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J. C. DANIEL & P. V. BOLE

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CONTENTS

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A note on *Pteropus* (Chiroptera: Pteropidae) from the Andaman Islands

BY

J. E. HILL

Department of Zoology, British Museum (Natural History)

A small collection of specimens of *Pteropus* from the Andaman Islands confirms the view that *P. tytleri* Mason, 1908 should be considered a subspecies of *P. melanotus*, and that *P. satyrus* Andersen, 1908 from the outlying island of Narcondam is also subspecifically related to *melanotus* rather than to *P. hypomelanus* with which it had been provisionally associated hitherto, being linked to *tytleri* from the principal islands of the Andamans by specimens from the geographically intermediate island of Barren. Parallelism in colour variation is demonstrated between *P. melanotus* from the Nicobar and Andaman Islands and *P. hypomelanus geminorum* from the islands of the Mergui Archipelago.

Two indigeneous forms of *Pteropus* are listed currently from the Andaman Islands, namely *P. tytleri* Mason, 1908, described from Rutland Island and considered to occur throughout the major part of the archipelago, and *P. satyrus* Andersen, 1908 from the outlying island of Narcondam. Although the genus has long been known to occur in the Andamans, relatively few specimens have been obtained, ever since Mason (1908) made the first critical examination of Andamanese examples, recognising *tytleri* but with the exclusion of *satyrus*, described almost concurrently and of which Mason was clearly unaware. The current classification of the two forms is based on the classic monograph of the Megachiroptera by Andersen (1912) who placed *tytleri* in the *melanotus* group with *melanotus* from the Nicobar Islands, *niadicus* from Nias Island, off Sumatra, *modiglianii* from nearby Enggano Island and *natalis* from Christmas Island, south of Java, and who associated *satyrus* with the *hypomelanus* group, widely distributed throughout Indo-Australia.

Chasen (1940 : 24) considered the purely Malaysian members of the *melanotus* group to be subspecies of *melanotus* with the comment (p. 29) that although ' from *Pteropus melanotus* to *natalis* is a long stretch .... the appearance of the intervening forms provides sufficient grounds to justify the use of a trinomial.' Following this lead, Ellerman & Morrison-Scott (1951 : 96) and later Hill (1968 : 3) listed *tytleri* as a provisional subspecies of *melanotus*. Ellerman & Morrison-Scott (p. 95) thought that from descriptions *satyrus* was very close to *hypomelanus*, of which they listed it as a provisional subspecies, a course subsequently adopted by Hill (p. 2). The relationships of the two forms are thus sufficiently uncertain that it is of considerable interest to report material obtained during successive visits by Mr. Humayun Abdulali to South Sentinel, Barren and Narcondam Islands in the Andaman Archipelago. The majority of these specimens remain the property of the Bombay Natural History Society, but the Society has generously agreed that duplicate examples should remain in the collections of the British Museum (Natural History).

Pteropus melanotus tytleri Mason, 1908

Pteropus tytleri Mason, 1908 : 162, Rutland Island, South Andaman Islands,
2♀♀ AN3, AN6, 1 immature ♀ AN5. South Sentinel Island, South Andaman Islands.

2♂♂ 9/70, 11/70; 2♀♀ 10/70, 12/70. Barren Island, Andaman Islands. 30th April 1970.

Included by early authors with specimens from the Nicobar Islands as *P. melanotus* Blyth, 1863 or *P. nicobaricus* Zelebor, 1869, Andamanese examples were separated as *tytleri* by Mason [Dobson had earlier (1876 : 189) invalidly applied this name] chiefly on account of the sexual colour dimorphism which they display and which apparently does not occur in *melanotus*. Andersen (1912 : 227, 820) gave further descriptions of *tytleri*, pointing out (p. 820) that it could be distinguished from *melanotus* by its much darker underparts. Few specimens have been collected since Mason described *tytleri* and Andersen reviewed it : during the intervening years the holotype and one other specimen from the original material examined by Mason have been added to the collections of the British Museum (Natural History), together with two skulls lacking skins from Rutland Island and South Sentinel Island, and three other specimens, one of these from Port Blair, South Andaman Island, the others from Car Nicobar, all three coming from the Mason Collection but collected many years after his description of *tytleri*.

Males (B.M. 10.7.26.1, the holotype B.M. 13.4.6.6) from Rutland Island have the back and rump blackish brown, lightly streaked with grey, with a dark blackish brown head, sprinkled with a few grey hairs. The mantle is ochraceous buff and very clearly demarcated from the head and back. The ventral surface is dark brown or blackish brown and lacks any paler mid-ventral area, which is represented only by a small area of hairs tipped with brighter chestnut brown. A young male (B.M. 13.4.6.5) from Rutland has a dark reddish brown mantle but otherwise exactly resembles the adult. A female (B.M. 13.4.6.7) from Rutland is uniformly dark both above and below, the mantle indicated only by a tinge of rufous. The two adult females from South Sentinel Island, collected by Mr. Abdulali, conform to the female from Rutland Island, but one (AN6) has a small mid-ventral patch of buff tipped hairs, while the immature female from South Sentinel is exactly like the young male from Rutland except only for the presence of a similar mid-ventral patch. A female (B.M. 34.7.2.24) from Port Blair, South Andaman Island has the back more liberally streaked with grey and has a browner, slightly more prominent mantle than do females from Rutland or South Sentinel. A young adult male (B.M. 34.7.2.23) from Car Nicobar is similar in most respects to adult males from Rutland but has a brown head, lacking any grey, and the mantle is dark reddish brown, closely similar to the mantle in young specimens from Rutland and South Sentinel. This specimen, which lacks a skull, is from the Mason Collection and has been labelled '*tytleri*' by Mason. A second specimen (B.M. 34.7.2.56) from Car Nicobar is also from the Mason Collection and has been labelled '*Pteropus* n. sp.' by Mason. It is an unmade skin in poor condition, with the skull *in situ*, and is very similar to the last but has a paler, more buffy mantle, a poorly defined buffy crown and nape patch and a small ochraceous mid-ventral area.

Mason (1908 : 163) remarked that *tytleri* occurs on Barren Island, where according to this author it shows a tendency to become smaller and to deviate from typical specimens by having a light and conspicuous oval-shaped area of greyish hairs occupying the chest and belly. The four specimens collected on Barren Island by Mr. Abdulali have the back and rump blackish, streaked with grey. The head and nape is similar in colour : a buffy crown and nape patch is present in males but not in females. Males have a prominent pale ochraceous buff or pale rufous mantle : in females the mantle is dark rufous brown or dark brown. The ventral surface in males is reddish brown anteriorly with blackish flanks and anal region but mid-ventrally is markedly paler, in one example (11/70) exactly like B.M. 34.7.2.56 from Car Nicobar, in the other (9/70) more extensively pale, the centre of the pale area becoming fawn to drab as in the specimens from Narcondam discussed below. Both female specimens from Barren are almost uniformly black ventrally, as in *tytleri*, the mid-ventral region bearing only a few ochraceous-tipped or rufous-tipped hairs. Specimens from Barren Island approach *satyrus* from Narcondam in some points of coloration, but are referred to *tytleri* chiefly on account of their larger size (Table 1) and especially larger teeth (Table 2).

TABLE 1

MEASUREMENTS (IN MILLIMETRES) OF ADULTS OF *Pteropus melanotus* FROM THE NICOBAR AND ANDAMAN ISLANDS

Number	Sex	Length of forearm	Greatest length of skull	Condylobasal length	Palatal length	Least interorbital width	Postorbital width	Zygomatic width	Width of braincase	Mastoid width	$c^1—c^1$	$m^1—m^1$	$c—m^2$	Length of mandible	$c—m^3$	Locality
P. m. melanotus																
85.8.1.99	—	157	—	—	—	8·7	6·6	—	—	—	13·8	18·5	27·5	55·2	30.8	'Nicobars'
85.8.1.108	♂	163	—	—	42·5	9·7	—	—	—	—	13·8	18·8	28·3	53·6	30·6	Trinkut
85.8.1.107	♀	154	—	—	40·1	9·2	8·0	—	23·7	—	13·8	19·6	27·6	52·0	29·6	,,
P. m. tytleri																
13.4.6.6 Holotype	♂	—	—	—	39·3	9·6	7·4	40·3	—	—	13·1	17·9	27·1	53·8	30·5	Rutland
10.7.26.1	♂	—	—	—	40·1	9·5	7·7	—	—	—	13·7	18·4	27·6	55·0	30·8	,,
13.4.6.7	♀	147	—	—	—	9·5	7·5	37·8	—	—	12·7	18·5	—	53·1	29·8	,,
26.10.8.10	—	—	67·3	66·8	39·3	8·9	6·9	37·2	23·0	21·6	12.7	18·2	25·4	51·4	28·1	,,
26.10.8.11	—	—	72·3	70·8	40·8	10·1	7·5	38·3	23·6	23·1	13.0	18·6	27·4	56·6	30·7	South Sentinel
AN3	♀	149	No skull													,, ,,
AN6	♀	148	No skull													,, ,,
34.7.2.24	♀	148	66·1	63·8	38·0	8·6	7·1	—	23·1	21·2	11·7	17·6	24·5	50·6	28·0	South Andaman
11/70	♂	141	—	—	37·7	8·9	—	—	—	—	11·8	17·5	24·7	50·3	28·8	Barren
10/70	♀	141	—	—	—	8·5	7·7	30·7	21·6	19·8	10·7	17·7	24·0	48·7	27·3	,,
12/70	♀	—	65·6	—	38·5	8·8	8·3	31·2	21·8	19·7	11·3	16·3	24·7	49·8	27·5	,,
P. m. satyrus																
6.9.1.1 Holotype	♂	137	61·3	—	35·2	8·4	6·9	—	—	—	10·8	16·3	23·0	46·6	26·6	Narcondam
AN12	♂	125	60·0	59·2	34·0	8·1	7·3	—	—	—	10·8	16·5	22·5	45·4	25·2	,,
AN15	♀	—	59·2	—	33·3	8·0	8·6	30·1	21·7	18·7	10·0	15·6	22·7	44·6	25·1	,,

TABLE 2

MINIMUM, MAXIMUM AND MEAN MEASUREMENTS (IN MILLIMETRES) OF UNWORN TEETH OF *Pteropus melanotus* FROM THE NICOBAR AND ANDAMAN ISLANDS

		P. m. melanotus	*P. m. tytleri*		*P. m. satyrus*
			Andaman Islands	Barren Island	
Number of specimens		6	5	3	5
pm^3	Length	4.8 - 5·0 (4·9)	4·3 - 4·7 (4·4)	4·2 - 4·7 (4·4)	3·5 - 3·8 (3·6)
	Width	3·2 - 3·5 (3·4)	3·0 - 3·4 (3·2)	3·0 - 3·1 (3·0)	2·6 - 2·8 (2·7)
pm^4	Length	4·6 - 5·0 (4·9)	4·3 - 4·6 (4·5)	4·0 - 4·4 (4·2)	3·7 - 4·1 (3·9)
	Width	3·4 - 3·8 (3·6)	3·3 - 3·5 (3·4)	3·2 - 3·3 (3·2)	2·8 - 3·0 (2·9)
m^1	Length	5·5 - 5·9 (5·7)	5·0 - 5·5 (5·2)	4·8 - 5·2 (5·0)	4·4 - 4·8 (4·6)
	Width	3·1 - 3·4 (3·2)	2·9 - 3·2 (3·1)	2·8 - 2·9 (2·9)	2·5 - 2·8 (2·7)
pm_3	Length	4·8 - 5·4 (5·0)	4·4 - 4·9 (4·6)	4·3 - 4·4 (4·4)	3·7 - 3·9 (3·8)
	Width	2·9 - 3·0 (3·0)	2·6 - 2·9 (2·8)	2·5 - 2·7 (2·6)	2·3 - 2·5 (2·4)
pm_4	Length	4·6 - 4·8 (4·7)	4·1 - 4·5 (4·4)	4·1 - 4·2 (4·1)	3·7 - 3·8 (3·8)
	Width	2·9 - 3·4 (3·1)	2·8 - 3·2 (2·9)	2·8 - 2·9 (2·8)	2·5 - 2·7 (2·6)
m_1	Length	4·6 - 5·0 (4·9)	4·3 - 4·8 (4·6)	4·3 - 4·5 (4·3)	4·0 - 4·2 (4·0)
	Width	2·8 - 3·2 (3·0)	2·7 - 3·0 (2·8)	2·6 - 2·7 (2·7)	2·3 - 2·5 (2·4)
m_2	Length	3·5 - 3·9 (3·7)	3·3 - 3·7 (3·6)	3·2 - 3·4 (3·3)	3·0 - 3·3 (3·2)
	Width	2·7 - 2·9 (2·8)	2·4 - 2·8 (2·6)	2·4 - 2·5 (2·4)	2·2 - 2·3 (2·3)

Hitherto, large *Pteropus* from all of the Nicobar Islands have been referred to *P. m. melanotus* Blyth, 1863, with *P. nicobaricus* Zelebor, 1869 (the name in common use until Mason wrote in 1908) from Car Nicobar in its synonymy. Specimens from Trinkut and Great Nicobar are available in the collections of the British Museum (Natural History) and have been described in detail by Andersen (1912 : 224). They differ from *P. m. tytleri* in having the head generally browner and less blackish grey, in the presence of a more evident reddish mantle in females and in a much paler and brighter ventral surface in both males and females : the paler area varies in colour from golden ochraceous buff to tawny, sometimes medianly faintly drab. Such specimens have been presumed hitherto to occur on Car Nicobar, apparently since Mason (1908 : 161) examined the holotype of *nicobaricus* and associated it with *melanotus*. However, the two specimens from Car Nicobar examined during the preparation of these notes seem to link *tytleri* to *melanotus*. Both have brownish rather than blackish grey heads : one, a young adult male, (B.M. 34.7.2.23) has a dark reddish brown mantle and uniformly dark underparts, while the other (B.M. 34.7.2.56) has a brighter mantle and ochraceous buff to rufous buff mid-ventral patch similar in colour to that of *melanotus* but less extensive. Comparison with the description by Zelebor (1869 : 11) suggests that *nicobaricus* may refer to such a specimen '. . . . the throat, the ventral surface and the anal region dark blackish brown, the occiput, the nape, the sides of the neck and shoulders are a shining glossy reddish fawn with rusty brown border. The individual hairs of the glossy mantle are fawn at the root, glossy reddish at the tip with a golden lustre. The central part of the chest and the upper abdomen is blackish umber brown with fawn and glossy rust red hair tips.' Clearly, the precise allocation of *nicobaricus* must await a re-examination of the holotype in the Naturhistorisches Museum, Vienna but in the meantime the close agreement in size between *melanotus* and *tytleri*, combined with a similar colour pattern which differs only in the greater degree of melanism exhibited by *tytleri* suggests that the two must be considered conspecific. There remains the possibility that pale-bellied *melanotus* may co-exist on Car Nicobar with dark bellied *tytleri*, a point to be resolved only by further collecting on that island or perhaps from the holotype.

Pteropus melanotus satyrus Andersen, 1908

Pteropus satyrus Andersen, 1908:362. Narcondam Island, Andaman Islands.

1♂ 8/70 (AN12) ; 3♀♀ 5-7/70 (AN13-15). Narcondam Island. 29th April 1970.

As long ago as 1906 Osmaston noted (p. 622) of Narcondam Island ' Among mammals I found two species of Fruit Bats. The Nicobar Flying Fox (*Pteropus nicobaricus*) and another smaller species.' Andersen, describing *P. satyrus* (which may be the Nicobar Flying Fox alluded to by Osmaston) was evidently unaware of this reference and later (1912 : 142) suggested that the affinities of *satyrus* lay with *P. hypomelanus*. Specimens obtained from Narcondam by Mr. Abdulali are similar in colour to the holotype of *satyrus*, with blackish back and rump overlaid with a sprinkling of grey, the head mixed black and grey, with a patch of buff on the crown and nape. The male differs from the reputedly male holotype in its much paler mantle which is greatly lightened with buff to the bases of the hairs, in contrast to the dark chestnut mantle of the holotype in which buff based hairs are found only in its posteriormost part. The three rather younger female examples have the back and rump more generously sprinkled with grey than does the male specimen and the mantle is browner, largely lacking red, the individual hairs brownish to the base. In both male and female the anterior part of the ventral surface is reddish brown, the flanks and anal region blackish grey, with a paler mid-ventral brownish buff area, lightening to drab at its centre. These specimens are smaller (Table 1) and have smaller teeth (Table 2) than *P. m. tytleri*.

Andersen (1912 : 142) thought that *satyrus* was most nearly related to *P. hypomelanus geminorum* from the Mergui Archipelago. However, in colour, size and tooth dimensions it is linked to *P. melanotus tytleri* by specimens from Barren Island which although nearer to *tytleri* are nevertheless intermediate between the two forms, and accordingly *satyrus* is considered to be a subspecies of *P. melanotus*. It is worth noting in this connection that the combined colour variation of *P. m. melanotus*, *P. m. tytleri* and *P. m. satyrus* is closely paralleled by similar variation in the series of *P. hypomelanus geminorum* in the British Museum (Natural History) from the islands of the Mergui Archipelago, even in specimens of *geminorum* from a single island. For example, in a series (B.M. 23.1.6.13-20) from Malcolm Island, the back and rump vary from blackish brown in males to predominantly greyish in females : a similar variation occurs in the coloration of the head, sometimes with an extensive buffy suffusion of the crown and nape in males. The mantle in male specimens varies from ochraceous brown or dark rufous to blackish brown and in females from ochraceous brown to dark chestnut brown. The ventral surface in two males has an extensive paler median area exactly as in *P. m. melanotus* and yet in two other male examples and in two females is uniformly dark brown or blackish brown as in *P. m. tytleri*, while two further female specimens are more greyish ventrally. Similar variation is found in specimens from the other islands of the Mergui Archipelago and the similarity in colour variation suggests that possibly *P. hypomelanus* and *P. melanotus* are more closely linked than is apparent from Andersen (1912). However, the status of the poorly known *P. faunulus* from Car Nicobar (thought by Anderson (p. 143) to represent *hypomelanus*) requires to be resolved before this point can be properly determined : furthermore, *niadicus* from Nias Island and *modiglianii* from Enggano (where it occurs with a presumed subspecies of *hypomelanus*, *P. h. engganus*) are also poorly known and further specimens seem essential to any study of the *melanotus* group as it is defined by Andersen.

References

Andersen, K. (1908) : Twenty new forms of *Pteropus*. *Ann. Mag. nat. Hist.* (8), 2 : 361-370.

——— (1912) : Catalogue of the Chiroptera in the collection of the British Museum. I. Megachiroptera. London.

Blyth, E. (1863) : Catalogue of the Mammalia in the Museum of the Asiatic Society of Bengal. Calcutta.

Dobson, G. E. (1876) : Monograph of the Asiatic Chiroptera and catalogue of the species of bats in the collection of the Indian Museum, Calcutta. London.

Ellerman, J. R. & Morrison-Scott, T. C. S. (1951) : Checklist of Palæarctic and Indian mammals, 1758-1946. 1st. ed. London.

Hill, J. E. (1967) : The bats of the Andaman and Nicobar Islands. *J. Bombay nat. Hist. Soc.* **64** : 1-9.

Mason, G. E. (1908) : On the fruit bats of the genus *Pteropus* inhabiting the Andaman and Nicobar Archipelago, with the description of a new species. *Rec. Indian Mus.* **2** : 159-166.

Osmaston, B. B. (1906) : A visit to Narcondam. *J. Bombay nat. Hist. Soc.* **16** : 620-622.

Zelebor, J. (1869) : Reise der Osterreichischen Fregatte Novara um die Erde in den Jahren 1857, 1858, 1859. Zoologischer Theil. **1**, (1), Saugethiere, 1-42. Vienna.

Foraminifera of the Gulf of Cambay

BY

K. Kameswara Rao[1]
National Institute of Oceanography, Bombay

(*With* 16 *figures in two plates*)

[*Continued from Vol.* 67 (2) : 273]

Family Rotaliidae

Subfamily Rotaliinae

Genus *Rotalia* Lamarck 1804

Rotalia beccarii (Linnaeus) (Fig. 69)

Rotalia beccarii Brady, 1884, vol. 9, p. 704, pl. 107, figs. 2, 3; Cushman, 1915, 71(5), p. 67, pl. 30, fig. 3; 1931, 104(8), p. 58, pl. 12, figs. 1-7, pl. 13, figs. 1, 2; Sethulekshmi Amma, 1958, p. 73, pl. 3, fig. 112; Ganapati & Satyavati, 1958, p. 110, pl. 5, figs. 122, 123.

Description : Test many chambered with both faces convex, all chambers visible on dorsal side but only those of the last whorl on ventral side. Outer whorl of eight to twelve chambers. Sutures on the dorsal side limbate, those on ventral side depressed. Umbilicus closed by a mass of shell material or umbonal plug. Wall smooth. Aperture a narrow slit situated on ventral side at inner margin of last chamber.

Diameter : 0·54 mm.

Locality : Stations A & D.

Distribution : North Pacific, Cebu, Philippine Islands, off Japan, Mediterranean and Red sea, British Isles, Ceylon coast and Arabian sea

Rotalia venusta Brady (Fig. 70 a, b).

Rotalia venusta Brady, 1884, vol. 9, p. 708 and 709, pl. 108, figs. 2 *a*, *b*, *c*; Heron-Allen & Earland, 1915, vol. 20, p. 720, figs. 15-22.

Description : Test slightly biconvex, compressed with two coils, the outer coil formed of eight chambers. Sutures slightly depressed and

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[1] *Present Address :* Indian Ocean Biological Centre, (National Institute of Oceanography), Ernakulam, Cochin-18.

distinct on both faces. Wall granulated on the ventral side. Aperture an elongate slit at the inner edge of last chamber.

Diameter : 0·14 mm.

Locality : Station D.

Distribution : South Pacific, Kerimba Archipelago and Arabian sea.

Genus *Pulvinulina* Parker and Jones, 1862

Pulvinulina concamerata (Montagu) (Fig. 71)

Rotalina concamerata Williamson, 1858, p. 52, pl. 4, figs. 102, 103 ; *Pulvinulina repanda* var. *concamerata* Brady, 1884, vol. 9, p. 685, pl. 104, figs. 19, *a-c* ; *Pulvinulina concamerata* Cushman, 1915, 71(5), p. 52, pl. 25, fig. 1.

Description : Test biconvex with six to eight chambers in final whorl. Sutures depressed on ventral side and limbate on dorsal side. Surface of test smooth on ventral side while on dorsal side ornamented with numerous rounded bosses.

Diameter : 0·13 mm.

Locality : Station D.

Distribution : North Pacific, off Japan, British Isles and Arabian sea.

Pulvinulina oblonga (Williamson) var. **scabra** Brady (Fig. 72)

Pulvinulina oblonga (Williamson) var. *scabra* Brady, 1884, vol. 9, p. 689, pl. 106, fig. 8 *a-c*; Brady, Parker & Jones, 1888, vol. 12, p. 229, pl. 46, fig. 5 ; Cushman, 1915, 71(5), p. 53, pl. 27, fig. 5.

Description : Test biconvex, chambers few about seven or eight in the outer whorl, the later formed chambers large in size and length. Peripheral edge acute, slightly carinate. Sutures somewhat depressed. Wall granular on the dorsal side and smooth on the ventral side.

Diameter : 0·38 mm.

Locality : Station C.

Distribution : North Pacific, off Philippines, Ceylon coast and Arabian sea.

Pulvinulina punctulata (d'Orbigny) (Fig. 73)

Pulvinulina punctulata Brady, 1884, vol. 9, p. 685, pl. 104, fig. 17 *a-c* ; Cushman, 1915, 71(5), p. 52, pl. 24, fig. 1, *Description :* Test planoconvex, chambers numerous. All chambers visible on the dorsal side but only those of the final whorl on the ventral side. Sutures limbate and curved above and depressed below. Surface smooth but the umbilical region somewhat granular. Aperture a curved slit on ultimate chamber.

Diameter : 0·26 mm.

Locality : Station C.

Distribution : North Pacific, Hawaiian Islands and Arabian sea.

Family GLOBIGERINIDAE

Subfamily Globigerininae

Genus *Globigerina* d'Orbigny, 1826

Globigerina bulloides d'Orbigny (Fig. 74 a, b)

Globigerina bulloides Williamson, 1858, p. 56, pl. 5, figs. 116-118 ; Brady, 1884, vol. 9, p. 593, pl. 77, pl. 79, figs. 3-7 ; Brady, Parker & Jones, 1888, vol. 12, p. 225, pl. 45, fig. 15 ; Cushman, 1914, 71(4), p. 5, pl. 2, figs. 7-9, pl. 9 ; Sethulekshmi Amma, 1958, p. 12, pl. 1, fig. 20 *a*, *b* ; Ganapati & Satyavati, 1958, p. 110, pl. 6, figs. 142-146.

Description : Test subtrochoid spire with few chambers. All chambers visible dorsally and only three or four chambers on the ventral side ; chambers of the outer whorl much inflated. Sutures deep and distinct. Wall calcareous and hispid. Aperture large situated on the inner margin of last chamber.

Diameter : 0·26 mm.

Locality : Stations A, C & D.

Distribution : This species is world wide in distribution.

Globigerina dubia Egger (Fig. 75)

Globigerina dubia Brady, 1884, vol. 9, p. 595, p. 79, figs. 17 *a-c* ; Cushman, 1914, 71(4), p. 6, pl. 4, figs. 1-3 ; 1924, 104(5), p. 8, pl. 2, figs. 5-8 ; Sethulekshmi Amma, 1958, p. 13, pl. 1, fig. 21.

Description : Test subglobular with many chambers, all the chambers visible dorsally and only those of the ultimate whorl about five or six inflated chambers on the ventral side. Wall calcareous, coarse and pitted. Aperture opening into the much depressed umbilical region on the ventral side.

Diameter : 0·11 mm.

Locality : Stations B, C & D.

Distribution : Indo-Pacific region, North and South Atlantic, British Isles, and Hawaiian Islands.

Genus *Globigerinella* Cushman, 1948

Globigerinella aequilateralis (Brady) (Fig. 76)

Globigerina aequilateralis Brady, 1884, vol. 9, p. 605, pl. 80, figs. 18-21. ; Cushman, 1914, 71(4), p. 12, pl. 2, figs. 1-3, pl. 10, fig. 5 ; 1924, 104(5), p. 25, pl. 4, figs. 7-8. *Globigerinella aequilateralis* Sethulekshmi Amma, 1958, p. 15, pl. 1, fig. 25; Ganapati & Satyavati, 1958, p. 111, pl. 6, figs. 152-154.

Description : Test somewhat circular in shape, many chambered with five to six planospirally arranged chambers visible from lateral aspect. Sutures deep and depressed. Peripheral margin rounded. Wall calcareous, hispid with broken spines. Aperture large and arched, situated at the base of ultimate chamber.

Diameter : 0·68 mm.

Locality : Station B.

Distribution: Indo-Pacific region, Atlantic, Honolulu, off Yokohoma, Guam, Philippine Archipelago, Galapagos Islands, and Kerimba Archipelago.

Family GLOBOROTALIIDAE

Genus *Globorotalia* Cushman, 1927

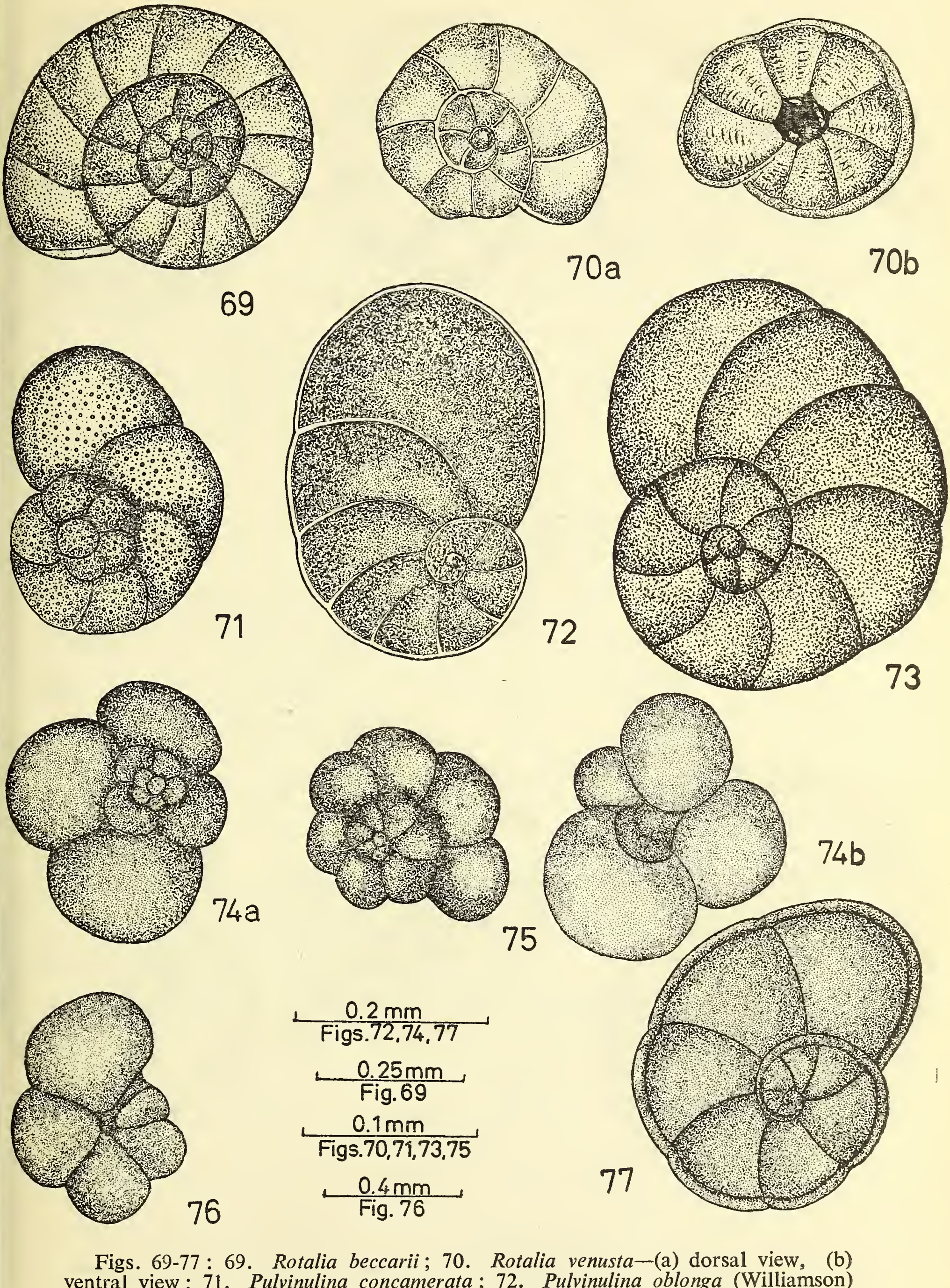
Globorotalia menardii (d'Orbigny) (Fig. 77)

Pulvinulina menardii Brady, 1884, vol. 9, p. 690, pl. 103, figs. 1, 2 ; Dakin, 1906, vol. 5, p. 239 ; Cushman, 1915, 71(5), p. 54, pl. 22, fig. 2 ; *Globorotalia menardii* Cushman, 1931, 104(8), p. 91, pl. 17, figs. 1 *a-c* ; Sethulekshmi Amma, 1958, p. 17, pl. 1, fig. 28 *a*, *b*, *c* ; Ganapati & Satyavati, 1958, pl. 5, figs. 136, 137.

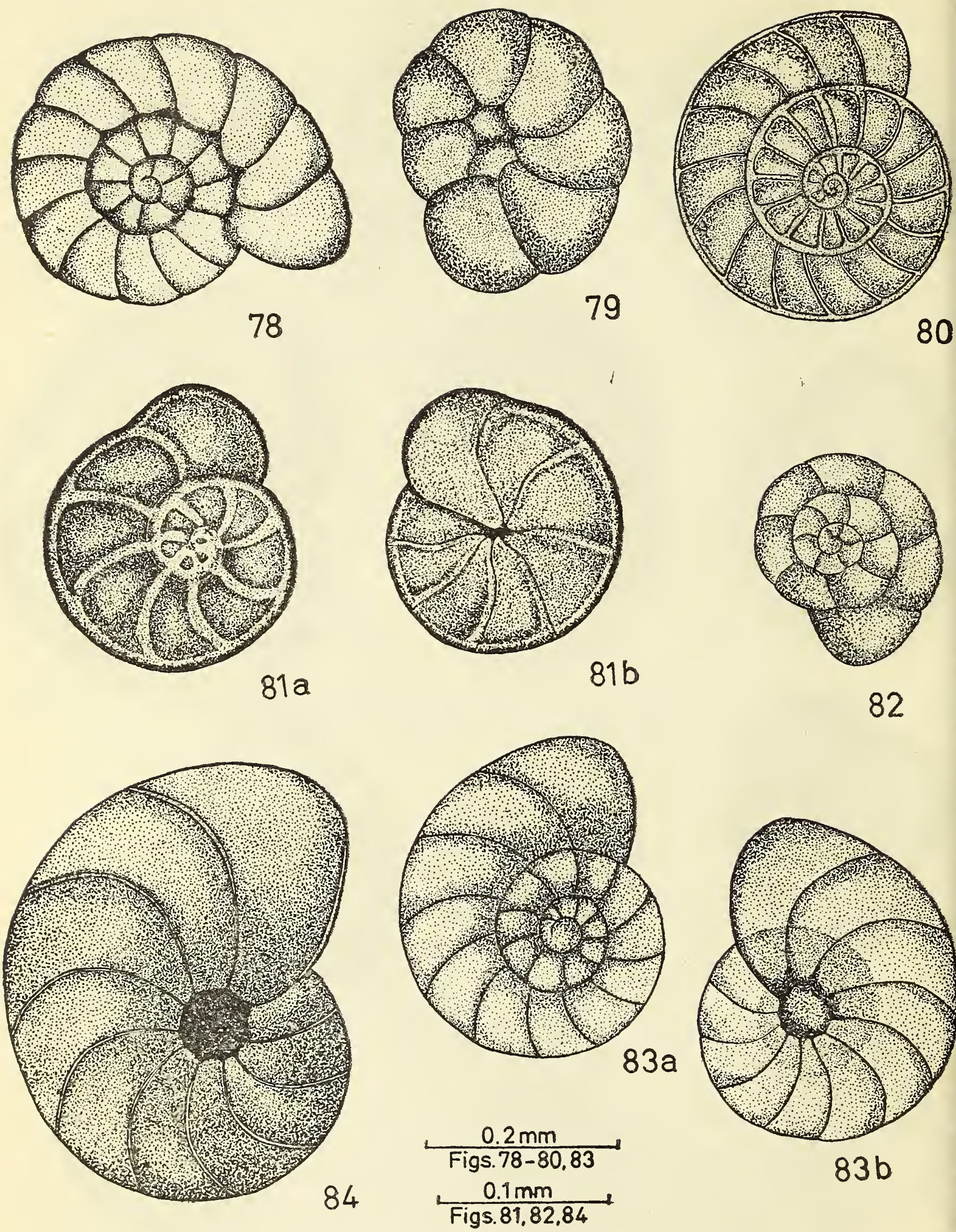
Description : Test planoconvex and compressed with usually two convolutions, the outer whorl composed of about five chambers. Sutures limbate above and depressed below. Periphery somewhat lobulated. Wall finely punctate. Aperture situated on the ventral side at the inner margin of ultimate chamber opening into the umbilical region.

Diameter : 0.33 mm.

Locality : Station C.



Figs. 69-77: 69. *Rotalia beccarii*; 70. *Rotalia venusta*—(a) dorsal view, (b) ventral view; 71. *Pulvinulina concamerata*; 72. *Pulvinulina oblonga* (Williamson) var. *scabra*; 73. *Pulvinulina punctulata*; 74. *Globigerina bulloides*—(a) dorsal view, (b) ventral view; 75. *Globigerina dubia*; 76. *Globigerinella aequilateralis*; 77. *Globorotalia menardii*.



Figs. 78-84 : 78. *Anomalina ammonoides* ; 79. *Anomalina coronata* ; 80. *Palmerinella palmerae* ; 81. *Cibicides refulgens*—(a) dorsal view, (b) ventral view ; 82. *Cibicides lobatulus* ; 83. *Cibicides pseudoungeriana*—(a) dorsal view, (b) ventral view ; 84. *Planulina wuellerstorfi*.

Distribution : North and South Atlantic, North and South Pacific, Hawaiian Islands, Mediterranean, Red sea, Ceylon coast and Indian seas.

Family ANOMALINIDAE

Subfamily Anomalininae

Genus *Anomalina* d'Orbigny, 1826

Anomalina ammonoides (Reuss) (Fig. 78)

Anomalina ammonoides Brady, 1884, vol. 9, p. 672, pl. 94, figs. 2, 3 ; Brady, Parker & Jones, 1888, vol. 12, p. 228, pl. 45, figs. 20-22 ; Dakin, 1906, vol. 5, p. 239 ; Cushman, 1915, 71(5), p. 46, pl. 19, fig. 2.

Description : Test with numerous chambers set in three or four coils, the last coil composed of twelve to sixteen chambers ; chambers slightly inflated. Sutures somewhat depressed. Peripheral edge rounded. On the ventral side umbilical region depressed. Wall calcareous, coarsely foraminated. Aperture a narrow curved slit situated at the base of margin of last chamber.

Diameter : 0·34 mm.

Locality : Station A.

Distribution : North Pacific, off Hawaiian Islands, Hongkong, Chatham Island, off Guam and between Guam and Japan, Ceylon coast and Arabian sea.

Anomalina coronata Parker and Jones (Fig. 79)

Anomalina coronata Brady, 1884, vol. 9, p. 675, pl. 97, figs. 1, 2 ; Cushman, 1915, 71(5), p. 47, pl. 18, fig. 5.

Description : Test biconvex with few chambers, the umbilical region depressed on both faces. Final whorl of test composed of eight inflated chambers. Wall coarsely perforated. Aperture a long curved slit placed obliquely on the ventral side at the inner margin of last chamber.

Diameter : 0·30 mm.

Locality : Station C.

Distribution : North Pacific, Hawaiian Islands and Arabian sea.

Genus *Palmerinella* Bermudez, 1934

Palmerinella palmerae Bermudez (Fig. 80)

Palmerinella palmerae Cushman, 1959, p. 333, pl. 54, figs. 11 *a, b. c* ; Ganapati & Satyavati, 1958, p. 111, pl. 6, figs. 167, 168.

Description : Test with numerous chambers, much compressed, all chambers visible above, but only those of the last whorl below. Wall calcareous, coarsely perforated. Aperture long slit-like on the last chamber in line with the peripheral margin.

Diameter : 0·33 mm.

Locality : Station A.

Distribution : Occurs in most seas.

Subfamily Cibicidinae

Genus *Cibicides* Montfort, 1808

Cibicides refulgens Montfort (Fig. 81 a, b)

Truncatulina refulgens Brady, 1884, vol. 9, p. 659, pl. 92, figs. 7-9 ; Cushman, 1915, 71(5), p. 30, pl. 12, fig. 2. ; *Cibicides refulgens* Daniel, 1949, p. 116, figs. 85, 86; Ganapati & Satyavati, 1958, p. 111, pl. 6, figs. 161-163.

Description : Test planoconvex, ventral side much convex, dorsal side flat, chambers numerous, eight chambers in the final whorl ; the early chambers on the dorsal side indistinct. Sutures on the ventral side slightly depressed and somewhat sigmoid ; on the dorsal side sutures broad and limbate. Periphery subcarinated. Wall calcareous, finely perforated.

Diameter : 0·15 mm.

Locality : Station D.

Distribution : Indo-Pacific region, Kerimba Archipelago, Malay Archipelago, Cebu, Tawi Tawi, Makyan Island, Macassar Straits and Indian seas.

Cibicides lobatulus (Walker and Jacob) (Fig. 82).

Truncatulina lobatula Williamson, 1858, p. 59, pl. 5, figs. 121-123 ; Brady, 1884, vol. 9, p. 660, pl. 92, fig. 10 ; pl. 93, figs. 1, 4, 5 ; pl. 95, figs. 4, 5 ; Dakin, 1906, vol. 5, p. 238 ; Cushman, 1915, 71(5), p. 31, pl. 15, fig. 1 ; *Cibicides lobatulus* Cushman, 1959, p. 335, pl. 36, fig. 11.

Description : Test planoconvex with numerous chambers. All the chambers visible on the dorsal side and only those of outer whorl visible ventrally ; outer whorl of seven or eight chambers. Sutures slightly depressed. Surface of the test smooth, coarsely punctate or covered with slight protuberances. Aperture a narrow slit situated ventrally at the base of the final chamber.

Diameter : 0·13 mm.

Locality : Station C.

Distribution : North Pacific, off Hawaiian Islands, Bering sea, Guam and between Guam and Yokohoma, off Japan, Ceylon coast and Arabian sea.

Cibicides pseudoungeriana (Cushman) (Fig. 83 a, b).

Truncatulina pseudoungeriana Brady, 1884, vol. 9, p. 664, pl. 94, figs. 9 *a-c* ; *Cibicides pseudoungeriana* Cushman, 1931, 104(8), p. 123, pl. 22, figs. 3-7 ; Daniel, 1949, p. 114, figs. 114, 145 ; Sethulekshmi Amma, 1958, p. 34, pl. 2, figs. 49 *a*, *b*.

Description : Test circular in outline, planoconvex, chambers numerous, the last formed whorl consists of ten or eleven chambers. Sutures depressed below and limbate above in the earlier chambers but become depressed in the last few chambers of the final whorl. Peripheral margin rounded. Wall calcareous and coarsely perforated. Aperture close to the peripheral margin on ventral side.

Diameter : 0·34 mm.

Locality : Station C.

Distribution : Atlantic and Indo-Pacific region.

Genus *Planulina* d'Orbigny, 1826

Planulina wuellerstorfi (Schwager) (Fig. 84).

Truncatulina wuellerstorfi Brady, 1884, vol. 9, p. 662, pl. 93, figs. 8, 9 ; Cushman, 1915, 71(5), p. 34, pl. 12, fig. 3 ; *Planulina wuellerstorfi* Cushman, 1931, 104(8), p. 110, pl. 19, figs. 5, 6 ; Sethulekshmi Amma, 1958, p. 35, pl. 2, figs. 51 *a*, *b*.

Description : Test planoconvex, many chambered, the final whorl of nine chambers. Sutures limbate. Peripheral margin rounded. Aperture an arched opening situated at the base of last chamber.

Diameter : 0·32 mm.

Locality : Station A.

Distribution : Pacific Ocean, Panama Bay, off Hawaiian and Midway Islands, Galapagos Islands, between Guam and Yokohama and Arabian sea.

General Considerations

Regional distribution of foraminiferal groups :

The regions along the Indian and adjacent coasts whose foraminiferan fauna studied in some details are (1) Laccadive region (Chapman 1895); (2) Gulf of Cambay region (present investigations) ; (3) Travancore coast off Arabian Sea (Sethulekshmi Amma 1958) ; (4) Bay of Bengal off Visakhapatnam coast (Ganapati & Satyavati 1958) ; (5) Gulf of Mannar off Krusadi and adjacent areas (Gnanamuthu 1943 & Daniel 1949) ; (6) Gulf of Mannar off Ceylon coast (Dakin 1906). From the above six regions a total number of thirty families representing various species of Foraminifera are on record, they being Astrorhizidae, Rhizamminidae, Saccamminidae, Hyperamminidae, Reophacidae, Ammodiscidae, Lituolidae, Textularidae, Verneuilinidae, Valvulinidae, Silicinidae, Miliolidae, Ophthalmidiidae, Trochamminidae, Lagenidae, Polymorphinidae, Nonionidae, Camerinidae, Peneroplidae, Buliminidae, Rotaliidae, Amphisteginidae, Calcarinidae, Cymbaloporidae, Cassidulinidae, Chilostomellidae, Globigerinidae, Globorotaliidae, Anomalinidae, and Planorbulinidae.

Of the above families Astrorhizidae, Textularidae, Miliolidae, Lagenidae, Nonionidae, Buliminidae, Rotaliidae, Globigerinidae, and Anomalinidae are common to all the six regions. From the Laccadive region a larger number of families has been recorded. The only families not so far known from this region are Rhizamminidae, Hyperamminidae, and Silicinidae. This region is also characterised by the presence of members of the families Ammodiscidae, and Chilostomellidae which are not known from any of the other five regions. The foraminifera fauna of the Travancore coast is represented by twenty-one families. Rhizamminidae, Hyperamminidae, Reophacidae, Ammodiscidae, Silicinidae, Polymorphinidae, Calcarinidae, Cassidulinidae and Chilostomellidae are not on record from this region.

Visakhapatnam region is characterised by the members of the family Silicinidae which is not known from other regions. Reophacidae, Ammodiscidae, Valvulinidae, Calcarinidae, Cymbaloporidae and Chilostomellidae are not on record.

In the Gulf of Mannar off Krusadi including adjacent areas and Ceylon coast, the families Rhizamminidae, Ammodiscidae, Valvulinidae, Silicinidae, Trochamminidae, Cassidulinidae and Chilostomellidae are not known.

In the present investigation, from the Gulf of Cambay region fifteen families have been recorded. Species recorded in the Gulf of Cambay region but not known from any of the other five regions are (1) *Quinqueloculina candeiana* d'Orbigny, (2) *Spiroloculina antillatrum* d'Orbigny *aequa* Cushman, (3) *S. depressa* var. *rotundata* Williamson, (4) *Biloculina* *lucernula* Schwager, (5) *Nodosaria subperversa* Cushman, (6) *Nonion depressula* (Walker & Jacob), (7) *Bolivina nitida* Brady, (8) *Bolivina aenariensis* (Costa), (9) *Rotalia venusta* Brady, (10) *Pulvinulina concamerata* Montagu, (11) *P. oblonga* var. *scabra* Brady, and (12) *Anomalina coronata* Parker & Jones.

Nature of Sediments in stations and species abundance :

The distribution of the Foraminifera appears to have some relationship to the type of bottom deposits. The sediment sample from Station A which is an admixture of mud and a large amount of coarse sand, has very rich foraminiferal fauna well represented both by the number of species and abundance of specimens. Miliolidae are dominant followed by Rotaliidae, Nonionidae and Textulariidae in the order of abundance. Arenaceous forms belonging to the family Textulariidae are common and lagenids are also found in the same frequency. Among the rotalids the most common are *Rotalia*, *Cibicides* and *Discorbis*. The large sized forms like *Nodosaria*, *Spiroloculina* and *Textularia* are abundant. Planktonic Foraminifera like *Globigerina bulloides*, *G. dubia* are present with the former being most common. All specimens are well preserved in the sediment with the exception of a few which have been found worn-out and damaged.

In Station B where the texture of the sediment is of very fine particles of mud, small forms like *Bulimina*, *Eggerella* and *Lagena* are most common. The station is poor in the abundance of specimens. Miliolids and Rotalids are sparsely present. Arenaceous forms are lacking. Planktonic forms of the genera *Globigerinella* and *Globigerina* have been observed. *Globigerina dubia* is most abundant and *Globigerinella aequilateralis* very rare.

The sediment from Station C which is slightly rough being composed of a fair amount of mud with a small proportion of sand has foraminifera represented by Rotaliidae, Miliolidae Nonionidae, Camerinidae, Textulariidae and Peneroplidae. Specimens from this station have been found to be in a good state of preservation. Planktonic forms are represented by *Globigerina bulloides*, *G. dubia*, and *Globorotalia menardii*.

In Station D where the sediment is muddy, the fauna is extremely poor. *Bulimina* and *Bolivina* are common. Miliolids and Rotalids are uncommon. Planktonic forms are represented by *Globigerina bulloides* and *G. dubia*.

In general, the foraminifera of the Gulf of Cambay are typical of shallow tropical warm waters of Indo-Pacific region.

Summary

1. Eighty-four species of Foraminifera belonging to 34 genera under fifteen families viz., Astrorhizidae, Textularidae, Valvulinidae,

Miliolidae, Ophthalmidiidae, Trochamminidae, Lagenidae, Nonionidae, Camerinidae, Peneroplidae, Buliminidae, Rotaliidae, Globigerinidae, Globorotaliidae and Anomalinidae have been collected and reported from dredge samples of INS 'Darshak' from the Gulf of Cambay.

2. Locations of the stations and the nature of the sediments and foraminiferal complexes therein have been described.

3. Emphasis has been laid on the geographical distribution of the species concerned. The foraminiferal fauna of different areas off the coasts of Bay of Bengal and Arabian sea including Laccadive sea have been compared.

4. *Quinqueloculina candeiana*, d'Orbigny, *Spiroloculina antillatrum* d'Orbigny *aequa* Cushman, *S. depressa var. rotundata* Williamson, *Biloculina lucernula* Schwager, *Nodosaria subperversa* Cushman, *Nonion depressula* (Walker & Jacob), *Bolivina nitida* Brady, *Bolivina aenariensis* (Costa), *Rotalia venusta* Brady, *Pulvinulina concamerata* Montagu, *P. oblonga* var. *scabra* Brady, and *Anomalina coronata* Parker & Jones have been reported for the first time from the Indian coasts.

5. The relationship of Foraminifera to the type of bottom deposits has been briefly discussed with regard to their species distribution and abundance.

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References

Anon, (1939) : Marine deposits of Arabian Sea. *Nature*, **144** : 841-842.

——— (1944): Pelagic Foraminifera. ibid. **153** : 322.

Bagg, R. M. (1908) : Foraminifera collected near the Hawaiian Islands by the steamer 'Albatross' in 1902. *Proc. U.S. Nat. Mus.* **34**.

Brady, H. B. (1884) : Report on the Foraminifera. *Challenger, Zoology*, **9** : 1-814.

———, Parker, W. K. & Jones, T. R. (1888) : On some Foraminifera from the Abrohlos Bank. *Trans. Zoo. Soc. London*, **12**: 211-240.

Carpenter, W. B., Parker, W. K. & Jones, T. R. (1862) : Introduction to the study of the Foraminifera. Ray Soc. Publ. London.

Carter, H. J. (1880) : Report on specimens dredged from the Gulf of Mannar. *Ann. Mag. Nat. Hist. Ser.* 5, **5**, **6**, and **7**.

Chapman, F. (1895) : On some Foraminifera obtained by the Royal Indian Survey Ship. SS 'Investigator' from the Arabian Sea. *Proc. Zool. Soc. London*, pp. 1-55.

——— (1902) : The Foraminifera. Vol. 8, Longman, Green & Co.

——— (1910) : On the Foraminifera and Ostracoda from soundings chiefly deep water collected round the Funafuti a toll by H.M.S. Penguin. *Jour. Linn. Soc. Zoology*. **30**.

Cushman, J. A. (1910-17) : A monograph of the Foraminifera of the North Pacific Ocean. *U.S. Nat. Mus. Bull.* **71**.

——— (1917) : New species and varieties of Foraminifera from the Philippines and adjacent waters. *Proc. U.S. Nat. Mus.* **51**.

——— (1921) : Foraminifera of the Philippine and adjacent Seas. *U.S. Nat. Mus. Bull.* **100**.

——— (1918-31) : The Foraminifera of the Atlantic Ocean. ibid. **104** (1942): The Foraminifera of the tropical Pacific Collections of the "Albatross", 1899-1900. ibid. **161**.

——— (1959) : Foraminifera. Cambridge, Mass. Harvard University Press.

Dakin, W. J. (1906) : Report on the Foraminifera collected by Professor Herdman, at Ceylon in 1902. Rept. Ceylon Pearl Oyster Fisheries, 5, pp. 225-242.

Daniel, J. C. (1949) : Encrusting Foraminifera of Krusadai Island. *Jour. Madras Univ.* **18** : 27-37.

——— (1949) : The Foraminifera of Krusadai Island and adjacent areas. M.Sc. thesis, Univ. of Madras, Dept. of Zoology.

Ganapati, P. N. & Satyavati, P. (1958) : Report on the Foraminifera in bottom sediments in the Bay of Bengal off the east coast of India. *Andhra Univ. Mem. Oceanogr.* **11** : 100-127.

Gnanamuthu, C. P. (1943) : Foraminifera of Krusadai Island. *Bull. Madras Govt. Mus.* **2**, (5) : 1-21.

Heron-Allen & Earland (1914-15) : The Foraminifera of the Kerimba Archipelago. *Trans. Zool. Soc. London* **20**, pt. 1, 1914. pt. II, 1915.

Hofker, J. (1927) : Foraminifera of Siboga Expedition. *Siboga Exped. Monogr.* 4 (1) : 1-78.

——— (1930) : Foraminifera of Siboga Expedition. ibid. 4a : 79-170.

Lankester, E. R. (1903) : Treatise on Zoology, Pt. **1**, *Protozoa*, pp. 47-149.

Millett, F. W. (1898-1904) : Report on the recent Foraminifera of the Malay Archipelago. *Jour. Roy. Micr. Soc.* p. 406.

Nuttal, W. L. F. (1927) : The localities whence the Foraminifera figured in Report of H.M.S. Challenger by Brady were derived. *Ann. Mag. Nat. Hist.* **19** (9) : 209-241.

Sethulekshmi Amma, J. (1958) : Foraminifera of the Travancore Coast. *Bull. Res. Inst. Univ. Kerala. Ser. C.* **VI (1)** : 1-88.

Stubbings, H. G. (1939) : Stratification of biological remains of marine deposits of the Arabian Sea. *Br. Mus. (Nat. Hist.). John Murray Exped.* 1933-34 ; *Sci. Rept.*, 1939, 3 (2): 31.

Williamson, W. C. (1858) : On the recent Foraminifera of Great Britain. *Ray Soc. Publ. London*, pp. 107.

Maturation and Spawning of *Bregmaceros mcClellandi* (Thompson)

BY

ARUN PARULEKAR[1] AND D. V. BAL[2]
Institute of Science, Bombay

(*With a plate and three text-figures*)

The maturation and spawning behaviour of *Bregmaceros mcClellandi* (Thompson), a common gadid fish of Bombay, is studied for the first time. The structure of gonads and the stages of maturity have been clearly described. The season and periodicity of spawning is determined by ova-diameter measurements and distribution of maturity stages in different months. Fecundity or reproductive potential in relation to different variables is estimated and the equations for conversion found out. The minimum size at maturity is discussed. Ponderal index or condition factor, in respect of size and time, has been determined for both the sexes.

INTRODUCTION

The gadid fish, *Bregmaceros mcClellandi* (Thompson), locally known as '*Tengali*' is quite common around Bombay. It occurs almost throughout the year and contributes about 3000 metric tons to the total annual fish landings made by mechanised and indigenous crafts at Bombay. Except for a short account on the food and feeding habits of this fish by Bapat & Bal (1952), very little information about its biology is available.

MATERIAL AND METHODS

The present study is based on observations of 2000 fish during a period of 18 months in the years 1962-64. The material was collected, once a week from the 'dol' net catches off the local fish-landing centres at Sassoon Dock and Versova.

The fish were properly cleaned, measured, weighed and sexed. The gonads were weighed and their colour and length, noted. A small part of each ovary was examined, microscopically, for determining the stage of maturity. The gonads were then preserved in 5% formalin, for further examination. The spawning habits were studied by direct observations on mature and spawning fish as well as by measuring the diameter of intra-ovarian eggs. Details of the method of study and discussion are included in the appropriate section of the paper.

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[1] National Institute of Oceanography, Miramar, Panaji, Goa.
[2] Kirti College, Bombay-28.

Maturation of Gonads

The seasonal changes in the development and maturation of gonads, was studied on the basis of arbitrary classification of maturity stages. The classification, which corresponds with the maturity stages adopted by the International Council for the Exploration of Seas, is based on observations, on the formation and extrusion of milt in the testes, and ova-diameter range and yolk-formation in the ovaries. Fish less than 50 mm. were indeterminate juveniles.

Male

Immature	Stage I	Testes in the form of thin thread-like strips of tissue. Crystalline-white in colour, and measuring about 3-5 mm. in length.
Maturing	Stage II	Testes slightly thick and compact. White in colour. Gonad length 5-9 mm.
	Stage III	Testes 9-16 mm. in length. Dorsal wall of each lobe with a prominent ridge. Milt formation commences.
	Stage IV	Testes much flattened and elongated (14-22 mm.). White to milky-white in colour. Milt oozes out on hard pressing.
Mature	Stage V	Testes quite large occupying more than 3/4 of the abdominal space. Milky-white in colour. Length 20-30 mm. Though turgid, there is no oozing of milt.
	Stage VI	More or less as Stage V. Milt oozes out on slightest pressure.
Spent	Stage VII	No milt. Testes hard and dull-white in appearance.

Female

(Plate I)

Immature	Stage I	Translucent and faint-white ovary, with minute ova having a distinct nucleus and clear cytoplasm. Length and weight of ovary varying between 3-5 mm. and 10-18 mgm., respectively. Largest ova 0·183 mm. in diameter.
Maturity	Stage II	Ovarian lobes well-developed and asymmetrical (right shorter than the left). White to light-red in colour. Length and weight of ovary varies from 4-12 mm. and 15-45 mgm., respectively.
	Stage III	Ovaries gain in weight. Rosy in colour. A few large ova measuring up to 0·444 mm. in diameter. Yolk formation is in initial stages. Length and weight of ovary generally, varies between 6-17 mm. and 20-55 mgm., respectively.
	Stage IV	Ovaries containing rounded ova. Dark in appearance due to heavy yolk deposition. Peripheral part of ova having vacuolar appearance. Ovarian length and weight varies within the range of 9-21 mm. and 35-70 mgm., respectively. Largest ova up to 0·570 mm. in diameter.

Mature	Stage V	Ovaries appear more flattened and have a light-red coloration. Ova with evenly spread granulated yolk. Largest ova is 0·583 mm. in diameter. Length and weight of ovary in the range of 12-29 mm. and 65-270 mgm. respectively.
	Stage VI	Ovaries very much distended. Ripe ova free in ovarian space and occasionally come out through the oviduct. Ova heavily yolk-ladened. Oil-globule absent. Dark and granular yolk frequently forming a central pasty core. Presence of a clear, colourless, fluid-filled perivitelline space. Length and weight of ovary varying between 15-35 mm. and 90-343 mgm., respectively. Largest ova measures 0·841 mm. or more in diameter.
Spent	Stage VII	Blood-shot, wrinkled and thick-walled ovary, containing a few residual ova.

Maturation of Ovarian Eggs

The maturation of ovarian eggs, through different months, was studied by taking ova-diameter measurements of intra-ovarian eggs, in different stages of growth. The procedure followed was the same as that of Clark (1934). The measurements were taken with an Oculometer, giving a magnification of 1 m.d. = 0·07 mm. From each ovary, irrespective of its stage of maturity, 500-800 ova, on an average, were measured, and in all 300 ovaries, examined. The measurements were grouped at intervals of 5 m.d. each.

The maturation of intra-ovarian eggs takes place by striking changes in the size and structure of the ova. The oocytes are formed by proliferation of germinal epithelium of the ovary. The developing ova are borne on the ovigerous lamellae, traversing the ovary. The maturation of the oocyte is accompanied by the deposition of yolk-granules in the cytoplasm, therein transforming the tiny transparent oocyte into a big opaque ripe ovum.

The monthly variations in the percentage of ova-diameter measurements, as shown in Fig. 1, reveals that the intra-ovarian eggs begin to mature from December (56·04% of stage V ova) and further advancement in maturation continues up to May. Details of the progression, can be summarized as follows :

(*a*) In June, the ovary predominantly contains immature ova of size described under Stage I.

(*b*) In July and August, majority of ova are in the Stages II and III.

(*c*) From September to November, the ovaries contain ova of the size described under Stage IV.

(*d*) From December to May, mature and ripe ova of Stages V and VI are conspicuous. The ripe ova (Stage VI), first appear in January and subsequently their percentage goes on increasing till May.

The above-mentioned observations tend to show that the spawning season of *B. mcClellandi*, falls during the months of December to May.

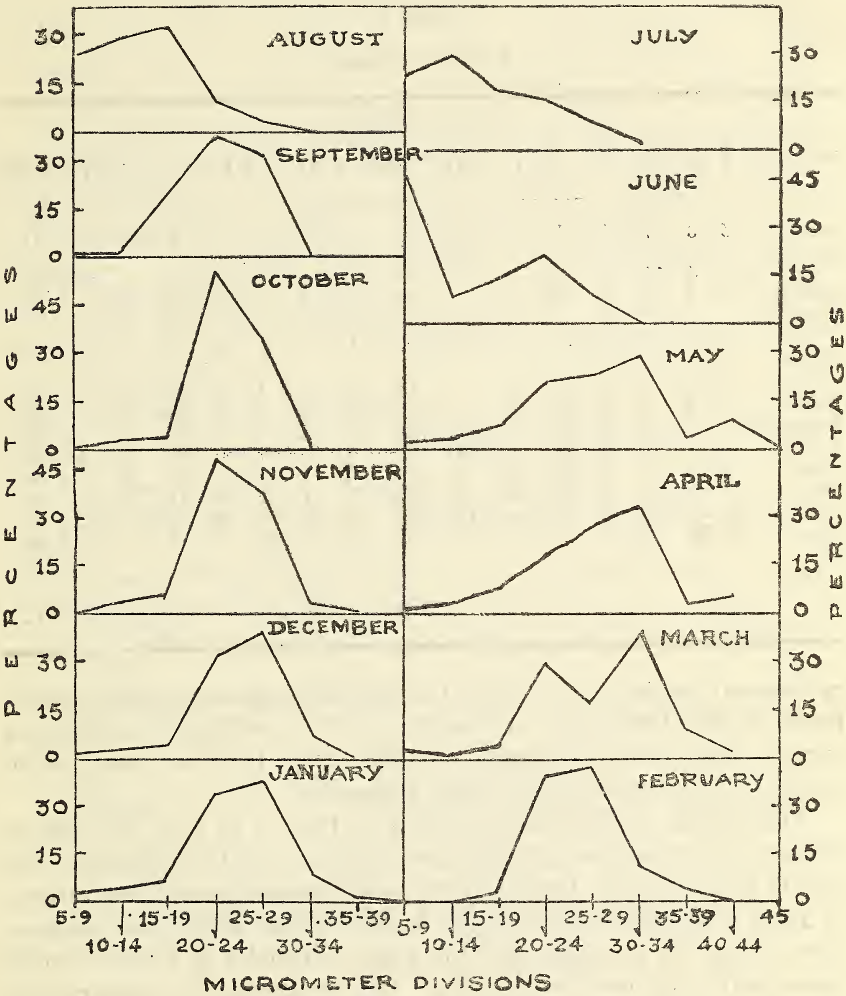


Fig. 1

Spawning Season

The spawning season of *B. mcClellandi* was determined by macroscopic examination of gonads in different months. Presented in Table 1 is the maturity stage-distribution data of males and females in different months,

Table 1 shows that the fish in Stage V occurs throughout the year in varying numbers and individuals in Stages VI and VII form low percentages. Such low occurrence of actual spawners and spent fish in the

TABLE 1

MATURITY STAGES

				♂								♀				
Month	I	II	III	IV	V	VI	VII	Total	I	II	III	IV	V	VI	VII	Total
August	5	8	7	3	1	—	—	24	7	11	10	2	1	—	—	31
September	2	4	11	19	7	—	—	43	2	4	12	22	9	—	—	49
October	1	4	5	36	23	—	—	69	2	5	5	42	29	—	—	83
November	—	2	3	20	17	—	—	42	1	1	3	25	25	—	—	55
December	3	—	2	23	38	5	—	71	2	1	1	14	22	2	—	42
January	2	3	3	43	66	6	—	123	3	—	2	50	85	14	—	154
February	1	1	4	34	58	7	—	105	2	1	2	21	36	5	—	67
March	—	1	1	11	36	7	1	57	1	—	1	13	41	6	2	64
April	2	1	1	5	34	2	2	47	2	1	—	7	39	4	1	54
May	1	1	2	7	29	6	5	51	1	1	1	6	31	5	3	48
June	17	3	11	12	7	—	18	68	23	4	11	16	5	—	17	76
July	19	30	15	7	5	—	—	76	21	27	18	15	8	—	—	89
								776								812

commercial catches may be due to the spawning migrations of the species. Bapat & Bal (1952) collected post-larvae of *B. mcClellandi* in plankton samples from fishing grounds, 5-8 miles away from the coast, which suggests the possibility of spawning migrations.

The number of individuals, as seen in Table 1 of both the sexes in Stage V, goes on increasing from October to May with the highest percentage (72·22%) in April. In June, there is a sudden decline in the occurrence of Stage V fish and it continues up to September. From these observations, it can be presumed that the Stage V females in October might spawn within the next two months. This presumption is supported by the appearance of Stage VI individuals in December. Although the number of such individuals is rather low, its very presence in the months of December to May indicates that *B. mcClellandi* has a prolonged breeding season, extending from December to May.

Spawning Periodicity :

The spawning periodicity in *B. mcClellandi* was determined by critically examining the distribution of ova-diameter frequencies in 20 ovaries, of which 12 were in Stage V and 8 in Stage VI, respectively.

A close examination of frequency polygons in Fig. 2, reveals that there are three distinct groups of ova, represented by modes 'a', 'b' and 'c', respectively. The mode 'a' at 5-9 m.d. represents the immature

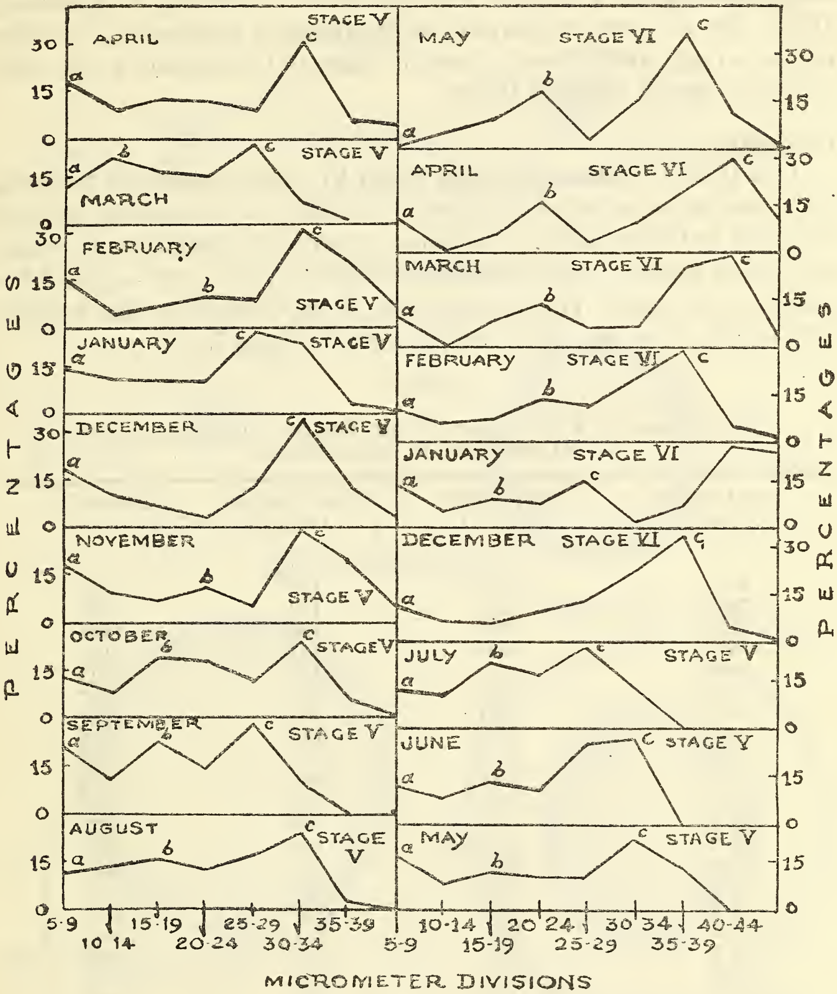


Fig. 2

stock. The maturing ova are represented by mode 'b' at 10-14 m.d., while mature ova (mode 'c') are spread within the wide range of 25-49 m.d. Thus the mature ova cover more than half the total range of intra-ovarian eggs.

Prabhu (1956) observed, 'in species, exhibiting the spawning of longer duration, the range in size of mature ova is nearly half the total range of intra-ovarian eggs of the entire ovary'. Hence, from ova-diameter measurements, it is evident that *B. mcClellandi* has a prolonged breeding season. Since the mature ova (mode 'c') are clearly differentiated from the immature and the maturing ones, it is clear that there is a definite periodicity in spawning and that the species may spawn in succession, during a definite breeding season (Hickling & Rutenberg 1936). By the time withdrawal of mature ova is effected, the other batches of egg attain maturity and are ready to be spawned, in the same spawning season (Prabhu 1956).

Fecundity :

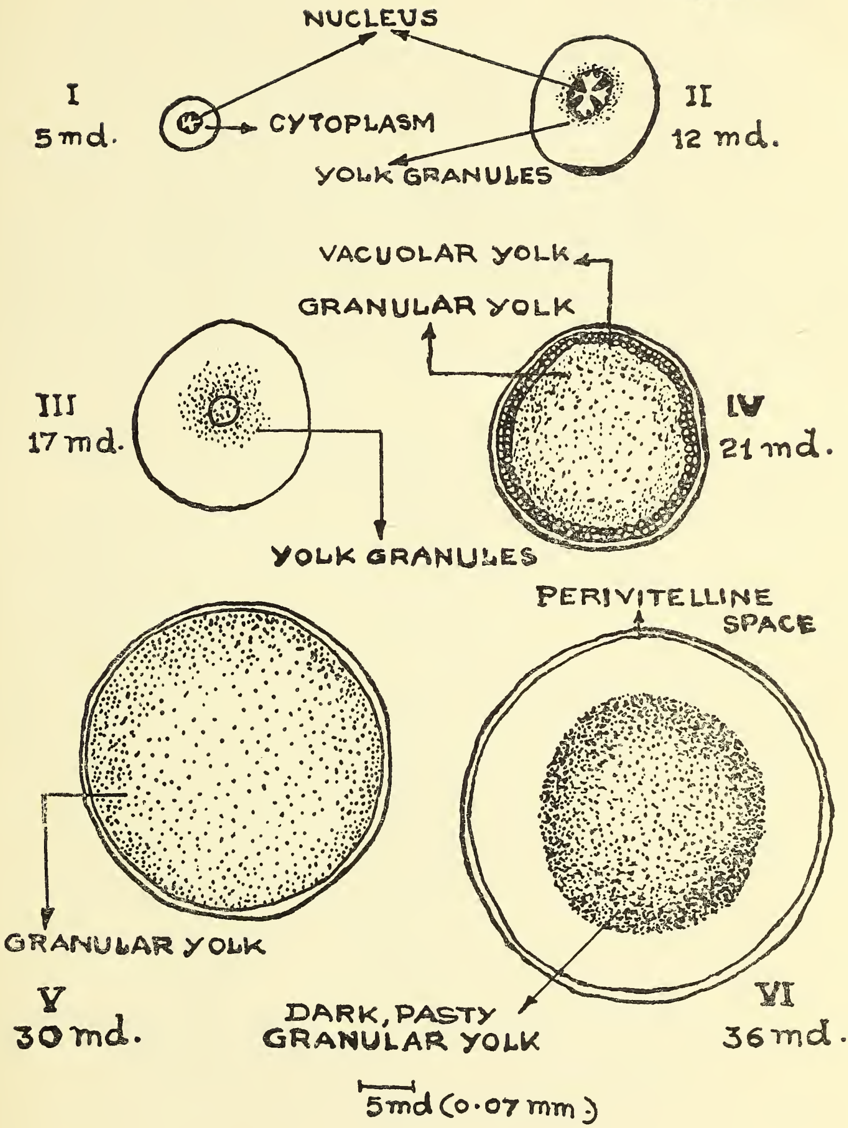
Ova from 33 ovaries of Stages V and VI, were counted for assessing the reproductive potential and also to establish the relationship between fecundity and three different variables, namely, total length, body weight and gonad weight. The procedure of Bagenal (1957), was adopted for counting the eggs. The fecundity in *B. mcClellandi* varies between 1161 and 6015 and the details are as shown in Table 2.

TABLE 2

TOTAL LENGTH, BODY WEIGHT, GONAD WEIGHT AND FECUNDITY OF 33 SPECIMENS OF *B.mcClellandi*

Total length (mm.)	Body Weight (mgm.)	Gonad Weight (mgm.)	Fecundity
69·5	1919	110	3418
70·5	1214	119	2350
71·0	2056	139	1554
76·0	2089	143	1161
79·0	2764	172	2823
80·0	2950	103	2097
80·0	3144	93	1897
80·0	2494	143	2202
81·0	3073	175	3767
81·5	3143	260	3200
82·0	3081	147	2258
83·5	3119	1·69	4077
84·0	3514	154	2290
85·0	3465	169	2438
85·5	3852	256	3386
85·5	3580	220	4101
85·5	3584	297	4862
86·0	3697	139	4060
86·0	4354	365	4588
86·0	4404	213	2609
86·5	4033	342	3370
86.5	4182	229	4186
87·5	3649	204	3074
88·0	4314	324	3875
88·0	4230	222	4202
89·5	4869	204	3685
90·5	4536	286	4787
90·5	4814	234	4454
91·0	5220	148	2608
91·0	3894	224	3692
91·0	3974	194	2044
93·0	4599	378	3729
97·0	6054	343	6015

Plate 1


NUCLEUS
I
5 md.
CYTOPLASM
II
12 md.
YOLK GRANULES
VACUOLAR YOLK
GRANULAR YOLK
III
17 md.
IV
21 md.
YOLK GRANULES
PERIVITELLINE SPACE
GRANULAR YOLK
V
30 md.
DARK, PASTY GRANULAR YOLK
VI
36 md.
5md (0·07 mm)

The equations, expressing the relationship, between fecundity and the variables, were calculated by the method of least squares, and these were found to be :

Length and Fecundity	:	$Y = (-1{\cdot}9607) + 2{\cdot}8325\ X$
Body weight and Fecundity	:	$Y = 1{\cdot}1961 + 0{\cdot}6563\ X$
Gonad weight and Fecundity	:	$Y = 0{\cdot}5459 + 1{\cdot}2857\ X$

where Y = Log F (Fecundity) and X = log. of the variable.

Minimum Size at Maturity :

The size at first maturity was determined by grouping the specimen into 5 mm. size groups and by classifying them into immature, maturing, mature and spent, depending upon the condition of gonads. It was observed that all fish below 50 mm. were indeterminate juveniles and those between 50-60 mm. were, immature. The maturing fish dominate the size group of 61-65 mm. The mature fish which first appeared in

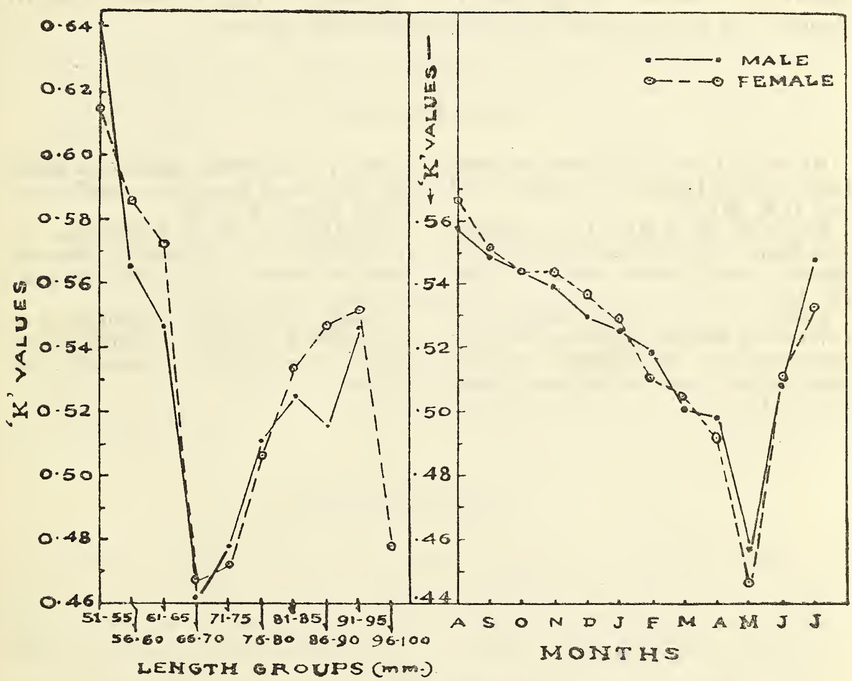


Fig. 3

66-70 mm. size group, were, thereafter, recorded in all the size groups up to 100 mm. Hence, it may be inferred that the fish attains maturity at 66-70 mm. size. The inference is supported by the occurrence of spent fish, for the first time, in the same size group of 66-70 mm.

Ponderal Index :

Ponderal index or condition factor for males and females, was calculated separately, by the usual formula $K = \frac{W}{L^3} \times 100$, where 'K' is the ponderal index, 'W' the weight of fish and 'L' the length of fish.

As shown in Fig. 3, the 'K' value for males in 51-55 mm. size group is higher than the corresponding value for females. This observation probably suggests that in earlier stages of growth, the males have a tendency to grow faster than the females. From 55-60 mm. size group, the values for both the sexes go on decreasing until they reach the minimum in 66-70 mm. size group. The point of inflexion at 66-70 mm., indicates the length at which the maturity is attained (Hart 1946). The gradual increase in 'K' values of fish larger than 70 mm. is in accordance with the recovery from metabolic strain due to spawning.

The monthly variations in 'K' values for both the sexes exhibit similarity. The decrease in values during December to May is due to spawning, whereas the gradual rise, as seen in Fig. 3, from June to August can be attributed to the post-spawning recovery.

References

BAGENAL, T. B. (1957) : Annual variations in Fish Fecundity. *J. Mar. Biol. Ass. U.K.* **36** : 377.

BAPAT, S. V. & BAL, D. V. (1952) : The food of young fishes from Bombay Waters. *Proc. Indian Acad. Sci.* (B) **36** : 105.

CLARK, F. N. (1934) : Maturity of Californian Sardine (*Sardinela caerulea*) determined by ova-diameter measurements. *Calif. Div. Fish & Game, Fishery Bulletin* 10.

HART, T. J. (1946) : Report on trawling surveys on Patagonian Shelf. *Discovery Reports* **23** : 223.

HICKLING, C. F. & RUTENBERG, E. (1936) : Ovary as an indicator of spawning period in fishes. *J. Mar. Biol. Ass. U.K.* **21** : 211.

PRABHU, M. S. (1956) : Maturation of intra-ovarian eggs and spawning periodicities in some fishes. *Indian J. Fish.* 3 : 59.

Orchids of Nepal—4

BY

M. L. BANERJI[1] AND B. B THAPA[2]

[*Continued from Vol.* 67 (2): 152]

In this instalment, species of *Chrysoglossum* Bl., *Liparis* Reichb., *Malaxis* Soland ex Sw. and *Oberonia* Lindl. that have been reported by others and collected by the authors from Nepal, are described. These genera, according to Schultes & Pease (1963) fall under the series *Acranthae* of tribe *Kerosphaeroideae*, thus the subtribes are indicated for convenience. Also, as suggested, we have added a key to the genera.

ARTIFICIAL KEY TO THE GENERA

Pollinia appendiculate. Viscidium rudimentary, caudicle viscous. Sepals subequal, two lateral ones connate to form a sac and adnate to the base of labellum. Labellum auricled at base, adpressed to the column and adnate to it Column slender.................................. *Chrysoglossum* (Collabieae)

Pollinia not appendiculate. Viscidium and caudicle absent—

Petals very much smaller than the sepals. Labellum more or less flat with hollow auricled lobes. Column short, winged. Anther on the back of the column. Pollinia not deciduous. Plants terrestrial.... *Malaxis* (Liparideae)

Petals narrower than sepals. Labellum adnate to the base of the column, basal lobes nil, posteriorly placed by resupination, edge toothed or fringed. Column long, curved, slightly winged at the apex. Plants terrestrial or epiphytic.... .... *Liparis* (Liparideae)

Flowers minute. Sepals subequal, petals smaller than the sepals. Labellum usually 3-lobed, hypochile concave, column very short; caudicle absent. Plants epiphytic.................................. *Oberonia* (Liparideae)

Chrysoglossum Bl.

Terrestrial orchids with a creeping rhizome, pseudobulbs narrow or absent, with a solitary leaf which is elliptic-lanceolate. Flowering scape lateral from the rhizome, erect; flowers in a lax raceme. Sepals subequal, lateral sepals connate into a mentum with the base of the lip, petals narrower than the sepals. Lip not jointed on the column, erect, broadly 3-lobed, sometimes the base auricled. Column incurved, margin 2 auricled or in some lobed to the middle; anthers 2-celled, pollinia 2, not connected.

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[1] University of Kalyani, Kalyani, W. Bengal.
[2] Horticultural Assistant, Indian Co-operation Mission, Kathmandu.

Chrysoglossum erraticum Hk.f. Ic. Pl. t. 2062, 1891 ; F.B.I. 5 : 784, 1890.

Flowers green, spotted brown, sepals and petals falcately oblong-lanceolate, acute. Lip hastately 3-lobed, base with 2 auricles, side-lobes broad, recurved, mid-lobe orbicular, spur very short.

Flowering during July and August. Collected from Bajrabarahi at *c.* 1220 m. In F.B.I. Hooker mentions under the species as only one specimen seen ; we have found this species only at one locality, and there were five plants growing. It may be a rare species.

Liparis Reichb.

The genus is closely allied to *Malaxis* in its habit. Plants are terrestrial rarely epiphytic, pseudobulbs usually present or absent. Leaves solitary or more, membraneous or coriaceous either continuous with their sheath or jointed on the sheath. Flowers generally small or of medium size in a raceme, resupinate. Sepals spreading, recurved with margins often rolled inwards. Petals as long as the sepals, very slender. Lip adnate to the base of the column, usually broad; column long, curved with 2 small wings on the sides of the stigmatic surface.

Artificial key to the species of *Liparis*

A. Lip not crenulate ; leaves 2, 3 or 4—
B. Sepals 1-nerved—
C. Flowering scape flattened or winged. Leaves 2 or 3 .... *platyrachis*
CC. Flowering scape not flattened or winged—
D. Leaves 3 - 4 ; column broadly winged at base and wings with a capillary tail .... *resupinata*
DD. Leaves 3; column short, obscure .... *viridiflora*
BB. Sepals 5-nerved. Lip with 2 callii .... *togashii*
AA. Lip crenulate ; leaf solitary ; sepals 3-nerved—
B. Leaf broad, rounded-ovate, deeply cordate, nerves few and faint......... *cordifolia*
BB. Leaf oblong or linear-oblong, nerves many and slender......... *glossula*

Liparis cordifolia Hk. f. Ic. Pl. t. 1811, 1889 ; F.B.I. 5 : 692, 1890 ; King & Pantl. 24, t. 28, 1896 ; Hara in Fl. Eastern Himal. 440, 1966.

Plants with short and stout stem, leaf sessile, broad, rounded-ovate, deeply cordate, nerves few and faint. Sepals lanceolate, 3 nerved ; petals with recurved margins. Lip large, flat, obcordate or orbicular-obovate, apiculate, crenulate, yellowish green, base narrow, callus obscure. *Flowering* during July to September. Collected from Sundarijal below Sheopuri. Distributed at 1650 m.

L. glossula Reichb. f. in Linnaea 41 : 43, 1877 ; F.B.I. 5 : 693, 1890 ; Kitamura in Fau. & Fl. Nep. Himal. 104, 1955.

Plants 5-8 cm. high, leaf solitary, sessile or shortly petioled oblong or linear-oblong, not jointed at the base on the leaf-sheath, nerves many, slender. Inflorescence stout, 10-15 cm. long, many-flowered. Flowers *c.* 1.5 cm. across, light green with a purple tinge. Sepals lanceolate, acute, 3-nerved. Lip large, broadly obovate-oblong, cuspidate, crenulate and overlying the lateral sepals, callus absent. Authority Kitamura.

L. platyrachis Hk. f. Ic. Pl. t. 1890 ; F.B.I. 5 : 706, 1890 ; King & Pantl. 34, t. 45, 1898 ; Hara, 441, 1966.

Plants small, leaves 2-3, jointed at the base upon the leaf-sheath. Inflorescence much longer than the leaves, scape flattened or winged. Flowers *c.* 4 mm. across ; sepals falcate, oblong, 1-nerved. Lip much shorter than the sepals, recurved, basal portion of the lip with two auricles. Authority Hara.

L. resupinata Ridley in Journ. Linn. Soc. 22 : 290, 1886 ; Hk. f. Ic. Pl. t. 1888, 1889 ; F.B.I. 5 : 705, 1890 ; King & Pantl. 36, t. 48, 1898 ; Hara, 441, 1966.

Plants small *c.* 2.5 cm. high ; leaves 3-4, sessile, linear-lanceolate, acuminate, submembraneous, 7-nerved. Inflorescence slender, more than 10 cm. in length, many-flowered, bracts exceeding the length of the pedicels. Flowers *c.* 8 mm. across, yellow, sepals broadly oblong, margin rolled inwards, 1-nerved. Lip broadly ovate-oblong, basal lobes rounded. Authority Hara.

L. togashii Tuyama in Hara. Fl. Eastern Himal. 441, 1966.

Plants small, leaves 3, linear-oblanceolate, acute or acuminate. Inflorescence smaller than the leaves, bracts smaller. Flowers *c.* 4·5 mm. across ; sepals linear-oblong ; lip much shorter than the sepals ovate-triangular, callii two. Authority Hara.

L. viridiflora (Bl.) Lindl. Gen. et Spec. Orch. 31, 1830 ; F.B.I. 5 : 704, 1890 ; Holttum, Fl. Malaya, 1 : 203, 1890 ; Hara, 443, 1966. *Malaxis viridiflora* Bl. Bijdr. 392, t. 54, 1825 ; *Liparis longipes* Lindl. ex Wall. Pl. Asiat. Rar. 1 : 31, t. 35, 1830, et Gen. et Spec. Orch. 30, 1830 ; F.B.I. 5 : 703, 1890 ; King & Pantl. 29, t. 37, 1898.

Leaves 2, jointed at the base upon the leaf-sheath. Inflorescence 10-15 cm. long, many-flowered, flowers very small, yellowish or whitish green ; sepals flat, broad not widely spreading, 1-nerved. Lip as long as the sepals, orbicular-ovate, very obscurely 3-lobed, callus absent, column short and incurved. Authority Hara.

Malaxis Soland ex Sw.

Microstylis is a later name for *Malaxis*, thus according to the rules of Botanical Nomenclature, *Malaxis* should, therefore, be used. These are terrestrial or rarely epiphytic orchids. The stem is creeping with erect leafy branches. Leaves broad, often unequal-sided at the base, thin, more or less plicate, sheathing at the base. The Inflorescence is terminal, few or many flowered raceme, flowers small, sepals free or the lateral ones connate. Lip sessile, erect or spreading, entire or 3-lobed, concave to saccate, often with a hollow near the base usually with 2 large lobes, the auricles, close to the sides of the column and extending downwards ; column very short, terete, hollow at the top, apex toothed, with or without fleshy arms. Anthers terminal, sessile, erect on the back of the column with its tip pointed upwards, pollinia 4, waxy. Fruit is a capsule which is either ovoid or ellipsoid. The genus *Malaxis* is distinguished from *Liparis* in having a superior lip and a very short wingless column, while in *Liparis* the lip is inferior, and the column is long with its upper part winged.

Artificial key to the species of *Malaxis*

A. Sides of lip not produced into auricles ; leaves 2 ; flowers yellowish green........ *muscifera*

AA. Sides of lip produced into auricles—

B. Bracts shorter than the ovary—

C. Inflorescence scape 8-20 cm. long ; flowers golden-yellow with reddish brown round the column, *c*. 1.8 cm. in diam........................ *josephiana*

CC. Inflorescence scape 20-25 cm. long; flowers greenish-purple or yellowish, *c*. 8 mm. in diam.. .... *acuminata*

BB. Bracts equalling or longer than the ovary—

C. Plants *c*. 4-5 cm. high ; leaves 3-4 ; flowers 4 mm. in diam........... *khasiana*

CC. Plants *c*. 50 cm. tall ; leaves 2 ; flowers 8 mm. in diam.......... *tamurensis*

Malaxis acuminata D. Don, Prodr. Fl. Nep. 29, 1825 ; Hara, 443, 1966. *Microstylis wallichiana* Lindl. Gen. et Spec. Orch. 20, 1830 ; F.B.I. 5 : 686, 1890 ; King & Pantl. 15, t. 18, 1898.

Flowers pedicellate, pedicels *c*. 1 cm. long, yellowish green, purplish near the centre, *c*. 8 mm. in diam., sepals oblong, lateral sepals oblong, 3-5-nerved, shorter than the dorsal, dorsal sepal 1-3-nerved ; petals 3-nerved, linear, longer than the sepals. Lip shield-like, broadly ovate, tip notched, auricles straight and slightly overlapping. *Flowering* during July and August. Collected from Tarebhir to Nagi ; Nagarjung; Kakni ; Dhunibesi ; below Sheopuri. Widely distributed at 1650 m.

In F.B.I. and also in Fl. East. Himal. a variety *biloba* is mentioned, which has bracts usually longer, shorter pedicels and the blade of the lip is contracted, but we have not been able to collect any specimen that would compare well with the description of the variety.

M. josephiana (Reichb. f.) O. Ktz. Rev. Gen. 2 : 673, 1891. *Microstylis josephiana* Reichb. f. in Hk. Bot. Mag. t. 6325, 1868 ; F.B.I. 5 : 687, 1890.

Inflorescence loosely-flowered, flowers large *c.* 1·8 cm. in diam. golden-yellow with reddish-brown round the column, sepals broad, connate at the base, 3-nerved, dorsal sepal saccate at the base ; petals broadly linear. Lip deeply cupped, auricles short, broad, rounded, column very short, thickly winged. *Flowering* during June and July. Collected from Ranibari ; Sankhu. Distributed at 1200 m.

M. khasiana (Hk. f.) O. Ktz. Rev. Gen. 2 : 673, 1891. *Microstylis khasiana* Hk. f. Ic. Pl. 19, t. 1831, 1889 ; F.B.I. 5 : 686, 1890.

Plants *c.* 4-5 cm. high, leaves 3-4. Flowers brownish-red, *c.* 4 mm. in diam., bracts equalling the ovary ; sepals broad, hooded, auricle of the lip, obtuse, shorter than or equalling the blade, blade constricted into a broadly rounded terminal lobe. *Flowering* during June and July. Collected from Chainpur ; below Sheopuri ; Dhunibesi. Distributed at 1220 to 1525 m.

M. muscifera (Lindl.) O. Ktz. Rev. Gen. Pl. 2 : 673, 1891 ; Hara, 444, 1966. *Dienia muscifera* Lindl. Gen. et. Spec. Orch. 23, 1830. *Microstylis muscifera* (Lindl.) Ridley in Journ. Linn. Soc. 24 : 333, 1888; F.B.I. 5 : 689, 1890 ; King & Pantl. 20, t. 25, 1898 ; Kitamura, Fau. & Fl. Nep. Himal. 104, 1955.

Plants usually 15-30 cm. tall, leaves 2, sessile. Inflorescence a dense flowered raceme, flowers minute, *c.* 3 mm. in diam., pale yellowish-green ; sepals broadly lanceolate, petals linear. Lip ovate, acute, abruptly pointed, no auricles, column sessile. *Flowering* during July and August. Collected from Sheopuri to Bagdoar ; also Chum Gompha (Kitamura). Distributed at 1825 to 3500 m.

M. tamurensis Tuyama in Hara; Fl. Eastern Himal. 444, 1966.

Plants *c.* 50 cm. tall, leaves 2, nerves 7, prominent. Inflorescence dense-flowered, bracts longer than the ovary, flowers *c.* 8 mm. in diam., sepals deflexed. Lip 5 mm. long and 6 mm. broad, more or less rounded quadrangular, sides produced into teeth or lobes, apex truncate and subirregular, column small, not appendiculate. Authority Hara.

Oberonia Lindl.

Erect or pendulous, tufted epiphytic orchids, which are unique. Holttum describes them as ' the plants are easy to recognise owing to their much flattened leaves, looking as though they have been put into a press. The leaves are so flattened laterally that they have practically no upper surface except at the sheathing base'. He adds 'the flowers are never more than 2 mm. long and hardly more than 1 mm.....The flowers are usually greenish to yellowish, orange or red, sometimes rich brown, they are often beautifully shaped. The inflorescence continues to grow at the base after the middle part is mature ; the middle flowers open first and the basal flowers usually last of all. Usually many fruits are produced'. Sepals are equal among themselves, erect or reflexed, petals usually narrower and shorter. Lip is sessile, concave at the base, fimbriate, entire or more or less 3-lobed.

Artificial key to the species of *Oberonia*

A. Leaves ensiform—
B. Side-lobes or all lobes of the lip deeply toothed or lacinate—
C. Leaves more than 3 cm. long ; flowers pale green ; mid-lobe of lip broadly bifid at tip.................................... *iridifolia*
CC. Plants small, leaves *c.* 2·5 cm. long ; flowers reddish-yellow ; mid-lobe of lip truncate, side-lobes pectinately toothed......................... *clarkei*
BB. Lip entire or 3-lobed, margins quite entire or erose but never pectinate—
CC. Petals broad, oblong or ovate—
D. Petals and lip pubescent ; lip longer than the sepals, mid-lobe obcordate.. *ensiformis*
DD. Lip longer than the sepals, mid-lobe deeply 2-lobed.................. *myriantha*
CC. Petals linear—
D. Lip orbicular or rounded-ovate, entire or obscurely lobed............ *pachyrachi*
DD. Lip with very small side-lobes, mid-lobe long—
E. Lip twice as long as the sepals, side-lobes obscure at the base ; bracts lanceolate.................................... *caulescens*
EE. Lip longer than the sepals, side-lobes filiform, bracts setaceous .... *rufilabris*
AA. Leaves falcate ; petals linear-oblong. Lip twice as long as the sepals, side-lobes small, directed upwards, mid-lobe deeply bifid................ *falcata*
AAA. Leaves all radical, elongate, terete, fleshy. Lip with two curved spurs on each side of its tip.. *myosurus*

Oberonia caulescens Lindl. Fol. Orch. Oberon. 7, 1852 et Gen. et Spec. Orch. 15, 1830 ; F.B.I. 5 : 682, 1890.

Plants with slender stem, leaves ensiform. Flowers subwhorled, pale, bracts lanceolate ; petals narrow. Lip twice as long as the sepals, obscurely lobed at the base and with two parallel lobes at the tip. *Flowering* during May. Collected from Those to Bhitrikhani. Distributed at *c.* 2250 m.

O. clarkei Hk. f. Ic. Pl. t. 1779, 1888 ; F.B.I. 5 : 676, 1890.

Plants small with leaves *c.* 2·5 cm., ensiform. Flowers very minute, whorled, reddish-yellow ; petals broadly ovate, obtuse, nearly as long as sepals. Lip 3-lobed, equalling the sepals, side-lobes pectinately toothed, midlobe small, truncate. *Flowering* during January to March. Collected from Hitaura-Bindraban forest area. Distributed at 510 m.

O. ensiformis (Sm. ex. Rees) Lindl. Fol. Orch. Oberon. 4, 1852 ; F.B.I. 5 : 679, 1890 ; King & Pantl. 9, t. 9, 1898. *Malaxis ensiformis* Sm. in Rees, Cycl. 22, n. 4, 1812.

Plants with ensiform leaves. Flowers *c.* 2 mm., orange yellow ; petals broad, ovate, pubescent. Lip longer than or equalling the sepals, pubescent, side-lobes broad, rounded, midlobe obcordate. *Flowering* during September and October. Collected from Lamidanda ; Pokhra. Distributed at 1220 m.

In F.B.I. Hooker mentions that the lip is hardly longer than the sepals. Our observations agree with those of Santapau & Kapadia (*J. Bombay nat. Hist. Soc.* **57** : 257, 1960).

O. falcata King & Pantl. in Journ. Asiat. Soc. Beng. 64 (2) : 329, 1895 et. Ann. Roy. Bot. Gard. Calc. 8 : 12, t. 14, 1898 ; Hara, 445, 1966.

Leaves falcate. Flowers minute, yellowish green ; petals linear-oblong ; lip twice as long as the sepals, broadly oblong, slightly depressed below the column, side-lobes directed outwards, small, midlobe deeply bifid, divergent. *Flowering* during July. Distributed commonly at 2100-2300 m. Authority Hara.

O. iridifolia (Roxb.) Lindl. Gen. et Spec. Orch. 15, 1830 ; F.B.I. 5 : 675, 1890 ; King & Pantl. 8, t. 8, 1898 ; Holttum, 215, 1953 ; Hara 445, 1966. *Cymbidium iridifolium* Roxb. Fl. Ind. ed. 2, 3 : 458, 1832. *Malaxis iridifolia* (Roxb.) Reichb. f. in Walp. Ann. 6 : 208, 1861.

Plants with ensiform leaves more than 3 cm. long. Flowers pale green in close whorls ; sepals subequal, reflexed ; petals oblong, erose reflexed. Lip more or less quadrate being broader than long, glabrous or slightly pubescent, sides deeply toothed, tip broadly bifid. *Flowering* during August and September. Collected from Hitaura ; Pokhra ; Brajabarahi ; Sankhu ; Dhunibesi. Distributed at 510 to 1220 m.

We have not been able to make out the varieties as given by Hooker in F.B.I., as the lips are not only longer than their breadth but also the tip is bifid, thus the characters of the two var. have been combined.

O. myosurus Lindl. Gen. et Spec. Orch. 16, 1830 ; F.B.I. 5 : 685, 1890.

Plants with leaves elongate, linear, terete, slightly curved. Flowers pale ; petals narrow, linear ; lateral lobes of lip rounded, sinuate toothed, midlobe of lip oblong-quadrate with sides toothed, two curved spurs on each side of the tip truncate. *Flowering* during August and September. Collected from Nagarjung. Distributed at *c.* 1650 m.

O. myriantha Lindl. Fol. Orch. Oberon. 4, 1852 ; F.B.I. 5 : 679, 1890.

Plants with ensiform leaves. Flowers *c.* 2 mm., yellow-green ; petals broad, entire. Lip longer than the sepals, side-lobes broad and notched, mid-lobe oblong, deeply 2-lobed, lobules rounded. *Flowering* during August and September. Collected from Rhingmo to Jubing ; Pokhra. Distributed at *c.* 1650 m.

O. pachyrachis Reichb. f. ex Hk. f. Fl. Brit. Ind. 5 : 681, 1890 ; King & Pantl. 4, t. 3, 1898 ; Hara, 446, 1966.

Plants with ensiform leaves. Flowers minute, *c.* 0·8 mm. or less, very compact on a thick spike ; petals linear ; lip rounded-ovate or orbicular, entire or obscurely lobed. Authority Hara.

O. rufilabris Lindl. Fol. Orch. Oberon. 5, 1852 ; F.B.I. 5 : 683, 1890.

Leaves ensiform. Flowers minute *c.* 8 mm. ; petals linear-oblong ; lip longer than the sepals, oblong, reddish brown with filiform side-lobes, close to the narrow base. *Flowering* during October and November. Collected from Lamidanda ; Nagarjung. Distributed at *c.* 1650 m.

(*to be continued*)

Food-Habits of water-birds of the Sundarban, 24-Parganas District, West Bengal, India—II

Herons and Bitterns

BY

AJIT KUMAR MUKHERJEE
Zoologist, Zoological Survey of India, Calcutta

(*With two text-figures*)

(*Continued from Vol.* **66** (2) : 360)

Ardea cinerea rectirostris Gould, The Indian Grey Heron

The Grey Heron, *Ardea cinerea rectirostris* Gould, is a resident bird of the Sundarban. In the reclaimed area it roosts generally on the larger trees in the vicinity of brackish water fisheries (*bheries*) or fresh-water jheels. During nesting period it is more common in the forested area and nests in large numbers in mixed heronaries on the mangrove trees. It hunts among reeds growing in water and also waits patiently in shallow waters and mud-flats for its prey to show up.

Jerdon (1864, p. 738) made a general statement about the food of the Ardeidae that they feed chiefly on fish, also on crabs, frogs and a few on insects which they seek for on land among cattle. Mason & Lefroy (1912, p. 287) stated that the herons, egrets and bitterns mostly feed on fish, frogs and such food as is found in shallow waters and, therefore, not beneficial to man.

In India there is a widespread belief that the Grey Heron is a fisherman's foe. Since its food consists of fishes, specially these of commercial value, it is regarded as destructive to pisciculture and is, therefore, persecuted to a great extent. Jerdon (1864, p. 742) states that it feeds chiefly on fish. Dewar (1909, p. 6) considers this bird as 'eel's foe'. Mason & Lefroy (1912, p. 284) obtained three frogs from an examination of a stomach of this heron. Whistler (1928, p. 393) states that its food consists of small mammals and birds, mollusca, insects and crustacea, but the diet mainly consists of fish whose scales are ejected in the form of castings. Baker (1929, p. 340) mentions that its food may be said to consist of any living thing small enough to swallow.

The food of the European subspecies, *Ardea cinerea cinerea* (Linnaeus), is better known. Archibald (1910, p. 3) states :

> ' The heron is often persecuted by fish preservers. Of course, it eats fish and is particularly fond of pikes and eels. It is not sufficiently known, however, that it feeds largely on water-rats, mice, frogs, snails and insects. Like hawks and owls, it disgorges the indigestible portions of its prey in the form of large castings an examination of which is very interesting.'

Florence (1912, 1914, 1915) examined 23 specimens and found that these contained remains of rodents, frogs, fishes, snails, insects (injurious, indifferent, and beneficial), crustaceans, earthworm, eggs of leech, and vegetable matter. Thomson (1923) found that the pellets show the remains of water-beetles, bones of water-vole, mole and other mammalian fur, claws of mole and the claws of a rat ; bones of birds are also included. Collinge (1927, pp. 228-229) examined the stomach-contents of only five specimens and stated that 98.5% of the total food-contents was animal matter of which 9.5% consisted of remains of voles, moles and shrews ; 2.5% of young birds ; 4.5% of frogs, toads and newts ; 61% of fish ; 3.5% of molluscs ; 8.5% of injurious insects ; 3% of crustaceans ; 1.5% of earthworms ; and 4.5% of miscellaneous unidentifiable matter. The only remains of vegetable matter was 1.5% of fragments of seeds and bits of stems of some aquatic plant. Townsend (1926) states that the fish of all sorts are chief food of the European heron but worms, water-insects, mites, newts, frogs, water-voles and young birds are all taken. Brown (1927) found that the chief large prey were chub 6, eel 10, trout 6, wood-mouse 6, water-vole 7, rabbit 2, obtained from regurgitated food in several nests in the Lake District, England. In Italy, Moltoni (1936, 1948) examined the stomach contents of nestling and adult herons during April, May and June. There were 20 snakes, 12 frogs and one mammal and 22 fishes among the large prey. The small prey consisted of insects, mole crickets, and beetles. In the opinion of Lowe (1954, p. 65) the heron in Great Britain feeds on aquatic and terrestrial animals such as fish, frogs, beetles, moles, water-voles and rats. It is omnivorous since it swallows much vegetable matter for pellet formation. Owen (1955, 1960) studied the food-habits of the heron in detail and found that it is essentially a fish-eating bird feeding chiefly at the edges of the rivers, streams, ponds and lakes. It also feeds on young water-birds, shrimps and insects. Usually fishes ranging from 50 to 600 mm. long are caught. It shows preference for prey within certain size-limits. He has also made minute observations of the food-habits of the young. He estimated that a brood of heron receives on an average 230 pounds of food during the nestling period and that certain herons tended to specialise on certain species of prey, apparently because they often returned to the same feeding area. Voous (1960, p. 16) stated that its food consists of a wide variety of aquatic marsh animals, apparently mainly fish of medium or small size; also frogs, newts, aquatic insects, snails, large land snails and small mammals. These records show how different the food habit of the Grey Heron may be in different localities.

The detailed analysis of the stomach-contents of 76 adult specimens of the Indian subspecies that the author collected in the Sundarban is given in Table 4.

TABLE 4

ANALYSIS OF THE STOMACH-CONTENTS OF THE GREY HERON

(N—Number of examples.
Weight—Total weight (in grammes) of examples of all species under a Class.
Length of fish—Its standard length).

Items of diet	No.	Wt.(g)	%(Wt.)	Remarks
Phylum Chordata				
Class Mammalia				
Order Rodentia				
Family MURIDAE				
Mus sp.	13			Partly digested.
Total:	13	400	2	
Class Aves				
Order Passeriformes				
Sturnus contra ? (chick)	12			Partly digested.
Total:	12	600	3.66	
Class Reptilia				
Order Squamata				
Suborder Serpentes				
Family COLUBRIDAE				
Natrix sp.	10			Partly digested.
Total:	10	350	1.8	
Class Amphibia				
Order Anura				
Family RANIDAE				
Rana cyanophlyctis Schneider	120			
Family BUFONIDAE				
Bufo sp. (tadpole)	15			Partly digested. Not identifiable.
Total:	135	450	2.35	

Items of diet	No.	Wt.(g)	%(Wt.)	Remarks
Series Pisces Class TELEOSTOMI Order Cypriniformes Family ARIIDAE				
Tachysurus sp.	21			
Family CLARIIDAE				
Clarias batrachus (Linnaeus)	47			Length 30-50 mm. Common in ponds.
Family BAGRIDAE				
Mystus gulio (Hamilton)	210			Length 20-50 mm. Estuarine form. Invariably present in stomachs.
Order Anguilliformes Family ANGUILLIDAE				
Anguilla bengalensis (Gray)	38			Length 40-70 mm. Estuarine form.
Family MURAENIDAE				
Muraena tile (Hamilton)	10			Length 50-75 mm. Estuarine form.
Order Beloniformes Family BELONIDAE				
Strongylura strongylura (Van Hasselt)	7			Length 30-45 mm. Estuarine form.
Order Cyprinodontiformes Family CYPRINODONTIDAE				
Aplocheilus panchax (Hamilton)	176			Length 25-35 mm. Common in inundated fields. Invariably found in stomachs.
Oryzias melastigmus (McClelland)	96			Length 30-50 mm. Common in inundated fields.
Order Muguliformes Family MUGULIDAE				
Mugil tade Forskål	39			Length 30-50 mm. Estuarine form.
Mugil parsia Hamilton	47			Length 40-60 mm. Estuarine form.
Chelon sp.	6			Length 45-65 mm. Estuarine form.
Rhinomugil corsula (Hamilton)	13			Length 30-60 mm. Estuarine form.
Order Polynemiformes Family POLYNEMIDAE				
Polynemus paradiseus Linnaeus	29			Length 50-80 mm. Estuarine form.
Order Ophiocephaliformes Family CHANNIDAE				
Channa gachua (Hamilton)	28			Length 40-60 mm.

Items of diet	No.	Wt.(g)	%(Wt.)	Remarks
Order Symbranchiformes				
Family AMPHIPNOIDAE				
Amphipnous cuchia (Hamilton)	35			Length 50-100 mm.
Order Perciformes				
Family LATIDAE				
Lates calcarifer (Bloch)	17			Length 50-90 mm. Estuarine form.
Family ANABANTIDAE				
Anabas testudineus (Bloch)	62			Length 40-70 mm.
Family GOBIIDAE				
Glossogobius giuris (Hamilton)	30			Length 50-75 mm.
Family PERIOPTHALMIDAE				
Boleopthalmus boddaerti (Pallas)	147			Estuarine form. Invariably present in stomachs.
Periopthalmus sp.	203			-do-
Order Mastocembeliformes				
Family MASTOCEMBELIDAE				
Mastocembelus armatus (Lacépéde)	14			Length 80-110 mm. Estuarine form.
Mastocembelus pancalus (Hamilton)	18			Length 70-100 mm. Estuarine form.
Order Tetrodontiformes				
Family TETRODONTIDAE				
Chelonodon patoca (Hamilton)	6			Estuarine form.
Chelonodon fluviatilis (Hamilton)	4			Estuarine form.
Miscellaneous fish remains	..			Not identifiable.
Total :	1303	6500	34.55	
Phylum Mollusca				
Class GASTROPODA				
Order Basommatophora				
Family LYMNAEIDAE				
Lymnaea sp.	22			Freshwater form.
Class BIVALVIA				
Family ARCIDAE				
Arca sp.	104			Estuarine form.
Total :	126	750	3.80	
Phylum Arthropoda				
Class CRUSTACEA				
Order Decapoda				
Family PENAEIDAE				
Metapenaeus brevicornis Milne-Edward	95			Estuarine form. Invariably present in stomachs.

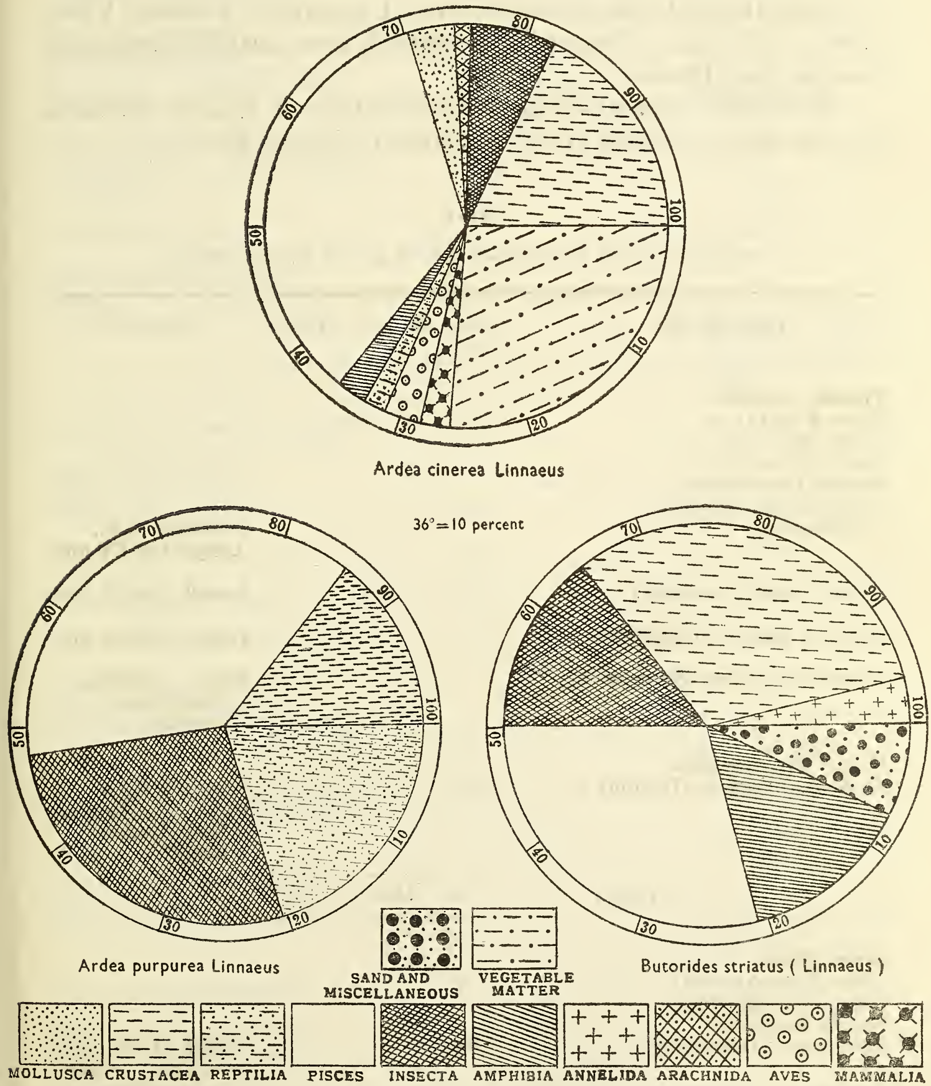
Items of diet	No.	Wt.(g)	%(Wt.)	Remarks
Metapenaeus monoceros Fabricius	172			Estuarine form. Invariably present in stomachs.
Family PORTUNIDAE				
Scylla serrata (Forskål)	180			Estuarine form. Invariably present in stomachs.
Portunus pelagicus (Linnaeus)	16			Estuarine form.
Family GRAPSIDAE				
Varuna litterata (Fabricius)	230			Estuarine form. Invariably present in stomachs.
Total:	693	3500	18.27	
Class INSECTA				
Order Hemiptera				
Family CORIXIDAE				
Micronecta sp.	182			Freshwater form. Invariably present in stomachs.
Family BELESTOMATIDAE				
Belestoma sp.	90			Quite common in stomachs.
Order Coleoptera				
Family DYTISCIDAE				
Eretes stictus Linnaeus	176			Quite common in stomachs.
Family HYDROPHILIDAE				
Berosus sp.	62			
Fragments of insects	..			Elytra, heads, appendages etc. Not identifiable.
Total:	510	1300	6.80	
Class ARACHNIDA				
Order Araneae Total ..	335	250	1.30	Partly digested.

The whole of the food consumed is of animal nature. Of this 2% consists of mammals (rodents), 3.66% birds, 1.80% water-snakes, 2.35% Amphibia (tadpoles, young frogs and toads), 34.55% fishes (except two species all are of commercial value), 3.80% Mollusca, 18.27% Crustacea (prawns and crabs, most of which are of commercial value), 6.80% aquatic insects and 1.30% spiders (Text-fig. 3).

Since nearly half the total bulk of its food is fishes and crustaceans of commercial importance, this species may be regarded as non-beneficial to human economy.

Ardea purpurea manilensis Meyen, The Purple Heron

The Purple Heron, *Ardea purpurea manilensis* Meyen, is found in well-watered regions of India, and inhabits marshes, jheels, estuarine creeks and the reedy vegetation along tidal rivers. It wades through



Text Fig. 3. Diagrammatic representation of the percentages of food of *Ardea cinerea*, *Ardea purpurea*, and *Butorides striatus*.

shallow waters and hunts in luxuriant vegetation of marshes, or stands motionless hiding itself in the reeds, grass, or thickets of mangrove waiting for aquatic organisms to come within its darting range to fall victim to it. It feeds mostly in the early morning and late evening hours.

Jerdon (1864, p. 744) recorded : ' It feeds on fish, frogs &c.' Blanford (1898, p. 381) mentioned that ' it not infrequently feeds at night.' Baker (1929, p. 338) remarked : ' Besides fish, frogs, newts, insects and mollusca, all form part of its ordinary fare and any unfortunate young birds which happen to come its way are at once bolted whole.'

About the food of the European form, *A. p. purpurea* Linnaeus, Voous (1960, p. 16) states : ' It seems to eat relatively more small fish and insects than the Grey Heron.'

The detailed analysis of the stomach-contents of 70 adult specimens that the author collected in the Sundarban is given in Table 5.

TABLE 5

ANALYSIS OF THE STOMACH-CONTENTS OF THE PURPLE HERON

Items of diet	No.	Wt.(g)	%(Wt.)	Remarks
Phylum Chordata				
Class REPTILIA				
Order Squamata				
Suborder Serpentes				
Family COLUBRIDAE				
Achrochordus granulatus (Schneider)	3			Estuarine form. Length 110-170 mm.
Natrix stolata (Linnaeus)	27			Length 80-190 mm.
Enhydris enhydris (Schneider)	3			Length 80-160 mm.
Cerberus rhynchops (Schneider) ?	5			Partly digested, identification doubtful.
Family HYDROPHIDAE				
Hydrophis obscurus (Daudin) ?	10			Estuarine form. Partly digested, identification doubtful.
Total :	48	2150	20.57	
Series Pisces				
Class TELEOSTOMI				
Order Cypriniformes				
Family Bagridae				
Mystus gulio (Hamilton)	300			Length 20-40 mm. Invariably present in stomachs.

Items of diet	No.	Wt.(g)	%(Wt.)	Remarks
Order Anguilliformes Family ANGUILLIDAE				
Anguilla bengalensis (Gray)	198			Length 40-75 mm. Estuarine form. Invariably present in stomachs.
Family MURAENIDAE				
Muraena tile (Hamilton)	18			
Order Beloniformes Family BELONIDAE				
Strongylura strongylura (van Hasselt)	3			Estuarine form.
Family HEMIRHAMPHIDAE				
Hemirhamphus gaimardi Valenciennes	4			-do-
Xenarchopterus sp.	2			-do-
Order Cyprinodontiformes Family CYPRINODONTIDAE				
Aplocheilus panchax (Hamilton)	29			Common in brackish water and inundated paddy-fields.
Oryzias melastigmus (McClelland)	21			-do-
Order Muguliformes Family MUGILIDAE				
Mugil parsia Hamilton	18			Estuarine form.
Mugil tade Forskål	16			-do-
Chelon macrolepis (Smith)	9			-do-
Chelon oligolepis (Bleeker)	6			-do-
Order Polynemiformes Family POLYNEMIDAE				
Eleutheronema tetradactylus (Shaw)	3			Estuarine form.
Polynemus heptadactylus Linnaeus	22			-do-
Polynemus paradiseus Cuvier & Valenciennes	7			-do-
Order Ophicephaliformes Family CHANNIDAE				
Channa gachua (Hamilton)	21			Length 30-70 mm. Freshwater form.
Channa punctata (Bloch)	7			Length 60-90 mm. Freshwater form.
Order Symbranchiformes Family SYMBRANCHIDAE				
Symbranchus bengalensis (McClelland)	6			Length 40-80 mm.

