more closely paired in *foveatus*. Internally, the prostates of *hingstoni* are more reniform and the prostatic ducts longer. The Sanghu specimens of *foveatus* differ from the original description in the spermathecal pores being somewhat more closely paired and the presence of dorsal pores. The position of the former were described in relation to the lateral margins of the ventral surface which may vary either in life or according to the method of killing, while dorsal pores are difficult to see even in the well-relaxed specimen reported here, so they may have been overlooked previously.

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Critical Notes on the Orchidaceae of Bombay State

XI. SOME OF THE SMALLER GENERA

BY

H. SANTAPAU, S.J., F.N.I., AND Z. KAPADIA, Ph.D.

(With two plates)

[Continued from Vol. 59 (3) : 842]

23. *SARCANTHUS* Lindl.

SARCANTHUS Lindl. Coll. Bot. t. 39 B, 1825, et Gen. Sp. Orch. 233, 1833 ; Endl. Gen. Pl. 206, 1837 ; Benth. & Hook. f. Gen. Pl. 3 : 580, 1883 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 212, 1889 ; Hook. f. Fl. Brit. Ind. 6 : 66, 1890 ; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 239, 1898 ; Duthie, *ibid.* 9 (2) : 149, 1906 ; J. J. Smith, Fl. Buitenz. 6 : 595, 1905 ; Schltr. Orchid. 577, 1927 ; Holttum, Rev. Fl. Malaya 1 : 645, 1953.

The generic name *Sarcanthus* is derived from the Greek words *sarks* = flesh, *anthos* = flower, referring to the very fleshy flowers in most of the species.

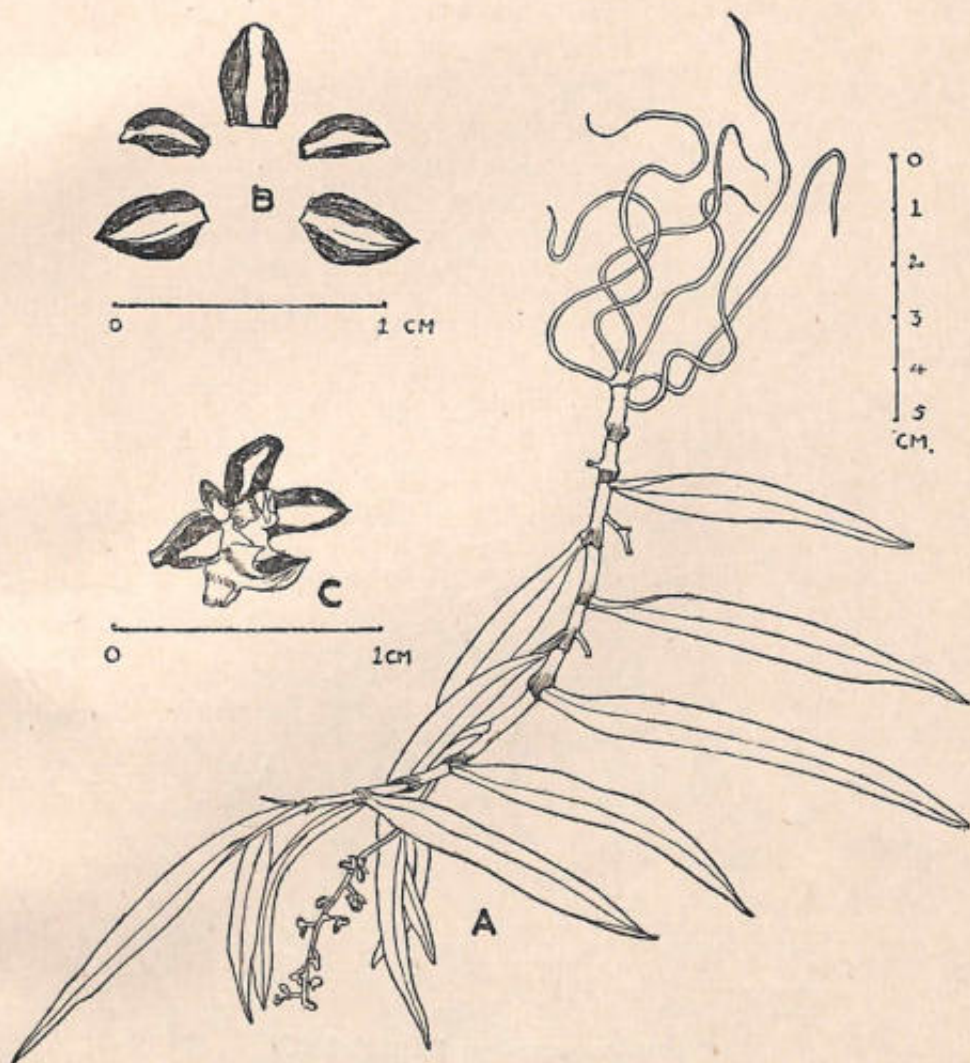
This genus contains over 70 species, occurring in Ceylon, India, Burma, Malaya, Sumatra, Java, S. China and New Guinea.

The date for *Sarcanthus* is usually given as 1821. But according to van Steenis (in *Fl. Males.* I, 4 (5) : CXCVII, 1954) the part of Lindley's *Coll. Bot.* containing *Sarcanthus* was not published before 1825.

The only species described by Lindley, when he erected the genus *Sarcanthus* in 1825, was *S. rostratus* ; this, therefore, must be considered to be the type species.

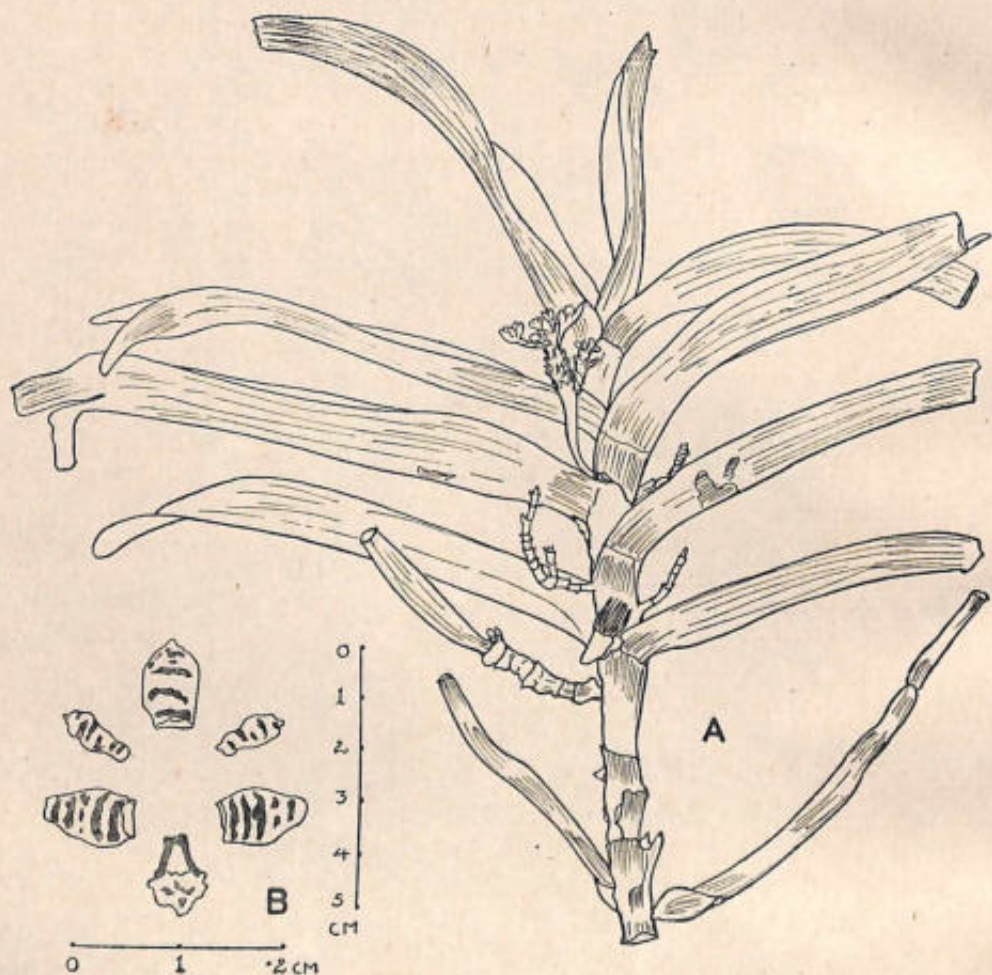
Type species : *S. rostratus* Lindl.

Sarcanthus peninsularis Dalz. in Hook. Kew Journ. Bot. 3 : 343, 1851 ; Lindl. in Journ. Linn. Soc. 3 : 39, 1858 ; Dalz. & Gibs. Bomb. Fl. 264, 1861 ; Hook. f. 67 ; Cooke, Fl. Pres. Bomb. 2 : 706, 1907 ; Gammie in Journ. Bombay nat. Hist. Soc. 20 : 128, 1910 ; Blatt. & McC. *ibid.* 35 : 495, 1932 ; Fischer, Fl. Pres. Madr. 1447, 1928. *Sarcanthus pauciflorus* Wight, Icon. 5 (1) : 20, t. 1747, 1851. (See Plate LIII.)



Sarcanthus peninsularis Dalz.

A. Whole plant. B. Sepals and petals dissected. C. Side view of flower.



Acampe praemorsa Blatt. & McC.

A. Whole plant. B. Sepals and petals dissected.

Pendulous *epiphytes*. *Stem* pendulous, dirty-green ; internodes about 1 cm. long, 3-5 mm. thick. *Leaves* 6-14 × 0.7-1 cm., thick, coriaceous, narrowly linear-oblong, somewhat acuminate, ± constricted about 1.5-2 cm. from the sharp apex. *Racemes* pointing downwards, usually arising opposite a leaf, simple, about 2-8 cm. long. *Flowers* about 7 × 7 mm., reddish-yellow, bracteate, shortly pedicellate. *Pedicel* with ovary about 2-3 mm. long, pale yellowish. *Bracts* 1.5 × 1 mm., minute, scarious, persistent, oblong, subacuminate. *Sepals* 4 × 2.5 mm., spreading, very fleshy, yellow with 2 broad brown-red bands along the margins, broadly oblong, entire, glabrous ; dorsal sepal obtuse ; lateral ones somewhat oblique, acute. *Petals* 3 × 1.5-1.75 mm., of the same colour as the sepals, very fleshy, oblong, subfalcate, acute, entire, glabrous. *Lip* 2.5 × 2 mm., 3-lobed, produced backwards and downwards into the spur ; lateral lobes erect, triangular, acute, minute, pale violet ; midlobe somewhat incurved, subacute, fleshy, arrow-head-like, with 2 yellow rounded calli in between the lateral lobes. *Spur* 2.5 × 1.5 mm. conical, obtuse, yellow, with a longitudinal septum from the mouth of the spur, ending in a rounded central callus in between the lateral calli of the midlobe. *Column* about 1.5 mm. long, stout, pale yellowish. *Anther* 2 × 1.5 mm. oblong with the anterior lip truncate and somewhat extended : pollinia 4, in pairs, globular with a narrow caudicle and a small gland. *Capsules* 17-19 × 6-8 mm. narrowly oblong, almost sessile, strongly ribbed.

Flowering : June. *Fruiting* : November.

Occurrence in Bombay State : KONKAN : Stocks ; Wari Country, Dalzell. N. KANARA : Kalanaddi, Ritchie ; Arbail Ghat, Sedgwick ; Anshi, Bell ; Yellapur, Bell 7870, Blatt. Herb. 233.17 (coll. Bell), Kapadia 1974-1979 ; Sirsi, Santapau 18640 ; Siddhapur, Kapadia 2365-2369 ; Jog, Kapadia 1775, 1777 (coll. Bole).

Distribution : India : Konkan, N. Kanara, W. Ghats of South India, Travancore. *World* : India, Ceylon.

24. *ACAMPE* Lindl.

ACAMPE Lindl. Fol. Orch. 1853 ; Benth. & Hook. f. Gen. Pl. 3 : 579, 1883 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 213, 1889 ; Schltr. Orchid. 578, 1927 ; Holttum, Rev. Fl. Malaya 1 : 620, 1953. *Saccolabium* sect. *Acampe* Hook. f. Fl. Brit. Ind. 6 : 62, 1890. *Saccolabium* King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 217, 1898 ; Duthie, ibid. 9 (2) : 136, 1906 ; (partim, non Blume 1825).

The generic name *Acampe* is derived from the Greek *akampes* = rigid, alluding to the brittle, rigid flowers of the species.

A small genus with but a few species, distributed mostly from India, Burma, to Southern China ; it is also represented in Africa and Madagascar.

According to Lindley, this genus is distinguished from *Vanda* R. Br. by its small, brittle, inflexible flowers ; by the lip, which is adnate to the edges of the column ; and by their slender caudicles with a very small gland ; it forms a very natural group. Holttum, however, has pointed out that the genus *Acampe* Lindl. has not been dealt with by those who have rearranged the orchids of the *Sarcanthus* group in recent years, and that the limits of the genus are not yet certain.

KEY TO THE SPECIES OF *ACAMPE* OF BOMBAY

- Inflorescence much shorter than the leaves,
up to 8 cm. long, in dense corymbose
racemes ; spur a small conical sac *praemorsa*
- Inflorescence much longer than the leaves,
up to 20 cm. or more long, laxly paniced ;
spur about 3-4 cm. long, oblong *ochracea*

Acampe praemorsa (Roxb.) Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35 : 495, 1932. *Epidendrum praemorsum* Roxb. Pl. Corom. 1 : 34, t. 43, 1795. *Cymbidium praemorsum* Swartz in Nov. Act. Upsal. 6 : 75, 1799 ; Roxb. Fl. Ind. 3 : 465, 1832 ; *Aerides praemorsum* Graham, Cat. Bomb. Pl. 204, 1839, (non Willd. 1805). *Saccolabium papillosum* Dalz. & Gibs. Bomb. Fl. 264, 1861 (non Lindl. 1832 nec Bot. Reg. t. 1552). *S. praemorsum* (Roxb.) Hook. f. Fl. Brit. Ind. 6 : 62, 1890 ; Prain, Beng. Pl. 1022, 1903 ; Haines, Bot. Bih. Or. 1180, 1924. *Acampe wightiana* Lindl. Fol. Orch. Acampe 2, 1853 ; Cooke, Fl. Pres. Bomb. 2 : 705, 1907 ; Fischer, Fl. Pres. Madr. 1447, 1928 ; Thwaites, Enum. Pl. Zeyl. 303, 1864. *Vanda wightiana* Lindl. ex Wight, Icon. 5(1) : 9, t. 1670, 1851. *Saccolabium wightianum* Hook. f. Fl. Brit. Ind. 6 : 62, 1890 ; Grant, Orch. Burma 286, 1895 ; Gammie in Journ. Bombay nat. Hist. Soc. 20 : 126, t. 10, 1910. (See plate LIV.)

Epiphytes. Stem about 1-1.5 cm. thick, sheathed ; sheaths brown, woody, longitudinally striated. Leaves thick, coriaceous, channelled, 12-30 × 1.5-3 cm., oblong, entire, emarginate with 2 unequal rounded lobes. Peduncle 1.5-6 cm. long, rarely branched ; racemes compact, corymbose. Flowers clustered at the apex of the peduncle, pedicellate, bracteate. Bracts minute, ovate-oblong, acute, persistent, brown. Sepals 8 × 5 mm. similar, coriaceous, entire, creamy-yellow with dark brownish-red irregular transverse bands ; lateral sepals ovate, obtuse, rarely subretuse ; dorsal sepal obovate-oblong, obtuse, mucronulate. Lip 7.5 mm. long, 5 mm. broad when spread out, creamy-yellow with 3-4 small

narrow, red lines arranged in the form of a cross on the broad midlobe; fleshy, saccate at the base, obscurely 3-lobed; lateral lobes small, erect, subentire; midlobe dilated beyond the lateral lobes, deflexed, obovate-suborbicular, acute or mucronulate, margin irregularly waved. *Column* 3 × 3 mm. short, stout, with 2 erect, minute horns produced on top from the sides of the column; broadly margined with deep brownish-red. *Anther* 2 × 2 mm. triangular-conical; pollinia 2, waxy, yellow, globose, with a narrow, linear-oblong, translucent caudicle and a small, oblong gland. *Stigmatic surface* broadly oblong, large, margined with brownish-red. *Ovary* with *pedicel* 1 × 0.4 cm. yellow, twisted. *Capsules* 6-7 × 0.6-0.8 cm. cigar-shaped, longitudinally ribbed.

Flowering : April to August. *Fruiting* : May onwards.

Occurrence in Bombay State : KONKAN : Kanheri, Gammie; Thana, Ryan; Bhandup, Blatter; Kapadia 1504; Kondita (Salsette), Blatter; Sion, Blatter; Indapur, Graham; Vehar, Santapau 11197; Kapadia 489; Andheri, Santapau 10015-10018; Borivli. R. Fernandez 77; Herbert 1615; Ghodbunder, Kapadia 1111, 1119-1120; Bassein, Santapau 10077; Mumbra, Shenoy 2437, 3490; Badlapur, Kapadia 1945. N. KANARA : Belgaum, Ritchie; Devicop, Sedgwick; Dandeli, Sedgwick 2546; Kapadia 2036; Ankola-Belikeri, Kapadia 2175; Kumbelli Mines, Kapadia.

Distribution : India : Bengal, Chota Nagpur, Konkan, W. Ghats of Bombay and south peninsular India, Godavari District, N. Kanara. *World* : India, Burma and Ceylon.

Notes : This is one of the commonest and most abundant orchids in Bombay State. It is usually found in masses epiphytic on *Mangifera indica* L., *Syzygium* sp., *Terminalia* sp.

Acampe ochracea (Lindl.) Hochr. in Bull. N. Y. Bot. Gard. 6 : 270, 1910. *Saccolabium ochraceum* Lindl. in Bot. Reg. misc. 2, 1842; Hook, f. 62; Grant 285; Brühl, Guide Orch. Sikk. 131. *S. lineolatum* Thwaites, Enum. Pl. Zeyl. 304, 1864. *Acampe wightiana* Lindl. var. *longepedunculata* Thwaites, Enum. Pl. Zeyl. 303, 1864.

Erect or pendulous epiphytes. *Leaves* coriaceous, sheathing at the base, 8.5-20 × 0.6-2 cm., narrowly oblong, entire, shallowly and unequally 2-lobulate at the apex. *Inflorescence* 8-20 cm. long; panicles lax, branching, longer or shorter than the leaves; peduncles terete, bracteate at the nodes. *Flowers* pedicelled, bracteate. *Bracts* minute, scarious, brown. *Sepals* and *petals* 6 × 2 mm., similar, yellow with pale red transverse markings, fleshy, obovate-oblong, obtuse, the lateral sepals subacute, entire, faintly 3-nerved. *Lip* 3.5 × 3 mm., 3-lobed, pale pinkish-white; lateral lobes erect, small, 2 mm. broad, irregularly toothed; midlobe obovate-triangular, irregularly serrulate,

acute. *Spur* 3-4 mm. long, oblong, subclavate, obtuse, parallel to the ovary, with 2 longitudinal septa within. *Column* small, with 2 erect, anterior horns; clinandrium with a central elevated boss. *Anther* 1 × 1.5 mm., transversely oblong-orbicular; pollinia 2-cleft, globular with a caudicle 1 mm. long and narrow linear, and a gland minute and transversely oblong. *Stigmatic surface* deeply seated within, below the projecting bosses of the rostellum. *Ovary* with *pedicel* 7.5 mm. long, oblong columnar, faintly ribbed. *Capsules* with stalk 3.5 × 0.7 cm., linear-oblong, faintly ribbed.

Flowering : December. *Fruiting* : May.

Occurrence in Bombay State : N. KANARA : Yellapur, Kapadia 1770, 2862; Sirsi—Siddhapur, Kapadia 2445.

Distribution : India : Sikkim, Khasia Hills, N. Kanara. *World* : India, Burma and Ceylon.

Notes : This species has not been found previously in Bombay State. It constitutes a new record for this area.

25. DIPLOCENTRUM Lindl.

DIPLOCENTRUM Lindl. in Bot. Reg. sub t. 1522, 1832, et Gen. Sp. Orch. 218, 1833; Endl. Gen. Pl. 204, 1837; Benth. & Hook. f. Gen. Pl. 3 : 582, 1883; Pfitz. in Engl. & Prantl, Pflanzenf. 2(6) : 209, 1889; Hook. f. Fl. Brit. Ind. 6 : 78, 1890; Schltr. Orchid. 580, 1927.

The generic name *Diplocentrum* is derived from the Greek words *diplos* = double, and *kentron* = a sharp point, a spur, in allusion to the 2 collateral spurs found in the species.

This genus contains 2 species restricted to south peninsular India.

Type species : *D. recurvum* Lindl.

Diplocentrum congestum Wight, Icon. 5(1) : 10, t. 1688, 1851; Hook. f. 78; Rolfe in Hook. Icon. Pl. 27 : t. 2687, 1901; Cooke, Fl. Pres. Bomb. 2 : 704, 1907; Gammie in Journ. Bombay nat. Hist. Soc. 20 : 129, 1910; Blatt. & McC. *ibid.* 35 : 497, 1932; Fischer, Fl. Pres. Madr. 1449, 1928.

Small *epiphytes*. *Stem* very short, sheathed. *Leaves* 2-4; coriaceous, somewhat channelled, recurved, 2-7 × 0.5-0.8 cm., narrowly linear-oblong, unequally and obtusely bilobed at the apex, green mottled with purple. *Racemes* up to 9 cm. long, arising from much below the leaves just a little above the roots, few- to many-flowered; peduncle 1-1.5 mm. thick, greenish, bracteate. *Flowers* about 5-7 mm. across, bracteate, very shortly pedicellate. *Ovary* with *pedicel* about 3 mm. long, greenish-brown, slightly curved in the apical part. *Bracts* minute, apiculate, pale brown. *Sepals* and *petals* pale green or pinkish-brown with a central deep pink streak, spreading, subobtusely entire, glabrous;

dorsal sepal 3×1 mm., narrowly elliptic-oblong. *Lip* 4-5 mm. long, white, pale pink, or pink-mauve, fleshy, somewhat reflexed and truncate at the apex, broader and produced at the base into 2 spurs which are shortly diverging, about 1 mm. long, somewhat tubercled and pale pinkish or greenish-brown. *Column* very short, white with 2 parallel, pink, somewhat kidney-shaped streaks on the sides. *Anther* 1×1 mm. oblong-obovoid, pale greenish-yellow or yellow, anterior lip truncate; *pollinia* 2, bipartite; *caudicle* 1.5 mm. long, apiculate, basal half ovate-oblong, about 1 mm. broad, glandular. *Capsule* $18 \times 3-4$ mm., broadly ovoid, slightly curved, ribbed, with a 2 mm. long pedicel.

Flowering : May. *Fruiting* : May onwards.

Occurrence in Bombay State : N. KANARA : Sirsi—Kumpta, Woodrow; Castle Rock, Blatt. Herb. 31030 (coll. T. R. Bell); Kapadia 2817-2818; Yellapur, Kapadia 2870-2871.

Distribution : N. Kanara, W. Ghats of Bombay State and South India, Travancore.

Notes : We have found this species epiphytic on *Syzygium* sp. in open deciduous forest.

26. EPIPOGIUM R. Br.

EPIPOGIUM R. Br. Prodr. 330, 1810; Santapau in Proc. nat. Inst. Sci. India 24 B : 138. *Epipogum* Gmelin, Fl. Sibir. 1 : 11, t. 2, f. 2, 1747; Endl. Gen. Pl. 212, 1837; Benth. & Hook. f. Gen. Pl. 3 : 617; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 111; Hook. f. Fl. Brit. India 6 : 124; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 252; Duthie, ibid. 9 (2) : 150; J. J. Smith, Fl. Buitenz. 6 : 61; Schltr. Orchid. 100; Holtum, Rev. Fl. Malaya 1 : 106. *Ceratopsis* Lindl. Gen. Sp. Orchid. 383, 1835. *Podanthera* Wt. Icon. 5 (1) : 22, t. 1759, 1851.

The name *Epipogium* is derived from the Greek, *epi* = upon, and *pogon* = beard, probably with reference to the glandular hairs on the lip.

Species about 5, very widely distributed in the temperate regions of Europe and Asia.

On the spelling of the generic name, see Santapau, loc. cit.

Epipogium roseum (D. Don) Lindl. in Journ. Linn. Soc. 1 : 177, 1857; Holtum 106; Santapau loc. cit. 139. *Limodorum roseum* D. Don, Prodr. Fl. Nep. 30, Febr. 1825. *Galera rosea* Bl. Bijdr. 416, f. 3, Dec. 1825. *Epipogum nutans* Reichb. f. in Bonpland. 5 : 36, 1836; Lindl. 177; Hook. f. 124; King & Pantl. 252, t. 335; J. J. Smith 61, f. 39; Brühl, Guide Orch. Sikk. 148; Fischer 1460; Blatt. & McC. 35 : 729. *Podanthera pallida* Wt. Icon. 5 (1) : 22, t. 1759, 1851.

Rhizome an ovoid horizontal tuber, about 5×3.5 cm., with few short internodes. Scapes leafless, 10-40 cm. high, hollow, fleshy, about 1 cm. thick at base, gradually narrowing upwards, sparsely sheathed in the basal region, yellowish. Flowers drooping, white, pedicellate, bracteate; pedicels about 3 mm. long, curved. Bracts $7-9 \times 3-4$ mm., shorter than the ovary. Sepals and petals $8-11 \times 2-4$ mm., not much spreading, narrowly linear, acute, entire, 3-nerved. Lip about equalling sepals and petals, concave, obovate-oblong in outline, irregularly crenulate, with the sides raised at the base, with a small blunt apiculum or without it; upper surface minutely warted in 2 rows; colour white with a few reddish brown spots. Spur short, somewhat bulbous, pointing backwards below the ovary, obtuse. Column very short. Anther larger than the column. Stigmatic surface at the base of the column, prominent. Ovary broadly ovoid, drooping, pale yellow, 8×4 mm.

Flowering : May.

Occurrence in Bombay State : N. KANARA : Yellapur, Bell 4068.

Distribution : Tropical Himalayas, Sikkim in hot valleys up to 1300 m., Khasia Hills up to 2000 m., southwards to N. Kanara, Coorg, Bolampati Hills at 1400 m., Anaimalais, Pulneys at 1600 m., Wynaad. World : W. Africa, India, Nepal, Ceylon, Malaya, Java, Australia.

ARTIFICIAL KEY TO THE GENERA OF ORCHIDACEAE IN BOMBAY STATE

1. Epiphytic or lithophytic plants :
2. Plants with distinct pseudobulbs :
 3. Pseudobulbs flattened, discoid, rounded :
 4. Pseudobulbs with distinct reticulate, lace-like sheaths; flowers orange or deep brown-red; sepals united to form a tube at least at base .. Porpax
 4. Pseudobulbs without lace-like sheaths; flowers greenish-yellow or white; sepals completely free .. Eria
 3. Pseudobulbs elongated, ovoid or conical :
 4. Pseudobulbs 2- or more-noded (rarely 1-noded in *Dendrobium* sect. *Stachyobium*) :
 5. Leaves thick, coriaceous, 20-25 cm. long; inflorescence lateral; lip with calli or keels at base .. Cymbidium
 5. Leaves thin, membranous, not exceeding 15 cm. in length; inflorescence terminal or lateral; lip without calli or keels :
 6. Flowers spurred; spur projecting beyond lateral sepals; sepals and petals about 4 cm. long; pollinia 8 .. Thunia

6. Flowers with a short mentum which is enclosed by lateral sepals; sepals and petals up to 2.5 cm. long; pollinia 4 or 8 :
7. Inflorescence terminal; lip superior; pollinia globular with a short broad caudicle .. *Polystachya*
7. Inflorescence terminal or lateral; lip inferior; pollinia linear or pyriform without caudicles :
8. Pedicel and ovary sparsely pubescent; pollinia 8, pyriform .. *Eria mysorensis*
8. Pedicel and ovary glabrous; pollinia 4, linear or linear-oblong .. *Dendrobium*
4. Pseudobulbs only of a single node :
5. Pseudobulbs with 2 or more thin, membranous leaves; leaves deciduous at time of flowering; scape bearing a fan-shaped, radiating umbel at apex; lateral sepals $2\frac{1}{2}$ - $3\frac{1}{2}$ times as long as the dorsal .. *Cirrhopetalum*
5. Pseudobulbs with a single thick coriaceous leaf on top; leaves persistent; scape 1-flowered or bearing an elongated raceme; sepals subequal :
6. Pseudobulbs 1×1.3 - 1.7 cm. shortly conical-ovoid; leaf 1.5-4.5 cm. long; scape 1-flowered; anther with a long horn .. *Trias*
6. Pseudobulbs 2-8 cm. long, oblong or conical-ovoid; leaf 4-30 cm. long; scape many-flowered; anther without a horn :
7. Pseudobulbs conical-ovoid, dark-green or brownish-purple with broad grooves along its length; leaf-apex acute; scape 20-45 cm. long .. *Pholidota*
7. Pseudobulbs oblong, yellowish-green, 3-5-angled; leaf-apex obtuse or emarginate; scape up to 12 cm. long .. *Bulbophyllum*
2. Plants without pseudobulbs :
3. Plants completely leafless, or rarely with scale leaves; scape small, glandular-pubescent, arising directly from cluster of greenish roots .. *Chiloschista*
3. Plants with normal green leaves :
4. Plants with fleshy rhizomes; scape pubescent; sepals united for about half their length; pollinia lamellate .. *Cheirostylis flabellata*
4. Plants without rhizomes; scape glabrous; sepals free; pollinia waxy :
5. Leaves membranous, plicate; lip superior
5. Leaves fleshy or coriaceous, not plicate; lip inferior : .. *Malaxis versicolor*

- 6. Plants without a distinct stem ; leaves radical :
 - 7. Leaves sessile, fleshy, laterally compressed ; flowers in terminal, dense, cylindric, simple spikes or racemes ; pollinia 4, without a gland or caudicle .. *Oberonia*
 - 7. Leaves petiolate, coriaceous, normal ; flowers in lateral, laxly branching racemes ; pollinia 4 with a broad gland .. *Sirhookera*
- 6. Plants with a distinct stem ; leaves cauline :
 - 7. Leaves terete ; scape up to 2 cm. long, stout, woody .. *Luisia*
 - 7. Leaves flat, scape longer, herbaceous :
 - 8. Scape branched, 2-5 times as long as leaves : flowers not spurred ; lip resembling a bee .. *Cottonia*
 - 8. Scape simple or rarely branched, not more than twice as long as leaves ; flowers spurred ; lip not resembling a bee :
 - 9. Spurs 2 .. *Diplocentrum*
 - 9. Spur 1 :
 - 10. Leaf-apex acute or sharply pointed ; flowers about 7 mm. across .. *Sarcanthus*
 - 10. Leaf-apex irregularly toothed with 1-3 sharp teeth ; flowers larger :
 - 11. Flowers whitish or pale pink ; lip scarcely lobed ; spur laterally compressed, truncate at apex .. *Rhynchostylis*
 - 11. Flowers variously coloured, not whitish or pale pink ; lip distinctly 3-lobed ; spur short oblong or conical, obtuse at apex .. *Vanda*
 - 10. Leaf-apex bilobed, lobes unequal or subequal, rounded or subacute ; flowers larger :
 - 11. Stem very short ; mid-lobe of lip semi-circular forming a brim on large ventricose, sacc-

- ate spur; pollinia shorter than narrow linear caudicle, with a small linear gland .. *Gastrochilus*
11. Stem long; midlobe of lip various; spur narrow, linear or rarely a small conical sac; pollinia about equalling oblong caudicle with a small more or less oblong or square gland:
12. Sepals and petals coriaceous, yellow with unequal, horizontal, crimson bars; lip 3.5-7.5 mm. long, column without a foot .. *Acampe*
12. Sepals and petals pale pink or pinkish-mauve; lip 10-28 mm. long, column with a stout foot *Aërides*
1. Terrestrial or saprophytic, rarely epiphytic plants (see *Cheirostylis*, *Malaxis*):
2. Lip spurred; spur projecting beyond lateral sepals:
3. Plants with green leaves; leaves not plicate; anther immovably affixed to column by a broad base:
4. Flowers about 7.5 cm. across, greenish-white; stigmatic surfaces flat, almost confluent .. *Platanthera*
4. Flowers not exceeding 3 cm. across, green, white or yellow; stigmatic surfaces not flat, separate:
5. Ovary and capsules \pm erect and parallel to peduncle, not spreading at an angle to it; stigmatic surfaces in form of small swellings on edge of lip .. *Peristylus*
5. Ovary and capsules widely spreading at an angle to peduncle; stigmatic lobes standing out as stalked appendages .. *Habenaria*
3. Plants with green leaves or rarely saprophytes; leaves plicate, rarely absent; anther separable from the column or often attached at base by a slender filament:
4. Plants with a cluster of stout fibrous roots; lip superior .. *Tropidia*

4. Plants with a fleshy rhizome or subterranean tuberous pseudobulbs; lip inferior :
5. Flowers appearing with the leaves :
6. Leaves puberulous; spur long, slender; pollinia 8 .. *Calanthe*
6. Leaves glabrous; spur short, rounded, conical or saccate; pollinia 2 :
7. Inflorescence erect; lip with a short, rounded or conical spur .. *Eulophia*
7. Inflorescence decurved; lip with a wide conical sac .. *Geodorum*
5. Leaves absent or flowers appearing after leaves :
6. Leafless saprophytes with fleshy, rounded or ellipsoid rhizomes lying horizontally on ground; pollinia 2, powdery, each with its own long, slender caudicle .. *Epipogium*
6. Leaves present appearing much before flowers; plants with fleshy, tuberous, irregularly shaped pseudobulbs; pollinia 2, waxy, attached to a short caudicle and a small gland .. *Eulophia*
2. Lip not spurred, often saccate at the base; sac never projecting beyond the lateral sepals :
3. Sepals united for about half their length :
4. Leafless, brown saprophytes; pedicels greatly elongating in fruit; limb of lip undivided .. *Didymoplexis*
4. Plants with green leaves; pedicels not elongating in fruit; limb of lip 2-cleft, lobes digitately fimbriate .. *Cheirostylis*
3. Sepals free :
4. Leaves and flowers not appearing together :
5. Leaves petiolate, cordate or orbicular; scape glabrous; pollinia 2, powdery, without caudicles or glands .. *Nervilla*
5. Leaves sessile, narrowly oblong-lanceolate; scape pubescent; pollinia 8, waxy, adhering to a small viscid mass .. *Pachystoma*
4. Leaves and flowers appearing together :
5. Plants with subterranean pseudobulbs; pollinia 4, waxy without caudicles, adhering in pairs to a small, viscid mass :
6. Lip inferior, without auricles; column long, winged in upper part .. *Liparis*
6. Lip superior, with or without auricles; column very short, wingless .. *Malaxis*
5. Plants with a rhizome or a cluster of fibrous roots; pollinia 2, lamellate with a caudicle and a small, orbicular gland :

6. Plants with a cluster of stout, fibrous roots ; spikes spirally twisted ; lip subsaccate at base, the apex not widened into a blade .. *Spiranthes*
6. Plants with a short or long rhizome ; spikes not spirally twisted ; lip with a prominent convex sac at base, the apex widened into a bilobed blade .. *Zeuxine*

(Concluded)

On the freshwater Molluscs of Poona

BY

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(With one map and six plates containing thirty-six figures)

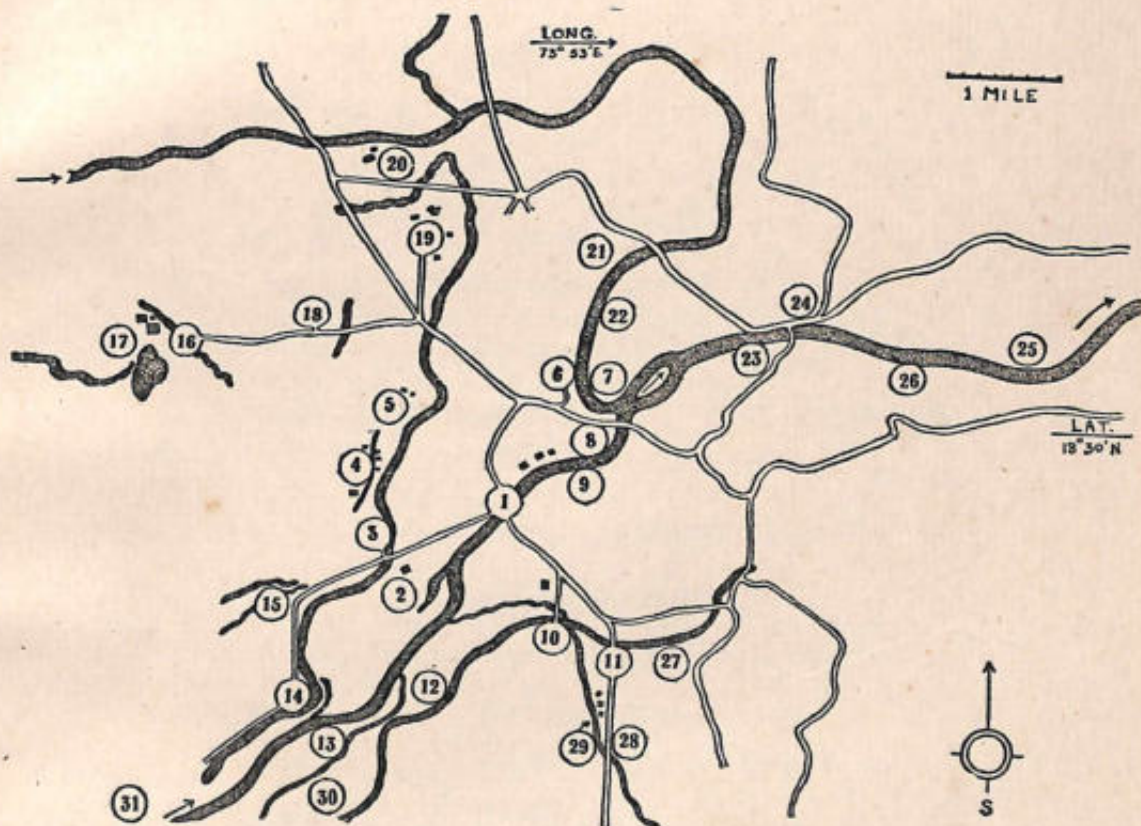
INTRODUCTION

The available information on the freshwater and amphibious Mollusca of Poona City and its neighbourhood is necessarily scanty and scattered. Some of the references are not even readily available. The volumes of the FAUNA OF BRITISH INDIA series on Mollusca, though comprehensive, provide Latin descriptions of many species and thus are of limited utility to Indian students of Mollusca. The lack of adequate illustrations of the species described has also made it difficult to understand these otherwise excellent works. Further, as has been rightly pointed out by Satyamurty (1960), the nomenclature of many species, their correct systematic position, and their true relationships with other groups have undergone serious revision during the last three decades. The few earlier records of the species available in this area are very vague in mentioning the localities and are practically devoid of any useful biological information. The present paper aims at giving a revised list of the species available in and around Poona City with brief information on their habitats. The list is provisional and is in no way complete, as the work is currently under progress and will be followed later by a full list of the species together with observations on their biology.

Satyamurty's (*loc. cit.*) recent contribution on the land and freshwater Mollusca in the collection of the Madras Government Museum, a most welcome addition to the literature on conchology, has proved very useful in the present work.

METHODS

Collection of the specimens was made in regular once-a-week visits to different aquatic habitats in and around Poona City. The sketch map shows the localities and area explored for this study.



Sketch map of Poona showing stations where collections of Freshwater Molluscs were made

1. Deccan Gymkhana ; 2. Yerandawane ; 3. Left Bank Canal ; 4. Law College area ; 5. Fergusson College area ; 6. Shivajinagar Station ; 7. Mula River near Sangam ; 8. Mutha River near Sangam ; 9. Nava Pool ; 10. Parvati ; 11. Swargate (Right Bank canal) ; 12. Vithalwadi area ; 13. Vadgaon region ; 14. S.N.D.T. Society ; 15. Kothrud Canal ; 16. Pashan tank ; 17. Pashan Canal ; 18. National Chemical Laboratory ; 19. University of Poona ; 20. Botanical Garden ; 21. Mula River near Kirkee, South ; 22. Mula River near Kirkee, East ; 23. Bund Garden area ; 24. Mula-Mutha River near Yerawada ; 25. Mula-Mutha River near Yerawada, two miles East ; 26. Mula-Mutha River near Yerawada, one mile East ; 27. Right Bank Canal near Shankarshet Road ; 28. Ambil Odha near Padmavati ; 29. Aranyeshwar Temple area ; 30. Vadgaon Canal ; 31. Mutha River towards Kharakwasala.

ABBREVIATIONS

The following contractions have been used in describing the different parts and usual measurements :

- L—length
 H—height
 D—diameter or depth
 DM—diameter major
 dm—diameter minor
 AH—apertural height
 AW—apertural width
 DV—depth of the two halves

The measurements are those of single specimens of the species and do not represent averages. Average measurements are deliberately not provided in this paper; unless a long series of specimens is examined it would be meaningless to give average measurements.

The bracketed numbers indicate other localities where a given species occurs.

SYSTEMATIC LIST OF THE SPECIES

Class	GASTROPODA
S. Class	PROSOBRANCHIATA
Order	MEGAGASTROPODA
Series	ARCHITAENIOGLOSSA
Family	CYCLOPHORIDAE

1. *Cyclophorus (Litostylus) involvulus* (Müller) (Fig. 1)

The shell is turbinate and the spire is elevated with inflated whorls. The shell is spirally striated and striae on the body whorl form spiral ridges. The aperture is oblique to the axis and is circular. The peristome is thick and markedly reflected. The umbilicus is broad and deep but partially occluded by the reflected peristome. The shell is chestnut coloured with brownish white wavy marks.

Locality. Only a single intact specimen was collected, along with some broken pieces, on the bank of Mutha River near Vithalwadi. Attempts to secure more specimens have not proved successful. The species is thus rare and not available readily in this area.

Measurements. H—13 mm. ; DM—26 mm. ; dm—16 mm. ; AH—12 mm. ; AW—12 mm.

2. *Cyclophorus (Annularia) aurantiacus* (Schumacher) (Fig. 2)

The shell is quite large, thick, and solid. The spire is turbinate, more depressed and relatively broad. The last whorl is broad and the whorls of the spire are convex. All the whorls are transpirally striated but the basal part of the body whorl is smooth and fine. The conspicuously large aperture is circular and has a thickened peristome which is reflected out. The shell is fulvous white with zig-zag deep brown marks. The interior of the apertural lip is bright orange while the inner portion is whitish.

Locality. Two specimens in good condition were collected from the bank of Mutha River near Vithalwadi. The species seems to be rare and has not been noticed elsewhere.

Measurements. H—20 mm. ; DM—33 mm. ; dm—22 mm. ; AH—16 mm. ; AW—16 mm.

Family	VIVIPARIDAE
S. Family	VIVIPARINAE

3. *Vivipara bengalensis* (Lamarck) (Fig. 3)

This is a familiar banded pond snail formerly known as *Paludina*. Satyamurty (loc. cit.) gives good information on the various allied species.

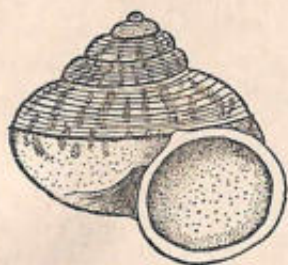
The shell is ovately conical. The lower part is more or less ovoid with a spire which is broadly conical. The whorls are rather inflated and the sutures are well impressed. The aperture is mango-shaped, i.e. angularly pointed above and rounded below. The sculpture consists of close-set fine transpiral lines and minute punctures. The coloration varies a great deal but usually the shell is olive-green with alternating broad and narrow dark brown spiral bands. The narrower bands are lighter in colour than the broad ones. The former alone are present in the basal part of the body whorl.

Locality. This species is quite common in Poona and is found in ponds and pools. The specimens were collected from all the localities ; the one figured is from the ponds in Sambhaji Park. (1, 2, 4, 5, 8, 13, 16, 19, 20, 23, 25, 29).

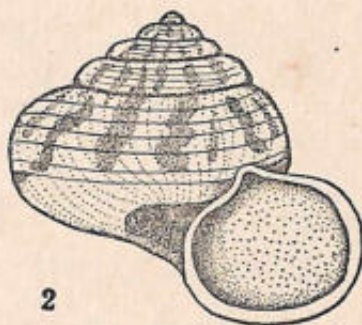
Measurements. H—25 mm. ; DM—21 mm. ; dm—17 mm. ; AH—15 mm. ; AW—11 mm.

4. *Vivipara dissimilis* (Müller) (Fig. 4)

This is also a common pond snail. It is treated by some authors as a variety of *V. bengalensis*. The shell is broader with a body whorl which is more ovoid. The sculpture consists of close-set delicate spiral striae and oblique transpiral growth striae which are prominent and well marked in the peripheral region of the body whorl. The ovoid



1



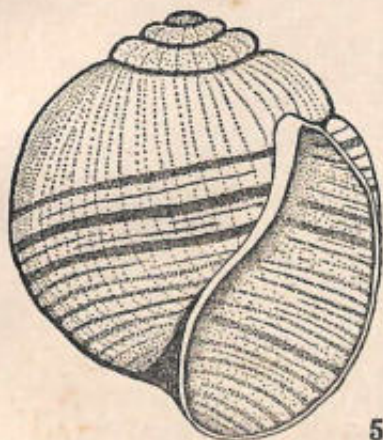
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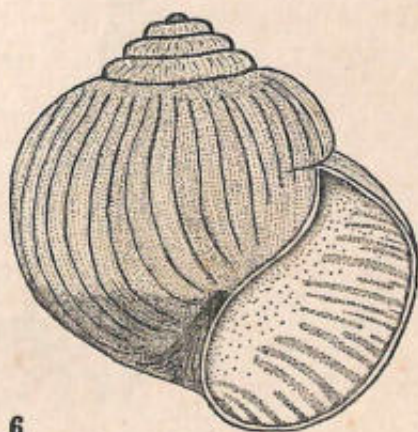
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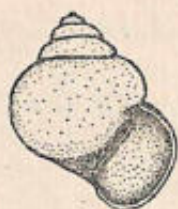


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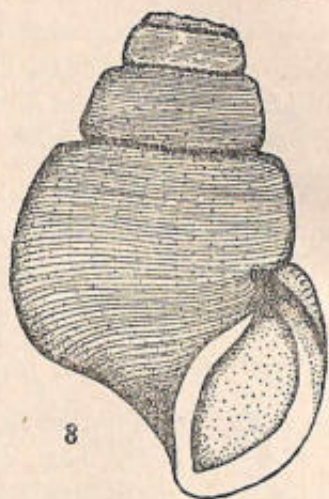


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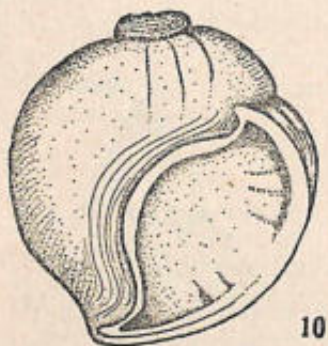
1. *Cyclophorus (Litostylus) involvulus* (Müller) × 0.8; 2. *Cyclophorus (Annularia) aurantiacus* (Schumacher) × 1; 3. *Vivipara bengalensis* (Lamarck) × 1.6; 4. *Vivipara dissimilis* (Müller) × 1.6; 5. *Pila globosa* (Swainson) × 1; 6. *Pila* sp. × 1.3



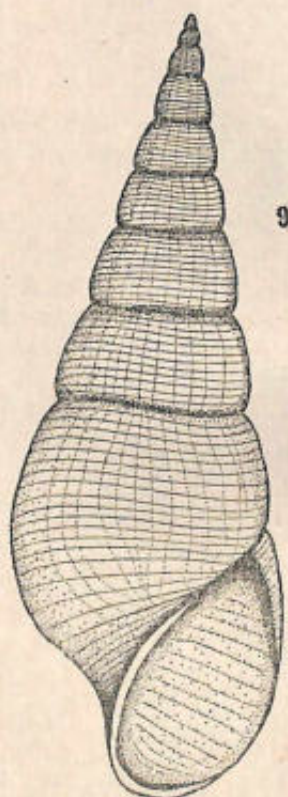
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11

7. *Bithynia stenothyroides* Dohrn. $\times 4$; 8. *Sulcospira* (*Sulcospira*) *hügelii* var. *compacta* Nevill. $\times 4$; 9. *Faunus ater* (Linné) $\times 2.5$; 10. *Paludomus* (*Stomatodon*) *stomatodon* Benson $\times 1.8$; 11. *Melania* (*Plotia*) *scabra* (Müller) $\times 2$

aperture is covered by a horny operculum which is narrowed above. The umbilicus is narrower in this species than in *V. bengalensis*. The shell is dirty olive-green; the interior is of dull bluish white colour.

Locality. Several specimens of empty dead shells of varying sizes have been collected from the Mutha River banks. They are abundantly available beyond M. E. S. College and Sambhaji Park area. Freshwater ponds often contain this species along with *V. bengalensis*, but it is of interest that the number of specimens of the species is relatively more in flowing water than *V. bengalensis*. (1, 8, 9, 13, 20, 26).

Measurements. H—21 mm.; DM—19 mm.; dm—14 mm.; AH—12 mm.; AW—9 mm.

Family

AMPULLARIDAE

5. *Pila globosa* (Swainson) (Fig. 5)

This species, with a globose shell, is most familiar. The spire is depressed but the whorls are inflated. The surface is very smooth and glossy. The aperture is oblong oval with the margin slightly thickened. The umbilicus is small, contracted by the raised peristome which is slightly reflected. The colour of the shell is brownish olive with irregular red-brown conspicuous spiral bands. The interior of the shell is shiny with yellow tinge and transverse reddish bands. The transpiral growth striae occur on the last whorl and are stronger near the aperture.

Locality. This species is not collected from Poona City area but is common in the adjoining parts and is used for dissections.

Measurements. H—47 mm.; DM—42 mm.; dm—32 mm.; AH—33 mm.; AW—20 mm.

6. *Pila* sp. (Fig. 6)

Since it has not been possible to determine its identity only a description of the shell is given here.

The shell resembles the preceding species; it differs in the spire being much more depressed but the whorls are less markedly inflated and convex. Consequently, the spire is more conical. The surface of the shell is not smooth and glossy but roughened by transpiral striae. The striae are particularly prominent on the body whorl and give a wrinkled appearance. The aperture is ovate but very slightly narrowed above and rounded below. The lips of the aperture are feebly reflected and so the columellar lip does not occlude the umbilicus. One of the characteristics of the species is the conspicuous and wide umbilicus. In this respect it does not resemble *P. layardi* (Reeve), *P. virens* (Lamarck), *P. nux* (Reeve), and *P. dolioides* (Reeve) with each of which it shares some characters. Moreover, it differs from these in coloration as the present species has a uniform olive-brown horny periostracum beneath which

the shell is whitish. The interior of the aperture is whitish but towards the outer side is yellowish with irregular red bands.

Locality. The species is often collected along with *P. globosa* and presumably occurs in the same habitats. It is not available in the City limits.

Measurements. H—37 mm.; DM—33 mm.; dm—14 mm.; AH—28 mm.; AW—17 mm.

Series RISSOACEA

Family HYDROBIIDAE

7. *Bithynia stenothyroides* Dohrn. (Fig. 7)

The shell is small ovately globose with four to five whorls. The last whorl is strongly inflated and is larger than all the others together. The whorls are convex with the spire conical. The aperture is broadly oval with the lip continuous but feebly reflected. The shell is semi-transparent, glossy with a faint bluish tinge. The shell is devoid of any conspicuous sculpture. The operculum is concentrically striated.

Locality. This is one of the common species occurring in Poona. The species is abundant in slow-moving streams, ponds, pools, and tanks. Specimens have been collected from the underside of stones in the Vithalwadi canal and the University campus in wet season. They collect in large numbers and seem to be gregarious in habit. (12, 13, 14, 16, 19, 20).

Measurements. H—6 mm.; DM—4.5 mm.; AH—2.3 mm.; AW—1.7 mm.

Series CERITHIACEA

Family MELANIIDAE

S. Family MELANATRIINAE

8. *Sulcospira (Sulcospira) hügelii* var. *compacta* Nevill. (Fig. 8)

This is a shorter and stouter variety of *S. hügelii*. The body whorl is markedly angular and the spire is more truncate. The upper whorls are often found missing in older shells. The aperture is more or less contracted with the basal margin markedly produced below. The outer lip is sharp and thin. The columellar margin is smooth and white. The characteristic smoky-brown colour is darker in the dead shells. The spiral sulcations at the base of the body whorl are conspicuous.

Locality. The specimens are common in Poona and were collected from Pashan tank area and particularly in muddy habitats. (16, 17, 28, 30, 31).

Measurements. H—15 mm.; DM—9 mm.; AH—6 mm.; AW—4 mm.

S. Family

MELANOPSINAE

9. *Faunus ater* (Linné) (Fig. 9)

The shells are elongatedly tapering and turreted with the whorls more or less flattened. The apex is acuminate and the sutures are well impressed. The lower whorls have widely-spaced spiral grooves mixed with dense transpiral striations on the surface. The aperture is small, ovately angled above but with a broad basal anterior canal. The columella is smooth, arched, and extends into a parietal callous. The labrum is sharp and thin. The surface is rough with iron rust colour and some specimens are bleached into yellowish olive-brown colour. The number of whorls are eleven to twelve with the following dimensions which are rather small compared to type specimens. But the species and its variety *F. ater* (Linnaeus) var. *perdecollata* Nevill. to which also this shows resemblance in coloration is extremely variable in size. Probably the specimens are not fully grown.

Locality. This species is quite common in Poona and is an inhabitant of small freshwater streams and brooks, occasionally of large ponds and river banks. They were usually found on muddy substrates. The specimens have been collected from Ambil Odha, Kothrud canal, Vithalwadi, and adjacent Mutha River. (1, 6, 7, 8, 9, 10, 12, 13, 16, 20, 26, 27, 31).

Measurements. H—36 mm. ; DM—12 mm. ; AH—10 mm. ; AW—5.6 mm.

S. Family

PALUDOMINAE

10. *Paludomus* (*Stomatodon*) *stomatodon* Benson (Fig. 10)

The shell is very thick and solid and has a neritoid form and appearance. The shell has a depressed spire with a very strongly inflated body whorl. The aperture is sigmoidly oval with a tooth-like projection in its basal margin. The apices of the spire are usually worn out or damaged. The shell is dark olive-brown but the apex is black.

Locality. Species belonging to this and other related genera are known to occur in Maharashtra but it is rare in Poona. Some shells were collected from the bank of Mutha River where Vadagaon stream joins it. The approach to this place is from Vithalwadi temple. Nowhere else have the shells been noticed again.

Measurements. H—21 mm. ; DM—17 mm. ; dm—14 mm. ; AH—17 mm. ; AW—10 mm.

S. Family

MELANIINAE

11. *Melania* (*Plotia*) *scabra* (Müller) (Fig. 11)

Quite apart from the other characteristics which separate this species from the succeeding one it is more broad in proportion to height than

M. tuberculata. The whorls of the spire bear spinous shoulders in their upper part. The whorls also bear well-developed transpiral ridges with spiny processes. The aperture is ovate. The shell is variable in its coloration but usually is brownish olive, spotted with few rust-coloured transpiral marks. The apical region is often darker than the body and the penultimate whorl. The prominent angular ridges and the spinous processes are often worn out in older specimens.

Locality. The species is quite common in Poona. The specimens were found to inhabit flowing clear water and sandy and gravelly habitats. (1, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 21, 22, 24, 25, 27, 28, 29, 30).

Measurements. H—20 mm. ; DM—12 mm. ; dm—9 mm. ; AH—7.5 mm. ; AW—5 mm.

12. *Melania (Plotia) scabra* (Müller) var. *elegans* Hutton (Fig. 12)

This is a variety of *M. scabra* and deserves separate treatment as has been given by other authors. The shell is markedly thick, more solid with a turreted spire. The whorls have well-developed angular shoulders which are occasionally provided with spinous projections. The small oval aperture is sinuous above and rounded below. The colour is variable between pale brown and sandy brown with fine reddish transpiral wavy elegant marks.

Locality. This species is quite common in Poona and is found to occur in similar and often the same habitats as the *M. scabra*.

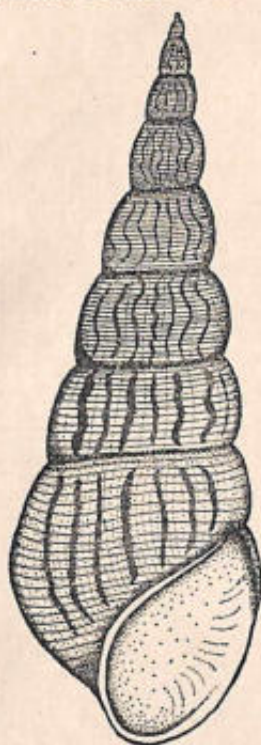
Measurements. H—20 mm. ; DM—8.5 mm. ; dm—7.5 mm. ; AH—8 mm. ; AW—4.5 mm.

13. *Melania (Striatella) tuberculata* (Müller) (Fig. 13)

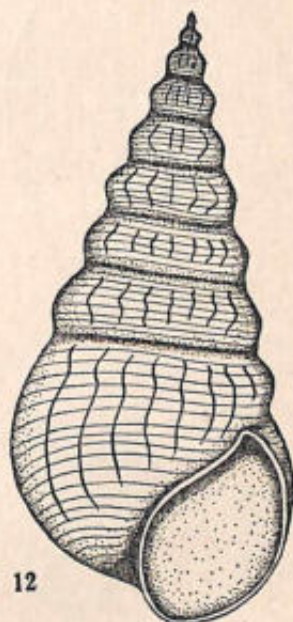
The shell is elongated with an acuminate apex. The whorls are neatly convex and progressively increase towards the body whorl. The aperture is oval but more narrowed above and broadly rounded below. The sculpture consists of transpiral tuberculated ridges with raised spiral striae. The body whorl is usually devoid of transverse tuberculated ridges. The colour of the shell is dark brown with rows of reddish undulating flame-shaped discontinuous bands. The interior of the shell is glossy with external marks faintly visible.

Locality. Living specimens and dead empty shells were invariably found in clear running water. The specimens have been collected from a large number of localities of which the following were found to contain relatively more abundant number of the species : 1, 3, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 21, 24, 25, 26, 28, 29, 31.

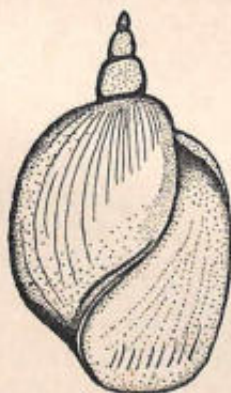
Measurements. The measurements of a specimen collected from the University area are as follows : H—30 mm. ; DM—9 mm. ; dm—7.5 mm. ; AH—8 mm. ; AW—5 mm.



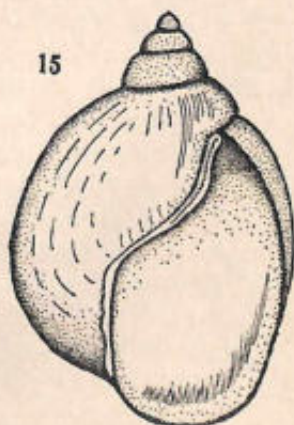
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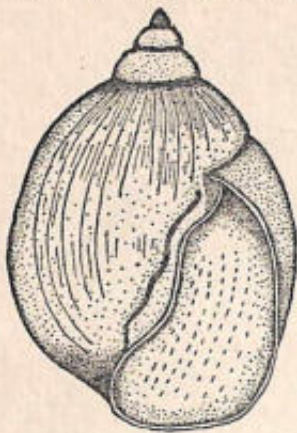


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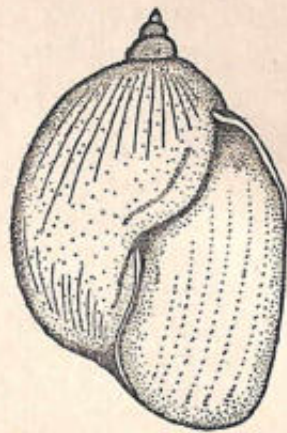


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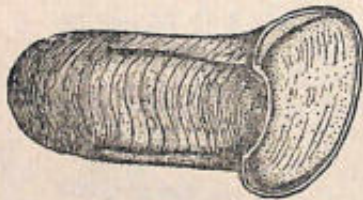
12. *Melania (Plotia) scabra* var. *elegans* Hutton $\times 4$; 13. *Melania (Striatella) tuberculata* (Müller) $\times 3$; 14. *Lymnaea acuminata* Lamarck $\times 1.5$; 15. *Lymnaea luteola* Lamarck $\times 2.5$



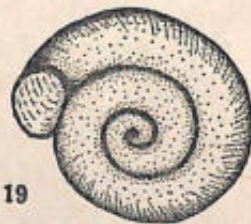
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16. *Lymnaea pinguis* Dohrn. $\times 2$; 17. *Lymnaea auricularia* (Draparnaud) $\times 2$; 18. *Planorbis* (*Indoplanorbis*) *exustus* (Deshayes) $\times 3$; 19. *Anisus* (*Gyraulus*) *convexiusculus* (Hutton) $\times 2.5$; 20. *Opeas gracile* (Hutton) $\times 4$; 21. *Zootecus chion* (Pfeiffer) $\times 4$; 22. *Zootecus insularis* (Ehrenberg) $\times 4$

S. Class	PULMONATA
Order	BASOMMATOPHORA
Series	HYGROPHILA
Family	LYMNAEIDAE
S. Family	LYMNAEINAE

The genera of non-operculate thin-shelled freshwater snails have a world wide distribution and are exceedingly plastic. A large number of varieties of each species has been described by previous authors.