Items of diet	No.	Wt.(g)	%(Wt.)	Remarks
Family AMPHIOPNOIDAE				
Amphiopneus cuchia (Hamilton)	7			Length 50-100 mm.
Order Perciformes				
Family LATIDAE				
Lates calcarifer (Bloch)	18			Estuarine form.
Family GOBIIDAE				
Glossogobius sp.	6			
Family PERIOPTHALMIDAE				
Boleopthalmus boddaerti (Pallas)	76			Common in tidal mudflats and shallow water.
Periopthalmus sp.	81			Common in tidal mudflats and shallow water.
Family ANABANTIDAE				
Anabas testidineus (Bloch)	19			Found in fresh and brackish water ponds.
Family AMBASSIDAE				
Ambassis sp.	22			Freshwater form.
Family THERAPONIDAE				
Therapon puta Cuvier	6			
Family Platycephalidae				
Platycephalus sp.	7			Estuarine form.
Order Pleuronectiformes				
Family CYNOGLOSSIDAE				
Cynoglossus lingula (Hamilton)	6			-do-
Order Mastocembeliformes				
Family MASTOCEMBELIDAE				
Mastocembelus armatus (Lacépéde)	8			Brackish water form.
Mastocembelus pancalus (Hamilton)	4			-do-
Order Tetrodontiformes				
Family TETRODONTIDAE				
Chelonodon patoca (Hamilton)	10			Estuarine form.
Chelonodon fluviatilis (Hamilton)	3			-do-
Total:	963	6000	57.0	
Phylum Arthropoda				
Class CRUSTACEA				
Order Decapoda				
Family Penaeidae				
Metapenaeus brevicornis Milne-Edward	29			Estuarine form.
Metapenaeus monoceros Fabricius	17			-do-
Family PORTUNIDAE				
Scylla serrata (Forskål)	31			Estuarine form. Invariably found in stomachs.

Items of diet	No.	Wt.(g)	%(Wt.)	Remarks
Portunus sp.	3			Estuarine form.
Family GRAPSIDAE				
Varuna litterata (Fabricius)	106			Estuarine form. Invariably present in stomachs.
Family OCYPODIDAE				
Uca sp.	18			Estuarine species, inhabiting mud-flats.
Total:	204	1500	14.34	
Class INSECTA				
Order Dermaptera				
Family LABIDURIDAE				
Labidura sp.	7			
Order Hemiptera				
Family GERRIDAE				
Halobates sp.	91			Aquatic form. Quite common in stomachs.
Order Odonata				
Suborder Anisoptera				
Family LIBELLULIDAE				
Libellulids	39			Aquatic form.
Suborder Zygoptera				
Ceriagrion sp.	8			-do-
Ischneura sp.	9			-do-
Order Coleoptera				
Family DYTISCIDAE				
Eretes stictus Linnaeus	25			Not identifiable.
Miscellaneous insect fragments				
Total:	179	800	7.65	

The bird appears to have little selection in its food. Anything actively moving is appropriated. Surprisingly, however, frogs and tadpoles are absent from its diet (Text Fig. 3). The main item of diet is fish (57%), but it also has a preference for reptiles (20.57%), specially snakes. Crustaceans and insects are also on the list, but in small percentages (14.34% and 7.65% respectively). Snakes as long as 190 mm. are swallowed, and fishes 20-100 mm. Most of the fishes are brackish water forms but those birds which have been collected from the fresh-water reedy swamps consumed freshwater fishes also.

Since it feeds on some commercial fishes and crustaceans it may be considered as a bird not particularly friendly to the fisherman.

Butorides striatus chloriceps (Bonaparte), The Little Green Heron

In Sundarbans, the Little Green Heron, *Butorides striatus chloriceps* (Bonaparte), is nowhere abundant and is met with only in secluded bogs and swamps. It prefers salt-marshes of tidal zone to freshwater marshes. The mangrove swamps are its haunt where between the knee roots, stilts and pneumatophores, it leads a secluded life stalking stealthily, taking to cover of vegetation when disturbed. It is nocturnal but sometimes hunts in the daytime under the canopy of dense foliage, specially during early morning and late evening. It perches on low branches overhanging water and with its keen observant eyes marks the target by swiftly diving upon it.

Its food chiefly consists, as stated by Jerdon (1864, p. 753) of crabs. Blanford (1898, p. 396) found that it looks for crabs, frogs and small fishes. Baker (1929, p. 358) mentions : 'They live almost entirely on small fish, frogs, crabs and molluscs . . . .' According to Ali (1955, p. 105) its food is crabs, shrimps, and mudfishes.

The detailed analysis of the stomach-contents of 26 adult specimens that the author collected in the Sundarban is given in Table 6.

TABLE 6

ANALYSIS OF THE STOMACH-CONTENTS OF THE LITTLE GREEN HERON

Items of diet	No.	Wt.(g)	%(Wt.)	Remarks
Phylum Chordata				
Class AMPHIBIA				
Order Anura				
Family RANIDAE				
Rana sp. (Tadpoles)	24			Partly digested.
Rana cyanophlyctis Schneider ?	2			Sub-adult. Partly digested.
Family BUFONIDAE				
Bufo melanostictus Schneider	3			Sub-adult.
Total :	29	95	13.80	
Series Pisces				
Class TELEOSTOMI				
Order Cypriniformes				
Family CYPRINIDAE				
Puntius sp.	19			Length 5-20 mm. Not uncommon in stomach.
Family BAGRIDAE				
Mystus sp.	10			Length 10-30 mm. Partly digested.

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Family ARIIDAE				
Tachysurus sp.	1			Estuarine form. Partly digested.
Family CLARIIDAE				
Clarius batrachus (Linnaeus)	1			Length 35 mm. Common in brackish water ponds.
Family SACCOBRANCHIDAE				
Heteropneustes fossilis (Bloch)	1			Length 40 mm. Not uncommon in fresh-water jheels
Order Ophiocephaliformes				
Family CHANNIDAE				
Channa punctata (Bloch)	3			Length 30-50 mm.
Order Perciformes				
Family ANABANTIDAE				
Anabas testidineus (Bloch)	2			Found in fresh and brackish water. Partly damaged.
Family GOBIIDAE				
Glossogobius giuris (Hamilton)	5			Length 30-50 mm. Found in fresh as well as brackish water pools.
Family PERIOPTHALMIDAE				
Periopthalmus sp.	55			Length 20-50 mm. Invariably present in stomachs. Very common in tidal mudflats.
Boleopthalmus sp.	11			
Miscellaneous fish remains				Not identifiable.
Total:	108	200	29	
Phylum Arthropoda				
Class CRUSTACEA				
Order Decapoda				
Family PENAEIDAE				
Metapenaeus sp.	28			Partly mutilated.
Family PORTUNIDAE				
Scylla serrata (Forskål)	17			Common in brackish water *bheries* and also in ponds.
Portunus pelagicus (Linnaeus)	3			Common in brackish water *bheries* and also in ponds.
Family GRAPSIDAE				
Varuna litterata (Fabricius)	30			Very common in brackish water and mudflats.
Miscellaneous Crustacea (fragments)				Not identifiable
Total:	78	220	31.80	

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Class INSECTA Order Orthoptera Family LOCUSTIDAE				
Chrotogonus sp.	5			Pest of paddy and other vegetables.
Family TETTIGIDAE				
Acrydium sp.	6			Pest of paddy nurseries.
Order Mantoidea Family MANTIDAE				
Mantis religiosa Linnaeus	9			Insect predator.
Order Dermaptera Family APACHYIDAE				
Apachyus sp.	3			Found in damp places under decaying leaves, etc.
Family LABIDURIDAE				
Labidura sp.	9			
Family FORFICULIDAE				
Forficula sp. (Claspers)	4			6 pairs.
Order Hemiptera Family GERRIDAE				
Halobates sp.	7			Brackish water bug. Seen on tidal waters.
Family CORIXIDAE				
Corixa sp.	3			Freshwater form.
Micronecta sp.	1			do
Order Coleoptera Family DYTISCIDAE				
Eretes stictus (Linnaeus)	11			Freshwater form.
Miscellaneous insect fragments				Not identifiable.
Total :	58	100	14·50	
Phylum Annelida Class CHAETOPODA Order Oligochaeta Family MEGASCOLICIDAE				
Earthworms	9+			Digested beyond identification.
Family NAIDIDAE *Limnodrilus* sp.	100+			Tangled mass.
Order Polychæta				In bits and digested beyond identification.
Total :	109+	25	3·62	
Sand and miscellaneous		50	7.25	

So far it has been reported to feed only on aquatic animals, but the above analysis reveals that it also takes terrestrial insects, such as grasshoppers and mantids, and toads. Crustaceans which form the major bulk of its food constitute 31.80% and consist mostly of commercial species. Next to the crustaceans are fishes (29.0%). In the stomachs of 26 birds, altogether 108 examples of fishes were found, representing 11 species of fresh and brackishwater forms, which are mostly mud-fishes of little commercial value. They are small, their length varying from 5 to 50 mm. Except some orthopteran pests of agriculture and the insect predator *Mantis*, other insects are of minor significance, the proportion of total insect food being 14.50%. More tadpoles than frogs and toads are consumed. They form 13.80% of the total bulk. Annelids, both freshwater as well as brackish water forms, are consumed in very small proportions (3.62%) (Text Fig. 3).

It is more or less a harmless bird, the only discredit being that it consumes some crustaceans of commercial value.

Ardeola grayii grayii (Sykes), The Indian Pond Heron

The Pond Heron, *Ardeola grayii grayii* (Sykes), is a bird invariably associated with creeks, estuaries, rivers, tanks, ditches, and other stretches of water. It is found throughout India. In the Sundarban, it is seen both in the reclaimed as well as in the forested areas. It is sedentary and is common in inundated paddy-fields and also in ditches running along embankments. In the forested area it is less common, being seen among reeds and mangroves, and on mud-flats of creeks and tidal rivers. It generally waits patiently with poised neck at the edge of water and as soon as its prey comes within range, it strikes with its bill and collects the prey.

Jerdon (1864, p. 751) stated : 'Its special food is crabs, for which it watches patiently, either in the water or in the fields, and specially on the small raised bunds or divisions between rice-fields. It will, of course, also eat fish, frogs, and various aquatic insects.' Mason & Lefroy (1912, p. 286) examined the stomachs of four examples and found that of the 76 insects taken by the bird, 52 were beneficial, 14 injurious and 10 neutral ; one stomach contained a fish and a prawn, and another a blade of grass. Whistler (1928, p. 397) mentioned : 'It feeds chiefly on frogs, crabs, small fishes, insects, and the other miscellaneous life that has its being in or near water . . . .' Baker (1929, p. 355) wrote : 'When waiting for its food, frogs, crabs, mudfish, etc., it sits hunched up, a dowdy patient little figure not easy to spot against a dark background . . . In addition to its fish and reptile diet it eats all kinds of large insects as well as worms, grubs, and termites.' Ali (1955, p. 105) observed that its food is frog, fish, crabs and insects.

The detailed analysis of the stomach-contents of 105 adult specimens that the author collected in the Sundarban is given in Table 7.

TABLE 7

ANALYSIS OF THE STOMACH-CONTENTS OF THE POND HERON

Items of diet	No.	Wt.(g)	%(Wt.)	Remarks
Phylum Chordata				
Class AMPHIBIA				
Family RANIDAE				
Rana cyanophlyctis Schneider	23			
Rana limnocharis Wiegmann	18			Common in paddy fields.
Rana sp. (tadpoles)	32			Partly digested.
Family BUFONIDAE				
Bufo melanostictus Schneider	16			Subadult.
Total:	89	640	16	
Series Pisces				
Class TELEOSTOMI				
Order Cypriniformes				
Family CYPRINIDAE				
Puntius sp.	17			Length 5-30 mm. Freshwater form.
Chela sp.	29			Length 10-30 mm.
Danio sp.	6			Length 10-25 mm.
Family BAGRIDAE				
Mystus gulio (Hamilton)	101			Length 30-60 mm. Estuarine form. Invariably present in stomachs.
Order Perciformes				
Family AMBASSIDAE				
Ambassis sp.	90			Freshwater form. Invariably, present in stomachs.
Family GOBIIDAE				
Glossogobius sp.	6			Brackish water form.
Total:	249	360	9	
Phylum Mollusca				
Class GASTROPODA				
Order Archaeogastropoda				
Family NERITIDAE				
Nerita sp.	4			Brackish water form.
Order Mesogastropoda				
Family VIVIPARIDAE				
Viviparus sp.	18			Freshwater form.
Family LITTORINIDAE				
Littorina sp.	3			Freshwater form.

Items of diet	No.	Wt.(g)	%(Wt.)	Remarks
Family MELANOIDAE				
Melanoides sp.	6			Freshwater form.
Order Basommatophora				
Family LYMNAEIDAE				
Lymnaea sp.	29			Freshwater form.
Family PLANORBIDAE				
Indoplanorbis sp.	7			Freshwater and land form.
Total:	67	640	16	
Phylum Arthropoda				
Class CRUSTACEA				
Order Decapoda				
Family PALAEMONIDAE				
Macrobrachium lamarrei (Milne-Edward)	26			Freshwater form. Quite common in stomachs.
Family ATYIDAE				
Caridina gracilipes de Man	6			Freshwater form.
Family PALAEMONIDAE				
Macrobrachium rude (Heller)	10			do
Family PENAEIDAE				
Metapenaeus brevicornis Milne-Edward	40			Brackish water form.
Metapenaeus monoceros Fabricius	31			do
Family POTAMONIDAE				
Paratelphusa (*Barytelphusa*) *jacquemontii* (Rathbun)	7			Freshwater form
Family PORTUNIDAE				
Scylla serata (Forskål)	18			Brackish water form.
Portunus pelagicus (Linnaeus)	3			do
Family GRAPSIDAE				
Varuna litterata (Fabricius)	28			do
Miscellaneous Crustacean fragments				Not identifiable.
Total:	169	940	23·50	
Class ARACHNIDA				
Order Araneae				
Family ARGYOPIDAE				
Araneus mitifica (Thorell)	27			
Family TETRAGNATHIDAE				
Ecuta javanica Thorell	12			

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Family LYCOSCIDAE				
Lycosa sp.	16			
Hippasa sp.	9			
Family OXYOPIDAE				
Oxyopes sp.	6			
Spiders in fragments				Not identifiable.
Total :	70	40	1·00	
Class INSECTA				
Order Orthoptera				
Family LOCUSTIDAE				
Chrotogonus sp.	11			Pest of paddy.
Attractomorpha sp.	28			Pest of cultivated plants.
Oxya sp.	6			do
Acrotylus sp.	37			do
Family TETTIGIDAE				
Acrydium sp.	6			do
Order Dermaptera				
Family LABIDURIDAE				
Labidura sp.	18			
Family FORFICULIDAE				
Forficula sp.	22			Head and claspers.
Order Odonata				
? species				Almost digested. Not identifiable.
Order Hemiptera				
Family NEPIDAE				
Laccotrephes sp.	29			Aquatic form.
Family BELOSTOMATIDAE				
Belostoma sp.	11			do
Order Coleoptera				
Family DYTISCIDAE				
Eretes stictus Linnaeus	52			do
Laccophilus sp.	33			do
Bidessus sp.	17			do
Family GRYNIDAE				
Dineutes sp.	29			do
Family HYDROPHILIDAE				
Berosus sp.	13			do
Hydrophilus sp.	31			do
Miscellaneous Insect fragments				Not identifiable.
Total :	343	300	7·50	
Vegetable matter Total :		880	22·00	Partly digested. Unidentifiable.

The food consists of arthropods, specially Crustacea (23.5%) and some Insecta (7.50%) representing both aquatic and terrestrial forms. Spiders are taken in very small quantity (1%). Mollusca found in the stomachs are generally with complete shells, representing mostly small, freshwater forms. Tadpoles, adult frogs and toads are taken in good proportion (16%). Tadpoles are preferred to adult frogs and toads. From the stomachs of 105 birds, 249 examples of fishes were found, representing six species, forming 9% of the total bulk. These fishes represent both fresh and brackish water forms of some commercial value, but are small-sized, the standard lengths varying from 5 to 60 mm. A good quantity of vegetable matter of aquatic origin (22%) is also added to the menu (Text-Fig. 4).

It may be regarded as a harmless bird.

Nycticorax nycticorax nycticorax (Linnaeus), The Night Heron

The Night Heron, *Nycticorax nycticorax nycticorax* (Linnaeus), is a common bird of the Sundarban area. It is found in colonies, and it occupies groves near about waters of jheels, tidal creeks and mangrove swamps. Its ideal resorts are the trees that stand in water of the brackish water fisheries (*gheries*), where water is sufficient and fishes are in plenty. Though it is nocturnal in habit yet it may be found to start its activities in the afternoon hours, specially on cloudy days. Normally it starts for the marshes for feeding at dusk, and it hunts in shallow waters of rivers, ponds throughout practically the whole night.

The food of the Night Heron in India as stated by Blanford (1898, p. 398) is composed of fish, frog, etc. Whistler (1928, p. 399) states that its food is varied; like that of the other herons, and consists of small fish, Amphibia, Crustacea and aquatic insects. Baker (1929, p. 361) mentions that it feeds on fish, frogs, crabs, Crustacea and worms. Ali (1955, p. 106) stated that the food items are crabs, fish, frogs and aquatic insects.

The food of the allied subspecies of the Night Heron in U.S.A. has been studied in greater detail. Judd (1900, p. 435), states that 10 adults and 10 nestlings' stomachs contained only fish; in another heronry, young were fed on trout, pickerel and herring. Baynard (1912, pp. 167-169) found that 50 meals of young Night Heron in Florida consisted of 60 crayfish, 610 small catfish, 31 small pickerel and 79 dragonflies. Latham (1914, p. 112) mentioned that it was also known to eat algae. Wetmore (1920, p. 394) found the birds feeding on dead salamanders in New Mexico. He further observed that it fed on water-dogs (Ambystoma) and frogs, at Lake Burford, New Mexico, where they acted as scavengers by eating dead Axolotls, floating on water. Gross (1923, pp. 1-30, 191-214) stated that at Sandy Neck, its food could be identified as marine annelids, chiefly *Nereis virens*, crustaceans, represented by numerous shrimps, sandhoppers and a few small crabs, insects (chiefly beetles), flies and dragonflies (nymphs), all present in negligible quantities. Of the Mollusca he found only squids which were probably picked up dead. The only freshwater animals found were tadpoles and adults of Fowler's toad. He further examined (1923, p. 19) some 100 regurgitations and found that these consisted of 80% fish, chiefly whiting, herring and cunners, the whiting found dead on beach, marine worms, crustaceans, insects and mollusca, young birds. Shapeles (cited by Bent, 1926, p. 208) found in the stomach of this species a frog and a snake about a foot long.

The European subspecies, Voous (1960, p. 18) mentions, feeds on a great variety of aquatic animals, mainly fish.

The detailed analysis of the stomach-contents of 78 adult specimens of the Night Heron that the author collected in the Sundarban is given in Table 8.

TABLE 8

ANALYSIS OF THE STOMACH-CONTENTS OF THE NIGHT HERON

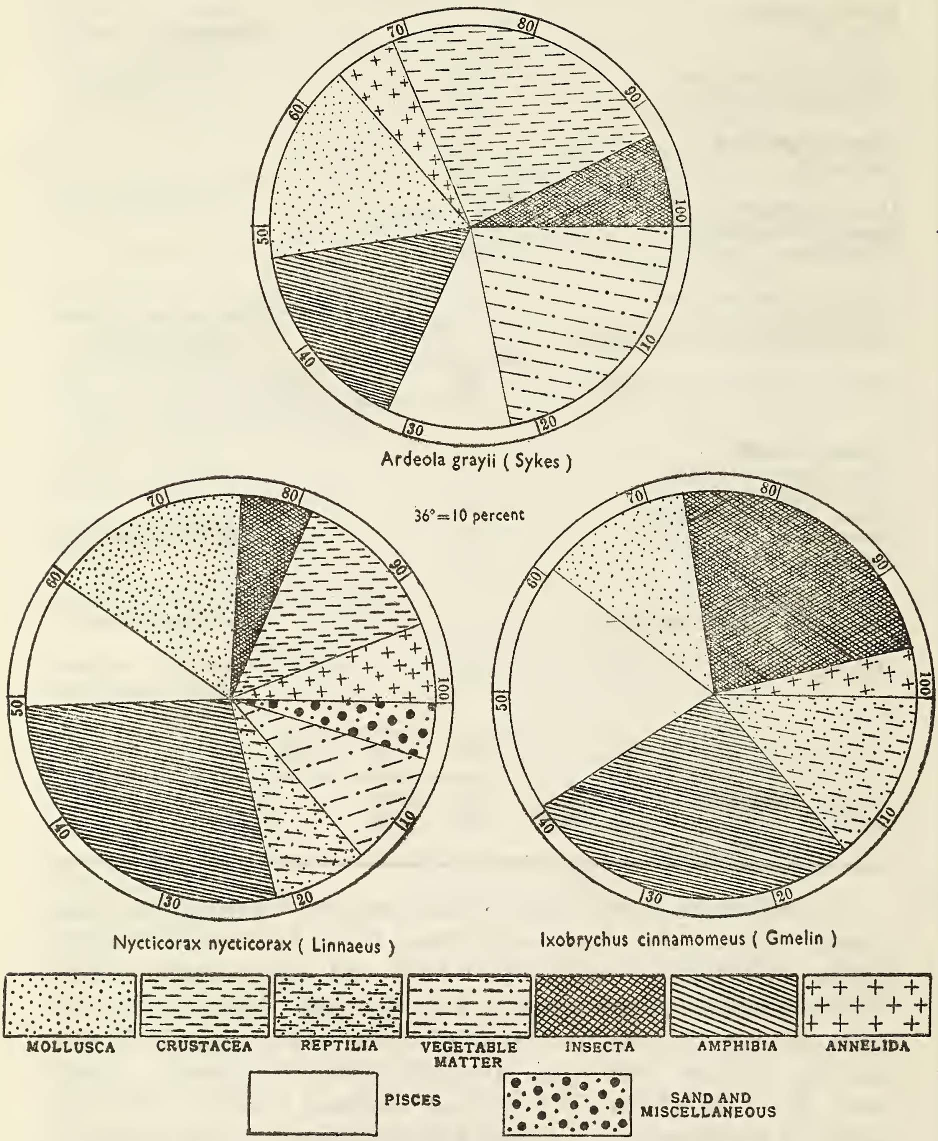
Items of diet	No.	Wt.(g)	%(Wt.)	Remarks
Phylum Chordata				
Class REPTILIA				
Order Squamata				
Suborder Serpentes				
Family COLUBRIDAE				
Natrix sp.	6			Total length 40-120 mm. Partly digested.
Family HYDROPHIIDAE				
Hydrophis sp. ?	3			Partially digested. Identification doubtful.
Total:	9	85	7·65	
Class AMPHIBIA				
Order Anura				
Family RANIDAE				
Rana sp. (tadpoles)	80			Some partly digested.
Rana limnocharis Wiegmann	15			
Total:	95	310	27·92	

Items of diet	No.	Wt.(g)	%(Wt.)	Remarks
Series Pisces				
Class TELEOSTOMI				
Order Cypriniformes				
Family BAGRIDAE				
Mystus gulio (Hamilton)	18			Length 5-20 mm.
Order Anguilliformes				
Family ANGUILLIDAE				
Anguilla bengalensis (Gray)	3			Length 20-60 mm.
Order Cyprinodontiformes				
Family CYPRINODONTIDAE				
Oryzias melastigmus (McClelland)	5			Length 10-20 mm.
Order Perciformes				
Family GOBIIDAE				
Goboides sp. ?	3			Partially digested.
Family PERIOPTHALMIDAE				
Periopthalmus koelreuteri (Pallas)	32			Partially digested. Invariably present in stomachs.
Boleopthalmus boddaerti (Pallas)	6			
Order Mastocembeliformes				
Family MASTOCEMBELIDAE				
Mastocembelus pancalus (Hamilton)	3			Length 60-100 mm.
Total:	70	115	10·36	
Phylum Mollusca				
Class GASTROPODA				
Order Basommatophora				
Family LYMNAEIDAE				
Lymnaea sp.	20			Freshwater form. Not uncommon in stomachs.
Family PLANORBIDAE				
Indoplanorbis sp.	12			
Order Archaeogastropoda				
Family NERITIDAE				
Nerita sp.	1			
Order Mesogastropoda				
Family VIVIPARIDAE				
Viviparus bengalensis (Lamarck)	22			Freshwater form. Not uncommon in stomachs.
Family MELANOIDAE				
Melanoides tuberculatus (Müller)	15			
Total:	70	180	16·16	

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Phylum Arthropoda				
Class CRUSTACEA				
Order Decapoda				
Family PENAEIDAE				
Metapenaeus sp.	2			Brackish water form. Partially digested.
Family PALAEMONIDAE				
Macrobrachium sp.	5			Freshwater form. Partially digested and partly damaged.
Macrobrachium rude (Heller)	8			Freshwater form.
Family PORTUNIDAE				
Scylla serrata (Forskål)	2			Brackish water form.
Portunus pelagicus (Linnaeus)	1			do
Portunus sanguinolentus (Herbst)	1			do
Family GRAPSIDAE				
Varuna litterata (Fabricius)	9			do
Family OCYPODIDAE				
Uca sp.	13			
Miscellaneous crustacean fragments.				Not identifiable.
Total :	41	135	12·17	
Class INSECTA				
Order Orthoptera				
Family LOCUSTIDAE				
Acrydium sp.	4			Found on grass and reeds growing near about or in standing water.
Chrotogonus sp.	6			
Order Odonata				
Suborder Zygoptera				
Naiads	2			Partially digested beyond identification.
Suborder Anisoptera				
Family AESCHNIDAE				
Aeschna sp. ? (naiads)	5			do
Family LIBELLULIDAE				
Pantala sp. (naiads)	7			
Order Hemiptera				
Family GERRIDAE				
Gerris sp.	5			Freshwater form.
Family NAUCORIDAE				
Laccocoris sp. ?	2			do

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Family NEPIDAE				
Nepa sp.	3			Freshwater form.
Family NOTONECTIDAE				
Notonecta sp.	6			do
Family CORIXIDAE				
Corixa sp.	8			
Order Coleoptera				
Family DYTISCIDAE				
Gyrinus sp.	2			do
Family HYDROPHILIDAE				
Berosus sp.	3			Freshwater form.
Miscellaneous insect fragments.				Not identifiable.
Total :	53	65	5·85	
Phylum Annelida				
Class CHAETOPODA				
Order Oligochaeta				
Family MEGASCOLECIDAE				
Pheretima sp.	10			Partially digested.
Eutyphoeus sp. ?	7			
Family NAIDIDAE				
Limnodrilus socialis Stephens	..			In tangled mass.
Order Polychæta	18			Partially digested, therefore not identifiable.
Total :	35	70	6·30	
Vegetable matter Total :	100	9·09		
Sand Total :	50	4·50		

The food of the Night Heron is chiefly composed of aquatic organisms, namely, aquatic snakes, frogs and tadpoles, fishes, molluscs, crustaceans, aquatic insects and annelids, both fresh and brackish water forms. Besides, it takes vegetable matter of aquatic origin. Mostly small organisms comprise its food ; the length of snakes varies from 40-120 mm. and that of fishes 5-100 mm. The bulk of food is, however, largely made up of Amphibia (27.92%) and Mollusca (16.16%) consisting mostly of freshwater and damp soil inhabiting species. The proportion of Crustacea is 12.17%, which comprises more crabs than shrimps. The bird consumes only 10.36% of fishes which have practically no commercial value and are mostly mud-dwellers. Except two terrestrial species (grasshoppers) all the insects are aquatic. It prefers soft-bodied insects, such as naiads of damselflies and dragonflies, and aquatic bugs and a few beetles also. The other group which constitute a comparatively small portion of its diet is Annelida (6.30%). The vegetable food is made up of aquatic weeds which form 9.0% of the total bulk (Text-Fig. 4).



Text Fig. 4. Diagrammatic representation of the percentages of food of *Ardeola grayii, Nycticorax nycticorax nycticorax* and *Ixobrychus cinnamomeus.*

Sand constitutes 4.50% and is perhaps accidentally taken while picking food.

It may, therefore, be concluded that it is a harmless bird.

Ixobrychus cinnamomeus (Gmelin), The Chestnut Bittern

The Chestnut Bittern, *Ixobrychus cinnamomeus* (Gmelin), is a common bird of lower Bengal, specially in the Sundarban area. It is a bird of the inner recesses of the mangrove swamps, thick rush and reedy marshes of the still or tidal waters. It is crepuscular in habit, and very secretive, though during the day time under cover of darkness of thick vegetation it frequently forages in a slow stealthy manner.

No published data on the food-habits of this bittern could be traced. However, with regard to a close cousin of this bird, the American Least Bittern, *Ixobrychus exilis* (Gmelin), Bent (1926, p. 88) found that it hunts for various forms of animal life found in the places it lives.

The detailed analysis of the stomach-contents of eight specimens of the Chestnut Bittern that the author collected in the Sundarban is given in Table 9.

TABLE 9

ANALYSIS OF THE STOMACH-CONTENTS OF THE CHESTNUT BITTERN

Items of diet	No.	Wt.(g.)	%(Wt.)	Remarks
Phylum Chordata				
Class REPTILIA				
Order Squamata				
Suborder Serpentes				
Family COLUBRIDAE				
Natrix stolata (Linnaeus)	1			Length 70 mm.
Natrix sp.	6			Length 40-60 mm. Partly digested.
Total :	7	75	13·40	
Class AMPHIBIA				
Order Anura				
Family RANIDAE				
Rana sp. (Tadpoles)	30 –			Partly digested.
Rana limnocharis Wiegmann	6			
Rana cyanophlyctis Schneider ?	3			
Family BUFONIDAE				
Bufo sp.	2			
Miscellaneous tadpoles				Not identifiable.
Total :	41	150	26·80	
Series Pisces				
Class TELEOSTOMI				
Order Ophiocephaliformes				
Family CHANNIDAE				
Channa punctata (Bloch)	10			Length 30-40 mm. Freshwater pond form.

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Order Perciformes				
Family AMBASSIDAE				
Ambassis sp.	7			Freshwater form. Partially digested.
Family SCIAENIDAE				
Johnius sp.	9			Length 20-30 mm. Brackish water form. Partly digested.
Family GOBIIDAE				
Glossogobius giuris (Hamilton) ?	2			Length 30-40 mm. Fresh and brackish water form.
Family PERIOPTHALMIDAE				
Periopthalmus koelreutari (Pallas)	40 –			Invariably present in stomachs, some mutilated.
Order Mastocembeliformes				
Family MASTOCEMBELIDAE				
Mastocembelus armatus (Lacépède) ?	2			Partly digested.
Mastocembelus pancalus (Hamilton)	10			Length 50-70 mm. Fresh and brackish water form.
Miscellaneous fish remains.				Not identifiable.
Total :	80	110	19·64	
Phylum Mollusca				
Class GASTROPODA				
Order Archaeogastropoda				
Family NERITIDAE				
Nerita sp.	6			Partly broken shells.
Order Mesogastropoda				
Family PILIDAE				
Pila sp.	19			do. Invariably present in stomachs.
Total :	25	65	11·60	
Phylum Arthropoda				
Class INSECTA				
Order Orthoptera				
Family LOCUSTIDAE				
Acrotylus sp.	15			Pest of paddy nurseries.
Acrydium sp.	8			do.
Chrotogonus sp.	12			Pest of vegetables etc.

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Order Dermaptera (Fragments, claspers etc.)				
Order Odonata Suborder Zygoptera Family COENAGRIIDAE Naiads	14			Invariably present in stomachs.
Suborder Anisoptera Family AESCHNIDAE Naiads	2			
Order Hemiptera Family PENTATOMIDAE *Coptosoma* sp.	2			Pest of bean, lab-lab.
Aspongopus sp. ?	1			Pest of Cucurbitaceae.
Family NEPIDAE *Laccotrephes* sp.	2			Aquatic form.
Ranatra sp.	2			do.
Family BELOSTOMATIDAE *Belostoma* sp.	2			do.
				Mostly elytra and appendages.
Order Coleoptera *Eretes stictus* Linnaeus	9			Aquatic form.
Laccophilus sp.	5			do.
Family GRYNIDAE *Dineutes indicus* Aube	3			do.
Family HYDROPHILIDAE *Hydrophilus* sp.	1			do.
Family RUTELIDAE *Anomala* sp.	2			Pest of garden plants
Family MELOIDAE *Mylabris* sp.	9			Pest of Graminae.
Canthris sp.	2			Pest of cowpea. Elytra only.
Order Lepidoptera (larvae)				Mutilated beyond identification.
Total:	91	140	23·21	

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Phylum Annelida				
Class CHAETOPODA				
Order Oligochaeta				
Family NAIDIDAE				
Limnodrilus sp.	100+			Tangled mass.
Family MEGASCOLECIDAE				
Pheretima sp.	10+			In bits. Partly digested.
Order Polychaeta sp. ?	10+			In bits. Digested beyond identification.
Total :	120+	20	2·56	

The food of the Chestnut Bittern consists wholly of animal matter (Text Fig. 4). Amphibia (tadpoles, frogs and toads) form the largest bulk of its food (26.80%). The fishes taken are small 20-70 mm. in standard length, mud-dwellers of fresh and brackish waters, and are of little commercial value. They constitute 19.64% of the total bulk of food. Snakes found in stomachs, representing two aquatic species are very small (total length of 40-70 mm). The insects constitute 23.21%, comprising mostly of aquatic forms and some terrestrial pests of agricultural crops. Out of the 91 examples of insects representing 15 species 51 representing 8 species were found to be injurious pests of agricultural crops. The Mollusca is represented by two species of gastropods (11.60%). A very small proportion of Annelida (3.56%) comprising freshwater Oligochaeta and brackish water Polychæta are also added to the menu.

From the above analysis it may be generalized that it is a bird helpful to agriculture to some extent.

(To be continued)

A Review of the Recovery Data obtained by the Bombay Natural History Society's Bird Migration Study Project

By

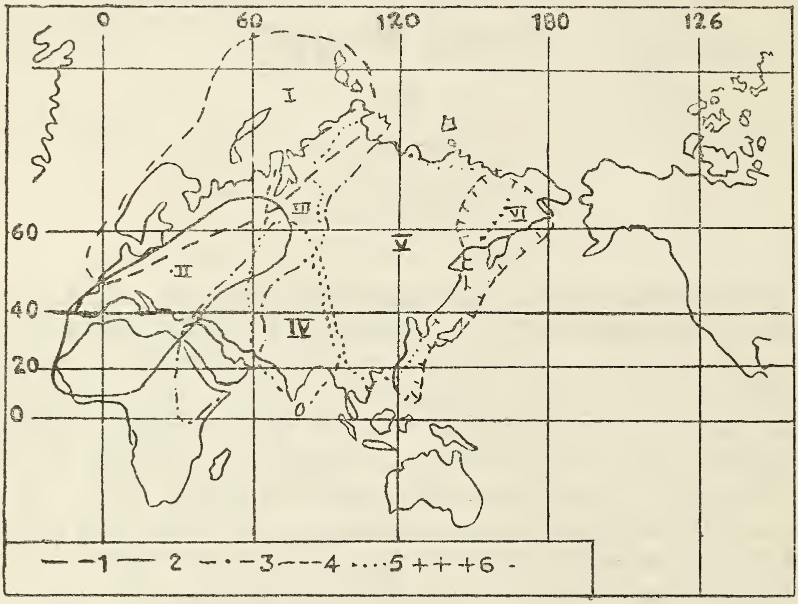
D. N. Mathew

(*With a text-figure*)

Study of bird migration on a continuing basis was started by the Society in September 1959 to investigate (1) the routes used by birds moving into and out of India in autumn and spring and (2) the role of birds in disseminating arthropod-borne viruses. Up to mid 1969, 1, 32, 368 migratory and resident passerine and non-passerine birds of 25 families and 150 species have been ringed, and recoveries recorded of 520 birds ; 451 of these being from places outside India, namely Burma, East and West Pakistan, Afghanistan, the U.S.S.R., and Cyprus, and 69 from within the country. The gross recovery is slightly under 4 birds for every thousand ringed, a figure far too low for suggesting definite conclusions. My aim in this paper is to review the recovery data in a consolidated form and to examine what light these throw on the origin and routes of our migratory birds. The recovery information on the more numerous species is discussed in detail and compared with local observations published in the Society's *Journal* and the *Ibis* within the last fifty years. The data obtained from random ringing of ducks by the Society's members between the years 1920 and 1940 are also used, but references to the total number of birds ringed mean unless mentioned otherwise only those ringed by the Society or its collaborators at various stations between 1959 and mid-1969.

Recoveries of Ducks and Teals

The Society has ringed 7740 migratory ducks and teals (Family Anatidae) mainly at Bharatpur, Rajasthan; Monghyr, Bihar; near Dibrugarh, Assam (M. J. S. Mackenzie) and at Chilka Lake in Orissa. At Orissa ringing was done in collaboration with the Genetics and Biometry Laboratory, Bhubaneshwar. Including recovery data from other sources I have examined 438 duck recovery records, out of which 386 were either ringed or recovered in the U.S.S.R. One has to examine not less than 50 cases of each species ringed or recovered in their breeding area to know precisely the area of origin of our ducks. This is possible only for one species at the present time. Yu. A. Isakov (1965) demarcated 7 distinct populations of waterfowl in Russia.



Area of the main geographical populations of the water fowl of the USSR
After Yu. A. Isakov and T. P. Shevareva

I. The Northern Baltic—North Sea. II. The European = Siberian—Black Sea = Mediterranean. III. The West Siberian—Caspian = Nile, IV. The Siberian = Kazakhstan—Pakistan = India. V. The East Siberian = Amur—Korean = Chinese. VI. The Far North = Eastern—Japanese. VII. (Not shown on map) The Cheukotka—North American population.

Isakov's grouping is summarised in the map above. As a rule the areas occupied by neighbouring populations overlap one another. Populations II-VI, all contain large numbers of surface feeding ducks (Mallard, Teal, Garganey, Pintail, Wigeon and Gadwall) all of which concern us. The wintering grounds of population II (Black Sea and Mediteranean) are getting reduced due to reclamation of wetlands. Members of IV (Kazakhstan-Indian) should, according to this grouping, be dominant among the ducks wintering in our country. This population breeds (Isakov 1965), in West Siberia to the north up to the mouth of the Irtish and the greater part of Kazakhstan and Middle Asia. Population V (East Siberian-Chinese) breeds, in an extensive area from the Enisei (longitude *c.* 90°E), in Central Russia to the Pacific

Ocean and from the Tundra of Siberia to the southern boundaries of Russia. In interpretation of recoveries of ducks ringed in India, one should keep in mind the drawbacks listed below :

1. There are only 438 recovery reports available for examination.
2. There is a possibility of mixing and interchange of breeding populations in areas where their breeding grounds overlap. This is possible in the cases of population II to V.
3. As Isakov points out the wintering grounds get altered by reclamation of wetlands and creation of artificial reservoirs. These may influence the selection of wintering grounds by birds.
4. Migration maps constructed by connecting points of ringing with those of recovery are therefore only of limited usefulness and are not meant to indicate actual migration routes.

Anas acuta Pintail

Out of a total of 1551 Pintail ducks ringed at Bharatpur, Chilka Lake, Orissa, Monghyr and Dibrugarh, Assam, 64 have been recovered from places in the U.S.S.R between Kara Kalpakskaya (*c*. 42° 25′N ; 59° 30′E.) and Yakutian (*c*. 62° 32′N ; 113° 48′E). Out of the 64, twenty-one were recovered within or before the next spring. There were 8 recoveries within Indian limits. Including recoveries of birds ringed elsewhere, I have examined 78 Pintail recoveries. From a total of 22 Pintails ringed by Mr. Mackenzie near Dibrugarh in February 1966, one was recovered in Buriyatian (*c*. 52° 20′N ; 106° 23′E) ASSR on 6 May, 1966 and another in Novosibirsk Region (*c*. 54° 22′N; 77° 18′E) on 5 October 1966. The northernmost point from which a Pintail was reported was in Tyumen Region (*c*. 66° 30′N ; 67° 48′E) where a Bharatpur ringed (19 October, 1965) bird was reported on 27 May 1967. Twelve other Pintails ringed at Bharatpur in October 1966 were recovered in the USSR (Table 1). A female Pintail ringed at Chilka Lake (*c*. 19° 49′N ; 86° 40′E) on 15 January 1967 was reported in Tomsk Region (*c*. 57° 22′N ; 83° 54′E) on 11 May 1967 at a straight-line map distance of some 4000 km. north of Orissa. There are old records of three Astrakhan Pintails recovered in Gujaranwala district, West Pakistan, Ahmedabad, and 50 km. south of Madras city. Two Kurgaldzhin (*c*. 50° 30′N ; 69° 35′E) birds were recovered at Srinagar, Kashmir and Bhuj, Kutch and a Novosibirsk Pintail near Etah, U.P. (*c*. 27°N ; 72′E). The oldest recovery is of a pintail ringed at Dhar (*c*. 22° 35′N ; 75° 29′E) in February 1926 and recovered near the River Tira (*c*. 62°N ; 100°E) on 25 May 1927. The following observations are also interesting :

Sheriff (1929) recorded many flights of Pintail between Yarkand and Karghalik (*c*. 39°N ; 77°E) late in February. Ludlow (1934) noted large flocks of Pintail passing through Kashgar, Chinese Turkestan, in late February and saw a female with ducklings at the junction of Rivers Agiass and Tekkas (*c*. 43°N ; 81′E) on 12 May, and collected

TABLE 1

RECOVERIES OF PINTAIL (*Anas acuta*) RINGED AT BHARATPUR

Sl. No.	Date of ringing	Sex	Date of recovery	Place of recovery	Co-ordinates	Straight-line map distance from Bharatpur
1.	21-x-1966	♂	3-iii-1967	Kara-Kalpa-kskaya	42° 25′N; 59° 30′E.	*c*. 2250 km.
2.	23-x-1966	♂	11-iii-1967	Tashkent	41° 15′N; 68° 00′E.	*c*. 2100 km.
3.	6-x-1966	♂	5-iii-1967	Fergana	40° 13′N; 70° 50′E.	*c*. 1750 km.
4.	6-x-1966	♀	19-iii-1967	Alma-Ata	43° 21′N; 77° 36′E.	*c*. 1750 km.
5.	10-x-1966	♂	22-iii-1967	Alma-Ata	45°40′N; 79° 26′E.	*c*. 2400 km.
6.	23-x-1966	♂	27-iii-1967	Alma-Ata	45° 56′N; 78° 45′E.	*c*. 1900 km.
7.	13-x-1966	♀	12-iv-1967	Altaisk	50° 54′N; 80° 06′E.	*c*. 2600 km.
8.	8-xii-1967	♂	3-v-1968	Tyumen	60° 40′N; 69° 45′E.	*c*. 3600 km.
9.	23-x-1967	♂	15-v-1968	Irkutsk	57° 24′N; 98° 10′E.	*c*. 3600 km.
10.	26-x-1967	0 ?	24-v-1968	Yakutian, ASSR.	62° 72′N; 113° 48′E.	*c*. 4600 km.
11.	27-ii-1968	♂	13-v-1968	Tomsk	57° 3′N; 86° 9′E.	*c*. 3400 km.
12.	3-iii-1968	♀	10-v-1968	Krasnoyarsk	63° 10′N; 88° 00′E.	*c*. 4100 km.

Pintails at Goma (*c*. 37° 40′N ; 78° 15′E) in September. Further south Pintail has been observed on passage at : Chitral (*c*. 36°N ; 71′E), Perreau (1910) ; Kohat (*c*. 33° 30′N ; 71° 30′E), Whitehead (1911) ; Zuildo, east of Wular Lake (*c*. 34° 20′N ; 76°E) on 27 June 1927, Osmaston (1930). Ticehurst (1927) and Christison (1941) observed Pintail passing through Baluchistan both in spring and autumn. One Bharatpur ringed pintail (February) was shot at Sangroor, Punjab in December the same year. Further east the species was observed at Ngayeze (*c*. 30° 40′N ; 81° 30′E) in June, Sâlim Ali (1946) ; Ghazipur (*c*. 25° 30′N ; 83° 30′E) Briggs (1934) ; on the large rivers at Jalpaiguri District (*c*. 27°N ; 89°E) Inglis *et al.* (1920) ; and at Kala Lake, Tibet (*c*. 38°20′N ; 89° 20′E) Ludlow (1928). In Northern Mongolia E. V. Kozlova (1932) recorded big flocks on Lake Orok Nor (*c.* 45°N ; 101'E), on 4 April. All these observations—except where months were given—were made between February and April.

An interesting local recovery of a male Pintail ringed at Bharatpur on 18-x-1965 was made at Karimnagar in Andhra Pradesh (*c.* 18° 26'N ; 79° 8'E) in the 2nd week of December, 1965. Further south, Nichols (1945) found Pintails fairly common in Madurai District up to March. In the recent wildfowl count organized by the wildfowl survey, Subbiah Pillai (*in lit.* ; 1967) counted about 1,000 Pintail at a tank in Tirunelveli District on January 9. Phillips (1956) considered the species as a frequent visitor to Ceylon arriving at the end of November and leaving in late March and April. Ringing of the species in south India will help in understanding its movements in peninsular India and Ceylon.

To summarise, 78 recoveries of Pintail were examined out of which 62 were from the breeding or wintering range of Kazakhstan population of Russia. Out of the 62, seventeen were of Indian ringed birds recovered in Russia between April and June, a period within which these could be either in movement or breeding. Ten Indian birds were recovered in East Siberia, (5 in May), and two in the range of the West Siberian population of the USSR.

Anas crecca Common Teal

The Society has ringed 3093 birds of this species, and up to August 1969, 185 birds were recovered, out of which 175 were from outside India. I have examined 21 recoveries of the species ringed elsewhere. Out of 567 common teals ringed in Monghyr District (*c.* 25° 30'N ; 86° 30'E) Bihar (1964-65), 39 were recovered till August 1969, 24 of the recoveries being reported in East Siberia. Of these 24, fifteen were recovered in April and May, and 7 among these within a space of 6 months from the time of ringing. Where these eastern birds cross the Himalayas and whether they fly over directly north from their wintering grounds as is suggested if one literally interprets recovery maps, cannot be satisfactorily answered with the available information.

La Touche (1934), recorded the Common Teal as occurring all over China in winter in very large numbers. In northern Mongolia, Kozlova (1932) found this teal to be a common breeding bird in the Kentei Region (they were on Lake Orok Nor from 5 April to middle of May). Inglis *et al.* (1920) found the Common Teal migrating in large flocks through Jalpaiguri District (*c.* 27°N ; 89°E), in April. Ludlow (1928) noted the species passing through Gyantse, Tibet, in spring and autumn and in 1944 found enormous numbers of Mallard, Common Teal, Wigeon, Pintail, Tufted and White-eyed Pochards at Yamdrok Tso (*c.* 29°N ; 91°E) in mid-March (Ludlow 1927). He believed that the ducks congregating around Gyantse, cross the Himalayas directly south and north at the appropriate time. Ludlow reasoned that since the distance between Gyantse and the Indian plains could be covered within a few hours' flight the birds would prefer a direct course. Dorst (1962) observes ' birds do not take the easiest routes over mountains— the travellers do not hesitate to cross the highest peaks '. Desirée Proud (1949) found the Common Teal to be abundant during the migrations and regularly crossing the Nepal Valley (*c.* 27-28°N ; 85-86°E) both during autumn and spring. The two Bihar ringed Common Teals recovered in Kashmir, and Uzbekistan (*c.* 40° 22'N ; 71° 47'E) fit Savage's (1965) suggestion that some of the eastern Indian birds may cross the Himalayas over the Hindukush as well.

At Bharatpur the Project ringed 2517 Common Teals up to July 1969 out of which 141 have been recovered so far; 110 of these 141 within the breeding area of the Kazakhstan population and 56 during or before the following spring (i.e. within the next 6 months), and 7 in West Pakistan. Earlier, the Bharatpur Durbar had ringed some Common Teals in winter from which 2 were recovered from West Pakistan and one from Kabul, in the following spring. Two Bharatpur ringed Common Teals were recovered in the breeding area of the European population (II) of Russia. The westernmost point from which a Bharatpur bird was reported is in Uralsk (*c.* 51° 17'N ; 51° 23'E) and the easternmost in Yakutian, ASSR (*c.* 60° 48'N ; 114° 12'E). Among Bharatpur birds recovered in the breeding area of population IV, thirty-one were reported within a narrow sector between latitudes 38° 06'N - 45° 24'N and longitudes 66° 56'E - 79° 58'E, (e.g. Tadjik 6, Uzbek 6, and Kazakh SSR 9) and 27 of these between 2 March and 12 April. Further south, Bharatpur-ringed birds were also recovered in Afghanistan, near Kabul* (*c.* 34°N ; 69°E) ; in Pakistan, Peshawar* (*c.* 34°N ; 71°E), Sialkot (*c.* 32° 30'N ; 74° 32'E), Chiniot (*c.* 31° 40'N ; 73°E) ; Sheikhpura (*c.* 34°N ; 74°E) ; Gujaranwala (*c.* 32°N ; 74°E), Swat (*c.* 34°N ; 73°E). One Bharatpur-ringed bird was collected at Jammu Tawi (*c.* 32° 30'N ; 75°E) near the River Chenab on 2-I-1967, and another in Kashmir (*c.* 35°N ; 75'E) according to a report dated 25-V-68. The exact date was not given.

Going through earlier observations one finds that Whistler (1922) noted the Common Teal to be most abundant in Jhang District, Punjab, and considered the Jhelum and Chenab as routes for migrating water birds moving north into Central Asia. In Afghanistan according to Whistler (1945), Common Teals are very common winter visitors as well as passage migrants. Ticehurst (1927), found the species passing through Munshi Char (*c.* 29°N ; 62°E) in Baluchistan ; Meinertzhagen

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* Indicates birds ringed by the Bharatpur Durbar.

(1927) saw a few on the Indus (at 10,500 ft.) at Moulbekh (*c.* 34° 20′N ; 76° 20′E) in April which he believed to be on passage. In sum the pattern of recoveries of Common Teals ringed by the Project align favourably with earlier observations. Generally Common Teals ringed in India were recovered in the breeding areas of 3 population, II, IV and V of water-fowl in the USSR. More precisely, 77% of the recoveries of Bharatpur-ringed birds were reported within the breeding area of the Kazakhstan population of Russia, and 39% in the spring following the ringing. Sixty-two per cent of the recoveries of Bihar-ringed Common Teals were reported in East Siberia, but only 25% of these recoveries were made in the spring following their ringing.

Anas querquedula Garganey

The Project has ringed 984 Bluewinged or Garganey Teals (927 of these at Bharatpur) till August 1969. Thirty-eight recoveries were reported till August 1969. Including data of birds ringed elsewhere, I have examined 45 recoveries of this species. Of the 38 recoveries obtained by the Society, 31 were from the breeding area of the Kazakhstan population of the USSR, in Kazakhstan, Altai and Novosibirsk. Ten out of the 31 recoveries were made between the months of May and July, and 13 were recovered in spring of the following year. There were 2 recoveries of Bharatpur-ringed Garganeys in the breeding area of the European population of Russia, one 4 months and the other 17 months after ringing. There is a reverse case of a Garganey ringed in Leningrad district on 22 July 1961 and recovered in Sangli district (*c.* 17°N ; 75° E—Maharashtra) on 28 December 1962. A male ringed at Bharatpur on 3 October 1965 and recovered at Krasnoyarsk (57° 42′N ; 93° 15′E) on 12 May 1967, is the only Bharatpur bird recovered in East Siberia. From the area between Bharatpur and Kazakhstan, one Garganey was recovered in Kashmir (*c.* 34°N ; 74°E) on 9 March 1969 and another in Haryana (*c.* 29°N ; 76°E) on 11 January 1969. There is a record of a Russian-ringed Garganey recovered at Larkhana, Sind (*c.* 27° 50′N ; 68° 8′E) in the same year.

In China, La Touche (1934) found the Garganey to be distributed generally as a migrant. In North Mongolia, Kozlova (1932) found nest with fresh eggs on the River Tola (*c.* 47° 37′N ; 107°E) on 9 June. Her first date for Lake Orok Nor was 21 April. In Chinese Turkestan, Ludlow & Kinnear (1934) found the Garganey in pairs on 11 May at Tekkes (*c.* 43°N ; 80° 30′E) and considered the species as common in Tekkes in May and early June. Ludlow also shot birds with gonads in breeding condition then. The same authors saw a flock of twenty Garganey on the Gabshan Lake, Ladak, on 12 August.

Meinertzhagen (1927) while camped at Khardong (*c.* 34° 20′N ; 77° 45′E) at an altitude of 13,500 ft. saw a party of eight Garganey Teals being forced to settle on earth on 30 July. He considered the incident as showing how autumn passage of ducks takes place over some of the highest parts of the Himalayas.

In Bharatpur the Garganey is chiefly a passage migrant, numbers arriving as early as August. Peak numbers are reached in October and by mid-November most of the birds have passed on presumably for S. India and Ceylon where vast concentrations occur in winter. The species is comparatively rare in winter but becomes abundant again in March/April when on return (northward) passage. It is one of the earliest migrant ducks to arrive and the last to leave its winter quarters.

There are four interesting local recoveries. In one case a Garganey ringed at Bharatpur on 17 October 1965 was shot near Madurai (*c.* 10°N ; 78°E) on 21 January 1966. A second bird ringed at Bharatpur on 12 October 1966, was recovered in roughly the same direction as the above but some 500 miles north of it in Medak District, A.P. (*c.* 18°N ; 79°E) on 8 January 1967. In another case a Bharatpur-ringed Garganey was reported two years later (in October) in Tiruchirapalli district (*c.* 10° 16′N ; 78° 8′E), and the last case was of a Bharatpur bird recovered at Attur, Salem district (*c.* 12°N ; 78°E) in January, a year after ringing. Nichols (1945) recorded Garganey as fairly common in winter in Madurai District. Subbiah Pillai (in lit. 1967) counted flocks of a few hundreds of Garganey at tanks in Coimbatore, Tiruppur, Palni and Tirunelveli, Tamil Nadu. At a tank in Thatchanellur, Tirunelveli district, Mr. Pillai counted about 2000 Garganey Teals on 4 December 1966. In Ceylon, Phillips (1956) found the Garganey to be a regular visitor between November and May. He surmised that the Garganeys visiting Ceylon cross the Himalayas over Nepal and move southwards to Ceylon along the east coast of India. The Bharatpur birds recovered in Salem, Tiruchirapalli and Madurai districts point to the possibility that the Garganeys from North-western India move down further south across the Deccan to southern India and Ceylon. These may cross the sea between Point Calimere and Adam's Bridge, but as yet there is no factual evidence to support this suggestion, and birds must be ringed in South India and Ceylon to test it. Two Bharatpur Garganeys ringed on successive days moved in nearly opposite directions : one ringed on 10 October 1966 was shot at Hardoi, U.P., about 160 miles east of Bharatpur on 1 November, the other ringed on 11 October was shot at Tonk, Rajasthan, 125 miles SW. of Bharatpur 3 days after ringing. Inglis (1920), and Desirée Proud (1955) found the Garganey migrating in large flocks through Jalpaiguri district and the Nepal Valley respectively between August and October. Biswas (1960) observed the Garganey on a tank in Kathmandu in mid-March and April. To summarise : 31 of 38 Garganey Teal ringed in India were recovered in the breeding area of the Kazakhstan population of Russia. These recoveries fit neatly with the earlier observations on Garganey migration at high altitudes in the Western Himalayas and in Chinese Turkestan. There were two recoveries of Bharatpur birds in the area of the European, and one in that of the East Siberian populations of Russia. There were four recoveries of Bharatpur Garganeys in south India (Tamil Nadu).

Anas clypeata Shoveller

Out of a total of 621 birds ringed by the Project, 36 were recovered outside India up to October 1968. Among these were 3 (out of 9) Shovellers ringed by P. V. George at Manjhaul, Bihar, in February and March 1964. The latter (2 females, 1 male) were all recovered in East Siberia : one of the 3 was recovered 78 days later, the second five months, and the third a year later. Savage (1965) suggested that the Shovellers wintering in eastern India breed and moult in E. Siberia. The other shoveller recoveries were as follows : December, one recovered at Samana, Patiala; January, one at Sargodha, W. Pakistan ; February, one each at Amritsar (near Sutlej), Punjab, Multan, W. Pakistan ; March, one each at Samarkand, near Asht in Tadjik, and on River Chu in Kazakhstan, and two in Alma Ata ; April, one each at Karaganda and Altai ; May, seven at Tomsk, two at Krasnoyarsk and one at Bulaevo, Kazakhstan. Between the months August and October there were 9 more recoveries of Bharatpur Shovellers at Fergana, Alma Ata, Altai, Pavlodar, Novosibirsk, Tomsk and Tyumen Regions and on the delta of the Selenga (*c.* 52° 20′N ; 106° 30′E) in the USSR. All these birds were ringed at Bharatpur between 1965 and 1969 and fifteen of the recoveries were reported within 6 months from date of ringing. A Shoveller ringed at Chilka Lake on 16-I-1967 was recovered at the Yakutian (*c.* 63°N ; 118°E) in E. Siberia on 26 August 1967. In Southern Tibet, Ludlow (1928) found the Shoveller to be fairly numerous in November. In North Burma, Stanford and Ticehurst (1939) found Shovellers passing farther south about 20 October. In north-east Chihili, China, La Touche (1921) found the Shoveller passing about the 10th of March to the middle of May and again in the early half of October. According to Madame Kozlova (1932) this species breeds in northwestern and northern Mongolia and was noted as early as 5 April on Lake Orok Nor. In the west, Meinertzhagen (1920) recorded Shovellers on migration at Quetta (Baluchistan) up to 19 May, in large numbers. Christison (1941) found the species on migration in large numbers at Zangi Nawar, Baluchistan, and Fulton (1904) in Chitral. Meinertzhagen (1927) found a large flock of the species on the Indus near Leh (*c.* 34° 20′N ; 77° 36′E) on 1 May, on passage. Ludlow & Kinnear (1934) found the Shoveller in the following places in Chinese Turkestan ; Charbagh (28 March) Maralbashi, Tekkes (May) and Deskit (5 July). At Maralbashi these authors had found Shovellers in pairs and were informed by the local people that the species breeds there.

The recovery of a female Shoveller ringed in Bharatpur on 24 October 1966 from Samana in Patiala (*c.* 30° 9′N ; 76° 15′E) on 26 December 1966 is interesting. W. M. Hutton had ringed Shoveller in Patiala some 40 years ago (*J. Bombay nat. Hist. Soc.* **47** : 694) and one of these ringed in March 1929 had been recovered near the River Tara (56° N ; 76°E) a month later. In summary the 38 recoveries obtained so far of the Shovellers ringed in India are from the breeding area of the Kazakhstan and E. Siberian populations of the U.S.S.R. Based on British ringing records, Dorst (1962) estimated the Shovellers to have a high percentage of recovery (19·8%). Perhaps we can expect more recoveries of the species.

Aythya ferina Common Pochard

Out of 428 pochards ringed by the Society up to 1969 the following birds were recovered (Table 2). All the recovered birds were ringed at Bharatpur in the winter of 1968.

Table 2

Recoveries of the Common Pochard (*Aythya ferina*)

Month of recovery	Place of recovery	Number recovered
1968		
November	Gurgaon Dt., Haryana (*c.* 28° N; 77°E)	1
December	Amritsar Dt., Punjab (*c.* 32°N; 75°E)	1
1969		
January	Gurgaon Dt., (*c.* 28°N; 77°E)	1
February	Surkhan-Darya, USSR (*c.* 37° 11′N; 67° 18′E)	1
March	Sargodha, W. Pakistan (*c.* 32° 4′N; 72° 43′E)	1
May	Tomsk Region, USSR (*c.* 56° 17′N; 84° 00′E)	1
,,	Tyumen Region, USSR (*c.* 64° 18′N; 65° 26′E)	1
,,	,, ,, ,, (*c.* 55° 56′N; 67° 39′E)	1
August	Balkhash Lake (*c.* 46° 6′N; 75°E)	1
September	Samarkand (*c.* 40° 34′N; 65° 41′E)	1
,,	Balkhash Lake (*c.* 46° 00′N; 74° 14′E)	1
,,	Aktyubinsk (*c.* 47° 50′N; 59° 36′E)	1
,,	Tselinograd (*c.* 52° 40′N; 70° 26′E)	1
,,	Sasyk-kul Lake (*c.* 46° 30′N; 81°E)	1
,,	Kokchetav (*c.* 53° 19′N; 69° 22′E)	1
,,	Novosibirsk (*c.* 55° 24′N; 78° 21′E)	1
,,	-do- (*c.* 54° 54′N; 80° 41′E)	1
,,	Semipalatinsk (*c.* 48° 45′N; 82° 25′E)	1
,,	Tyumen (*c.* 55° 48′N; 68° 19′E)	1

To sum up all our recoveries of the Common Pochard from Bharatpur have been reported from the breeding and/or wintering area of the Kazakhstan population of this duck in the USSR.

Recoveries of Waders

Family Charadriidae

Tringa glareola Spotted Sandpiper

The Project has ringed 4645 birds of this species to date and has received reports of 13 recoveries, three within the country and 10 extra-limitally. These birds were ringed at Bharatpur, in Bihar, and near Calcutta. Besides, two of the Spotted Sandpipers ringed by Dr. B. Biswas near Calcutta since 1967 with rings of the Zoological Survey of India have also been recovered in Eastern Siberia in July and August 1967. Of the ten recoveries of this species mentioned earlier six were reported in East Siberia. These six included 3 ringed at Monghyr district, Bihar, and 3 ringed near Calcutta. A Bharatpur bird was recovered in Tyumen Region, some 19 months after ringing and another at Krasnoyarsk 20 months after ringing. A Calcutta bird (5 April 1967) was recovered in Novokazalinsk (*c.* 45° 45′N ; 62° 9′E) USSR on 20 May 1967.

An interesting recovery of a Bharatpur sandpiper (ringed 30.x.1967) was reported from Periakotta village near Sivaganga (*c.* 9° 51′N ; 78° 30′E) on 22.xii.1968 ; and another Bharatpur bird (6.x.1967) at Rail Bazar, Lyallpur, W. Pakistan (*c.* 31° 42′N ; 73° 12′E) on 23.iv.1968. For the very long distances covered by this species between points of ringing and recovery, the spotted sandpipers apparently travelled fairly fast. One individual ringed at Calcutta on 6 April reached the Magadan Region in E. Siberia on 24 May. If one were to assume that this bird had moved out of Calcutta on the day after ringing and had covered the approximate straight-line map distance of *c.* 6100 km. within the next 48 days, its average rate of movement would be about 123 km./day. Between northeast India and E. Siberia there are a few records of its movement. La Touche (1921) found the spotted sandpiper very common on passage through Chinwangtao (*c.* 40°N ; 120°E) China, in August, 1st week of September and again in the beginning of May, Kozlova (1932) noted the species as a common breeding bird throughout SW. Transbaikalia, and the Tola and Kangai Regions of Mongolia. It first appeared on Lake Orok Nor on 19 May. Stanford and Ticehurst (1939) found the species to be very common in North Burma from August to the 3rd week of May. In the Nepal Valley, Desirée Proud (1955) found the species to be a common passage migrant during both spring and autumn. From the northwest there are records of the species as a passage migrant in Punjab : abundant passage migrant from March to May and July to September in the Jhang and Rawalpindi district, (Whistler 1922, 1930) ; Baluchistan plentiful on passage in April and May at Quetta, (Meinertzhagen 1920) ; Ladak, (*c*. 34° 20′N ; 77° 36′E), at altitude of 11,500 ft. on 7 and 14 May in Leh, (Meinertzhagen 1927) ; and one female obtained on 18 September at Yarkand, (Ludlow & Kinnear 1934). In summary, eight out of nine sandpipers ringed in Monghyr and Calcutta were recovered from East Siberia. There were only four recoveries of Bharatpur-ringed birds. These were from Sivaganga (Tamil Nadu), Rail Bazar (W. Pakistan), Krasnoyarsk and Tyumen (USSR). There are observations on the movements of this widespread species between India and Russia from the west as well as the east.

Philomachus pugnax Ruff

The Society has ringed 4293 birds of this species and has had 25 recoveries from Russia and East and West Pakistan and twelve from within India. Twenty-three of the extralimital recoveries are of Bharatpur-ringed birds. The Russian recoveries were reported from a wide area stretching from Turkmenia (*c*. 42° 20′N; 58° 55′E) in the west to Magadan (*c*. 62° 50′N ; 148° 11′E) in the east, and from Tedzhen (37° 23′N ; 60° 30′E) in the south to Norlinsk (*c*. 69° 20′N ; 88° 13′E) in the north. Seven of these Russian recoveries were from points west of longtitude 90°E. and 4 from east of it. There was one recovery of a Bharatpur Ruff four months after ringing from north of Kabul City.

In West Pakistan our birds were recovered near Lahore, at Hafizabad in Gujaranwala district and at Sargodha ; in East Pakistan in Jessore district (*c*. 23°N ; 89° 30′E) and Rupganj in Dacca (*c*. 23° 40′N ; 90° 20′E).

Three interesting inland recoveries of Ruff from eastern India are presented below (Table 3) along with two extralimital ones suggesting

TABLE 3

RECOVERIES OF THE RUFF (*Philomachus pugnax*)

Sl. No.	Sex	Ring No.		Date of ringing	Date of recovery	Place of recovery
1.	♀	B	8245	1-x-1965	23-xii-1966	Gonda, U.P. (*c*. 27° 28′N ; 81° 31′-82° 46′E)
2.	♂	B	1609	3-x-1965	13-ii-1966	Ramkola, U.P. (*c*. 26° 30′N; 83° 30′E)
3.	♂	AB	8264	20-x-1965	16-ii-1966	Jessore Dist., E. Pakistan (*c*. 23°N; 89° 30′E)
4.	♀	AB	8926	17-x-1965	16-i-1967	Darbhanga Dist. (*c*. 26°N; 85° 54′E)
5.	♂	B	1721	10-x-1965	28-ii-1966	Syrlarya, Uzbek, SSR (*c*. 40° 50′N; 68° 42′E)

an easterly trend of the migratory movement after arrival in the north-west. All the birds were ringed at Bharatpur soon after arrival.

AB 8926 which was recovered 15 months after ringing in Bharatpur had presumably returned from its breeding grounds. B 1721, a male ringed in the same month and place as the others had already reached the USSR (crossing the Himalayas in the Northwest?) by end February. Another female ringed by Dr. Biswas near Calcutta on 23 March 1967 was shot at Dacca on 19 November 1967. There are some interesting observations on the movements of Ruff. In Jhang District, Whistler (1922) found the species to be an uncommon spring passage migrant from late March to 18 May. At Rawalpindi he noted it as a passage migrant found on the plateau in small numbers. In Quetta, Meinertz-hagen (1920) observed large flocks on spring passage in March. In Afghanistan, Whistler (1945) found Ruff to be common passage migrant passing through all parts of the country between 19 March and 8 May. Ludlow & Kinnear (1934) quoted Henderson as stating the species to be very common near the city of Yarkand where it bred. In the east Proud (1955) observed and collected Ruff at Manora in Nepal Valley on September 16 ; these were on passage. Ludlow (1928) found the Ruff passing through southern Tibet in autumn in fair numbers. Kozlova (1932) found the species moving in small numbers in the Tola River Valley towards the end of August. To summarise, there are many more records of the movements of Ruff between northwest India and Central Asia, and virtually none from northeastern India.

The few recoveries so far obtained of Bharatpur birds are from points situated in nearly all directions between northwest and east of Bharatpur.

Recoveries of Passerine birds

Out of a total of some 75,398 migratory passerine birds ringed up to August 1969, only 32 have been so far recovered (7 inland, 25 extra-limital). There was no recovery at all of the 2895 Swallows (*Hirundo rustica*) ringed all over India. This is perhaps not so surprising since Dorst (1962) records a recovery rate of 0.7% for Swallows in England. Out of 55,962 migratory Wagtails ringed by the Project 7 were recovered within the country and 13 outside our limits.

Motacilla indica Forest Wagtail

Out of 2210 birds ringed in Alleppey District, Kerala and in Gal Oya Valley, Ceylon (Mr. R. Mcl. Cameron) there was only a single recovery. This bird was ringed at Edanad (c. 9° 20′N ; 76° 38′E) on 25 February 1963 and recovered at Tiddim in the Chin Hills of Burma (*c*. 23° 50′N ; 93° 71′E) on 25 April 1963. The species was recorded at Shwebo (*c*. 22°

35′N ; 95° 04′E) by Roseveare (1949) between 26-30 April. The Forest Wagtail has been recorded on the upward and downward migration at Gopaldhara (*c.* 26° 55′N ; 88° 20′E) in the Sikkim area by Stevens (1925). La Touche (1923) recorded the species at Mengts, E. China (*c.* 23° 14′N ; 103° 30′E) both in spring and in autumn, the latest spring date being 5 May.

In Siberia (Neufeldt 1961) it is widely distributed as a breeding bird in Amurland eastward from Kumava Village (*c.* 51° 30′N ; 126° 41′E) and breeds from the first half of June. Between Kerala and Burma, on the eastern side of India, there is very little recent information on the movements of this Wagtail. At Tambaram, Chingleput district (*c.* 12° 30′N ; 80°E), Sanjeevaraj (1960) noted it on 19th September and 28 April. I saw a solitary Forest Wagtail at Reddipalli, Rajampet (*c.* 13° 30′-14°N ; 79°-79′ 30′E) on 30 September, 1969. At Mananur, Farahabad (*c.* 16° 16′N ; 79°E) Sálim Ali (1933) recorded it on 17 October. Since the species has not been recorded in the Eastern Ghats it has been suggested, (Sálim Ali 1953) that the bird probably reaches India by way of the Andamans where it has been recorded as arriving in early October and leaving in April (Osmaston 1906). On the whole the information available on the movements of the species is fragmentary.

Motacilla flava Yellow Wagtail

Out of a total of 50,438 Yellow Wagtails (*Motacilla flava thunbergi, M.f. beema, M.f. melanogrisea* and *M. f. simillima*) 15 were recovered, 5 within the country and 10 extralimital. Those recovered belonged to the Greyheaded and Blueheaded subspecies and were reported from West Pakistan, Afghanistan and the USSR between latitudes 30° and 54°N and longitudes 69° 10′E and 74° 34′E. They were ringed in Kerala and at Bharatpur. The details of ringing and recovery of birds ringed in Kerala, all at Edanad in Alleppey District (*c.* 9° 20′N ; 76° 38′E) are given in Table 4 for comparison.

The birds recovered in W. Pakistan and Kabul (in May) were presumably, on the outward passage. Two Bharatpur Yellow Wagtails were recovered in Kirghiz, SSR and Omsk (*c.* 53° 33′N ; 74° 22′E), in May and June the first 41 days and the second 7 months from the dates of ringing. Between Kerala and north-western India, there are very few records of movement of the Yellow Wagtail to support Phillips's suggestion (1956), that passerine migrants like wagtails, pipits and flycatchers visiting Ceylon follow the western and eastern coasts of Peninsular India. In the Maldives (8°-10°N; 72°-74°E) Phillips (1956) observed the Yellow Wagtail as follows ; 40 miles south of Addu Atoll (*c.* 10° 13′S ; 73° 37′E) *flava* or *beema* observed on 10 April 1957, and an immature of *thunbergi* seen between October 27 and November 1, at Male (*c.* 4° 10′N ;

73° 45′E) Yellow Wagtails were reported to arrive in small numbers in November. In general Phillips considered the yellow wagtails to be passage migrants or irregular winter visitors to Maldives. At Bitra

TABLE 4

RECOVERIES OF YELLOW WAGTAILS (*Motacilla flava*)

Ring No.	Species	Date of ringing	Place of ringing	Date of recovery	Place and co-ordinates
A 5531	*M.f.beema*	18-ii-1963	Edanad, Alleppey Dt., Kerala (*c.* 9° 20′N; 76° 38′E)	13-xii-1963	Erode, Madras (*c.* 11° 20′N; 77° 46′E)
A 44543	*M.f.thunbergi*	5-xii-1963	do	2-v-1964	Gujaranwala District (*c.* 32° 6′N; 74° 11′E)
A 19452	*M.f.beema*	20-xii-1962	do	10-ix-1963	Lakki, West Pakistan (*c.* 32° 36′N; 70° 56′E)
A 13014	*M.f.*ssp?	2-iii-1962	do	7-v-1964	Kohat, -do- (*c.* 33° 35′N; 71° 20′E)
A 33005	*M.f.beema*	2-ii-1963	do	10-v-1963	Near Nowabah, Afghanistan (*c.* 34° 30′N; 69° 13′E)
A 19082	*M.f.thunbergi*	18-xii-1962	do	8-viii-1963	Kara Balty Kirghiz, SSR (*c.* 42° 50′N; 73° 50′E)
A 30394	*M.f.thunbergi*	21-ix-1963	do	4-v-1964	Chimkunt, Kazakhstan (*c.* 43°N; 70°E)
A 22268	*M.f.beema*	16-xii-1962	do	16-v-1963	Karaganda, Kazakhstan (*c.* 46°N; 72°E)
A 58509	*M.f.thunbergi*	21-i-1964	do	14-v-1964	Karabas, Karaganda, USSR (*c.* 49° 30′N; 72° 55′E)

Island, Laccadives (*c.* 11° 35′N ; 72° 10′E), Mathew & Ambedkar (1963) saw about 6 birds of the race *thunbergi* in October, on the beach.

At Quetta (*c.* 30°N ; 67°E), Meinertzhagen (1920) recorded the Blue-headed Wagtail on spring passage from 16-20 March and the Greyheaded only in August. At Peshawar, Briggs and Osmaston (1928) found the Greyheaded Wagtail passing through in large numbers in both seasons, and up to 13 May in spring. At Jhang District, Whistler (1922) found *beema* abundant on both seasons (passing along the course of the Chenab

River), as did Waite (1948) at Salt Range (*c.* 32° 30′N ; 72° 50′E). Whistler (1930) collected 2 Greyheaded Wagtails at Rawalpindi (*c.* 33° 36′N ; 75° 7′E) on May 4 and quoted Magrath as saying that this Wagtail passes through the vicinity of Tret in considerable numbers up to May. In Afghanistan, Meinertzhagen (1938) recorded the Blue and Greyheaded Wagtails at Ghorband Valley near Bamian (*c.* 34° 84′N ; 67° 87′E) up to 20 April and the Greyheaded at Kunduz (*c.* 36° 40′N ; 68° 50′E) on 20 May. Whistler (1945) found the race *beema* to be a spring passage migrant in northern and the race *thunbergi* to be a double passage migrant to northern and southern Afghanistan. There were no recoveries of the Yellow Wagtails in the east. Desirée Proud (1955) noted Blue and Greyheaded Wagtails as regular passage migrants along Kosi River in the Nepal Valley. In sum the few recoveries obtained of the Yellow Wagtails align favourably with observations published earlier from north and northwestern India, and generally support the supposition that these Wagtails cross the Himalayas in the northwest around Kabul moving along the course of the Indus system.

Motacilla alba White Wagtail

The Project ringed 468 White Wagtails (*Motacilla alba dukhunensis* and *leucopsis*) at Bharatpur, Kutch and Kerala, out of which two birds ringed at Kutch on 16 and 17 March 1961 were recovered at Kiev (*c.* 50° 35′N ; 30° 50′E) in June-July 1961 and at Stalingrad (*c.* 49° 35′N ; 49° 7′E) on 11 July 1961 respectively. The following observations provide useful comparison. In the Salt Range, W. Pakistan, Waite (1948) found the subspecies *dukhunensis* to be a double passage migrant in October and March-April. At Quetta, Meinertzhagen (1920) found this subspecies *dukhunensis* to be a common passage migrant in March and October. At Rawalpindi, Whistler (1930) and Peshawar, Briggs & Osmaston (1928) record this Wagtail as very common in winter. In Afghanistan, Meinertzhagen (1938) found it abundant for a few days about 20 April and passing in flocks at Khanabad and Kunduz about 2 May. Ludlow & Kinnear (1934) referred to 2 specimens collected at Suget Kraul (*c.* 36°N ; 78°E) on 23 and 29 September. In the Nepal Valley, Desirée Proud (1955) found *dukhunensis* to be a common double passage migrant. The subspecies *leucopsis* and *alboides* have been recorded as occurring at altitudes up to the snowline, in the Tsangpo Valley, Southern Tibet, Ludlow (1944) ; at east Everest (17,000 ft.) Kinnear (1922) ; and along the River Vishnumathi in the Nepal Valley in thousands, Proud (1955). The data on the White Wagtails are thus fragmentary.

Passer domesticus parkini and/or **bactrianus**
Migratory House Sparrow

Out of the 1728 birds ringed by the Project at Bharatpur up to 1966 December, 4 were recovered in Kazakh and Tadjik SSR in Russia in May, June, September and November. Between 1967-69 another 3760

TABLE 5

SHOWING THE SUMMARY OF RECOVERY DATA OBTAINED BY THE BNHS/WHO BIRD MIGRATION PROJECT 1959-1969 JULY-AUGUST.

Species	Years	Total number ringed	Total number recovered	Recoveries	
				Inland	Extra-limital
Anas acuta	1964-69	1551	72	8	64
Anas crecca	1962-69	3093	185	10	175
Anas strepera	1966-69	492	6	3	3
Anas penelope	do do	183	7	3	4
Anas querquedula	do do	984	38	7	31
Anas clypeata	do do	621	38	2	36
Netta rufina	1967-69	78	2	1	1
Aythya ferina	do do	428	22	4	18
Aythya nyroca	do do	183	5	2	3
Circus macrourus	1960-62	4	1	..	1
Tringa totanus	1962-67	56	1	..	1
Tringa stagnatilis	do do	283	2	..	2
Tringa glareola	do do	4645	13	3	10
Philomachus pugnax	do do	4293	37	12	25
Motacilla indica	1962-64	2210	1	..	1
Motacilla flava thunbergi	1961-66	15924	7	2	5
Motacilla flava beema	1961-67	18750	4	2	2
Motacilla flava ssp.	do do	12638	4	1	3
Motacilla citreola	1961-67	2890	2	2	..
Motacilla alba dukhunensis	1962-63	175	1	..	1
Motacilla alba ssp.	1959-65	232	1	..	1
Passer domesticus parkini-bactrianus	1962-66	5488	1	..	1
Passer hispaniolensis	do do	4690	4	..	4
Emberiza melanocephala	1959-64	399	2	..	2

sparrows were ringed at Bharatpur; one of these, ringed on 22-I-1969, was recovered at Kulate (*c.* 37° 55′N; 69° 48′E) on 19-V-1969. Dr. E. Gavrilov who recovered two of these, identified the specimens, as *Passer domesticus bactrianus*. The limits of the subspecies *parkini*, Vaurie (1965) are the foothills or outer ranges of the Himalayas in the north and the border of Afghanistan in the north-west. The subspecies *bactrianus* which comes from Transcaspia and Russian Turkestan, according to Dr. Vaurie also winters in Sind and the plains of north-western India. About this point Dr. Sâlim Ali commented 'If these (*bactrianus*) are really different from *parkini* as he (Dr. Gavrilov) maintains, it could make a great difference in our conclusion about the origin of the birds. Then again there is the possibility that the birds ringed by us contained both subspecies.' Earlier, Whistler (1922) found large flocks of *Passer domesticus parkini* flying through Jhang District in September and October and quoted Magarth that vast flocks of migrating House Sparrows pass through Kohat in April and May in company with Spanish Sparrows and Rosy Pastor. Meinertzhagen (1938) considered *bactrianus* to be synonymous with *parkini* and found the subspecies migrating at Bamian in Afghanistan from 20-29 April. He found them breeding at Haibak (*c.* 36° 20′N ; 68°E) in mid May and at Ghorband and in Kabul River Valley. Whistler (1945) considers *Passer domesticus griseiogularis* to be the same as Meinertzhagen's *bactrianus*, and records it as a very numerous visitor both in the northern and southern parts of Afghanistan. He referred to it as 'this large migratory House Sparrow so common in Turkestan, Tibet, Afghanistan, Kashmir, and other neighbouring areas, which winters in parts of India'. Thus the migratory House Sparrows visiting Bharatpur may contain 2 different subspecies (if recognized)—*parkini* moving between north India and the outer ranges of Himalayas, and *bactrianus* between North India and Kazakhstan. This can be confirmed only by careful study and by ringing many more sparrows in the Bharatpur area.

Passer hispaniolensis transcaspicus Spanish Sparrow

Out of 1782 Spanish Sparrows ringed at Bharatpur in 1962 and 1963, 3 birds, ringed on 3 April, 25 and 31 March 1962 were recovered in Chokpar (*c.* 43° 02′N ; 73° 43′E) and Dzambul (*c.* 42° 38′N ; 70° 31′E) Kazakh, SSR on 29 May 1962, 2 June 1962, and 9 May 1965 respectively. From another lot of 2908 Spanish Sparrows ringed at Bharatpur between 1967 and 69, one ringed on 17-xii-1967 was recovered in Dzambul (*c.* 42° 38′N ; 70° 31′E) on 5-vii-1968. In USSR, *vide* Gavrilov (1963) 'It is distributed in Kazakhstan from the administrative frontier at the south, northward as far as the valleys of the Rivers Sir-Daria and Chu. It is also found in the lowlands adjoining the Kirgizsky Zailyisky and Dzungarsk, Ala-Tau north to Lake Alakoul. It reaches Kazakhstan in April and May'.

Emberiza melanocephala Blackheaded Bunting

Out of 399 birds ringed, there were two recoveries. One of these, ringed at Bhuj, Kutch (*c.* 23° 15′N ; 69° 49′E) on 26 September 1959, was recovered at Krasnodar (*c.* 45° 30′N ; 40° 45′E) on 26 May 1961 ; the other ringed by Yuvraj Shivrajkumar at Jasdan (*c.* 22°N ; 71°E) on 22

September 1964, in Famagusta, Cyprus (*c.* 35° 6′N ; 33° 57′E) on 16 May 1965. It is widely distributed, in south-eastern Europe eastward to Iran and in parts of Italy, Greece, Bulgaria, Rumania, Cyprus, Crete, Iraq and in Russia north to the region of Stalingrad (Vaurie 1965).

There was one recovery of a Rosefinch *Carpodacus erythrinus* ringed at Bharatpur on 18-iii-1969, in the Vligunousk region near Inza (*c.* 53° 50′N ; 46° 21′E) ; another of a Great Reed Warbler *Acrocephalus stentoreus* ringed at Salt Lake, Calcutta on 10-IV-1965 in the Uzbek SSR, (*c.* 39° 41′N ; 66° 58′E) on 3-ix-1968.

Summary

I. The recovery rates of birds ringed by the Society's Migration Project is very low compared to recovery data from European ringing study stations. In all only (0·40%) of the banded birds were recovered, and from only 25% of the migratory species ringed.

II. The highest recoveries have been of migratory ducks and teals ; among the waders, Spotted Sandpipers and Ruffs, and among the passerine birds Yellow Wagtails have yielded some significant results. This is probably due to the fact that ducks and teals are regularly shot by sportsmen.

III. Generally, birds ringed by the Society were reported mainly at places in West and East Pakistan, and USSR. Ducks and teals ringed here were recovered in the breeding area of the Kazakhstan and East Siberian populations of Wildfowl of the USSR. More than 50% of all duck recoveries were from the Kazakhstan area. Individually 79% of the Pintail recoveries, 77% of the Common Teals, 80% of the Garganeys and 82% of the Shovellers, were reported from Isakov's Kazakhstan population area. However, 61% of the Common Teals and all the Shovellers ringed in the more easterly part (Bihar) were reported in the East Siberian parts of the USSR.

IV. Four Garganeys and one Pintail ringed at Bharatpur were recovered in Andhra Pradesh and Tamil Nadu.

V. Among the passerine birds, the few recoveries obtained were from West Pakistan, Burma, Afghanistan, USSR and Cyprus.

In conclusion the recoveries of ducks and teals ringed by the Society suggest that the ducks and teals wintering in India belong to at least two separate USSR wildfowl populations as categorised by Isakov (1965), namely, the Kazakhstan population and the East Siberian population. Recoveries of passerine and non-passerine birds tend to support—by and large—the hypothetical routes of migration through northwest Pakistan

and Afghanistan and along the tributaries of the Indus and Oxus postulated by earlier workers. There is also a suggestion, but not sufficient evidence as yet, that a considerable amount of trans-Himalayan migration takes place directly across the mountain barrier. To secure incontrovertible proof of this, and an estimate of the extent of such migration is one of our important aims. The recovery of Bharatpur-ringed birds in Andhra Pradesh and Tamil Nadu suggest that certain species of ducks and teals from northwestern India move south across the Deccan. Generally speaking the recoveries of India-ringed birds, are as yet too meagre to suggest any definite routes of migration or patterns of dispersal. But our data at this stage serve to broadly supplement those obtained by Russian workers for extralimital movements of the Anatidae. We have no recoveries at all from the eastern Himalayas or from countries beyond, like Tibet, China and Mongolia, though some of our birds must undoubtedly go there. A curious and rather striking anomaly is that while we obtain regular and sizable recoveries of Indian-ringed Anatidae in the territories of the USSR, we have been getting practically no recoveries at all of Russian-ringed birds in India. And this notwithstanding the fact that ringing is done on a much vaster scale in USSR than in India.

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References

Ali, Sálim (1933): The Hyderabad State Ornithological Survey. ibid. **36**: 909.

——— (1946): An Ornithological Pilgrimage. ibid. **46**: 307.

——— (1953): Birds of Travancore and Cochin. Oxford University Press.

Biswas, B. (1960): The Birds of Nepal. ibid. **57**: 523.

Briggs, Rev. F. S. (1934): A note on the Birds of Ghazipur. ibid. **37**: 390.

——— & Osmaston, B. B. (1928): A note on the Birds of the Peshawar District. ibid. **32**: 754.

Christison, Brigadier, A. F. P. (1941): Birds of Chagai. *Ibis* (14), **5**: 555.

Dorst, J. (1962): The Migration of Birds. Hienmann, London.

Fulton, Captain, H. T. (1904): Notes on the Birds of Chitral. *J. Bombay nat. Hist. Soc.* **16**: 64.

Gavrilov, E. I. (1963): The Biology of the Eastern Spanish Sparrow etc. ibid. **60**: 301-321.

Inglis, C. M., Travers, W. L., O'Donel, H. V. & Shebbeare, E. O. (1920): A tentative List of the Vertebrates of Jalpaiguri District, Bengal ibid. **27**: 157.

Isakov, J. A. (1965): The Main Geographical Populations of Waterfowl in the USSR and International Measures on their Protection and right use. VII• Congress des Biological Du Gibier Beograd—Ljubljona. September 1965.

Kinnear, N. B. (1922): On the Birds collected by Mr. A. F. R. Wollaston during the First Mt. Everest Expedition. *Ibis* **4** (11): 515.

Kozlova, E. V. (1932): The Birds of Northern Mongolia etc. *Ibis* (13), **2**: 412, 577.

La Touche, J. D. D. (1921): Birds of North-East Chihli. *Ibis* (11), **3**: 45.

——— (1923): On the Birds of South-East Yunnan, S. N. China. ibid. (11), **5**: 629.

——— (1934): A Handbook of the

Birds of Eastern China. Taylor and Francis, London.

LUDLOW, FRANK (1927): Birds of the Gyantse Neighbourhood, Southern Tibet. Part I. *Ibis* (12), **3**: 657.

——— (1928): ——— ——— Part III. ibid. (12), **4**: 230.

———, & KINNEAR, N. B. (1934): A contribution to the Ornithology of Chinese Turkestan. Part IV. ibid. (13), **4**: 95-125.

——— (1944): The Birds of South-eastern Tibet. ibid. **86**: 388.

MATHEW, D. N. & AMBEDKAR, V. C. (1963): A Bird Study trip to the Laccadives. *J. Bombay nat. Hist. Soc.* **61**: 190.

MEINERTZHAGEN, COL. R. (1920): Notes on the Birds of Quetta. *Ibis* (11), **2**: 182.

——— (1927): Systematic results of Birds collected at high altitudes in Ladak and Sikkim. Part II. ibid. (12), 3: 615.

——— (1938): On the Birds of Northern Afghanistan. ibid. (14), **2**: 480-520, 671-717.

NEUFELDT, IRENE (1961): The Breeding Biology of the Forest Wagtail *Motacilla indica*. *J. Bombay nat. Hist. Soc.* **58**: 559-579.

NICHOLS, EDWARD G. (1945): Occurrence of Birds in Madura District. Part III. ibid. **45**: 122-132.

OSMASTON, B. B. (1906); Notes on Andaman birds with accounts of the nidification of several species whose nests and eggs have not been hitherto described. ibid. **17**: 156-163: 486-491.

——— (1930): A Tour in Further Kashmir. ibid. **34**: 124.

PERREAU, CAPT. G. A. (1910): Notes on the Birds of Chitral. ibid. **19**: 922.

PHILLIPS, W. W. A. (1956): Bird Migration with respect to Ceylon. *Jour. Ceylon Branch Roy. Asiat. Soc.* New Series 5. Part I.

PROUD, DESIRÉE (1949): Some Notes on the Birds of the Nepal Valley. *J. Bombay nat. Hist. Soc.* **48**: 719.

——— (1955): More notes on the Birds of the Nepal Valley. ibid. **53**: 57-78.

ROSEVEARE, W. L. (1949): Notes on the Birds of the Irrigated area of Shwebo District, Burma. ibid. **48**: 528.

SANJEEVARAJ, P. J. (1960): The Forest Wagtail, *Motacilla indica* (Gmelin) in Madras, Chingleput District. ibid., **57**: 220.

SAVAGE, C. D. W. (1965): A Review of Ringing Data on Wildfowl migration in South-West Asia Working paper, 1965/2.

SHERRIFF, G. (1929): Migration notes from Kashgar Chinese Turkestan. *J. Bombay nat. Hist. Soc.* **33**: 989.

STANFORD, J. K. & TICEHURST, CLAUDE, B. (1939): On the Birds of Northern Burma. *Ibis* (14), **3**: 255.

STEVENS, HERBERT (1925): Notes on the Birds of the Sikkim Himalayas. *J. Bombay nat. Hist. Soc.* **30**: 378.

SUBBIAH PILLAI (1967): In lit.

TICEHURST, CLAUDE, B. (1927): The Birds of British Baluchistan. *J. Bombay nat. Hist. Soc.* **32**: 93.

VAURIE, CHARLES (1965): The Birds of the Palaearctic Fauna, Non-Passeriformes. H.F. & G. Witherby Limited, London.

WAITE, H. W. (1948): The Birds of the Punjab Salt Range. *J. Bombay nat. Hist. Soc.* **48**: 104.

WHISTLER, HUGH (1922): The Birds of Jhang District, S.W. Punjab. Part II. *Ibi* (11), **4**: 420.

——— (1930): The Birds of the Rawalpindi District, N.W. India. ibid. (12), **6**: 247-279.

——— (1945): Materials for the Ornithology of Afghanistan. ibid. **45**: 106-122.

WHITEHEAD, LIEUT. C. H. T. (1911): The Birds of Kohat and the Kurram Valley. ibid. **20**: 978.

Eco-Toxicology and Control of Indian Desert Gerbil, *Meriones hurrianae* (Jerdon)

VII. Relative number in relation to ecological factors

BY

ISHWAR PRAKASH, G. C. TANEJA AND K. G. PUROHIT
Animal Studies Division, Central Arid Zone Research Institute, Jodhpur

INTRODUCTION

There is no literature on the fluctuations of desert gerbil population except for some stray remarks by naturalists (Adams 1899 ; Blanford 1888-91 ; Jerdon 1867). To fill up this lacuna in our knowledge of the desert gerbil, attempts were made by us to undertake a population study on this species by the conventional capture-recapture technique, but the inherent trap-shyness of these rodents led us to abandon this technique. The present study was, therefore, done employing an indirect census method which only required the counting of freshly-opened burrow openings. Although this technique may have certain limitations, yet, for purposes of comparison between localities and between seasons, it has sufficient validity. This paper deals with the annual and seasonal numbers of the Indian desert gerbil, *Meriones hurrianae* (Jerdon) in the rainfall zones of the Rajasthan desert. An attempt has also been made to correlate gerbil numbers with various ecological factors.

METHODS

Number of Desert Gerbils :

It was observed that soon after venturing out of their burrows in the morning, the desert gerbils feed continuously for 30-45 minutes and do not indulge in burrow digging. This habit of the gerbil was utilized in formulating the census method which involved plugging of all the burrow openings in the evening after cessation of all surface activity followed by counting of all the freshly-opened burrow openings in the next morning within about half an hour of the start of their morning activity. Since during this period a gerbil is not likely to make more than one burrow opening, each fresh burrow opening should represent one gerbil. This was checked in small plots by ocular counting before initiating the study. Plots measuring 90×90 m. were worked and divided in subplots of $7{\cdot}5 \times 7{\cdot}5$ m. In each subplot all the burrow openings were closed at evening and the freshly opened ones were counted next morning. The plots were situated at Jaisalmer and Chandan (180 mm. average annual rainfall) ; Barmer and Gadra Road (300 mm.) ; and Lachhmangarh and Palsana (450 mm.) representing the main rainfall zones of the Rajasthan desert. Census by burrow closing-opening method was carried out in summer (June), monsoon (August), post-monsoon (October), and winter (December) seasons. The trend of the population number being similar the data for both the work sites in each rainfall zone was pooled.

Vegetation : The vegetation was studied by the line intercept method (Cainfield 1941) in 8 transects at each work site in every season.

Soil Characteristics : The field density of soil was worked out by the British Standard Test No. 10 C and the per cent clay and permeability of the soil according to Darsy's Law method (SOIL MECHANICS FOR ROAD ENGINEERS, HMSO, London, 1961).

Climate : The climatic data have been taken from Pramanik & Hariharan (1952) and also from the Climatology section of the Institute.

Results and Discussion

Vegetation Cover :

The vegetation in all the three zones comprise chiefly of grasses, the most common species being : *Cenchrus ciliaris, Cenchrus setigerus, Cenchrus biflorus, Lasiurus sindicus, Aristida adscensionis, Eleusine compressa, Perotis hordeiformis, Chloris virgata, Cymbopogon jwarancusa, Digitaria marginata, Brachiaria ramosa* and *Dactyloctenium scindicum* etc. The other prominent species of plants occurring, in these sites are *Zizyphus nummularia, Tephrosia purpurea, Aerva tomentosa, Crotalaria burhia, Capparis aphylla, Calotropis procera, Pulicaria wightiana, Leptadenia pyro-technica, Calligonum polygonoides, Indigofera* sp. etc. The main tree species are : *Prosopis spicigera, P. juliflora, Acacia* spp., *Azadirachta indica, Salvadora oleoides,* etc. On the basis of frequency and density, the following plant communities were found at the three experimental sites : Barmer and Gadra Road (BG), *Cenchrus-Indigofera-Dactyloctenium-Aristida* community : Jaisalmer and Chandan (JC), *Eleusine-Aristida-Lasiurus* community ; Lachhmangarh and Palsana (LP), *Digitaria-Aristida-Cenchrus-Pulicaria* community.

The average annual plant cover at JC, BG and LP tracts was 6·66, 3·0, 2·69 per cent respectively and the grass cover was 1·19, 5·98, 1·80 per cent respectively. Table 2 shows the fluctuations in the total plant as well as grass covers during the various seasons. It will be observed that at BG and JC regions the cover was more in summer than in spring which was presumably due to early showers in the month of June.

Soil Characteristics : The field density of soils from LP and JC regions show very little difference (Table 3). These soils are denser than the soil at BG region since the field density of soils in the region is 1.36 gm./cm. as compared to 1·80 to 1·82 gm./cm. at the LP and JC regions respectively. The soils of JC region have the maximum amount of clay whereas the clay content is least in the soils of BG tract. Permeability of the soil for the seepage of water is maximum in the JC region and lowest in the BG tract.

Desert gerbil number :

Average annual number in three rainfall zones : The average annual number of the desert gerbils was maximum per experimental plot in the Barmer-Gadra Road tract and minimum at the Jaisalmer-Chandan tract (Table 1).

TABLE 1

AVERAGE ANNUAL NUMBER OF DESERT GERBIL IN RELATION TO CLIMATIC FACTORS AND VEGETATION

Rainfall zone	Average annual number of desert gerbil per 90 m. × 90 m. plot	Total plant cover %	Grass cover %	Rain-fall (mm.)	Mean maximum temp. °c	Mean minimum temp. °c	% Relative humidity of air 08.00 hrs.
Jaisalmer-Chandan	31	6·66	5·98	178	33·6	18·7	66
Barmer-Gadra Road	458	3·5	1·29	314	33·6	20·2	60
Lachhmangarh-Palsana	247	2·69	1·80	441	32·5	17·5	64

Seasonal fluctuations in gerbil numbers : The gerbil numbers show an annual trend which is identical for the Jaisalmer-Chandan and Lachhmangarh-Palsana regions. In these two tracts, their number is low in summer, slightly builds up during monsoon and reaches a peak in winter ; whereas at Barmer-Gadra Road tract, their number is minimum during summer, somewhat higher in winter, reaches a peak in spring and declines in summer (Table 2). The differences in number between seasons were maximum in the JC region, which also has the maximum adverse climatic conditions as compared to the other two tracts.

TABLE 2

SEASONAL FLUCTUATIONS IN NUMBERS OF DESERT GERBIL IN RELATION TO CLIMATIC FACTORS AND VEGETATION

Season	Gerbil No. per 90 m. × 90 m.	% plant cover	% grass cover	Rainfall %/mm.	Max. temp. °c	Min. temp. °c	% Relative humidity of air at 08.00 hrs.
			Jaisalmer - Chandan region				
Monsoon (August)	12	9·97	9·2	62	34·6	24·9	93
Winter (December)	107	5·4	5·3	2	24·8	6·2	43
Spring (March)	3	4·5	3·95	3·6	31·7	16·9	55
Summer (June)	5.5	5·9	5·5	14	40·4	26·8	83
			Barmer - Gadra Road region				
Monsoon	110	42·2	1·30	86	33·6	24·9	82
Winter	560	1·7	0·67	2	26·7	11·9	56
Spring	795	2·2	0·68	3	32·3	17·9	58
Summer	367	3·9	2·57	24	39·7	26·8	73
			Lachhmangarh - Palsana region				
Monsoon	388	3·4	2·8	147	33·5	24·6	80
Winter	488	3·42	2·5	7	23·9	5·3	73
Spring	91	2·3	1·28	7	31·0	14·2	47
Summer	21	1·62	0·66	47	40·6	28·6	51

Average annual number of Desert Gerbil in relation to climatic factors : It is evident from Table 1 that the variation in the mean maximum and mean minimum temperatures at the three zones is only of the order of 1·6°C to 2·7°C whereas the gerbil number varies from 31 to 458. It, therefore, appears that the number of desert gerbils is not perhaps affected by temperature fluctuations in these three zones, which is expected since their burrows are comparatively cooler than the surrounding soil surface (Prakash *et al.* 1965). As the rodents develop hyperthermia due to exposure to the sun during their diurnal surface activity, they enter the burrows and the excess body heat is then intermittently unloaded to the cooler environment (Schmidt-Nielsen 1964; Fitzwater & Prakash 1969). It has, however, been observed that in JC tract where the gerbil number was the least per plot, the mean annual relative humidity was the highest and vice versa at BG region. It would appear therefore, that the population density of gerbils is inversely related to atmospheric relative humidity. However, the constancy of the humidity conditions prevailing inside the burrows should be of more immediate consequence for population build-up in this species. The number of desert gerbils was found to be minimum in JC tract where the amount of annual precipitation is also the lowest. The next higher rainfall zone (BG), however, shows the maximum number of desert gerbils (Table 1). It, therefore, appears that the amount of precipitation is not an important factor for the density distribution in various zones. Another possibility is that a medium rainfall zone like Barmer-Gadra Road region, is more suitable for their population build up as it is neither too dry nor too wet.

Average annual number of desert gerbils in relation to vegetation : It was observed that the number of gerbils was higher in plots which had *Dactyloctenium scindicum, Aristida adscensionis, Lasiurus sindicus, Perotis indica, Digitaria marginata* and lower in plots having a high frequency of *Cenchrus biflorus* plants. The above mentioned grasses are preferred as food by the desert gerbils. Although it also feeds on *C. biflorus* but when the inflorescence ripens the awns become so sharp that they are repulsive to the rodents.

The average annual number of gerbils was minimum in JC tract where the total plant cover as well as the grass cover was the highest. In the two other tracts the higher gerbil numbers were associated with a lower plant as well as grass cover. This would look paradoxical since in areas with the higher plant cover food available should be more and a higher gerbil population should therefore, be expected. This paradox can be explained on the basis of their burrowing habit. The gerbils cannot easily dig their extensive burrows when they are confronted with the anastomosing, fibrous roots of grasses which form by far the majority of the vegetation of these tracts. Moreover, the extensive root systems make the soils more compact making burrowing more arduous. Our observations in the field also confirm that gerbils are densely distributed in open sandy plains as compared to heavily vegetated patches. Smith (1958) also observed that the dense vegetation is a limiting factor in the establishment of new dogtowns of the prairie dog, *Cynomys ludovicianus.*

Average annual number in relation to edaphic characteristics : A comparison of soil characteristics and the gerbil numbers (Tables 1 & 3) reveals that in the tracts where field density, permeability and clay per cent of soil was maximum (JC), the gerbil number was minimum, and vice versa (BG), which indicates that the gerbil numbers tend to be low where the soil is denser, has a higher permeability for seepage of water and is clayey in nature. Denser soils are usually more clayey and, therefore, burrowing should be difficult. It may, therefore, be one of the important factors affecting the relative abundance of desert gerbils in various localities. Another reason for their shunning the compact clayey soils could be that more permeable soil will allow more seepage of rain water which would retain it for greater durations as compared to the looser soils which would probably disturb the micro-climatic balance inside the burrows.

TABLE 3

CHARACTERISTICS OF SOILS OF BG, LP AND JC REGIONS

Localities	Field density gm./cc.	% clay	Permeability gm./hr.
Jaisalmer-Chandan	1·80	5·3	0·8081
Barmer-Gadra Road	1·36	3·1	0·1622
Lachhmangarh-Palsana	1·82	4·5	0·3485

Seasonal fluctuations in gerbil numbers with respect to ecological factors : The desert gerbils stay during the periods of unfavourable climate inside the burrows which provide them with a comfortable and homogeneous micro-climate (Prakash, Kumbkarni & Krishnan 1965). Moreover, the desert gerbils are by behaviour adapted to avoid the extremes of heat and cold in the arid regions (Prakash 1962 ; Fitzwater & Prakash 1967). It is, therefore, expected that climatic fluctuations during a year may not play an important role in influencing the fluctuations in gerbil numbers. The soil characteristics are constant in all the seasons. Only vegetation cover could be one of the factors governing the seasonal fluctuations in gerbil numbers. However, it would appear from Table 2, that when the vegetation cover decreases the gerbil numbers increase. A similar situation was also reported by Ashby (1967) for *Apodemus sylvaticus* in Durham. The availability of green food, however, has been reported to have a direct enhancing effect on the rate of breeding of wild rabbits (Hughes & Rowley 1965). It was observed in a previous study (Prakash 1963) that the rate of littering of *Meriones hurrianae* also increases during the monsoon. This enhanced breeding which is apparently due to availability of green food, would explain the peak numbers met with during the winter in two zones, and during spring in Barmer-Gadra Road region. A plausible cause of low numbers during summer could be the low survival of the offsprings delivered after spring, as has been observed in the case of the desert hare, *Lepus nigricollis dayanus* (Prakash & Taneja 1969). Hence the seasonal fluctuations in gerbil numbers are influenced by the rate of breeding which is enhanced by the availability of green food during monsoon.

Rainwater flooding the burrows of fossorial rodents, is another factor which may matter in regulating the gerbil numbers. In all the experimental zones their numbers tended to increase after the monsoon and as such it may be difficult to attribute any mortality of gerbil to this limiting factor. Moreover, the burrows of Indian desert gerbils are so extensive (Fitzwater & Prakash 1969) that the scanty rains of the desert region may not be sufficient to flood their burrow systems.

The role of predators, mostly snakes and predatory birds, in regulating the gerbil numbers is not clearly known but peak gerbil numbers are met with during the period when the snakes, their chief predators, hibernate. The gerbil population tends to fall after winter when reptiles are active.

To explain the seasonal fluctuations in rodent population is an intricate problem since, in nature, only one factor cannot be held responsible for these changes but several factors working together. Moreover, without studies on their behaviour, genetics and the endocrine mechanism, it is all the more difficult to work out the details of the population turnover.

Summary

The annual and seasonal numbers of Indian desert gerbil, *Meriones hurrianae* Jerdon, based on the counting of freshly-opened burrow openings, in three rainfall zones of Rajasthan desert, are described. Their numbers are related to soil characteristics, the population being less in clayey and compact soils. An inverse relationship between grass cover and population density has been observed. The seasonal fluctuations show an annual cycle, low during summer with a build up resulting in a high level during winter and spring. This population explosion may be mainly due to the higher rate of breeding during and after monsoon which is influenced by the availability of green food at this time.

Acknowledgements

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References

Adams, A. (1899): The Western Rajputana States. Taylor and Francis, London.

Ashby, K. R. (1967): Studies on the ecology of field mice and voles (*Apodemus sylvaticus, Clethrionomys glareolus* and *Microtus agrestis*) in Houghall Wood, Durham. *J. zool.* **152**: 389-513.

Blanford, W. T. (1888-91): The Fauna of British India, *Mammalia.* Taylor and Francis, London.

Cainfield, R. H. (1941): Application of the line intercept method in sampling range vegetation. *J. Forestry* **39**: 388-394.

Fitzwater, W. D. & Prakash, Ishwar (1969): Burrows, behaviour and home range of the Indian desert gerbille, *Meriones hurrianae* (Jerdon). *Mammalia* **33**: 598-606.

Hughes, R. L. & Rowley, I. (1965): Breeding season of female wild rabbits in natural population in the Riverina and Southern Tableland districts of New South Wales. *C.S.I.R.O., Wildl. Res.* **11**: 1-10.

Jerdon,. T. C. (1867): Mammals of India. Thacker and Spink, Simla.

Prakash, Ishwar (1962): Ecology of the gerbils of the Rajasthan desert, India. *Mammalia* **26**: 311-331.

——— (1963): Eco-toxicology and control of the Indian desert gerbil, *Meriones hurrianae* (Jerdon). II. Breeding season, litter size, and post-natal development. *J. Bombay nat. Hist. Soc.* **61**: 142-149.

———, Kumbkarni, C. G. & Krishnan, A. (1965): ibid. III. Burrow temperature. ibid. **62**: 237-244.

———, & Taneja, G. C. (1969): Reproduction biology of the Indian desert hare, *Lepus nigricollis dayanus* Blanford. *Mammalia* **33**: 102-117.

Pramanik, S. K. & Hariharan, P. S. (1952): The climate of Rajasthan. *Bull. Nat. Inst. Sci. India.* **1**: 167-178.

Ryley, K. V. (1913): Bombay Natural History Society's Mammal Survey of India. Report No. 10, *J. Bombay nat. Hist. Soc.* **22**: 464-513.

Schmidt-Nielsen, K. (1964): Terrestrial animals in dry heat; desert rodents. Chapter 32, pp. 493-507, in Handbook of Physiology—Environment.

Smith, R. E. (1958): Natural history of the prairie dog in Kansas. *Univ. Kansas Mus. nat. Hist. Miscel. Publ.* **16**: 1-36.

The Thalassinoidea (Crustacea, Anomura) of Maharashtra

BY

K. N. SANKOLLI[1]

Marine Biological Research Station, Ratnagiri

(*With four text-figures*)

[*Continued from Vol.* 67 (2) : 249]

Family CALLIANASSIDAE

KEY TO THE SUB-FAMILIES OF CALLIANASSIDAE

1. Rostrum large ; first pair of legs equal ; no *appendix interna* on third to fifth abdominal appendages ....Upogebiinae
2. Rostrum small ; first pair of legs unequal ; *appendix interna* on third to fifth abdominal appendages ....Callianassinae

Sub-family Callianassinae.

Remarks : In Maharashtra, this sub-family is represented by a single genus *Callianassa* Leach.

3. **Callianassa (Callichirus) kewalramanii** sp. nov. (Figs. 5 to 8)

Description

Sex : Male (Fig. 5, a) :

Length of carapace = 11·5 mm.
Length of abdomen = 35·0 mm. } Total length = 46·5 mm.

Rostrum simple, fairly long, pointed, triangular, broad at base, reaching about the middle of the basal segment of the antennule and beyond the base of the second segment of the antenna. The frontal margin, on either side of the rostrum mainly concave, sloping to form a minute tooth-like antennal spinule, which is very much smaller than the rostral spine. Carapace is smooth, shiny and well grooved on the inner side all around except behind the rostrum. Cervical groove distinct.

Eye flattened anteriorly with a lobe narrowing anteriorly and its tip curved slightly outwards and upwards. The eyes extend beyond the

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[1] Present Address :—Marine Zoology & Fisheries Div., Dept. of Zoology Karnatak University, Dharwar-3, Mysore State.

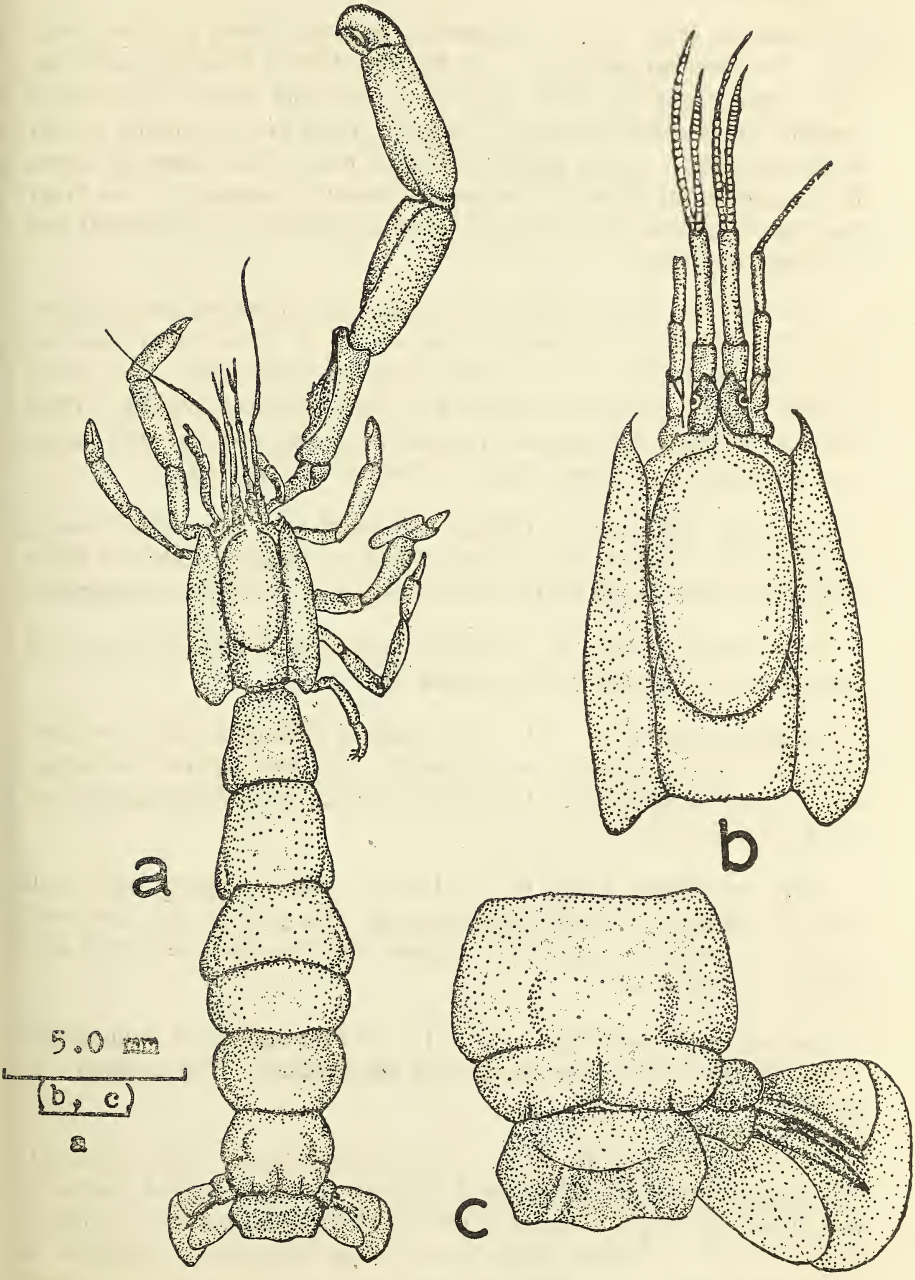


FIG. 5. *Callianassa* (*Callichirus*) *kewalramanii* sp. nov. (*a*) entire animal, (*b*) carapace showing antennule, antenna etc., (*c*) telson with uropods.

distal margin of the basal segment of antennule and the second segment of antenna. Cornea well-developed, situated laterally on the dorsal surface (Fig. 5, b).

Antennule (Fig. 6, a): Antennular peduncle about $\frac{1}{4}$ times longer than the antennal peduncle. Its flagella shorter than the peduncle. First segment slightly longer than the second and the first and second together are less than the third in length. There are no spinules on any of the segments. Upper flagellum shorter, more slender than the lower, but broader at the tip and is composed of about 28 segments. The lower flagellum is broader than the upper, gradually narrowing distalwards and is fringed with setae.

Antenna (Fig. 6, b): Peduncle shorter than the antennular peduncle. The fifth and fourth segments equal, about $1\frac{1}{2}$ times longer than the second segment which bears a small triangular scaphocerite. The fourth segment has on its upper margin, a distinct proximal tubercle. Third segment ventrally situated and covered by the second and only partly seen in outer-lateral view; much smaller than the second.

Mandible (Fig. 6, c): Though well developed, it is rather poorly calcified. The ventral plate is armed with all unequal teeth and below these there is one tooth seen on the dorsal plate. Palp three-segmented.

First maxilla (Fig. 6, d): Both the lower and upper endites are well developed and its palp has a deflexed tip.

Second maxilla (Fig. 6, e): It consists of 2 bilobed endites, of these the upper lobe of the lower endite is small. The palp and the scaphognathite are well developed but the outer margin of the scaphognathite does not have any notch.

First maxilliped (Fig. 6, f): Lower endite triangular and small whereas the upper is large and elongated. The palp is well developed and is of a peculiar shape with a distinct notch on the inner distal end. There is no exopodite.

Second maxilliped (Fig. 6, g): In the four-segmented endopodite, carpus is the longest and dactylus is the smallest. The exopodite is lamellar.

Third maxilliped (Fig. 6, h): Exopodite wanting. The ischium is the longest segment, slightly less than thrice as long as broad; merus is nearly half the length of the ischium and as broad as ischium; carpus is less than half as long as merus and narrows proximally; propodus is much expanded, nearly twice as broad as long; dactylus is long and narrow.

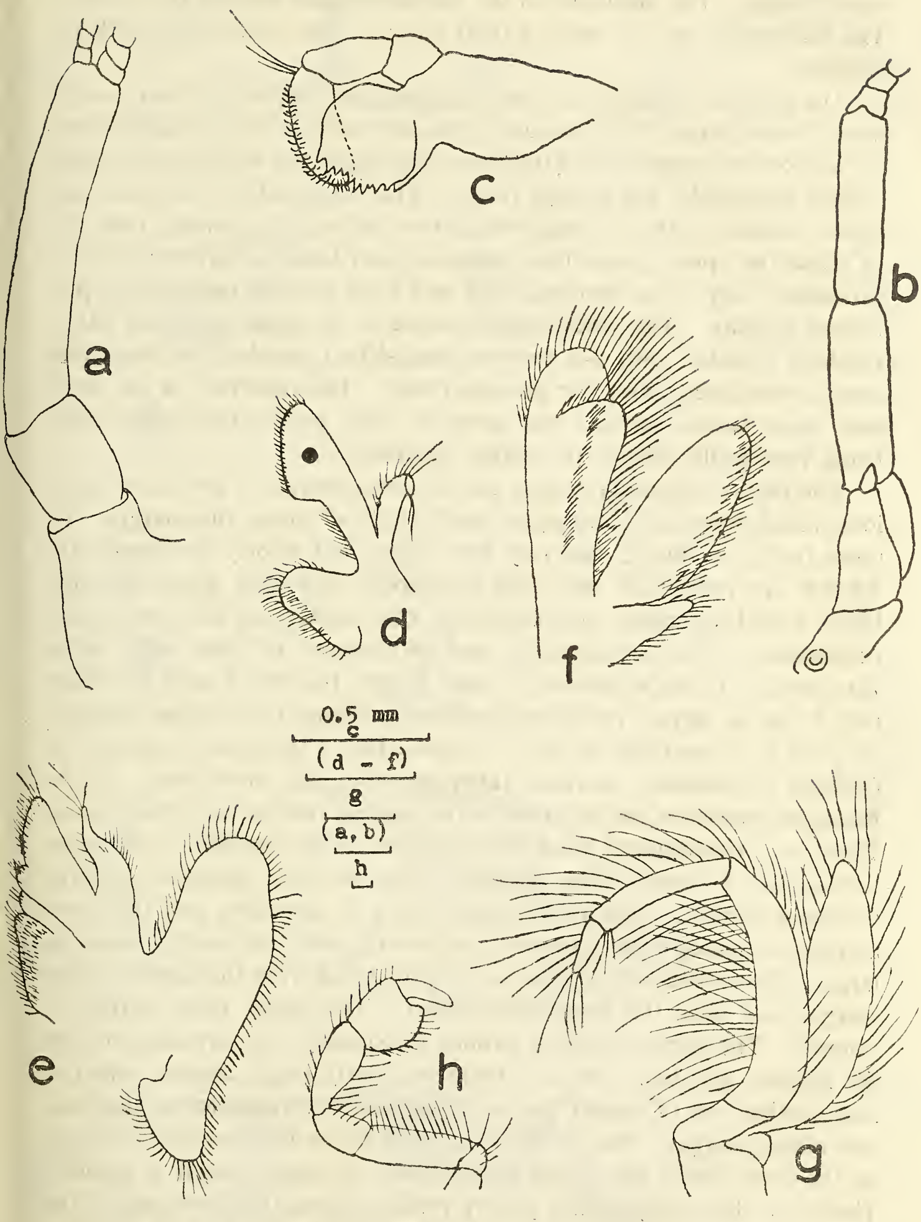


FIG. 6. *Callianassa* (*Callichirus*) *kewalramanii* sp. nov. (*a*) antennule, (*b*) antenna, (*c*) mandible, (*d*) first maxilla, (*e*) second maxilla, (*f*) first maxilliped, (*g*) second maxilliped, (*h*) third maxilliped.

Periopods :

Chelipeds or 1st pair : (Fig. 7, a-d) : Unequal, left or right being much larger. The distal end of the ischium extends beyond the rostrum. The basipodite has an outer lateral spine at the articulation with the ischium.

The ischium is slightly less than the length of carpus and bears on the outer lower margin 12-14 minute, spine-like teeth of which the proximal 5-6 are low and granular and the remaining larger and well-spaced. Upper margin proximally has a large tooth. The lower half of the outer surface is studded with 3-4 longitudinal rows of minute granular tubercles of which the upper 2 rows have comparatively larger tubercles which are prominent only in the proximal half and from then on become less prominent distally. The inner lateral surface in its upper proximal half is similarly studded with 4-5 rows of bead-like tubercles, but these fade away immediately after the proximal half. The tubercles of the inner and outer lateral surfaces are generally very poorly developed, often being practically absent, in smaller specimens.

The merus is about $\frac{3}{4}$ carpus and its lower margin is produced into a lobe which bears 12-15 unequal small teeth all along the margin. Of these teeth, the first 3 are very low, blunt and poorly developed, the 4th-9th are prominent and well developed, 10th-12th again low and blunt, 13th-14th rather well developed but smaller and last one or two rudimentary. The arrangement and prominence of these teeth often vary much. In a specimen of 32 mm. length, the first 2 teeth are blunt, next 3 well developed, prominent and the remaining 7 are minute tubercle-like and in a specimen of size 22·5 mm., first 6 teeth are large and remaining 7 granular, distinct tubercles but less developed. In the Ratnagiri specimen, the 8th tooth is the longest and the last 2 are minute. There is a longitudinal crest-like elevation at the middle of the outer surface and a curved ridge parallel to but at some distance from the proximal margin. The area between these 2 elevations and the lower margin is studded with granular tubercles of which the middle ones are large. The tubercles fade away at little distance from the toothed lower margin and near the longitudinal crest. The upper outer surface is smooth. The upper margin is swollen proximally at its articulation with the ischium and bears about 7 blunt but fairly large, distinct tubercles and another row of similar but less prominent 4-5 tubercles on the inner side of this margin. But for these tubercles and a distal swollen structure on the inner side at the carpal articulation, the upper margin is smooth. There is a thin, longitudinal groove running along the inner side of the upper margin joining the tuberculated proximal part with the swollen structure of the distal margin. A similar groove is present on the inner side parallel to the meral lobe. The inner surface is armed with about 6 irregular rows of well developed but blunt tubercles. This area has

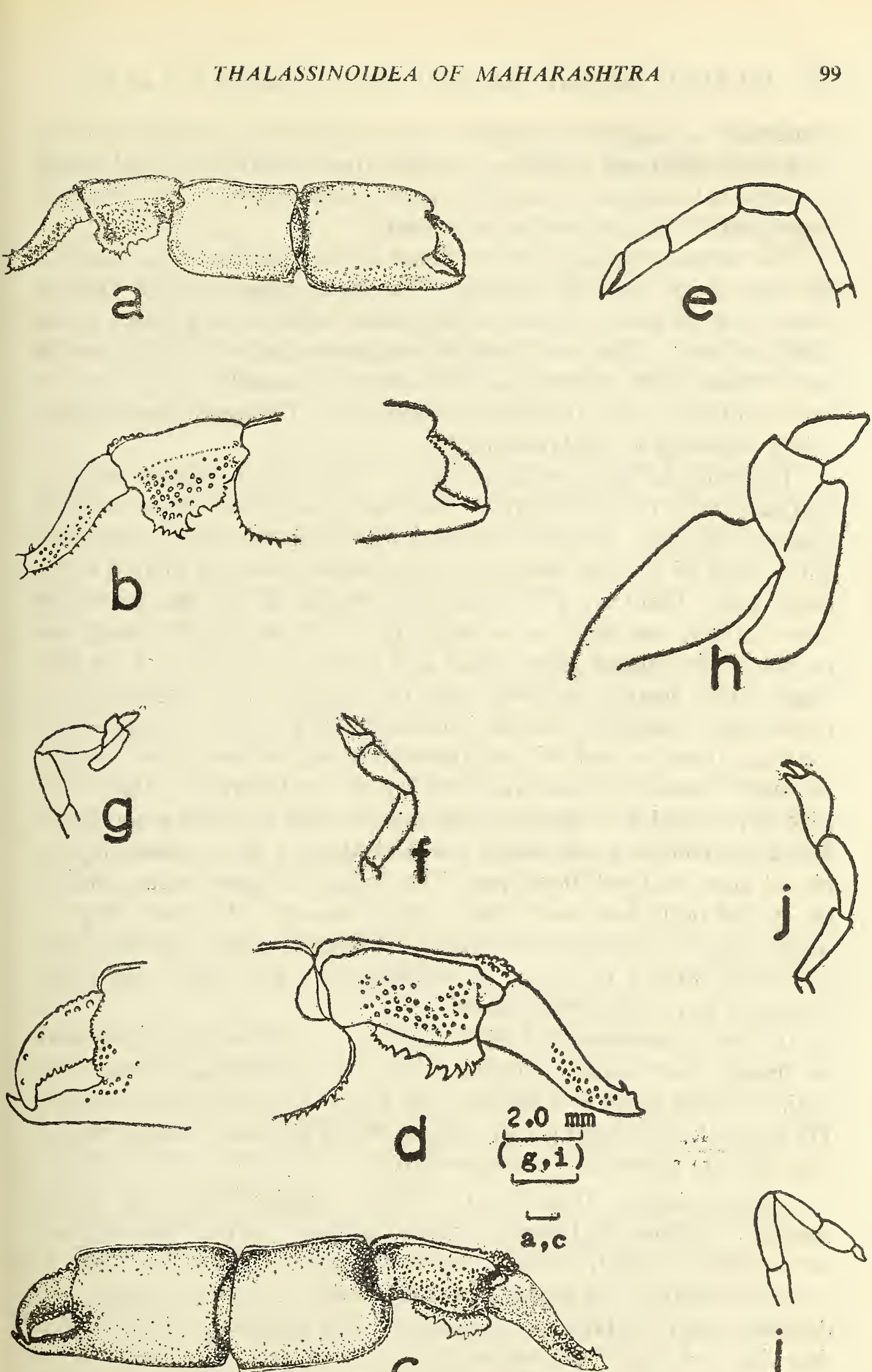


FIG. 7. *Callianassa* (*Callichirus*) *kewalramanii* sp. nov. (*a*) major cheliped (outer view), (*b*) details of 'a', (*c*) major cheliped (inner view), (*d*) details of 'c', (*e*) minor cheliped, (*f*) second leg, (*g*) third leg, (*h*) anterior part of third leg magnified, (*i*) fourth leg, (*j*) fifth leg.

proximally a somewhat triangular, swollen structure at the articulation with the ischium and a peculiar, swollen structure along its distal margin as shown in the figure. Except for these studded tubercles, the remaining upper half of the inner surface is smooth.

The carpus is broad, nearly as broad as the propodus and in length it measures more than the ischium. The lower margin is well differentiated so as to form a sort of a thin carina which is seen clearly in the distal half only. The lower proximal margin is edged with 12-18 rounded but distinct teeth interspersed with setae. In smaller specimens, the number of these teeth is reduced to as low as 7. The upper border is also thinly carinated as the lower border.

The propodus is longer than broad. The distal margin on the outer surface at the articulation with the dactylus, is edged with about 14 small, unequal tubercles. So also, the distal margin on the inner side is edged with about 16 unequal tubercles which extend from the margin to the finger gap. There are a few bead-like tubercles in two patches on the inner surface, one patch in the finger gap with the dactylus along with its distal tuberculated inner margin and another at the base of the fixed finger. The dactylus is about half the length of the propodus. Its outer-upper margin is provided proximally with 3 well developed blunt teeth-like tubercles and 3-6 such tubercles along the inner upper margin. In smaller specimens, there are in all 3-4 of such tubercles. The cutting edge is provided with about 9 tubercle-like teeth of which generally the first 5 are confluent and rather low and about 4 of the remaining are placed apart and well developed. The dactylus is quite robust with its tip curved both downwards and slightly inwards. The fixed finger is slightly shorter than the dactylus and its cutting edge is generally plain and rarely with 1 or 2 low, small tubercles. The fingers cross each other and leave a gap when closed.

In smaller specimens (of 24·5 mm. length), the cutting edge of both the fingers bears several, minute, blunt, closely arranged tubercle-like teeth, of which about 4 of the proximal are more prominent on dactylus. The fingers leave a slight gap or none at all and are nearly straight though their tips are somewhat bent downwards.

Smaller cheliped (Fig. 7, e): Much smaller than the larger cheliped. Ischium and merus slender compared to the propodus and the ischium is slightly longer than the merus. Carpus less than $1\frac{1}{2}$ times the length of the propodus and in breadth less than $\frac{1}{2}$ its own length. Propodus nearly as broad as the carpus. The dactylus is slightly longer than the fixed finger but shorter than the propodus. Fixed finger bears about 14 minute teeth on the cutting edge and these are more clearly seen in the inner view. The upper and lower margins of the propodus are fringed with setae. The fingers leave a slight gap or none at all, when closed.

In smaller specimens, the teeth on the fixed finger are practically absent, though there is just a trace of them. The dactylus is smooth.

Second leg (Fig. 7, f) : The second pair is chelate with its carpus and merus being much larger and stouter than the remaining segments. The merus is slightly longer than the carpus and nearly three times as long as broad ; the carpus widens distally and is nearly twice as long as broad. The propodus is very short and the dactylus is as long as the fixed finger.

There are no spines on any segments except on the ischium which has a distal spine on its lower margin.

Third leg (Fig. 7, g) : The merus is slightly longer than the carpus which broadens distally. The propodus is shorter than the carpus but is produced posteriorly beyond the articulation with the carpus. This produced part (Fig. 7, h) extends well beyond the posterior margin of the carpus and has parallel to its posterior margin a sort of a line, more or less in line with the posterior margin of the carpus.

Fourth leg (Fig. 7, i) : Simple. Merus nearly $1\frac{1}{2}$ times the length of the carpus which is larger than propodus. The dactylus is about one-half the length of the propodus.

Fifth leg (Fig. 7, j) : Chelate, with all its segments long and cylindrical. The merus is longer than the carpus which is slightly longer than the propodus. The dactylus is nearly half the length of the propodus and longer than the fixed finger.

Abdomen (Fig. 5, a) : Of the abdominal segments, the 2nd and the 6th are longer than the rest and 3rd to 5th are broader. The 6th segment (Fig. 5, c) is one and one-fourth times broader than long. There are two horizontal sutures, one on either side at the distal 1/3 distance, extending inside nearly $\frac{1}{4}$ the width of the segment. The posterior margin shows a central suture which fades away just near the level of the horizontal sutures, dividing the posterior margin into two halves. Each lateral half has again a small vertical suture which is situated more on the outer side than on the middle.

There are 5 pairs of pleopods borne on the 1st to 5th abdominal segments, of these the 1st two pairs do not have *appendix interna*.

1*st pair :* It is uniramous in both the sexes, but the ramus is ribbon-like, oval and partially two-segmented in male (Fig. 8, a) and slender, sabre-like in female (Fig. 8, c).

2*nd pair :* It is biramous, consisting of a protopodite and a terminal exopod and a lateral endopod. In female, (Fig. 8, d), the endopod is nine times its width and the exopod which is broader than the endopod,

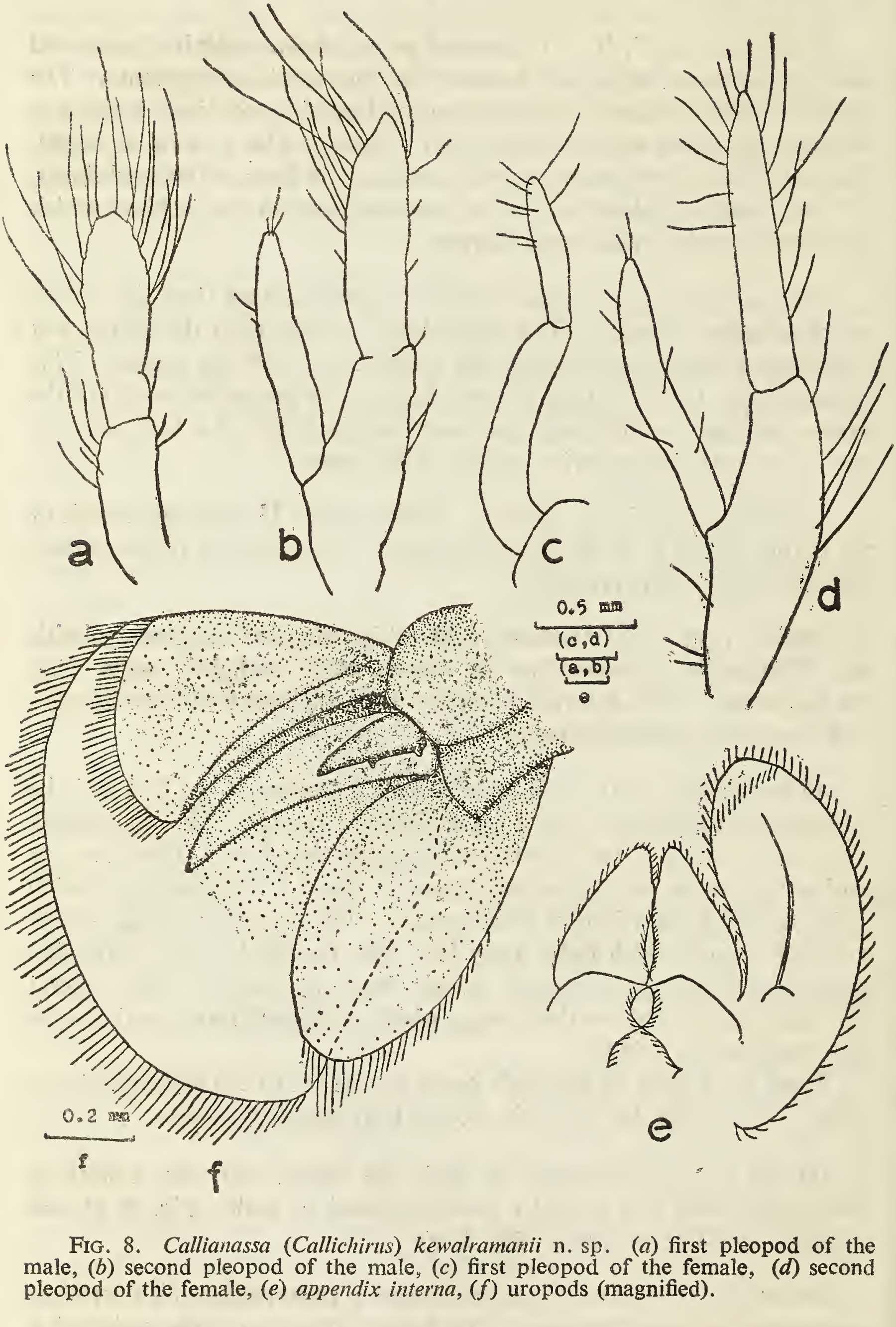


FIG. 8. *Callianassa* (*Callichirus*) *kewalramanii* n. sp. (*a*) first pleopod of the male, (*b*) second pleopod of the male, (*c*) first pleopod of the female, (*d*) second pleopod of the female, (*e*) *appendix interna*, (*f*) uropods (magnified).

is nearly seven times its own width. In male (Fig. 8, b), the stalk and the rami are more or less of the same length, the endopod is nearly six times longer than broad and the exopod is nearly three and a half times its breadth.

3rd to 5th pairs (Fig. 8, e) : These are with *appendix interna* and are similar in shape and size. The outer ramus is sickle-shaped, much longer than the inner, rounded at the tip with its outer margin curved. There is a narrow groove running almost at the middle. The lower inner part of the inner ramus is rectangular and the upper rather conical in shape. There are small hooks on *appendix interna.*

Uropods and telson (Fig. 8, f and 5, c) : Uropods are much longer than the telson.

The protopodite of the uropod bears a small, elongated process which is armed with two tubercles on its posterior margin. The exopodite is nearly two and a half times as broad as and is one and a half times the endopodite which is oval. The exopodite is more or less triangular in shape with its anterior and posterior borders almost straight whereas the distal margin is finely curved. The anterior raised part of the exopod falls short of reaching the middle and there are two longitudinal carinae, one situated on the posterior margin of the anterior raised part and the other posterior to the first and near about the middle of the exopod. Of these carinae the anterior one fades away near the distal 2/3 and the posterior extends a short distance beyond the anterior one.

Telson (Fig. 5, c) : It is one and a half times broader than long and has a raised portion, somewhat semicircular, in its anterior half. The portion below this, slopes down in the middle to form two longitudinal faint lateral carinae at 1/3 distance from either lateral side. The areas outside these carinae again slope down towards the lateral margin.

MATERIAL :

15 specimens collected from Bombay (Cuffe parade and Chowpatty) and a single specimen from Ratnagiri. The males ranged from 21·0 mm. to 46·5 mm. and the non-ovigerous females 20·0 mm. to 27·0 mm.

One holotype and three paratype specimens are deposited in the Rijksmuseum Van Natuurlijke Histoire, Leiden, and following are their registration numbers :

Holotype, ♂, Crust D. 21250 ; paratypes 1 ♂ Crust D. 16615 (collected from Ratnagiri) ; ♀, Crust D. 21248 ; ♂, Crust D. 21249.

The remaining paratypes will, in due course, be deposited in the Z. S.I. at Calcutta.

Colour : Whitish with shiny carapace and cheliped.

Variation : The tubercles on the outer lateral and inner lateral surfaces of ischium and merus of the major cheliped are well-developed in larger specimens and very feebly developed in smaller specimens. So also the tubercles on the proximal upper border of the merus and on the inner surface of the palm at the base of the fingers, are feebly developed in smaller specimens.

ECOLOGY. This is rather a rare species as compared to *Upogebia* (*Upogebia*) *kempi* n. sp. and its burrows are generally found underneath loose stones in sandy mud strewn with pebbles and small stones in the intertidal zone. The opening of the burrows is comparatively narrower than that of Upogebiid burrows and the burrows seem to extend more horizontally than vertically downwards as in Upogebiids. The burrows are not very rigid and their walls are quite coarse unlike the polished walls of the Upogebiid burrows.

Three berried females were collected, in the month of October, 1965.

RELATIONSHIP. According to de Man's (1928) key for determining the species of the sub-genus *Callichirus*, the species works out to be somewhat nearer to *Callianasa* (*Callichirus*) *martensii* Miers, though it does not at all fit into the key. The description of *martensii* (Miers 1884a) which was based on a single male specimen is rather poor and I have not been able to compare with the actual type specimen of the species. Under the circumstances, I think it best to compare the present species with the available account of *martensii*, as under :

1. In *martensii*, the antennal spines (lateral spines according to Miers) of the front are fairly large, i.e. little shorter than the rostrum whereas in this species these are minute but distinct and very much shorter than the rostrum.

2. The eyes project very little, i.e. very slightly beyond the rostrum and they are bluntly pointed at their inner distal angle and the cornea is small, placed on the dorsal surface whereas in the present species the eyes project well beyond the rostrum and though bluntly pointed at their distal angle, their shape is quite different from those of *martensii* and they are curved both upwards and outwards and cornea is fairly large, situated on the latero-dorsal surface.

3. The antennule is less than one-half the length of the antenna, its terminal joint very slightly exceeding the penultimate joint, but in the present species, the antennule is distinctly longer than the antenna and its terminal joint is 3 times the penultimate joint.

4. In *martensii*, the antennal peduncle has no tubercle or spine on the penultimate segment, but the antepenultimate segment bears a small distal spinule on the outer margin, whereas in the present species, the

penultimate segment has a proximal tubercle on the outer margin and the antepenultimate segment is smooth.

5. *Major cheliped :*

Ischium : Its lower border is crenulate with about 12 small obtuse teeth but with no acute spines and no tooth on the upper margin (as per de Man's key) whereas in the present species, its lower border is armed with 12-14 distinct spine-like teeth and upper border with a large proximal tooth.

Carpus : It is rather shorter than but as broad as palm, smooth its inferior margin acute and entire. The present species also agrees in this respect but its lower margin in its proximal half is edged with minute serrations.

Merus : It is less than twice as long as broad, its lower margin acute and serrated but without strongly developed teeth or spines whereas in the present species it is more than twice as long as broad, its lower margin acute, serrated but with strongly developed teeth or spines ; granular tubercles on inner and outer lateral surfaces.

Propodus : The present species agrees with *martensii* but has its distal margin on the outer surface edged with several small tubercles, so also the distal margin on inner surface which has 2 small patches of granular tubercles near the base of the fingers.

Fingers : These are shorter than palm with their tips incurved and the fixed finger with a small tooth or lobe on the inner margin whereas in the present species, fingers are nearly $\frac{1}{2}$ the length of palm and dactylus is minutely toothed on its cutting edge and the fixed finger is generally plain and rarely with 1 or 2 low tubercles (small specimens with both the fingers minutely denticulated).

6. *Smaller cheliped :* According to de Man, fingers are shorter than palm and gaping in *martensii* whereas in the present species, they are shorter than palm but leave a slight gap or none at all when closed.

7. *Third leg :* In *martensii*, the carpus is armed with a low triangular lobe on its posterior margin and the produced posterior lobe of the propodus is rather broad and obtuse whereas in the present species the carpus lacks a lobe on its posterior margin and the propodus is rather narrow, elongated, and differs distinctly in its shape.

8. *Abdomen :* In *martensii*, the 1st, 2nd and the 6th segments are longest and the 6th is about as long as 4th+5th together. But in the present species, the 2nd and 6th alone are the longest and the 6th is about

2/3 the length of 4th and 5th together and the 6th segment has two lateral and three posterior distinct notches or sutures which are not seen in Mier's figure nor is there any mention of this in his description.

9. *Uropods :* According to de Man's key, the anterior raised part of the exopod reaches beyond the middle and bears no spinules near the proximal end of its posterior border ; the endopodite is lanceolate and pointed in *martensii* whereas in the present species, the anterior raised part falls short of reaching the middle and has proximally an elongated process with 2 tubercles ; its endopodite is oval.

Thus it is clearly seen from the above comparison that the present species differs widely from *martensii* and has its own characters which rank it as a distinct species.

Remarks : I am happy to name the new species as *Callianassa* (*Callichirus*) *kewalramanii* in honour of my guide, Dr. H. G. Kewalramani of the Taraporevala Marine Biological Research Station, Bombay.

Random notes on Birds of Kerala

BY

M. C. A. JACKSON

These notes are based on observations made by the author over a number of years, mostly in the Vandiperiyar-Peermade area of Kerala situated at *c.* 3000 ft. A.S.L. They should be read with reference to Sálim Ali's BIRDS OF KERALA as they are intended to supply additional information to that contained in that very comprehensive work.

Podiceps ruficollis (Pallas). Indian Little Grebe or Dabchick

Occurs on the lakes in the High Range 4000 ft. A.S.L. Observed on Periyar Lake (3,000 ft.) on 16th and 17th August 1969. A solitary bird in breeding plumage.

Phalacrocorax niger (Vieillot). Little Cormorant

Occasionally straggles up to the Periyar Lake, 3,000 ft. A.S.L. Usually in parties of five or six birds in hot weather.

Ardea cinerea Linnaeus. Eastern Grey Heron

I have seen it during most months of the year on the Periyar Lake but have no record of it breeding there.

Butorides striatus (Linnaeus). Indian Little Green Bittern

Rather uncommon on the Periyar Lake and stream beds in the Peermade area, 3,000-3,500 ft. A.S.L.

Dupetor flavicollis (Latham). Black Bittern

Rare on the edge of the Periyar Lake. I have three sight records.

Elanus caeruleus vociferus (Latham). Blackwinged Kite

Not very uncommon in Peermade area. Resident? Nests in *Albizzia* and *Grevillea* trees in tea plantations, June to September. A pair was once seen mating on a high tension line, a truly acrobatic performance! Its call is a rather high-pitched 'choee' followed by a churring note.

Pandion haliaetus haliaetus (Linnaeus). Osprey

Occurs on the Periyar Lake from October to May. The earliest record I have of the arrival of this bird, is the one seen on 16th and 17th August 1969 on the Lake.

Falco tinnunculus objurgatus (Baker). Indian Kestrel

Found nesting in May in Peermade area. Sometimes nests in open cavities in trees on plantations. Once seen nesting on the flat top of an old tree stump in the Periyar Lake about 16 feet above the water level.

Coturnix chinensis (Linnaeus). Bluebreasted Quail

I have once seen a single bird in October in elephant grass (*Imperata*) at Thanikudi near the head-water of the Periyar Lake. The bird ran a few feet in front of me for some distance before ' freezing ' thus making identification possible.

Perdicula erythrorhyncha (Sykes). Painted Bush Quail

I have found nests with eggs in October at Peermade.

Rallina eurizonoïdes amauroptera (Jerdon). Banded Crake

I have sight records of this species every month of the year in Vandiperiyar. The alarm note is a subdued ' chuck-chuck '.

In September 1956 a pair were flushed out of the Tea by my dog and shortly afterwards a black downy chick ran out from under the bushes and took cover again on seeing me.

In July of the same year 3 similar black chicks were brought to me but I could not identify them. They all died within 24 hours in spite of my efforts to feed them.

In October 1960 I caught a quick sight of what I thought was a Banded Crake running into lantana scrub but the identification was uncertain. The bird was followed by three small black downy chicks such as I have described above.

Circumstantial evidence indicates that the Banded Crake breeds here but I have yet to find a nest.

In November 1967 a single bird flew into my sitting room through an open window at 8 p.m. I released it in the garden.

Amaurornis fuscus zeylonicus Baker. Ruddy Crake

Seen nesting in June on small island in a pond at Vandiperiyar.

Numenius phaeopus (Linnaeus). Whimbrel

A single straggler seen on the Peermade golf course on 15th August 1962. 3,500 ft. A.S.L. About 50 miles from the sea coast.

Arenaria interpres (Linnaeus). Turnstone

A small flock observed on sea shore near Alleppey pier feeding in areas fouled by people. October 1960.

Capella minima (Brünnich). Jack Snipe

Occurs occasionally in paddy areas at Kumili 3,000 ft. A.S.L.

Clamator coromandus (Linnaeus). Redwinged Crested Cuckoo

Very rare. I have only two sight observations in Peermade, January 1967 and January 1970.

Clamator jacobinus (Boddaert). Pied Crested Cuckoo

Occasionally seen in Vandiperiyar 3,000 ft. A.S.L. in dry weather. A pair once remained for more than two months, May/June, near or in my garden. They called to each other frequently.

Cacomantis sonneratii (Latham). Banded Bay Cuckoo

I have records of it in the Peermade Hills for all months except August and September.

I have seen young birds being fed by Ioras (May) and Red-whiskered Bulbuls (April).

Otus bakkamoena Pennant. Collared Scops Owl

Resident at Peermade—Vandiperiyar—3,000 ft. Usually around plantation bungalows, where they have been known to breed in holes under the eaves.

In one bungalow I occupied they were very tame and would sit on open windows at night and on one occasion actually entered the house.

Bubo nipalensis Hodgson. Forest Eagle Owl

I quote from my note-book :—

'On 9-2-1963 when sleeping in a Vullum (dug out canoe) on the Periyar Lake I was awoken by loud screaming which I attribute to this owl. The scream has been likened to that made by a woman in terror but it could also be said to be like the sound made by a person blowing violently through a blade of grass held between cupped hands.'

Shortly after being woken up by this screaming, a large owl, clearly visible in the moonlight, flew over the boat.

Bubo zeylonensis (Gmelin). Brown Fish Owl

Not uncommon at 3,000 ft. Peermade—Vandiperiyar. Its eerie call is considered to be very unpropitious by plantation labourers.

It is fairly alert during day-light and flies without difficulty when approached too closely.

Caprimulgus indicus Latham. Indian Jungle Nightjar

Not uncommon in the Periyar Lake environs during the dry weather but it is not usually heard during the monsoon and I suspect that it is a local migrant to the dryer zone outside the S.W. monsoon belt. However, on the nights of 15th and 16th August 1969, I heard the call near the Periyar Lake. This is the first occasion I have heard this bird during the monsoon months and its presence may have been due to the exceptionally fine spell we enjoyed at that time. I heard it again on 1st September 1969, near Aranya Nivas Hotel at the Periyar Lake.

It is possible also that the Great-eared Nightjar, (*Eurostopodus macrotis* Vigors) and Franklin's Nightjar, *Caprimulgus affinis* Horsfield, which occur quite frequently in the dry weather around the Periyar Lake move away to the dryer zone during the monsoon. This dry zone which is not generally affected by the S.W. monsoon is only about five-ten miles away to the east of the Periyar Lake in Tamil Nadu. I have found Franklin's Nightjar there in August.

Caprimulgus affinis Horsfield. Franklin's Nightjar

As far as I can make out a dry weather visitor only from October to May.

I have found a ' nest ' with a single downy fledgling on 8-v-1966 on the shore of the Periyar Lake and on 8-iv-1967 I found two more nests, one with two eggs and one with a single egg also on the shore of the Periyar Lake.

All the ' nests ' were shallow hollows on bare ground in stony areas. The mother bird sits very closely flying off only when nearly trodden on. A quiet ' chuck-chuck ' is uttered when disturbed. She does not fly for a long distance but usually alights within sight of the nests on the ground where her protective colouring makes her nearly indistinguishable.

Ceryle rudis Linnaeus. Pied Kingfisher

In the past twenty years has become quite common on the Periyar Lake. I think this may be due to the fact that several suitable breeding cliffs at the waters edge have not been submerged for many years because of the extra off-take from the Lake since the hydroelectric generators at Lower Camp were commissioned. In previous times the water level always used to rise above such banks and cliffs at least once a year.

Halcyon pileata (Boddaert). Blackcapped Kingfisher

A pair was observed by me in a secluded backwater of the Periyar Lake on 27-iv-1963.

I have seen this species on several occasions at a tank near Uthamapalayam in the Cumbum valley of Madurai District, Tamil Nadu, since 1961. This tank is about 20 miles from the Periyar Lake but a considerable distance from the sea coast.

Merops leschenaulti Vieillot. Chestnut-headed Bee-eater

Breeds in April and May in the Peermade area.

Upupa epops Linnaeus. Hoopoe

Appears to ascend to the Peermade Hills in the dry weather only but I have records of seeing the species on 22-vi-1964 during the monsoon.

I have no evidence of its breeding in this area but once in February I observed a bird flying with something held in its beak as if it was on its way to feed young.

Megalaima zeylanica (Gmelin). Green Barbet

Occurs in the deciduous low elevation jungle to the east of Kumili just outside the Kerala State boundary. Does not appear to ascend to the wet zone surrounding the Periyar Lake.

Jynx torquilla Linnaeus. Wryneck

Single bird seen at Vandiperiyar on 10th March 1967.

Picus xanthopygaeus (J.E. & G.R. Gray). Little Scalybellied Green Woodpecker

Observed nesting in March and April in this area. Both sexes appear to incubate.

Dendrocopus nanus Vigors. Pigmy Woodpecker

Observed nesting March, April, May.

Pitta brachyura (Linnaeus). Indian Pitta

Earliest arrival date recorded October 3rd but usually regularly arrives between 10th and 18th October.

Latest departure date recorded 19th May.

Hirundo concolor Sykes. Dusky Crag Martin

This little bird has become increasingly common in Peermade and Vandiperiyar and now many bungalows and tea factories provide nesting sites for it.

Its favourite time for breeding is August-September but I have also observed it nesting in April. It is possible that sometimes two broods are raised but I have yet to verify this.

The nest takes about 12 days to complete before the first egg is laid. Eggs appear to be laid in the early morning. Old nests are sometimes patched up and re-lined in the following year. Both sexes incubate and feed young. Young birds have pale grey almost white gapes.

Lanius vittatus Valenciennes. Baybacked Shrike

I have one sight record of this species at Peermade (3,500 ft.) on 15th March 1966.

Lanius schach Linnaeus. Rufousbacked Shrike

Very rare in this area. I have only one sight record on 31st January 1969 in Vandiperiyar.

Lanius cristatus Linnaeus. Brown Shrike

Our commonest shrike during winter months. Earliest date of arrival recorded 16th September but nearly every year arrives between 20th and 30th September.

Latest departure date recorded 8th May but it is usually very regular in leaving during the first week of May.

Dicrurus leucophaeus Vieillot. Indian Grey Drongo

Winter visitor only, arriving in October and leaving in April.

Artamus fuscus Vieillot. Ashy Swallow-Shrike

Nests March, April. I once found a nest in a large hole in a hollow tree stump in the Periyar Lake. These dead tree stumps provide good nesting sites for this species.

Acridotheres tristis (Linnaeus). Common Myna

Though becoming more abundant at Kumili (3,000 ft.) it is still rare at this elevation. Parents have been observed feeding young in a hollow tree in the Periyar Lake in August.

Corvus splendens Vieillot. House Crow

In the last fifteen years this species has become more numerous at Kumili and in the villages along the main Kumili-Kottayam highway at about 3,000 ft. The species is by no means common at this elevation but appears to be becoming well established along with the increase in the human population.

Rhopocichla atriceps (Jerdon). Blackheaded babbler

I once brushed against an old nest at sundown and five or six fully grown birds burst out of it. It would seem that parties of this species roost together in old nests.

Garrulax jerdoni Blyth. Whitebreasted Laughing Thrush

A small isolated colony is resident at the top of the Annanthambi Hills at about 4,000 ft. This is the highest point in the Vandiperiyar-Peermade district and it is interesting to note that these birds never seem to descend any lower although ' rubus ' is to be found on the lower slopes of the hills. Apart from this colony in its very restricted habitat I have not observed the species anywhere else in the district even on the tops of other hills with similar vegetation.

Muscicapa latirostris Raffles. Brown Flycatcher

I have observed the species in every month of the year here but it becomes more numerous in the winter months.

I have found nests in March, April and May and have observed young being fed in June.

The nests I have seen have all been rather high up in trees where branches join the main stem, the *Grevillea robusta* being a favourite tree.

I have heard a faint twittering song in January.

Muscicapa parva Bechstein. Redbreasted Flycatcher

As Sálim Ali (1969), writes this species is very rare. I have only two records of having seen it in Vandiperiyar on 14th March 1948 and 9 March 1971. Both males.

Prinia hodgsonii Blyth. Franklin's Wren Warbler

Nests commonly at 3,000 ft. elevation in Peermade district. I have found a nest with young as late as September.

Prinia socialis Sykes. Ashy Wren Warbler

The breeding season extends until September in Peermade.

Orthotomus sutorius (Pennant). Tailor Bird

The breeding season extends until September in Peermade.

Schoenicola platyura (Jerdon). Broadtailed Grass Warbler

During May/June grass warblers attract attention by their linnet-like song which is uttered from the top of a bush or while soaring 10-15 feet above the ground. When soaring the tail feathers are fanned.

I have found a nest with two young in August (26-viii-1956) and another nest with three eggs, subsequently damaged by dogs and deserted, in July (7-vii-1963).

The nests were very well concealed in clumps of imperata grass (illuk) about 3 feet above the ground. They were ball-shaped, rather untidy, with a hole at the side. They were constructed from blades of coarse grass lined with finer grass stems.

It seems that only one bird builds, presumably the female, while her mate stays nearby entertaining her with song from vantage points close by.

The eggs were light pinkish with reddish brown specks.

Erithacus brunneus (Hodgson). Indian Blue Chat

For some time after its arrival in its winter quarters its song can be heard throughout October and November.

Saxicoloides fulicata Linnaeus. Indian Black-backed Robin

From about March 1965 to about March 1968 a female bird resided in a patch of waste land near the main Kottayam-Kumili road not far from Vandiperiyar. She seemed to keep company with Pied Bush chats.

She must have straggled up from the low country, probably Tamil Nadu, and become stranded because she is the only specimen of the species I have seen in this district in over thirty years.

Monticola solitarius (Linnaeus). Blue Rock Thrush

The earliest arrival date I have recorded is 27th September but this species usually appears here early in October.

Zoothera wardii (Blyth). Pied Ground Thrush

I have two observation records. A male on 8-iv-1956 and female on 18-xii-1960. The former at 3,000 ft. in Vandiperiyar and the latter in Peermade at 3,500 ft.

Motacilla indica Gmelin. Forest Wagtail

The earliest date of arrival recorded here by me is 19th September and the latest I have seen it is 6th May.

Motacilla flava Linnaeus. Grey-headed Yellow Wagtail

Small parties of yellow wagtails occasionally visit the marshy area of the Periyar Lake near Thekkadi at 3,000 ft. A.S.L. during the winter months especially during October, November and December.

Motacilla maderaspatensis Gmelin. Large Pied Wagtail

Nested in the attic loft of Munjamullay Tea Factory, Vandiperiyar, 18th November 1959.

Nectarinia asiatica (Latham). Indian Purple Sunbird

This species and the Small Sunbird, *N. minima*, are the only two sunbirds seen in the Peermade area and the population fluctuates considerably, the greatest number being seen in dry weather.

Breeding here appears to be uncommon. I have found only two nests of the Purple Sunbird in March and have not observed any nesting of the Small Sunbird.

Zosterops palpebrosa Temminck. Nilgiri White-eye

Breeds in September and October in this area as well as March to May.

Ploceus philippinus Linnaeus. Baya

Since 1959 there has been a breeding colony at Kumili, 3,000 ft., presumably because the paddy cultivation in the area has increased considerably in recent times.

Studies on the freshwater and amphibious Mollusca of Poona with notes on their distribution—Part II

BY

G. T. Tonapi
Department of Zoology, University of Poona, Poona-7

(*With twenty-one figures in four plates*)

Introduction

Earlier studies on the freshwater and amphibious Mollusca of Poona (Tonapi & Mulherkar 1963) and adjoining areas had revealed their occurrence in appreciable number both in species and genera. Further explorations and detailed systematic studies have now confirmed some of the earlier conclusions. A few of the specimens which were known to occur in this region have now been collected and some others form new records for this region. New populations of the small-sized species have also been detected. The true identity of a few genera with annectant forms and doubtful systematic position have now been determined. It is needless to emphasise the importance of such field studies on the freshwater and amphibious mollusca and their role in agriculture (*Achatina*), horticulture (*Opeas; Glessula*) and still others which are casual agents of well known diseases such as schistosomiasis.

Methods of study

Methods of collection and localities explored for this study are essentially similar to those reported earlier (Tonapi & Mulherkar loc. cit.). The sketch map has already been provided in the paper under reference. The same contractions have been used to abbreviate the descriptive terms used in the present study. Measurements are those of single specimens. However, they represent a fairly average size of the species. It was noticed in the earlier studies that Indian ink line drawings do not always reflect the correct shape and fine contours of these delicate forms. In the present paper, therefore, actual photographs have been provided to facilitate their easy identification. Scale lines have been totally omitted since detailed measurements are given with the descriptions. The bracketed numbers indicate other localities where also a given species occurs.

Systematic list of the species

Class	..	Gastropoda
S. Class	..	Prosobranchiata
Order	..	Megagastropoda
Series	..	Architaenioglossa

Family Cyclophoridae

Cyclophorus (Glossostylus) indicus Deshayes. (Fig. 1 A & B)

Shell orbicular, turbinated, with an acute apex. Spire conical and composed of 6-7 convex whorls. Sutures hardly impressed. Body whorl distinctly inflated bearing a projecting keel in the circumference. Umbilicus very narrow and deep. External surface of shell covered, particularly near the sutures, with thick and thin transpiral striations. Circular aperture oblique to the axis with both lips thickened and reflected. Shell, fawn coloured but the lower part often mottled with dark brown flames. Banding conspicuous on the body whorl and surrounding the umbilicus. The original Latin description has been supplemented by Gude (1921) with additional information which is in French. However, the present description is based on shell characters.

Locality: This is an uncommon species and one comes across the dead/dry shells rather infrequently (30, 31).

Measurements: H—14 mm.; DM—18 mm.; AM—12 mm.; AH—11 mm.; AW—10 mm.

Family Potamiasidae

Cyclotopsis semistriata (Sowerby). (Fig. 2 A and B)

Orbicular shell conspicuously and widely umbilicated. Spire depressed with obtuse apex. Whorls 4-5 inflated with distinct spiral surface striations, which are more prominent on the upper side while the lower surface is relatively smooth. Sutures distinct and well impressed. Circular aperture inclined and feebly acuminated at the upper part. Operculum spirally voluted. Shell whitish with straw colour and a series of pale brownish transpiral bands.

Locality: This species is quite common in the hill ranges. It has never been collected from plains, farms and fields (4, 5).

Measurements: H—8 mm.; DM—16 mm.; AM—12 mm.; AH—7 mm.; AW—6·5 mm.

Family Amnicolidae (Hydrobiidae)

Digoniostoma pulchella Benson. (Fig. 3 A and B)

This genus has been separated from such allied and related genera as *Bithynia, Alocinma* and *Hydrobiodes* on the basis of the lip characters. Shells broadly and irregularly ovate with apex slightly compressed. There are about 4-5 whorls of which the first two are not so conspicuous. Body whorl rather inflated. Sutures oblique linear and well impressed. Aperture small, oblique ovately round. Outer lip thickened and produced; its extremities subangulated. Columellar callus thickened and laminated in appearance. A distinct projection is developed where the columellar callus meets the lip. Umbilicus almost closed. The channel running forward from it is not well formed and is smaller.

Locality: These have been collected from several slow moving streams around Poona. They are also found sometimes associated with aquatic plants. Many have been collected from underside of stones in the dried up canals (27, 28, 29, 30).

Measurements: H—3±1 mm.; DM—2±5 mm.; dm—1·5±·2 mm.; AH—1·1±·1 mm.; AW—·75±·1 mm.

Alocinma orcula (Benson) var. **producta** (Nevill). (Fig. 4 A and B)

Shells narrow and elongated. However, they have typical globose or subglobose appearance. Whorls somewhat tumid with body whorl rather more inflated. Sutures rather wide. Aperture ovate and oblique to the axis. In this genus the peristome is neither thickened nor attenuated. The columellar fold is never prominent though always forming a ridge. The umbilicus is rimate and almost entirely closed. The groove proceeding downwards from the umbilicus is not so well defined. Shell sculpture microscopic. Operculum incapable of withdrawal into the shell; its nucleus is eccentric with concentric spiral lines on both surfaces.

Locality: An abundant species in slow moving streams. Often found under stones in streams and canals. Any place is good enough for collection (28, 29, 30).

Measurements: H—6±·5 mm.; DM—3±·5 mm.; dm—2·5±·1 mm.; AH—1·5±·1 mm.; AW—1·1±·1 mm.

Family Melanidae

Paludomus obesa (Philippi). (Fig. 5 A and B)

Shell oblong, thick and solid with transpiral ridges. Three to four rather depressed whorls (probably more in perfect shells); upper ones often eroded, damaged and missing. Whorls regularly convex. Body whorl at least subangular. There are distinct transpiral striae and grooves on the shell. Aperture oblong ovate with vertical lip. External margin sharp. Columellar slightly thickened and white. Shell yellow olive, occasionally smoky brown.

Locality: Rather common in Poona and noticeable around hill streams and rock pools during the wet season. Often washed down to the plains (12, 13, 17, 31).

Measurements of eroded shells: H—12·5 mm.; DM—6 mm.; dm—5·5 mm.; AH—5 mm.; AW—3·5 mm.

Subclass Pulmonata

Order Stylomatophora

Series Vertiginacea

Family ENIDAE

Rachis punctatus (Anton.). (Fig. 6 A and B)

Shell ovately conical with an elevated spire forming an obtuse apex. Six whorls with almost flattened walls. Aperture oblique-ovate with sharp outer lip and the columellar lip reflected over the umbilicus. Shell surface smooth and glossy; striae fine and microscopic. Shell pale fuscous white with a fine transverse line of infraperipheral brownish band. This is perhaps the most distinctive character of the species. Often an additional narrow band below the principal is also known to occur in some specimens. But this variety has not been noticed from this region. The recorded variety with a single band occurs in large numbers especially during the rainy months. They are known to hibernate during the other seasons. Considerable variation in the size of the shell has been noticed as recorded below.

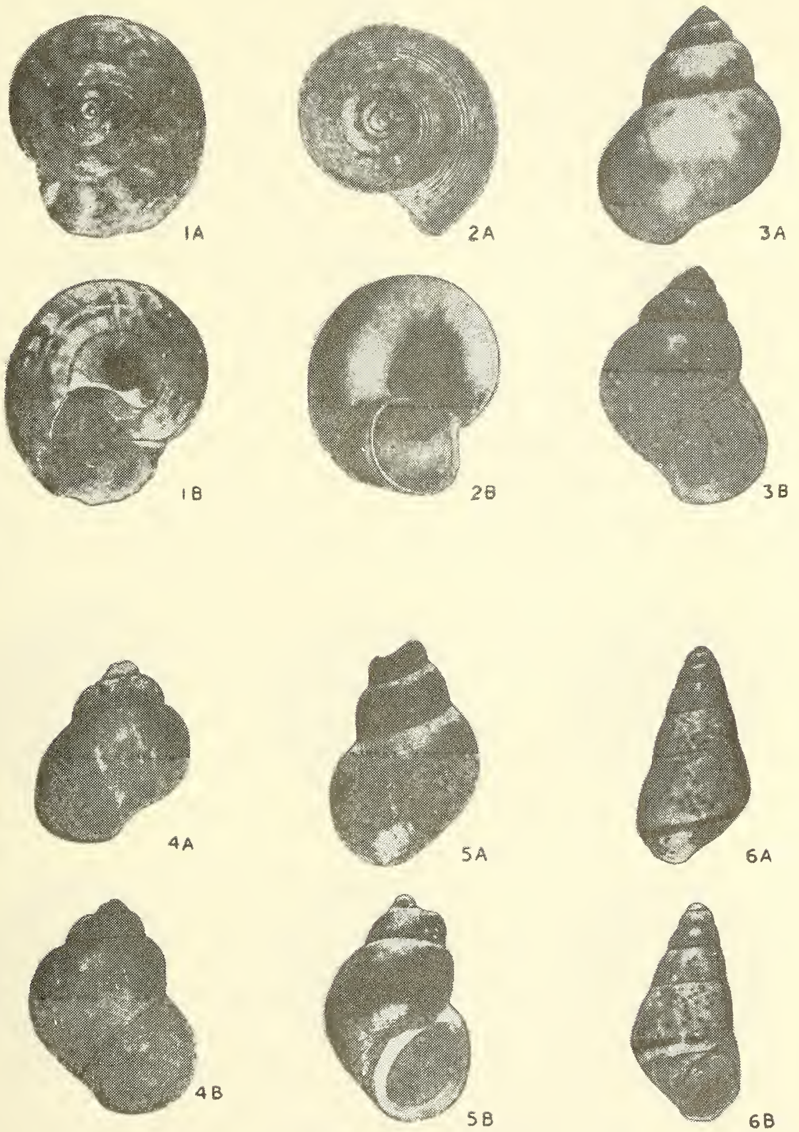
Locality: This species is perhaps the commonest in Poona during the rainy season. It has been collected from localities with abundant luxuriant vegetation (4, 5, 14, 18, 19, 20).

Measurements: H—10±3 mm.; DM—5±1 mm.; dm—4±1 mm.; AH—4·5±·5 mm.; AW—2·5±·5 mm.

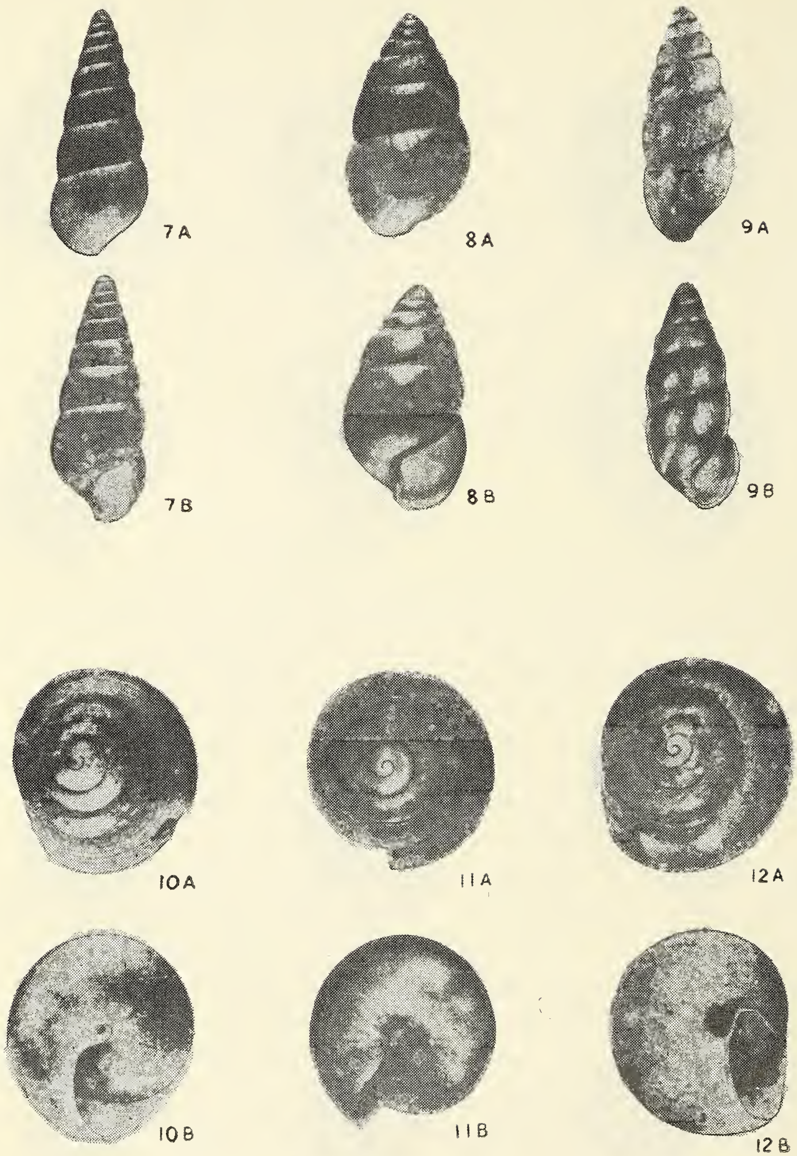
Series Achatinacea

Family GLESSULIDAE

A large number of species of this interesting family has been recorded from Poona proper and many from the adjoining districts. However,



1 A & B. *Cyclophorus* (*Glossostylus*) *indicus* Deshayes × 4; 2 A & B. *Cyclotopsis semistriata* (Sowerby) × 4·0; 3 A & B. *Digoniostoma pulchella* Benson × 8·0; 4 A & B. *Alocinma orcula* (Benson) var. *producta* (Nevill) × 10; 5 A & B. *Paludomus obesa* (Philippi) × 6; 6 A & B. *Rachis punctatus* (Anton) × 8.



7 A & B. *Glessula* (*Glessula*) *notigena* Benson × 4; 8 A & B. *Glessula* (*Glessula*) *ceylanica* Pfeiffer × 5; 9 A & B. *Glessula* (*Rishetia*) *dikarngense* Godwin-Austen × 6; 10 A & B. *Sitala denselirata* Preston × 18; 11 A & B. *Kaliella bullula* (Hutton) × 17; 12 A & B. *Macrochlamys* (*Macrochlamys*) *tenuicola* (Adam) × 9·5.

these records relate to conditions over five decades ago. It is interesting to note that rapid urbanisation and industrial growth have contributed in no small measure to the displacement and perhaps to some extent extinction of many species. The *Glessula* are a case in point. Where I had once collected these delicate animals now stands a large industrial house, surrounded by housing colonies. Some of the well known recorded species are *Glessula hebes* Pfeiffer (*see* Gude loc. cit., p. 380) : *G. tornensis* Blanford (p. 389) ; *G. singhurensis* Blanford (p. 419) ; *G. pulla* Blanford (p. 430) ; *G. brevis* Pfeiffer (p. 439) ; *G. rugata* Blanford (p. 443). The present records make new additions to the rich Glessulid fauna of Poona and environs.

Glessula (Glessula) notigena Benson. (Fig. 7 A and B)

The imperforate shell is elongated, conical with an attenuated apex. Spire slender, turretted with obtuse apex. Sutures rather deeply impressed with about 9-10 whorls which are feebly convex. The body whorl is not so tumid. The last whorl is 1/3 of the rest. Aperture rather oblique and semiovate. The peritremal margin is acute and thin while the columellar margin and the columella are curved and truncated obliquely near the base. The shells are horny brown glossy with crenulations particularly near the sutures. Some have even a fulvous horny colour.

Locality : These are common in the open country around Poona especially under trees. Abundant in the rich humus of dead and decaying leaves under vegetation (4, 5, 14, 15, 20).

Measurements : H—18 mm. ; DM—7 mm. ; dm—5 mm. ; AH—5 mm. ; AW—4 mm.

Glessula (Glessula) ceylanica Pfeiffer. (Fig. 8 A and B)

Shell imperforate ovately oblong with a pyramidal spire. Apex obtuse and conical. There are about seven convex whorls, the last being about 3/7 of the total length. Aperture semioval and obliquely pyriform. Columella deeply arched and basally truncated, rather abruptly. Shells not markedly sculptured though closely and minutely striated with crenulations near the sutures. Lustrous with characteristic horny brown glossy appearance. This species has also not been recorded from Poona and the measurements are smaller than those given by Gude (1914).

Locality : These occur along with the preceding species.

Measurements : H—14 mm. ; DM—7 mm. ; dm—3·5 mm. ; AH—5 mm ; AW—3 mm.

Glessula (Rishetia) dikarngense Godwin-Austen. (Fig. 9 A and B)

This species has not been dealt with by Gude (1914). The shells are quite small and appear pupiform. The shell is elongately conoid, rather ovate, thick, opaque and extremely variable in ground colour. There are about 7½-8 whorls increasing slowly at first the last two inflate rather suddenly. The body whorl more than equals 1/3 of the shell. Spire conoid with flattened sides and angular apex. Aperture obovate and rather oblique. The outer peristomal margin is thickened while the basal margin is curved and arcuate. Columella obliquely truncated. Coloration varies from dull white, dark brown, greenish corneous to dark fuscous.

Locality : The species occurs in the same areas as in the preceding species and does not show any specific habitat preference.

Measurements : H—9±1 mm. ; DM—2·5±·5 mm. ; dm—1·5±·1 mm. ; AH—1·7±·1 mm. AW—1·1±·1 mm.

Series Ariophantacea

Family Ariophantidae

Sitala denselirata Preston. (Fig. 10 A and B)

Shell trochid with the spire conical. Body whorl convex basally. Whorls 5-6 with not so convex sides and nearly flat. The last slightly carinated peripherally. Apex obtuse. The sutures are well impressed. The aperture is diagonal almost semicircularly lunate. The peristome is thin with reflected columellar margin. The shell is obliquely transpirally striated. The shell is whitish horny and semitranslucent. Only two shells are in the collection.

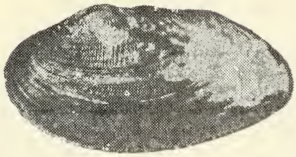
Locality : 28, 29, 30.

Measurements : H—2·25 mm. ; DM—. 75 mm. ; dm—1·1 mm. ; AH— ·65 mm. ; AW—·45 mm.

Kaliella bullula (Hutton). (Fig. 11 A and B)

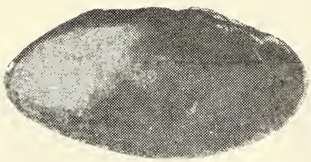
This species also forms a new record. The shell is semiperforated with globose, turbinated and trochiform appearance. The spire is conical with obtuse apex. There are five whorls with convex slides. The

13 A & B. *Macrochlamys* (*Eurychlamys*) *platychlamys* Blanford × 7·5 ; 14 A & B. *Xesta* (*Fretum*) *semirugata* (Beck) × 2·2 ; 15 A & B. *Ariophanta bistrialis* (Beck) × 2·75 ; 16 A & B. *Planispira* (*Trachia*) *crassicostata* (Benson) × 5·0 ; 17 A & B. *Eulota scalpturita* (Benson) × 2·75.



18 A

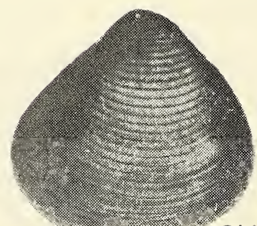
19 A



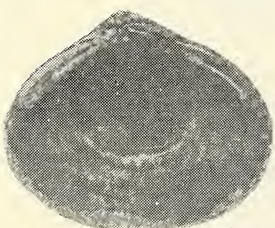
18 B

19 B

20 A



21 A



20 B

21 B

18 A & B. *Indonaia coerulea* (Lea.) × 1·65 ; 19 A & B. *Lamellidens consobrinus* (Lea.) × 1 ; 20 A & B. *Corbicula striatella* Deshayes × 3 ; 21 A & B. *Corbicula peninsularis* Prashad × 3.

sutures are well impressed. The body whorl is slightly angulate at the periphery, and convexly inflated below the keel. Aperture oblique and broadly crescent-shaped. Peristome simple, thin, with slightly reflected columellar margin. Shell horny and not so opaque, finely sculptured with fine oblique ribs on the upper surface while indistinct concentric striae traverse the basal surface. Only one shell was obtained.

Locality : The area of collection is the same as in the preceding species.

Measurements : H—2+·1 mm. ; DM—2·5+·2 mm. ; dm—1·5+·2 mm. ; AH—·3+·1 mm. ; AW—·2+·1 mm.

Macrochlamys (Macrochlamys) tenuicola (Adam). (Fig. 12 A and B)

Shell openly perforated with turbinate subglobose shape; apical region convexly rounded ; spire subconical with 5-6 convex whorls obtuse apex and well impressed sutures. Body whorl distinctly angulated and has a developed peripheral keel, the basal part below the keel convex and glossy. Aperture oblique and broadly crescent-shaped. Peristome thin, sharp-edged, while the columellar margin is curved and reflected over the umbilicus. Shell is glossy, translucent, with a pale fulvous horny colour. The upper whorls are covered with fine microscopic striae.

Locality : This species is quite common (2, 4, 5, 19, 20, 23, 28, 29, 30).

Measurements : H—4 mm. ; DM—7 mm. ; dm—4 mm. ; AH—2·5 mm. ; AW—1·7 mm.

Macrochlamys (Eurychlamys) platychlamys Blanford. (Fig. 13 A and B)

Shell depressedly conoid and openly perforate. Spire low with obtuse apex. There are five feebly convex whorls. Sutures not well impressed. Body whorl rounded at the periphery and convex beneath, the oblique aperture is lunately suboval. Peristomal lip thin, with curved margin while the columellar margin is diagonal and expanded over the umbilicus. The shell is thin, smooth, translucent and fulvous horny coloured.

Locality : This fragile species is common during the wet months. Dry shells are common in other seasons (4, 5, 19, 20).

Measurements : H—5+1 mm. ; DM—9+1 mm. ; dm—7+1 mm. ; AH—3·5+·5 mm. ; AW—2+·5 mm.

Xesta (Fretum) semirugata (Beck.). (Fig. 14 A and B)

Shell openly perforated, somewhat variable in the elevation of its spire. Conoidal globose or depressedly conoid with dull brown or white colour. There are 5-6 convex whorls of which the body whorl is much swollen and descends near the aperture. Sutures are not well impressed. Shell finely decussated with oblique striae and occasional transpiral lines, relatively smooth below. The aperture is broadly crescent-shaped. The peristome is thin and that on the columellar side is reflected near the umbilicus.

Locality : This is one of the common species (5, 14, 15, 30, 31).

Measurements : H—20±5 mm. ; DM—25±3 mm. ; dm—21±2 mm. ; AH—15±1 mm. ; AW—10±1 mm.

Ariophanta bistrialis (Beck.). (Fig. 15 A and B)

Shell normally perforated, round or globosely depressed. The spire is very low and the 4½ flat whorls increase in diameter rather rapidly. Body whorl does not descend, and is convex beneath. Aperture large, oblique and lunately oval. Peristome thin and columellar margin slightly reflected. The shell is relatively thin, pale horny and finely striated above the well impressed spiral lines. Two rufous lines separated by a whitish band between them is the usual form available in Poona.

Locality : This is perhaps the most common Ariophantid available in Poona area. The specimens of this species frequent particularly the gardens and parks.

Measurements : H—14±2 mm. ; DM—20±5 mm. ; dm—26±2 mm. ; AH—12±3 mm. ; AW—9±2 mm.

Series Heliacea

Family Helicidae (Pleurodontidae ?)

Planispira (Trachia) crassicostata (Benson). (Fig. 16 A and B)

Shell moderately sized, circular and has a perspective umbilicus. Shell depressed with almost flattened spire which is hardly elevated. There are four whorls ; the last or body whorl is carinated. The surface is finely transpirally striated and oblique ribbing inconspicuous. Aperture subhorizontal, oval, and transversely rounded. The margins of the peristome approach each other and the columellar side overhangs the umbilicus which is infundibuliform.

Locality : Live specimens are common in the hill ranges in the rainy season. Dead shells can be collected from several other localities (4, 5, 10, 16, 19).

Measurements : H—4±1 mm.; DM—13±1 mm.; dm—9±1 mm.; AH—4·5±·5 mm.; AW—4·5±·5 mm.

Eulota scalpturita (Benson). (Fig. 17 A and B)

Shell depressedly conical with a broad flat base and a short spire, which is never acuminate. There are about five whorls which increase gradually in size. The body whorl is not keeled. Sutures well impressed. Umbilicus small but perforate. The parietal lip is sharp while the columellar one is slightly reflected over the umbilicus. The shells are whitish, almost translucent with a characteristic brown stripe around the periphery of the body whorl. The shell is strongly striated in the basal whorls while those on the apex have finer striae.

Locality : This species is commonly found in and around ponds and pools.

Measurements : H—10±2 mm.; DM—14±2 mm.; dm—11±1 mm.; AH—4·5±·5 mm.; AW—4±·5 mm.

Class Pelecypoda

Order Eulamellibranchiata

Family UNIONIDAE

Indonaia coerulea (Lea). (Fig. 18 A and B)

Shell oblong elliptical, transversely inequilateral narrow and subcylindrical. Valves thin, the anterior side short and rounded while the posterior is feebly angulated and broader. The shell is not so swollen. The umbones are not prominent but rounded. The dentition is lamelliform with a single cardinal tooth in the left valve. Beaks often sculptured with many fine riblets with central ones joining below, the ribbing produces a zig zag pattern. The periostracum is dirty green. The epidermis is bluish green often iridescent.

Locality : Common in the rivers especially near 21, 27.

Measurements : L—48±5 mm.; H—22±3 mm.; DV—14±1 mm.

Lamellidens consobrinus (Lea). (Fig. 19 A and B)

Shell elongately elliptical, rhomboidal and slightly inflated. It is inequilateral with anterior rounded and posterior with obtuse angle. The beaks are rather more elevated than in allied forms as *L. marginalis.* Moreover, the hinge arrangement is quite different from *L. marginalis.* The two widely separated pseudocardinals of the right valve lie one below the other. The lower is longer and better developed. The left valve also possesses somewhat rugged pseudocardinals ; The anterior of the two is better developed. The lateral teeth are clearly arched. In the right valve a rudiment accompanies a well developed one whereas in the left both are equal. The interior is salmon-coloured with a tinge of iridescence.

Locality : This species is also common in the river beds (20, 30, 31).

Measurements : L—70±5 mm.; H—40±5 mm.; DV—18±2 mm.

Family CORBICULIDAE

Corbicula striatella Deshayes. (Fig. 20 A and B)

Shell triangularly oval but more rounded in the adult. The anterior side is a little more produced than the posterior but is regularly rounded. The shell is definitely tumid with prominent umbones. The surface is glossy with olive green periostracum. The concentric alternate grooves and ribs form the main sculpture. These striae are finer in the umbonal region. The hinge is well developed with the anterior cardinals more elongated. Muscle scars are deeply impressed with pallial line and a trace of sinus.

Locality : Common (31).

Measurements : L—22±2 mm. ; H—19±1 mm. ; DV—8±1 mm.

Corbicula peninsularis Prashad. (Fig. 21 A and B)

These are definitely large corbiculids. They are thicker and triangularly oval with the upper slope which is convex with slightly projecting curved anterior margin. The posterior margin is rather drawn out into an indistinctly marked process. The umbones are well raised, tumid, curved inward and forward especially in uneroded shells. The surface is brown green and glossy with regular concentric ribs. Hinge is well developed with the anterior laterals not so long as the posterior. Interior is whitish but often with bluish tinge.

Locality : Common (31).

Measurements : L—22±1 mm. ; H—18±1 mm. ; DV—10±·5 mm.

In addition the exact identity of the following species has been now determined since they were reported earlier as common from Poona (Tonapi & Mulherkar 1963).

1. *Lymnaea (Pseudosuccinea) acuminata* f. *typica* Lamarck
2. *Lymnaea (Pseudosuccinea) acuminata* f. *gracilior* Martens

3. *Lymnaea* (*Pseudosuccinea*) *acuminata* f. *patula* Troschel
4. *Lymnaea* (*Pseudosuccinea*) *luteola* f. *typica* Lamarck
5. *Lymnaea* (*Pseudosuccinea*) *acuminata* f. *hians* ? (Sowerby)
6. *Viviparus bengalensis* (Lamarck) phase *incrassata* Annandale
7. *Indoplanorbis exustus* (Deshayes)

General remarks

Conditions of life in Poona and adjacent areas are quite favourable to support a wide variety of freshwater and amphibious molluscan fauna. The continental climate is characterised by diurnal temperatures. On account of elevation and dryness, Poona is cool during nights even in summer. These conditions even in the absence of luxuriant forest near-about are not so inimical to the existence of a broad spectrum of Molluscan fauna. Since the system of rivers, rivulets, streams and canals not to speak of lakes like Pashan provide a safe sanctuary for many of them. However, during the last decade or two physical conditions have changed considerably affecting the complexion of many waterways of Poona (*see* Tonapi & Mulherkar 1963). Post-war increase in the population and industries with the consequent land and water use have polluted the waters which are deterrent to the growth and the development of Molluscan populations. It is a paradox that even here such genera as *Lymnaea* and *Planorbis* bloom to further foul the water.

In all 21 species belonging to 9 families and 17 genera have been recorded. These together with the 32 species of 20 genera of 12 families recorded earlier constitute the rich Molluscan fauna of the area. The spatial distribution of the Mollusca is interesting. The *Planispira*, *Cyclotopsis* and the not so common *Cyclophorus* are always seen in the hills, and are presumably faunal elements of temporary hill streams and other water courses. The *Digoniostoma* and the related *Alocinma* are common inhabitants of slow moving perennial streams. There are no true hill streams which flow vigorously throughout the year. The temporary water courses do not really provide adequate support to the existence of varied Molluscan elements. *Paludomus* occurs during the rainy season on rocks and in rock pools and is often washed down from the western hill ranges into the plains. The species of *Rachis* and *Glessula* are commonest in wet humus soil, occurring commonly amongst the dead and decaying leaves under large trees. The *Sitala* and the allied *Kaliela* are found on shrubs and herbs in the vicinity of canals, ponds and lakes. They seem to show marked preference to open conditions as do the *Macrochlamys* and *Ariophantids*. These genera are frequently associated with vegetation near water.

The bivalve genera *Lamellidens* and *Indonaia* inhabit that part of

Mula River which has muddy substratum while *Corbicula* predominate in the Mutha River with sandy, gravelly and pebbly substratum.

There are no unsurmountable physical barriers or deterrent ecological conditions for one species to intrude into a neighbouring habitat. Therefore, more than two species may sometimes occur in the same habitat.

Acknowledgements

I wish to express my deep gratitude to Dr. H. C. Ray of the Zoological Survey of India, Calcutta, for the invaluable help he gave in the identification of some of the specimens. My thanks are due to the authorities of the University of Poona for facilities and to Prof. (Dr.) L. Mulherkar for interest. Thanks are also due to the artist Mr. Naik for the photographs.

References

Annandale, N. (1920) : Indian freshwater Mollusca assigned to the genus *Bithynia*. *Rec. Ind. Mus.* **19** (2) : 41-46.

——— (1921) : Materials for the generic revision of the freshwater gastropod Molluscs of the Indian Empire No. 3. The freshwater genera of Hydrobiidae. *Rec. Ind. Mus.* **22** : 1-7.

——— & Prashad, B. (1919) : Fauna of certain small streams in the Bombay Presidency. *Rec. Ind. Mus.* **16** : 109-162.

——— & Aminuddin (1921): The aquatic and amphibious Mollusca of Manipur. *Rec. Ind. Mus.* **22** (4) : 529-632.

——— & Srinivasa Rao, H. (1925) : Material for a revision of the recent Indian lymnaeidae (Mollusca Pulmonata). *Rec. Ind. Mus.* **27** (3) : 137-190.

Blanford, W. T. & Godwin-Austen, H. (1908) : Fauna of British India. Series I. (Mollusca, Testacellidae and Zonetidae).

Gude, G. K. (1914) : Fauna of British India, Series II. (Mollusca—Trochomorphidae V. Janellidae).

——— (1921) : Fauna of British India. Series III. (Mollusca—Land operculates).

Prashad, B. (1928) : Revision of the Asiatic species of the genus *Corbicula* I. the Indian species of *Corbicula*. *Mem. Ind. Mus.* **9** (1) : 13-27+4 pts.

——— (1929) : Revision of the Asiatic species of the genus *Corbicula* II. The Indo-chinese species of the genus *Corbicula* III. The species of the genus *Corbicula* from China, South-Eastern Russia, Tibet, Formosa and the Philipine islands. *Mem. Ind. Mus.* **9** (2) : 29-68+8 pts.

——— (1930) : Revision of the Asiatic species of *Corbicula IV*. The species of the genus *Corbicula* from Sunda islands, the Celebes and New Guinea. *Mem. Ind. Mus.* **9** (5) : 193-203+26 pts.

Preston, H. B. (1915): Fauna of British India (Mollusca-Freshwater Gastropoda and Pelecypoda).

Tonapi, G. T. & Mulherkar, Leela (1963) : On the freshwater Molluscs of Poona. *J. Bombay nat. Hist. Soc.* **60** (1) : 104-120.

——— & ——— (1963a) : Notes on the freshwater fauna of Poona, Part I. Fishes. *Proc. Ind. Acad. Sci.* **58** (B) **4** : 187-197.

——— (1967) : Studies on the freshwater and amphibious Mollusca of Poona with notes on their distribution—Part II. *Proc. Ind. Sci. Cong.* **54** (4) : Abstract, p. 19.

A Catalogue of the Birds in the Collection of the Bombay Natural History Society—8

Pteroclididae and Columbidae

BY

HUMAYUN ABDULALI

[*Continued from Vol.* 67 (2) : 298]

This part covers 724 specimens of 73 species and subspecies up to No. 544a in INDIAN HANDBOOK (**3** : 161). Miss Shanta Nair has continued to assist.

485 **Syrrhaptes tibetanus** Gould (Tsomoriri Lake, Ladak, Tibetan Sandgrouse **5** : 277

5 : 1 ♂ 4 ♀♀

1 *Lake Ruhas Tal*, 1500′, 2 *Gyantse*, 13,100′, *Tibet*; 2 Tso Morari, Ladak.

	Wing	Bill	Tail
♂	252 (254-270)	14 (16-20)	215 (203-263)*
♀♀	251, 253, 255, 261 (248-266)	12(3), 13(16-20)	164(2), 175, 182 (203-216)

* BIRDS OF THE SOVIET UNION **2**: (107) gives the male tails as 196-230, and quotes Stuart Baker's measurements, which are repeated in IND. HANDBOOK, with a query.

485a **Syrrhaptes paradoxus** (Pallas) (Southern part of Tartarian Desert) Pallas's Sandgrouse **5** : 276

1 ♀ Gujner, Bikanir, Rajasthan. 31 December 1924.

This record is omitted in SYNOPSIS, but is referred to in IND. HANDBOOK (**3** : 79). In 1928 (FAUNA **5** : 276) Stuart Baker referred to the Nawab of Dhar shooting a single specimen, presumably in Dhar, Central India, and made no reference to the Bikanir record. No specimen from India is available at the British Museum (Nat. Hist.).

486 **Pterocles alchata caudacutus** (S. G. Gmelin) (Northern Persia) Large Pintail Sandgrouse **5** : 268

23 : 11 ♂♂ (5 by plumage) 12 ♀♀ (4 by plumage)

12 *Mesopotamia*; 2 *Persian Gulf*; 1 Quetta, 1 Baluchistan; 1 Malar Kotla, Punjab; 5 Bikanir, Rajasthan; 1 Deesa, Palanpur, Gujerat.

The plumages are difficult to follow and one has to accept Stuart Baker's statement that the transition to the adult plumage is in patches.

I have accepted the chocolate shoulder to the wing as an invariable male character, and measure the sexes :

	Wing	Bill
♂♂	200-219 av. 209 (213-224)	11-14 av. 13 (♂♀ 12·5-14·5, IH c. 13-15)
♀♀	195-213 av. 204 (194-231)	12-14 av. 13·3

There does not appear to be any appreciable difference in size between the sexes.

487 **Pterocles exustus erlangeri** (Neumann) (El Hota, Lahej, Southern Arabia) Indian Sandgrouse 5 : 271

37 : 24 ♂♂ 13 ♀♀

2 *Muscat, Arabia* ; 1 Gawah, 3 miles east of Mand, Baluchistan ; 1 Ambala, 5 Bahawalpur ; Punjab ; 2 Delhi ; 1 Koshmor, Upper Sind, 1 Pithoro, 2 Barun, Kohistan, Sind ; 2 Kutch ; 5 Bhopal, 2 Shamgarh, Indore ; 3 Drangadhra, 2 Bhavnagar, 3 Deesa, 1 Patan, Mehsana, 2 Kaira, 1 Kharagodha ; 1 Bassein, Thana.

	Wing	Bill	Tail, with central pin-feathers
24 ♂♂	174-183 av. 176	11-13 av. 11·7	108-144 av. 127
	(IH 177-185	17-20 from skull	105-142
13 ♀♀	165-180 av. 172	11-13 av. 11·6	87-107 av. 99
	(IH 171-177	16-19 from skull	85-104

Sp. No. 13156, a female from Deesa (14 July) has no barring on the black of the underparts and is also patchily marked on the upperparts, being quite different from the adults of both sexes. No. 13146, a ♂ from Barun, Kohistan, has the black band on the upper breast extending half way across the upper back on one side only ! No. 13138, a female from Muscat, appears to have the upperparts more closely barred than in the other females, but with only two specimens from Muscat it is not possible to express any opinion as to whether *erlangeri* and *hindustan* Meinertzhagen are separable.

488 **Pterocles senegallus** (Linnaeus) (Senegal *errore*, Algeria) Spotted Sandgrouse 5 : 273

21 : 12 ♂♂ 9 ♀♀

12 *Mesopotamia*; 1 Ormara ; 1 Sind ; 2 Pacham Island, 4 Dhordi in Bunni, Kutch ; 1 no locality.

	Wing	Tail[1]
♂♂	193-204 av. 198	121-157 av. 139·8
	(190-208)	(127-167)
♀♀	187-199 av. 192	103-118 av. 112
	(176-197)	

[1] Birds without pins in the tail are excluded.

Four specimens (2 ♂♂ 2 ♀♀) obtained in Bunni in Kutch in February are all darker, above and below, than the others. Both males and females show more brownish (or ochre) yellow, and almost no grey on the back. Neumann's description of *remotus* (xerox copy kindly sent by Dr. Ripley and translated by Dr. Sálim Ali) agrees with this, but his statement that the 'middle of the abdomen and spots of ♀♀ (are) pure black (in *P. s. senegallus* mixed with dark brown); and the crown pure grey, not with reddish or sandy tinge as in *P. s. senegallus*' cannot be confirmed. He designated a ♂ obtained at Kunaria in Kutch, NW. India, as the type and, speaking from memory, stated his impression that the Indian specimens (at the B.M.), none of them from the island of Kutch, were paler than the specimens from Kutch, which he received afterwards. In the absence of the material which prompted this remark, he expressed his inability to decide if on the island of Kutch 'there lives a separate race which is different from the birds from continental N. India'.

Except for the 4 specimens referred to above, all the others, including two collected on Pacham Island, Kutch, show no separable differences, and I am inclined to offer the following suggestions :—

(1) The resident population in Kutch is darker and separable.

(2) The material available from India, excluding that resident in the island of Kutch, is not different from that from Mesopotamia.

(3) Though *remotus* is based on a specimen from Kutch, it represents a migrant form which may or may not be different from nominate *senegallus*.

489 **Pterocles orientalis orientalis** (Linnaeus) (in Oriente=Anatolia) Imperial or Blackbellied Sandgrouse 5 : 262

21 : 17 ♂♂ 4 ♀♀ (1 *partial albino)

1 *Sheik Saad, Iraq*; 2 *Shiraz*, 1 *Teheran-Kasvin Rd., Iran*; 1 Chitral, N.W.F.P.; 1 Malarkotla, 2 Sirsa, 2 Bahawalpur, 1 Punjab; 7 *Bikanir, 1 Rajasthan; 1 Karachi; 1 Deesa, Gujerat.

	♂♂	♀♀
Wing	225-248 av. 234	236, 241, 243
	(226-248)	(203-234)
Tail	86-104 av. 97	94, 99, 103
	(IH 101-128)	

Both males and females show considerable variation in colour, but the plumages do not appear to be well understood and it is not possible to express an opinion as to whether Indian birds differ from those from Iraq and Iran. The map in IND. HANDBOOK (3 : 87) shows *arenarius* Pallas (type locality between the lower Ural River and the lower Volga) west of the nominate race, while Vaurie (1961, PAL. BIRDS **50** : 5) refers to it as the eastern race occurring in India.

The female wings are larger than suggested in IND. HANDBOOK (ex FAUNA) and the male tails smaller.

490 **Pterocles coronatus atratus** Hartert (Eastern Persia*) Coronetted Sandgrouse 5 : 267

*Vaurie (1965 : 532) found that the type was collected at Kaskin, 40 kilometres north of Bambur, Persian Baluchistan.

9 : 6 ♂♂ 3 ♀♀

1 6 *miles*, 1 18 *miles, south-west of Gusht, Persian Baluchistan*; 2 Pasni, 1 Zayak Kharun, 65° 57′E., 27° 57′N., 1 Ormara, Kalat; 2 Wano, 1 Waziristan.

	Wing	Bill	Tarsus	Tail
6♂♂	185-192 av. 189	12-13	23-25 av. 24	78-89 av. 83·5
ladas ♂♂	182, 192	12, 13	24, 25	78, 86
	(178-196)	(13-14)	(*c*. 25)	(*c*. 120-132)
3 ♀♀	179, 182, 183	13(3)	24, 25(2)	77, 78, 86
ladas ♀	192	12	24	86

The tails are much shorter than recorded earlier.

490a **Pterocles coronatus ladas** Koelz (Soneri Lake, Sind) Sind Coronetted Sandgrouse

3 : 2 ♂♂ 1 ♀

2 Bataro, Kerchat, Kohistan, 1 Jhimpur, 80 miles east of Karachi, Sind.

The three birds listed above are outstandingly paler than the others, except one marked ♀ from Wano, Waziristan. This specimen No. 13114 differs from the other females in having the lower belly unmarked, which *may* be a juvenile plumage. Supported by the fact that this race is accepted by Vaurie (1965 : 533), I am leaving them separate.

With the assistance of the Zoological Survey of Pakistan, ' Soneri Lake ' has been traced to be within two miles north-west of Sonda Dak Bungalow, about 20 miles from Thatta on the Thatta-Hyderabad Road. The lake is now merged with the old Kalri Lake to form the new Kalri Lake. It may be noted that accepting Bataro as east of the Kohistan hills west of Karachi, these birds are well isolated from those from Baluchistan by the hills and by 400 miles from Waziristan.

491 **Pterocles indicus arabicus** Neumann (Lahej, Arabia) Closebarred Sandgrouse **5** : 265

14 (details below)

(*a*) 4 : 2 ♂♂ (one marked ♀) 2 ♀♀ 20 *miles from Muscat, Arabia*.

These were obtained by Major A. R. Barton and are dated 23 October 1916. One of the original labels is marked ' Cage bird ' and this would presumably apply to all of them. They (particularly the females) are distinctly paler than those under (b), which include two more males from Muscat. There has been no concurrence of opinion regarding the separability of *arabicus* from the race occurring in Iran and India, and Ticehurst (*JBNHS* **34** : 479 and *Ibis* 1937 : 408) held that *arabicus* could not be recognised and birds from Sind were identical with nominate *leichensteini* (now synonymised with *P. i. arabicus*) from Nubia, presumably assuming that birds from the type locality of *arabicus* (Lahej, near Aden) were similar to those from Nubia. The material available does not permit any definite opinion but suggests that a pale form (like the cage bird) exists in a restricted area in Arabia. If so, the birds from Muscat to India will not be *arabicus*. In *JBNHS* 25, p. 751, Major Barton stresses the fact that he did not find it breeding near Muscat, where it was migratory.

(*b*) 10 : 6 ♂♂ (1 juv.) 4 ♀♀

1 *near Muscat* (Maj. A. R. Barton, 18 Feb. 1916), 1 *Muscat, Arabia* ; 2 Panjgur, 1 Pirander *c*. 180 miles SSW. of Kalat, 1 Kodap, Mand, 1 Kalat, Baluchistan ; 1 Wano, Waziristan, 1 Parachinar, Kurram Valley, N.W.F.P., 1 Lhandu, 20 miles from Karachi (trans-Indus).

The possibility of these specimens not being *arabicus* has been referred to above. The two males from Parachinar and Lhandu show a similarity to the cage birds from Muscat under (a), while both the males from Muscat included in (b) are heavily blotched with black as also is a male from Panjgur.

Sp. No. 13096 a juvenile ♂ from Pirander resembles the female except that the area to be enclosed by the two blackish bands in the adult (male) is almost unmarked.

The light and the dark males appear very distinct but, in the absence of any evidence to the contrary, have to be accepted as variations of the same race.

	Wing	Bill	Tarsus	Tail
2 ♂♂	*arabicus* (a)			
	—, 165	16(2)	24, 25	65, 69
6 ♂♂	*arabicus* (b)			
	166-180 av. 171	14-16 av. 15	22-25 av. 24	60-72 av. 66·5
	(175-190 IH *ex* Hartert)			
2 ♀	*arabicus* (a)			
	—, 157 mltg.	14, 16	24(2)	—, —,
4 ♀♀	*arabicus* (b)			
	158, 159, 166, 171	—, 14, 15, 16	23, 24(3)	63, 64, 70, 72
	(IH 172-187 *ex* Hartert)			
(♂♀	166-186	*c*. 12-14	*c*. 22-27	72-77)

492 **Pterocles indicus indicus** (Gmelin) (Coromandel, India) Painted Sandgrouse 5 : 264

20 : 14 ♂♂ (1 juv.) 6 ♀♀

1 Tonk, 1 Danta*, 1 Rajputana ; 3 Bhuj, 1 Mata-No-Madh, Kutch ; 3 Shangarh, Indore ; 1 Kuno, Gwalior, 1 Bhopal ; 1 Vagjipur, 3 Deesa, Palanpur, Gujerat ; 4 Vijayanagar, Bellary, Mysore.

The specimens show a certain amount of variation and, though not referred to in the FAUNA (5 : 274), Stuart Baker in 'Game Birds of the Indian Empire' (*JBNHS* 22 : 221) says : 'Females of this species vary almost more than the males and the difference in tint on the back is very great, varying from a rich almost rufous bay, which is very rare, to a pale sandy buff which is very common.'

The two females from Vijayanagar, Bellary, Mysore, have their upper parts strongly rufous, with the wing coverts similarly tinged, and are strikingly different from the others. Two males from the same place have the bars on the upper back rufous, and not white as in the others, except No. 19200 from Tonk, Rajasthan. This difference is not so striking as in the females.

Whistler (*JBNHS* **38** : 680) referred, among the few from Southern India, to two from Madras and Arkonam in the Government Museum at Madras. As these are mounted and could not be sent, representative specimens were sent to Dr. Satyamurthi, the Director, who kindly confirms that both the ♂ and ♀ resemble the birds from Vijayanagar and are different from the others.

I have listed (*JBNHS* **66** : 263) 2 Rock Bush Quail from Vijayanagar, Bellary (also collected by G. C. Shortridge who obtained the four present Sandgrouse from Vijayanagar) as *Perdicula argoondah salimalii* Whistler (type locality Marikanive, Mysore), which are separated by their bright rufous upper parts and which are very similar to those of the female sandgrouse from the same area.

Though one juvenile male (No. 13087* from Rajputana) is as rufous as the southern females, it would appear that the northern birds are appreciably different from topotypical and southern ones, and need separation.

	Wing	Bill	Tarsus	Tail
13 ♂♂	167-185 av. 175 (IH 166-180, once 188, once 208)	13-16 av. 15·5	24-26 av. 24·8	68-81 av. 77
5 ♀♀	164, 167, 171, 176 (IH 166-176)	12, 14, 15	24(2), 25(3)	75, 76, 78, 80(2)
	(♂♀ 158-184	*c*. 13-15	*c*. 23-25	80-101).

The tails are shorter than recorded and females have smaller wings. IND. HANDBOOK does not indicate where the exceptionally large male was obtained. The key on p. 91 (vol. 3) separating *arabicus* from *indicus* is not very satisfactory. In ♂ *arabicus*, the closer ' barring ' on the lower throat may perhaps be better termed ' spotting ' and the reference to the shape of the black bar on white forecrown can just be understood when both are placed together. In several *indicus* of both sexes, the feathered front of the tarsus cannot be seen to be barred or spotted.

493 **Treron apicauda apicauda** Blyth (Southeastern Himalayas and hill ranges of Assam) Pintailed Green Pigeon 5 : 199

8 : 6 ♂♂ (1 by plumage) 1 ♀ 1 o ?

1 Sadiya, 1 Cachar, 1 Changchang Pani, Assam ; 1 Tezu, Lohit Valley ; 2 *Saidon*, 1 *Tista Valley, Upper Burma* ; 1 *Mindon Yoma, Thayetmyo*.

Wing	♂♂ 165-171 av. 167 (160-175)	1 ♀ 160	1 o ? 155
Tail	♂♂ 164-224 av. 184 (220-254)	1 ♀ 111	1 o ? 112

As in some of the other pigeons, there is a dense growth of upper and undertail coverts which necessitates special care to ensure that measurements are taken from the base of the tail.

494 **Treron sphenura sphenura** (Vigors) (Himalayas*) Wedgetailed Green Pigeon 5 : 200

23 : 12 ♂♂ 11 ♀♀ (2 pull., 1 juv.)

1 Doola, Kishtwar, Kashmir; 7 Simla, 1 Koti State, 1 Patiala; 4 Garhwal, 1 Almora, 1 Mussoorie; 3 Nepal; 1 Kurseong; 2 *Chin Hills*; 1 Lamta Thack (?).

	Wing		Tail	
♂♂	175-190 av. 181·6)	(173-185)	111-127 av. 121·5	114-139
♀♀	170-180 av. 174·6)		107-129 av. 120	

It may be worth keeping in mind the fact that Osmaston thought he saw and heard this species in April at Pachmarhi, C.P. (*JBNHS* **28**: 458).

* The type locality was restricted to 'Simla-Almora area' in Himachal Pradesh by Ticehurst and Whistler, *Ibis* 1924, p. 472.

495 **Treron curvirostra nipalensis** (Hodgson) (Nepal) Thickbilled Green Pigeon 5 : 196

8 ♂♂ (3 by plumage)

1 Golaghat, Assam; 1 *North Kraung*, 1 *Megok*, *Ruby Mines District*, *Upper Burma*; 1 *Myitkyina*; 1 *Taunggyi*, *South Shan States*; 2 *Sandoway*; 1 *Nam Lai*, *Siam*.

All the specimens, some of which were originally correctly named, were found listed with *Treron pompadora* which they resemble very closely.

The red gape and red base of the bill said to be diagnostic in live birds are not visible in the skins.

Wing 139-150 av. 145 (124-146, repeated in IH; Ticehurst, *Ibis* 1939, p. 212 measures 142-155 and opines that Baker has measured juveniles)

Tail 70-90 av. 81 (84-95)

496 **Treron pompadora affinis** (Jerdon) (West Coast of Indian Peninsula) Greyfronted Green Pigeon 5 : 188

19 : 10 ♂♂ 8 ♀♀ 1 o?

1 Pen, Kolaba; 1 Poona; 1 Ratnagiri; 9 Kanara; 2 Mercara, Coorg; 1 Hikkeri, Sagar, Mysore; 1 Nilgiris; 1 Ponmudi, 1 Pulanayarkotta, Kerala; 1 Pattanpur (T. R. Bell—North Kanara?)

	Wing		Tail
♂♂	140-149 av. 145	(138-150)	78-90 av. 84
♀♀	135-148 av. 142		79-86 av. 82

497 **Treron pompadora pompadora** (Gmelin) (Ceylon) Ceylon Greyfronted Green Pigeon 5 : 185

1 ♂ Ceylon. Wing 147, tail 89.

Sp. No. 12768 differs from the southwestern birds in having a yellow forehead and no chestnut on the undertail coverts.

498 **Treron pompadora conoveri** Rand & Fleming (Butwal, Nepal) Nepal Greyfronted Green Pigeon

nil

Compared with *phayrei* it is said to be a brighter form, with the yellow of the throat and the orange of the breast more intense, and the green of the breast and abdomen and hind neck duller and less greyish (Birds from Nepal, *Fieldiana* 41, p. 70).

499 **Treron pompadora phayrei** (Blyth) (Tounghoo, Burma) Ashy-headed Green Pigeon 5 : 186

9 : 6 ♂♂ 3 ♀♀

2 Tezu, Lohit Valley, 1 Golaghat, 1 Sadiya, 1 Dayang, Assam ; 1 *Upper Burma*, 1 *Prome*, 1 *Myitkyina*, 1 *Henzada*.

	Wing	Tail
6 ♂♂	153-160 av. 158 (143-165)	85-91 av. 89
3 ♀♀	150-155 av. 152·6 (145-160)	82, 87, 88

Stanford & Ticehurst have drawn attention (*Ibis* 1939, p. 211) to the wing measurements in the FAUNA as probably including juveniles, and have corrected them to 156-165. Sp. No. 12779 from Lohit Valley, Assam, has a bill shorter and stouter than in the others.

500 **Treron pompadora chloroptera** Blyth (Nicobars) Nicobar Greyfronted Green Pigeon 5 : 188

13 : 8 ♂♂ 5 ♀♀ (2, wings only)

4 Car Nicobar ; 2 Katchal, 3 Camorta, 1 Trinkut, 1 Nankowry, Central Nicobars ; 2 Campbell Bay, Great Nicobar.

500a **Treron pompadora andamanica** (Richmond) (Macpherson Strait, South Andamans) Andaman Greyfronted Green Pigeon

6 : 3 ♂♂ 3 ♀♀

1 Port Blair, 4 Wrightmyo, 1 South Andamans.

Wing ♂♂ 163, 177, 178 ♀♀ 169, 177, 178

I have explained (*JBNHS* **64**, p. 164) my reasons for maintaining this race.

501 **Treron bicincta bicincta** (Jerdon) (Sea coast south of Tellicherry) Orangebreasted Green Pigeon 5 : 191

8 : 6 ♂♂ (2 by plumage) 2 ♀♀

3 North Kanara ; 1 Thekadi, Travancore ; 1 Sankrametta, Vizagapatam ; 1 Besai, Mourbhanj, 1 Kutri, Daspalla, Orissa ; 1 *Kamaing, Upper Burma.*

	Wing	Tail
6 ♂♂	153-165 av. 159	86-92 av. 89
2 ♀♀	148, 153	82, 82.
	(♂♀ : 153-164, once 170	(91-110)

In the SYNOPSIS the distribution is said to be ' from Bombay and U.P. south and east through peninsular India . . . . . . ' Though there is a record of a single female obtained at Karachi (*JBNHS* **40** : 330), on the west the northernmost records which I can trace are from North Kanara.[1]

502 **Treron bicincta leggei** Hartert (Ceylon) Ceylon Orangebreasted Green Pigeon **5** : 192

1 ♂ Ceylon. Wing 151 Tail 82.

The single specimen (No. 12788 obtained in 1914) is very similar to the Indian birds listed above.

503 **Treron phoenicoptera phoenicoptera** (Latham) (India) Bengal Green Pigeon **5** : 181

14 : 8 ♂♂ 5 ♀♀ 1 o?

2 Baghat State, NW. Himalayas; 1 Saugar, 1 Mandikheri, Hoshangabad, M.P.; 1 Rajputtee, 1 Champaran, 3 Tirhut, 1 Hazaria, 1 Pathargata, Bhagalpur, Bihar; 1 Shahjehanpur, 1 Pilibhit, U.P.; 1 Bankulwa Morang, Nepal.

	Wing	Tail
♂♂	181-195 av. 188 (184-200)	98-125 av. 109 (110-118)
♀♀	180-185 av. 183 (180-186)	94, 100, 103, 112.

Birds of both sexes from Bihar and U.P. (Nos. 12726, 12730, and 12732) have the grey of the underparts washed with yellowish. The yellow of the upper breast is however distinctly separate.

In many places, these pigeons disappear almost completely at certain seasons and, though these movements are no doubt linked with the availability of their food (in places largely *Ficus* spp.), the directions of their movements are quite unknown. It is possible that the birds taken in Madhya Pradesh were non-breeding migrants, but the southern form *chlorigaster* is said to have been found with the nominate form at Ambala, Punjab (Jones, *JBNHS* **31**, p. 1006). A more detailed examination of larger numbers may perhaps provide an explanation.

Except for the yellow on the lower belly, Sp. No. 12738 (o ?) from Champaran, Bihar, is grey like a *Columba* sp. with almost no yellow or green. Derek Goodwin of the British Museum (N.H.) to whom I mentioned this informs me that they have one specimen of *Treron sphenura* which similarly lacks green and adds : ' As this is a specimen that looks as if it has been in captivity I put its coloration down to its having been fed with "sattoo" (flour made from roasted gram—H.A.) and deprived of yellow carotenoids in its foods. As you will know, many birds moult out grey and white where they are normally green and yellow if given arti-

[1] This has now been suitably altered in IND. HANDBOOK 3 ; 105

ficial foods that do not contain carotenoid pigments. When this is done with the green and yellow *Parus major newtoni* it moults out grey and whitish and looks very like *Parus major cinereus* ! I suppose one could also get aberrant individuals that had no yellow pigment or lacked the ability to deposit it in their feathering, as one does in blue Budgerigars or the so-called blue Canaries (which are really grey) '.

504 **Treron phoenicoptera chlorigaster** (Blyth) (Indian Peninsula) Southern Green Pigeon 5 : 184

21 : 8 ♂♂ 13 ♀♀

1 Sanchi, Bhopal ; 1 Kolkaz, Berar ; 1 Deesa, Palanpur, 1 Vagjipur, 3 Pandwa, 1 Mahul, Surat Dangs ; 1 Salsette, Bombay ; 1 Murbad, Thana, 1 Panvel, Kolaba, 2 Bhor, Poona, 1 Ratnagiri ; 2 Kanker, 1 Bailadila, M.P. ; 2 Badrama, Orissa ; 2 Bulandshar, U.P.

	♂♂	♀♀
Wing	170-192 av. 187 (184-200)	170-193 av. 183 (180-186)
Tail	84-118 (110-118)	116-135 av. 124

There is some confusion and uncertainty regarding the type locality. Blyth (1843, *J. Asiat. Soc. Bengal* 12 (1 : 167) when describing this bird does not refer to its origin, but Sclater, 1892, *Ibis* p. 86, while listing the type specimen in the Indian Museum states that it was obtained by Blyth ' near Calcutta ', in which area it does not normally occur and was no doubt a straggler. Whistler (1936, *JBNHS* **38** : 672) restricted it to Salem District, South India, which if tenable would be most reasonable.

505 **Treron phoenicoptera phillipsi** Ripley (Nilgala, Uva, Ceylon) Ceylon Green Pigeon

nil

EL **Treron phoenicoptera viridifrons** Blyth (Tenasserim)* 5 : 183

4 : 1♂ 1 ♀ 2 o?

1 *Henzada*, 1 *Thayetmyo*, 1 *Prome*, 1 *Maymyo*.

Wing	Tail
192, 191, 176, 177 (184-200)	135, 125, 116, 123

* The type locality was restricted to Moulmein, Amherst District, Tenasserim, by Deignan (1963) *U.S. Nat. Bull.* 226, p. 48.

EL **Ducula aenea aenea** (Linnaeus) (Flores, Indonesia) Malay Green Imperial Pigeon 5 : 207

1 ♀ *Pahang, Malaya*. Wing 232, bill 26, tarsus 25, tail 139.

The upper parts are a clearer green than in most of the others.

506 **Ducula aenea sylvatica** (Tickell) (Borabhūm) Northern Green Imperial Pigeon 5 : 208

16 : 9 ♂♂ 2 ♀♀ 5 o?

3 Chanda, 3 Bastar, M.P. ; 3 Orissa ; 1 Pasi Ghat, Assam ; 1 *Chindwin R.*, 2 *Upper Burma*, 2 *S. Shan States*, 1 *Prome Dist., Burma*.

Birds from Assam and Northern Burma are slightly larger than those from Central India, which again are very slightly larger than *pusilla* from further south.

	Wing	Bill	Tarsus	Tail
3 ♂♂ 4 o? Assam & N. Burma.	229-255 av. 241	25-29 av. 27	25-27 av. 26	139-150 av. 146
6 ♂♂ Chanda, Bastar & Orissa.	218-235 av. 225	22-26 av. 24·3	25-26 av. 25·5	140-150 av. 144.
2 ♀♀ Bastar	219, 219	25, 26	25(2)	140, 144
		pusilla		
1 ♂ *3o?	212*, 221, 223, 224	23* 25(2), 28	24*, 25, 26(2)	139*, 143, 146

In some birds the upper parts are dark green with little or no sheen. Both varieties occur in the same area but, while only one of the seven from Assam and Burma is ' dark ', seven of the nine from India are ' dark ' rather than shiny green.

507 **Ducula aenea pusilla** (Blyth) (Nilgiris*) Southern Green Imperial Pigeon 5 : 209

4 : 1 ♂ 3 o?

3 N. Kanara, Mysore ; 1 Chitteri Range, Salem District.

These birds have been trinomially named in accordance with the generally accepted ranges of *pusilla* and *sylvatica* but, apart from the usual north-south decline in size, there does not appear to be sufficient reason for separating them.

It may also be recalled that, though the type locality is usually accepted as ' Nilgiris ', Jerdon (1864, BIRDS OF INDIA, 3 : 456) wrote : ' Mr. Blyth was mistaken when he stated (1849, *J. Asiatic Soc. Bengal* 18 : 816) that the specimen sent in by myself, from which he made his *pusilla*, was from the Neilgherries ; indeed I have not even seen this pigeon in the Wynaad.' I have looked up Blyth (1849) where it is said to be from the Nilgiris but I can find no reference to Jerdon.

*Whistler (Eastern Ghats, *JBNHS* **38** : 675) accepts the type locality as ' Nilgiris ' but states on the following page : ' There seem to be no records from the Nilgiris'. It has been obtained at 2000 ft. in the Biligirirangan Hills (*JBNHS* **44** : 24) but Baker & Inglis (1930) in BIRDS OF SOUTHERN INDIA, p. 278, say that the only records in Madras, Mysore, and Kerala are from the plains.

508 **Ducula aenea nicobarica** (Pelzeln) (Nicobars, restricted Car Nicobar) Nicobar Green Imperial Pigeon **5** : 210 (*insularis*)

10 : 7 ♂♂ 3 ♀♀

3 Car Nicobar ; 3 Camorta, 1 Nancowry, Middle Nicobars ; 3 Great Nicobars.

(See comments on measurements, Abdulali *JBNHS* **64** : 164/5).

508a **Ducula aenea andamanica** Abdulali (Betapur, Middle Andamans) Andaman Green Imperial Pigeon

8 : 5 ♂♂* 3 ♀♀ (*including type)

1 Narcondam Island ; 3 Betapur, Middle Andamans ; 4 South Andamans.

509 **Ducula bicolor** (Scopoli) (New Guinea) Pied Imperial Pigeon

9 : 6 ♂♂ (1 juv.) 2 ♀♀ 1 juv. o?

5 South Sentinel Island, Andamans ; 1 Camorta, Central Nicobars ; 3 Pulu Bhabi, Great Nicobar.

	Wing	Tail
♂♂	235(2), 241, 242(2)	130(3), 134, 136
	(IH 233-238	127-133)
♀♀	235, 235	128, 135
		(♂♀ 125-135)

In my report on Nicobar birds (*JBNHS* **64** : 165) and in *Bull. B.O.U.* 86 : 162, I have offered an explanation for the patches of 'creamy' colour often noted on these birds.

510 **Ducula badia insignis** Hodgson (Nepal) Hodgson's Imperial Pigeon **5** : 203

nil.

511 **Ducula badia cuprea** (Jerdon) (Wynaad) Jerdon's Imperial Pigeon **5** : 205

7 : 3 ♂♂ 1 ♀ 3 o?

1 Gopshitta (Col. by T. R. Bell, N. Kanara ?) ; 1 Castle Rock, 1 Supa Petha, 1 North Kanara ; 2 Thattakad, Periyar, Kerala ; 1 Madura.

	Wing	Tail
♂♂	229, 230, 243 (210-234)	171, 178
♀	230	165

512 **Ducula badia griseicapilla** Walden (Karen Hills, between 4000 and 4200 feet) Greyheaded Imperial Pigeon **5** : 204

8 : 3 ♂♂ 1 ♀ 4 o?

2 Lakhuni, 1 Dibrugarh, Assam ; 1 *Htamgaw*, 1 *Upper Burma* ; 1 *Pangping, South Shan States* ; 2 20 *miles west of Rabeng, Siam.*

♂♀ Wing 228-258 (♀) (228-259) Tail 170-188

Of the two birds obtained on the same day at Lakhuni, Assam, the male (Sp. No. 12823) has a slight wash of pale lilac on the crown which is almost concolorous with the neck, while the female (No. 12824) has it grey. No specimens of *insignis* are available for comparison, but the distribution of the races in eastern India and Burma appears to need sorting out.

513 **Columba leuconota leuconota** Vigors (Himalayas, type probably from Nepal) West Himalayan Snow Pigeon 5 : 224

14 : 5 ♂♂ 8 ♀♀ 1 o?

1 Liddar Valley 12,000′, 2 Kishtwar 10,000′, 1 Kashmir; 2 Palanpur 4000′, 1 Simla 6500′, NW. Himalayas; 2 Jalki, Mussoorie, 1 Kulu, 1 Phurkia, Pindar Valley, Kumaon, 1 Badrinath, Garhwal; 1 Thangu 7000′, 1 Lachen, N. Sikkim.

	Wing	Bill	Tarsus	Tail
♂♂	228-246 av. 239	18(3), 19(2)	28(2), 29(2), 30	128-138 av. 133
♀♀	229-241 av. 235	18-20 av. 18·8	28-30 av. 28·5	121-136 av. 126·7
	(IH ♂♀ 240-258	c. 24-25 (from skull)	c. 31-35	122-137)

514 **Columba leuconota gradaria** Hartert (Sungpan, Szechuan) East Himalayan Snow Pigeon 5 : 225

nil.

515 **Columba rupestris turkestanica** Buturlin (Altai) Turkestan Hill Pigeon 5 : 222

7 : 3 ♂♂ 3 ♀♀ 1 o?

1 *Pamir* 13,000′; 1 Killia Drosh, Chitral, N.W.F.P.; 2 Gaik, Indus Valley, 1 Pannanick, Nabra, 1 Lamyaru, Ladak; 1 Badrinath, Garhwal.

	Wing	Bill	Tarsus	Tail
♂♂	230, 234, 236	15(2), 16	25(2), 26	125, 128, 131
♀♀	223, 224, 225	16(3)	24, 25(2)	119, 120(2)
(♂♀	216-243	15-17	c. 25-28	118-130)

This confirms Stresemann's measurements 5 ♂♂ 230-240 (av. 233·4) 6 ♀♀ 219-228 (av. 233·8) quoted in IND. HANDBOOK.

EL **Columba livia** subsp.

1♂ *Temple of Heaven, Peking, China*, 2-9-1900.

Peters (CHECKLIST 3 : 59) lists *nigricans* Buturlin from Mongolia, and northern China in provinces of Shansi, Chihli, and Kansu, but adds that he has seen no Chinese wild-killed specimen with a white rump. The present bird has a sooty head and neck, a light brownish wash over the whole body, and a white rump. However, it may well be a cage or domesticated bird.

Wing 215; Bill 17; Tarsus 27; Tail 116.

EL **Columba livia gaddii** Zarudny & Loudon (Hill region of Jebel-Tyne and in the mountains east of Ahwaz and Nasiri, Lower Karun River, Southwestern Persia).

11 : 4 ♂♂ 6 ♀♀ 1 o?

1 *Hawi Plain, Tigris, Mesopotamia**; 1 *Akberabad* 52° 47′E., 29° 13′N., 1 *Kaftarak*, 1 *Shiraz*, 3 *Birjand, E. Persia*; 1 *Chah Bahar, Persian Gulf*; 3 *Gusht, Persian Baluchistan.*

This is no doubt the bird with the 'lower back and rump white' said to be of the nominate race in FAUNA. On the average they are noticeably paler above than those listed as *neglecta* ; but the croup is not consistently white, which remark applies to *neglecta* also. Of the three from Birjand only two have white croups, while of another three from Gusht two may be included with *intermedia*. The measurements are under No. 517 and do not appear to differ from those of the other races.

No. 12857* from Mesopotamia was marked *C. l. palestinae* which it may well be, but the single specimen can be included in the variation existing in this group.

516 **Columba livia neglecta** Hume (Ladak) Blue Rock Pigeon **5** : 220

7 : 3 ♂♂ 2 ♀♀ 2 o?

1 Jandola, 3 Chitral, N.W.F.P. ; 2 Ladak, 1 Hunza Valley, Kashmir.

Five of these (except one each from Chitral and Jandola) have their croups white or grey as in *gaddi*, but are generally paler above than *intermedia*. Hume in the original description however stated that *neglecta* could be :

'distinguished from *intermedia* by its much darker general hue and by its white or more or less greyish white lower back contrasting strongly with the blackish slaty rump and upper tail coverts. This species replaces *C. intermedia* in most places in the interior of the Himalayas. The other specimen a ♀ shot at Dras, June 23, belongs to what seems to be a hybrid race between *C. neglecta* and *C. intermedia*. The general colour of the upper back, scapulars and coverts, is that of *C. intermedia*, but the lower back is a pale albescent grey or bluish white, very different from that of the latter, and resembling in this respect *C. neglecta*, but not contrasting so strongly with the dark iron grey rump and upper tail coverts as does the white lower back of *neglecta* . . . . this has been characterized by Capt. Halton (*in epis.*) as *C. spelaea*, but I scarcely think it merits specific separation.'

The formal description then reads :

'Pure white across lower back never exceeds 1·25 and in some is scarcely above an inch in extent. The whole rump, upper tail coverts and basal portion of the tail is a very deep slaty grey, contrasting very strongly with the white of the lower back. In the intermediate form the white is more or less tinged with grey and the conspicuously white portion of the back does not exceed half an inch in breadth.'

Though both *gaddi* and *neglecta* differ from *intermedia* in having a white or pale grey croup, it will be noticed that in the description *neglecta* is said to have a much darker general hue than *intermedia*, further complicated by the statement that the 'hybrid' from Dras was similar to *neglecta* in having a pale lower back and, like *intermedia* above, without clarifying if this was darker or paler than *neglecta*. Vaurie (1965 : 545) found a pure white rump in only two of about 125 *neglecta* (including the type) examined by him. The small series available does not show much difference in size between the sexes. Paludin (1959, BIRDS OF AFGHANISTAN, pp. 112/3), who discusses the races in Afghanistan and, without access to either *neglecta* or *intermedia*, lists those from Central and Western Afghanistan as *gaddi* (*à la* Meinertzhagen 1938 : 707) and others with dark rumps as *neglecta*, does not help in clarifying matters.

With the material available it is not possible to express any opinion except to suggest that *neglecta*, like the other races, is liable to variation, and is really an intermediate form between *gaddi* and *intermedia*.

517 **Columba livia intermedia** Strickland (India=Calcutta) Indian Blue Rock Pigeon

25 : 11 ♂♂ 11 ♀♀ 3 0?

1 Rawalpindi, N.W.F.P.; 2 Harunabad, Bahawalpur, 2 Hissar, Punjab; 1 Delhi; 2 Gwalior, 1 Solon, Bhopal State, 1 Indore, C.I.; 1 Bhuj, Kutch; 1 Gir, 1 Deesa, Palanpur, 1 Bhavnagar, 2 Surat Dangs; 1 Nasik, 1 Koregaon, Poona, 1 Bombay City, 1 Ratnagiri; 1 Gersoppa, Mysore; 1 Nilambur Valley, Kerala; 1 Nellore, A.P.; 1 Garhwal, U.P.; 1 *Prome, Burma.*

It is unfortunate that the type locality has been fixed as Calcutta, for as far back as 1857 (*J. Asiatic Soc. Bengal* 26 : 223) Blyth said : ' In the vicinity of Calcutta the pure wild race can hardly be obtained'.

There is considerable variation in the depth of grey, and the birds from the northwest (Rawalpindi and Hissar, Punjab) are almost as pale as *neglecta* but lack the pale croup. Among the others, those from the west (Kutch southwards through Gujarat and Poona to Nilambur) appear darker, particularly on the underparts. Series of wild breeding birds from different parts of the country are necessary to permit any conclusions[1].

	Wing	Bill	Tarsus	Tail
gaddi ♂♂	215, 226, 228, 229	18, 19(3)	27(2), 28(2)	111, 116, 121, 123
	(Vaurie 230-240 av. 234)			
neglecta ♂♂	225, 228(2)	20(3)	27(2), 28	116(2), 120
	(Vaurie 230-242 av. 236)			
intermedia ♂♂	215-227 av. 224	19-21 av. 20	27-29 av. 28·1	111-115 av. 113·7
gaddi ♀♀	215-235 av. 224	18-20 av. 18·1	27-29 av. 27·6	109-121 av. 114·5
	(Vaurie 224-235 av. 229·5)			
neglecta ♀♀	225, 230(2)	20(2)	27, 29	110, 112
	(Vaurie 218-241 av. 228·1)			
intermedia ♀♀	212-223 av. 216	18-21 av. 19·8	26-28 av. 27	107-116

[1] After this was completed, I noticed among the several hundred semi-wild pigeons which collect to be fed in the enclosed island in the middle of the road opposite the G.P.O. in Bombay, a much greater range of intensity of colour than is shown among the different subspecies referred to above. Though some show a pale rump, none have it all-white, as in some *neglecta* and *gaddi*.

518 **Columba eversmanni** Bonaparte (Western and central Asia) Eastern Stock Pigeon 5 : 226

5 : 2♂♂ 2 ♀♀ 1 o?

2 Harunabad, Bahawalpur, Punjab; 1 Gwalior, C.I.; 1 Dhunapur, Darbhanga, Bihar; 1 Hardoi, U.P.

	Wing	Bill	Tarsus	Tail
♂♂	200, 208	18, 18	25, 25	97, 106
♀♀	206, 206	19, 20	25, 26	99, 105
(♂♀	200-210	*c.* 16-19	*c.* 26-28	96-105 *ex* Hartert)

The specimen from Gwalior extends the known winter range of the species (*JBNHS* 67 (2) : 331).

One each of *Columba livia gaddi* and *C. oenas* from Persia were listed under this species.

EL **Columba oenas** subsp. Stock Dove

1♀ *Pir-i-Bann, Shiraz, Persia.*

Wing 202; Bill 18; Tarsus 26; Tail 114

This was included under *C. eversmanni*, but differs in having a grey (not white) croup and a grey (not vinous) head. The tail is also longer.

519 **Columba palumbus casiotis** (Bonaparte) (Chinese Tartary) Eastern Wood Pigeon or Cushat 5 : 227

5 : 1 ♂ 2 ♀♀ 2 o? juveniles*

1* *Basra, Mesopotamia*; 1* Kotri, Sind; 2 Koti State, 1 Dhami State, Simla Hills.

	Wing	Bill	Tarsus	Tail
♂	259	22	31	171
2♀♀	247, 251	22, 25	31, 32	166, 167
2 juv. o?	225, 231	23	25, 28	152, 156
	(♂♀ 243-263	*c.* 17-18	—	—)

The male is the greyest above, while the juveniles are the dullest in colour.

520 **Columba hodgsonii** Vigors (Nepal) Speckled Wood Pigeon 5 : 234

16 : 8 ♂♂ 7 ♀♀ 1 o?

2 Pujas, Kishtwar, Kashmir; 2 Mussoorie; 3 Bhimtal 4300′, 1 Rhurkia, 2 Gorikund, Kederinath, Kumaon; 1 Chala-Khel, Nepal; 2 *Dubin, Aka Hills, S. Shan States*; 2 *Saidon, Myitkyina Dt., Burma*, 1 Lambathuch?

	Wing	Bill	Tarsus	Tail
♂♂	225-235 av. 232	16-18 av. 17·1	24-26 av. 24·6	143-148 av. 145·3
♀♀	222-236 av. 230	16-19 av. 17·5	23-26 av. 24·5	139-150 av. 145
	(♂♀ 228-244	*c.* 16-18	*c.* 24-26	140-153)

521 **Columba elphinstonii** (Sykes) (The Ghauts of Dukhun) Nilgiri Wood Pigeon 5 : 228

5 : 2 ♂♂ 3 o?

1 Bhimashanker, Poona; 1 Kirma Valley, Satara; 1 Castle Rock, N. Kanara; 1 High Wavy Mountains, 1 Edluth, Biligirirangan Hills, Coimbatore.

Wing	Bill	Tarsus	Tail
204-210 av. 205·8	19-21 av. 20·1	24-26	150-153
(204-224)	(*c*. 17-18)	(*c*. 25-26)	(152-178)

522 **Columba torringtoni** Bonaparte (Ceylon) Ceylon Wood Pigeon 5 : 229

1 ♂ Hakgalla, Ceylon.

523 **Columba pulchricollis** Blyth (Nepal) Nepal or Ashy Wood Pigeon 5 : 230

3 : 2 ♂♂ 1♀

1 Hathiban, 1* Walung Forest, Nepal; 1 Woodcot, Darjeeling.

* This specimen is out on loan to the Zoological Survey of India and not available.

Bill from feathers, 18, 18 (16-17).