14. *Lymnaea acuminata* Lamarck (Fig. 14)

The shell is ovately oblong, smooth, thin, and semi-translucent. The body whorl is slightly angular above and inflated below the middle. The spire is short, narrow, with the attenuated whorls forming a pointed apex. The aperture is wide with the columellar lip twisted. There is a fine close-set transpiral striation on the surface of the shell. The body whorl is clearly demarcated from the spire with an abruptly narrowed base.

Locality. This is a common and widely distributed species inhabiting ponds, pools, and ditches with abundant aquatic vegetation with sphagnum. (1, 2, 3, 4, 6, 12, 15, 16, 19, 20, 29, 31).

Measurements. A dry shell from Law College Ponds measured : H—31 mm. ; DM—18 mm. ; AH—24 mm. ; AW—10 mm. ; Body whorl—27.5 mm. ; Spire—4.5 mm.

15. *Lymnaea luteola* Lamarck (Fig. 15)

The shell is broader in proportion to the height in this species than in *L. acuminata*. The spire is short, conical, with a broader base which gradually merges with an inflated body whorl. The whorls of the spire are clearly inflated. The ovate aperture is rather angularly narrowed above but is rounded below. The shell is smooth, glossy, with a pale yellow horny tinge. The sculpturation consists of close-set fine transpiral striations, which are seen only under binocular microscope. In addition to these a few widely-spaced spiral striae were also seen. The colour of the columellar fold is opaque white and is a rather characteristic feature of this species.

Locality. This species has been so far noticed only in streams and standing water on the banks of rivers Mula and Mutha. They were found attached to various floating objects such as twigs. (1, 7, 8, 9, 13, 21, 22, 23, 24, 26, 31).

Measurements. H—18 mm. ; DM—10 mm. ; AH—10 mm. ; AW—6 mm.

16. *Lymnaea pinguis* Dohrn. (Fig. 16)

The shell is ovately oblong or more or less spindle-shaped. The shell is narrower in the middle in relation to its height than the other *Lymnaea* species. The spire is elevated and consists of about four whorls which are slightly concave. The spire terminates in an acute apex. The body whorl is elongately ovate, inflated, and measures more than two-thirds of the total length. The aperture is slightly oblique and elongately oval. The outer lip is thin and the columellar lip slightly reflected and bears callus. The surface of the shell is closely striated transpirally. The shell is pale horny brown and semi-translucent.

Locality. This is a very widely distributed species occurring on Mutha River banks and in ponds and pools. The specimens were collected from habitats with abundant sphagnum and other emergent aquatic vegetation. (1, 2, 3, 4, 5, 7, 13, 16, 19, 20, 29).

Measurements. H—22 mm.; DM—10 mm.; AH—16 mm.; AW—9 mm.

17. *Lymnaea auricularia* (Draparnaud) (Fig. 17)

The shell is semiglobose, squarish, and rather thin, with pallid horny colour. The conical spire consists of three whorls which are convex and form a sharply pointed apex. The body whorl is abruptly widened and is greatly inflated. The large and broad aperture has a thin and expanded outer lip. The columellar lip is callus, twisted, and covers the narrow umbilicus. The surface of the shell is irregularly striated in the direction of the lines of growth.

Locality. This species is very cosmopolitan in distribution and occurs in every type of habitat. It has been noticed in all the spots visited and particularly in standing water.

Measurements. H—22 mm.; DM—13 mm.; AH—16 mm.; AW—8.7 mm.

Family

PLANORBIDAE

18. *Planorbis (Indoplanorbis) exustus* (Deshayes) (Fig. 18)

It has been quite difficult to determine the identity of the various Planorbids collected in the course of this work. The species is extremely variable in its size, form of its spire, and other architectural details.

The shell is relatively large, moderately thick, and flattened on both sides. The shell is usually sinistral, discoidal, with the spire depressed and sunk in the expanded body whorl. The three whorls are quite convex and are spirally coiled in the horizontal plane. The basal part of the shell shows the wide umbilicus and the whorls of the spire. The aperture is ear-shaped and enlarged. The outer lip is relatively thickened and feebly reflected outwards. The shell is transpirally and finely

striated throughout, and the body whorl shows more distinct transpiral ridges. The range of variation in colour is considerable.

Locality. The species has been collected from sluggish streams, stagnant ponds, marshy spots, and is so common that none can miss it. The presence of haemoglobin enables them to inhabit even foul water. Specimens were collected even from portion of the Mutha River where the city sewage flows out (almost everywhere except fast flowing rivers and streams).

Measurements. H—7 mm. ; DM—15 mm. ; dm—10 mm. ; AH—10 mm. ; AW—7.5 mm.

19. *Anisus (Gyraulus) convexiusculus* (Hutton) (Fig. 19)

This is one of the smallest mollusca recorded in this account. The shell is strongly depressed with the sunken spire giving an appearance of a flattened disc. The shell is dextral with four to five whorls and has well-defined sutures. The oblique aperture is lunately oval with the outer lip evenly rounded. The umbilicus is wide, exposing the involutions from below. The surface is polished and of pale horn colour, with close-set oblique transpiral striae.

Locality. The species is common and occurs in abundance in tanks, ponds, ditches, and many other places with vegetation. It is widely distributed. The one figured and measured is from the University campus. (2, 3, 4, 5, 12, 16, 19, 20, 29).

Measurements. H—1.78 mm. ; DM—6.5 mm. ; dm—4.5 mm. ; AH—1.80 mm. ; AW—2 mm.

Order	STYLOMMATOPHORA
Series	ACHATINACEA
Family	SUBULINIDAE
S. Family	OPEATINAE

20. *Opeas gracile* (Hutton) (Fig. 20)

The shell is small, thin-walled, and turreted. The spire is gradually tapering and the apex is rounded. The body whorl is conspicuous and equal to two preceding ones. The number of whorls is variable from eight to twelve. The aperture is distinctly longer than broad, semi-ovate, but slightly narrowed above. The columellar lip is almost straight and partly reflected, while the outer lip is thin and sharp-edged. The shell is uniformly pale-horny-coloured but variable in the different hues of yellow colour. Striae are not discernible to the naked eye.

Locality. A couple of specimens were collected from the Mula River near Yerawada. The species is reported from Poona before and

has a wide range of distribution. However, it is not so common in the Poona area.

Measurements. H—9 mm. ; DW—2.9 mm. ; AH—2.8 mm. ; AW—1.9 mm. The measurements are smaller than those given by previous authors.

S. Family RUMININAE

21. *Zootecus chion* (Pfeiffer) (Fig. 21)

The shell is of moderate size, smooth, and glossy. The spire is elongated and terminates in a conical apex. There are seven whorls, of which the body whorl is large and is approximately one-third the total length and is well rounded below. The penultimate and ante-penultimate whorls are almost as broad as the body whorl. Thus the shell has a characteristic cylindrical pupiform appearance. The aperture is semi-oval with inner lip slightly reflected to partly occlude the umbilicus. The peristome is slightly thickened, with callus. The surface of the shell is covered by close-set fine transpiral striae.

Locality. The species is represented by a single intact shell. The specimen was collected from the banks of Mula-Mutha River near Bund Garden. This species has not been reported before from Poona.

Measurements. H—12 mm. ; DM—5 mm. ; dm—4 mm. ; AH—3 mm. ; AW—2.2 mm.

22. *Zootecus insularis* (Ehrenberg) (Fig. 22)

The shell is pupiform, subcylindrical, and thin. There are about seven-and-a-half whorls and they are moderately convex. The body whorl is slightly above the aperture. The aperture is semi-oval pointed above with the columellar margin dilated, thickened, and partially covering the narrow umbilicus. The sculpture consists of close-set fine subvertical striae. The shell is translucent, corneous-white.

Locality. The specimen was collected from the same locality as the preceding one.

Measurements. H—8.5 mm. ; DM—3.7 mm. ; dm—1.8 mm. ; AH—18 mm. ; AW—1.3 mm. The species is extremely variable in size but the specimen measured here confirms to the measurements given by Gude (1914).

Series	ARIOPHANTACEA
Family	ARIOPHANTIDAE
S. Family	MACROCHLAMYDINAE

23. *Macrochlamys pedina* (Benson) (Figs. 23 & 24)

The genus *Macrochlamys* is represented by a little over hundred species in this continent and it is difficult to recognise the different forms

as the differences in the shells are so small indeed, that they had to be arranged according to locality (Blanford & Godwin-Austen, 1908).

The shell is depressed, very thin, and translucent. The spire is conoid but very low. The whorls are six-and-a-half to seven in number and are slightly convex above. The body whorl is bluntly subangulate above the periphery but rounded below. The lunately round aperture is oblique to the axis. The peristome is thin, while the columellar lip is vertical and reflected to cover part of the umbilicus. The umbilicus is wide and conspicuous. The shell is more or less smooth with minute close-set transpiral striations. The colour is variable from pale yellow to fulvous horny.

Locality. This species has been reported from Poona and is known to be common in a considerable part of old Bombay Presidency. The specimen was collected from the vicinity of a tank in the Poona University campus.

Measurements. H—15 mm. ; DM—33 mm. ; AH—14 mm. ; AW—8.5 mm. The measurements are slightly more than those given by Blanford & Godwin-Austen (1908). This is one of the largest Indian species.

24. *Macrochlamys infausta* Blanford (Fig. 25)

The shell is thin, depressed, and subglobose. There are six whorls, rather convex, with well-impressed sutures. The spire is very low and broadly conoidal. The body whorl is relatively broader and rounded at the periphery. The aperture is oblique to the axis, and is lunately round. The peristome is thin and the columellar margin curved and carried forward without being reflected. The sculpture consists of fine close-set longitudinal striae. The shell is translucent, delicate, and fragile, with a dull oily lustre above. The colour is brownish tawny and glassy below. The species differs from *M. pedina* by its smaller size, rounded periphery, and relatively more open perforation.

Locality. The species is quite common in gardens and parks. Specimens were collected from the ponds of the Sambhaji Park and the University campus. (1, 4, 5, 8, 19, 20).

Measurements. H—9 mm. ; DM—18 mm. ; dm—15 mm. ; AH—8 mm. ; AW—5 mm.

25. *Cryptozona (Xestina) belangeri* var. *bombayana* (Pfeiffer) (Fig. 26)

The shell is large, more or less globose, with depressed and low spire. The whorls are slightly inflated and distinctly convex with well-impressed sutures. The aperture is roundly lunate, not as broad as high. The peristome is thin and the columellar margin is slightly reflected. The surface of the shell is obliquely striated with decussated impressed lines which are sometimes absent. The basal region is relatively smooth. The

colour is extremely variable, ranging from dull white, pale horny, and sometimes to tawny brown.

Locality. This is considered as a variety of *C. belangeri* on account of its small size. There is significant variation in the size of shells collected from different localities. The species is available in large numbers in the Poona University campus especially during the wet season. (19, 20).

Measurements. One specimen: H—25 mm.; DM—28 mm.; dm—22 mm.; AH—20 mm.; AW—14 mm.; Another specimen: H—20 mm.; DM—24 mm.; dm—18 mm.; AH—15 mm.; AW—10.5 mm.

26. *Ariophanta laevipes* (Müller) (Fig. 27)

The shell is relatively depressed, rather thin, with coloured bands. The spire is low, and there are five whorls which are more or less convex. The body whorl has an angulated periphery but is rounded below. The apex is depressedly conoidal. The aperture is very oblique and almost diagonal to the axis. The peristome is moderately thickened and reflected below. The shell is obliquely striated and decussated with fine spiral lines. The lower part of the body whorl is smooth. The ground colour of the shell is variable from white to brown or dark brown. But the species is characterised by three spiral chestnut bands, one close to the suture, and one above and one below the periphery. The parietal wall of the aperture and the area surrounding the umbilicus (*Periomphalus*) have the same colour as the body whorl.

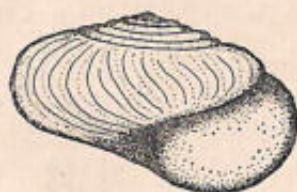
Locality. The specimens are not so abundant in Poona as *Cryptozona*. The species is common in gardens and the specimens in the collection are from the University campus. (19, 20).

Measurements. H—17 mm.; DM—28 mm.; AH—11 mm.; AW—8 mm.

27. *Ariophanta bajadera* (Pfeiffer) (Fig. 28)

The shell is of moderate size and rather thin. The spire is bluntly conical with apex which is broadly obtuse. There are four-and-a-half to five whorls which are convex with the well-impressed sutures. The body whorl is swollen and rounded at the periphery. The body whorl is slightly inclined below at the aperture. The aperture is diagonal to the axis and roundly lunate. The peristome is thin and whitish. The surface of the shell is sculptured with coarsely plicate striae but is relatively smooth below the body whorl. The shell is brownish horny and is glossy.

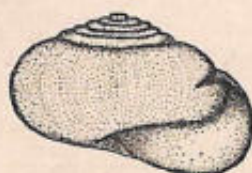
Locality. A few broken pieces together with an intact empty shell were collected from the banks of Mutha River near Vithalwadi (Aran-yeshwar). The area was covered with small shrubs. The specimens were few and probably this species is not so common. (20, 23).



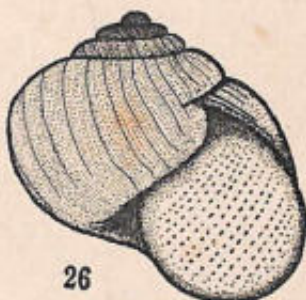
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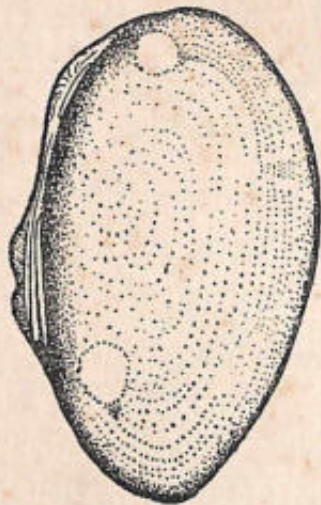
23. *Macrochlamys pedina* (Benson) $\times 1$; 24. *Macrochlamys pedina* (lower view) $\times 1$; 25. *Macrochlamys infausta* Blanford $\times 1.5$; 26. *Cryptozona* (*Xestina*) *belangeri* var. *bombayana* (Pfeiffer) $\times 1.3$; 27. *Ariophanta laevipes* (Müller) (lower view) $\times 1$; 28. *Ariophanta bajadera* (Pfeiffer) (lower view) $\times 1$; 29. *Planispira proxima* (Férussac) $\times 1.5$; 30. *Planispira proxima* (Férussac) (lower view) $\times 1.8$



31



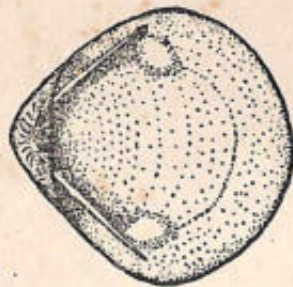
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31. *Parreysia (Parreysia) corrugata* var. *nagpoorensis* (Lea) \times 1.5; 32. *Parreysia (Parreysia) corrugata* var. *nagpoorensis* (Lea) \times 1.5 (hinge); 33. *Lamellidens marginalis* (Lamarck) (inner view of the left valve); 34. *Lamellidens marginalis* (Lea); 35. *Corbicula regularis* Prime (outer view) \times 1.2; 36. *Corbicula regularis* Prime (inner view) \times 1.2.

Measurements. H—20 mm. ; DM—27 mm. ; dm—20 mm. ; AH—14 mm. ; AW—12 mm.

Series	HELICACEA
Family	PLEURODONTIDAE

28. *Planispira proxima* (Férussac) (Figs. 29 & 30)

The shell is moderate in size, conoidly depressed, and is rather globose. The whorls are five to five-and-a-half in number, increasing rapidly in size until the body whorl is dilated near the aperture. The whorls are convex and sutures are deeply impressed. The apex is obtuse as the spire is depressed. The body whorl is slightly inclined towards the aperture, which is somewhat oblique to the axis and is broadly ovate. The margins of the aperture approach towards each other and are united by a thin callus on the parietal wall. The peristome is thickened, expanded, and reflected. The umbilicus is moderately open and more or less perspective. The sculpturation consists of close-set, rather coarse, oblique transpiral striations. The colour of the shell is light fawn with a brown band at the periphery.

The genus is characterised by the body whorl strongly deflexed in front and the converging ends of the aperture. The species shares some characters with *P. albicostis*, *P. fallaciosa*, *P. crassicostata*, *P. colletti*, *P. footei*, and *P. vittata*, but can be separated from them on the basis of the above characters.

Locality. The genus has been reported from Poona and the adjoining parts of Maharashtra. The shells are not common. A couple of good specimens were collected from Mutha River banks near Vithalwadi.

Measurements. H—12 mm. ; DM—21 mm. ; dm—15 mm. ; AH—9 mm. ; AW—8.5 mm.

Class	PELECYPODA (BIVALVIA)
Order	EULAMELLIBRANCHIATA
S. Order	SCHIZODONTA
Series	UNIONACEAE
Family	UNIONIDAE

29. *Parreysia* (*Parreysia*) *corrugata* var. *nagpoorensis* (Lea) (Figs. 31, 32)

The shell is of large size, transversely ovate, sub-triangular and inequilateral. The shell is moderately inflated and the valves are almost as long as high. The anterior end is narrowly rounded, while the poste-

rior end is more or less broadly angular above and below. The prominent umbo is slightly inclined forwards. The periostracum is rufous-brown tinged with green towards the ventral margin. The umbonal region is ornamented with divaricating obliquely radial ridges. The hinge margin is slightly inclined downwards in front of and behind the umbo. The inner surface of the shell is pearly, slightly pinkish, and brilliantly iridescent. The cardinals are strong, jagged, and crenulated. The laterals are lamellar, elongated, and slightly curved.

Locality. The specimens are quite common on the banks of Mutha, Mula, and Mula-Mutha Rivers. The empty shells have also been noticed in the canals which have more or less permanent water throughout the year. (20, 23, 24, 25, 26).

Measurements. L—45 mm. ; H—22 mm. ; DV—20 mm.

30. *Lamellidens marginalis* (Lamarck) (Fig. 33)

The shell is oblongly ovate, approximately twice as long as high, and relatively more inflated. The umbones are prominent. The anterior margin is narrower than the posterior, the former evenly rounded while the latter is roundly angular. The shell is thin and covered with blackish brown or greenish brown epidermis which is frequently worn away in the adult shells and more particularly near the umbones. The inner surface is iridescent and pearly.

Locality. This species is available in Poona but is not so common as the next one. The species is available in the Mula-Mutha River ; the specimens were collected from the river near Yerawada and a mile further up.

Measurements. L—76 mm. ; H—40 mm. ; DV—30 mm.

31. *Lamellidens corrianus* (Lea) (Fig. 34)

The shell is narrowly elliptical, strongly transverse, and is longer in proportion to the height. The valves are relatively thin. The anterior margin is rounded, while the posterior margin is sub-angular. The beaks are not so prominent and usually the periostracal layer is eroded in fully grown shells. The ventral margin is roundly curved. The cardinal teeth, single in the left valve and paired in the right valve, are thin and bladed. The lateral teeth are elongated and nearly straight. The pearly white iridescence of the nacreous layer is characteristic.

Locality. This species is more common in Poona rivers than *L. marginalis*, of which this was considered as a variety. Specimens are available in Mula and Mutha rivers.

Measurements. L—74 mm. ; H—37 mm. ; DV—20 mm.

S. Order	HETERODONTA
Series	SPHAERIACEA
Family	CORBICULIDAE

32. *Corbicula regularis* Prime (Figs. 35, 36)

The shell is triangular, ovate, transverse, and equilateral. The anterior and posterior margins are similarly rounded. Externally the shell is strongly and concentrically striated. The periostracum is dark brownish green while the interior is violet and glossy. The hinge bears three divergent cardinal teeth which are well developed in each valve. The lateral teeth are elongated, lamelliform, and bear fine transverse striae. The pallial line is continuous and is distinct with a shallow pallial sinus.

Locality. This is a common species in this area and empty shells are abundant on the banks of the river. The specimens were collected from many places near the rivers which had a muddy bottom.

Measurements. L—25 mm. ; H—20 mm. ; DM—14 mm.

CONCLUSIONS

A consideration of the preceding systematic account leads to a few generalisations and the following points of interest :

- i. The species belonging to the genera *Cyclophorus* and *Paludomus* do not seem to be the true residents of the area investigated. It is probable that they are washed down from the westerly mountainous region.
- ii. The small size of the species of *Opeas* and *Zootecus* adds to the difficulties in their detection in the field. Even so they have been reported previously from this region and are probably distributed more widely than indicated here.
- iii. The most common Molluscan residents of Poona are the species belonging to the Gastropod genera, viz. *Vivipara*, *Bithynia*, *Melania*, *Lymnaea*, *Planorbis*, *Anisus*, *Macrochlamys*, *Cryptozona*, and *Ariophanta*. The Pelecypoda, represented by the genera, viz. *Parreysia*, *Lamellidens*, and *Corbicula*, are equally common.
- iv. Other genera such as *Rachis*, *Cerastus*, *Euplecta*, and *Ptychotrema* of Gastropoda and *Nodularia*, *Vellorita* of Pelecypoda are not only known to occur in this region but have also been collected in the course of the present study. However, they have not been included in this account as these genera contain several annectant forms and their exact identity is being determined.

- v. It has been noticed in the course of this work that the various species of the genus *Planorbis* are difficult to separate on the basis of only the shell characters.

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The nidification of some common Indian birds—Part 1

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INTRODUCTION

Very little is known about the breeding habits of common Indian birds. Monumental works of savants like Hume (1873, 1889) and Baker (1932) on the subject of nidification deal mainly with the breeding seasons, situation and location of nests, descriptions and measurements of nests and eggs. Many interesting aspects like courtship, nest building, territory, incubation, etc. have been completely left out in the majority of the cases. Although many ornithologists and naturalists have written from time to time about one or more of these aspects of some species or the other, yet our present knowledge of the subject remains sadly deficient.

Material and method. I first got interested in the subject while I was working on the systematics of birds of Hoshiarpur at Panjab University during 1951-52. But the really good opportunity to pursue my interest was provided by the Virus Research Centre, Poona¹, where I worked during 1953-57. In 1953 the Virus Research Centre became interested in nestling birds considering the possibility of their being potential propagators of arthropod-borne viruses. I was asked to keep an eye on the breeding pattern of some of the common species of birds in and around Poona. Accordingly, nests of common species of birds in and around Poona were located by scouting the area. A systematic record was kept of the situation and location of the individual nests. The nests were visited at intervals of one to four days and the contents noted after having a look at the nest. Similar observations were repeated at the Vellore (N. Arcot, Madras) Field Station of the V. R. C., Poona, in 1955-56 and at the Akividu (W. Godavari, Andhra) Field Station in 1956-57 where, in addition to the resident breeding birds, many species of water birds collect in enormous numbers to breed in and around Kolair Lake. On joining the Zoological Survey of India in December

¹ The Virus Research Centre is jointly maintained by the Indian Council of Medical Research and the Rockefeller Foundation.

1957, I was encouraged to keep up my studies, and made observations in and around Calcutta, at Chilka Lake (Puri, Orissa), and in the Balaghat Forest Division (Madhya Pradesh).

Data gathered from these observations and other observational notes kept from time to time are being utilised in the preparation of this series.

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1. THE COMMON INDIAN HOUSE CROW, *Corvus splendens* (VIEILLOT), WITH NOTES ON BROOD PARASITISM ON IT BY THE INDIAN KOEL, *Eudynamys scolopacea* (LINN.)¹

Previous work. The Common Indian House Crow needs no introduction. It is by far the commonest bird of India and yet not much is known about its nidification. Hume (1873 : 413-14) was perhaps the first ornithologist to collate the data then available on the subject. But the information was rather sketchy and far from complete. Many interesting aspects like courtship, nest building, territory, incubation, mortality in young and feeding the young, etc. were, however, left completely untouched even in his later (Hume 1889 : 8-12) and more elaborate compilation, presumably because nothing much was then known about them. Dewar (1905) gave a very useful, still more elaborate and original account of the breeding habits of this bird, but he too failed to throw any light on some of these aspects, especially territory, incubation period, and mortality in the young. Many ornithologists and naturalists (Adam, 1873 ; Butler, 1875 ; Davidson, 1878 ; Cripps, 1878 ; Scully, 1879 ; Doig, 1879 ; Vidal, 1880 ; Ried, 1881 ; Swinhoe, 1885 ; Barnes, 1886 ; Davidson, 1887 ; Taylor, 1887 ; Oates, 1889a ; Munn, 1894 ; Jesse, 1902 ; Fergusson, 1903 ; Prater, 1926 ; Ali, 1926, 1946, 1953 ; Ali & Abdulali, 1937 ; Baker, 1926, 1932 ; Whistler, 1928 ; Inglis, 1931-34 ; Rao, 1936 ; Sen, 1947 to cite a few) have written about the nidification of this bird from time to time but the subject is still far from exhausted.

¹ This section is based almost entirely on observations made when I was working with the Virus Research Centre, Poona.

Breeding season. The breeding season of the common Indian House Crow, *Corvus splendens* (Vieillot), seems to differ slightly in different parts of India. In this connection Hume as early as 1889 stated that the 'breeding season par excellence is June and July but an occasional nest will be found earlier even in Upper India and in Southern and Eastern India a great number lay in May'. According to Dewar (1919 : 27-28) the breeding season of this species 'in Northern, Western and Central India is June to August, most eggs being laid between June 10th and 30th. In Bengal and Burma from March to May, also in January and December. In South India from April to June, a few birds however, nest in November and December or February and March.' Whistler (1928 : 8) remarked that the 'breeding season is very regular in the North-west, eggs being laid from the middle of June till the middle of July. In the rest of India numbers lay in April and May and occasionally nests are found in November, December and January.' Baker (1932 : 16) writing on the subject stated : 'Over Eastern Bengal, Bihar and Arakan the normal breeding season is March and April but in Dacca and Mymensingh there are two well-defined seasons : December, January and February in winter and April, May, and rarely June in the hot weather. In Ratnagiri and in other parts of Bombay Presidency Messrs. Vidal and Davidson found that they had two similar seasons, the principal months being November and December and then again in April and May. Over the rest of India the favourite months seem to be June and July.' Ali (1946 : 2) writing on the subject states : 'In Western India, House-Crows nest between April and June, in Bengal slightly earlier; while in the heavy rainfall areas of SW. India breeding is usually over before the onset of the South-west Monsoon in May.'

Around Poona where a part of this study was made, the breeding season commenced by the end of April, most eggs and nests were found in May-June, and fledglings in June-July. Occasional nests were also met with in August. On the other hand at Vellore (N. Arcot, Madras) where a major portion of the present work was executed the nests did not start coming up till nearly the middle of May. Most of the eggs were found in June and most fledglings in July. The breeding season lingered fairly well into August, when a few nests with fledglings could be located.

Mating. With the advent of the breeding season large flocks, which feed and habitually hang about near markets, rice and ground-nut mills, municipal refuse-dumping grounds and cultivated fields, start breaking up. Partners are now sought out and courted. The pairs keep fairly close together even when feeding. At this time if any one happens to look for crows one can find them sitting in pairs on shady

trees or in other shady spots, resting after their meals, during the hottest part of the day.

Apparently the crow does not like to make a public exhibition of its connubial affections. Whereas it does not mind a little indulgence in public, by way of head-tickling in a tree, on a house top, or any other convenient spot, it is rather discreet about its sexual intercourse. Although the most common bird everywhere, very rarely indeed does one observe crows copulating. Copulation usually takes place in trees, sometimes on house tops or on the ground, and occasionally even in the middle of a busy road (Acharya, 1951). No particular part of the day is preferred, and it is most frequent when the nest is under construction. It may be preceded by mild spooning (head-tickling) or the passage of a toothsome morsel from male to female but, as frequently as not, it comes off without any preliminaries. The male having secured a hold on the female's head with his beak mounts on her back, and she in turn sits quietly with neck drawn in and wings spread out a little. Balancing himself with his foot-and-beak hold the male brings his hind quarters down to effect a cloacal connection. The whole process hardly takes a few seconds. Sometimes, however, the male is not able to establish the connection at the first attempt, either because of losing his balance while lowering his hind part or owing to the movement of the female at the crucial moment under his weight. In such cases the male lowers his hind quarters a number of times against the female cloacal opening.

Nest building. Mating in crows is indicative of the fact that they have either started building nests or are going to do so shortly. The first step towards the construction of the nest is the selection of a suitable site, of which there appears to be no lack for the House Crow. It is not known which sex makes the final decision as regards the suitability of the site, but I have reasons to believe that the female does have an important say in the matter. It is not an uncommon sight in the breeding season to see a bird, stick in beak, moving from one tree to another, hesitant to put it down, being followed closely by another bird with or without a stick. On three such occasions I have shot the leader in order to determine the sex and all the three turned out to be females.

A thin vertical fork near the top of the tree, or on one of the outermost branches of any of the larger trees like *Dalbergia sissoo*, *Acacia arabica*, *Tamarindus indicus*, *Melia azadirachta*, or *Ficus* is a favourite site. But in the localities where large trees are wanting or have already been occupied by others of its own species, it does not hesitate to avail itself of other sites provided by smaller trees, edges and nooks of buildings (Hume, 1889 : 8 ; Baker, 1932 : 17), telephone and telegraph

poles and wires (Dewar, 1905 : 25). It is seldom that a site inside a building is selected; the most famous and historic of such cases on record is that reported by Benjamin Aitken to A. O. Hume (1889 : 10) of a pair of Madras crows who selected the very narrow top ledge of a pillar in the verandah of an office to construct a nest and took nearly five months to finally build a nest which did not fall off the ledge. The site selected is invariably in or near human habitation.

After the site for the nest has been selected construction starts in right earnest. Both the birds go hunting for twigs/sticks together. Dry, usually thorny, sticks and twigs are picked up from under trees, hedges around the fields and farms, and from the firewood piles of the poorer classes of labourers who collect dry sticks for cooking. If fallen sticks are not easily available, green twigs are wrenched off trees. Having secured a stick the female returns directly to the nesting site to fix it in position. The male usually accompanies her back even if he has not yet secured or found a stick of his own, though he usually manages to find one. The female first arranges her stick, and later the one passed on to her by the male if he has brought one. The male does not do any actual building himself but waits till she has fixed both the sticks and then they fly off together in search of more. The arranging of a stick generally does not take more than a few seconds. However, when a difficult spot is reached it may take a couple of minutes for the female to adjust a projecting stick to her satisfaction. As many as thirty sticks may be brought and arranged in an hour during the peak of building activity.

In the earlier stages of construction the sticks are arranged in the fork in criss-cross fashion resulting in a circular platform 22-27 cm. in diameter. When this platform is three to four sticks thick, additional sticks are laid on it tangentially, converting it into a shallow cup 7-10 cm. high and 5-8 cm. thick. The sticks, however, are not the only material used in the construction of this outer cup. Instances are on record when soda-water bottle wires, brandy bottle wires (Hume, 1889 : 9, Baker, 1932 : 16, Dewar, 1929 : 27-28), and gold and silver spectacle frames (Dewar, 1905 : 26) have been used in the construction of this outer structure.

The inside of this cup is lined with finer material like khus and other grass roots, coconut and other vegetable fibres, grasses, human and horse hair. Hume (1889 : 9) mentions finding wool and rags in addition to the above materials. Dewar (1929 : 27-28) writes of having come across pine needles, hard twigs and feathers, while Baker (1932 : 16) mentions a nest with the lining comprised of an old cap.

Coming back to the mode of construction, the actual construction of the outer cup and the inner lining is done by the female alone, the male only helping by bringing in suitable material. For the purpose of

lining, wet or green vegetable material is sought probably for their flexibility; dry material is also collected and wetted before use. The female sits inside the nest and spends hours at a stretch fixing up the lining, and during this time the male brings in the required material. When supplies from the male are inadequate, both the partners make trips together.

Both the male and the female keep busy throughout the better part of the day bringing in material. There are interludes, of course, for meals, a little bit of love-making or a rest for a few minutes, in between the material-hunting trips. From observations made of 14 separate nesting pairs it appears that it usually takes an average pair about four to seven days for completion of a nest with lining and all.

The time factor appears to be directly proportional to the availability of the building material in the locality.

The finished nest is, generally speaking, a large (25-30 cm. diameter) shallow cup of sticks and twigs, roughly put together and occasionally containing metal strips and wires; the inner cavity is 12-15 cm. across and 7-10 cm. in depth, lined with roots, grass, vegetable fibres, animal hair, and other soft materials already mentioned.

Territory. The house crow does not seem to mind other members of the species building their nests in the same tree or as a matter of fact on the same branch. As many as nine nests are sometimes located in one large tree. To all appearances there are no territorial limitations and all birds, except birds of prey and the koel, are welcome to make use of the nesting tree in any way they think fit.

Laying and clutch size. The eggs are laid only when the nest is complete; sometimes a couple of days may lapse between the completion of the nest and the laying of the first egg. The female starts sitting in the nest from the time the first egg is laid. Four or five eggs are normally laid at intervals of twenty-four to forty-eight hours each; occasionally three (Dewar, 1929 : 27-28), and rarely six (Hume, 1889 : 9, Dewar, 1929 : 27-28) eggs, may be laid.

As much variation in the clutch size of this bird has been recorded by various workers in the past it will not, perhaps, be entirely irrelevant to mention here that the clutch size in indeterminate layers like this bird is conditioned by a number of ecological and physiological factors, details of which can be found in Lack's (1947) paper on the significance of clutch size.

The eggs vary a good deal in shape, size, colour, and markings. Typically the eggs are broad ovals pointed towards the small end, but pyriform, elongate, and globular varieties are commonly met with. The eggs are hard and fine in texture and fairly glossy. The ground colour is any shade of bluish green. All eggs are blotched, speckled

and streaked with dull reddish brown, sepia, grey, and neutral tints. The shade and intensity of blotches, specks, and streaks vary a great deal in the various eggs and also in various parts of the same egg, usually near the ends. The size varies from 24-29 mm. \times 33-40 mm.

Incubation. The incubation for the most part is done by the female. The male relieves her at intervals during the day when she goes out for food and a much needed outing. At night the female alone sits in the nest.

It will be interesting to remark here the reaction of the incubating birds to strange eggs and foreign objects appearing all of a sudden in the nest. Usually the nest is never left unattended. One of the birds mounts guard when the other is away and does not ordinarily leave the nest till the partner relieves him or her. But the sight of a koel in the neighbourhood or of a man climbing the tree on which the nest is located or another tree in the vicinity is too much for the crow to endure. Losing all self control it launches in sudden fury an attack all by itself or joins the *mêlée* of the brotherhood for an attack on the intruder, forgetting for a while its own eggs. It is probably in such unguarded moments of extreme excitement that it is deceived by a female koel or an experimenting ornithologist who seizes the opportunity of placing its eggs in the nest or replacing the crow's eggs by some other object (s).

Intelligent as the bird is, it is hard to believe that it does not notice the change when it returns. But it may react differently to the visit of the two intruders. After having noticed the man's approach and then the change in the contents of the nest, it may attribute the change to the visit of the man and may abandon the nest, with its contents. But such desertions are very rare ; in my experience they are not more than 5 per cent, presumably because the crow is not much afraid of man.

If the nest has been robbed completely it is sure to be deserted. If only a part of the contents has been removed or replaced, apparently no great notice is taken no matter how strikingly different the replacement may be. On several occasions I have removed one or two of its eggs and replaced them after painting them scarlet and brown with transparent photographic water dyes, and they have been accepted coolly. Thrice a crow accepted eggs of a jungle crow, twice of a common Myna and once a Paddy bird's added by ones and twos to its own clutch. It refused to incubate a full clutch replaced by Myna's eggs and another one by those of a Drongo, but readily accepted a jungle crow's clutch in replacement. It appears that this species accepts strange eggs and foreign objects if they resemble its own clutch or if one or more of its own eggs are left in the nest along with the replacements.

Period of incubation. By the period of incubation I here mean the time lag between laying of the last egg and the appearance of the last hatchling. Of the 20 nests watched at Vellore for the determination of the period of incubation, in fifteen the eggs hatched out after sixteen days of incubation, in two it took 17 days, in two the eggs did not hatch at all, while one was deserted on the 7th day.

It will be interesting to note here that, in the cases where the eggs did not hatch, the birds incubated for 27 days in one and 30 days in the other before giving up and finally deserting the nest.

At Poona on two occasions I collected crow's nests with eggs, for ectoparasite study, which according to my previous observations should have been incubated for more than a week. To my surprise they failed to show any signs of developing embryo on being opened; evidently the clutches were infertile.

All the eggs in a clutch, do not hatch, especially in clutches of five. Clutches of four and three hatch a comparatively larger percentage than those of five. At Vellore it was observed that of twenty-five eggs from five clutches of five eggs each, twenty (80%) hatched, of thirty-two eggs from eight clutches of four eggs each twenty-eight (87.5%) hatched, while all the 12 eggs (100%) from four clutches of three eggs each hatched out.

The young in the nest. The young hatch out one after the other, at intervals of twenty-four to forty-eight hours. The newly hatched young, like other nidicolous young, are entirely devoid of nestling down. They are unable to stand up and lie helplessly on their delicate and almost transparent abdomens. The body is light flesh coloured. The eyes are closed. The beak and claws are soft and fleshy, and are of the same colour as the rest of the body. The Neossoptiles make their first appearance between forty-eight and seventy-two hours after hatching. They consist of prepennae which are duly replaced by regular contour feathers. The remiges and rectrices appear in the second week and look like gramophone needles at first. Then a tuft of hair-like feathers (barbs) appears at the needle point. At this stage, with elongated shafts and tufts of hair at the distal end, they resemble miniature artists' brushes arranged in rows of uneven sizes. The tuft gradually elongates into rachis and vane while the shaft ultimately forms the calamus. By the end of the fourth week the young are fully fledged. The colour of the plumage of the fully fledged young is similar to that of adult bird.

Apparently the freshly hatched nestlings are not fed, or rather are not able to accept food, till about 24 hours after their emergence from the shell. Some time between forty-eight and seventy-two hours their eyes open and by that time the feeding of the young by the parents is in full swing. Both parents bring food and feed the young. One of the

parents is always around during the early days to guard them from predators, to warn them, or to protect them from the hot sun or a light shower of rain, while the other is hunting food for them.

Just as all the eggs that are laid do not hatch, all the young ones that hatch out do not live to leave the nest as will be seen from Table I.

Table I

MORTALITY IN FLEDGLINGS OF THE HOUSE CROW *Corvus splendens*

Nest No.	No of eggs laid	No. of fledglings hatched out	No. of fledglings flew out of nest	No. of fledglings died
1	4	4	3	1
2	5	5	3	2
3	4	4	4	0
4	3	3	3	0
5	5	4	2	2
6	4	4	3	1
7	4	3	3	0
8	3	3	2	1 (1 Koel present)
9	5	3	3	0
10	4	Nest deserted		
11	4	3	2	1
12	3	3	3	0
13	5	4	3	1
14	4	Nest deserted		
15	4	4	2	2
16	4	3	3	0
17	5	4	3	1
18	4	Nest deserted		
19	3	3	1	2 (1 Koel present)
20	4	3	1	2 (1 Koel present)

The majority of deaths occur in the first week. Most deaths amongst the young ones of the crow are due to want of food. It is rarely due to a chance fall from the nest or as a result of some marauder's attack. Although the birds keep bringing in food from dawn till

dusk they cannot usually meet the full demand of a clutch of five, and sometimes even of four, nestlings who, for the first few days, are supposed to consume more than their own weight of food; unless, of course, there is abundance of food in the locality, in which case they do get around to the feeding of all the five or four of the clutch satisfactorily. When the fledglings are very young, the parents seem to make no discrimination whatever, in feeding them. The parent on arrival at the nest with bill full of food is confronted with a number of gaping mouths as each of the nestlings raises its neck and gapes widely. The parent stuffs the food into one of the gaping mouths, probably that which happens to be the nearest, until the food it has brought is finished, or the chick is unable to swallow any more; in such cases what remains is pushed down another throat. This is repeated at every visit by the parent. The young which are not fed until their stronger brethren have received all they can take start losing ground with the passage of time, and soon become so weak that they cannot even raise their necks to demand food. The parents do not seem to take any notice of such weaklings, and certainly do not make any special attempts to feed them. The weakest thus go to the wall. The dead are thrown out by the parents without the slightest concern. Most such deaths occur during the first week and very rarely during the second week.

The nestlings who survive the critical early phase in the nest remain there for three to four weeks, closely guarded and devotedly fed by the affectionate parents. A three-to-four-week-old nestling is fully fledged and can fly short distances if forced to do so. After leaving the nest they stay around in the branches of the nesting tree where they are fed by the parents. Later they stay close to the parents for a few weeks, usually the mother, and follow her wherever she goes. As soon as she picks up a little bit of food the demand by the young one starts. It opens and shuffles its wing and presents a gaping bill to be fed. Generally the mother transfers the morsel to it.

Nesting success. By nesting success I mean here the ratio of the fledglings that flew from the nest to the number of eggs laid. As already indicated the nesting success in crows depends on many factors, the most important ones being the amount of food available for the young at the nesting stage, the fertility of the eggs laid, and interference by parasites (koels) and predators (including man). In the present study a total of eighty-one eggs were laid in twenty nests. A total of forty-four young excluding the three koel fledglings left the nest. It roughly works out to fifty-four per cent.

Parasitising by the Koel [*Eudynamys scolopacea* (Linnaeus)]. Coming back again to the subject of deceiving the clever crow, none can beat the

Koel *Eudynamys scolopacea* (Linnaeus). This species of parasitic cuckoo, whose breeding season happens to coincide with that of the crow, has decided to entrust, rather thrust, the responsibility of a part of her own domestic duties to this crow, and has made the crow its main host.

The crow, not liking to be exploited, guards its nest all the twenty-four hours, but the mere sight of a koel prompts it to leave its nest and chase the koel. Knowing this weakness of their victim the male and female koels seem to have worked out a clever bit of a strategy. When the female koel is ready to lay, the male flies up to the crow's nest and makes himself known by emitting loud notes. The very sight of him infuriates the crow, who is usually incubating alone. Leaving the nest unguarded the crow attacks the koel, who turns tail the moment the owner or owners of the nest go for him. Being a better flier the male koel manages to keep only a little ahead, thus encouraging the crows to chase further and leads them away from the nest. The female koel who sits hidden, watching the proceedings, then takes possession of the deserted nest and relieves herself of her egg. She then flies away emitting a shrill *kuil-kuil-kuil*, apparently to tell the male that the strategy has been successful. The male then shakes off the pursuers and proceeds at full speed to join the female. Sometimes, however, things go wrong and the male or the female koel is caught red-handed and punished for its crimes by the indignant crows. I have myself seen and there are instances on record (Butler, 1876, quoted by Hume, 1889) when koels have been mauled by an angry mob of crows.

Usually only one egg is laid by the koel in one nest. Sometimes, however, more than one koel's egg may be found in crow's nest (Jacob, 1915; Jones, 1916; Abdulali, 1932¹; Burton, 1935); probably, they are the produce of more than one bird. It is difficult to say whether or not the koel destroys one of the crow's eggs, when she lays one of her own in its nest. To all appearances she does not (Dewar, 1907). A koel leaving a crow's nest with an egg in its beak is yet to be seen.

Meanwhile the crows, pleased with themselves for having successfully driven away the treacherous koel, return to their nest only to be confronted with a strange egg lying amongst their own. Whether they recognise it or not is a controversial question, but the fact remains that the crows neither desert the nest nor try to throw out the koel's egg.

The koel's egg has a superficial resemblance to that of a crow but it is smaller and has a green ground colour instead of blue. The green may be olive, sea-green, or almost stony colour. The texture is compact and fine and is entirely devoid of gloss. It is speckled, spotted,

[¹ The nest contained 11 koel eggs and none of the crow.—Eds.]

streaked and clouded with brown, or red or purple tint. The average size is 30 mm. in length and 23 mm. in breadth.

The koel's egg (or eggs) is (are) hatched along with (its) their own by the crows in the most matter of fact way. The period of incubation for koel's eggs as observed during the present study in three cases was 13 days. The young koel usually hatches a little before its foster brethren and hence has a little start on them. The freshly hatched koel like the young one of all other nidicolous species is blind, pinkish red in colour, entirely devoid of down or feathers, with a very soft and fleshy beak and claws. But for its zygodactyl claws it could easily pass for a crow fledgling. The crows do not appear to see this difference, and feed it in right earnest, even before any one of their own eggs is hatched. The young koel seems to have an insatiable hunger and greedily devours large quantities of food brought by the foster parents. By the time the young crows hatch out, it is usually big and strong enough to attract the greater attention of its foster parents by stretching out its neck towards them as they come in with food, and thus obtains a greater share of it. The great hunger of the koel nestling tells on some of the young crows, who fight a losing battle in the struggle for existence in the nest and perish. All but one, sometimes two of the young crows die for want of food if their nests include a koel nestling. Twice I have collected crow's nests at Poona, with only two koel fledglings, about three weeks old and no crows. As the brood size is limited by the feeding capacity of the parents (Lack, 1947) I am inclined to believe that the young crows in those nests could not compete with the two koels.

The young koel is usually the healthiest occupant of the nest. It acquires its feathers faster than its foster brethren. The plumage is uniformly black spotted with white all over the body, wings, and tail. It is still in this plumage when it leaves nest and when it finally takes leave of its foster parents. It leaves the nest along with and about the same time as the young crows, provided there are any left. The crows continue to feed it even after it has left the nest. On many occasions I have seen crows paying more attention to this foster child, whose demand for food never ceases, than to their own. The procedure for asking for food is the same as that of young crows. Although not well adapted for terrestrial movement, after leaving the nest it often alights on a stone or boulder to demand food when the foster parents are feeding on ground.

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Additions to the Flora of Bombay State : Grasses from Salsette Island (Malad-Madh Area)

BY

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Lisboa (1891), Cooke (1908), and Blatter & McCann (1935) described the grasses of the Bombay Presidency. Santapau (1950, 1953, and 1957) enumerated the grasses from Saurashtra, Khandala, and Purandhar. We add the following grasses which are recorded for the first time for Bombay State. The herbarium specimens referred to herein, with the collectors' names and numbers, are deposited in Blatter Herbarium, St. Xavier's College, Bombay.

The authors are deeply grateful to Dr. N. L. Bor, Kew Gardens, England, for their identification.

Digitaria adscendens (H.B.K.) Henrard ssp. **chrysolephara** Henrard, Mon. Gen. Digitaria 998, 1950; Bor 299.

Annual herbs; stems glabrous, simple or branched, 45-60 cm. tall, ascending from a geniculate base or prostrate, rooting at the lower nodes. Leaf-blades 5.5-20×0.6-1 (15×0.8) cm., hairy, flat; sheaths 3-6 cm. long, glabrous or sparsely hairy. Spikes 4-10, 6-15 cm. long. Spikelets 2-3-nate, closely appressed to the wavy or nearly straight, somewhat winged rachis.

Collected from Madh Island, along roadsides (*Fernandez* 2082, 2084, 2086-87).

Spikelets: September.

World distribution: Tropical Africa and in tropical Asia from India to China and Japan.

Digitaria timorensis (Kunth) Bal. ssp. **blepharophora** Henrard, Mon. Gen. Digitaria 747, 1950.

Annual herbs; culms tufted, simple or branched from the base, erect or ascending, 45-60 cm. tall, deeply striate, glabrous, at times rooting at the lower nodes. Leaves 12-20 cm. long, linear-lanceolate,

glabrous or sparsely pilose above, somewhat scaberulous on the margins; sheaths 4-11 cm. long, somewhat compressed, glabrous or more or less pubescent, at least the lower ones. Racemes 6-8.5 cm. long, secund, spreading, digitate. Spikelets 2.5-3 mm. long, very narrowly linear-lanceolate, on a flattened, narrowly-winged, green, glabrous rachis. Glume III (sterile lemma) glabrous between the broad central interspaces along the mid-nerve, apparently 3-nerved, the indistinct marginal nerves double and not conspicuous in front; margins provided with a row of crateriform protrusions from which arise long, stiff, yellowish, spreading bristles which are as long as or longer than the diameter of the spikelets; between them there are moreover soft, shorter common hairs. Fruit about as long as the spikelet, very narrowly lanceolate.

Occasionally found along roadsides (*Shah* 714 is the only sheet of this plant in Blatter Herbarium).

Spikelets: November.

World distribution: For the distribution Henrard writes: 'Hitherto only known from Timor'. We add locality 'Bombay' from India.

Eragrostis tef (Zucc.) Trott. in Bull. Soc. Bot. Ital. 62, 1918 in Obs.; Bor 513. *Poa tef* Zucc. Diss. Ist. Pianta Panizz. Abiss. 1774.

Annual herbs; about 40 cm. tall; culms tufted, slender, striate, glabrous, pale-green, erect or geniculately ascending from the short creeping base, simple or branched in the lower part; nodes glabrous. Leaf-blades 4-10 (6.5) cm. long, very narrowly linear or almost subulate, erect or spreading, flat or convolute, many-nerved, central mid-rib prominent, glabrous, setaceous, acuminate at the apex, somewhat contracted and subrotund at the base; sheaths 3.5-7 (5.5) cm. long, tight, close-fitting, glabrous, striate. Panicles 15-20 cm. long, open; branches almost filiform, erect, straight or slightly wavy. Spikelets about 2-4 mm. long, olive-green or greenish-purple, ovate, laterally compressed, pedicellate, glabrous. Florets 4-6 or more, exerted from the glumes. Glumes membranous, 1-3-nerved. Lemmas about 1.5 mm. long ovate with a short acumen, membranous, 1-3-nerved; when 3-nerved, the central nerve prominent and somewhat keeled on the dorsal side. Palea about 1 mm. long, hyaline, prominently 2-keeled. Stamens 2. Caryopsis oblong, brown, shorter and enclosed by the lemma and palea and falling with the lemma only.

Rare in the district; noted only once along roadsides (*Shah* 696). According to Bor, the plant is a native of Ethiopia, introduced in several parts of the world.

Spikelets: September.

Critical notes: This plant so far is not recorded in any of our Indian floras; however, Bor cites two sheets of this plant from India: (1) J. S. Gamble 21404 Nilgiris and (2) J. F. Duthie s.n., north India. We add the locality 'Salsette Island, Bombay'. Our collection is the only sheet of this plant in Blatter Herbarium.

Isachne dispar Trin. Sp. Gram. Icon. t. 86, 1828; FBI. 7 : 26; Bor 580.

Annual herbs; 15-40 cm. tall; culms spongy, somewhat polished, glabrous, prostrate, rooting at the nodes and then geniculately becoming erect. Leaf-blades 2.3-6.5×0.4-1 (4.5×0.6) cm., ovate to lanceolate, flat, rather stiff, striate, scaberulous; apex finely acute or acuminate; base subcordate or rounded; upper leaves sometimes sparsely hairy at the base; margins minutely scabrid and thickened; sheaths 1.8-3.5 cm. long, smooth, shining, striate, glabrous, hairy at the mouth. Panicles 1.5-5 cm. long, pyramidal and open, or contracted and ovoid. Spikelets about 1 mm. long, green or purple, obtuse, pedicellate, smooth and polished.

Common along water ditches and in moist ground (*Shah* 7669, 8622).

World distribution: India (western Peninsula, Assam, and North-West) and China.

Critical notes: This plant is very similar to *Isachne globosa* O.Kuntze; the two are common and often grow together in moist ground and water-logged soil. For *I. dispar* Trin. Hooker in FBI. 7 : 26, 1896 writes in the note: 'This again is perhaps a variety of *I. australis* R. Br. [= *I. globosa* O.Kuntze] of low stature, with more rigid scaberulous strongly margined leaves, sometimes ciliate at the base and smaller panicles with shorter pedicels'. Bor distinguishes the two species as follows:

- Panicles lax; leaf-blades narrowly lanceolate;
pedicels with glandular bands ... *I. globosa*
Panicles dense; leaf-blades ovate-lanceolate ... *I. dispar*

There are some sheets of this plant, identified by Dr. Bor, in Blatter Herbarium from Khandala, Dangs, Saurashtra, and Mount Abu; it seems the plant is common in Bombay State. Santapau does not give this plant (1950, 1953).

Oryza rufipogon Griff. Notul. 3 : 5, 1851; Bor 605. *Oryza fatua* Koen. ex Trin. in Mem. Akad. Petersb. (VI) 2 : 177, 1839 nom. nud. *Oryza sativa* L. var. *fatua* Prain, Beng. Pl. 1184, 1903. *Oryza sativa* var. *rufipogon* Watt, Dict. Econ. Prod. Ind. 5 : 504-05, 1891.

Annual herbs, 60-90 cm. tall; culms soft, glabrous, pale-green, spongy below. Leaf-blades 15-30×0.8-1.2 (20×1) cm., linear, flat, acuminate at the apex, scabridly hairy on both surfaces; sheaths smooth, glabrous. Panicles 8-20 cm. long, effuse, at first erect, at length nodding. Spikelets 7-8 mm. long, pale-green, drying pale-brown, scabridly hairy; hairs whitish; awns 4.5-8 cm. long, coarsely scabrid, pale-brown, polished.

A common, abundant and gregarious, marshy grass, often forming large patches in shallow water-ditches (*Shah* 702, 4992, 7825).

Spikelets: September-October.

Local name: Dev-Bhat.

World distribution: India, Ceylon, Burma, Malaya, Indo-China, Indonesia, and Thailand. *Type loc.*: India.

Critical notes: This plant is not given by Cooke and Santapau. Blatter & McCann treat it as a synonym of *O. sativa* L., to which it is closely related. However, the two species can be separated as follows:

Spikelets persistent awned or awnless	...	<i>O. sativa</i>
Spikelets caducous, always awned	...	<i>O. rufipogon</i>

Paspalum orbiculare Forst. Fl. Ins. Austr. Prodr. 7, 1786; Bor 340.

Perennial herbs; culms 30-45 cm. tall, loosely tufted, branched near the base, erect or ascending from a somewhat geniculate base, deeply striate, glabrous, terete above, slightly spongy below; nodes glabrous, dark-brown. Leaf-blades 5-10×0.2-0.6 cm., linear or sublanceolate, glabrous; margins involute, glabrous or minutely scabrid or scarcely rough, finely acute or acuminate at the apex, somewhat contracted at the base, densely hairy behind the ligule; sheaths 4-6 cm. long, compressed, persistent, striate, glabrous or hairy, with scarious, glabrous, or ciliate margins. Spike-like racemes 4-5 cm. long, solitary or subdigitately paired, erect, closely appressed or spreading. Spikelets many, about 2 mm. long, biseriate, plano-convex, yellowish-brown, glabrous and polished, much imbricating, ovate-elliptic, broadly ovate or orbicular; lower floret sterile, upper one hermaphrodite; upper glume and lower lemma 3-nerved, subcoriaceous or subcrustaceous, punctate, polished. Stamens 3.

Rare; noted only once along margins of a pond on Madh Island (*Shah* 7191).

Spikelets: August.

World distribution: Forster described this plant from Society Islands; now distributed in the tropics and subtropics of the Old World but in tropical Asia rarer than *P. scrobiculatum* L. Bor

(p. 340) writes: 'south-east Asia generally, but not found in north-west India, Central India, or Bombay, extending to Polynesia and Australia'. We add locality Bombay.

Critical notes: Our collection is the only sheet of this plant in Blatter Herbarium and so far it has not been collected or reported by any previous worker from Bombay State.

Paspalum orbiculare Forst., and *Paspalum scrobiculatum* L. occur in the present area; they apparently look very similar and are liable to be confused. Hook. f. in Fl. Brit. Ind. 7 : 10, 1896 treated *P. orbiculare* Forst. as a synonym of *P. scrobiculatum* L. Stapf. (Fl. Trop. Afr. 579, 1919), and Bor (Fl. Assam 254, 1940 and Mon. Grasses p. 340) considered the two species as distinct. For *P. orbiculare* Henrard (Blumea 3 : 440, 1940) remarks: 'In this specimen the small green spikelets are distinctly apiculate and not rounded at the summit as is the case in *P. scrobiculatum* L. and both glumes are 3-nerved. We are thus able to separate this species which occurs rather plentiful in Lingga Archipelago.' Rheder (Journ. Arn. Arbor. 29 : 300, 1948) writes for the present plant: 'Readily distinguishable from *P. scrobiculatum* L. by its 3-nerved glume and sterile lemma and its usually more numerous racemes which are distant on the axis.' The following is the key to separate the two species:

- | | | |
|--|-----|-------------------------|
| Annuals; upper glume and lower lemma 5-7-nerved; spikelets obtuse or rounded at the apex | ... | <i>P. scrobiculatum</i> |
| Perennials; upper glume and lower lemma 3-nerved; spikelets distinctly apiculate | ... | <i>P. orbiculare</i> |

Setaria pallide-fusca (Schum.) Stapf. & Hubb. in Kew Bull. 1930: 259; Bor 363. *Panicum pallide-fuscum* Schum. Beskr. Guin. Pl. 58, 1827.

Annual herbs; 30-60 cm. tall; culms tufted, slender, glabrous, geniculately ascending from a short base. Leaf-blades 3.5-25 (15) cm. long, linear, flat or folded, glabrous or slightly hairy towards the base; apex finely acuminate; base rounded; sheaths glabrous, lower ones somewhat compressed, upper terete. Spike-like panicle 5-12 (8) cm. long, erect, cylindric, continuous, densely flowered. Spikelets 2-2.5 mm. long, on slender rachis; bristles mostly rufous, rarely purplish.

Common in open grass lands on hills (*Shah* 33, 109, 704, 7278).

Spikelets: July-September.

World distribution: From tropical and south Africa to tropical Asia, northern Australia and Polynesia. *Type loc.:* West Africa.

Critical notes: This plant is recorded here for the first time from

Bombay State. It is very similar to *Setaria glauca* (L.) P. Beauv. and the two are likely to be confused. Both the species are purely monsoon plants; they are common, abundant, and often gregarious, in pure stands or mixed together. The large patches of these plants, with their reddish-brown spikelets, especially by the end of monsoon, are conspicuous along roadsides, railway lines, in open grass lands on hills, etc.; occasionally they have also been noted on walls.

The two species are distinguished as follows:

Spikelets 3 mm. long; upper lemma coarsely rugose, boat-shaped and slightly keeled upwards, broad and dorsally strongly curved on the back in profile	...	<i>S. glauca</i>
Spikelets 2-2.5 mm. long; upper lemma finely rugose, narrow and dorsally gently curved, not at all keeled	...	<i>S. pallide-fusca</i>

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New Breeding Records of Malayan Birds

BY

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(With three plates)

Family ARDEIDAE

Cattle Egret : *Ardeola ibis coromanda* (Boddaert)¹

Having discovered in 1956 and reported in the *Malayan Nature Journal*, December 1959, 13 (2) : 92, a breeding colony of Little Egrets, *E. g. garzetta*, in Perak, I had for a long time before this felt convinced that the Cattle Egret, *A. i. coromanda*, also bred in Malayan territory. This conviction was based on my own records of cattle egrets wearing their full regalia of breeding plumes while present in Penang right through April, May, and into the first week of June, after which they vanished. Eventually, however, when I did find them breeding it was a long way from Penang. This was in mid June 1959 in Kelantan, when on my way to revisit the pratincole colony discovered the previous year. I first noticed a few egrets around a group of the smallish black buffaloes which are a characteristic feature of Kelantan landscapes. Six birds were visible and all had golden plumes. The area was seared by the sun, miles inland from the coast, and the birds were simply following the meandering buffaloes. The date being 16 June gave me reason to hope that they might be mates of brooding birds; or if not already nesting they probably intended doing so. Therefore, I devoted the day to watching them. Great stretches of flat land in three directions lacked limitless vistas due to numerous 'islands' of mixed trees irregularly scattered over it, thus conveying a distinct sense of contraction and interrupted horizons. In the afternoon, after having noted numerous flights to and from one particular 'island' about half a mile (c. 1 km.) distant, I headed directly towards this objective and there ultimately found a colony.

¹ Nomenclature as in AN ANNOTATED CHECKLIST OF THE BIRDS OF MALAYA (C. A. Gibson-Hill, 1949).

There were ten nests in thinly foliated fringe trees along a frontage of twenty yards (c. 18 m.) facing east. The lowest and highest of these nests were 8 and 18 feet (c. 2 and 5 m.) respectively, and the remainder between 12 and 15 feet (c. 4 and 5 m.) high. Their ragged loosely constructed appearance from the ground was an illusion as I soon discovered on close inspection, when I was surprised by their compactness and solidity. Exterior diameters averaged around 16 inches (c. 40 cm.); interiors were spacious and deeper than expected and had no lining other than rootlets and broken twigs. Eight nests contained eggs: two with four, three with three, two with two, one with one, while two nests were empty. The eggs had smooth glossless texture and unique colour—uniform pale milky blue—with no trace of heron green. Average measurements of the twenty-two eggs were: c. 45×35 mm. At least half of the bill and end of the tail of an incubating bird projected over the nest rim. I made a complete circuit of the 'island' and then went through it in two directions but saw no trace of old nests, and so concluded that this present colony was freshly established, although in all probability it had been sited at other 'islands' in other years. At any rate, this prosperous nucleus of beautiful birds was flourishing again in 1960, but since then I have not been back.

Tiger Bittern : *G. melanolophus melanolophus* Raffles

Compared with the small bitterns the Tiger Bittern is considerably longer [20 inches (c. 50 cm.)], rounder, and as a breeder in Malaya very much rarer. In forty years I have seen four nests: October 1923, September 1931, August 1941, and September 1953—the first two in Penang, the third in Province Wellesley, and the last in Kelantan. The salient features of this shy and solitary bird are its plumage, its bill, and its nest. The adult has a black crest projecting beyond the back of the crown to the nape; the sides and back of the neck are rufous; the back, mantle, and wings are cinnamon, with close stipplings of black; some primary coverts and primaries are black with touches of white at the tips. The upper side of the tail is oily black, the underside white. The whole of the underparts from throat to vent may be described as ochreous yellow, streaked, barred, and mottled with black, and the impact on the observer is very striking. In addition, the bird has a noticeably thick, slightly down-curved green bill with a black tip, more like that of a gallinaceous bird than a heron. The 1923 nest was placed in the summit of a dense reed bed mixed with scrub a little less than 7 feet tall, and was made of stiff reed stems and twigs with a lining of dried iris flags and water hyacinth leaves.

The others, however, were high up in trees constructed entirely of sticks and lined with dead leaves. The 1953 nest was highest of all, 60 feet (c. 18 m.) up in a mangrove tree (Kelantan River estuary, in the vicinity of Tumpat). Each nest when found contained four eggs, but although the tree nests were definitely in the heron-type category, excepting of course the leaf-lining, the eggs were very definitely not, being slightly pointed at both ends and pure mat-white. The average measurements of sixteen are c. 49×39 mm. The birds fed habitually by day during the nesting period.

Schrenck's Bittern : *Ixobrychus eurhythmus* (Swinhoe)

Schrenck's Bittern [length 12 inches (c. 30 cm.)] is the smallest of the three small Malayan bitterns, the two others being the Yellow (*I. sinensis*) [length 14 inches (c. 35 cm.)], and the Chestnut (*I. cinnamomeus*) [length 15 inches (c. 38 cm.)]. At a glance Schrenck's might be mistaken for the Chestnut, but there are two features which distinguish it at once. Generally speaking the Chestnut in flight is uniformly chestnut over all its upper surface, whereas Schrenck's is chestnut with blue-black wing primaries and tail. The Chestnut and the Yellow are resident breeding birds and, although the Yellow and Schrenck's stand in official records as winter visitors only, Schrenck's also breeds but is not resident. Full accounts by me of the breeding of the Chestnut and the Yellow Bitterns have been published (vide *Malayan Nature Journals* 1941 and 1954) but hitherto the breeding of Schrenck's has not. The latter, of course, is the rarest of the three and can easily be missed or its identity mistaken as cited above. However, over many years of field work amongst bitterns, and long before I got a nest, I noted it occurring more frequently than it was supposed to do. My first nest was found on 7 July 1941. It was composed of living herbage bent over and interlocked to form a substantial pad about 2 feet (c. 60 cm.) above ankle-deep water in dense reeds (*Scirpus grossus*) at the corner of a paddy field. Lined with dry menerong (*Scirpus grossus* blades) it contained three eggs on the point of hatching. So began an irregular series of odd nests all on Penang Island, the most recent one occurring in August 1961. These comparative factual observations may be useful: Nests of Chestnut Bitterns are large open platforms at water level; nests of Yellow Bitterns are domed suspended small pads from 3 feet to 6 feet (c. 90 to 180 cm.) above water level; nests of Schrenck's Bitterns are open supported small pads usually about 2 feet (c. 60 cm.) above water. Again, Chestnut Bittern eggs are broad chalky white ovals averaging c. 34×27 mm.; Yellow Bittern eggs are smooth pale green ovals averaging c. 32×24 mm.;

whilst Schrenck's Bittern eggs are smooth creamy-white ovals averaging c. 30×23 mm.; each a thin-shelled distinctive type. When clearing land for paddy planting Malays come across many bittern nests and gather the eggs for food. On several occasions in different years I have seen the eggs of all three species being carried home in coconut shells and other receptacles, which means there must be more nests of Schrenck's Bitterns about than those now recorded.

Family ANATIDAE

Cotton Teal : *Nettapus coromandelianus coromandelianus* (Gmelin)

This small resident duck is also something of a phenomenon. It is known from every Malay State, yet no breeding has ever been reported which, to say the least, is quite extraordinary since a resident bird must breed regularly. It is a fact, however, that I have never found them breeding in the same place in consecutive years, although all such places are secluded and remote. In addition, as soon as egg laying begins the birds become completely silent so that seclusion and silence may have some bearing on the lack of information. First nests were found in Kedah in September 1947. There were five within the area of a small backwater surrounded by secondary forest. Two of these were placed in a reed bed and three were in hollow tree-limbs projecting over the reeds. The open nests were made entirely of dried reeds lined with down and the whole wedged into and supported by the densely growing stems. The tree nests were made entirely of down, creamy with dusky centres, sparingly mixed with slivers of desiccated herbage. The reed nests contained six (eventually ten) and nine eggs respectively, while the contents of the tree nests were seven, eight, and eight. Near Chalag, Kelantan, in September 1950, I got one tree nest containing eleven. The eggs are smooth ivory-white ovals averaging c. 43×32 mm., which is somewhat smaller than the cream-shelled eggs of the Whistling Teal, *D. j. javanica*. According to my observations only the duck incubates. The drake is a striking bird; bill black, crown and nape dark brown; face, neck, and all underparts pure white with a broad black collar round the base of the neck. Back and wings shiny green-bronze with white wing patches very noticeable in flight. The duck's face and neck are grey with no collar. Her back is brown, breast grey, flanks tinged with buff, belly dull white. The male looks like a pigmy goose and his peculiar voice is a goose-like gabble in minor key. In November 1956 a Malay

fisherman with whom I had contact for many years sailed his *prahu* all the way from Port Weld to Penang to tell me he had found some ducks' nests in mangrove forest! *Itek belabas* he called them, which is the Malay name for Cotton Teal, and at the same time handed me a small basket containing three eggs. Next day we started the long trip back to Port Weld. Eventually I was taken to the place and saw six nests of Cotton Teal wedged into the mingled arches of mangrove roots in old forest. Three adjacent trees were involved in supporting the little colony. On our approach I noticed that all the disturbed birds flew inland and not seawards. The nest from which the three eggs had been taken still contained three, so that the clutch in this case had been six when found. Two others held nine each, and three held ten each. The principal breeding period appears to be September through to December, but characteristically the bird and the month and the place are unpredictable.

Family ACCIPITRIDAE

Bat Hawk : *Machaerhamphus alcinus alcinus* Westerman

9 November 1959 was bright blue and sunny. At 9.30 a.m. of that day I happened to be in a remote area of Penang Island when a large black falcon-like bird passed overhead with what appeared to be a snake but was in reality a small branch dangling under its body. Through my glasses I followed the bird to its destination, which was a tall tree on the edge of swamp backed by forest about 400 yards (c. 365 m.) distant. Moving inside the forest fringe to within 20 yards (c. 18 m.) of the tree I discovered that the bird was none other than a splendid Bat Hawk or Pern, *M. a. alcinus*, serenely employed in shaping the foundation of an eyrie. From that day on I learned some new facts concerning the habits of Bat Hawks, supplementing the meagre known ones. Because of its appearance the species is quickly and easily identified. In the field it shows entirely black with conspicuous white throat and central breast. A closer look reveals white patches above and below the eyes and a long black crest down the nape. The bill is black and the legs and feet are reddish black with black claws. Through the four weeks following, nest building by both birds was a daily routine, especially between 9 a.m. and noon, but if it rained all such activity ceased. Longish flights were taken to collect material usually in one direction, which might or might not indicate preference for certain sticks. At any rate it is to be noted that, although the birds are definitely crepuscular in habit when feeding, as I will soon describe, the entire nest was built during the

brightest part of 28 consecutive days and at no time did the birds show any sign of embarrassment or distress through the dazzle of tropical light. Flight was swift and sure at all times and no different from the feeding flight at dusk. After 9 December no more material was collected and for the next 7 days both birds perched close to the nest several times daily, but between these visits disappeared altogether. The nest was a fair-sized structure of sticks, which looked smaller than it actually proved to be, due to its being sited a short way out on a limb in a bower of foliage, and could only be wholly seen from directly below. On 16 December my climber made his first ascent which presented no difficulty. The nest was empty. It measured 1 foot (c. 30 cm.) high and 2 feet (c. 60 cm.) wide with a shallow central depression 1 foot (c. 30 cm.) across. The lining consisted of fine roots and fibres but no leaves. Height from the ground was 110 feet (c. 33 m.). The fineness of the sticks comprising the upper exterior structure gave a close-packed effect suggestive of a squirrel's drey. At 10 a.m. on 17 December there was one egg in the nest and one spray of green leaves. At 10 a.m. on the 18th there was no change. At 10 a.m. on the 19th there were two eggs and three green sprays. On the 20th, no change. At 10 a.m. on the 21st there were 3 eggs and 5 green sprays. This proved to be the complete clutch and, as shown, egg-laying occurred on alternate days. Individual measurements of the 3 eggs were: c. 63×47 , c. 60×46 , c. 61×47 mm., giving an average of 61×47 mm. All were smooth, without gloss and blue-white in colour, yet each egg was different. The largest was unmarked blue-white, the second largest had submerged clouding of pale grey, whilst the smallest, also clouded with pale grey, had in addition pale red freckles sparingly sprinkled over the small end. This egg was laid first and the largest last. Nesting on one previous occasion is on record but the nest and eggs were not examined or described. The Bat Hawk's method of hunting is fascinating; and over a period of months I never saw either bird chase or catch anything other than bats. Invariably about 6.50 p.m., the bat-echelons in depth began their erratic coursing, always north to south, past the Hawk's tree and, strange to relate, the bird on watch never attempted to interfere with these first flights. When attacks did begin, however, they were continuous and amazingly successful. On several evenings, no less than seven bats were caught and devoured in 12 minutes by the same bird. The captures were not made by power dives from above like a Peregrine; the Bat Hawk always flew level with and straight through the flank of advancing bats, then curved up under its victim, and in one simultaneous movement turned on its back,

reached upward with its talons, and literally plucked the bat out of the air, before swerving away into normal flying position. Bats so caught were often devoured piecemeal in the air at once or just as frequently after flying back to the favoured perch. When consumption occurred in flight I was able to observe that some part of the bat was always dropped—wings, I think—but this was not definitely established. Another remarkable fact was noted; the hawk at no time ever flew into a flock of bats to chase them indiscriminately. Every sally out of the tree was fast and straight towards what was quite evidently a pre-selected bat and all others were ignored. How and why this selection was made I cannot even remotely determine; and the solution will no doubt continue to remain as elusive as this very elusive bird.

Sparrow-Hawk : *Accipiter virgatus* (Temminck)

In any year in all kinds of country Sparrow-Hawks are frequently encountered from October through to April. Presumably these birds are members of the Japanese race, *A. v. gularis*, and regular winter visitors to Malaya. The existence of a resident race, however, has long been suspected but definite status never established. In view of this the finding of a Sparrow-Hawk's nest in Malaya becomes an important ornithological record. On 26 May 1957, in mountain forest east of Selama, Perak, I found one containing 3 eggs. My first glimpse of the bird as it flashed out of the tree made me think it was some species of cuckoo, but on hearing its voice I knew it was a Sparrow-Hawk. The alarm consisted of a querulous phrase of six notes, *keh-keh-keh-keh-ki-kee*, exactly to the time and accent of the song 'Ta Ra Ra Boom De-Ay' uttered in quick time. It was this call that encouraged me to expect a nest, since migratory birds rarely break silence when disturbed. Examining the tree from various ground positions I eventually spotted what appeared to be something denser and darker than a mere mass of foliage, sited on a horizontal bough where it branched into a treble fork about 8 feet (c. 2 m.) out from the main trunk; and when measured later found to be 65 feet (c. 20 m.) up but still well below the canopy. Changing to $\times 15$ binoculars I could see a few flecks of white down and so knew the answer. On instructions my Malay climber went on up beyond the bough and looking down, reported three red-marked white eggs in the shallow centre of a structure of fine sticks about 18 inches (c. $\frac{1}{2}$ m.) wide. Although the nest was surrounded by green foliage no leaf, green or brown, or lining material of any kind was used in the fabric. Tufts of white down flecked the inner and outer perimeters: and all

was fresh and new, indicating that the hawks had completely built their own nest and not used any older relic as a foundation. Next day 27th I got a good long look at the female preening on a bough some 10 feet above her nest. The head was dark grey; wings, back, and tail earth brown marked with darker brown. The throat was white with a dark vertical line in the centre. The breast and abdomen were off-white barred with medium strength brown. The under tail coverts were white; the iris, cere, and legs yellow tinged with green; and the beak was blackish grey. From her behaviour it was evident the clutch was incomplete. On examination my climber again reported three eggs, but as sparrow-hawks lay on alternate days the clutch, as shown later, was incomplete. Awang lowered the eggs in a basket for inspection. All were bluish white, unglossed, richly splashed with dull red. One had a claw hole at the side and this I retained. Individual measurements were: 39×30 , 39×30 , 40×31 mm.

Counting in reverse the third egg must have been laid on 26 May, the second on 24 May, and the first on 22 May. After the two eggs were hoisted back to the nest the male appeared. He was uniform grey above including the tail which had four bars across it. The throat, central belly and undertail were cream while all remaining underparts were very rich rufous without bars. The bill appeared to be black and the tarsi an impure yellow. I judged him to be a foot (c. 30 cm.) in length and the bulkier female about 15 inches (c. 38 cm.). On the 28th the female definitely flew off the nest which, as anticipated, again contained 3 eggs including the new laid fourth egg which was very handsome. A fifth egg in the nest on 30 May was uniformly blue-white without a single mark. On account of anti-bandit operations no further visits were possible.

By this record breeding is established but racial identity remains unsolved. I could detect no difference other than the male's rich colour between them and normal visiting sparrow-hawks, some males of which have pink underparts, and think it possible that this pair might have been *A. v. gularis* which stayed to breed. Eventually this may be confirmed or contradicted if and when breeding birds are subsequently taken and proved to be some other race. In the meantime these facts are cited in support of the *gularis* concept. Bay-headed Bee-eater, Brown-breasted Bee-eater, Black-capped Kingfisher, Pied Imperial Pigeon, Little Grebe, Bronze-winged Jacana, Philippine Banded Crake, Short-toed Eagle, Tiger Bittern, Yellow Bittern, Schrenck's Bittern, Night Heron, Little Egret, Cattle Egret, Pratincole—all classed as migrants and winter visitors—remain to breed, so there would appear to be no valid reason why any species

at any time should not extend the conventionally known limits of its breeding range.

Blyth's Hawk-Eagle : *Spizaetus nipalensis alboniger* (Blyth)

Early in January 1950 when vacationing on Penang Hill, I became aware of the presence of a pair of birds, and after seeing and hearing them continuously every day for three weeks they became as familiar as Fairy Bluebirds. Smaller than Changeable Hawk-Eagles and entirely different in colour, they are adequately described as being all black above and streaked and barred black and white below. The bill is black and the feet are yellow. On this occasion I was fortunately placed for observation. The house I occupied, situated at 2200 feet (c. 670 m.) elevation, overlooked the densely forested valley which was their favoured habitat; and it was in this valley they built their nest. In doing so the birds passed just beyond and below the house level when bringing material, and I could watch whilst sitting in the garden or from any southward-facing window. Sticks were occasionally carried crosswise in the bill, but more frequently in one foot either crosswise, lengthwise, or hanging below the foot. Both legs were always down but only one foot held the stick. For a week this was the daily routine. Then all activity ceased after 10 January, so they must have started early December. In the meantime I had located the selected tree, which was actually higher up the valley than the house and was approximately 2350 feet (c. 720 m.) above sea-level. Knowing from experience the leisurely habits of the big Raptores I left it severely alone and devoted my time to other species. Every day I saw the eagles circling and winging their courses just above the treetops and calling repeatedly in flight. This call is a resounding tri-syllable *kee-lu-kuk*, which echoes round the hills and totally unlike the Changeable Hawk-Eagle's clear, double *blee-kwik*. Time passed and it was 28 January when I eventually returned to the eagles' tree with my climber Awang, the best of many I ever had. He was more than half way to the nest before the eagle went off in a hurry, the vibrations of his ascent having registered rather late, probably because she was asleep. The nest proved to be 75 feet (c. 23 m.) up, placed in a stout treble fork of the tree bole and at least 20 feet (c. 6 m.) below the canopy. The exterior diameter measured 2 feet 6 inches (c. 75 cm.), the interior 1 foot 6 inches (c. 45 cm.), and the stick pile 1 foot 3 inches (c. 38 cm.) thick. It contained a single egg lying on desiccated green leaves with four sprays of green leaves round the inner perimeter. The unglossed grey-white shell was strewn with flecks of claret and had sub-surface grey patches at

the smaller end, which may or may not have been leaf stains. It measured 59×48 mm. Subsequent history shows that a pair, probably the same, bred in the same locality in 1951. In 1956 a pair bred in another forested valley 3 miles (c. 5 km.) to the south at an elevation of not more than 1000 feet (c. 300 m.), and in 1959 a pair bred in Batu Ferringhi Forest Catchment Area at not more than 600 feet (c. 180 m.) elevation. The relics of this eyrie still linger.

Black Eagle : *Ictinaëtus malayensis* (Temminck)

The Black Eagle is unmistakable. Including the bill it is completely black with numerous faint grey bars across both sides of the tail; and bright yellow legs, and feet.¹ It is larger than the Hawk-Eagle with a longer tail; and on the wing is truly a magnificent bird. Strangely enough, although resident, its breeding in Malaya has not been reported, probably because its chief habitat, mountain forest, is difficult of access and more than difficult to negotiate. Thereafter guess work and frustration begin as all who have entered mountain forest must know. Once in, there is no way of seeing out, and even if an eagle or any bird passes above the canopy it cannot be seen or cast a shadow which in the open normally betrays a large bird passing overhead. If the forest is scanned from some vantage point above it there is no way of seeing in, and eagles' nests are always below the canopy. My first inclination was to use the vantage point method, try to locate a bird on the wing and watch it down to its final tree-fall. Then it occurred to me that, if I could locate a bird on the wing whilst I myself was outside the forest altogether and looking up some hill face, I might do better; so for 7 consecutive days from a different place each day, I gazed over green treetops into birdless blue skies. This was April and I did not know whether Black Eagles nested in April or any other month earlier or later, but on the 8th day, just before 10 a.m., I picked up two birds in the field of my glasses, one slightly larger than the other and evidently a pair. They were swinging round in opposing circles, drifting gradually towards the hill forest which faced south-east. Using ×15 binoculars, I followed the aerial evolutions of the female and gave a pair of ×10 to my climber to follow the male. At 10.20 a.m. she stopped gliding, dropped her feet and, on slightly retracted wings, sped towards and into the trees at an elevation close to 300 feet (c. 90 m.). She did not alight on a tree but went straight through a gap in the forest 'roof'. In the meantime the male had simply drifted off southward. After memorising everything possible that would help

¹ The yellow cere, and gape are very noticeable in the Indian bird.—Eds.

to guide us, we sat in deep shade by a stream and shared a big pomelo—the best thirst deterrent in forest work. Starting about noon and surmounting the tortuous hazards of the ascent we finally, at 3.30 p.m., came upon an eyrie in a big tree. At the striking of the trunk with a heavy bough off went the Black Eagle uttering as she left one loud whistling squeal. The eyrie was a massive structure, the basal sticks weathered grey denoting considerable age, whilst the upper mass was fresher and some green-leaved sprays were visible at the rim. It was placed in a great central junction of three boughs at 90 feet (c. 28 m.) from the ground—the canopy another 30 feet (c. 10 m.) above it—with not a single branch on the entire 90 feet (c. 28 m.) of the trunk. Seeing no more of the eagle and being too late in the day to make such a climb, we returned to camp for the night. The date was 25 April 1958. Starting at dawn next morning we were approaching the tree by 8 a.m. There was an eagle on a bough above the nest, and within moments another rose out of the nest and stood on the rim. This was the male. There was no alarm since our presence was still unsuspected. At 8.20 a.m. the female came down to the nest and settled. Not until then did the male glide out of the forest.

Malays have two methods of tackling big trees and Razali, my climber on this occasion, was an adept at both. The first method is slow and laborious; it consists of lashing saplings to the bole of the tree all the way up, with short cross pieces for resting at 10 foot (c. 3 m.) intervals. This 'pipe', of course, has to be fixed in sections one at a time and is a most arduous undertaking since the higher it goes the longer each descent for and ascent with the next section becomes. This is always the method employed if the bark is smooth or wet after rain. If the bark is rough and dry (in the present case it was), then two loops of half-inch (c. 12 mm.) rope are sufficient, one stretched between his feet, the other passed round the trunk and stretched between his hands, thus completely spanning the circumference which his arms alone could not do; he then 'stands' by the pressure of the taut foot-rope, flicks the hand-rope upwards, leans back on it, brings up his feet and so, by a continuous series of caterpillar loops, goes up in no time at all.

The eyrie interior was clean, fresh, shallow, and about 2 feet (c. 60 cm.) wide, and contained two eggs lying on a bed of flattened green leaves. Exterior diameter was $3\frac{1}{2}$ feet, so that the rim all round was a foot and a half wide. The height of the structure was 2 feet 6 inches (c. 75 cm.). Razali had taken up with him 200 feet (c. 60 m.) of half-inch (c. 12 mm.) rope for the dual purpose of letting



Black Eagle. Male leaving eyrie



Pratincole's nest, containing two eggs and showing remarkable harmony with surroundings



Nest and nesting tree of the Lesser Fishing Eagle

Photo : J. Cairns

down the contents for inspection and measurement, and making his descent easily and quickly simply by leaning outwards facing the tree and 'walking' down while holding the rope double slung from above. One egg was white, handsomely splashed with rich brown and clouded with ochreous pink and soft grey, and measured c. 69×53 mm. The second egg was also white clouded with pink and grey, but had no dark splashes. Slightly larger, it measured c. 69.5×53 mm. From the appearance and feel of the shells I estimated that incubation had begun about a week before. Whilst Razali was at the nest around 10 a.m. the eagles were not heard or seen, but after his descent one bird returned and settled, and although we kept watch till mid-afternoon, we did not see it leave. Inaccessibility and security are surely synonymous for breeding success, yet Black Eagles still remain rare birds and never seem to increase. The nest described above is located in the Jedok Forest Reserve, Kelantan.

Lesser Fishing Eagle : *Ichthyophaga nana nana* (Blyth)

Over a period of 40 years I have seen five nests of the Lesser Fishing Eagle, four in Kedah and one in Perak. This species is considerably smaller than the Black Eagle and, of course, strikingly different in appearance. The entire head, neck, breast, flanks, and underwings are unblemished ash-grey. The abdomen, thighs, and underside of the tail are pure white. The back, wings, rump, and upper side of the tail are brown. The grey of the breast and the white of the abdomen do not merge. They meet and remain sharply contrasted across the body, and this forms the most striking feature of the plumage. The bill is blue-grey, and the legs and feet are pale grey. Although this bird is not particularly scarce, yet it is rarely encountered since it avoids open country and frequents inland forest and river reaches with heavily forested banks. Finding a nest is a matter of luck; a bird may be seen flying into or out of a tree and there it is. Nest building takes a very long time, as the bird seems to be exceedingly fussy over sticks, many of which are either deliberately discarded or accidentally dropped, judging by the numbers that strew the ground at the base of the tree. I never have seen sticks at the base of a nesting tree used by any other species of eagle. My experience is that a bird which starts building in December lays its eggs in February. The large structure of sticks is wide and flat and not piled high, with a spacious shallow interior lined with green leaves mixed with leaf debris. The eggs, two or three in number, laid at intervals of 4 days, are smooth in texture and uniformly grey-white without marks. The average measurements of twelve are

57×45 mm. One constant factor applies to all 5 nests. They were placed very high in big trees—three isolated and two not—at the edge of dense forest, and in every case far out from the trunk near the end of a strong horizontal bough. The call in flight is a double-syllabled nasal yelp which echoes among the trees.

Short-Toed Eagle : *Circaëtus gallicus* (Gmelin)

One mid-November day in 1954 I was working through heavy swamp immediately east of the mangrove belt along Penang's west coast and, on pausing for a quick survey ahead, I picked up through my glasses and a long way off a large bird perched on a low stump. It was obviously a raptore but too white and also perched too low to be in character with more familiar species. Taking advantage of available cover I pushed on and closed the gap to about 50 yards (c. 45 m.). The bird was still on the stump intently gazing down into the swamp herbage. Presently it jumped off without using its wings into deep growth on its right, remained out of sight for perhaps ten seconds, then flapped back to the perch with a snake about three feet long, wriggling in its talons. This was a fortunate occurrence from the observational point of view, because the bird was now forced to adopt many attitudes with wings outspread for balance while manoeuvring with the snake. I was therefore able to note every aspect of plumage and identify it as a splendid adult Short-toed Eagle, *Circaëtus gallicus* subsp. The snake was eventually swallowed whole head first. Seen in flight from below this eagle is the whitest of all eagles, and the present specimen was almost uniformly white with dark wing tips and only slight duskiness across the breast. The white undertail showed three cross-bars, the bill was blue-grey, the naked tarsi pale grey, and all upper parts including tail showed a marbled effect of honey-brown with flecks of grey. The head had a slightly flat-faced appearance reminiscent of an owl's. Leaving it undisturbed I veered away on a wide detour but returned in the afternoon when I saw it again, about 20 feet (c. 6 m.) up, quartering the swamp like a harrier and hovering briefly at intervals. Back in the vicinity on 4 December I found to my surprise a pair of birds. I watched them soaring, searching, feeding, preening, resting; and incredibly also building an eyrie already of considerable bulk. From then on they became my sole obsession, and I returned three times every week to record progress. The chosen tree was a fringe tree of the mangrove forest overlooking the swamp, stout but not very tall, and the eyrie was placed against the trunk at a double fork and only 65 feet (c. 20 m.) from the ground. In the course of time it became

a huge structure of sticks and could be seen against the sky from a long distance. Yet it survived all hazards and was never disturbed. Although the birds seemed never to do very much building the aggregate of material was astonishing. By 8 January 1955, all building appeared to have ceased and not a bird was seen all day. In order to get a clue to possible events I had my climber examine the nest. It was empty. On the 15th again no birds and no egg. On the 19th still no birds and no egg and then, on the 22nd, as we approached the tree the tail of the brooding eagle was visible. After one sharp tap on the trunk she rose out of her eyrie and stood on the rim a few moments before launching herself over the forest. The single large egg was oval in shape, unglossed, bluish white with very few specks of russet here and there but scarcely noticeable—and measured *c.* 73×57 mm. The egg was lying on shiny dry leaves surrounded by fresh green ones and must have been laid on the 20th, 21st, or 22nd, practically two whole months after nest building began. Five tufts of white down were noted. The bird returned and left twice during the next hour but did not settle.

The strange absences and long delays between completion of nest and egg-laying are also typical of Changeable Hawk-Eagles, *S. c. limnaeetus*, and Serpent Eagles, *S. c. bassus*. Incubation lasted 28 days and the eaglet remained in and at the eyrie for 3 months. The Short-toed Eagles also bred in 1956 and 1957 in the same area but used different trees. In 1958 they moved to the foothills east of the swamp.

This eagle is unique in that it moves about on the ground and perches near the ground looking and waiting for food, and this is the only successful hunting method I witnessed. It also soars and glides and cavorts grandly and easily, and rockets earthward at great speed with half closed wings. I believe this to be solely a spectacular way of descending and not a prelude to pursuit or capture of prey. The adult call is a soft but far-carrying *plu-ee*.

Family HELIORNITHIDAE

Masked Finfoot : *Heliopais personata* (G. R. Gray)

The Finfoot is a resident bird, yet its nest has never been reported within Malayan territory. This is surprising because, although it is a shy bird, it is not a small bird [being some 20 inches (*c.* 50 cm.) long] but it is definitely rare. In my experience it is not so widely distributed as it is said to be. On the contrary I consider its range extremely limited. Having made extensive explorations through

every State in Malaya I never have seen or heard a finfoot anywhere except in Perlis and Kedah, and it was in the latter State I eventually found the bird breeding. There is no other waterbird like it. The sexes are similar with the exception of one distinguishing feature which is easily seen and remembered. The male has a black throat and foreneck with a thin white border all round the black; the female has a white throat and foreneck with a black border all round the white, and the black in turn is narrowly edged with white. Otherwise, both have black crowns, grey necks, oily-greeny-brown backs, wings, and tails, white underparts, yellow bills, and light green feet. The legs are placed far back, and the bird has a sleek appearance when swimming low in the water like a grebe. When taking off, which is seldom, it runs along the surface with pattering feet until air-borne. Flight is strong and straight. What astonished me most was its running ability on land. It is an expert diver when fishing, but when alarmed submerges by sinking without a ripple. The call of the male is a phrase of falsetto bubbling notes, and that of the female a lower pitched gurgling akin in quality to the frenzied nuptials of White-breasted Waterhens. To me the breeding season is synonymous with rains. Although I have examined sixteen nests: one in July, three in September, and twelve in October, yet before the discovery of the first of these in October 1941 I had been twenty years in Malaya. During the twenty years since, knowing where to look and when to look, the fifteen others were, of course, confined to the years 1946 to 1961, giving a yearly average of one, but this component includes four nests in one season. The Finfoot breeds in flat scrub jungle flooded by overflowing small streams. If there is no flood water it does not breed. I have proved this to my own satisfaction by visiting the habitat monthly through a calendar year. Thus, the solitary July discovery was made because there was flood water, the depth of which is usually from 6 to 9 inches (*c.* 15 to 23 cm.). Nesting sites vary in height above water, 3 to 6 feet (*c.* 1 to 2 m.) being normal, and lower or higher abnormal. One does not naturally associate waterbirds with sticks, yet all the Finfoot nests I have seen were made of fine sticks and lined with dried bamboo leaves. Each structure was about one foot thick and closely packed into a neat tight mass. This neatness has always impressed me and is diagnostic. The most favoured sites were recesses in the 'walls' of big upturned tree roots, on vertical tree stumps, and near the ends of horizontal tree boughs thrusting into ground scrub. Both sexes incubate and in doing so sleep swan-like with necks over their backs. When disturbed they simply plop

into the water and melt away into the forest mazes. Full clutches of eggs range from five to eight in number, seven being most frequent. They are roundish ovals with medium glossy textures. Typical eggs are creamy-white bearing rich chestnut splashes and violet areas which, however, become pale grey with the passage of time. Another type is moorhen-grey with similar colours but the grey reduces the colour intensity. Average dimensions are c. 49×41 mm.

Family GLAREOLIDAE

Pratincole : *Glareola maldivarum* J. R. Forster

In my experience pratincoles with red underwings are irregular November visitors to north Malaya: numerous, scarce, or absent altogether for reasons unknown. I have no earlier record of arrival; and my records for northward passages are all in February. Considering that these records cover a period of 40 years this dual consistency is remarkable. Nor have I ever discovered where the birds go in the intervening months. On the other hand, E. H. Bromley once told me that when he resided in Alor Star, pratincoles were present from March to July. This undoubtedly spans the breeding season but no nest or nestling was ever found or seen. It is therefore gratifying to be able to report now that pratincoles do breed in Malaya.

In 1958 I spent three months—April, May, June—in Kelantan and Trengganu and when I made the discovery no thought of pratincoles had even remotely entered my mind. I was quartering some old ploughed and tussocky land looking for the nests of 3 pairs of Red-wattled Lapwings, *L. i. atronuchalis*, whose habitat I had previously noted, and in doing so walked into the pratincole colony. The date was 20 June. In the ensuing three hours I located 15 pratincole nests over an area of approximately six acres and the lapwing nests as well. One of these containing 4 eggs was 10 feet (c. 3 m.) from a pratincole nest with 2. The other lapwings' nests contained 4 and 3 eggs respectively and were outside the precincts of the colony. Of the 15 pratincole nests three contained 3 and twelve contained 2 eggs in various stages of incubation from fresh to near-hatching; ground colours varied—pale straw, grey, or green—and carried spots and fine broken scrawls of sepia and black bloomed with violet. All nests were slight depressions: ten in dry broken-down earth, four on dried cow-pats, and one on solidified mud. Not a single nest had any shelter, and under the boiling sun the birds brooded their eggs with wide open bills and throbbing throats. Average measurements

for the 33 eggs were 32×23 mm. The pratincole's flight is easy, leisurely, and buoyant. From the ground it starts off low and gains height by a long gentle upward trend. The double call note *kee-tik* has a light timbre and tern-like quality. Notes of protest sounded like *tee-tirek*, *tee-tirek*. When the bird is incubating or standing the long crossed wing-tips can be mistaken for the deeply forked tail. In flight the prominent feature is the white rump.

A Malay shepherd on the spot with whom I spoke knew of no Malay name for the bird, but was so familiar with it as to show no abnormal interest, merely adding that he had seen eggs in previous years in different places and that the birds would disappear in August. These simple facts were given in reply to my relative questions and at least confirm the new status of this dainty bird probably the Eastern Pratincole, *Glareola maldivarum*, as a breeding summer visitor. The breeding ground is in Trengannu, practically on the same latitude as Penang, which for comparison is at least 60 miles (c. 97 km.) further south than Alor Star.

Family TIMALIIDAE

Rail-Babbler : *Eupetes macrocerus macrocerus* Temminck

On 29 May 1958 I entered the Lebir Forest Reserve in the vicinity of Jeram Chalil, after travelling for several days some twenty miles up the Sungei Lebir from Manek Urai. This Forest Reserve throughout its whole length of 30 miles (c. 48 km.) lies between the Sungei Lebir on the west and the Kelantan-Trengannu State Boundary on the east, while its southern end, about 7 miles (c. 11 km.) wide, meets the north-eastern extremity of King George V National Park under the great north massif of Gunong Tahan. In this forest at an elevation of about 500 feet (c. 150 m.) above the river I stumbled across what is probably the first Rail-Babbler's nest ever found in Malaya. As usual I was not looking for or expecting such a rarity, since I have yet to meet an ornithologist who has even seen the Malayan bird, and until I found this nest I was in the same category. My chief objectives—hornbills, pheasants, peafowl—were forgotten and abandoned and throughout the day I made observations and notes on the nest which are now rendered verbatim. 'A ragged assembly of thin sticks, tangled tendrils, and black leaf-mould forms the basic structure; on this foundation rests the cup-shaped open nest composed of fibrous roots, lichens, and some moss in places; densely and neatly woven. The diameter of the interior is 4 inches (c. 10 cm.); its central depth 1½ inches (c. 4 cm.), and the entire lining composed

of skeleton leaves. On this gauze-like bed lie two beautiful pink eggs, the larger ends circled by zones of russet. They are longish slightly pointed ovals, have a fine texture and slight gloss, are quite fresh, and measure *c.* 30×22 mm. The nest is placed on a flat-topped boulder well-covered with vegetation and only 2 feet (*c.* 60 cm.) high, and even when known is scarcely visible at very short range. In fact the only reason I did see it is because the bird jumped off close to my knee. Both birds are alike and, although exquisitely plumaged, appear soberly coloured in the sombre forest light. They have no fear of me. They do not fly; simply move about on or near the ground and jump up to or down from the nest, turn over leaves, pass food to each other, and neither has uttered a single note in four hours.'

Family PARIDAE

Sultan Tit : *Melanochlora sultanea flavocristata* (Lafresnaye)

In the hill forest of Penang there is no other small bird like the Sultan Tit. For a tit, its plumage is revolutionary. All underparts of the male's body below the chest and the striking head crest are bright yellow, while the rest of the bird is entirely black. The female is not quite so yellow and not quite so black. Two other non-tit-like features are the large size [8 inches (*c.* 20 cm.)] and the graduated tail. However, its voice, nest, eggs, and nesting sites are similar to those of the true tit family, Paridae. Small parties move about in forest glades above the 2200 foot (*c.* 670 m.) contour and attract attention by their continuous churring chuckling as they search for food among green foliage; although decaying timber, standing or fallen, always receives special attention. When so encountered at ground level watching them is indeed a pleasure—absorbed in their searching and showing no concern or apprehension of possible danger. Their actions are deliberate, not jerky, and convey an impression of never being in a hurry. Spiders, caterpillars, grubs are placed under the feet and the contents only of their bodies eaten piecemeal. Butterflies are also caught and devoured in the same way after nipping off and dropping the wings. One call phrase is a pleasant *zip-tree-tree*, another is *zup-zee zup-zee zup-zee* repeated over and over; another, a slow mournful plaint, *pay-pay-pay*, when disturbed from the nest: besides the customary puffed-throated churring at any time. As in the case of the Malayan Great Tit, *P. m. ambiguus*, whose life-history and nesting habits I have fully described in the *Journal of the Bombay Natural History Society*, 1956, (53 : 367-73), the female

collects all materials and builds the nest with the male accompanying her to and fro on every trip. Breeding activity is greatest during the period February to May, its peak March-April with an occasional late nest in June. The only way of locating a nest comes through a fortunate chance encounter with the female collecting materials, which she usually does near or on the ground, and watching her to the site, which may be difficult or easy according to the forest density. Holes in living trees are favourites, ranging in height from 8 to 50 feet (c. 3 to 16 m.) though most nests are around the 30 foot (c. 10 m.) mark. I have always wondered and wished to know why the chosen hole is chosen, with so many others in the vicinity, but I suppose I never shall. The nest is a thick pad of green mosses, soft lichens, and spider-silk, lined with cream-coloured flower floss mixed with thread-like fibres and shaped to the mould of the cavity. Four to six eggs are laid, five predominating. They are pure white, splashed and spotted with clear light red, and although similar in colour to those of the Great Tit and the Velvetfronted Nuthatch are, as they should be, distinctly larger averaging c. 18×14 mm. During incubation, there is no sound or clue to any nest location, but when eggs hatch on the 14th day both parents enter upon a period of prodigious feeding activity. They enter and leave the nest without reference to anything or anybody close by. At this time I am always surprised by the number of females I did not see when they were building one month earlier. Fledglings come out of the nest around the 15th or 16th day after hatching and wait to be fed on convenient boughs. For a few more days both parents still feed them, but when they are able to fly and follow through the trees, the male alone caters for the family. This peculiar habit is also true of the Great Tit.

Family SITTIDAE

Velvetfronted Nuthatch : *Sitta frontalis saturatior* Hartert

This beautiful little bird is widely dispersed through the forest on Penang Hills, also above the 2200 foot (c. 670 m.) contour. Just 5 inches (c. 13 cm.) long, its violet-blue upper parts, lilac-peach underparts, combined with its bright vermilion bill, are arresting features as the bird runs up and down tree trunks with jerky movements. It descends head first, not tail first like Woodpeckers. In the brilliant months of January and February it is more frequently seen than in any other month, probably because of its fondness for 'wintering' trees. In addition, these are the nuptial months of pairing, nest building, and flying together. Small parties are also fond of

travelling together at this time of the year, and exhibit an astonishing habit of visiting the same group of trees every morning about the same time; constantly twittering, whether feeding or flying. This would appear to indicate a scheduled daily circuit of territory. Appearances and departures are instantaneous and for this reason disconcerting. Never a sign of site prospecting! Never a clue to nest building! My constant surmise for many years was simply how, when, where do they build, for in any dense rainforest there is no way of following small fast birds and everything is relatively accidental. When eventually I had the solution its simplicity was slightly fantastic and will no doubt appear so now in retelling. Over and over again I had noted that favoured feeding trees were in glades of thinner forest or at forest fringes which received strong sunlight. One day I decided to examine one closely (something I had not done before) after the visiting party had gone. I struck the trunk sharply with a stick and from a crevice in the trunk only 10 feet (c. 3 m.) up there emerged a female nuthatch. I soon reached the crevice which was 6 inches (c. 15 cm.) tall \times 2 inches (c. 5 cm.) wide, and using a torch I could see six eggs in a fur and feather lined green moss nest about 5 inches (c. 13 cm.) down in the cavity. By the pink appearance of the white shells I could tell they were fresh. Markings (freckles and small splashes) were red. There was no plastering at the entrance. The date was 4 February 1950. So, in this case at least, the feeding tree was the nesting tree of one pair, and the morning parties were visitors. This discovery sent me off on a speculative visit to two more party feeding trees which I knew, incidentally far apart, and a pair of nuthatches had a nest in each. This phenomenon invariably happens in bird-nesting. Years may pass before finding a first nest; yet as soon as this is found a second and third turns up, sometimes immediately or very soon afterwards. Because of this experience I am not implying that these are the only sites used. There must be others but I have yet to find them. Five or six eggs are normal clutches. They measure c. 17×13 mm., and the exact nesting season I place from the last week of January through February to the first week of March. The richly coloured birds on Penang Hills are undoubtedly *S. f. saturator*. Only once have I ever heard and seen this species away from the hills; and that was a single bird in one of the tall Angsanna trees bordering Light Street near the General Post Office on 11 March 1949. Out of these notes emerges one unresolved surmise as to what birds are free to make up the parties which continue their morning visits throughout the breeding season.

Entomological Survey of Himalaya

Part XXVI. A Contribution to our Knowledge
of the Geography of the High Altitude Insects
of the Nival Zones from the North-West
Himalaya

PART 6

BY

M. S. MANI, D.Sc., F.L.S., AND SANTOKH SINGH, Ph.D., F.R.E.S.

(With one text-figure)

[Continued from Vol. 59 (3) : 861]

VII. CONCLUDING REMARKS

The zoogeographical problems of the nival insects from the NW. Himalaya centre largely around the high endemism of a cold-adapted, ecologically highly specialized, Tertiary-mountain fauna. Attention has already been drawn to the very high proportion of the Tertiary-mountain element and it has also been shown that at least 60% of the mountain species, found at present above the timber-line, have had their origin within the region of the NW. Himalaya. Large-scale migrations of the present species-complex of the nival zones from outside is thus at once ruled out.

From his extensive studies on the Palaearctic bumble-bees, Skorikow (142) concluded that the region of the Tertiary mountains constitutes an independent place of origin of many fauna within the Palaearctic Realm. The NW. Himalaya is one such important region of recent faunal development and differentiation. The possibility of the origin of many races, subspecies, species, and even genera in such a recently disturbed area was not overlooked by Eidmann (34) in his general remarks on the ants from the Nanga Parbat area. It is also readily apparent that the endemism of the Tertiary-mountain autochthone fauna of the NW. Himalaya is naturally closely bound up with the rise of this mountain system.

At least in so far as the NW. Himalaya is concerned, there seems to be little doubt that the present nival insect fauna above the timber line certainly did not ascend to these high elevations, either from the surrounding lowlands or even from comparatively lower elevations. On the other hand, there is every indication that the territory, which the ancestors of the present nival insect fauna occupied, was uplifted by the Tertiary orogenic movements to the high elevations where the endemites and others are now found. The endemites thus arose *pari passu* with this uplift of the Himalaya and are therefore in every sense products of the growth of the mountain system itself.

The origin of endemism. As is well known, the Himalaya is a series of more or less parallel or nearly converging ranges of high mountains, intersected by longitudinal valleys (18, 81, 82, 153). The NW. Himalaya is connected with the other Tertiary and older mountain ranges of Asia in the so-called Pamir Knot (Fig. 35). This is really an enormous area of the earth's surface, which has undergone considerable recent folding, crumpling, thrusting, and other violent crustal movements during the Tertiary Epoch. The equator-ward movements of the Angaran land mass caused the uplift of the Tethyan sediments and the obliteration of the Tethyan sea. The Gondwana land mass on the south also produced an under-thrust towards the central Asiatic mass and thus contributed to the uplift of the Himalaya. These orogenic movements are believed to have occurred in four major phases respectively in the Upper Eocene, the Middle Miocene, Pliocene, and Pleistocene. The thrusting movements produced a series of folds. The curving of the NW. Himalaya away from the rest of the Himalaya east of the River Sutlej is believed to be due to the resistance by the Gondwana mass to the equator-ward movements from the north.

The obliteration of the Tethyan sea and the uplift of the Tethyan sediments opened up the possibilities of the southward extension of the Angaran lowland and mountain (Asiatic) faunal elements. While the central granite mass of the Great Himalaya was breaking up through the Tethyan sediments, and other crustal movements succeeded one another, the insect fauna, which had already peopled the region, was also simultaneously uplifted to elevations, often even higher than those which species generally inhabit at the present time. The Angaran ancestral stock of the older Asiatic mountain-autochthones spread by way of the Pamir to the NW. Himalaya. The occurrence of *Conophyma* and *Gomphomastax* on the Turkestan mountains, Pamir, and NW. Himalaya is explained, for example, by Uvarov (149) on the basis of the tropical and sub-tropical Angaran

faunal elements of the region being elevated at the same time as the uplift of the mountains and simultaneous evolution to the cold-adapted types. With the uplift of the Tertiary mountain system, the Tertiary tropical and sub-tropical fauna were in a sense transported to alpine and arctic climates. That the present nival insect fauna of the NW. Himalaya are really central Asiatic derivatives, and have had very little or no substantial contribution from the southern Gondwana stock is indicated by the absence of the latter and the presence of numerous typical Angaran and high northern genera like *Nemoura*, *Nysius*, *Chlamydatus*, *Bembidion*, *Cymindis*, *Nebria*, *Trechus*, *Atheta*, *Parnassius*, *Colias*, etc. The present distribution of *Bembidion fuscicrus* Motsch. (Fig. 16), *Catapionus* and *Scepticus* (Fig. 20), *Subterraneobombus melanurus* (Lepel) (Fig. 23), the fourteen subspecies of *Karnasa hübneri* Feld. (Fig. 30), Deuterophlebiidae (Fig. 31), and *Aedes (Ochlerotatus) pullatus* Coq., and *Ephydra glauca* Meig. (Fig. 32) is also additional evidence of the northern origin. The higher endemism and other peculiarities of the Indus province, to which we have already referred, are also best explained by the northern stock. The crest line of the Great Himalaya seems to have been an effective barrier to the Gondwana elements. Furthermore, it was not until the uplift of the NW. Himalaya had progressed sufficiently high to start deposition of sediments on the south that any direct route became available for the Gondwana fauna to the Himalaya (27, 32). The only endemite of undoubted southern source is *Phaeropsopus stenoderus* Chaud., which, as we have already indicated, is confined to the timber line altitudes on the outer Himalayan ranges and is never found north of the crest line of the Great Pir Panjal Range. This species is obviously neo-endemite (Post-Pleistocene origin).

Although the southward extension of the Angaran lowland insect fauna must have followed soon after the obliteration of the Tethyan sea, the transformation of the tropical and sub-tropical lowland forms to the cold-adapted mountain-autochthone elements seems to have come about probably only during the late Miocene, when the Pamir-Karakorum-NW. Himalaya region had reached sufficient elevation. The ecologic specialization of these cold-adapted Tertiary-mountain fauna seems to have reached its climax during the Pliocene uplift of the Himalaya and thus also culminated in the origin of the endemism that characterizes the nival insect fauna at present. The endemites are thus largely of Pliocene origin. The entire nival insect fauna of the region is indeed of Tertiary development. None of the genera, and often even many of the families represented in the present nival

fauna, are known to have existed before late Eocene. The genera *Amara*, *Trechus*, *Nebria*, and *Bembidion* are known as fossils only from the late Eocene and others like *Aleochara* and the family Bombidae are known from the Miocene (52, 53). It is, therefore, not possible to assign an age older than late Pliocene for the greatest majority of the endemic species. It is also only the phylogenetically young and thus plastic groups that could be expected to evolve the high altitude specializations for life in a newly elevated region. Thus, most endemic genera like *Dicranophyma*, *Dolmacoris*, *Tibetocoris*, *Chaetobroschus*, *Ascelosodis*, *Bioramix*, and *Stenophylina* would appear to be of late Pliocene or also of Pleistocene development. Petersen (118), who studied the speciation in the cold-adapted Holarctic fauna, concluded that at least in the case of insects it was not before the Pliocene that cold specialization arose. It is also apparently during the Pliocene that the central Asian, cold-adapted mountain-autochthone species spread north-east to the Nearctic Realm and south-west and south to the NW. Himalaya, using the chain of mountains as migration route. The Mediterranean elements also appear to have more or less penetrated the NW. Himalaya about the same time. Though the bulk of the endemites are of Pliocene development, many would also appear to have become differentiated during the Pleistocene. The local subspecies of Coleoptera, Hymenoptera, and Lepidoptera are without doubt neo-endemites. The Tibetan-Himalayan elements seem to represent Post-Pleistocene arrivals.

The Pleistocene survival. The Pliocene origin of the endemism of the nival insect fauna above the timber line in the NW. Himalaya involves considerations of the Pleistocene survival of the cold-adapted Pliocene endemites and other central Asian elements.

The Pleistocene survival of fauna is now an admitted fact. The older belief in the total destruction and migration of flora and fauna with the advancing Pleistocene ice has long ago been shown to be quite erroneous. Incredible numbers of species of both plants and animals were neither annihilated nor even did they migrate away from the glaciated areas, but have survived in the heavily glaciated areas in various parts of the world. Several workers like Erhard (36), Holdhaus (57-67), Lindroth (84, 85, 86, 87), Schweiger (126), Horion (69), Franz (43), and others have demonstrated the survival of different animals on the Alps. Recently Janetschek (75, 76) has brought together a mass of evidence for the survival of the boreo-alpine species in the heavily glaciated areas on the inner-alpine nunatak system. Even at the present time, surprising numbers of insects are in fact associated with the nunataks in Greenland and Antarctic ice sheets and in the Arctic Alaska.

in all of which places the Pleistocene conditions still continue to persist.

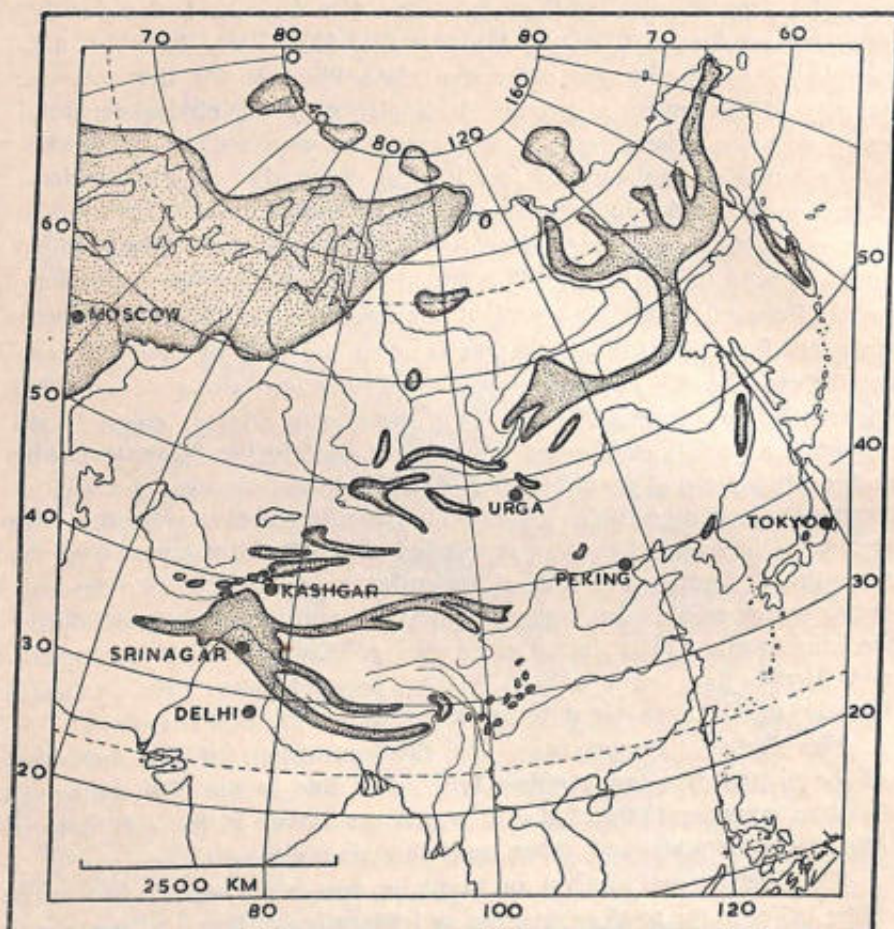


Fig. 55. Map of Asia and part of Europe, showing the areas which were glaciated at one time or another during the Pleistocene. (Equal area azimuthal projection, scale 1 : 4,000,000. After Antevs, 4).

The Pleistocene glaciations in Asia (Fig. 55) were small in comparison to those of Europe and North America. There were no great ice sheets comparable to those of Greenland and Antarctic ice of today, but only numerous ice-covered areas and extensive valley glaciers in mountains and plateaux. During the Pleistocene, general atmospheric aridity seems to have prevailed in large parts of the elevated areas of central Asia, more or less exactly as today. Ice covered the Pamir, Himalaya, Hindukush, Kuen-Lun, and the connecting ranges in Tibet and Sinkiang (Fig. 55). In Altai, the valley

glaciers reached a length of about 320 kilometres and width of about 96 kilometres. There were large ice sheets in Pamir and in Kashmir. There are even at the present time nearly 1200 glaciers in the Pamir area, including some of the largest valley glaciers in the world. The Pamir Valley glaciers of Pleistocene were about 240 kilometres long. The ice sheet often attained a thickness of 150 metres in central Asia and Himalaya. The central Asian mountains like Alai (39° N., 70° E.), Tienshan, Alexander Mountains (43° N., 74° E.), Ala Tau Mts. (45° N., 80° E.) carried numerous valley glaciers. These glaciations are believed to have depressed the permanent snow line by 800 metres on the north slope and by 1600 metres on the south slope on the NW. Himalaya (4, 27, 89). Above the glaciers and ice sheets nunataks existed during the Pleistocene as they do today in these areas. As in Greenland, Antarctica, and the Himalaya at the present time, even during the maximum Pleistocene glaciation, high and massive rocky areas projected above the general mass of ice sheet and valley glaciers, bare and not covered by snow and ice, either because of the steepness, effects of wind, or because of various other local peculiarities. Such rock islands in the midst of ice and snow known as *nunataks* (from the Eskimo language), represent ecologically optimal islands or survival centres for flora and fauna, at present and during the Pleistocene.

Extensive nunatak systems and simultaneous adaptations to the changing conditions accounted for the survival of this fauna. The nunatak system was on a more massive scale than in the Alps. There were further large ice-free, dry, elevated and cold areas. According to Hutchinson (74), genera like *Dolmacoris* are, for example, not recent migrants, but the Heteropteran endemites have certainly survived the Quaternary glaciations in ice-free areas. Numerous ecologic and distributional peculiarities indicate such survival of the nival insect fauna on the nunataks. We have shown earlier (100) that the nival insects are bound to the seasonal snow cover, and it is justifiably conceivable that this was so even during the Pleistocene. The ability of genera like *Nysius* and *Chlamydatus* to survive in the vicinity of Pleistocene ice is referred to by Hutchinson (74). The pronounced massing of the nival species, especially the endemites, around high peaks and ridges, above the present permanent snow line and in areas, such as for example, the Pongong Valley, which were formerly heavily glaciated, and the concentrations in the neighbourhood of the present day glaciers are indications that these were the centres of the origin, evolution, and Pleistocene survival of the nival insect fauna. The Pliocene origin and

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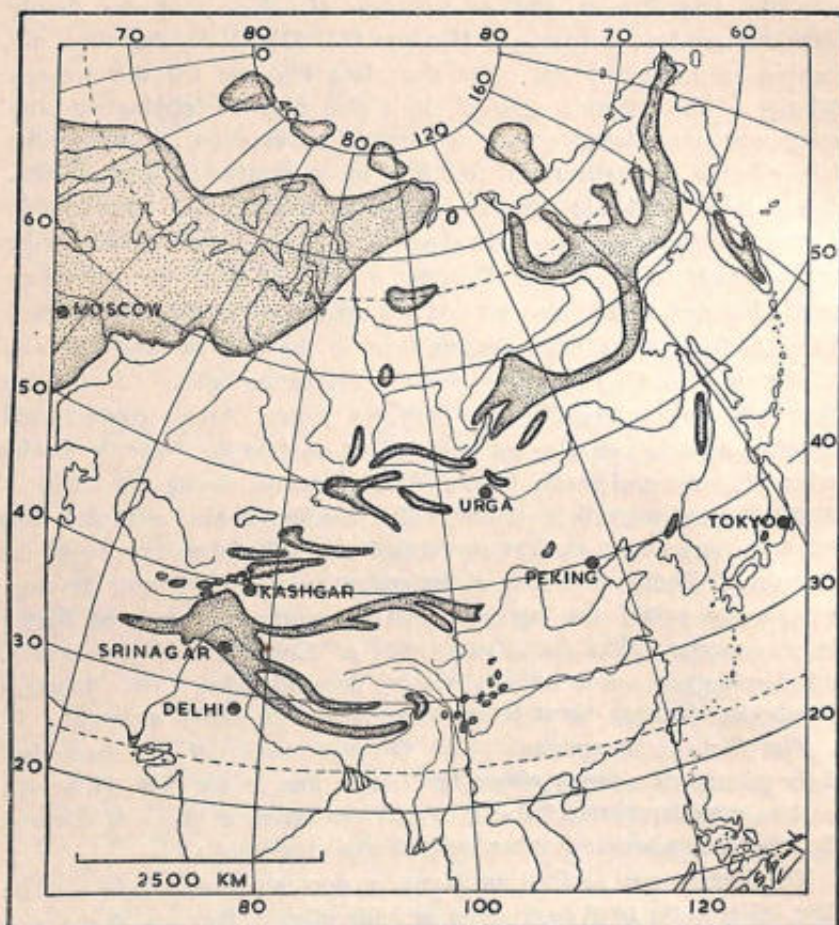


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glaciers reached a length of about 320 kilometres and width of about 96 kilometres. There were large ice sheets in Pamir and in Kashmir. There are even at the present time nearly 1200 glaciers in the Pamir area, including some of the largest valley glaciers in the world. The Pamir Valley glaciers of Pleistocene were about 240 kilometres long. The ice sheet often attained a thickness of 150 metres in central Asia and Himalaya. The central Asian mountains like Alai (39° N., 70° E.), Tianshan, Alexander Mountains (43° N., 74° E.), Ala Tau Mts. (45° N., 80° E.) carried numerous valley glaciers. These glaciations are believed to have depressed the permanent snow line by 800 metres on the north slope and by 1600 metres on the south slope on the NW. Himalaya (4, 27, 89). Above the glaciers and ice sheets nunataks existed during the Pleistocene as they do today in these areas. As in Greenland, Antarctica, and the Himalaya at the present time, even during the maximum Pleistocene glaciation, high and massive rocky areas projected above the general mass of ice sheet and valley glaciers, bare and not covered by snow and ice, either because of the steepness, effects of wind, or because of various other local peculiarities. Such rock islands in the midst of ice and snow known as *nunataks* (from the Eskimo language), represent ecologically optimal islands or survival centres for flora and fauna, at present and during the Pleistocene.