524 **Columba punicea** Blyth (Chyebassa, Bihar) Purple Wood Pigeon 5 : 232

2 : 1 ♂ 1 ♀

1 Bailadila, Bastar, M.P. ; 1 Tezu, Lohit Valley, Upper Assam,

	Wing	Bill	Tarsus	Tail
♂	223	18	23	154
	(210-236	*c*. 16-17	*c*. 23-25	152-178)
♀	218	17	24	135
	(203-225)	—	—	—

525 **Columba palumboides palumboides** (Hume) (Port Mouat, Andamans) Andaman Wood Pigeon 5 : 233

5 : 2♂♂ 3♀♀ (1 juv.)

1 Long Island, 1 Bakultala, 1 Betapur, Middle Andamans; 1 Bambooflats, 1 South Andamans.

525a **Columba palumboides nicobarica** (Walden) (Trinkut, Nicobars) Nicobar Wood Pigeon

3 ♂♂

1 Nancowry, 1 Camorta, Middle Nicobars; 1 Campbell Bay, Great Nicobar.

See Abdulali, *JBNHS* **64** : 166/7, *re* measurements and validity.

526 **Macropygia unchall tusalia** (Blyth) (Darjeeling) Bartailed Cuckoo-Dove 5 : 253

8 : 5♂♂ 3♀♀

1 Balasun, 2000′ near Darjeeling; 2 Pashok, Sikkim; 2 Kangpokpi, Manipur; 2 *Kachin Hills*, 1 *Irrawady R., Ruby Mines, Burma*.

Both males and females are in two plumages, presumably representing immature and adult. In males, the young have the head and underparts barred throughout, the barring lessening with age and being absent in both places in the adult. The females are all barred below, but only the juvenile is barred on the head (*contra* IH **3** : 138).

	Wing	Bill	Tarsus	Tail
Adult ♂	195, 196, 196	16, 17, 18	21, 22, 23	181, 185, 197
	(177-203)	(13-15)	(16-18)	(200-210)
Imm. ♂	185, 189	16	22(2)	164, 190
Adult ♀	183, 187	15, 16	22, 23	176, 178
	(191-200)	—	—	—
Imm. ♀	186	17	22	176

527 **Macropygia rufipennis rufipennis** Blyth (Central Nicobars) Nicobar Cuckoo-Dove **5** : 255

3 : 2♂♂ 1♀
2 Camorta, 1 Nancowry, Central Nicobars.

	♂♂	♀
Wing	197, 199	199 (♂♀ 180-193)
Bill	18, 18	.. (♂♀ 12-13)
Tail	194 broken, 205	194 (♂♀ 210-233)

Sclater (*Ibis*, 1892, pp. 72-87) in a list of type specimens of birds in the Indian Museum refers to types of *M. rufipennis* collected by Capt. Lewis and Rev. P. Barbe, S.J. Blyth (1846) described this species in ' Notes on the Fauna of the Nicobar Islands ', which is preceded by ' Notice of Nicobar Islands ' by Barbe. Both these papers indicate that the specimens were obtained in the Central Nicobars and, in view of the possibility of the birds from further south (Kondal and Great Nicobar) being separable (see *JBNHS* **64** : 167), I am restricting the type locality to Central Nicobars.

527a **Macropygia rufipennis andamanica** Abdulali (Betapur, Middle Andamans)

3 ♂♂
1 Bakultala, 1 Betapur, Middle Andamans ; 1 Calicut, South Andamans.

I am afraid my observation in my description of *M. r. andamanica* (*JBNHS* **63** : 421), that ' none of my specimens show the " lilac-purple gloss on the crown of the male " mentioned in most earlier descriptions,' has led to a mistake in the key to the subspecies of *M. rufipennis* at p.139 of INDIAN HANDBOOK Vol. 3. The distinguishing character between the two races was given earlier in my description, namely a fine rufous fringe to the outer web of the primaries in contrast to basal two-thirds entirely rufous in *M. r. rufipennis* making a striking patch of colour in the folded wing. When I spoke later of the absence of the lilac-purple gloss I was referring to all the specimens obtained by me in this trip, which included both the subspecies.

EL **Streptopelia turtur turtur** (Linnaeus) (England) Turtle-Dove 5 : 236

2 o ? *Felujah, R. Euphrates, Mesopotamia.*

Nos. 12933 and 12934 are slightly darker than those listed under *arenicola* and are marked as of the nominate race by Ticehurst (*JBNHS* **28** : 947).

529 **Streptopelia turtur arenicola** (Hartert) (Fao on the Persian Gulf) Persian Turtle-Dove 5 : 237

15 : 5♂♂ 9♀♀ 1 o ? (4 juv.)

4 20 m. from *Muscat, Arabia* ; 1 *Wadi, R. Tigris,* 1 *Zobair,* 2 *Basra, Mesopotamia* ; 1 *Persian Gulf* ; 2 *Tanhat,* 3 *Shiraz, Persia* ; 1 4100′ *Kashgar, Chinese Turkestan.*

The four from near Muscat are juveniles (?) in two separate phases and differ from the others, which show a varying amount of rufous on the upperparts. Their underparts are also a dull khaki brown, showing no white as in the others.

Wing	♂♂	168-178 av. 172
	♀♀	159-167 av. 163·5

The present measurements confirm Paludin's figures from Afghanistan indicating that the males are larger than the females.

530 **Streptopelia orientalis orientalis** (Latham) (China) Rufous Turtle-Dove 5 : 238

2 : 1♂ 1♀ *Temple of Heaven, Peking.*

	Wing	Bill	Tarsus	Tail
♂♀	201, 205	19, 17	26, 26	138, 130
(♂♀	180-198	15-17	25-28	130-135
				IH, ex Hartert)

These two with slightly larger wings, pale and almost unicolorous underparts, followed by *white* undertail coverts, cannot be matched with any of the others available for examination.

531 **Streptopelia orientalis meena** (Sykes) (Dukhun) Western Turtle-Dove 5 : 239

30 : 13♂♂ 12♀♀ 5 o ?

1 *Kushak, Mashkil, Persian Baluchistan* ; 1 Wano, Waziristan ; 2 Chitral ; 7 Simla ; 1 8000′ Dalhousie, Punjab ; 1 Gwalior ; 1 Chikalda, Berar ; 2 Chickli Surat Dangs ; 1 Wada, 3* Bhiwandi, 1 Vajrabai, Thana ; 1 Panvel, Kolaba ; 1 Khandala ; 2 Mahableshwar ; 1 Singewadi, 1 Supa Petha, Kanara ; 1 Rajputtee, Chupra, Bihar ; 2 Garhwal. *(1 missing).

All have white lower bellies and undertail coverts and cannot be confused with any of the other forms accepted in Indian limits. There is considerable variation in the intensity of the colours of the upper breast and the upperparts, but it is not possible to isolate them in any manner and this variation must for the moment be accepted as normal within the subspecies. Four specimens from Persian Baluchistan, Wano, Simla (No. 12964), and Mahableshwar (No. 19170), all obtained in October-November, are not distinctly marked on the wing coverts and probably represent an immature phase.

The three races of which we have specimens obtained in India measure :—

meena	*agricola*	*erythrocephala*
	Males	
Wing 184-210 av. 193	183-192 av. 180	177-186 av. 182
(IH ♂♀ 185-207 av. 196·2)	(186-198)	(183-193)
Bill 16-18 av. 17	15-18 av. 17	16-18 av. 17
(From skull ♂♀ *c.* 22-23)	(22-24)	(22-24)
Tarsus 23-26 av. 23·7	22-26 av. 23	22-24 av. 23
(IH ♂♀ *c.* 26-28)	(*c.* 26-27)	(25-28)
Tail 113-136 av. 127	119-138 av. 128	118-131 av. 124
(IH ♂♀ *c.* 122-140)	(135-140)	(122-134)
	Females	
Wing 181-196 av. 188	194	173-184 av. 176
(IH ♂♀ 185-207 av. 196·2)	(184-191)	(179-190)
Bill 15-18 av. 17	17	16-18 av. 17
(IH ♂♀ from skull *c.* 22-23)	(22-24, once 28)	(22-23)
Tarsus 23-25 av. 23	23, 25	21-24 av. 23
(IH ♂♀ *c.* 26-28)	(26-27, once 30)	(26-27)
Tail 118-138 av. 126	128-130	110-120 av. 117
(IH ♂♀ *c.* 122-140)	(112-132)	(112-127)

Ludlow and Kinnear (*Ibis* 1934 : 97-98) have given sufficient reasons to accept *meena* as the form with white belly and undertail coverts, which is a cold weather visitor to the Deccan.

532 **Streptopelia orientalis agricola** (Tickell) (Jungles of Borabhúm and Dholbhúm) Eastern Turtle-Dove

8 (details below)

(*a*) 3 : 2♂♂ 1♀

2 Sadiya, Upper Assam, 1 Manipur.

(*b*) 5 : 4♂♂ 1♀

1 *S. Tibet*, 1 Sipuri, Nepal ; 2 Rinchingpong, 5500′, West Sikkim ; 1 Assam.

Group (a) resembles *orientalis* in the lack of rufous on the upper parts but has dark grey undertail coverts. Group (b) has much rufous above, dark grey (slightly paler in 12957 from Tibet) undertail coverts, and cannot be separated from those listed as *erythrocephala* below. All except two of the eight specimens have been marked *agricola* by Sálim Ali or Ripley.

Tickell's original description is incomplete and may well apply to either (a) or (b), but it is significant that it is prefaced by the words ' Foxy Pigeon ', a term which applies better to the specimens in group (b).

Sálim Ali has in recent years collected a fair series from Bastar and also from Orissa, some of the camps in which State were a hundred miles south of Dholbhúm, the type locality of *agricola*. These specimens are now accepted as *erythrocephala*, as they are similar to the form resident in most of peninsular India.

Roonwal (1941, *Rec. Ind. Mus*, **43** : 332) groups birds with dark grey undertail coverts from Manbhúm and Ranchi in Bihar, Kendrapara in Orissa, and others from further south and east as *agricola* and goes on to quote Stuart Baker (5 : 231) that *agricola* straggles as far south-west as Mahableshwar ; he makes no reference to *erythrocephala*. A series obtained in 1966 by Sálim Ali in Bhutan is very similar to group (a) above. There is apparently no record supported by a specimen of the variety in group (a) north of the type locality up to the Himalayas, and there seems to be ground for holding that the name *agricola* really covers the ' foxy ' birds now grouped under *erythrocephala* (1855) and resident over most of peninsular India. If this is correct, the name *agricola* (1833) would take precedence over *erythrocephala*.

533 **Streptopelia orientalis erythrocephala** (Bonaparte) (Mysore)

23 : 13♂♂ 9♀♀ 1 o?

2 Bhimashanker, Poona ; 1 Mahableshwar, 1 Helwak, Koyna Valley, Satara ; 1 Sirsi, N. Kanara ; 1 Jubbulpore, 1 Balaghat ; 2 Antagarh, 2 Darbha, 2 Chota Dongar, 1 Kameli, 1 Barsur, Bastar ; 1 Bhanuprattapur, 1 Lohatter, Kanker ; 3 Koira, 2 Badrawa, 1 Kuldiha, Nilgiri, Orissa.

These birds (collected October to February) are distinguished from the others by their dark grey undertail coverts, darker rufous above and below, and the absence of white on the lower belly. The amount of rufous on the forehead is variable, being tinged with grey or even having the foremost one-third of the head pure grey (Sp. 19153, ♂ testes : 20×10 mm., Kanker, M.P.). Nine of them with underparts slightly darker than in the others include 7 males, 5 of them with developed gonads, and 2 females. The paler birds, which also include breeding males and females, may possibly represent a first year plumage.

A male and a female (Nos. 19158 and 19167), marked juvenile by the collector (Sálim Ali) can be distinguished by their slightly paler upperparts and the rufous edges to the tips of the primaries.

Nos. 19151 (Jubbulpore 19 February), 12970 (Sonawain 28 December), and 19172 (Bhimashanker, Poona 21 October) are peculiar in having pale grey or almost white undertail coverts, but differ from *meena* in the absence of white on the lower belly.

Under *agricola* I have referred to the possibility of the specimens marked as of this subspecies being in fact the form described earlier as *agricola*, and I have spent considerable time examining and trying to sort out the differences between the specimens of this species available to me. There is still much that is not clear, and I am certainly not in a position to explain Davidson's (*JBNHS* **5** : 330) shooting of specimens, right-and-left, one with white and the other with grey undertail coverts, and Barnes's addition to this notes : 'I have shot moulting birds with the new under-tail coverts white, and the old ones grey'. A more elaborate explanation than possible in the process of cataloguing the collection is necessary and so I am leaving the present distribution under the subspecies undisturbed.

534 **Streptopelia decaocto decaocto** (Frivaldszky) (India, based on a pale domesticated bird) 5 : 248

38 : 18♂♂ 17♀♀ 3 o? (1* albino ♀)

1 *Baghdad*; 1 *Fao*, 2 *Persian Gulf*; 1 *Shustar*, 1 *Duzdab*, *Persia*; 1 Shadad, 72 m. south of Kalat, 1 Muradkhan, 2 Dandar (W. Kolwa), 2 Sib, 1 Rohtak R., Baluchistan ; 2 Chitral, 1 Sarorogha, N.W.F.P. ; 1 Simla, 1 Keonthal ; 1 Bahawalpur ; 1 Garo, Sind ; 2 Bharatpur ; 1 Gwalior ; 1 Gir, 1 Ahmedabad, 1 Dabka, Baroda ; 3 Kalyan, Thana ; 1 Rewas, Kolaba ; 1* Jalna, Aurangabad ; 2 Satara ; 1 Bastar, M.P. ; 1 Meerut, 1 Garhwal, U.P. ; 1 *Kashgar* ; 1 Bhuzawani ?

Four (2 ♂♂ 1 ♀ 1 o?) from Duzdab, Sib (2), and Kalat collected in September/October are noticeably paler above, have the neck-rings brownish, and are also slightly smaller (wings 159, 162, 151, 154 ; tails 117, 122, 113, 106), and are probably juveniles.

Fresh specimens of both sexes appear greyer and less brown than the older ones, while the males have greyer heads than the females, most of which are pale brown all over.

	Wing	Bill	Tarsus	Tail
♂♂	159-175 av. 167	15-17 av. 15.9	20-22 av. 21.2	115-139 av. 128
♀♀	151-180 av. 162·5	15-16	20-22 av. 20·9	113-133 av. 124
(♂♀	158-169	16-18	23-26	117-140)

535 **Streptopelia tranquebarica tranquebarica** (Hermann) (Tranquebarica) Indian Red Turtle-Dove 5 : 250

9: 8♂♂ 1♀ (in male plumage)

1 Dhirpur, 1 Ambala, Punjab ; 1 Bharatpur, Rajasthan ; 1 Kalyan, Thana ; 1 Panvel, Kolaba ; 2 Poona ; 1 Bulandshar, 1 Cawnpur, U.P.

It is curious that there is only female specimen, and that in male plumage. The measurements are included under the next form.

536 **Streptopelia tranquebarica humilis** (Temminck) (Bengal and Luzon) Burmese Red Turtle-Dove 5 : 251

10 : 4♂♂ 6♀♀ (1 juvenile*)

1 Long Island, 1 Bakultala, Middle Andamans ; 1 Wrightmyo, 1 Ferrarganj, 2 South Andamans ; 1* Mirpur, Bengal ; 1 *Maymyo*, 1 *Prome*, 1 *Henzada, Burma*.

Wing	Bill	Tarsus	Tail
tranquebarica			
♂♂ 132-144 av. 137·8	13-15 av. 13·7	17-19 av. 18·3	77-89 av. 83·3
♀ 138	14	18	84
humilis			
♂♂ 137, 137, 139, 146	14(3), 15	19(2), 20(2)	83, 84(2), 88
♀♀ 134-143 av. 138·4	13, 14(2), 15(2)	17, 18(2), 19(2)	78-84 av. 81·6
(IH ♂♀ 136-145	from skull 16-19	17-21	84-92)

In my Andaman report (*JBNHS* **61** : 527), I have already referred to females of both races in male plumage and to the difficulty of understanding, with the material available, the sequences of plumage of this species.

537 **Streptopelia chinensis suratensis** (Gmelin) (Surat, Gulf of Cambay)
Indian Spotted Dove 5 : 242

44 : 25♂♂ 18♀♀ 1 o? (2 juveniles)

1 Chitral, N.W.F.P.; 1 Kishtwar, Kashmir; 1 Keonthal State, 3 Simla; 1 Nadiad, Gujarat; 2 Mumbra, 1 Kalyan, Thana; 1 Andheri, 1 Powai Lake, 1 Santa Cruz, Bombay; 1 Panvel, 2 Pen, 1 Apte, Kolaba; 1 Santyal, Kanara; 1 Udipi, Mysore; 1 Nilambur Valley, Kerala; 1 Shevaroy Hills, 1 Chitteri Range, S. Arcot; 1 Koira, 2 Konta, 1 Bijapur, Bastar, 4 Bhanuprattapur, Kanker; 1 Barkot, 1 Keongarh, Orissa; 1 Patharghatta, Bihar; 1 Meerut, 1 Almora, 1 Naini Tal, 1 Gharwal; 1 Rongi Valley, Sikkim; 1 Cherali, Nakacheri, Naga Hills, 1 Margherita, 1 Lohit Valley; 3 Dimapur, Manipur.

There is a wide range of variation in the number and colour of the spots and the general intensity of the colour of the upper parts, but except for a dimunition in size from north to south it is not possible to associate any of these differences with sex, season, age, or locality. Those from Bastar, Kanker, and Orissa appear to have heavier bills and are in series darker above, and lack the spots on the back, showing a similarity to those from the north-east, the tendency continuing and merging with *tigrina* of Burma (q.v.). The Assam specimens are of different shades of colour but there are none which I can separate as *edwardi* or *tigrina*, and I am leaving all from Indian limits as *suratensis*.

The collection contains only one juvenile No. 19185 ♂ wing 132, tail 110 Kanker, in which the upperparts and wing coverts are edged with rufous resembling *orientalis* rather than this species. Another (No. 12979 ♀ Nilambur Valley wing 119, tail 100) appears to be juvenile, but already has the spotted pattern on the neck. In addition the upperparts are unevenly marked with white, indicating an aberrant plumage. Goodwin (1959), in ' Some Colour Varieties of Wild Pigeons ' (*Bull. B.O.C.* **79** : 3-9) refers to an unsexed female of this species at the British Museum (N.H.) being marked with silvery grey. In his note he draws attention to the fact that such deviations from the norm are only found in females.

	Wing	Bill	Tarsus	Tail
♂♂	127-149 av. 139	14-17 av. 15·5	18-23 av. 20·5	106 (next 118)-143 av. 133
	(IH 135-146	..	21-24	118-143)
♀♀	128-146 av. 136	15-17 av. 15·8	20-22 av. 20·3	122-129 av. 127
	(IH 132-143	..	20-24	117-133)
		tigrina		
♂♂	138, 141, 142, 146	14, 16, 16, 17	20, 21, 22, 23	128, 134, 136, 137
♀	146	15	23	144
	(♂♀ 137-155	..	..	..)

538 **Streptopelia chinensis ceylonensis** (Riechenbach) (Ceylon) Ceylon Spotted Dove 5 : 245

1 o? Ceylon
Wing 129 (123-129 ; IH 128-136); Tail 129 (♂ 114-132 ; ♀ 118-127)

The wing measurements in Stuart Baker are smaller than those quoted from Whistler in IH **3**, p. 154. In the latter, the key requiring a wing under 130 mm. is not in keeping with the measurements cited (128-136).

539 **Streptopelia chinensis tigrina** (Temminck) (Java) Burmese Spotted Dove 5 : 244

6 : 1♂ 4♀♀ 1 o?
2 *Da Lu, Chindwin R.*, 1 *Pakoku* ; 1 *Khayauk, Thayetmyo Dist.* ; 1 *Prome Dist.* ; 1 3-*Stockade* (collected by Linching)?

As explained under 537, these birds have been arbitrarily separated on geographical grounds. The birds from 3-Stockade and Pakoku District have spots on their upperparts and may be included with those from India. The two from Da Lu, bearing the labels of the Vernay-Hopwood Chindwin Expedition, are dark above with black centres to the feathers and no buff or white spots.

540 **Streptopelia chinensis edwardi** Ripley (Chabua, Lakhimpur Dist., NE. Assam.) NEFA Spotted Dove

nil.

After these notes were completed, I was able to examine through the courtesy of Dr. Ripley and the U.S. National Museum four female specimens of *edwardi* from Chabua (3) and Nangpoh, Garo Hills (1). The upperparts of two from Chabua are darker than in any of the others, but the other two are spotted above and may well be included with the series of *suratensis*, except that all four have almost pure grey heads with none of the vinous tinge invariably present in *suratensis*. The specimens of *edwardi* do not show spots of "darker buff" as stated in IND. HANDBOOK. The measurements also average slightly larger.

Wing	Tail
138, 141, 146, 147	126, 133 (2), 135

A larger series from Burma and north-east India needs to be compared with topotypes of *tigrina* to determine the distribution of these races.

541 **Streptopelia senegalensis cambayensis** (Gmelin) (Gulf of Cambay), Indian Little Brown Dove 5 : 246

28 : 20♂♂ 8♀♀ (1 missing)

2 Quetta, 2 Karak, Baluchistan ; 1 Chitral, 1 Jandola, N.W.F.P. ; 1 Bhajji, H.P. ; 1 Ambala ; 2 Bharatpur ; 1 Kutch ; 1 Cambay, 1 Bhavnagar ; 1 Ghoti, Nasik, 1 Kalyan, 5 Belapur, Thana ; 1 Cumbala Hill, Bombay ; 1 Nagotna, Kolaba ; 1 Panchgani, 1 Satara ; 1 Cumbum Valley, Kurnool ; 2 Hoshangabad, M.P. ; 1 Bulandshar, U.P.

Old skins are browner than fresh ones.

The birds measure :

	Wing	Bill	Tarsus	Tail
♂♂	120-139 av. 129	13-17 av. 15·2	17-22 av. 18·7	103-126 av. 116
	(IH 121-137	From skull 17-19	18-22	107-119)
♀♀	123-130 av. 126·5	13-16 av. 15·1	17-18 av. 17·1	104-116 av. 107·8
	(IH 124-134	From skull 17-19	20-21	104-113)

The northern birds average slightly larger than the southern.

542 **Chalcophaps indica indica** (Linnaeus) (Amboina) Indian Emerald Dove 5 : 215

18 : 9♂♂ 6♀♀ 3 o?

2 Simla ; 1 Mahal, Surat Dangs ; 1 Anshai Ghat, 1 Santgal, N. Kanara ; 2 Shembaganoor, 1 Palni Foothills, 1 Manalur, Palni Hills, 1* Tenmalai, S. Travancore ; 1 Lamasinghi, Vizagapatam ; 1 Berbera, Puri ; 1 Hazaria, Patharghatta, Bihar ; 1 Chang Chang Pani, 1 Margherita, Assam ; 1 *Myitkyina*, 2 *Singha Ling*, *Burma*.

Two marked females (Patharghatta, Bihar, and Margherita, Assam) have a little white on the forehead, the one from Assam further resembling the male in being greyish-vinous and less brown on the underparts. The type specimen* of *C. indica salimalii* Mukherjee, from Tenmalai, Central Travancore, has the grey of the nape connected by a narrow median line with the grey on the upper back, presumably resembling *robinsoni* Baker, from Ceylon. *Salimalii* is not now recognised.

Measurements are under 544.

543 **Chalcophaps indica robinsoni** Baker (Cocawatte Estate, Ceylon) Ceylon Emerald Dove 5 : 214

nil.

544 **Chalcophaps indica maxima** Hartert (Golapabung, South Andamans)

6 : 4♂♂ 2♀♀

2 Wrightmyo, 1 Bakultala, 1 Chirria Tapu, S. Andamans ; 1 Car Nicobar ; 1 Camorta, Central Nicobars.

Only two males, one each from South Andamans and Car Nicobar, have been added to the collection after my notes on Nicobar birds (*JBNHS* **64**, p. 168). The former (wing 154, tail 98) confirms the difficulty of separating *maxima* by size, while the latter, a poor skin, has a large 159 mm. wing, and 95 mm. tail.

	Wing	Tail
Nominate ♂	141-156 av. 147·7 (IH 147-156	85-98 av. 93 93-100)
maxima ♂	150, 154, 154 (Hartert 157-164)	88, 96, 98
Nominate ♀	140-149 av. 143·5 (IH 147-149	83-98 av. 90 89-91)
maxima ♀	148	90
Camorta ♀	148	83

Subject to the remarks in the abovementioned paper, I am leaving the Camorta specimen with *maxima*.

544a **Calaenas nicobarica nicobarica** Linnaeus (Nicobar Islands) Nicobar Pigeon **5** : 213

7 : 2♂♂ 3♀♀ 2o? (1* chick in spirit)

1 North Reef Island; 1 Mannarghat, 2 South Sentinel Island, Andamans; 3* Battye Malve, south of Car Nicobar.

	Wing	Bill	Tarsus	Tail
♂♂	240, 255	24, 25	38, 41	88, 90
♀♀	245, 265	25, 25, 25	37, 38, 41	88, 89, 94

A ♂ and a ♀ obtained on South Sentinel Island on 16 and 15 March 1969 respectively are identical, both being brilliantly green above and with the hackles longer in the female. The other two females from Battye Malve are not so brilliantly green, but this may be due either to the fact that they are both poorly preserved or that they represent an intermediate plumage.

The reference to a slaty grey pigeon in IND. HANDBOOK appears to be in error.

The claws in the preserved specimens are all pale coloured, almost white.

(*to be continued*)

The nesting of *Pareumenes brevirostratus* (Saussure), involving a primitive form of co-operation

BY

S. D. JAYAKAR[1] AND H. SPURWAY[2]

Genetics and Biometry Laboratory, Government of Orissa, Bhubaneswar-3, Orissa, India

Pareumenes brevirostratus is a squatter species practising mass provisioning. The only individual watched provisioned with pyralid prey, and all her offspring entered diapause, one for two seasons. While working she was disturbed by individuals of *Rhynchium brunneum* and *R. carnaticum*. Some of the mutual reactions of these wasps may simulate the early stages of social behaviour in some hymenoptera.

INTRODUCTION

We know no description of the breeding biology of any[3] member of the genus *Pareumenes* Saussure, certainly none for the present species, for which van der Vecht (1963, p. 19) gives the bibliography, and a reappraisal.

We are presenting the one diary which we have collected. This must be exceptional for the species considered but reveals capabilities of the solitary vespoids which suggest speculation on the origin of social behaviour.

Members of the 4 vespoid families referred to have been identified by Dr. J. van der Vecht of Leiden, Dr. K. Iwata of Sasayama has examined the lepidopteran larvae used as prey, and Dr. M. Chujo of Takamatsu has identified the parasitic beetle. We are extremely grateful to these authorities for their help.

THE NEST BOXES

Nest boxes were narrow strips of wood each numbered by an arabic figure hung up on walls and vertical fitments of our house in Bhubaneswar. In these had been bored a single row of short horizontal blind tunnels

Present address: [1] Laboratorio di Genetica Biochimica ed Evoluzionistica, Pavia, Italy.
[2] Habshiguda 16, Hyderabad-7, A.P., India.

[3] *Pseumenes depressus* (Saussure) whose habits are described by Iwata (1964) who also refers to the previous literature, has in some of this, been regarded as a species of *Pareumenes* (van der Vecht 1963, p. 21).

numbered in roman figures from top to bottom. The circumference of one tunnel was about 1·75 cm. distant from those adjacent to it. In any one strip all the tunnels were one length but of two diameters. As they were bored with tools calibrated to 1/16″ (1·6 mm.) this is the unit used in Table 1 which gives the diameters of the tunnels, their horizontal lengths and the locations of the three nest boxes referred to in this paper. A tunnel is referred to by the two numbers given above e.g. 7.XV and the wasp cell built in it is referred to by the same double number preceded by the initials of its mother's taxonomic name and her serial number.

Table 1

	1.	diameter	6.	diameter	7.	diameter
	I	3	I	4	I	4
	II	4	II	4	II	7
	III	3	III	5	III	4
	IV	4	IV	4	IV	7
	V	3	V	5	V	7
	VI	4	VI	4	VI	4
	VII	3	VII	5	VII	7
	VIII	4	VIII	4	VIII	4
	IX	3	IX	5	IX	7
	X	4	X	5	X	4
			XI	5	XI	7
			XII	4	XII	7
			XIII	4	XIII	7
			XIV	4	XIV	7
			XV	5	XV	4
			XVI	5	XVI	4
					XVII	4
length of tunnels	12		16		24	
location	indoors		on verandah facing 12° W of S		on verandah facing 12° W of S	

all measurements in 1/16″ or 1·6 mm.

The behaviour of one female ; *P.b.*1

On 12/9/1964, first noticed at 10.45, a long petiolate russet and yellow vespoid later identified by her offspring as a member of *Pareumenes brevirostratus* (Saussure), surprised us by working for 12 minutes cleaning two of the empty cells of the giant nest of *Eumenes emarginatus conoideus* (Gmelin) *E.e.c.* 10, on which we have previously published (Jayakar & Spurway 1965). We were unaware that wasps of this body form, which is sometimes described as an adaptation to oviposition in a small mouthed pot, could have squatter habits. Next day (13/9) a similar wasp (now, knowing the rarity of the species, presumed to be the same individual) was seen in the same area.

No wasp of this species was seen again until 18/9 when in the morning one (she ?) was seen flying round electric wiring fitments indoors, and at 15.12 she was seen feeling inside tunnel 1.VI. When she left it was found that at the blind end of this tunnel there was suspended a eumenid egg of about the size laid by some species of *Rhynchium* Spinola. No individual belonging to *Rhynchium* has used any tunnels in this nest box before or since. This is interpreted as being because they are too small. At the time described, nest box 1 was empty and no other wasp used it before she deserted it.

She did not pernoctate (Jayakar & Spurway 1966) in this tunnel but on 19/9 was seen feeling tunnels 1.VI, 1.II and 1.IV as early as 07·32. She provisioned tunnel 1.II and had sealed it by 09·45 ; at 09·54 she had returned to seal 1.VI and at 10.02 she was again working on 1.II. 1.II must have contained an egg with adequate provisions because the individual by which the species has subsequently been identified, emerged from it. At 11.39 the wasp was captured etherised and a spot of yellow enamel paint was applied to the thorax. From this time therefore the identity of *P.b.*1 was established.

1.VI was subsequently reopened by an *Antodynerus flavescens* (Fabricius), *A.f.* 32 on 26/9/1964. As this female had simultaneously opened a cell in 1.I which she herself had provisioned and sealed on 24/9 we do not know from which came the many prey dropped on the floor.

On 20/9, *P.b.*1 once more investigated nest box 1, and 2 hours later had returned to the verandah and the large deserted nest of *E.e.c.*10.

She was not seen again for 13 days when on 3/10 she was found, still painted, investigating nest box 7 on the same verandah and on a similar window shutter to *E.e.c.*10. An egg was seen in 7.VII.

On 4/10 this egg was absent. *P.b.*1 returned and worked on 7.VII for over two hours, occasionally investigating and entering 6.III a few metres away and in a similar position. During this time it was established both that she spent much time in the tunnel facing out as do the inconspicuously petiolate squatters of the genera *Rhynchium* and *Antodynerus* Saussure, and *Subancistrocerus sichelii* (Saussure), and also if the tunnel has a sufficiently large diameter she could, like these, enter it head first and turn round inside. As with the other squatters the egg was laid suspended during one of these periods and first seen again in 7.VII at 10.07. This egg was provisioned with a species of green glassy caterpillar which becomes yellowish when preserved in alcohol. By 17.16 this cell was sealed, the lid being 10 mm. within the tunnel, and its contents were thus called *P.b.*1, 7.VII.1. It was hoped that another egg 7.VII.2 would be laid and provisioned distal to this diaphragm. *P.b.*1 did not pernoctate where we could observe her.

During 4/10 a *Rhynchium brunneum* (Fabricius) *R.b.*4 had begun working on nest box 7, sealing 7.XIV with 2 separate diaphragms, after which she too was marked ; she sealed 7.IV (details of sealing unknown), and oviposited and provided two prey in 7.II, but did not pernoctate in it. This is exceptional for individuals of this species of *Rhynchium*.

It was noticed that *R.b.*4 was provisioning with the same species of prey as *P.b.*1. This has been confirmed by Professor Iwata who informs us that this is a species of pyralid moth, but because the early stages of so many Indian lepidoptera are undescribed, he is unable to classify it further.

On 5/10, *R.b.*4 continued provisioning 7.II and sealed it just before 9 o'clock. Though the tunnel only contained one offspring she made two discrete lids with a space of over 1 mm. between them. The second lid, often made by these *Rhynchium* are more granular than the first, and these granulations are usually spread in ribbons around the mouths of the tunnels over the wooden surface of the nest box. In texture, as in timing, these second lids are convincingly comparable with the crépissage of the pot building *Eumenes* Latreille (Jayakar & Spurway 1965). At 09.28, *R.b.*4 felt 7.IV and entered 7.V, but 5 minutes later she arrived with mud and after feeling 7.V and 7.VI she began making a diaphragm level with the surface over the mouth of 7.VII which *P.b.*1 had sealed 10 mm. within the tunnel the previous afternoon. Four minutes later, when *R.b.*4 was next seen to arrive with mud, *P.b.*1 was present on 7.VII ; *R.b.*4 walked up to 7.V but immediately returned to 7.VII and *P.b.*1 made way for her. *R.b.*4 began working the mud into the incomplete diaphragm over 7.VII ; *P.b.*1 attacked her. Both wasps pecked at each other with their mandibles and both flew away at 09.38. We did not see *P.b.*1 again on 5/10, but *R.b.*4 finished the second lid on 7.VII and put on the crépissage ribbons. She immediately began working in tunnel 7.IX at 10.10 arriving with mud which she put in 7.IX and then turned round in the tunnel into the ovipositional position. At 10.22 she was again seen in 7.IX and at 10.46 she was absent and an egg was present in 7.IX. The deposit behind this egg at the bottom of the tunnel was unexpectedly white. These times are given in detail because they led us to believe that the egg in 7.IX had been laid by *R.b.*4. Very few eggs in our records of all species except those of females watched continuously, are associated with their putative mothers by a closer sequence of observations. However, though this egg did not produce an imago we became subsequently convinced that the larva recovered from this cell had come from an egg laid by *P.b.*1. *R.b.*4 was not seen again on 5/10 but one pyralid larva was found added to 7.IX by 13.40, but no more during the afternoon.

On 6/10 by 07.53, 2 larvae were present in 7.IX, at 08.08 *P.b.*1 was seen inserting a larva, and 2 more were added before 09.17. At this time *R.b.*4 arrived also carrying a similar larva, landed on 7.IX and immediately threw her larva away so that it fell from her at an angle·

*R.b.*4 then removed the 5 larvae in tunnel 7.IX flying with each in turn to drop it several metres from the nest box. The egg alone was left in 7.IX, again, and incorrectly, confirming the previous diagnosis that it had been laid by *R.b.*4. At 10.29 *P.b.*1 began reinserting fresh larvae into 7.IX, and 3 were again found on the verandah at 12.52, the egg being once more left alone.

At 13.44 there was once more a larva in 7.IX and at 13.46 *P.b.*1 brought mud, went to nest box 6, flew to 7, and found 7.IX, but after entering it returned to the garden still carrying the mud with her. It was now noticed that the egg had hatched and the larva was hanging from the shell so that it touched the prey on the floor of the relatively enormous tunnel. Between 14.00 and 14.16 *P.b.*1 was seen bringing 3 loads of mud, with the last she remained inside until 14.23, working on a diaphragm deep in the tunnel.

Meanwhile, at 14.18, *R.b.*4 arrived with a larva. After hovering near 7.IX she left with the larva and returned 3 minutes later without a load. She then walked all over nest box 7 entering and feeling 7.XII and 7.XIII but always pausing near 7.IX. She was hovering when *P.b.*1 came out and stood over 7.IX before flying for a moment to return and feel the rim of 7.IX. When *P.b.*1 left we saw that the diaphragm within 7.IX was newly completed. The next load of mud was brought at 14.29. *This was brought by R.b.*4 *who added it to the diaphragm made by P.b.*1.

*R.b.*4 brought 6 more loads of mud during the afternoon, and though with the first she entered 7.IX, she put it down on 7.XIV, with the second she again flew to 7.IX, but only hovered over it, and continued adding to the crépissage of 7.XIV. During this work she was continually feeling other tunnels, the typical behaviour when a cell has been completed and a new tunnel is being selected. She laid in 7.XIII and returned through heavy rain to typically pernoctate in it. *P.b.*1 meanwhile brought a load of mud *and after feeling her previous diaphragm to which R.b.*4 *had contributed, began with this load a second diaphragm at the mouth of the tunnel.* To this she added 4 more loads during the afternoon. During this she was several times attacked by a *Rhynchium carnaticum* (Fabricius), *R.c.*5, who at 15.14 had begun investigation of 7.V.

Thus on 6/10 both *P.b.*1 and *R.b.*4 worked mud in tunnel 7.IX, and though *P.b.*1 alone was seen inserting prey, no other cell was open to receive the larvae brought by *R.b.*4 at 09.17 and 14.18, and it is difficult not to assume that they too were intended for 7.IX.

On 7/10, *R.b.*4 continued work on 7.XIII, *R.c.*5 on 7.V, and *P.b.*1 after feeling the lid of 7.IX spent many hours examining tunnels 7.XII and 7.XI. *P.b.*1 and *R.b.*4 buzzed round one another many times stimulating each other to cease work and fly. *R.b.*4 sealed 7.XIII and began examining 7.XII and 7.XI herself. This produced much more definite aggressive behaviour, especially by *R.b.*4. *R.b.*4 for some time left the nest box to examine a piece of bamboo. Between 13.25 and 13.27, an exceptionally short interval, *P.b.*1 laid an egg in 7.XI and brought the first prey for it at 13.37. *R.b.*4 at 14.00 was in 7.XII facing out i.e. she might be assumed to be ovipositing. She was disturbed by an *Antodynerus flavescens* on the surface of the nest box. She walked out of tunnel 7.XII and very slowly, while feeling the surface of the nest box, walked up to 7.XI, removed and dropped the prey from 7.XI, and returned to 7.XII. This she did not re-enter backwards until after much feeling of the tunnel with her antennae and hovering over it. *R.b.*4 laid an egg in 7.XII the same evening and pernoctated in it. At 15.00, *P.b.*1 arrived at 7.XI without a load, worked in it, and then turned round inside it so she was facing out. She then repeated the curious wriggling which had been noticed before when she was ovipositing, or had just oviposited. After 53 minutes she walked out, and only 1 egg was seen in tunnel 7.XI.

On 8/10 both *P.b.*1 and *R.b.*4 continued provisioning though *R.b.*4 changed her prey. At 11.47 immediately after sealing 7.XII, *R.b.*4 removed 7 larvae from 7.XI and for the first time the egg as well. She then removed the egg laid by *R.c.*5 in 7.V. *R.c.*5 immediately laid a new egg, provisioned and sealed it, and laid another egg in the same tunnel. Curiously this outer egg, *R.c.*5, 7.V.2 metamorphosed successfully, whereas the inner egg was parasitized by the rhipiphorid beetle *Macrosiagon ferrugineum* (Fabricius). *R.b.*4 then inspected nest box 6 but finally transferred her attentions to the nest *E.e.c.*10 in which she laid 10 eggs.

*P.b.*1 after examining 7.XI moved to the lid of 7.XII sealed by *R.b.*4 10 minutes previously, from this she took wet mud, and immediately began a diaphragm 8 mm. deep in the now completely empty 7.XI. She continued working on this lid 7.XI, fetching mud from the garden for the next 1¾ hours. She then disappeared for good. During the 6 days, 3-8/10, 2 individuals of *Antodynerus flavescens* were also working in nest box 7, all 17 tunnels of which were sealed by the evening of 8/10.

The offspring

We assume we had three offspring of *P.b.*1, namely 1.II, 7.IX and 7.VII ; all entered diapause, and were removed from the tunnels to corked glass tubes. 1.II, a ♂, pupated on 7/7/65 emerged on 20/7 from the pupa and was killed on 22/7 when he had become active. 7.IX was judged to have died on 23/7/65, but 7.VII did not die until just before 17/5/66. We have had only one other larva remain in diapause for 2 seasons, and this interestingly, but perhaps not significantly, was from the second egg laid in 1.I by *A.f.*32 on 27/9/64 after she had removed both an egg and provisions of her own from this tunnel, and that laid by *P.b.*1 in 1.VI. This female later squatted in *E.e.c.*10 also.

That these larvae diapaused confirms that 7.IX was the offspring of *P.b.*1 and not *R.b.*4. Five of the offspring of *R.b.*4 already described developed to imagines, and 8 laid by her in *E.e.c.* 10. These 13 all emerged the same autumn, the longest preimaginal period being 29 days. Therefore the larva in 7.IX would not only have been the only member of the family to diapause, but would have had both older and younger sibs that did not.

Discussion

Despite the bizarreness of this single history, there can be little doubt that despite its body shape *Pareumenes brevirostratus* is a typical squatter practising mass provisioning. It also competes with the sibling species *Rhynchium brunneum* and *R. carnaticum* for nest sites, and with the former at least for prey. We have not yet recognised the ecological differences which, according to Gause's principle (*see* e.g. Lack 1966), must be expected between these two morphologically similar species of *Rhynchium*. In a so-called domestic, environment, this individual of *P. brevirostratus* was a slower worker than the individual of *R. brunneum* with which she competed, but wasps vary much, even the same individual at different periods of their lives, in their speed of work (Jayakar & Spurway 1965). Also, in this history, though the *brunneum* destroyed more of the effort of the *brevirostratus* than vice versa, more of the effort of the *brunneum* effectively contributed to the care of the *brevirostratus* offspring than vice versa.

The repeated removal of prey brought by the *brevirostratus* by the *brunneum* was not a simple example of the extreme sensitivity of solitary vespoids to alien handling of their prey (Roubaud 1916), for this prey was removed by the *brunneum* from the *brevirostratus* eggs. This probably was because the prey brought by the *brevirostratus* was of the same species as that which *brunneum* was, at that time, collecting, probably for the same egg. If the prey had been of a different species she might not have been disturbed by the alien wasp smell on it because she would not have interpreted this as interference with her own work.

Most important is that though such wasps resent so strongly an alien smell on prey, they have no such reaction to an alien smell on mud, though the gastric secretion with which this mud is mixed would be expected to be vivid, especially before it had dried.

One of the suggestions for an origin of the co-operation shown by the social hymenoptera is that they might be descended from species whose solitary nests were constructed in aggregates. They might sometimes have worked on each other's constructs because these incomplete constructs, independently of the builder, provided the releasers to evoke the relevant behaviour. We have previously described (1963) how the sphecoid *Chalybion bengalense* (Dahlbom) is stimulated to deposit her faecal crépissage on the naked mud lids of *Antodynerus flavescens.* The present history records how similar effective co-operation may be stimulated while the work is in progress. This co-operation was not only performed by one animal, but *accepted* by the other, in a context where much mutual destruction of work also occurred, and where all reactions by the 2 wasps to each other, face to face, were aggressive.

As may have been implicit already, during the period considered these nest boxes provided baits, producing an artificial concentration of individual wasps in an environment in which the boxes themselves provided a somewhat unnatural, or experimental, feature.

References

Lack, D. (1966): Population Studies of Birds. Clarendon Press, Oxford.

Iwata, K. (1964): Bionomics of non-social wasps in Thailand. *Nature and Life in Southeast Asia* III: 323-383.

Jayakar, S. D. & Spurway, H. (1963): Use of vertebrate faeces by the Sphecoid wasp *Chalybion bengalense* Dahlb. *J. Bombay nat. Hist. Soc.* **60**: 747-748.

——— (1965): Normal and abnormal nests of *Eumenes emarginatus conoideus* (Gmelin) including notes on crépissage in this and other members of the genus. ibid. **62**: 193-200.

——— (1966): Re-use of Cells and Brother-Sister Mating in *Stenodynerus miniatus* (Sauss.) (Vespidae: Eumeninae). ibid. **63**: 378-398.

Roubaud, É. (1916): Recherches. Biologiques sur les Guêpes Solitaires et Sociales d'Afrique.—La Genèse de la Vie Sociale et l'Evolution de l'Instinct Maternel chez les Véspides. *Annales des Sciences Naturelles* (*Zoologie*) Ser. X, 1, 1-160.

Vecht, J. van der (1963): Studies on Indo-Australian and East Asiatic Eumenidae (Hymenoptera, Vespoidea). *Zool. Verh. Leiden.* **60**: 1-116.

Triops granarius (Lucas) (Crustacea: Branchiopoda) from Tamil Nadu, and a Review of the Species from India

BY

P. J. Sanjeeva Raj
Department of Zoology, Madras Christian College, Tambaram, Madras-59

(*With two text-figures*)

Introduction

Specimens of the Notostracan genus *Triops* Schrank (*Apus* Schaeffer), have been reported from time to time, from isolated localities in India and have been described under different specific names. This genus is notorious for its intraspecific morphological variations so that some times, the same species from a different locality, or juveniles of the same species, have been described under different specific names, adding to the taxonomic confusion within the genus.

Packard (1871) was the first to record from India, two specimens of *Triops* (*Apus*) from a stagnant pool on the Himalayas and assigned them to the species *himalayanus*. Walton (1911) subsequently reported *Triops* (*Apus*) from Bulandshahr District, United Provinces and indicated their resemblance to *Triops* (*Apus*) *cancriformis* (Bosc). Kemp (1911) surveying the records of *Triops* (*Apus*) in eastern Asia, pointed out that Major Walton's specimens from the United Provinces and his own from Kashmir were identical with *Triops* (*Apus*) *cancriformis* (Bosc) and indicated that Packard's *Triops* (*Apus*) *himalayanus* is perhaps not distinct from *Triops* (*Apus*) *cancriformis* (Bosc), with which view Gurney (1925) agreed. Besides reporting *Triops* (*Apus*) *cancriformis* (Bosc) from Kashmir, Gurney (1925) described *Triops* (*Apus*) *asiaticus* from Panchgani in Bombay State. *Triops* (*Apus*) *asiaticus* was only a *nomen novo* reluctantly introduced by Gurney (1921) for specimens of *Triops* (*Apus*) *granarius* from Baghdad. Since these and similar ones from the Chingham Mountains in Central Asia described by Sars (1901) were thought to be different from *Triops* (*Apus*) *granarius* (Lucas) from Africa, Gurney resorted to this new specific name. Tiwari (1951) in turn, considering the Panchgani forms to be not identical with the Central Asian forms of *Triops* (*Apus*) *asiaticus* of Gurney, described the Panchgani forms as *Triops* (*Apus*) *orientalis* and the juvenile forms of the same species from Mavli in Rajasthan, as *Triops* (*Apus*) *mavliensis*. Longhurst (1955), however, in his exhaustive revision of the genus, synonymised *Triops* (*Apus*) *orientalis* and *Triops* (*Apus*) *mavliensis* with *Triops* (*Apus*) *granarius* (Lucas). Shanbhag & Inamdar (1968) basing on collections from Port Okha (Gujarat), maintain that *Triops* (*Apus*) *mavliensis* (Tiwari) is a valid species, but I feel that the armature of the telson falls within the range of intraspecific variations described by Longhurst (loc. cit.) for *Triops granarius* (Lucas).

Longhurst (loc. cit.) in his revision of the genera and species of Notostraca, remarks graphically, 'Individual Notostraca are notoriously variable and differences in the armature of spines on the exoskeleton, or in the body proportions can be found in any pair of animals, even those from the same pool. This together with the lack of morphological discontinuities within the genera, makes the group a 'difficult' one systematically, and has resulted in the excessive number of descriptions of specimens rather than species, with which the synonymies are now burdened.' Accordingly, he reduced nearly 45 'species' of the genus *Triops* (*Apus*) described in literature to just four species, providing exhaustive synonymies for each of the valid species and a key for the identification of the species. He indicated that these four valid species seem to conform to four major geographic areas of distribution, with tendencies for sub-speciation and racial differences within each.

According to this revision, only two species, *T. cancriformis* (Bosc) and *T. granarius* (Lucas) occur within the limits of India, the former in northern localities like the Himalayas, Kashmir, United Provinces and Gujarat and the latter in the rest of India from Panchgani in Maharashtra State to the southernmost part of India.

Subsequently, Tiwari (1955) provided additional information on the sex-ratio and apodous segments, Pai (1958) described the post-embryonic stages, and Karande & Inamdar (1959) analysed the taxonomic characters of *Triops* (*Apus*) *granarius* from Panchgani.

Chacko (1950) reported on the occurrence of a single male of *Triops* (*Apus*) *sudanicus* Brauer from Nagasunni Temple Tank in the Tirunelveli District of the Madras State and Tiwari (1951) described it in detail under the same specific name. Longhurst (loc. cit.) however, has not considered it in his revision, perhaps owing to lack of material. Since the present collection of a large number of males and females are from the same district and since the descriptions of Chacko (loc. cit.) and Tiwari (1951) agree with the present material, with due allowances for intraspecific variations, it is believed that *Triops* (*Apus*) *sudanicus* of

Chacko and Tiwari are synonyms of *Triops* (*Apus*) *granarius* (Lucas), under the present study.

The following taxonomic analysis of *T. granarius* (Lucas) collected from the Tirunelveli District in Madras State and the comparison of these specimens with earlier records of this species from India, are all based on Longhurst's (loc. cit.) revision.

During October-November 1965, hundreds of specimens of *Triops* from rain water ponds and tanks in villages like Rajagopalpuram and Perumalpuram around Palayamkottai, in the Tirunelveli District were collected by Prof. M. H. Martin of St. John's College, Palayamkottai. Nearly thirty of them preserved in formalin were sent to me together with notes on live specimens. Some got accidentally dried up in one vial but fourteen in the other vials are left in good condition for study. These specimens were said to occur commonly at other places like Srivaikuntam in the same district.

SYNONYMY FOR INDIAN RECORDS OF *Triops granarius* (LUCAS)

1864. *Apus granarius* Lucas.
1921. *Apus asiaticus* (nom. nov.) for *Apus granarius* (Sars) Gurney.
1924. *Apus asiaticus* Gurney.
1925. *Apus asiaticus* Gurney.
1950. *Apus sudanicus* Chacko.
1951. *Apus orientalis* Tiwari.
1951. *Apus mavliensis* Tiwari.
1951. *Apus sudanicus* Tiwari.
1955. *Apus orientalis* Tiwari.
1955. *Triops granarius* Longhurst.
1958. *Triops* (*Apus*) *granarius* Pai.
1959. *Triops orientalis* Karande and Inamdar.
1968. *Triops mavliensis* Shanbhag and Inamdar.

TAXONOMIC ANALYSIS

The six male and the eight female specimens in this collection are mature individuals with eggs in the brood pouches of the females.

Carapace : Since the total length of specimens or the length of abdomen are so variable, depending on growth differences so common in the genus *Triops*, and also dependent on the degree of contraction of the abdominal segments, measurements of carapace and its parts alone are given here, because Longhurst (loc. cit.) mentions that the growth of carapace is isometric and is therefore, a valid measurement of size at all stages.

As evident from the dimensions of the carapace, females are larger than males in this collection. Carapace is oval and about 1/6 longer

MEASUREMENTS FOR 14 SPECIMENS (SIX MALES AND EIGHT FEMALES) IN MM.

	♂♂ Range	♂♂ Mean	♀♀ Range	♀♀ Mean
Length of carapace (median) ..	18-20	18·6	18-24	20·6
Width of carapace ..	14-16	15·2	15-18	16·4
Length of carina ..	10-12	10·5	10-13	11·6
Length of fifth endite of first thoracic leg ..	16-20	18·9	15-24	19·2
Width of sulcus ..	5-7	5·2	6-7	6·7
Depth of sulcus ..	3-4	3·9	4-5	4·3

than breadth (Fig. 1). Carina is a little over ½ the length of carapace, along its median line. Carina is in the form of a single ridge bearing a few spines towards its hinder end nearer the sulcus. There is no prominent terminal spine. Sulcus is deeply oval, about 1/3 the breadth of carapace and about 2/3 as deep as broad. It bears about 43-54 sulcal spines on its free edge.

Posterior angles of carapace are not drawn out nor its lateral margin concave at angles. Edge of carapace is finely serrated towards hinder end and the serration may take the form of minute spines at the hindermost part. Carapace bears fine denticles here and there on its dorsal surface, particularly at its posterior region.

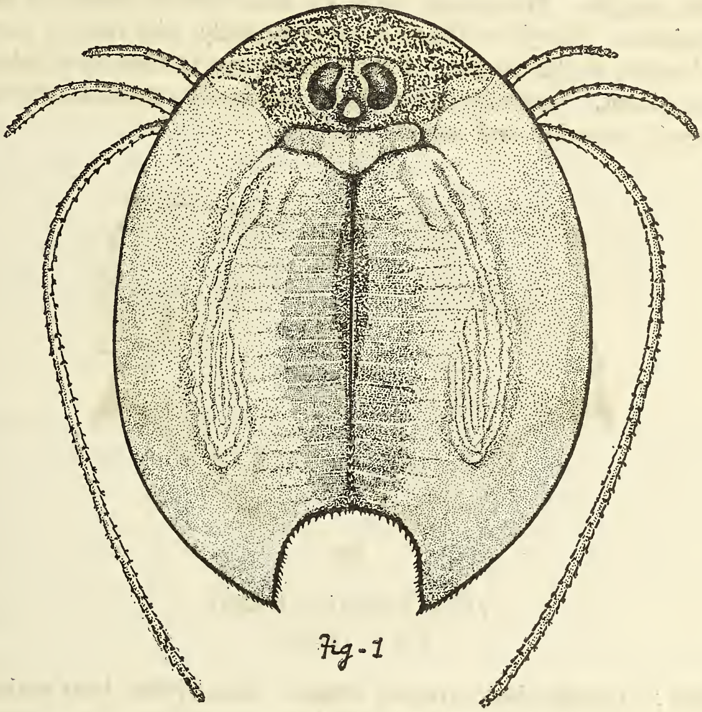
Dorsal organ triangular and is clearly elevated rather than depressed. Fifth endite of the first pair of thoracic legs is certainly as long as carapace length, and it may extend slightly beyond the hind end of carapace.

Coloration : Their coloration in live condition according to Prof. Martin who collected them was, ' Carapace translucent greyish-brown dorsally and orange-red ventrally. Abdomen and appendages also are orange-red.' This agrees with the known fact that specimens from poorly aerated waters have more haemoglobin intensity, giving deep orange-red colour. Sexual differences in coloration are not quite evident in this collection.

In the preservative formalin, carapace is translucent-grey along its lateral edges but opaque olive-green medially. Eyes dark-grey. Mandibles and other chitinous parts anterior to them are dark-brown. Appendages are colourless. Abdomen is light-brown and furca dark-brown.

Abdomen : Abdomen varies in length in the preserved material but on the average, it is slightly less than ½ but decidedly over 1/3 of the total length of the body. Total number of movable somites in the body is about 33-35 in females and 34-37 in males, of which 13-20 in females and

15-25 in males are exposed behind the carapace. Number of apodous segments is on the average, about 6 for females and 9 for males (Table *vide infra*). Each abdominal segment has 7-11 spines dorsally and



Triops granarius (Lucas)
Fig. 1. Carapace

about the same number ventrally also, but the ventral spines are smaller. Usually, spines are more in anterior abdominal segments, so that posterior abdominal segments may have just 6-8 spines dorsally. Last abdominal segment in some cases, may be seen on one side alone, either dorsally or ventrally.

FREQUENCY OF APODOUS SEGMENTS IN SIX MALES AND EIGHT FEMALES

	No. of segments	No. of individuals	Average No. of segments
♂♂	8	1	
	9	3	6
	10	2	
♀♀	5	2	
	6	3	
	7	2	8
	8	1	

Telson : Broader than the last abdominal segment (Fig. 2). Emarginate and bears two to four median spines in a row and three to four very large posterior marginals in a transverse row, well forward of the posterior margin. Three setal spines on each side but setae not seen in any specimen. Margin of telson is spiny laterally, with four to six more spines interior to the margin. Furcal spines two to three in number are very prominent. Ventrally, telson bears numerous small denticles along the lateral, posterior and median regions.

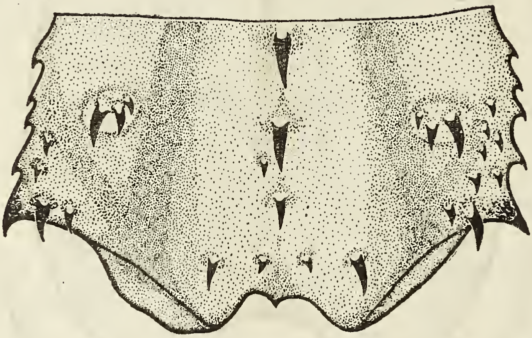


Fig - 2

Triops granarius (Lucas)
Fig. 2. Telson

Furca : Longer than carapace length. Basal joints bear scales and bristles but distal joints bear bristles alone.

A male and a female of these specimens have been incorporated in the National Zoological Collections with the Registration No. C 4791/1.

Observations on live animals

The following notes on live specimens, is compiled from information kindly provided by Prof. M. H. Martin who has collected and kept these animals alive in his laboratory for some days.

Triops granarius is noted to occur in temporary ponds alone, just after the first rains of the northeast monsoon, obviously hatching out of the resistant dormant eggs, deposited in the mud prior to the drought season. They are abundant, just for a short time and dwindle down fast in numbers, so that by the end of November, practically none of them can be seen in the ponds.

They swim on their backs as the Common Fairy Shrimp, *Streptocephalus*, perhaps feeding about and they can occasionally swim in normal posture also. In the laboratory, specimens of *Triops granarius* were kept alive for two or three days when they were found to feed on *Streptocephalus*, which seems to be their chief food and occasionally, they seem to feed on dead ones of their own kind also. During the day time, they seem to congregate in deeper ditches of the ponds, where *Streptocephalus* abounds. Quite often in the laboratory, they were found to chase each other. Whether this is a courting habit or a cannibalistic habit, is not certain. However, *Triops granarius* is described by Karande & Inamdar (1959) to have cannibalistic tendencies.

In the aquarium, when they touch the bottom as they swim about, they turn on to their belly and can crawl fast on the floor, by their appendages. Egg-laying was noticed in the aquarium when they dig the bottom mud with their appendages, deposit eggs and cover them up with loose mud, with the aid of the very same appendages.

Discussion

Males and females in this collection, unlike those of *T. cancriformis* (Bosc) are roughly equal in number. Since males in this lot are smaller in size, they may not outnumber the females. However, Karande & Inamdar (loc. cit.) and Shanbhag & Inamdar (loc. cit.) have reported that females outnumber males in this species but Tiwari (1955) noted more and larger males. It may be inferred that *T. granarius* may show variability in the sex-ratio depending on season and locality.

In the present collection, the dorsal organ is not oval as described by Tiwari (1951) for *Triops* (*Apus*) *sudanicus* but is triangular and elevated. As Barnard (1931), while assessing the characters of taxonomic importance in *Triops* says, ' The essential differences lie not in the shape of the pellucid area so much as in the shape and position of the raised area as seen in profile.'

Exposed segments show a wide variation in number in this lot of specimens also, as in the descriptions by Karande & Inamdar (loc. cit.). The number of apodous segments is fairly constant in all individuals of any one sample described in the past, and in the present lot the number is smaller than what is described for this species by Tiwari (1955) and by Shanbhag & Inamdar (loc. cit.), but certainly fall within the wide range of variations assigned to this species by Longhurst (loc. cit.).

The present lot of *Triops* from the Palayamkottai region resembles more closely the descriptions of the single male collected and described as *Apus sudanicus* by Chacko (loc. cit.) and Tiwari (1951). They also agree with *Apus mavliensis* with regard to the exposed abdominal segments and the apodous segments but seem to differ to some extent from *Apus orientalis*. However, the range of all these variations mentioned in earlier descriptions, apparently come within the range of intraspecific variations known and established by Longhurst (loc. cit.), for *Triops* *granarius* (Lucas). Therefore, there need be no further confusion regarding the specific status of *Triops* that occurs in south India.

ACKNOWLEDGEMENTS

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REFERENCES

BARNARD, K. H. (1931): Contributions to the crustacean fauna of south Africa. *Ann. S. African Mus.* **39**: 229-241.

CHACKO, P. I. (1950): Occurrence of the Fairy Shrimp, *Apus*, in a temple tank in Tirunelveli District, Madras. *J. Bombay. nat. Hist. Soc.* **49**: 571.

GURNEY, R. (1921): Fresh water Crustacea collected by Dr. P. A. Buxton in Mesopotamia and Persia. ibid. **27**: 836-843.

——— (1924): Some notes on the genus *Apus*. *Ann. Mag. Nat. Hist.* (9) **XIV**: 559-568.

——— (1925): Some Asiatic specimens of *Apus* (i) *Apus cancriformis* Schaeffer (ii) *Apus granarius* Lucas. *Rec. Indian. Mus.* **27**: 439-442.

KARANDE, A. A. & INAMDAR, N. B. (1959): Observations on the taxonomic characters of *Triops orientalis* (Tiwari) with a note on its biology. *J. Bombay nat. Hist. Soc.* **56**: 215-225.

KEMP, S. (1911): Notes on the occurrence of *Apus* in Eastern Asia. II. Notes on Major Walton's specimens and on others from Kashmir with a list of previous records from Eastern Asia. *Rec. Indian. Mus.* **6**: 353-357.

LONGHURST, A. R. (1955): A Review of the Notostraca. *Bull. Brit. Mus.* (*Nat. Hist.*) **3** (1): 1-57.

PACKARD, A. S. (1871): Monograph of Phyllopod Crustacea. *Ann. Mag. Nat. Hist.* (4) **VIII**: **334.**

PAI, P. G. (1958): On post-embryonic stages of phyllopod crustaceans *Triops* (*Apus*), *Streptocephalus* and *Estheria*. *Proc. Ind. Acad. Sci.* (B) **XLVIII**: 229-250.

SARS, G. O. (1901): On the Crustacean fauna of Central Asia. *Ann. Mus. St. Petersburg.* **6**: 130-164.

SHANBAG, S.V. & INAMDAR N.B. (1968): On the occurrence of *Triops mavliensis* (Tiwari), Notostraca, (Crustacea), in the Okhammandal Region of Saurashtra (India). *J. Bombay nat. Hist. Soc.* **65**: 408-417.

TIWARI, K. K. (1951): Indian species of the genus *Apus*, with descriptions of two new species. *Rec. Indian. Mus.* **49**: 197-206.

——— (1955): Sex-ratio and variability of apodous segments in *Apus* (Phyllopoda: Crustacea). *J. Bombay nat. Hist. Soc.* **52**: 641-644.

WALTON, H. J. (1911): Notes on the occurrence of *Apus* in Eastern Asia I. On the occurrence of *Apus* Latreille, in the United Provinces of India. *Rec. Indian. Mus.* **6**: 351-352.

Pteridophytic Flora of Kodaikanal

BY

S. S. Bir and Surinder Mohan Vasudeva

Department of Botany, Punjabi University, Patiala (India)

Introduction

Matthew (1959) and Gupta (1960, 1962) have given a comprehensive account of the Angiospermic Flora of Kodaikanal situated on Palni Hills in south India. Detailed information is not available about the Pteridophytic Flora of this region. Only scanty information about the Ferns of Palni Hills is found in Beddome's (1863, 1864, 1865 ?) ' Ferns of Southern India ' wherein the author had enumerated 24 species in all. As far as the ' Fern Allies ' are concerned, Chowdhury (1937) and Alston (1945) have given some information. However, detailed account about the altitudinal distribution and ecology of different species of ferns and fern-allies is lacking. Therefore, in the absence of any authoritative taxonomic account of the Pteridophytic Flora of Kodaikanal, the present work was taken up.

Kodaikanal, a beautiful health resort of south India is located at about 10°14′ N., 77°28′ E. with an average altitude of about 2,100 m.

The present observations concerning the Pteridophytic Flora are largely based on the collections made during June, 1962 and September to November, 1966.

Areas explored

The area explored in and around Kodaikanal is very extensive. Intensive collections were made in the dense forest areas falling within an altitudinal range of 300-2400 m. Each locality was visited several times so as to make a complete note of the habitats of different species and also about their frequency of occurrence. Frequently visited forests around Kodaikanal include Levinge (2100 m.), Shembaganur (1950 m.) and Perumal Malai (1500 m.). Excursions on foot were taken to all the places of picnic interest, namely, Coaker's Walk (2100 m.), Observatory Hill (2200 m.), Pillar Rocks (2200 m.), Bear Shola Falls (2100 m.), Silver Cascade (1700 m.), Parvat Vihar (1250 m.), Perumal Peak (1800 m.) and Fairy Falls (2000 m.). The sampling of high altitude vegetation was done around Moir Point (2300 m.) and Berijam Lake

(2400 m.) along Cochin road. These excursions were extended to lower altitude areas such as Falls View (500 m.), Vellagevi village (600 m.), Kavanji (700 m.), Uttu (900 m.), Tanikkudi (800 m.) and Periyakulam (300 m.).

Ecological notes on Pteridophytes

Kodaikanal is very rich in Pteridophytes and the members constitute a conspicuous element of the flora. Thick forests around Shembaganur, Silver Cascade, Perumal Malai and Bear shola are particularly very rich in ferns. Most of these are either ground-growing or lithophytic but several of them grow as epiphytes as well, usually on angiospermic trees and very few on conifers. The epiphytes mainly belong to fern family Polypodiaceae. Members of Aspidiaceae, Thelypteridaceae, Pteridaceae and Athyriaceae are largely terrestrial.

The Pteridophytes collected from the area, can be described under following altitudinal zones :

Species growing up to 600 *m. altitude :*

At lower altitudes *Lygodium flexuosum* (L.) Sw. grows on the forest floor and with the help of the twining rachis it climbs on the neighbouring bushes. *Ampelopteris prolifera* (Retz.) Copel. and *Microsorium punctatum* (Linn.) Copel. flourish very well at the foot of the hills. About 600 m. altitude *Adiantum lunulatum* Burm. grows prolifically in moist situations. The exposed rocks and dry boulders are largely inhabited by *Hemionitis arifolia* (Burm.) Moore and *Actiniopteris radiata* (Sw.) Link. *Adiantum incisum* Forsk. flourishes extremely well *en route* Falls view and Cooly ghat in open spaces.

Species growing between 600-1200 *m. altitude :*

Blechnum orientale Linn. prefers sunny situations on calcareous soil along Uttu-Parvat Vihar road and near Vellagavi village. *Adiantum incisum* Forsk. and *Actiniopteris radiata* (Sw.) Link are common everywhere up to 1000 m. altitude. *Selaginella radicata* (Hook. & Grev.) Spreng., *Cheilanthes mysurensis* Wall. ex Bedd., *Asplenium falcatum* Lam. var. *bipinnatum* Sledge, *Polystichum amabile* (Bl.) J. Smith and *Asplenium varians* Hook. & Grev. are exceedingly common on rocks near Panakaddu. *Pyrrosia lanceolata* (L.) Farwell colonizes several exposed rocks near Falls view and Cooly ghat. Occasionally it also grows epiphytically on tree trunks. On the forest floor near Shembaganur there is abundant growth of *Adiantum hispidulum* Sw. One of the most common ferns of this zone is *Hemionitis arifolia* (Burm.) Moore, *Species growing between* 1200-2000 *m. altitude :*

The maximum number of species grow in this zone. Amongst the ferns met with along water channels in shola near Perumal Malai or Parvat Vihar, in Shembaganur forest and near Silver Cascade may be mentioned *Diplazium maximum* (Don) C. Chr., *D. latifolium* (Don) Moore, *D. polypodioides* Blume, *D. muricatum* (Mett.) V.A.V.R., *Thelypteris repens* (Hope) Ching, *Cyathea gigantea* (Wall. ex Hook.) Holttum, *Cyathea nilgirensis* Holttum, *Marattia fraxinea* Smith, *Angiopteris evecta* (Forst.) Hoffm. and *Microlepia trapeziformis* (Roxb.) Kuhn.

On clay soil in ravines, *Diplaziopsis javanica* (Bl.) C. Chr. is met with, while *Diplazium esculentum* (Retz.) Sw. prefers moist but rather open situations.

The epiphytes are very conspicuous. *Vittaria elongata* Swartz, *Loxogramme lanceolata* Presl and *Asplenium ensiforme* Wall. ex Hook. & Grev. are seen on the middle or basal portions of the tree trunks. Occasionally *Selaginella involvens* (Sw.) Spr. which normally grows on rocks is found as an epiphyte. The commonest epiphytic ferns around Kodaikanal within this altitudinal range are *Antrophyum plantagineum* (Cav.) Klf., *Asplenium auritum* Sw., *Loxogramme involuta* (Don) Presl, *Pyrrosia mollis* (Kze.) Ching, *Lepisorus nudus* (Hook.) Ching, and *Ctenopteris subfalcata* (Bl.) Kunze. Several individuals of *Nephrolepis cordifolia* (Linn.) Presl were seen growing on a palm tree, *Borassus flabellifer* Linn. near Shembaganur. Several of the epiphytic species may also grow lithophytically.

Among the ferns which prefer shaded moist rocks may be mentioned *Adiantum capillus-veneris* Linn., *A. cuneatum* Langsd & Fisch., *A. aethipicum* Linn., *Mecodium javanicum* (Spr.) Copel. *Lindsaya cultrata* (Willd.) Swartz, *Sphenomeris chinensis* (Linn.) Maxon, *Araiostegia pulchra* (Don) Copel., *Leucostegia immersa* (Wall.) Presl, *Nephrolepis cordifolia* (Linn.) Presl, *Olendra wallichii* (Hook.) Presl, *Polystichum auriculatum* (L.) Pr., *Elaphoglossum laurifolium* (Thouars) Moore, *Arachniodes speciosa* (Don) Ching, *Elaphoglossum petiolatum* (Sw.) Urban, *Athyrium japonicum* (Thbg.) Copel., *A. anisopterum* Christ., *Cyclosorus dentatus* (Forsk.) Ching, *Asplenium unilaterale* Lamk., *A. tenuifolium* Don, and *A. ensiforme* Wall. ex Hook. & Grev.

Lycopodium cernuum Linn., *Adiantum incisum* Forsk., *Cheilanthes chrysophylla* Hook., *C. mysurensis* Wall. ex Bedd., *Pellaea geraniaefolia* Fée, and *Pityrogramma chrysophylla* (Sw.) Link, grow in exposed situations under xeric conditions either on rock boulders or gravelly soil, all along roadside between Perumal Malai-Parvat Vihar.

Dicranopteris linearis (Burm.) Underwood, forms huge green thickets along roadside especially near Silver Cascade. *Pteridium aquilinum* (L.) Kuhn, is a weedy species and grows in open spaces along roadside or forest paths. In similar situations *Botrychium lanuginosum* Wall. grows in abundance near Tiger shola.

Several ferns as *Microlepia platyphylla* (Don) J. Smith, *Hypolepis punctata* (Thbg.) Mett., *Dryopteris atrata* (Wall.) Ching, *Diplazium polypodioides* Blume, and *Pteris quadriaurita* Retz., often inhabit forest floor and forest fringes near Shembaganur and Silver Cascade.

Species met with above 2000 *m. altitude :*

At higher elevations the epiphytic growth in the open places or hill tops gradually decreases. Most of the epiphytic species recorded from this zone grow in the shola near Moir Point where enough of humus is available on the tree trunks. The common species are *Asplenium indicum* Sledge, *Lepisorus amaurolepida* (Sledge) Bir & Trikha (comb. nov.)[1], *Phymatodes hastata* (Thunb.) Ching, *Microsorium membranaceum* (Don) Ching, *Loxogramme involuta* (Don) Presl and *Pleopeltis macrocarpa* (Bory ex Willd.) Kaulf. which hang downwards from lower portions of tree trunks. Occasionally *Athyrium puncticaule* (Bl.) Moore, *Asplenium erectum* Bory ex Willd., and *Asplenium aethiopicum* (Burm.) Bech., which are normally lithophytic or terrestrial species, also grow on the trunks in Bombay Shola and Bear Shola falls. *Mecodium exsertum* (Wall. ex Hook.) Copel. is a rare epiphyte.

The species which colonize moist and shaded rocks in this zone are *Adiantum cuneatum* Langsd. & Fisch., *Mecodium polyanthos* (Sw.) Copel., *Polystichum aculeatum* (L.) Schott, *P. auriculatum* (L.) Pr., *Dryopteris odontoloma* (Moore) C. Chr., *D. sparsa* (Don) O. Kuntze, *Athyrium japonicum* (Thbg.) Copel., *A. pectinatum* (Wall.) Presl, *A. puncticaule* (Bl.) Moore, *Thelypteris brunnea* (Wall.) Ching, *Cyclosorus dentatus* (Forsk.) *Leptogramme totta* J. Smith. Ching, *Asplenium normale* Don, *A. cheilosorum* Kunze, *A. trichomanes* Linn., *A. erectum* Bory ex Willd., *A. zenkeranum* Kze. Linn., *A. affine* Sw., *Loxogramme involuta* (Don) Presl, etc.

At about 2100 m. *Pteridium aquilinum* (L.) Kuhn grows in extensive beds in open spaces to form an extremely prolific vegetation even obliterating the normal footpaths. Occasionally *Cyathea crinita* (Hook.) Copel. ascends higher up to about 2200 metres and grows in forest near Pillar Rocks. Often *Pteris quadriaurita* Retz., *Polystichum auriculatum* (L.) Pr., *Arachniodes aristata* (Forst. f.) Tindale, *Dryopteris wallichiana* (Spreng.) Hyl., *D. atrata* (Wall.) Ching, and *Asplenium aethiopicum* (Burm.) Bech., grow along the forest fringes.

Amongst the higher altitude ferns, *Cheilanthes chrysophylla* Hook. thrives well in exposed rock crevices near Observatory. Two club mosses, namely, *Lycopodium cernuum* Linn. and *L. clavatum* Linn. grow

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[1] Basinym : *Pleopeltis amaurolepida* Sledge in Bull. Brit. Mus. (nat. Hist.) 2 (5): 136, 1960.

on calcareous soil along roads at about 2400 m. altitude near Berijam Lake. Several species such as *Botrychium daucifolium* Wall., *B. lanuginosum* Wall., *Lycopodium wightianum* Wall., *Ophioglossum petiolatum* Hook. and *Osmunda regalis* Linn. grow in open grass lands near Pillar Rocks and Moir Point.

Enumeration of the Genera and Species

The arrangement of families and genera is mainly based on the scheme proposed by Mehra (1961) and later on adopted by Mehra & Bir (1964). In our opinion taking into consideration the gross morphological characters, *Pteridium* Scopoli and *Nephrolepis* Schott belong to family Pteridaceae and Davalliaceae respectively rather than the former genus to family Hypolepidaceae and the latter genus to family Oleandraceae as earlier placed by Mehra & Bir (loc. cit.). Some species of *Selaginella* and *Lycopodium* recorded from Kodaikanal by Alston (1945) and Chowdhury (1937) respectively have also been included so as to compile a comprehensive account. The species included on the basis of earlier published data, are marked with an asterisk(*).

In case of ferns only references have been made to Clarke's (1880) 'A Review of Ferns of Northern India' (F.N.I.), Beddome's (1863, 1864, 1865 ?) 'Ferns of Southern India' (F.S.I.), and Beddome's (1883, 1892) 'A Handbook to the Ferns of British India, Ceylon and Malaya Peninsula' (Handb.). Species mentioned in Mehra and Bir's account of 'Pteridophytic flora of Darjeeling and Sikkim Himalayas are cited as Mehra & Bir, 1964 wherein complete information is provided for basinyms and common synonyms. Therefore, in case of such species references to Clarke's and Beddome's works or other literature are omitted. Further, full reference to the original publication of the specific name is given only in case of those species that are not included in Christensen's 'Index Filicum' with Supplements I-III (1905-1906, 1913, 1917, 1934) and Pichi-Sermolli's Index Filicum Supplementum Quartum (1965).

Voucher specimens are placed in the Herbarium of the Punjabi University, Chandigarh, India and reference to the herbarium number/s of each species collected from Kodaikanal is given within parenthesis after distribution.

FERN ALLIES

Family Psilotaceae

Psilotum triquetrum Swartz; *P. nudum* (L.) Griseb.; Clarke, F.N.I. 589.1880.

Grows on rocks in the Botanical garden of Sacred Heart College, Shembaganur. It is extremely rare and was not seen anywhere else.

Family EQUISETACEAE

Equisetum debile Roxb. ex Vaucher ; Mehra & Bir 99, 1964.

Cultivated in the Botanical garden of Sacred Heart College, Shembaganur. It may possibly be found at lower altitudes.

Family SELAGINELLACEAE

Selaginella involvens (Sw.) Spr. ; Mehra & Bir 100, 1964.

It grows on calcareous soil along road side or as lithophyte on big rocks at moist places in forests. Extremely common on forest floor between 1500-1800 m. especially near Silver Cascade (1800 m.), Shembaganur (1950 m.) and Perumal Malai (1500 m.). It also grows epiphytically on trees in shola below Perumal Malai (1500 m.). (4710-4712, 5712-5715).

S. radicata (Hook. & Grev.) Spring

Met with at low levels between 900-1200 m. altitude growing luxuriantly on roadside slopes. It is common in the Panakaddu area (1300 m.). (5710, 5711).

***S. cataractarum** Alston

Collected from rock near Silver Cascade (1680 m.) and Pambar stream by Munch (cf. Alston 1945, p. 228).

Family LYCOPODIACEAE

Lycopodium wightianum Wall.

Extremely common in open grassy spaces between 1950-2250 m. altitude especially in Pillar Rocks area (2300 m.) and near Holiday Home (2100 m.). (4497-4500, 5718, 5719).

L. setaceum Hamilt. ; Mehra & Bir 101, 1964.

One of the commonest epiphytes in Tiger Shola (1700 m.) near Silver Cascade. The plants are beautifully pendulous from tree branches. It may also occur on moist rocks. It was not seen in any other locality. (5720, 5721).

L. hamiltonii Spreng. ex Hook. & Grev. ; Mehra & Bir 101, 1964.

Cultivated in the Botanical garden of Sacred Heart College, Shembaganur (200 m.). It is very rare. Also recorded by Chowdhury (1937) from Kodaikanal. (5716).

L. cernuum Linn. ; Mehra & Bir 102, 1964.

Grows on calcareous soil along the roadside slopes near Perumal Malai (1400 m.) and Berijam Lake (2200 m.). It is common between 1300-2300 m. altitude. (5724, 5725).

L. clavatum Linn. ; Mehra & Bir 102, 1964.

It is extremely rare. It was collected only once growing on calcareous soil along the road slopes near Berijam Lake (2200 m.). (5722, 5723).

L. phlegmaria Linn. ; Mehra & Bir 102, 1964.

Collected from the Botanical garden of Sacred Heart College, Shembaganur (2000 m.). It is extremely rare. Also recorded from Bear Shola (cf. Chowdhury 1937). (5717).

L. serratum Thunberg ; Mehra & Bir 101, 1964.

Collected by Iyengar from Bear shola (2100-2400 m. altitude) (cf. Chowdhury, loc. cit.).

L. complanatum Linn. ; Clarke, F.N.I. 593, 1880.

According to Chowdhury (loc. cit.) this species was collected by Levinge from Kodaikanal, 2100 m.

L. phyllanthum Hook. & Arn.

It was collected by Iyengar from Kodaikanal, 2100 m. (cf. Chowdhury loc. cit).

FERNS

I. Ophioglossaceous series

Family Ophioglossaceae

Ophioglossum petiolatum Hook. ; Mehra & Bir 103, 1964.

Grows in the meadows near Pillar Rocks (2100 m.). The plants are rare, small-sized and rather inconspicuous. These are usually overshadowed by grass. Extremely rare. (4870).

Botrychium lanuginosum Wall. ; Mehra & Bir 102, 1964.

Extremely common in the open grassy places all over between 1600-2100 m. altitude. Collected from Tiger Shola near Silver Cascade (1600 m.) and from Levinge Forest (2000 m.). (4477, 4780, 5728, 5729).

B. daucifolium Wall. ex Hook. & Grev. ; Clarke, F.N.I. 587, 1880 ; Bedd., Handb. 469, t. 294, 1892. *Botrychium subcarnosum* Wall. ; F.S.I.t. 68, 1863.

Quite abundant in Levinge Forest (2000 m.) and grows in rather exposed places. Not seen anywhere else. (5726, 5727).

II. MARATTIACEOUS SERIES

Family MARATTIACEAE

Marattia fraxinea Smith; Bedd., F.S.I.t. 79, 1863 & Handb. 460, t. 286, 1883.

Grows near water in Shembaganur forest (1800 m.). Extremely rare. (4473, 5732, 5733).

Angiopteris evecta (Forst.) Hoffm.; Mehra & Bir 103, 1964.

It is a large-sized fern and is occasionally met with near water in the ravines and flourishes very well at low altitudes especially in Perumal Malai area (1400 m.). (4785, 4786, 5730, 5731).

III. OSMUNDACEOUS SERIES

Family OSMUNDACEAE

Osmunda regalis Linn.; Clarke, F.N.I. 583, 1880; Bedd., Handb. 450, 1883.

This is a high altitude fern and flourishes near water channel in Holiday Home (2000 m.) and also in open meadows *en route* Moir Point (2250 m.). (4474, 4475).

IV. SCHIZAEACEOUS SERIES

Family SCHIZAEACEAE

Lygodium flexuosum (L.) Sw.; Mehra & Bir 104, 1964.

It grows frequently at lower altitudes between 300-600 m. and sometimes covers adjacent small bushes in forests *en route* Kodaikanal (600 m.). (4688, 4689, 4781, 4782).

Family ADIANTACEAE

Adiantum capillus-veneris Linn.; Mehra & Bir 105, 1964.

Grows at relatively lower altitudes (below 1800 m.) on moist and shady rocks especially along streams in Shembaganur forest (1,500 m.) and is locally abundant. (4779).

A. lunulatum Burm.; Mehra & Bir 105, 1964.

It is a low level fern, never ascending above 1350 m. and grows in moist situations along motor road to Kodaikanal (600 m.). (4828).

A. cuneatum Langsd. & Fisch. ; Mehra & Bir 105, 1964.

Common on moist rocks along Coaker's Walk (2100 m.), possibly an escape from cultivation. Also it is extremely common at damp places between 1600-2100 m. altitude. (4507-4510, 5739-5740).

A. incisum Forsk. ; Mehra & Bir 105, 1964.

One of the commonest species at lower levels flourishing in rather exposed situations near Perumal Malai (750 m.), Shembaganur forest (900 m.) and near Falls View (200 m.). It is frequently met with along roadsides from 1000 m. downwards. (5734, 5735).

A. aethiopicum Linn. ; Bedd. ; F.S.I.t.5, 1863 & Handb. 84, 1883.

It is a low level fern found between 800-1000 m. altitude. It covers rocks along roadside and especially near Uttu (900 m.). (5738, 5739 a).

A. hispidulum Sw. ; Bedd., F.S.I.t.3, 1863 & Handb. 86, 1883.

It mostly covers moist shaded rocks between 600-1000 m. especially near Uttu (800 m.), and Shembaganur forest (1000 m.). This fern is exceedingly common in moist situations on the forest floor *en route* Periyakulam. (5736, 5737).

Family Vittariaceae

Vittaria elongata Swartz ; Mehra & Bir 106, 1964.

It grows as an epiphyte and is often pendulous from the tree trunks in Tiger Shola (1700 m.) near Silver Cascade in moist dark situations. The fronds often have a grass-like appearance. It is a very rare species and was collected only once. (4813, 5741, 5742).

Family Antrophyceae

Antrophyum plantagineum (Cav.) Klf. ; Mehra & Bir 107, 1964.

It is common between 1000-1500 m. altitude, usually growing on moist rocks or tree trunks in Sholas especially in Tiger Shola (1500 m.) and in shola near Perumal Malai (1000 m.). (5743-5746).

Family Sinopteridaceae

Cheilanthes chrysophylla Hook. ; Mehra & Bir 109, 1964.

This fern is common in dry rock crevices near Perumal Malai (about 1200 m.) and Observatory (2200 m.). The stipes are scaly throughout. Bright golden-yellow powder is present on the underside of the laminæ. The outline of the frond is similar to that of the typical *C. farinosa* but much smaller in size. (4818, 4819, 5765, 5766).

C. mysurensis Wall. ex Bedd., F.S.I.t. 190, 1864 & Handb. 89, t.46, 1883.

It grows in dry rock crevices all along Uttu-Perumal Malai road (700-1000 m.) and is quite common between 600-1200 m. altitude. (4520, 5763, 5764).

Pellaea geraniaiefolia F'ee ; *Pellaea concolor* Bak. ; Bedd., Handb. 100, t. 52, 1883. *Pteris geraniaiefolia* Raddi; Bedd., F.S.I.t. 37, 1863.

It is a low level fern, common between 1000-1400 m. altitude and grows on dry rocks near Perumal Malai (1300 m.) and Uttu (1100 m.). Also grows epiphytically near Parvat Vihar (1200 m.). (5767, 5768).

Family Gymnogrammaceae

Hemionitis arifolia (Burm.) Moore ; Bedd., Handb. 413, t. 245, 1883. *Hemionitis cordata* Hook. & Grev.; Bedd., F.S.I.t. 53, 1863.

This low altitude fern is extremely common between 600-1200 m. and it grows on dry exposed rocks in open sunny places all along the road between Falls View and Perumal Malai (500-1300 m.). (5747, 5748).

Pityrogramma chrysophylla (Sw.) Link; *Ceropteris chrysophylla* Link.

It is met with in rather exposed places on calcareous soil at low levels along Perumal Malai-Parvat Vihar road. It is quite common between 1000-1450 m. Bright yellow powder is present on the underside of the lamina. (5749, 5750).

Family Pteridaceae

Pteris quadriaurita Retz. ; Mehra & Bir 113, 1964.

Extremely common between 1500-2000 m. altitude. It grows in open spaces along roadsides or in meadows and is common near Silver Cascade (1700 m.) and along Coaker's Walk (2000 m.). Individuals growing in open situations have stunted growth. (4527-4529, 4687, 5772, 5774, 5775).

Actiniopteris radiata (Sw.) Link ; Bedd., F.S.I. t. 124, 1864. *Actiniopteris dichotoma* Kuhn ; Clarke, F.N.I. 505, 1880 ; Bedd., Handb. 197, t. 98, 1883.

This is a fern of low levels and is frequently met with along Uttu-Falls View road in dry exposed rocks between 500-1000 m. altitude. (5769-5770).

Pteridium aquilinum (L.) Kuhn ex Deck. ; Mehra & Bir 118, 1964.

It is one of the commonest ferns in open grassy places all over between 1200-2300 m. especially abundant near Coaker's Walk (2100 m.), Moir's Point (2300 m.), Pillar Rocks (2200 m.), Holiday Home (1950 m.), Shembaganur Forest (1800 m.) and Perumal Malai (1400 m.). It grows on sunny grassy hill sides and is often very large and gregarious. (4513, 5771, 5773).

V. HYMENOPHYLLACEOUS SERIES

Family HYMENOPHYLLACEAE

Mecodium javanicum (Spr.) Copel. ; Mehra & Bir 115, 1964.

This rare fern grows on moist shaded rocks along Shembaganur foot-path (1800 m.). Rhizome widely creeping and stipe and rachis broadly winged. (4788).

M. exsertum (Wall. ex Hook.) Copel. ; Mehra & Bir 115, 1964.

Quite rare, epiphytic on the lower part of the tree trunk. Collected from near Pillar Rocks (2200 m.). (4789).

M. polyanthos (Sw.) Copel. ; Mehra & Bir 115, 1964.

It grows on moist dark rock near Coaker's Walk (2250 m.) and is extremely rare. Fertile fronds are infrequently found. (4799).

Family DENNSTAEDTIACEAE

Microlepia trapeziformis (Roxb.) Kuhn ; Mehra & Bir 117, 1964.
M. polypodioides Bedd., F.S.I.t.15, 1863.

This species flourishes very well as forest undergrowth near Perumal Malai (1400 m.) and Shembaganur (1900 m.) in shaded and damp situations. It is rather rare in the area. (5776, 5772).

M. platyphylla (Don) J. Smith ; Mehra & Bir 118, 1964.

This low altitude fern is of large size and grows in abundance on the forest floor near Shembaganur (1200 m.) and in shola near Parvat Vihar (1100 m.). (5778-5779).

Family HYPOLEPIDACEAE

Hypolepis punctata (Thbg.) Mett. ; Mehra & Bir 118, 1964.

It prefers open situations and is common near Lake (2000 m.), Shembaganur (1800 m.) and Silver Cascade (1700 m.). It is found in large populations because of widely creeping and branching nature of the rhizome. (4472, 5759, 5760).

Family Lindsayaceae

Lindsaya cultrata (Willd.) Swartz ; Mehra & Bir 118, 1964.

It is extremely common and grows gregariously on rocks or stone walls near water or in moist situations between 1600-2000 m. especially along Kodaikanal-Perumal Malai road, Shembaganur Forest (1900 m.) and Silver Cascade (1800 m.). (4501, 4502, 4976, 5782, 5783).

Sphenomeris chinensis (Linn.) Maxon ; Mehra & Bir 119, 1964.

It is abundant on moist rocks between 1600-2000 m. altitude especially near Lake (2000 m.) and Silver Cascade (1800 m.) (4468-4471, 5780-5781).

Family Davalliaceae

Araiostegia pulchra (Don) Copel ; Mehra & Bir 119, 1964.

Extremely common on moist rocks in Tiger Shola near Silver Cascade (1800 m.) and in Shembaganur forest (1600 m.). Usually grows between 1500-1800 m. altitude and is rare at higher elevations. (5785, 5785a)

Leucostegia immersa (Wall.) Presl ; Mehra & Bir 120, 1964.

It grows abundantly on moist shaded rocks in Shola near Perumal Malai, 1500 m. altitude. Quite rare elsewhere, collected only once. (4811, 4812, 5788, 5789).

Davallia bullata Wall. ex. Hook. ; Bedd., F.S.I.t.17, 1863 & Handb. 61, t. 31, 1883 ; Clarke, F.N.I. 445, 1880.

Cultivated in the Botanical garden of Sacred Heart College, Shembaganur.

Nephrolepis cordifolia (Linn.) Presl ; Mehra & Bir 121, 1964.

This is a low level fern and grows lithophytically. It is quite common up to 1900 m. altitude particularly near Shembaganur (1900 m.), Silver Cascade (1800 m.), Perumal Malai (1500 m.) and along Shembaganur-Perumal Malai road. Quite often it is met with as an epiphyte on the tree ferns and other trees along Kodaikanal road. The special character is the presence of underground tubers which help in perennation. Wherever it grows, it forms extensive populations. (5786, 5787, 5790, 5791).

N. exaltata (Linn.) Schott ; Bedd., F.S.I.t.93, 1863 & Handb. 282, 1883.

This is again a low altitude species and is extremely common along roadside in exposed situations. It is quite abundant around Perumal Malai (1500 m.) *en route* Thevenkariar (1300 m.) and near Parvat Vihar (1200 m.). (5949, 5950).

Family Oleandraceae

Oleandra wallichii (Hook.) Presl ; Mehra & Bir 121, 1964.

It grows on moist rocks in shola near Silver Cascade (1700 m.). An entire rock was covered with this fern. The roots are long and wiry and the fronds are simple and soft. These possess sori in a single row on each side of and close to the midrib. It is extremely rare in other areas. (5792, 5793).

VI. Gleicheniaceous Series

Family Gleicheniaceae

Dicranopteris linearis (Burm.) Underwood ; Mehra & Bir 122, 1964.

This fern forms huge thickets along roadside in exposed, sunny places and covers extensive areas on dry barren hill sides around Kodaikanal between 1700-2000 m. altitude. Especially met with near Silver Cascade (1750 m.), Shembaganur forest (1900 m.) and Lake (2000 m.). (4511, 4512, 4796-4798, 5794, 5795).

Family Cyatheaceae

Holttum (1965) construed *Cyathea* Smith so as to include *Alsophila* R.Br., *Hemitelia* R.Br., *Gymnosphaera* Bl. and *Schizocaena* J. Smith. According to him the earlier distinctions of Baker, Beddome and Clarke on the basis of indusial characters of *Hemitelia* and *Alsophila*, are not natural ones. Taking into consideration the stipe-scales, the comprehensive genus *Cyathea* is divided by Holttum (loc. cit.) into two subgenera, namely, *Cyathea* and *Sphaeropteris*.

The subgenus *Cyathea* as described by Holttum, is characterised by flabelloid stipe-scales consisting of a median band of elongate thick-walled cells, with fragile margins of shorter thin-walled cells and bearing rather long flexuous thick-walled setae. It is further subdivided into two sections as *Cyathea* and *Gymnosphaera*. In the former section the sori are indusiate, induism sometimes hidden by mature sorus and the latter section is characterised by sori without indusia. It may be mentioned that *Cyathea spinulosa* Wall. ex Hook. and *C. nilgirensis* Holttum belong to section *Cyathea* whereas *Cyathea gigantea* (Wall. ex Hook.) Holttum belongs to section *Gymnosphaera*.

The subgenus *Sphaeropteris* to which *Cyathea crinita* (Hook.) Copel. belongs is recognised by setiferous stipe-scales consisting entirely of uniform elongate cells with regular short, oblique dark or concolorous setae along the edges.

Cyathea nilgirensis Holttum[1]; *Alsophila latebrosa* Wall. ex Hook., pro parte quoad Bedd., Handb. 11, 1883. *A. latebrosa* Wall. ex Hook. var. *schmidiana* Kunze.

Extremely common in all the forests between 1600-2000 m. and is especially abundant around Silver Cascade (1800 m.) and in Tiger Shola (1700 m.), Shembaganur forest (1900 m.) and Lake area (2000 m.) near water. It is a lofty tree fern. The costae and costules of the pinnules characteristically possess bullate scales. The primary and secondary rachises are often muricated. (4521-4526, 5757, 5758).

The south Indian specimens referrable to *Cyathea latebrosa* (Wall. ex Hook.) Copel. (=*Alsophila latebrosa* Wall. ex Hook.) belong to this species (*cf.* Holttum 1965).

C. spinulosa Wall. ex Hook.; Bedd., F.S.I. t.57, 1863; Handb. 6, 1883; Suppl. 2, 1892; Clarke, F.N.I. 429, 1880.

It is met with in south India at 600-900 m. (*cf.* Holttum, loc. cit.). It is possible that this species may also be growing in the forests around Kodaikanal though the writers have not collected it.

C. gigantea (Wall. ex Hook.) Holttum; *Alsophila gigantea* Wall. ex Hook.; *A. glabra* sensu Bedd., F.S.I. t. 60, 1863 & Handb. 14, 1883; Hook. & Bak., Syn. Fil. 43, 1874 (pro parte); Clarke, F.N.I. 433, 1880.

This tree fern is abundant at low altitude especially in ravines or at moist places. It was collected from Shola near Perumal Malai *en route* Thevenkariar (1400 m.). (5755, 5756).

C. crinita (Hook.) Copel.; *Alsophila crinita* Hook.; Bedd., F.S.I.t. 59, 1863 & Handb. 16, t. 6, 1883.

A large-sized tree fern, occasionally grows between 1800-2000 m. altitude, especially abundant in Shembaganur forest (1900 m.) and near Pillar Rocks (2200 m.). It is far less common than *Cyathea nilgirensis* Holttum. It has also been cultivated in Bruton Garden near Lake (2000 m.) (5753, 5754).

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[1] Kew Bull., 19 (3): 468. 1965.

Family Aspidiaceae

Polystichum aculeatum (L.) Schott ; Mehra & Bir 127, 1964. Occasionally met with at higher altitude, generally in rock crevices. Collected from near Bombay Shola (2100 m.). (4689, 4699, 4884-4886, 5862, 5863).

P. amabile (Bl.) J. Sm. ; *Lastrea amabilis* Moore ; Bedd., F.S.I.t. 109, 1863 & Handb. 228, 1883.

It is a low altitude fern, growing on moist rocks near Uttu (1000 m.). Rhizome is characteristically creeping and the surfaces of pinnae are shining. This fern is quite rare and only a few specimens were collected. (5860, 5861).

P. auriculatum (L.) Pr. ; Bedd., F.S.I. t. 120, 1863 & Handb. 203, t. 102, 1883.

Met with at moist places or on shaded moist rocks between 1600-2100 m. in all forests especially in Shembaganur forest (1900 m.), forest near Bombay Shola (2100 m.) and Silver Cascade (1700 m.). The stipes are densely paleaceous. It was also seen, growing epiphytically on tree trunks in forest near Bombay Shola (2100 m.). (4515, 4517).

Arachniodes aristata (Forst. f.) Tindale ; Mehra & Bir 128, 1964.

It is a large-sized fern with densely paleaceous stipes and is common in open and damp places all over between 1600-2000 m. altitude especially near Bear Shola Falls (2000 m.), Bombay Shola (2100 m.) and Shembaganur forest (1900 m.). A few specimens were seen growing epiphytically on tree trunks in Levinge forest. (4696, 4697, 5846, 5847).

A. speciosa (Don) Ching ; Mehra & Bir 129, 1964.

Often met with in Shembaganur forest (1900 m.). Also common along Perumal Malai-Thevenkariar old path (1400 m.). Pinnae are shining. (5844, 5845).

Cyrtomium caryotideum Presl ; Mehra & Bir 129, 1964.

Cultivated in the Botanical garden of Sacred Heart College, Shembaganur (1900 m.). It was not collected in wild state.

Elaphoglossum laurifolium (Thouars) Moore; Bedd., F.S.I.t. 200, 1864 ; Mehra & Bir 130, 1964. *E. latifolium* sensu Bedd., Handb. 416, t. 248. 1883.

It grows on moist shaded rocks and was collected only from one, place near Bear Shola (2000 m.). Fronds are dimorphic. This species is characterised by the fact that the margin of the frond is hyaline chartaceous. (5840, 5841).

E. petiolatum (Sw.) Urban; *E. viscosum* Schott; Bedd., F.S.I. t. 196, 1864 & Handb. 420, t. 250, 1883.

Collected only once near Perumal Malai (1500 m.) growing on moist shaded rocks. It is locally abundant. Fertile fronds are extremely rare. (5842, 5843).

E. conforme (Sw.) Schott; Mehra & Bir 130, 1964.

Epiphytic on the lower part of tree trunk at moist shaded and protected places. It is extremely rare and was collected only once in forest near Moir Point (1800 m.). (4814, 4815).

Dryopteris ramosa (Hope) C. Chr.; *Nephrodium ramosum* Hope.

This is a high altitude fern common near Coaker's Walk (2000 m.). Shembaganur (1950 m.) and Tiger Shola (1800 m.). It grows on calcareous soil. (5855, 5856).

D. marginata (Wall.) Christ; Mehra & Bir 133, 1964.

It is a quite common fern between 1500-2000 m. and is generally found in valleys or wooded ravines. Abundant at Silver Cascade (1700 m.), Observatory Hill (2000 m.) and below Bombay Shola (2100 m.). (4693, 4483-4485, 5857, 5858).

D. wallichiana (Spreng.) Hyl[1]. *Dryopteris paleacaea* (Don) Hand.—Mazz.; Mehra & Bir 131, 1964.

Rhizome is ascending and the stipes are densely clothed with dark brown scales. This is a high altitude fern and is very common near Coaker's Walk (2100 m.), Holiday Home (2150 m.), Pillar Rocks (2200 m.) and Moir's Point (2300 m.). It grows on calcareous soil. (4690, 4691, 5850-5852).

D. odontoloma (Moore) C. Chr.; Mehra & Bir 132, 1964.

This fern is found in and around Kodaikanal in partially shaded situations at higher altitudes especially abundant in Shembaganur forest (1900 m.), near Observatory (2100 m.) and near Bear Shola (2000 m.). (4478-4482, 5848-5849).

D. sparsa (Don) O. Kuntz; Mehra & Bir 133, 1964.

It is quite frequently met with between 1500-2100 m. especially near Silver Cascade, Observatory Hill and in forest near Shembaganur. (4486-4489, 4692, 5853, 5854).

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[1] For details of Synonymy see Alston (1957), Alston & Bonner (1956) and Nair (1968).

D. atrata (Wall.) Ching ; Mehra & Bir 130, 1964.

It is quite common between 1600-2200 m. and is especially met with on the forest floor near Shembaganur (1900 m.), Silver Cascade (1800 m.) Bombay Shola (2000 m.) and is abundant along Silver Cascade-Perumal Malai road. Once one was seen growing epiphytically on tree trunk in Shembaganur forest. (5859).

Family Athyriaceae

Athyrium japonicum (Thbg.) Copel. ; Mehra & Bir 144, 1964.

Extremely common at moist places between 1500-2100 m. altitude. It is locally abundant on forest floor in damp shaded situations near Silver Cascade (1700 m.). In similar situations it was seen near Bryant Park (2000 m.). The stipes and the lamina are more densely hairy as compared to the Himalayan examples. These plants have often been described under *Diplazium lasiopteris* Kze. (4680-4682, 5800, 5803).

A. anisopterum Christ ; Mehra & Bir 143, 1964.

It is extremely common on moist shaded rocks between 1600-2100 m. particularly at Silver Cascade (1700 m.) and near Pillar Rocks (2100 m.). (4683).

A. pectinatum (Wall.) Presl ; Mehra & Bir 141, 1964.

It grows in rather moist situations between 1200-2100 m. altitude, common near Silver Cascade (1600 m.) and near Lake (2100 m.). (4790).

A. puncticaule (Bl.) Moore ; Mehra & Bir 143, 1964. *A. macrocarpum* (Bl.) Bedd., F.S.I.t. 153, 1964.

It is locally abundant on moist rocks near Silver Cascade (1800 m.), in Shembaganur forest (1900 m.) and Levinge Forest (2100 m.). (4791, 4809, 4810,5796, 5797).

A. praetermissum Sledge[1] ; *A. nigripes* sensu Bedd., F.S.I. 52, t. 157, 1864 & Handb. 166, 1883, pro parte ; non T. Moore.

Very rare, only few plants were seen growing in damp shaded situations in Tiger Shola (1800 m.). (5798, 5799).

A. solenopteris (Kunze) T. Moore *var.* **solenopteris** Sledge[1].

Rhizome ascending or decumbent ; stipes upto 20 cm. long ; lamina broadly lanceolate, 30 cm. × 15 cm. ; pinnae ascending, middle ones the

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[1] For nomenclature see Sledge (1956, 1962).

largest, about 3 cm. apart, up to 10 × 3 cm., with narrowly winged rachis; pinnules well spaced with somewhat decurrent base.

Extremely common at high altitudes around Observatory (2200 m.). The densely crowded fronds give a characteristic appearance. (5939).

A. solenopteris (Kunze) T. Moore *var.* **pusillum** (Kuze) T. Moore.

Fronds small, about 20 × 10 cm. (including 5 cm. long scaly stipe); lamina narrow, 4-10 cm. wide; pinnae patent, lower ones often deflexed, crowded, lower ones 1-1½ cm. wide apart, 4 × 1½ cm.; pinnules small, approximate, inciso-serrate or often shallowly pinnatifid.

Common between 1700-2100 m. throughout, often growing in extensive beds, near Bombay Shola (2100 m.), Observatory Hill (2200 m.) and near Lake (2000 m.). (5940).

Athyrium sp.

This is a high-altitude fern, flourishing abundantly in crevices of boulders near Lake (2100 m.).

Some of the specimens have morphology between *Athyrium solenopteris* (Kunze) T. Moore and *Athyrium praetermissum* Sledge and cannot be with certainty referred to either of the species. (5801-5802).

Diplazium esculentum (Retz.) Sw.; Mehra & Bir 148, 1964.

It is met with in damp situations especially along water channels and was collected in the forest *en route* Kodaikanal, 7th mile stone (1400 m.) It is a rather rare fern. Rhizome is wide creeping so that it covers large area. (4803, 4804).

D. polypodioides Blume; Mehra & Bir 146, 1964.

This large sized fern, often giving an impression of a 'tree fern' from a distance, grows between 1000-2100 m. altitudes and is usually found in ravines along water courses. Often it also grows on the forest fringes. It is abundant near Shembaganur *en route* Periyakulam (1000 m.) and in Shola near Parvat Vihar (1300 m.). (4700, 4805, 5826, 5827).

D. latifolium (Don). Moore; *Asplenium latifolium* Don (1825), non Bory (1803); *D. indicum* Nair[1] (Moore's name is legitimate).

Grows on forest floor, *en route* Kodaikanal near Silver Cascade (1500 m,). It is usually found in damp situations. Rhizome ascending, stipes sparsely scaly below, naked above. (4806).

D. maximum (Don) C. Chr.; Mehra & Bir 147, 1964.

It is rather a rare fern and was collected only once as growing in damp situations near water in shola near Perumal Malai.

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[1] Indian Forester, **94**: 169, 1968.

D. muricatum (Mett.) V. A. V. R.; Mehra & Bir 148, 1964. *Athyrium gymnogrammoides* Bedd., F.S.I.52, t. 156, 1864, pro parte, quoad descr. & fig.; Handb. 168, 1883. *A. australe* sensu Bedd., F.S.I. 52, t. 158, 1864. *Asplenium procerum* (Hook. & Bak.) Wall. ex Clarke, F.N.I. 495, 1880.

It is one of the commonest ferns of ravines in all the forests between 1600-2200 m. and grows in moist situations. Collected from Picnic Shola (2200 m.) and from forest near Bombay Shola (2100 m.). (5941, 5942).

Diplaziopsis javanica (Bl.) C. Chr.; Mehra & Bir 149, 1964.

Only once collected from forest near Shembaganur, 1650 m. altitude as growing along water channel on clay soil. (4792, 4793).

Family Thelypteridaceae

Thelypteris repens (Hope) Ching; Mehra & Bir 149, 1964.

This is a high altitude fern and flourishes well in rather moist situations. Common on forest floor near Coaker's Walk (2200 m.) and generally grows in extensive beds near water. (5838, 5839).

T. xylodes (Kunze) Ching; Mehra & Bir 150, 1964.

It grows in abundance near lake (2100 m.) and near Observatory (2200 m.) and flourishes very well in rather moist situations. Abundant between 1600-2100 m. altitude. (4492, 4493, 5836, 5837).

T. brunnea (Wall.) Ching; Mehra & Bir 151, 1964.

It often grows near water or in damp situations all round between 1700-2200 m. altitude. Especially abundant near lake (2100 m.), Holiday Home (2200 m.) and Observatory (2300 m.). (4495, 4496, 5832, 5833).

T. erubescens (Wall. ex Hook.) Ching; Mehra & Bir 152, 1964.

Common on forest floor or on moist shady places near Silver Cascade (1800 m.). Also met with along Bombay Shola and near Holiday Home. (4491, 4494).

T. beddomei (Baker) Ching; *Nephrodium beddomei* Baker. *Lastrea beddomei* (Baker) Bedd., Handb. 239, 1883. *Lastrea gracilescens* Bedd., F.S.I.t. 110, 1863 (non Moore 1858, nec. Hook. 1857).

It grows in rather moist situations and is occasionally met with along road sides in open spaces at Observatory Hill (2100 m.). Rhizome is shortly creeping. Stipe and lamina are throughout hairy. (4709).

Leptogramme totta J. Smith; Mehra & Bir 153, 1964.

It is a very rare fern and was collected only once growing on moist shaded rocks in a ravine near Bear Shola at an altitude of 2100 m. (4490, 5828, 5829).

Ampelopteris prolifera (Retz.) Copel. ; *Polypodium proliferum* Roxb.; Clarke, F.N.I. 548, 1880. *Goniopteris prolifera* Presl ; Bedd., Handb. 296, t. 153, 1883.

It is a low altitude fern. Collected only once in forest *en route* Kodaikanal (450 m.). This fern is often rooting by apical bud. (4708, 4783, 4784).

Cyclosorus dentatus (Forsk.) Ching ; Mehra & Bir 154, 1964.

It is exceedingly common between 1300-2000 m. altitude along Uttu-Shembaganur road and is found at moist places generally in the open or along water courses especially in Shembaganur forest (1950 m.) and near Silver Cascade (1800 m.). (4701-4707, 5834, 5845).

C. **parasiticus** (L.) Farwell; Mehra & Bir 155, 1964.

It is met with at low altitudes along Perumal Malai-Parvat Vihar road (1300 m.) and grows in rather dry and exposed situations. (5830, 5831).

C. **gongilodes** (Schkuhr) Link (*gongylodes*); *Dryopteris gongilodes* (Schkuhr) O. Ktze.

var. **hirsutus** (Mett.) Farwell; *Nephrodium unitum* R.Br. ; Bedd., F.S.I. t. 88.

1863. *Dryopteris gongylodes* var. *propinqua* (R.Br.) C. Chr.

Extremely common on Uttu-Silver Cascade road between 1000-1800 m. It is quite abundant near Silver Cascade (1800 m.) and grows on gravelly soil. (5945, 5946).

C. **arbusculus** (Willd.) Ching ; *Dryopteris arbuscula* (Willd.) O. Ktze. *Nephrodium arbuscula* (Willd.) Desv. ; Bedd., F.S.I. t. 87. 1863.

This is a low altitude fern around Perumal Malai (1200 m.). It is rare and grows on calcareous soil near water channel. The fern is densely hairy underneath and the entire lower surface is covered with sori. (5947, 5948).

Family Aspleniaceae

Asplenium ensiforme Wall. ex Hook. & Grev. ; *A. ensiforme* Wall. (nomen nudum) ; Bedd., F.S.I.t. 125, 1864 & Handb. 141, t. 71, 1883 ; Clarke, F.N.I. 476, 1880.

Only one plant was observed as growing on shaded rock near streamlet in khud below Silver Cascade (1200 m.). (4802).

A. normale Don ; Mehra & Bir 156, 1964.

It grows on moist shaded dark rocks all around between 1600-2100 m. altitude especially near Bear Shola (2100 m.), Shembaganur (1900 m.) and Pillar Rocks (2200 m.). Apical vegetative buds are present on the lamina. The auricle of the pinna is very much pronounced as compared to the Himalayan specimens. (4476, 5807, 5808).

A. indicum Sledge[1] ; *Asplenium planicaule* Wall. ; Bedd., F.S.I.t. 139, 1864.

It is rather a rare fern, collected from near Moir Point (1800 m.). It is locally abundant on tree trunks in the shola near Moir Point (1800 m.). (4674).

A. cheilosorum Kunze ; Mehra & Bir 157, 1964.

It is a fern of moist shaded rocks and flourishes in protected places. It is a rare fern in the area having been collected only once near Pillar Rocks (2100 m.). (4829, 4830).

A. unilaterale Lam. ; *Asplenium resectum* J. Smith ; Bedd., F.S.I.t. 132, 1864.

It is one of the commonest species growing luxuriantly on moist shaded dark rocks in Shembaganur forest (1900 m.) and near Pillar Rocks (2200 m.). (5824, 5825).

A. unilaterale Lam. var. **rivale** Bedd. (Handb. 153, 1883).

Some plants were found growing on dark dripping rocks in Shembaganur forest (1900 m.) and also few individuals were seen near Pillar Rocks (2200 m.). (5822, 5823).

A. varians Hook. & Grev. ; Mehra & Bir 158, 1964.

This is a rare low altitude fern and grows on moist shaded rocks along Panakaddu-Uttu road (1200-1300 m.). (4795, 5816, 5817).

A. tenuifolium Don ; Mehra & Bir 158, 1964.

Collected only once from shola below Shembaganur (1900 m.). It grows on moist shaded rocks at protected places and is locally abundant. (4800, 4801, 5818, 5819).

A. nidus Linn. ; Mehra & Bir 158, 1964. *Thamnopteris nidus* Presl ; Bedd., Handb. 137, 1883.

Cultivated in the Botanical garden of Sacred Heart College, Shembaganur (1950 m.). (5821).

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[1] Bull. Brit. Mus. (nat. Hist.), 3 (6) : 264, 1965.

A. trichomanes Linn. ; Clarke, F.N.I. 477, 1880 ; Bedd., Handb. 143, 1883.

Some plants were found growing on a dark shaded rock along roadside near Moir Point (1800 m.). It is a rare fern and was collected only at one place. (4787).

A. inaequilaterale Willd. ; *Asplenium trapeziforme* sensu Bedd., F.S.I. 45, t. 134, 1864 ; non Roxb. *A. lunulatum* var. *trapeziforme* Bedd., Handb. 148, 1883, pro parte (non *A. trapeziforme* Roxb.).

It is a rare and low altitude fern. It grows in crevices of moist, dark rocks near Parvat Vihar (1200 m.). (5943, 5944).

A. erectum Bory ex Willd.; *Asplenium brasiliense* sensu Bedd., F.S.I. 45, t. 135, 1864 ; non Raddi. *A. lunulatum* var. *camptorhachis* (Kunze) Bedd., Handb. 148, 1883.

This is occasionally met with as an epiphyte or lithophyte between 1600-2300 m. altitude, especially common in forest below Shembaganur (1900 m.), near Bear Shola (2100 m.) and at Moir Point. (4677, 4678, 5805, 5806).

A. zenkerinum Kunze ; Bedd., Hand. 148, t. 75, 1883 (*zenkerianum*). *Asplenium persicifolium* Sensu Bedd., F.S.I. t. 128, 1864.

It is an high altitude fern flourishing in the crevices of moist shady rocks and boulders in Picnic Shola (2000 m.) and near Pillar Rocks (2200 m.). Apical vegetative buds are frequently present. (4504, 4506, 5814, 5815).

A. decrescens Kunze ; *Asplenium contiguum* sensu T. Moore, Index Fil., 121, 1859 quoad specim. Zeyl. ; ? non Kaulf. ; Bedd., F.S.I. 47, t. 140, 1864. *A. caudatum* sensu Hook., Sp. Fil., 3 : 152, 1860 quoad specim. Zeyl., pro parte ; non Forst. f ; Bedd., Handb. 151, 1883.

This species prefers moist shaded dark rocks and luxuriantly flourishes in protected places. It is quite abundant between 1500-2300 m. altitude especially common in Shembaganur (1950 m.) and in forest below Silver Cascade (1700 m.). (5820).

A. affine Swartz

This large sized fern is quite rare in the area and grows in the crevices of moist shaded rocks near Pillar Rocks (2100 m.). (4670). For nomenclature of this as well as following species consult Sledge (1965).

A. aethiopicum (Burm. f.) Becherer; *Asplenium furcatum* Thunb.; Bedd., Handb. 157, 1883. *A. laserpitiifolium* sensu Bedd., F.S.I. 75, t. 225, 1864 ; non Lam.

It is extremely common on moist rocks, along footpaths and occasionally grows epiphytically on lower portions of tree trunks between 1400-2300 m. and is abundant in forests near Observatory (2300 m.), Shembaganur (1800 m.), Tiger Shola (1800 m.) and Silver Cascade. (4716-4718, 5810, 5811).

A. **falcatum** Lam. var. **bipinnatum** Sledge[1]. *Asplenium spathulinum* sensu Bedd., F.S.I. 75, t. 226, 1864 ; non J. Smith ex Hook.

It is rare fern and only few plants were collected as growing on shaded rock near Uttu (1100 m.) along Uttu-Falls View road. (5804, 5809).

A. **auritum** Swartz ; Bedd., F.S.I. t. 137, 1864 & Handb. 149, 1883.

It is occasionally met with as an epiphyte or on moist shady rocks around Silver Cascade (1800 m.), Moir Point (2200 m.), Tiger Shola (1700 m.) and in forest near Shembaganur (1950 m.). (5812, 5813).

A. **caudatum** Forst ; Bedd. ; F.S.I. t. 143, 1864.

It is often met with on moist shady rocks or stony walls between 1600-2300 m. especially near Pillar Rocks (2200 m.), Moir Point (2300 m.), Shembaganur (1900 m.), Silver Cascade (1800 m.) and Perumal Malai (1500 m.). (4671-4673, 4765).

Family BLECHNACEAE

Blechnum orientale Linn. ; Mehra & Bir 160, 1964.

It is extremely rare fern and grows in open sunny places usually in the crevices of rocks along Uttu road (950 m.) and near Vellagavi village (700 m.) (5761, 5762).

Family LOXOGRAMMACEAE

Loxogramme involuta (Don) Presl ; Mehra & Bir 160, 1964.

It is an epiphytic or a rock-loving fern and is common in all the forests between 1600-2400 m. altitude. Abundant near Observatory Hill (2300 m.), Moir Point (2200 m.), Pillar Rocks (2100 m.), Bear Shola (2000 m.), Tiger Shola (1800 m.) and in Shembaganur forest (1950 m.). (4807, 4808, 5751, 5752).

L. **lanceolata** Presl ; Mehra & Bir 161, 1964.

This is an extremely rare fern and was collected only once as an epiphyte in Shembaganur forest (1800 m.).

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[1]Bull. Brit. Mus. (nat. Hist.). 3 (6) : 262, 1965.

Family Polypodiaceae

Pyrrosia mollis (Kze.) Ching ; Mehra & Bir 163, 1964.

Met with on rocks or as an epiphyte in Shembaganur forest (1900 m.) near Bear Shola falls (2100 m.) and near Silver Cascade (1800 m.). This fern is common between 1500-2000 m. altitude (4820, 4821, 5869, 5870).

P. lanceolata (L.) Farwell ; Mehra & Bir 161, 1964.

This low level fern is found below 1000 m. altitude and generally forms mats on rocks and walls between 500-900 m. altitude especially at Falls View (600 m.) and Cooly Ghat (700 m.). Occasionally it may grow as an epiphyte on the lower portions of tree trunks. (4826, 5871, 5872).

Paraleptochilus decurrens (Bl.) Copel. ; Mehra & Bir 166, 1964.

It is an extremely rare fern and was collected only once as growing on moist shaded rocks in forest near Pillar Rocks (2100 m.). It has characteristic dimorphic fronds. (4503).

Lepisorus nudus (Hook.) Ching ; Mehra & Bir 169, 1964.

Occasionally grows as an epiphyte or lithophyte in Shembaganur forest (1950 m.), along Tiger Shola road (1700 m.) and also near Moir Point (2300 m.). (4713-4715, 5868).

L. amaurolepida (Sledge) Bir & Trikha[1].

It grows on rocks or tree trunks in moist shaded situations in sholas near Moir Point (2100 m.), Pillar Rocks (2000 m.), Shembaganur (1950 m.) and Silver Cascade (1700 m.). (4776, 4777, 4825, 5866, 5867).

Pleopeltis macrocarpa (Bory ex Willd.) Kaulf[2]. *Pleopeltis lanceolata* Kaulf. ; Bedd., Handb. 357, t. 197, 1883. *P. lepidota* (Willd. ex Schlecht.) Presl; Bedd., F.S.I. 60, t. 181, 1864. (nom. illegit.).

A very rare epiphyte, collected only once as growing on a tree trunk from near Bear Shola (2100 m.). (5864, 5865).

Phymatodes hastata (Thunb.) Ching ; Mehra & Bir 170, 1964.

This fern is extremely rare and was collected only once as growing on tree trunk at damp shaded places in shola near Moir Point (2100 m.). (4817, 4818).

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[1] Basinym : *Pleopeltis amaurolepida* Sledge in Bull. Brit. Mus. (nat. Hist.) 2 (5) : 136, 1960.

[2] For nomenclature and synonymy see Pichi-Sermolli (1965) and Bir and Trikha (1968).

P. montana (Sledge) Bir & Devi[1].; *Pleopeltis oxyloba* Bedd., F.S.I. 59, t. 175, 1864 pro parte ; *Pleopeltis hastata* Bedd., Handb. 362, 1883 pro parte (non *Polypodium hastatum* Thunb.).

It is recorded from Kodaikanal by Bourne in May and June, 1898 from Bear Shola and Pillar Rocks stream respectively (*cf.* Sledge 1960), Sauliere in September 1913 from Shembaganur and Saldhna in September 1959 (without locality).

Colysis hemionitidea (Wall.) Presl; Mehra & Bir 173, 1964.

It is a lithophytic fern and grows in moist and shady situations near Pillar Rocks (2100 m.). (4819).

Microsorium membranaceum (Don) Ching ; Mehra & Bir 175, 1964.

This rare fern was collected only once inside shola near Moir Point (1500 m.) as growing on the lower part of moist shaded tree trunk. (4822, 4824).

M. punctatum (Linn.) Copel.; Mehra & Bir 175, 1964.

This low level fern is very rare and was collected only once as growing on moist shaded rock in a khud *en route* Kodaikanal (600 m.). (4827).

Family GRAMMITIOACEAE

Ctenopteris subflacata (Bl.) Kunze ; Mehra & Bir 176, 1964.

It grows at the basal portions of tree trunks in the forest near Shembaganur (1500 m.) and is very rare. (4778).

Recently Bhavanandan (1968) recorded *Dryopteris hirtipes* (Bl.) O. Ktze., *D. boryana* (Willd.) C. Chr. [=*Dryoathyrium boryanum* (Willd.) Ching], *Cyclosorus unitus* (L.) Ching and *Thelypteris paludosa* (Bl.) K. Iwatsuki from Kodaikanal but no specific localities are mentioned.

SUMMARY

The preceding account clearly indicates that Kodaikanal is very rich in members of Pteridophytes. Summary of recorded species from the area, belonging to different genera is on p. 194.

Amongst the genera very well represented at Kodaikanal mention may be made of *Lycopodium*, *Adiantum*, *Cyathea*, *Athyrium*, *Dryopteris*, *Diplazium*, *Thelypteris* and *Asplenium*. Eighteen species of the last mentioned genus are met with in the area.

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[1] Bull. Bot. Surv. India **10** : 209, 1968.

Name of the genus	No. of species	Name of the genus	No. of species
		FERN-ALLIES	
Psilotum	1	*Equisetum*	1
Selaginella	3	*Lycopodium*	9
		FERNS	
Ophioglossum	1	*Botrychium*	2
Marattia	1	*Angiopteris*	1
Osmunda	1	*Lygodium*	1
Adiantum	6	*Vittaria*	1
Antrophyum	1	*Cheilanthes*	2
Pellaea	1	*Hemionitis*	1
Pityrogramma	1	*Pteris*	1
Actiniopteris	1	*Pteridium*	1
Mecodium	3	*Microlepia*	2
Hypolepis	1	*Lindsaya*	1
Sphenomeris	1	*Araiostegia*	1
Lecostegia	1	*Davallia*	1
Nephrolepis	2	*Oleandra*	1
Dicranopteris	1	*Cyathea*	4
Polystichum	3	*Arachnoides*	2
Cyrtomium	1	*Elaphoglossum*	3
Dryopteris	7	*Athyrium*	7
Diplazium	5		(one variety also)
		Dryoathyrium	1
Thelypteris	6	*Diplaziopsis*	1
Cyclosorus	5	*Ampelopteris*	1
Asplenium	18 (also one variety)	*Leptogramme*	1
		Blechnum	1
Laxogramme	2	*Pyrrosia*	2
Paraleptochilus	1	*Lepisorus*	2
Pleopeltis	1	*Phymatodes*	2
Colysis	1	*Microsorium*	2
Ctenopteris	1		

Total : FERN-ALLIES : Genera : 4 and Species : 14.
FERNS : Genera : 52, Species : 118 and varieties : 2 (120 different ferns)

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References

Alston, A. H. G. (1945): An enumeration of the Indian species of *Selaginella*. *Proc. nat. inst. Sci. India* **11** (3): 211-235.

——— (1957): American Fern usually known as *Dryopteris paleacaea*. *Amer. Fern Jour.* **47**: 91-92.

——— & Bonner, C. E. B. (1956): Resultats Des Expeditions Scientifiques Genevoires Au Nepal en 1952 et 1954 (Partie Botanique) 5-Pteridophyta, *Candollea* **15**: 193-220.

Beddome, R. H. (1863, 1864, 1865 ?): The Ferns of Southern India. Gantz Brothers, Madras.

——— (1883): A Handbook to the Ferns of British India, Ceylon and Malay Peninsula. Thacker Spink and Co., Calcutta.

——— (1892): A Handbook to the Ferns of British India, Ceylon and Malay Peninsula. With Supplement. Thacker Spink and Co., Calcutta.

Bhavanandan, K. V. (1968): Studies on the Cytology of sixteen species of south Indian Ferns. *Caryologia* **21**: 333-338.

Bir, S. S. & Trikha, C. K. (1968): Taxonomic revision of the Polypodiaceous genera in India—III. *Pleopeltis* Humboldt. et Bonpl. ex. Willd., *Amer. Fern. Journ.* **58**: 119-125.

Chowdhury, N. (1937): Notes on some Indian species of *Lycopodium* with remarks on the distribution of the genus in India. *Trans. nat. Inst. India* **1** (9): 183-226.

Christensen, C. (1905-1906): Index Filicum. Hagerup (Hafinniæ).

——— (1913): Index Filicum Supplementum, 1906-1912. Hagerup (Hafinniæ).

——— (1917): Index Filicum Supplement Preliminaire. Pour Les Annes, 1913, 1914, 1915, 1916. Hagerup (Hafinniæ).

——— (1934): Index Filicum Supplementum Tertium. Pro. Annis, 1917 1933. Hagerup (Hafinniæ).

Clarke, C. B. (1880): A review of Ferns of Northern India. *Trans. Linn. Soc. London II Bot.* **1**: 425-611.

Gupta, R. K. (1960): Vegetation of Kodaikanal in South India. I. Systematic list of Trees, Shrubs and Herbs. *J. Bombay nat. Hist. Soc.* **57** (1): 45-65.

——— (1962): Vegetation of Kodaikanal in South India. II. A Supplementary list of Trees, shrubs and Herbs. ibid. **59** (1): 185-199.

Holttum, R. E. (1965): Tree Ferns of the genus *Cyathea* Sm. in Asia (Excluding Malaysia). *Kew. Bull.* **19** (3): 463-487.

Hooker, W. J. & Baker, J. C. (1874): Synopsis Filicum. 2nd ed. Robert Hardwicke, 192, Piccadilly, London.

Hope, C. W. (1903): The Ferns of North Western India. *J. Bombay nat. Hist. Soc.* **14**: 720-749.

Matthew, K. M. (1959): The Vegetation of Kodaikanal grassy slopes. *J. Bombay nat. Hist. Soc.* **56** (3): 387-422.

Mehra, P. N. (1961): Cytological evolution of ferns with particular reference to Himalayan forms. *Proc. 48th Indian Sc. Congr. Session.* part II. pp. 130-153.

——— & Bir, S. S. (1964): Pteridophytic flora of Darjeeling and Sikkim Himalayas. *Res. Bull. Punjab Univ.* (n.s.) *Sci.* **15**: 69-182.

Nair, N. C. (1968): Nomenclature of some Indian ferns. *Ind. Forester* **94**: 169-170.

Pichi-Sermolli, R. E. G. (1965): Index Filicum. Supplementum Quartum Pro annis 1934-1960. Regnum Vegetabile vol. 37. Published by International Bureau for Plant Taxonomy and Nomenclature, Utrecht, Netherlands.

——— (1965): On the nomenclature of '*Pleopeltis lanceolata*'. *Webbia*, **20**: 349-354.

Sledge, W. A. (1956): The nomenclature and taxonomy of *Athyrium nigripes* (Bl.) Moore, *A. solenopteris* (Kunze) Moore and *A. praetermissum* Sledge. *Ann. Mag. nat. Hist.*, Ser. 12, **9**: 453-464.

——— (1960): The Polypodiaceae and Grammitidaceae of Ceylon. *Bull. Brit. Mus.* (nat. Hist.) **2** (5): 133-158.

——— (1962): The Athyrioid Ferns of Ceylon. ibid. **2** (11): 275-323.

——— (1965): The Ceylon species of *Asplenium*. ibid. **3** (6): 235-277.

Some aspects of Bio-Ecology of *Podagrica orbiculata* (Motsch.) (Coleoptera: Chrysomelidae) as a pest of *Abelmoschus esculentus* at Sehore (M.P.)

BY

R. R. RAWAT AND R. K. SINGH

Department of Entomology,
Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur

(*With two text-figures*)

Podagrica orbiculata (Motsch.) *bowringi* (Baly.) appeared as a serious pest of young plants of Lady's finger (*Abelmoschus esculentus*) during 1960 from July onwards in and around Sehore (M.P.). This is the first record of the occurrence of the pest and economic damage thereof in Madhya Pradesh. There is no published work on this pest except some occasional records of its occurrence in some parts of India. Maulik (1926) included it in his key to the spp. of the genus *Podagrica* in the FAUNA OF BRITISH INDIA on Chrysomelidae. Ayyar (1940) mentioned it as an occasional minor pest of 'bhindi' in south India. Chowdhary (1962) recorded it as a major pest of *Hibiscus cannabinus* in Tripura, the adults appearing in large numbers after rain in July 1956 and feeding on the leaves in abundance. Many other species of *Podagrica* have been reported from other countries as major pests, mostly on malvaceous plants, like *P. puncticollis* Weise. and *P. pallida* Jac. on cotton and *Hibiscus* spp. in Sudan (Pollard 1955 ; Schmutterer 1962), *P. breweri* Baly. on cotton seedlings in Queensland (Sloan 1937), *P. malvae* Illig. on cotton in Russia (Vasilev 1924), *P. ceylonensis* Jac. on *Hibiscus rosasinensis* in Ceylon (Hutson 1939) etc. In view of the serious infestation of *P. orbiculata* (Motsch.) on 'bhindi' and the scanty published work on it, some aspects of its bio-ecology were studied at Sehore, the findings are reported in this paper.

MATERIALS AND METHODS

Mass collections of the adult beetles were made from the College Farm and other fields. The beetles were confined in glass bell jars with the open top tied with muslin cloth, and containing moist soil in large petridishes. Fresh tender ' bhindi ' leaves were provided as food regularly. The beetles oviposited readily in moist soil. The eggs were removed from the soil under a binocular microscope with fine soft wet brush and counted daily.

For determining the incubation period the eggs were kept on moist blotting paper in petridishes. Effect of moisture on extent of oviposition was studied by providing a choice of wet, moist and air-dry soils in small petridishes to the ovipositing beetles and the number of eggs laid in each type of soil was recorded daily. Effect of moisture on the survival and viability of eggs was studied by keeping the freshly laid eggs on dry and wet blotting papers in petridishes.

Incidence of the pest was recorded on the basis of percentage of plants infested and number of beetles per plant every fourth day from the beginning of the activity of the pest and was correlated with the meteorological data.

Observations and Discussion

Mating : Mating occurs frequently both during day and night and a male is able to fertilize a number of females. Mating pairs are very commonly seen in the field. Mating period, as observed in seven cases, ranged from 7 to 15 minutes with an average of 10·7 minutes.

Oviposition : Eggs are usually laid in loose moist soil either singly or in small groups each of 2 to 6 eggs near the base of host plants at a depth of about 0·3″. Similar observations have been made in case of other species of *Podagrica* by Manolache, Dobreanu & Manolache (1938, 1943). Rate of oviposition of field collected beetles was found to decline progressively from July to September (Table 1).

Table 1

Oviposition rate of *P. orbiculata* during different periods of its activity

Period	No. of beetles confined		Average no. of eggs laid per female per day
	Male	Female	
19th to 24th July	12	8	15·0 to 18·7
2nd to 8th August	11	14	5·0 to 7·5
1st to 8th September	30	20	4·0 to 5·5
19th to 27th September	30	20	0·0 to 0·3

The oviposition was thus maximum during later part of July and declined progressively to zero by the end of September when the beetles were found to contain mostly immature ovaries.

Effect of Temperature and Moisture on Oviposition : As in nature the eggs were usually found in moist soil and very few or none in wet or dry soil, a laboratory experiment was conducted to assess the effect of moisture on oviposition. The daily oviposition by the same 20 ovipositing female beetles in wet, moist and air-dry soils is given in Table 2.

TABLE 2

OVIPOSITION BY *P. orbiculata* IN AIR-DRY, MOIST AND WET SOILS

Date of observation	No. of eggs laid by 20 females				Mean Temp. in °F.
	Total	In air-dry soil	In wet soil	In moist soil	
31-viii-'60	100	Nil	25	75	85·0
1-ix-'60	83	,,	18	65	84·0
2-ix-'60	105	,,	20	85	84·5
3-ix-'60	101	,,	10	91	84·5
4-ix-'60	114	,,	25	89	89·0
5-ix-'60	80	,,	30	50	90·0
6-ix-'60	95	,,	40	55	90·5
7-ix-'60	100	,,	60	40	91·0
8-ix-'60	80	,,	30	50	89·0
9-ix-'60	84	,,	30	54	87·0
10-ix-'60	70	,,	25	45	87·0
11-ix-'60	55	,,	15	40	87·0
12-ix-'60	55	,,	20	35	84·5
Grand Total	1122	Nil	348	774	

The moisture status of the soil was found to have a profound influence on the oviposition. Out of a total of 1122 eggs, the largest number (774) were laid in moist soil, comparatively much less (348) in wet soil and nil in dry soil. There is also an indication that temperature has a modifying effect on the oviposition response in relation to soil moisture. At a relatively higher mean temperature of 90° and 90·5° the difference in the number of eggs laid in moist and wet soils was much minimised and at 91·0°F there were actually more eggs laid in wet soil than in moist soil. However, this point needs further investigation.

Egg incubation period and effect of moisture on viability : Freshly laid eggs are light yellowish, later turning to deep orange. The eggs are oval, about 0·75 to 1 mm. in length and 0·50 to 0·65 mm. in width (Fig. 1). The incubation period, in contact with free moisture ranged from 4 to 6 days (average 5·1 days) during July and 5 to 13 days (average 7·0 days) during August (Table 3).

The influence of moisture on viability of eggs was assessed by keeping the eggs simultaneously on wet blotting paper (thus providing constant contact with free moisture) and on dry blotting paper (Table 3).

TABLE 3

INCUBATION PERIOD AND PERCENTAGE VIABILITY OF EGGS OF *P. orbiculata* ON WET AND DRY BLOTTING PAPERS

Eggs kept on	Date of egg laying	No. of eggs kept	No. of eggs hatched	Egg period (in days)	Percentage hatched
Wet blotting paper	20-vii-'60	25	22	4 to 6 (average 5·1)	88·0
Wet blotting paper	28-vii-'60	100	75	5 to 13 (average 7·0)	75·0
Dry blotting paper	28-vii-'60	100	4	6 to 10 (average 7·5)	4·0

Contact with free moisture was found to increase viability up to 75 to 88% as against only 4% on dry blotting paper. Contact with free moisture also seemed to accelerate egg development to some extent.

First larval instar and total life cycle : The first instar larva (Fig. 1)

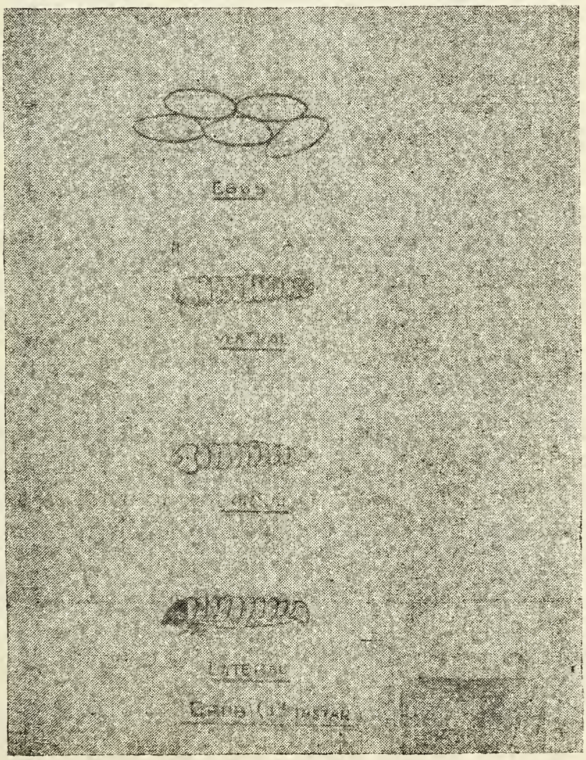

Fig. 1. Eggs and 1st instar grub of *Podagrica orbiculata* (Motsch.)

is minute, about 1 mm. in length and 0·25 mm. in width, rather sluggish and dirty yellowish-white. The head capsule is light yellowish and the mouth parts are light reddish brown. Antennae are minute papillae-like and single segmented. Thoracic legs are 5-segmented. Abdomen is devoid of legs and terminates in a dorso-ventrally flattened rounded plate. Minute setae are present all over the body and head. Those on the dorsal side of the body are smaller and clubbed but those on the head and ventral side of the body are relatively longer and tapering.

As the pest could not be reared in dishes beyond the 1st larval instar, various larval instars and pupae could not be studied. The total life-cycle could, however, be studied in a few cases by confining 10 to 15 ovipositing beetles on each of the four potted Lady's finger plants, removing them on the 2nd day and noting the date of emergence of adult beetles of the next generation (Table 4).

TABLE 4

DURATION OF TOTAL LIFE-CYCLE OF *P. orbiculata*

Pot No·	Date of egg laying	Date of emergence of beetles	No. of beetles emerged	Life-cycle (in days)	Average room temperature (in °F)
1	26-viii-'60	20-ix-'60	1	25	83·2
2	27-viii-'60	19-ix-'60	2	23	83·2
3	1-ix-'60	23-ix-'60	1	22	85·1
4	1-ix-'60	..	Nil	..	85·1

The total life cycle from egg to adult was thus 22 to 25 days during late August and September. The average egg period during this time being 5 to 7 days, the total larval plus pupal period can be said to be about 17 to 18 days.

Adult beetles, habits and sex ratio : Freshly emerged beetles are pale coloured but the colour deepens soon afterwards. The body length is about 4-5 mm. The head capsule, pronotum and antennae are reddish in colour. The elytra are black with punctuations arranged in double rows, completely covering the abdomen. The legs are also black in colour. The hind legs are longer than other legs and their femora are conspicuously thickened (Fig. 2).

The beetles are quite active and sensitive. On touching or approaching them they usually press their antennae and legs against their body and fall off or jump off the plants, and remain quiescent for sometime before commencing activity again. They are usually found on the upper surface of leaves but during noon they move to the undersurface of leaves or under grasses and weeds growing in the field. On cloudy days the beetles remain on the upper surface of leaves throughout the day.

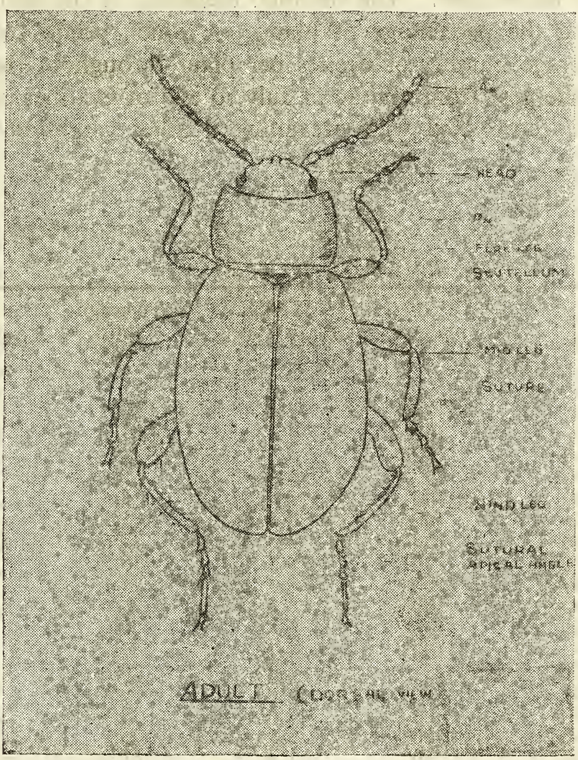

Fig. 2. Adult beetle of *Podagrica orbiculata* (Motsch.)

In the beginning (July) and end (October) of the pest activity the males slightly out-number the females but during August-September the number of females was about 1½ times that of males. The average ratio of females to males during the whole period of seasonal activity was 53 : 47.

Nature and extent of damage : The damage is caused both by the adults which feed on the leaves as well as the larvae which feed on the roots, but chiefly by the adults. Young tender leaves are more subject to attack but in severe infestation all the leaves are damaged. The beetles cut small holes in leaf blades and in case of heavy damage completely skeletonize them. Most severe damage is caused to seedlings having 2 to 4 leaves. Similar damage by adult beetles and larvae has been reported in other species of *Podagrica* by Manolache, Dobreanu & Manolache (1938, 1943). As a result, plant growth is considerably hindered, fruit setting is delayed and the fruits formed are undersized and less in number. When the beetles feed on the terminal shoots, young leaf buds are destroyed, which checks the apical growth.

Seasonal abundance : The seasonal incidence of the pest was noted by recording the percentage of plants on which beetles were present and the average number of beetles per plant throughout the period of activity of the pest from middle of July to end of October on every 4th day and was correlated with prevailing weather conditions (Table 5).

TABLE 5

SEASONAL INCIDENCE OF *P. orbiculata* WITH PREVAILING TEMPERATURE AND RELATIVE HUMIDITY

Date of observation	% of plants infested	Average no. of beetles per plant	Average temp. (in °F)	Average percentage R.H.
17-vii-'60	100	4·6	82·3	75.6
21-vii-'60	100	4·0	85·7	76.6
25-vii-'60	100	5·5	80·7	84.8
29-vii-'60	100	5·6	77·5	88.5
2-viii-'60	100	6·5	75·6	91.5
6-viii-'60	100	8·3	75·5	94.0
10-viii-'60	100	8·6	73·6	91.5
14-viii-'60	100	8·3	75·5	95.5
18-viii-'60	100	8·3	74·1	91.0
22-viii-'60	100	8·0	77·0	86.2
26-viii-'60	100	6·8	75·0	87.7
30-viii-'60	100	4·4	77·7	80.2
3-ix-'60	84	3·3	78·8	83.3
7-ix-'60	68	3·0	79·0	80.3
11-ix-'60	68	2·0	78·1	86.7
15-ix-'60	50	1·5	78·3	80.3
19-ix-'60	50	1·0	81·1	81.0
23-ix-'60	50	1·0	82·5	80.5
27-ix-'60	50	1·0	79·2	81.0
1-x-'60	33	0·5	75·6	82.0
5-x-'60	16	0·3	77.2	79.0
9-x-'60	16	0·3	79.6	82.1
13-x-'60	16	0·2	79·0	66.2
17-x-'60	16	0·1	78·0	59.2
21-x-'60	16	0·1	72·8	58.2
25-x-'60	0	0·0	71·7	60.6
29-x-'60	0	0·0	68·2	59.0

The data presented in Table 5 show that from mid-July to end of August, when average relative humidity was high (above 85% for most of the time) and temperature was moderately high (in the neighbourhood of 75°F), 100% plants were infested. The incidence of the pest was at its peak with 6·5 to 8·6 average number of beetles per plant from 2nd August to 26th August when the average relative humidity was very high (from 86·2 to 95·5%) and temperature averaged from 73·6 to 77.0°F. The incidence declined fast during September when there was relatively lower relative humidity averaging about 80% associated with relatively higher average temperature (78·1 to 82·5°F). During October, the incidence continued to decline further, becoming nil in the last week ; this seems to be more due to the adverse effect of low relative humidity which fell to about 60% than to low temperature. Chowdhary (1962) also recorded it feeding in large numbers after rain in July in Tripura.

Seasonal history and number of generations : The pest was active from mid-July to October, being most active during August. Breeding period was found to be confined only from July to about 3rd week of September. Therefore, taking the length of life cycle from egg to adult as 22 to 25 days, the pest seems to have 3 overlapping generations in a year. As the female beetles stopped oviposition and contained only immature ovaries during October after which they were not seen, it can be taken as a circumstantial evidence that hibernation occurs as adult beetles in soil. Hibernation as adult beetles has been recorded to take place, either singly or in batches, on the underside of leaves or among clods of earth in *P. fuscicornis* L. and *P. malvae* Illig. which pass through 1 to 2 generations in a year in Rumania (Manolache, Dobreanu and Manolache 1938, 1943).

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References

Ayyar, T. V. Ramakrishna (1940) : Hand book of Economic Entomology for South India. Govt. Press, Madras.

Chowdhary, A. N. (1962) : *Podagrica bowringi* Baly. as a major pest of *Hibiscus cannabinus* commonly known as 'mesta'. *Indian J. Ent.* **23** (2) : 152.

*Hutson, J. C. (1939) : Report of the work of the Entomological Division. Adm. Rep. Dir. Agric. Ceylon, 1938 : 36-41.

*Manolache, C. I., Dobreanu, E. & Manolache, F. (1938) : Recherches morphologiques et. biologique Sur L'attise de La mauve (*Podagrica fuscicornis* L.) *Verh. 7. int. Kongr. Ent. Berlin* **4** : 2544-2560.

*——— (1943) : Observations on morphology and biology of *P. malvae*. *Bull. Soc. Nat. Roman* **17** : 27-66.

Maulik, S. (1926) : Fauna of British India, Coleoptera, Chrysomelidae, 3, Taylor and Francis Ltd., London.

Pollard, D. G. (1955) : The identity of cotton flea beetle (*Podagrica* spp.). *Ann. Mag. Nat. Hist. London* **12** : 713-717.

*Schmutterer, H. (1962) : Control tests against the flea beetle *Podagrica puncticollis* Weise. on Kenaf (*Hibiscus cannabinus*) in the central rain lands of the Sudan. *Z. angew. Ent.* **49** (2) : 408-418.

Sloan, W. J. S (1937): Seedling pests of cotton and their control. *Qd. Agric. J., Brisbane* **47** (6) : 538-541.

*Vasilev, I. V. (1924) : Cotton pest—cotton industry, Moscow **III** : 86-166.

* Original papers not seen. Only summaries seen from Review of Applied Entomology.

Asymmetry in Palm leaves

BY

T. ANTONY DAVIS, S. S. GHOSH, AND A. MITRA
Indian Statistical Institute, Calcutta

(*With nine text-figures*)

The phyllotaxy of palms is always alternate. As the angular deflection between any two consecutive leaves of palms is approximately 137°, the younger of the two leaves will be nearer to the older one either by its left side or right side. This results in left-handed and right-handed palms, and the individuals of the two types of any species are generally distributed equally in any locality.

Because of this spiral mechanism arising due to the alternate arrangement of leaves, a palm leaf is always asymmetric bilaterally and the number of leaflets on one half differs from that of the other. In order to measure the degree of this asymmetry, fifteen species of which eight belonging to the pinnate type, five to the palmate type and the remaining two to a type having bipinnate leaves were selected. Among the individuals selected from these types, 54 were left-spiralled and 53 right-spiralled. The foliar spirality of the single *Nypa fruticans* palm could not be made out. The number of leaflets from the left and right halves of 453 leaves from left-spiralled palms and 457 from right-spiralled ones (excluding those of *Nypa*) were counted and the differences between halves calculated.

The pinnate palms showed a higher degree of asymmetry in the leaves. Here the left half of leaves from left-spiralled palms, and the right half of these from right-spiralled palms bore excess leaflets than their counterparts. The two species of *Caryota* bearing bipinnate leaves bore almost equal numbers of primary leaflets (rachises) on both the halves, but the ultimate leaflets in *C. mitis* showed a difference between halves. The palmate palms showed least variation between halved of leaves. Young *Rhapis excelsa*, though palmate type, behaves like a pinnate palm by showing the maximum asymmetry in the leaf.

A positive correlation exists between the number of green leaves a crown possesses and the percentage difference in the number of leaflets between halves of leaves.

INTRODUCTION

From the form of the lamina, palms may be grouped into those having pinnate or feather-like leaves as *Cocos nucifera*, palmate or fan-leaved palms as *Borassus flabellifer*, and those having bipinnate leaves as *Caryota urens*. In palm leaves, the petiole extends into the lamina region which divides the leaf blade more or less into two halves. This is not only the case with pinnate and bipinnate leaves, but also with most palmate leaves which in fact are costa pinnate. The number of leaflets on one linear half of the leaf usually differs from the other, and this variation has a positive association with the foliar spirality of the palm. Such an asymmetry in the leaf has been studied in a number of palm species and the salient data presented in this paper.

Palm Leaves

The leaves of palms exhibit great diversity in size, shape, and division of the lamina. The largest leaf in the plant kingdom is that of a palm. Many leaves at different levels stages of maturity constitute the magnificent palm crown at the tip of the trunk, the number of green leaves in a crown varying considerably with species and individuals of the same species. The leaves are arranged spirally at the crown, the number of spirals varying with species (Davis 1970a). The foliar spiral or spirals of an individual palm either veer clockwisely or counter-clockwisely. In a species, the left-handed and right-handed individuals according to foliar spirals are distributed more or less in a 1 : 1 ratio as has been observed with the coconut (Davis 1963) and the arecanut (Davis & Kundu 1966). The foliar asymmetry in palms does not appear to be genetically inherited (Davis 1962). In very few species like *Wallichia disticha*, *Chrysalidocarpus madagascariensis*, *Neodypsis decaryi*, *Syagrus treubiana*, the leaves are not arranged spirally, instead, they fall one over another along two, three or five vertical rows (Davis 1970b).

A palm leaf may be divided into three parts—the sheath, the petiole and the blade. The lowermost part of the leaf which partially or fully surrounds the stem is the leaf-sheath. In palms like *Roystonea* sp., the sheath is tubular and elongated and appears like a continuation of the trunk, which is often spoken of as the crown-shaft. In many other species, the leaf sheath forms a beautiful mat with diagonally-moving strong fibres. The petiole represents the portion of the leaf above the sheath and having no leaflet. It is rarely round in cross-section, but mostly grooved as in *Cocos nucifera*. The margins of the petiole may be entire or provided with sharp and prominent prickles as in *Borassus flabellifer*, or beset with short and spiny leaflets as in *Phoenix sylvestris*. The leaf blade consists of the central continuation of the axis called the rachis, and the leafy tissue divided into leaflets. There are two main types of leaf blades—the palmate and the pinnate which are popularly known as 'fan-type' leaves and 'feather-type' leaves respectively. When the leaflets arise from a single point (or a narrow region) at the tip of the petiole and where the distal rachis is very much shortened, the leaf is said to be palmate. Here the leaflets, which are united at their base, are referred to as segments. The leaf of young *Borassus flabellifer* is a typical example. In *Licuala spinosa* or *Rhapis excelsa*, the clefts between groups of fused leaflets reach up to the petiole. In the leaves of many palmate palms, a projection known as comb may be seen at the starting place of the lamina on the upper surface and/or the lower surface. In the case of pinnate leaves, the rachis is fairly long on which the leaflets are borne. The leaflets of bearing pinnate palms are free except in species such as *Areca catechu* where clusters of 2-10 leaflets remain fused. Palms like *Asterogyne martiana* with their unsplit lamina are exceptions. *Cocos nucifera* represents a typical pinnate leaved palm. Many palms described as palmate are in fact intermediaries between true palmate and pinnate types by having their rachis (or costa) only partially compressed. Such palms are said to be costa palmate, and *Livistona chinensis* forms a good example. In a few other species of palms, the leaflets or segments are further divided (pinnatisect), their ultimate divisions resembling the fin or tail of a fish in shape as in the genus *Caryota*.

Unequal halves of leaves

Palm leaves to an uncritical eye may appear to be bilaterally symmetric, one half of the lamina resembling the mirror image of the other. But on careful examination, the two halves of the leaves of most species are found to be dissimilar. This is caused presumably by the spiral arrangement of the leaves on the stem. To study the degree of this asymmetry, several leaves from 15 species of palms of which 8 belonging to the pinnate type (*Areca catechu, Chrysalidocarpus lutescens, Cocos nucifera, Nypa fruticans, Phoenix paludosa, Phoenix sylvestris, Ptychosperma macarthurii* and *Roystonea regia*), 5 to the palmate type (*Borassus flabellifer, Licuala spinosa, Livistona chinensis, Livistona rotundifolia* and *Rhapis excelsa*) and the remaining 2 to the group having branching leaflets (*Caryota mitis* and *Caryota urens*).

Individual palms ranging from six to twelve (usually half the number having right-handed, and the rest left-handed foliar spirals) from each species were selected and from each, 6-20 mature green leaves collected for making measurements and counts. However, with *Nypa fruticans*, the number of experimental palms was less than the usual number. The lengths of the lamina region as well as the longest leaflet were measured for each leaf. The numbers of leaflets (and their branches where present) on both the halves of the lamina were accounted for separately.

Presentation of Data

A. Pinnate palms

In *Areca catechu, Chrysalidocarpus lutescens, Phoenix paludosa, Ptychosperma macarthurii* and *Roystonea regia*, regular leaf spirals as seen in the coconut or *Borassus* are difficult to be traced out. But palm leaves are always alternate, and as they are not distichous as in grasses or some scitaminaceous species, one can detect a spiral mechanism in the arrangement. *Nypa fruticans* is very odd as the leaves are always vertical arising from the horizontal rhizome. The spiralling may be clockwise or counter-clockwise. To determine the direction of the spiral, it is enough if the positions of any two consecutive leaves on the trunk are examined. If the younger leaf lies nearer the older one along the right-hand side of an observer looking from the mid-position of the older leaf, then the spirality of the palm is regarded as right-handed. If nearer by the left hand, it is considered as having a left-handed foliar spiral (Davis & Kundu 1966). In all cases, the ventral (lower) surface of the leaf has been considered for observation and accordingly, the left and right halves of the leaves refer to those halves when viewed from below, and the leaf held vertically. It may be mentioned that in species like *Borassus flabellifer*, *Cocos nucifera*, *Phoenix sylvestris*, clear foliar spirals numbering 3, 5 and 8 respectively are discernible. But in order to maintain uniformity in the data and their interpretation, palms are considered to have a single foliar spiral (based on the positions of two consecutive leaves) running clockwisely or counter-clockwisely.

1. **Areca catechu** Linn.

Table 1 shows data on the number of leaflets on halves of leaves of the two kinds of *Areca catechu* palms. In a left-spiralled palm, there is an excess of leaflets on the left half, and also the right half bears more leaflets in a right-spiralled palm. Dorsal views of leaves from a left-spiralled and a right-spiralled areca palms seen are in Fig. 1.

TABLE 1

Areca catechu: NO. OF LEAFLETS ON HALVES OF LEAVES FROM LEFT- AND RIGHT-HANDED PALMS

Palm	Spiral	No. of leaves	Leaflets on halves		Total	Variance of (L-R)	% difference
			Left	Right			
1	L	7	446	407	853		
2	L	8	576	537	1113		
3	L	8	469	450	919		
Total		23	1491	1394	2885	3·279	06·96
Mean per leaf			64·83	60·61	125·43		
4	R	8	471	490	961		
5	R	8	491	529	1020		
6	R	8	507	547	1054		
Total		24	1469	1566	3035	4·040	06·60
Mean per leaf			61·21	65·25	126·46		

In all the 23 leaves from the left-spiralled palms, the left-half bore excess leaflets, the excess in a leaf ranging from 1 to 9. Variance was calculated to compare the degree of variation the difference in the number of leaflets between halves of leaves from left-spiralled and

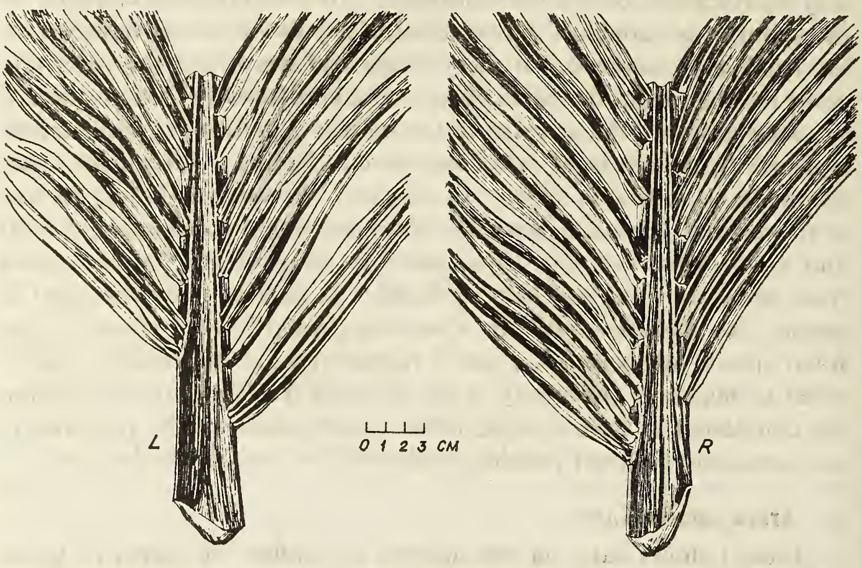


FIG. 1. Dorsal view of portions of leaves from left- and right- spiralled *Areca catechu*.

right-spiralled palms make. For the left-spiralled palms, the variance was 3·279. Tree No. 3 had the least difference in the number of leaflets between halves. The percentage excess of leaflets on the left-half over the right as given in Table 1 is 6·96. In the 24 leaves from the right-spiralled palms, the right half bore more leaflets and the difference for the different leaves ranged from 1 to 9. Tree 4 showed the least variation. The percentage excess of leaflets on the right half over the left is 6.60 which is slightly smaller than the corresponding figure for the left-spiralled palms. All the six palms examined were 15 years old. On an average, a leaf of the left-spiralled palm bore 125·43 leaflets, and a right-spiralled palm bore 126·46, and the difference is only 0·82 per cent. Even in adult *Areca catechu* palms, many leaflets remain fused, and sometimes up to ten leaflets were found to be united along their margins. This peculiarity was exhibited in all the six palms. Only 26·79 per cent of the leaflets in these palms were free like those of an adult coconut palm.

2. **Chrysalidocarpus lutescens** H. Wendl.

Chrysalidocarpus lutescens is a suckering ornamental palm, one clump possessing even as many as one hundred shoots. Six clumps were marked at the premises of the Indian Statistical Institute, Calcutta, each bearing

20-40 suckers. The different suckers of a clump usually are of different ages and heights. Some shoots in a clump are right-handed, and others left-handed. From each clump, two almost similar shoots in stature, but one with left-handed and the other right-handed foliar spirals were selected, and six to eight leaves from each shoot lopped for recording observations on them. Data collected on these 12 shoots are presented in Table 2.

TABLE 2

Chrysalidocarpus lutescens: NO. OF LEAFLETS ON HALVES OF LEAVES FROM LEFT- AND RIGHT- HANDED PALMS

Clump	Shoot	Spiral	No. of Leaves	Leaflets on halves		Total	Variance of (L-R)	% difference
				Left	Right			
I	1	L	8	275	258	533		
II	1	L	7	320	309	629		
III	1	L	7	285	263	548		
IV	1	L	6	294	266	560		
V	1	L	7	275	268	543		
VI	1	L	7	291	283	574		
Total	6		42	1740	1647	3387	3·713	05·65
Mean per leaf				41·43	39·21	80·64		
I	2	R	8	353	377	730		
II	2	R	7	299	313	612		
III	2	R	8	339	366	705		
IV	2	R	7	321	360	681		
V	2	R	8	285	290	575		
VI	2	R	8	317	331	648		
Total	6		46	1914	2037	3951	4·959	06·43
Mean per leaf				41·61	44·28	85·89		

Of the 42 leaves from the six left-spiralled shoots, 4 leaves had equal numbers of leaflets on both the halves and in 3 others, the right half had more leaflets. In the remaining leaves, the left half had excess leaflets and the difference per leaf ranged from 1-6. On the whole, the leaflets on the left half were in excess of the right half, and the percentage difference was 5·65.

Of the 46 leaves from the six right-spiralled shoots, the leaflets on both the halves in one were equal in number and in three others, the left half had more leaflets than the right. It may be mentioned that all these abnormal leaves were from only one shoot (No. V). For the remaining

14

leaves, the right half had excess leaflets compared to their counterparts; the excess per leaf ranging from 1-10. On the aggregate, a leaf of a right-spiralled palm bore 6·43 per cent more leaflets than the left half.

On an average, a leaf of a mature shoot of *Chrysalidocarpus lutescens* possess 83·26 leaflets. There is a tendency for the lowest two leaflets on each half to remain fused. Also the topmost two leaflets on each half are united. The chance of the lowest two leaflets fusing with each other is twice as large as those at the apex. The frequency of fusion seems to be the same for leaflets on both the halves of leaves of the two types of shoots. In this respect, *Chrysalidocarpus lutescens* is more remotely connected to *Areca catechu* than *Ptychosperma macarthurii*.

3. **Cocos nucifera** Linn.

Cocos nucifera is normally a single-stemmed palm although exceptional cases of suckering and branching have been reported. The large crown possesses about 25 fully opened leaves at a time and several others in an unopened condition.

12 mature leaves each from three left-spiralled palms and a similar number each from three right-spiralled palms were harvested and measurements and counts were made on them. The data are presented in Table 3.

TABLE 3

Cocos nucifera: NUMBER OF LEAFLETS ON HALVES OF LEAVES FROM LEFT- AND RIGHT- SPIRALLED PALMS

Palm	Spiral	Number of leaves	Leaflets on halves			Variance of (L-R)	% difference
			Left	Right	Total		
1	L	12	1213	1193	2406		
2	L	12	1276	1243	2519		
3	L	12	1166	1151	2317		
Total		36	3655	3587	7242	3·543	1·90
Mean per leaf			101·53	99·64	201·17		
4	R	12	1300	1293	2593		
5	R	12	1194	1237	2431		
6	R	12	1170	1183	2353		
Total		36	3664	3713	7377	6·092	1·34
Mean per leaf			101·78	103·14	204·92		

Of the 36 leaves from the left-spiralled palms, 8 leaves had equal numbers of leaflets on both the halves and in one, the right half had two leaflets in excess of the left. In the remaining leaves, the extra number per leaf ranged from 1-8. On an average, a leaf of a left-spiralled palm bore only 1·90 per cent leaflets more than that on the right half. All the left-spiralled palms produced on an average more leaflets on the left half.

Of the 36 leaves of the right-spiralled coconuts, 5 had equal numbers of leaflets on both the halves and in 8 leaves, the left half had excess leaflets. It may be pointed out that palm No. 4 had most of the 'aberrant' leaves (9) while palm No. 5 had none. Accordingly, palm No. 4 produced on an aggregate more leaflets on the left half. In the remaining two right-spiralled palms, the right half had more leaflets. These palms, in spite of an 'abnormal' individual, produced 1·34 per cent leaflets more on their right half over those on the left.

All the six experimental palms were adults of about 45 years old. A leaf on an average produced 203·04 leaflets. In none of the leaves was any fusion of leaflets noticed.

4. **Nypa fruticans** Wurmb.

Nypa fruticans is a prostrate, aesturial, gregarious palm with a stout branching root-stock. The green leaves, which are produced alternately one on either side of the horizontal rhizome, are erect, and this vertical posture is maintained till their drying away. In India, the natural home of *Nypa fruticans* is the Sundarbans wet forest commencing from 150 km. south of Calcutta and extending up to the shores of the Bay of Bengal. During my brief visit to the Sundarbans I could make detailed observations on the leaves of only one clump which data are presented in Table 4.

TABLE 4

Nypa fruticans : DATA ON LEAVES

Palm	No. of leaves	No. of leaflets on halves		Length of lamina
		Left	ht	
1	10	44.3	44.7	3 metres

N.B.—It was difficult to determine the spirality of this palm (shoot).

Although the data are very limited, one gets the impression that the leaves are more or less bilaterally symmetric so far as the number of leaflets are concerned.

5. **Phoenix paludosa** Roxb.

This species is also found flourishing in the Sundarbans in a wild condition. There are a few dense clumps of *Phoenix paludosa* at the Indian Botanic Garden, Calcutta, and observations were made on some of them. Unlike the species described earlier which are androgynous, *P. paludosa* as well as the next one (*P. sylvestris*) are dioecious. *P. sylvestris* is single-stemmed while *P. paludosa* is a suckering species.

Six shoots (3 left-spiralled and 3 right-spiralled) were selected from two clumps of which one is female and the other male, and 10 fully developed green leaves were harvested from each of them for recording observations. The data are presented in Table 5.

TABLE 5

Phoenix paludosa : NUMBER OF LEAFLETS BETWEEN HALVES OF LEAVES

Spirality of palm	No. of leaves	Mean length of whole leaf	No. leaflets on L. half/ leaf	No. leaflets on R. half/ leaf	Difference	Percentage
1 L	10	90·85	30·4	29·9	0·5	1·67
2 L	10	105·95	41·4	41·4	—	—
3 L	10	122·10	50·9	50·7	0·2	0·39
Total	30	318·90	122·7	122·0		
Mean	1	106·30	40·90	40·67	0·23	0·57
1 R	10	89·30	38·2	38·5	0·3	0·78
2 R	10	101·85	38·8	39·6	0·8	2·06
3 R	10	105·80	42·7	43·2	0·5	1·17
Total	30	296·95	119·70	121·30		
Mean	1	98·98	39·90	40·43	0·53	1·33

It is evident from Table 5 that the leaves of the left-spiralled palms produce a small excess of leaflets on the left half, and those of right-spiralled palms produce 1·33 per cent extra leaflets on the right half. However, the difference is far from being significant statistically.

6. **Phoenix sylvestris** Roxb.

Phoenix sylvestris, true to its popular name, wild date, grows in a wild state particularly in the sub-Himalayan belt of India and extending downward to Andhra Pradesh.

Determining the leaf spirals is relatively difficult with *Phoenix sylvestris* on account of the numerous leaves in the crown and because of the conspicuous genetic spirals running opposite to the normal spirals. In a right-spiralled palm, the bunch hangs on the right side of the subtending leaf stalk, and vice versa in a left-spiralled palm. In a leaf of a right-spiralled palm, generally the leaflets on the right half begin to develop from a position lower than the other half, but it is not universal. Mirror image situation is the case with a leaf of a left-spiralled palm (Fig. 2).

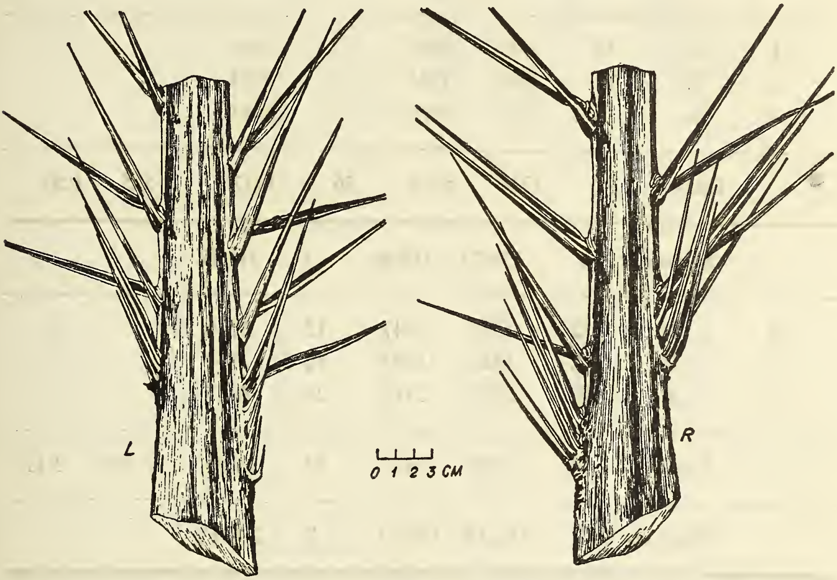


Fig. 2. Dorsal view of portions of leaves from left- and right -spiralled *Phoenix sylvestris.*

Six palms (3 left-spiralled and 3 right-spiralled ones) between 20 and 50 years, growing at the premises of the Indian Statistical Institute, Calcutta, were selected, and 12 leaves from each (20 leaves from tree No. 6) were cut, and measurements and counts made. Data obtained from them are presented in Table 6.

Of the 36 leaves of the left-spiralled palms, two had equal numbers of leaflets on both the halves and in a further 8, the right-half possessed excess leaflets. The excess leaflets on the left half in the remaining 26 leaves ranged from 1 to 8. On the aggregate, a leaf of the left-spiralled palm bore 1·50 per cent more leaflets. Of the 44 leaves from the right-spiralled palms, 3 leaves had the same number of leaflets on both the halves, and in another 6, the left half had extra leaflets. It may be mentioned that all the ' aberrant ' leaves were from a single tree (No. 4) and for this tree the left half produced on an average more leaflets than the right. In the remaining leaves, the extra number of leaflets per leaf ranged from 1-11. Ignoring tree No. 4 with negative values, it is found

TABLE 6

Phoenix sylvestris : NO. OF LEAFLETS ON HALVES OF LEAVES FROM LEFT- AND RIGHT- SPIRALLED PALMS

Palm	Spiral	No. of leaves	Leaflets on halves		Central leaflet	Total	Variance of (L-R)	% difference
			Left	Right				
1	L	12	1914	1868	12	3794		
2	L	12	1996	1985	12	3993		
3	L	12	1823	1795	12	3630		
	Total	36	5733	5648	36	11417	8·565	1·50
	Mean per leaf		159·25	156·89	1	317·14		
4	R	12	1751	1747	12	3510		
5	R	12	1525	1593	12	3130		
6	R	20	2987	3118	20	6125		
	Total	44	6263	6458	44	12765	13·040	3·11
	Mean per leaf		142·34	146·77	1	290·11		

that the leaves of right-spiralled palms bore on their right half 3·11 per cent more than the left half.

7. Ptychosperma macarthurii H. Wendl.

Ptychosperma macarthurii resembles *Chrysalidocarpus lutescens* in producing suckers, bearing a smaller crown and possessing smaller numbers of leaves and leaflets per leaf. Two fruit-bearing shoots each of six clumps were selected, of which one was left-spiralled and the other right-spiralled. All mature leaves from each shoot were cut and measurements and counts taken on them. The number of fully opened green leaves available per shoot ranged from 6-9. The data on the 12 shoots are presented in Table 7.

TABLE 7

Ptychosperma macarthurii: NO. OF LEAFLETS ON HALVES OF LEAVES FROM LEFT- AND RIGHT- SPIRALLED SHOOTS

Clump	Shoot	Spiral	No. of leaves	Leaflets on halves		Total	Variance of (L-R)
				Left	Right		
I	1	L	7	181	174	355	
II	1	L	7	181	170	351	
III	1	L	8	224	204	428	
IV	1	L	6	166	150	316	
V	1	L	6	143	132	275	
VI	1	L	8	216	191	407	
		Total	42	1111	1021	2132	1·99
		Mean per leaf		26·45	24·31	50·76	
I	2	R	7	181	199	380	
II	2	R	7	165	170	335	
III	2	R	8	213	242	455	
IV	2	R	7	174	189	363	
V	2	R	8	192	204	396	
VI	2	R	9	198	212	410	
		Total	46	1123	1216	2339	2·19
		Mean per leaf		24·41	26·44	50·85	

Of the 42 leaves examined from 6 left-spiralled palms, 3 had equal numbers of leaflets on both the halves and in another, the right half had excess leaflets. In the remaining leaves, the excess leaflets on the left half ranged from 1-5. On the aggregate, a leaf of the left-spiralled palm bore 8·81 per cent more leaflets on the left-half. Of the 46 leaves from the 6 right-spiralled palms, 5 leaves bore equal numbers of leaflets on both the halves and in 2 others, the left half bore one leaflet more. The excess leaflets ranged from 1 to 5 per leaf. On the whole, a leaf of the right-spiralled palm bore 8·28 per cent more leaflets on the right half. A leaf of a bearing shoot of *Ptychosperma macarthurii* bears 50 to 80 leaflets on both the halves.

8. **Roystonea regia** (H.B.K.) Cook.

Roystonea regia, popularly known as the Royal Palm, or Bottle palm on account of the peculiar bottle-like appearance of the trunk is very popular in Calcutta. The crown of a mature palm bears about 17 green leaves, and with some difficulty it may be possible to follow the normal leaf spirals. Portions of leaves from the two kinds of palms are shown in Fig. 3. Six leaves each from six palms were collected. Of these

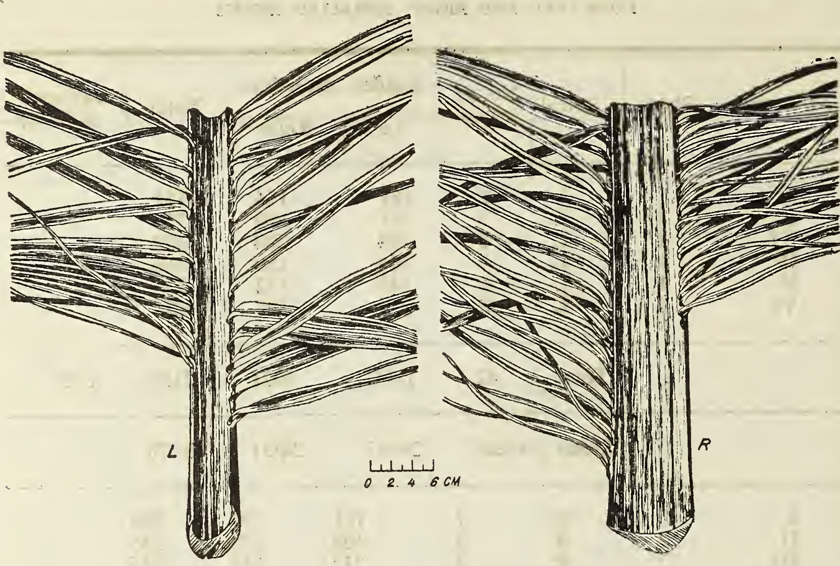


FIG. 3. Dorsal view of portions of leaves from left- and right- spiralled *Roystonea regia.*

4 had left-handed foliar spiral and the others, right-handed spiral. The data are presented in Table 8.

TABLE 8

Roystonea regia : NUMBER OF LEAFLETS ON HALVES OF LEAVES FROM LEFT- AND RIGHT- HANDED PALMS

Palm	Spiral	Number of leaves	Leaflets on halves Left	Leaflets on halves Right	Total	Variance of (L-R)
1	L	6	803	760	1563	
2	L	6	855	830	1685	
3	L	6	1315	1290	2605	
4	L	6	1198	1173	2371	
	Total	24	4171	4053	8224	6·06
	Mean per leaf		173·79	168·88	342·67	
5	R	6	1284	1321	2605	
6	R	6	1184	1217	2401	
	Total	12	2468	2538	5006	11·18
	Mean per leaf		205·66	211·50	417·17	

All the 24 leaves of the four left-spiralled palms bore extra leaflets on their left half, the excess leaflets varying from 1-12 per leaf. The overall excess leaflets on the left half over the right was 2·91 per cent.

Among the 12 leaves from the two right-spiralled palms, only one had an extra leaflet on the left half, and in the rest, the excess leaflets on the right half ranged from 2-12 per leaf. The overall excess on the right half in a leaf was 2·84 per cent. All the leaflets remained free like those of the coconut.

B. Palmate palms

Among the five species of palms with palmate leaves studied, *Licuala spinosa* and *Rhapis excelsa* are suckering species. While the very useful *Borassus flabellifer* grows wild in West Bengal as well as in most other regions in India, the other four species are grown in parks and near houses as ornamentals.

9. **Borassus flabellifer** Linn.

In this species, the leaves are arranged in three clear spirals, all running either clockwisely or counter-clockwisely in a palm. The leaves are costa-pinnate and most of them paripinnate. In some leaves, it is rather difficult to make out whether the leaf ends in a pair of leaflets or a single one. Since the mid-ribs of leaflets always appear to fork away from the rachis, the uppermost two leaflets appear as though each belongs to a different half of the lamina, and hence the leaf may be regarded as paripinnate so far as the accounting of the leaflets is concerned.

12 leaves each from 6 palms (3 left-spiralled and 3 right-spiralled) were cut, and counts and measurements made on them. The data are presented in Table 9.

TABLE 9

Borassus flabellifer : NUMBER OF LEAFLETS ON HALVES OF LEAVES FROM LEFT- AND RIGHT-HANDED PALMS

Palm	Spiral	Number of leaves	Leaflets on halves		Total	Variance of (L-R)
			Left	Right		
1	L	12	444	443	887	
2	L	12	420	419	839	
3	L	12	510	503	1013	
	Total	36	1374	1365	2739	0·80
	Mean per leaf		38·17	37·92	76·09	
4	R	12	461	464	925	
5	R	12	509	506	1015	
6	R	12	561	547	1108	
	Total	36	1531	1517	3048	1.76
	Mean per leaf		42·53	42·14	84·67	

Of the 36 leaves from the left-spiralled palms, 14 had equal numbers of leaflets on halves, and in 6 others, the right-half had more leaflets. In the remaining 16 leaves, the excess leaflets on the left-half was only one per leaf excepting an odd case where the difference was two. The percentage excess of leaflets on the left half over the right is 0.66%. Among the 36 leaves from the right-spiralled palms, 5 leaves had the same number of leaflets on both the halves, and in a further 19, the left half bore more leaflets. The percentage excess on the right half is in the negative, reaching – 0·92%. Thus, in this species the left half of leaves from both the types of palms possessed a small excess number of leaflets, although the difference is not statistically significant.

10. **Licuala spinosa** Wurmb.

As its name suggests, *Licuala spinosa* is beset with numerous prominent spines on the long and slender petioles on either margin, and many suckers at various ages spring from the same clump. Observations were made on a single clump growing at the Indian Statistical Institute having over 40 suckers. Shoots bearing over three metres of stem and bearing flower bunches only were cut and their leaves examined. Only five left-handed and 6 right-handed shoots were available for observation. Portions of the two kinds of leaves are shown in Fig. 4. The data collected on these 11 shoots are presented in Table 10.

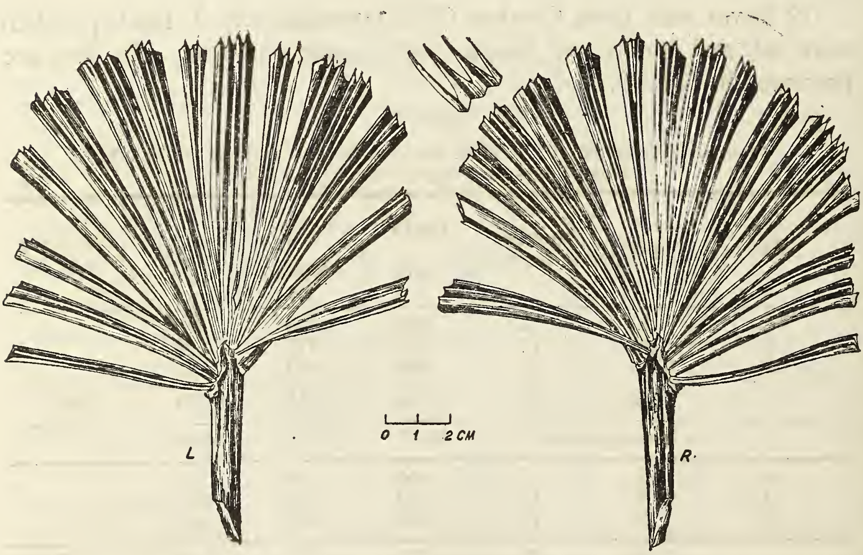


FIG. 4. Dorsal view of portions of leaves from left- and right- spiralled *Licuala spinosa*.

TABLE 10

Licuala spinosa: No. OF LEAFLETS ON HALVES FROM LEFT- AND RIGHT- SPIRALLED SHOOTS

Shoot	Spiral	No. of leaves	Leaflets on halves		Central	Total	Variance of (L-R)
			Left	Right			
1	L	9	216	207	56	479	
2	L	8	180	169	48	397	
3	L	8	193	187	46	426	
4	L	6	137	123	37	297	
5	L	16	374	337	119	830	
	Total	47	1100	1023	306	2429	2·40
	Mean per leaf		23·40	21·77	6·51	51·68	
6	R	14	361	371	81	813	
7	R	11	270	286	61	617	
8	R	6	143	145	31	319	
9	R	7	171	172	34	377	
10	R	5	117	118	25	260	
11	R	5	115	117	26	258	
	Total	48	1177	1209	258	2644	1·51
	Mean per leaf		24·52	25·19	5·37	55·08	

In a left-spiralled palm, usually the leaflets on the right half are seen developing from below those on the other half, and vice versa in a right-spiralled palm. Among the 47 leaves from 5 left-handed shoots, the number of leaflets on both the halves was the same in 10, and only in 2 others, the leaflets on the right half were in excess. On the whole, a leaf of a left-spiralled palm produced 2·72 extra leaflets on the left half than on the right. However, a minor deviation was followed with this species. The leaf is costa-pinnate and the leaflets remain fused in twos, threes, fours and even fives. Only a little over one per cent of the leaflets are, however, free. A few leaflets remain fused at the tip of the compressed peduncle and this cluster is regarded as the odd group and ignored for estimating the number of leaflets on the halves. The central cluster is composed of 4-9 leaflets, which is about 11% of the total leaflets. In the left-spiralled palms, the mean figure for the central leaflets (6·51) was slightly in excess of that for the right-spiralled palms (5·37).

Of the 48 leaves of the six right-spiralled palms, 18 had equal numbers of leaflets on the halves and in a further 5, the left half had more leaflets. However, on the aggregate, the right half of a right-spiralled leaf bore 2·73 per cent excess leaflets.

11. **Livistona chinensis** R. Br.

Livistona chinensis with its luxuriant green crown bearing about 50 green leaves flourishes in Calcutta. Since the stalk of the fruiting bunch is quite long, it clearly slants either to the left of the subtending leaf or to its right. In a left-spiralled palm, the bunch leans (or hangs) on the left side of the subtending leaf, and vice versa, in a right-hander. Leaves from left-spiralled and right-spiralled palms are seen in Fig. 5. Twelve

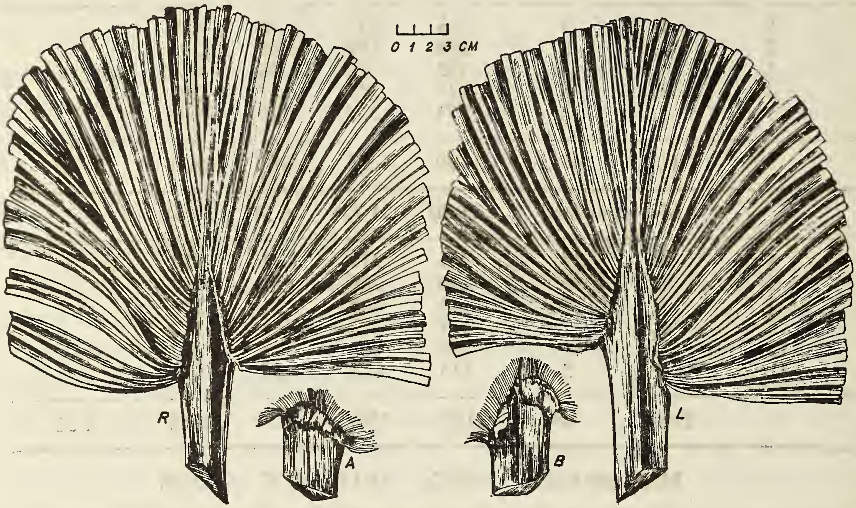


FIG. 5. Ventral view of portions of leaves from right- and left- spiralled *Livistona chinensis.*
Inserts *A* and *B* show the comb on the dorsal side of the lamina-base in these leaves.

leaves each of the 6 palms were harvested and measurements and counts made on them. Data on the left-and right-spiralled palms are presented in Table 11.

TABLE 11

Livistona chinensis: NO. OF LEAFLETS ON HALVES OF LEAVES FROM LEFT- AND RIGHT- SPIRALLED PALMS

Palm	Spiral	No. of leaves	Leaflets on halves: Left	Leaflets on halves: Right	Total	Variance of (L-R)
1	L	12	524	520	1044	
2	L	12	546	541	1087	
3	L	12	568	574	1142	
	Total	36	1638	1635	3273	0·69
	Mean per leaf		45·50	45·42	90·92	
4	R	12	545	555	1100	
5	R	12	500	497	997	
6	R	12	537	540	1077	
	Total	36	1582	1592	3174	2·36
	Mean per leaf		43·94	44·22	88·16	

Of the 36 leaves from the left-spiralled palms, 9 had equal numbers of leaflets on both the halves and in a further 13, the left half had more leaflets. The difference in the rest of the leaves between halves was not appreciable and the number of leaflets on both the halves of many leaves was almost similar. The percentage difference between halves was only 0·18. Among the 36 leaves of the right-spiralled palms, in 13, the number of leaflets on both the halves were similar, and in a further 10, the leaflets on the left half were slightly in excess of those in the right half. The overall picture did not show that the right half has significantly more leaflets than the left, the percentage difference being only 0·63.

Though the leaf of *L. chinensis* is also costa-pinnate, the tip of the rachis can be hardly made out, and the last leaflet may be regarded as deviating either to the left half or the right. Thus, there is no terminal odd leaflet as in *Phoenix sylvestris* or a cluster of leaflets as in *Licuala spinosa*.

12. **Livistona rotundifolia** Mart.

The adult *Livistona rotundifolia* palm is much taller than *L. chinensis* and the former flowers once every year in February-April in Calcutta. It has fewer leaves than the latter. The data are presented in Table 12.

TABLE 12

Livistona rotundifolia : NO. OF LEAFLETS ON HALVES OF LEAVES FROM LEFT- AND RIGHT- SPIRALLED PALMS

Palm	Spiral	No. of leaves	Leaflets on halves		Central	Total	Variance of (L-R)
			Left	Right			
1	L	12	573	575	12	1160	
2	L	11	513	506	6	1025	
3	L	12	505	505	11	1021	
	Total	35	1591	1586	29	3206	3·89
	Mean per leaf		45·46	45·31	0·83	91·60	
4	R	12	568	571	2	1141	
5	R	12	493	498	8	999	
6	R	12	489	500	10	999	
	Total	36	1550	1569	20	3139	2·58
	Mean per leaf		43·06	43·58	0·56	87·20	

Of the 35 leaves from the left-spiralled palms, 8 had the same number of leaflets on both the halves. In a further 12 leaves, the right half bore more leaflets. On the aggregate, the difference between the two halves was not significant. The left half bore only 0·32 per cent excess leaflets. As seen from Table 12, one tree on an average produced more leaflets on the right half of its leaves and another had equal numbers of leaflets on both the halves.

Of the 36 leaves from the right-spiralled trees, 6 leaves had equal number of leaflets on both the halves and in another 12, the left half had excess leaflets. In spite of these deviations, each tree produced a small extra number of leaflets on the right half. However, the difference in no tree was statistically significant. The overall percentage difference between the two halves is 1·23.

Unlike *L. chinensis*, many leaves of *L. rotundifolia* are imparipinnate and the odd leaflet was difficult to be grouped with any side. However, it is not universal with all the leaves. Tree 1 had all the leaves ending with an odd terminal leaflet while only 2 out of 12 leaves of tree 4 had odd leaflets. Sixty per cent of the leaves from all the 6 palms were imparipinnate.

13. Rhapis excelsa Bl.

The rattan, *Rhapis excelsa* in India is an ornamental palm although occasionally its stem is used as a walking stick. In young palms the lamina is bilobed and resembles a pinnate leaf. The number of leaflets that form one of the lobes is significantly more than that on the other

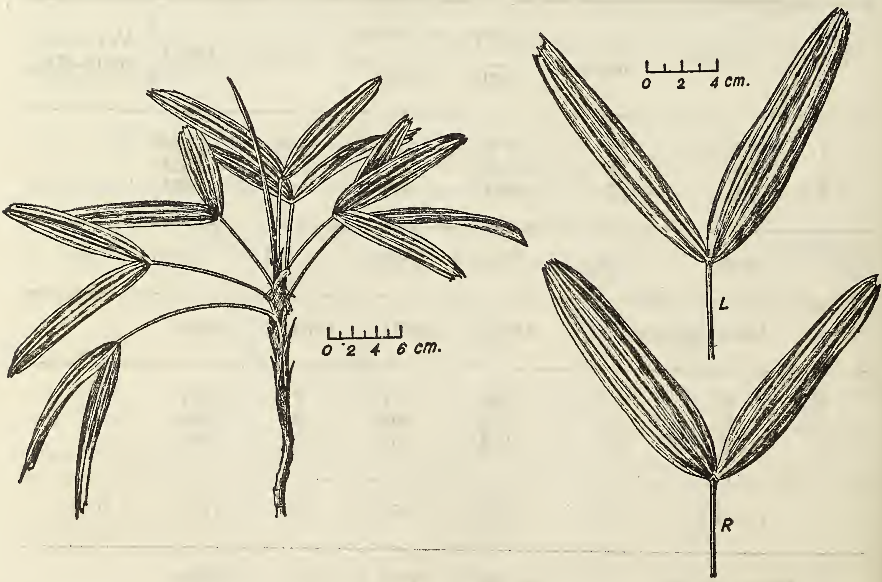


FIG. 6. A shoot of young *Rhapis excelsa*. *L* and *R* are dorsal view of leaves from left-spiralled and right-spiralled palms.

lobe. In a left-spiralled palm the left half possesses significantly more leaflets than its right half, and vice versa, for a leaf of a right-spiralled palm. In Fig. 6 is seen a shoot of a young *Rhapis* palm and dorsal view of one leaf each from left-spiralled and right-spiralled palms.

45 leaves from 6 left-spiralled shoots and 34 leaves from 5 right-spiralled leaves were examined for the number of leaflets, and the data presented in Table 13.

TABLE 13

Rhapis excelsa : NUMBER OF LEAFLETS ON HALVES OF LEAVES FROM LEFT- AND RIGHT- SPIRALLED PALMS

Palm	Spiral	No. of leaves	Length of lamina (cm.)	Leaflets on halves			Variance
				Left	Right	Total	
1	L	10	215·0	67	56	123	
2	L	6	117·5	36	26	62	
3	L	8	131·0	51	40	91	
4	L	7	108·3	38	28	66	
5	L	8	139·3	57	42	99	
6	L	6	94·0	36	28	64	
Total		45	805.1	285	220	505	4·3
Mean per leaf			17·89	6·33	4·89	11·22	
1	R	6	79·0	24	36	60	
2	R	8	131·0	41	56	97	
3	R	5	99·5	25	35	60	
4	R	6	136·5	31	42	73	
5	R	9	156·5	42	59	101	
Total		34	602·5	163	228	391	7·04
Mean per leaf			17·72	4·79	6·70	11·50	

The left lobe of all the leaves from all the left-spiralled plants had excess leaflets compared to their corresponding right half. Similarly without any exception the right lobe of all the leaves from right spiralled plants bore extra leaflets. The percentage difference between halves of leaves of the left-spiralled shoots was 29·54 per cent and the corresponding figure for the right-spiralled ones was 39·88. *Rhapis excelsa* had shown the maximum value for the difference among all the species studied so far.

C. Palms with bipinnate leaves

The species, *Caryota mitis*, is much smaller than *C. urens*, and the former is a suckering species while the latter is single-stemmed. Both are monocarpic palms which complete their life after the first flush of flowering as the main stem ends in an inflorescence.

14. **Caryota mitis Lour.**

Within a clump, left- and right- spiralled shoots are generally noticeable. A shoot at the flowering stage may produce a trunk of 2-4 metres high. The leaves are bipinnate. Usually the distal 2-4 secondary rachises are unbranched. The lamina of a mature leaf measures a little less than 3 metres. The main rachis is paripinnate, but almost all secondary rachises are imparipinnate. Portions of two leaves are shown in Fig. 7.

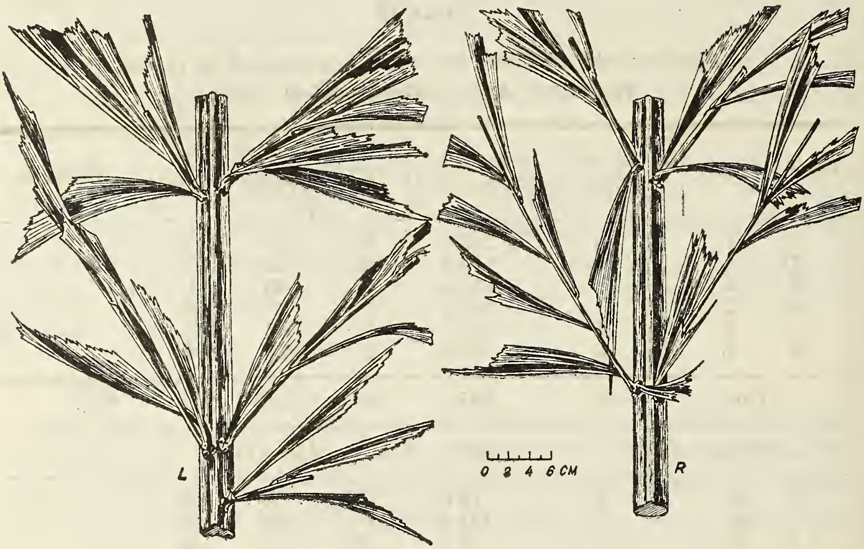


FIG. 7. Dorsal view of portions of leaves from left- and right- spiralled *Caryota mitis*.

Twelve leaves from three left-spiralled palms and 11 from three right-spiralled palms were examined at the Indian Botanic Garden, Calcutta. The secondary branches/leaflets and the leaflets on the secondary as well as primary rachises were counted separately for each half and the data on 23 leaves are given in Table 14.

The general trend that a left-spiralled palm produces an excess of leaflets on the left half of the leaf (compared to the right) is indicated in the present case also since the left half bore 1·98% more leaflets. The reverse situation with a leaf of a right-spiralled shoot is also apparent. Here the right half bore more leaflets than the left half, and the difference was 2·24 per cent. It is also clear from Table 14 that the number of rachises on a particular half increases if it bears a greater number of leaflets.

Each secondary rachis bears one odd leaflet at its tip and two rows of leaflets spread along the same plane of the main rachis (also that of the secondary rachises). Hence some leaflets are distributed with their tips pointing towards the distal end of the leaf, while the others pointing towards the base of the leaf. These leaflets were separately accounted

TABLE 14

Caryota mitis : NO. OF LATERAL RACHISES (LEAFLETS) ON HALVES OF LEAVES FROM LEFT- AND RIGHT- SPIRALLED PALMS

Shoot	Spiral	No. of leaves	Lateral rachises/leaflets on halves: Left		Right		Total	
			Rachises	Leaflets	Rachises	Leaflets	Rachises	Leaflets
1	L	6	95	1508	92	1476	187	2984
2	L	5	56	643	56	637	112	1280
3	L	1	14	222	14	214	28	436
	Total	12	165	2373	162	2327	327	4700
	Mean per leaf		13·75	197·75	13·50	193·92	27·25	391·67
1	R	5	58	998	61	1023	119	2021
2	R	5	69	1106	70	1126	139	2232
3	R	1	14	216	15	223	29	439
	Total	11	141	2320	146	2372	287	4692
	Mean per leaf		12·82	210·91	13·27	215·64	26·09	426·55

for with the leaves of two shoots. A greater number of leaflets are produced on the side of the lateral rachises facing the stalk than those pointing to the distal end.

A secondary rachis with the leaflets it bears is morphologically similar to a leaflet in other species of palms (Periasamy 1962, 1966a & b). In an embryonic palm leaf, two main regions are perceivable—the main body (which develops into the leaf sheath, the petiole and the main rachis), and the lamina wing which develops into leaflets including the secondary rachises in *Caryota* sp.

15. **Caryota urens** Linn.

Eighteen leaves each from 4 right-spiralled and 9 leaves from three left-spiralled *Caryota urens* palms were examined. The lamina region of *C. urens* is much larger than that of *C. mitis* although this varies greatly with individuals. Lower portions of two leaves from right-spiralled and left-spiralled palms are seen in Fig. 8. The number of secondary rachises for each leaf and the number of leaflets in each secondary

FIG. 8. Dorsal view of portions of leaves from left- and right-spiralled *Caryota urens*.

rachis as well as the main rachis were accounted for separately. The data are presented in Table 15.

TABLE 15

Caryota urens : NO. OF LATERAL RACHISES/LEAFLETS ON HALVES OF LEAVES FROM LEFT- AND RIGHT-SPIRALLED PALMS

Palm	Spiral	No. of leaves	Lateral rachises & Leaflets on halves				Total	
			Left		Right			
			Rachises	Leaflets	Rachises	Leaflets	Rachises	Leaflets
1	L	3	72	1845	70	1823	142	3668
2	L	3	72	2165	72	2185	144	4350
3	L	3	71	1957	70	2040	141	3997
Total		9	215	5967	212	6048	427	12015
Mean per leaf			23.89	663.00	23.56	672.00	47.45	1335.00
1	R	3	58	1772	61	1911	119	3683
2	R	3	70	1930	70	1834	140	3764
3	R	6	123	2567	127	2615	250	5182
4	R	6	108	2762	114	2806	222	5568
Total		18	359	9031	372	9166	731	18197
Mean per leaf			19·94	501·72	20·67	509·22	40·61	1010·94

* A leaf of the left-spiralled palm bore on an average 47·44 secondary rachises and 1335·00 leaflets. Out of the nine leaves, only two had extra secondary rachises on the left half and all did not bear extra leaflets on this left half. But the right half bore, on an average, 1·36 per cent more leaflets than the left half.

From observations made on the 18 leaves of the right-spiralled palms, it was found that a leaf on an average bore 40·61 secondary rachises and 1010.90 leaflets. The right half of a leaf of a right-spiralled palm bore a slight excess of secondary rachises as well as leaflets. The percentage excess of leaflets on the right-half over the left accounted for only 1·49 per cent.

Discussion

The leaves of all types of palms are practically asymmetric bilaterally as evidenced by the data on the number of leaflets presented in the preceding tables. This asymmetry is caused primarily by the spiral arrangement of leaves on the trunk. From a study on the arrangement of leaves in a number of palm species, Davis (1970c) had generalised that any two consecutive leaves on a palm are placed at an angle of 137·5°. This angular deflection makes with the remaining angle (222·5°) to complete one full revolution, a proportion, 0·618 which is spoken of as Golden Proportion.

In some species of palms like *Areca catechu*, only a single foliar spiral is visible. But in *Arenga pinnata* two spirals are clearly visible. Palms like *Borassus flabellifer* possess three distinct spirals. *Cocos nucifera* bears five and *Elaeis guineensis* eight clear spirals. From the scars of *Phoenix canariensis*, thirteen spirals can often be made out. All the above numbers (1, 2, 3, 5, 8, 13) happen to be the stages in the Fibonacci Sequence. That a palm gets a foliar number synchronising with one of the Fibonacci Numbers has been attributed to the fact that the leaves are arranged according to the Golden Proportion. The Fibonacci Numbers, excepting the few lower ones, also make the same ratio between consecutive ones. One point arising from the number of spirals per tree has been given adequate consideration. All species of palms which show only one spiral each will fall in conformity with the spiral formed on the basis of two consecutive leaves from the direction of the older towards the younger leaf. But in a palm having two clear spirals, the direction of the spirals will be opposite to the single spiral. The direction of the spirals of palms showing three or eight spirals is like that of the single spiral. But the two, five as well as the thirteen spirals run opposite to the single spiral. It may be remembered that the numbers 1, 3, 8 etc. alternate with 2, 5, 13 etc. in the Fibonacci Sequence. Therefore, the apparently visible foliar spirals in some species of palms do not synchronise with the direction of the single spiral based on the position of two consecutive leaves. Therefore, the direction of the single spiral was followed for all the species.

The pinnate leaves show bilateral asymmetry more vividly than the palmate and bipinnate types. However, young *Rhapis excelsa* of the palmate type is an exception. Although all *R. excelsa* palms later on develop palmate leaves, young seedlings with their two undivided halves appear more pinnate.

In *Caryota* sp., the secondary rachises which correspond to the leaflets in other species do not show any significant difference in their numbers between halves although the difference is in the expected direction. However, the number of the ultimate leaflets happen to be slightly more on the right half of leaves belonging to the left- as well as the right-spiralled palms. But the difference is very small.

A mention may be made in favour of Corner (1966) who described the *Caryota* as having imparipinnate main rachis, which was criticized by Moore Jr. (1967). But the main rachis in 34·62% of the leaves of *Caryota urens* examined by us ended in a single leaflet. Of the 1158 secondary rachises relating to the 27 leaves, 8·64% deviated from the general rule by having a pair of leaflets at their tip (instead of a single leaflet). It would appear, therefore, that Moore's criticism on this point is not based on the whole truth.

In order to find out the possible factors influencing the asymmetry, the number of green leaves a palm bears at a time, number of leaflets per leaf, length and area of the lamina, thickness of the stem, and the number of foliar spirals per species were considered. Of these, the number of green leaves per crown seems to have a positive association on the asymmetry of the lamina. Table 16 gives the mean number of leaves per species and the percentage difference in the number of leaflets between halves of leaves for 15 species. In some of them the percentage difference relating to the leaves of left-spiralled palms differed greatly from those of the right-spiralled ones as in *Rhapis excelsa*. Hence, the mean of the two percentages was worked out and the values given under the last column of Table 16.

When the above data are plotted (Fig. 9), the species with pinnate leaves (young palms of *Rhapis excelsa* are regarded as pinnate) show a greater degree of association between the number and the asymmetric nature of the leaves. The palmate species occupy the lower position in the graph. The two species having bipinnate leaves fall between the pinnate and palmate types. *Phoenix sylvestris* having about eighty green leaves and showing an appreciable difference between halves of leaves finds its position very odd. The data on *Nypa fruticans* are too limited to attach importance on their significance.

Species having smaller numbers of green leaves per crown show the difference between halves more conspicuously than those with larger number of leaves.

One of the reasons for this situation seems to be that with fewer leaves in the crown, they undergo a greater torsion to cope up with the wider space available than a species having a greater number of leaves in the crown. In the latter case, the leaves making very narrow internodes on relatively thick stems seem to show the least torsion and thus

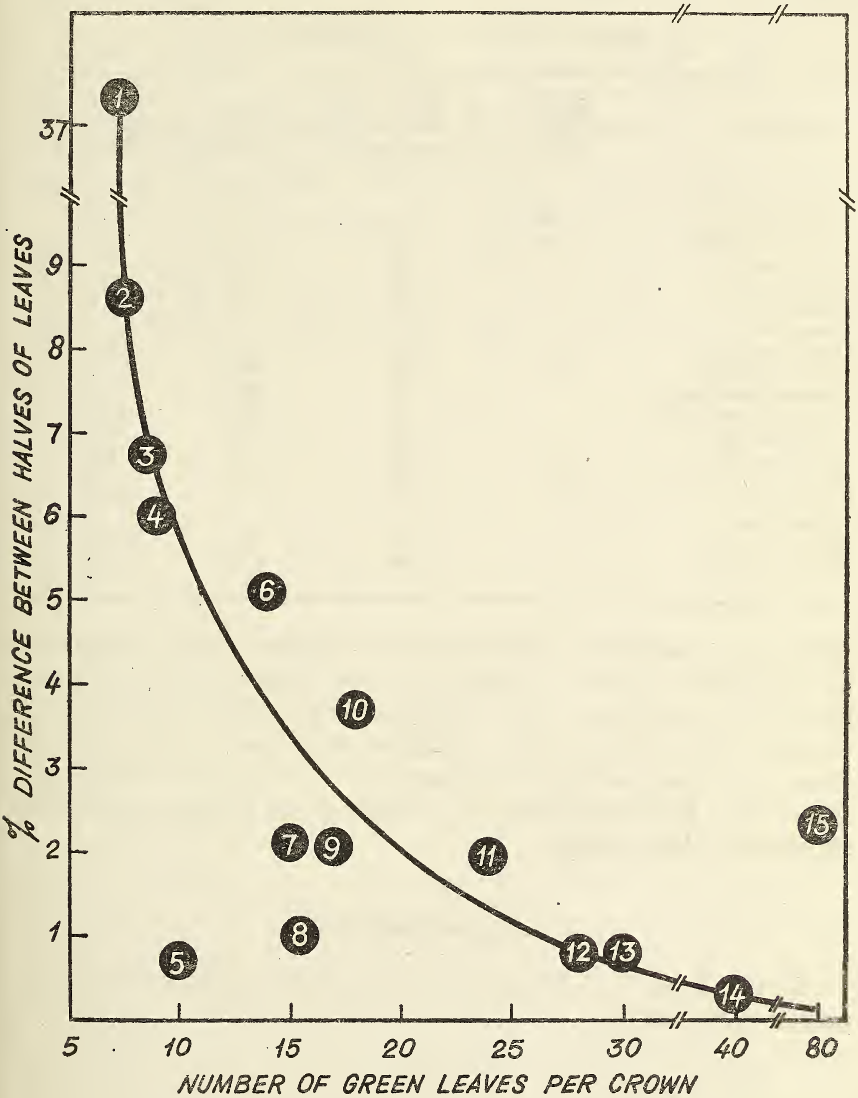


FIG. 9. Graph showing the percentage difference in the number of leaflets between halves of leaves.

The numbers represent: 1. *Rhapis excelsa*; 2. *Ptychosperma macarthurii*; 3. *Areca catechu*; 4. *Chrysalidocarpus lutescens*; 5. *Nypa fruticans*; 6. *Licuala spinosa*; 7. *Caryota mitis*; 8. *Phoenix paludosa*; 9. *Roystonea regia*; 10. *Caryota urens*; 11. *Cocos nucifera*; 12. *Livistona rotundifolia*; 13. *Borassus flabellifer*; 14. *Livistona chinensis*; 15. *Phoenix sylvestris*.

unfold along the same direction of their origin. The structure of the stem also supports this view. A striking analogy is the situation met

TABLE 16

SUMMARY OF DATA ON 15 SPECIES OF PALMS

Species	No. of experimental palms	No. of leaves examined	No. of green leaves per palm	% diff. between halves of leaves
Areca catechu	6	47	8·5	6·78
Borassus flabellifer	6	72	30·0	0·72
Caryota mitis	6	23	15·0	2·11
Caryota urens	7	27	18·0	1·44
Chrysalidocarpus lutescens	12	88	9·0	6·04
Cocos nucifera	6	72	24·0	1·93
Licuala spinosa	11	95	14·0	5·11
Livistona chinensis	6	72	40·0	0·41
Livistona rotundifolia	6	1	28·0	0·77
Nypa fruticans	1	10	10·0	0·90
Phoenix paludosa	6	60	15·5	0·96
Phoenix sylvestris	6	80	80·0	2·31
Ptychosperma macarthurii	12	88	7·5	8·56
Rhapis excelsa	11	79	7·2	33·94
Roystonea regia	6	36	17·0	2·88

with in *Agave sisalana*. The leaves of young agave plants having three or four leaves are greatly asymmetric. The numbers of spines on both the margins are unequal. In a left-spiralled plant the left margin bears a significantly greater number of spines, when young. But when the plants grow and possess 40-50 green leaves, the leaves become more symmetric. That is, the numbers of spines on the margins do not differ significantly (Mitra 1968).

ACKNOWLEDGEMENT

We thank Mr. S. K. De, Artist of the Indian Statistical Institute, for preparing the drawings.

REFERENCES

CORNER, E. J. H. (1966): The Natural History of Palms. London.

DAVIS, T. A. (1962): The non-inheritance of asymmetry in *Cocos nucifera*. *J. Genet.* **58**: 42-52.

——— (1963): The dependence of yield on asymmetry in coconut palms. *J. Genet.* **58**: 186-213.

——— (1970*a*): Fibonacci Numbers for palm foliar spirals. *Acta Botanica Neerlandica* **19**: 236-243.

——— (1970*b*): Right-handed, Left-handed and Neutral palms. *Principes, J. Palm. Soc.* (In press).

——— (1970*c*): Why Fibonacci system for palm leaf spirals. *Fibonacci Quart.* (In press)

—— & KUNDU, A. (1966): Aestivation of perianths of *Areca catechu* Linn. fruits. *J. Bombay nat. Hist. Soc.* **63**: 270-282.

MITRA, A. (1968): Thesis for the degree of D. Phil. (Science), Calcutta University.

MOORE, H. E. Jr. (1967): Review of E. J. H. Corner's, "The Natural History of Palms." *Nature* **215**: 560-561.

PATEL, J. S. (1938): The coconut, a monograph. Govt. Press, Madras.

PERIASAMY, K. (1962): Morphological and ontogenetic studies in palms. I. Development of the plicate condition in the palm leaf. *Phytomor.* **12**: 54-64.

——— (1966*a*): Morphological and ontogenetic studies in palms. III. Growth pattern of the leaves of *Caryota* and *Phoenix* after the initiation of plicates. *Phytomor.* **16**: 474-490.

——— (1966*b*): Morphological and ontogenetic studies in palms. IV. Ontogeny of vascular pattern in four genera. *Aust. J. Bot.* **14**: 277-291.

Reviews

1. BEAUTIFUL GARDENS. By M. S. Randhawa. pp. 168 (28·5 × 22 cm.). With 18 coloured and 12 monochrome plates. New Delhi, 1971. Indian Council of Agricultural Research. Price Rs. 29.50.

This is not intended to be a book on gardening. It seeks to interest the reader in, and to introduce him to, beautiful flowering plants and their uses. The author does this by telling the reader about gardens and gardening in different countries at different times, and by suggesting how flowering plants may be used. We Indians have always been fond of flowers, as will appear from the extracts from folk songs cited by the author from different parts of India. Flowers have been and still are important to the Indian, particularly in religious worship, and one often wishes that we still believed, as the author tells us we once did, that there is no merit in an offering of flowers unless they come from the devotee's own garden! As regards the use of flowering trees, economic conditions being what they are today, private persons are seldom in a position to use the knowledge here offered. The advice contained herein might properly be addressed to persons concerned in the planning and upkeep of public parks or the construction of roads and other places of public resort. The book is well illustrated in colour and monochrome, but for some reason there are no acknowledgements to the artists and photographers.

Several flowering plants are referred to in the text only by their vernacular names, e.g. *kikar, phulahi, lodhra, maghya, piayo, kuravaka, sumanasa,* and *kovidara.* The scientific names should have been added to help the reader to identify the plants referred to. I would suggest that, if a second edition of the book is called for, an appendix be added showing the scientific names against the vernacular names used in the text.

I cannot understand the author's assertion at page 12 that 'ornamental trees have no place on our national or State highways and canal plantations'. I have seen several flowering trees used very effectively as roadside trees, e.g. the Gul Mohur (*Delonix regia*), the Kadamb (*Anthocephalus indicus*), the Rusty Shield-bearer (*Peltophorum inerme*), the Laburnum (*Cassia fistula*), the Karanj (*Pongamia pinnata*), and the Dandus (*Lanceolaria dalbergia*). Also, there are such trees which are beautiful apart from their flowers, such as the Spanish Mahogany (*Swietenia mahagoni*), the Deodar (*Polyalthia longifolia*), the Pipal (*Ficus religiosa*), etc.

Speaking of the Padauk (*Pterocarpus indicus*) the author says at p. 145, serial 45, that it is a native of Burma and Malaya, and at page 148, serial 9, describes it as a native of the Andamans. Father Blatter in SOME BEAUTIFUL INDIAN TREES and A. P. Benthall in THE TREES OF CALCUTTA AND ITS NEIGHBOURHOOD agree that it came to us from Malaya.

D. E. R.

2. WORLD WILDLIFE: THE LAST STAND. By Philip Kingsland Crowe. pp. 308 (24×16 cm.). With many illustrations. New York, 1970. Charles Scribner's Sons. Price $7.95

This book is the account of wildlife missions undertaken by Ambassador Crowe in 54 countries over a period of 6 years. When one is travelling at the pace at which the author has done, it becomes extraordinarily difficult to catch the essence of the conservation problems facing different areas, or not to miss out some crucial factor, or overemphasize some aspect that is presented to the visitor by persons with particular predilections. One has also to do ones homework fast and efficiently to be able to recount later the persons and places one has been to. From this point of view the book is a fine example of how much one can take in. Placed as he was, the author has made use of his opportunities to the full, and has done a remarkable job in stimulating conservation in all the countries he visited.

Obviously this pace makes for some errors. In the Chapter on India he refers to the 'Flame of the Woods' instead of the Flame of the Forest. His assessment of the Indian problem is based entirely on his talks with E. P. Gee, and his visits to Kaziranga and Manas. About Manas he says 'Later on the officials of the Manas Sanctuary reported to Gee that his efforts to stop the grazing of domestic buffalo in the Sanctuary have been successful.' One earnestly wishes that this was true but overgrazing by domestic animals remains one of the most serious problems of the Indian scene. Describing his visit to the Carribean he refers to the Columbian Boa Constrictor as a poisonous species, while in fact it is a non-poisonous snake.

But this book refers scientifically and interestingly to a whole lot of threatened species round the world: the Nyan (*Ovis ammon hodgsoni*) in Sikkim, the largest of all wild sheep; the Howling Monkeys (*Alouatta*) of Panama; the Sea Turtles (*Chelonia mydas*) of Ascension Island equidistant from the coast of S. America and Africa; the Whitewinged Doves of Costa Rica; Colobus Monkeys, Gorillas and the world's largest frog (*Conrua goliath*) of Equatorial Africa. There are valuable references to books, institutions and people connected with Natural History and Conservation and in fact travelling with Philip Crowe through 54 countries in this book is a very good way to refresh ones geography. We cannot but agree with Prince Bernhard of the Netherlands, who says in the foreword that 'this book will bring the cause of Wildlife Conservation nearer to the hearts of a great number of people'.

Z. F.

3. LAC LITERATURE: A BIBLIOGRAPHY OF LAC INSECTS AND SHELLAC. By Rajendra Kumar Varshney. pp. vi+216 (22×14 cm.). Calcutta, 1970. Shellac Export Promotion Council.

Lac is one of the rare commercial products which has not lost its commercial value or general interest from time immemorial to this day. It is of common knowledge that it is produced in mass by innumerable small insects. This crude lac is collected by poor people generally and is marketed. There are regular cultivations in some areas. There are also organised markets and a large number of people dealing in it both local and foreign. The crude lac is refined and is used for producing different valuable products involving a very large number of people. A vast literature has, therefore, developed on this subject written by Indian and foreign workers and published all over the world. This deals with the production of lac involving insect types and the host plants, marketing, refining and the uses to which the lac is put. The present publication includes the titles of all such literature including the names of the authors arranged alphabetically and their publishers. It will be very useful for reference for workers on lac and shellac in any branch. The author has taken great pains in compiling an index at the end dividing the whole literature in five parts viz. General, Lac insects, Lac cultivation, Enemies of lac and Shellac. In the first he gives references to books, monographs and reports of historical, geographical and such other literature, giving greater details about Indian work. In the second he includes taxonomy, regions of work, fundamental studies etc. In the third he has given references to host plants, their cultivation etc. The pests, parasites on insects and their biological control etc. are dealt with in the 4th and the 5th deals with the chemical and technological studies. It will be, therefore, an excellent guide for references on anything dealing with lac and lac products. It claims to include almost all literature on the subject published from the earliest times up to 1966 and contains about 2600 references.

Some errors have crept in probably due to undue haste in the publication of the book. They are in the authors own words: 'At the printing stage some alterations have been made, due to which, unfortunately, the material to be printed in italics, like scientific names and names of Journals, has also been given in roman print; the volume number have not been given in bold types; and many other errors, particularly of punctuations, have crept in.' Grammatical and spelling mistakes also have occurred and one or two pages at the end are missing.

N. T. N.

4. THE BIOCRATS: By Gerald Leach. pp. 317 (22×14 cm.). London, 1970. Jonathan Cape. Price £1·75.

Gerald Leach has written a fascinating and thought provoking book, which should be read by everyone connected with the biological sciences.

In this book the possible, and probable, implications of the rapid technical advances in the biological sciences are discussed. The author starts with birth control — disdaining the prevailing euphemisms for this activity — the methods available for this purpose, and the possible, as well as preferred directions of further research. He points out that the prevailing methods have had very little impact on the population problem as a whole, mainly because of our unsystematic approach to the problem. True population control, he feels, can come only after we have made up our minds what is desirable i.e. what strength of numbers we consider optimum. It is only when a desirable norm is set by intelligent discussion, that we can set about discussing the ways of applying existing knowledge and of directing further researches to achieve it. Whether we can agree on the desired size of our population is another problem, fraught with difficulties, but it is emphasized that it has to be done, if any effective action is to be planned.

To a certain extent, such agreement on desirable norms is an essential prerequisite for effective application of many of the other advances in biology. Artificial insemination to help childless couples, is already resorted to. Artificial implantation of an ovum fertilized in vitro (which is as far as the author considers 'test tube babies' likely to become a reality) may be the next logical step. Such methods cannot, in all conscience, be applied haphazardly, and most doctors concerned with A.I.D. do take pains to get healthy, and, as far as possible on general grounds, eugenically desirable donors. If both parents are 'external' there is no restriction of choice and obviously the most desirable donors should be sought. As to what constitutes desirability in a donor we must establish standards by genetic mapping or other means, which would be acceptable to most people. The question then arises, why such genetically 'ideal' babies should be provided only to the childless. Even mothers who can have their own children may desire to have offspring which, having a perfect or near perfect set of genes, are likely to be strong, intelligent and potential leaders. This raises many questions. Where does this stop? Who is to regulate the processes of selection? How do we ensure that any official or semi-official body entrusted with such selection and regulation will not misuse its powers?

The book goes on to discuss the problem of children with metabolic defects. The localization and treatment of such defects has advanced considerably in recent years. However, these children, in many cases, need special care, special nursing, special schools etc. The cost of providing such services to all who need it, and the resultant increased cost due to survival of larger numbers under such care are discussed.

Expenditure is also a factor to be considered where patients are kept alive by machines substituting for irremediably damaged organs. The kidney machine and the heart lung machine are still so expensive that there is no hope of providing them for every patient in need. Transplant surgery, the artificial heart etc. are all developments which offer hope in this field. The author believes that transplants could be made available to replace all the damaged organs, if proper international agencies are set up. (This presupposes, of course, the doubtless valid, but depressing assumption that deaths from violent causes will keep pace with the growing population). Training of the requisite number of surgeons and auxiliary workers, and equipping of hospitals etc. for this purpose may be more difficult. The author gives some interesting figures for the probable costs involved in various procedures. Where such huge costs are involved, it is inevitable that decisions must be taken at governmental or semi-governmental levels. While a single hospital doing transplant surgery can manage with donations and special grants, the position will change if it becomes a routine procedure. The selection of suitable patients for such treatment can no longer be left to the expert, or even to a lay jury. While not explicitly stated, the implication is obvious, that there are grave dangers of abuse of power, where new techniques and advances are ushered in without also laying down the criteria for their application. In many cases these involve social and economic considerations and can only be decided by general discussion with full awareness of the facts and their implications, so that society can decide firstly on the goals they desire to attain in a particular direction, and secondly on what should be spent on achieving that goal, both in the way of developmental research, and in actual cost of implementation. Such awareness and discussion would also be a safeguard against abuse of the powers which these techniques would confer on agencies which incur the necessary expenditure. The author believes that people 'will not stand' for excessive interference in their personal lives. The fear that a government may lay down 'desirable' genetic characters for the succeeding generation, or use the power of selection for special services like transplants, as a political lever, appear to him to be far fetched. But the possibility cannot be ignored and is inherent in any technical advance which, by virtue of complexity or cost must depend on government for its application. The Biocrats, therefore should act now to discuss the implications of such trends, to define the desirable goals to be achieved, and to lay down acceptable criteria for application of the new biological techniques in ways which would be to the best advantage of society.

A. N. D. N.

5. THE WEALTH OF INDIA: A DICTIONARY OF INDIAN RAW MATERIALS AND INDUSTRIAL PRODUCTS. Raw Materials. Vol. VI Supplement. pp. xi+274 (27·5×21·5 cm.). With 6 plates and 30 text figures. New Delhi, 1970. Council of Scientific & Industrial Research. Price Rs. 70/-, $21.00, 140*s*.

This volume, issued as a supplement to Vol. VI (L-M) of the RAW MATERIALS series, comprises one article which, under the title 'Livestock (including poultry)', deals with all aspects of the livestock wealth of India. The extent of the ground covered will be indicated by the headings of the component sections: Cattle and Buffaloes, Sheep, Goats, Pigs, Horses and Ponies, Donkeys and Mules, Camels, Yaks, Chemistry of Livestock Products, Marketing and Trade, Poultry. The article is compiled from contributions made by specialists in the different subjects and gives in concise and general terms the latest information available. A sectional bibliography is appended to guide readers in search of more detailed or later information.

The authors indicate the work that has been done improve existing livestock for the different purposes for which it may be used, and point out that local conditions and the demands of the local market will generally dictate for what purpose livestock may usefully be kept in any particular locality. It is up to intending livestock keepers, therefore, to decide on the needs of the local market and then to avail themselves of the facilities available to provide themselves with suitable livestock.

D. E. R.

6. SIGNALS FOR SURVIVAL: By Niko Tinbergen and Hugh Falkus. Drawings by Eric Ennion. pp. 80 ($28 \times 21 \cdot 5$ cm.). Oxford, 1970. Clarendon Press. Price £2.00 net.

A fascinating book, profusely and beautifully illustrated. Animals communicate with each other by means of posture, movement, sound, and colour. The authors take us through the life of a lesser black-backed gull colony, and interpret the signals as they take us along.

D. E. R.

7. NATURE CONSERVATION IN BRITAIN: By Dudley Stamp. pp. xiv+273 (22×15 cm.) with 23 illustrations and 5 maps. London, 1969. Collins. Price 36*s*. net.

The aim of the New Naturalist series in the words of the Editors is 'to interest the general reader in the wild life of Britain by recapturing the enquiring spirit of the old naturalists'. This series was planned during the war years when the meetings of the Editors were always intercepted by air raid warnings. Yet their objective has been splendidly accomplished, because the initial printing order was increased from 5,000 to 10,000, and then to 20,000 at the last minute. The other books in the series printed to date include: British Game by Brian Vesey — Fitz Gerald; Wild Flowers by John Gilmour & Max Walters; Insect Natural History by A. D. Imms; Birds and Men by

E. M. Nicholson; British Mammals by L. Harrison Mathews; Man and the Land by Sir Dudley Stamp; The World of Spiders by W. S. Bristowe, etc.

To write well on conservation one has to be a polymath, and Sir Dudley an outstanding geographer with an obsession for so many sciences was ideally suited to write on this subject.

Conservation is ultimately concerned with establishing priorities of land use, and in a country as crowded as Britain, where there is only one acre per person as against 12 acres per head in the United States, and a world average of 11 acres per individual, shortage of land is the core of the British problem. The Author draws attention to the interesting fact that many of the most aesthetically pleasing features of the British landscape, the Moors and the Heaths are not 'natural' or even 'semi-natural'. These resulted from the mediaeval destruction of forest and woodland. We have to accept change for granted, but so long as there are a large number of people interested in the outdoors, it will always be possible to retain the essential elements of the countryside within the broad plan of a country's development. The Author pays justifiable tribute to the work of the various county Naturalist Trusts which have played such an outstanding part in identifying species and habitats needing special protection. It is ultimately the interest of the British public that has been responsible for saving so much of their wild scenery against the onslaught of development, and the Author discusses constructively the work done by voluntary societies in preserving England's green and pleasant land. The Commons, Open Spaces and Footpaths Preservation Society (1865), the Royal Society for the Protection of Birds (1904), the National Trust (1895), the Society for the Promotion of Nature Reserves (1912), are but a few which have been crucially involved with the landscape of the country.

These Societies and the score of others which exist in various Counties paved the way for the establishment in March, 1949 by Royal Charter of the Nature Conservancy. It was set up to provide scientific advice on the conservation and control of the natural flora and fauna of Great Britain; to establish, maintain and manage nature reserves in Great Britain, including the maintenance of physical features of scientific interest, and to organize and develop the scientific surveys related thereto'. The Nature Conservancy has established National Nature Reserves, Forest Nature Reserves, Local Nature Reserves, National Wild Fowl Refuges, Research Stations, Field Stations and Experimental Stations. The phenomenal success of the Conservancy was due to the genius of Max Nicholson its Director General from 1952 to 1966. Though every country must evolve its own institutions based on local conditions, a detailed study of the working of the Nature Conservancy in England would be of great value to this country in shaping the new conservation organizations that are being set up by the Centre and the States.

The book contains useful indices including a bibliography, a brief account of the structure of the Nature Conservancy, and a list, County-wise, of conservation and allied areas.

Z. F.

Miscellaneous Notes

1. A NOTE ON THE BIRTH OF A GOLDEN CAT (*FELIS TEMMINCKI*) IN CAPTIVITY

The female of a pair of normal coloured golden cats (*Felis temmincki*) with the Nandankanan Zoo (Orissa) since 29.iii.1967 gave birth to a black coloured female cub on 19.iv.1970. However, the cub died within 48 hours of birth. The dead cub weighed 110 gm. and measured 29 cm. from tip to tip including the 9 cm. long tail. The body coat was thick and black without any pattern.

In the available literature there is no mention of birth weight and size (Crandall 1965; Walker *et al.* 1964; Prater 1965). According to Prater (loc. cit.) the cubs have longer and thicker coat than the adults and lack pattern. According to Walker *et al.* (loc. cit.) melanistic specimens are fairly common. There are several records of birth of this cat in captivity in U.S.A.

ACKNOWLEDGEMENT

The author is grateful to the Wild Life Conservation Officer, Orissa, Cuttack-1 for the facilities provided.

NANDANKANAN ZOO,
P. O. BARANG,
DIST: CUTTACK,
ORISSA,
December 17, 1970.

L. N. ACHARJYO

REFERENCES

CRANDALL, LEE S. (1965): The management of Wild Mammals in captivity. The University of Chicago Press, Chicago and London. p. 365.

PRATER, S. H. (1965): The Book of Indian Animals. Bombay Natural History Society and Prince of Wales Museum of Western India, Bombay. pp. 72-73.

WALKER, EARNEST P. *et. al.* (1964): Mammals of the World, Vol. II, The Johns Hopkins Press, Baltimore. p. 1276.

2. OCCURRENCE OF THE FLAMINGO IN INTERIOR MAHARASHTRA

Approximately sixty flamingos, *Phoenicopterus roseus*, were sighted near the village of Madh 112 kilometres from the Arabian Sea on September 7, 1970.

Flamingos are recorded sporadically throughout the Indian continent but no specific reference is given to their occurrence in the interior. Madh is located 15 kilometres north of Junnar in Poona District, Maharashtra (74° E., 19·5° N.) at an altitude of 2000 feet. Flocks of several hundred flamingos have been reported by the forest guards for the last three years in the flooded valley of the Pushpavati River during the height of the monsoon. This flat valley is approximately 10 square miles in area with many tanks and flooded rice fields. Steep mountains border the valley. The birds stay in the area for approximately one week depending on the amount of rain.

If during the monsoon flamingos regularly come to the area near Madh, it offers an opportunity to study their migratory patterns and freshwater food. Unfortunately, during that time, Madh is accessible only by foot or bullock cart.

We wish to thank Shri Wayal, the Forest Range Officer at Madh, for information and facilities.

MUSEUM OF ARTHROPODA,
471 SHANWAR,
POONA 30,
September 24, 1970.

S. M. KETKAR
LINCOLN GRAY

3. OCCURRENCE OF THE BARHEADED GOOSE, *ANSER INDICUS* IN JASDAN (GUJARAT)

The Barheaded Goose has been recorded once in Gujarat at Jamnagar in 1951, and Maharao Vijayaraji of Kutch mentioned years ago that it was a rare winter visitor to Kutch. There seem to be no other records for Gujarat, so it was a pleasant surprise to see 4 Barheaded Geese on a nearby lake on the 16.xii.70. Surprisingly the birds allowed a close approach to within 50 yards without being unduly disturbed.

JASDAN,
GUJARAT,
December 17, 1970.

SHIVRAJKUMAR KHACHAR

4. NOTE ON BREEDING OF RUDDY SHELDUCK, *TADORNA FERRUGINEA* (PALLAS) AT DELHI ZOOLOGICAL PARK

During winter months, the ponds of Delhi Zoological Park teem with water fowl of every description. Eleven species of migratory ducks including Ruddy Shelduck have been observed and recorded from November to February each year.

The ponds which were constructed in 1959 for displaying pinioned water birds are about two acres in area. These ponds are part of a continuous channel system forming a barrier on one side for the animal enclosures. A few prosopis trees growing on four small islands in the ponds, provide ideal nesting places for cormorants, egrets, herons and painted storks which congregate on these trees in large numbers during their nesting season. Clusters of typha and other reeds growing along the banks of these ponds provide good cover for the birds to nest.

The Ruddy Shelduck is largely a palaearctic breeding species and it is thus of interest to record that Ruddy Shelducks have bred twice in the ponds of Delhi Zoological Park which is outside their usual breeding range.

On 22nd April, 1969, a pair were seen with seven freshly hatched ducklings in the ponds. The parents kept a constant watch always keeping them in sight. Out of the seven, four fledged, and three were killed by crows and kites.

Again in 1970, a Shelduck laid six eggs on one of the islands of the pond. Four hatched on 27th April, 1970 and all the four ducklings fledged.

DEPUTY DIRECTOR, J. H. DESAI
DELHI ZOOLOGICAL PARK,
NEW DELHI,
November 19, 1970.

5. THE PIED MYNA, *STURNUS CONTRA* (LINNAEUS) IN BOMBAY

After the onset of monsoon, on 29 June, 1969, I saw a mixed flock of the Common [*Acridotheres tristis* (Linnaeus)] and the Pied Myna (*Sturnus contra* Linnaeus) feeding in a marshy corner in the compound of the Fertilizer Corporation of India, Trombay, Bombay. The Pied Myna was more numerous and some of them appeared to be juvenile.

For more than a week, I found these birds visiting the same place in the mornings at about 7. Later, I only saw an occasional individual or a pair.

This year (1970) after the first few showers of rain on June 4th, a pair of these birds was seen at the side of the Sion-Trombay Road. After a few days, on June 17th, 1970, another (?) pair was found near the Marouli Church, Trombay, busy collecting twigs, straw etc. and carrying them to a tamarind tree near the church. The nest was large and globular. Another, slightly smaller, was also seen on a mango tree about a furlong away. Both these nests were exposed to the sky with no branches over them.

After a few days, the adults were seen carrying food to the five young in the nest on the tamarind tree. Later, the young were flying about with their parents in the vicinity of their nest.

This note was prompted by the fact that the Pied Myna was not included in THE BIRDS OF BOMBAY AND SALSETTE (1937), but my attention has been drawn to a note by Messrs Sálim Ali and Humayun Abdulali in 1953 (*JBNHS* **51**: 736) in which they record this species breeding near Dharavi. Mr. Abdulali informs me that he has since continuously seen this bird, often in pairs and small parties, and there appears to be little doubt that it has now established itself in this area.

NATURAL HISTORY SECTION, PRINCE OF WALES MUSEUM, BOMBAY, *October* 22, 1970.

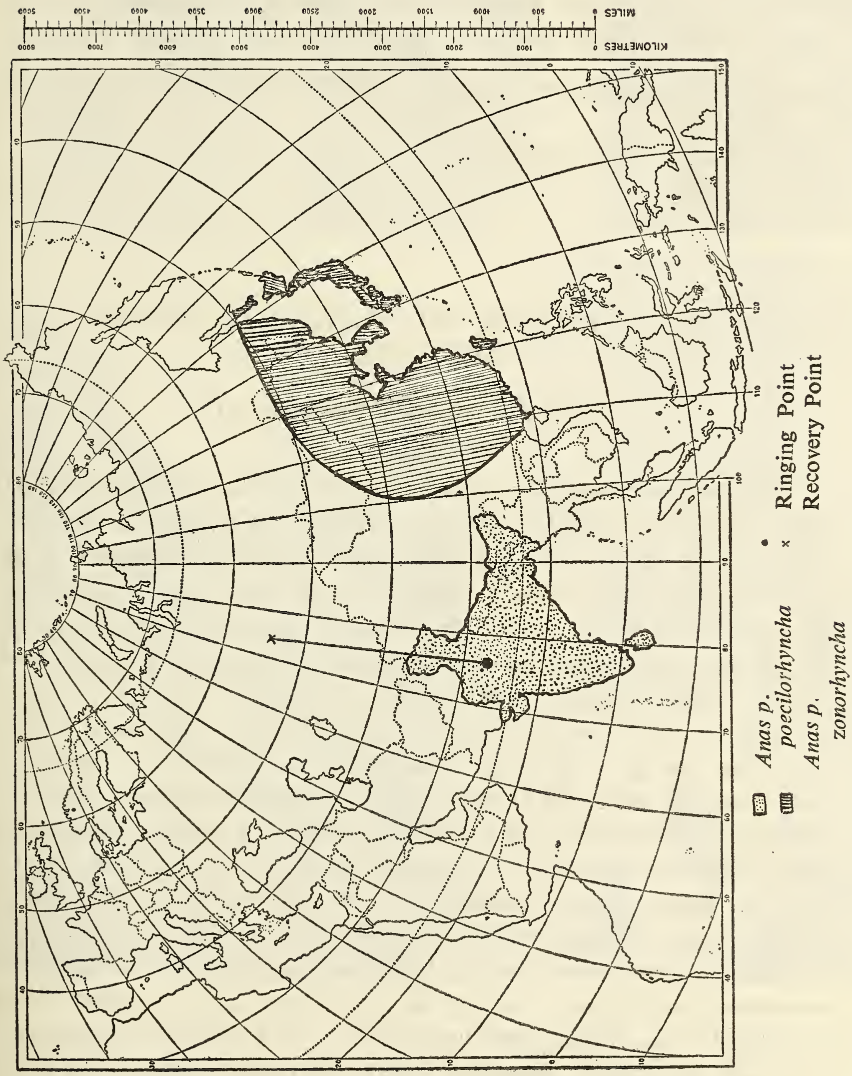
N. J. GEORGE

6. RECOVERY OF A SPOTBILL DUCK (*ANAS POECILORHYNCHA*) IN U.S.S.R.

(With a map)

The Bird Ringing Centre, Moscow, U.S.S.R. have reported the recovery of a Spotbill Duck (*Anas poecilorhyncha*) bearing the Society's ring No. F-8510, at Novosibirsk near Bagan (*c.* 54° 06′N.; 74° 38′E.) sometime during August 1970. The bird, an adult female was ringed by the Society's field party at Bharatpur (*c.* 27° 13′N.; 77° 32′E.) Rajasthan on 5th December 1969.