Extensive nunatak systems and simultaneous adaptations to the changing conditions accounted for the survival of this fauna. The nunatak system was on a more massive scale than in the Alps. There were further large ice-free, dry, elevated and cold areas. According to Hutchinson (74), genera like *Dolmacoris* are, for example, not recent migrants, but the Heteropteran endemites have certainly survived the Quaternary glaciations in ice-free areas. Numerous ecologic and distributional peculiarities indicate such survival of the nival insect fauna on the nunataks. We have shown earlier (100) that the nival insects are bound to the seasonal snow cover, and it is justifiably conceivable that this was so even during the Pleistocene. The ability of genera like *Nysius* and *Chlamydatus* to survive in the vicinity of Pleistocene ice is referred to by Hutchinson (74). The pronounced massing of the nival species, especially the endemites, around high peaks and ridges, above the present permanent snow line and in areas, such as for example, the Pongong Valley, which were formerly heavily glaciated, and the concentrations in the neighbourhood of the present day glaciers are indications that these were the centres of the origin, evolution, and Pleistocene survival of the nival insect fauna. The Pliocene origin and

Pleistocene survival of endemites explain the lack of affinity to the Alps and the absence of the boreo-alpine type of distribution. While both the Alps and the Himalaya would seem to belong to the same Tertiary mountain system, their nival insect fauna have had totally different origins and histories. There has been no east-west faunal exchange. Hormuzaki (70, 71) has shown, for example, that even in the case of Lepidoptera, there has been no east-west exchange between Himalaya and the Alps, but the few species which are common to these areas are of northern origin. The differences in the Pleistocene glaciations of Europe and Asia would also account for some of these peculiarities. Not only is there no affinity between the nival insect fauna of the Alps and NW. Himalaya, but also in the Himalaya itself the endemism and faunal components of the NW. Himalaya are quite unrelated to those of the rest of the Himalaya, for example, Kumaon, Nepal, or Darjeeling Himalaya.

Rapid speciation. The high endemism and the occurrence of large numbers of local subspecies are evidence of the high phylogenetic plasticity and the intense speciation in the nival insect fauna of the NW. Himalaya. We have also found other direct evidence in the field in support of the high speed of speciation. We propose to discuss the subject in some detail on a future occasion. The extreme dynamism of the ecological conditions (100), recent geological, physiographical, topographical, and altitudinal changes, Pleistocene glaciations¹, isolation in small and localized allopatric patches on high massifs with intense potentialities for Sewall Wright phenomena (166), the phylogenetic youth and plasticity in spite of cold-specialization, and simultaneous appearance of variations in entire populations of an ecological niche are some of the major factors which govern the intense rate of speciation that is in progress among the nival insects at the present time. Even a minor topographic change, such as the damming of the River Chandra by the Bara Shigri Glacier about 180 years ago, so alters the ecological complex that a totally different type of allopatric population becomes rapidly differentiated. Many of the Pliocene endemites are at present developing local races and subspecies in a number of localities. In the montane tundra above the timber line in the NW. Himalaya there exists a high potential for rapid speciation. We are indeed witnessing still the birth of a unique new insect fauna on one of the largest, highest, and youngest elevated regions of the world.

¹ The presence of a considerable proportion of neo-endemites is evidence of Pleistocene and Post-Glacial evolution. Petersen (118) has discussed the Pleistocene and Post-Pleistocene evolution in Holarctic fauna. Rand (122) has recently shown the importance of Pleistocene as an isolating factor in speciation.

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(Concluded)

The Birds of Nepal

PART 9

BY

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[Continued from Vol. 59 (3) : 821]

Family PARIDAE

Most of the specimens of this family listed below have already been dealt with by Vaurie (1950a).

***645. *Parus ater aemodius* Hodgson. Himalayan Coal Tit.**

Scully (1879), Ripley (1950b), and we did not come across the Himalayan Coal Tit in Nepal. However, Proud (1949, p. 698) once observed it on Nagar Jong (c. 1830 m.), Nepal Valley, in December. It has subsequently been reported in central Nepal by Polunin (1955, p. 888) from the Langtang Valley at c. 3350 m. upwards in summer, and Lowndes (1955, p. 30) from Manangbhot at c. 2440-3655 m. in August. Rand & Fleming (1957, p. 115) recorded it in November from c. 2895 m. in the Kali Gandak Valley, west-central Nepal—the most westerly record for the subspecies. They also found it in Okhaldhunga District, eastern Nepal, at c. 3050 m. in winter. Biswas (1960a) reported it from Khumbu, eastern Nepal, at c. 3655-4265 m. between February and May.

646. *Parus major nipalensis* Hodgson. Nepal Grey Tit.

TARAI : Simra : 3 ♂♂, 1 unsexed (March 4, 5). BHABAR : Amlekhganj : 1 imm. ♂ (June 8). DUN : Hitauna : 1 ♂, 3 imm. ♂♂, 1 ♀, 2 imm. ♀♀, 1 unsexed, 1 imm. unsexed (May 11-26, June 18).

The Grey Tit is common in lower central Nepal from the tarai to the dun in light forests and forest edges, on bushes and trees, singly, in small flocks or in mixed feeding parties with other small birds.

Scully (1879, p. 323) found it in the Trisul Ganga Valley, central Nepal, in November, and Proud (1955, p. 57) occasionally in the

Nepal Valley in winter and spring. Ripley (1950b, p. 407) and Rand & Fleming (1957, p. 114) noted it from western through eastern Nepal from the tarai and dun up to the lower valleys, and Biswas (1960a) on the bank of Charnawati Khola, Ramechhāp District, eastern Nepal, in January.

Measurements :

	Wing	Tail	Bill
4 ♂♂ :	63, 64+, 65, 65+	55 (2), 60 (2)	11.5 (2), 12 (2)
1 ♀ :	61	53	12
2 unsexed ^a :	64, 65	58, 59	12 (2)

^a Both these appear to be males.

647. *Parus monticolus monticolus* Vigors. Himalayan Greenbacked Tit.

CHITLANG VALLEY : Chitlang : 1 ♂ (March 15). NEPAL VALLEY : Thankot, Crest of Chandragiri : 6 ♂♂, 3 ♀♀ (March 21-24, April 16-20).

The Greenbacked Tit is common in central Nepal from about 1525 m. above. It is found in small parties or pairs, in open parts of forests on bushes and trees.

It has further been reported from the northern regions of central Nepal in summer by Polunin (1955, p. 888) in the Langtang Valley at c. 2745-3350 m., and Lowndes (1955, p. 30) in the Marsiyandi Valley, and Manangbhot at c. 1830-3655 m.; from western through eastern Nepal at c. 1220-3050 m. in winter by Rand & Fleming (1957, pp. 114-115). It was also once spotted by Biswas (1960a) at c. 3960 m. in Khumbu, eastern Nepal, in February.

It was breeding in March-April. A female dated April 17 had quite an enlarged ovary with the three largest ova measuring 2.5, 3, and 4 mm., in addition to a 7 mm. oviducal ovum without layers of albumen. A male taken April 20 had much swollen testes, R: 6×6, L: 6×5 mm.

Colours of soft parts : Iris dark brown ; bill black ; legs, feet and claws bluish slaty, horny black on tips of claws ; pads light grey.

Measurements :

	Wing*	Tail	Bill
7 ♂♂ :	66, 68, 68.5, 69 (2), 69.5, 71	54, 56 (4), 57 (2)	11.5 (3), 12 (4)
3 ♀♀ :	67, 68, 70	53, 54, 56.5	12 (2), —

Baker (1922d, p. 80) has given 60-65 mm. as the wing length of the female. However, I measure the wing of 25 female specimens from western and central Himalayas (Murree to Nepal Valley) 63-71 mm. (average 66.9 mm.).

The population of the Greenbacked Tit from eastern Nepal and Sikkim was separated by Meinertzhagen (1926) as *lepcharum*. Ticehurst (1935, p. 40), and Kinnear (1937a, p. 23) did not recognize

lepcharum and considered it indistinguishable from nominate *monticolus*. Vaurie (1950a, p. 37) accepted *lepcharum*, and placed the birds from the Nepal Valley, Sikkim, and Darjeeling District under it. After a careful comparison I find that the depth of green on the dorsal side and yellow on the ventral side varies clinally from western Himalaya eastward to China, the variation being very gradual and not very well marked, although the two extremes are quite distinct. It further appears that *lepcharum* consists of nothing more than intergrades between *monticolus* and *yunnanensis*. Many individual specimens from the intergrading zone (Nepal Valley to Bhutan) can be matched with *monticolus*, while many others can be matched equally well with *yunnanensis*—a fact also noted by Vaurie (op. cit., p. 36). I do not think any useful purpose will be served by recognizing such a poorly characterized race as *lepcharum*, and I would prefer to follow Ticehurst and Kinnear in considering it as a synonym of nominate *monticolus*. Recently, however, Vaurie (1957b, pp. 34-35) has agreed with this view. Still recently, Ripley (1961, p. 548) has also synonymized *lepcharum* with *monticolus*.

648. ***Parus xanthogenys xanthogenys* Vigors.** Western Blackspotted Yellow Tit.

Parus xanthogenys Vigors, 1831, *Proc. zool. Soc. Lond.* (1) : 23. (Himalayas, restricted to Murree, West Pakistan, by Baker, 1920b, p. 236.)

DUN : Bhimphedi : 2 ♂♂ (March 12). MARKHU VALLEY : Deorali : 1 subad. ♂, 1 ♀ (April 28, May 2). CHITLANG VALLEY : Chitlang : 2 ♂♂ (April 23, 24). NEPAL VALLEY : Kathmandu, Phulchauki Danda above Godavari, Thankot, Chandragiri above Thankot : 5 ♂♂, 3 ♀♀ (March 22-30, April 9-11, May 13).

The Blackspotted Yellow Tit is common in central Nepal during March-May from c. 1220 m. upwards in small flocks or pairs in tree forests as well as in woods.

Ripley (1950b, p. 407), and Rand & Fleming (1957, p. 115) recorded it from western through eastern Nepal. Biswas (1960a) observed it in Bhota Kosi and Khinti valleys, eastern Nepal, at c. 1065-1830 m. early in February.

It was breeding in March, April, and May.

Colours of soft parts : Iris dark brown ; bill black, sometimes horny on tip ; legs, feet, and claws bluish slaty or horny slaty ; pads white.

Measurements :

	9 ♂♂	1 subad. ♂	4 ♀♀
Wing :	67, 68 (2), 70, 71.5, 72 (2), 73, 74	69 +	65, 66, 68, 71
Tail :	52 (2), 53, 54 (2), 55, 55.5, 56 (2)	50	50, 51, 52, 54
Bill :	12 (3), 12.5 (3), 13 (2), —	12	12 (2), 12.5 (2)

*649. *Parus xanthogenys spilonotus* Bonaparte. Eastern Blackspotted Yellow Tit.

The only records of the occurrence of this eastern race in Nepal are furnished by Hodgson's later collection (Gray, 1863, p. 37) presumably from eastern Nepal, and by Stevens (1923b, p. 725) from the Mai Valley, extreme eastern Nepal, at c. 2135-2440 m. in March-April.

*650. *Parus rubidiventris rufonuchalis* Blyth. Simla Black Tit.

The sole record of the occurrence of the Simla Black Tit in Nepal is furnished by Rand & Fleming (1957, p. 116) on a single example, obviously a stray one, taken in winter in the Kali Gandak Valley, west-central Nepal, at c. 2805 m., within the range of nominate *rubidiventris*.

Vaurie (1950a, pp. 41-44) has discussed at length the advisability of uniting the blackbellied forms (formerly *P. rufonuchalis* and races) with the rufousbellied *P. rubidiventris*. Dr. Walter Koelz, however, informs me (*in litt.*) that he had seen both of them together in Garhwal and Kumaon, although he did not collect any blackbellied example there.

*651. *Parus rubidiventris rubidiventris* Blyth. Rufousbellied Crested Tit.

Since Hodgson's days, the Rufousbellied Crested Tit has been recorded from Nepal by Smythies (1948, p. 439), and Proud (1952a, p. 362) in the Gandak-Kosi watershed between c. 3050 and 3960 m., Polunin (1955, p. 888) in the Langtang Valley at c. 3200-3960 m., and Lowndes (1955, p. 30) in Manangbhot at c. 2440-3960 m.—all in northern central Nepal; and by Rand & Fleming (1957, p. 116) in the Kali Gandak Valley, west-central Nepal, at c. 2805 m.

*652. *Parus rubidiventris beavani* (Jerdon). Sikkim Black Tit.

The post-Hodgsonian records of the Sikkim Black Tit from Nepal consist of Ripley's (1950b, p. 407) in the Tamur Valley, eastern Nepal, at c. 2745 m. in winter, and Biswas's (1960a) in Khumbu, eastern Nepal, at c. 3655-4265 m. between March and May.

*653. *Parus dichrous dichrous* Blyth. Brown Crested Tit.

Scully (1879), Ripley (1950b), and we were unable to find the Brown Crested Tit in Nepal. It has, however, been reported from the Kali Gandak Valley, west-central Nepal, at c. 3655 m. in December by Rand & Fleming (1957, p. 116), from the northern regions of

central Nepal by Smythies (1948, p. 440), and Proud (1952a, p. 362) in the Gandak-Kosi watershed between c. 3350 and 3655 m., Polunin (1955, p. 888) in the Langtang Valley at c. 3350 m., and Lowndes (1955, p. 30) in Manangbhot at c. 3050 m., and from eastern Nepal by Rand & Fleming (loc. cit.) in Okhaldhunga District at c. 2895 m. in winter, and Biswas (1960a) in Khumbu at c. 3655-3960 m. between February and May.

Snow (in Vaurie, 1957b, pp. 39-40) has shown that *izzardii* Biswas, 1955, is a synonym of nominate *dichrous*.

654. *Sylviparus modestus modestus* (Burton). Eastern Yellowbrowed Tit.

MARKHU VALLEY : Deofali : 1 ♀ (April 28). CHITLANG VALLEY : Chitlang, Chandragiri above Chitlang : 3 ♂♂, 2 ♀♀, 1 unsexed (March 15, April 18-27). NEPAL VALLEY : Thankot, Crest of Chandragiri : 4 ♂♂, 3 ♀♀ (March 23-April 15).

The Yellowbrowed Tit is not particularly common in central Nepal during March-May. We found it at c. 1525-2440 m. in small flocks in open parts of forests on bushes, small trees, and lower branches of large trees.

Smythies (1948, p. 440) recorded it from the Gandak-Kosi watershed at c. 4265 m. in autumn. Except Ripley's (1950b, p. 407) report from eastern Nepal, it has been known in Nepal only from its central region.

It was breeding in April. Two females taken April 15 and 18 had well-developed ovaries.

Colours of soft parts : Iris dark brown ; upper mandible dark horny, bluish slaty on base and greyish white on the sides of its anterior half ; lower mandible bluish slaty with dark tip and greyish white on the sides of its anterior half ; legs, feet and claws bluish slaty ; pads greyish white.

Measurements :

	7 ♂♂	6 ♀♀	1 unsexed
Wing :	57, 58.5, 60, 60.5, 62 (2), 63	55.5, 56, 56.5, 57 (2), 58	62
Tail :	35, 36, 37, 38, 40 (2), 41	34 (2), 35, 36, 37, 39	41
Bill :	9 (5), 9.5, 10	9 (4), 9.5, 10	9.5

655. *Melanochlora sultanea sultanea* (Hodgson). Indian Sultan Tit.

DUN : Hitaura : 1 ♂ (May 24).

The Sultan Tit was noted by us to be a rare bird in central Nepal, having been found only once in the forest at Hitaura in the dun. Ripley (1950b, p. 408) observed it only once in the eastern Nepal tārai, and Rand & Fleming (1957) found none. However, 80 years ago Scully (1879, p. 324) found it 'fairly common in December' between Nimboatar and Hitaura in the central dun.

Measurements : 1 ♂ : Wing 113 ; tail 94 ; bill 18.

*656. *Aegithalos iouschistos iouschistos* Hodgson. Rufousfronted Tit.

Neither Scully (1879) nor we came across the Rufousfronted Tit in Nepal. Of the post-Hodgsonian records of the species from Nepal, except Proud's (1952a, p. 362) sighting in the Gandak-Kosi watershed at c. 2745-3655 m. in spring, it has been found only in eastern Nepal (Stevens, 1923b, p. 724; Ripley, 1950b, p. 408; Rand & Fleming, 1957, p. 118; and Biswas, 1960a)

657. *Aegithalos concinnus iredalei* (Baker). Himalayan Redheaded Tit.

DUN : Bhimphedi : 1 ♂ (March 13). MARKHU VALLEY : Deorali : 1 unsexed (April 29). CHITLANG VALLEY : Chitlang, Chandragiri above Chitlang : 2 ♂♂, 2 imm. ♂♂, 2 ♀♀, 2 unsexed, 1 imm. unsexed (March 15, April 19-24). NEPAL VALLEY Godavari, Thankot, Chandragiri above Thankot, Crest of Chandragiri : 9 ♂♂, 4 ♀♀, 1 imm. unsexed (March 21-April 16, May 11).

The Redheaded Tit is common in central Nepal between c. 1370 and 2285 m. It occurs in small flocks in open parts of forests on bushes and trees.

It has been reported from western Nepal by Ripley (1950b, p. 407) and Rand & Fleming (1957, p. 117); from the northern region of central Nepal by Polunin (1955, p. 888); and from eastern Nepal by Stevens (1923b, pp. 723-724), Rand & Fleming (op. cit., p. 118) and Biswas (1960a).

It was breeding in late March and April.

Colours of soft parts : Iris yellowish white ; bill black ; legs and feet orange brown or brownish yellow ; claws pale horny or brownish horny ; pads fleshy yellowish fleshy or white.

Measurements :

	12 ♂♂				6 ♀♀				3 unsexed		
Wing :	52 (4),	52.5 (2),	53 (2),	54 (2),	55 (2)	49 (2),	50 (2),	51,	52	50, 51, 51+	
Tail :	50.5,	51 (3),	52(2),	52.5,	53 (2),	45,	47,	48,	49,	49.5, 50	49+, 50 (2)
			55(2),	58							
Bill :	8,	9(8),	9.5 (2),	—		8.5 (4),	9 (2)			8.5, 9 (2)	

Of late there has been some difference of opinion as to the validity of an eastern Himalayan race, *rubricapillus* Ticehurst. While Ripley (loc. cit., and 1961, p. 555), and Rand & Fleming (loc. cit.) admit *rubricapillus*, Vaurie (1950a, p. 65, and 1957c, pp. 15-16) does not recognize it. It would appear that this difference of opinion is due to the fact that when individual specimens or small series are compared, *rubricapillus* appears distinct. In large series such as that present in the British Museum, however, the differences between the western and eastern Himalayan populations are reduced to insignificant proportion, leaving, to quote Snow (in Vaurie, 1957c, p. 16) 'many many birds [that] are not separable'. To me it appears inadvisable to accept *rubricapillus*, especially 'as other subspecies of this species

are rather distinct, it seems doubly undesirable to admit this poorly marked form' (Snow, in Vaurie, loc. cit.).

*658. *Cephalopyrus flammiceps olivaceus* Rothschild. Eastern Fire-capped Tit.

Although Nepal lies within the range of the species, I am unable to trace any definite record of the Firecapped Tit from that country, except Gadow's (1883, p. 70) entry of a single specimen as 'Nepal Purchased'.

Family SITTIDAE

Subfamily SITTINAE

659. *Sitta castanea almorae* Kinnear & Whistler. Western Cinnamon-bellied Nuthatch.

TARAI: Simra: 1 ♂ (March 5). BHABAR: Amlekhganj: 2 ♂♂, 1 ♀, 1 subad. ♀ (March 6-9). DUN: Hitaura, Bhimphedi: 9 ♂♂, 2 imm. ♂♂, 1 ♀, 1 subad. ♀, 3 imm. unsexed (May 13-June 19). NEPAL VALLEY: Pashupatinath, Phulchauki Danda above Godavari, Thankot: 3 ♀♀ (March 22, April 11, May 13).

The Cinnamonbellied Nuthatch is a common bird of central Nepal. We found it more numerous in the dun during May-June than in the tarai and bhabar in early March or in the Nepal Valley during March-May. It occurs usually in pairs, but sometimes singly, on trees in forests and woods.

Rand & Fleming (1957, p. 118) recorded it from west-central to eastern Nepal.

In the Nepal Valley it was breeding in April and early May. A female taken April 11 was actually laying, having a 10 mm. oviducal egg without shell. By late May breeding was over in the duns, for specimens taken then or in June had spent up ovaries and reduced testes.

Colours of soft parts: Iris dark to reddish brown; upper mandible black with bluish slaty on base; lower mandible bluish slaty with black anterior quarter; legs, and feet slaty horny; claws horny; pads grey-white to white.

Measurements:

	Wing	Tail	Bill
12 ♂♂:	81, 83 (3), 84(4), 84.5, 85 (3)	41, 42 (3), 43 (5), 44, 47,—	22.5 (3), 23 (4), 23.5 (3), 24 (2)
6 ♀♀:	79, 82, 83 (2), 84, 84.5	40, 41, 42, 43, 45, 48	22 (3), 22.5, 23 (2)

The specimens from central Nepal are somewhat intermediate between the western *almorae* and the eastern *cinnamoventris* Blyth (type locality Darjiling), but closer to the former, as has already been

shown by Vaurie (1950b, p. 6). Ripley (1950b, p. 408) placed his birds under *cinnamoventris*, while Rand & Fleming (1957, pp. 118-119) followed Vaurie in designating their specimens from west-central, central, and eastern Nepal as *almorae*. Recently, Ripley (1961, p. 558) has given the range of *almorae* eastward up to east-central Nepal (presumably Kamala Valley, Mahotari District, where Rand & Fleming's single eastern specimen was taken) where it has been said to intergrade with the eastern race *cinnamoventris* whose western limit has been given as eastern Nepal. Since I cannot trace any definite record of the occurrence of *cinnamoventris* in Nepal, I am not listing it in this paper.

*660. *Sitta castanea castanea* Lesson. Chestnutbellied Nuthatch.

The sole record of the occurrence of the Chestnutbellied Nuthatch in Nepal has been provided by Ripley's (1950b, p. 408) specimens taken in the western tarai and central plains during winter.

661. *Sitta himalayensis himalayensis* Jardine & Selby. Himalayan Whitetailed Nuthatch.

DUN : Bhimpheedi : 1 imm. ♂, 1 imm. unsexed (May 6, 8). MARKHU VALLEY : Deorali : 1 ♂ (May 1). CHITLANG VALLEY : Chitlang, Chandragiri above Chitlang : 4 ♂♂, 1 imm. ♂, 2 ♀♀, 1 imm. ♀ (March 15, April 17-20). NEPAL VALLEY : Thankot, Crest of Chandragiri : 4 ♂♂, 3 ♀♀ (March 21-April 15).

The Whitetailed Nuthatch is common in central Nepal from c. 1370 to 2285 m., and probably further upward. It is found singly or in pairs on trees in forests.

In west-central Nepal it has been reported by Rand & Fleming (1957, p. 118) from the Kali Gandak Valley at c. 1830 m. in winter; in northern central Nepal by Proud (1952a, p. 362) from the Gandak-Kosi watershed up to c. 2895 m. in spring, and Polunin (1955, p. 888) from the Langtang Valley at c. 2440-2745 m. in summer; and in eastern Nepal by Stevens (1924a, p. 1008) from the Mai Valley at c. 2590 m. in April, Ripley (1950b, p. 408) from the Tamur Valley in winter, and Rand & Fleming (loc. cit.) from the Maulung and Dudh Kosi valleys at c. 2285 and 3050 m. in winter.

March and April birds were all breeding.

Colours of soft parts : Iris brown ; upper mandible horny black with ashy on base of culmen ; lower mandible pale bluish white with horny black tip ; legs, feet, and claws horny brown ; pads greyish white.

Measurements :

	9 ♂♂	5 ♀♀
Wing :	71, 72 (2), 73, 74, 75(2), 76,—	72(2), 72.5, 73,—
Tail :	35, 36 (2), 36.5, 37, 38 (3), 41	35(2), 36, 37.5, 38
Bill :	16.5, 17 (4), 17.5 (2), 18 (2)	16.5, 17 (3), 18

662. *Sitta frontalis frontalis* Swainson. Velvetfronted Nuthatch.

TARAI : Simra : 4 ♂♂ (March 4, 5). DUN : Hitaura, Bhimphedi : 3 ♂♂, 1 imm. ♂, 3 ♀♀, 1 imm. unsexed (May 5-28, June 15).

The Velvetfronted Nuthatch is not uncommon in the dun and tarai of central Nepal. It occurs in pairs or small parties on trees in the forests. We had not been able to locate it in the Nepal Valley where Ripley (1950b, p. 408), Smythies (1950, p. 513), and Rand & Fleming (1957, p. 119) observed it. Scully (1879) did not find it in Nepal. Rand & Fleming recorded it also from western, west-central and eastern Nepal.

The unsexed juvenile specimen (May 11) has some spots on the anterior crown.

The June 15 specimens are very worn but there is no sign of moult.

Measurements :

	Wing	Tail	Bill
7 ♂♂ :	72, 72.5 (2), 74, 75 (2), 77	39 (2), 40 (2), 40.5, 41, 43	15.5 (2), 16 (3), 16.5,—
3 ♀♀ :	69, 72, 72.5	36.5, 37, 38	15.5, 16, 16.5

I agree with Vaurie (1950b, pp. 11-13) that *corallina* Hodgson (type locality Nepal) cannot be upheld.

Subfamily TICHODROMADINAE

*663. *Tichodroma muraria nepalensis* Bonaparte. Himalayan Wall Creeper.

Scully (1879, p. 262) recorded the Himalayan Wall Creeper in the Nawakot District, and the Nepal and Markhu valleys during winter, 'but not in any great numbers'. Stevens (1924a, p. 1011) found it on the Nepal side of the Singalila Range, eastern Nepal, near Sandakphu at c. 3597 m. in March. Proud (1949, p. 699) noted it once on Sheopuri, Nepal Valley. Ripley (1950b, p. 409) sighted it once in eastern Nepal at c. 1980 m. in February. Polunin (1955, p. 890) recorded it from the Langtang Valley, central Nepal, at c. 2745 m. in summer. Rand & Fleming (1957, p. 121) found it from west-central through eastern Nepal at c. 550-2745 m. in winter.

Family CETHIIDAE

*664. *Certhia familiaris mandellii* Brooks. Mandelli's Tree Creeper.

Gadow's (1883, pp. 328-329) lists of specimens under '*Certhia discolor*' and '*Certhia nipalensis*' are a curious mixture of *C. familiaris mandellii*, *C. nipalensis*, and *C. discolor*. Thus, under *C. nipalensis*

(with *C. mandellii* as a synonym), he enters six specimens from Nepal, four from Hodgson's collection and two from Gould's and under *C. discolor* (with *C. stoliczkae* as a synonym), two specimens ex Gould collection from Nepal are listed. In point of fact, however, *C. mandellii* has nothing to do with *C. nipalensis*, being accepted as a subspecies of *C. familiaris*, and *C. stoliczkae* in its turn is no close relation of *C. discolor*, being only a synonym of *C. nipalensis*.

The first definite record of Mandelli's Tree Creeper from Nepal was made by Smythies (1948, p. 440) from the Gandak-Kosi watershed, central Nepal, at c. 3505 m. in autumn, followed by Proud (1949, p. 699) from the Nepal Valley at above 1980 m. Both these are, however, visual records. The first post-Hodgsonian specimens taken in Nepal are Ripley's (1950b, p. 409) from the Tamur Valley, eastern Nepal, at c. 2745 m. in winter. It was subsequently reported from central Nepal by Proud (1952a, p. 363) in the Gandak-Kosi watershed at c. 2440-3505 m. in spring, Polunin (1955, p. 890) in the Langtang Valley at c. 3350-3960 m. in summer, and Lowndes (1955, p. 31) in Manangbhot at c. 3350-4115 m. in summer; from west-central Nepal by Rand & Fleming (1957, p. 119) in the Kali Gandak Valley at c. 3655 m. in winter; and in eastern Nepal by Rand & Fleming (loc. cit.) in the Maulung Valley at c. 3505 m. in December, and Biswas (1960a) in Khumbu at c. 3655-3960 m. between February and May.

*665. *Certhia nipalensis* Blyth. Nepal Tree Creeper.

Scully (1879), and we were unable to find the Nepal Tree Creeper in Nepal. Stevens (1924a, p. 1010) came across it on the Singalila Range, eastern Nepal, at c. 2745-3505 m. between January and May—a fact apparently overlooked by Ripley (1950b, p. 409) when in reporting his single specimen from the Tamur Valley, eastern Nepal, he said that the only earlier Nepali record of the species was Hodgson's. Rand & Fleming (1957, p. 120) found it not only in eastern Nepal (Maulung Valley) at c. 3505 m. but also in west-central (Ulleri) at c. 2440 m. in December. This last constitutes the most westerly record known for the species.

Regarding the early Nepali collections of this species, see under *C. familiaris mandellii* (p. 181).

*666. *Certhia himalayana infima* Ripley. Dark Himalayan Tree Creeper.

The Dark Himalayan Tree Creeper was not included in the catalogues of Hodgson's collections (Gray & Gray, 1846; Gray, 1863).

but Gadow (1883, p. 328) listed two specimens in the British Museum presented by Hodgson. Since Hodgson's days it was not known from Nepal, until Ripley (1950a, p. 106; 1950b, pp. 408-409) collected it from the western tarai in winter, and separated the Nepal population from the farther western Himalayan birds. It has also been obtained by Rand & Fleming (1957, p. 121) from western Nepal at c. 1065 and 1830 m. in winter.

Vaurie (1959a, pp. 544-545) does not recognize *infima* as distinct from the nominate *himalayana*.

667. *Certhia discolor discolor* Blyth. Sikkim Tree Creeper.

CHITLANG VALLEY: Chitlang: 1 ♂ (April 23).

This Tree Creeper appeared to be scarce in central Nepal where we found it only on two occasions, once on Chandragiri near Chitlang, when the specimen was collected, and again on Phulchauki Danda above Godavari at about 1830 m. on May 13.

Reporting on our specimen, Vaurie (1950b, pp. 38-39) remarked that this was the first specimen that was undoubtedly taken in Nepal. Subsequently, however, examples were collected in the Nepal Valley by Ripley (1950b, p. 409), and in western through central Nepal by Rand & Fleming (1957, p. 120). Earlier, Smythies (1950, p. 515) observed Tree Creepers at c. 2135-2440 m. on Sheopuri Range, which he recorded as *C. discolor*.

Regarding the early Nepali collections of this species, see under *C. familiaris mandellii* (p. 181).

Our specimen was breeding.

In pointing out certain variations in colour of their Nepal specimens from northern Bengal, Rand & Fleming (loc. cit.) commented that Vaurie (loc. cit.) did not note those differences. However, no critical comparison was possible between the Nepal specimen and the specimens from Sikkim-Darjeeling, since, as Vaurie (op. cit., p. 39) has distinctly noted that 'The Nepal bird is very worn while the plumage is fresh in the others'.

Measurements: 1 ♂: Wing 72; tail 77+; bill 17.5.

Family DICAEDIDAE

*668. *Dicaeum agile agile* (Tickell). Thickbilled Flowerpecker.

Scully (1879, p. 260) was the first to report the occurrence of this species of flowerpecker in Nepal. He found it 'not uncommon in the central part of the Nepal Valley, from May to September'. We were,

however, unable to locate it in central Nepal. Proud (1949, p. 713) noted it to be very common in the Nepal Valley up to c. 2135 m. from summer to autumn. Ripley (1950b, p. 410) found it in the eastern tarai and dun in winter. Polunin (1955, p. 895) reported it from the Trisul Valley, central Nepal, in summer. Rand & Fleming (1957, p. 198) recorded it in the western tarai and central plains in winter.

*669. *Dicaeum chrysorrheum chrysorrheum* Blyth. Yellowvented Flowerpecker.

The lone record of the Yellowvented Flowerpecker from Nepal is based on Hodgson's collection (Gray, 1863, p. 26; Sharpe, 1885, p. 44).

670. *Dicaeum melanozanthum* (Blyth). Yellowbellied Flowerpecker.

NEPAL VALLEY: Thankot: 1 ♂, 1 subad. ♂ (April 2).

This flowerpecker appeared rather scarce in central Nepal. We came across it only occasionally in pairs on tall trees in open parts of forests. It was not included by Scully (1879), and Ripley (1950b) in their lists. Lowndes (1955, p. 35) reported it from the Marsiyandi Valley, central Nepal, at c. 2440 m. in August. Proud (1955, p. 69) found it occasionally during December-February in the Nepal Valley where Rand & Fleming (1957, p. 198) took a single specimen in March.

Measurements:

	Wing	Tail	Bill
1 ♂:	71	41	11
1 subad. ♂:	70	37	11.5

671. *Dicaeum erythrorhynchos erythrorhynchos* (Latham). Tickell's Flowerpecker.

TARAI: Simra: 1 ♂, 1 ♀ (March 4).

This flowerpecker is not a common bird of central Nepal. We found it in pairs in the tarai in tree-groves growing in open country.

Scully (1879) did not report it from Nepal. Proud (1949, p. 713) noted it as common in the Nepal Valley all summer. Ripley (1950b, p. 409) came across it in the western and central tarai, and Rand & Fleming (1957, p. 197) in the western through eastern lowland in winter.

Measurements:

	Wing	Tail	Bill
1 ♂:	46	23	12
1 ♀:	47.5	24	13

Rand & Fleming (loc. cit.) questioned the validity of the statement by Mayr & Amadon (1947, p. 19) that this species 'is a close relative

of *concolor* and so similar to it that occasional specimens may not be identifiable'. Although not clearly indicated, Mayr & Amadon referred in all probability to living birds in the field. Indeed, *D. concolor* and *D. erythrorhynchos* are exceedingly similar in their habits, call, and general appearance, and they are easily and frequently mistaken in the field, unless particular attention is paid to the colour of the bill, which is blackish in the first-named species but pale yellowish or fleshy in the other. This again is not always possible to note accurately, for it depends to a large extent on the distance between the observer and the bird, restlessness of the bird, and the direction of the light.

672. *Dicaeum concolor olivaceum* Walden. Plaincoloured Flowerpecker.

DUN : Hitaura : 6 ♂♂, 3 ♀♀ (May 13-28, June 19, July 9).

The Plaincoloured Flowerpecker is not uncommon in the central dun. It occurs in pairs, sometimes several pairs feeding together, on large trees and tree-groves growing in open country.

Scully (1879) did not find it in Nepal, but Ripley (1950b, p. 409), and Rand & Fleming (1957, p. 198) collected it in the Nepal Valley.

Measurements :

	Wing	Tail	Bill
6 ♂♂ :	44(2), 45(2), 46, 47	21(2), 22(2), 23(2)	11.5, 12(5)
3 ♀♀ :	43, 44(2)	22(3)	11, 11.5, 12

*673. *Dicaeum cruentum cruentum* (Linnaeus). Scarletbacked Flowerpecker.

Hodgson's collection furnishes the only record of the Scarletbacked Flowerpecker for Nepal.

674. *Dicaeum ignipectus ignipectus* (Blyth). Firebreasted Flowerpecker.

DUN : Bhimphedi : 3 ♂♂, 2 ♀♀ (March 11, 13). CHITLANG VALLEY : Chitlang : 1 ♀ (April 18). NEPAL VALLEY : Thankot, Crest of Chandragiri : 7 ♂♂, 6 ♀♀, 1 (♀), 1 imm. ♀ (March 22-April 16).

The Firebreasted Flowerpecker is common in central Nepal, especially in the forests on the bases of the hills surrounding the Nepal Valley. It occurs in pairs in bushes as well as on trees.

Polunin (1955, p. 894) found it in the Langtang Valley, northern central Nepal, at c. 2745 m. in summer. Rand & Fleming (1957, pp. 197-198) recorded it from west-central to eastern Nepal at c. 915-2285 m. in winter.

The juvenile specimen (♀, April 9) has chin and throat white, and the buff on the underside much paler and duller than that of adult.

March and April birds were breeding. A female taken March 23 was marked 'laying' on its label.

Colours of soft parts : Iris brown to dark brown ; bill black with a patch on the base of lower mandible—whitish in male but yellow to orange in female ; legs, feet, and claws dark horny, sometimes black on the claws ; pads greyish white.

Measurements :

	10 ♂♂	10 ♀♀
Wing :	47(2), 48, 49(5), 51(2)	45, 46(5), 47(3), 48
Tail :	25(4), 26(3), 27(2), 28	23, 24(5), 25(2), 26, —
Bill :	10, 10.5, 11(6), 11.5, 12	10, 10.5(3), 11(2), 11.5, —(3)

Family NECTARINIIDAE

*675. *Anthreptes singalensis rubinigentis* (Baker). Indian Rubycheek.

Ripley's (1950b, p. 410) collection of a single specimen in the eastern tarai forms the sole record of the occurrence of the Indian Rubycheek in Nepal.

As I have pointed out elsewhere (Biswas, 1963, in press¹), Baker's name *rubinigentis* should be used for the Indian Rubycheek.

676. *Nectarinia asiatica asiatica* (Latham). Purple Sunbird.

TARAI : Simra : 1 ♀ (March 6). BHABAR : Amlekhganj : 2 ♂♂ (March 6, 8). DUN : Hitaura, Bhimpheedi : 1 ♂, 1 ♀ (March 11, May 28). NEPAL VALLEY : Kathmandu : 1 subad. ♂, 1 juv. ♂, 2 ♀♀ (July 23, 24).

The Purple Sunbird is not uncommon in central Nepal in gardens, on hedges, bushes, and smaller trees about villages and edges of forests.

Ripley (1950b, p. 410) found it in eastern Nepal, and Rand & Fleming (1957, pp. 194-195) in western and west-central Nepal also.

The subadult male specimen (July 23) corresponds with the description of the eclipse plumage given by Whistler (in Ali, 1936b, p. 773). The black stripe on its underside is with very little gloss, but there is a greenish wash on the dorsal side, and the ventral side is yellow.

The juvenile male specimen (July 23) has merely an indication of black throat stripe.

Measurements :

	Wing	Tail	Bill
4 ♂♂ :	54 ^a , 56, 57(2)	31 ^a , 35, 37, 38	20 ^a , 20.5, 21.5(2)
4 ♀♀ :	51.5, 52.5, 53, 54	30(2), 31, —	20(2), 20.5, —

^aSubadult

¹ Comments on Ripley's A SYNOPSIS OF THE BIRDS OF INDIA AND PAKISTAN, to be published in *J. Bombay nat. Hist. Soc.*

*677. *Aethopyga gouldiae gouldiae* (Vigors). Mrs. Gould's Sunbird.

Although not listed in any of the catalogues of Hodgson's collections, Sharpe (1884, p. 28) traced a single specimen of Mrs. Gould's Sunbird in the British Museum from Nepal presented by Hodgson. The only other record of this sunbird from Nepal appears to be Biswas's (1960a) sight record from eastern Nepal in the Bhote Kosi Valley at c. 3655 m. in February-May, the Dudh Kosi Valley at c. 3050 m. in June, and the Hongu Valley at c. 3350-3655 m. in June.

*678. *Aethopyga nipalensis horsfieldi* (Blyth). Blyth's Yellowbacked Sunbird.

Blyth's Yellowbacked Sunbird is known from Nepal only through Ripley's (1950b, p. 410) collection from the western tarai, and Rand & Fleming's (1957, p. 195) record from western and west-central Nepal at c. 1065-1830 m. in November-December. The west-central specimens are, however, intermediate between *horsfieldi* and the eastern nominate *nipalensis*.

679. *Aethopyga nipalensis nipalensis* (Hodgson). Nepal Yellowbacked Sunbird.

CHITLANG VALLEY: Chitlang: 5 ♂♂, 1 ♀ (April 15-26). NEPAL VALLEY Thankot, Crest of Chandragiri: 9 ♂♂, 9 ♀♀ (March 21-April 14).

The Yellowbacked Sunbird was found common in central Nepal between c. 1525 and 2285 m. during March-April on bushes, shrubs, etc., especially those with flowers. Several pairs of them were frequently found feeding together.

It has been reported from central Nepal in the Chandragiri Pass by Smythies (1950, p. 516), the Gandak-Kosi watershed at c. 2440-2745 m. in spring by Proud (1952a, p. 363), the Langtang Valley up to c. 3505 m. in summer by Polunin (1955, p. 894), and the Marsiyandi Valley at c. 1980-2440 m. in September by Lowndes (1955, p. 35); and from eastern Nepal by Ripley (1950b, p. 410) in the Tamur Valley at c. 2745 m. in winter, and Rand & Fleming (1957, p. 195) in Okhaldhunga District at c. 305 and 2285 m. in December.

Colours of soft parts: Iris reddish brown; legs, feet, and claws dark horny; pads grey.

Measurements:

	14 ♂♂	10 ♀♀
Wing:	51 (2), 52, 53, 54 (3), 55 (2), 56 (2), 57 (2), 58	47, 48 (3), 49 (2), 49.5, 50, 51, 52
Tail:	61, 63, 64 (3), 65, 66, 67, 70 (3),—(3)	42 (2), 43 (2), 44 (2), 45 (2), 46, 49
Bill:	20.5, 21 (2), 22 (2), 22.5 (2), 23, 23.5,—(5)	20 (4), 20.5, 21 (2), 21.5, 22,—

680. *Aethopyga saturata saturata* (Hodgson). Blackbreasted Sunbird.

DUN: Hitaura, Bhimphedi: 5 ♂♂ (March 11, 13, May 4-16). CHITLANG VALLEY: Chitlang: 1 juv. ♂ (April 26). NEPAL VALLEY: Thankot: 3 ♂♂, 1 ♀ (March 30-April 8).

The Blackbreasted Sunbird is not uncommon in central Nepal from about 455 m. up to some 1830 m. It is found mostly on bushes in the forests.

Scully's (1879) list does not include this species. Rand & Fleming (1957, p. 196) have also recorded it from western and west-central Nepal at c. 455 and 760 m. in winter.

One of my male examples (Thankot, March 31) has no yellow on the rump.

Measurements:

	Wing	Tail	Bill
8 ♂♂:	53, 54 (3), 55 (3),	70, 73 (2), 76 (2),	20 (2), 21 (2), 21.5 (2),
	57	79, 80,—	22,—
1 ♀:	49	—	22

681. *Aethopyga siparaja seheriae* (Tickell). Indian Scarletbacked Sunbird.

BHABAR: Amlekhganj: 5 ♂♂, 1 juv. ♂, 1 ♀ (March 6-8). DUN: Hitaura, Paharé Ghat, Bhimphedi: 9 ♂♂, 5 ♀♀ (March 11, 13, May 18-30, June 11-18). NEPAL VALLEY: Thankot: 1 ♂, 1 ♀ (March 26, 29).

The Scarletbacked Sunbird is common in central Nepal, especially in the bhabar and dun.

Scully (1879) did not find it in Nepal. Ripley (1950b, p. 410) reported it from western Nepal, and Rand & Fleming (1957, p. 196) from western, west-central, and eastern Nepal up to c. 1370 m. in winter.

Two of my female specimens taken March 8 and 11 have their forecrowns in moult.

Two male specimens taken June 11 and 18 had breeding testes measuring, respectively, 6×6 (each), and R: 6×5, L: 5×5.

Colours of soft parts: Iris dark brown; upper mandible dark horny, black on posterior third; lower mandible horny brown; legs, feet, and claws dark horny; pads greyish or yellowish white.

Measurements:

	15 ♂♂	7 ♀♀
Wing:	56 (2), 56.5, 57 (5), 57.5, 58 (2), 59, 59.5, 60 (2)	49, 50 (2), 51(4)
Tail:	62 (2), 64 (3), 66, 69, 70, 71 (2), 73,—(4)	34, 35 (2), 36, 38 (2), 39
Bill:	20, 20.5 (2), 21 (7), 21.5, 22,—(3)	19.5, 20 (4), 20.5, 21

Baker (1926, p. 378) did not recognize Hodgson's *miles* from Nepal on the basis of Hodgson's ancient skins, although they were

dull grey on the underside. Ticehurst (1927a, p. 355), however, upheld *miles* saying that the 'Nepal birds (*miles*) stand out rather prominently with dull grey under parts'. He apparently ignored the fact that Hodgson's skins were then about 90 years old (and for some years they were kept in the tropics). Baker (loc. cit.) had also cautioned about the peculiar coloration of those skins by saying that it may be 'due . . . to his [Hodgson's] method of curing the skins'. I accept Baker's opinion on the status of *miles*, for all fresh skins of the species (Col. Bailey's at the British Museum, and ours) are not separable from *seheriae*. Rand & Fleming (loc. cit.) have arrived at the same conclusion.

682. *Aethopyga ignicauda ignicauda* (Hodgson). Firetailed Sunbird.

DUN : Bhimphedi : 2 ♂♂, 1 ♀ (March 13, 14). CHITLANG VALLEY : Chitlang : 1 ♂ (March 15). NEPAL VALLEY : Thankot : 2 ♂♂, 4 ♀♀ (March 22-31).

The Firetailed Sunbird was occasionally found by us in central Nepal during March and early April on bushes or shrubs with flowers at elevations over 1525 m. In the Nepal Valley we did not find them after the first week of April, they evidently having gone up to their breeding grounds.

Ripley (1950b, p. 410) found it in the Tamur Valley, eastern Nepal at c. 1525 m. in winter. Polunin (1955, p. 894) reported it from the Langtang Valley, central Nepal, at c. 3050 m. in summer. Rand & Fleming (1957, pp. 196-197) recorded it from west-central through eastern Nepal at c. 1370-2895 m. in winter. Biswas (1960a) came across it occasionally in Khumbu, eastern Nepal, at c. 3050-3655 m. between February and May.

Most of our specimens are in different stages of moult from eclipse to breeding plumage, but nearing completion.

Measurements :

	Wing	Tail	Bill
5 ♂♂ :	57, 58 (4)	moulting (5)	21.5, 23,—(3)
5 ♀♀ :	53, 54, 55 (3)	40 (2), moulting (3)	21, 22 (2),—(2)

683. *Arachnothera magna magna* (Hodgson). Indian Streaked Spiderhunter.

DUN : Hitaura : 2 ♀♀ (June 21, 27).

The Streaked Spiderhunter appeared scarce in central Nepal, having been found by us only two or three times about Hitaura. Our two specimens referred to above are the only ones obtained in Nepal since Hodgson's time.

Measurements : 2 ♀♀ : Wing 84 (2); tail 44, 45; bill 41, 42.

Family ZOSTEROPIDAE

684. *Zosterops palpebrosa palpebrosa* (Temminck & Schlegel). Eastern White-eye.

TARAI: Simra: 1 ♀ (March 6). BHABAR: Amlekhganj: 2 ♀♀ (March 6, 8). DUN: Hitaura, Bhimpheedi: 13 ♂♂, 1 subad. ♂, 4 ♀♀, 2 unsexed (March 11, 13, May 3-June 16). MARKHU VALLEY: Deorali: 1 unsexed (May 1). CHITLANG VALLEY: Chitlang: 2 ♂♂, 1 ♀ (April 17-26). NEPAL VALLEY: Kathmandu, Godavari, Thankot: 6 ♂♂, 4 ♀♀ (March 30-April 2, 14, 27, May 13, 15, July 24).

We found the white-eye as a common bird of central Nepal from the tarai up to the Nepal Valley. It was abundant in the duns, and occurred in pairs or parties of three to a dozen birds or so in gardens, orchards, forests, on trees overhanging ravines, etc.

Rand & Fleming (1957, p. 198) reported it from western through eastern Nepal.

The birds were approaching breeding condition in March and April, and had fully breeding gonads in May.

The spring moult appears to be rather late or prolonged in this species. A male specimen taken on May 13 still has a few growing feathers on the crown, while another male (May 20) has the central tail feathers in moult.

A subadult male taken on May 18 is moulting into adult plumage.

Colours of soft parts: Iris usually hazel, but grey-brown, brownish buff, yellowish buff, and even creamy white iris was also seen; bill black with grey on the base of lower mandible (once upper mandible horny with paler horny on base, lower mandible pale bluish slate on basal two-third and dark horny anteriorly); legs, and feet bluish slate; claws horny; pads white or yellowish white.

Measurements:

	21 ♂♂	12 ♀♀	3 unsexed
Wing:	50, 51, 51.5, 52 (2), 52.5, 53 (10), 54 (2), 54.5, 55 (2)	51 (2), 51.5, 52 (2), 52.5, 53 (2), 53.5, 54, 54.5, 55	51, 54 (2)
Tail:	34, 35, 36 (2), 36.5 (2), 37 (6), 38 (3), 38.5, 39 (3), 41,—	35, 36 (2), 37 (3), 37.5 (2), 38, 39 (2),—	34, 36, 39
Bill:	12, 12.5 (4), 13 (7), 13.5 (5), 14 (3),—	12.5, 13 (8), 13.5, 14 (2)	13 (2), 13.5

In the latest review of the Indian races of the species, Mees (1957, pp. 26-63) has recognized four races in India, namely *palpebrosa* (Nepal, Sikkim, Bengal, probably eastern Bihar, and eastern Orissa, eastward to the greater part of Burma and Yunnan, etc.), *sálimalii* (Eastern Ghats north to Godavari), *nilgiriensis* (Nilgiris, Palnis and associated ranges of south-western India), and *egregia* (Ceylon and the rest of India). While I have not made any special study of the species, I do think that the arrangement proposed by Mees is not entirely satisfactory. For instance, Mees (op. cit., pp. 40, 50) synonymizes *amabilis* Koelz (type locality Sasan, Kathiawar, Gujarat)

with *egregia* Madarasz (type locality Ceylon). I do not know if he had the opportunity to examine fresh specimens from Kathiawar, but on comparing recent collections from the Gir Forest (Kathiawar), Balaghat District (Madhya Pradesh), Darjeeling District (West Bengal), etc., I find that the Kathiawar series stands out quite distinctly, so that Koelz's *amabilis* is, in my opinion, a valid race.

It may be further mentioned here that *amabilis* appears to be the most distinct of the Indian races, and the difference between *amabilis* and *egregia* is more than the differences between the four races admitted by Mees, which are nowhere perfectly clear-cut.

Family EMBERIZIDAE

685. *Emberiza pusilla* Pallas. Little Bunting.

BHABAR : Amlekhganj : 1 ♂, 1 ♀, 3 ? subad. ♀♀ (March 6, 8). NEPAL VALLEY : Thankot : 3 ♂♂ (April 3, 9).

The Little Bunting was seen by us only on a few occasions in central Nepal. We observed it in small flocks on hedges and shrubs about cultivation at Amlekhganj (bhabar) and Thankot (Nepal Valley).

Scully (1879), and Ripley (1950b) did not find it in Nepal, but Rand & Fleming (1957, p. 209) recorded it from the Nepal Valley in March, and from the Kamala and Maulung valleys at c. 305 and 1830 m. in December.

Two of my male specimens (April 3 and 9) had already attained the summer plumage. Three of my female specimens taken March 6 (listed above as ? subad.) do not appear to be in full adult plumage. They are, moreover, somewhat smaller in size.

Measurements :

	Wing	Tail	Bill
4 ♂♂ :	71, 72, 73.5, 74	57, 60 (2), 61	12 (2), 12.5, 13
1 ♀ :	70	57	12
3 ? subad. ♀♀ :	65, 66.5, 67.5	55, 57, 57.5	11.5, 12 (2)

*686. *Emberiza fucata arcuata* Sharpe. Indian Greyheaded Bunting.

Hodgson's later collection (Gray, 1863, p. 57) has furnished the only record of the Greyheaded Bunting for Nepal.

*687. *Emberiza cia stracheyi* Moore. Eastern Meadow Bunting.

The Eastern Meadow Bunting has only recently been recorded for the first time from Nepal by Lowndes (1955, p. 34) who found it in Manangbhot, northern central Nepal, at c. 3050-3960 m. during

summer. Later, Rand & Fleming (1957, p. 210) have come across it in the Kali Gandak Valley, west-central Nepal, at c. 2440-2775 m. in November-December.

Rand & Fleming's specimens represented a variable series from *par* to *stracheyi*.

*688. *Emberiza stewarti* (Blyth). Whitecapped Bunting.

The lone record of the occurrence of the Whitecapped Bunting in Nepal has been furnished by Rand & Fleming (1957, p. 210) from specimens taken in western and west-central Nepal at c. 290 and 1370 m. in winter.

*689. *Emberiza spodocephala sordida* Blyth. Blackfaced Bunting.

Hodgson's collection has provided the only record of this bunting from Nepal.

*690. *Emberiza aureola aureola* Pallas. Yellowbreasted Bunting.

The Yellowbreasted Bunting was not observed by us, nor by Ripley (1950b). Scully (1879, p. 334), and Proud (1949, p. 711; 1955, p. 66) found it as a winter visitor to the Nepal Valley; and Rand & Fleming (1957, p. 210) obtained a single specimen from the central duns (Chitawan District) in April.

*691. *Emberiza rutila* Pallas. Chestnut Bunting.

Rand & Fleming's (1957, p. 210) collection of a single example from the Nepal Valley furnishes the sole record of the Chestnut Bunting for Nepal.

692. *Melophus lathami subcristatus* (Sykes). Indian Crested Bunting.

BHABAR : Amlekhganj : 1 ♀ (March 9). DUN : Bhimphedi : 2 ♂♂, 1 ♀ (March 11, 13, May 6). MARKHU VALLEY : Deorali : 1 ♂ (April 30). CHITLANG VALLEY : Chitlang : 1 ♂, 1 ♀ (April 20, 24). NEPAL VALLEY : Thankot : 2 ♂♂, 2 imm. ♂♂, 5 ♀♀, 2 imm. ♀♀ (March 28-April 11).

The Crested Bunting is not uncommonly found in central Nepal. It usually occurs on bushes and shrubs about cultivation.

Ripley (1950b, p. 412), and Rand & Fleming (1957, p. 211) have found it from western to eastern Nepal. Polunin (1955, p. 894) has recorded a single example from the Trisul Valley, central Nepal, at c. 1830 m. in summer; and Biswas (1960a) has observed it in the Bhota Kosi Valley, Ramechhāp District, eastern Nepal, at c. 1370 m. in February.

One of my male specimens from Bhimphedi, taken on March 11, still has traces of olive-brown edges to black feathers.

A female specimen taken April 11, has the wing coverts in moult.

Measurements :

	6 ♂♂	8 ♀♀
Wing :	81, 82, 82.5, 83 (2), 84	76, 77 (2), 77.5 (2), 78, 78.5, 80
Tail :	66, 68 (3), 69 (2)	64, 65 (2), 66 (2), 67 (2), 69
Bill :	15 (2), 15.5 (2), 16 (2)	14.5, 15 (3), 15.5 (2), 16, —

Family FRINGILLIDAE

693. *Carduelis spinoides spinoides* Vigors. Himalayan Greenfinch.

Carduelis spinoides Vigors, 1831, *Proc. zool. Soc. Lond.* (1) : 44. (Himalayas, restricted to Simla, Himachal Pradesh, by Baker, 1921b, p. 730.)

CHITLANG VALLEY : Chitlang : 1 ♂, 2 ♀♀, 1 imm. ♀ (March 14, April 16, 19).
NEPAL VALLEY : Kathmandu, Thankot : 3 ♂♂, 1 (♂), 1 imm. ♂, 5 ♀♀, 1 (♀), 3 imm. ♀♀ (March 20-April 12).

This greenfinch is a common bird of the Chitlang and Nepal valleys. During March-April it occurred in parties consisting of several pairs, sometimes in flocks of about 30-50 individuals, on the edges of forests or on trees about cultivation such as on the suburbs of Kathmandu. During this period the flocks were tending to break up into pairs.

It has been reported from the northern regions of central Nepal by Smythies (1948, p. 442) in the Gandak-Kosi watershed up to c. 3655 m. in autumn, Proud (1952a, p. 365) in the same zone but at c. 2135 m. in spring, Polunin (1955, p. 893) in the Langtang Valley up to c. 3350 m. in summer, and Lowndes (1955, p. 34) in Manangbhot at c. 2440-3655 m. in summer. In western and west-central Nepal it has been recorded only by Rand & Fleming (1957, p. 202).

Vaurie (1949c, p. 9) has already reported on the moult of most of my specimens listed above. Some of the immature specimens are beginning to undergo post-juvenile moult; for instance, a male (April 10), two females (March 20 and April 16).

The gonads of the adult birds showed signs of enlargement.

Colours of soft parts : Iris brown to dark brown ; upper mandible brownish fleshy, darker on base and tip ; lower mandible fleshy with dusky tip ; legs and feet brownish fleshy to pale horny ; claws horny ; pads white.

Measurements :

	Wing	Tail	Bill
5 ♂♂ :	76, 79 (2), 80, 81	47, 49, 50 (3)	12.5, 13 (2), 13.5 (2)
8 ♀♀ :	76 (4), 77 (4)	46, 47 (2), 48 (2), 49, 50, —	12.5, 13 (3), 13.5 (3), —

*694. *Carduelis carduelis caniceps* Vigors. Himalayan Goldfinch.

The sole record of the occurrence of the Himalayan Goldfinch in Nepal has been furnished by Lowndes (1955, p. 34) who found it in Manangbhot, central Nepal, between c. 3050 and 3960 m. in summer.

Ripley (1961, p. 611) does not include Nepal within the range of this species.

*695. *Carduelis thibetana* (Hume). Tibetan Siskin.

The Tibetan Siskin was not found by us in Nepal, or by Scully (1879) or Ripley (1950b), but Proud (1955, p. 66) observed it in the Nepal Valley late in winter, and Rand & Fleming (1957, p. 202) took specimens there at Godavari in January.

*696. *Leucosticte nemoricola nemoricola* (Hodgson). Hodgson's Mountain Finch.

The first post-Hodgsonian record of this mountain finch from Nepal has been provided by Ripley (1950b, p. 411) who came across it in the Tamur Valley, eastern Nepal, at c. 2440-2745 m. in winter. It has subsequently been reported from northern region of central Nepal by Polunin (1955, p. 894) in the Langtang Valley at c. 2745-3350 m. in summer, and Lowndes (1955, p. 34) in Manangbhot at c. 4265-4725 m. and higher in summer; from eastern Nepal by Rand & Fleming (1957, p. 209) in the Maulung Valley at c. 3050 m. in winter, and Biswas (1960a) in the Likhu Valley at c. 3655 m. in February and in Khumbu at c. 4265-5335 m. in late March-May.

*697. *Leucosticte brandti audreyana* Stresemann. Stresemann's Mountain Finch.

The only record of Stresemann's Mountain Finch from Nepal has been provided by Biswas (1960a) who found it in Khumbu, eastern Nepal, between c. 4570 and 4875 m. in February-May.

Nepal has generally been excluded from the range of the species *L. brandti* in standard books, except Ripley's (1961, p. 616) where *L. b. haematopygia* (Gould) is said to extend 'east probably to Nepal'. However, Biswas's specimens are no doubt *audreyana*.

698. *Erythrina erythrina* nr. *erythrina* (Pallas). Russian Rosefinch.

DUN : Bhimphedi : 1 ♂, 1 ♀ (March 14, May 6). CHITLANG VALLEY : Chitlang : 2 ♂♂, 1 imm. ♂ (April 16). NEPAL VALLEY : Kathmandu, Thankot, Chandragiri above Thankot : 8 ♂♂, 5 imm. ♂♂, 7 ♀♀, 3 imm. ♀♀, 1 unsexed (in ♀ plumage) (March 26-April 23).

The Russian Rosefinch is common in central Nepal above c. 1220 m. during March-April. We found it in small flocks of about half-a-dozen to a dozen birds on bushes and trees, usually about cultivation. On Chandragiri and elsewhere it was found to be particularly fond of the flowers and buds of *Polygonum* sp. on which it was noticed to frequently congregate.

Scully (1879, p. 335) reported it on passage in spring in the Nepal Valley. Ripley (1950b, p. 412) recorded it from western and central Nepal in winter, and Rand & Fleming (1957, p. 203) from western to eastern Nepal in winter, spring and summer.

The immature males are all in feminine plumage. Of them, the one taken on April 4 has a reddish tinge on the chin, and its mantle, wing coverts, and the edges of wings have a slight reddish tone, while another specimen taken on April 10 has only a reddish tinge on the cheeks.

All the specimens had non-breeding gonads.

Colours of soft parts: Iris brown to dark brown; upper mandible horny or brownish horny with darker horny on culmen; lower mandible pale horny with darker tip (once much paler, almost white tip) or horny with greyish on base; legs and feet horny brown; claws horny; pads white.

Measurements:

	11 ♂♂	8 ♀♀	1 unsexed
Wing:	81, 82.5, 83 (4), 83.5, 84 (3), 86	80, 81 (2), 82 (2), 83 (2), 86	82
Tail:	56 (2), 57 (3), 58 (2), 59 (2), 60, 61	55, 56, 57 (3), 58, 59 (2)	56
Bill:	14 (6), 14.5 (4), 15	13.5, 14 (4), 14.5 (2), 15	14

Vaurie (1949c, pp. 36-44), Ripley (1950b, pp. 411-412), and Rand & Fleming (1957, p. 203) have commented on the status of the races of the species in India, and I agree that all my winter specimens are 'non-roseatus' type, as given by Vaurie (op. cit., p. 44) under 'erythrinus subspecies'.

*699. *Erythrina erythrina kubanensis* (Laubmann). Caucasian Rosefinch.

Ripley's (1950b, p. 412) single example from western Nepal furnishes the sole record of this Rosefinch from Nepal.

*700. *Erythrina erythrina roseata* (Blyth). Common Indian Rosefinch.

The Common Indian Rosefinch was reported from the Nepal Valley on passage in spring by Proud (1949, p. 710; 1955, p. 66). Ripley (1950b, pp. 411-412) took it in western Nepal in winter. It was further reported from the northern region of central Nepal by Proud (1952a, p. 364) in the Gandak-Kosi watershed at c. 2440 m. in spring, Polunin (1955, p. 893) in the Langtang Valley at c. 3350 m. in summer, and Lowndes (1955, p. 34) in Manangbhot at c. 2745-4265 m. in summer.

*701. *Erythrina rubescens* (Blanford). Blanford's Rosefinch.

The first record of this rosefinch from Nepal is based on Mandelli's collection of a single specimen at Dolakha, Bhota Kosi Valley.

Ramechhāp District, eastern Nepal, in August 1875. The only other Nepali report of the species appears to be Polunin's (1955, p. 893) from the Sun Kosi watershed, northern central Nepal, at c. 2745 m. in summer.

702. *Erythrina nipalensis nipalensis* (Hodgson). Nepal Dark Rosefinch.

NEPAL VALLEY : Thankot : 1 ♀ (March 21).

The only specimen of the Dark Rosefinch obtained by us was observed in a party of four birds on a tree overlooking a cultivated field at the edge of forest. Very likely, most examples had by then gone to their breeding grounds.

Scully (1879, p. 336) recorded it from the Nepal and Chitlang valleys in winter. Stevens (1925a, p. 371) found it in the Mai Valley, eastern Nepal, at c. 2440-2745 m. in April-May. Proud (1949, p. 711) noted it in the Nepal Valley above c. 1830 m. in winter. Ripley (1950b, p. 412) came across it in the Nepal Valley and eastern Nepal in winter. Polunin (1955, p. 893) observed it in the Langtang Valley, central Nepal, at c. 3050-3350 m. in summer. Rand & Fleming (1957, p. 203) reported it from west-central, central and eastern Nepal between c. 1370 and 2285 m. in winter.

Measurements : 1 ♀ : Wing 81 ; tail 53 ; bill 12.

703. *Erythrina rhodochroa* (Vigors). Pinkbrowed Rosefinch.

CHITLANG VALLEY : Chitlang : 1 ♀ (March 15).

Only once a party of about half-a-dozen individuals of the Pinkbrowed Rosefinch was observed by us on scrub at Chitlang. Like the Dark Rosefinch (see above), most of the individuals appeared to have already left for the breeding grounds.

Scully (1879), and Ripley (1950b) did not find it in Nepal. Polunin (1955, p. 893) reported it from the Langtang Valley, central Nepal, at c. 3350 m. in summer. Proud (1955, p. 66) observed it on Sheopuri Range bordering the Nepal Valley on the north at c. 2440 m. upwards in winter and early spring. Rand & Fleming (1957, p. 204) recorded it from western and west-central Nepal between c. 915 and 2745 m. in winter. Biswas (1960a) came across it in Khumbu, eastern Nepal, at c. 4265 m. early in May.

Measurements : 1 ♀ : Wing 71 ; tail 55 ; bill 11.5.

*704. *Erythrina rhodopepla* (Vigors). Spottedwinged Rosefinch

The first post-Hodgsonian record of this rosefinch from Nepal appears to be that of Polunin (1955, p. 893) who found it in the Langtang Valley, central Nepal, in summer. It has subsequently been reported

also by Rand & Fleming (1957, p. 206) from the Kali Gandak Valley, west-central Nepal, and the Maulung Valley, eastern Nepal, between c. 2135 and 3050 m. in winter.

***705. *Erythrina edwardsii rubicunda* Greenway.** Nepal Large Rosefinch.

Stevens's (1925a, p. 370) collection of a single example of the Large Rosefinch from the Mai Valley, eastern Nepal, at c. 2440 m. late in March, provides the first post-Hodgsonian record of the species from Nepal. Later, Rand & Fleming (1957, p. 206) have also reported a single specimen from western Nepal at c. 1065 m. in December.

***706. *Erythrina pulcherrima pulcherrima* (Moore).** Beautiful Rosefinch.

Since Hodgson's days, Smythies (1948, p. 442) was the first to report this rosefinch from Nepal. He found it fairly common in the Gandak-Kosi watershed, central Nepal, up to c. 3960 m. in autumn. Subsequently, it has been recorded from central Nepal by Polunin (1955, p. 893) in the Langtang Valley at c. 3655 m. in summer, and Lowndes (1955, p. 34) in Manangbhot at c. 3960-4570 m. in summer. Furthermore, Rand & Fleming (1957, p. 206) found it in the Kali Gandak Valley, west-central Nepal, and the Maulung Valley, eastern Nepal, at c. 2135-3050 m. in winter; and Biswas (1960a) noted it as very common in Khumbu, eastern Nepal, between c. 3655 and 4570 m. in March-May.

***707. *Erythrina thura thura* (Bonaparte & Schlegel).** Nepal White-browed Rosefinch.

The post-Hodgsonian records of the Whitebrowed Rosefinch from Nepal consist of Smythies's (1948, p. 442) observation in the Gandak-Kosi watershed, central Nepal, up to c. 4265 m. in autumn; Ripley's (1950b, p. 412) in the Tamur Valley, eastern Nepal, at c. 2440 m. in winter; Proud's (1952a, p. 364) in the Gandak-Kosi watershed at c. 2560 m. in spring; Polunin's (1955, p. 893) in the Sun Kosi watershed, central Nepal, at c. 3960 m. in summer; Rand & Fleming's (1957, p. 204) in the Kali Gandak Valley, west-central Nepal, and the Maulung Valley, eastern Nepal, at c. 2745-3050 m. in winter; and Biswas's (1960a) in Khumbu, eastern Nepal, at c. 4265 m. early in May.

***708. *Erythrina rubicilloides lucifer* (R. & A. Meinertzhagen).** Tibetan Great Rosefinch.

The only record of the Tibetan Great Rosefinch from Nepal has been furnished by Rand & Fleming (1957, p. 205) who found it in the

Kali Gandak Valley, west-central Nepal, at c. 2775 and 2805 m. in winter.

*709. *Erythrina punicea punicea* (Blyth). Nepal Redbreasted Rosefinch.

The first post-Hodgsonian record of the redbreasted rosefinch from Nepal is based on Smythies's (1948, p. 442) observation in the Gandak-Kosi watershed, central Nepal, at c. 3655 m. in autumn. It has subsequently been reported by Lowndes (1955, p. 34) from Manang-bhot, central Nepal, at c. 4265-4420 m. in summer; Rand & Fleming (1957, p. 205) from the Kali Gandak Valley, west-central Nepal, at c. 2745 m. in winter; and Biswas (1960a) from Khumbu, eastern Nepal, at c. 4875 m. in mid-May.

*710. *Propyrrhula subhimachala* (Hodgson). Redheaded Rosefinch.

Since Hodgson's days, the Redheaded Rosefinch has been recorded from Nepal by Smythies (1948, p. 442) in the Gandak-Kosi watershed, central Nepal, at c. 3350 m. in autumn; Ripley (1950b, p. 412) in the Tamur Valley, eastern Nepal, at c. 2745 m. in winter; Polunin (1955, p. 893) in the Langtang Valley, central Nepal, at c. 3960 m. in summer; and Rand & Fleming (1957, p. 209) in the Maulung Valley, eastern Nepal, at c. 3050 m. in winter.

Vaurie (1956a, pp. 36-37) has discussed the question of geographical variation in this species.

*711. *Loxia curvirostra himalayensis* Blyth. Himalayan Crossbill.

The only two post-Hodgsonian records of the Crossbill from Nepal are Stevens's (1925a, p. 368) in the Singalila Range, eastern Nepal, at c. 3505 m. in March, and Rand & Fleming's (1957, p. 209) in the Maulung Valley, eastern Nepal, at c. 3050 m. in winter.

712. *Pyrrhoplectes epauletta* (Hodgson). Goldheaded Blackfinch.

NEPAL VALLEY: Thankot: 6 ♂♂, 3 imm. ♂♂, 3 ♀♀, 1 imm. ♀ (March 18-April 12).

The Goldheaded Blackfinch is not uncommon in small parties of three to six birds on bushes and trees in the forests around Thankot during March and April.

The only other post-Hodgsonian record of this species from Nepal appears to be that of Stevens's (1925a, p. 368) from the Mai Valley, eastern Nepal, at c. 1830 m. in April.

The immature birds (♂♂: March 21, April 1, 5; ♀: March 25) are all moulting into adult.

Measurements :

	Wing	Tail	Bill
6 ♂♂ :	75+, 78, 79(2), 80(2)	54+, 58, 59, 60, 61(2)	12.5(4), 13(2)
3 ♀♀ :	74, 75, 77	53, 56(2)	12(3)

713. *Haematospiza sipahi* (Hodgson). Scarlet Finch.

DUN : Bhimphedi : 3 ♀♀ (May 6).

We did not find the Scarlet Finch at all common in central Nepal. Once a party of eight birds was observed in the pine forest off Bhimphedi when the three specimens listed above were taken. Ours appears to be the only post-Hodgsonian record of the species from Nepal.

Measurements : 3 ♀♀ : Wing 99, 101, 102; tail 63(2), 67, bill from anterior edge of nostril 12(3).

*714. *Pyrrhula erythrocephala* Vigors. Redheaded Bullfinch.

Ripley (1950b, p. 412) has provided the first post-Hodgsonian record of the Redheaded Bullfinch from Nepal. He came across it in the Tamur Valley, eastern Nepal, at c. 2440 m. in winter. It has also been found by Proud (1952a, p. 364) in the Gandak-Kosi watershed, central Nepal, at c. 2440-2745 m. in spring; Polunin (1955, p. 893) in the Langtang Valley, central Nepal, at c. 3655-3960 m. in summer; Lowndes (1955, p. 34) in Manangbhot, central Nepal, at c. 3655-3960 m. in July-August; Proud (1955, p. 66) on Sheopuri Range, Nepal Valley, at c. 2440 m. in April-May; Rand & Fleming (1957, pp. 206-207) in the Kali Gandak Valley, west-central Nepal, and in the Maulung Valley, eastern Nepal, at c. 2135-3960 m. in December; and Biswas (1960a) in Khumbu, eastern Nepal, at c. 3655-4265 m. in March-May.

715. *Pyrrhula nipalensis nipalensis* Hodgson. Nepal Brown Bullfinch.

CHITLANG VALLEY : Chitlang : 3 ♂♂ (April 17). NEPAL VALLEY : Thankot : 1 ♂ (March 24).

The Brown Bullfinch did not appear to us to be particularly common in central Nepal during March-April. We came across it on a few occasions in small flocks of about six to a dozen birds on bushes and trees in the forests on Chandragiri at c. 1525 m. upwards above both Thankot and Chitlang.

Scully (1879, p. 335) found it only once in the Nepal Valley in February. Smythies (1948, p. 441; 1950, p. 516) noted it on Sheopuri Range, Nepal Valley, and further northward in the Gandak-Kosi watershed at c. 2135-2440 m. in autumn. Proud (1955, p. 66) observed it on Sheopuri Range and Phulchauki Danda in the Nepal Valley

from winter until May. Rand & Fleming (1957, p. 207) also found it in the Nepal Valley on Phulchauki Danda and its base at Godavari in March and May.

Measurements : 4 ♂♂ : Wing 85, 87, 88.5, 89 ; tail 71, 74, 75, 79 ; bill 14(2), 14.5, —.

*716. *Mycerobas affinis* (Blyth). Allied Grosbeak.

The only post-Hodgsonian records of the Allied Grosbeak from Nepal appear to be Stevens's (1925a, p. 366) from the Singalila Range, eastern Nepal, at c. 2895 m. on January 31, and Lowndes's (1955, p. 33) from Manangbhot, central Nepal, at c. 3810 m. in August.

*717. *Mycerobas carnipes carnipes* (Hodgson). Whitewinged Grosbeak.

Since Hodgson's days the Whitewinged Grosbeak has been reported from Nepal several times. Thus, in west-central Nepal, it has been found by Rand & Fleming (1957, p. 207) in the Kali Gandak Valley at c. 2745 m. in December; in the northern region of central Nepal in the Gandak-Kosi watershed by Smythies (1948, p. 441) at c. 3655 m. in autumn, and Proud (1952a, p. 364) at c. 3200-3655 m. in spring, and in Manangbhot by Lowndes (1955, p. 34) at c. 3050-4265 m. in summer; in eastern Nepal by Biswas (1960a) from Khumbu at c. 3655-4265 m. in February-April.

718. *Mycerobas melanozanthos* (Hodgson). Spottedwinged Grosbeak.

CHITLANG VALLEY : Chitlang : 1 ♀ (April 21).

The Spottedwinged Grosbeak appeared to be decidedly a rare bird in central Nepal. We saw it only once in a small flock of perhaps eight birds on a tree near Chitlang.

Scully (1879), and Ripley (1950b) did not find it in Nepal, but Rand & Fleming (1957, pp. 208-209) recorded a single example from the Nepal Valley in February.

My specimen was just finishing a complete (prenuptial) moult.

Measurements : 1 ♀ : Wing 129 ; tail 72 ; bill 24.

Vaurie (1956b, p. 22) has discussed the geographical variation in this species.

(To be continued)

Studies on the Freshwater Oligochaeta of South India

I. Aeolosomatidae and Naididae

PART 5

BY

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(With eight text-figures)

[Continued from Vol. 59 (3) : 921]

c. Subfamily STEPHENSONIANINAE nov.

Type genus : *Stephensoniana* Černosvitov

Prostomium simple. No eyes. Dorsal setae begin in II, consist of hairs and needles. Ventral setae of 2 types. Pharynx with dorsal diverticulum. Coelomocytes absent. Nephridia present. Testes and spermathecae in IV; ovaries and atria in V. Four segments formed anteriorly by budding.

9. Genus *Stephensoniana* Černosvitov, 1938

Generic characters : Prostomium triangular. Dorsal bundles from II with hairs and simple-pointed anodulate needles. Ventral setae of II-V distinct from the rest. Stomach absent. Septa present, no septal glands. Dorsal vessel lateral mostly, mid-dorsal anteriorly. Budding zone single.

28. *Stephensoniana trivandran* (Aiyer, 1926)

Fig. 28 A-D

Stephensoniana trivandran (Aiyer). Sperber, 1948, pp. 208-209, fig. 28c.

Material examined : Several worms collected from the Bugga stream, Cuddapah, in May and December 1955; from the Brucepettah tank, Bellary, in April 1954.

Worms small, filiform, reddish brown, tapering abruptly from VI anteriorly, gradually from middle to posterior end, Prostomium bluntly

triangular. Eyes absent. Anterior $\frac{1}{2}$ - $\frac{2}{3}$ covered by mucus sheath to which fine sand particles and clay adhere around annuli and give papillated appearance; posterior $\frac{1}{2}$ - $\frac{1}{3}$ delicate without sheath, probably for respiration.

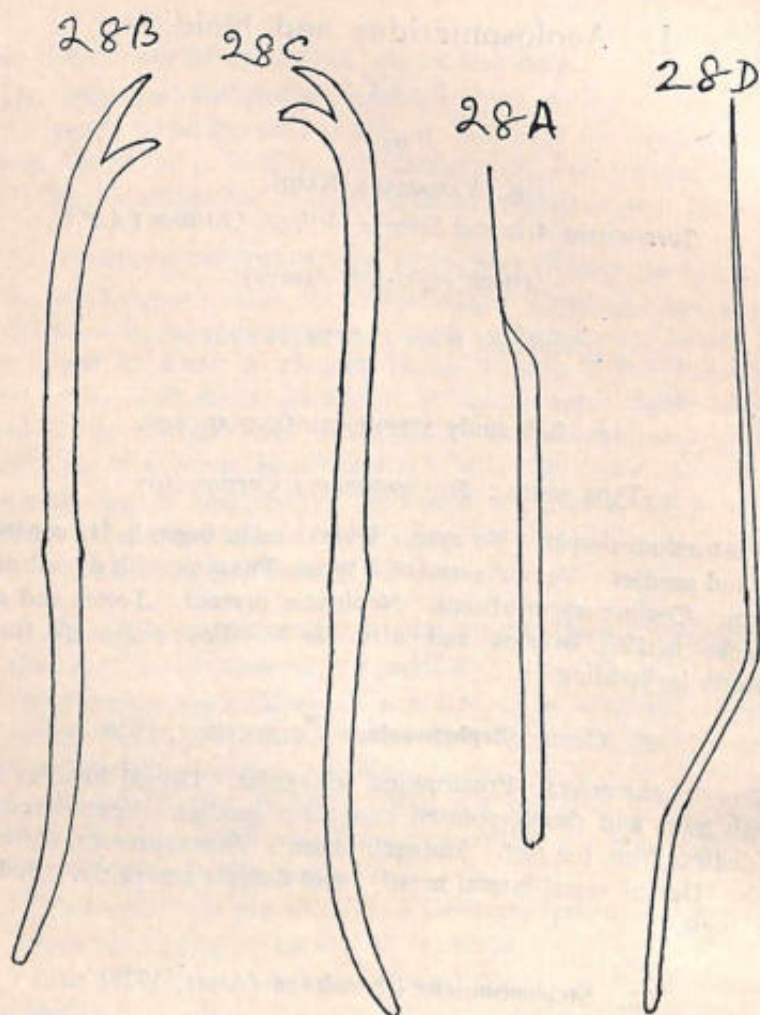


Fig. 28. *Stephensoniana trivandrana* (Aiyer): A. Needle seta $\times 1450$; B. Ventral seta of II $\times 1450$; C. Ventral seta of V $\times 1450$; D. Hair seta $\times 1000$.

Dorsal setae start in II, 3-5 hairs and 3-5 needles in couples of 1 hair and 1 needle per bundle. Hair (Fig. 28 D) clearly bayonet-shaped, 115-175 μ long. Needle (Fig. 28 A) simple, straight, suddenly tapering and slightly curved near the tip, without nodulus, 42-52.5 μ long. Ventral setae (Fig. 28 B, C) 4 per bundle anteriorly, decreasing to 1 posteriorly; in II-IV straight with proximal nodulus (D : P :: 14 : 12), 77-93 μ

long, less curved, distal prong thicker and longer than proximal; in rest 76-91 μ long with distal nodulus (D : P :: 16 : 10), distal prong twice as long and as thick as proximal and prongs end in sharp points.

Pharynx in II-III, wide with dorsal diverticulum protrusible through mouth for feeding. Oesophagus in IV-V, thin and sinuous. Stomach absent. Intestine starts in VI and wide all through. Chloragogues cover the gut from VI, and brown. Intestinal antiperistalsis and ascending ciliary vibration occur. Septa well developed; no septal glands. Coelomocytes absent. Intestinal wall posteriorly has orange-red pigment.

Blood orange-red. Dorsal vessel ventrally attached to gut on the left from hind end to V, where it takes a spiral course and runs mid-dorsally in anterior segments. Contractile vascular vessels 1 pair in V, connect dorsal and ventral vessels.

First nephridium in VI with its pre-septal funnel in V; post-septal has a fusiform ampulla and a long coiled duct ending in nephridiopore ventrally.

One budding zone developed at a time; some hind segments for anterior zooid are budded off earlier than prostomium and four anterior segments of posterior zooid, before fission.

Sexual worms not encountered.

l (p.) = 2 mm.; d (p.) = 0.2 mm.; s = 32 + undifferentiated zone; n = 12-14.

Lengths of longest setae in μ and position of nodulus in ratio D : P ::

	II	III	IV	V
Hair	126	157	175	175
Needle	42	52.5	52.5	52.5
V. seta	92.7	91	77	91
	14:12.5	14:12	12:10	16:10

Distribution in Indian sub-continent : Trivandrum in Travancore (S. India). Now recorded from Cuddapah and Bellary (S. India).

Remarks : The worms move very slowly on muddy substratum and wriggle briskly in water. When disturbed or taken into pipette they coil into flat and close spirals like *Aulophorus michaelsoni* and *Pristina synclites*. Stomach absent. Gut abruptly widens in VI and continues so throughout.

Parasites : Large number of holotrichus astomatous ciliate parasites have been found in the gut of several worms. These parasites emerge out of their bodies through the mouth when slight pressure is exerted on them with cover glass on slides.

Habits : Swim by brisk wriggling movement.

Subfamily PRISTININAE Lastočkín, 1924

10. Genus *Pristina* Ehrenberg, 1828

Generic characters: No eyes. Prostomium with or without proboscis. Dorsal setae from II or III or IV, hairs and needles; ventral setae all of one type. Pharyngeal glands present; stomach fusiform or pear-shaped, usually with intracellular canals. Intestinal anti-peristalsis and ascending ciliary vibration occur. Septa well developed; septal glands present. Coelomocytes present. Dorsal vessel median (lateral in *P. synclites*). Nephridia start in IX, with pre-septal and post-septal in two successive segments. Budding zones 1-3, produce prostomium and seven anterior segments to the posterior zooid and some hind segments to the anterior zooid before fission.

KEY TO ALL THE KNOWN AND VALID SPECIES AND SUBSPECIES OF
PRISTINA

- A-1 Needles simple-pointed
 B-1 Prostomium with proboscis; needles fine, straight
 C-1 Dorsal setae beginning in II
 D-1 Hairs of III specially elongated
 E-1 Distal tooth of ventral setae of II and III nearly twice as long as proximal .. *longiseta longiseta*
 E-2 Distal tooth of ventral setae of II and III thrice as long as proximal
 F-1 Ventral setae of III fewer than in following segments; serrations of hair close and fine .. **longiseta sinensis*
 F-2 Ventral setae of III not fewer than in following segments; teeth of serrations of hair far apart .. **longiseta leidyi*
 D-2 Hairs of II-VII shorter, in others specially elongated .. **biserrata*
 D-3 Hairs not specially elongated in any segment .. *proboscidea*
 C-2 Dorsal setae beginning in III or IV .. **macrochaeta*
 B-2 Prostomium without proboscis; needles bayonet-shaped .. *menoni*
- A-2 Needles double-pointed
 G-1 Prostomium with proboscis
 H-1 Hairs specially elongated in one or more segments
 I-1 Hairs of III specially elongated .. **longiseta bidentata*
 I-2 Hairs of IV-VI specially elongated .. **schmiederi*
 H-2 No specially elongated hair in any segment
 J-1 Needle teeth fine
 K-1 Giant ventral setae present
 L-1 Giant ventral setae in IV, bifid .. *aquiseta*
 L-2 Giant ventral setae in V, single pointed .. *evelinae*

* Species not known from the Indian sub-continent.

- K-2 Giant ventral setae absent
- M-1 Dorsal bundles with not more than 4 hairs and 4 needles; ventral setae of III not shortest; length of worms up to 6.5 mm. .. *foreli*
- M-2 Dorsal bundles with 1 hair and 1 needle; ventral setae of III shortest; length of worms up to 2 mm. .. *sperberae* sp. nov.
- J-2 Needle teeth long and unequal
- N-1 Distal tooth of needles longer than proximal .. **plumaseta*
- N-2 Distal tooth of needles shorter than proximal
- O-1 Distal tooth of needle slightly shorter than proximal; hairs non-serrate .. *synclites*
- O-2 Distal tooth of needle about half as long as the proximal; hairs serrate .. **americana*
- J-3 Needle teeth long and equal
- P-1 Needle teeth diverging; dorsal bundles with 1 hair and 1 needle; hair non-serrate; stomach in VII .. *breviseta*
- P-2 Needle teeth parallel; dorsal bundles with 2-4 hairs and 1-3 needles; hairs closely serrate; stomach in VIII .. **peruviana*
- G-2 Prostomium without proboscis
- Q-1 Needle teeth short and about equal
- R-1 Dorsal setae stout in III; hairs of III-IV specially elongated up to 1200 μ long .. **bilongata*
- R-2 Dorsal setae start in II; hairs not specially elongated in any segment
- S-1 Intermediate teeth 2-3 between main teeth in needles .. **sima*
- S-2 No intermediate teeth between main needle teeth
- T-1 Needle teeth parallel; hairs serrate .. **bilobata*
- T-2 Needle teeth diverging with wide angle; hair non-serrate .. *minuta*
- T-3 Needle teeth diverging at acute angle; hairs serrate .. **notopora*
- Q-2 Needle teeth long, distal tooth shorter than proximal
- U-1 Distal tooth of needles much shorter than proximal, teeth diverging; hair non-serrate; needles thicker in IV (and V) than in others .. **amphibiotica*
- U-2 Distal tooth of needles shorter than proximal
- V-1 Needle teeth parallel and long, distal slightly shorter than proximal; needles in IV longer and stouter than in others; hairs non-serrate .. **idrensis*

* Species not known from the Indian sub-continent.

- V-2 Needle teeth diverging ; distal tooth about half as long as proximal
 W-1 Proximal tooth of needles 5-10 μ long ; hairs non-serrate ; nodule median in anterior ventral setae and distal in others .. *jenkinae*
 W-2 Proximal tooth of needles 3-5 μ long ; hairs finely serrated ; all ventral setae with slightly distal nodule .. **rosea*

29. *Pristina minuta* (Stephenson, 1914)

Fig. 29 A-C

Naidium minutum Stephenson. Stephenson, 1915 a, p. 786.

Pristina minuta (Stephenson). Sperber, 1948, pp. 222-223.

Material examined : Several worms collected from the Bugga stream, Cuddapah, in December 1955 and January 1956.

Worms pale white, minute, slender. Prostomium bluntly triangular without proboscis. Anterior 7 segments shorter than succeeding segments in all adult worms. Anus in a notch bounded by 2 lobes on either side.

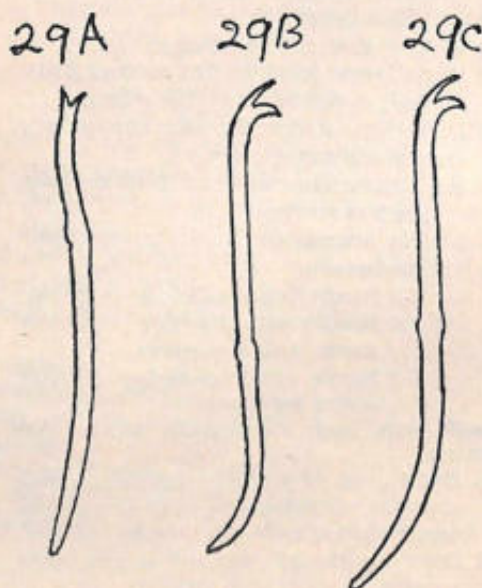


Fig. 29. *Pristina minuta* (Stephenson) : A. Needle seta $\times 2000$; B. Ventral seta of II $\times 2000$; C. Ventral seta of a middle segment $\times 2000$.

*Species not known from the Indian sub-continent.

Dorsal setae start in II, each bundle with 1 hair and 1 needle. Hairs non-serrate, straight, 91-112 μ long. Needles (Fig. 29A) bifid, 24.5-35 μ long, with distal nodulus (D : P : : 3 : 7), teeth of equal length and diverging. Ventral setae (Fig. 29 B, C) 3-5 per bundle, decreasing to 2-3 posteriorly, 31.5-36.5 μ long, shortest in II gradually increasing in succeeding segments, nodulus median (D : P : : 5 : 4 or 5.5 : 5.5), prongs of equal thickness, distal longer than proximal.

Pharynx in II-IV ; oesophagus in V-VII ; stomach in VIII, abrupt and pear-shaped ; intestine thin and flexed on itself in IX and wide from X. Chloragogues begin in VIII, yellowish brown. Coelomocytes granular, morula-like, grey, largest 14 μ in diameter. Septal glands on 4/5, 5/6 and 6/7.

Blood tinged with light shade of red. Dorsal vessel contractile and mid-dorsal.

Nephridia in IX-XII or XIII, 1 per segment. Each nephridium has nephrostome-bearing pre-septal funnel in one segment and post-septal with a long coiled duct and nephridiopore in next segment.

Only one budding zone develops at a time in a worm.

Sexual worms not encountered.

l (living) = 1.5-1.85 mm. ; d (living) = 0.13 mm. ; s = 16 ; n = 12.

Lengths of longest setae in μ and position of nodulus in the ratio D : P : :

	II	III	IV	V	VI	VII	VIII	IX	X	XI
Hair	91	94	101.5	108.5	112	108.5	87.5	87.5	91	—
Needle	26.3	28	31.5	33.3	35	35	35	35	35	35
	3:4.5	3:5	3:6	3:6.5	3:7	3:7	3:7	3:7	3:7	3:7
V. seta	31.5	35	35	36.5	36.5	38.5	38.5	38.5	35	36.7
	5:4	5:5	5:5	5.5:5	5:5.5	5.5:5.5	5.5:5.5	5.5:5.5	5:5	5:5.5

Distribution in Indian sub-continent : Lahore (Pakistan). Now recorded from Cuddapah (S. India).

Habits : No swimming. Backward progression present.

Remarks : These worms have longer needle teeth than the worms of Stephenson. Length of setae, body length, and segment number of the present worms agree with those given by Stephenson (1914), and Marcus (1943).

Naidium osborni Walton (1906, Galloway 1911, Smith 1918) with l = 1.6 mm., s = 15-16, stomach in VIII, agrees very well with *Pristina minuta* (Stephenson). It, however, differs greatly from the latter in having very much longer needles and hairs (needles 50 μ as against 35 μ and hairs 140 μ as against 120 μ). If they are identical, *N. osborni* (with similar body length as *Pr. minuta*) ought to have had setae of similar length. With very much longer setae (particularly needles) for such a small specimen, as Marcus (1943) suggested, it is not identical with *Pr. minuta*, but a distinct species *Pr. osborni* (Walton).

30. *Pristina synclites* Stephenson, 1925

Fig. 30 A-D

Pristina synclites Stephenson. Sperber, 1948, p. 225.

Material examined: Several worms collected from the Bugga stream, Cuddapah, in March 1954, May 1955; from the Kandakam tank, Bellary, in April 1954; from Miller's tank and Langford Town tank, Bangalore, in May 1958.

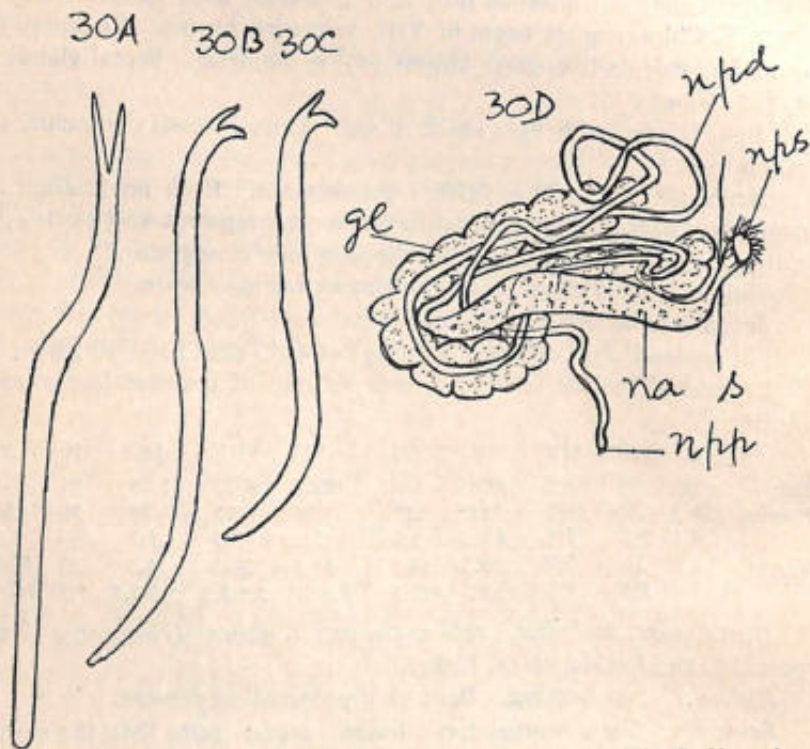


Fig. 30. *Pristina synclites* Stephenson: A. Needle seta $\times 1400$; B. Ventral seta of II $\times 1400$; C. Ventral seta of a posterior segment $\times 1000$; D. Nephridium.
gl: gland; *na*: nephridial ampulla; *npd*: nephridial duct; *npp*: nephridiopore; *nps*: nephrostome; *s*: septum.

Worms largest among the 7 species of *Pristina* in the locality, light red in colour. Posterior half of body is slender, highly vascularised, decreasing gradually in diameter to blunt hind end. Prostomium with a delicate proboscis, with sensory hairs, frequently breaking off partly or wholly. Proboscis shorter than the triangular prostomium.

Dorsal setae start in II, each bundle with 1-2 hairs and 1-2 needles. Hairs slightly bayonet-shaped, non-serrate $175-350 \mu$ long, shorter than body-diameter. Needles (Fig. 30A) bifid, bayonet-shaped $70-101.5 \mu$ long, with weak, distal nodulus (D : P :: 9 : 17), teeth faintly diverg-

ing, proximal slightly longer and thicker than distal. Ventral setae (Fig. 30 B, C) 4 per bundle, decreasing to 2 posteriorly, 63-87.5 μ long, length increasing from II-V and gradually decreasing from VI onwards. Nodus median in II-IV and distal from V on. Prongs equally long, distal thinner than proximal.

Pharynx in II- $\frac{1}{2}$ IV, wide. Oesophagus in $\frac{1}{2}$ IV-VI, thin and straight. Stomach in VII-VIII, gradual and fusiform without intracellular canals. Intestine thin and wavy in IX-XI, wide and sacculated behind, opening at hind end in a notch. Chloragogues cover from VI on, brownish and cover also dorsal vessel. Septal glands in IV-V. Coelomocytes grey, granular, spherical and largest measure 17.5 μ in diameter.

Brain incised deeply in front and less deeply behind.

Blood orange-red. Dorsal vessel contractile, laterally attached to left of gut up to XII, unattached in IX-VIII, again attached in VII-VI, and mid-dorsal in anterior 5 segments. Contractile lateral vessels, 4 pairs, first 2 pairs in the middle of IV and V, other 2 pairs nearer posterior septa of VI and VII. Non-contractile loops in II-III. Dorsal vessel thicker in slender hind part of body and gives off several non-contractile vessels to body-wall, 1 pair per segment. Vascular plexus exists anteriorly.

First nephridium (Fig. 30 D) in IX with its short pre-septal funnel in VIII; post-septal with a long cylindrical granular ampulla followed by a coiled duct, partly passing through gland tissue and opening by nephridiopore.

Single budding zone common, 2 zones rare; buds off hind part of anterior zooid and proboscis prostomium and 7 anterior segments to posterior zooid before they separate. In fact it is only after the production of hind part to anterior zooid budding of anterior segments to posterior zooid takes place.

l (p.) = 4-4.5 mm.; d (p.) = 0.35 mm.; s = 42-63; n = 18-23.

Lengths of longest setae in μ and position of nodulus in the ratio

D : P ::		<i>Cuddapah worm</i>									
	II	III	IV	V	VI	VII	VIII	IX	X	XI	
Hair	126	182	238	241.5	245	255.5	259	259	266	227.5	
Needle	52.5	61.5	75.2	80.5	80.5	80.5	80.5	80.5	80.5	77	
	5:10	6:9.5	8:13.5	10:13	10:13	10:13	10:13	10:13	10:13	9:13	
V. seta	63	63	77	70	73.5	73.5	73.5	73.5	73.5	73.5	
	9:9	9:9	10:12	9:11	10:11	10:11	10:11	10:11	10:11	10:11	
		<i>Bellary worm</i>									
	II	III	IV	V	VI	VII	VIII	IX	X	XI	
Hair	175	227.5	266	350	315	371	280	201	301	301	
Needle	70	73.5	89.3	94.5	91	98	101.5	87.5	87.5	87.5	
	7:13	7:14	6.5:17	9:18	9:17	9:19	9:20	9:16	9:16	9:16	
V. seta	63	66.5	73.5	80.5	84	77	77	73.5	71.7	73.5	
	9:9	9.5:9.5	10:11	10:13	10:14	10:12	9:13	9:12	9:11.5	9:12	

Distribution in Indian sub-continent: Recorded only from Mysore (S. India). Now recorded from Cuddapah, Bellary, and Bangalore (S. India).

Habits: Worms coil into flat spirals when disturbed. They live in soft mud along with *Dero dorsalis*, *Aulophorus michaelsoni*, *Limnodrilus socialis*, etc. Swimming absent.

Remarks: Needles and ventral setae of these specimens are longer than in the specimens of Stephenson (1925b). As reported by Stephenson the hind half of the body has numerous vascular loops similar to those seen in the tubificids. During budding the hind segments of the anterior zooid are budded off before the anterior segments of the posterior zooid start forming.

31. *Pristina jenkiniae* (Stephenson, 1931)

Fig. 31 A-B

Pristina jenkiniae (Stephenson). Sperber 1948, pp. 224-225; 1958, p. 51, fig. 17.

Pristina rosea (Piguet). Yamaguchi, 1953, p. 286.

Material examined: One worm collected from the Kandakam tank, Bellary, in May 1954.

Worm small and pale white. Prostomium bluntly triangular without proboscis.

Dorsal setae begin in II, each bundle with 1-2 hairs and 1-2 needles. Hairs nearly straight, non-serrate, 108-210 μ long, about equal to body-diameter, in II nearly half, in III $\frac{3}{4}$ as long as, in following segments. Needles (Fig. 31 A) bifid, bayonet-shaped, nodulus distal (D : P : : 6 : 11), 53-65.5 μ long, teeth faintly diverging, unequal and blunt, proximal tooth twice as long and as thick as distal. Ventral setae (Fig. 31 B) all of one type, 4-5 per bundle, decreasing to 2-3 posteriorly, nodulus median (D : P : : 6 : 6.5 or 6 : 7) in anterior segments, and slightly distal (D : P : : 6 : 8) in rest; shortest setae in II-III, 43.7-45.5 μ long, abruptly increasing to 52.5 μ in IV and decreasing in middle and hind segments; with teeth about equally long, distal thinner than proximal.

Pharynx in II-IV, wide. Oesophagus in V-VI, thin and sinuous. Stomach in VII- $\frac{1}{2}$ VIII, gradual and fusiform. Intestine thin in IX, wide from X on, opening by anus in a notch at hind end. Septa delicate and complete. Coelomocytes spherical, granular, largest 12 μ in diameter. Chloragogues cover gut from VI, brownish.

Blood yellowish red. Dorsal vessel attached laterally to left from hind end to VI, mid-dorsal in anterior 5 segments. Simple vascular vessels 6 pairs in II-VII, latter 4 pairs contractile.

First nephridium in IX with its nephrostome in VIII, post-septal coiled duct opens by nephridiopore ventro-laterally.

Budding occurs as seen in a single worm. As the worm was in early stage of budding, the number of segments budded off to posterior zooid cannot be stated. The presence of first nephridium in IX as in other

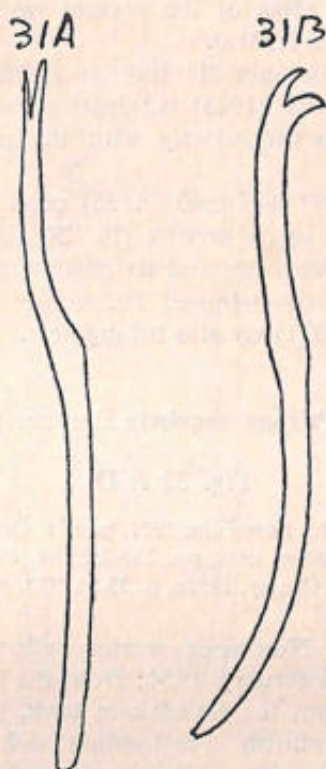


Fig. 31. *Pristina Jenkinae* (Stephenson): A. Needle seta $\times 1600$; B. Ventral seta $\times 2000$.

species of the genus, indicates that 7 anterior segments are budded off here also.

Sexual worm not encountered.

l (living) = 25 mm. ; d (living) = 0.17 mm. ; s = 22 + undifferentiated region ; n = 16 (in one).

Lengths of longest setae in μ and position of nodulus in the ratio D : P : :

	II	III	IV	V	VI	VII	VIII	IX	X
Hair	108.5	150.5	178.5	210	175	175	175	168	157.5
Needle	38.5	52.5	64.7	66.5	59.5	59.5	59.5	59.5	59.5
	4:7	6:9	6.5:12	7:12	6:11	6:11	6:11	6:11	6:11
V. seta	43.7	45.5	52.5	52.5	52.5	52.5	52.5	49	49
	6.5:6	6:7	7:8	7:8	7:8	7:8	7:8	6:8	6:8

Distribution in Indian sub-continent : Now recorded from Bellary (S. India), first record for the Indian sub-continent.

Habits : Swimming absent.

Remarks : The description given here is from a single non-sexual worm. The lengths of setae of the present worm agree very closely with those of Stephenson (1931a).

Sperber (1948) is undoubtedly right in pointing out that *Naidium roseum* Piguët of Marcus (1943) is identical with *Pristina jenkinæ* (Stephenson). It agrees very closely with the present species in all respects.

Pristina rosea (Piguët) of Kondô (1936) certainly belongs here, as pointed out by Sperber, as its needles (Pl. 24, fig. 16a) are stated to resemble those of *Pr. jenkinæ*, and its chalk-white colour agrees with that of latter, not with rose-coloured *Pr. rosea*. *Pr. rosea* (Piguët) of Michaelsen & Boldt (1932) may also belong here.

32. *Pristina aequisetæ* Bourne, 1891

Fig. 32 A-D

Pristina aequisetæ Bourne. Lastoĉkin, 1927. p. 67 ; Černovsĭtov, 1938, pp. 536, 538 ; Berg, 1948, p. 50 ; Sperber, 1948, pp. 230-232, fig. 24, pl. XXI fig. 5 ; 1950, p. 77, fig. 28b, pl. III fig. 8 ; Causey, 1953a, p. 55 ; 1953b, pp. 422-423 ; Yamaguchi, 1953, pp. 284-285, fig. 4.

Material examined : Numerous worms collected from the Bugga stream, Cuddapah, in February 1954 ; from the Balaji tank, Kakinada, in November 1956 ; from the Kandakam tank, Bellary, in April 1954.

Worms small and whitish. Prostomium with fairly long, mobile proboscis with sensory hairs. Anus in a notch bounded by rounded lobes on either side.

Dorsal bundles start in II, each bundle with 1-2 hairs and 1-2 needles. Hairs finely serrated, straight, 100-240 μ long, not specially elongated in III, increase in length from II-IV. Needles (Fig. 32 A) bifid, bayonet-shaped, 31-45 μ long, without nodulus and with fine teeth. Ventral setae (Fig. 32 B, C) 5-6 per bundle, in II, 52-56 μ long, thicker and longer than the rest, with nodulus slightly proximal (D : P : : 9 : 7), distal prong 1.5 times as long as proximal ; in III 43-45.5 μ long with slightly distal nodulus (D : P : : 6 : 7), distal prong slightly longer than proximal ; in IV giant setae 1-2 per bundle (Fig. 32 D), longest of all 66.5-70 μ long and peculiarly shaped, with distal prong strongly hooked and thicker than the rudimentary proximal prong and distal nodulus (D : P : : 8 : 11) ; in the rest 45-51 μ long, prongs of about equal length and thickness ; with slightly distal nodulus (D : P : : 6 : 7).

Pharynx in II-IV, wide with inner wall ciliated and roof eversible. Oesophagus in V-VII, thin and sinuous. Stomach in VIII, abrupt and pear-shaped with intracellular canals. Intestine thin and wavy in IX

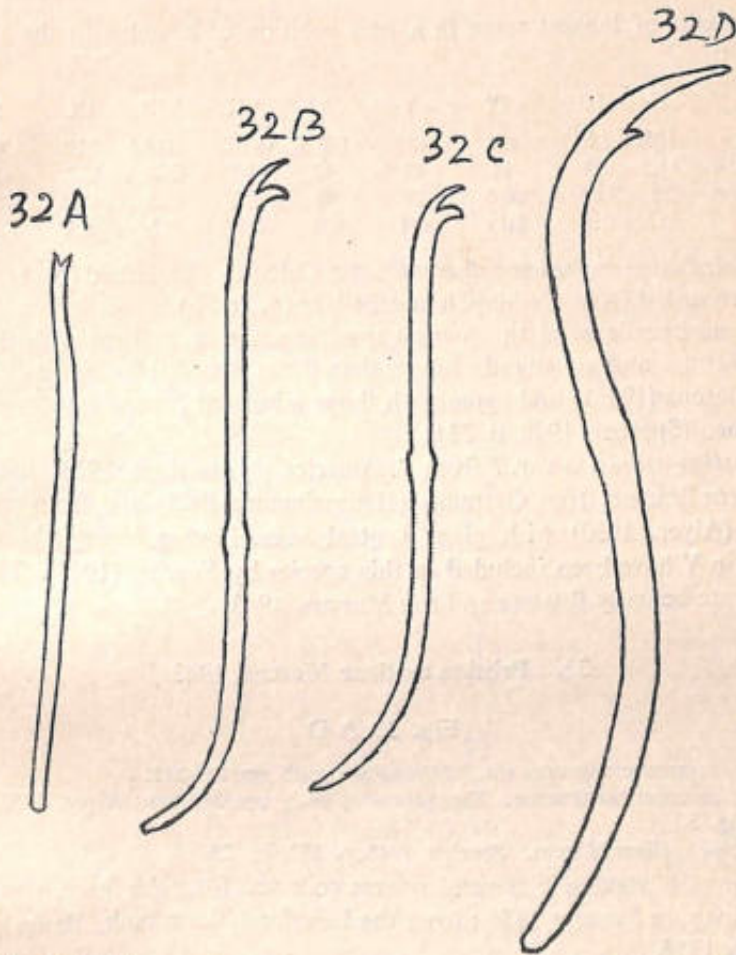


Fig. 32. *Pristina aquiseta* Bourne : A. Needle seta $\times 2000$; B. Ventral seta of II $\times 2000$; C. Ventral seta of IX $\times 2000$; D. Giant ventral seta of V $\times 2000$.

and wide from X. Chloragogues start in VI and greenish brown. Septal glands in III-V. Coelomocytes spherical, morula-like with grey granules, largest of 14μ diameter.

Brain incised anteriorly and posteriorly.

Blood tinged with yellow. Dorsal vessel contractile and mid-dorsal. Contractile vascular vessels 6 pairs in II-VII connecting dorsal and ventral vessels.

First pair of nephridia in IX with pre-septal nephrostome in VIII.

Single budding zone common, two zones rare, second zone always developing in anterior zooid a segment in front of the first zone.

l (p.) = 1-1.5 mm. (single), 1.5-2 mm. (chain) ; d (p.) = 0.2 mm.; s = 17-20 ; n = 12-18.

Lengths of longest setae in μ and position of nodulus in the ratio D : P ::

	II	III	IV	V	VI	VII	VIII	IX	X
Hair	105	140	161	189	192.5	192.5	210	210	210
Needle	31.5	35	42	42	42	43.7	43.7	43.7	43.7
V. seta	56	45.5	66.5	49	49	49	45.5	45.5	45.5
	9:7	6:7	8:11	6:8	6:8	6:8	6:7	6:7	6:7

Distribution in Indian sub-continent : Calcutta, Allahabad (N. India). Now recorded from Cuddapah and Bellary (S. India).

Remarks : Setae of the present specimens agree in form with those in literature, and are slightly longer than those recorded by Piguet (1906) and Marcus (1943), and agree with those tabulated for a single Swedish specimen (Sperber, 1948, p. 231).

Pristina aequiseta var. ? from S. America (Michaelsen, 1913) and *Pr. aequiseta* Bourne from Germany (Hempelmann, 1923) and from south India (Aiyer, 1930) with giant ventral setae having a single hooked prong in V have been included in this species by Sperber (1948). These forms are actually *Pristina evelinae* Marcus, 1943.

33. *Pristina evelinae* Marcus, 1943

Fig. 33 A-D

Pristina aequiseta Bourne var. ? Michaelsen, 1913, pp. 209-211.

Pristina aequiseta Bourne. Hempelmann, 1923, pp. 380-444 ; Aiyer, 1930, pp. 25-26, fig. 5.

Pristina evelinae Marcus. Sperber, 1948, p. 232, fig. 25.

Material examined : Several worms collected from the Bugga stream, Cuddapah, in January 1956 ; from the Langford Town tank, Bangalore, in May 1958.

Worms minute, brownish, capable of high contractility, hence very short in preserved condition. Proboscis longer than prostomium with sensory hairs. Anterior 7 segments shorter than following segments. Anus posterior in a notch between 2 lobes with sensory hairs.

Dorsal setae from II on, 1 hair and 1 needle per bundle. Hairs nearly straight 91-175 μ long, longer than diameter of body. Needles (Fig. 33 A) finely bifid, 28-42 μ long, slightly curved distally, nodulus distal (D : P :: 4 : 8), teeth fine, short, diverging. Ventral setae (Fig. 33 B, C) 4-7 per bundle, higher number in middle segments, 38.5-52.5 μ long ; in II, 49-52.5 μ long, longer than rest, in III, 38.5 μ long and

shortest. Nodulus proximal in II (D : P :: 8 : 7 or 8 : 6) and distal in others (D : P :: 5 : 7). Giant setae (Fig. 33 D) 1 per bundle in V, 70-77 μ long, single-pointed with double curve with shape resembling a pruning knife, nodulus strong and distal.

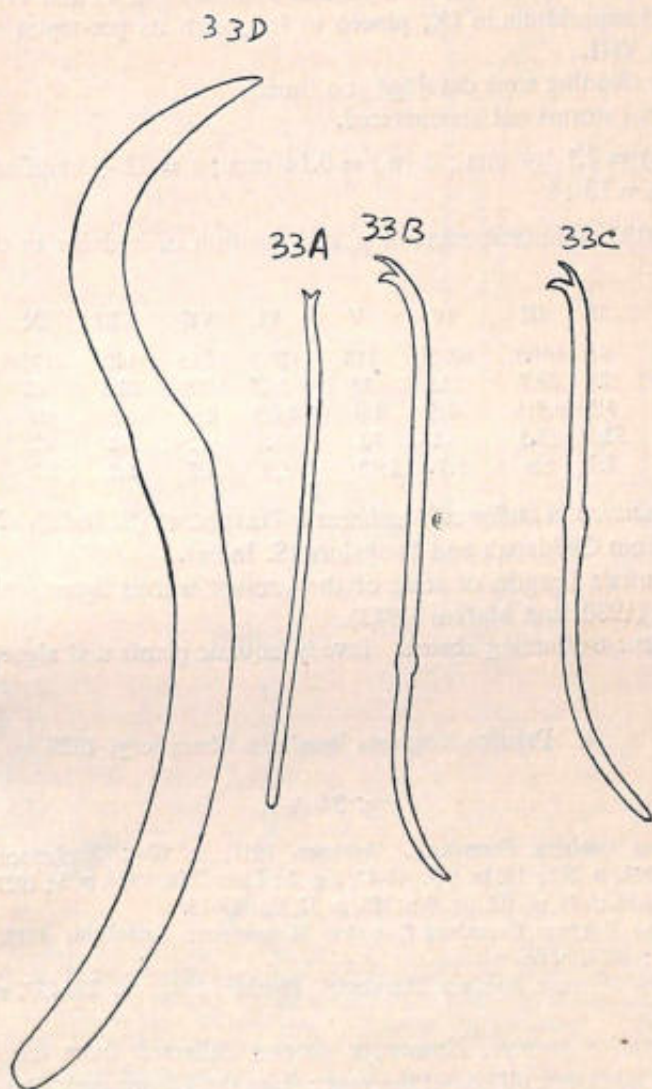


Fig. 33. *Pristina evelinae* Marcus : A. Needle seta \times 2250 ; B. Ventral seta of II \times 2250 ; C. Ventral seta of posterior segment \times 2250 ; D. Giant Ventral seta of IV \times 2250.

Pharynx in II-III, wide. Oesophagus in IV-VII, thin. Stomach abrupt and narrowing posteriorly with intracellular canals in VIII. Intestine

from IX onwards. Coelomocytes granular, spherical, largest 12μ in diameter. Septal glands in III-V, whitish.

Brain incised in front and behind.

Blood red. Dorsal vessel mid-dorsal all along. Transverse commissural vessels from II-VII, enlarged and contractile in VI and VII.

First nephridium in IX, placed to left, with its pre-septal nephrostome in VIII.

One budding zone develops at a time.

Sexual worms not encountered.

l (p.) = 1.1-1.4 mm.; d (p.) = 0.14 mm.; s = 22 + undifferentiated zone; n = 13-14.

Lengths of longest setae in μ and position of nodulus in the ratio D : P ::

	II	III	IV	V	VI	VII	VIII	IX	X
Hair	91	101.5	108.5	112	129.5	129.5	140	175	140
Needle	28	29.7	35	35	36.7	35	38.5	42	38.5
	3:5	3.5:5	4:6	4:6	4:6.5	4:6	4:7	4:8	4:7
V. seta	52.5	38.5	42	70	45.5	42	42	42	42
	8:7	5:6	5:7	8:12	5:8	5:7	5:7	5:7	5:7

Distribution in Indian sub-continent : Travancore (S. India). Now recorded from Cuddapah and Bangalore (S. India).

Remarks : Lengths of setae of the present worms agree with those of Aiyer (1930) and Marcus (1943).

Habits : Swimming absent. Live in aquatic plants and algae.

34. *Pristina longiseta longiseta* Ehrenberg, 1828

Fig. 34 A-K

Pristina longiseta Ehrenberg. Pointner, 1911, p. 634; Stephenson, 1916, p. 304; 1922, p. 282; 1931a, pp. 41-42, fig. 2; Lastoĉkin, 1924, p. 5; 1927, p. 66; Sperber, 1950, p. 77, pl. III, fig. 9; 1958, p. 52, figs. 18-19.

Pristina longiseta Ehrenberg f. *typica* Michaelsen; Lastoĉkin, 1918, p. 59; 1924, p. 5; 1927, p. 66.

Pristina longiseta longiseta Ehrenberg. Sperber, 1948, pp. 236-237, pl. XXI, figs. 2, 6.

Material examined : Numerous worms collected from the Bugga stream, Cuddapah, all round the year; from the Ulsoor tank, Bangalore, in May 1958.

Worms small, slender and light yellow. Prostomium (Fig. 34 A, B) with a mobile proboscis, latter longer than former, both with sensory hairs. Anus posterior in a notch between 2 lobes with sensory hairs (Fig. 34 C).

Dorsal bundles from II onwards, each bundle with 1-3 hairs and 1-3 needles. Hairs of III specially elongated, straight non-serrate, highly

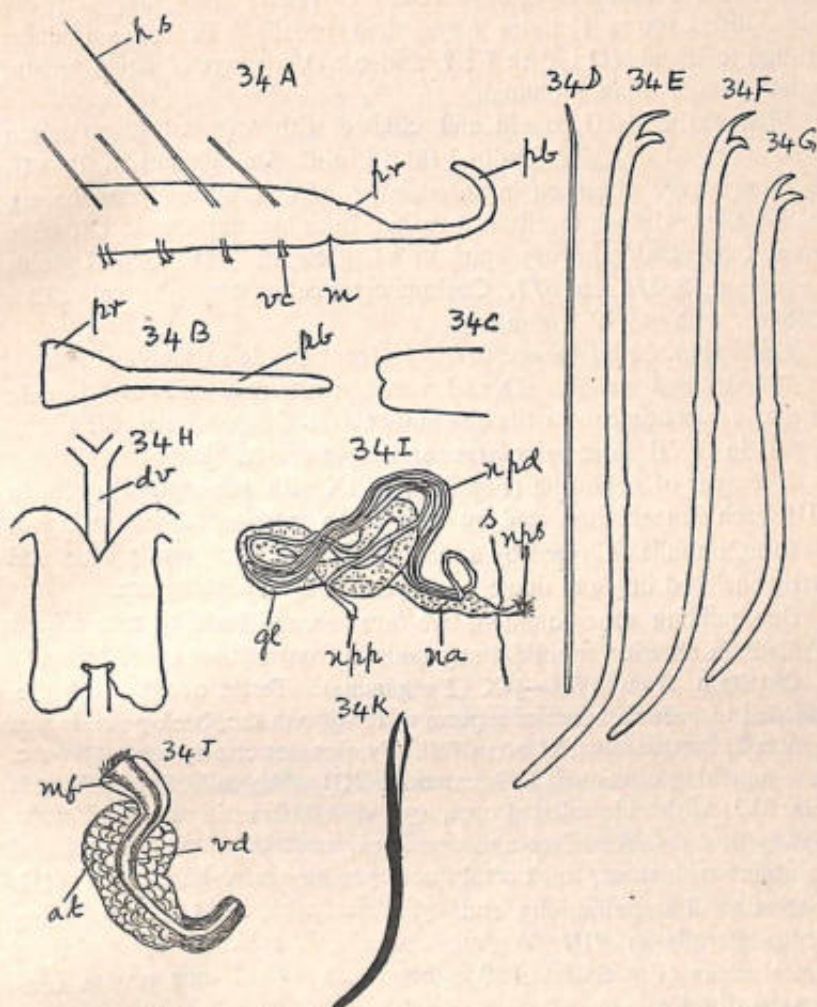


Fig. 34. *Pristina longiseta longiseta* Ehrenberg : A. Anterior part of the worm (lateral view) ; B. Prostomium (dorsal view) ; C. Posterior part of the worm (dorsal view) ; D. Needle seta $\times 1700$; E. Ventral seta of II $\times 1700$; F. Ventral seta of III $\times 1700$; G. Ventral seta of posterior segment $\times 1700$; H. Brain ; I. Nephridium ; J. Seminal funnel and atrium ; K. Genital seta $\times 650$.

at : atrium ; dv : dorsal vessel ; gl : gland ; m : mouth ; mf : male funnel ; na : nephridial ampulla ; npd : nephridial duct ; npp : nephridiopore ; nps : nephrostome ; pb : proboscis ; pr : prostomium ; s : septum ; vc : ventral seta ; vd : vas deferens.

mobile, 658-714 μ long, reaching beyond tip of proboscis when turned forwards; in others nearly straight with close serrations on convex border, up to 315 μ long. Needles (Fig. 34 D) fine, straight with distal end simple pointed and curved, without nodulus, 35-49 μ long. Ventral

setae (Fig. 34 E, F, G) 4-5 per bundle in anterior segments and 5-6 in later segments; in II longest, 63-66.5 μ long; in others 49-56 μ long. In II and III nodulus proximal (D : P :: 11 : 7) and prongs equally thick, distal prong 1½ times longer than proximal, in others nodulus median to distal (D : P :: 7 : 7 and 6 : 7), prongs of equal length, distal thinner than proximal.

Pharynx in II-III, ovoid and ciliated with a dorsal diverticulum communicated by a longitudinal slit in roof. Oesophagus in IV-VII, thin and wavy. Stomach in anterior half of VIII, abrupt pear-shaped, thick-walled with intracellular canals. Intestine narrow in IX, wide from X on. Chloragogues start in VI, greenish grey. Septal glands on septa 4/5, 5/6 and 6/7. Coelomocytes colourless, spherical of 10 μ diameter with greyish granules.

Brain (Fig. 34 H) incised deeply in front and less deeply behind.

Blood light yellow. Dorsal vessel contractile and mid-dorsal; ventral vessel non-contractile and mid-ventral. Simple contractile lateral vessels in II-VII, later pairs larger and more contractile.

First pair of nephridia (Fig. 34 I) in IX with pre-septal funnels in VIII, each funnel connected by a neck to post-septal, consisting of fusiform ampulla followed by a coiled, ciliated duct, partly free and partly enclosed in gland tissue, and opening by nephridiopore.

One budding zone common, two rare, second budding zone always develops in anterior zooid 3-4 segments in front of first zone.

Clitellum from ½VII—½IX (2 segments). Testes ovoid and white, attached to posterior face of septum 6/7. Sperm-sac, back-pouching of septum 7/8 extends to XI when full. Ovaries not clearly seen. Ovi-sac, back-pouching of septum 8/9, extend to XII when full. Sperm-funnels (Fig. 34 J) with wide ciliated openings, vasa deferentia short and wide, slightly bent on themselves and opening into atria. Atrium ovoid and glandular with short, thick ectal duct opening ventro-laterally in VIII. Spermathecal ampulla long and cylindrical with short ducts opening ventro-laterally in VII. Ventral setae of VI replaced by a pair of genital setae (Fig. 34 K) of 80 μ long, each with 2 long prongs converging distally.

As in *Stylaria fossularis* worms developing sex organs go through asexual reproduction repeatedly producing fission zones.

l (living) = 2-3 mm. (simple), 4-5 mm. (chain); d (living) = 0.12 mm.; s = 22-26; n = 14-17.

Lengths of longest setae in μ and position of nodulus in the ratio D : P ::

	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Hair	161	714	178.5	196	217	70	63	241.5	245	245	255.5
Needle	35	42	42	45.5	45.5	45.5	49	49	49	49	49
V. seta	63	52.5	49	49	45.5	56	52.5	52.5	52.5	52.5	52.5
	11:7	8:7	7:7	7.5:6.5	7:6	8:8	7.5:7.5	7.5:7	8:7	8:7	8:7

Distribution in Indian sub-continent : Calcutta (N. India) ; Bheemanager, Trivandrum (Travancore, S. India) ; Bombay (W. India) ; Gwalior (C. India) ; Lahore (Pakistan). Now recorded from Cuddapah and Bangalore (S. India).