This recovery is unexpected as all standard Indian literature considers the nominate race as resident and locally migratory, only the


MILES
KILOMETRES
Anas p. poecilorhyncha
Anas p. zonorhyncha
• Ringing Point
× Recovery Point

Chinese Spotbill (*Anas p. zonorhyncha*) being recorded as truly migratory. It must, however, be noted that Dementiev *et al.* (1952) in BIRDS OF THE SOVIET UNION describe this race as a straggler to the Soviet Union having been recorded from northern Japan to SE. China and Korea.

This particular bird had travelled a distance of about 2884 km. in a northern direction from the point of release in about 8 months.

BOMBAY NATURAL HISTORY SOCIETY, (MISS) SHAILAJA S. SOMANE
HORNBILL HOUSE,
SHAHID BHAGAT SINGH ROAD,
BOMBAY-1 BR,
December 3, 1970.

7. BAYA WEAVERBIRD NESTING ON HUMAN HABITATIONS

(With eight figures in two plates)

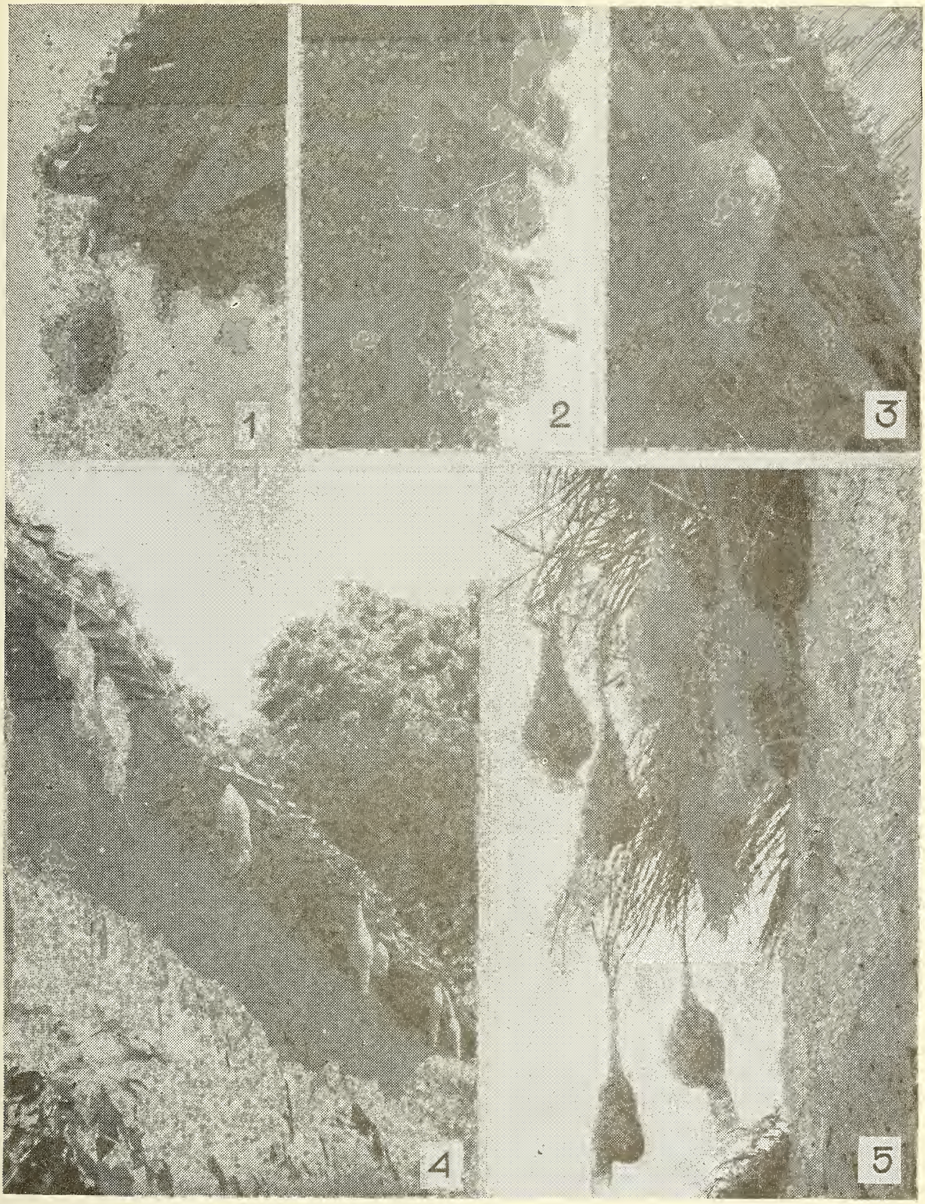
The Baya weaverbird (*Ploceus philippinus*) distributed throughout India, Burma, Ceylon, Malaysia and Thailand is famous for its intricately woven, retort-shaped, dangling nest. Equally important is the bird's capacity in selecting a variety of trees and other objects most suitable for siting its nests. In India, at least 30 different species of trees have been preferred as hosts besides telegraph and power lines, sides of wells, copium of compound walls and even eaves of houses.

Jerdon (1863)[1] wrote about the Bayas in India not using houses as nesting sites thus, 'In India I have never seen the Baya suspend its nests except on trees, but in some parts of Burma, and more particularly in Rangoon, the Bayas usually select the thatch of a bungalow to suspend their nests from, regardless of the inhabitants within. In the Cantonment of Rangoon, very many bungalows may be seen with twenty, thirty, or more of these long nests hanging from the end of the thatched roof, and, in one house in which I was an inmate, ... a small colony commenced their labours towards the end of April, and, in August, when I revisited that station, there were above one hundred nests attached all round the house'. Smythies (1953)[2] also mentions that the eaves of village huts in Burma is one of the preferred places for *Ploceus philippinus* to hang their nests. Recent Indian literature on the Baya

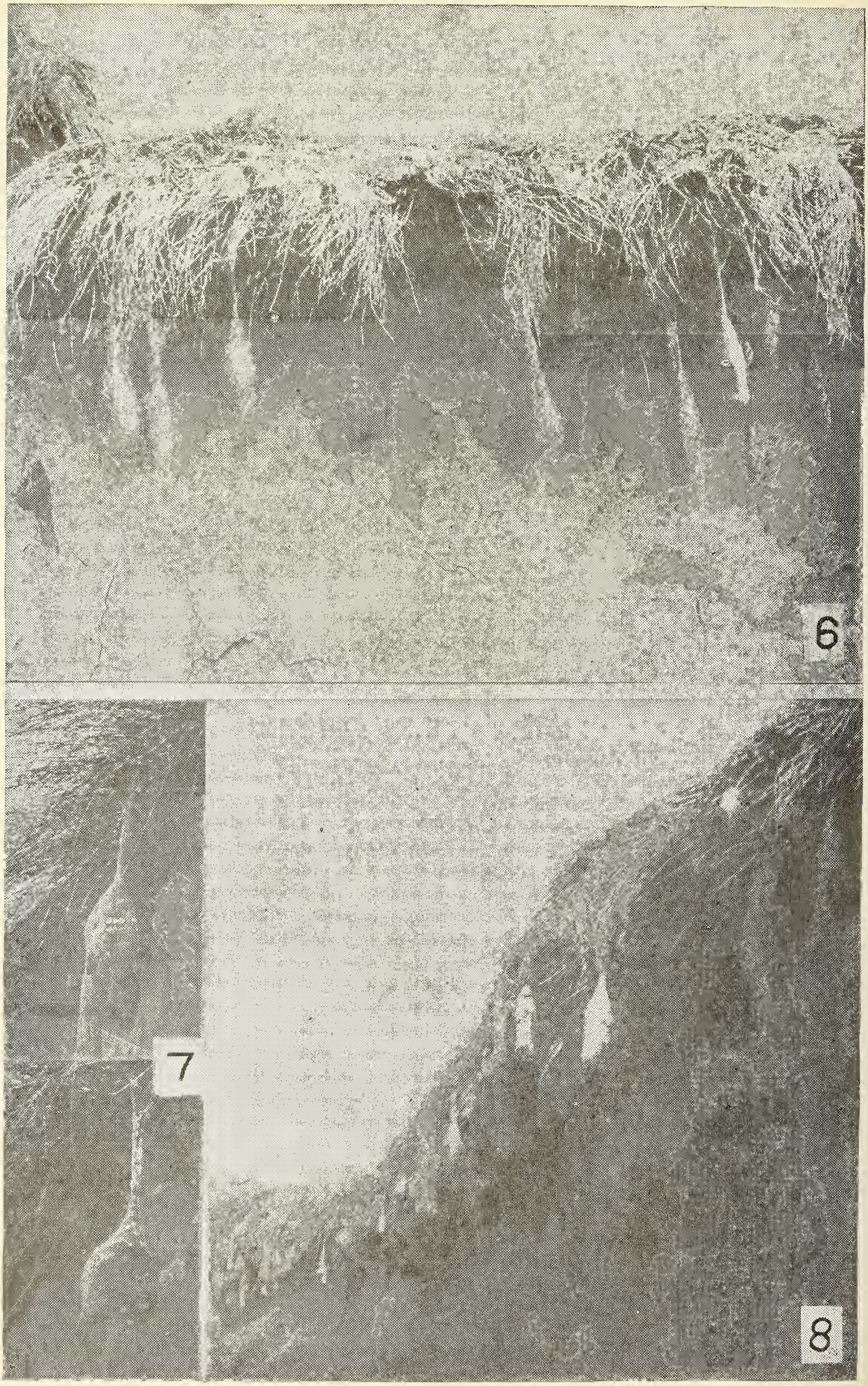
[1] JERDON, T. C. (1863):—The Birds of India **2**, pt. I. The Military Orphan Press, Calcutta.

[2] SMYTHIES, B. E. (1953):—The Birds of Burma. Oliver & Boyd, London.

Davis : Baya nests



Figs. 1. A complete nest of Baya weaverbird hanging from the corner of a roof; 2. Another complete nest suspended from the grass-lining under a tiled roof; 3. A splinter separating from a bamboo split used as a reeper for a roof supports a large, complete nest of the Baya; 4. Seven nests hanging on the eaves of a house. Note the egg-chamber of all the nests facing the wall; 5. Seven of the approximately 30 nests attached to one side of the grass roof of a house near Lucknow.



Figs. 6. Closer view of a group of nests hanging on another side of the roof referred to in fig. 5. ; 7. These only two nests (complete) hang on the same roof (same level), 5 metres apart, of another house ; 8. General view of a side of the house referred to in fig. 6 showing over 250 nests. Many of the nests were partially damaged at the time of observation.

do not mention the eaves of roofs in India as a site for attaching the nests of this familiar bird.

During an all-India survey conducted to study the Baya colonies in 1964-1966, I did come across a few cases where the bird had selected human dwellings to hang their nests. Some of these are reported here with illustrations.

A colleague at the Central Coconut Research Station, Kayangulam, Kerala State wrote to me that a Baya cock made an incomplete nest on the edge of his roof, thatched with coconut leaves. However, by the time I visited the place, the thatch was renewed. Near Kanpur (Uttar Pradesh) I saw four complete nests hanging on one side of a metre-high mud wall demarcating field boundaries. These nests were attached to the grass and brambles that formed a copium for the wall to protect it from the rains. I could not take a picture of these impressive nests.

While I was trekking in some suburbs in Uttar Pradesh, a village 30 km. west of Varanasi interested me most. On a tile-roofed house, there were two complete nests of Baya hanging from one of the reepers. One of them seen in Fig. 1 occupied the south-eastern corner of the roof, the other being located two metres away from it but attached to the same reeper (not visible in picture). Several children and grown-ups used to move about just under these nests from morning till night, but the birds did not seem to be disturbed.

Figures 2 and 3 show portions of the roof of another house in the same village. This house was also tiled in addition to having a lining of grass below the tiles. The nest in Fig. 2, a complete one, was founded on some fine twigs used for the lining. But the one in Fig. 3 was attached to a strip of bamboo partially separated from a half-split bamboo used as a reeper. The attachment of this nest in particular seemed very weak. But the nest being located on the safe side of the house, there was least disturbance from wind, and hence the single thin strip of bamboo was a sufficient support as is evident from the fact that the nest is a complete one. At the time of observation it was occcupied by two grown-up fledglings.

In another house of the same village, I saw seven nests hanging on the reepers of its roof along a side safe from wind (Fig. 4). Very close to this house was a plot of sugarcane whose leaves supplied the nest-building material. It may be noted that the nests in Fig. 4 as well as the earlier ones were built in conformity with a particular alignment. That is, their egg-chamber faced the wall so that the entrance was away from it. This is the convenient alignment for the hen bird to reach directly the egg-chamber during her homeward flights.

Some of the nests in Fig. 4 were attached to the bamboo splits and the others on the fibrous cords used for tying the bamboos.

In a village 10 km. north of Lucknow, I saw a thatched house bearing along an edge of its roof over 250 Baya nests (Fig. 8). On another side of the same roof, about 30 nests were hanging, part of which are shown in Fig. 5. It was late November when I visited the locality and the Bayas had completely deserted the colony. Many of the nests were damaged by rats and birds. The adversities of weathering was also apparent on many nests. Practically all the nests were suspended on the grass and fine twigs with which the roof was built. There was no tile roofing for this house.

Fig. 6 is a closer view of a portion of the wall (and roof) shown in Fig. 8. Here the mud wall of the house and the grass thatch can be clearly seen. Out of the 15 nests visible here, only one is incomplete. This particular wall of the house-cum-store for agricultural commodities is about 15 metre long behind which is a two metre wide drain of running water. The drain as well as its margin away from the house were overgrown with many species of grass, some of them being wild sugarcane. The leaves of these plants provided the material for weaving the numerous nests. In addition, the house was surrounded by paddy fields on the two sides facing the sides having Baya nests.

Fig. 7 shows two complete nests from the eaves of another house located in a village one kilometre away from the previous one. The only two nests were hanging along the same direction of the roof about 3 metres apart. As this roof was located in close proximity with another only intercepted by a narrow lane, I could not get a convenient view for photographing the nests, and hence the two nests are shown separately. The roof of the house having the nests was very low and the lane was busy practically throughout the day. In spite of the crowd or because of it, the Baya preferred to select such a place for siting its nests. No one disturbed the birds in this village, even the dogs ignored them. Presuming these nests were long deserted, I pulled out the one shown in Fig. 7 (lower). But from within, seven fairly grown-up fledglings of Munia made their way out.

During the all-India survey, I came across as many as 1386 colonies of Baya, each colony possessing one to over 250 nests. But only the above limited cases of human dwellings which the Baya selected for building nests were observed.

INDIAN STATISTICAL INSTITUTE, T. A. DAVIS
CALCUTTA-35, INDIA,
December 7, 1970.

8. RECOVERY OF RINGED BIRDS

Ring No. and Sex	Date and place of ringing	Date and place of Recovery	Remarks
	Greylag Goose (*Anser anser*)		
69-2 Ad.	18-1-1969. Bharatpur, Rajasthan (*c* 27° 13′ N., 77° 32′ E.)	27-1-1970. Near Pyagpur, 15 m. away from Bahraich, U.P. (*c*. 27° 34′ N., 81° 36′ E.)	Reported by Mr. V. S. Mathur, Police Supdt.
	Pintail (*Anas acuta*)		
F-1012 ♂	27-9-1965. Bharatpur, Rajasthan (*c*. 27° 13′ N., 77° 32′ E.)	+17-11-1969. Uzbek SSR., Fergana Reg., near Kokand (*c*. 40° 34′ N., 70° 56′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-1105 ♀	18-10-1966. -do-	+ 31-8-1969. Krasnoyarsk Reg., near Kezhma (*c*. 59° 00′ N., 101° 05′ E.)	-do-
F-1248 ♂	11-10-1966. -do-	+ 15-5-1969. Tomsk Reg., near Aleksandrovskoe (*c*. 56° 46′ N., 85° 22′ E.)	-do-
F-1350 ♂	13-10-1966. -do-	+ 23-5-1970. Yakutian ASSR, Velyui Reg., Mastakh River (*c*. 65° 36′ N., 119° 35′ E.)	-do-
F-1690 ♂	30- 9-1967. -do-	+ 12-11-1969. Kazakh SSR, Dzhambul Reg., near Novotroitskoe (*c*. 43° 40′ N., 73° 43′ E.)	-do-
F-1819 o?	24-10-1967. -do-	+ 15-4-1970. Kemerov Reg., near Topki (*c*. 55° 09′ N., 85° 35′ E.)	-do-
F-1880 ♀	27-10-1967. -do-	+ 10-10-1969. Kazakh SSR., Alma-Ata Reg., near Akkum (*c*. 46° 18′ N., 75° 15′ E.)	-do-
F-2134 ♀	5-11-1967. -do-	+ 10-10-1969. Tyumen Reg., near Surgut (*c*.61° 18′N., 73° 22′E.)	-do-
F-2575 0?	24-11-1967. -do-	+ 23-5-1970. Tyumen Reg., Surgut Dist., near Lokosovo (*c*. 61° 08′ N., 74° 41′ E.)	-do-
F-2952 ♂	9-12-1967. -do-	+ 0-9-1969. Tomsk Reg., near Nazina (*c*. 60° 09′ N., 78° 58′ E.)	-do-

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No. and Sex		Date and place of ringing	Date and place of Recovery	Remarks
		Pintail (*Anas acuta*) —*contd.*		
F-2992	♂	11-12-1967. Bharatpur, Rajasthan (*c* 27° 13′ N., 77° 32′ E.)	+ 3-9-1969. Ob River 13 km. from its confluence with Parabel River, Tomsk. (*c.* 56° 45′ N ; 84°75′ E.)	Reported by Zoological Museum of Tomsk
F-2994	♂	11-12-1967. -do-	+ 4-6-1970. Tyumen Reg., near Tarko-sale (*c.* 64° 56′N., 77° 49′E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-3125	♂	12-12-1967. -do-	+ 13-9-1970. Altai Reg., near Kamen-na-Obi (*c.* 53° 50′ N., 81° 18′ E.)	-do-
F-3745	♂	1-1-1968. -do-	+ Spring 1968. Altaisk Reg., near Ust-Chernyshevskaya (*c.* 52° 24′N., 83° 35′ E.)	-do-
F-4132	♀	21-1-1969. -do-	+ 16-10-1969. Kazakh SSR., Karaganda Reg., near Litvinskii (*c.* 50° 42′ N., 72° 42′ E.)	-do-
F-4391	♂	30-1-1968. -do-	+ 14-10-1969. Kazakh SSR., Pavlodar Region (*c.* 53° 33′N., 75° 22′E.)	-do-
F-4748	♂	11-2-1968. -do-	+ 25-9-1969. Kazakh SSR., Taldy-Kurgan Reg., Alakul Dist., near Druzhba (*c.* 45° 17′ N., 82° 30′ E.)	-do-
F-4875	♂	21-1-1969. -do-	+ 12-6-1970. Tyumen Reg., near Tarko-sale (*c.* 64° 56′N., 77° 49′E.)	-do-
F-5004	♂Ad.	18-2-1968. -do-	+ 31-8-1970. Novosibirsk Reg., near Zdvinsk (*c.* 54° 43′N., 78° 33′E.)	-do-
F-5216	♂	26-2-1968. -do-	+ 0-10-1969. Kazakh SSR., near Alakol (*c.* 46° 20′N., 81° 20′E.)	-do-
F-5258	♂Ad.	26-2-1968. -do-	+ 5-6-1970. Tyumen Reg., Purov Dt., near Khalesavaya (*c.* 63° 23′ N., 78° 26′ E.)	-do-
F-5693	♀Ad.	4-3-1968. -do-	+ 10-3-1970. Kazakh SSR., Dzhambul Reg., near Oital (*c.* 42° 54′ N., 73° 15′ E.)	-do-

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No. and Sex	Date and place of ringing	Date and place of Recovery	Remarks
		Pintail (*Anas acuta*)—*contd.*	
F-5875 ♂	22-1-1969. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	March 1970. Maqsoodpur Vill., Etah Dist., U.P. (*c.*27° 34′ N., 78° 41′ E.)	Reported by Majid Ali Khan
F-6081 Fg.	24-1-1969. -do-	+ 12-7-1969. Altai Reg., near Kamen-na-Obi (*c.* 53° 48′ N., 81° 21′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-6317	7-2-1969. -do-	1-3-1970. Hokra, Srinagar, Kashmir (*c*,34° N., 74° 5′ E.)	Reported by Abdul Rashid
F-6334 ♂	7-2-1969. -do-	+ 25-5-1970. Tyumen Reg., near Surgut (*c.*61° 18′ N., 73° 29′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-6392 Fg.	11-2-1969. -do-	+ 3-10-1969. Altai Reg., near Kamen-na-Obi (*c.*53° 48′ N., 81° 21 ′E.)	-do-
F-6418 ♀	11-2-1969 -do-	+ 27-9-1969. Dzhambul Reg., Talas River, near Usharal (*c.* 43° 53′ N., 70° 30′ E.)	-do-
F-6507 ♂	15-2-1969. -do-	+ 0-5-1969. Tomsk Reg., near Kozhevnikovo (*c.* 56° 16′ N., 83° 59′ E.)	-do-
F-7136 ♀	1-11-1969. -do-	+ 6-9-1970. Omsk Reg., near Znamenskoe (*c.* 57° 04′ N., 74° 11 ′E.)	-do-
F-7151 ♂	1-11-1969. -do-	+ 29-9-1970. Tyumen Reg., near Salekhard (*c.*66°34′N.66°40′E.)	-do-
F-7162 ♂	1-11-1969. -do-	9-2-1970. Hajin Teh., Sonawari Game Reserve in Kashmir.	Reported by Ghulam Mohd.
F-7245 ♂	2-11-1969. -do-	+ 2-6-1970. Tyumen Reg., near Tarko-Sale (*c.*64°56′N.,77°49′E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-7318 ♀	5-11-1969. -do-	+ 1-3-1970. Patiala (*c.* 30° 20′ N., 76° 28′ E.)	Reported by Yuvraj Amarinder Singh
F-7322 ♂	5-11-1969. -do-	+ 29-8-1970. Altai Reg., near Klyuchi (*c.* 52° 16′ N., 78° 56′ E.)	Reported by Bird Ringing Centre, Moscow, USSR

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No. and Sex		Date and place of ringing	Date and place of Recovery	Remarks
		Pintail (*Anas acuta*)—*contd.*		
F-7333	♂	5-11-1969. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	+ 22-3-1970. 50/60 km. north-east of Alma-Ata (*c.* 44°53′ N; 76°14′ E.)	Reported by E. I. Gavrilov, Russia
F-7334	♂	5-11-1969. -do-	+ 10-5-1970. Tyumen Reg., near Kondinskoe (*c.*62°30′N.,66°00′E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-7458	o?	6-11-1969. -do-	+ 7-12-1969. Agra Dist., Agra (*c.* 27° 10′ N., 78° 3′ E.)	Reported by R. S. Rathor
F-7726	♂	12-11-1969. -do-	+15-5-1970. Yakutian ASSR, near Oleminsk (*c.* 60° 22′ N., 120° 29′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-7736	♀	12-11-1969. -do-	24-3-1970. Kadri Village, Kanpur, U.P. (*c.* 26° 91′ N., 80° 4′ E.)	Reported by Sultan Ali-Akbar Ali
F-7750	♀	12-11-1969. -do-	+ 29-8-1970. Altai Reg., near Kamen-na-Obi (*c.* 53° 50′ N., 81° 18′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-7797	♂	13-11-1969. -do-	27-2-1970. Simri Lake Bachrawan, Dt. Rae Bareli. U.P.,	Reported by A. H. Khan
F-8493	♀	5-12-1969. -do-	+ 21-5-1970. Yakutian ASSR., near Olekminsk (*c.* 60° 22′ N., 120° 28′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-9230	♂	30-10-1969. -do-	14-3-1970. Rae-Bareli, Kaiperganj, U.P. (*c.* 26° 14′ N., 81° 14′ E.)	Reported by Hakim Mushtaq Ahmed
F-10854	♂	3-2-1970. -do-	+ 0-5-1970. Tomsk Reg., near Parabel (*c.* 38° 41′ N., 81° 29′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-11575	♂	12-2-1970. -do-	+ 15-3-1970. Kazakh SSR, Kyzyl-Orda Reg., near Chiili (*c.* 44° 11′ N., 66° 45′ E.)	-do-
F-12072	♀	13-12-2969. Pt. Calimere, Tamil Nadu (*c.* 10°59′ N, 79° 52′ E.)	+ 15-5-1970. Tyumen Reg., near Kondinskoe (*c.* 62° 30′ N., 66° 00′ E.)	Reported by Bird Ringing Centre, Moscow, USSR

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No. and Sex	Date and place of ringing	Date and place of Recovery	Remarks
	Common Teal (*Anas crecca*)		
C-1589 ♀	11-10-1966. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32 ′E.)	+ 1-9-1969. Kazakh SSR, Semipalatinsk Reg., Ayaguzskii Dt., near Karakum (*c.* 46° 49′ N., 79° 33′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
C-2585 ♂	19-10-1966. -do-	+ 26-3-1967. Kirghiz SSR, Kara- Dariya River (*c.* 40° 32′ N., 74° 00′ E.)	-do-
C-2917 ♀	24-10-1966. -do-	+ 25-9-1970. Kazakh SSR, Pavlodar Reg., near Uspenka (*c.* 52° 54′ N., 77° 27′ E.)	-do-
C-2979 ♀	18-1-1967. -do-	+ 20-9-1969. Kemerov Reg., near Leninskkyznetskii (*c.* 54° 40′ N., 86° 11′ E.)	-do-
C-3053 e?	1-10-1967. -do-	+ 13-10-1969. Kazakh SSR, south-east part of Lake Balkhash.	-do-
F-3054 ♀	9-2-1969. Assam, Bogapai T.E., Digboi (*c.* 27° 23′ N., 95° 37′ E.)	13-2-1970. Duamara Reserve, Dooma Dooma, Upper Assam. (*c.* 27°4′N, 95°3′ E.)	Reported by J. N. Hazarika.
C-3122 o?	27-11-1969. Calcutta Museum.	28-11-1969. Calcutta (*c.* 22° 34′ N., 88° 20′ E.)	Reported by Amal Chowdhury
C-3485 o?	28-10-1967. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	+ 10-9-1969. Krasnoyarsk Reg., near Eniseisk (*c.* 58° 26′ N., 92° 11′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
C-3646 ♂	5-11-1967. -do-	+ 23-8-1969. Kemerov Reg., near Leninsk Kuznetskii (*c.* 54° 40′ N., 86° 11′ E.)	-do-
C-3683 ♀	5-11-1967. -do-	+ 15-2-1970. Hokra Reserve, Kashmir (*c.* 34° N. 74° 5′ E.)	Reported by G.A. Goorus Game Warden's Office, Srinagar
C-4170 ♂	14-11-1967. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	+ 15-4-1970. Novosibirsk Reg., near Kolyvan (*c.* 55° 21′ N., 82° 44′ E.)	Reported by Bird Ringing Centre, Moscow, USSR

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No. and Sex		Date and place of ringing		Date and place of Recovery	Remarks
				Common Teal (*Anas crecca*) contd.	
C-4318	♂	26-11-1967.	-do-	+ 23-5-1970. Krasnoyarsk Reg., Turukhansk Dt., near Vorogovo (*c.* 61° 04′ N., 89° 36′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
C-4327	♀	29-11-1967.	-do-	+ 15-11-1969. Kazakh SSR, Alma-Ata Reg., near Alma-Ata (*c.* 43° 22′ N., 77°11′ E.)	-do-
C-4352	♂	29-11-1967.	-do-	+ 13-9-1969. Uzbek SSR, Syrdariya Reg., near Yangier (*c.* 40° 17′ N., 68° 49′ E.)	-do-
C-4425	♀	30-11-1967.	-do-	+ 24-10-1969. Altai Reg., near Uglovskoe (*c.* 51° 22′ N., 80° 11′ E.)	-do-
C-4506	♂	1-12-1967.	-do-	+ 20-5-1970. Tyumen Reg., near Khanty-Mansiisk (*c.* 61° 00′ N., 69° 07′ E.)	-do-
C-4617	♂	6-12-1967.	-do-	+ Spring 1970. Tyumen Reg., near Zavodoukovsk (*c.* 56° 32′ N., 66° 30′ E.)	-do-
C-4625	♀	6-12-1967.	-do-	+ 12-7-1970. Krasnoyarsk Reg., near Turukhansk (*c.* 65° 49′ N., 88° 00′E.)	-do-
C-4629	♀	6-12-1967.	-do-	+ 10-5-1969. Tyumen Reg., near Surgut (*c.* 61° 18′ N., 73° 22′ E.)	-do-
C-5005	♀	7-1-1968.	-do-	16-3-1970. Kabul, Afghanistan (*c.* 34° 30′ N., 69° 13′ E.)	Reported by Mr. Fracesoii Naurille
C-5017	♀	3-1-1968.	-do-	+ 28-9-1969. Kazakh SSR., Dzhambul Reg., near Novotroitskoe (*c.* 43° 37′ N., 73° 44′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
C-5298	♂	1-3-1968.	-do-	+ 20-5-1970. Yakutian ASSR., near Suntar (*c.* 62° 10′ N., 117° 39′ E.)	-do-
C-5362	♂	21-1-1969.	-do-	+ 16-10-1969. Kazakh SSR, Chimkent Reg., near Chardara (*c.* 41° 20′ N., 67° 56′ E.)	-do-

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No. and Sex		Date and place of ringing	Date and place of Recovery	Remarks
		Common Teal (*Anas crecca*)—contd.		
C-5378	♀	21-1-1969. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	12-10-1969. Hamidkot Village, 8m. from Chashma Jhelum Link Canal, West Pakistan.	Reported by Abdul Rahim Khan Rao
C-5488	♂	29-2-1968. -do-	+21-10-1969. Uzbek SSR, Tashkent Reg., Begovat Dist. (*c.* 40° 00′ N., 69° 00′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
C-5676	♂	27-1-1969. -do-	+ 29-8-1970. Novosibirsk Region, near Chany (*c.*55°22′N., 76° 45′E.)	-do-
C-5741	♀	23-1-1969. -do-	+27-9-1969. Kazakh SSR, Taldy-Kurgan Reg., near Mulaly (*c.* 45° 30′ N., 78° 21′ E.)	-do
C-5747	♀	23-1-1969. -do-	+ 26-9-1969. Altai Reg., near Kamen-na-Obi (*c.* 53°48′ N., 81° 21′ E.)	-do-
C-5748	♀	23-1-1969. -do-	+ 28-5-1969. Yakutian ASSR, near Nyurba (*c.* 63° 20′ N., 118° 23′ E.)	-do-
C-5757	♀	27-1-1969. -do-	+ 31-8-1969. Vostochno, Kazakh Reg., Near Zaisan (*c.* 47° 30′ N., 84° 51′ E.)	-do-
C-5851	♀Ad.	6-2-1969. -do-	31-10-1969. Srinagar, Kashmir (*c.* 34° 5′ N., 74° 5′ E.)	Reported by The Game Warden, Jammu and Kashmir
C-5879	♂	9-2-1969. -do-	+ 18-5-1969. Tomsk Reg., Kolpashevo (*c.* 58° 21′ N., 82° 56′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
C-5897	♀	9-2-1969. -do-	+ 6-9-1969. Novosibirsk Reg., near Kuibyshev (*c.*55°28′N., 78° 19′ E.)	-do-
C-5926	♂	10-2-1969. -do-	+ 15-9-1969. Novosibirsk Reg., near Kupino (*c.*54° 23′N., 77° 18′E.)	-do-
C-5951	♀	11-2-1969. -do-	+ 1-2-1970. Jheel Kalijri, Aligarh Dt., U.P. (*c.* 27° 53′N., 77° 4′E.)	Reported by Yunus Masih

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No. and Sex	Date and place of ringing	Date and place of Recovery	Remarks
		Common Teal (*Anas crecca*)—contd.	
C-6008 ♂	18-1-1969. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	+ Autumn 1969. Tyumen Reg., near Khanty-Mansiisk (*c.* 61° 00′ N., 69° 07′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
C-6063 ♀	17-2-1969. -do-	+ 17-5-1970. Yakutian ASSR, near Bolshoi Peledui (*c.* 59° 39′ N., 112° 46′ E.)	-do-
C-6069 ♀	17-2-1969. -do-	+ 10-10-1969. Kazakh SSR, Taldy-Kurgan Reg., Alakul Dt., Alakul Lake	-do-
C-6204 ♀	27-2-1969. -do-	+ 1-9-1969. Krasnoyarsk Reg., near Boguchany (*c.* 58° 14′ N., 97° 28′ E.)	-do-
C-8542 ♀	16-11-1969. -do-	+ 6-3-1970. Madhopur, Barele Jheel, 12ml. south of Sultanpur, U.P. (*c.* 32° 22′ N., 75° 37′ E.)	Reported by Barkat Ali Khan and Syed Masood Ali Naqvi
C-8694 ♀	22-11-1969. -do-	24-2-1970. Kohat, Peshawar Dvn., W. Pakistan (*c.* 34° 1′ N., 71° 35′ E.)	Reported by H. Faqir Mohd.
C-8792 ♀	5-12-1969. -do-	+ 30-8-1970. Tomsk Reg., near Belyi-yar (*c.* 58° 27′ N., 83° 21′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
C-8839 ♂	21-12-1969. -do-	2-4-1970. Shaikhupura, W. Pakistan	Reported by Mohd. Islam
C-8929 ♀	30-12-1969. -do-	Feb.-1970. South-West of Gujranwala District, West Pakistan (*c.* 32° 14′ N., 74° 11′ E.)	Reported by Rai Muhammad Bashir Khan
C-9406 ♀	13-12-1969. -do-	8-4-1970. In a river near Nowshera, Peshawar Dist., W. Pakistan (*c.* 34° 04′ N., 72° 2′ E.)	Reported by Dr. Abdul Rashid Khan Tajik
C-9414 ♀	10-12-1968. -do-	+ 18-1-1970. Chilhuwa Lake, 2ml. north of Gorakhpur, U.P. (*c.* 26° 45′ N., 83° 22′ E.)	Reported by V. K. Shanker, Sevarthi
C-9469 ♀	12-12-1969. -do-	17-3-1970. 5 ml. east of Kabul, Afghanistan (*c.* 34° 53′ N., 69° 2′ E.)	Reported by Dr. K. M. Price
C-9925 ♀	13- 3-1970. -do-	+ 14-4-1970. Kazakh SSR, near Kyzyl-orda (*c.* 44° 53′ N., 65° 30′ E.)	Reported by Bird Ringing Centre, Moscow. USSR

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No. and Sex		Date and place of Ringing	Date and place of Recovery	Remarks
		Spotbill Duck (*Anas poecilorhyncha*)		
F-8510	♀	5-12-1969. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	+ 0-8-1970. Novosibirsk Reg., near Bagan (*c.* 54° 06′ N., 74° 38′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
G-075	o?	22- 3-1969. -do-	29-7-1970. 24 ml. from Bara Banki Dist., U.P. (*c.* 26° 56′ N., 81° 12′ E.)	Reported by K. D. Singh
G-1165	♀	14-11-1969. -do-	10-9-1970. Etawah, U.P., India (*c.* 26° 46′ N., 79° 1′ E.)	Reported by Suresh Rolston
		Gadwall (*Anas strepera*)		
F-2663	♀?	29-11-1967. Bharatpur, Rajasthan (*c.* 27° 23′ N., 77° 32′ E.)	+ 9-10-1969. Tyumen Reg., near Armizonskoe (*c.* 55° 56′ N., 67° 39′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-2832	♀?	5-12-1967. -do-	+ 18-11-1969. Akkoul Lake, 80 km. NW. of Djamboul town, Russia	Reported by E. I. Gavrilov
F-2961	♂	9-12-1967. -do-	+ Autumn 1969, Kazakh SSR, Balkhash Lake, South Part	Reported by Bird Ringing Centre, Moscow, USSR
F-3372	♀?	22-12-1967. -do-	+ 15-9-1969. Alma-Ata Reg., near Bakanas (*c.* 44° 50′ N., 76° 18′ E.)	-do-
F-4015	♂	14-1-1968. -do-	+ 0-9-1969. Kazakh SSR, Alma-Ata Reg., near Chilik (*c.* 43° 35′ N., 78° 15′ E.)	-do-
F-4133	♀	21-1-1969. -do-	+ 19-9-1969. Alma-Ata Reg., near Bakanas (*c.* 44° 49′ N., 76° 19′ E.)	-do-
F-5406	♂	2-2-1968. -do-	+ 0-4-1969. Kazakh SSR, Alma-Ata Reg., near Narynkol (*c.* 42° 43′ N., 80° 10′ E.)	-do-
F-6149	♂	27-1-1969. -do-	3-2-1970. Alipur Khera, Mainpuri, U.P. (*c.* 27° 14′ N., 79° 3′ E.)	Reported by M. C. Chaturvedi
F-6403	♂	11-2-1969. -do-	+ 25-3-1970. Kazakh SSR, Alma-Ata Reg., near Bakanas (*c.* 44° 49′ N., 76° 20′ E.)	Reported by Bird Ringing Centre, Moscow, USSR

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No. and Sex		Date and place of Ringing	Date and place of Recovery	Remarks
		Gadwall (*Anas strepera*)—contd.		
F-6461	♂	13-2-1969. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	+ 7-10-1969. Kazakh Reg., Taldy-Kurgan Dt., Sysykkol Lake (*c.* 46° 30′ N., 81° 00′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-6584	♂	2-2-1969. -do-	+ 18-1-1970. Near Sutlej River, Ludhiana Dt., Punjab (*c.* 30° 71′ N., 75° 64′ E.)	Reported by Jagjit Singh
F-6652	♀	23-2-1969. -do-	+ 14-9-1969. Uzbek SSR, Fergana Reg., near Iziyavan (*c.* 41° 41′ N., 71° 45′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-6668	♀	25-2-1969. -do-	24-11-1969. River Sutlej, Rampur Bushahr (H.P.) (*c.* 31° 27′ N., 77° 40′ E.)	Reported by Lt. Col. K. S. Rana
F-6782	♂	20-3-1969. -do-	+ 31-8-1969. Kazakh SSR, Alma-Ata Reg., near Bakanas (*c.* 44° 50′ N., 76° 18′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-8150	♀	19-11-1969. -do-	12-4-1970. Srinagar, Hokra, Kashmir (*c.* 34° 5′ N., 74° 5′ E.)	Reported by Zaffar Iqbal, Forest Ranger
F-8449	Fg.	3-12-1969. -do-	5-2-1970. Nowrangpur, Haryana (*c.* 28° 36′ N., 76° 40′ E.)	Reported by Nandaram
F-8736	♂	12-12-1969. -do-	+ 6-9-1970. Tselinograd Reg., near Astrakhanka (*c.* 51° 32′ N., 69° 48′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-8814	♀	14-12-1969. -do-	+ 26-2-1970. Peshawar, W. Pakistan (*c.* 34° 1′ N., 71° 35′ E.)	Reported by Amin Khan
F-9213	♂	30-12-1969. -do-	26-3-1970. Ramsu Vill., Ramban Teh., Jammu Province, Dist. Doda (*c.* 32° 44′ N., 74° 55′ E.)	Reported by Ramam Tullah Mir
F-8987	♀	9-1-1970. -do-	30-3-1970. Sohan River, 16m. away from Rawalpindi, W. Pakistan (*c.* 33° 36′ N., 73° 7′ E.)	Reported by Abul Hassan Bokhari

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No. and Sex	Date and place of Ringing	Date and place of Recovery	Remarks
		Gadwall (*Anas strepera*)—contd.	
F-10715 ♂	31-1-1970. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	7-3-1970. Hunza State, Gilgit, W. Pakistan (*c.* 35° 55′ N., 74° 23′ E.)	Reported by The Mir of Hunza
F-10821 ♀	3-2-1970. -do-	+ 10-4-1970. Kazakh SSR, Alma-Ata Reg., Balkhash District	Reported by Bird Ringing Centre, Moscow, USSR
		Wigeon (*Anas penelope*)	
F-3671 ♀	29-12-1967. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	+ 3-9-1969. Tomsk Reg., Tomsk (*c.* 56° 45′ N., 85° 1′ E.)	Reported by Zoological Museum of Tomsk
F-5965 ♀	22-1-1969. -do-	+ 20-5-1969. Tomsk Reg., near Kolpashevo (*c.* 58° 21′ N., 82° 56′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-8499 ♀	5-12-1969. -do-	+ 0-5-1970. Tomsk Reg., near Kargasok (*c.* 59° 04′N., 80°51′ E.)	-do-
F-8634 ♂	9-12-1969. -do-	4-4-1970. Sargodha Dt., W. Pakistan (*c.* 32° 4′ N., 72° 66′ E.)	Reported by Div. Forest Officer, Sargodha
F-9061 ♀	27-12-1969. -do-	+ 20-5-1970. Krasnoyarsk Reg., near Turukhansk (*c.* 65° 49′ N., 88° 00′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-10657 ♂	30- 1-1970. -do-	+ 5-6-1970. Krasnoyarsk Reg., near Turukhansk (*c.* 65° 49′ N., 88° 00′ E.)	-do-
F-10802 ♀	3- 2-1970. -do-	+ 20-5-1970. Yakutian ASSR, near Nyurba (*c.* 63° 20′ N., 118° 23′ E.)	-do-
F-14636 ♂	19- 3-1970. -do-	30-3-1970. Zangli Kupwara, Kashmir	Reported by Afzal Khan, Game Warden's Office
		Garganey (*Anas querquedula*)	
C-1630 o? juv.	12-10-1966. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	+ 0-10-1969. Omsk Reg., near Lyubinskii (*c.* 55° 10′ N., 72° 42′ E.)	Reported by Bird Ringing Centre, Moscow, USSR

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No. and Sex		Date and place of Ringing	Date and place of Recovery	Remarks
		Garganey (*Anas querquedula*)—contd.		
C-2506	♂	14-10-1966. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	+ 0-4-1969. Gorkii Reg., near Bor (*c.* 56° 22′ N., 44° 05′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
C-3278	♀	13-10-1967. -do-	+ 5-2-1970. Maina Village, Saharsa Dt., Bihar (*c.* 25° 93′ N., 86° 4′ E.)	Reported by Kumar Bhola Prasad Singh
C-3288	o?	14-10-1967. -do-	+ 2-9-1969. Omsk Reg.	Reported by Bird Ringing Centre, Moscow, USSR
C-3355	♀	23-10-1967. -do-	+ 2-9-1969. Krasnoyarsk Reg., near Krasnotuansk (*c.* 54° 18′ N., 91° 26′ E.)	-do-
C-3416	o?	21-10-1967. -do-	+ 23-11-1969. Kirghiz SSR, near Kalininsk (*c.* 42° 27′ N., 72° 07′ E.)	-do-
C-4378	♂	29-11-1967. -do-	20-3-1970. Mokur Village, Somandarkudi, South Arcot Dist., Tamil Nadu	Reported by Arumugum
C-6312	♂	9-3-1969. -do-	+ 30-8-1969. Kazakh SSR, Pavlodar Reg., near Akkulskii (*c.* 52° 23′ N., 75° 05′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
C-6378	♂	11-3-1969. -do-	+ 12-9-1969. Kurgan Reg., Makushino Dist., near Zolotoe (*c.* 55° 06′ N., 66° 57′ E.)	-do-
C-6514	♂	21-3-1969. -do-	+ 16-9-1969. Kazakh SSR, Alma-Ata Reg., the Ili Delta (*c.* 45° 17′ N., 74° 06′ E.)	-do-
C-6551	♂	25-3-1969. -do-	+ 30-8-1969. Severokazakh Reg., near Bulaeva (*c.* 54° 54′ N., 70° 28′ E.)	-do-
C-7165	♂	12-10-1969. -do-	Between Nov. and Dec. 1969. Muthupet, Tanjore Dt., Tamil Nadu (*c.* 10° 59′ N., 79° 53′ E.)	Reported by K. V. M. Bara

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No. and Sex	Date and place of Ringing	Date and place of Recovery	Remarks
		Garganey (*Anas querquedula*)—contd.	
C-7177 ♀	12-10-1969. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	22-1-1970. Bundala, Hambantota Dt., SW. Coast of Ceylon, (*c.* 6° 12′ N., 81° 15′ E.)	Reported by R. A. Lushington, Ceylon
C-7282	15-10-1969. -do-	11-1-1970. Chandragiri Tank, A.P., Karimnagar (*c.* 18° 26′ N., 79° 2′ E.)	Reported by Fakeer Mohamad
C-7373 ♂	17-10-1969. -do-	+ 29-8-1970. Omsk Reg., near Krutinka (*c.* 55° 54′ N., 70° 59′ E.)	Reported by Bird Ringing Centre Moscow, USSR
C-8195 Fg.	29-10-1969. -do-	+ 13-6-1970. Tomsk Reg., near Molchanovo (*c.* 57° 35′ N., 83° 45′ E.)	-do-
C-10149 ♀	8-4-1970. -do-	+ 28-8-1970. Omsk Reg., near Tyukalinsk (*c.* 55° 54′ N., 72° 14′ E.)	-do-
		Shoveller (*Anas clypeata*)	
F-2598	25-11-1967. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	+ 0-9-1969. Kazakh SSR, Kokchelav Reg. near Shchychinsk (*c.* 52° 57′ N., 70° 11′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-4402 ♀	31-1-1968. -do-	+ 2-10-1969. North Kazakh Reg., Sergeevka Dt., near Konovalovka (*c.* 53° 40′ N., 67° 14′ E.)	-do-
F-5351 ♀	26-2-1968. -do-	+ 3-11-1969. Kazakh SSR, Dzhambul Reg., near Burnoe (*c.* 42° 18′ N., 70° 44′ E.)	-do-
F-5481 ♀	27-2-1968. -do-	+ 6-9-1969. Kurgan Reg., near Makushino (*c.* 55° 12′ N., 67° 14′ E.)	-do-
F-5981 ♂	22-1-1969. -do-	+ 5-11-1969. Dzhambul Reg., near Novotroitskoe (*c.* 43° 37′ N., 73° 44′ E.)	-do-
F-6276 ♀	6-2-1969. -do-	+ 2-10-1969. Omsk Reg., near Krutinka (*c.* 56° 00′ N., 71° 28′ E.)	-do-
F-6510 ♂	15-2-1969. -do-	7-2-1970. Jumna Bridge, U.P.	Reported by P. Bencshaff, New Delhi

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No. and Sex		Date and place of Ringing	Date and place of Recovery	Remarks
		Shoveller (*Anas clypeata*)—contd.		
F-6610	♀	21- 2-1969. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	+ 14-9-1969. Kazakh SSR, Dzhambul Reg., near Baikadam (*c.* 43° 43′ N., 69° 52′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-6754	♀	10- 3-1969. -do-	+ 28-9-1969. Kazakh SSR, Kustanai Reg., near Kushmurun (*c.* 52° 25′ N., 64° 39′ E.)	-do-
F-6762	♂	12- 3-1970. -do-	12-4-1970. Srinagar (*c.* 34° 5′ N., 74° 5′ E.)	Reported by Mr. Krishen Kumar, Game Warden's Office
F-7914	♀	15-11-1969. -do-	+ 29-8-1970. Omsk Reg. near Sargatskoe (*c.* 55° 39′ N., 73° 30′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-8403	♂	3-12-1969. -do-	April 1970. Nowshera Teh., Peshawar, W. Pakistan (*c.* 34° 04′ N., 72° 2′ E.)	Reported by Mosil Khan Khaishki Bala
F-10828	♂	3- 2-1970. -do-	+ 4-6-1970. Krasnoyarsk Reg., near Turukhansk (*c.* 65° 49′ N., 88° 00′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-10979	♂	3- 2-1970. -do-	+ 0-5-1970. Tomsk Reg., near Kargasok (*c.* 59° 04′ N., 80° 51′ E.)	-do-
F-11338	♀	10-2-1970. -do-	7-3-1970. Naryasal, 2ml. away from Sambhar Lake, Rajasthan (*c.* 26° 91′ N., 75° 28′ E.)	Reported by Ratan Lal Tak
F-11927	♀	27-2-1970. -do-	7-3-1970. Hunza State, Gilgit, W. Pakistan (*c.* 35° 55′ N., 74° 23′ E).	Reported by The Mir of Hunza
F-14206	♀	5- 3-1970. -do-	16-3-1970. Hafizabad, Gujranwala District, W. Pakistan (*c.* 32° 4′ N., 74° 01′ E.)	Reported by Mohammad Siddique Qureshi
F-14235	♀	5- 3-1970. -do-	10-4-1970. Wular Lake, Kashmir (*c.* 34° 39′ N., 74° 78′ E.)	Reported by Gh. Nabi

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No. and Sex	Date and place of Ringing	Date and place of Recovery	Remarks
	Shoveller (*Anas clypeata*)—contd.		
F-14298 ♀	8- 3-1970. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	+ 13-5-1970. Kazakh SSR, Semipalatinsk Reg., near Ayaguz (*c.*47° 59′ N., 80° 24′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-14388 ♀	6- 3-1970. -do-	+ 31-8-1970. Kazakh SSR, Semipalatinsk Reg., near Borodulikha (*c.* 50° 44′ N., 80° 55′ E.)	-do-
F-14464 ♀	8- 3-1970. -do-	29-3-1970. Kabirwala Teh., Multan Dt., W. Pakistan (*c.* 30° 12′ N., 71° 31′ E.)	Reported by Ch. Abdul Hameed
F-14688 ♀	13- 3-1970. -do-	+ 29-8-1970. Altai Reg., near Rebrikha (*c.* 53° 06′ N., 82° 19′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
	Redcrested Pochard (*Netta rufina*)		
F-3965 ♀	11- 1-1968. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	+ 20-9-1969. Kazakh SSR, Alma-Ata Region	Reported by Bird Ringing Centre, Moscow, USSR
	Common Pochard (*Aythya ferina*)		
G-196 ♂	10-12-1969. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	3-2-1970. Pathki Tola, Maurawan, Unnao, U.P. (*c.* 26° 43′ N., 80° 92′ E.)	Reported by Kamalapati Tripathi
G-307 ♀	11-12-1969. -do-	+ 30-8-1970. Kazakh SSR, Semipalatinsk Reg., near Charskii (*c.* 49° 40′ N., 81° 02′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
G-312 ♂	1-12-1969. -do-	19-1-1970. Near Lucknow, U.P. (*c.* 26° 86′ N., 80° 96′ E.)	Reported by Chandra Bhan
G-324 ♀	11-12-1969. -do-	+ 17-2-1970. Kandahar City, Afghanistan (*c.* 31° 27′ N., 65° 43′ E.)	Reported by Mohammad Yusuf
G-761 ♂	1- 1-1970. -do-	17-2-1970. -do-	-do-
G-925 ♀	20-11-1969. -do-	13-2-1970. Dholaua, Gulljarpur, Unnao Dt., U.P.	Reported by Motilal Kahar

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No. and Sex		Date and place of Ringing	Date and place of Recovery	Remarks
		Common Pochard (*Aythya ferina*)—contd.		
G-992	♂	30-11-1969. Bharatpur, Rajasthan (*c*. 27° 13′ N., 77° 32′ E.)	+ 0-5-1970. Novosibirsk Reg., Chany Dt., near Starye Karachi (*c*. 55° 28′ N., 77° 03′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
G-1005	♂	30-11-1969. -do-	+ Jan. 1970. Rae Bareli U.P. (*c*. 26° 14′ N., 81° 14′ E.)	Reported by B. K. Mukerji
G-1180	♀	18-11-1969. -do-	+ 8-9-1970. Altai Reg., near Zavyalovo (*c*. 52° 54′ N., 80° 55′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
G-1497	♀	31- 1-1970. -do-	+ 8-3-1970. Nabi-Shah Lake, Bhalwal, Sargodha Dt., W. Pakistan (*c*. 32° 4′ N., 72° 43′ E.)	Reported by Syed Ijaz Hussain
F-3306	♂	22-12-1967. -do-	+ 23-7-1969. Somme, France (*c*. 50° 6′ N, 2° 7′ E.)	Reported by Association National Chasseurs Gibier Deau
F-3889	♂	8- 1-1968. -do-	+ 0-10-1969. Novosibirsk Region, Chany Lake (*c*. 54° 76′N., 77° 13′E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-4019	♀	14-1-1968. -do-	+ 29-9-1969. Novosibirsk Reg., near Kupino (*c*. 54° 23′ N., 77° 18′ E.)	-do-
F-4300	♂	28- 1-1968. -do-	+ 29-8-1970. Omsk Reg., near Krutinka (*c*. 55° 54′ N., 70° 59′ E.)	-do-
F-4380	♂	30-1-1968. -do-	+ Between 15th-25th June 1969, near Alakoul Lake, 30km. Oso of Vch-Aral Village.	Reported by Dr. E. I. Gavrilov, Russia
F-4599	♂	6-2-1968. -do-	+ 6-9-1969. Novosibirsk Reg., Chulym Dt., near Seryabryanka (*c*.54° 54′ N., 80° 41′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-4789	♂	13-2-1968. -do-	+ 22-5-1970. Tyumen Reg., near Surgut (*c*.61° 18′ N., 73° 29′ E.)	-do-
F-4881	♂	21-1-1969. -do-	+ 20-12-1969. Novosibirsk Reg., near Zdvinsk (*c*.54° 43′ N., 78° 41′ E.)	-do-

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No. and Sex	Date and place of Ringing	Date and place of Recovery	Remarks
		Common Pochard (*Aythya ferina*)—contd.	
F-5125 ♀	22-2-1968. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	+ 27-8-1969. Sverdlovsk Reg., near Nizhnii Tagil (*c.*57° 55′ N., 60° 00′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-5276 ♀	26-2-1968. -do-	+ 2-9-1969. Kazakh SSR, Pavlodar Reg., near Irtyshskoe (*c.* 53° 23′ N., 75° 23′ E.)	-do-
F-5457 ♀	27-2-1968. -do-	+ 14-9-1969. Kazakh SSR, near Tselinograd (*c.*51° 11′ N., 71° 27′ E.)	-do-
F-9624 ♀	14-1-1970. -do-	+ 4-9-1970. Omsk Reg., near Tyukalinsk (*c.*55° 54′ N., 72° 14′ E.)	-do-
F-10088 ♀	13-1-1970. -do-	+ 30-8-1970. Kurgan Reg., near Kazarkino, Makushino Dt., (*c.*55° 22′ N., 67° 24′ E.)	-do-
F-11017 ♀	6-2-1970. -do-	26-6-1970. Bhupendra Sagar Lake, Haryaoo Vill., Patiala Dt., Punjab (*c.*30° 36′ N., 76° 45′ E.)	Reported by Nirmal Singh
F-11280 ♂	8-2-1970. -do-	+ 6-9-1970. Kurgan Reg., near Safakulevo (*c.*55° 00′ N., 62° 32′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-11726 ♂	18-2-1970. -do-	+ 8-5-1970. Lake Ubinskoe, near Village Krestehenka, Ubinsky Dt., Novosibirsk Reg., (*c.* 54° 79′ N., 81° 43′ E.)	Reported by T.K. Yurlov, Russia
F-14298 ♀	8-3-1970. -do-	+ 8-6-1970. Tselinograd Reg., near Ermentau (*c.*51° 29′ N., 71° 08′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
		White-eyed Pochard (*Aythya nyroca*)	
F-3288 ♀	21-12-1967. Bharatpur, Rajasthan (*c.* 27 °13′ N., 77° 32′ E.)	+ 8-10-1969. Kazakh SSR, Alma-Ata Reg., near Bakanas (*c.* 44° 49′ N., 76° 19′ E.)	Reported by Bird Ringing Centre, Moscow, USSR

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No. and Sex		Date and place of Ringing	Date and place of Recovery	Remarks
			Tufted Duck (*Aythya fuligula*)	
F-3364	♂	22-12-1967. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	+ Spring 1969. Tomsk Reg., near Kolpashevo (*c.*58° 21′ N., 82° 56′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-3371	o?	22-12-1967. -do-	+ 30-5-1970. Krasnoyarsk Reg., near Norilsk (*c.* 69° 20′ N., 88° 14′ E.)	-do-
F-3864	Fg.	7-1-1968. -do-	+ 19-10-1968. Kirghiz SSR, near Frunze (*c.* 42° 51′ N., 74° 33′ E.)	-do-
F-8133	♂	19-11-1969. -do-	+ 10-1-1970. Amritsar, Punjab (*c.* 31° 38′ N., 74° 53′ E.)	Reported by Bishan Singh
F-8379	♂	3-12-1969. -do-	+ 25-5-1970. Zhigansk Reg., USSR (*c.* 66° 6′ N., 124° 8′ E.)	Reported by Nikolaev Egorovich
F-8664	♂	10-12-1969. -do-	+ 12-1-1970. Old Sutlej River bed, near Chunian Dt., Lahore, W. Pakistan (*c.* 30° 93′ N., 74° 20′ E.)	Reported by Capt. Abdul Aziz, Mohd. Ali Park, W. Pakistan
F-8665	♂	10-12-1969. -do-	29-3-1970. Kanspora Jheel Kashmir Teh., Baramulla (*c.* 34° 38′ N., 74° 42′ E.)	Reported by Wali Mohammed Dar
F-8692	♂	11-12-1969. -do-	+ 31-8-1970. Novosibirsk Reg., near Krutologovo (Kochenev Dt.) (*c.* 55° 11′ N., 82° 06′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-8701	♂	11-12-1969. -do-	+ 25-5-1970. Yakutian ASSR, near Vilyuisk (*c.*63° 48′ N., 121° 33′ E.)	-do-
F-9302		1-1-1970. -do-	+ 13-6-1970. Krasnoyarsk Reg., near Dudinka (*c.* 69° 30′ N., 68° 26′ E.)	-do-
F-10158	♀	14-1-1970. -do-	+ 20-5-1970. Yakutian ASSR, near Borogontsy (*c.* 62° 43′ N., 131° 09′ E.)	-do-
F-10501	♂	27-1-1970. -do-	+ 25-5-1970. Tyumen Reg., near Surgut (*c.* 61° 18′ N., 73° 29′ E.)	-do-

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No. and Sex	Date and place of Ringing	Date and place of Recovery	Remarks
	Tufted Duck (*Aythya fuligula*)—contd.		
F-11003 ♀	5-2-1970. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	+ 5-6-1970. Novosibirsk Reg., near Chistoozernoe (*c.* 54° 46′ N., 76° 12′E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-11045 ♀	6-2-1970. -do-	+ 20-5-1970. Yakutian ASSR, near Nyurba (*c.* 63° 20′ N., 118° 23′ E.)	-do-
	Comb Duck (*Sarkidiornis melanotos*)		
K-081 ♀	11-11-1969. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	+ 26-12-1969. Budaun, U.P. (*c.* 28° 2′ N., 79° 7′ E.)	Reported by K. K. Singh
	Grey Partridge (*Francolinus pondicerianus*)		
F-6950 ♂	16-9-1969. Kalyan, Maharashtra (*c.* 19° 14′ N., 73° 10′ E.)	15-11-1969. Kalyan, Maharashtra (*c.* 19° 14′ N., 73° 10′ E.)	Reported by Ganu B. Patil
	Coot (*Fulica atra*)		
F-2265	14-11-1967. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	+ 25-1-1970. Bhadesa Tank, about 6 miles from Unnao, U.P. (*c.* 26° 00′ N., 80° 00′ E.)	Reported by Mashooq Ali Siddiqi
F-3424	27-12-1967. -do-	+ 0-9-1969. Kazakh SSR, near Alma-Ata (*c.* 43° 15′ N., 76° 55′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-3920	9-1-1968. -do-	+ 26-10-1969. Kazakh SSR, Dzhambul Reg., near Dzhambul (*c.* 42° 53′ N., 71° 21′ E.)	-do-
F-6211	31-1-1969. -do-	14-2-1970. Ganduan Vill., near Railway Station, Sangrur Dt., Punjab (*c.* 30° 15′ N., 75° 59′ E.)	Reported by Jagjit Singh
F-6243 Ad.	11-2-1969. -do-	+ 10-9-1969. Novosibirsk Reg., near Barabinska (*c.* 55° 24′ N., 78° 23′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-6401 Ad.	11-2-1969. -do-	5-1-1970. Hygam Reserve in Kashmir (*c.* 34° N., 74° 5′ E.)	Reported by A. R. Wani

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No. and Sex	Date and place of Ringing	Date and place of Recovery	Remarks
		Coot (*Fulica atra*)—contd.	
F-8710	11-12-1969 Bharatpur, Rajasthan c. 27° 13′N., 77° 32′ E.)	+ 29-8-1970. Altai, near Pankrushikha (c. 53° 54′ N., 80° 21′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-9006	20-12-1969. -do-	April 1970. Wah-Cantt., W. Pakistan	Reported by Bostan Khan
F-9805 Ad.	8-1-1970. -do-	+ 9-3-1970. Tyumen Reg., near Deinau (c. 39° 17′ N., 63° 12′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-10200	11-1-1970. -do-	+ 29-8-1970. Novosibirsk Reg., Near Kupino (c. 54° 23′ N., 77° 17′E.)	-do-
F-10345	18-1-1970. -do-	+ 10-9-1970. Kazakh SSR, Kokchetav Reg., near Chshuchinsk (c. 52° 57′ N., 70° 11′ E.)	-do-
F-10541 Fg.	28-1-1970. -do-	13-3-1970. Bhupendra Sagar Lake, Haryaoo Vill., Patiala Dt., Punjab (c. 30° 36′ N., 76° 45′E.)	Reported by Nirmal Singh
F-10618	29-1-1970. -do-	+ 27-2-1970. Sunam, Sangrur Dt., Punjab (c. 30° 15′ N., 75° 59′ E.)	Reported by Jagroop Singh
F-11414 Fg.	13-2-1970 -do-	+ 29-8-1970. Kazakh SSR, near Semipalatinsk (c. 50° 32′ N., 80° 51′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
F-11448	13-2-1970. -do-	+ 29-8-1970. Altai Reg., near Kamen-na-Obi (c. 53° 50′ N., 81° 18′ E.)	-do-
F-11824 Fg.	25-2-1970. -do-	29-3-1970. Mazar-i-sharif Wilayet Balkh, Afghanistan (c. 36° 7′ N., 67° 21′ E.)	Reported by Ghulam Mohd. Tokhi
F-14125 Fg.	4-3-1970. -do-	26-4-1970. Afghanistan Balkh (c. 36° 46′ N., 66° 53′ E.)	Reported by Ghulam Sakhi
F-14763 Ad.	17-3-1970. -do-	27-3-1970. Hajin Teh., Sonawari Srinagar (c. 34°5′ N., 74°5′ E.)	Reported by Gh. Mohmd. Parey

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No. and Sex	Date and place of Ringing	Date and place of Recovery	Remarks
	Coot (*Fulica atra*)—contd.		
F-14803 Fg.	19-3-1970. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	27-3-1970. Hajin Teh., Sonawari, Srinagar (*c.* 34°5′ N., 74°5′ E.)	Reported by Gh. Mohmd. Parey
MOSCOW B-121809	28-5-1969. Kazhak SSR, Taldy-Kurgan Reg., Alakul Dt., Delta of the Tentak R. (*c.* 46° 13′ N., 80° 51′ E.)	8-11-1969. Bharatpur, Rajasthan (*c.*27° 13′ N., 77° 32′ E.)	Recaptured by B. N.H.S. Staff and released again withB. N. H. S. ring No. F-7593.
MOSCOW D-485483	14-7-1967. Lake Saykul-Delta of Tentak R., Alma-Ata Reg., SSR.	2-2-1968. Anchar Lake, near Srinagar, Kashmir (*c.* 34° 5′ N., 74° 5′ E.)	Reported by A. R. Wani
F-14783	19-3-1970. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	+ 31-8-1970. Kazakh SSR, Severo Kazakh Reg., near Mamlyutka (*c.* 55° 00′ N., 68° 34′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
	Wood Sandpiper (*Tringa glareola*)		
AB-12495	4-4-1970. Calcutta, Mitpukuria, 24 Parganas Dist., (W.B.)	4-4-1970. Near Fort William, Calcutta-21 (*c.* 22°34′ N., 88°22′ E.)	Reported by W/o S.V. Arumugam
AB-20328	27-2-1969. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	+ Spring 1970. Tyumen Reg., near Salekhard (*c.* 66° 34′ N., 66° 40′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
AB-21007 Ad.	18-3-1969. -do-	+ 24-5-1970. Tyumen Reg., near Khanty Mansiisk (*c.* 69° 00′ N., 61° 07′ E.)	-do-
	Fantail Snipe (*Capella gallinago*)		
B-11943	7-3-1970. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	+ 30-8-1970. Kemerov Reg., near Osinniki (*c.* 53° 37′ N., 87° 20′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
AB-13960	11-10-1967. -do-	23-2-1970. Mardan (N. W.F.P.) W. Pakistan (*c.* 34° 12′ N., 72° 2′ E.)	Reported by Mohd. Saleem Khan
AB-19592	29-1-1969. -do-	+ 4-10-1969. Kazakh SSR, Alma-Ata Reg., Balkhash Dt., near Karoi (*c.* 45° 53′ N., 74° 50′ E.)	Reported by Bird Ringing Centre, Moscow, USSR

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No. and Sex	Date and place of Ringing	Date and place of Recovery	Remarks
	Fantail Snipe (*Capella gallinago*)—contd.		
AB-22250	14-11-1969. Calcutta	5-12-1969. Calcutta market (*c.* 22° 34′ N., 88° 22′ E.)	Reported by Krishnajit, Calcutta
	Little Stint (*Calidris minutus*)		
A-92674	26-9-1969. Point Calimere, Tanjore Dt. (*c.* 10° 18′ N., 79° 51′ E.)	19-10-1969. Karaikal, Pondicherry State (*c.* 11° N., 79° 82′ E.)	Reported by S. Mohmed Yousuf
A-93756	11-10-1969. -do-	20-10-1969. Vanjur, nr., Karaikal (*c.* 11° N., 79° 82′ E.)	Reported by S. Annamalai
A-96317 Ad.	26-11-1969. -do-	9-6-1970. Khairpur Sadirat, Alipur Teh., W. Pakistan (*c.* 29° 35′ N., 72° 18′ E.)	Reported by Rasheed Ahmed Qurashi
A-96998	1-12-1969. -do-	Mid Dec. 1969. Thanikadu 12m. from Muthupet (*c.* 10° 24′ N., 79° 30′ E.)	Reported by S. Veerayan
A-95882 Ad.	20-11-1969. -do-	4-8-1970. Karaikal, Pondicherry State (*c.* 11° N., 79° 82′ E.)	Reported by E.K.M. Iqubal
	Curlew-Sandpiper (*Calidris testaceus*)		
AB-29450 Ad.	22-11-1969. Point Calimere, Tanjore Dt. (*c.* 10° 18′ N., 79° 51′ E.)	11-2-1970. Adirampattinam, (*c.* 10° 20′ N., 79° 23′ E.)	Reported by Prof. of Zoology, Khadir Mohideen College
AB-29614	25-11-1969. -do-	27-2-1970. Adirampattinam, Tanjore Dt., (*c.* 10° 20′ N., 79° 23′ E.)	Reported by V. Govindan
	Ruff (*Philomachus pugnax*)		
B-2194 ♂	24-1-1969. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	17-11-1969. Aligarh, U.P. (*c.* 25° 36′ N., 76° 03′ E.)	Reported by Khan Aslam Rauf
B-4175 ♂	6-10-1967. -do-	+ 26-5-1970. Yakutian ASSR, near Porrovsk (*c.* 61° 30′ N., 129° 08′ E.)	Reported by Bird Ringing Centre, Moscow, USSR

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No. and Sex	Date and place of Ringing	Date and place of Recovery	Remarks
	Ruff (*Philomachus pugnax*)—contd.		
B-4582 ♂	25-10-1967. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	+ 18-5-1970. Yakutian ASSR, near Suntar (*c.* 62° 10′ N., 117° 39′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
B-4998 ♂	7-1-1968. -do-	+ 1-9-1969. South Kazakh Reg., near Turkastan (*c.* 43° 20′ N., 68° 14′ E.)	-do-
B-6304 ♀	18-3-1969. -do-	+ 11-1-1970. Shahjahanpur, U.P. (*c.*27° 53′ N., 79° 54′ E.)	Reported by D. R. Misra
B-7519 ♂	2-10-1969. -do-	10-12-1969. Madhepura, Saharsa Dt., Bihar (*c.* 25° 96′ N., 86° 4′ E.)	Reported by R. N. Singh
B-7561 Ad.	3-10-1969. -do-	April 1970 Vill. Dhansinghpur, Etah Dt., U.P. (*c.* 27° 34′ N., 78° 41′ E.)	Reported by Syed Fida Ali alias Wali Jan
B-8006 ♂	15-10-1969. -do-	12-11-1969. Kanpur. (*c.* 26° 4′N., 74° 91′ E.)	Reported by Zahoor Ahmed.
B-8143 ♀	16-10-1969. -do-	+ 9-5-1970. Yakutian ASSR, near Namtsy (*c.* 62° 42′ N., 129° 35′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
B-8163 ♀	16-10-1969. -do-	+ 0-5-1970. Yakutian ASSR, near Vilyuisk (*c.* 63° 48′N., 121° 33′ E.)	-do-
B-10009 ♀	18-10-1969. -do-	22-1-1970. Kadai Mahimapur Mill, about 30ml. east from Sitapur District, U.P. (*c.* 27° 35′ N., 80° 4′ E.)	Reported by Awadh Prakhash Sinh
B-10054 ♀	19-10-1969. -do-	+ 7-6-1970. Yakutian ASSR, near Olenek (*c.* 68° 29′ N., 112° 30′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
B-17381 ♀	8-1-1970. Point Calimere, Tanjore Dist., Tamil Nadu (*c.* 10° 18′N., 79° 51′ E.)	17-9-1970. Sirupattakarai, Tanjore Dt., Tamil Nadu (*c.* 10°N., 79° 22′ E.)	Reported by K. Masilamani
B-17511 ♂	9-1-1970. -do-	27-1-1970. Nagore, S. India (*c.* 10° 32′ N., 79° 34′ E.)	Reported by M/s. Arts & Crafts Co., Nagore
C-6825	3-10-1969. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	9-5-1970. Hasanpur, Moradabad Dt., U.P. (*c.* 28° 44′ N., 78° 41′ E.)	Reported by Tanvir Khan

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No. and Sex	Date and place of Ringing	Date and place of Recovery	Remarks
	Ruff (*Philomachus pugnax*)—contd.		
C-6842 ♂	4-10-1969. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	+ 22-5-1970. Yakutian ASSR, near Verkhnevelyuisk (*c.* 63° 27′ N., 120° 18′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
C-7347 ♂	17-10-1969. -do-	+ 0-5-1970. Magadan Reg., near Pevek (*c.* 69° 43′ N., 170° 16′ E.)	-do-
C-7494 ♂	21-10-1969. -do-	+ 17-5-1970. Yakutian ASSR, Megino-Kangalasskii Reg., near Tyungyulyu (*c.* 62° 13′ N., 130° 43′ E.)	-do-
C-7498 ♂	21-10-1969. -do-	27-2-1970. Lahore at Village Daruke, Gujranwala Dt., W. Pakistan (*c.* 32° 14′ N., 74° 10′ E.)	Reported by Mian Chiragh Din
	Blackwinged Stilt (*Himantopus himantopus*)		
C-3237	12-10-1967. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	17-4-1970. On the outskirts of Balkh, N. Province of Afghanistan.	Reported by Abdul Hamid
C-15309 Ad.	24-2-1970. Muthupet, Tamil Nadu (*c.* 10° 59′ N., 79° 53′ E).	16-6-1970. Pattukkottai Taluk, Tanjore Dt. (*c.* 10° 35′ N., 78° 55′ E.)	Reported by R. Raju
	Rosy Pastor (*Sturnus roseus*)		
AB-20432	5-3-1969. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	19-4-1970. South Waziristhan (*c.* 31° 55′ N., 69° 20′ E.)	Reported by Sayed Badshah Khan
	Yellowbrowed Bulbul (*Hypsipetes indicus*)		
AB-23233	5-5-1969. Mahabaleshwar, Maharashtra (*c.* 17° 56′ N., 73° 40′ E.)	19-5-1970. Mahabaleshwar, Maharashtra (*c.* 17° 56′ N., 73° 40′ E.)	Reported by Fr. I. Hernandes S.J.
	Rufousbellied Niltava (*Muscicapa sundara*)		
A-82364 ♂	23-10-1968. Gedu, Bhutan (*c.* 27° N., 89° E.)	7-3-1970. Gedu, W. Bhutan (*c.* 27° N., 89° E.)	Reported by B. Biswas

RECOVERY OF RINGED BIRDS—(*contd.*)

Ring No. and Sex	Date and place of Ringing	Date and place of Recovery	Remarks
	Yellow Wagtail (*Motacilla flava beema*)		
A-40575	7-10-1963. Bharatpur, Rajasthan (*c.* 27°13′N., 77°32′E.)	+ 0-6-1970. Tselinograd Reg., near Astrakhanka (*c.* 51°35′N., 69°47′E.)	Reported by Bird Ringing Centre, Moscow, USSR
	Spanish Sparrow (*Passer hispaniolensis*)		
A-77464 ♂	19-1-1969. Bharatpur, Rajasthan (*c.* 27° 13′ N., 77° 32′ E.)	+ 5-7-1969. Kazakh SSR, Alma-Ata Reg. Enbekshikazath Dt., near Issyko (*c.* 43° 22′N., 77° 28′ E.)	Reported by Bird Ringing Centre, Moscow, USSR
A-86138 ♀	6-3-1969. -do-	+ 13-10-1969. Chokpak, Russia (*c.* 42° 38′ N., 70° 31′E.)	Reported by E. Gavrilov
MOSCOW ♀ S-269 480	6-5-1968. Kazakh SSR, Dzhambul Reg., near Chokpak (*c.* 42° 31′ N., 70° 38′ E.)	24-12-1969. Bharatpur, Rajasthan, India (*c.* 27° 13′ N., 77° 32′ E.)	Recaptured and released by B.N.H.S. Staff with a new ring B.N.H.S. No. A-91428

+ Bird killed or shot by man.

BOMBAY NATURAL HISTORY SOCIETY,
HORNBILL HOUSE,
SHAHID BHAGAT SINGH ROAD,
BOMBAY-1.
October 20, 1970.

EDITORS

9. *TESTUDO ELEGANS* IN WESTERN RAJASTHAN

According to Smith (1931) the Starred Tortoise, *Testudo elegans* Schoepff has a wide range of distribution in Central and Peninsular India, extending west as far as Sind and south to Ceylon. From Rajasthan, however, Smith reported the tortoise from Udaipur, east of the Aravalli ranges. Recently, the tortoise has been observed at Bisalpur, about 5 km. north of Jawai Bandh railway station on the western side of the Aravallis. They inhabit foothill grasslands composed of *Sporobolus helvolus, Heteropogon contortus, Cymbopogon parkari, C. martinii, Dichanthium annulatum* and *Aristida* spp. The tortoise are, however, not very common. They were found to be quite active during the day. One of the tortoise collected in March passed very loose excreta and in a large quantity. It contained only plant matter and grasses like *Sporobolus, Dichanthium, Cymbopogon* and *Aristida* could be identified. The same species of grasses were also identified from the faecal matter of a tortoise collected in the month of October.

Smith (1931) reported that a female *T. elegans* deposited four eggs on 11 November. Minton (1966) mentioned that these tortoise in semi-domestication in the suburbs of Karachi copulate soon after the onset of rains. A clutch of five eggs was reported in the month of November. Young ones were collected late during August and September. Minton regarded them to be several months old and suspected that hatching occurs during February and March. The hatchlings remain buried and quiescent until the onset of rains. The young tortoise collected at Bisalpur in September, however, appeared to be a newly-hatched one as its shell was membranous and could be punctured with a pin. I, therefore, suspect that female tortoise lays eggs during the summer also. The eggs require slightly over three months for hatching as is the case with *Testudo horsfieldi* (Sergeev 1941). It is not, therefore, unlikely that *Testudo elegans* lays eggs during winter and second time during the summer. The observed hatchling might have been from a summer brood.

I could not make further observations on the young one as a House Rat, *Rattus rattus rufescens* cut open the membranous shell and scooped the hatchling for its dinner.

ANIMAL ECOLOGIST
CENTRAL ARID ZONE RESEARCH INSTITUTE, JODHPUR,
November 18, 1970.

ISHWAR PRAKASH

REFERENCES

MINTON, S. A. (1966): A contribution to the herpetology of West Pakistan. *Bull. Amer. Mus. nat. Hist.* **134**: 1-184.

SERGEEV, A. M. (1941): On the biology of the reproduction of the Steppe Tortoise (*Testudo horsfieldi* Gray). *Zool. Zh.* **20**: 118-133.

SMITH, M. A. (1931): The Fauna of British India, Ceylon and Burma. Reptilia and Amphibia, Vol. I: 138-140. Taylor & Francis, London.

10. THE CATCHING OF SNAKES

Finding a snake is the first problem a prospective ophiologist must take up. One can learn by experience, by searching 'likely' places repeatedly, at different times of day and night, during different seasons of the year, to ascertain which species may be found where and when.

Even in areas of heavy snake population a collector may not find many snakes because he has not 'learned' the area. In India if a local snake-catcher with a good knowledge of the area is available for help, he will provide very important shortcuts to what could be the tedious job of years of gaining experience. A rewarding (but be prepared to be bothered) practice is to publicize the fact that you're interested in snakes, and if your area is suitable the monsoon will not only bring rain but a deluge of village people to tell you of the snake that is currently inhabiting their dwelling or field. In looking over collection data I find that of fifty snakes recently caught, thirty of them were from information brought to me by farmers, field workers etc. Today while working on this paper I was called down the road to the quarry where I found a fine two foot long Russell's Viper that had taken refuge under a pile of stones.

During and just after the monsoon are usually the best seasons for collecting snakes; early morning and evening hours the times of day of most activity. Areas such as rock piles or old ruins, paddy harvest and storage places (rodents are numerous), hedges, roadsides etc. are all good places to look. Walk slowly and lightly and look carefully—snakes are well camouflaged and though deaf are extremely sensitive to the vibration of your foot-falls. During the dry season especially, listen for snakes crawling; any rustling in the undergrowth should be at least briefly investigated. Hunting at night on likely roads (check during the day for snakes killed at night by vehicles which will help determine the potentiality of the road) either by walking with a torch or better still by car or motorbike can be very rewarding especially on very humid or rainy nights. I have found as many as twenty snakes of five different species on roads in the outskirts of Bombay while driving at night, and other collectors have told me of very large numbers collected by this method. If you are interested in catching aquatic varieties such as *Natrix, Cerberus* and *Gerardia,* night hunting in flooded paddy fields, especially around and in fish traps and drainage streams will yield good results. The listing of possible spots for snakes is endless, you will discover your own best spots, the main thing is to be persistent, keep looking. Turn over rocks, look in old tree stumps, tear pieces of loose bark from dead trees, search around stacked building materials etc.

Upon finding a snake, the next thing is to catch and bag it. There are some 'standard' methods of snake-catching, but each capture depends a lot on the type of snake and the circumstances. One of the first pre-requisites to snake catching is to learn the species, which are poisonous and which aren't. If you suddenly come upon (and it usually is sudden) a snake and ascertain that it is harmless, let's say a fast one like a Rat Snake or Bronze-back, the only way to get it is to make a fast grab, or even dive on it if the terrain permits. Once you get over the fear of the only superficial scratches a non-poisonous snake can make with its bite (big ones like large water snakes, big dhamans and pythons excepted of course), jumping on a snake becomes a reflex action, your only thought is that you are sure its a harmless one. You have to know your snakes well, for a cobra (or a king cobra) can look like a dhaman (rat snake) to someone who has not seen plenty of both, and it would be a dangerous surprise to land on the former.

Gloves, clamp-sticks, nooses and other apparatus you may try, but you'll probably not use them long; they just make you clumsy, and if the snake doesn't escape you may still end up injuring a specimen. The snake hunting tool many snake men find to be most useful is a 'snake hook' which I will describe shortly. Once you have grabbed a harmless snake you can best control it if you secure a grip behind the neck with one hand, using the other hand to control its flailing body (I make light of non-poisonous snake bites but there is no reason to invite being bitten). Always support the snake's weight as it can easily injure its delicate neck vertebrae by its whip-like activity while trying to escape. You may evolve your own procedures for securing the neck grip; one that I find useful is to swing the snake back between your legs (long pants of course) and, legs pressed together, ease it through until you have the neck encircled by thumb and fingers. Then bag the snake; a double-stitched muslin bag the size of a pillow cover but longer (for knot tying) is probably the most convenient container for harmless and poisonous species until transferred to a cage or terrarium. Fangs easily penetrate cloth, therefore hold a bag containing a venomous snake above the knot and keep it away from inquisitive people and animals.

Ideally, a poisonous snake should be captured without ever touching it with your hands, but this is by no means always possible. As I mentioned, using mechanical devices or nooses on a snake will too often result in the snake being injured, sometimes an internal injury, not immediately apparent, but later the snake may refuse to eat and die of injury and/or starvation. A snake hook, made from a length of bamboo, golf club shaft (or whatever else is convenient), with a heavy wire L attached to the working end, is the most versatile tool in the snake business. If the wire L is made strong enough it can be used for turning over rocks, probing holes etc. as well as its most valuable function, that of lifting and 'pinning' a snake. When it is feasible to lift or guide a venomous snake into a bag or other container with the snake hook this is obviously to be preferred to picking it up. A useful apparatus to have is a snake bag pinned (so it can be easily removed) to a butterfly net frame which holds the bag wide open from a safe handle-length distance and has often facilitated an easy and safe catch. When this procedure is impossible because the snake is too active or otherwise, the procedure of pinning must be adopted. This is the most common method of snake catching, used by catchers in the forest, professional snake men in zoos and venom production laboratories. A fast snake like a cobra must first be detained, a careful foot or stick pressure on the tail is usually enough to cause a cobra to rear up in its defence. Then the snake hook or other rounded stick is placed horizontally across the junction of the snake's head and neck and pressed gently but firmly, enough to keep the snake from pulling out before you are able to get a safe grip. Extreme care must be taken in dealing with any poisonous snake, both for yourself and for sake of the snake. A Russell's Viper or Cobra will often thrash about once it feels the pressure of the stick on its head and neck; if it looks as though it may injure itself, release the pressure and try again. Secure a firm but not strangling grip just at the base of the snake's head so it cannot reach around and bite. An interesting and instructive note is that some long-fanged species like Russell's Viper may bite so vigorously when being held as to penetrate their own lower jaw, and your thumb if you happen to have it in the wrong place. Occasionally I hear of someone being bitten at the moment of letting the snake go into the bag or box. If some help is available, have him hold the bag open while you place the snake's body deep in, keep your eyes on the position of the snake's head. When you feel the snake pulling away from your hand or it is relaxed let go and jerk your hand clear off the bag. The reason for long bags becomes clear, you are much safer with the snake at the bottom in that few seconds gap in letting the snake go and twisting the top of the bag for tying a secure knot. If alone, or without help, tuck one edge of the bag into belt or wherever convenient, holding the other edge of the bag with the hand not engaged with the snake. Keep snakes in separate bags when possible, small snakes shouldn't be kept with large ones, poisonous ones separate from non-poisonous ones, and Russell's Vipers and kraits away from other species or you may have dead and/or devoured snakes.

It seems hardly adequate for me to try to explain snake catching methods in writing, but it will serve as introductory. The rest comes with observation of a skilled snake handler (*not* most 'jadhu walas'), and finally personal experience.

C/o K. Chattopadhyaya,
6, Chateau Marine,
Marine Drive,
Bombay,
January 10, 1969.

ROMULUS WHITAKER

11. NEW LOCALITY RECORDS OF *HORAICHTHYS SETNAI* KULKARNI, FROM NARMADA AND TAPTI RIVERS

Horaichthys setnai Kulkarni (Family Horaichthyidae) is a small, translucent cyprinodont fish, with elongate, narrow and somewhat compressed body. Being a small fish, it is 'absolutely insignificant and worthless as food', but is 'a suitable species for use in malarious areas of coastal waters' (Job 1940). The distribution of this species, as recorded by Kulkarni (1940), is 'the backwaters and tanks within tidal limits along the western coast of Peninsular India, about 160 km. (=100 miles) north and south of the city of Bombay'. Job (op. cit.) has recorded this species 'from shallow inlets within tidal influence of backwaters in Cochin and Travancore' and in his opinion, 'this fish extends throughout the western coast of Peninsular India'. As this fish is 'a valuable adjunct to other major larvivores like *Aplocheilus lineatus* and *A. panchax*' (Job, op. cit.), it is of prime importance to have exact knowledge of the distribution of this larvicidal fish. Based on the collections of this species from Narmada and Tapti rivers during the 1962 monsoon season, two new locality records are reported in the present communication.

Several specimens of *H. setnai* were collected from spawn-collection nets, while the spawn prospecting investigations were in progress in the lower reaches of Narmada and Tapti Rivers in Gujarat State during the 1962 monsoon season. 18 specimens of this species, measuring 17-25 mm. in total length, were collected from Narmada River at Jhanor, about 64 km. from the sea and about 24 km. below the tidal limit (at Bhalod) on 22nd, 25th and 28th July 1962 and 21st August 1962. 197 specimens in the size range 18-30 mm. were collected from Tapti River at Kathor, about 40 km. from the sea and about 5 km. above the tidal limit (at Abhrama) from 9th to 22nd July 1962, and one solitary specimen measuring 22 mm. in total length at Bodhan, about 50 km.

from the sea and about 15 km. above the tidal limit (at Abhrama) on 14th July 1962.

Narmada and Tapti Rivers are located outside the known range of distribution of *H. setnai* and the collection of the species from these localities, extends the range of its distribution, along the coast, as far as the Narmada estuary, about 320 km. north of Bombay.

Although this species has been recorded, in summer, from a creek near Mahad in Kolaba district, about 56 km. (= 35 miles) from the sea (Kulkarni, op. cit.), its ascent in Narmada and Tapti Rivers, against the fast current during monsoon floods or even against the feeble current in summer months, as far inland as 64 km. from the sea in the case of the former river and to freshwater regions beyond the tidal limits of the latter river is of some significance in view of the statement of Kulkarni (op. cit.) that it is a typical backwater species and has not been found in flowing waters.

According to Kulkarni (op. cit.) *H. setnai* is able to withstand a wide range of salinity (1·348% during monsoon to 4·363% during summer). He conducted a few experiments to acclimatize this species to freshwater and found that the fish lived in freshwater aquarium for about 2½ months, but did not show its characteristic vigour or active habits in freshwater. The occurrence of this species in large numbers in freshwater zone of Tapti River at Kathor during monsoon season has, however, indicated that it is capable of thriving in flowing freshwater.

The authors are extremely grateful to Dr. V. G. Jhingran, Director and Shri H. P. C. Shetty, Fishery Scientist, of the Institute, for their interest in the work, and to the Director, Zoological Survey of India, Calcutta, for confirming the identification of the fish. They are thankful to the survey staff of the Unit for placing the fish collections at their disposal.

NARMADA TAPTI UNIT,
CENTRAL INLAND FISHERIES
RESEARCH INSTITUTE,
HOSHANGABAD (M. P.),
August 25, 1970.

S. J. KARAMCHANDANI[1]
P. K. PANDIT[2]

REFERENCES

JOB, T. J. (1940): Notes on the geographical distribution and larvicidal propensities of *Horaichthys setnai* Kulkarni. *J. Bombay nat. Hist. Soc.* **42** (1): 447.

KULKARNI, C. V. (1940): On the systematic position, structural modifications, bionomics and development of a remarkable new family of Cyprinodont fishes from the province of Bombay. *Rec. Indian Mus.*, Calcutta **42** (2): 379-423.

Present address: 1. Small Reservoirs Unit, Central Inland Fisheries Research Institute, Rewa (M.P.).
2. Central Fisheries, Kakdwip P.O., District 24 Parganas, West Bengal.

12. ON TWO DORIDACEAN NUDIBRANCHS (MOLLUSCA: GASTROPODA), FROM THE GULF OF KUTCH, NEW TO THE INDIAN COAST

The present note reports the occurrence, in the Gulf of Kutch, of two Doridacean Nudibranchs, *Peltodoris rubescens* Bergh (1905) and *Platydoris pulchra* Elliot (1903), which do not appear to have been recorded from the Indian coast. The specimens studied are deposited in the Museum of the Fisheries Research Station, Government of Gujarat, Jamnagar.

Peltodoris rubescens Bergh

Material: A single specimen measuring 30 mm. in length, 16 mm. in breadth and 10 mm. in height, collected from Okha (22° 28′N. & 69° 05′ E.) on May 15, 1967.

Body doridiform with a cream-coloured mantle, with yellow margin. Notum papillose with secondary points. Papillae brown with pale margin. Rhinophores black and finely lamellate, with approximately 20 lamellae. Secondary branchiae five to six in number, bipinnately branched and black and yellow in colour. Oval foot, measuring 27 mm. in length and 10 mm. in breadth, is anteriorly broad and notched. Sole is smooth and brown. Oral tentacles conical. Salivary glands long and colourless. Labium smooth and does not bear any armature. Radula 3·2 mm. long and 1·8 mm. wide and pale yellowish in colour. There are 36 hamate teeth arranged on either side of the naked rachis in each row. In all there appears to be 35 rows. Seminal vesicles are semiserial. Penis unarmed and has cuticular lining.

The dental formula places the present form with *Peltodoris mauritiana* Bergh (1889) and *Peltodoris rubescens* Bergh (1905). The former is said to be minutely granulate on the dorsum and latter finely knotty. The East African form, *P. aurea* Elliot (1903), though it appears similar to the present specimen, has a smaller radula (25 × 25·0·25), warty dorsum, eight gills and is bright orange in life.

In body coloration and radular formula the present form resembles *P. rubescens* Bergh, and in its stronger dorsal ornamentation, *P. aurea* Elliot, but differs from the latter in the longer radular formula and fewer gills.

Though the genus, *Peltodoris,* is reported to be widely distributed in the Atlantic, Mediterranean, Indian Ocean and Western Pacific coasts, I am not aware of any previous record of this genus from the Indian coasts.

Platydoris pulchra Elliot

Material: Two specimens (30 and 20 mm.) caught in the trawl net of the Survey Vessel, 'Gulfshrimp', of the Directorate of Fisheries, Gujarat State, from a depth of about 13 fathoms off Pirotan Island (22° 33′ N., 69° 58′ E.).

Body flat, oval and hard in texture. Mantle rough, spiculate and provided with many small granulations, which are bigger in the mid-dorsum and smaller on the periphery. Both the specimens are yellowish orange on both sides. The mid-dorsum has a greyish tinge, due to the sandy grey granules. There are a few chocolate spots, which are more on the ventral side. At certain places, the granules are surrounded by small chocolate rings. Rhinophores are pinkish brown and laminated. Gills six, tripinnately branched and coloured as the rhinophores. Foot, about 18 mm. long, and notched anteriorly. Sole flat and oval. The genital organs could not be studied, as they are completely shrunk. Radula has 44 rows of simple hamate teeth. Each row bears about 55 teeth on either side of the naked rachis.

The present forms differ from the Indian species, *Platydoris elliotti* (Alder and Hancock), in the dental formula and approximate the East African species, *Platydoris pulchra* Elliot (1903). *P. pulchra* Elliot appears to be new to the Indian coast.

ACKNOWLEDGEMENTS

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FISHERIES RESEARCH STATION,
DIRECTORATE OF FISHERIES,
GOVT. OF GUJARAT,
JAMNAGAR-1,
August 1, 1969.

K. R. NARAYANAN

13. BIOMETRICAL COMPARISON BETWEEN *BALANUS TINTINNABULUM* L. AND *BALANUS AMARYLLIS* D.

(With three text-figures)

Introduction

It has been customary in ecological work on barnacles to express their growth in terms of various parameters determined from repeated measurements of the shell (Barnes & Barnes 1959). Such studies of different species, most of them from temperate waters, have been made by various workers. However, there seems to be diversity of opinion regarding the adoption of a standard parameter for comparison. Some have used volume of the shell calculated from height and basal diameters (Moore 1934); some employed area of bases (Costlow & Bookhout 1953, 1956); Mawatari *et al.* (1954a, 1954b); orifice area (Marshall 1955); and others have adopted basal diameter measured through the rostro-carinal axis (Hatton 1938; Barnes & Powell 1953; Barnes 1956, 1958).

In the present studies, an altogether different parameter viz. the rostro-carinal diameter of the apical orifice, has been employed. This parameter has been found to be the most convenient one, to measure during field-work. Its utility is further enhanced by the fact that by using this parameter alone, repeated measurements of the same population can be taken over a long period without destroying the individuals.

In order to prove the suitability of this parameter, comparative biometrical studies of two species of barnacles viz. *Balanus tintinnabulum* L. and *Balanus amaryllis* D. have been made. These two species were selected for this purpose because their shells are not so much deformed due to crowding, as was found to be the case in other, small-sized barnacles. In addition, the specimens of both these species are found in the same zone—the lowermost—of the intertidal region, although there are other ecological factors which determine their distribution (Wagh & Bal — in press). The shells of both the species attain fairly large size and were available in sufficient numbers at Bombay.

Material and Methods

The specimens were collected from the field at random. The collection was brought to the laboratory and the shells were cleaned of the various organisms attached to them. The required lengths were measured to the nearest 0·1 mm. by using Vernier's callipers. The measurements were taken of about 600 individuals of *B. amaryllis* and 1000 those of *B. tintinnabulum*. Each specimen was measured for, rostro-carinal diameter along basis (Fig. 1 RC — BASAL) so also along

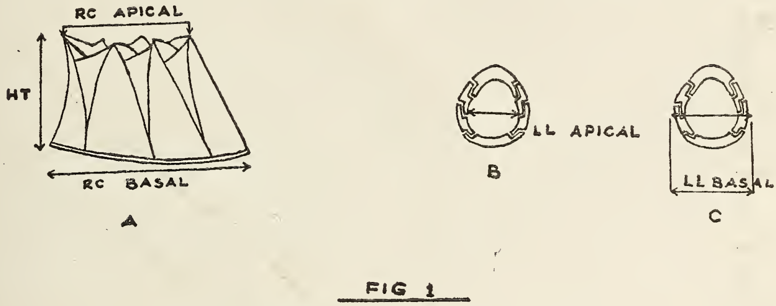

Fig. 1 Diagrams showing apical and lateral views of barnacle shell explaining the parameters used.

apical orifice (Fig. 1 RC — APICAL), latero-lateral diameter along basis (Fig. 1 LL — BASAL) and apical orifice (Fig. 1 LL — APICAL) and height (Fig. 1 HT). The observations made, were grouped on the basis of rostro-carinal diameter of apical orifice into suitable size groups, the group interval being 1·5 mm.

The relationship between rostro-carinal diameter of the apical orifice and any other parameter is expressed by the equation $Y=a+bX$ where X denotes diameter of the apical orifice measured along the rostro-carinal axis and Y the variable. The values of constants 'a' and 'b' were calculated by the formulae:

$$b = \frac{XY - \bar{N}\bar{X}\bar{Y}}{X^2 - NX^2} \quad \& \quad a = \bar{Y} - b\bar{X}$$

where N = number of size groups.

The regression lines as shown in Figs. 2 and 3 were drawn.

Observations

The regression equation $Y=a+bX$ has the following values in *B. tintinnabulum* and *B. amaryllis*.

Different Parameter	*B. tintinnabulum*	*B. amaryllis*
Height	$Y = 9{\cdot}7 + 1{\cdot}0964\ X$	$Y = 5{\cdot}2 + 1{\cdot}3031\ X$
Rostro-carinal Basal diameter.	$Y = 14{\cdot}2 + 1{\cdot}6822\ X$	$Y = 15{\cdot}1 + 1{\cdot}5301\ X$
Latero-lateral Basal diameter.	$Y = 18{\cdot}0 + 1{\cdot}2610\ X$	$Y = 12{\cdot}8 + 1{\cdot}6020\ X$
Latero-lateral Apical diameter.	$Y = 3{\cdot}5 + 0{\cdot}7032\ X$	$Y = 1{\cdot}5 + 0{\cdot}7009\ X$

It may be seen that the regression coefficients for parameters rostro-carinal basal and latero-lateral basal are more in *B. tintinnabulum* than those in *B. amaryllis.*

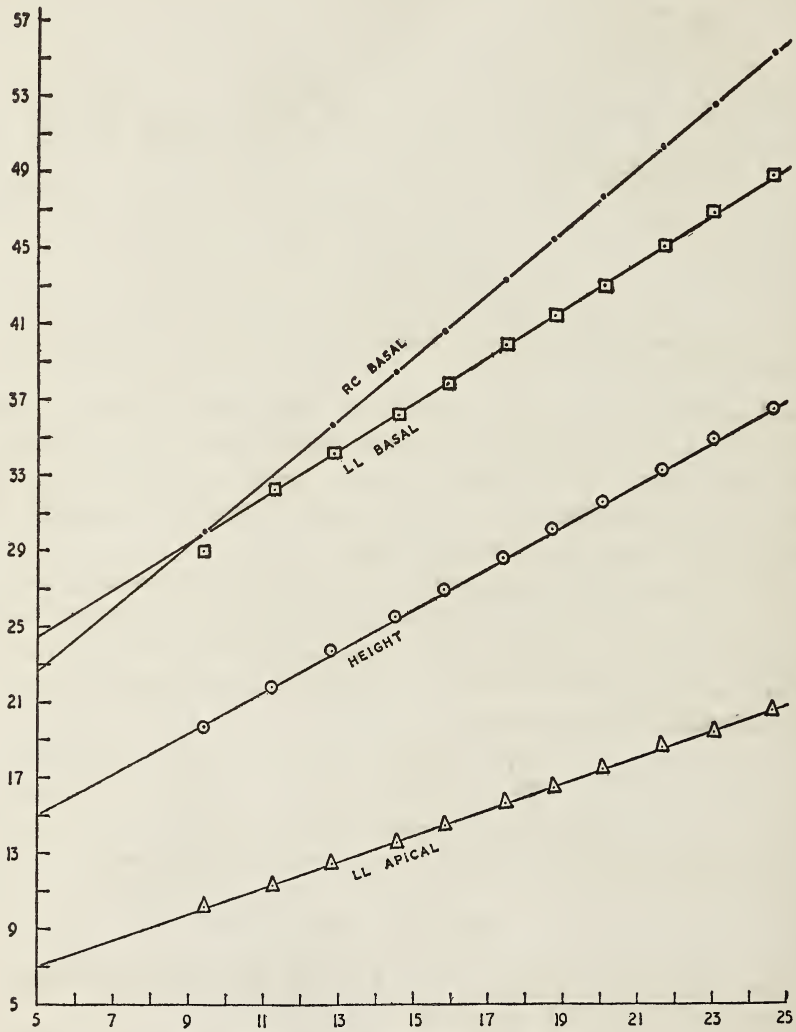

Fig. 2 A graphical presentation of relationship between RC-APICAL diameter and various other shell parameters in *Balanus tintinnabulum* L.

From the Figs. 2 and 3 it is evident that the parameter RC basal has the fastest growth in *B. tintinnabulum* whereas in *B. amaryllis* the rate of growth seems to be more or less uniform.

An inspection of the slope of the regression line reveals that LL basal and height grow more rapidly than other parameters in *B. amaryllis.*

The parameter LL apical has slow growth in both the species.

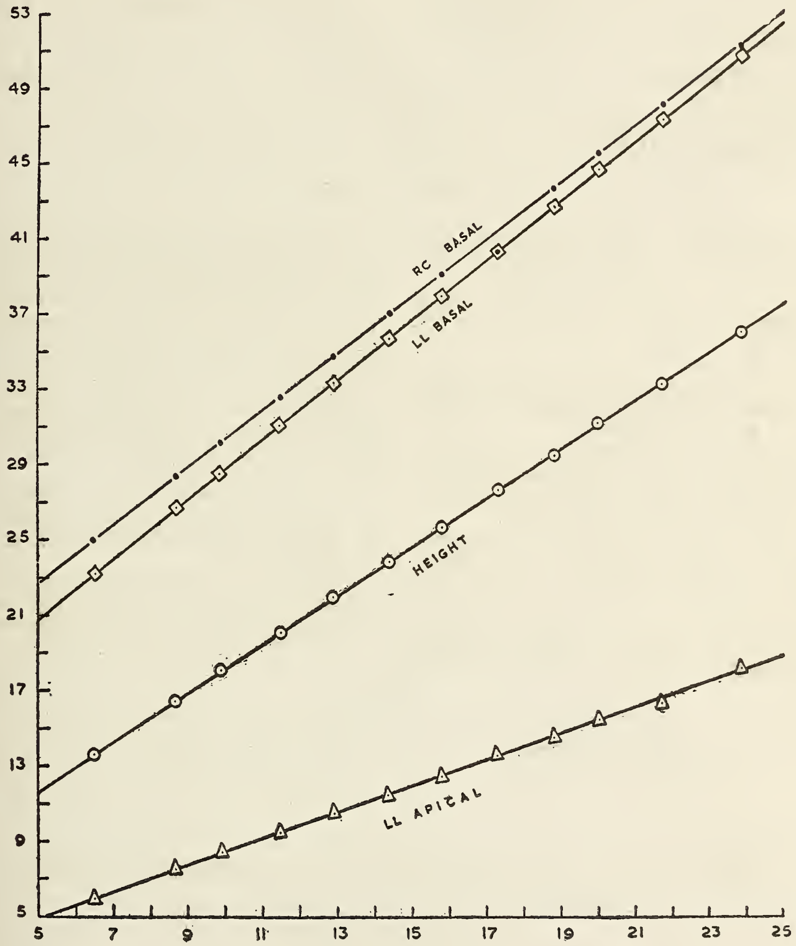

Fig. 3 A graphical representation of relationship between RC-APICAL diameter and various other shell parameters in *Balanus amaryllis* D.

Acknowledgements

We are grateful to Dr. N. K. Panikkar, Director, Indian Programme of the International Indian Ocean Expedition (at present the Director, National Institute of Oceanography, Panaji-Goa) for his keen interest and constant encouragement in the investigations and its outcome. We are also thankful to Dr. A. H. Parulekar for his most valuable and willing help. One of us (ABW) gratefully acknowledges the award of fellowship by the Indian National Committee on Oceanic Research, C.S.I.R., New Delhi.

NATIONAL INSTITUTE OF OCEANOGRAPHY, PANAJI, GOA — ARUN B. WAGH

KIRTI COLLEGE, BOMBAY-28, — D. V. BAL

February 13, 1970.

REFERENCES

BARNES, H. (1956): The growth rate of *Chthamalus stellatus* (Poli). *J. Mar. biol. Ass. U. K.* **35** (2): 355-361.

——— (1958): The growth rate of *Verruca stroemia* (O. Müller). ibid. **37**: 427-433.

——— & BARNES, MARGARET, (1959): Some parameters of growth in the common intertidal barnacle *B. balanoides* (L). ibid. **38**: 581-587.

——— & POWELL, H. T. (1953): The growth rate of *B. balanoides* (L). and *B. crenatus* under varying conditions of submersion. ibid. **32**: 107-128.

COSTLOW, J. D. (JR.) & BOOKHOUT, C. G. (1953): Molting and growth in *B. improvisus. Biol. Bull. Woods Hole* **105**: 420-433.

——— & ——— (1956): Molting and shell growth in *B. amphitrite niveus.* ibid. **110**: 107-116.

*HATTON, H. (1938): Essais de bionomie explicative sur quelques especes intercotidales d'algues et d'animaux. *Ann. Inst. Oceanogr. Monaco* **17**: 241-248.

MARSHALL, N. (1955): Measurements of plankton feeders in relation to gross production. *Ecology* **36** (2): 360.

MAWATARI, S. Y. HIROSAKI & KOBAYASHI, S. (1954a): Settlement and growth of acorn barnacle, *B. amphitrite communis* Darwin. *Misc. Rep. Res. Inst. Nat. Resour*; Tokyo **33**: 46-55.

———, ——— & ——— (1954b): Settlement and growth of acorn barnacle, *B. amphitrite communis* Darwin. II. ibid. **34**: 48-57.

MOORE, H. B. (1934): The biology of *Balanus balanoides.* I. Growth rate and its relation to size, season and tidal level. *J. Mar. biol. Ass. U.K.* **19**: 851-868.

* Not referred in original.

14. A POSSIBLE EXPLANATION OF THE PECULIAR ACCIDENT TO THE BUTTERFLY, *DELIAS EUCHARIS* DRURY

In the April 1970 issue of the Journal of the Bombay Natural History Society (Vol. **67** (1): 118) Zafar Futehally reported that a Common Jezebel (*Delias eucharis*) was found struggling to detach its proboscis from a white Lantana bloom.

When collecting butterflies in the Surat Dangs (1951-64), I observed several species of butterflies which appeared to be attached to the white flowers of some Lantana bushes growing in our mission compound. A careful examination usually disclosed the presence of one of the several species of crab-spiders of the family Thomisidae. These tiny spiders mimic the colour of the flower, spin no webs, and wait in ambush for the unsuspecting butterfly to alight on the flower for nectar.

April 21, 1960, I carefully removed a fluttering Common Jezebel (*Delias eucharis*) from a white Lantana blossom and then collected a tiny crabspider (*Thomisus pugilis*) hiding in the same blossom. Details may not be necessary to support my theory, but I have records of the Lemon Pansy (*Precis lemonias*), the Painted Lady (*Vanessa cardui*) and of a large female Great Eggfly (*Hypolimnas bolina*) feeding on Lantana which were either stunned or killed by the poison of the crab-spiders. It therefore seems like a logical explanation that the accident described was caused by a crab-spider hiding in ambush to kill the unsuspecting nectar-feeding butterfly. The butterfly was probably too numbed by the poison to detach its proboscis from the flower.

SAINT FRANCIS COLLEGE, E. M. SHULL
PORT WAYNE,
INDIANA,
September, 28, 1970.

15. A CURE FOR WASP STING

At 8 p.m. on 10th November 1970, while trying to switch on the light on our staircase, I felt a shock not at the fingertips but half way up the forearm and a sharp pain was felt immediately along the arm down to the wrist. With the light on, I saw a wasp which I swatted.

I was really leaving to fetch a doctor for my wife, and as I drove along I thought of a cure I had successfully tried for scorpion sting some years ago—by making passes over the painful area (*JBNHS* **57**:688). While driving I tried this with the other hand but with no effect.

After returning home I related this to Dr. (Miss) C. de Quadros and she immediately (about 8-20) tried the cure—her movements consisted of a light massage with the thumb criss-crossing distally from the site of the sting on the radial aspect on the upper third of the forearm, towards the wrist. Except at the lump which had formed at the place of the sting, the pain towards the wrist immediately lessened. As a small area *above* the sting was still painful, I asked her to 'treat' this too, and the pain disappeared immediately

The wasp was later picked up and identified at the Society by Mr. Nadkerny as *Icaria marginata* Lepel.

75, ABDUL REHMAN STREET, BOMBAY-3, *November* 16, 1970.

HUMAYUN ABDULALI

16. A SIMPLE AND CONVENIENT ARTIFICIAL NEST FOR MAINTAINING AN ANT COLONY IN THE LABORATORY

Different types of artificial nests for maintaining ant colonies in the laboratory have been designed by some workers, involving varying degrees of convenience, practicability, complexity and cost (Morley 1953; Skaife 1961; Wheeler 1910). The authors have been maintaining colonies of several species of ants in the laboratory for the past four years and have found that the following artificial nest designed by them is simple, inexpensive and very convenient from many points of view.

A circular polystyrene plastic container, about 15 centimetres in diameter and about 4 centimetres in height and with a closely fitting transparent lid is used for the purpose. The size of the container may be changed according to the size of the ants and the colony. A glass tube, about one centimetre in diameter and about 10 centimetres in length is taken and one of its ends is bent over a flame at an obtuse angle, about a point 2-3 centimetres from that end. The straight end of the tube is then heated and passed through the wall of the plastic container close to the base so that this end reaches close to the centre of the base of the container. The bent tip of the tube outside the container is turned upwards. Care should be taken to see that the end of the tube inside the container is not blocked by plastic material after insertion through the wall. A paste of Plaster of Paris in water is then poured into the container up to a height of about 1·5 centimetres and it is allowed to set and dry thoroughly. At the centre of the lid of the container, a circular opening, about 2 centimetres in diameter is made and is covered with a brass wire-gauze of very fine mesh. The gauze can be fixed in position by heating and pressing it against the plastic. This gives the ants adequate ventilation.

A smaller polystyrene plastic container, about 6 centimetres in diameter and about 3 centimetres in height, with a transparent lid is also taken and it is provided with a fine brass wire gauze circular ventilator, about one centimetre in diameter, at the centre of its lid. This container is connected with the larger one mentioned above, by means of a transparent polythene tube, about one centimetre in diameter and about 10 centimetres in length. The two ends of this tube open into the containers, through their walls. The length of this tube may be changed according to the habits of the ant-species concerned.

The above set-up is left for at least two to three weeks because it has been noticed that freshly cast Plaster of Paris has some kind of deleterious effect on the ants. Then, the nest is ready for use. The bent glass tube projecting outside is used for damping the plaster inside by passing small quantities of water through it at regular intervals. This maintains, inside the nest, a humid atmosphere which the ants require. The ant colony with the queen is introduced into the large container which serves as the nest proper or colony chamber. The smaller container is used as the feeding chamber in which food is kept. Under this arrangement, it is possible to maintain proper humidity conditions and to feed the ants without disturbing the ants in the colony chamber. It is also possible to observe the activities of the ants inside the colony chamber and also the foraging and feeding behaviour through the transparent lids of the containers and the connecting tube. The colony chamber should be covered with black cloth or some other opaque material as the ants seek darkness in their habitation in nature. Extra containers with a base of Plaster of Paris inside and with suitable ventilators may also be connected to the main colony chamber by means of polythene tubes so that the ants may, if they have the habit, use them for starting subsidiary nests.

Department of Zoology, A. B. SOANS
Malabar Christian College, J. S. SOANS
Calicut-1, Kerala State,
July 21, 1969.

REFERENCES

Morley, D. W. (1953): The ant world. Penguin Books Ltd., pp. 191.

Skaife, S. H. (1961): The study of ants. Longmans, Green and Co. Ltd., London, pp. 178.

Wheeler, W. M. (1910): Ants—Their structure, development and behaviour. Columbia University Press, New York, pp. 663.

17. A CASE OF INTERGENERIC COMPETITION AND REPLACEMENT IN THE ANTS, *OECOPHYLLA SMARAGDINA* FABRICIUS AND *ANOPLOLEPIS LONGIPES* JERDON (HYMENOPTERA: FORMICIDAE)

When two genera of ants with somewhat common requirements meet in an area, the resulting competition generally involves considerable hostility but there are many ways of avoiding or reducing this contingency where major individual differences in size and structure as well as social organization and feeding method can occur (Brian 1965). When such factors facilitating intergeneric co-existence do not operate, the interactions between the competing genera may be so violent that one of the genera may become predominant and finally replace the other. The various patterns of interactions in the ant fauna have been reported by Way (1953, 1954 a&b) and Vanderplank (1960). The following is the report of the interactions between two species of ants, *Oecophylla smaragdina* Fabricius and *Anoplolepis longipes* Jerdon in a square enclosed compound in Calicut.

Oecophylla smaragdina had, for many years been living in leaf-nests on the mango trees, with apparently well established territories in the compound and was found in large numbers. In the middle of 1966, *Anoplolepis longipes*, an immigrant ant species first appeared in the compound, nesting in bare soil. *A. longipes* is an active ant and its workers could be seen carrying away small insects and sometimes, the workers of *O. smaragdina.* The workers of *A. longipes* were also seen climbing the mango and other trees in large numbers, probably for predation. In 1967, *A. longipes* became conspicuous by its large numbers and a large number of its nests could be seen in the soil. The populations of *O. smaragdina* showed a gradual and steady decline. By 1968, *A. longipes* replaced *O. smaragdina* which completely disappeared from the compound.

Department of Zoology,
Malabar Christian College,
Calicut-1, Kerala,
July 14, 1969.

A. B. SOANS
J. S. SOANS

REFERENCES

Brian, M. V., (1965): Social Insect Populations. Academic Press, London —New York.

Vanderplank, F. L. (1960): The bionomics and ecology of the red tree ant, *Oecophylla* sp., and its relationship to the coconut bug *Pseudotheraptus wayi* (Brown) (Coreidae). *J. Anim. Ecol.* 29: 15-33.

Way, M. J. (1953): The relationship between certain ant species with particular reference to biological control of the coreid, *Theraptus* sp. *Bull. Ent. Res.* 44: 669-691.

Way, M. J. (1954a): Studies on the life history and ecology of the ant *Oecophylla longinoda* (Latreille). *Bull. Ent. Res.* 45: 95-112.

——— (1954b): Studies on the association of the ant *Oecophylla longinoda* (Latr.) (Formicidae) with the scale insect *Saissetia zanzibarensis* (Williams) (Coccidae). *Bull. Ent. Res.* 45: 113-134.

18. A NEW SEA ANEMONE, *CRIBRINOPSIS ROBERTII*, (ENDOMYARIA: ACTINIIDAE) FROM MAHARASHTRA AND GOA COAST[1]

(With three text-figures)

The first few specimens of this species collected from Cuffe Parade, Bombay (19°00′N., 72°55′E.) in November 1966, were described as *Cribrinopsis* sp. (Parulekar 1968). During 1966-69, many more specimens were collected from Arnala, Bombay, Alibag, Ratnagiri, Devgad, Malvan, Vengurla and Redi on Maharashtra Coast as well as from Baga (Calangute) and Caranzalem in the Union Territory of Goa. All the abovementioned localities are situated between 15°26′N. to 19°27′N. and 72°44′E. to 73°41′E. Recently a small collection of Sea Anemones from Mandapam, South India, sent for identification by Dr. Robert Robertson of the Academy of Natural Sciences, Philadelphia, held a few individuals of the new species.

This small-sized anemone commonly occurs attached to oyster shells and to the sand veneered rocks in the intertidal region. At Mandapam, Dr. Robertson (personal communication) reports, 'specimens are found in association with four different species of Epitoniid gastropods'. At first sight, this actiniarian can be confused with *Anemonia indicus*, Parulekar 1967, occurring in the same habitat, but can be differentiated by the presence of dark red verrucae on a light pink column. The specimens are, generally, found in large assemblages, completely covering the lee face of rocks. The area inhabited by this species is between the supralittoral fringe and the midlittoral zone of Stephenson's classification (1949).

The new species is named after Dr. Robert Robertson, in appreciation of his goodwill and co-operation in the preparation of this paper.

Cribrinopsis robertii, sp. nov.

(Text-figs. 1, 2, & 3)

Material: Holotype, collected at Malvan (16° 03′ N.; 73° 28′ E.) in Ratnagiri District of Maharashtra State, India, on 31st March 1968. Paratypes: five well grown specimens from the same locality. Both the holo- and the paratypes would in due course be deposited in the National Collections, Zoological Survey of India, Calcutta.

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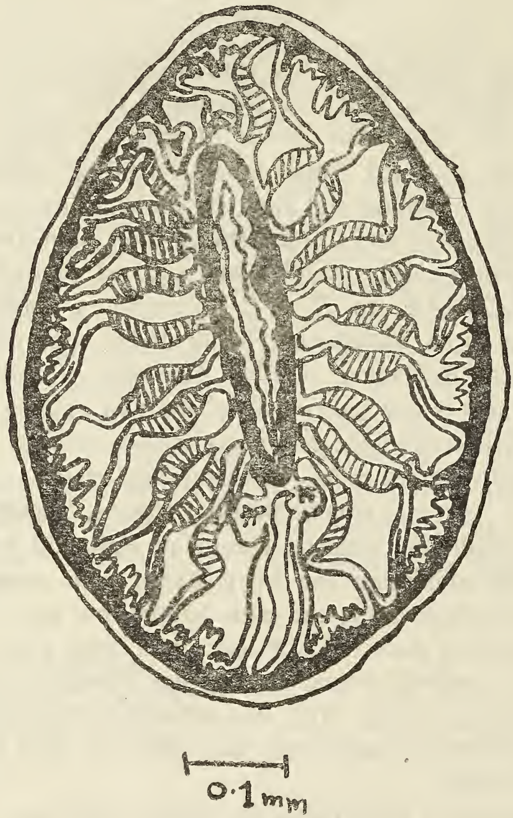
[1] Part of this work was carried out at the Bombay Natural History Society, during the tenure of a Post-Doctoral Research Fellowship of C.S.I.R., India.

Description

Basal disc. Well developed, strongly adherent, flat, disc-like and somewhat irregular in outline. Colour translucent, pinkish-white.

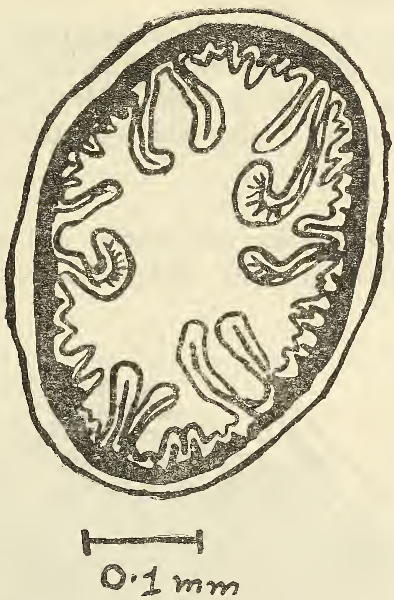


Text-fig. 1: *Cribrinopsis robertii* sp. nov.: Horizontal section through actinopharynx, showing mesenterial arrangement.