Parasites : Sporocysts of the microsporid sporozoan, *Mrazekia caudata* Leger & Hesse (Naidu, 1959a), were found in the coelom of two worms and of the actinomyxid sporozoan, *Triactinomyxon* sp. (Naidu, 1959b) were found in the gut wall of one worm.

Habits : No swimming. Backward progression present. Live in algae.

Remarks : Lengths of setae of the present specimens agree with those of the Swedish worms. Genital setae agree with those of Aiyer (1930).

Pristina longiseta Ehrenberg from W. Australia (Jackson, 1931) and *Pr. longiseta* Ehrenberg f. *typica* Michaelsen from East Indies (Michaelsen & Boldt, 1932) are probably identical with the present species. To determine their identity a re-investigation of the forms is necessary.

35. *Pristina sperberae*¹ sp. nov.

Fig. 35 A-D

Material examined : A few worms collected from the Bugga stream, Cuddapah, in October 1953, January 1954 and 1956.

Worms minute, slender, and whitish. Prostomium with proboscis, latter slightly longer than prostomium and does not snap. Both prostomium and proboscis bear sensory hairs. Eyes absent.

Dorsal bundles start in II, each bundle composed of 1 hair and 1 needle. Hairs non-serrate, nearly straight, 100-190 μ long, in III not specially elongated but slightly longer than hairs of II and slightly shorter than those of IV. Needles (Fig. 35 A) bifid, 28-35 μ long, with weak distal nodulus (D : P :: 2 : 10), curved above nodulus, with fine unequal and diverging teeth. Ventral setae (Fig. 35 B, C) 7-8 per bundle in anterior 7 or 8 segments, gradually decreasing to 4 posteriorly ; in II, 43.8-45.5 μ long, longer than the rest, with proximal nodulus and distal prong longer than proximal ; in III shortest 35-36.7 μ long, with median nodulus (D : P :: 5 : 5.5) ; in others 38.5-45.5 μ long, with distal nodulus (D : P :: 5 : 7). Prongs about equal in thickness, distal longer than the proximal in anterior 7 segments, and prongs equally long, distal thinner than proximal in rest.

Pharynx in II-III, wide and ciliated, with eversible roof. Oesophagus in IV-VII, thin and wavy. Stomach in VIII abrupt, pear-shaped with

¹ Named after Dr. Christina Sperber of Uppsala, Sweden, for her valuable contribution on the taxonomy of the Naididae.

intracellular canals. Intestine thin and sinuous up to X, wide and sacculated from XI. Chloragogues start in VI, greenish grey. Coelomocytes morula-like, spherical with grey granules. Septa well developed, septal glands on septa 4/5, 5/6 and 6/7.

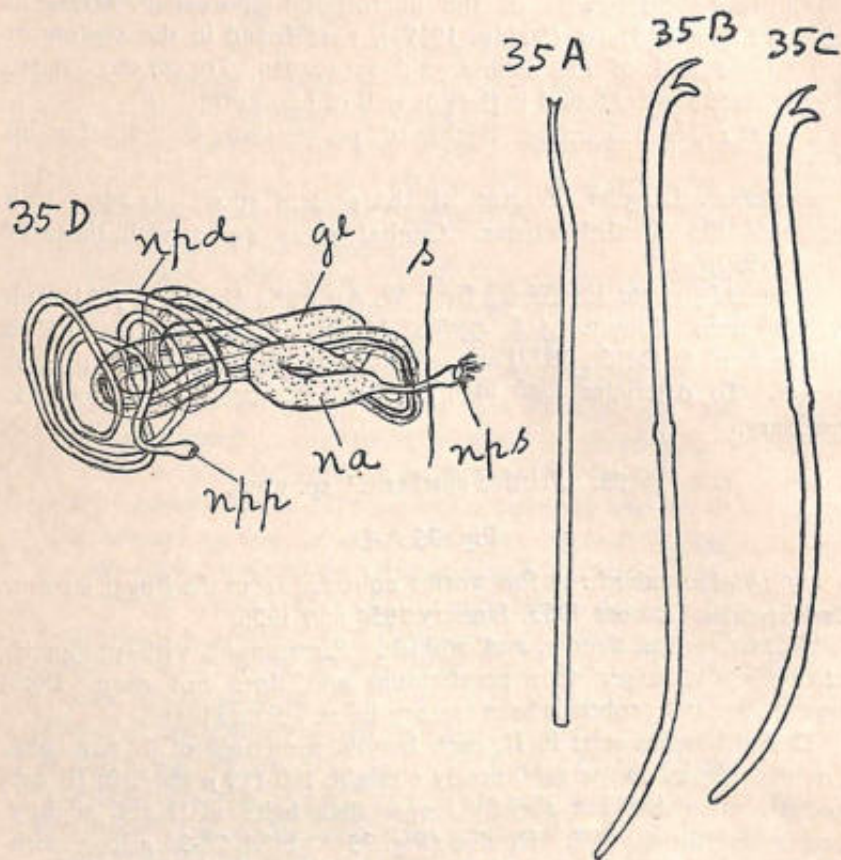


Fig. 35. *Pristina sperberae* sp. nov. : A. Needle seta $\times 3000$; B. Ventral seta of II $\times 3000$; C. Ventral seta of VIII $\times 3000$; D. Nephridium.

gl : gland ; na : nephridial ampulla ; npd : nephridial duct ; nph : nephriodipore ; nps : nephrostome ; s : septum.

Brain incised deeply behind and less deeply in front.

Blood tinged with yellow. Dorsal vessel median on gut, covered partially by chloragogues and contractile. Transverse commissural loops in II-VII. Ventral vessel mid-ventral and non-contractile.

First pair of nephridia in IX and 1 in each of the succeeding segments. Each nephridium (Fig. 35 D) has pre-septal with nephrostome and a post-septal with a fusiform ampulla followed by a long, coiled, ciliated duct, partly passing through gland tissue and partly free, ending in nephriodipore.

One budding zone develops at a time.

Sexual worms not encountered.

l (living) = 1.5-2 mm. ; d (living) = 0.12 mm. ; s = 20 ; n = 14-15.

Lengths of longest setae in μ and position of nodulus in the ratio D : P ::

	II	III	IV	V	VI	VII	VIII	IX	X
Hair	98	101.5	122.5	164.5	154	164.5	189	185.5	185.5
Needle	28	31.5	35	35	35	35	35	35	35
	1.5:6.5	2:7	2:8	2:8	2:8	2:8	2:8	2:8	2:8
V. seta	45.5	36.7	45.5	43.7	42	42	40.3	38.5	38.5
	8:5	5:5.5	6:7	6:6.5	5:7	5:7	5:6.5	4.5:6.5	5:6

Type : The type specimen is being deposited with the Zoological Survey of India, Calcutta.

Habits : Lives among water plants and filamentous algae. No swimming.

Commensals : Sessile vorticillids are found attached to ventral setae.

Taxonomic remarks : The present species closely resembles *Pr. foreli* out of the 21 species recognized for the genus (Sperber, 1948). It differs from the latter in having lesser number of hairs and needles per bundle, (1 hair and 1 needle as against 1-4 hairs and 1-4 needles), smaller size of body (2 mm. as against 3-6.5 mm.), simple hairs (non-serrate as against serrate hairs), with shortest ventral setae in III (as against setae of normal length in *Pr. foreli*). Hence it is described here as a new species.

Diagnosis of Pristina sperberae sp. nov. : Prostomium with proboscis. Eyes absent. Dorsal setae from II on, 1 non-serrate hair and 1 bifid needle with fine teeth, weak distal nodulus and slight curve distally. Ventral setae 4-8 per bundle, of II longer and of III shortest with proximal nodulus ; in the rest nodulus distal ; in II-VII distal prong longer than proximal, from VIII prongs equally long. Stomach in VIII, pear-shaped with intracellular canals. Dorsal vessel mid-dorsal. Transverse commissural vessels in II-VII. n = 14-15 ; s = 20.

VI. SUMMARY

Till 1958 the aeolosomatids and naidids known for the Southern region and Indian sub-continent were 27 and 36 species respectively. Recording of 18 species in this paper for the Southern region has established 45 species for the region and 54 species for the sub-continent [cf. pp. 643-644, *J. Bombay nat. Hist. Soc.* 58 (3)].

The thirty-five species treated here include 7 new species, and 11 new records for the Southern region, inclusive of 2 new records for the Indian sub-continent. They are *Nais menoni* sp. nov., *Dero indica* sp. nov., *D. plumosa* sp. nov., *Aulophorus hymanae* sp. nov., *A. indicus* sp.

nov., *Allonais rayalaseemensis* sp. nov., and *Pristina sperberae* sp. nov. The new records for the Southern region are all 3 species of *Chaetogaster*, *Stylaria fossularis*, *Haemonais waldvogeli*, *Dero cooperi*, *D. sawayai*, *Allonais gwaliorensis*, *Pristina minuta*, *Pr. jenkinsae*, and *Pr. aquiseta*. Of these *Dero sawayai* and *Pristina jenkinsae* are new records for the Indian sub-continent.

All the 35 species treated here were collected by the author in the ten localities [see p. 640, *J. Bombay nat. Hist. Soc.* 58 (3)]. A record collection of 32 species belonging to the Aeolosomatidae and Naididae was made from the Bugga stream, Cuddapah. From the other localities 1-11 species of worms were collected. Geographical distribution of all the forms is tabulated [see pp. 643-645, *J. Bombay nat. Hist. Soc.* 58 (3)].

The section on systematics deals with the descriptions of new species and redescriptions of known species of worms. *Lastočkina* gen. nov.¹ is created for an aberrant species, *Aeolosoma niesvestnovae* Lastočkin, with its diagnosis. Stephensonianinae nov. is created for the reception of a solitary genus *Stephensoniana* Černovitov, with its diagnosis. Key to all the genera of the Aeolosomatidae, key to all the known and valid species of *Aeolosoma* are given. Also, the key to subfamilies of the Naididae, keys to all the genera of the subfamilies, and keys to all the known and valid species of *Chaetogaster*, *Nais*, *Stylaria*, *Branchiodrilus*, *Allonais*, *Pristina*, *Dero*, and *Aulophorus* are given. Diagnostic characters of twelve genera and subgenera treated here are given.

Description of each species includes external characters, details of setae, internal anatomy, budding zones, sex organs, habits of worms, etc. Prostomium is rudimentary in *Chaetogaster*, simple and triangular in others except in *Stylaria fossularis* and *Pristina* (except in *Pr. minuta* and *Pr. jenkinsae*) which have antero-median proboscis. Eyes are present only in *Nais communis* and *Stylaria fossularis*.

Dorsal bundles of setae begin in II in *Pristina*, *Stephensoniana trivandran*; from IV in *Dero dorsalis*; from V in *Aulophorus* (except in *A. tonkinensis*); from VI in *Dero*, *Stylaria fossularis*, all *Nais*, *Allonais*, and *Aulophorus tonkinensis*; from V or VI in *Branchiodrilus semperi*. They are absent in *Chaetogaster*.

Hair setae plumose in *Dero plumosa* sp. nov., bayonet-shaped in 15 species, and straight or slightly curved in 16 others. Needle setae are simple-pointed in *Aeolosoma*, *Stylaria fossularis*, *Branchiodrilus*

¹ Ruttner-Kolisko (1955) has created genus *Rheomorpha* to receive the aberrant species *Aeolosoma niesvestnovae* Lastočkin. Hence *Lastočkina* gen. nov. [see pp. 645-646, *J. Bombay nat. Hist. Soc.* 58 (3)] created in the present paper to receive the above species is invalid and the name *Lastočkina* is *nomen nudum*.

semperi, *Stephensoniana trivandrana*, and *Pristina longiseta longiseta*; in the first two they are bayonet-shaped, in the later two they are straight, in the last two they are straight but with distal part curved. Needle setae are pectinate in *Aulophorus indicus* and *Allonais inaequalis*, oar-shaped in *Aulophorus tonkinensis*, and bifid with sickle or bayonet-shape in others. Giant ventral setae are observed in IV of *Pristina aequisetata* and in V of *Pr. evelinae*. Penial setae are observed only in *Nais communis*, *Stylaria fossularis*, all species of *Allonais*; and genital setae in *Pristina longiseta longiseta* among those in which the sexual worms were examined.

Gilled forms are *Branchiodrilus semperi* with dorso-lateral gills in anterior and middle segments; all species of *Dero* and *Aulophorus* with gills situated posteriorly in branchial fossa.

Stomach is absent in *Haemonais waldvogeli*, *Branchiodrilus semperi*, *Dero dorsalis*, *Aulophorus furcatus*, *A. michaelsoni*, *A. hymanae*, and *Stephensoniana trivandrana*. Intracellular canals observed in stomachal wall of *Pristina aequisetata*, *Pr. evelinae*, *Pr. longiseta longiseta*, and *Pr. sperberae* are absent in *Pr. synclites*, and are not known from *Pr. minuta* and *Pr. jenkiniae*. Anti-peristalsis and ascending ciliary vibration of intestine occur in all the species treated here except in *Chaetogaster*.

Dorsal vessel is mid-dorsal in *Aeolosoma*, *Chaetogaster*, and *Pristina* (lateral in *Pr. synclites*), and ventro-lateral in all others. Blood is colourless in *Aeolosoma* and *Chaetogaster*, and coloured in others, the colour varying from pale yellow to bright orange-red. Statocyst in the brain, hitherto not reported, is reported for *Chaetogaster cristallinus*.

Nephridia commence in II or III in *Aeolosoma*, in VI or VII in *Chaetogaster*, in VI in *Stephensoniana trivandrana*, in VIII or IX in *Aulophorus tonkinensis*, in X in *Aulophorus indicus*, in XII in *Branchiodrilus semperi*, in IX in *Pristina*, and in VII or VIII in all others. They are exonephric in *Chaetogaster* and coelomonephric in others.

Asexual reproduction is by formation of budding zones in all species treated here except in *Allonais*, where fragmentation occurs. Prostomium and 4 anterior segments are produced in *Stephensoniana trivandrana*, 7 in *Pristina*, and 5 in all others. The anterior segments of the posterior zooid start budding only after complete formation of the hind part of the anterior zooid in *Pristina synclites*. Positions of testes and spermathecae, and ovaries and atria are in VII and VIII in *Pristina longiseta longiseta*, and in V and VI in others in which sexual worms were examined.

Among the Naididae the species of *Dero* and *Aulophorus* are known to construct tubes of mucus and foreign matter to live in. Of the 8 species of *Dero* and 5 species of *Aulophorus* treated here all were

observed to live in tubes except 3 species of *Dero* and 2 of *Aulophorus*. *Stephensoniana trivandran*a lives in soft mud and has a part of its body covered by thin mucus film studded with mud particles. Among the species of *Aeolosoma*, *Ae. travancorense* live in tubes much larger than their body, evidently tubes vacated by larger species of worms.

Swimming was observed in *Nais menoni* sp. nov., *Stylaria fossularis*, all species of *Dero*, *Aulophorus*, *Allonais* (except in *Dero dorsalis* and *Aulophorus indicus*) and in *Stephensoniana trivandran*a. Species of *Aeolosoma* glide on substratum like turbellarians. *Chaetogaster cristallinus*, *Ch. diastrophus*, all species of *Nais*, *Allonais*, *Pristina* (except *Pr. synclites*), and *Stylaria fossularis* live in filamentous algae and water plants; others live in soft mud. *Chaetogaster langi* lives in encrustations of plant and animal matter.

Vorticellids were observed as commensals attached to the setae of *Chaetogaster cristallinus*, *Nais communis*, *Dero digitata*, *Aulophorus hymanae*, *Allonais gwaliorensis*, and *Pristina sperberae*. Some holotrichous astomous ciliate parasites were found in the gut of *Aeolosoma travancorense*, *Chaetogaster cristallinus*, *Allonais gwaliorensis*, and *Stephensoniana trivandran*a; sporocysts of actinomyxid sporozoan parasites were found in the gut wall of *Nais communis* and *Pristina longiseta longiseta*; and sporocysts of microsporid sporozoan parasites were found in the coelom of *Nais communis*, *Dero sawayai*, and *Pristina longiseta longiseta*.

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The Early Stages of Development in *Achatina fulica* Bowdich (Mollusca : Gastropoda)

BY

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(With three plates)

INTRODUCTION

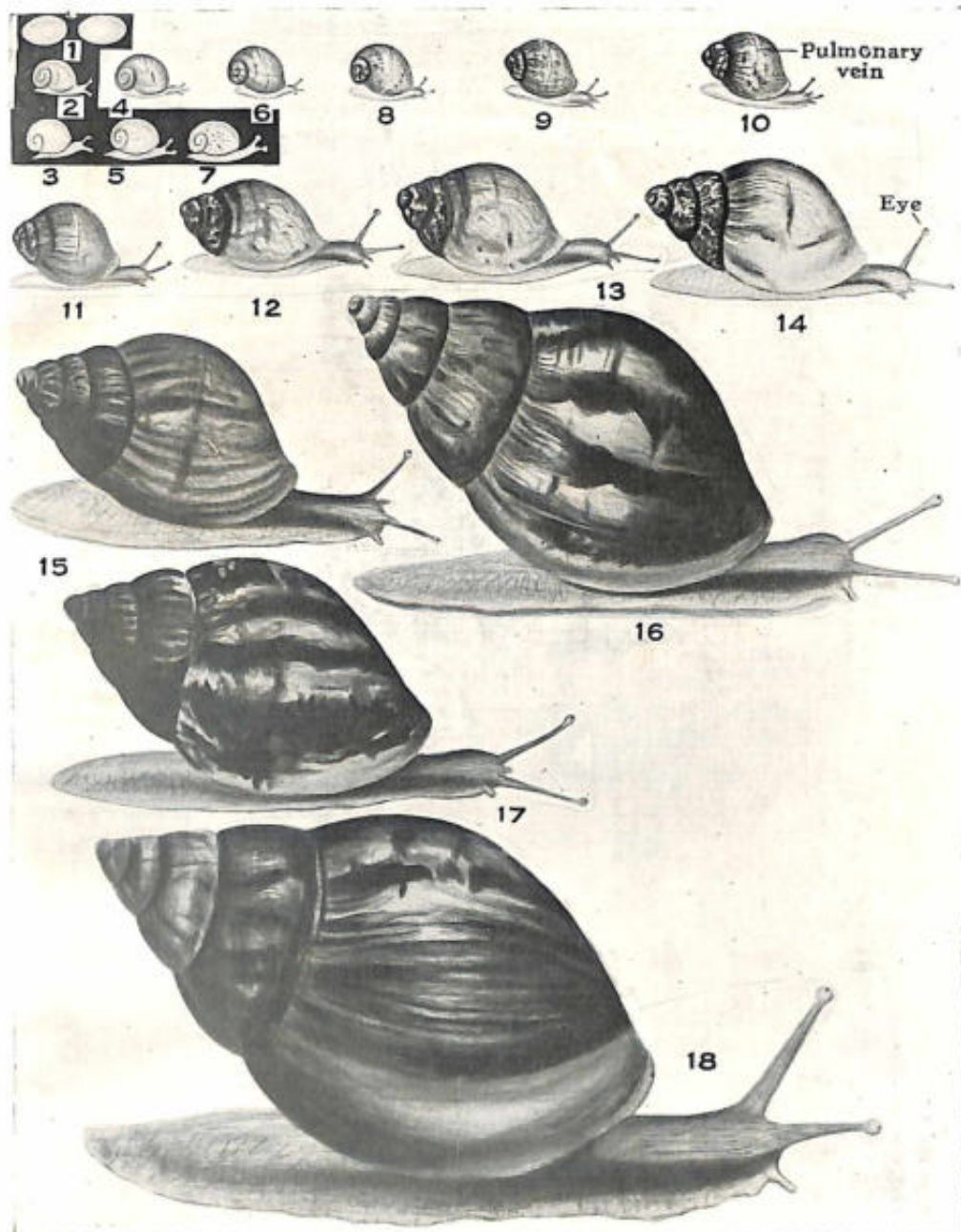
Records on the early stages of *Achatina fulica* are far from complete. Rees (1950) described these stages briefly and Bequaert (1950) recorded only some of the features of young shells. Snails bred and reared in the laboratory (Ghose, 1959) attain sexual maturity at the age of about six months, but in nature they require more than one year to attain the same phase as aestivation starts when they are three to four months old or even still less.¹ The coloration of the adult shell is influenced to some extent by the climatic conditions in different countries, but sunlight seems to have no effect on pigmentation during early stages of growth.

OBSERVATIONS

Since eggs with embryos in different stages of development are laid, the period of hatching out of the snails is variable. In a brood, the first young snail comes out of the egg within 1 to 14 days after laying, and most of the embryos hatch out within a further period of seven days. Hatching may continue in some cases for about a week more. The healthy individuals come out first, and only the weaker and smaller ones, especially those from the small eggs, emerge later. The percentage of hatching in the eggs laid with embryos in late stages of development is 82.5, whereas in the eggs laid with embryos in early stages of development it is only 26 approximately.

The egg shells lose their brilliance and toughness considerably during incubation; they become fragile and can be easily broken by

¹ This depends on the period of time between the hatching out of the young snail and the appearance of dry and cold weather.



Stages in growth of *Achatina fulica*

1. Eggs; 2. Newly hatched snail 4 mm.; 3. Same as Fig. 2 (shell removed); 4. 4.5 mm. snail; 5. Same as Fig. 4 (shell removed); 6. 5 mm. snail; 7. Same as Fig. 6 (shell removed); 8. 5.5 mm. snail; 9. 6.5 mm. snail, 8 days old; 10. 8 mm. snail; 11. 9 mm. snail, 16 days old; 12. 12 mm. snail, 24 days old; 13. 15 mm. snail, 32 days old; 14. 18 mm. snail, 46 days old; 15. 24 mm. snail, 60 days old; 16. 31 mm. snail, 74 days old; 17. 38 mm. snail, 88 days old; 18. 48 mm. snail.

the pressure of the foot of the young snails. The young snails come out in most cases carrying broken egg shells on their back. The cracking of the shells with a sharp click (Rees, 1950) at this stage was never heard by me.

Some of the newly hatched snails remain inactive for a few hours, while others are active from the moment of hatching. They show considerable variation both in the size of the shell and in that of the body. In most cases, the young snails begin feeding on soil, leaves of plants, and broken egg shells, lying on the soil or on the backs of other young snails, and in this way they meet their demand for calcium, which is very high in the early stages. While feeding on leaves, they scrape off their surface and make small holes in them.

Snails in captivity thrive well on lettuce, mustard, cabbage, cauliflower, and various types of leafy vegetables. I never found young snails cannibalistic as observed by Rees (1950).

In spite of all possible care mortality is very high among young snails being about 85.2 per cent. In a batch of 425 snails, only six survived to reach sexual maturity. The death rate is highest in very early stages; it then comes down gradually but again sharply increases in the first few weeks of aestivation. In India, the cold and dry period comes when the snails are young; this acts as an effective check on the increase of *Achatina* population. The growth rate is nearly uniform up to the attainment of sexual maturity, and slows down subsequently which is shown in Plates II and III.

The measurement (in mm.) and weight of four snails, three months old, are given in the table below:

Sl. No.	Shell		No. of spirals	Aperture		Weight of the living snail in gr.
	Length in mm.	Breadth in mm.		Length in mm.	Breadth in mm.	
1	38	22	6	22	15	7.9
2	37	21	6	21	12	6.6
3	36.5	21	6	22	13	7.3
4	34	20	6	20	11	5.1

FEATURES OF THE EARLY STAGES

Stage 1. (Newly hatched snail) (Pl. I, Fig. 2)

The shell is globose, very thin, almost transparent, glossy, without any decussation, and of uniform light horny colour. The first whorl is very small, but the next one is quite large.

The colour of all the organs except eyes (black), kidney (cream-white), and digestive gland (light brown) is almost glass-like. In the larger snails (4 mm. and above), which constitute about ten per cent of the total, black pigment in the form of small rods and dots is scattered irregularly on the mantle over the pleuropedal visceral mass.¹ Reticulation on the body is entirely absent. The heart, kidney, and pulmonary vein are distinctly visible through the shell. The heart-beat of some snails at this stage may be as low as 20 per minute².

Young snails are very active and begin to feed on soil³. Their activity increases during the night.

From the fourth day onwards, very light brown pigment begins to be deposited on the dorsal surface of the visceral stalk and foot, and reticulation appears on the dorsal surface of the visceral stalk.

Stage 2. (Age 8 days) (Pl. I, Fig. 9)

The ground colour of the shell is uniformly light horny. Fine vertical wrinkles, not visible to the naked eye, appear on the post-nepionic whorl. Narrow, almost parallel, very faint light-brown, vertical stripes run from suture to columellar lip. Black pigmentation on the mantle increases; the digestive gland becomes brownish black and occupies the first two whorls; kidney yellowish, and foot cream-white. Light brown pigment appears on the visceral stalk, ventral tentacles, ocular tentacles, and dorsal surface of the foot. Pigmentation is heavier on the dorso-lateral sides of the visceral stalk, posterior to ocular tentacles and at the junction of the visceral stalk and foot.

The snails are very active, especially during rain. Feeding takes place mainly at night, and leaves are eaten from the margins. They can consume comparatively hard substances like germinating pea and gram seeds. Occasionally, the snails burrow holes in the soil and rest there.

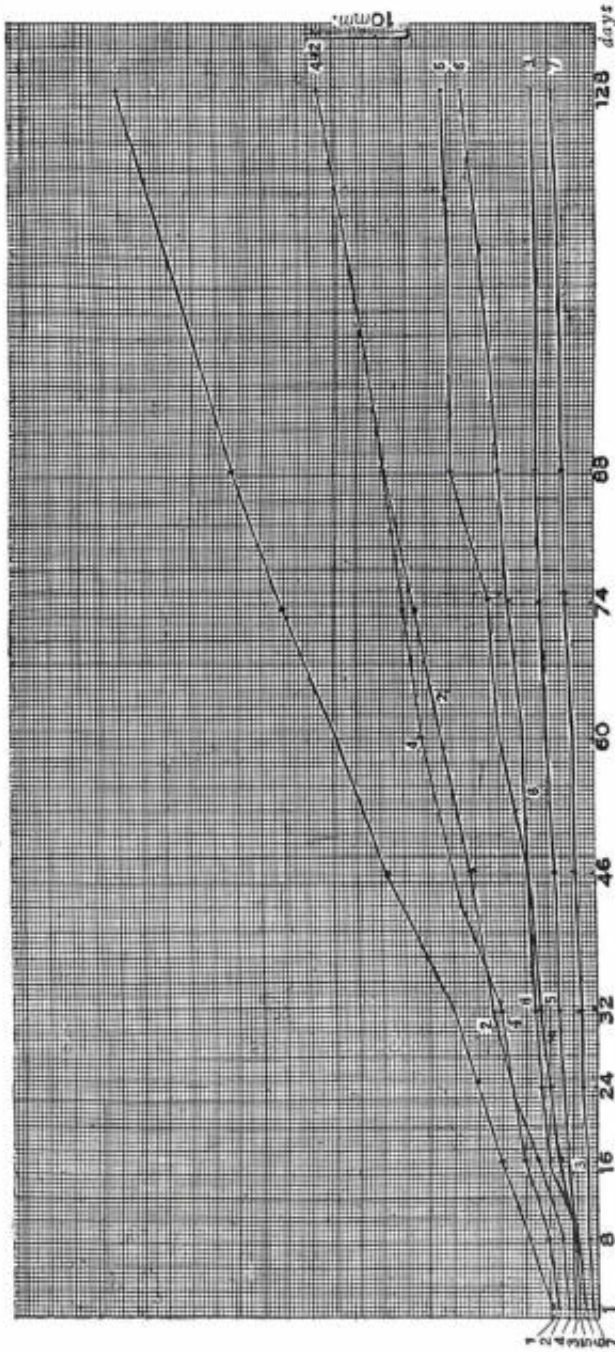
Stage 3. (Age 16 days) (Pl. I, Fig. 11)

The shell appears thicker and more opaque with a flexible and greyish horn lip. White patches in the form of small rods and dots placed at regular intervals appear on the apical visceral mass. The

¹In order to ascertain the effect of sunlight on the deposition of pigments, eggs were kept in a dark room. The young snails hatched and reared in the dark did not exhibit any difference in their pigmentation when compared with the controls.

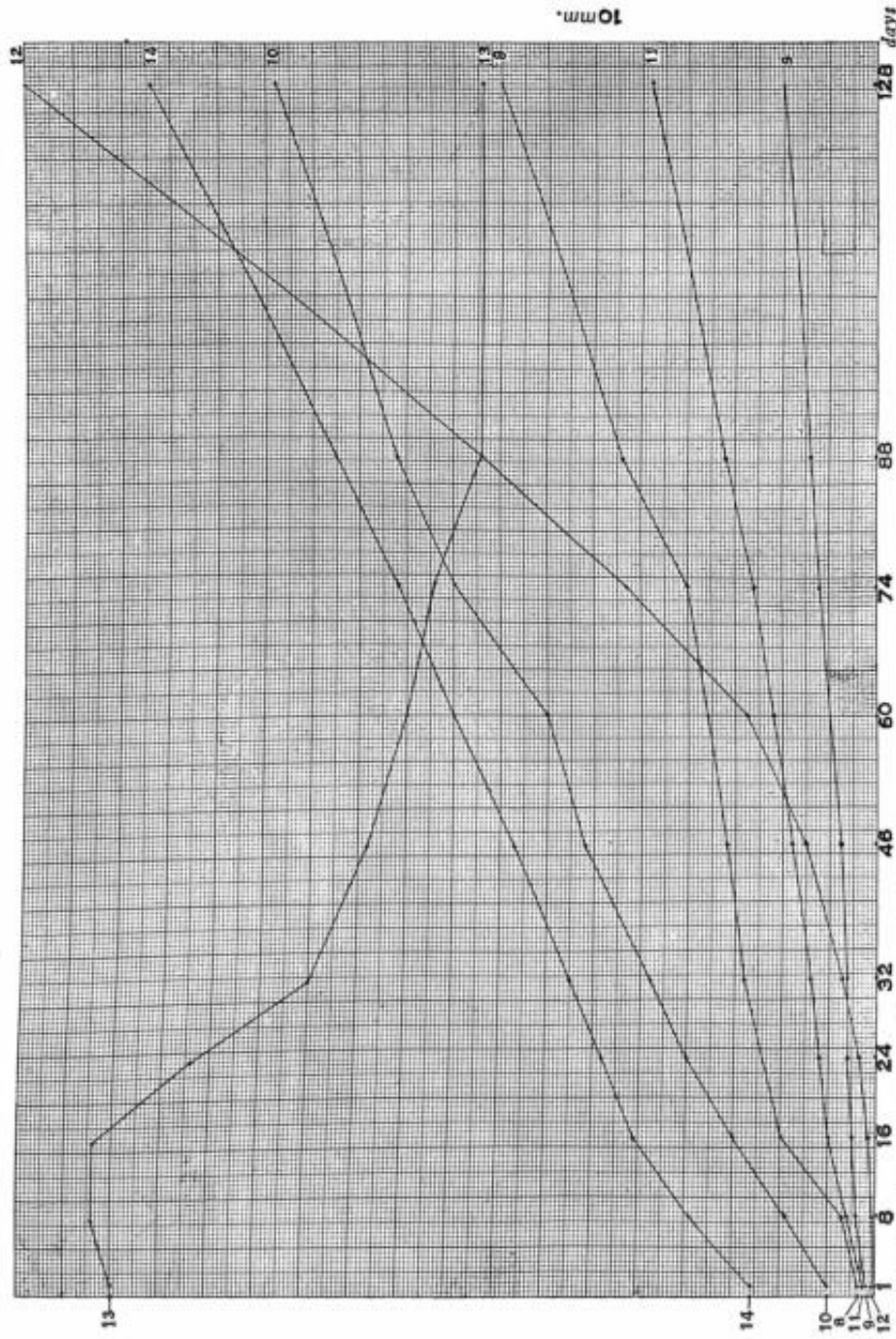
²The maximum heart-beat in the larval stage was noted to be 150 per minute.

³Embryos not allowed to come in contact with soil did not thrive well. So it appears that they obtain the supply of certain requirements of their early stages from the soil.



Graphs showing the rates of growth of the shell, aperture, and tentacles in *Achatina fulica*

Graph 1. Length of shell; 2. Breadth of shell; 3. Number of spirals; 4. Length of aperture; 5. Breadth of aperture;
6. Length of ocular tentacle; 7. Length of ventral tentacle.
(In graphs 1, 2, and 4-7, two small divisions represent 1 mm.; in graph 3, two small divisions represent 1 spiral.)



Graphs showing the rates of growth of the visceral stalk and foot, weight, heart-beat, and movement in *Achatina fulica*
 Graph 9. Length of visceral stalk ; 9. Breadth of visceral stalk ; 10. Length of foot ; 11. Breadth of foot ; 12. Weight ; 13. Rate of heart-beat per minute ; 14. Rate of movement per minute.

(In graphs 8-11, two small divisions represent 1 mm.; in graph 12, one small division represents 100 mg.; in graph 13, two small divisions represent 1 heart-beat ; in graph 14, one small division represents 1 mm.)

digestive gland occupies almost the whole of the first two and one-fourth whorls. The colour of the tentacles is like that of the visceral stalk. Pigmentation on the foot increases to light brown, and reticulation appears on it.

Stage 4. (Age 24 days) (Pl. I, Fig. 12)

The shell loses its globose shape, but it cannot yet be called elongate. This stage resembles the stage number 3 in every respect except that the pigmentation on the body becomes deeper and the reticulation on the visceral stalk appears more prominent.

Stage 5. (Age 32 days) (Pl. I, Fig. 13)

The shell is slightly elongate. It loses its glossy appearance and is light roseate in colour with increased opacity. The vertical wrinkles on the body whorl are slightly bent at the sutures. The brown stripes on the body-whorl are deeper but, instead of running from suture to columellar lip, stop at the middle, being slightly deflected at the end. The white spots on the apical visceral mass and the black pigment on the pleuropedal visceral mass assume elongated appearance and form small scattered stripes. Pigmentation on the rest of the body approaches a deep brown colour. The foot is light brown. Reticulation on the foot and visceral stalk is very prominent.

Stage 6. (Age 46 days) (Pl. I, Fig. 14)

The shell is elongate-ovate, the apex forming a broad cone. The vertical wrinkles are cut by a few incised lines. The brown stripes are broad and deeper and fraying appears at the margins. The digestive gland shifts its position, and the first whorl of the shell becomes empty. The pigmentation on the apical and pleuropedal visceral mass is no more visible. Pigmentation and reticulation on the body and foot increase, and the foot is brown in colour.

Stage 7. (Age 60 days) (Pl. I, Fig. 15)

The shell is still partially transparent. The shape and pigmentation of the shell nearly approach those of an adult. Similarly, the reticulation on the foot and visceral stalk is almost like that of an adult. The colour of the exposed parts of the body is deep brown.

Stage 8. (Age 74 days) (Pl. I, Fig. 16)

Pigmentation on the body and the shell is adult-like.

Stage 9. (Age 88 days) (Pl. I, Fig. 17)

It resembles an adult in every respect. Only the heart can be seen through the shell against light¹.

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¹ The heart-beat can be counted through the shell up to the age of four and half months.



Richard Watkins Burton

Obituary

LIEUTENANT-COLONEL RICHARD WATKINS BURTON

(With a photograph)

With deep regret we record the death at Woodcote Park, Surrey, England, of this old and valued member of our Society. He died on the 12th January 1963 in his 95th year.

Richard Burton was the sixth son and seventh child of the late General E. F. Burton of the Madras Staff Corps and Georgiana his wife. All the nine sons followed their father's profession.

Commissioned from Sandhurst in the 1st Battalion of the Lancashire Fusiliers on the 23rd March 1889, he was transferred to the 2nd Battalion in India and landed at Bombay on the 5th April 1890. On being posted to the Indian Army he joined at Belgaum on the 16th December 1890. After serving in Burma he was appointed to the Hyderabad Contingent at Aurangabad in 1891.

Permanently crippled by a riding accident in December 1903, he was saved from half-pay on the understanding that he would enter the Cantonment Magistrate's Department. After various assignments under the Foreign Department of the Government of India he was appointed to the Cantonment Magistrate's Department in 1906.

Col. Burton joined the Bombay Natural History Society in 1893 and was, at the time of his death, our oldest member. He wrote for the *Journal* regularly during the 70 years of his membership, his last contribution being in Volume 58 (3) in 1961. Throughout his long connection, Col. Burton was a staunch supporter and well-wisher of the Society. His note on the Duties of Members of the Society (Vol. 53 : 507), a confession of faith which he himself discharged in full measure, needs to be read and re-read and acted upon by all members. Among his nearly 200 contributions—original articles, compilations, miscellaneous notes, and book reviews—some of special interest and importance are the following:

Notes from the *Oriental Magazine*—New Series—1869 to 1879.
Vol. 25 : 491.

Notes from the *Oriental Sporting Magazine*—New Series—June 1828 to June 1833. Vol. 26 : 309.

Three months up the Valley of the Sutlej River. Vol. 31 : 23; 31 : 352.

The Indian Wild Dog. Vol. 41 : 691.

On the banks of the Narbada. (Compiled from the Note Books of Major H. G. H. Munrowd.) Vol. 42 : 757; 43 : 48.

Some Reminiscences of Sport in Assam. Vol. 45 : 199; 45 : 321; 45 : 485; 46 : 108; 46 : 269.

Wild Life Preservation : India's Vanishing Asset. Vol. 47 : 602.

Preservation of Wild Life in India: Supplement to the article published in Vol. 47, pp. 602-622 of this Journal. Vol. 48 : 290.

A History of Shikar in India. Vol. 50 : 845.

Wild Life Preservation in India (Text of the farewell address given to members of the Bombay Natural History Society at Bombay on 15 April 1953). Vol. 51 : 561-578.

The Ahmedabad Tent Club in earlier days. Vol. 51 : 732.

His shikar articles are not merely chronicles of success or failure in killing; most of them carry a lesson which has helped many a novice or less experienced sportsman to keep out of trouble. They contain valuable field observations on the habits and behaviour of the quarry—information of the type that forms the core of our knowledge of the natural history of Indian game animals. By means of a rather elaborate but extremely efficient cross-referenced index of the *Journal* from its inception, which he prepared for his own use and meticulously kept up-to-date almost to the end, he could put his finger immediately on anything and everything that had ever been published in previous volumes. The editors had reason to be thankful to him again and again for the promptness with which he could refer them back, when in difficulty, to the exact volume and page. He generously offered this index to the Society for publication for the benefit of its members, but on scrutiny it was found to need so much editing and simplification before any one but himself could make proper use of it, that the offer had to be regretfully declined.

Col. Burton was a fearless big game hunter, a keen and knowledgeable fisherman, and an ardent upholder of the highest ethics and traditions of sportsmanship. And he had lived through many thrilling encounters with wounded or man-eating tigers and panthers, and runaway shikar elephants, and survived a serious mauling by a wounded bear. Once he almost lost an eye, and indeed very nearly his life, when the bolt of a much-advertised new type of magazine rifle with the 'Straight Pull' action—all the rage at the time—blew back and took away with it a large part of his cheek. The deformity

caused by this accident he carried the rest of his life. In his later years he dedicated himself with missionary zeal to the cause of nature conservation and wild life preservation. To him, perhaps more than to any other single individual, must go the credit for awakening the public conscience to the urgent need for practical conservation during the early years of our independence when conditions were somewhat disorganized and the wild life position in the country looked particularly bleak. His formal campaign for the preservation of wild life in India may be said to commence with the publication in the *Journal* of his article 'Wild Life Preservation: India's Vanishing Asset' in 1948. This article, reprinted in pamphlet form, was widely circulated among governmental circles—from the Prime Ministers of India and Pakistan down to many individual forest officers—also among sportsmen, game associations, and influential politicians and private citizens throughout the newly partitioned countries, often with a personal covering letter from the author himself or from the Society. The matter was also widely publicized through the press. Although no immediate response was apparent—partly owing to public and official apathy and lack of vision, partly to other important preoccupations following upon the political change-over—there is little doubt that in the long run the effort did contribute towards drawing attention to the deteriorating state of affairs. It paved the way for the formation of the Indian Board for Wild Life which, at least on paper and in an advisory capacity, is today the central agency responsible for governmental policy pertaining to wild life preservation in the country.

In 1949 in Vol. 48 (2) he published a supplement to the above article which added considerably to its value and completeness. This was followed up in October 1950 by a Memorandum to the Under Secretary, Government of India, Ministry of Scientific Research, New Delhi, for the use of the Advisory Committee for coordinating scientific research charged with examining the question and suggesting ways and means for setting up National Parks and Wild Life Sanctuaries in India. In 1953, with the financial sponsorship of H. H. the Maharaja of Mysore, who meanwhile had been nominated President of the newly formed Indian Board for Wild Life, Col. Burton prepared a compendium indexing, summarizing, or reproducing all the more important articles on wild life preservation in India that had appeared in the *Journal* since its inception. This booklet forms an indispensable, handy reference and guide for everyone interested in the problem.

Col. Burton was perhaps the last of the illustrious band of 'Anglo-Indian' sportsmen-naturalists who, by their unquenchable thirst for scientific enquiry, contributed so significantly to what may be termed the 'marginal gains' of game shooting in India, namely a knowledge of the natural history of the animals they hunted. At the same time they built up and codified exemplary traditions and ethics of sportsmanship which it seems imperative to inculcate and encourage, and even scrupulously enforce, among shikaris of the present generation, if wild life in this country is to be saved from early total extinction.

S.A.

Reviews

1. FLOWERING TREES OF THE WORLD FOR TROPICS AND WARM CLIMATES. By Edwin A. Menninger. pp. xv+336 (25×20 cm.). With 425 plates in full colour and 40 line drawings. New York, 1962. Hearthside Press Incorporated. Price \$ 18.95.

The author has spent more than twenty-five years in a search for beautiful flowering trees to introduce into South Florida. The hunt involved the study of the extensive botanical literature of all the tropical countries—nearly 150 references are mentioned in the bibliography appended to the text. More useful for his purpose, however, was personal correspondence with residents and workers in the various countries. The collection of seed at the appropriate time, often in places remote from human habitation, the proper handling of it after collection, and its packing and despatch by air to its destination abroad involved a considerable expenditure of time and effort, and it speaks very well for the innate goodness of human nature that the author found ready co-operation from those whom he approached. Perhaps, the labour was not without its humour, witness the correspondent in Madagascar whose parcel of *Harpagophytum grandidiere* seeds was accompanied by the warning: 'Open and handle with great care'. One look at the seeds was sufficient. Thorns recurved like fish-hooks made the seeds dangerous to any living creature which might brush against the plant or step on a pod, and the box was hastily taken to the back lot and burnt!

Incidentally, the author gives an account of how he discovered the proper treatment for the seeds of the Teak (*Tectona grandis*)—I mention this as it is of interest to us in India:

* These seeds are about the size of garden peas, but each one is covered with a thick corky rind, making the whole as big as a marble. The seeds were dry, so were placed in a glass of water to be soaked overnight, but they were so buoyant that the water failed even to wet their surfaces. Another glass jammed into the first kept the pellets under water, but next morning when released they popped to the top as dry as ever despite the immersion. Out came a knife and file, and a lot of the corky rind was cut away. The seeds were soaked another 24 hours, then planted. No germination. Every few days an exploratory dig showed that nothing was happening. Perusal of some Indian books turned up a chapter in Cleghorn on 'How to Grow Teak Trees from Seed'. This sounded pertinent and the 18 pages were greedily devoured; about all the book said was that germination was difficult. However, a gleam of light emerged from one sentence. Observers had found, the book said, that after the annual brush fires swept through the teak

forests of Burma, an immediate upcropping of seedlings resulted. Oh! Oh! The author went out to the propagating shed, dug up the poor little teak seeds for the umpteenth time, put them in the family popcorn popper, and shook them over a slow fire. Pop! Pop! went the seeds, like so many little firecrackers. Back into vermiculite they were plunged and 100 per cent germination resulted.'

Starting out with the idea of describing 500 species of beautiful flowering trees, the author found the material at hand so extensive as to require twice that number for adequate treatment. Even so, he thought it necessary to add a chapter about 'Flowering Trees That Were Left Out of the Book'.

Numerous trees with which we are familiar in India figure in the pages of this book, and it is pleasant to look at them through the eyes of a foreigner. They are not always the same in appearance and behaviour as they are in this country. I mention, for example, a Kanakchampa (*Pterospermum acerifolium*) in Orlando, Florida, planted about seventy-five years ago: 'Repeatedly frozen back to the ground, it has as repeatedly come back from the roots, so that today its dozen trunks still proudly support a leafy crown 30 feet or more in the air.' Also, the tree has never been known to set seed in Florida. Similarly, in Florida our stately Queen's Flower Tree (*Lagerstroemia speciosa*) is 'a great sprawling shrub that makes no effort to become treelike unless tied to a stake and forced up'.

There is much more of interest, but I think I have given enough samples to tempt my reader to go to the original for it. I must, however, give one more extract, which will explain for itself why I feel compelled to do so:

'What matters it whether the tree you plant grows in your own yard or in your neighbor's? All you can do anyway is feast your eyes on its beauty. You can probably see it better if it is planted in the yard across the street, than if it is crowded into your own place. Who owns the real estate where a thing of beauty stands is of small consequence. If there is no more room in your yard and you feel your job there is complete, it is time to start all over again. Plant a beautiful tree in your neighbor's yard, or in the city parkway, or in that ugly vacant lot next door.'

The text is enriched by 425 beautiful plates in full colour, mostly showing the flowers or the fruit, but including some, e.g. plates 378 and 379, showing the beauty of the tree as a whole. In addition, there are 40 line drawings by Eva Melady, drawn with meticulous care by an artist who evidently loves the work.

For the fare provided the price is not unreasonable.

There is one strange error to be corrected. Though the bibliography correctly mentions Blatter & Millard's SOME BEAUTIFUL INDIAN TREES as published by the Bombay Natural History Society, the text incorrectly says that it first appeared as a series of articles in 'The Bombay

Journal of Botany'. The fact is that the authors of the book were valued members of the Bombay Natural History Society and the series of articles first appeared in the Society's *Journal*.

S.R.

2. THE HOUSE SPARROW. By J. D. Summers-Smith. pp. xvi+269 (13.5×20.0 cm.). With a colour frontispiece, 32 photographs in black and white, and 36 text-figures. London 1963 (Collins). Price 25s. net.

As a species the House Sparrow (*Passer domesticus*) is, at the present time, certainly one of the most ubiquitous birds, sharing with man an almost worldwide distribution. In Great Britain it ranks with the Chaffinch and the Blackbird as the most common and abundant resident species.

Despite its being such a regular commensal of man—making itself completely at home around his habitations, fields, and factories—surprisingly little precise information was available regarding its ecology and life-history. Over a period of 11 years the author studied the entire yearly cycle and every phase of House Sparrow activity in Great Britain with the aid of colour-ringed local populations in a rural as well as an urban-industrial environment. Pair formation, nest building, sexual and communal display, courtship, egg-laying, clutch size, incubation and nesting success, care of the young and their subsequent dispersal, enemies, mortality, sex ratio, and the behaviour patterns motivated by all these activities are some of the topics that form this fascinating record. He discusses the extreme adaptability of the House Sparrow as shown by its ability to thrive as a sedentary breeding bird—without recourse to seasonal migration—in countries with temperatures as divergent as -15° F. and 110° F., and at altitudes ranging from sea-level to 15,000 feet, and to profit from the liveable conditions which man has artificially created for himself in such inhospitable climes. Its bumptious aggressiveness combined with a natural wariness, and its catholicity in food and feeding habits have contributed in large measure to its phenomenal success as a colonist, whether by natural expansionism or by human introduction, in such far-flung ends of the earth as the Americas and Australasia. The history of its introduction into different parts of the world is very fully documented in Chapter 15—'Origins and Distribution'.

The communal displays known as 'Sparrow Weddings' or 'Sparrow Parties'—always an intriguing situation for the bird watcher—where a single female seemingly on the defensive is mobbed by a swelling circle of noisily strutting amorous cocks, is well described, and an explanation of its function is suggested.

It is found that house sparrows pair for life, but that, if one of the mated pair is accidentally killed or otherwise disappears, he or she is quickly replaced by another from an apparently ever-present 'waiting list,' or reservoir, of unmated birds of either sex. An instance is cited of seven cocks thus rapidly filling the vacancy caused by the shooting of one cock after another at a nest on which a female was incubating a clutch of eggs. Curiously enough this episode is almost identical in nearly every detail with an experience of the reviewer in India, recorded in the *Newsletter for Birdwatchers* for June 1962. Social behaviour, particularly concerning roosts and roosting in urban areas in Great Britain, seems to differ in certain respects from what has been casually observed in Indian birds (*P. d. indicus*) in Bombay City for example. The difference may be of degree rather than of kind, but nevertheless a comparative study of roosting habits under the more or less uniform tropical conditions prevailing here—without anything like a northern winter to interrupt the yearly rhythm—would be of great interest and may possibly disclose some adaptive significance. For instance there is no reference to a type of roost common in Bombay City, sited in moderate-sized leafy roadside trees, frequently in the heart of a bustling bazaar, where house sparrows—presumably from the immediate neighbourhood—gather noisily to sleep at sunset and depart near sunrise preceded by much twittering and chatter. Such roosts, strung out every few hundred yards along busy thoroughfares, seem to remain in use more or less the year round. In our area, moreover, the birds breed practically throughout the year with perhaps a slight slackening during the rainy season, June to September—a fact which may bear some correlation.

Young birds after fledging are said to wander between the various breeding colonies, but never more than a few miles. Once a nest site and mate have been acquired (the young breed when less than 12 months old) sedentary life begins and the house sparrow is reluctant to move across even a short stretch of unsuitable country. This extreme sedentariness accounts for the curiously patchy local occurrences of the bird and is doubtless the origin of the genetically different populations that have developed within the House Sparrow's circumglobal distribution.

Chapter 19 sums up the secret of the House Sparrow's success as a colonist. Among the chief ingredients are: catholicity of food and feeding habits, adaptability for commensalism with man in both town and country environments, and capacity for learning quickly and profiting from the experience of others of its kind how to avoid dangers and natural enemies such as cats, hawks, and occasionally even man. But the main reason for immediate colonising success where deliberately introduced by man seems to be that the bird is already conditioned to occupy an ecological niche that has not been exploited by any native species, namely human habitations, and therefore meets with no serious competition from 'vested interests'.

The book ends with six useful appendixes and a selected bibliography of 66 titles. Both the author and the publishers deserve congratulation on this admirable production which, incidentally, is No. 19 of the well-known monographs on British animals in 'The New Naturalist' series. The book is fascinating to read and well documented throughout. It provides a valuable reference source for comparative ethological studies on the house sparrow in other climatic regions of the world.

S.A.

3. A CLASSIFICATION OF LIVING ANIMALS. By Lord Rothschild. pp. vii+106 (26×17 cm.). Glasgow, 1961. Longmans Green & Co. Ltd. Price 25s.

This handy little book fulfils a long felt need in the study of the animal kingdom by providing a comprehensive, summarized, and up-to-date classification of animals, and should prove very useful not only to zoologists but also to students of allied disciplines.

The scope of the book is best explained in the author's words: 'The book and its index can be used to find out how the animal kingdom, or parts of it, are classified, which are the eutherian mammals, what phasmids and Homoptera are, etc. Neither the book nor its index can necessarily provide answers to questions about the systematic positions of individual genera, because there are some two hundred thousand genera in the animal kingdom.' Chapter I explains the purpose of the book and how to use it. Chapter II is a summarized classification of living animals. Chapter III is a classification of living animals, with examples of genera in each class, order, sub-order, etc. Appendix I provides references for further

reading. Appendix II is a list of the authorities consulted on the classifications.

One hopes that the book will not be 'dated' within a few years for systematics is a field in which stability is noted in very few of animal groups, new finds and new methods of approach and outlook frequently up-setting apparently established arrangements. For instance the present publication offers alternative classifications for three groups and the author notes that alternative classifications are available for several more. Indian zoologists who are not systematists and who graduated a decade ago will be surprised at the changes that have since occurred in Systematic Zoology.

J.C.D.

4. A BIRD AND ITS BUSH. By Michael Lister. pp. 142 (22×14.5 cm.). With 35 photographs and 16 text-figures. London, 1962. Phoenix House Ltd. Price 16s. net.

The first stage in the scientific study of birds has been the collecting of specimens in the field and taxonomy in the museum. In most parts of the world, the bulk of the taxonomic work has been completed and ornithologists are exploring various aspects of ecological and other studies both in the field and in the laboratories. Indian ornithology is still in its infancy and our few field workers have not yet provided the preliminary background of knowledge to facilitate more detailed studies of the finer problems of ecology.

This little book tries to create the background for English conditions. The 'Bush' described in 8 chapters includes geology, soils and topography, climate and weather, vegetation, as well as other inhabitants of the area. Such a book is badly needed in India to enable the birdwatcher to identify and name the many factors which make up a habitat. A rose by any other name may be the same, but restriction to one definite name is essential to permit its study. The worker must be able to give a name to the phenomenon, plant, or other object with which his observation is associated. Alternatively, without such knowledge, he cannot record it suitably nor benefit by the information already recorded by others.

While we may not have a birdwatcher with the supplementary knowledge required for such a book, it may be possible to produce it collectively. It would certainly be of great assistance to all concerned.

H.A.

5. BIRD. By Lois and Louis Darling. pp. xi+261 (23×15.4 cm.). London, 1962. Methuen & Co. Ltd. Price 30s.

This husband-and-wife team of ornithologists set themselves a very ambitious task—nothing less than 'a basic, simplified but scientifically valid account of evolution, behaviour, anatomy, and physiology of birds as well as comparison of these features with those of the animals'. It was not a modest target and one would be justified in being sceptical about the competence of anyone to fulfil a task so comprehensive. But after reading the book one concedes that it is an undoubted success. In spite of being filled with detail the book can be read effortlessly throughout. For this, a great deal of the credit must go to Mrs. Darling whose superb illustrations help to illuminate and clarify all the more difficult portions of the text. In his foreword Niko Tinbergen says: '... the authors had a strong urge to communicate. They have kindled the fire of motivation... they delight in detail, but the results of scientific analysis are continually put back into their proper functional context.' The great merit of the book is the sense of proportion with which it has been written; we never lose sight of the wood for the trees.

The book consists of three main parts: Time and Birds, Behaviour, and Anatomy and Physiology. As may be imagined the first two sections are the more absorbing ones for the general reader.

The initial chapters on Evolution refer to the highlights in man's discovery of the process. A glance at a neat tabulation of Eras, Periods, and Epochs helps to assess the geologic time, e.g. that birds arrived in the world in the Jurassic period of the Mesozoic era, that is 165 million years ago—man it may be recalled is only one million years old. The fossil *Archaeopteryx*, the first creature that can be called a bird, was found in Bavaria in 1861. The authors point out, with the help of a striking sketch, that the most fortunate feature of the fossil was the imprint of the feathers embedded in the limestone. Without this clue it may have appeared that the fossil belonged to a reptile and studies in bird evolution would not have progressed as rapidly as they did. In 1872 the discovery of the fossil of the sea-bird *Hesperornis* was another valuable guide post, and then scientists could confidently assert that by the time of the Eocene epoch, 60 million years ago, there were already fifteen orders of birds in existence as against 28 at present. Immediately Man arrived on the scene he started to take an interest in birds, as pre-historic cave drawings and

engravings show. Unfortunately his contact with birds has not always been to the advantage of the latter.

Darwin's visit to the Galapagos Islands in 1835 on the equator, 600 miles to the west of South America, was an event of decisive importance to the progress of evolutionary studies. In these islands, cut off from the mainland, the effects of the forces of Natural Selection and Survival of the Fittest could be clearly seen. From a single ancestral seed-eating ground finch fourteen other types developed. The bill of each species was a pointer to the type of food it ate and the habitat which it preferred. At this stage the authors emphasise a point which is not quite obvious to a layman; that hereditary changes always come first, and adaptation to the environment follows. For instance, ducks started with normal feet, not with webbed toes perfected for swimming. Webs were developed from fortuitous natural variations in the direction of webbed feet, giving a slight advantage, or survival value, in swimming and food-getting to the possessors over other birds without them. Thus, by working upon and improving the minor variations, Natural Selection gradually eliminated the less fitted in the struggle for existence, and perfected the webbed feet of ducks and other specially adapted swimming birds seen today.

The chapters on Behaviour are written with a sureness which could only be shown by persons who have the knack of handling birds and maintaining the most intimate relations with them. The authors frequently 'imprinted' themselves on the minds of young birds, and occasionally goslings and ducklings preferred their companionship to that of the natural parents.

It is a rule of thumb that if a species has an outstanding brightly coloured mark it will be used in display. The authors refer to the interesting fact that closely related birds which have overlapping breeding ranges have distinct colour insignia or behaviour patterns of their own. Mallard, Pintail, and Widgeon, for instance, should have little difficulty in recognizing one another, and a female mallard could offer no legitimate excuse for flirting with a male widgeon. But birds whose breeding ranges are separate, like the Black Duck and the Mottled Duck, can afford to look the same without endangering racial purity.

Describing the flight mechanism of birds is a difficult matter. Some writers treat the subject so technically that one forgets that birds are involved in it. Some simplify it to such an extent that there seems

nothing to it except the simple fact that speed increases lift and vice versa. The Darlings, because of their ability to relate details to their functional context and with the assistance of lively sketches, give the reader a feeling of knowing a lot more than he did before. If only for this, the book is well worth possessing.

Z.F.

Miscellaneous Notes

1. ON THE CRANIAL CHARACTERS OF *MACACA SILENUS* (LINN.) (PRIMATES : CERCOPITHECIDAE)

(With a plate)

The specific differences in the cranial characters of catarrhine monkeys are not conspicuous and are often masked by individual variations. This caused many earlier workers to rely more on external characters and devote less attention to cranial variations. In many cases the published accounts of specific cranial characters are not based on a sufficiently good series of specimens to sift out the individual variations. Of the Indian species of the genus *Macaca* (Primates : Cercopithecidae), the least known in this respect is *M. silenus* (Linn.), the Liontailed Macaque of the Western Ghats of India. The only known descriptions of the cranial characters of this species are those of Anderson (1879) and Pocock (1939). Elliot (1912) records only the measurements of a skull. Anderson's description of the skull, based on a single male specimen, is extremely general and vague. The features described by him are either common or individual, none being characteristic of the species. Pocock, having only an incomplete skull, relied for the most part on Anderson's description, adding as far as the broken specimen would permit some of his own observations. The sulky, savage nature of this monkey and its inaccessible forest abode make it difficult to procure material and there is a paucity of skulls in many zoological collections. The present detailed description of the cranial characters of this species is based on a series of five specimens (2 ♂♂ and 3 ♀♀). In addition, four adolescent skulls were examined to study the lines of cranial development. I wish, in this connection, to express my sincere thanks to the Bombay Natural History Society who kindly spared two specimens for my examination.

DESCRIPTION

The brow-ridge is well developed and curved backwards acutely. The temporal ridges start from the two sides of the brow-ridge and

join the occipital crest separately, although in one skull they are very close together at this confluence. In female skulls the temporal ridges are very faint and never converge posteriorly. The occipital ridge in the male is well developed, especially at the mastoid region. The orbital ring and the inter-orbital septum are more vertical and steeply curved than in allied species. In adult male skulls the maximum width of the orbital margin, which is across the lowermost point of the vertical wall of the orbit (jugal), is slightly greater than the mastoid width.

The jaws are fairly long, but not as long as in *M. nemestrina* (Linn.). The anterior zygomatic root is directly in a line running vertically in between the second and the third molars. In short-jawed forms the corresponding line will be through the second molar. The post-canine depression on the sides of the muzzle is prominent and extends upwards along the ascending process of the maxilla up to the base of the inter-orbital septum. The nasal and the ascending process of the maxilla tend to be slightly raised above the general level of the maxilla, so that this part often forms a distinct table on the muzzle.

Ventrally, the pterygoids curve outwards symmetrically so that the mesopterygoid fossa is narrowest in the middle. The posterior palatine foramina are situated anterior to, or in line with, the third or last molar, never posterior to it, which again is an indication of jaw length. The transbullar width is markedly less than the mastoid width, as the external auditory meatus does not extend up to the fringe of the squamosal. This feature is more marked in female skulls.

The measurements of the specimens examined by me are noted in the table on page 248.