Radial lines of mesenterial insertion, clearly visible, in preserved anemone. Diameter of basal disc: 12-18 mm.

Ectoderm cells of the basal disc are narrow, cylindrical and glandular. The outer surface of ectoderm is bordered with wide distal part of narrow gland cells. There are many long eosinophilic glandular threads in the basal part of the ectodermal cells.

Column. Not divisible into scapus and capitulum. Short, as long as broad. Column wall thin and translucent. Longitudinal lines of insertion of mesenteries, clearly visible through column wall, in preserved specimens. In live anemone, the colour of the column light-pink or light-yellowish with dark red verrucae, arranged in longitudinal rows from margin to base. Colour becomes lighter towards the proximal part of the anemone. Verrucae are large near the marginal part of



Text-fig. 2: *Cribrinopsis robertii* sp. nov.: Horizontal section through the basal part of the column.

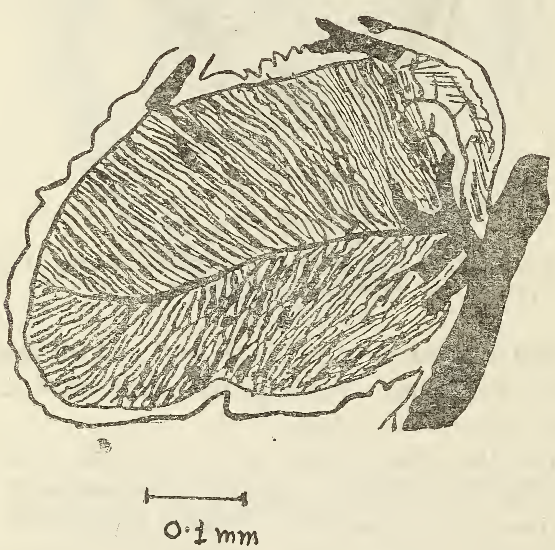
the column and very small in the basal part and, therefore, likely to be overlooked. Frequently, shell fragments are attached to the column. Length of the column 10-18 mm.

Ectoderm of the column made up of very high cells, arranged in two layers. The outer cells are mostly glandular and eosinophilic, whereas, the inner cells are narrow with basal innervations. Mesogloea thinner than the ectoderm, with a number of sparsely distributed wandering cells, from which arise the endodermal muscles. Endoderm made up of conical glandular cells with many dark granules in the upper part.

Tentacles and Oral Disc. Tentacles hexamerously arranged in 4 cycles of 6+6+12+24=48. Inner tentacles longer than outer ones. Tentacles thin and gently tapered. A deep fosse present. Pseudospherules present. In between pseudospherules and the last cycle of tentacles, there are 4-6 marginal spherules (acrosphere), with spirocysts, basitrichs and, possibly, atrichs. The marginal spherules, with the exception of basal part, are covered, with nematocysts arranged in rows. Oral disc circular in outline, broad and translucent. Stomodeum slightly raised up. Colour of the oral disc and the tentacles whitish semitransparent. In some specimens, the tentacles on their sides possess two longitudinal pink stripes.

Ectoderm of the tentacle is about four times the height of the endoderm. The cells are interlocked and covered with long spirocysts. Ectodermal muscles are slightly folded. Mesogloea thin. Endoderm of tentacles and oral disc is laden with algae (zooxanthellae) and pigmented granules.

Mesenteries. Not divisible into macro- and microcnemes. Irregularly to hexamerously arranged. 2nd and 3rd cycles of mesenteries,



Text-fig. 3 : *Cribrinopsis robertii* sp. nov. : Longitudinal section of sphincter.

fertile. In lower part of the column, number of mesenteries decreases and there are approximately half as many mesenteries at the base as in the oral region (Figs. 1 & 2). Retractors of the mesenteries well developed, diffuse and circumscribed. 3 pairs of directives and 3 siphonoglyphs. The presence of more than two siphonoglyphs may be due to asexual fission. As remarked by Uchida (1938), 'the siphonoglyphs have secondarily formed in the parts corresponding to the mesenterial parts of the first series after the fission. When the fission is repeated, the actinian comes to have more than two siphonoglyphs'. Algae (zooxanthellae) present in the endoderm of the mesenteries. Sphincter (Fig. 3) is small but strong, pinnately circumscribed. Parietal muscles weakly developed.

Cnidom. The distribution and size (in microns) of different categories of nematocysts, are as follows:

Tentacles :	
Spirocysts	8·4-22·4 × 1·4-2·1
Basitrichs	14·0-16·8 × 2·1
Acrosphere :	
Spirocysts	14·4-21·0 × 1·7-3·3
Basitrichs	11·1-20·0 × 2·2-3·3
Atrichs	20·2-27·2 × 1·6-3·3
Actinopharynx :	
Basitrichs	14·0-16·6 × 2·1
Microbasic p-mastigophores	15·2-17·5 × 1·6-2·8
Column :	
Basitrichs	12·0-16·2 × 2·1-2·8
Basitrichs	20·8-23·1 × 3·5-4·1
Atrichs	7·5-10·6 × 1·4-2·1

Remarks: Cribrinopsis robertii sp. nov., is the first species of the genus *Cribrinopsis* to be recorded from tropical waters. The new anemone is the third species assigned to this genus, the other two being the type species, *C. similis* (Carlgren 1921 & 1942) and *C. williamsi* (Carlgren 1940) reported from low Arctic and Alaska, respectively. *C. robertii* sp. nov., differs from the previously described species in its habitat, anatomical features as well as in geographical distribution.

NATIONAL INSTITUTE OF OCEANOGRAPHY, ARUN H. PARULEKAR
MIRAMAR, PANJIM - GOA,
November 15, 1969.

REFERENCES

CARLGREN, O. (1921): Actiniaria. Part I. The Danish Ingolf Expedition, Vol. 9, Part 1. Copenhagen.

——— (1940): Actiniaria from Alaska and Arctic Waters. *J. Washington Acad. Sci.* 30, no. 1.

——— (1942): Actiniaria. Part II. The Danish Ingolf Expedition, Vol. 12. Copenhagen.

PARULEKAR, ARUN, H. (1967): Two new species of sea anemones (Actiniaria) from Maharashtra. *J. Bombay nat. Hist. Soc.* 64: 524-529.

PARULEKAR, ARUN, H. (1968): Sea Anemones (Actiniaria) of Bombay. ibid. 65 (1): 140.

STEPHENSON, T. A. & STEPHENSON, A. (1949): The Universal features of zonation between tide-marks on rocky shores. *J. Ecol.* 37.

UCHIDA, TOHRU (1938): Report on the biological survey of Mutsu Bay. 33. Actiniaria of Mutsu Bay. *Sci. Rep. Tohoku Imperial Univ.* xii Nr. 3: 281-317.

19. *CARALLUMA EDULIS* (EDGEW.) BENTH. & HOOK. : A NEW RECORD FOR INDIA

(With a plate)

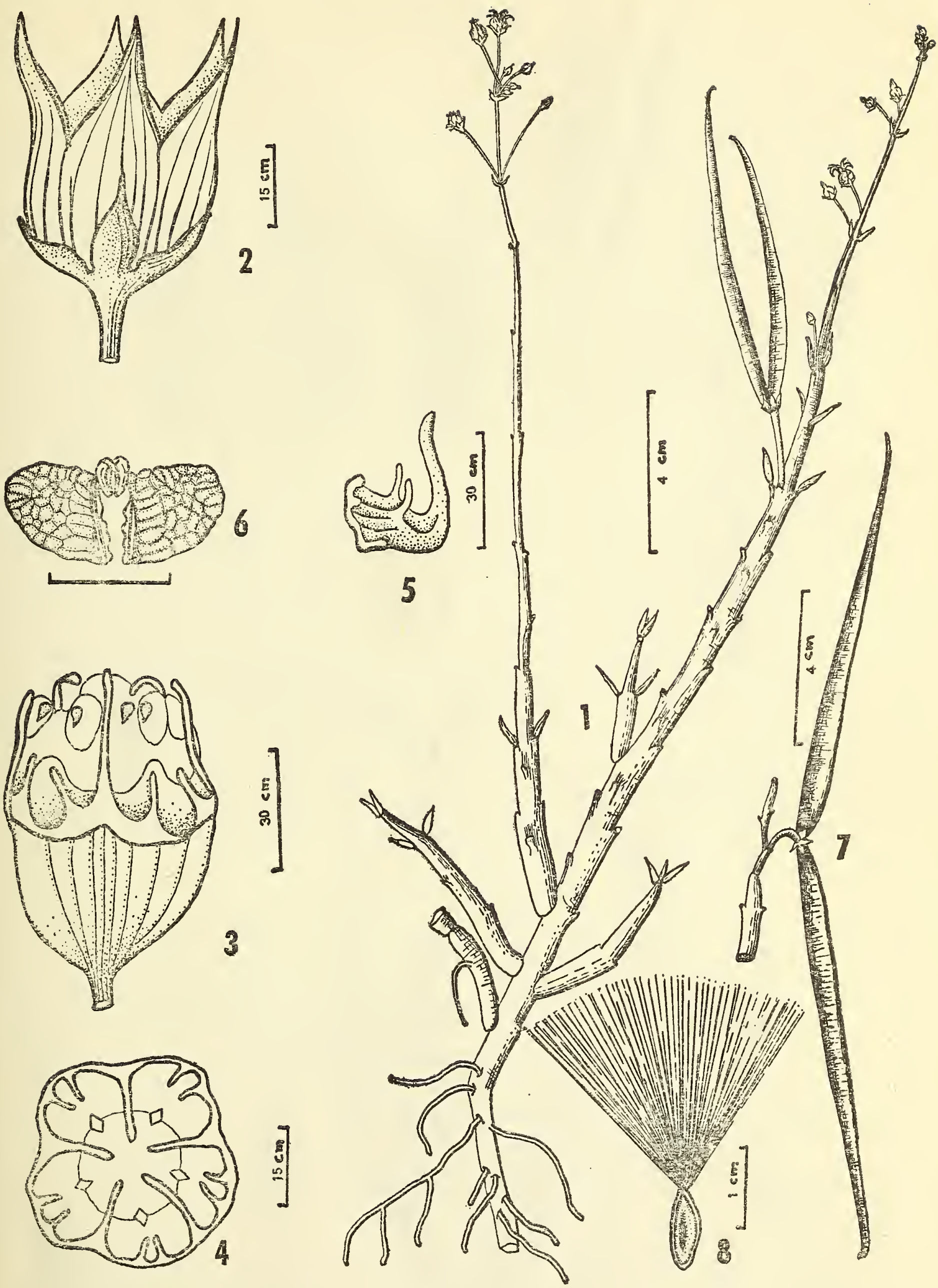
During a floristic survey of the Indian Desert, the author collected a species of *Caralluma* which was identified as *C. edulis* (Edgew.) Benth. & Hook. This species has been previously reported only from West Pakistan and since there exists no specimen of it at the Central National Herbarium, Calcutta (CAL), or for that account, in any of the Indian Herbaria, a detailed description and a diagram of the plant has been given.

Caralluma edulis (Edgew.) Benth. & Hook. Gen. Pl. 2:782, 1876; Hook. f. Fl. Brit. India 4:76, 1883; Cooke, Fl. Pres. Bombay 2:1083; Gravely & Mayurnathan, Bull. Madras Govt. Museum, N. S. (Nat. Hist. Sect.) 4 (1):8, t. 1, f. 1-3, 1931. *Boucerosia edulis* Edgew. in J. Linn. Soc. 6:205, t. 1, f. 1-8, 1862; *B. stocksiana* Baiss. Fl. Orient. 4:64, 1870.

An erect, succulent, branched, perennial herb, 15-60 cm. (often reaching up to 1 metre if growing with *Panicum turgidum* Forsk.) high with viscous, watery sap. *Stem* creeping; stolons whitish; erect branches green or with longitudinal grey blotches throughout, distinctly tapering distally, 4-angled and grooved; angles rounded and toothed with the scars of the fallen leaves. *Leaves* 6-11×2 mm., opposite, ovate-lanceolate, sessile, acute, caducous, leaving upwardly directed protuberances on the stem. *Flowers* 1-3 in the axil of leaves all along the distal nodes; pedicels 1-1·7 cm. long, filiform, glabrous, terete. *Calyx:* lobes 3×1 mm., divided to the base, ovate-lanceolate, acute, with membranous margins. *Corolla* companulate, 7-8 mm. across, with longitudinal, purplish lines inside; tube inflated, 5-partite, divided half-way down, glabrous; lobes 3-4 mm. long, ovate-lanceolate, acute, margins slightly recurved. *Corona* 15-fid, in double rows, those of the outer row 3 mm. long, 5-lobed, cupular and each lobe produced into 2, distinct, subulate teeth; lobes of inner corona 1 mm. long, linear, subacute. *Staminal column* short, arising from the bottom of the corolla; pollen masses subhorizontal, pellucid at the apex. *Style-apex* truncate, not exerted. *Follicles* in pairs, 12-17×0·8-0·9 cm., slender, smooth, terete, tapering to a sharp point. *Seeds* 9×3 mm. long, brown, margins winged; coma 2·5 cm. long.

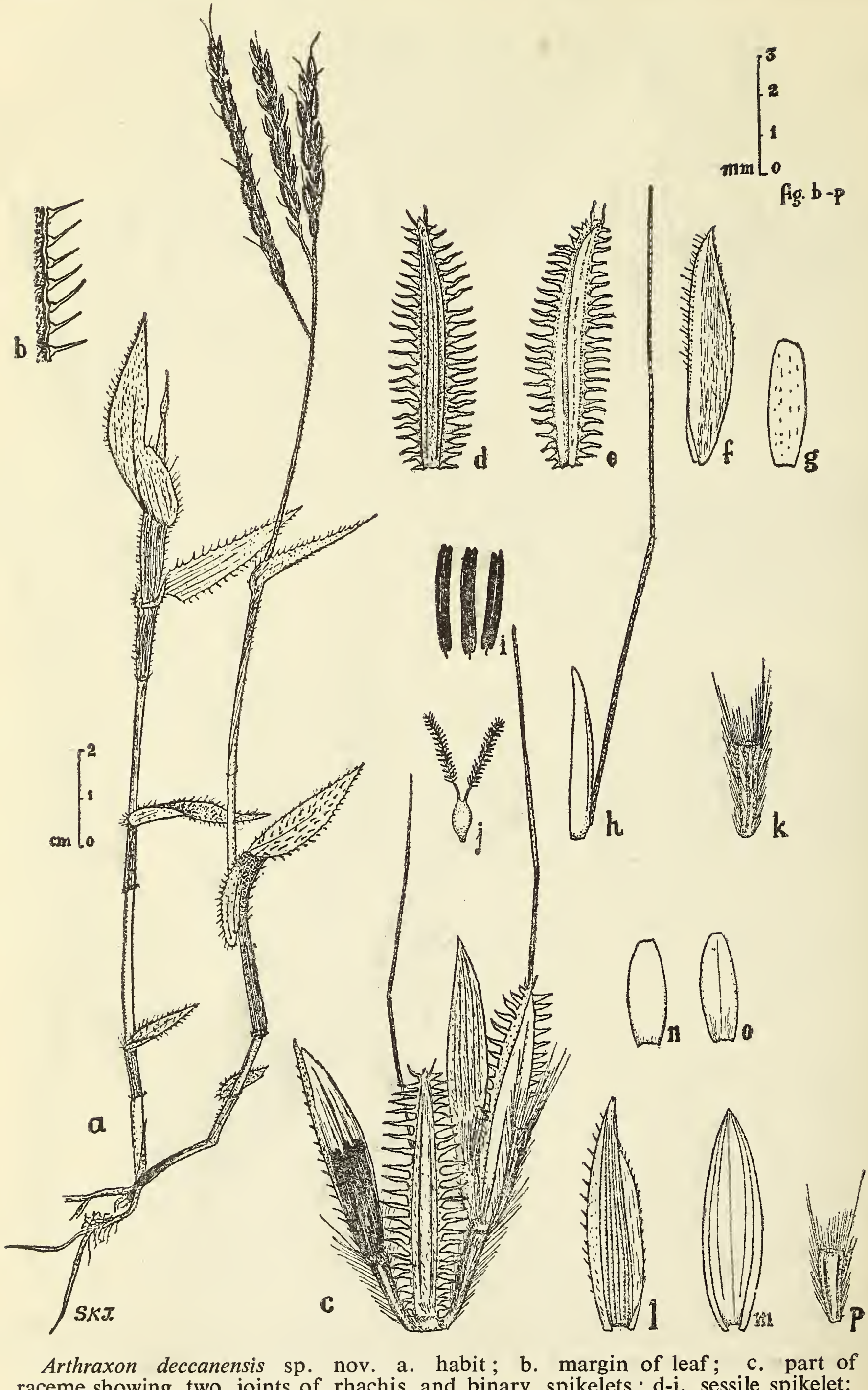
Local name: 'Pinpa'.

Bhandari : *Caralluma edulis*



Caralluma edulis (Edgew.) Benth. & Hook.—1. a plant. 2. open flower. 3. flower with calyx and corolla removed showing corona. 4. corona from above. 5. one of the corona lobes—lateral view. 6. pollinium. 7. a pair of follicles. 8. comose seed.

Jain: *Arthraxon deccanensis*



Arthraxon deccanensis sp. nov. a. habit; b. margin of leaf; c. part of raceme showing two joints of rhachis, and binary spikelets; d-j. sessile spikelet: d. lower glume (dorsal); e. same (ventral); f. upper glume (side view); g. lower lemma; h. upper lemma with awn (side view); i. stamens; j. ovary with stigmas; k. a joint of the rhachis; l-o. pedicelled spikelet: l. lower glume; m. upper glume; n. lower lemma; o. upper lemma; p. pedicel (All based on type).

Flowers: Sept.-Feb.; *Fruits:* Dec.-May.

Herbarium specimens examined: JAISALMER Bhandari 1969.

Distribution: W. PAKISTAN, Baluchistan, E. Punjab — Rawalpindi & Multan and Sind — Jamadar Ka Landa, near Karachi (Stocks, Dalzell — Mulir; 6 miles from Karachi, Woodrow); INDIA — Jaisalmer.

Field notes: The plant grows abundantly amongst *Panicum turgidum,* Murat grass, when it sprouts immediately after the first rains. It becomes concolorous with the grass and getting support from it often reaches up to 1 metre in length. Old stems often become grey during winter and show black and white streaks. The corolla are longitudinally lined internally, the gynostegium is yellow, and the corona lobes are white.

Local uses: The plant is used as a vegetable; only the young stems which have a sub-acidic or bitterish taste are edible since on maturity they become fibrous and brittle. The plants are sold in the bazar of Jaisalmer and are also eaten in the form of pickles or are made into 'chutney'.

This species has, up till now, been reported only from Baluchistan, Sind and W. Punjab in W. Pakistan. In the Central National Herbarium, Calcutta, there is no sheet of this species.

BOTANY DEPARTMENT, M. M. BHANDARI
UNIVERSITY OF JODHPUR,
JODHPUR,
May 25, 1970.

20. *ARTHRAXON DECCANENSIS* SP. NOV., A NEW GRASS FROM INDIA

(With a plate)

Arthraxon deccanensis sp. nov.

Affinis *Arthraxon lanceolato* Roxb., ab eodem tamen differt spiculis sessilibus longioribus (6-6·5 mm. longis), carinis glumae inferioris spiculae sessilis ornatis serie arcta spinarum ad 1 mm. longarum.

Holotype: R. M. Patil 7825 November 1956, Sinhagad, Poona district, Maharashtra State (CAL).

Arthraxon deccanensis sp. nov.

(Poaceae — Andropogoneae)

Annual. *Culms* very slender, erect or ascending, 20-40 cm. or more tall, finely puberulous or glabrous. Leaf-sheaths terete or slightly compressed, upper spathaceous, hirsute with tubercle-based hairs on back and margins; nodes shortly bearded. Ligules short, membranous, ciliate. Blades ovate-lanceolate to lanceolate, base amplexicaule, cordate, finely acuminate at apex, 2·5-5 cm. long, 1-1·5 cm. broad, puberulous on both surfaces, the dorsal surface, margins and the midrib below covered with tubercle-based hairs; primary lateral nerves 3-4 on each side of midrib.

Racemes 1-several, slender, green or suffused with purple, 3-6 cm. long, fascicled and borne on a slender puberulous peduncle, partly enclosed in, or far exserted from, the uppermost sheath. Rachis fragile, bearded at nodes; joints 2-2·5 mm. long, slender, broader above, hairy; hairs increasing in length upwards up to 2 mm.; spikelets paired on each joint, one sessile, the other pedicelled; pedicels similar to the joints, slightly shorter. *Sessile spikelet* awned, lanceolate or narrowly lanceolate, 6-6·5 mm. long; excluding the tubercles of the lower glume 0·75-1 mm. wide, including the tubercles 1·5-2·5 mm. wide. Lower glume 5·5-6·5 mm. long, excluding the tubercles linear lanceolate, including the tubercles oblong lanceolate or elliptic oblong, sometimes slightly oblique, chartaceous, 4-5 nerved, nerves distinct, more or less equidistant, 2 marginal ones usually more conspicuous than others, back puberulous, rarely faintly muriculate on nerves, strongly 2-keeled, each keel muricate with 20-25 spreading or pointing 0·5-1 mm. long, strong but fine-pointed tubercles; margins hyaline, 0·25-0·4 mm. wide, inflexed. Upper glume 5·5-6 mm. long, 2 mm. wide, oblong lanceolate, boat-shaped, strongly 1-keeled, membranous hyaline, 1-nerved, scabrous on the keel, puberulous on sides of the midnerve, margins hyaline, bearing few but long hairs. Lower floret reduced, neuter; lemma 3 mm. long, oblong lanceolate, membranous, hyaline nerveless. Upper floret hermaphrodite; lemma about 4 mm. long, lanceolate, entire, acute, membranous, hyaline, 1-nerved, aened from near the base; awn 10-15 mm. long, fine, kneed at about the middle, twisted below. Stamens 3, anthers 2·5-3 mm long; stigmas 2, feathery. *Pedicelled spikelet* unawned, lanceolate, acute. Lower glume 5-6 mm. long, lanceolate, slightly oblique, membranous herbaceous, acute, puberulous, scabrous on the outer two, and faintly so on the inner 4-5 nerves, margins hyaline, shortly ciliate. Upper glume 5-6 mm. long, membranous, hyaline, 3-5 nerved, puberulous and ciliate on margins. Lower floret reduced, neuter; lemma hyaline, 2·5-3 mm. long, oblong lanceolate, obtuse, nerveless, empty. Upper floret male; lemma faintly nerved. Stamens 3, anthers as in sessile spikelet.

Holotype: R. M. Patil 7825, Nov. 1956, Sinhagad, Poona dist., Maharashtra State, India; deposited in Central National Herbarium, Sibpur, Howrah (CAL).

Paratypes: V. D. Vartak 5884/6, 16th Sep. 1956, Sinhagad; *M. Y. M. E. Ansari* 99978 A, 26th Aug. 1964, Sitabai Dara, Arvi, Haveli Taluka, Poona district (BSI). *A. P. Young* 1884, South Maratha Country and North Canara, Bombay Presidency (Leningrad Herbarium, U. S. S. R.).

In nervation of the lower glume of sessile spikelet, this grass slightly resembles *Arthraxon lanceolatus* Roxb., but it markedly differs in following characters: Sessile spikelet 6-6·5 mm. long; lower glume of sessile spikelet not flat on back, but slightly rounded; spines on keels of this glume very stout, projecting out to even 1 mm. *A. deccanensis* differs from *A. prionodes* (Steud.) Dandy in larger spikelets, and conspicuous nervation but absence of tubercles on dorsal surface of the lower glume of sessile spikelet.

Acknowledgements

I am grateful to Dr. K. Subramanyam and Dr. Rolla S. Rao for giving me the opportunity of studying this material. Dr. H. Santapau had kindly provided the Latin translation of the diagnostic characters. My thanks are also due to the Directors of the Komarov Botanical Institute, Leningrad, U. S. S. R., and Royal Botanic Gardens, Kew, U. K., for facilities of working in their herbaria.

Botanical Survey of India, S. K. JAIN
Calcutta - 16,
October 28, 1970.

21. A NEW GRASS FROM INDIA, *ARTHRAXON JUNNARENSIS* SP. NOV.

(With a plate)

Arthraxon junnarensis sp. nov.

Affinis *A. quartiniano* (A. Rich.) Nash; ab eedem tamen differt spiculis multo brevioribus (1·5-2 mm. longis), et gluma inferiore leviter muriculata et nervosa.

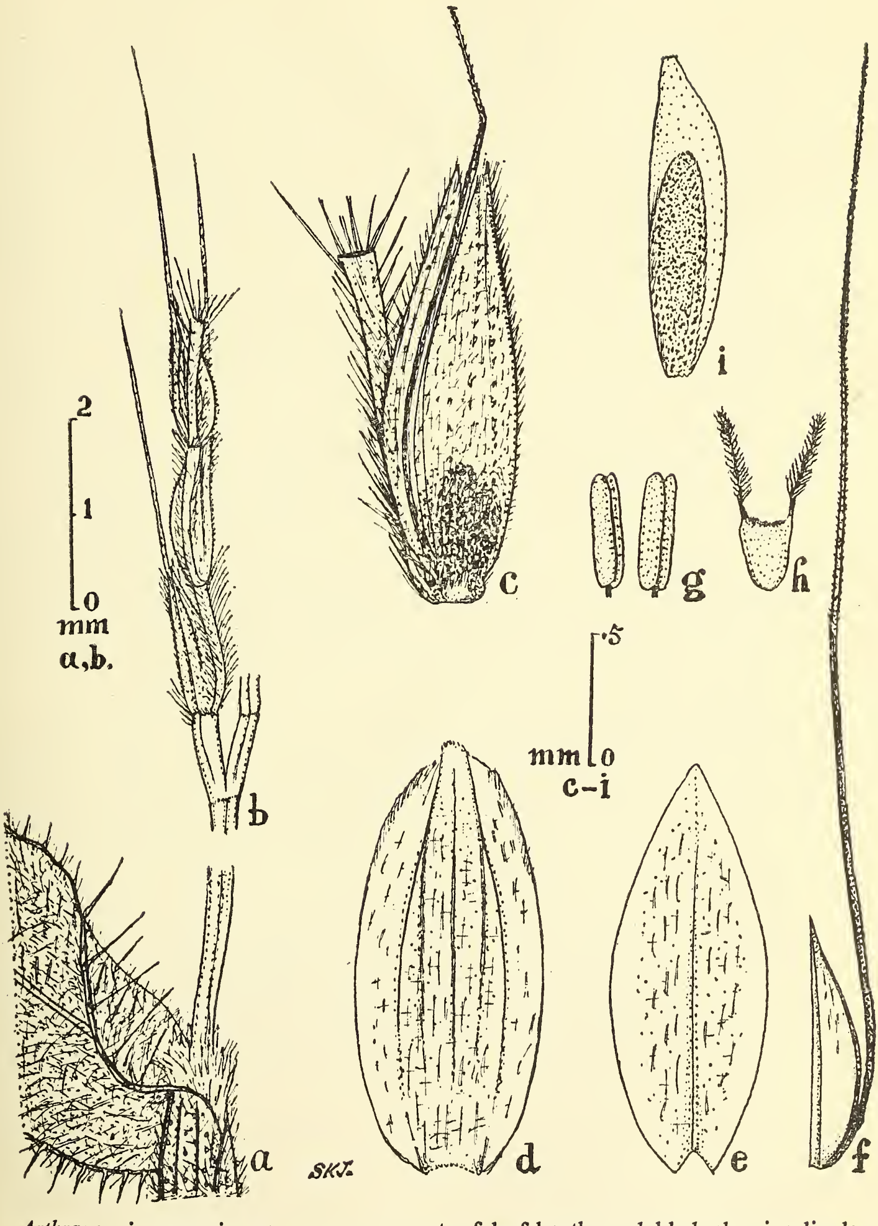
Holotype: K. *Hemadri* 106849 A/I, 6-10-1965, Warsubai plateau, 16 km. west of Junnar, Poona district (CAL).

Arthraxon junnarensis sp. nov.

Weak annual grass up to about 20 cm. long; *stem* capillary, ascending and rooting at lower nodes; *nodes* hairy at length glabrous; *leaf-sheath* 0·5-1·75 cm. long, striate, clothed by tubercle-based hairs; *ligule* hyaline, about 0·7 mm. long, lacerated; leaf-blade 1-2·5×0·5-0·75 cm., ovate or ovate-lanceolate, both surfaces and margins with tubercle-based hairs.

Inflorescence a short panicle borne on long (up to 3 cm. long) glabrous peduncle; *spikes* 5-12 in number, 1-1·75 cm. long; *rachis-joint* 1·25-1·8 mm. long, linear, lower joints glabrous, upper ones with long white hairs; *spikelets* solitary, sessile, hermaphrodite, 1·5-2×0·5 mm.; *callus* minute, of the lower spikelets glabrous and of the upper ones shortly hairy; *lower glume* 1·2-1·8 mm. long, laterally compressed, ovate-lanceolate and acute when spread open, 0·75-0·9 mm. broad, 5-nerved, short bristled to spinulose in the upper half; *upper glume* more or less as long as the lower glume, boat-shaped, almost laterally compressed, entire or minutely apiculate at apex, keel somewhat thick and short, bristly to spinulose particularly in the upper half; *lower lemma* minute and hyaline; or absent; *upper lemma* about 1 mm. long, hyaline; boat-shaped with acuminate, entire or shortly bifid apex and an awn arising from the mid-rib at its base; *awn* 4-5 mm. long, geniculate, the lower portion smooth and the upper minutely scabrid;

Jain & Hemadri: *Arthraxon junnarensis*



Arthraxon junnarensis sp. nov. a. a part of leafsheath, and blade showing ligule; b. a part of inflorescence; c. one joint bearing single spikelet; d. lower glume (ventral view); e. upper glume (ventral view); f. Upper lemma with its awn; g. stamens; h. gynoecium; i. a more mature ovary.

stamen 2, yellow 0·3-0·5 mm. long. *ovary* minute; *style* 2; *stigma* plumose; *grain* linear, cylindrical about 1·2 mm. long.

Holotype: K. Hemadri 106849 A/I, 6-10-1965, Warsubai plateau, 16 km. west of Junnar, Poona district (Maharashtra State), 'Small grass, stem weak and rooting at lower nodes. Spikes light green; spikelets solitary and sessile. Rare, growing in the shade of *Euphorbia neriifolia* Linn, bushes, on the undulating open plateau'. *Isotypes* 106849 A/II and A/III mounted on same sheet, deposited in Central National Herbarium, Calcutta, (CAL). *Isotypes K. Hemadri* 106849 B-C are deposited in *BSI;* D in *K;* E in *L;* F in *MO* and G in *LE.* Also deposited. *Paratypes S. D. Mahajan* 27170 A-B, 12-10-1957, Wilson Point Road, Mahabaleshwar, Satara District (Maharashtra State) in *BSI.*

Arthraxon junnarensis closely resembles *A. quartinianus* (A. Rich.) Nash in absence of the pedicelled spikelet and pedicel; in shape of sessile spikelets and in size of anthers; but differs in following characters:—

	A. quartinianus (A. Rich.) Nash	*A. junnarensis* Jain et Hemadri
1.	Plant comparatively robust and tall, reaching up to 75 cm.	Plant very weak, capillary, not exceeding 25 cm. long.
2.	Spikelets 3-4 mm. long.	Spikelets 1·5-2 mm. long.
3.	Nerves of the lower glume quite distinct, scabrid, often muriculate	Nerves rather faint, scabrid, not so muriculate, scabrid also between nerves.
4.	Lower lemma well developed, 1·75-2·5 mm. long.	Lower lemma minute or absent.

Distribution: The species, though located for the present from the Western ghats along Junnar and Mahabaleshwar, is likely to grow along the entire ghat belt extending to Mysore State which, however, needs further study and confirmation.

ACKNOWLEDGEMENTS

We are grateful to Director, Botanical Survey of India, for facilities and to Dr. Rolla Seshagiri Rao, Regional Botanist, Botanical Survey of India, Western Circle, Poona, for many useful suggestions. Dr. H. Santapau had kindly provided the Latin translation of the diagnostic characters.

BOTANICAL SURVEY OF INDIA, S. K. JAIN
CALCUTTA - 14.

BOTANICAL SURVEY OF INDIA, KOPPULA HEMADRI
POONA - 1,
October 6, 1970.

22. THE TAXONOMIC STATUS OF THE GENUS *PONGAMIA* VENT. (PAPILIONACEAE)

The genus *Pongamia* Vent. has been treated as a distinct genus from *Derris* Lour. mainly on the characters, wingless woody pod in the former and winged thin pod in the latter. *Derris* Loureiro (1790) is conserved against its earlier names *Salken* Adans. (Fam. 2:322, 600. 1763), *Solori* Adans. (l. c. 327, 606) and *Deguelia* Aublet (Pl. Guiane 750. 1775). *Pongamia* Vent. (Jard. Malm. t. 28. 1803) is conserved against its earlier names *Pongam* Adans. (l. c. 322, 593), *Galedupa* Lamarck (1788-89), and *Pungamia* Lamarck (1796). Other synonyms are given by Hutchinson (1964) in his Genera of Flowering Plants. Bentham and Hooker treated these two genera under the subtribe *Lonchocarpeae* of the tribe *Dalbergieae*. Hutchinson raised this subtribe to the rank of a tribe. De Candolle (1825) and Roxburgh (1832) have recognised 5 species under *Pongamia*, but Roxburgh adopted the name *Galedupa*. Some more species have been added by few other botanists. Out of the 5 species recognised under *Pongamia* by De Candolle and Roxburgh some species were with well developed wings on the sutures of the pod. Then except the typical species with wingless fruit, *Pongamia pinnata* (Linn.) Pierre, all other species have been transferred to other genera, *Derris* and *Milletia*, and Bentham (1860), Bentham and Hooker (1865), Taubert (1891) and Hutchinson restricted the circumscription of the genus to the only species.

Regarding the generic status of *Pongamia*, — eventhough the distinctive characters, which were used to keep it as a distinct genus from *Derris*, were good at the time when these two genera were described, the addition of more and more species to the latter genus made its circumscription to expand in such a way to make clear that the above characters no longer hold good enough to maintain the former as a distinct genus. This will be evident from the facts that the specimens represented in Central National Herbarium, Calcutta, show, wings well developed almost equally on both sutures in *Derris marginata* (Roxb.) Benth., distinct on upper suture and obscure or minute on lower suture in *D. ferruginea* (Roxb.) Benth., *D. heyneana* Benth. and *D. monticola* (Kurz) Prain, narrow or obscure on both sutures in *D. microptera* Benth. and *D. benthamii* (Thw.) Thw., distinct only on the upper suture in *D. robusta* (DC) Benth. and *D. pseudorobusta* Thoth., or faintly only on the upper suture in *D. sinuata* Thw. Also in some sheets of *D. microptera*, in some pods the wings could be hardly seen. Added to that, the pods of *Derris cuneifolia* f. *assamica* Thothathri

(1962) are almost similar to *Pongamia* in being woody and 1-seeded, but having distinct to very obscure wing.

Prain (1897) raised the variety *malaccensis* described by Bentham (1860) under *Derris cuneifolia* to specific rank and described two varieties *aptera* and *milletioides*. Prain tentatively placed his new varieties under *D. malaccensis* and while dealing with the systematic position of them states (p. 108) 'The pods of var.? *aptera* are however obviously those of a *Pongamia* rather than those of a *Derris*, if *Pongamia* be really entitled to a separate generic position which the writer hardly believes.' Since the distinctive characters used so far, to distinguish *Pongamia* as a distinct genus no longer hold good, which is obvious from the above observations and Prain's remark, and the studies so far done did not reveal any other character to maintain it as a distinct genus, here *Pongamia* is reduced as a section under *Derris*.

DERRIS sect. PONGAM (Adans.) Bennet stat. nov.

Pongam Adans., Fam. 322, 593. 1763.

Derris indica (Lamk.) Bennet comb. nov.

Galedupa indica Lamk. Ency. 2:594. 1788-89.

Cytisus pinnatus Linn. Sp. Pl. 1:741. 1753 (non *Derris pinnata* Lour. 1790).

Robinia mitis Linn. Sp. Pl. 2:1044. 1763, (nom. illegit.)

Pongamia glabra Vent. Jard. Malm. t. 28. 1803.

P. pinnata (Linn.) Pierre, Fl. Cochinch. sub. t. 385. 1899; Thothathri in Bull. Bot. Surv. Ind. 3:418. 1962.

Derris indica var. *xerocarpa* (Prain) Bennet comb. nov.

Pongamia glabra Vent. var. *xerocarpa* Prain in J. AS. Soc. Bengal 66:95. 1897.

P. pinnata var. *xerocarpa* (Prain) Thothathri *l. c.* 83.

BOTANICAL SURVEY OF INDIA,
76, LOWER CIRCULAR ROAD,
CALCUTTA - 14,
April 28, 1969.

S. S. R. BENNET[1]

[1] Present Address:—Research Officer, Systematic Botany, Forest Research Institute, New Forest P.O., Dehra Dun. (U.P).

REFERENCES

Bentham, G. (1860) : Synopsis of Dalbergieae, *J. Linn. Soc. Bot.* **4** : Suppl. 1-134.

———, & Hooker, J. D. (1865) : Genera Plantarum **1** : 454, 549-50.

De Candolle, A. P. (1825). : Prodromus **2** : 415-416.

Hutchinson, J. (1964) : The Genera of Flowering Plants **1** : 383-384.

Lamarck, J.B.A.P.M. (1788-89) : Encyclopedie Methodique Botanique **2** :594.

——— (1796) : Tableau Encyclopedique **2** : t. 603.

Loureiro, J. D. (1790) : Flora Cochinchinensis 432.

Prain, D. (1897) : King's Materials for the Flora of the Malayan Peninsula. *J. As. Soc. Bengal* **66** : 94-108.

Roxburgh, W. (1832) : Flora Indica ed. **2** : 239-243.

Taubert (1891) : in Engl. & Prant. Pflanzenfamilien 3(2) : 344-345.

Thothathri, K. (1962) : A Taxonomic revision of the genus *Derris* Lour. in India. *Bull. Bot. Surv. India* **3** : 175-200.

Notes and News

Sálim Ali-Loke Ornithological Research Fund

A very generous donation of £5,000 was received from the Cheng Kim Loke Foundation through the kindness of Lady Peng McNeice, Dato Loke Wan Tho's sister and one of the Trustees of the Foundation. With this donation the Corpus of the Fund has passed the total which permits the Fund to become operative.

Awards

Royal Zoological Society, Antwerp, Gold Medal

For his contributions in ornithology, ecology and international conservation, Professor S. Dillon Ripley, Secretary of the Smithsonian Institution, received the seldom-given Gold Medal of the Royal Zoological Society of Antwerp, Belgium on September 1, 1970.

Sunder Lal Hora Gold Medal

The Sunder Lal Hora Gold Medal of the National Academy of Sciences, India, was awarded to Dr. Sálim Ali for his contributions to the study of Indian Ornithology.

Padma Shri

The President of the Republic of India has been pleased to award Padma Shri to Mr. Zafar Futehally, for his services to the Conservation of Indian Wildlife.

Announcement

GRANTS FOR BIRD STUDY

The Bombay Natural History Society has instituted a fund known as the **Sálim Ali-Loke Ornithological Research Fund** for fostering field research on Indian birds. Small grants are available, either *ad hoc* or tenable for a specified period, to students of zoology and serious amateur bird watchers who wish to investigate a specific problem of bird ecology. The main object is to encourage and foster among all classes an intelligent interest in the *living bird* in its natural habitat. Preference will be given to young people whether post-graduate or not. Details of the problem, and the ways in which it is proposed to study it, should be submitted with the application, together with evidence of the candidate's competence and an indication of the financial assistance required, to the Honorary Secretary, Bombay Natural History Society, Hornbill House, Bombay 1-BR.

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CONTENTS

Journal of the Bombay Natural History Society

Vol. 68, No. 2

Editors

ZAFAR FUTEHALLY,
J. C. DANIEL & P. V. BOLE

AUGUST 1971

Rs. 18 (Inland), Sh. 30 (Foreign)

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3. All scientific names to be printed in italics should be underlined. Both in zoological and in botanical references only the initial letter of the genus is capitalized. The specific and sub-specific names always begin with a small letter even if they refer to a person or a place, e.g. *Anthus hodgsoni hodgsoni* or *Streptopelia chinensis suratensis* or *Dimeria blatteri*.

4. Trinomials referring to subspecies should only be used where identification has been authentically established by comparison of specimens actually collected. In all other cases, or where identification is based merely on sight, binomials should be used.

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7. References to literature should be placed at the end of the paper, alphabetically arranged under author's name, with the abridged titles of journals or periodicals underlined (italics) and titles of books *not* underlined (roman type), thus:

Banerji, M. L. (1958): Botanical Exploration in East Nepal. *J. Bombay nat. Hist. Soc.* **55**(2): 243-268.

Prater, S. H. (1948): The book of Indian Animals, Bombay. Titles of papers should not be underlined.

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EDITORS,
Journal of the Bombay Natural History Society.

Hornbill House,
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VOLUME 68, No. 2—AUGUST 1971

Date of Publication : 29-11-1971

CONTENTS

JOURNAL
OF THE
BOMBAY NATURAL
HISTORY SOCIETY

1971 AUGUST Vol. 68 No. 2

An assessment of annual damage to Crops by Elephants in Palamau District, Bihar

BY

J. MISHRA

Deputy Conservator of Forests, Bihar

(*With a plate*)

INTRODUCTION

It is generally thought that elephants have occurred in Palamau forests from time immemorial. However, D. H. Sunder's survey settlement report of the district of Palamau (1896), though it records even the smallest member of the wildlife, does not include elephants and apparently there were none. Elephants migrated to this area sometime in early 1920. Why and where they came from is being investigated. At the time of this report (1970) the number of elephants in Palamau does not exceed sixty.

Every year, since 1950, there has been great publicity on damage to agricultural crops by elephants. Formerly the damage was confined to the thinly populated Garu Range, and was negligible. Slowly in later years the damage spread to Latehar and Barwadih areas. Villages near Betla were the worst affected, for the elephants stayed in Betla from the beginning of the rainy season till the advent of summer. Prior to 1950, elephants had never visited Betla area in the memory of the oldest resident. From 1950 onwards, elephants numbering two to a dozen were recorded to have visited Betla forests. From the year 1965 more elephants started visiting Betla—the maximum number now going up to 45. Another departure that has been noticed in the behaviour of elephants for the last three years (beginning from the year 1968) is their regular visits to Chainpur area, after crossing the River Koel. The reasons for the extension of range have not been investigated. In their movement from one area to another they visit the fields along their way and the crops are heavily damaged by them.

Though it was known that there was yearly damage to crops by elephants, the quantum of damage remained unknown till this study was undertaken in the year 1969. I set myself to this work with the help of a handful of staff in the National Park and the credit is theirs in taking all pains to make this study a success.

Methods

To collect day-to-day statistics of the quantum of damage done to crops by elephants, all forest guards were instructed to find out if there had been any damage to crops by wild elephants in their sub-beats. Any damage was recorded the same day in the following proforma.

Name of Village................................Range ....

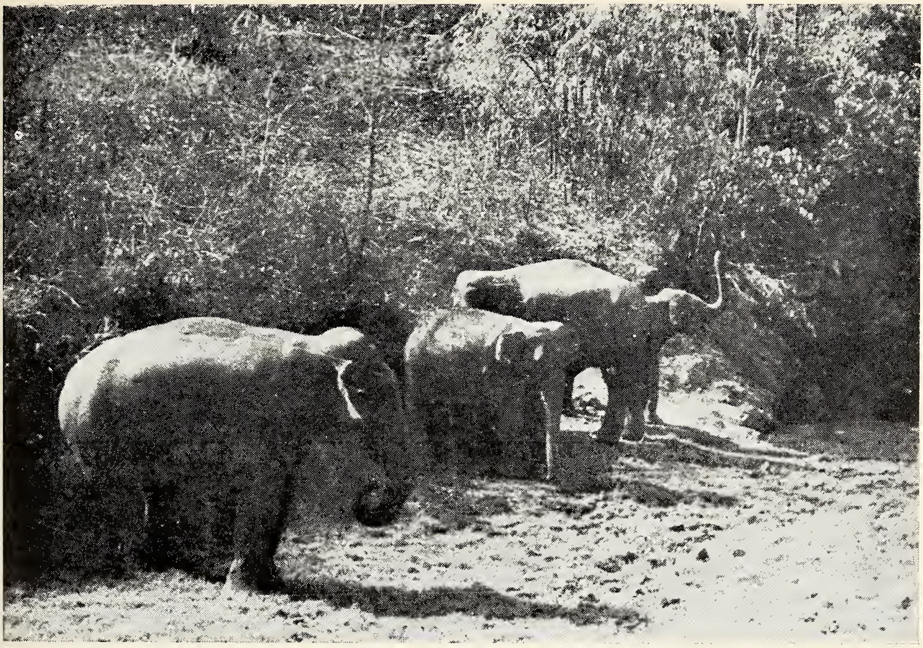
Date	Name of villagers whose crops had been damaged	Area	Damage in Quintals		Total
			Destroyed	Trampled	
1	2	3	4	5	6

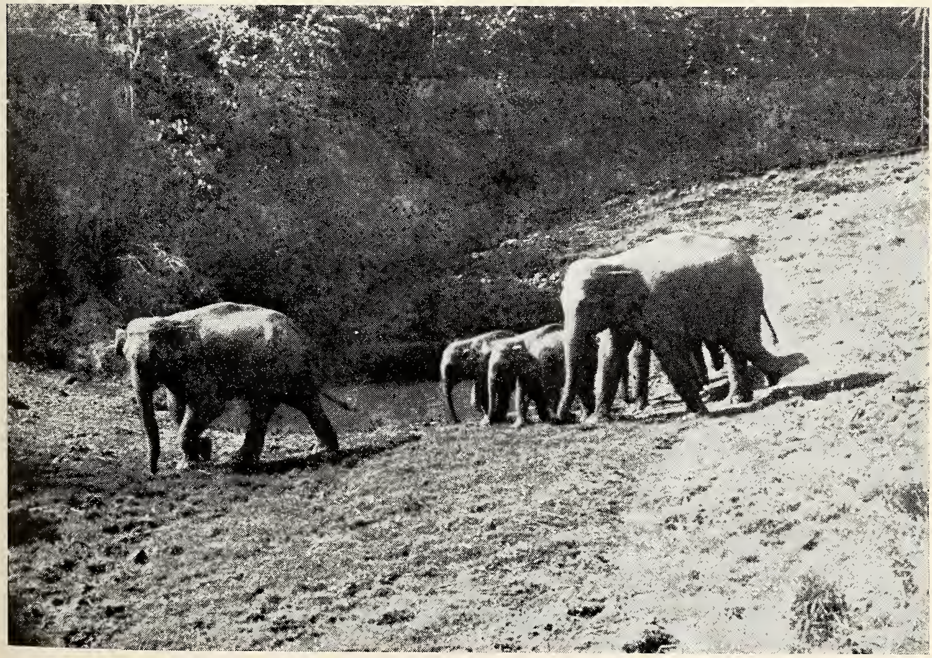
Value of damaged crops	Number of elephants visiting the area	Hours of stay of elephants	Remarks
7	8	9	10

The forest guard's report was checked by the Beat Officer who visited the site and if satisfied made an entry in the register kept in the Range Office for this purpose. This scheme worked well and we received reliable statistics of yearly damage to agricultural crops by elephants at Garu, Lat and Barwadih thanas. For Latehar and Chainpur thanas, the data were collected by a single forest guard deputed for this purpose, as both these areas fell outside my jurisdiction.

Results

The study started with the rainy season of the year 1969 when elephants began entering maize fields. From August up to April of the





Elephant herd in the Palamau Forest.
(*Photos: Author*)

following year, the damage was recorded and therefore the data examined in the present paper covers the period August 1969 to April 1970.

The Range-wise abstract of damage to crops in Palamau District is given in the following table.

Sl. No.	Range	Produce in Quintals		Rate	Total	Grand Total
1	Garu Range ..	Paddy (good quality) ..	16.60	50.00	830	
		Paddy Gora ..	6.00	37.50	225	
		Maize	17.40	50.00	870	
		Sawa	3.20	25.00	80	
						2,005.00
2	Lat Range ..	Paddy (very good quality)	1.60	75.00	120	
		Paddy Gora ..	11.20	37.50	420	
		Maize	16.50	50.00	825	
						1,365.00
3	Chhipadohar ..	Paddy (good quality)	332.60	50.00	16,630	
		Sugarcane.. ..	2.40	20.00	48	
		Gaudli	2.00	40.00	80	
		Marua	4.00	50.00	200	
		Jinor	12.12	40.00	485	
						17,443.00
4	Manika Range..	Paddy (good quality)	80.00	50.00	4,000	
		Marua	2.00	50.00	100	
						4,100.00
5	Chainpur Range ..	Paddy	280.00	50.00	14,000	
		Marua	12.00	50.00	600	
		Jinor	10.00	40.00	400	
						15,000.00
						39,913.00

or say Rs. 40,000

The total yearly damage to agricultural crops by elephants in Palamau works out to approximately Rs. 40,000.

Recommendations

There is no complete remedy for the damage to crops by elephants, but some suggestions are made:

1. *Scaring off elephants:* The conventional methods of lighting torches, beating of drums and exploding crackers and providing spotlights and batteries to villagers have been adopted. So far we have concentrated our efforts in Betla areas where we provide the villagers with kerosine

oil for lighting 'Masals,' give them torches, and have allotted two 12-volt batteries and two spotlights together with two National Park Guards to help them to organise the scaring of elephants. The growing discontent of the villagers necessitated that this be done on a larger scale to cover most of the villages surrounding the National Park. A scheme costing nearly Rs. 5,000 is under preparation for meeting the annual demand.

2. *Elephant trench:* Our experiments in Betla with the digging of elephant-proof trenches (7′×5′×4′) have been very successful. So far, elephants have not been able to cross them. Such trenches cost nearly Rs. 7,000 per mile. The trenches must be extended to all sides of Betla National Park. This will create confidence in the villagers residing round the Park.

3. *Compensation to villagers:* It is difficult to talk of wildlife protection to villagers when their crops, almost on the eve of harvesting, are destroyed by the elephants. They must be compensated in terms of money. When Government can come to the rescue of villagers affected by flood or fire, there seems no justification why people should not be compensated when their crops are damaged or destroyed by elephants which are Government property. The statistics of damage should be prepared and the payment of compensation made. At least 50% of the value of the damaged crops should be paid as compensation and the rent for the damaged field waived.

Until such steps are taken there seems to be no future for the elephants in Palamau District.

Cassias commonly occurring or Cultivated in India

BY

YASHODANANDAN PANDEY

National Botanic Gardens, Lucknow

(*With 38 figures in two plates*)

INTRODUCTION

The genus *Cassia* is known for its ornamental, economic and medicinal value. There are 500-600 spp. of *Cassia* occurring in the tropical and warm temperate regions of the world (Willis 1966). They are trees, shrubs or herbs. Bentham (1869) has given a comprehensive account of the genus containing 338 species. In India, Hooker *et al.* (1879) have reported 18 spp. of *Cassia*. Taxonomic description of spp. is given in regional floras by Duthie (1903), Cook (1903), Haines (1922), Gamble (1915), Maheshwari (1963) and others. Ornamental species by Blatter *et al.* (1937), Randhawa (1965) and others. Economical and medicinal species by Watts (1889), Gamble (1902) and Chopra *et al.* (1956).

An artificial key based on broad morphological characters has been prepared and a description of the important species commonly found wild or cultivated in India is presented along with few illustrations.

ARTIFICIAL KEY TO THE SPECIES OF *Cassia* LINN.

A. **Trees:**

B. Pod dehiscent .. .. *C. siamea*

BB. Pod indehiscent

C. Fls. in lax pendulous racemes, very large *C. fistula*

CC. Fls. in corymbose racemes:

D. Bract at the base of flower stalk absent. Young leaflets finely hairy and with coppery tinge. Fls. rose coloured .. *C. grandis*

DD. Bracts conspicuous at the base of flower stalk, persisting till the fls. open:

E. Fls. yellow .. .. *C. multijuga*

EE. Fls. not yellow:

F. Fls. pink:

G. Leaflets 6-14 pairs:

H. Leaflets pointed at the apex, smooth .. .. *C. nodosa*

HH. Leaflets rounded at the apex, hairy below .. .. .. *C. javanica*

GG. Leaflets 8-20 pairs .. .. *C. renigera*

FF. Fls. terracotta-red .. .. *C. roxburghii*

AA. **Shrubs, undershrubs or herbs** (*C. glauca* sometimes a small tree):

B. Sepals spathulate obtuse; rachis without glands *C. alata*

BB. Sepals broad, obtuse:

C. Rachis without glands between the leaflets:

D. Leaflets lanceolate, acute; pods slightly curved, not crested .. .. .. *C. angustifolia*

DD. Leaflets oblong, obtuse; pods much curved, crested on the valves opposite the seeds .. .. *C. obtusa*

CC. Rachis usually with several glands between the leaflets:

D. Large shrubs; stipules falcate, narrowly lanceolate, caducous .. .. .. *C. glauca*

DD. Large shrubs; stipules large, semicordate, persistent .. .. *C. auriculata*

DDD. Herbs or undershrubs; leaflets 3 pairs; glands 1-2 only .. .. *C. tora*

CCC. Rachis with a single gland at the base:

D. Leaflets 3-5 pairs, more or less ovate.. *C. occidentalis*

DD. Leaflets 4-8 pairs, not at all ovate .. *C. sophera*

BBB. Sepals narrow, acute:

C. Leaflets moderate sized, 2 pairs .. .. .. *C. absus*

CC. Leaflets small and many:

D. Petiole with a small sessile gland.. .. *C. mimosoides*

DD. Petiole with a long stipitate gland .. *C. pumila*

Description of Species

Cassia siamea Lamk. (Figs. 1-9) A medium-sized to large tree. Bark grey. Leaflets 6-12, oblong. Flowers in corymbose racemes clustered at the end of branches, yellow. Pods slightly curved at the posterior end, flat, dehiscent, 20-35 cm. long, 1-3 cm. broad with thickened sutures. Fls. April-July and October-December. Country of origin: Ceylon and Siam.

The wood of the plant is hard and highly valued, though seldom obtained in large size. Walking sticks and mallets are made from the wood.

Pods and leaves are used in medicine.

Cultivated. Plants can be raised through seeds sown a couple of months before the rains and seedlings transplanted in pits when they are 3 to 4 months old during rains.

Cassia fistula L. Popularly known as the Indian Laburnum and in vernacular as *Amaltas*. A medium-sized tree frequently planted in garden compounds and road sides. The tree is a mass of bright yellow flowers in summer. It has thick greenish grey bark; leaflets large, 4-8 pairs, glabrous, ovate, 8-16 × 6 cm. Bright yellow flowers occur in long, drooping racemes. Pods cylindrical, dark brown or black when ripe, 25-65 cm. long, 2-3 cm. in diameter, with many transverse septa. The flat seeds are embedded in sweetish pulp. Fls. April-July. Country of origin: India.

The wood of the plant is very durable, it makes excellent posts and is good for carts and other agricultural implements. The plant also yields valuable tanning material. The stem exudes gum used in industry.

Root bark, leaves and seeds are used as laxative. Fruit applied in rheumatic pain and snake bite. Leaves and fruit pulp contain anthraquinone derivatives.

Wild as well as cultivated. The plants are raised through seeds sown in March-April. Transplanting can be done in rains when plants are 3-4 months old.

Cassia grandis L. A medium-sized tree, popularly known as Horse Cassia. It has deep green foliage. The terminal leaflets have distinctive coppery tinge. Leaflets hairy to touch, 10-20 pairs, oblong, abruptly rounded at both ends. Flowers in axil of leaves in corymbose racemes, rose coloured. Pods 7.5-10 cm. in length, compressed, smooth, cylindrical and transversely wrinkled. Fls. February-April. Country of origin: Tropical America.

Wood is used for making small agricultural implements. Bitter fruit pulp is used as a purgative.

Cultivated. Plants can be raised through seeds.

Cassia multijuga Richard. A medium-sized tree. Leaflets 20-25 pairs, oblong, elliptic. Flowers bright yellow. Fls. February-September. Country of origin: South America.

Leaves are known to be used as substitute for senna.

Cultivated. Plants can be raised through seeds.

Cassia nodosa Buch.-Ham. A medium-sized evergreen tree. Bark reddish brown or ash coloured. Leaflets 6-14 pairs, oblong, pointed at the apex, smooth. Flowers in racemes, showy, pink, fading to dull white. Pods cylindrical, 30–45 cm. long. Fls. May-June. Country of origin: Burma, India and Malaya.

Cultivated. Plants can be raised through seeds.

Cassia javanica L. A medium-sized tree, popularly known as Java Cassia. Leaflets 6-14 pairs, 2.5-5 cm. long, 1-2.5 cm. broad, short stalked, oblong, ovate, rounded at the tips, hairy below. Flowers pink, fading to white. Sepals red. Stamens 10, three with swelling. Fls. May-July. Country of origin: Java.

Cultivated. Plants can be raised through seeds. It is reported that H. V. Kemball introduced the plants in Bombay around 1910.

Cassia renigera Wall. A medium-sized tree, popularly known as Burmese Pink Cassia. Leaflets 8-20 pairs, pointed at the apex, glossy and kidney-shaped, deciduous; stipules present at the leaf base. Flowers large, pinkish fading to rosewhite, borne on racemes in leafless branches. Sepals red. Pods smooth, 30-60 cm. long, similar to those of Indian Laburnum. Fls. April-June. Country of origin: Burma.

Wood is very hard and well suited for wheel making and handles for tools.

Cultivated. Plants can be raised through seeds. In Bombay the plant is reported to have been introduced by R. A. Forbes Sempill around 1902.

Cassia roxburghii DC. (Syn. *Cassia marginata* Roxb.). A small tree, popularly known as the Red Cassia. Leaflets 10-20 pairs, leathery above and blunt at the tips. Flowers in small clusters growing from axil of leaves on young twigs. Petals terracotta-red with fine green veins. All stamens bear anthers. The uppermost are the longest, and have no swelling in the middle. Base of flower stalk contains pale green bracts. Pods cylindrical, 20-30 cm. long, with transverse partitions. Fls. May-June. Country of origin: Ceylon and India.

Heartwood is light brown and very hard. The wood is well adapted for turning naves of wheels and handles of tools are made of it.

Cultivated. Can be raised through seeds. It is reported the plant was introduced into Calcutta in 1802. H. P. Dimmock originally planted them in Bombay.

Cassia alata L. Known in vernacular as *Dadmurdan*. A medium-sized shrub, with very thick finely downy branches, mostly cultivated, though uncommonly found wild. Rachis without glands. Leaflets oblong, large. Flowers large, yellow. Sepals spathulate, obtuse. Pods 10-20 cm. long furnished with a wing down the middle of each valve. Seeds 50 or more. Fls. October-December. Country of origin: West Indies.

Leaves are used in ringworm and snake bite. Decoction of leaves and flowers used internally in bronchitis, asthma and for washing eczematous patches. The plant is poisonous to livestock and fish. Plants contain chrysophanic acid.

Mostly cultivated. The plant is uncommonly found wild as a weed in neglected fields and open scrub jungle; it can be raised through seeds.

Cassia angustifolia Vahl. Popularly known as Tennevelly Senna and in vernacular as *Hindisana.* Shrub with leaflets 5-8 pairs, narrow, lanceolate, acute tapering from the middle towards the apex, glabrous or furnished with a scant pubescence. Racemes long with large yellow flowers. Sepals broad and obtuse. Pods flat 3.8-6.3 cm. long, 1.5-1.7 cm. broad, slightly curved. Seeds 6-12. Fls. November-March. Country of origin: Somaliland and Arabia.

The leaves of the plant yield "Senna Drug". Leaves and fruits are used as laxative, and purgative. The leaves contain Kampferin, anthraquinone, chrysophanic acid, isorhamnetin and calcium oxalate.

Cultivated usually on dry lands, sowing is either by broadcasting or dribbling. The seeds have a tough seed coat and a certain amount of abrading the surface is necessary to induce even and quick germination. Plants require bright sunshine and occasional drizzling. When leaves are fully grown, thick and bluish in colour, they are stripped off by hand. A second stripping is done after about a month and the plants allowed to bear flowers to set seeds. The wet land crop is also very successful under controlled conditions. (WEALTH OF INDIA 1950.)

Cassia obtusa Roxb. (Syn. *C. obovata* L.). A diffuse herb found as weed. Leaflets oblong, obtuse. Flowers pale yellow in narrow few flowered racemes. Sepals broad, obtuse. Pods much curved, crested on the valves opposite the seeds, flexible, glabrous. Seeds 6-12 obovate, cuneate, separated by the partition, funicles long. Fls. July-October.

Leaves are given in stomach ailments like indigestion and irritation. Leaves and pods contain oxymethyl-anthraquinone.

The plants are found wild along road sides, and on fallow land, etc. They can be raised through seeds.

Cassia glauca Lamk. (Figs. 10-17.) A large shrub (at times a small tree). Rachis usually with several glands between the leaflets. Stipules falcate, narrowly lanceolate, caducous. Leaflets ovate, acute. Flowers in axillary corymbose racemes. Anthers 10, all perfect and subequal. Pods 10-20 cm. long, flat, with 20-30 seeds. Seeds small, smooth, dark brown attached with filiform funicles. Fls. February-July. Country of origin: India.

Bark and leaves are used in diabetes and gonorrhoea.

Wild as well as cultivated. Seeds are sown two months before rains and seedlings transplanted during the rainy season.

Cassia auriculata L. Known in vernacular as *Tarwar* or *Avaram*. A shrub or undershrub, cultivated but often found wild, with finely downy branches. Leaflets nearly sessile; rachis grooved, pubescent, furnished with a single linear gland between the leaflets of each pair. Stipules large, leafy, semicordate, persistent. Leaflets 8-12 pairs, 1.3-2.5 cm. long, obovate, oblong, obtuse or emarginate. Flowers in corymbose racemes, bright yellow. Pods 10-12.5 cm. long, slightly curved, obtuse, glabrous. Seeds 10-12. Fls. October-January.

The plant yields valuable tanning material used in leather industry; it is suitable for clothing barren tracts and as green manure crop. Leaves are eaten as green vegetable in time of famine. Branches used as tooth sticks.

Almost all parts of plant except flowers are used in the cure of skin diseases, anthelmintic, ophthalmia and conjunctivitis, in diabetes and chylous urine.

The plant is commonly found as a weed in barren tracts and scrub jungle. It can be raised through seeds. The twig bark is stripped off and dried in small cornets. Plants grown on lime rich soils are richer than those grown on red loam and gravelly soils. (WEALTH OF INDIA 1950).

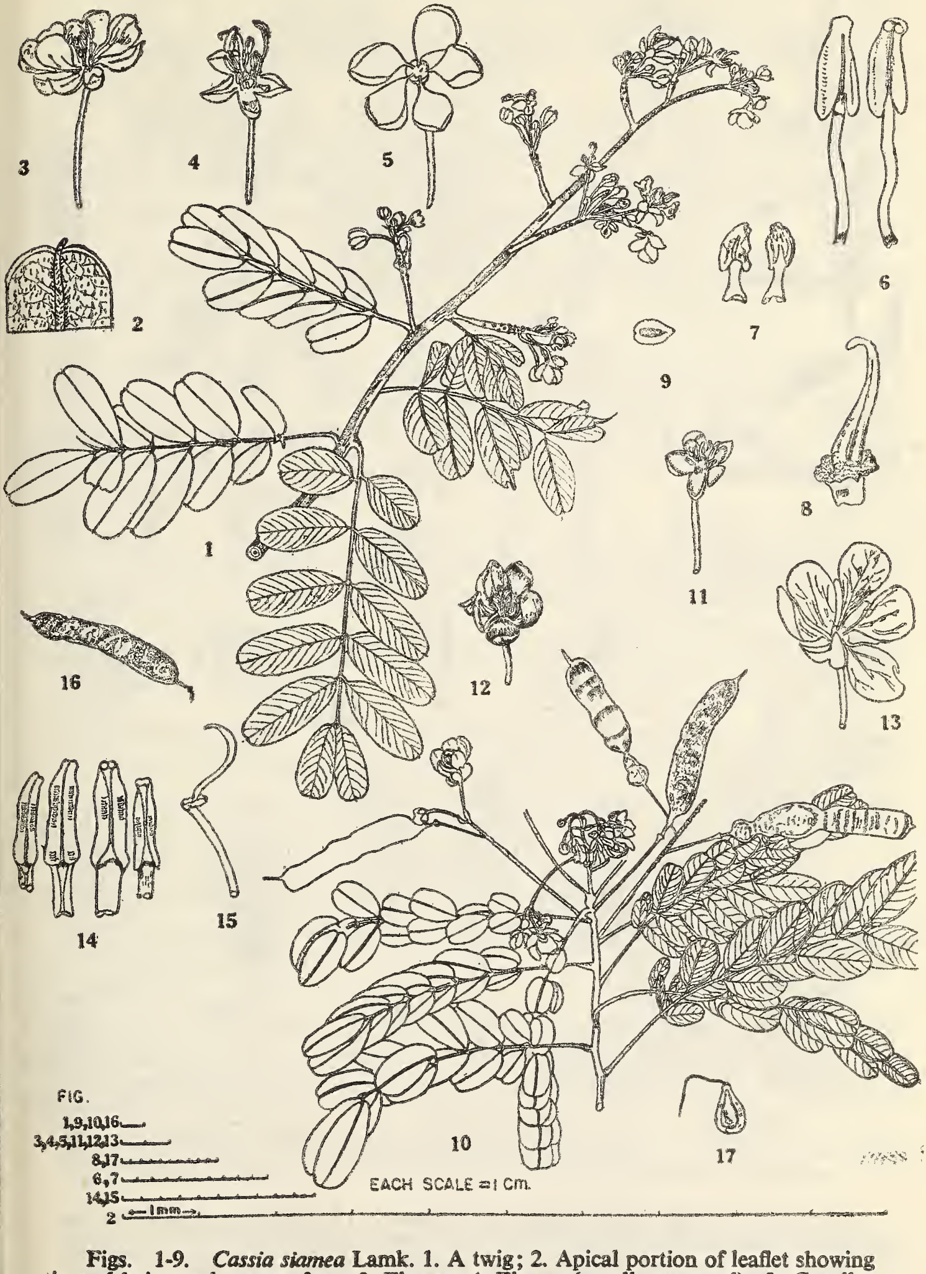
Cassia tora L. (Figs. 32-38.) Known in vernacular as *Chakramarda*, *Dadmari* or *Chakunda*. A herb or under-shrub. Leaflets 3 pairs, 3-5 cm. long, 1.5-2.5 cm. broad, obovate, oblong, with a gland between the lowest pair. Flowers bright yellow, fertile stamens 7, the upper reduced to staminodes. Pods 15-25 cm. long, 4-6 mm. broad, stout, obliquely septate. Fls. August-October. Country of origin: Tropical America.

Leaves are used as laxative. Leaves and seeds are also used in skin diseases like ringworm and itch. Roots used in snake bite. Plant contains emodin, glucosides and an unpleasant smelling fixed oil.

The plants are found as weeds everywhere; can be raised through seeds.

Cassia occidentalis L. (Figs. 26-31.) Known in vernacular as *Kasondi*. A diffuse undershrub found as weed, 60-150 cm. tall. Leaves with an

PLATE - I. FIG. I - 17.



Figs. 1-9. *Cassia siamea* Lamk. 1. A twig; 2. Apical portion of leaflet showing tip and hairs on lower surface; 3. Flower; 4. Flower (corolla removed); 5. Corolla; 6 & 7. Stamens; 8. Pistil; 9: Seed.

Figs. 10-17. *Cassia glauca* Lamk. 10. A twig; 11. Flower (corolla removed); 12, Flower (calyx removed); 13. Corolla expanded; 14. Stamens; 15. Pistil; 16. Pod; 17. Seed with funicle attached.

PLATE-2. FIG. 18-38.

Figs. 18-25. *Cassia pumila* Lamk. 18. A branch; 19. A portion of leaf showing two pairs of leaflets; 20. Flower; 21. Sepal; 22. Petal; 23. Stamens; 24. Pistil; 25. Seeds.

Figs. 26-31. *Cassia occidentalis* L. 26. A twig; 27. Flower with buds; 28. Sepals; 29. Petals; 30. Flower androecium and gynoecium shown; 31. Stamen.

Figs. 32-38. *Cassia tora* L. 32. A twig; 33. Apical portion of leaflet showing hairs on the lower surface; 34. Flower (corolla and androecium removed); 35. Corolla; 36. Flower (calyx and corolla removed); 37. Stamens; 38. Staminode.

ovoid gland at the base of rachis. Leaflets 3-5 pairs, ovate, oblong, or oblanceolate. Flowers yellow in corymbiform axillary clusters. Fertile stamens 6-7. Pods 8-12 cm. long transversely partitioned. Seeds 15-30 pale brown. Fls. August-November. Country of origin: West Indies.

Leaves, seeds and roots are used as tonic, purgative and in skin diseases. Roots are also used in snake bite. Plant contains emodin, oxymethyl anthraquinones, toxalbumin. Seeds contain tannic acid, mucilage, fatty oil, emodin, atoxalbumin and chrysarobin.

Common along road sides and in fallow land; can be raised through seeds.

Cassia sophera L. Known in vernacular as *Kasunda*. A shrubby plant. Rachis with a single gland at the base. Leaflets 4-8 pairs, oblong, lanceolate, acute or tapering. Flowers yellow in corymbose racemes. Pods straight or curved transversely septate. Fls. August-December. Country of origin: S. America.

Leaves are used externally in ringworm. Decoction of plant used in acute bronchitis. Plant contains emodin and chrysophanic acid.

Common as weeds in unattended places; can be raised through seeds.

Cassia absus L. Known in vernacular as *Chaksu*. An erect annual, 30-60 cm. high, clothed with grey bristly viscoid hairs. Rachis with a small linear gland between the leaflets of each pair. Leaves on long petioles. Stipules small, linear, acute, persistent. Leaflets 2 pairs, 2.5-5 cm. long, 2-3 cm. broad. Flowers yellow, small, racemose. Sepals narrow, acute. Petals with long claws, veined. Pods 2.5-3.8 cm. long, oblique, beset with grey bristly hairs. Seeds 5-7 compressed, blackish, shining. Fls. August-November.

The bitter leaves are used as astringent and cough remedy. Seeds used as astringent, carthartic, for ringworm, skin affections, in conjunctivitis and ophthalmia. Seeds contain alkaloid chaksine and isochaksine.

The plant grows wild in neglected fields as a weed; can be raised through seeds.

Cassia mimosoides L. A low diffuse glabrous or pubescent perennial or sometimes suffrutescent common weed with a simple or much branched stem. Rachis puberulous with a small sessile gland below the lowest pair of leaflets. Leaflets small, 40-60 pairs. Stipules 5 mm. subulate. Flowers solitary or 2-3 together. Stamens perfect, alternately longer and shorter. Pods 2.5-5 cm. long, flattish. Seeds 20-25. Fls. July-September.

The plants are common as weeds in fields and along road sides; can be raised through seeds.

Cassia pumila Lamk. (Figs. 18-25.) A prostrate, ascending or sub-erect deep-rooted stout herb. Stems and branches often reddish brown. Leaflets small, 10-40 pairs, linear, acute. A stipitate gland is present at the base of pinna. Flowers yellow, usually solitary. Pods 2.5-4 cm. long, 5 mm. broad, straight, flat, torulose. Seeds somewhat rectangular, polished. Fls. September-October.

Seeds are given as purgative.

The plants are wild as weeds in crevices of rocks, under the shade of trees, shrubs and in open gravelly soils; can be raised through seeds.

Acknowledgements

I am indebted to the late Rev. Fr. Dr. H. Santapau, S.J., Ph.D., F.N.I. for his keen interest and guidance in this work and to Dr. R. V. Sitholey, Scientist-in-charge, National Botanic Gardens, Lucknow for constant encouragement and help. I am grateful to Prof. K. N. Kaul for suggesting the problem.

References

Anonymous (1950): Wealth of India. Raw Materials. New Delhi: 2: 93-98.

Bentham, G. (1869): Revision of Genus *Cassia. Trans. Linn. Soc. London.* 18: 503-591.

Blatter, E., & Millard, W. S. (1937): Some Beautiful Indian Trees. pp. 19-37.

Chopra, R. N., Nayar, S. L., Chopra I. C., (1956): Glossary of Indian Medicinal Plants. New Delhi. pp. 53-55.

Cooke, T. (1903): Flora of the Presidency of Bombay. 1: Pt. III.

Duthie, J. F. (1903): Flora of the Upper Gangetic Plain. 1: 290-297.

Gamble, J. S. (1902): A Manual of Indian Timbers. pp. 271-275.

——————— (1915): Flora of the Presidency of Madras. 1: 398-404.

Haines, H. H. (1922): The Botany of Bihar and Orissa. 1: 301-306.

Hooker, J. D. *et al.* (1879): The Flora of British India. 2: 261-267.

Maheshwari, J. K. (1963): Flora of Delhi. pp. 139-143.

Randhawa, M. S, (1965): Flowering trees in India. I.C.A.R. New Delhi. pp. 163-164.

Watt, G. (1889): A Dictionary of Economic Products of India. 2: 210-226.

Willis, J. C. (1966): A Dictionary of the Flowering Plants and Ferns. Cambridge University Press. pp. 205-206.

Studies on the Life History of a predatory Pentatomid Bug, *Andrallus spinidens* (Fabr.)[1]

M. K. Rajendra[2] and R. C. Patel

Institute of Agriculture, Anand

(*With seven figures in a plate & a text-figure*)

Andrallus spinidens (Fabr.) is a predator on a wide range of insect pests of economic importance. Studies on the life history revealed that a single female laid from 11 to 1,084 eggs with an average of 370 eggs. The incubation period of eggs was 5.29 ± 0.96 days at room temperature ranging from 85 to 92°F and 7.63 ± 0.51 days in a constant laboratory maintained temperature of 80 ± 2°F. No eggs hatched at relative humidity 20% and below. The maximum hatching was observed to be 95.09 per cent at 100% R.H. The nymphal durations was recorded to be 12.48 ± 0.50 days when the nymphs were reared in the laboratory at the average temperature of 87.09 ± 3.89°F. When the nymphs were reared at constant temperature of 80 ± 2°F., the nymphal duration was 21.98 ± 1.78 days. When the adults were provided with *Prodenia* larvae and lucerne leaves, the males and females survived for 43.62 and 49.33 days respectively.

Introduction

Andrallus spinidens (Fabr.), nymphs and adults were found associated with *Heliothis armigera* (Hb.) larvæ infesting lucerne and redgram crops on various farms of the Institute of Agriculture, Anand. The nymphs as well as the adults were observed to attack the larvae and suck out the body contents. This predatory activity of the bug was quite interesting since *Heliothis* is a very serious pest of a variety of important crop plants. Studies were therefore taken up to determine the usefulness of this bug to regulate populations of its hosts in nature.

Review of Literature

Andrallus spinidens was first reported from India in 1902 under the name *Audinetia spinidens* (Fabr.). A brief description of the species has been given by Distant (1902) and Ramakrishna Ayyar in ICHNOGRAPHIA INSECTORUM JAPONIORUM (1956). In 1906, Bengroth transferred it to the genus *Andrallus* since the generic name *Audinetia* was preoccupied. Lefroy & Howlett (1909) reported the species as a rare insect feeding upon *Thermesia rubricans* larvae and other caterpillars which are found among herbage and low crops. Subsequently, Fletcher (1914) reported it from south India as feeding on caterpillars of *Chloridea obsoleta*. Ramakrishna

[1] Abstracted from the thesis submitted to Sardar Patel University, Vallabh Vidyanagar in partial fulfilment of the requirements for M.Sc. (Ag.) degree by the first author under the guidance of the second.

[2] Present address: Development Officer, NOCIL, Sandoz House, Dr. Annie Besant Road, Worli, Bombay-18.

Ayyar (1940) has mentioned the species as a predatory insect on caterpillars. Cherian & Brahmachary (1941) have briefly listed its distribution, seasonal incidence, hosts, life history and feeding habits. Nageswara Rao (1967) has mentioned this species as [a predator on *Parnara mathias* Fb., commonly known as the rice skipper. The biology of this bug has not been studied in detail so far.

Distribution and Host Range

A. spinidens is widely distributed and has been recorded from several islands of the Malay Achipelago; Fiji; Tahiti; E. Africa; Mexico; Pakistan; and Japan. In India, it has been recorded in Sikkim, Assam, Khasi Hills, Harnath, Bengal, Bihar, Orissa and Madras.

The bug attacks a number of insect pests of economic importance which include *Tarache nitidula* (Fabr.) *Earias fabia* (Stoll), *Orthaga* sp., *Spodoptera mauritia* (Boisd.), *Cirphis unipuncta* (Haw.), *Psalis pennatula* (Hb.), *Euproctis fraterna* (Moore), *Utetheisa pulchella* (Linn.), *Argira cribraria* (Clirck), *Hypsa sericea* (Moore), *Amsacta albistriga* (Wlk.), *Stomopteryx nerteria* (Meyr.), *Sylepta derogata* (Fabr.), *Tryporyza incertulas* (Wlk.), *Scripophaga* sp., *Papilio demoleus* Linn., *P. aristolochia* (Fabr.), *Acherontia styx* Westw., *Melanitis ismene* Cram., *Parnara mathias* Fabr., *Achaea janata* (Linn.), *Laphyygma exigua* (Hb.), *Leucinodes orbonalis* Guen., *Prodenia litura* F., *Corcyra cephalonica* Staint and *Heliothis armigera* (Hb.).

Material and Methods

A. spinidens adults were found in association with *H. armigera* larvae infesting redgram (*Cajanus cajan*). The adults were held in glass containers 7.0 cm. in diameter and 3.5 cm. in height along with *Heliothis* larvae and host plant. Later they were provided with lucerne leaves and *Prodenia* larvae.

To study the effect of humidity on hatching, eggs were held in closed containers having different concentrations of sulphuric acid to maintain desired humidity. Calcium chloride and distilled water were used to maintain 0 and 100 per cent relative humidity respectively.

Description of Developmental Stages

The eggs are small and cylindrical (Plate 1, Fig. 1) with broader top. The operculum is fitted into a raised rim ornamented with fourteen to twenty micropilar processes. They are creamy white in colour when laid. When the eggs are about to hatch, the colour changes to bright orange reflecting the colour of the nymphs under the chorion. The eggs are laid in batches, usually in two or three regular rows. The eggs measured on an average 1.149 ± 0.083 mm. in height and 0.840 ± 0.0008 mm. in diameter. At hatching, the chorion ruptures around the margin of the operculum which is then pushed away by the nymph as it eomes out.

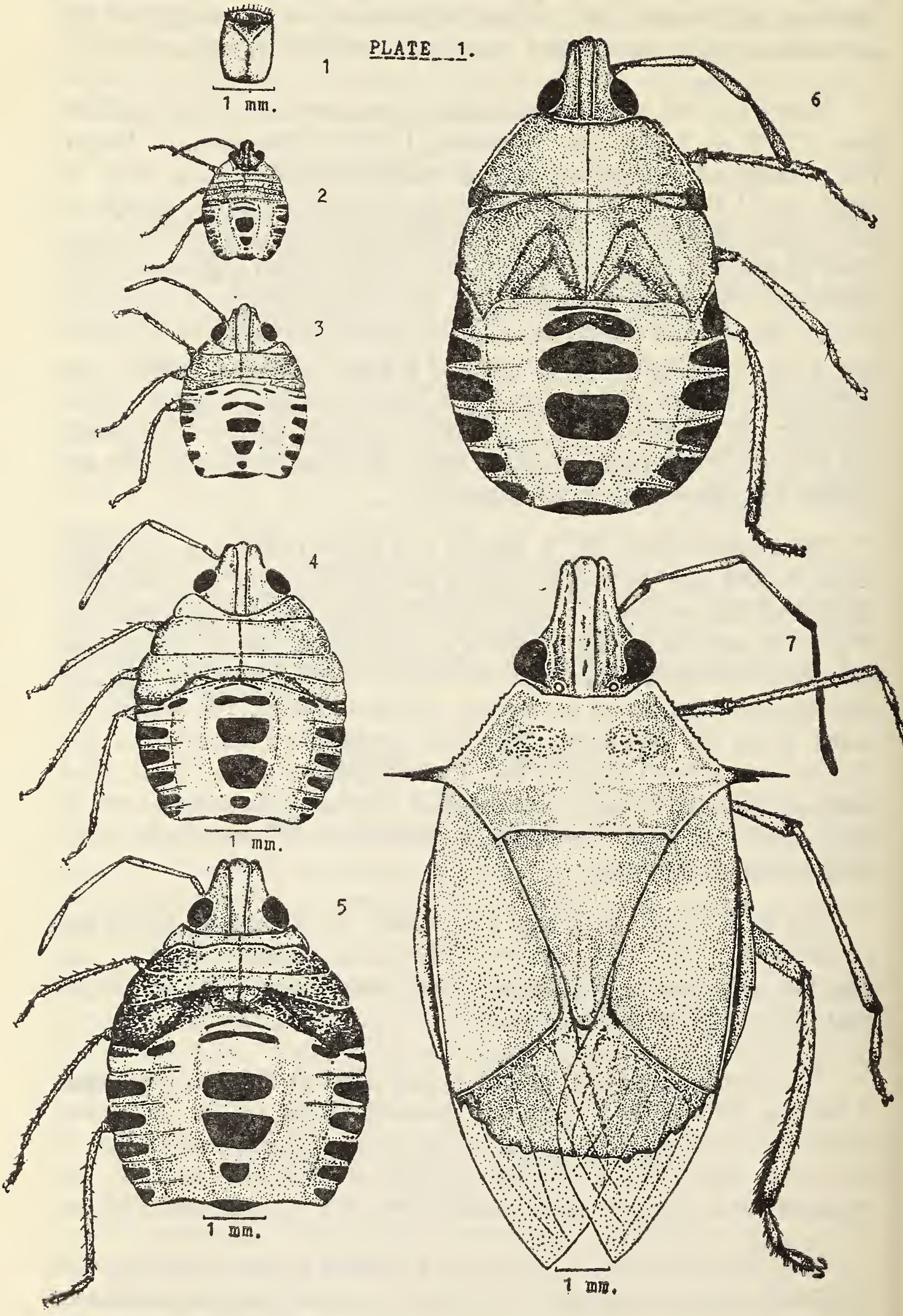
Newly hatched nymphs are bright orange in colour and measure from 0.960 to 1.200 mm. averaging 1.084 ± 0.046 mm. in length. Fully developed first instar nymphs measure 1.339 ± 0.720 mm. in length and 1.045 ± 0.063 mm. in breadth and their colour changes to pitch black. The whole surface of the body is covered with setae of which those on the antennae and the legs are quite prominent. Antennae, four-segmented, the distal segment being relatively thicker and lighter in colour. The rostrum comprises of four segments and tapers to a pointed end. First basal segment is shorter and thicker than the remaining segments. The thorax and abdomen are bright orange in colour. Small brownish patches present on first, second and third abdominal segments and two big brown round patches appear covering fourth and fifth and seventh and eighth abdominal segments.

The second instar (Pl. 1, Fig. 3) is 1.630 ± 0.082 mm. in length, 2.690 ± 0.092 mm. in breadth and is closely similar to the first instar except that the rostrum is relatively much longer than in the first instar. A pair of irregularly shaped patches on the second abdominal segment and two oval-shaped big patches covering third and fourth and fifth and sixth abdominal segments are present on the abdomen. The abdomen is raised along the mid-dorsal line and slopes down laterally to join with the connexivum which is flat. Each connexivum has a pitch black patch on either side. At the beginning of this stage, the nymphs remain close together. Later, they begin to disperse to different parts of the plant in search of food.

The third instar (Pl. 1, Fig. 4) is 2.890 ± 0.121 mm. in length and 2.690 ± 0.092 mm. in breadth with abdominal patches bigger in size than the earlier instar. Rudimentary wing pads appear and the nymphs start feeding avidly at this stage.

The fourth instar (Pl. 1, Fig. 5) is 5.820 ± 0.920 mm. in length, 4.340 ± 0.180 mm. in breadth and generally similar to the third instar except for the growing wing pads which are more clearly visible than in the earlier instar. The pitch black patches on abdominal segments and connexivum are bigger in size and clearly seen even without magnification.

The fifth instar (Pl. 1, Fig. 6) is 9.740 ± 0.60 mm. in length and 5.662 ± 0.141 mm. in breadth. The lateral margin of the thorax is thorny and the wing pads extend up to the second abdominal segment. The



Life history stages of *Andrallus spinidens* (Fabr.)

abdomen is bright orange in colour with black patches all over. There is a pair of black patches on the first abdominal segment, a black stripe and a ' spectacle ' shaped patch on the second abdominal segment and four irregular black patches each covering two abdominal segments. On each connexivum, there is a pitch black patch on either side.

The newly transformed adult is yellow to light salmon in colour which slowly changes to pale brown or yellow with slight tinge of brown. The body is elongate and measures from 10.00 to 14.00 mm. in length and 6.40 to 7.00 mm. in breadth. The measurements recorded for 20 males and 20 females showed that females are longer and broader than the males. The average length and breadth are 10.85 ± 0.75 mm. and 6.48 ± 0.056 mm. for males and 13.20 ± 0.69 mm. and 6.70 ± 0.058 mm. for females.

The head is lobular and somewhat long with a blackish broad line on each side of central lobe. The lateral lobes are slightly larger than the central lobe. The head width varied from 2.24 to 2.40 mm. with an average of 2.341 ± 0.058 mm. Compound eyes are prominent and brick red in colour. A pair of bright red lustrous ocelli is present near the compound eyes. The antennae are five segmented measuring 6.40 to 6.88 mm. in length with an average of 6.520 ± 0.205 mm. Distal part of the third segment and fourth and fifth segments of the antennae are black. The rostrum averages 5.916 ± 0.162 mm.

The pronotum is deflected anteriorly and it bears a pale, smooth and lustrous band between the pronotal angles. The pronotal angles bear straight and pointed spines, the distance between them ranges from 7.68 to 7.92 with an average of 7.758 ± 0.063 mm. The scutellum is moderately long and slender. The posterior part of the scutellum in the middorsal region as well as its apex are pale yellow in colour. The costal margin of the wing in the corium region is also pale yellow in colour. The abdomen is 6.40 to 6.64 mm. in width, averaging 6.504 ± 0.072 mm. It is densely punctate and pale yellow with a slight tinge of brown.

Life History and Habits

After hatching, the nymphs form a cluster on or near the egg mass. This gregarious habit is very pronounced among nymphs for the first two days and the only movement noticed is for adjustment among themselves. They do not feed during this period and after moulting on the third day they move about in search of food and thus get scattered among the plants. In the second instar, the nymphs suck sap from lucerne leaves or join the older nymphs or adults in sucking the host larvae.

Beginning from the third instar, the nymphs suck plant sap as well as attack the host larvae of all stages.

When advancing to attack, both nymphs and adults follow the prey with the proboscis extended in front and when they are within reach, introduce the proboscis into the host body and anchor it so firmly that it is not taken out till feeding is over. If the host larva feigns death when attacked and tries to drop down, the victim merely remains suspended at the tip of the rostrum of the bug. On very slight disturbance, they hide under soil clods or plant parts. Since they also suck the sap from the foliage, the predatory nature of the insect is of less significance.

The sexes, male and female occur in 1 : 0.77 ratio and mate several times during their lives. The female usually lays her eggs on the leaves, but eggs have been found also on stem and cloth surface in the laboratory. The results of fecundity studied for 24 pairs of adults are given in table 1.

TABLE 1

FECUNDITY OF *Andrallus spinidens* (FABR.) FROM AUGUST TO DECEMBER 1965

Pair No.	No. of egg batches	No. of eggs in a batch			Total No. of eggs	Days in		
		Min.	Max.	Aver.		Pre-ovi-position	Ovi-position	Post-ovi-position
1	20	26	83	54.2	1,084	15	49	1
2	7	18	68	28.6	200	27	24	4
3	7	43	111	74.0	518	15	22	7
4	6	29	68	50.0	300	16	22	22
5	8	36	91	52.0	416	13	18	2
6	6	16	98	54.0	271	17	20	2
7	10	20	122	70.1	709	14	24	5
8	10	9	64	30.2	302	19	64	1
9	11	15	76	43.2	475	28	38	1
10	4	17	54	34.5	138	13	14	2
11	6	26	61	47.0	281	22	8	2
12	3	41	60	51.0	153	12	9	8
13	2	17	94	55.5	111	58	1	2
14	8	30	121	59.4	475	11	39	12
15	4	13	95	46.7	187	39	18	7
16	5	29	83	65.2	326	32	23	3
17	11	15	111	70.0	769	20	27	2
18	1	11	11	11.0	11	38	1	16
19	5	14	64	46.4	232	30	21	4
20	1	53	53	53.0	53	10	1	25
21	2	38	39	38.5	77	7	6	1
22	12	25	104	68.3	819	12	43	2
23	13	21	137	71.3	927	10	79	2
24	1	46	46	46.0	46	6	1	8
Av.	6.79			54.47	370	20.12	23.83	5.87

The temperature in the laboratory varied from 78°F. to 104°F, with a mean of 81.07°F.

The results in the above table indicate that each female laid on an average 6.79 egg batches each having an average of 54.47 eggs. The number of eggs laid by a female varied from 11 to 1,084 with an average of 370 eggs per female. The pre-oviposition, oviposition and post-oviposition periods were 20.12, 23.83, and 5.87 days respectively.

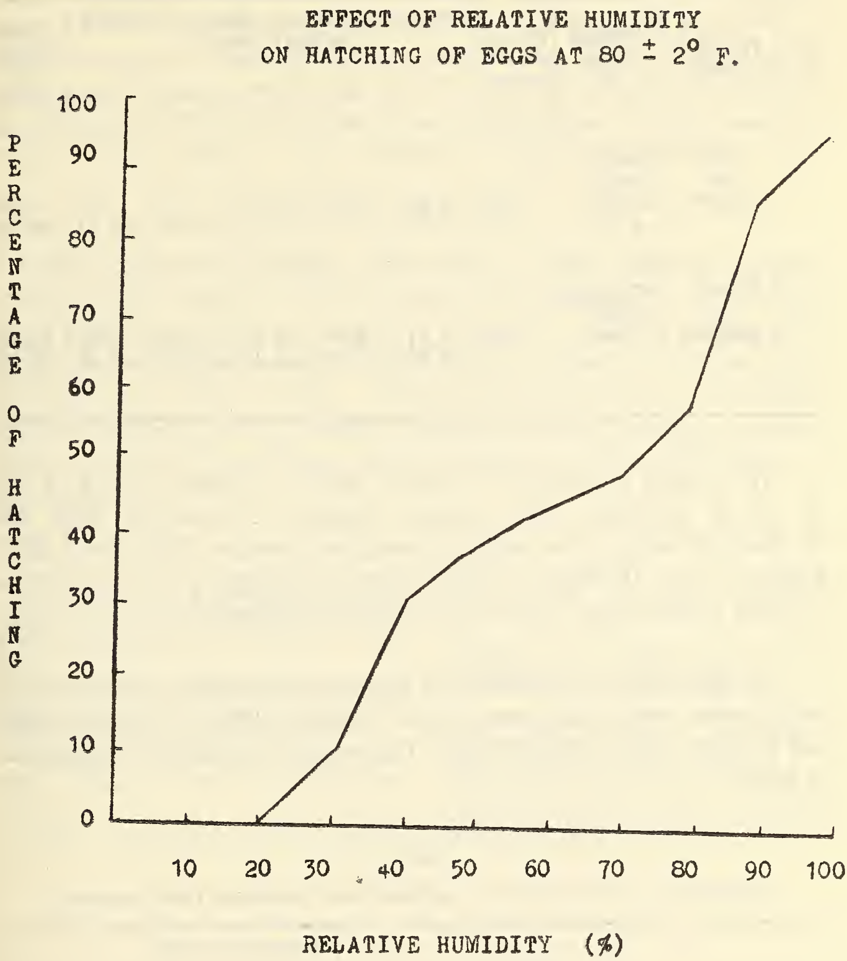
The effect of relative humidity on the hatching percentage of eggs was determined by holding egg masses in airtight containers having different concentrations of sulphuric acid. The results obtained are given in table 2 and are graphically represented in text-figure 2.

TABLE 2

EFFECT OF RELATIVE HUMIDITY ON THE INCUBATION PERIOD OF EGGS AT 80±2° F.

S. No.	R.H. (%)	Period of study	No. of sets	No. of eggs kept for hatching	No. of eggs hatched	Time taken for hatching in days	Percentage of hatching
1	100	29-3-66 to 24-4-66	3	274	260	9	95.09
2	90	8-3-66 to 5-4-66	3	200	178	8	88.14
3	80	10-2-66 to 29-2-66	3	191	120	8	62.45
4	70	13-2-66 to 30-3-66	3	254	129	8	50.86
5	60	13-2-66 to 3-3-66	3	258	125	8	44.62
6	50	14-2-66 to 26-3-66	3	189	72	8	40.13
7	40	15-2-66 to 4-3-66	3	271	88	8	32.13
8	30	15-2-66 to 2-4-66	3	186	21	8	10.19
9	20	1-3-66 to 1-5-66	3	187	0	0	0

The results in the above table indicate a maximum of 95.09% hatching at 100% R.H. No eggs hatched at 20% R.H. Between 20 and 100% R.H., the hatching percentage increased with the increase in R.H.



The number and duration of nymphal instars were determined as indicated in table 3.

TABLE 3

DURATION OF DIFFERENT NYMPHAL INSTARS OF *A. spinidens*

Sl. No.	Period of study	Average temp. °F.	No. of observations	Average duration of different nymphal instars in days					Total nymphal period
				I	II	III	IV	V	
1	6-9-65 to 22-9-65	Room temp. 87.09 ±3.89	159	2.00	2.00	2.06 ±0.28	2.65 ±0.50	3.52 ±0.50	12.48 ±0.50
2	23-9-65 to 16-10-65	Constant temp. 80±2	86	3.11 ±0.06	5.00 ±0.22	3.30 ±0.41	3.46 ±0.10	5.38 ±0.54	21.98 ±1.78

The results in the above table show five nymphal instars in the life of *A. spinidens*. The average duration of nymphal stage was 12.48±0.50 days at the average room temperature of 87.09±3.89°F. whereas it was 21.98±1.78 days when the nymphs were reared in the constant temperature laboratory maintained at 80±2°F.

To determine the longevity of adults and the influence of food on its duration, newly transformed adult bugs were kept in glass containers and provided with different foods. The results obtained are summarised in table 4.

TABLE 4

LONGEVITY OF THE ADULT OF *A. spinidens* WITH DIFFERENT FOOD MATERIALS

Sl. No.	Food	No. of adults under study		Longevity in days					
				Male			Female		
		♀	♂	Min.	Max.	Aver.	Min.	Max.	Aver.
1	Lucerne leaves with *Prodenia* larvae	24	24	11	70	43.62	14	91	49.33
2	*Prodenia* larvae	15	14	2	37	19.67	15	77	32.00
3	Lucerne leaves	16	13	6	18	13.19	10	25	15.92
4	Water	11	12	2	6	3.45	2	7	3.67
5	No food	15	12	2	6	3.60	2	7	3.58

The results indicate that the female lives longer than the male. The longest survival recorded for the male and female was 70 and 91 days with an average of 43.62 and 49.33 days respectively. The insect can survive both on plant and animal food but both foods are necessary for longest survival. When the adults were reared in the laboratory in glass bowls with lucerne leaves and *P. litura* larvae, each consumed on an average 100.55 third and fourth instar *P. litura* larvae with a minimum of 53 and a maximum of 133 caterpillars during their adult life.

Acknowledgements

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References

Cherian, M. C. & Brahmachary, K. (1941): Notes on three predatory Hemipterons from South India. *Indian J. Ent.* 3 (1): 115-319.

Distant, W. L. (1902): The fauna of British India, including Ceylon and Burma. Rhynchota, Vol. 1, p. 253.

Fletcher, T. B. (1914): Some South Indian Insects. Govt. Press, Madras. p. 475.

Lefroy & Howlett (1909): Indian Insect Life II. *Agri. Res. Inst.*, Pusa. p. 677.

Ramakrishna Ayyar, T. V. (1940): Handbook of economic entomology for South India. Govt. Press, Madras. p. 61.

—————————— (1956): Ichnographia Insectorum Japoniorum. Hokuryukan Ltd., Tokyo. p. 209.

Nageswara Rao, V. (1967): *Andrallus (Audinetia) spinidens* Fabr., as predator on rice pests. *Oryza*, 1965, Vol. 2, No. 1.

A Catalogue of the Birds in the Collection of the Bombay Natural History Society-9

Psittacidae

BY

HUMAYUN ABDULALI

(*Continued from Vol.* **68** (1): 152)

This part deals with 236 specimens of 23 species and subspecies upto No. 568 in IND. HANDBOOK (**3**: 191) and No. 23465 of the Society's Register. Miss Shanta Nair assisted with the measurements.

545 **Psittacula eupatria nipalensis** (Hodgson) (Nepal) Large Indian Parakeet **4**: 199

20: 13 ♂♂ (2 juv.) 7 ♀♀

1 Lahore, 1 Chandigarh, 2 Bahawalpur, Punjab; 1 Raipur, Melghat, Berar; 1 Mheskatri, 1 Chikli, 2 Mahul, Surat Dangs; 1 Bhanuprattapur, 1 Amraoti, 1 Lohattar R., Kanker, M.P.; 1 Badrama, Bamra, 1 Kanta, Keonjhar, 1 Daspur, 1 Orissa; 1 Bairia, Patharghatta, Bihar; 1 Jalpaiguri, 1 Tindharia, Darjeeling, Bengal; 1 Cage bird, Trivandrum Zoological Garden (origin ?, wing 225).

There is considerable variation in the width of the black moustacial streak (which is likely to vary with the method of preparation of the skin) and the differences in the colour of the tarsi cannot be appreciated in dry skins. In this series, the 3 males from the Punjab have larger wings and tails than the others, and the blue next to the red collar is slightly darker than in southern birds. The latter are more yellowish, less green on their underparts. There are no specimens from south of 18° N. latitude and, with only one male from Burma and two from the Andamans, the subspecific groupings are mostly on the basis of the distribution in IND. HANDBOOK.

	Wing*	Bill	Tarsus	Tail
Punjab ♂♂	228, 230, 241*	38, 29, 39	18, 18, 20	324, 326, 355
Other ♂♂	209-228 av. 220 (IH 200-234	36-39 —	16-19 av. 17 19-22	285-359 av. 317 220-361)
Punjab ♀	219	34	16	329
Other ♀♀	194-218 av. 206 (IH 192-221	31-37 av. 34 —	15-19 av. 16.6 19-22	200-293 av. 263 206-325)

* 3♂♂ from Kashmore, Jacobabad, Sind, in the collections of the Zoological Survey of Pakistan, Karachi, have wings 214, 224, and 228 mm.

Whistler (1935, *JBNHS* 37: 751) disagreed with the arrangement in the FAUNA and said " Birds from Sikkim and the Duars are attributed to the race *indoburmanica* (Hume, S.F. 7: 459) as are also birds from Burma generally. I have examined a good series of these Parakeets from the Sikkim *Duars* (italics mine) area and cannot find that they differ in any particular character from *Psittacula e. nepalensis* (Nepal, Punjab, United Provinces). Burmese birds on the other hand are definitely distinguishable from *nepalensis* .... The difference between the Sikkim *Duars* (italics mine) and Burmese birds was recognised by Hume when naming......... *indoburmanicus*......... but he expressly stated that further subdivision was unnecessary. How he came to accept the Sikkim *Duars* (italics mine) birds separable from *nepalensis* is not clear to me. Accepting their identity there is no doubt that the name *indoburmanicus* must become a synonym for *nepalensis*. Reading the original description one has no difficulty in seeing that Hume primarily intended to apply it to the Sikkim bird with which he contrasts Burmese birds........ Kloss made this point clear by restricting the type locality to Sikkim. He then named the Burmese birds *avensis* (type locality Bhamo)", and this name is now accepted for birds from Cachar and further east and southwards.

An examination of the original description reveals that Hume's statements have been misinterpreted. Hume referred to birds from the Sikkim *Terai* and the Duars further east while Whistler's conclusions are based on material from the Sikkim *Duars*, a more deciduous area north of the Sikkim Terai.

Hume indicated clearly that Hodgson's name *nepalensis* could not apply to the birds in "the Sikkim Terai and then eastwards through Assam, Cachar and with slight modifications throughout Burma into Tenasserim ", all of which differed from *nepalensis* in having no tinge of glaucous blue on nape and cheeks. He continued: " though the northern (or Sikkim Terai) and southern (or Burmese) birds do not agree perfectly inter se; as a body they are well distinguished from the three other races", i.e. *eupatria* (Ceylon), *nepalensis* (Nepal), and *magnirostris* (Andamans), and because he considered that " there must be a limit to splitting up this form " he kept them as one species under the name of *P. indoburmanicus*.

Hume (loc. cit) draws attention to the fact that, though Hodgson described the birds from Nepal, his drawings are based on the eastern form for he got his specimens at Darjeeling. The copy of *Asiatic Researches* (1836) in the library of the University of Bombay contains no drawings of this bird and in the description Hodgson specifically states that the bird is found in " the Saul Forests exclusively, and is not known to the Parrot-tamers. "

The single specimen from Tindharia, Darjeeling, together with another from Burma differ from the others in having green cheeks without the glaucous blue in those from further west. The difference is not visible on the nape.

When describing *indoburmanicus*, Hume was referring to the form extending eastwards into Burma, and this would predate *avensis*. Though Sàlim Ali omits this species from BIRDS OF SIKKIM, there can be little doubt that *nepalensis* occurs in Sikkim *Duars* and *indoburmanicus*, originally from Sikkim *Terai* further south, is found through Darjeeling and the Duars into Burma. However, in the absence of sufficient material, I will not reshuffle the position in IND. HANDBOOK, and only reiterate that *indoburmanicus* is not synonymous with *nepalensis*.

546 **Psittacula eupatria eupatria** (Linnaeus) (Gingee) large Ceylonese Parakeet 4: 198

nil.

547 **Psittacula eupatria avensis** (Kloss) (Bhamo, Upper Burma) Large Burmese Parakeet 4: 200

4: 2 ♂♂ 2 ♀♀

1 Cachar, Assam; 1 *Gagyi, Lower Chindwin*, 1 *Upper Burma*, 1 *Prome, Burma*.

	Wing	Bill	Tarsus	Tail
♂♂	187, 215	36, 37	16, 17	172, 324
	(Type ex IH 217	Culmen 38	21	342)
♀♀	197, 200	32, 33	17, 17	—

548 **Psittacula eupatria magnirostris** (Ball) (Andaman Islands) Large Andaman Parakeet 4:201

6 : 2 ♂♂ 4 ♀♀

1 Wrightmyo, 1 Ferrarganj, South Andamans; 4 Narcondam Island.

	Wing	Bill	Tarsus	Tail
♂♂	221, 224	42, 42	17, 17	221, 348
	(205-217)	(39-45)	—	—
♀♀	188, 189, 192, 205	37 (3), 38	15, 17, 17, 19	217, 255, 282
	(190-209)	(34-39)		

549 **Psittacula krameri borealis** (Neumann) (Assam) Northern Rose-ringed Parakeet 4: 204

21 : 13♂♂ (5 juvenile) 6 ♀♀ 2 o ?

1 Chandigarh, Punjab; 1* Jacobabad, Upper Sind Frontier, 1 Dadu, Larkana Sind; 2 Bharatpur, Rajasthan; 1* Delhi; 2** Patharghatta, 1* (juv.) Baghowni, Darbhanga, 1 Samastipur, Bihar; 1 Salukapur, 4* Meerut, U.P.; 1 Calcutta; 1* Goalpara, Assam; 1* *Upper Burma*, 2** (1 juv.) *Burma*; 1* no locality (col. C. G. Nurse).

The birds with all-red lower mandibles are marked with asterisks. In dry, preserved specimens, it is sometimes difficult to be sure as to whether the colour is all-red or parti-coloured. Whistler (1935, *JBNHS* **37**: 752) examined 45 specimens which included 2 with black lower mandibles both from Assam (9 all-red and 8 parti-coloured) and Punjab and Sind (6 red, 6 parti-coloured) against 8 black (none red, 6 intermediate) from South India and Ceylon. He had no material obtained north of Nallamalai Range (*c.* 16° N. lat.) and south of Sind (*c.* 26° N. lat.), but arbitrarily fixed the 20° North latitude as the dividing line between the two races. Sálim Ali (1954, *JBNHS* **52** : 432) refers to 10 out of 11 from Kutch (*c.* 23° N.) and adjoining Gujerat, as having the lower mandible largely black, but leaves them as *borealis*.

Of 38 specimens of the species 13 (8 ♂♂ 5 ♀♀) have the lower mandible all-red, 3 all-black (all males), and the rest a varying amount of red and black. There are some variations in the green and yellow of the underparts, but none which can be geographically or otherwise isolated, and similar remarks apply to the measurements. The red lower mandible appears to be most consistent in Burma and Assam, and then lessens in frequency westwards through U.P. and Bihar to Jacobabad in Upper Sind. The character is found both in females and juvenile males, and appears sporadically as far south as Kanara, in the same way that the black form may also be found in Assam (Whistler loc. cit.).

The black lower mandible occurs in 3 males from Ajwa in Gujerat, Ratnagiri, and Nallamalai Range.

With the evidence available, I cannot accept birds from Kutch and Gujerat as *borealis*, thus moving the arbitrary line further northwards. A reasonable series from say Assam and south India may perhaps explain the differences more clearly. The measurements are under the next form.

550 **Psittacula krameri manillensis** (Bechstein) (Ceylon) Roseringed Parakeet **4**: 202

18 : 12 ♂♂ (2 juv.) 5 ♀♀ 1 o?

1 Kharivohar, 1 Talpeshwari, Bhuj, Kutch; 1 Gir Forest, 1 Kharaghoda, 1 Ajwa, Gujerat; 1 Melghat, Berar; 1 Kalyan, Thana, 1 Bombay City, 1 Bombay Market*, 1 Kolaba; 2 Ratnagiri; 1 Gundala, Karwar; 1 Nallamalai Range, 1 Vizagapatnam; 1 Golapatti, 1 Antagarh, Bastar, M.P.; 1 Daspalla, Orissa.

The bird from Gundala, Karwar, has the lower mandible completely red, while individuals from Ajwa, Gujarat, Ratnagiri, and Nallamalai Range have them black.

The specimens include a lutino* (yellow) male from the Bombay Market (red bill) and No. 10889 from Kutch which is in male plumage but is marked a female by the collector.

	Wing	Bill	Tarsus	Tail
borealis				
♂♂	162-177 av. 171 (164-183)	24-26 av. 25 (24-26)	13-16 (16-17)	213-234 av. 225 (240-282)
♀♀	159-176 av. 167 (162-170)	24-25 av. 24.5 (24-26)	13-16 (16-17)	177-235 av. 207 (190-240)
manillensis				
♂♂	167-177 av. 170 (IH* 159-172	24-26 av. 25 22-25	13-17 16-17	190-260 av. 226 186-238)
♀♀	161-164 av. 162	23-24 av. 23.7	13-16	164-212 av. 190

* These measurements are of 11 adult males from Ceylon, Kerala, and Mysore only, and not up to the 20° N. lat.

551 **Psittacula alexandr ifasciata** (P. L. S. Müller) (Arakan) Indian Redbreasted Parakeet **4 : 210**

23: 11 ♂♂ (3 juv.) 10 ♀♀ (3 juv.) 2 o?

1 Bhimtal 3500′, Kumaon; 1 Nepal; 3 Darjeeling, 1 Darjeeling Terai; 1 Bhutan; 1 Buxa Duars; 4 Jazraguri, 1 Bishmuri, Goalpara; 1 Rema, Sylhet, 1 Larsingah, Cachar, 1 Golaghat, Assam; 1 *Kyaukpyu-Sandoway border*, 4 *Sandoway District*, 1 *Thayetmyo*, 1 *Legongyi, Henzada, Burma.*

In both sexes there is considerable variation in the colour of the breast, as also the green of the underparts.

Of the six juveniles, the three males have red breasts, one a red bill and the other two black, a character of the female. The juveniles perhaps show more variation in the colours of the head and breast, and the green of the underparts than the adults.

The red-billed juvenile (so listed for its small size) has pale edges to the frayed feathers of the head and cheeks creating a barred appearance, a character lacking in the others and only faintly visible in a ♂ of the next race.

	Wing	Bill	Tarsus	Tail
♂♂	168-175 av. 171.6 (162-174)	27-28 (23-28)	15-17 (16-17)	160-197 av. 183 (168-189)
♀♀	158-170 av. 163.6 (157-162)	25-27 (23-28)	13-15 (16-17)	140-178 av. 154 (145-171)*

* See note under next form.

552 **Psittacula alexandri abbotti** (Oberholser) (South Andaman Island) Andaman Redbreasted Parakeet

5 : 3♂♂ 1 ♀? 1 o? juv.

1 Bakultala, Middle Andamans; 1 Bambooflats, 2 Wrightmyo, 1 South Andamans.

	Wing	Bill	Tarsus	Tail
♂♂	172, 173, 174	27, 28, 29	15, 15, 16	157, 192, 195

The measurements of the tails of the same three males in IH **3** : 174 read 187-193 while the key on page 172 requires a longer tail 196-198.

One unsexed bird (No. 21943) has an all-black bill and a red breast and is probably a female (wing 168, tail 169). The other (No. 23371) is evidently a juvenile (wing 161, tail 68) but has a red bill, no red on breast, and brownish, and not grey, head. The black on the chin and forehead is also paler.

The female (?) (No. 21943) has the colours of the soft parts noted on the label : "Bill dark slaty black; iris china white; legs and feet greenish plumbeous." The legs, feet, and claws are now dark and blackish as in the others, but the feet are much paler or whitish in *fasciatus*. This difference will probably be confirmed in fresh specimens and, if so, may be a better distinguishing factor than " the paler upper and lower plumage" which is scarcely discernible in the specimens available.

553 **Psittacula caniceps** (Blyth) (Nicobars) Blyth's Nicobar Parakeet **4** : 212

1 ♂ Campbell Bay, Great Nicobar.

554 **Psittacula derbyana** (Fraser) Lord Derby's Parakeet (no locality, cage bird)

nil.

555 **Psittacula longicauda tytleri** (Hume) (Andaman Islands) Andaman Redcheeked Parakeet **4** : 214

4 : 2 ♂♂ 2 ♀♀

1 Bakultala, 1 Long Island, Middle Andamans; 2 Wrightmyo, South Andamans

	Wing	Bill	Tarsus	Tail
♂♂	173, 181 (173-182)	24, 25 (23-25)	15, 16 (*c.* 19-20)	228, 234 (235-253)
♀♀	169, 170 (165-173)	22-24 (22-23)	16(2) (*c.* 17-18)	138, 161 (178-204)

One of the males has its pale back delicately tinged with lilac and blue, but the other is just paler green as in the presumably adult males of *nicobarica.*

[170]

556 **Psittacula longicauda nicobarica** (Gould) (Nicobars) Nicobar Redcheeked Parakeet **4** : 213

12: 7♂♂ (4 juv.) 5 ♀♀

1 *Car Nicobar; 4 Camorta, 2 Trinkut, 1 Nancowry, Central Nicobars; 4 Campbell Bay, Great Nicobar.

	Wing	Bill from cere	Tarsus	Tail
Car Nicobar				
♀ *	198	27	17	219
	(178-187)	(24-25)	(18-20)	(180-205)
Central Nicobars				
3 ad. ♂♂	197, 199, 202	26, 27 (2)	16 (2), 17	254, 266, 285
	(186-192)	(26-28)	(18-20)	(250-286)
1 juv. ♂	182	25	16	225
3 ♀♀	177, 188, 191	25 (2), 26	15, (16 (2)	124, 179, 201
Great Nicobar				
3 juv. ♂♂	191, 192, 195	24 (3)	15, 16 (2)	191, 216, 225
1 ♀	199	26	17	217

* This was wrongly listed as a ♂ (*JBNHS* **64**: 169)

The key for the distinction of the Andaman and Nicobar subspecies in IND. HANDBOOK (**3**: 176) is not satisfactory. One male *tytleri* has pale patch on the upper back, not concolorous with the crown, but quite similar to that in 3 *nicobarica* males, presumably adult. All the seven females of both races (2 and 5) have their upper back concolorous with the head.

The female from Great Nicobar is a slightly lighter green than the juvenile males, and has the bill partly red, suggesting that the females have a juvenile phase with a red bill as in *Psittacula columboides.*

557 **Psittacula cyanocephala bengalensis** (Forster) (Bengal, restricted to Calcutta) Northern Blossomheaded Parakeet **4**: 206

21: 13 ♂♂ (2 juv.) 8 ♀♀ (2 juv.)

1 Dera Ismail Khan, N.W.F.P.; 2 Ladwa, Karnal, 1 Chandigarh, Punjab; 2 Vaghjipur, Mehsana, 1 Deesa, Palanpur, 1 Dabka, Gujerat; 3 Bina, C.P.; 2 Keonjar, 1 Kutri, Daspalla, 1 Badrama, Bamra, Orissa; 1 Baghowni, 1 Darbhanga, 1 Tirhut, Bihar; 2 Bulandshar, 1 Pilibhit, U.P.

558 **Psittacula cyanocephala cyanocephala** (Linnaeus) (Gingi, South Arcot, Madras) Southern Blossomheaded Parakeet **4**: 404

14: 7 ♂♂ (1 juv.) 7 ♀♀

1 Ratnagiri; 2 Pakmani, North Kanara; 1 Kopalgadda, Sorab, 1 Talguppa, Sagar, 1 Yadebatti, Shimoga, Mysore; 1 Travancore; 1 Kurumbapatti, Salem District; 4 Foothills, Palni Town; 1 Bhopalpatnam, 1 Konta, Bastar, M.P.

In 1951, Biswas (*Am. Mus. Nov.* 1500 : 1-8) examined a large number of specimens *Psittacula cyanocephala* and decided (1) that the birds from northeastern India extending into Burma are a different species, *roseata* Biswas, and (2) that there are three forms of *cyanocephala :*

(a) *bengalensis* Forster (Bengal, restricted to Calcutta) occurring from Punjab eastwards to Bhutan Duars, Western Bengal, southwards to Central Provinces, Northern Eastern Ghats, Western Satpuras, Kathiawar, etc.;

(b) *rosa* Boddaert (Mahe, Malabar Coast) in Bombay, Hyderabad south to Travancore, and smaller than *bengalensis*; and

(c) nominate *cyanocephala* (Gingi, South Arcot District, Madras), the most brightly coloured, less red and more blue on the head.

In IND. HANDBOOK (3: 178) *rosa* is synonymised with *cyanocephala* which is said to meet *bengalensis* at the arbitrary line of 20° N. lat., and to have the head of the male richer coloured, more blue less red, and the underwing coverts and rump (♂ ♀) bluish green against green in *bengalensis.* This is evidently a mistake for the only difference between the two races was said to be in size, being the two extremes of the cline from north to south, and all the subspecies have the underwing coverts pale-blue (presumably the same colour referred to as "verdigris" by Biswas), those with green having been transferred to *roseata.*

The material available is listed in two groups from north and south of 20° N. lat., but there is very little difference in size or colour :

	Wing	Bill	Tarsus	Tail
Northern				
11 ♂♂	135-149 av. 139	17-19	11-12	173-221 av .204
(IH ex Biswas	138-150	17-19	—	183-253)
Southern				
5 ♂♂	132-142 av. 137	17-19	11-12	123-212 av. 150
(IH ex Biswas	132-145	16-18	—	180-240)
Northern				
5 ♀♀	130-136 av. 132	15-17	12-12	123-175 av. 152
(IH ex Biswas	135-144	16-18	—	185-200)
Southern				
7 ♀♀	121-136 av. 129	16-17	12-13	102-159
(IH ex Biswas	126-140	16-18	—	164-176)

5 ♂♂ obtained in April (3), July, and August have pinkish-red heads with no gloss of red or blue and indicate a worn plumage, rendering them very different from the other males between October and February. A local dealer to whom specimens were shown said that all males of this species " changed their plumage " in the breeding season and no brightly coloured specimens would be available till October. Two females obtained on 3 April and in August have sooty-brown heads with a light tinge of blue, apparently indicating a similar " transformation " in the female.