DIFFERENCES IN CRANIAL CHARACTERS BETWEEN THE SEXES

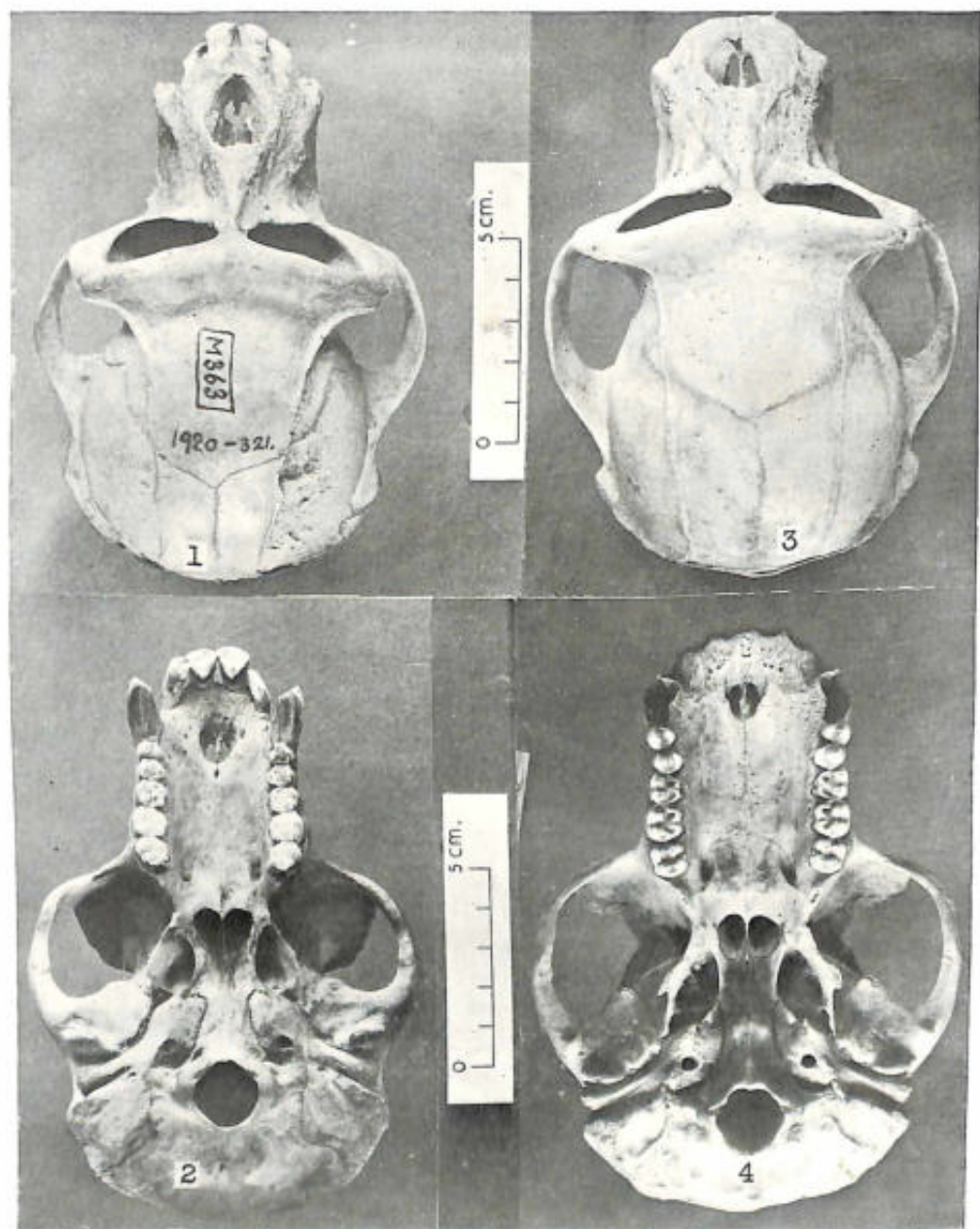
Certain differences between the sexes in cranial characters are particularly striking. Many of them may be common to the genus, but as this aspect has not been discussed much in this genus, it may be worth recording them here. The most obvious is the marked difference in size, the female skull being much smaller. On the whole, the female skull shows less muscular development, the various crests that are present in the males are often absent or feebly developed in the female. Generally, it can be said that the female skull retains the juvenile condition in its cranio-muscular relations. The transbullar width is less than the mastoid width by a greater

TABLE
CRANIAL MEASUREMENTS (IN MM.) OF *MACACA SILENUS* (LINN.)

Reg. No.	Sex	Total length	Condyle basal length	Facial-axis length	Palatal length	Check teeth row length	Bulla length	Zygomatic width	Mastoid width	Transbulbar width	Maxilla width at canines	Inter-orbital septum thickness	Mandibular length	Lower check teeth length
7752	Female	103.2	77	44.3	38	28	25.5	73.2	59.2	51.5	26	3.8	69	31.7
7753	Female	106.2	80.4	48.2	43.2	28	26.5	72	62.2	54	26.3	3.3	69	33
7750	Female	107.7	80	50	42.6	28.2	25.6	73.2	61.2	53.5	26	4	69	29
M10 B.N.H.S.	Male*	127	103	68	58	31.2	31.8	87.4	71	62.4	36.4	6.2	89.5	48.7
M363 B.N.H.S.	Male	135	107	69.6	62	33.2	35.6	93.3	76.2	69.8	38	6.8	90.7	40.1

* This skull is unsexed, but is obviously male

1. *Facial-axis length*: Taken from the anterior end of the muzzle to the maxillo-sphenoid suture in the meso-pterygoid fossa.
2. *Transbulbar width*: Transverse distance between the extremities of the external auditory meatuses.
3. *Mandibular length*: Maximum length at the alveolar line.



Figures 1 & 2 : dorsal and ventral views of skull of *M. silenus* (♂) ; Figures 3 & 4 : dorsal and ventral views of skull of *M. nemestrina* (♂).

degree in females. The facial length is also proportionately less and, owing to the smaller size of the canines, the muzzle is more tapering in front. The measurements indicate that the difference between the upper and lower cheek teeth is proportionately more in males than in females. The orbital margin width is lesser than the mastoid width in female skulls because of the inflated condition of the latter and the lesser development or bulging of the orbital ring.

COMPARISON WITH ALLIED *M. NEMESTRINA*, (LINN.)

<i>Macaca silemus</i>	<i>Macaca nemestrina</i>
1. Post-canine depression on the muzzle extends along the ascending process of the maxilla up to the base of inter-orbital septum.	1. Post canine depression on the muzzle extends only up to the mid-lateral line.
2. Nasal bone region elevated above near-by areas of the maxilla	2. Nasal bone region flat
3. The pterygoid bones are evenly curved outwards so that the narrowest part of the meso-pterygoid fossa is in the middle.	3. The pterygoid bones are straight and closer to each other posteriorly so that the narrowest part of the meso-pterygoid fossa is on its posterior end.
4. The posterior palatine foramina are situated either anterior to, or in line with, the last molar.	4. The posterior palatine foramina are posterior to the last molar.
5. Size smaller	5. Size larger

ZOOLOGICAL SURVEY OF INDIA,
INDIAN MUSEUM,
CALCUTTA, 13,
January 14, 1963.

G. U. KURUP
Asst. Zoologist (Mammals)

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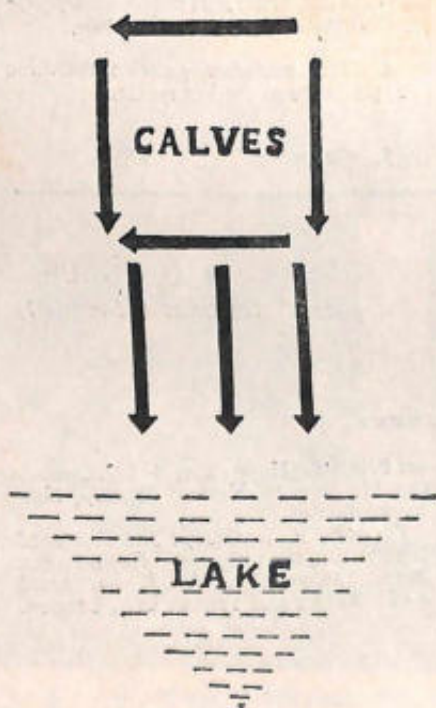
2. A CURIOUS PROTECTIVE DEVICE AMONG WILD ELEPHANTS¹

(With a text-figure)

Recently, I had an opportunity of making a faunistic survey at Thekkady (Kerala State) on the bank of Periyar Lake. The lake is an artificial one, formed out of the impounded waters of the Periyar River for irrigating the Vaigai Valley in Madras State. Part of the original forest on the hillocks on the way is submerged by the diverted river water and, in the midst of the lake, we can see isolated hillocks and, on them, remnant strips of the forest. The Kerala Government has established a game sanctuary for wild elephants at this beautiful place.

On 23-3-1962, our party proceeded to Periyar head-water works. On the way, we noticed 23 wild elephants (all cows) feeding on the grass on an isolated hillock. One of us started taking a movie from our boat, when we were still some distance from the shore. Probably disturbed by the sound of the motor boat and of the movie camera, one of the elephants gave a loud trumpet call. Immediately, another

batch of 14 elephants, which included one old tusker, two smaller tuskers, and five calves, came running. This new batch obviously belonged to the same herd, since they mingled freely with the old batch. Three of them, including the one which trumpeted, stood facing the boat. Four cows formed square behind them (see text-figure, in which the arrowheads represent the heads of the elephants), and two calves were driven into the square. A similar square was formed for the other three calves. Both the squares were closely packed. This phenomenon is obviously a curious protective device for the young. Some of the elephants led by the old tusker



¹ Communicated by Dr. K. K. Tiwari, Zoological Survey of India, Calcutta 13.



Section of the larg : herd of Nilgiri T.L.r

Photo : E.R.C. Davidar.

started moving towards the water's edge at an angle (following the usual route through which they enter the lake), probably to charge us in case of need.

The boatmen stopped the engine, and prepared to row away lest the elephants charge us. We stopped taking the movie and waited for a while. The elephants then calmed down, and the two small tuskers even started a mock fight.

ZOOLOGICAL SURVEY OF INDIA,
34, CHITTARANJAN AVENUE,
CALCUTTA 12,
December 12, 1962.

K. V. LAKSHMINARAYANA

[Mr. E. O. Shebbeare, I.F.S. (Retd.) to whom this note was sent for opinion comments: 'I have never seen a wild herd behave at all as your correspondent tells us the Periya one did, but there is no reason why elephant behaviour should be the same throughout Asia: for example reports have been published that, in S. India, a herd is sometimes led by a bull—a thing I have never come across. My experience with wild elephants has been restricted almost entirely to N. Bengal, Assam, and Chittagong except for a few years as a game-warden in Malaya.'—EDS.]

3. CENSUS OF THE NILGIRI TAHR *HEMITRAGUS* *HYLOCRIUS* (OGILBY) IN THE NILGIRIS

(With a plate)

A census of the Nilgiri Tahr *Hemitragus hylocrius* (Ogilby) (locally known as the Ibex) on the Nilgiri Plateau was taken at the end of January 1963. The tahr country was divided into four blocks and four parties did a simultaneous count in them. Every precaution was taken to avoid duplication. The tahr live among the cliffs and, if undisturbed, come up during the day to feed on grass on the mountain tops. Therefore, the visual method of counting is most suitable and was adopted. Binoculars and telescopes were used as aids. The tahr actually seen and counted amounted to 292. On a very conservative estimate, at least a third of this number escaped observation on account of unfavourable ground, wind, and weather conditions. So it can be safely estimated that there are about 400 tahr in the Nilgiris and their number appears to be registering an increase.

The largest herd consisted of 38 animals. Several fine saddle-backs and brown bucks were seen, also a number of young tahr. Although the herds move from area to area the places where the saddle-backs were found are not given for obvious reasons.

The herd on the eastern slopes around Glen Morgan has been wiped out by poachers, thanks to the ban imposed on shooting and the consequent absence of licence holders who provide a check on illegal shooting. No tahr were seen in the Nilgiri Peak area and it is reported that this is because of poaching by the estate labour. Licence holders will be doing a great service by frequenting this area.

In the Kundah Hydro-Electric Scheme area roads are being laid in the tahr country and forest wattle plantations are also being pushed through. Poaching activity is therefore expected to increase. This seems a crucial stage in the protection of this species.

In conclusion I may state that unless the licence holder is allowed to pursue the saddle-backs, most of which are useless for breeding purposes, and thus patrol the area, there is no doubt that tahr will eventually share the fate of the Glen Morgan herd.

THE NILGIRI WILD LIFE ASSOCIATION,
OOTACAMUND,
NILGIRIS, SOUTH INDIA,
February 14, 1963.

E. R. C. DAVIDAR,
Honorary Superintendent

[Leslie Brown in a note entitled 'Wild Life in some areas of South India', published in Vol. 57 (2) : 403-408, 1960, of our *Journal*, at p. 404, says: 'In the Nilgiris, on the high plateau sambar were few, but I saw without difficulty a herd of 16 Nilgiri Tahr.'—Eds.]

4. STRANDING OF A BLUE WHALE *BALAENOPTERA* *MUSCULUS* (LINN.) NEAR SURAT, GUJARAT, WITH NOTES ON EARLIER LITERATURE

On press reports of the stranding of a whale, which were confirmed by the local Superintendent of Fisheries, an assistant of the Society, Shri V. C. Ambedkar, was sent to collect data. The whale was stranded on 23 February 1963 close to village Gavier, near Magdalla Port, about seven miles from Surat. On 27 February when the body was examined, decomposition had progressed considerably

and the skin had almost completely peeled off. A patch of skin still on the body near the flipper was slate-grey in colour. Some portions of the floor of the mouth were dirty yellow. The following measurements were obtained:

Total length	20.28 m. (66 ft. 6 in.)
Length of flipper	3.30 m. (10 ft. 10 in.)
Upper jaw	5.60 m. (18 ft. 4 in.)
Lower jaw	4.10 m. (13 ft. 5 in.)

Among species of *Balaenoptera*, the Blue Whale [*Balaenoptera musculus* (Linn.)] has the longest flipper, approximately 1/7th of the body length as against 1/9th or lower in other species of the genus. The length of the animal and ratio of the length of its flipper to its total length establish the identity of the specimen as *B. musculus*. In the Fin Whale [*Balaenoptera physalus* (Linn.)], the only other species of the genus which grows to over 60 ft. in total length, the ratio is 1/9th; the average of its total length is also less than that of *B. musculus* being 63 ft. male, 65 ft. female as against 74 ft. male and 77 ft. female (Gibson-Hill, 1950). The present specimen is apparently immature. This species is referred to a distinct genus *Sibbaldus* in American classifications, a position that has not been accepted by Ellerman & Morrison-Scott (1951) and most other European authors.

It might be of interest to mention some points arising out of the literature on the stranding of whales on the coasts of India. Gibson-Hill (loc. cit.) has commented on the probable species of the strandings recorded in S. T. Moses's (1947) list of whales stranded on the coasts of India and in near-by areas. He has, however, overlooked the specimen from Naduvattum, Kerala, in the list, first reported by P. K. Jacob & Devidas Menon (1947), the length (45 ft.), colour, and number of ventral furrows (45) of which agree with his description of the Sei Whale, *Balaenoptera borealis* Linn., and which was probably of this species. Ellerman & Morrison-Scott (1951) give its distribution in the tropics as Borneo, Java, and Siam.

One very interesting fact noted by Jacob & Menon (loc. cit.) is that the animal had fed on a large shoal of mackerel (*Rastrelliger kanagurta*)—the usual food of this species in the North Atlantic is a tiny crustacean *Calanus finmarchicus*. In this connection, the popular name of the species in Norway and Japan may not be without significance. The Norwegian 'Seievhal' seems to comment on the arrival of the whale in Norwegian coastal waters when the Sei or coalfish (*Gadus virens*) are migrating; and the Japanese name 'Iwashikujira' is translated as 'Sardine Whale'. There is, however, little evidence to prove that the names are in fact associated with the food

habits of the animal. Shoals of mackerel occur along the west coast of India in January, the month of the stranding at Naduvattam. Feeding on fish is not peculiar to *B. borealis*, for the Fin Whale [*B. physalus* (Linn.)] is known to feed on herring and other fish, particularly *Osmerus arcticus* (Sanderson, 1958).

Since Gibson-Hill's (1950) note on Rorquals there has been one additional report in the *Journal* on the stranding of a whale (V. K. Chari, 1951). The species is recorded as *Balaenoptera indica* Blyth [= *Balaenoptera musculus* (Linn.)] but the measurements noted (total length 68 ft., flipper 6 ft. 1 in.) show a rather short flipper for *B. musculus* and the possibility that the whale was *Balaenoptera physalus* (Linn.) cannot be overlooked.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6-WB.,
April 8, 1963.

J. C. DANIEL,
Curator

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5. 'TRANSMISSION OF RABIES WITHOUT BITING'

With reference to our Miscellaneous Note in the April 1962, Vol. 59 (1), number of the *Journal* on the transmission of rabies by a non-bite route, Dr. Alan Gilroy, Principal, Ross Institute of Tropical Hygiene, India Branch, Assam, has drawn our attention to an announcement by Dr. G. Stuart in the *Tropical Diseases Bulletin*, Vol. 59, No. 8, p. 776, August 1962, London, referring to a paper published in Prague [Yurkovsky, A. M. (1962): Hydrophobia following the Bite of Apparently Healthy Dogs. *J. Hyg., Epidemiol.,*

Microbiol. & Immunol. v. 6, No. 1, 73-8. (13 refs.), Prague 1962]. Dr. Stuart, himself a specialist in rabies, writes:

'An analysis of reports from Pasteur Institutes in the U.S.S.R. reveals that since 1947, in different republics or regions in the territory, there have been 21 cases of hydrophobia in persons bitten by apparently healthy dogs. In these cases, in which the length of the incubation period varied from 1 month to 2 years, diagnosis was based mainly on the typical clinical picture presented, but in 5 of 6 on whom a post-mortem examination was carried out Negri bodies were found to be present in the brain. Reports on the 21 dogs responsible for the biting showed all to have remained clinically healthy after their victims had developed rabies.

'These findings confirm the view previously expressed by many authors that apparently healthy dogs may act as carriers and transmitters of the rabies virus and that risk of infection is not, therefore, limited to contact with a clinically rabid animal which develops rabies within 14 days after the time of biting.

'Inasmuch as apparently healthy carriers as well as clinically rabid animals secrete the rabies virus in their saliva, the author stresses the importance of examining the salivary gland to determine the degree of danger of an animal bite. In this connexion it is noteworthy that, in the opinion of some workers, absence of virus from the saliva, even when it is present in the brain, provides sufficient reason for withholding specific treatment. 5 case histories are given. (See this *Bulletin*, 1958, v. 55, 30.)¹

We may add that all specialists do not accept these findings as conclusive. For instance, Dr. A. N. D. Nanavati, Assistant Director, Department of Virology, Haffkine Institute, Bombay, who was asked for his opinion writes:

'May I point out that your note "Transmission of rabies without biting" is likely to give rise to the impression (though you have not said so) that all the bat species mentioned are capable of causing rabies without biting and may be responsible for indiscriminate bat-slaughter by readers of the *Journal* unless you clarify this point!! *The Frio Cave incident is the only known instance* of such infection occurring. Various explanations for this are possible, or it may turn out to be inexplicable, but it still needs a lot of investigation.

'The known information on rabies can be summed up as follows:

1. Rabies can occur in an individual (human or animal) who comes into contact with saliva or raw flesh of a rabid

¹ We are grateful to the Editor of the *Tropical Diseases Bulletin* for permitting us to reproduce this extract.—EDS.

animal, i.e. the infecting animal, even if symptom free at the time, must die of rabies, usually within 10 days. (The only known exception to this is the vampire bat which is reported to be an immune carrier. No other bats have been found immune so far.)

2. The rabies virus (infection) cannot penetrate through unbroken skin. The infecting saliva must, therefore, come in contact with a break in the skin (as in biting) or with the mucous membranes (conjunctiva, mouth, etc.).

'The reference mentioned by you is an abstract of a recent WHO report discussing about 21 cases, and mentioning others, where rabies is said to have been caused by contact with *non-rabid* dogs. Since all the necessary data are not available one does not know what to make of these reports. Such transmission can only be proved by showing the presence of infective virus in the animal's saliva, which has never so far been done. Contacts with dogs are very common, (the only incidents recalled later being ones of actual biting etc.) and it is very likely that the actual infecting contact, if a minor scratch, or a lick over a cut or abrasion on the skin, may have passed unnoticed. I would not rule out the WHO reports completely, but would be very chary of accepting any such incident without the positive evidence of virus in the saliva. This is very difficult to provide, since suspicion is not aroused until long after the incident, when symptoms start appearing.'

As we would not like to be responsible for a holocaust of bats in India we are glad to publish Dr. Nanavati's observations. Incidentally, the genus *Tadarida* to which *T. brasiliensis mexicana* Saussure found in the Frio Cave belongs, occurs in India, but not this particular species; nor have we any species of vampire bats (*Desmodus*).

BOMBAY NATURAL HISTORY SOCIETY,

91, WALKESHWAR ROAD,

BOMBAY 6-WB.,

February 16, 1963.

EDITORS

6. SOME RECORDS OF PETRELS HANDLED IN THE NORTHERN INDIAN OCEAN

Although H. G. Alexander (1929, 1931) and W. W. A. Phillips (1947, 1950, 1954, 1955) and numerous subsequent authors have reported that many petrels can sometimes be seen in the northern

Indian Ocean, few of these birds have ever been examined in the hand. The most important evidence for the identity of the birds seen at sea therefore rests on reviews of birds collected on ships by Junge (1941), of the large dark petrels by Jouanin (1955, 1957), and of the 'Persian' Shearwater *Puffinus lherminieri persicus* by Phillips & Sims (1958). Although it is well known that Wilson's Storm Petrel *Oceanites oceanicus* winters in this area (Roberts 1940), and Junge reported the collection of a number of moulting Whitefaced Storm Petrels of the Australian race *Pelagodroma marina dulciae* all round the northern border of the Indian Ocean during the southern winter, the only evidence for the identity of another species in the area has previously been a specimen of the Blackbellied Storm Petrel *Fregatta tropica* labelled 'Bay of Bengal' in the Tweeddale collection in the British Museum (Gibson-Hill 1948).

During the course of a cruise through the Indian Ocean in an aircraft carrier in 1960 the first author saw numerous petrels come to the deck-lights at night, and was able to handle some, including a Blackbellied Storm Petrel. Photographs of two of the larger petrels handled have already been published in the journal of the Royal Naval Bird Watching Society, *Sea Swallow*, for 1960, together with an account of the petrels of the area by the second author, and many other observations of the seabirds of the area will be found there; since the Blackbellied Storm Petrel is the first which has actually been handled in recent times in the Indian Ocean north of the equator, it seems desirable to call attention to this record in particular here.

THE BLACKBELLIED STORM PETREL

A bird came to the deck-lights at night at 08° 03' N., 72° 50' E., 14 miles SE. of Minicoy, on 9 September 1960. The head, neck, upperparts, wings, tail, bill, and legs were more or less black, the rump, belly, flanks, and under tail coverts were white, the underwing was grey, and there was a dark line down the centre of the belly. The overall length was 180 mm., the overall wingspan 410 mm., the wing 168 mm., the tail 70 mm. and almost square, the exposed culmen was 15 mm., the tarsus 40 mm., and the middle toe 28 mm. The account agrees exactly with the more southerly populations of *Fregatta tropica* which breed to the south on Kerguelen among other subantarctic islands. Numerous sight records of storm petrels of the genus *Fregatta* by Phillips (1947) and a number of subsequent observers suggest that this species is a common visitor to the central Arabian

Sea during the southern winter, arriving about May and leaving about September. The very similar Whitebellied Storm Petrel *Fregetta grallaria* may occur as well, but we are not aware that one has been handled yet.

OTHER SPECIES

A Whitefaced Storm Petrel *Pelagodroma marina* came on board and was photographed in much the same area as the last species earlier in the year, at 08° 05' N., 73° 00' E. on 28 May.

Examples of *Bulweria (bulwerii) fallax*, recently described by Jouanin (1955), came on board at 16° 40' N., 55° 15' E. and 18° 50' N., 57° 50' E. on 14 February, and 11° 24' N., 57° 05' E. on 25 May in the central Arabian Sea off the mouth of the Gulf of Aden. They agreed in appearance with the original description, except that one was said to have a paler chin. The overall length in life was 295-300 mm., the overall wingspan 790 mm. The local water temperature was 78° F. in February, and 83° F. in May. The third bird vomited a small squid about 2 cm. long. The Indian specimen of the Mascarene Petrel *Pterodroma aterrima*¹ quoted by Ripley (1961) should perhaps be re-examined to see if it is this species.

Wedgetailed Shearwaters *Puffinus pacificus* came on board at 09° 25' N., 66° 24' E. on 27 May and at 05° 10' N., 84° 00' E. on 1 June. The bill was described as steel-grey with the tip black in the first case, and black in the second; the legs and feet were pink. The overall length in life was 370-380 mm. (15 in.), the overall wingspan 860 mm. The water temperature was 83° F. in both cases, and the first bird also vomited squid.

THE GREEN,
RAVENSTHORPE, NORTHANTS.,
ENGLAND.
46, WILBURY ROAD,
HOVE 3, SUSSEX,
ENGLAND.
November 24, 1962.

N. BAILEY

W. R. P. BOURNE

¹ The specimen of *Pterodroma aterrima* first reported by Sálím Áli & Humayun Abdulali in *J. Bombay nat. Hist. Soc.* 42 : 193, and later listed by Ripley in A SYNOPSIS OF THE BIRDS OF INDIA AND PAKISTAN (p. 5) cannot now be traced.—Eds.

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7. THE BLUETAILED BEE-EATER *MEROPS PHILIPPINUS* LINNAEUS, NESTING IN CEYLON

You will be interested to hear that I have recently established that the Bluetailed Bee-eater, *Merops philippinus* Linnaeus, nests in Ceylon.

I found a single pair at Kumana, in the Eastern Province, nesting in a sandy slope leading down to an estuary, during Easter 1962. I think that these birds were incubating as I saw one of the birds enter the hole and stay within for about 3 minutes only possibly feeding the mate. If young were being fed the visits would have been more frequent and regular.

Again, a fortnight later, I came upon some of these birds further north up the same coast obviously feeding young. They were catching flies over the sea and returning very regularly to the nest at intervals of about 5 minutes. Unfortunately, I could not get to where they had their nests as this was on the other side of a river over which I had no means of crossing.

PINGARAWA,
NAMUNUKULA,
CEYLON,
May 19, 1962.

C. E. NORRIS

8. THE COMMON HAWK-CUCKOO (*CUCULUS VARIUS VARIUS* VAHL) IN THE PUNJAB

When in 1930 Stuart Baker (FAUNA OF BRITISH INDIA, Birds 4: 149) excluded the Punjab from the range of the Common Hawk-Cuckoo it had long been known to occur in several Punjab districts. Whistler (*J. Bombay nat. Hist. Soc.* 26: 177, 287, 592) found it common in Ambala in 1916 and in Ludhiana in 1917, and in 1918 recorded it from Lahore. In Kangra in 1921-1923 he met with it each year in small numbers along the Kangra Valley up to about 4000 feet (*Ibis*, 1926, : 749). In 1933-1935 I myself found it common in Ambala and also collected specimens in the adjoining districts of Hoshiarpur and Karnal. In 1923 I took one at about 3000 feet in the Rawalpindi District in June and in the following month another at Jhelum, where several were haunting the Cantonment. From 1949 to 1954 I was stationed at Sargodha, the headquarters of the Shahpur District. There I repeatedly heard its call in the first half of June 1949, from the middle of March to the middle of July in 1950, and in the first half of August 1951. I have, however, no record of having heard it in the three following years. In 1960 I met with it for the first time in the Salt Range, which I had been frequently visiting for over forty years. On 11th and 12th March it was heard calling all day at Choa Saidan Shah (c. 2000 ft.) in the Jhelum portion of the Range, and a fortnight later at Sodhi, in the Shahpur portion, some 40 miles further west. It will be interesting to see how much further, if at all, it extends its range in this direction.

KALABAGH,
MIANWALI DISTRICT,
WEST PAKISTAN,
February 16, 1963.

H.W. WAITE

[Ripley in A SYNOPSIS OF THE BIRDS OF INDIA AND PAKISTAN (p. 176) gives the distribution of *C. v. varius* as: 'Breeds throughout most of India at lower altitudes than the preceding species (*Cuculus sparverioïdes*). A straggler in Rajasthan. Occurs east to Assam and East Pakistan, from the plains to 3000 feet; in open scrub land, light forest, and near cultivation.'—EDS.]

9. THE FOREST WAGTAIL *MOTACILLA INDICA* GMELIN
IN THE GIR FOREST, SAURASHTRA

Recently I went to the Gir forest and while walking in a nullah where a stream was flowing I came across a Forest Wagtail, (*Motacilla indica* Gmelin) which flew away on seeing me, and I could distinctly see the white barring on the wings. This is the first time I have seen this bird in the Gir forest and perhaps constitutes a first record. In a SYNOPSIS OF THE BIRDS OF INDIA AND PAKISTAN (p. 574) the bird is mentioned as 'a straggler on passage in Gujarat (rare) and later said to 'winter in India from Saurashtra (Junagadh), Surat Dangs . . . and southwards'. I do not know on what basis it is said to occur in Saurashtra.

DIL BAHAR,

BHAVNAGAR,

December 20, 1962.

R. S. DHARMAKUMARSINHJI

[Sálim Ali (*J. Bombay nat. Hist. Soc.* 52 : 779) obtained it in the Surat Dangs and said 'not observed elsewhere in that area, but possibly occurs in the Gir forest of Junagadh (Saurashtra)'. We were unable to trace any other published record in support of Dr. Ripley's statement, and Dr. Ripley also could not recall whence he had obtained this information, but thought it may have been based on a specimen collected by Dr. Walter Koelz. Inquiry at the American Museum of Natural History, New York, Chicago Natural History Museum, Chicago, Illinois, and Museum of Zoology, University of Michigan, where most of the Koelz collection is housed reveals no specimen (of this species) from Saurashtra, and it is possible that Dr. Ripley misquoted Sálim Ali and that the present is the first record from that area.—EDS.]

10. FIRST RECORD OF BEDDOME'S WOLF-SNAKE
LYCODON TRAVANCORICUS (BEDDOME), FROM THE
LACCADIVE ARCHIPELAGO

A juvenile specimen of the Wolf-Snake *Lycodon travancoricus* (Beddome), measuring 199 mm. in length, was captured during March 1962 by student-members of a Social Service League Camp engaged in the construction of a road at Androth (Long. 73° 57' E., Lat. 10° 48' N.), and was handed over to me later by P. Gopinathan Nambiar, now Headmaster of the Government High School, Ameni Island.

Though rare, it is well known to the natives of Androth who call it *Chera* [Malayalam name on the mainland for *Ptyas mucosus* (Linn.)] and what is interesting is that they refuse to consider this reptile as a snake at all! In Kerala this snake is called *Cheralav*, because of its superficial resemblance to *Ptyas mucosus* (Linn.).

Of the ten inhabited islands in the Laccadive group, Androth lies closest to the Indian peninsula, the distance to Calicut being only 139 miles. Inhabitants of no other island except Androth remember having ever come across a snake. The proximity of Androth to the mainland would suggest transportation as an easy possibility for the occurrence of the species in the island, and the collection of a juvenile indicates that the species is probably now breeding on the island. No other species of snake is known from the Laccadives.

Lepidosis

Costals at mid-body	..	17
Ventrals	..	185
Caudals	..	67
Anal	..	1

ACKNOWLEDGEMENT

The author is indebted to Miss Jennifer A. Cochrane of the British Museum (Natural History) for her help in lepidosis and identification of the specimen.

DEPARTMENT OF ZOOLOGY,
ST. JOSEPH'S COLLEGE,
DEVAGIRI, KOZHIKODE-8,
KERALA STATE,
September 23, 1962.

K. G. ADIYODI

[It is interesting to note that A. O. Hume in his article 'The Laccadives and the West Coast', *Stray Feathers*, Vol. IV, pp. 413-459, 1876, states that to control the rat population of the inhabited islands of the Archipelago 'Government sent down a lot of snakes and mongooses; the former, the people exterminated as undesirable colonists'. Perhaps the extermination was not complete and the specimen collected is a descendant of the ones that got away.—EDS.]

11. THE DIET OF THE INDIAN BULL FROG *RANA TIGERINA* (DAUD.)

The frog has been one of the most extensively studied laboratory animals. Yet sufficient attention has not been paid to its dietary habits particularly in the different seasons of the year, even though many species of frogs have been examined to ascertain their diet. Noble (1918, 1924) examined the stomach contents of several species of tree frogs and also of *Bufo bufo vulgaris* and *Rana temporaria*. The stomach contents of *Rana ridibunda* were examined by Smith (1953). Many others such as Needham (1905), Drake (1914), Liu & Chen (1932) examined the stomach contents of *Rana catesbiana*, *Rana pipiens*, *Rana limnocharis*, and *Rana nigromaculata* respectively. Studies have also been made on the diet and the feeding habits of the edible frogs, *Rana esculenta* (Linnaeus) and *Rana pretiosa*, by Tyler (1958) and Turner (1959). The latter author has studied the seasonal variation in the diet of the western spotted-frog.

From the observations of different authors the following could be listed as the food items of frogs: larvae of various invertebrates, molluscs, insects, young batrachians, the eggs and young ones of fishes. Tyler (1958) has recovered several species of various orders of insects and has concluded that *Rana esculenta* as a species is not selective in its food habits.

The frog *Rana tigerina*, popularly known as the Indian Bull Frog on account of its large size and loud call, is widely distributed in eastern Asia. The published records on the diet of this species refer to the unusual rather than the normal food of the animal. The present study was undertaken with the object of determining the ordinary diet of the species by the examination of the stomach contents during the different months of the year.

MATERIAL AND METHODS

The frogs were collected from a small pond, mainly rain-fed, with a surface area of approximately 150 sq. ft., on the outskirts of Baroda city. The depth of the water was about 20 ft. during the rains and between 5 to 10 ft. in summer. Water weeds were plentiful and the pond fauna consisted of aquatic insects, insect larvae, small crustaceans, and snails. The average maximum/minimum temperatures during the summer (March-June), monsoon (July-October), and winter (November-February) of the year under study were

39.8/22.8, 32.4/24.4, and 31.6/13.9 in degrees centigrade, and the total rainfall 75.2, 1359.6, and 8.4 mm. respectively.

OBSERVATIONS

The frogs were captured at night when out on land to feed. They were immediately killed and the stomach contents of each were separately preserved in 5% formalin. A report on the stomach contents is presented on pp. 265-7.

DISCUSSION

Frogs are known to prefer live moving animals chiefly insects, motionless creatures often being ignored. From the observations recorded in the present study it can be noticed that there is no special selection of food: Dermaptera (Earwigs) were found in the stomachs throughout the year, but the number was greater during the months of November and February. Thus it is seen that Dermaptera formed the chief item of diet in winter when these insects are found in large numbers, while Diptera were found to be the major item during late winter and early summer.

Coleoptera were found throughout the year except in January and February. Hemiptera reached their highest mark in the month of December. They were also found in good number during the last three months of the year. Hymenoptera were taken in only when they were available in large numbers. The number of ants was high in the months of April and May. The same was the case with Isoptera.

Lepidoptera, Arachnida, and Isopoda were also occasionally found. Myriopoda were found only after the first rain, while Orthoptera were obtained throughout the year except during the months of January and February. Young frogs during the breeding period fall a prey to the adult ones. At times bigger animals like mice, birds, and geckos become the victims of the adult frogs.

During the winter the feeding was comparatively less but in the rainy season the feeding reached its highest mark as during this period the adult frogs have just finished breeding and their reserve food is all depleted. In this season the insects are also plentiful. It was also observed that frogs captured on full-moon nights contained considerably more food in their stomachs. This was apparently due to their greater ability to find food in the moonlight.

Number collected/Number of stomachs from which collected

Months	January	February	March	April	May	June	July	August	September	October	November	December	Remarks
No. of stomachs examined	10	11	15	16	9	24	21	11	15	13	18	24	..
<i>Contents</i>													
MOLLUSCA Snail (<i>Limnaea gul-naria</i>)	^a 1/1	1/1	..	..	^a Shell
ANNELIDA Earthworms (<i>Pheretima</i> sp.)	4/1	..	1/1	2/1	..	2/1	..
ARTHROPODA Class DIPLOPODA Millipedes	27/19	2/1	3/2	..	..	..	..
Class CHILOPODA Centipedes	1/1	..
THYSANURA <i>Lepisma</i> sp.	1/1	1/1 3/1	..	..	..	..	..	..	..
Class INSECTA DICTYOPTERA Cockroach (Blattidae)	1/1	..	..	..	1/1	^b 1/1	..	..	..	2/1	^b With a ootheca
ISOPTERA (Termites)	^c Several/5	^c 50+/6	1/1	..	..	..	..	..	^c Winged forms
ORTHOPTERA Mole Cricket (<i>Gryllotalpa</i> sp.)	7/5	1/1	2/1	25/11	10/4	..	2/2	23/10	4/4	3/1	

Months	January	February	March	April	May	June	July	August	September	October	November	December	Remarks
No. of stomachs examined	10	11	15	16	9	24	21	11	15	13	18	24	..
<i>Contents</i>													
DERMAPTERA (Earwigs)	13/5	20/11	1/1	2/1	1/1	6/4	2/1	2/2	7/3	10/4	12/6	7/3	..
HEMIPTERA (Bugs)	..	1/1	..	..	..	..	1/1	..	4/1	2/2	..	..	..
Geranium Bug (<i>Cydnius indicus</i>)	..	..	1/1	..	1/1	..	..	..	..	..	17/5	137/17	..
COLEOPTERA Families : Cicindeli- dae, Scarabidae, Curculionidae, Tenebrionidae	..	2/1	7/5	4/4	14/6	20/8	36/18	14/7	15/7	18/6	11/5	12/6	..
LEPIDOPTERA Moths (Rhaphalocera)	..	6/4	..	..	..	4/2	2/1	^e 8/4	^d 9/5	^e 4/2	1/1	..	^d Larvae
DIPTERA <i>Eristalis</i> sp. (larvae)	21/8	27/9	30/12	22/9	1/1	1/1	..	..	..	3/3	6/6	..	..
Housefly (<i>Musca</i>)	..	..	..	..	..	..	2/1	4/2	2/2	..	..	..	..
Other Diptera larvae	..	..	..	..	..	..	..	..	^e 4/2	..	..	215/6	^e Mosquito larvae

The type and number of the prey caught depends more on the availability of these animals during certain seasons rather than any particular preference.

DEPARTMENT OF ZOOLOGY,
M.S. UNIVERSITY,
BARODA,
March 16, 1962.

U. L. WADEKAR

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12. FURTHER STUDIES ON INDIAN SPIDERS OF THE GENUS *CYRTARACHNE* (FAMILY ARGIOPIDAE)

(With four text-figures)

INTRODUCTION

The Oriental spiders of the genus *Cyrtarachne* were first described by Thorell (1895). Pocock (1900) recorded two known and one new species. Tikader (1960) revised the Indian spiders of this genus and recorded two known and three new species.

Recently, I have received from my friend Dr. F. Schmid, some interesting spiders of the genus *Cyrtarachne* collected by the Swiss/Indian Zoological Expedition 1960-61. He made this collection from Assam and NEFA, during his Trichoptera collection tour. I have also made some collection of spiders of this genus from Maharashtra and Mysore States.

While examining the above-mentioned material of spiders, I came across four new and three known species. The present paper contains descriptions of the four new species. The type specimens will, in due course, be deposited in the collections of the Zoological Survey of India, Calcutta.

Cyrtarachne inaequalis Thorell

Cyrtarachne inaequalis Thorell, 1895, *Spiders of Burma*, London : 201 ; Pocock, 1900, *Fauna Brit. India, Arach.* : 229 ; Tikader, 1960, *J. Bombay nat. Hist. Soc.* 57 (3) : 548.

Material: 1 ♀ from Songpekmum, Manipur, Assam, 1-9-1960. Coll. Dr. F. Schmid.

Distribution: Burma : Toungoo and Tharrawaddy; India : West Bengal, Balaghat, Madhya Pradesh, Songpekmum, Manipur, Assam.

Cyrtarachne raniceps Pocock

Cyrtarachne raniceps Pocock, 1900, *Fauna Brit. India, Arach.* : 229 ; Tikader, 1960, *J. Bombay nat. Hist. Soc.* 57 (3) : 550 ; 1963, *J. Poona University* 23 : 41.

Material: 1 ♀ from Kotigehar, Dist. Chikmagalur, Mysore, 29-12-1960. Coll. B. K. Tikader.

Distribution: India : West Bengal, Mysore; Ceylon.

Cyrtarachne graveleyi Tikader

Cyrtarachne graveleyi Tikader, 1960, *J. Bombay nat. Hist. Soc.* 57 (3) : 553.

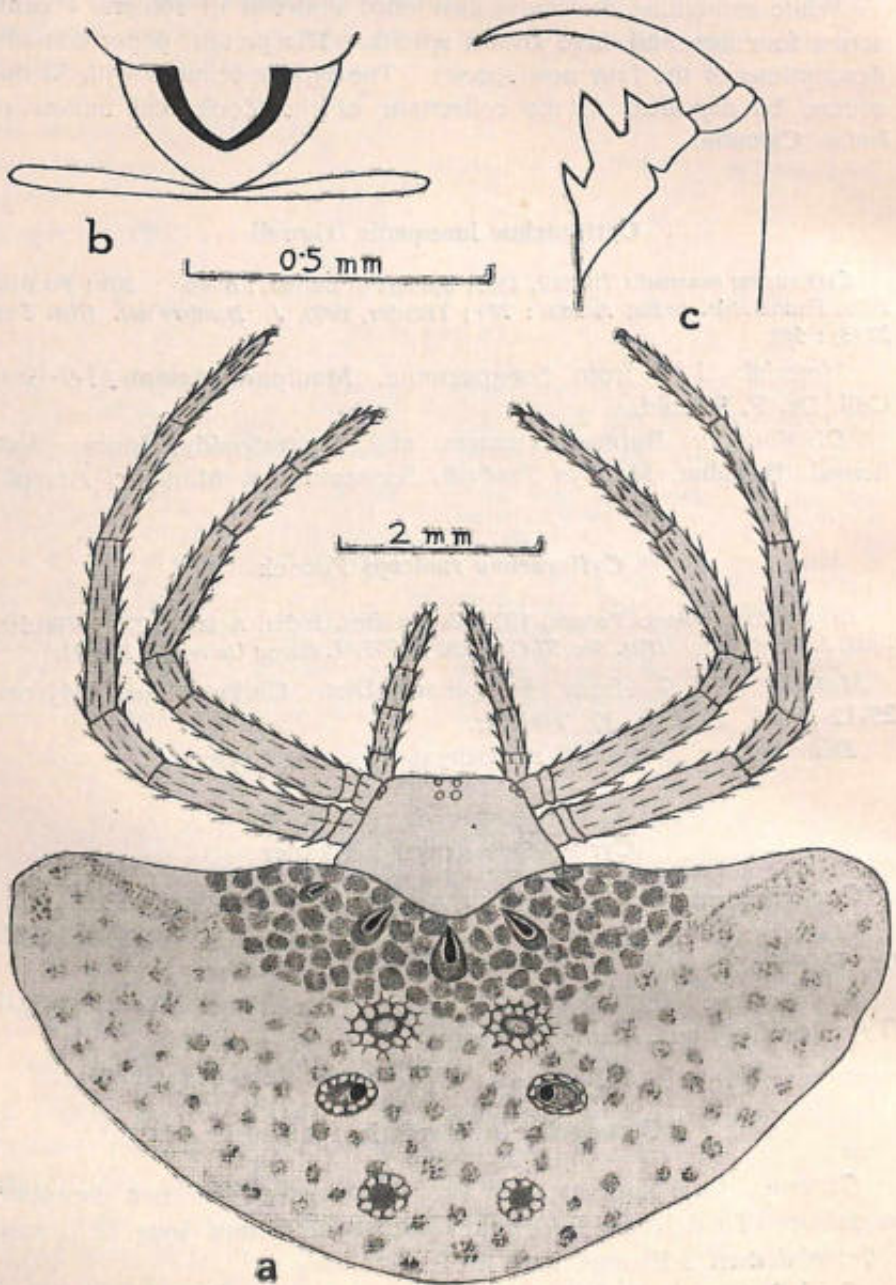
Material: 1 ♀ from Khaorang, Manipur, Assam, 28-8-1960. Coll. Dr. F. Schmid.

Distribution: India : Pashok, Dist. Darjeeling, West Bengal (Type locality), and Manipur, Assam.

Cyrtarachne avimerdaria sp. nov.

General: Cephalothorax and legs light brown, abdomen chocolate in colour. Total length 5.10 mm. Carapace 2.00 mm. long, 2.20 mm. wide; abdomen 3.70 mm. long, 8.50 mm. wide.

Cephalothorax: Relatively broader in front, slightly wider than long. Ocular quad slightly longer than wide, median eyes encircled by a black ring on the base, lateral eyes smaller than medians. Clypeus narrow. Chelicerae subapically with outer row of three large



Text-fig. 1. *Cyrtarachne avimerdaria* sp. nov.
a. Dorsal view of female; b. Epigyne; c. Chelicera

teeth and inner row only one small tooth. Text-fig. 1, c. Sternum heart-shaped, pointed behind. Legs short, clothed with hairs.

Abdomen: Strongly rounded posteriorly and overlapping the posterior region of cephalothorax in front, much wider than long, dorsal surface provided with brown granular patches but anterior portion deeper than the other parts of abdomen and the anterio-lateral portion also provided with a pale patch. Epigyne V-shaped at the base as in Text-fig. 1, b.

Holotype: One female in spirit.

Type-locality: Cherrapunji, Assam, 15-10-1960. Coll. Dr. F. Schmid.

This species resembles *Cyrtarachne bengalensis* Tikader but is readily separated as follows: (i) Abdomen chocolate colour and strongly rounded posteriorly and dorsal surface provided with brown granular patches, but in *C. bengalensis* abdomen uniform chocolate colour and moderately rounded posteriorly. (ii) Chelicerae subapically with outer row of three large teeth and inner row with only one small tooth, but in *C. bengalensis* chelicerae with outer row of three large and inner row of three small teeth.

Cyrtarachne schmidi sp. nov.¹

General: Cephalothorax and legs light yellowish, abdomen light greenish. Total length 4.80 mm. Carapace 1.50 mm. long, 2.00 mm. wide; abdomen 3.50 mm. long, 8.00 mm. wide.

Cephalothorax: Relatively broad in front, wider than long. Ocular quad square, lateral eyes smaller than medians. Clypeus narrow. Chelicerae subapically with outer row of three medium size teeth and inner row of two small teeth. Text-fig. 2, f. Sternum heart-shaped, pointed behind. Legs short, clothed with hairs.

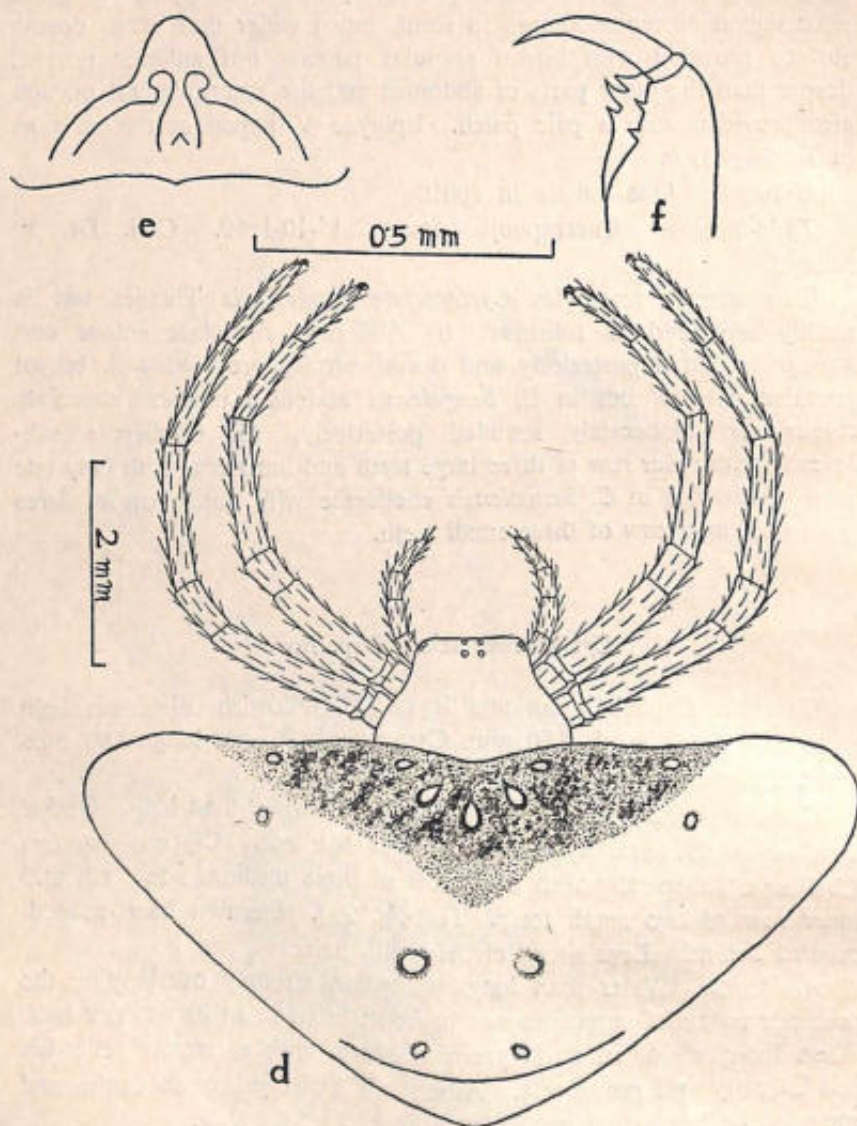
Abdomen: Wider than long, triangular, strongly overlapping the posterior region of cephalothorax in front; broadest in its anterior half. When living abdomen dark, greenish brown with a narrow yellowish belt laterally and posteriorly. Almost all sigilla yellow in centre and encircled by brown patch. Epigyne as in Text-fig. 2, e.

Holotype: One female in spirit.

Type-locality: Amatulla Kameng (NEFA.), India, alt. 1500 feet (c. 460 m.), 18-10-1961. Coll. Dr. F. Schmid.

¹I have pleasure in naming this species after Dr. F. Schmid, who made this collection.

This species is closely allied to *Cyrtarachne biswamoyi* Tikader but differs as follows: Abdomen wider than long and triangular in shape,



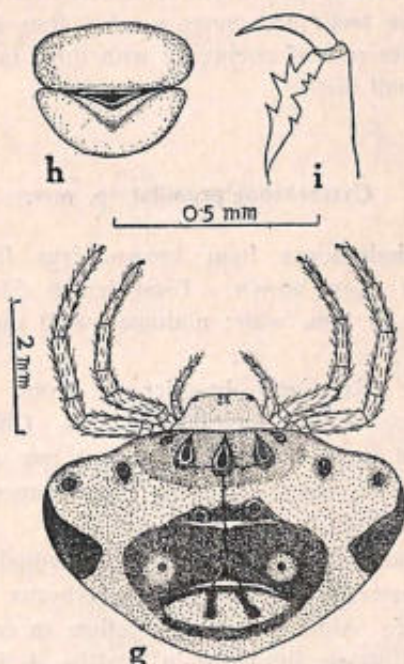
Text-fig. 2. *Cyrtarachne schmidi* sp. nov.

d. Dorsal view of female; *e.* Epigyne; *f.* Chelicera

but in *C. biswamoyi* abdomen wider than long and widely rounded posteriorly, dorsal surface armed with a few symmetrically placed tooth-like tubercles.

Cyrtarachne sundari sp. nov.

General: Cephalothorax, legs and abdomen brownish red. Total length 4.00 mm. Carapace 1.00 mm. long, 1.60 mm. wide; abdomen 3.50 mm. long, 5.50 mm. wide.



Text-fig. 3. *Cyrtarachne sundari* sp. nov.

g. Dorsal view of female; h. Epigyne; i. Chelicerae

Cephalothorax: Relatively broader in front, slightly wider than long. Ocular quad slightly longer than wide, lateral eyes smaller than medians. Clypeus narrow. Chelicerae subapically with outer row of three large teeth and inner of four small teeth. Text-fig. 3, i. Sternum heart-shaped, pointed behind. Legs short, clothed with hairs.

Abdomen: Moderately rounded posteriorly, strongly overlapping the posterior region of cephalothorax in front, wider than long, the anterior lateral and mid-dorsal areas furnished with dark brown patches. All sigilla prominent and encircled by a yellowish ring. Epigyne as in Text-fig. 3, h.

Holotype: One female in spirit.

Type-locality: Poona University Compound, Maharashtra, 6-9-1962. Coll. B. K. Tikader.

This species resembles *Cyrtarachne bengalensis* Tikader but is separated as follows: (i) Abdomen brownish red and the anterior lateral and mid-dorsal areas furnished with dark brown patches, but in *C. bengalensis* abdomen pale chocolate colour and anterior lateral extremities with a white patch; (ii) Chelicerae subapically with outer row of three large teeth and inner row of four small teeth, but in *C. bengalensis* outer row of chelicerae with three large teeth and inner row with three small teeth.

Cyrtarachne promilai sp. nov.

General: Cephalothorax light brown, legs light greenish, and abdomen dark or deep brown. Total length 5.00 mm. Carapace 1.50 mm. long, 2.40 mm. wide; abdomen 4.00 mm. long, 7.00 mm. wide.

Cephalothorax: Relatively broader in front, wider than long. Ocular quad as long as wide, lateral eyes small. Chelicerae subapically with outer row of three large teeth and of two small teeth. Text-fig. 4, l. Clypeus narrow. Sternum heart-shaped pointed behind. Legs short, clothed with hairs.

Abdomen: Wider than long, nearly pentagonal in shape strongly overlapping the posterior region of cephalothorax in front, broadest in its anterior half. Almost all sigilla yellow in centre and encircled by black patch. Epigyne simple as in Text-fig. 4, k.

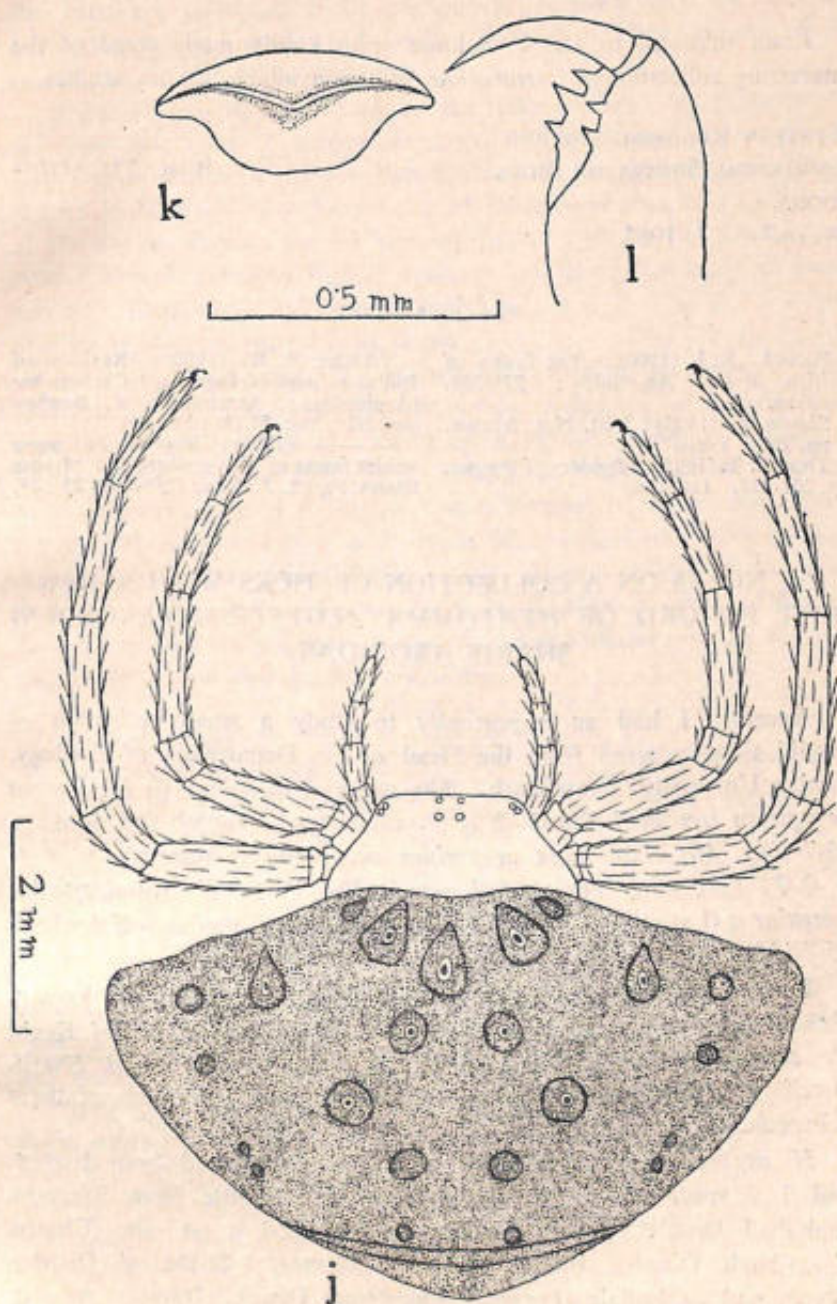
Holotype: One female in spirit.

Type-locality: Poona University Compound, Maharashtra, 6-9-1962. Coll. B. K. Tikader.

This species resembles *Cyrtarachne biswamoyi* Tikader but is readily separated as follows: (i) Abdomen wider than long and pentagonal in shape and dark or deep brown colour, but in *C. biswamoyi* abdomen wider than long and armed above with a few symmetrically-placed tooth-like tubercles; (ii) Abdomen deep brown, but in *C. biswamoyi* abdomen light yellowish grey.

SUMMARY

Four new and three known species of Indian spiders of the genus *Cyrtarachne*, family Argiopidae, are recorded in this paper. All specimens were collected from Assam, NEFA, Maharashtra, and Mysore, India.



Text-fig. 4. *Cyrtarachne promilai* sp. nov.
j. Dorsal view of female ; k. Epigyne ; l. Chelicera

ACKNOWLEDGEMENT

I am thankful to Dr. F. Schmid, who kindly made some of the interesting collection of *Cyrtarachne* spiders available for my studies.

WESTERN REGIONAL STATION,
ZOOLOGICAL SURVEY OF INDIA,
POONA,
December 27, 1962.

B. K. TIKADER

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13. NOTES ON A COLLECTION OF TICKS WITH A NEW HOST RECORD OF *HYALOMMA AEGYPTIUM FERZDENI* SHARIF (IXODIDAE)

Recently I had an opportunity to study a small collection of Ixodid ticks received from the Head of the Department of Zoology, Panjab University, Chandigarh. The material includes: (i) *Hyalomma aegyptium ferzdeni* Sharif—2 ♂♂, Chandigarh, Panjab (off donkey), 15-7-1961; (ii) *Hyalomma aegyptium aegyptium* (Linnaeus)—8 ♂♂, 4 ♀♀, Ferzapore, Panjab (off camel) 30-7-1961; (iii) *Rhipicephalus sanguineus* (Latreille)—4 ♂♂, 2 ♀♀, Chandigarh, Panjab (off donkey), 15-7-1961.

Four subspecies of *Hyalomma aegyptium* (Linnaeus) are known, viz. *H. aegyptium aegyptium* (Linn.), *H. aegyptium dromedari* Koch, *H. aegyptium isaaci* Sharif, and *H. aegyptium ferzdeni* Sharif. Sharif (1928) reviewed the taxonomy, distribution, and hosts of these subspecies.

H. aegyptium ferzdeni Sharif (1928) was described from 3 ♂♂, and 1 ♀ specimen, found to be parasitic on cattle from Sasaram, Shahabad District, Bihar. Sharif also recorded it on cow (Chatra, Hazaribagh District, Bihar), on pony (Sasaram, Shahabad District, Bihar), and on buffalo (Porahat, Singhbhum District, Bihar). According to Sen (1938) cattle (*Bos indicus*), buffalo (*Bubalus bubalis*), and horse (*Equus caballus*) only are the hosts of *H. aegyptium ferzdeni*.

This collection is quite interesting for two reasons. A perusal of the literature shows that the subspecies *ferozdeni* has not hitherto been recorded on donkey; secondly, this is the first record of its occurrence outside Bihar State.

Nagar (1962), while working on the ticks of Delhi State, expressed the view that both *H. aegyptium ferozdeni* Sharif and *H. aegyptium isaaci* Sharif belong to *H. detritum* Schulze, *H. aegyptium* f. *aegyptium* (Linn.) to *H. excavatum* Koch, and *H. aegyptium dromedari* Koch to *H. dromedari* Koch. In the present paper, Sharif's (1928) key has been followed, pending further research on the systematics of these species. Incidentally, it may be worth mentioning that *H. detritum* Schulze is also not recorded on donkey.

In the present case *H. aegyptium ferozdeni* has been found associated with *Rhipicephalus sanguineus*, which is of considerable economic importance as the vector of malignant jaundice of dogs in India caused by *Babesia canis* (Piana & Galli-Valerio) and of Marseilles fever due to *Rickettsia conori* Brumpt in the Mediterranean region and Kenya colony, and which is a suspected vector of tick typhus fever in man and *Babesia gibsoni* (Patton) in jackals and dogs in India (Sharif 1938). It may be interesting to investigate whether *H. aegyptium ferozdeni* plays a part in the distribution of the diseases transmitted by *Rhipicephalus sanguineus*.

ZOOLOGICAL SURVEY OF INDIA,
34, CHITTARANJAN AVENUE,
CALCUTTA 12,
December 24, 1962.

G. MATHAI,
Asst. Zoologist

REFERENCES

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14. OCCURRENCE OF THE BUTTERFLIES *HYPOLIMNAS MISIPPUS* FORM *INARIA* (CRAMER) AND *CIRROCHROA THAIS* (FABRICIUS) IN THE SURAT DANGS, SOUTH GUJARAT

The Danaid Eggfly [*Hypolimnas misippus* (Linnaeus)] is found in India, Ceylon, and Burma. Its range includes also southern Florida, the Antilles, and the northern part of South America. It is very common in Africa, tropical Asia, and the islands south as far as northern Australia (Holland, 1940).

Male and female Danaid Eggflies are common in the Dangs, but the female is more seclusive and less commonly observed. In addition to the regular female form of the Danaid Eggfly there are two rare female forms: 'alcippoides', which mimics the 'alcippoides' form of *Danaus chrysippus*, and 'inaria', which mimics the 'dorippus' form of *D. chrysippus*. Wynter-Blyth (1957) states that the female form 'inaria' is very rare but not as rare as the form 'alcippoides'.

On 28 September 1960 one 'inaria' was sighted at Ahwa. Another was seen on 29 September 1960 at Mulchond. Again on 23 August 1962 one escaped capture at Ahwa. On 12 September 1962 the writer saw this rare 'inaria' form in his garden at Ahwa. By the time a net had been found this butterfly had flown into a near-by rice field. After several futile swings of the net and wading through a muddy rice field, a perfect specimen of *Hypolimnas misippus* ♀ form 'inaria' was captured.

It was not difficult to recognize this female form from the dozens of the common female *H. misippus* captured in the past sixteen years of collecting in India. In the female form 'inaria' the front wings have the elongated spots yellowish, instead of white as in the common female form; also, the middle of the black apical area is tawny in the 'inaria' form.

On 27 September 1962 the writer caught another rare butterfly a Tamil Yeoman *Cirrochroa thais* (Fabricius) in the Mission compound at Ahwa while it was feeding on nectar from *Lantana* flowers.

Wynter-Blyth (1957) states that the Tamil Yeoman is found in Ceylon, the Western Ghats, Coorg, Wynaad, the Nilgiris, and the Palnis (p. 227), and remarks that it is commonest in south India from February to May (p. 228). He gives its size as 60-70 mm. The specimen netted measures 2½ inches (about 64 mm.). The writer has collected butterflies in the Surat Dangs since October 1952 and frequently in various parts of Gujarat since 1946, but not a single species of *Cirrochroa* genus was ever observed in this large area.

C. B. Antram (1924) gives the range of the Tamil Yeoman as southern India (p. 194). Marshall & De Niceville (1886) give a complete description of the genus *Cirrochroa* (pp. 107-119). Here the habitat of *C. thais* is listed as south India. According to the records of the Bombay Natural History Society *C. thais* has been taken only as far north as Karwar in Mysore State.

Thus, the capture of a Tamil Yeoman in south Gujarat extends its northern range by about five hundred miles. However, the presence of a single *Cirrochroa thais* (Fabricius) in Gujarat State is probably an accidental occurrence.

ACKNOWLEDGEMENT

The writer expresses gratitude to the Bombay Natural History Society for providing several boxes of *Cirrochroa* butterflies for study.

DANGS RURAL BOARDING SCHOOL,
CHURCH OF THE BRETHREN MISSION,
AHWA, VIA BILLIMORA, DANGS DIST.,
November 29, 1962.

ERNEST M. SHULL

REFERENCES

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15. THE MATING OF THE ATLAS MOTH *ATTACUS ATLAS* LINNAEUS

In September last year, when I was taking photographs of some landslides on one of our estates (Balur Estate, alt. 3500 ft.) with a colleague, we suddenly came on two pairs of Atlas Moths (*Attacus atlas* Linnaeus) mating about ten feet from one another. They were on small bushes about 4 to 5 feet in height. The moths were facing each other with the lower portions of their abdomens touching, and were clinging to a cocoon presumably the one from which the female had emerged.

They took not the slightest notice of us even when we approached very close to them. When we disturbed one of the pairs, the larger of the two, the female, flopped to the ground. The male flew only a few yards and alighted on a coffee bush from where it was caught. Although we caught the female and threw her gently up in the air she seemed unable to fly and, after fluttering about, flopped on to the ground.

I regret I was unable to watch them mating over a longer period, as I had very little time and had to return to my estate the same evening.

MYLEMONEY ESTATE,
JOLADALU P.O.,
CHIKMAGLUR DIST.,
MYSORE STATE,
December 13, 1962.

K. R. SETHNA

16. DETAILED DESCRIPTION OF DIASPINE SCALE
INSECT *CHIONASPIS VENUI* MENON & KHAN, 1961.
(DIASPIDIDAE : COCCIDEA)¹

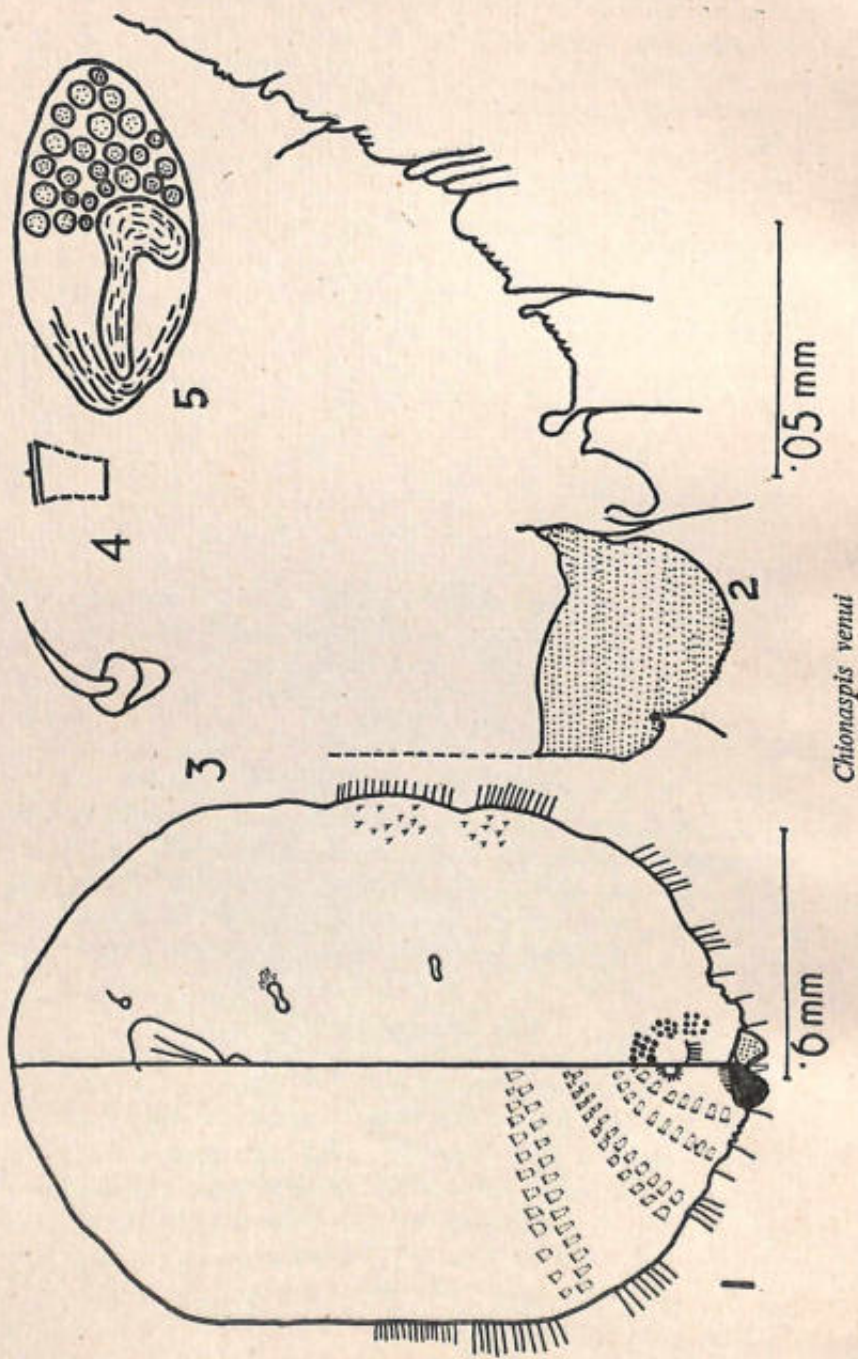
(With a plate)

The authors came across certain specimens of Diaspine scale insects in the National Pusa Collection, which on closer study proved to be a new species of the genus *Chionaspis* Signoret. A short description of the same was published in 1961 (Menon & Khan 1961). A detailed description is given here. It is confined to the female, as a complete male specimen has not been available.

Chionaspis venui

Female. Body oval and distinctly segmented, broadest at the second abdominal segment; antennae knob-shaped with distinct setae, set close to each other (Fig. 3); mouth-parts of typical diaspine type; spiracles two pairs, anterior pair slightly away from the apex of the rostralis, with its anterior end surrounded by numerous quinquelocular disc pores (Fig. 5); posterior pair much smaller than anterior; ducts 'two-barred' type, about 0.015 mm. long; macroducts broader than long (Fig. 4); microducts more clearly seen in prosoma, long, thin.

¹ Communicated by Dr. Md. Zaka-ur-Rab, Dept. of Zoology, Muslim University, Aligarh, U.P.



1. Female holotype showing the dorsal and ventral views ; 2. Dorsal half of the right side of the pygidium showing the arrangements of the spines ; 3. Antenna ; 4. 'Double-barred' macroduct ; 5. Anterior spiracle.

and metamericly disposed in clusters; segmental rows of ducts distinctly marked into submarginal and submedian ducts; submarginal ducts more numerous on segments 3-5; submedian ducts numerous on segments 4-6; gland spines long, projecting from the body; arrangements of spines: one between median and second lobes, one between second and third lobes, one between third and fourth lobes, four on segment six, seven on segment five, and numerous on segments three and four (Fig. 1). Median lobes zygotic, round, strongly sclerotized and projecting from the margin of pygidium, inner and outer margins of median lobes faintly serrate; no gland spines present between the bases of median lobes, only a single pair of setae present between the bases (Fig. 2). Second lobe distinctly bi-lobed; first lobule well developed, apically rounded; second lobule small and conical; third lobe stumpy, with serrate margins, setae numerous. Perivulvar pores in five distinct groups; anus at a considerable distance from the median lobes.

Measurements. Length of scale of male 1.5 mm.; length of scale of female 2.901 mm., breadth of the scale of female 1.938 mm.; length of female 1.669 mm.; breadth of female 1.023 mm.; length of antennae 0.025 mm.; length of the antennal seta 0.017 mm.; length of anterior spiracle 0.06 mm.; length of posterior spiracle 0.02 mm.; length of 'two-barred' ducts 0.015 mm.; length of median lobes 0.045 mm.; length of second lobe 0.025 mm.

Habits. Occurring for the most part on leaves but also to some extent on twigs and petioles; scales of female outnumber the scales of male; dirty white, slender, and long, carina not visible; puparia conspicuous, brownish, elongate, and measuring about one-fourth of the length of male scale; scale of female dirty white, pear-shaped, exuvial end narrow, broadening gradually with posterior half almost parallel, moderately convex.

Type material. A number of females deposited in National Pusa Collection, Indian Agricultural Research Institute, New Delhi, collected on 12 March 1902.

Host plant. *Ficus palmata* Forsk.

Locality. Palampur, Kangra District, Panjab, India.

Discussion. The genus *Chionaspis* Signoret is represented in India by 22 species. The present species possesses certain important characters, which markedly differ from those hitherto described. It comes very close to *C. pusa* Rao and *C. manni* Green, but differs from them as follows:

<i>Chionaspis venii</i> Menon & Khan	<i>C. manni</i> Green	<i>C. pusa</i> Rao
1. Median lobes faintly serrate	Median lobes clearly serrate	Median lobes non-serrate
2. Second lobule of second lobe half of the first lobule	Second lobule of the second lobe a little smaller than first lobule	Second lobule of second lobe nearly equal to first lobule
3. Third lobe stumpy, without any lobule	Third lobe bi-lobed	Third lobe bi-lobed
4. Arrangements of spines: 1,1,1, 4, numerous	1,1,1, 3,6,7	1,1,1, 3,6,7
5. Antennae are not very far from each other	Antennae far from each other	Antennae very close to each other
6. Base of the antennae oval and setae emerge from above	Base of the antennae slightly serrate, setae from lateral side	Base of antennae lobed, setae long
7. Disc pores numerous in anterior spiracle	Disc pores not many in anterior spiracle	Disc pores few on anterior side of anterior spiracle
8. Anterior spiracle not very close to rostrum	Anterior spiracle close to rostrum	Anterior spiracle at a considerable distance

ACKNOWLEDGEMENT

The authors wish to thank Dr. E. S. Narayanan, Head, Division of Entomology, Indian Agricultural Research Institute, New Delhi, for his kind permission to examine the National Pusa Collection.

DEPARTMENT OF ZOOLOGY,
ALIGARH MUSLIM UNIVERSITY,
ALIGARH,

M. G. RAMDAS MENON
M. S. H. KHAN

September 9, 1962.

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17. INTELLIGENT BEHAVIOUR BY THE MASON WASP
(*EUMENES PETIOLATA* FABR.)

Major R. W. G. Hingston in part III of his interesting paper on the mason wasp *Eumenes conica* (*J. Bombay nat. Hist. Soc.* 31 (4): 890-896) described the experiments by which he tested the capacity of the wasp to act intelligently. He came to the conclusion that it is far from being a mere automaton whose actions are governed by instinct. May I be permitted to describe an instance of intelligent behaviour by another mason wasp *Eumenes petiolata* Fabr. ?

I noticed her at the beginning of September 1962 building her egg-chambers against the vertical side of a concrete pillar in my verandah—I did not see when the work began. At 7.30 a.m. on the 4th a new cell was complete and ready for filling—about five or six cells had already been closed and plastered over. At 4 p.m. that day the cell had been closed and the whole construction plastered over. There was nothing to indicate that further building was contemplated and I took it that the wasp had completed her labour.

At about 4.50 p.m., I noticed that the construction had been attacked by small red ants. They were in fair numbers and fresh reinforcements were coming up. The ants were moving about over the plaster and going in and out of several little holes which did not appear to be very deep.

Coming back to the place at about 5.35 p.m. I was surprised to see the wasp back on her egg-chambers and battling with the ants. She was darting quickly backward and forward, attacking individual ants and biting them. From where I was I could not see what she did with them. I could not see wounded or dead ants lying about and it looked as if she was eating the ants. Later, however, I discovered several wounded or dead ants lying on or near the field of combat, though not enough in number to account for all the ants I saw being attacked. An explanation of this latter fact is suggested by my experience when I attempted to collect some of the victims with a painting brush—the wounded ones bit fiercely at the bristles of the brush and were dislodged with difficulty. So it is possible that many of the wounded ants held on to the wasp and were brushed off somewhere else. The wasp seemed to be able to see ants close to her, but some ants moving about slowly a little more than an inch from her escaped notice. By about 5.50 p.m. the field was practically clear of ants and the survivors withdrew in a thin line.

From then on the wasp worked with feverish rapidity, replastering the egg-chambers. Every $1\frac{1}{2}$ to 2 minutes she returned with a ball of

clay about the size of a pea and spread it on in patches. The plastering took $\frac{1}{2}$ to 1 minute each time according to the size of the area covered, and she started out immediately to bring her next pellet of clay. In this way she covered the whole construction, including the cells first made by her. At about 6.30, when the light was fading slightly, she flew away and did not return.

On the 5th at 8 a.m. there was no sign of activity and the wasp was not to be seen. At 9 a.m. I noticed a few red ants on the construction. There were again a few holes in it, and the ants were passing into and out of them. At about 10 a.m. the wasp appeared on the scene and came within three feet of the construction, when my two daughters and I were examining it closely. We drew away at once, but probably our sudden movement disturbed her and she departed without drawing nearer and did not come back—this was the last time she was seen. Only a few ants were at work, and fine grains of soil lying on and below the construction suggested that the ants had made the holes that we saw and that they had been at work longer than I had first imagined—probably they were there when I first inspected at 8 a.m. It was easy to overlook the presence of the ants, as I discovered later the same morning when I watched for about 10 minutes without seeing any ants and then, seeing something moving at the mouth of one of the holes, used a magnifying glass and found it to be the waving antennae of ants moving cautiously inside the hole. Similarly, in the next ten minutes apart from the waving antennae I saw only two red ants move inconspicuously on the surface of the construction for a short while.

The secret tunnelling seemed to be still in progress at 12.40 p.m. At 1.10 p.m. reinforcements arrived in a thin line and about 13 ants joined those already at work. By 1.55 p.m. the ants, though still few in number, were more openly at work, and small numbers of ants were coming and going in a thin line.

Work continued like this till the 12th. It was noticeable that on and after the 10th the grains brought out by the ants were black in colour, instead of being grains of red soil as they were before. By about the 21st all activity died down.

During all this time there were ants coming and going and moving about, but never in large numbers. Evidently the ant colony was a small one, which explains why the wasp was able to prevail in its fight with the ants. Never at any time did we notice the ants carrying away anything from the nest chambers.

I waited about three months and opened up the nest-chambers on the 17th December. There were seven cells in all, containing dry,

broken-up, and shapeless remnants of dark crumbly matter. The two lowest cells, evidently the first that were built by the wasp, were completely lined with silk. Here the eggs seem to have developed up to the pupal stage; there was no sign of development in any other cell. Holes in the walls separating the cells from each other indicated that the ants had succeeded in penetrating them and had eaten the contents.

49, PALI HILL,

BANDRA,

BOMBAY 50-AS,

December 19, 1962.

D. E. REUBEN

18. *ODONTOTERMES OBESUS* RAMB. AS A PEST OF
JAPANESE MINT.

(With two plates)

The termite *Odontotermes obesus* Ramb., the common mound-building termite, is widely distributed throughout India and has been observed to attack a large number of trees like *Grevillea*, Coconut Palm, *Ficus*, etc. in addition to sugar-cane setts, paper, cloth, and other articles of economic importance. The insect is an occasional wood-eater, otherwise making fungus beds for its food.

The present paper describes damage to standing crop of *Mentha arvensis haplocalyx* Briquet var. *piperascens* Holmes, the common Japanese mint, cultivated for the production of mint oil and menthol.

Japanese mint is a perennial herb propagated by suckers, planted in February. It begins to sprout after spring rains in early March. The aerial portions of the plant are harvested and distilled. A first crop is usually harvested in June-July and a second in October. This is an essential oil-bearing plant of major economic importance.

The attack was observed in May at Chakrohi, Jammu District, J. & K. State, and attacked plants were collected from Miran Sahib farm at Jammu District in early August 1962, by the authors. The attack was more intensive on plants growing on raised portions of the field. It was first thought that this withering was due to some soil fungi but closer examination revealed the presence of numerous termites.

The affected portion of the field looked dry. In fact 50-60% of the plants were either in a process of drying or totally dry. In

addition some of the green plants were also found to be attacked. Of these, 15-20% had no roots at all and showed symptoms of wilting. A good number of the others had no main root but were sustained by the presence of side shoot or shoots, supplying necessary nutrients to the main stem (Plate II, C).

The infested plants show progressive wilting from the lower leaves upwards, and growth is inhibited as the roots are continuously eaten by the termites. This wilting is succeeded by gradual drying and yellowing of the leaves and the plant ultimately dies when no side shoots are thrown out with supporting roots to supply the necessary nutrients. Sometimes the roots are eaten up so fast that the plants remain standing as such while the root is totally consumed (Plate II, D).

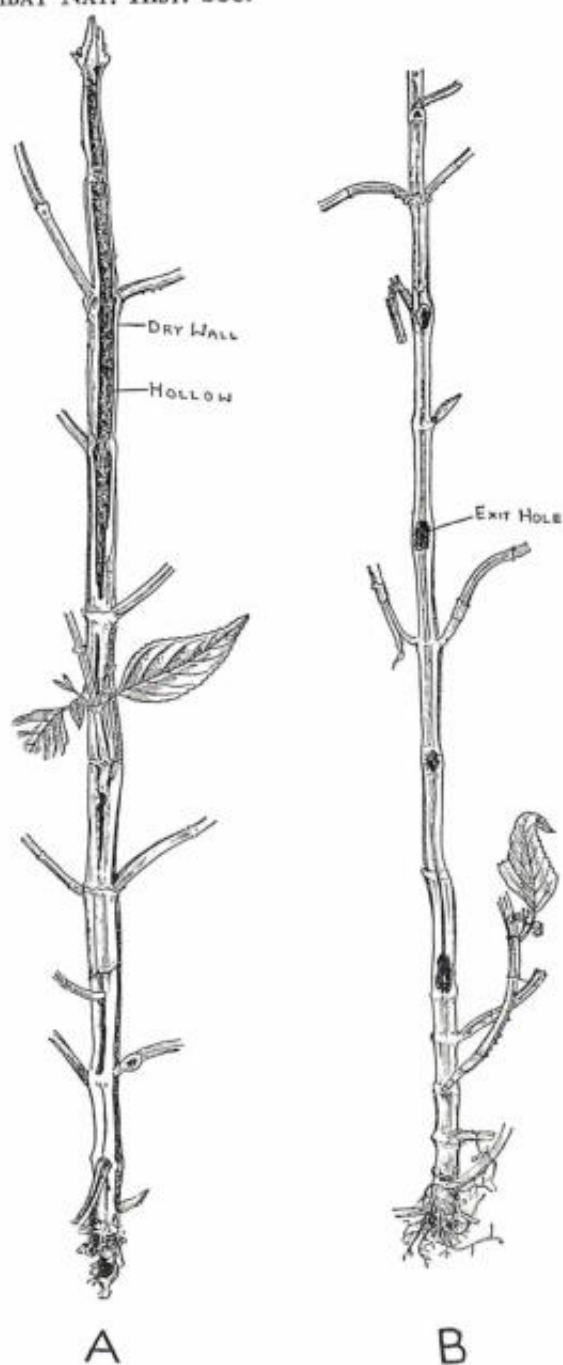
The damage is usually restricted to the underground parts which are destroyed partially or completely by the termite leaving no trace of the root in the soil. At times, when the injury is not confined to the roots alone, the insect enters the stem by tunnelling through the cortex into the pith of the stem. The epidermis together with the left-over hypodermal portion dries up but is strong enough to keep the dry plant standing on the soil. In certain other cases, these termites have been observed to go up to the very tip of the shoot that they infest. In this case the insects were observed to have one or several exit holes to the outside on the hollow stem. Many holes are therefore observed on the dry, hollow, standing stem (Pl. I, B and II, E, a). This mode of boring out is in no way universal and at times the termites find their way back through the tunnel through which they enter (Pl. II, D, a).

A split stem at this stage of acute infestation shows a hollow tunnel formed of the original vascular and cortical regions together with the hollow pith, surrounded by a thick or thin layer of epidermal and hypodermal cells (Pl. I, A and II, F). Sometimes the hollow tunnel is seen to be full of a spongy, clayey substance together with black particles of organic matter and fungus bodies.

Termite mounds, about 6 ft. tall, were located in a garden adjacent to the infested fields of Miran Sahib farm, and a smaller one about a foot in height was found at the base of a tree near the infested field.

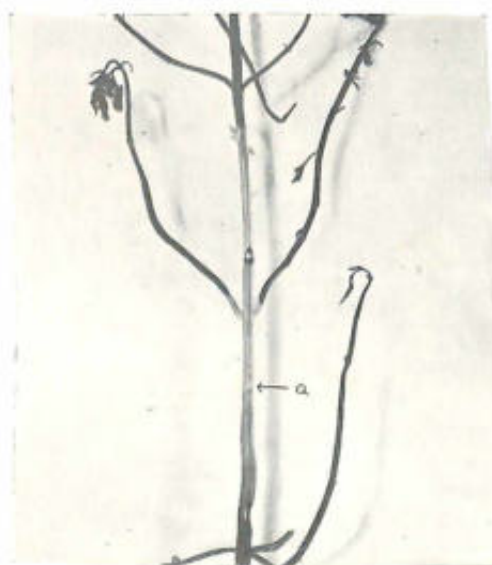
CONTROL

(1) As the attack is more intensive on plants growing on raised patches of soil, levelling of the field is recommended.



Japanese Mint Plant

- A. Showing the split stem. Only a thin wall is left encircling a hollow ;
B. Showing the holes made by the termites for their exit.



Japanese Mint Plant

C. The Plant is still green though the original root is missing. The side shoot with roots is also seen; D. The plant appearing normal and green but devoid of any root (a); E. The 'Exit Holes' formed by the termites (a); F. Stem split longitudinally to show the hollow and the surrounding dry epidermal and hypodermal portions.

(2) As soon as the attack is observed, a light hoeing to allow water to percolate through the soil, followed by flood-watering for 24-36 hours, is found to be an effective deterrent.

(3) *Heptaf*, a 3% Heptachlor dust at the rate of 40-50 lb. per acre is recommended. The chemical should be dusted in rows and raked into the soil to effect fair mixing.

This, as far as we know, is the first record of this termite attacking Japanese mint.

ACKNOWLEDGEMENTS

The authors wish to express their sincere thanks to the Director, Commonwealth Institute of Entomology (British Museum of Natural History) and Dr. M. L. Roonwal, Director, Zoological Survey of India, for their valuable help in identifying the termite.

RAJENDRA GUPTA

M. K. AGARWAL

CENTRAL INDIAN MEDICINAL PLANTS ORGANISATION,
(COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH)

OLD MILL ROAD,

NEW DELHI,

February 19, 1963.

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19. THE TERMITE *CRYPTOTERMES HAVILANDI* (SJÖSTEDT) FROM THE INTERIOR OF INDIA¹

(With a plate)

Species of the genus *Cryptotermes* are dry-wood termites and are serious pests of woodwork in buildings, household furniture, etc. They are generally restricted to the coastal regions and islands.

¹ Communicated by Dr. M. L. Roonwal, Director, Zoological Survey of India, Calcutta.

Until now there has been only a single specific record of the genus from an area at a distance from the coast, viz. Ituri Forest, Belgian Congo, Africa (Emerson 1952).

Cryptotermes havilandi (Sjöstedt) [= *C. bengalensis* Snyder] (Family: Kalotermitidae) has been recorded from the Ethiopian, Malagasy, Neotropical, and Oriental regions. Its native habitat appears to be the eastern coast of Africa, south of the Sahara Desert, where it exists in a natural state. It has been found to occur in human habitations on the western coast of Africa and in Brazil (South America), where it has been regarded as a serious pest.

From India *Cryptotermes havilandi* has been recorded by Snyder (1934) from the Sundarbans (Sea Forest, Bengal) as *C. bengalensis* sp. nov. from the wood of *Heritiera fomes*, and by Beeson (1941) from the woods of *Heritiera fomes* and *Erythrina indica*. Roonwal & Pant (1953) and Roonwal & Chhotani (1962) have recorded this species from Jokhai Reserve (Assam), Sundarbans (Bengal), and Dacca (East Pakistan).

During a survey in November 1959, I found this species nesting in a branch of *Ficus bengalensis* Linn. at Mandla Fort (lat. 22° 43' N., long. 88° 35' E.) in Madhya Pradesh. This town is located in hilly area (alt. c. 450 m.) on the banks of Narbada River and about 600 km. from the nearest sea-coast. From this present record, and the previous record of Jokhai Reserve Forest (lat. 27° 10' N., long. 95° 25' E.) by Roonwal & Pant (1953) and Roonwal & Chhotani (1962), which also is about 600 km. from the nearest sea-coast, it appears that after introduction into India the species travelled inland (probably through human agency—infested wood) and later got established in a semi-wild state far inland.

ZOOLOGICAL SURVEY OF INDIA,

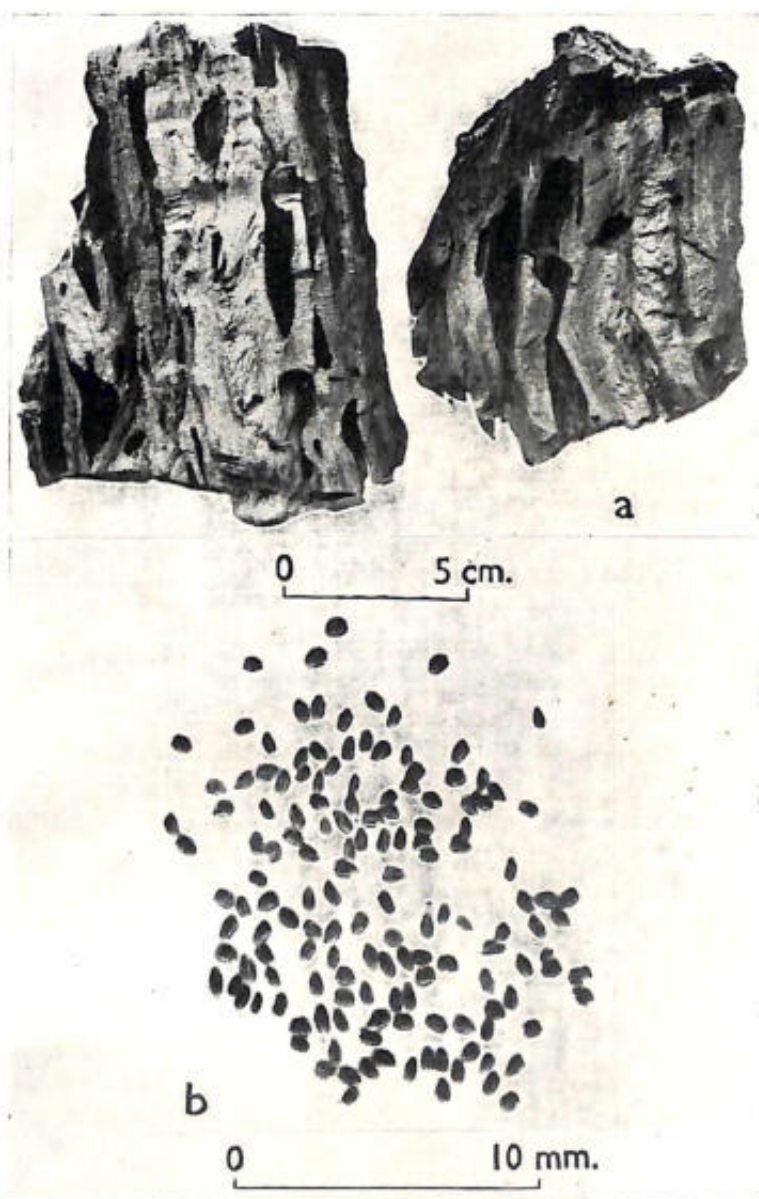
CALCUTTA 12,

November 2, 1962.

O. B. CHHOTANI

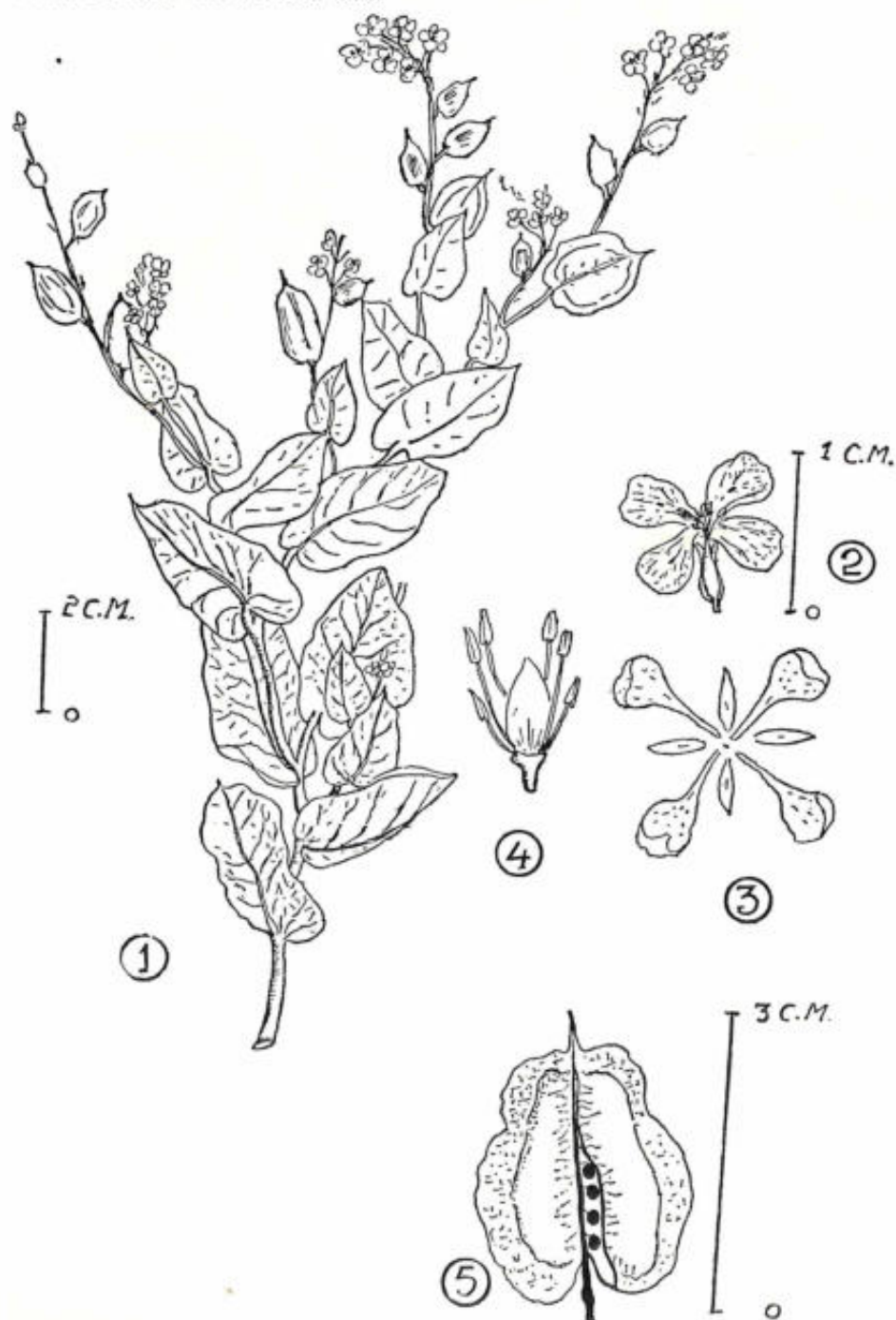
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Cryptotermes havilandi (Sjöstedt)

(a) Damaged wood of *Ficus bengalensis* Linn. (b) faecal pellets. Mandla Fort (Madhya Pradesh, India) coll. O.B. Chhotani, November, 1959.



Schouwia purpurea (Forsk.) Schweinf.

(1) A branch with leaves, flowers, and fruits; (2) Entire flower; (3) Petals and sepals; (4) Tetradynamous stamens; (5) Silique.

20. OCCURRENCE OF *SCHOUWIA PURPUREA* (FORSK.)
SCHWEINF. = *S. ARABICA* DC. IN INDIA

(With a plate)

An erect, much branched leafy undershrub, 60-90 cm. high; spreading about 80 cm.; stem glabrous, divaricately branched. Leaves simple, sessile, semi-amplexicaul, 4-5 by 2-3 cm. long; ovate glaucous, green.

Flowers violet, in terminal and in leaf-opposed racemes. Sepals 5 mm. long sub-erect, more or less saccate; the margins dull white. Petals 7 mm. long, spathulate, violet, truncate, varied. Stamens 6, tetradynamous, the 4 inner 5 mm. long; the 2 outer 3.5 mm. long. Siliqua more or less orbicular or obcordate, about 2 cm. across, flat with an ensiform seedless beak. Seeds many, 2-seriate, round, reddish brown with cotyledons conduplicate.

The plant is not mentioned either in Cooke's *FLORA OF BOMBAY* (1901) or Hooker's *FLORA OF BRITISH INDIA* (1875). However, it has been described in De Candolle's *PRODROMUS SYSTEMATIS NATURALIS* (1824), *GENERA PLANTARUM* of Bentham & Hooker (1876), *INDEX KEWENSIS* (1893), *MANUAL FLORA OF EGYPT* by Muschler (1912), *FLOWERING PLANTS OF AFRICA* by Thonner (1915), and *FLOWERING PLANTS OF ANGLO-EGYPTIAN SUDAN* by Andrews (1950). According to these authors three species of *Schouwia*, all natives of Arabia, occur in south and north Africa and the desert regions, bordering the Red Sea.

This plant was first located at Indapur, district Poona, in Maharashtra State, by Dr. M. B. Ghatge, Director of Agriculture, M.S., in 1961. It was identified by Dr. A. S. Rao of the Botanical Survey of India, Western Circle, Poona, and was confirmed by the Director, Royal Botanic Gardens, Kew.

With a view to observe the distribution of this plant, the eastern part of Poona district was surveyed in 1962. It was found that the plant grows profusely in Dhond and Indapur talukas on light sandy soils as well as in low-lying areas. The soils are absolutely dry from January to March when the plants flower and produce fruits. It often grows in cultivated lands, frequently infesting the entire fields. Cultivators of these areas report that they have been observing this plant every season for the last 15 years. This plant is rare at Yevat, frequent at Patas and Kedgaon, common at Dhond and Bhigwan, and abundant at Sakhargaon and Indapur.

ACKNOWLEDGEMENTS

My sincere thanks are due to Dr. A. S. Rao, Botanical Survey of India, Western Circle, Poona, for identification and to Prof. V. D. Vartak of Fergusson College, Poona, for the description.

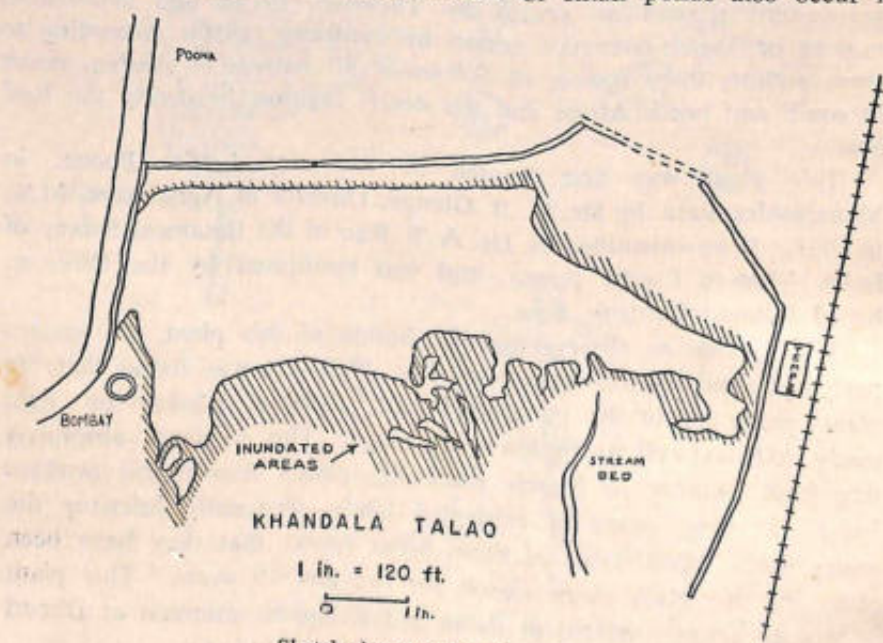
BOTANY DIVISION,
COLLEGE OF AGRICULTURE,
POONA 5,
July 20, 1962.

M. V. THOMBRE

21. THE AQUATIC PLANTS OF THE KHANDALA TALAO

(With a sketch)

In his paper presented to the symposium of the Indian Botanical Society at the 1955 Indian Science Congress (summary published in 1957) H. R. Ladwa reviewed the literature pertinent to the aquatic and marsh flora of the freshwater tanks of India. He stressed the need for intensive study of the permanent tanks, since they represent an interesting habitat with their seasonal changes in water level. Seasonal changes in the water content of small ponds also occur in



Sketch showing the Khandala talao

other countries, e.g. Byars (1959) studied the fauna and flora of a small, young New Zealand pond which fluctuated in area from c. $\frac{1}{3}$ to 1 acre depending on the season.

The talao at Khandala although very small does exhibit seasonal changes and, since it is easy to reach as well as being in an area which is well known floristically, it was felt that a detailed study of the talao would be of some value. The talao is in the centre of Khandala village in Maharashtra State. The Bombay-Poona road passes through the village and along the north side of the talao.

Biotic factors affecting the talao are present in two main forms: the local people, who uproot many of the 'kamal' plants (*Nymphaea pubescens* Willd.) for food and medicinal use, and animals which graze the slopes of the talao. The uprooting of kamal takes place mostly in the shallow water of the southern end and the grazing is usually restricted to the grassy areas on the west slope, above the water edge.

The water area and level increase during the monsoon, so that the gentle grassy slope on the western side is inundated. The water retreats with the approach of the dry season, and normally (most of the year) maintains an area of c. $1\frac{1}{2}$ acres and a depth of 1-4 ft. New aquatic plant growth starts toward the end of the monsoon, but does not reach a maximum until the water recedes to the normal. At the height of the monsoon the water of the talao flows over the eastern retaining wall and the overflow drains off rapidly. The water in the talao is supplied mainly by a stream which flows from the hills west of the talao during the monsoon and for a short while afterward. Eventually the stream dries up. The other three sides of the talao are faced by retaining walls (see sketch). The water is not used at all for irrigation or for drinking and the talao never dries up even at the height of the dry season. In the north-west corner by the road is a large well made of stone blocks which contains a dense growth of *Ceratophyllum demersum* L. No stagnation seemed to occur in the well and it is said to have been used for water supply many years ago. The shallow areas around the talao contain water from the depth of a few inches to almost a foot in some areas; however, the shore drops off sharply to a depth of 3 feet and attains a maximum of 4 feet in the centre, the deepest part being the area against the north wall. Along the eastern side a narrow, steep embankment exists between the wall and the water's edge, and a wider, more gradual slope is present at the southern end.

I visited the talao during January, February, and April of 1960

after the monsoon and observed the plant associations in the water and those appearing on the moist soil left by the retreating water.

All of the plants described here can be found in Santapau's work (1953) with the exception of *Marsilea minuta* L., a common water fern, and *Najas minor* All., a common pond weed which seems to be a new plant in this area. The climate of the area is also recorded in Fr. Santapau's work and he informs me the talao is at least over 100 years old, as it is known to exist since the railway lines were laid in 1850.

Submerged plants. The bottom of the talao is entirely covered with a dense mass of *Ceratophyllum demersum*; it is the commonest plant in the water. The older plants were covered by diatom growth and attained a height of c. 2 feet. A large round mass of *Najas minor* appeared every yard or so and this plant grew up above the rootless *Ceratophyllum* 'carpet' so that the tops of the *Najas* plants reached just to the water surface. *Lagarosiphon alternifolius* was common in patches along the west shore with a few plants of *Blyxa octandra*. These plants were not affected most of the year except for the drying along the west shore. Dead dry plants could be found here and in areas higher up on the west slope.

Floating plants. Patches of *Hygroriza aristata*, a floating grass, were found in the shallow southern portion and these patches increased in size by February but later died back after fruiting. Those plants which became established near the shore flourished into April. None of the 'duckweeds' or floating ferns were seen and have not been reported in the area. Their absence indicates that the organic content of the water is not yet sufficient for their growth.

The water lily, *Nymphaea pubescens*, sprouts from turions stranded in the grassy mat along the west and south shores. These turions can also be found along with the dead remains of *Ceratophyllum* and seeds of *Limnanthemum* spp. high up on the west slope which is inundated during the wet phase (see Gaudet, 1960, for an account of the early growth of these *Nymphaea* turions). The *Nymphaea* spreads into water $3\frac{1}{2}$ feet deep but does not grow in the deepest water along the north or east shore. As was mentioned earlier these plants are thinned out especially in the shallow areas by the local people. *Potamogeton indicus* is common among the *Nymphaea* as well as in shallow water and can even be found doing well on wet mud. In the water it reaches its peak in April. Two *Limnanthemum* species occur among the *Potamogeton* patches in the water and on wet mud, and although the two species are found growing close together, one species, *L. indicum*, is more often in deeper

water. *Marsilea minuta* was found floating only in one patch near the south-east shore, but occurred on wet mud also.

Wet mud. On the west shore a large stand of the grass *Pseudoraphis aspera* covered the whole slope from the water edge to the drained soil higher up, except for some bare spots where the dry mud plants mentioned below were prevalent. Other wet mud plants often formed large stands on the west shore, e.g. *Limnophila indica* spread into patches of stranded *Potamogeton* and *Limnanthemum* plants. *Myriophyllum spathulatum* was also abundant here, but later in April it was dying off. On the south-east shore *Dysophila stellata* and *Salvia plebeia* did very well as long as the soil remained moist, but as drying continued they died off. These last plants spread along the east shore but they could not compete against a pure stand of *Polygonum glabrum* which thrived on the moist soil along this shore. The soil here is protected by the retaining wall.

Dry mud. On the mounds along the west side where the *Pseudoraphis* was absent, *Gnaphalium indicum* was the first plant to establish itself, along with a few individuals of *Mollugo oppositifolia*. Drying proceeded from the centre of the mounds and by February the plants on the crest of the mounds had died and the soil appeared dry, cracked and light-coloured. *Argemone mexicana* grew very well in and along the sides of the empty bed of the stream that drains surface run-off from the hills into the talao (see sketch).

The talao has been approaching old age for some time. Sediments washed from the surrounding hills and organic material from the decay of plant material, as well as that contributed by biotic factors, have caused the soft bottom now present in the talao. Since no earlier work is available for comparison, we can only surmise that the talao is much shallower at present. No doubt the flora of the talao is at a 'peak' in terms of the number of aquatic species present. The only new aquatics which could enter now would be of the 'duckweed' type. The talao flora resembles that of the Mugad tank described by Ladwa (1955). This is the oldest of the four near Dharwar studied by him and it has remained perennial for at least a century. It is quite large (97 acres) and deep, yet much organic matter is present and it contains the largest number of aquatic plant species compared to the other three.

If the Khandala talao were not subjected to such high grazing pressure, possibly *Polygonum glabrum* would be more prevalent along the shallow shores, but young seedlings are easily damaged by trampling. This plant is limited to a narrow protected bank along the east shore. As the bottom of the talao fills gradually through the years

it would be interesting to follow the effect on the vegetation. At present the grassy slope seems to be encroaching along the west side where its new shoots are protected in the shallow water.

The talao will most likely become a marshy, grassy area in the future, and, since it is so small, this succession can be followed.

ACKNOWLEDGEMENTS

The author would like to thank the faculty and staff of the Botany Department of St. Xavier's College, Bombay, for their help and advice during the course of this and earlier work, which was done while the author was a Fulbright Scholar at the above institution.

LIST OF PLANTS IN AND AROUND THE TALAO

SUBMERGED

- Ceratophyllum demersum* L.
Najas minor All.
Lagarosiphon alternifolius (Roxb.) Druce¹
Blyxa octandra Planch.

FLOATING (non-rooted)

- Hygroriza aristata* (Roxb.) Nees

FLOATING (rooted)

- Limnanthemum indicum* (L.) Griseb.
Limnanthemum cristatum (Roxb.) Griseb.
Potamogeton indicus Roxb.
Nymphaea pubescens Willd.
Marsilea minuta L.

WET MUD

- Myriophyllum spathulatum* Blatt. & Hallb.
Alternanthera sessilis (L.) R. Br.
Pseudoraphis aspera (Koen.) Pilger
Limnophila indica (L.) Bruce
Polygonum glabrum Willd.
Hygrophila polysperma (Roxb.) Anders
Dysophylla stellata Benth.
Salvia plebeia R. Br.

¹ The correct name of this plant is *Nechamandra alternifolia* (Roxb.) Thw.; the genus *Lagarosiphon* does not seem to occur in India. On the subject see Subramanyam & Balakrishnan in *Bull. bot. Surv. India* 3: 23-24, 1962.—EDS.

DRY MUD

Alternanthera sessilis (L.) R. Br.
Mollugo oppositifolia L.
Gnaphalium indicum L.
Argemone mexicana L.
Physalis minima L.
Tithonia tagetiflora Desf.
Ageratum conyzoides L.
Cyperus eleusinoides Kunth
Polygonum plebeium R. Br.

DEPARTMENT OF BOTANY,
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 BERKELEY, CALIFORNIA, U.S.A.,
 March 6, 1962.

JOHN J. GAUDET

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[A. L. Adams, M.D., in WANDERINGS OF A NATURALIST IN INDIA, THE EASTERN HIMALAYAS AND CASHMERE, pp. 30-31, 1867, writes of the Khandala talao at about the middle of the nineteenth century:

'... Kandala is a little highland paradise . . . I spent a delightful day toiling over these rugged ravines, and after a hard scramble at length gained the camp, and was reclining on my couch, when a soldier rushed into the tent, to inform me that one of his comrades was drowning in a pond close by, and no one could attempt to save him, in consequence of the dense weeds which covered the surface. On repairing to the spot, we found the poor fellow in his last struggle, manfully attempting to extricate himself from the meshes of rope-like grass that encircled his body; but, to all appearance, the more he laboured to escape, the more firmly they became coiled round his limbs. At last he sank, and the floating plants closed in, and left not a trace of the disaster. After some delay, a raft was made, and we put off to the spot, and sinking a pole some 12 feet, a native dived, holding on by the stake, and brought the body to the surface . . .'

EDS.]

22. NOMENCLATORIAL NOTES ON SOME BOMBAY PLANTS—II

(Continued from Vol. 59, page 322)

PAPILIONACEAE

(1) **Alysicarpus glumaceus** (Vahl) DC. Prod. 2 : 353, 1825; Andrews, Fl. Pl. Anglo-Egypt. Sudan 2 : 175, 1952. *Hedysarum glumaceum* Vahl, Symb. Bot. 2 : 106, 1791. *Hedysarum violaceum* Forsk. Fl. Aegypt.-Arab. 136, 1775 (non Linn. 1753). *Hedysarum rugosum* Willd. Sp. Pl. 3 (2) : 1172, 1803. *Alysicarpus violaceus* (Forsk.) Schindl. in Fedde, Repert. 21 : 13, 1925. *Alysicarpus rugosus* (Willd.) DC., Prodr. 2 : 353, 1825; Cooke 1 : 348.

The earliest basionym for the present plant is *Hedysarum violaceum* Forsk. (1775) and it should have been called *Alysicarpus violaceus* (Forsk.) Schindl.; however, Forskal's name cannot be taken up here, it being a later homonym to that of Linné (1753), which is *Lespedeza violacea*. Willdenow in Sp. Pl. 3 (2) : 1172, 1803 considers *Hedysarum violaceum* Forsk. and *Hedysarum glumaceum* Vahl conspecific. The next valid name, therefore, is *Hedysarum glumaceum* Vahl and the correct name for the present plant should be *A. glumaceus* (Vahl) DC. as adopted by Andrews.

(2) **Desmodium heterocarpum** (L.) DC. Prod. 2 : 337, 1825; Merrill in Trans. Amer. Phil. Soc. (N.S.) 24 : 200, 1935. *Hedysarum heterocarpon* Linn. Sp. Pl. 747, 1753. *Hedysarum polycarpum* Poir. in Lamk. Encycl. 6 : 413, 1804. *Desmodium polycarpum* (Poir.) DC. Prod. 2 : 334, 1825; Cooke 1 : 354.

This plant goes under the name *D. polycarpum* in our Indian floras; however, it must be called *D. heterocarpum*, based on *Hedysarum heterocarpon* Linn. 1753.

(3) **Indigofera spicata** Forsk., Fl. Aegypt.-Arab. 138, 1753; Gillett in Kew Bull. 1958 (Add. Ser. I) : 119. *Indigofera hendecaphylla* Jacq. Coll. Bot. 2 : 358, 1788; Cooke 1 : 314. *Indigofera endecaphylla* Jacq.; Lamk. Encycl. Suppl. 3 : 147, 1813 (per Sphalm); Baker in Hk. f. Fl. Brit. Ind. 2 : 98, 1876.

(4) **Tephrosia pumila** (Lamk.) Pers., Syn. 2 : 330, 1807; Prain, Beng. Pl. 406, 1903; Haines, Bot. Bih. & Oris. 2 : 242, 1921; Santapau, Fl. Saurashtra 1 : 137, 1962. *Galega pumila* Lamk. Encycl. 2 : 599, 1788. *Tephrosia purpurea* (L.) Pers. var. *pumila* (Pers.) Baker in Hk. f. Fl. Brit. Ind. 2 : 113, 1876; Cooke 1 : 325. *Tephrosia procumbens*

Buch.-Ham. in Trans. Linn. Soc. 13 : 54, 1822; Gamble, Fl. Madr. 320, 1915.

Baker, and following him Cooke, treated this plant as a variety of *T. purpurea*. Gamble raised it to specific rank as *T. procumbens*. Prain, Haines, and Santapau also treat it as a distinct species. The prostrate habit, 1-3-flowered inflorescence and the overall small size of all its parts make it quite distinct from *T. purpurea*; in our opinion it deserves specific rank and we agree with Prain, Haines, and Santapau in calling our plant *T. pumila*.

(5) *Vigna unguiculata* (Linn.) Walp. Repert. 1 : 779, 1842; Andrews, Fl. Pl. Anglo-Egypt. Sudan 2 : 246, 1952. *Dolichos unguiculatus* Linn. Sp. Pl. 725, 1753. *Dolichos sinensis* Linn. Cent. Pl. 2 : 28, 1756. *Vigna catjang* Walp. in Linnaea 13 : 533, 1839; Cooke 1 : 380. *Vigna sinensis* (L.) Savi ex Hassk. Cat. Hort. Bogor. 279, 1844. *Vigna catjang* var. *sinensis* Prain, Beng. Pl. 389, 1903.

Merrill (*Enum. Phil. Fl. Pl.* 2 : 320, 1923), Bailey (*Man. Cult. Pl.* 576, 1949), and Santapau (*Rec. Bot. Surv. Ind.* 16 (1) : 80, 1953) name this plant *V. sinensis* (L.) Savi ex Hassk.; on the authority of Andrews the correct name should be *V. unguiculata* (L.) Walp., based on *Dolichos unguiculatus* L. 1753.

MIMOSACEAE

(6) *Neptunia prostrata* (Lamk.) Baill. in Bull. Soc. Linn. Par. 1 : 356, 1883. *Mimosa prostrata* Lamk. Encycl. 1:10, 1783. *Neptunia oleracea* Lour. Fl. Cochinch. 654, 1790; Cooke 1 : 435.

EUPHORBIACEAE

(7) *Manihot esculenta* Crantz, Inst. Rei Herb. 1 : 167, 1766; Andrews, Fl. Pl. Anglo-Egypt. Sudan 2 : 86, 1952. *Jatropha manihot* Linn. Sp. Pl. 1007, 1753. *Manihot utilissima* Pohl. Pl. Bras. Icon. 1 : 32, t. 24, 1827; Cooke 2 : 627.

(8) *Baliospermum montanum* (Willd.) Muell.-Arg. in DC. Prod. 15 (2) : 1125, 1866; Hoffm. in Pfreich. 63 : 208, 1914. *Jatropha montana* Willd. Sp. Pl. 4 : 563, 1805. *Baliospermum axillare* Bl. Bijdr. 604, 1825; Cooke 2 : 608.

CYPERACEAE

(9) *Eleocharis acutangula* (Roxb.) Schult. in R. & S. Syst. Veg. Mant. 2 : 91, 1824; Andrews, Fl. Pl. Sudan 3 : 359, 1960. *Scirpus*

fistulosus Poir. Encycl. 6 : 749, 1806 (non Forsk. 1775). *Scirpus acutangulus* Roxb. Fl. Ind. 1 : 213, 1820. *Eleocharis fistulosa* Link ex Spreng. Jahrb. Gewäch. 3 : 78, 1820; Cooke 2 : 888.

(10) **Eleocharis dulcis** (Burm. f.) Trin. ex Henschel, Vita Rumph. 186, 1833; Blake in Journ. Arn. Arbor. 28 : 227, 1947. *Andropogon dulce* Burm. f. Fl. Ind. 219, 1768. *Scirpus plantagineus* Retz. Obs. 5 : 14, 1789. *Eleocharis plantaginea* (Retz.) R. & S. Syst. 2 : 150, 1817; Cooke 2 : 888.

The name *E. dulcis* Trin. ex Henschel is accepted here on the authority of Blake (1947), based on *Andropogon dulce* Burm. f. Burmann in Fl. Ind. describes the present plant 'Spica solitaria, imbricata, flosculis muticis. Habitat in India', and refers to *Cyperus dulcis* Rumph. Herb. Amb. 6 : 7, t. 3, f. 1, 1750. I have not been able to check the later reference.

(11) **Fimbristylis falcata** (Vahl) Kunth, Enum. Pl. 2 : 239, 1837; Kern in Blumea 8 (1) : 113, 1955. *Scirpus falcatus* Vahl, Enum. Pl. 2 : 275, 1806. *Trichelostylis junciformis* Nees in Wt. Contrib. Bot. Ind, 106, 1834. *Fimbristylis junciformis* (Nees) Kunth, Enum. Pl. 2 : 239, 1837; Cooke 2 : 886.

ST. XAVIER'S COLLEGE,
BOMBAY 1,
January 8, 1963.

G. L. SHAH, M.Sc., Ph.D.

Notes and News

RINGING OF FLAMINGOS AT LAKE MAGADI, KENYA COLONY

As a result of a co-operative effort by the East African Natural History Society, the British Museum, and the Africana Flamingo Fund, 8000 young Lesser Flamingos (*Phoeniconaias minor*) and 80 young Greater Flamingos (*Phoenicopterus ruber*) were ringed at Lake Magadi, Kenya Colony, in 1962. The rings used were 16 mm. monel rings, attached above the tibio-tarsal joint. Should anyone find a ringed flamingo, or even only the ring, the ring should be returned to the Bird Ringing Committee, British Museum (Natural History), Cromwell Road, London S.W. 7, with details of the locality and date. Although the British Museum will be co-ordinating all recoveries, the East African Natural History Society will be most interested to hear of the find, and the finder should send details of the ring number, date, and locality to the Ringing Committee, East African Natural History Society, Coryndon Museum, Nairobi. The ring itself should be returned to the British Museum.

Finders in India, if any, may communicate with the Honorary Secretary, Bombay Natural History Society, 91 Walkeshwar Road, Bombay 6-WB, who will be glad to arrange for the transmission of the ring to the British Museum (Natural History).

* * * *

XIV INTERNATIONAL ORNITHOLOGICAL CONGRESS

The XIV International Ornithological Congress will be held at Oxford in Great Britain in July 1966 with Dr. David Lack as President. Dr. N. Tinbergen has been elected as Secretary-General and a British Executive Committee has been formed. If it proves practicable, one excursion will be organised—a week's cruise of Scottish sea-bird islands in a ship of sufficient size to accommodate most members of the Congress. The provisional dates are: 16-23 July 1966 for the cruise, and 24-30 July for the meeting in Oxford.

The British Executive Committee gratefully acknowledges \$200 received from the American Ornithologists' Union. If other countries wish to contribute, cheques should be sent to the Treasurer (Mr. A. G. S. Bryson), 7 Forres Street, Edinburgh 3.

* * * *

EAST AFRICAN WILD LIFE JOURNAL

The East African Wild Life Society is producing a Journal for the publication of scientific papers and research notes relating to all aspects of wild life. The contents, although primarily based on observations and research in East Africa, will not be limited to this region. Initially the Journal will be published yearly; it will cost 15s. within East Africa and 17s. 6d. (U.S. dollars 2.50) elsewhere, inclusive of postage and packing. The first issue will appear on September 1st, 1963, and will include papers by L. H. Brown (Birds of prey), H. F. Lamprey (The Ecological Separation of East African Mammals), D. L. W. Sheldrick and P. Napier Bax (Food Plants of Elephants), J. Glover (The Elephant Problem in Tsavo), J. Procter (Spotted-Necked Otters), A. Ritchie (The Black Rhinoceros), H. P. Ledger (Carcase analysis), and D. R. M. Stewart (The Arabian Oryx). Mrs. Elspeth Huxley, the well-known writer on East African affairs and supporter of wild life conservation, will contribute an introductory article.

All enquiries and subscriptions should be sent to the Executive Officer, East African Wild Life Society, P.O. Box 20110, Nairobi.

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