559 **Psittacula roseata roseata** Biswas (Gunjong, North Cachar, Assam) Assam Blossomheaded Parakeet

4: 1 ♂ 3 ♀♀

1 Sukna, Darjeeling; 2 Shillong, Assam; 1 *North Shan States, Burma.*

560 **Psittacula roseata juneae** Biswas (Arakan, Burma) Arakan Blossomheaded Parakeet

2 ♂♂
1 *Irbin, Henzada ;* 1 *South of Irrawady.*

561 **Psittacula intermedia** (Rothschild) (India)
nil.

562 **Psittacula himalayana** (Lesson) (Valleys of the Himalayas) Himalayan Slatyheaded Parakeet. **4** : 206

22: 14 ♂♂ (1 juv.) 8 ♀♀ (3 juv.)
3 Chitral, N.W.F.P.; 1 Keonthal State, 1 Koti, 6 Simla, 2 Kalka, 1 Patiala, Punjab; 2 Kistwar, 1 Kashmir, 1 Mukteshwar, 1 Almora, 1 Garhwal, 1 Chamoli, Kumaon; 1 Nepal.

Compared with *finschii* from Burma, the head is slightly darker, the upper and underparts lack the yellowish tinge, the bluish wash on the underwing coverts is absent, the tail is distinctly yellow at the terminal third and also broader. There is some variation in the grey of the head and the green of the upperparts, and the material available does not permit one to comment on K. Z. Hussain's (1959, *Ibis* 101(2): 249-50) finding that *himalayana* and *finschii* cannot be races of the same species.

The two species measure :

	Wing	Bill	Tarsus	Tail
himalayana				
♂♂	163-174 av. 167.4	21-24 av. 22.9	12-14 av. 12.8	182-253 av. 225
	(IH 157-175 av. 166	—	—	175-275 av. 233)
finschii				
♂♂	151 152, 159*	22, 22, 24	11, 12, 13	241, 268
				240-305 av. 270)
himalyana				
♀♀	156-166 av. 163	21 (5)	12-14	118-222 av. 184
	(IH 153-165 av. 160	—	—	149-270 av. 200)
finschii				
♀	149	23	13	221
	(IH 141-149 av. 143	—	—	212-150 av. 223)

The measurements in IND. HANDBOOK are from Hussain (loc. cit). It will be noticed that one *finschii* ♂ has a 159 mm. wing overlapping that of *himalayana*.

563 **Psittacula finschii** (Hume) (Kollidoo, 3500-5000 ft., Upper Salween River, Burma) Eastern Slatyheaded Parakeet **4** : 208

4: 3 ♂♂ 1 ♀
1 *Thayetmyo Dist.;* 1 *Prome;* 2 *Kgurzin, Henzada Dist., Burma.*

564 **Psittacula columboides** (Vigors) (No locality=Aneichardi, Travancore) Bluewinged Parakeet.

23: 16 ♂♂ (5 juv.) 7 ♀♀ (4 juv.)

1 Bhimashankar, 1 Khopoli, Khandala Ghat, Poona; 3 Ratnagiri; 1 Castle Rock, 1 Karwar, 1 Santgal, 1 North Kanara, 3 Sagar, Mysore; 2 Coonoor, 1 Nilgiris; 1 Mercara, Coorg; 3 Honnametti, Billigirirangan Hills; 4 Thekady, Periyar Lake, Travancore.

	Wing	Bill (from cere)	Tarsus	Tail
11 ad. ♂♂	142-156 av. 147 (IH 142-156)	22-26 av. 23 (22-26)	12-14 (14-18)	191-223 av. 212 (204-246)
3 ad. ♀♀	143, 143, 146 (135-145)	21, 22, 23 (22-26)	13 (3) (14-18)	171-199 (170-190)

The adult males curiously fall into two distinct size groups, six with wings 141-145 av. 143 and five 149-156 av. 151, the latter including the two northernmost birds, but otherwise they overlap in range.

The head, neck-collar, and bill of the juveniles of both sexes show a variation of colour which appears to be in the following sequence. To begin with the bill is red, the head green, and the black collar is restricted to the lower surface with a trace of blue-green above. This is followed by a bluish head, a slight darkening of the collar, and the bill mixed red and black. After this both sexes acquire all the colours of the adult female, which later change in the males only—the acquisition of a red bill and the bluish-green rim to the back collar. One male No. 20113 (Khopoli, Khandala Ghat) unsexed but ♂ by plumage has the longest wing and a black, not red, lower mandible.

565 **Psittacula calthorpae** (Blyth) (Ceylon) Layard's Parakeet
4 : 209

1 ♂

Cage bird in Bombay, said to be from Candy, Ceylon.

Though it has no black collar and appears to be juvenile, the bill (25 mm. from cere) is larger than indicated in IND. HANDBOOK (**3** : 188) 21-23 mm.

566/7 **Loriculus vernalis vernalis** (Sparrman) (No locality=Cachar) Indian Lorikeet **4** : 217

30: 24 ♂♂ 5 ♀♀ 1 o?

1 Salsette, Bombay; 1 Karjat, Poona, 2 Ratnagiri; 1 Alanki, N. Kanara; 1 Koppalgudda, Sorab, 2 Gamataghatta, 1 Sagar, Mysore; 1 Somawarpet, Coorg, 1 Runnymede, Nilgiris; 2 Manalur, Palnis; 1 Santanpara, Cardamum Hills; 1 Tenmalai, Travancore; 1 Anantgiri, Vizagapatam; 1 Kuldiha, 1 Chabala, Simlipal Hills, Orissa; 2 Sylhet, Assam; 2 *Sandoway Dist.*, 1 *Nyaungyo, Prome Dist., Burma*: 2 Bakultala, 1 Long Island, Middle Andamans; 1 Maymyo, 1 Wrightmyo, 1 Bamboofiats, South Andamans; 1 Perren Godda (Travancore ?).

When examining the Andaman birds (*JBNHS* **61** : 531), I admitted my inability to separate *rubropygialis* (Baker, type loc. Belgaum) from the nominate race, but referred to the greater frequency and prominence of the blue throat patch in South Indian birds. In the course of this examination, it was found that 4 males from Mysore, collected in 1960 but added to the collection recently, could be easily picked out by their prominent blue throats. This is not mentioned by Baker but it may be possible, with more material, to isolate the birds from peninsular Indian on this character.

There appear to be no differences in size :

	Wing	Bill (from cere)	Tarsus	Tail
Assam & Burma				
♂♂	85-95 av. 88.4	11-13 av. 12	9-11 av. 10.2	36-40 av. 38.2
Andamans				
♂♂	90-93 av. 91.4	12-13 av. 12.1	9-11 av. 10.2	39-44 av. 41
Peninsular India				
♂♂	90-99 av. 93	11-13 av. 11.9	10-11 av. 10.6	39-46 av. 41
	(IH.91-100	11-15	10-12	38-45)
5♀♀	90-96 av. 93	10-12	9-12	39-44 av. 42
	(IH 96-100	11-15	10-12	45-48)

The preponderance of males cannot be explained by any known aspect of their social behaviour.

I notice that IND. HAND. (**3** : 189) continues to refer to the occurrence of the species in the Nicobars (see *JBNHS* **64** : 170).

568 **Loriculus beryllinus** (J. R. Forster) (Ceylon) Ceylon Lorikeet
4 : 219

		Wing	Bill	Tarsus	Tail
Ceylon 1 o?		92	13	11	43
(IH	♂♀	90-98	12-13	10-12	36-44)

(*to be continued*)

Additions to Duthie's Flora of the Upper Gangetic Plain

BY

V. SINGH

School of Plant Morphology, Meerut College, Meerut

The Flora of the Upper Gangetic Plain and of the adjacent Siwalik and Sub-Himalayan Tracts including the descriptions of the families Ranunculaceae to Juncaceae was published by Duthie in three volumes from 1903-1920. Before his death in 1922, the families Palmae to Cyperaceae and Alismaceae were also completed by him. The descriptions of the rest of the families (except Gramineae) were written by Parker and Turrill and thus the families Palmae to Cyperaceae were published in 1929. The Flora of the Upper Gangetic Plain does not include an account of grasses but Duthie (1883, 1886, 1888) published some papers based on his extensive collections of the grasses of this region. Later, Bor (1941) published an account of 92 species of grasses from Uttar Pradesh in his treatise COMMON GRASSES OF UNITED PROVINCES. However, it was Raizada (1954) who gave a consolidated account of the grasses of this region listing 250 species distributed among 100 genera.

After the publication of Duthie's flora and Raizada's list of grasses of the Upper Gangetic Plain a large number of additions have been made to them. So far 314 species and 14 varieties belonging to 257 genera and 79 families have been reported by Raizada (1931, 1935, 1936, 1939, 1950, 1958); Raizada & Sharma (1962); Maheshwari, P. (1935); Mukherjee (1953); Srivastava (1955); Bharadwaja *et al.* (1956); Jain (1958); Venkatesh (1960, 1962); Kapoor and Srivastava (1960); Murty & Singh (1961 *a*, *b*, 1964, 1966); Rolla (1962); Bhattacharyya (1963 *a*, *b*, 1964); Maheshwari, J. K. (1963, 1966); Singh (1963, 1967); Vaid (1964); Bhandari & Singh (1965); Rajagopal (1965); Dixit & Siddiqui (1966); Malhotra (1966); Rajagopal & Panigrahi (1966, 1967); Husain (1967); Panigrahi & Rajagopal (1967); Saxena (1967); Singh & Murty (1966); Dixit & Singh (1968); Prakasa Rao & Biswas (1968) and Deva (1968) as new records for the Upper Gangetic Plain. While some of these species have escaped notice of earlier collectors, the others are recently introduced exotics which have become naturalized in this region.

While dealing with the plants of the Upper Gangetic Plain, Duthie's flora is being constantly referred to both by the students and the teachers of our colleges and universities and also by foresters. Hence at times necessity has been felt to have a consolidated account of all those species which have been added in recent years. With this in mind, and as a first step in this direction, a list of all those plants, which have so far been reported as new records for the Upper Gangetic Plain by the various authors, has been compiled. The list is not claimed to be a complete one since many more plants will be added to it in the coming years. But it can serve as a supplement to Duthie's flora for the time being and will be of much help to those who consult the Flora of the Upper Gangetic Plain. The sequence of families, in the list given in the following pages is the same as adopted by Duthie in the Flora of the Upper Gangetic Plain. As far as possible, the names have been amended in accordance with the latest views on the subject.

RANUNCULACEAE

Clematis cadmia Buch.-Ham.
C. grata Wall.
Naravelia zeylanica DC.
Ranunculus laetus Wall.
R. muricatus Linn.
R. arvensis Linn.

MAGNOLIACEAE

Michelia champaca Linn.

ANONACEAE

Uvaria hamiltoni Hook. f.

MENISPERMACEAE

Tinospora sinensis (Lour.) Merr. (= *T. malabarica* Miers.)

PAPAVERACEAE

Argemone ochroleuca Sweet

CRUCIFERAE

Lepidium ruderale Linn.
L. parviflorum Linn.

CAPPARIDEAE

Cleome monophylla Linn.
C. burmanii W. & A.
Crataeva lophosperma Kurz
Capparis sepiaria Linn. var. **retusella** Hook. f.
C. spinosa Linn. var. **vulgaris** Hook. f. & Thoms.

VIOLACEAE

Viola canescens Wall.

POLYGALEAE

Polygala cantoniensis Lour.
P. irregularis Boiss.
P. furcata Royle

FRANKENIACEAE

Frankenia pulverulenta Linn.

CARYOPHYLLEAE

Cerastium vulgatum Linn.
Stellaria paniculata Edgew.
Sagina apetala Linn.

PORTULACACEAE

Portulaca tuberosa Roxb.
P. parvula Gray
Talinum paniculatum Gaertn.

TAMARISCINEAE

Tamarix troupii Hole

HYPERICACEAE

Hypericum oblongifolium Choisy (= *H. cernuum* Roxb.)

TERNSTROEMIACEAE

Actinidia callosa Lindl.

MALVACEAE

Abutilon theophrasti Medic. (= *A. avicennae* Gaertn.)
Abutilon hirtum G. Don
Bogenhardia crispa (Linn.) Kearney [= *Abutilon crispum* (Linn.) Medic.]
Pavonia zeylanica Cav.
P. patens (Andr.) Chiov. (= *P. procumbens* Boiss.)
Hibiscus beddomei Rakshit et Kundu

TILIACEAE

Grewia hainesiana Hole
Triumfetta annua Linn.

GERANIACEAE

Geranium nepalense Sweet
G. rotundifolium Linn.
Oxalis intermedia A. Rich. (= *O. latifolia* Just non H.B. & K.)
O. martiana Zucc. (= *O. corymbosa* DC.)
O. pescaprae Linn.
Impatiens cristata Wall. (= *I. scabrida* DC.)
Hydrocera triflora W. & A.

RUTACEAE

Boenninghausenia albiflora Reichb.

MELIACEAE

Dysoxylum binectariferum Hook. f.

OLACINEAE

Natsiatum herpeticum Buch.-Ham.

CELASTRINEAE

Gymnospora falconeri Lawson
Salacia prinoides DC.

RHAMNEAE

Zizyphus hysundrica Hole

AMPELIDEAE

Cayratia auriculata (DC.) Gamble
(= *Vitis auriculata* Roxb.)
Vitis parkeri Gagnep. ex Osmaston

ANACARDIACEAE

Rhus cotinus Linn.

LEGUMINOSAE

Argyrolobium flaccidum Jaub. & Spach.
Crotalaria saltiana Andr.
C. quinquefolia Linn.
Trifolium resupinatum Linn.
Atylosia elongata Benth.
Rhynchosia minima DC. var. **laxiflora** Baker
R. aurea DC.
Clitoria biflora Dalz.
Psoralea plicata Delile.
Tephrosia hamiltonii J. R. Drumm.
T. falciformis Ramasw.
T. uniflora Pers. subsp. petrosa (Blatt. *et* Hall) Gillett *et* Ali.
Indigofera sessilifolia DC.
Vicia tetrasperma (Linn.) Moench.
Alysicarpus meeboldii Schindler
Caesalpinia digyna Rott.
Cassia laevigata Willd.
Acacia ferruginea DC.
A. lenticularis Buch.-Ham.
A. gageana Craib.

ROSACEAE

Pygeum acuminatum Colebr
Potentilla kleiniana W. & A.
Agrimonia eupatoria Linn.
Rosa moschata Hermann

COMBRETACEAE

Anogeissus coronata Stapf
Combretum ovalifolium Roxb.

ONAGRACEAE

Epilobium hirsutum Linn.

PASSIFLORACEAE

Passiflora foetida Linn.
P. suberosa Linn.
P. morifolia Masters

CUCURBITACEAE

Gymnopetalum cochinchinense Kurz
Gymnostemma pedata Bl.
Luffa graveolens Roxb.
Dactyliandra welwitschii Hook. f.

BEGONIACEAE

Begonia picta Smith

CACTACEAE

Opuntia dillenii Haw.

FICOIDEAE

Sesuvium sesuvioides (Fenzl) Verdocourt
Orygia decumbens Forsk.
Limeum indicum Stocks ex T. Anders.

UMBELLIFERAE

Apium tenuifolium (Moench.) Thell
(= A. *leptophyllum* F. Mueller ex Benth.)
Oenanthe benghalensis Benth. & Hook.f.
Psammogeton biternatum Edgew.

RUBIACEAE

Acanthocephalus indicus A. Rich.
(= *A. cadamba* Micq.)
Agrostemma tetrasperma Wall.
Randia tetrasperma Benth. & Hook. f. ex Brandis
Meyna laxiflora Robyns.
(= *Vangueria spinosa* Hook. f.)
Paederia scandens (Lour.) Merr.
(= *P. foetida* Auct. non Linn.)
Leptodermis lanceolata Wall.
Galium vestitum Don
G. rotundifolium Linn.
G. aparine Linn.

COMPOSITAE

Elephantopus spicatus Aubl.
Adenostemma lavenia (Linn.) O. Kuntze var. **elata** Kitamura
Ageratum houstonianum Mill.
(= *A. conyzoides* Linn. var. *mexicanum* DC.)
Eupatorium glandulosum H. B. & K.
Mikania cordata (Burm. f.) Robinson
(= *M. scandens* Clarke)
Erigeron bonariensis Linn.
(= *E. linifolius* Willd.)
E. mucronatus DC.
Laggera pterodonta Benth.
Pluchea wallichiana DC.
Sphaeranthus senegalensis A. Gray
Athrosima laciniatum DC.
Anaphalis busua (Buch.-Ham.) Hand.-Maz. (= *A. araneosa* DC.)
Inula cuspidata Clarke
I. eupatorioides DC.
Vicoa cernua Dalz.
Carpesium abrotanoides Linn.
Lagascea mollis Cav.

Wedelia chinensis (Osbeck) Merr. (= *W. callendulacea* Less.)
Flaveria trinervia (Spreng.) C. Mohr.
Ximenesia encelioides Car.
Acanthospermum australe (Linn.) Kuntze
Verbesina encelioides Benth. & Hook.
Artemisia parviflora Buch.-Ham. ex Roxb.
Emilia javanica (Burm. f.) C. B. Rob. (= *E. sagittata* DC.)
Senecio hewrensis (Dalz.) Hook. f.
Echinops cornigerus DC.
Cnicus argyracanthus DC.
Gerbera lanuginosa Benth.
Launaea chondriolloides (DC.) Hook. f.
Tithonia diversifolia A. Gray
Crassocephalum crepidioides (Benth.) S. Moore
Parthenium hysterophorus Linn.
Soliva anthemifolia R. Br.

CAMPANULACEAE

Lobelia rosea Wall.
Campanula colorata Wall.

PRIMULACEAE

Lysimachia pyramidalis Wall.

MYRSINACEAE

Maesa indica Wall.
Ardisia floribunda Wall.

EBENACEAE

Diospyros holeana Gupta & Kanjilal

OLEACEAE

Jasminum auriculatum Vahl
Ligustrum robustum Bl.

APOCYNACEAE

Rauvolfia tetraphylla Linn. (= *R. canescens* Linn.)
Chonemorpha macrophylla G. Don
Rhynchodia wallichii Benth.

ASCLEPIADACEAE

Asclepias curassavica Linn.
Sarcostemma acidum (Roxb.) Voigt (= *S. brevistigma* W. & A.)
S. intermedium Decaisne
Tylophora exilis Colebr.
T. indica (Burm. f.) Merr. (= *T. asthamatica* W. & A.)
Heterostemma alatum Wight
Cryptostegia grandiflora R. Br.
Hoya longifolia Wall.
Ceropegia angustifolia Wight

BORAGINACEAE

Sericostoma pauciflorum Stocks
Nonnea pulla Lamk. *et* Ec.

CONVOLVULACEAE

Cuscuta hyalina Roth
C. chinensis Lamk.
Volvulopsis nummularia (Linn.) G. Roberty (= *Evolvulus nummularis* Linn.)
Convolvulus microphyllus Sieb.
Merremia dissecta (Jacq.) Hall. f. (= *Ipomoea sinuata* Ortega)
Ipomoea purpurea Roth
I. clarkei Hook. f.
I. fistulosa Mart. ex Choisy
Argyreia roxburghii Choisy
A. sericea Dalz.
A. bella (Clarke) Raizada

SOLANACEAE

Solanum torvum Swartz
S. hispidum Pers.
S. pseudocapsicum Linn.
Withania coagulans (Stocks) Dunal
Nicandra physaloides Gaertn.
Datura suaveolens H. B. & K. ex Willd.
D. innoxa Mill.
Nicotiana plumbaginifolia Viv.

SCROPHULARIACEAE

Mazus delavayi Bonati
Mecardonia dianthera (Swartz) Pennell
Anticharis senegalensis (Walper) Bhandari [= *A. linearis* (Benth.) Hochst. ex Aschers.]
Limnophila chinensis (Osbeck) Merr. (= *L. hirsuta* Benth.)
L. rugosa (Roth) Merrill (= *L. roxburghii* G. Don)
Lindernia hyssopioides (Benth.) Haines (= *Ilysanthes hyssopioides* Benth.)
L. viscosa (Hornem.) Merr. (= *Vandellia hirsuta* Benth.)
L. nummularifolia (D. Don) Wettst.
Peplidium maritimum (Linn. f.) Wettst.
Alectra thomsoni Hook. f.

OROBANCHACEAE

Aeginetia indica (Linn.) var. **alba** Santapau

LENTIBULARIEAE

Utricularia striatula Sm.

GESNERIACEAE

Aeschynanthus maculata Lindl.
Chirita bifolia Don

PEDALIACEAE

Pedalium murex Linn.

ACANTHACEAE

Thunbergia coccinea Wall.
Synnema pinnatifida O. Kuntze (= *Cardenthera pinnatifida* Benth. ex C. B. Clarke)

S. triflorum (Roxb. ex Nees) O. Kuntze (=*Cardenthera triflora* Buch.-Ham. ex Benth.)

Hemiadelphis ployspermus (Roxb.) Nees var. **joshianus** Rao *et* Biswas

VERBENACEAE

Lippia alba (Mill.) N.E. Br. ex Britton & Wilson (=*L. geminata* H.B. & K.)
Verbena bonariensis Linn.
Callicarpa longifolia Lamk. var. **laceolaria** C. B. Clarke
Premna scandens Roxb.
Vitex leucoxylon Linn. f.
Chascanum marrubifolium Fenzl ex Walp.

LABIATAE

Plectranthus gerardianus Benth.
P. striatus Benth.
Coleus barbatus Benth.
Mentha piperita Linn.
Scutellaria scandens Don (=*Scutellaria angulosa* Benth.)
Hyptis suaveolens Poit.
Leucas diffusa Benth.
L. martinicensis R. Br.
Nepeta bombaiensis Dalz.
Salvia coccinea Linn.
Lamium amplexicaule Linn.
Ajuga parviflora Benth.

PLANTAGINACEAE

Plantago pumila Willd.

AMARANTHACEAE

Alternanthera paronichioides St. Hill (=*Achyranthes polygonoides* (Linn.) Lamk.)
A. repens (Linn.) O. Kuntze (=*A. pungens* H. B. & K.)
Gomphrena celosioides Mart.

CHENOPODIACEAE

Chenopodium ambrosioides Linn.

POLYGONACEAE

Polygonum recumbens Royle
P. chinense Linn. var. **ovalifolium** Meissn.
P. strigosum R. Br.

ARISTOLOCHIACEAE

Aristolochia indica Linn.

PIPERACEAE

Piper longum Linn.
P. nepalense Miq.

LORANTHACEAE

Taxillus vestitus (Wall.) Danser

EUPHORBIACEAE

Euphorbia heliscopia Linn.
Euphorbia prostrata Ait.
E. perbracteata Cage.
E. heterophylla Linn. (=*E. geniculata* Ortega)
Bridelia verrucosa Haines
Andrachne cordifolia Muell.
Phyllanthus debilis Buch.-Ham.
Prosorus indicus Dalz.
Glochidion assamicum Hook. f.
Sauropus brevipes Muell.-Arg.
Antidesma bunius Spreng.
Jatropha heterophylla Steud. (=*J. gossypifolia* Linn.)
Croton bonplandianum Baill. (=*Croton sparsiflorus* Morung.)
Micrococca mercurialis Thw.
Acalypha brachystachya Buch.-Ham.
A. lanceolata Willd.
A. australis Linn. (=*A. chinensis* Roxb.)
Mallotus repandus Muell.-Arg.

URTICACEAE

Celtis tetrandra Roxb.
Ficus benjamina Linn. var. **comosa** King (=*F. comosa* Roxb.)
F. oligodon Miq. (= *F. pomifera* Wall. ex King)
F. tsiela Roxb.
F. clavata Wall.
Urtica parviflora Roxb.
Fleurya interrupta (Linn.) Gaud.
Pilea scripta Wedd.
Elatostema surculosum Wight
Distemon indicum Wedd.

GNETACEAE

Ephedra foliata Boiss. var. **ciliata** (C. A. Mey) Stapf

HYDROCHARITACEAE

Blyxa echinosperma Hook. f.

ORCHIDACEAE

Eulophia graminea Lindl.
Spiranthes sinensis (Pers.) Ames
Habenaria graveolens Duthie

SCITAMINEAE

Zingiber roseum Rosc.
Phrynium parviflorum Roxb.

AMARYLLIDACEAE

Pancratium verecundum Ait.

LILIACEAE

Asparagus acerosus Roxb.
A. currillus Buch.-Ham.
A. gracilis Royle
Smilax aspera Linn.
S. indica Vitm.
Gagea reticulata Schult.
Lilium wallichianum Schult. f.

PONTEDERIACEAE

Eichhornia crassipes Solms

COMMELINACEAE

Commelina kurzii Cl.
Cyanotis arachnoidea C. B. Clarke (=*C. fasciculata* Schult. f.)
Amiscophacelus cucullata (Roth) Rolla Rao *et* Kammathy (= *Cyanotis cucullata* Kunth)

PALMAE

Wallichia densiflora Mart.

AROIDEAE

Remusatia hookeriana Schott
Rhaphidophora glauca Schott
Pothos cathcartii Schott
Acorus calamus Linn.

LENNACEAE

Lemna trisulca Linn.

ALISMACEAE

Limnophyton obtusifolium Miq.
Butomus unbellatus Linn.

NAIADACEAE

Aponogeton natans (Linn.) Engl. & Kr. (=*A. monostachyon* Linn. f.)

CYPERACEAE

Cyperus platystylis R. Br.
C. haspan Linn.
Cyperus arenarius Retz.
C. atkinsoni C. B. Clarke
C. alulatus Kern.
C. silletensis Nees
Juncellus inundatus C. B. Clarke
Kyllinga cylindrica Nees
Eleocharis fistulosa Schult.
Bulbostylis cappillaris Kunth
Scirpus grossus Linn. var. **kyscor** C. B. Clarke
Fuirena umbellata Rottb.
Rhynchospora longisetis R. Br.
Scleria biflora Roxb. subsp. **biflora**
Carex spiculata Boott.

GRAMINEAE

Poa infirma H. B. & K.
Vulpia megalura (Nutt.) Rydb.
Eragrostis tremula Hochst. ex Steud.
E. poaeoides P. Beauv.
E. nigra Nees ex Steud.
Aeluropus lagopoides (Linn.) Trin.
Tripogon filiformis Nees ex Steud.
T. roxburghianus (Steud.) Bhide
Sporobolus tenuissimus (Schrank) O. Kuntze [=*S. minutiflorus* (Trin.) Link]
S. helvolus (Trin.) Th. Dur & Schinz.
S. violascens Mez
Garnotia elata (Arn. ex Miq.) Janowski
Alopecurus geniculatus Linn.
Cymbopogon schoenanthus (Linn.) Spreng.
Aristida depressa Retz.
Isachne himalaica Hook. f.
Digitaria violascens Link
Urochloa panicoides P. Beauv. var. **panicoides**
U. panicoides P. Beauv. var. **pubescens** (Kunth) Bor
Setaria megaphylla (Steud.) Dur. *et* Schinz.
Imperata cylindrica (Linn.) P. Beauv. var. **major** (Nees) C. E. Hubbard ex Hubb. *et* Vaugham
Pennisetum orientale L. C. Rich.
Leersia hexandra Sw.

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REFERENCES

BHANDARI, M. M. & SINGH, DALBIR (1965): *Datyliandra* (Hook. f.) Hook. f.—a cucurbitaceous genus new to the Indian flora. *Kew Bull.* **19**: 133-138.

BHARADWAJA, R. C., BASU CHAUDHARY, K. C. & SINHA, S. (1956): The grasses of Agra District. *Agra Univ. Journ. Res.* (Science). **5**: 285-320.

BHATTACHARYYA, U. C. (1963*a*): A contribution to the flora of Mirzapur-I. Some new records for the district and for Upper Gangetic Plain. *Bull. bot. Surv. India.* **5**: 59-62.

——————— (1963*b*). *Soliva anthemifolia* R. Br. (Compositae)—a new record from India. *Bull. bot. Surv. India* **5**: 375-376.

———————— (1964). Contribution to the Flora of Mirzapur—II. *Bull. bot. Surv. India.* **6**: 191-210.

DEVA, SOM (1968): A critique on Duthie's Flora of the Upper Gangetic Plain. *Bull. bot. Surv. India.* **10**: 177-182.

DIXIT, S. N. & SIDDIQUI, M. O. (1966): *Cardenthera pinnatifida* Benth. A new record for Northern India. *Ind. For.* **92**: 739-741.

DIXIT, S. N. & SINGH, A. K. (1968): *Synnema triflorum* (Roxb. ex Nees) O. Kuntze—A new record for Upper Gangetic Plain. *Ind. For.* **94**: 769-771.

DUTHIE, J. F. (1883): A list of grasses of N. W. India, indigenous and cultivated. Roorkee.

———— (1886): Illustrations of the indigenous fodder grasses of the plains of N. W. India. Roorkee.

———— (1888): The fodder grasses of Northern India. Roorkee.

———— (1903-20): The Flora of the Upper Gangetic Plain and of the adjacent Siwalik and Sub-Himalayan Tracts. 3 Vols. Calcutta.

HUSAIN, WAZAHAT (1967): Some new records for plants in the Upper Gangetic Plain. *Ind. For.* **93**: 582-585.

JAIN, R. K. (1958): Hitherto unrecorded occurrence of *Datura innoxia* Mill, in the Upper Gangetic Plain and the Rajasthan desert. *Curr. Sci.* **27**: 395.

KAPOOR, S. L. & SRIVASTAVA, G. S. (1960): *Cleome monophylla* Linn. A new record from Upper Gangetic Plain. *Sci. & Cult.* **26**: 352.

MAHESHWARI, J. K. (1963): The Flora of Delhi. C.S.I.R., New Delhi.

———— (1966): *Parthenium hysterophorus. Curr. Sci.* **35**: 181-183.

MAHESHWARI, P. (1935): Some new or little known plants from parts of Eastern Rajputana and Upper Gangetic Plain. Proc. 22nd Ind. Sci. Cong., Calcutta.

MALHOTRA, C. L. (1966): New distributional record of plants from the Upper Gangetic Plain. *Bull. bot. Surv. India.* **8**: 77-78.

MUKHERJEE, SUNIL KUMAR (1953): Vegetation of Delhi 'Ridge.' *J. Bombay nat. Hist. Soc.* **51**: 439-465.

MURTY, Y. S. & SINGH, V. (1961*a*): New plant records for the Upper Gangetic Plain from Meerut and its neighbourhood. *Proc. Nat. Ins. Sci. India.* **27B**: 13-17.

———— (1961*b*): Flora of Hastinapur. *Agra. Univ. Journ. Res.* (Science). **10**: 193-242.

———— (1964): Two new plant records for the Upper Gangetic Plain. *Sci. & Cult.* **30**: 150-151.

———— (1966): Some little known plants from the Upper Gangetic Plain. *Sci. & Cult.* **32**: 597-598.

PANIGRAHI, G. & RAJAGOPAL, T. (1967): Studies in the flora of Allahabad, IV. The family Gramineae—I. *Proc. Nat. Acad. Sci. India.* **37**: 1-20.

PRAKASA RAO, C. S. & BISWAS, S. N. (1968): A new variety of *Hemiadelphis polyspermus* Nees (Acanthaceae) from India. *Ind. For.* **94**: 657-58.

RAIZADA, M. B. (1931): Contribution to Duthie's Flora of the Upper Gangetic Plain from the neighbourhood of Dehradun. *J. Indian bot. Soc.* **10**: 155-158.

———— (1935): Recently introduced or otherwise imperfectly known plants from the Upper Gangetic Plain. *J. Indian bot. Soc.* **14**: 339-348.

———— (1936): Recently introduced or otherwise imperfectly known plants from the Upper Gangetic Plain. *J. Indian bot. Soc.* **15**: 149-167.

———— (1939): Recently introduced or otherwise imperfectly known plants from the Upper Gangetic Plain. *Ind. For. Rec. (N.S.) Botany* **1**: 223-235.

———— (1950): New or noteworthy plants from the Upper Gangetic Plain. *Ind. For.* **76**: 489-497.

———— (1954): Grasses of the Upper Gangetic Plain and some aspects of their ecology. *Ind. For.* **80**: 24-46.

———— (1958): New plant records for the Upper Gangetic Plain. *Proc. Nat. Inst. Sci. India.* **24B**: 198-208.

———— & SHARMA, V. S. (1962): New Plant records for the Upper Gangetic Plain from Ajmer-Merwara. *Ind. For.* **88**: 356-369.

RAJAGOPAL, T. (1965): New records of species for 'Flora of Allahabad.' *Proc. Nat. Acad. Sci. India.* **35**: 25-45.

———— & PANIGRAHI, G. (1966): New records of species for 'Flora of Allahabad'—II. *Proc. Nat. Acad. Sci. India.* **36**: 57-84.

——— (1967): Studies in the Flora of Allahabad—V. The family Gramineae—2. *Proc. Nat. Acad. Sci. India.* **37**: 21-50.

Saxena, H. O. (1967): New plant records for the Upper Gangetic Plain. *Ind. For.* **93**: 329.

Singh, N. P. (1963): *Vicia tetrasperma* (Linn.) Moench.—a new record for the Upper Gangetic Plain. *Bull. bot. Surv. India.* **5**: 333-334.

——— (1967): *Acalypha australis* Linn.—an addition to Indian flora. *Ind. For.* **93**: 186.

Singh, V. & Murty, Y. S. (1967): *Eleocharis fistulosa* Schult. A new record for the Upper Gangetic Plain. *J. Bombay nat. Hist. Soc.* **63**: 462-463.

Srivastava, J. G. (1955): A note on flora of Mirzapur (U.P.). *J. Bombay nat. Hist. Soc.* **53**: 152-153.

Vaid, K. M. (1964): *Aeginetia indica* L. var. *alba* Santapau—A new record for Northern India. *J. Bombay nat. Hist. Soc.* **61**: 471-472.

Venkatesh, C. S. (1960): A species of *Argemone* hitherto unreported from India. *Proc. Ind. Sci. Cong. Allahabad.* **47**: 401.

——— (1962): *Argemone ochroleuca* Sweet. sub-sp. *ochroleuca* a new record for India. *Curr. Sci.* **31**: 250.

A note on the status of the Nilgiri Tahr *(Hemitragus hylocrius)* on the Grass Hills in the Anamallais

BY

E. R. C. Davidar

(*With a sketch map*)

Introduction

The Grass Hills is a 25 sq. mile (65 sq. km.) plateau placed at an elevation of approximately 6,000 ft. above mean sea level in the Anamallai Hills forming part of the Western Ghats and is situated in the Coimbatore District in the State of Tamil Nadu. The approach is through the Peria Karamalai Estate on the road to Valparai from Pollachi, the last seven miles over a forest road which is more suited for jeeps than cars. The Hills take their name from the undulating grass-topped hills in the region, reminiscent of the ' Downs ' on the Nilgiri plateau; the Grass Hills Downs, however, are not as extensive as the Nilgiri Downs as high ridges often rise between one series of hills and the next. The cliffs are not sheer and vast and are not invulnerable. The grass on the grass hills is the coarse (*Agrostis schmidi*) variety. Evergreen sholas clothe the folds and valleys.

The plateau is bounded on the north and north-west by jungle and tea plantations and on the north-east, west and south-west by jungle and on the south and south-east by similar grass hills of the Kannan Devan Concession in Kerala.

A sketch of the area is given with the number of tahr spotted in the different localities noted thereon.

Population

I spent six days between 3-iv-1971 and 8-iv-1971 (inclusive) on the Grass Hills conducting a census of the tahr. Weather conditions were ideal and visibility was excellent. Grass had burnt extensively and fresh young grass was growing in patches and the tahr tended to congregate in such places.

Altogether five herds were seen in the following areas.

1. **Kallar Malai**—First sighted on 4-iv-1971 on the S.E. slopes—moved on to the northern slopes on 5-iv-1971. Remained there breaking up and regrouping until 9-iv-1971.

Saddle back	0
Brown buck	2
Light brown male	6
Adult female	24
Yearling	8
Young	14
	54

2. **Chadayandi Malai**—First sighted on 4-iv-1971 on this hill. From 5-iv-1971 until 9-iv-1971 this herd was seen on the Kaludai Katti Malai where it had moved.

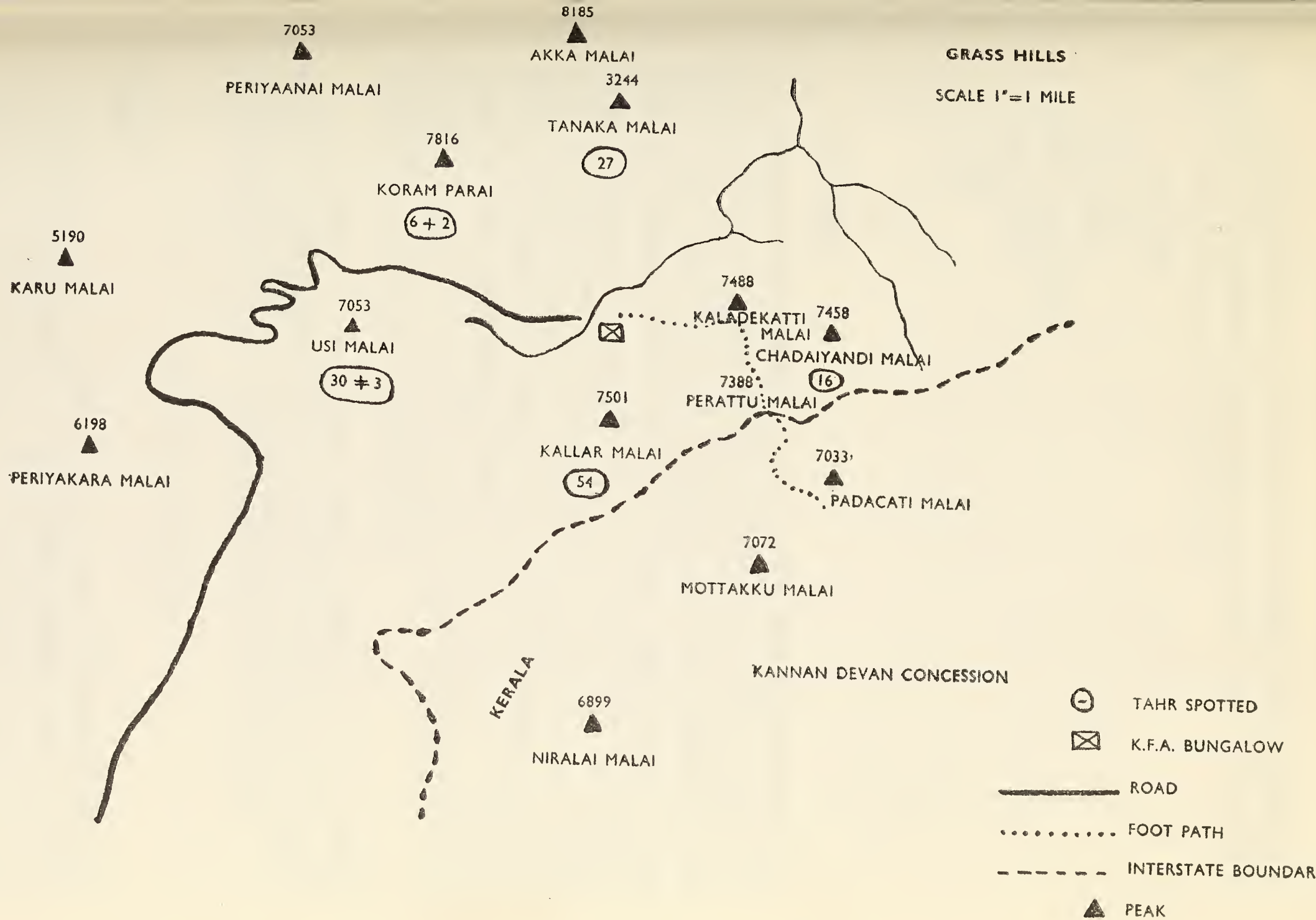
Saddle back	0
Brown buck	1
Light brown male	1
Adult female	9
Yearling	1
Young	4
	16

3. **Tanaka Malai**—First sighted on 5-iv-1971 on S.E. slopes—later the herd had moved higher up and towards the west.

Saddle back	0
Brown buck	0
Light brown male	3
Adult female	10
Yearling	7
Young	7
	27

4. **Tanaka Malai**—Western slope towards Koram Parai.

Saddle back	1
Brown buck	0
Light brown male	0
Adult female	4
Yearling	1
Young	0
	6



Sketch map of Grass Hills

Apparently these two herds had come together and on 8-iv-1971—altogether 35 animals were seen against the skyline late in the evening. The two new entrants could not be identified.

5. **Usi Malai**

Saddle back	0
Brown buck	1
Light brown male	3
Adult female	13
Yearling	2
Young	11
	30
Unidentified	3

Except for Tanaka Malai and the Koram Parai area between which and the hills on the south, wattle plantations have sprung up, the other tahr areas are interlinked by grass-topped hills and the animals are free to roam where they please. Similarly there is no hindrance to free movement between Koram Parai and Tanaka Malai. Great care was taken to ensure that the animals were not disturbed. Besides field glasses a powerful telescope was used in the census woik. Except for the Tanaka Malai and Usi Malai herd of 27 and 30, the other herds were checked and double-checked for accuracy. Inspite of all these precautions errors cannot be ruled out altogether because of the nature of the terrain and the difficult nature of the work. A 10 per cent margin is a reasonable allowance for errors. So far as the total count is concerned the error is more likely to be on the conservative side.

An experienced professional shikari (guide) from the Nilgiris assisted in keeping track of the movement of the herds to ensure that there was no duplication. The census figures are summarised in Table 1. Unfortunately no earlier estimates are available for comparison.

Population Dynamics

General:

As it grows older the male tahr which, in the early stages of adulthood, is almost indistinguishable from the female, becomes distinctly stocky and turns a dark sepia brown, at which stage it is popularly known as the ' Brown buck ' and from about the fifth year onwards while turning almost black develops a well defined saddle mark of lighter coloured hair on the back and are then known as the saddle back. In the census adult males have been divided into these three classes.

TABLE 1

CLASSIFICATION OF THE TAHR POPULATION

	Saddle back	Brown buck	Light brown male	Adult female	Yearling	Young	Total
	–	1	3	13	2	11	30
	1	–	–	4	1	–	6
	–	–	3	10	7	7	27
	–	2	6	24	8	14	54
	–	1	1	9	1	4	16
	1	4	13	60	19	36	133
Percentage in population rounded off	.8% or 1%	3%	10%	45%	14%	27%	
				Not classified		..	5
				Grand Total		..	138

TABLE 2

COMPOSITION OF THE TAHR POPULATION IN NILGIRIS, HIGH RANGE AND GRASS HILLS

Sex and age class	Nilgiris %	High Range %	Grass Hills %
Saddle back	9.1	11.0	1.0
Dark brown male	4.3	4.2	3.0
Light brown male	7.9	4.2	10.0
Adult female	34.2	33.6	45.0
Yearling	18.9	17.3	14.0
Young	25.6	29.6	27.0

Tahr in the age class of 1 to 2 years have been classified as yearling and kids below 1 year as young.

Yearling could not be classified into male and female as it is extremely difficult to distinguish between the sexes at that age, from a distance.

Composition of population:

Adult females topped the list with 42 per cent of the population and there was only one saddle back. The proportion of adult male to adult female was 1 : 3 and that of yearling to young 1 : 2. There were 78 adults compared to 55 yearling and young.

The composition of the Grass Hills tahr population on a percentage basis is compared with the Nilgiri and High Range populations

(Schaller 1971) in Table 2. It is seen that the saddle back population is strikingly low.

Reproduction

The Grass Hills Tahr have a high breeding potential with 36 per cent of the total population being kids and about 60 per cent of the females having kids. Almost all the young were in the age group 1 to 4 months. December to February would appear to be the peak birth period. One female was noticed to be heavily pregnant. Odd young may be born throughout the year. Each mother seemed to have only one young at heel. Whether there were any exceptions could not be observed in the crowd of youngsters. No sexual activity was observed during the period of observation.

Predation

Predation is not a serious problem on the Grass Hills. The signs indicated that there were no resident tigers, panthers or wild dogs. But there is evidence of these predators having visited the area periodically. An examination of the droppings, most of which were old and not easy to come by, places the frequency and numerical strength of the visitors in the following order:—Panther, wild dog and tiger. One of my men disturbed a young panther stalking a herd of tahr. And we saw a pack of four wild dogs—a dog, a bitch and two pups—passing through the area, showing no interest in the tahr. I do not agree with Thiagarajan (*Indian forester*, **84**; March 1958) in his assessment that wild dogs are a menace in the area. Even if they were in 1958, they are no longer so. In country frequented by wild dogs they leave evidence of their handiwork in the shape of skeletons and scattered bones of their victims. But there was no such evidence. Suppiah, the fish watcher of the Konalar Fishing Association comes across them only rarely. According to him sambar are their main prey and he reported that on the last occasion the dogs visited the area in strength, which was a year previously, they killed four sambar in one pool in the river. While the country may be suitable for hunting with dogs, it is doubtful if dogs unaided by human strategy can operate successfully in the area.

An analysis of food items in a sample collection of predator droppings is given in Table 3.

Table 3

Analysis of a sample collection of predator droppings

Panther

1. Barking deer—75%; black monkey—25%
2. Bonnet monkey—50%; small rodents—50%

3. Bonnet monkey—80%; tahr—10%
4. Various items—90%; tahr—10%
5. Small rodents and other small animals.
6. Black monkey—50%; hare—50%
7. Tahr—75%; small rodents—25%

of total c. 700%, tahr 95% or 1/7th part.

TIGER

1. Tahr —100%
2. Small rodents, grass and miscellaneous.
3. Tahr—25%; sambar and miscellaneous—75%
4. Sambar—100%
5. Sambar—100%

of total 500%, tahr 125% or ¼th part (25%)

WILD DOGS

1. Jungle fowl (!); barking deer etc.
2. Tahr—100%
3. Sambar and other deer

of total 300%, — 100% tahr or 1/3rd part.

CONSERVATION

On 4-iv-1971 and 5-iv-1971 five shots were heard on the Kerala side of the hills not far from the border. On 6-iv-1971, we saw 2 well organised gangs of poachers beating for game on the Kerala side. There were altogether 5 guns, all muzzle-loaders. It was obvious that we had foiled their attempt at a raid across the border. There was no hiding the fact that they had their eye on the tahr hills on the Tamil Nadu side.

A long chat (employing some shrewd cross-examination) with the leader of the larger party, a Muduvan, was revealing. He said that the area they were operating in was a no man's land where they were free to poach, and that the only deterrent was the weather which brought all operations to an end during the four months of rains. He also told me that the vast expanse of grass hills on their side was devoid of tahr and that there could not be more than 20 tahr on the high hills which lined the horizon on the south-west some 15 to 20 miles away. The presence of the Konalar fishing bungalow with its watcher and the ever-present danger of its members dropping in there, he admitted, is a nuisance.

Thiagarajan reported the capture of a tahr in a wire snare and the seizing of about a hundred such snares on these hills. This method of capture appears to have been abandoned and except for 2 old rusted snares we did not come across any.

Fish watcher Suppiah who has lived in the fishing bungalow for over 10 years and with his wife is the sole permanent resident on the hills, told me that these days estate labour hunted down tahr with dogs by driving them away from the cliffs into the sholas. He estimates that a good number of tahr are killed in this manner annually and that many of the animals killed are young. This probably accounts for the high rate of mortality between the young and yearling stage. The nearest forest subordinates live 7 miles away and the poaching is said to be done with their connivance.

The role played by the K. F. A. in preserving wild life in this area cannot be under-estimated, and but for the presence of the Association the wild life in the area would have suffered much more. The members being local planters and the bulk of the poachers being drawn from the ranks of their labour, it is but natural that the poachers should take every precaution to avoid being seen by them. This was done by simply not visiting the area on the days when the planters were expected to be there. Thus the tahr and the other creatures on the Grass Hills enjoyed, besides the 4 monsoon months, many off days when they were free from persecution. With the large-scale exodus of the British planter and with few Indian planters stepping in to fill the breach and with the purely Indian planting companies' reluctance to support the Fishing Association, the position of the Grass Hills tahr is becoming tenuous and might become difficult unless the protection machinery is strengthened sufficiently.

Attempts are being made, inspite of the fact that several have failed on account of unsuitable soil and other conditions, to raise wattle plantations on the hills, thus encroaching upon the tahr's feeding grounds and creating conditions suitable for the poacher. The Tamil Nadu Government is planning a sanctuary in the area and it is hoped that the sanctuary will have sufficient supervisory staff.

Conclusion

The Grass Hills is full of promise. Besides tahr, herds of gaur are known and elephants are not uncommon. Sambar signs were seen but they remained elusive. Barking deer are scarce. With a certain amount of protection all these creatures should thrive. Bears are unknown. Both varieties of black monkeys—the Nilgiri langur and the Lion-tailed Macaque occur. There are a few pigs about. The hills are also rich in bird life.

It is one of the very few places where tahr can be observed without much foot-slogging. It is also unique in that tahr can be studied from its first waking moments until it retires for the night. This is possible because the tahr grounds and camp are not far from each other. Observations on the habit and behaviour of the animal made during the trip and other trips will be covered in a separate note.

Acknowledgements

I am indebted to George Schaller's report on the tahr in an earlier issue of this Journal for methods. I am extremely thankful to Mr. D. W. Mayow, the president of the Konalar Fishing Association for helping me in various ways.

Dominance of Mollusca in the Benthic Population off Cochin

BY

B. N. Desai

Biological Oceanography Division, National Institute of Oceanography, Cochin, Kerala

(*With a map and a text-figure*)

The importance of molluscan fauna in the benthic population in and around Cochin harbour has been shown. The molluscs contribute a substantial portion of the benthic biomass; where the substrata and the environmental conditions are favourable, rich molluscan beds occur, forming more than 90% of the total biomass. Even in areas where the total biomass is poor, the molluscan fauna still forms a substantial portion of the benthos. The presence of rich beds of lamellibranch *M. ovum* and *M. striatus* off Cochin harbour might, it is suggested, contribute substantially as a food of larger carnivores.

Introduction

An account of the distribution and abundance of the benthic fauna of the Cochin backwater and the nearshore region around Cochin has been given recently (Desai & Krishnan Kutty, 1967a, 1967b). The ecological features influencing their distribution and abundance have also been discussed. A striking feature of the data was the predominance of mollusca over all other organisms, both in the backwater and in the nearshore regions. A study of the distribution and dominance of mollusca in this region was therefore made and the salient features are discussed here.

Material and Methods

Data for the present paper were obtained from the samples collected for the general study of the bottom fauna during the period, September 1965 to January 1968. The method of collection, gears used and the mode of preservation have already been described elsewhere (Desai & Krishnan Kutty 1967a). The molluscan forms were sorted out from the samples and preserved separately in 5% formalin. These were identified and the number of organisms belonging to each species was recorded separately. Their dry weight was determined after removing the shells. The shells were removed either by dissection or by dissolving them in weak hydrochloric acid in the case of smaller forms. Samples of the substrata were also collected from the same stations for determining the nature of the bottom sediment.

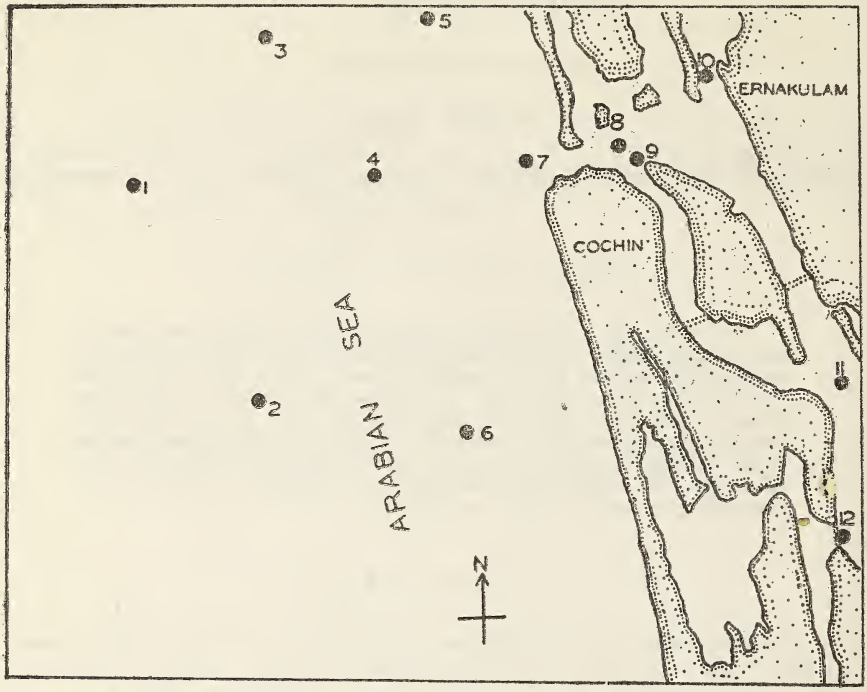


Fig. 1—Map of the Cochin backwater and the nearshore region off Cochin, showing 12 sampling stations.

Sampling Area

Twelve sampling stations were selected in the area under investigation (Map). Stations 1 to 6 were located in the nearshore region, whereas station 7 was at the confluence of the sea and the backwater. Stations 8 and 9 were in the marine zone of the backwater. The depth at different stations varied from 1-5 metres in the backwater and 10 to 12 metres at stations 2, 3, 4, 5 and 6 and about 18 metres at station 1 which was located at a distance of about 7 miles off Cochin. The area sampled presented a variety of habitat both in hydrographic conditions and in the nature of substrate. Typically brackish conditions were prevalent at the surface of the backwater, where the salinity showed wide fluctuation. The bottom salinity varied from 33.06‰ to 35.41‰ in the pre- and post-monsoon months. For details of hydrographic condition see Desai & Krishnan Kutty (1967 a & b).

Substrata

The substrata of the different stations studied could be broadly classified into three main groups: (1) muddy, (2) sandy and (3) mixed type with fine sand and varying amounts of silt and clay. The percentage of sand, silt and clay in a typically muddy, sandy and mixed substrata is given in Table 1. Stations 1, 2, 3, 6 and 10 had muddy bottom, whereas stations 4, 7, 8 and 12 were sandy and stations 5, 9 and 11 were characterised by a mixed type of substrata, consisting of fine sand with varying amounts of silt and clay.

TABLE 1

PERCENTAGE COMPOSITION OF A TYPICALLY MUDDY, SANDY AND MIXED TYPE OF SUBSTRATA AROUND COCHIN HARBOUR

Nature of substrata	Gravel	Very coarse sand	Coarse sand	Medium sand	Fine sand	Silt	Clay
Muddy	..	..	..	..	2.38	62.15	35.46
Sandy	16.31	2.52	8.50	46.88	25.76	..	..
Mixed	..	..	4.54	34.57	22.62	12.53	25.73

Molluscan fauna in relation to substrata

Although molluscs predominated over other groups of benthic forms, their abundance and species composition varied at different stations mainly because of the nature of substrata and changes in the salinity. Since the bottom deposits can be classified into three main types, it is proposed to describe the molluscan fauna in relation to these three types of substrata.

Muddy bottom :

At stations 1, 2, and 3 which are characterised by a muddy substratum, the bivalves were represented by *Meretrix ovum* which was fairly abundant. Only juveniles of *M. ovum*, measuring 1.5 to 2 mm. in size were collected at this station. This indicated a fairly recent settlement of this bivalve, which probably were transported by the waves from the shore stations, where rich beds of *M. ovum* were found. Among the gastropods, *Canculus clanguloides*, *Nassa ceylonica*, *Conus punctatus* and *Cerethium tressa* were the most common forms. *Dentalium esper* and *Cavelinea* sp. occurred occasionally in fairly large numbers. The planktonic pteropod's (*Cavelinea*) occurrence at the bottom may be due to accidental sinking.

Station 6 which was nearer to the shore, was expected to be predominantly sandy, but was found to have a muddy substratum. This was due to the deposition of mud dredged from the port's approach

TABLE 2

NUMBER AND DRY WEIGHT OF MOLLUSCA AT 12 STATIONS LOCATED AROUND COCHIN HARBOUR

Faunal Groups	Stations											
Nature of Substrata	1	2	3	4	5	6	7	8	9	10	11	12
	Muddy	Muddy	Muddy	Sandy	Mixed	Muddy	Sandy	Sandy	Mixed	Muddy	Mixed	Sandy
BIVALVIA												
1. *Meretrix ovum*	158	20	50	42	—	*	2,135	475	12	—	—	—
2. *Modiola striatus*	—	—	—	—	484		—	433	28	—	—	—
3. *Nuculana mauritiana* ..	—	—	—	—	—		—	—	—	5	68	750
GASTROPODA												
4. *Canculus clanguloides* ..	146	40	20	504	60		750	68	80	—	—	—
5. *Conus punctatus*	149	—	100	525	—		—	—	—	—	—	—
6. *Nassa ceylonica*	74	—	—	63	—		—	—	—	—	—	—
7. *Cerethium tressa*	—	40	60	—	50		—	—	—	—	—	—
8. Settling Stages	—	—	—	—	—		—	—	3,000	1,817	11,268	250
9. *Dentalium esper*	65	—	—	—	—		—	—	—	—	—	—
Biomass—gm./m² Mollusca	3.929	0.3818	0.980	3.434	20.468		386.610	113.22	11.158	0.077	0.978	10.435
Total ..	6.368	0.7818	1.510	3.453	22.868	0.036	394.426	118.17	15.647	3.351	2.442	10.674

* Plenty of dead shells.

channels. This muddy bottom extended for about 5 miles from the approach channel. Only the empty shells of the bivalve *Modiola striatus* were found here in large numbers. A few polychaetes were the only live organisms recorded in this area.

Station 10 in the backwater was also predominantly muddy, but the fauna here was poor. This might be due to considerable variations in the salinity, which probably reaches unfavourable limits for the benthic animals. None of the molluscs recorded from the nearshore region was present at this station. A small bivalve, *Nuculana mauritiana* and some newly settled stages of gastropods were the only molluscan representatives.

Sandy bottom :

Rich and extensive beds of the bivalve, *M. ovum* were found at stations 4, 7 and 8 which had sandy substrata. Bivalves of all sizes from settling to the adult stages were collected in large numbers; but at station 4 only smaller forms were present. During the monsoon months another bivalve, *M. striatus* was also seen quite abundantly at stations 7 and 8. This species appears to be an estuarine form which extends seawards when the salinity of water during the monsoon months becomes appreciably low. Cherian (1968) has reported extensive beds of this bivalve off Ernakulam jetty in the estuarine zone of the backwater. Among the gastropods, *C. clanguloides* was the most common form. *N. ceylonica, C. punctatus, Murex* sp. and *Subulina* sp. were also present.

Station 12, which was farthest from the sea, was situated in the southernmost part of the backwater and had a sandy bottom. *N. mauritiana* was the only abundant bivalve and the gastropods were represented by newly settled stages. No adult gastropods were normally recorded at this station.

Mixed bottom :

Substratum consisting of fine or medium sand with varying amounts of silt and clay were found in the Cochin backwater at stations 5, 9 and 11. Station 5 was located in the nearshore region opposite to the coastline of Vipeen Island and station 9 was in the marine zone of the backwater, near the confluence region. These stations supported a rich fauna consisting of *M. ovum, M. striatus* and *C. clanguloides,* apart from polychaetes and other organisms.

Station 11 which was situated in the estuarine zone of the backwater and had a mixed type of bottom sediments, had a poor molluscan fauna. *N. mauritiana* and a large number of settling stages of gastropods were recorded. These probably failed to grow any further due to adverse hydrographic conditions or migrated shorewards where the conditions were suitable for growth.

Numerical abundance and biomass

The results of the quantitative examination of the samples collected from 12 stations are summarised in Table 1 and text-figure. The results indicate that a large portion of the biomass was composed of molluscs alone, at almost all the stations; but these were particularly dominant at those stations which had sandy substrata (Fig. 2). From Table 2 it can be seen that the fauna on the whole is poorer in the estuarine region of the backwater and in the nearshore region, excepting at station 12 where because of favourable sandy substratum, the biomass was high. Relatively poor biomass at stations 4 and 6 in the nearshore region, despite the favourable hydrographic conditions, may be because of the effect of the constant dredging of the approach channel for navigational purposes, thus disturbing the settled animals.

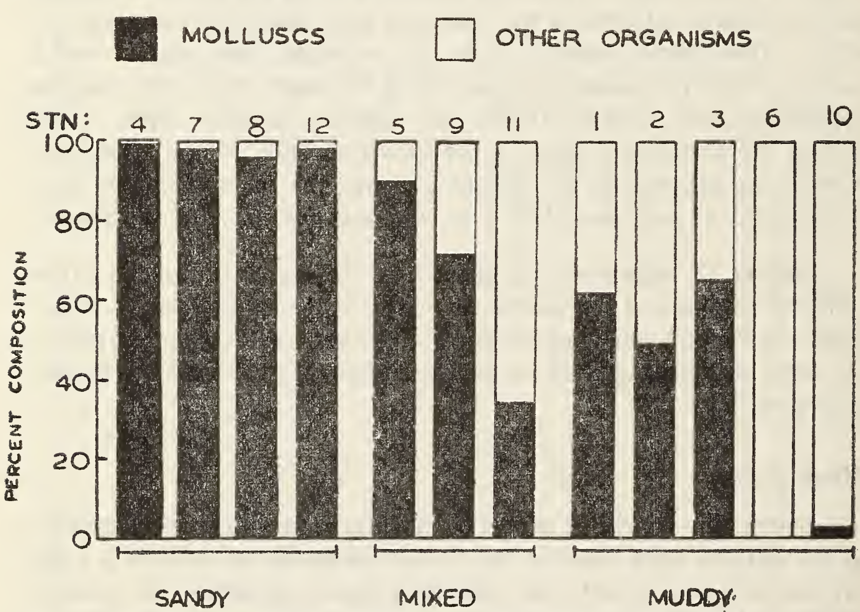


Fig. 2—Present composition of the molluscan biomass in relation to the total biomass at twelve sampling stations in the backwater and the nearshore regions off Cochin.

The highest biomass (386 gm./m^2) was recorded at station 8 which is situated at the confluence zone. The presence of rich beds of *M. ovum* was mainly responsible for this high value. The presence of hard substratum and less turbid waters probably favoured the successful settlement of the molluscan larvae. On a muddy or mixed type of substrata of fine sand with varying amounts of silt and clay, the faunal groups, other than molluscs were better represented. It is evident from Fig. 2 that on a sandy substratum the molluscs contribute as much as 90 to 95% of the total biomass, whereas on muddy and mixed bottoms the total biomass is largely contributed by the other groups, mollusca forming nearly 30 to 60% of the total biomass.

Since quantitative studies on the benthos of Indian waters are few, the abundance of molluscan fauna around Cochin harbour cannot be easily compared with those of other areas. Sheshappa (1953) has reported the benthic fauna near Calicut, at 6 to 10 fathoms, ranging from 10 to 35 gm./m^2, which was largely contributed by molluscs. However, the figures given by Sheshappa refer to wet weight of animals with shells and tubes intact and hence it appears that the areas around Cochin harbour sustain a richer molluscan fauna than the Calicut areas. Cherian (1968) has also indicated that a rich molluscan fauna exists in this region. Kurian (1955) while studying the benthic fauna of the Travancore coast showed that the foraminifera, mollusca and the crustaceans constitute the benthos of that region.

Several instances of the dominance of different groups in different parts of the world are available. Ellis (1960), for instance, while studying the marine benthos fauna in the Arctic region of North America, stated that various groups of animals were dominant in various places. The lamellibranchs represented between 60 and 80% of the biomass in North Baffin Island and New Godthaab but these were partly replaced by polychaetes in shallow waters in Disco Bay. He reported a biomass of 438 gm./m^2 on sandy bottom and 100 gm./m^2 on muddy shores. Southward (1957) described the dominance of polychaetes in the offshore deposits of the Irish Bay.

A comparison of these values with those reported in the present communication shows that some areas on the west coast of India are significantly rich in molluscan forms. Their abundance may conceivably be an important link in the food chain of higher carnivores. Although the adults of larger molluscs such as *Meretrix* may not be directly utilised because of their thick shells, the younger stages of the species may form an important item of food of demersal fish, crabs and prawns.

ACKNOWLEDGEMENTS

I am grateful to Dr. N. K. Panikkar, Director, National Institute of Oceanography, India, for constant encouragement and advice and to Dr. S. Z. Qasim, Scientist, National Institute of Oceanography, for critically reading the manuscript. Thanks are also due to my colleagues, especially Dr. M. Krishnan Kutty for their help in collection of samples.

References

Cherian, P. V. (1968): A collection of Molluscs from Cochin harbour area. Mar. biol. Ass. India, Symposium on Mollusca, Ernakulam (India).

Desai, B. N. & Krishnan Kutty, M. (1967a): Studies on the benthos of Cochin backwater. *Proc. Indian Acad. Sci.* 66 (4): 123-142.

———— (1967b): A comparison of the marine and estuarine benthic fauna of the nearshore region of the Arabian Sea off Cochin. *Proc. Nat. Inst. Sci. India*, Indian Ocean Symposium number (In Press).

Ellis, D. V. (1960): Marine infaunal benthos in Arctic North America. Technical Paper No. 5, Arctic Institute of North America, pp.1-53.

Kurian, C. V. (1955): A preliminary survey of the bottom deposits of the Travancore coast within 15 fathom line. *Proc. Nat. Inst. Sci. India* 19: 747-776.

Sheshappa, G. (1953): Observations on the physical and biological features of the inshore sea bottom along the Malabar coast. *Proc. Nat. Inst. Sci. India* 19: 256-279.

Southward, E. C. (1957): The distribution of Polychaeta in offshore deposits in the Irish sea. *J. mar. biol. Ass. U.K.* 36: 49-75.

Some additions to our knowledge of the Plants of Ramtek (Maharashtra)

BY

K. M. Balapure

National Botanic Gardens, Lucknow

In the present communication about 112 species are reported from Ramtek as an addition to the list by Graham in 1912. The families Nymphaeaceae, Linaceae, Loganiaceae, Nyctaginaceae, Alismaceae, Eriocaulaceae and Cyperaceae are here recorded for the first time. The species listed here are accompanied by additional notes and have been grouped as 1. Aquatic and semiaquatic, 2. Weeds, 3. Introduced plants. Each species is provided with short descriptive notes, locality and collection number.

Introduction

The town of Ramtek, the headquarters of the tehsil bearing the name, is situated at 21° 24′ N and 79° 20′ E, 45 km. north-east of Nagpur. It is approached by a short deviation on the main Nagpur-Jabalpur road and even from a distance the white-coated temples on the hill can be seen gleaming in the sun. Enclosed in the remains of an old Maratha fortress, the ancient temples of Ramtek are picturesquely situated on the top of a hill about 200 m. high. The little town of Ramtek, which lies at the foot of this hill, derives its name from the temple of Rama, *tek* meaning hill. Hallowed by tradition as a place of pilgrimage, Ramtek owes much of its significance to the rich lore connected with the origin of the temples. The legend goes that Rama stayed for some time at Ramtek on his way to Lanka.

There are a large number of lakes and tanks about Ramtek, one of which goes by the name of "Amba Talao." It has a large number of modern temples built around it, framed against the hills. Pilgrims and tourists begin their trek up the hill from the Amba tank, from where a flight of steps leads up to the temples at the opposite side and another flight descends to the town of Ramtek.

The temples on the hill are Ramtek's pride. In a more earthy way, Ramtek is celebrated for the cultivation of a special quality of " pan " which is exported to Bombay and Poona. In the vicinity are also some manganese mines of importance and 8 km. beyond, the picturesque Khinsi tank with a dak-bungalow overlooking it, is a favourite picnic spot.

R. J. D. Graham visited this area in the first week of September 1912 and made observations on the flora of Ramtek (*J. Bombay nat. Hist. Soc.* **22**: 237-241, 1913). His main object in undertaking this tour was to compare the flora of transition formations with that of the Deccan trap. He collected about 216 plant specimens, which included dicots and monocots and ferns. But he did not include any member of the Cyperaceae and very few grasses and Eriocaulons, as the late rains delayed their flowering. Only grasses, which flowered early, were included. Graham states : " From a botanical point of view the Central Provinces (in which Ramtek was included previously—before the reorganization of states) form a particularly interesting area as they furnished the meeting place of the Bombay or western flora and the Bengal or eastern flora. Nagpur may particularly be taken as the eastern limit of the Deccan trap and with it the Deccan flora. Eastwards through Bhandara and Chattisgarh the Bengal flora commences."

During the last five years some new records of plants have been published based on the material collected from Ramtek. In 1963, Kapoor and others published " A note on the occurrence of *Rhynchospora longisetis* R. Br. (Family : Cyperaceae) in India with some interesting observations " (*J. Bombay nat. Hist. Soc.* **60** : 379-380). This note was based on the material collected by me during 1959 and deposited in the Herbarium, National Botanic Garden, Lucknow. The previous record of this plant was by Graham from Jubbulpore Farm, Jabalpur (Madhya Pradesh) which lies about 217 km. north-east of Ramtek. It will be worthwhile to mention here that Graham in his paper on the vegetation of Ramtek, based on the collection made in September 1912, does not report the occurrence of this interesting species in that area. Another taxon of Cyperaceae, a new record for India, is a plant collected from this area by Vinodini P. Donde (*Bull. Bot. Surv. India* **8**: 358, 1966). During her floristic studies on the Cyperaceae of Nagpur and its neighbourhood she came across *Scirpus kernii* Raymond, which so far was thought to be restricted to Africa. The material was collected at Amba tank near Ramtek on October 2, 1962, and deposited in the Central National Herbarium, Calcutta. In 1966, the author published " Some Plant Records from the erstwhile Central Provinces and Berar " (*J. Bombay nat. Hist. Soc.* **62** : 455-462, 1966) and reported the following plants from Ramtek: *Nymphaea nouchali* Burm. f., *Ageratum conyzoides* Linn., *Tridax procumbens* Linn., *Vernonia cinerea* (Linn.) Less.; and *Hyptis suaveolens* Poit.

Since then there is no record of any published work on the plants of Ramtek.

Some additional notes on the Flora of Ramtek

Since Graham explored this area in 1912, a large number of changes in the vegetation have taken place. Some species which were recorded from this locality are not to be found today even after an intensive search while a number of species not recorded in that list, are very common these days. The species which have appeared recently can be divided into the following heads.

(1) Those species which have appeared in ponds, lakes and rivers and marshy places. These may be classed as aquatic and semiaquatic plants. These include : *Nymphaea nouchali* Burm. f.; *Jussiaea repens* Linn.; *J. linifolia* Vahl; *Trapa natans* Linn. var. *bispinosa* (Roxb.) Makino, *Nymphoides cristatum* (Roxb.) O. Kuntze, *Ipomoea aquatica* Forsk.; *Utricularia flexuosa* Vahl, *Lindernia ciliata* (Colsm.) Pennell; *Veronica anagallis* Linn.; *Stemodia viscosa* Roxb.; *Sagittaria sagittifolia* Linn.; *Butomopsis lanceolata* Kunth, *Eriocaulon quinquangulare* Linn.; *Eleocharis atropurpurea* Kunth, *Cyperus iria* Linn.; *C. pumilus* Nees, *C. diffusus* Roxb.; *C. eleusinoides* Kunth, *C. flavidus* Retz.; *Scirpus supinus* Linn. etc.

(2) Those species which are found in the undergrowth in the forest, along roads, paths and in waste lands. These may be termed *Weeds.* A large number of weeds have spread in the forest and have become troublesome pests in recent years. Mention is made here of *Hyptis suaveolens* Poit. which is very common in the forests. This is an American plant and has spread in other states also. The following weeds are common these days at Ramtek : *Heliotropium ovalifolium* Forsk., *Indigofera glandulosa* Willd.; *I. trita* Linn. f.; *Phyllanthus maderaspatensis* Linn.; *Sida acuta* Burm. f.; *S. spinosa* Linn.; *Trichodesma indicum* R. Br., *T. zeylanicum* R. Br.; *Vernonia cinerea* Less.; *Ageratum conyzoides* Linn.; *Polycarpaea corymbosa* Lam.; *Corchorus fascicularis* Lam.; *Alysicarpus rugosus* DC.; *A. hamosus* Edgew.; *Smithia sensitiva* Ait., *Melothria maderaspatana* (Linn.) Cogn., *Goniocaulon glabrum* Cass., *Rungia parviflora* Nees; *Justicia simplex* D. Don; *Boerhaavia diffusa* Linn.; *Aerva lanata* Juss.; *Euphorbia hirta* Linn. etc.

(3) *Planted trees :* Planting of trees along roadsides, in the fields, parks and near temples and mosques is an important source of introduced plants. In the past a large number of forests have been cut and burnt down. But recently there is a move to plant more and more trees and shrubs to beautify roads and parks. Trees of economic importance are cultivated in the fields and gardens and plantations are raised. Generally near towns and villages there are cultivated forests of " Babool " (*Acacia*

nilotica (L.) Del. ssp. *indica* Brenan) for firewood and for gum and tannin. This species is also an important source of fodder for goats. This species, it seems, was not introduced in Graham's time. Graham's list does not include the mango (*Mangifera indica* Linn.) and *Acacia farnesiana* Willd.; which is a native of tropical America. The above mentioned trees are commonly cultivated these days.

On scanning Graham's list, it becomes clear that this area has not been thoroughly surveyed. Some species have been overlooked and there are some recent additions. Some of the common shrubs and trees of economic importance such as 'Dikamali' (*Gardenia resinifera* Roth), 'Nirmali' (*Strychnos potatorum* Linn. f.), 'Tendu' (*Diospyros melanoxylon* Roxb.) have been left out in Graham's list.

It was found that the following families were not represented in Graham's list : 1. Nymphaeaceae, 2. Linaceae, 3. Loganiaceae, 4. Nyctaginaceae, 5. Alismaceae, 6. Eriocaulaceae, and 7. Cyperaceae. In the present paper more than a hundred species belonging to 35 families have been added to the flora of this region since Graham explored this area in 1912.

The author had an opportunity to survey the vegetation of Ramtek and make a collection of plants from this area during two tours, the first in the last week of January 1959 and the second in the middle of October same year. During these tours more than 400 plant specimens were collected. The following localities of Ramtek were visited : 1. Nagarjun hill forest, 2. Bank of the Sur River, 3. Lakes and ponds about the town, 4. Ramtek Forest Division, the hills near the temples, 5. Khinni tank, 6. Neighbourhood of the town, 7. Cultivated fields and waste lands.

In the present paper only those plants have been included which are not given in Graham's paper. All the specimens have been deposited in the Herbarium of the National Botanic Garden, Lucknow.

The plants have been arranged according to Bentham and Hooker's system of classification and every attempt has been made to adjust the nomenclature of plants according to the latest findings on the subject.

After a very short description of the plant, which is helpful in the identification of the plant in the field, the locality from which the plants were collected, is given. The numbers indicate the field book numbers attached to the specimens.

ADDITIONAL PLANTS[1]

Nymphaeaceae

Nymphaea nouchali Burm. f. (*N. pubescens* Willd.)

Large aquatic herb with pink, bluish and pale yellow flowers. Loc.: Common in ditches and tanks about Ramtek (M.S.). (57544).

Capparidaceae

Capparis zeylanica Linn.

A shrub scrambling or climbing by means of its recurved thorns, flowers pink. Common in hedges and thickets. (57507).

Malvaceae

Hibiscus cannabinus Linn.

A tall herb with pink flowers. Cultivated. Vern. Ambadi. (57502)

H. lobatus (Murr.) O. Ktze. (*Solandra lobata* Murr., *Hibiscus solandra* L'Herit.)

Herbaceous, erect; flowers white; quite common. Loc.: Nagarjun hill forest, Ramtek. (70714).

Sida spinosa Linn.

Herb with pale yellow flowers. (57511).

Pavonia zeylanica Cav.

Herb, not common. Loc.: Ramtek Forest Division. (57475).

Tiliaceae

Corchorus fascicularis Lam.

Herb with yellow flowers. Common near ponds. (57484).

Linaceae

Linum usitatissimum Linn.

Herb with blue flowers. Cultivated. Vern. Jawas, Alsi. (57538).

Malpighiaceae

Aspidopterys wallichii Hook. f.

A woody climber with winged fruits. (57471).

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[1] The numbers given in brackets represent herbarium specimens; unless the contrary is stated, the collectors are Balapure & Party.

Anacardiaceae

Mangifera indica Linn.

Mango tree. Cultivated.

Papilionaceae

Crotalaria albida Heyne ex Roth

Herb with yellow flowers. Loc.: Ramtek Forest Division. (57473)

Indigofera linifolia Retz.

Herb with pink flowers. Common. (57500).

I. trita Linn. f.

Tall herb with reddish flowers. Common. (57485).

I. glandulosa Willd.

Herb with pods. Common. (57547, 57495).

Alysicarpus rugosus DC. var. **styracifolius** Baker

Herb with pinkish-yellow flowers. Common. (57509).

A. hamosus Edgew.

Prostrate herb on ground, flowers pinkish. Very common. Loc.: Nagarjun hill forest. *Balapure* 70705.

Dolichos lablab Linn.

Large climber with white flowers. Cultivated. (57504).

Smithia sensitiva Ait.

Herb with yellow flowers, very common in wet places. Loc.: Nagarjun hill forest. *Balapure* 70790.

Phaseolus trilobus Ait.

Climbing legume, cultivated. (57488).

Desmodium diffusum DC.

A legume with yellow flowers. (57491).

Cicer arietinum Linn.

Herb with bluish-violet flowers. Cultivated. Vern. Harbhara, Chana. (57549).

Rhynchosia bracteata Benth.

Herb, twining, not common. Loc.: Nagarjun hill forest. *Balapure* 70712.

Sesbania bispinosa (Jacq.) W. F. Wight. *S. aculeata* Pers.

Shrub in fruiting state, common near lake. (57501).

Lathyrus sativus Linn.

Cultivated. (57550).

Clitoria ternatea Linn.

A climber with blue flowers. Common on field hedges. *Balapure* 70811.

Caesalpiniaceae

Bauhinia racemosa Lamk.

A small crooked tree. Common. (57462).

Acacia farnesiana Willd.

A shrub with dark yellow flowers. (57537).

A. nilotica (L.) Del. ssp. **indica** Brenan (*A. arabica* Willd).

A small tree. Planted near the town.

A. leucophloea Willd.

A tree with yellowish bark. Vern. Hivar. (57467)

Trapaceae

Trapa natans Linn. var. **bispinosa** (Roxb.). Makino.

Cultivated in ponds and lakes. (57530).

Onagraceae

Jussiaea linifolia Vahl.

Herb, common in dried ponds. Loc.: Ramtek Forest Division. (57454).

J. repens Linn.

An aquatic herb. (57531).

Cucurbitaceae

Cucumis trigonus Roxb.

A procumbent plant with yellow flowers. (57520).

Melothria maderaspatana (L.) Cogn.

Annual. Common. Loc.: Nagarjun hill forest. (70716)

RUBIACEAE

Oldenlandia corymbosa Linn.

Herb near marshy places. (57525).

COMPOSITAE

Ageratum conyzoides Linn.

Annual weed with pale blue flowers. (57494).

Grangea maderaspatana Poir.

A composite herb with yellow flowers. Common in wet places. (57513).

Goniocaulon glabrum Cass.

A composite tall herb with pinkish-violet flowers. Common in fields. (57510).

Vernonia cinerea Less.

Herb with pinkish-violet flowers. Common. (57451).

Volutarella ramosa (Roxb.) Santapau (*V. divaricata* Benth. & Hook.)

A composite herb. Common in cultivated fields. (57487).

PLUMBAGINACEAE

Plumbago zeylanica Linn.

Shrubby plant with white flowers. Calyx sticky. Rare. Loc.: On way to Sur River. (70801).

EBENACEAE

Diospyros melanoxylon Roxb.

A medium-sized tree. Common in forest. (57448), *Balapure* 70881.

APOCYNACEAE

Ichnocarpus frutescens Br.

A climber in fruiting state. Common. (57468).

Wrightia tinctoria R. Br.

A small tree in fruiting state, bark white. Most dominant tree. (57460).

LOGANIACEAE

Strychnos potatorum Linn. f.

A small tree. Very common. *Balapure* 70894.

GENTIANACEAE

Nymphoides cristatum (Roxb.) O. Kuntze (*Limnanthemum cristatum* Griseb.)

An aquatic floating herb with white flowers. Common. (57523).

Nymphoides indicum (L.) O. Kuntze (*Limnanthemum indicum* Griseb.)

An aquatic herb with white flowers. (57522).

Exacum pedunculatum Linn.

Herb with blue flowers, not common. (57486).

Enicostemma littorale Blume

Herb of medicinal importance. (57496), *Balapure* 70676.

BORAGINACEAE

Heliotropium ovalifolium Forsk.

Herb with white flowers; common. (57512).

Trichodesma zeylanicum R. Br.

Herb with light violet flowers. Common in waste lands. (57508).

CONVOLVULACEAE

Ipomoea aquatica Forsk.

A creeping herb, very common. (57521).

I. hispida (Vahl) R. & S.

A spreading herb, common. (57557).

SCROPHULARIACEAE

Lindernia ciliata (Colsm.) Pennell (*Bonnaya brachiata* Link & Otto).

Herb with white flowers. Common. Loc.: Nagarjun hill. *Balapure* 70703, 70620.

Veronica anagallis Linn.

Herb with violet flowers, common near lake-water. (57519).

Striga euphrasioides Benth.

Herb with white flowers, common. Loc.: Nagarjun hill forest. *Balapure* 70709.

Stemodia viscosa Roxb.

Herb in dried pond, common. (57554).

LENTIBURIACEAE

Utricularia flexuosa Vahl.

Aquatic herb with yellow flowers, common in pond. (57528).

ACANTHACEAE

Hygrophila polysperma T. Anders.

Herb with white flowers, common. (57517).

Daedalacanthus purpurascens T. Anders.

Herb with purple flowers, very common in the forest. Loc.: Nagarjun hill forest. *Balapure* 70708.

Barleria cristata Linn.

Herb, common. Loc.: Nagarjun hill forest. (57450), *Balapure* 70713.

Justicia simplex D. Don.

Herb with pinkish flowers, common. Loc.: Nagarjun hill forest. *Balapure* 70704.

Rungia parviflora Nees.

Herb, common. Loc.: Forest near Khinni tank. *Balapure* 70858.

LABIATAE

Hyptis suaveolens Poit.

A tall, rigid sweet-smelling herb with 4-angled rough haired stem. Flowers small and blue. Loc.: Ramtek Forest Division. (57479).

NYCTAGINACEAE

Boerhaavia diffusa Linn.

Herb, diffuse, common. Loc.: Nagarjun hill forest. *Balapure* 70738.

AMARANTHACEAE

Amaranthus tricolor Linn.

Herb, common. (57514).

Aerva lanata Juss.

Herb with small white flowers, common. Loc.: Nagarjun hill forest. *Balapure* 70735.

Nothosaerva brachiata Wight.

Herb with whitish flowers, common. Loc.: Ramtek Forest Division. (57480).

Digera muricata (Linn.) Mart.

Herb with pink flowers, common. (57555).

POLYGONACEAE

Polygonum hydropiper Linn.

Herb with white flowers, common. Loc.: Nagarjun hill forest. *Balapure* 70710.

EUPHORBIACEAE

Euphorbia hirta Linn.

Herb, common. Loc.: Ramtek Forest Division. (57449).

E. perbracteata Gage.

Herb, rare. (57552).

Phyllanthus maderaspatensis Linn.

Herb, common in waste lands. (57505, 57534).

Tragia cannabina Linn. f.

An evergreen climbing hispid herb with stinging bristles, variable in foliage. Rare. *Balapure* 70802, (57476).

URTICACEAE

Ficus tomentosa Roxb.

Large shady tree. (57482).

COMMELINACEAE

Commelina hasskarlii C.B.Cl.

Herb with blue flowers, common in fields. Loc.: On way to Sur River. *Balapure* 70785.

Cyanotis axillaris (Linn.) Schultz. f.

Herb. Loc.: Nagarjun hill forest. *Balapure* 70784.

ALISMACEAE

Sagittaria sagittifolia Linn.

An aquatic herb with white flowers, common. (57524).

Butomopsis lanceolata Kunth

A hydrophyte, common. (57463).

ERIOCAULACEAE

Eriocaulon quinquangulare Linn.

Herb with small white flowers in heads, quite common in moist places. Loc.: Nagarjun hill forest. *Balapure* 70631.

CYPERACEAE

Bulbostylis barbata Kunth

A slender herb, quite common. Loc.: Nagarjun hill forest. *Balapure* 70636.

Eleocharis atropurpurea Kunth

A sedge in water. (57466).

Cyperus sanguinolentus Vahl

Sedge, quite common. On way to Sur River. *Balapure* 70752.

C. pumilus Nees

Sedge, quite common in moist places. Loc.: Nagarjun hill forest. *Balapure* 70635, 70726.

C. iria Linn.

Sedge, quite common near ponds. Loc.: Nagarjun hill forest. *Balapure* 70640, 70737. On way to Sur River. *Balapure* 70754.

C. diffusus Roxb.

Sedge, common near lake. On way to Sur River. *Balapure* 70758.

C. eleusinoides Kunth

Sedge, common in moist places. Loc.: Nagarjun hill forest. *Balapure* 70711.

C. flavidus Retz.

Sedge, common near lake. On way to Sur River. *Balapure* 70757, 70633.

Scirpus supinus Linn.

Sedge in water. (57466).

S. kernii Raymond

Collected by V. P. Donde from Ramtek, near Amba tank on 2 Oct. 1962. This is a new record for India. D. 44 (CAL).

Fimbristylis schoenoides Vahl

Sedge, common. Loc.: Nagarjun hill forest. *Balapure* 70628.

F. tetragona R. Br.

Sedge, common. Loc.: Nagarjun hill forest. *Balapure* 70630.

F. monostachya Hassk.

Sedge. On way to Sur River. *Balapure* 70788.

F. diphylla Vahl

Sedge, quite common. Loc.: Nagarjun hill forest. *Balapure* 70637.

Rhynchospora longisetis R. Br.

Sedge, common in moist places. Loc.: Nagarjun hill forest. *Balapure* 70606.

Gramineae

Aristida depressa Retz.

Common, Ramtek Forest Division. (57446).

Brachiaria eruciformis Griseb.

Common. (57541).

Elytrophorus spicatus (Willd.) A. Camus

Near ponds. (57464).

Eragrostis unioloides Nees

Common. Loc.: Nagarjun hill forest. *Balapure* 70629.

E. diarrhena Steud.

Spikes, reddish; common in fields. (57548).

E. gangetica Steud.

Common near water. (57469).

E. tenella R. & S.

Common grass in waste lands and in cultivated fields. (57492).

Ischaemum rugosum Salisb.

Common. (57546).

I. molle Hook. f.

Common near drying ponds. (57489).

Iseilema laxum Hack.

Common in waste fields. (57490).

Oryza sativa Linn.

Commonly cultivated rice which is also the staple food here. (57526).

Sorghum bicolor Moench.

Ramtek near Nagpur. (57516).

Themeda quadrivalvis O. Ktze.

Common in waste lands. (57497).

Rottboellia sp.

An aquatic grass, common in lake. (57499).

Dichanthium caricosum A. Camus

D. annulatum Stapf

Common. *Balapure* 70678.

Vetiveria zizanioides (Linn.) Nash

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References

Anonymous (1908): Imperial Gazetteer of India. Vol. 21. New Edition. Oxford.

Balapure, K. M. (1966): Some Plant records from the erstwhile C. P. and Berar. *J. Bombay nat. Hist. Soc.* **62**: 455-462.

———— (1966): A Botanical tour to the Marble Rocks, Jabalpur (M.P.). *Bull. Bot. Surv. India* **8**: 189-196.

Cooke, T. (1901): The Flora of the Presidency of Bombay. London.

Donde, V. P. (1966): *Scirpus kernii* Raymond—a new record for India. *Bull. Bot. Surv. India* **8**: 358.

GRAHAM, R. J. D. (1913): List of Grasses and sedges found on the Nagpur and Telinkheri Farms—including a few common species from other parts of the Provinces, Nagpur.

——— (1913): Notes on a collecting tour at Ramtek, C. P. *J. Bombay nat. Hist. Soc.* **22**: 237-241.

HOOKER, J. D. (1872-97): Flora of British India. Vols. 1-7, London.

KAPOOR, S. L. *et al.* (1966): A note on the occurrence of *Rhynchospora longisetis* R. Br. in India with some interesting observations. *J. Bombay nat. Hist. Soc.* **60**: 479-480.

MIRASHI, M. V. (1959): New Plant records from Nagpur. *Proc. 46th Indian Sci. Congr. Part* **3**: 286.

——— (1960*a*): Some new Plant records for Nagpur. *J. Indian bot. Soc.* **39**: 30-34.

——— (1960*b*): Some new Plant records for Nagpur—II. *Bull. Bot. Soc. Coll. Sci. Nagpur* **1**: 23-30.

PATEL, R. I. (1968): Forest Flora of Melghat. Dehra-Dun.

RAIZADA, M. B. (1939). Recently introduced or otherwise imperfectly known plants from the Upper Gangetic Plain. *Indian For. Rec.* **1**: 223-236.

——— (1966): Nomenclatural changes in Indian Plants. *Indian For.* **92**: 299-339.

SANTAPAU, H. (1953): The Flora of Khandala on the Western Ghats of India. *Rec. bot. Surv. India* **16**(1): 1-396.

TIWARI, S. D. N. (1954): The Grasses of Madhya Pradesh. *Indian For.* **80**: 601-611, 681-689.

——— (1963): Supplement to the Grasses of Madhya Pradesh. *Indian For.* **80**: 593-602.

——— & MAHESHWARI, J. K. (1964): The Cyperaceae of Madhya Pradesh. *Indian For.* **90**: 147-158, 616-629.

WITT, D. O. (1908): List of trees, shrubs and climbers and other plants of Economic Importance found in Berar Forest circle of the Central Provinces in Forest Flora of the Berar Circle. Nagpur.

Notes on a collection of small Mammals from Western Ghats, with remarks on the status of *Rattus rufescens* (Gray) and *Bandicota indica malabarica* (Shaw)

BY

K. K. TIWARI, R. K. GHOSE, AND S. CHAKRABORTY

Zoological Survey of India, Calcutta

(*With a map*)

The present paper is based on material and field observations made during a faunistic survey of the Western Ghats in July-September 1964, by the first and second authors.

The langur, *Presbytis entellus* (Dufresene), in troops and the Ruddy Mongoose, *Herpestes smithi* Gray, were found to be very common between Wai and Mahabaleshwar on Poona-Mahabaleshwar Road, and in the forest around Sinhagarh Fort and Poona, respectively. However, these and a few other small mammals observed in the field have not been incorporated here.

The external and skull measurements (in millimetres) of the specimens are in Table 1.

We are grateful to Dr. B. Biswas for his valuable suggestions in the preparation of the manuscript.

SYSTEMATIC ACCOUNT

Family RHINOLOPHIDAE

Rhinolophus lepidus lepidus Blyth, The Horseshoe Bat

MATERIAL: 1 ♀ ; Khopoli, Kolaba district, 28 September, 1964.

Remarks: According to Ellerman & Morrison-Scott (1951), this bat occurs in ' Central Provinces, Ganges Valley, Kumaon, Bengal.' Apparently a record by Wroughton (1918, p. 574) of this bat from Koyna Valley (Western Ghats) has been overlooked by these authors. More recently, Brosset (1962) has reported it from various localities in Maharashtra.

The specimen was collected with a butterfly net while eating a moth at about 23.00 hours. It had only one pair of mammae (axillary). About 5 mm. area of the skin around each nipple was naked.

TABLE 1

MEASUREMENTS OF SEVEN SPECIES OF SMALL MAMMALS OF WESTERN GHATS

Name of species	Locality	Sex	External					Skull					
			Head and body	Tail	Hind-foot	Ear	Forearm	Condy-lobasal length	Inter-orbital width	Bullae	Upper molar tooth row	Zymatic width	Mandi-bular length
Rhinolophus lepidus lepidus Blyth	Khopoli	1 ♀	51.5	23.5	8	17.5	41.5	—	—	—	—	—	—
Pipistrellus ceylonicus indicus (Dobson)	Panchgani	1 ♀	50.0	42.0	10.0	13.0	35.6	13.5	3.1	3.2	3.2	9.6	10.1
Funambulus palmarum ? bellaricus Wroughton..	Panchgani	1 ♂	159	155	40	16.5	—	38.5	13.2	8.1	8.2	23.1	25.5
Funambulus pennanti Wroughton	Wai	2 ♀	147, 149	74, 140	38.5, 40.0	16, 16	—	35.2, 36.1	10.5, 11.1	7.5, 7.8	6.5, 7.0	20.2, 20.9	20.7 21.5
Rattus rufescens (Gray) ..	Satara	7 ♂	136–166	173–237	29–35	20–25	—	34.2–39.2	5.9–6.4	6.7–7.0	6.1–7.0	17.5–20.0 (6 exs)	19.0–21.8
,, ,, ..	Satara	8 ♀	141–168	172–234	28–38	21–24.5	—	35.2–39.9	5.0–6.0	5.8–7.2	6.0–6.7	17.0–19.2 (6 exs)	20.0–22.1
,, ,, ..	Khopoli	2 ♀	146, 189	200, 250	22.5, 33.5	23, 30	—	34.6, 41.5	5.6, 6.5	7.1, 7.7	6.5–7.0	18–20.8	19.6–24.0
Mus booduga booduga Gray	Near Khopoli	1 ♂	65	63.5	15	10.5	—	18.3	3.1	3.6	3.2	9.1	10.1
Bandicota indica malabarica (Shaw)	Kolhapur	1 ♀	281	319	58	32	—	63.2	9.3	9.7	10.4	31.5	39.0

Family VESPERTILIONIDAE

Pipistrellus ceylonicus indicus (Dobson), Kelaart's Pipistrelle

MATERIAL: 1 ♀; Panchgani, Satara district, 24 August, 1964.

Remarks: According to Wroughton (1918), Tate (1943), and Ellerman & Morrison-Scott (1951), *P. ceylonicus indicus* occurs in the Malabar coastal area around Mangalore, which is considerably south of the Panchgani-Mahabaleshwar Plateau. The present record, therefore, extends its range further northwards.

Brosset (1962) has mentioned extreme colour variations in *P. ceylonicus chrysothrix* Wroughton, which are also shown by the material of this subspecies present in the Zoological Survey of India. *Pipistrellus ceylonicus indicus* can be easily distinguished externally by the deep brown colour of the body.

In the skull the canine and the second upper premolar are situated close to, but not touching, each other. In other details it agrees with Dobson's (*fide* Tate 1943) description.

Family LEPORIDAE

Lepus nigricollis nigricollis F. Cuvier, The Black-naped Hare

MATERIAL: 1 subad. ♂; Satara (near Ajintara Fort); 2 September, 1964.

Remarks: Individuals of *Lepus n. nigricollis* were common in Western Ghats from Khopoli to Kolhapur. This specimen was caught alive in a low thorny bush on the slopes of Ajintara Fort at Satara. Black-naped hares were frequently observed in thorny bushes in the slopes of hills during day hours.

The specimen was caught in a bag net. It remained alive in the camp for 35 days. It accepted cabbage, green-pea leaves and groundnut as food. Unfortunately, it died due to an accident during transhipment.

Family SCIURIDAE

Funambulus palmarum? bellaricus Wroughton, The Indian or Three-striped Palm Squirrel

MATERIAL: 1 ♂ Panchgani, Satara district; 2 September, 1964.

Remarks: This species is very common at Panchgani. During a fortnight's stay, no other species of this genus came to our notice.

Occipitonasal length (41.8 mm.), and lengths of nasal (13.1 mm.), frontal (=interorbital width) and upper toothrow (Table 1) appear to be a little more than those given by Ellerman (1963) for *F. p. palmarum*, *F. p. bellaricus* and *F.p. robertsoni*, but common to many specimens of the ceylonese subspecies *kelaarti*. As such, this specimen has provisionally, been placed under the above-named subspecies on geographical consideration. It may be mentioned that Ellerman (1963, p. 239) has also recorded one specimen from Bundha, Bombay, provisionally under this subspecies.

Funambulus pennanti Wroughton, Northern Palm Squirrel

MATERIAL: 2 ♀ ; Wai (alt. *c.* 614 m.), Satara district; 21 and 28 August, 1964.

Remarks: The Northern Palm Squirrel, *Funambulus pennanti*, was very common at Wai, situated at the base of hills forming the Panchgani-Mahabaleshwar Plateau. Up in the hills, the Three-striped Palm Squirrel, *F. palmarum* was common, but it was not noticed anywhere around Wai at the base.

Moore & Tate (1965), citing from a personal communication of Charles McCann, have also reported similar observations on the two species, occurring within the same geographical range, but in different habitats. The Panchgani-Mahabaleshwar Plateau is situated at a higher elevation and is cooler, moister and more thickly forested than the area around Wai. The forests around Panchgani are of the semi-evergreen type, while those around Wai are deciduous. It was noticed that *F. palmarum* was more arboreal in habits, spending less time on ground. *Funambulus pennanti* on the other hand, was commonly seen on ground, scampering among bushes and hedges, entering holes in the ground, or clambering up and down the neem trees (*Azadirachta indica*) from morning to evening except during the two to three hot hours of midday.

Petrol-tin traps, as devised by Roonwal (1949), were employed for trapping the squirrels, using ground-nut as bait. However, more than once, many individuals escaped from the traps after eating the bait.

Two pairs of mammae (1 pair abdominal, 1 pair inguinal) were noticed in our two specimens.

Family MURIDAE

Rattus rufescens (Gray), House Rat

MATERIAL: 8 ♂, 8 ♀, 9 subad. (5 ♂, 4 ♀), Satara, 2 and 3 September, 1964; 2 ♀, Khopoli, Kolaba district, 27 September and 2 October, 1964.

Remarks: All the specimens from Satara were collected in one wiretrap on two consecutive nights. Following were the trapping records: 2 September, 1964: 6 ♂, 3 ♀, 3 subad. ♂, 2 subad. ♀ ; 3 September, 1964:

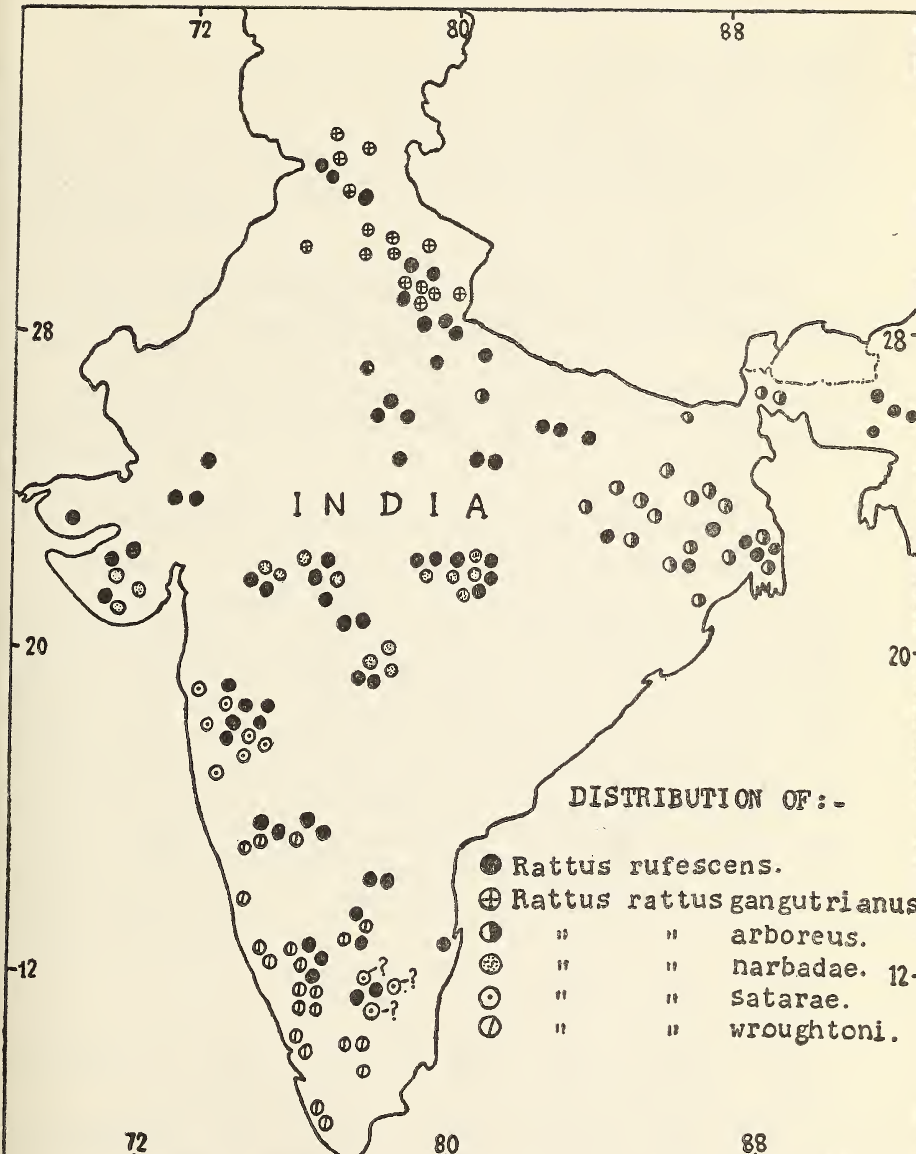
2 ♂, 5 ♀, 2 subad. ♂, 2 subad. ♀. Ghose (1970) has already reported about their cannibalistic habits.

Ellerman & Morrison-Scott (1951) have treated *Rattus rufescens* (Gray) as a subspecies of *Rattus rattus* (Linn.); but we do not agree with their opinion for the following reasons:

One of the basic premises of subspecies concept rests on the allopatric distributions of distinct populations, with zones of intergradation where the two populations meet. If the contention of Ellerman & Morrison-Scott is correct, *rufescens* co-exists as a subspecies with *R. rattus narbadae* Hinton, *R. r. satarae* Hinton, and *R. r. wroughtoni* Hinton in the southern peninsula, and with *R. r. gangutrianus* Hinton and *R. r. arboreus* (Horsefield) in northern hill regions and in eastern India (Map). A study of the distribution of *rufescens* and the five subspecies of *Rattus rattus* indicates that while the latter are allopatric in geographical relationship with each other, the former (*rufescens*) is sympatric with all of them.

Theoretically this is possible in commensal rats which are introduced in new localities through human agencies. However, generally a species or population introduced in a new area is scarcely able to hold its own against the indigenous competitors. The case of *Rattus norvegicus* (Berkenhout) can be cited as an example, which though regularly transported into India by incoming ships, has not been able to spread except in port towns where its stock is periodically replenished. *Rattus rufescens* is a successful rat wherever it is found in India, living side by side with other local populations.

If *rufescens* were a subspecies of *Rattus rattus*, hybrids should have been met with in the areas of overlap with other subspecies. A careful examination of 140 specimens, in addition to the present material, in the Zoological Survey of India fails to reveal any intermediate forms, except that in one adult from Dharwar, Mysore (Regd. No. 12817), there is a small white neck patch and in another subadult from Sakot, Hoshangabad district, Madhya Pradesh (Regd. No. 12753) a white streak is seen from chin to neck. The slight colour differences met with in these two specimens do not appear to be due to intergradation, but seem to be merely individual variations, which are not unknown in other species of *Rattus*. The five subspecies of *R. rattus*, occurring with *rufescens*, are all white-bellied forms with clear line of demarcation between the dorsal and ventral coloration. *Rattus rufescens* is dark-bellied, and is easily distinguishable from these populations because of its distinctive belly colour.



Map of India showing the distribution of the Rats, *Rattus rufescens, Rattus rattus satarae, R. r. wroughtoni, R. r. narbadae, R. r. gangutrianus* and *R. r. arboreus* in India. (Based on material in the Zoological Survey of India, Ellerman, 1947, 1963 and Sclater, 1891.)

The sympatric distribution of *R. rufescens*, with complete absence of intermediate forms in zones of overlap with different populations of *R. rattus*, clearly indicates that it is a distinct species.

The present specimens of *R. rufescens* were commensal forms caught in a granary at Satara and from the Rest House at Khopoli (Kolaba District). We have, however, collected this species in the wild at Kisli (Kanha National Park) and Motinala, in Mandla District of Madhya Pradesh; there was no difference in the belly coloration of the wild and commensal individuals.

Mus booduga booduga (J. E. Gray), Little Indian Field Mouse

MATERIAL: 1 ♂; *c*. 5 km. from Khopoli on way to Khandala Ghat on Bombay Poona Road, Poona District; 2 October, 1964.

Remarks: The specimen was caught by hand from below a stone in the forest, along the slope of the Western Ghats on the way to Khandala from Khopoli.

Bandicota indica malabarica (Shaw), Large Bandicoot Rat

MATERIAL: 1 ♀; Kolhapur, Kolhapur District; 13 September, 1964.

Remarks: Ellerman (1947, 1963) and Ellerman & Morrison-Scott (1951) have treated *Mus malabarica* Shaw as a synonym of *B. i. indica* (Bechstein). Ellerman (1947, p. 366) said: " I am inclined to doubt whether the typical *B. indica* of Wroughton is based on anything but two small individuals, and I feel fairly certain that if enough specimens came to hand from the Nilgiri Hills region the supposed size differences between the two named forms would cease to exist." However, from the material examined by us as well as further data currently available from Ellerman (1963), it appears that *malabarica* and *indica* are distinct subspecies of *B. indica*, the former being larger as shown by the measurements given below:

		Head & body	Tail	Hind-foot	Ear	Occipitonasal length
B. i. indica:	1 ♂	213	252	56	31	50
	* 1 ♀	245	266	45	30	55.5
	* 1 unsexed	—	—	—	—	52.7
B. i. malabarica:	1 ♂	335	338	61	39	—
	6 ♀♀	250-335	273-338	54-61	30-39	56-63.2

Wroughton (1908, p. 748) also treated *malabarica* and *indica* separately on the basis of hindfoot-length (*malabarica:* 54-55, *indica:* 48-51),

* Measurements marked with an asterisk are from Ellerman (1963). Other measurements are taken from material collected by us and also from specimens available in the Zoological Survey of India.

to which can now be added the lengths of head and body, tail, ear and occipitonasal length.

ADDITIONAL MATERIAL EXAMINED: *B. i. malabarica:* 1 ♂; Danta, Gujarat. 5 ♀; Devikop, S. Mahratta; Madhavaram, Vontimetta Range, A.P.; Khed, Ratnagiri District, Maharashtra; Sasan, Gir Forest; Virajpet, S. Coorg; Chinturajapalli, Palkonda Hills, E. Ghats.

B. i. indica: 1 ♂, Murumabapalli, Salem.

References

BROSSET, A. (1962): The bats of Central and Western India. Part 2. *J. Bombay nat. Hist. Soc.* 59(2): 583-624. Part 3. ibid. 59(3): 707-746.

ELLERMAN, J. R. (1947): A key to the Rodentia inhabiting India, Ceylon and Burma, based on collections in the British Museum. Part 2. *J. Mammal.* 28(4): 357-387.

——————— (1963): Fauna of India including Pakistan, Burma and Ceylon. Mammalia, 3. Rodentia, Part 1 & 2. Manager of Publications, Government of India, Delhi.

——————— & MORRISON-SCOTT, T. C. S. (1951): Checklist of palaearctic and Indian Mammals. Brit. Mus. (Nat. Hist.), London.

GHOSE, R. K. (1970): Cannibalism in the House Rat, *Rattus rattus rufescens* (Gray). *Labdev J. Sci. & Tech.* 8 B(3): 170-171.

MOORE, J. C. & TATE, G. H. H. (1965): A study of the diurnal squirrels, Sciurinae, of the Indian and Indo-Chinese Subregions. *Fieldiana. Zool.* 48: 1-351.

ROONWAL, M. L. (1949): Systematics, ecology and bionomics of mammals studied in connection with tsutsugamushi disease (scrub typhus) in the Assam-Burma War Theatre during 1945. *Trans. natn. Inst. Sci. India* 3(2): 67-122.

SCLATER, W. L. (1891): Catalogue of Mammalia in the Indian Museum, Calcutta. Indian Museum, Calcutta.

TATE, G. H. H. (1943): Results of the Archbold Expeditions. No. 45. Review of the vespertilioniae bats, with special attention to genera and species of the Archbold Collections. *Bull. Amer. Mus. nat. Hist.* 80: 221-297.

WROUGHTON, R. C. (1908): Note on the classification of the Bandicoots. *J. Bombay nat. Hist. Soc.* 18(4): 736-752.

——————— (1918): Summary of the results from the Indian Mammal Survey. ibid. 25(4): 547-598.

Narcondam Island and notes on some birds from the Andamans Islands

BY

HUMAYUN ABDULALI

(*With a plate and a text-figure*)

While working on the birds of the Andaman and Nicobar Islands, both in the field and indoors, I often thought of the Narcondam Hornbill (*Rhyticeros narcondami*) discovered and described by Hume (1875 *Stray Feathers* **1**: 411) in the following words:—

" As we neared the island of Narcondam, which is a single large hill, some 1,700 feet in height, densely wooded, and standing up solitary in the sea, between the Andamans and the Coast of Burmah, we noticed a number of black looking birds with white tails, flying about from tree to tree; every one at first pronounced them to be *Calaenas nicobarica*, of which we had, a few days previously, at Battye Malve seen such vast numbers. As we, however, neared the shore, it became apparent that both the necks and tails of these unknown birds were too long, and the former too clumsy to belong to the Nicobar pigeon. The island is a very difficult one to land on; everywhere rock-bound, and its foundation running sheer down into deep water, so that a few yards from the water's edge the sea is many fathoms deep. When at last we landed, the whole interior, if I may so call it, of the island, i.e. from beach to summit, was found to be absol tely impenetrable; cyclone after cyclone had prostrated generation after generation of trees, amidst the debris of which, a new, and densely packed generation had sprung up, interlaced with canes and other thorny creepers, and it was with great difficulty that we succeeded in bagging a pair of this strange bird, which turned out to be a small hornbill exactly like *ruficollis*. One or two more were shot, but the jungle was too dense to permit their being retrieved."

Narcondam Island is in the Bay of Bengal about 80 miles off the Andamans towards Burma. It is part of the same submerged line of hills which includes the Andaman and Nicobar Islands. It is less than 5 square miles in extent, heavily forested, and contains the hill already referred to by Hume. Wadia in GEOLOGY OF INDIA (1966) refers to it as " a craterless volcano composed wholly of andesetic lavas. From the amount of denudation that the cone has undergone it appears to be an old extinct volcano."*

In the Andamans and Nicobars themselves, several species of birds differ from those on the adjoining mainland and have again broken up into two or more subspecies, and it appeared probable that the circumstances that evolved so distinctive a bird as a hornbill would also have affected smaller forms.

Until 1968, the island was uninhabited, and though I flew over it on one of my trips to the Andamans the only means of visiting it was a chartered boat, the cost of which (at least to me) was prohibitive. Some

* The name Narcondam, derive from *naraka*=hell and *kundam*=pit, suggests that it was an active volcano within human memory.

time that year, noticing that our Prime Minister had visited the Andamans, I sent her reprints of my paper, and the very kind reply I received prompted me to ask her to help me make the visit. I was referred to the Ministry of Education and in the course of correspondence was informed that the island was now occupied by a police picket and that I could go out on the launch which called there every 3 or 4 weeks and come back on the next trip.

Apart from the difficulty of leaving town for so long, the absence of any details regarding the nature of the island, the conditions there, and the possibility of not being well occupied for 3 or 4 weeks made me hesitate, but after some negotiations it was decided that my party would be taken out on one trip, have at least two days on the island, and then decide if we should stay longer or not. Accordingly Robert B. Grubh (who had visited the Andamans with me earlier) and Rex Pimento, both of the Bombay Natural History Society, reached Port Blair by boat on 3rd March 1969, while I flew in later on the same day via Calcutta and Rangoon intending to leave for Narcondam by a boat scheduled to leave the following evening. In the evening we drove out far towards Wimberleyganj and saw some birds, both migrant and resident, with most of which we were now fairly familiar—introductions like Mynas (*Acridotheres tristis*) and House Sparrows (*Passer domesticus*), migrants e.g. Osprey (*Pandion haliaetus*) and Marsh Harrier (*Circus aeruginosus*), Golden Plover (*Pluvialis dominicus*), Common and Spotted Sandpipers (*Tringa hypoleucos* and *T. glareola*), Redshank (*T. totanus*), Common Swallow (*Hirundo rustica*), and resident Imperial Pigeon (*Ducula badia*), Greyfronted Green Pigeon (*Treron pompadora*), Greyrumped (*Collocalia fuciphaga*) and Whitebreasted Swiftlets (*C. esculenta*), and many others. The following morning (4th) we drove to Chiria Tapoo in an attempt to visit the cave which gives this place its name, where the Whitebreasted Swiftlets nest and which I had visited on an earlier trip. We could not secure a local guide and though we did some hard walking we failed to find the cave. We saw in knee-deep tidal water a party of about 5 chital, an introduced species reportedly now numerous but seen by me in the Andamans for the first time. What were they there for, to drink water or eat crabs or both (*see* K. K. Tiwari, *JBNHS* **60**: 725)? Chital skins are available in the bazar at Port Blair and I understood that 15/20 come in every month. I was also told of some wonderful (!) night-shooting when many were shot from a boat with searchlights.

We were informed that the boat would be a day late, but were not particularly concerned and accepted a local shikari's offer to take us out duck-shooting. On the 5th we were taken to a long, drying jheel which held a few moorhen on a patch of clear water, but they soon scuttled into grass. A shot at an impossibly high *Accipiter* sp. put up a flock of Lesser Whistling Teal (*Dendrocygna javanica*) which I had not seen on the Andamans, and we saw a pair of Purple Moorhen (*Porphyrio porphyrio*) which had not been recorded here before. There were quite a few snipe, and four shot and examined were all Pintail (*Capella stenura*). Eight Whistling Teal also were collected.

A specimen of the Striped Squirrel (*Funambulus pennanti* Wroughton) which appears to have established itself here fairly recently (*see* Y. Chaturvedi, *JBNHS* **62**: 545) was obtained. We returned to the dak-bungalow hoping to leave for fresher fields on the morrow.

I visited the (boat) *Yamuna* in the morning (6th March) to ascertain when we were scheduled to leave and was perturbed to learn that the crew had not been paid their salaries and the boat would be further delayed till the night or the following morning. In the afternoon news trickled in that there would be a further delay of two or three days, for the boat was being diverted northwards to Landfall Island to greet the canoe *Angre* in which two young men had rowed down from Calcutta. My patience was exhausted and, with the assistance of the Chief Commissioner, I booked my passage back to Calcutta for the morrow (7th) leaving the others behind to try and tag on to a party of the Survey of India which was leaving for some of the southern islands (Cinque, South Sentinel, etc.) in two or three days, and with the hope that they would be able to reach Narcondam some time later.

Grubh who, with Pimento, did most of the collecting reports as follows:

On the 7th morning we went to Sipighat for the Purple Moorhen and obtained one within a short time. Arrangements were then completed with the Survey of India party to visit different islands including Battye Malve and Narcondam in the chartered vessel the *Yamuna* scheduled to leave on the 11th.

South and North Cinque 11-12 *March*

We reached South Cinque on the 11th evening, but there was not enough time for any satisfactory study or collecting. North and South Cinque are within 2 furlongs of each other and consist of low hills covered with forests of Padauk (*Pterocarpus indicus*). Fresh water is available only on South Cinque. Introduced spotted deer are found on both these islands, those on North Cinque being reportedly emaciated because of the non-availability of fresh water to drink. Orange-headed Ground Thrush (*Zoothera c. andamanensis*) were often met with on South Cinque and were tame and confiding. Once a flock of five was seen feeding on the ground. Pimento saw two Barn Owls (*Tyto alba*) on North Cinque. Both these islets are uninhabited.

South Sentinel 12-18 *March*

The Survey party had five days' work here which enabled us to cover the island satisfactorily. South Sentinel is a flat coral island of about 5 miles circumference with a distinct continuous lagoon along half the shore, the rest being rocky and sandy beach.

Although there is dense vegetation, the island looks very recent and is undisintegrated madreporian coral wherever the ground is exposed. Along nearly half the circumference of the island, and on the same side as the lagoon, there is a depression within a few yards of the sea-shore. This is filled with saline water, apparently replenished during the monthly tides.

The entire island is belted along the shore by *Pandanus* sp. interspersed with patches of mangroves enclosing a dense jungle of the Andaman Bulletwood [*Manilkara littoralis* (Kurz)], distinguished by a thick canopy of horizontal branches sprouting from a height of 60 to 80 ft., shutting out even the midday sun and making it gloomy inside the forest. Fresh water is not available on the island and there were no human habitations.

Mammal species are few in number. Rats came to the kitchen tents at night to feed on the refuse. They were also seen running around on the forest floor at night near the shore and when disturbed climbed low branches. Flying Foxes (*Pteropus* sp.) were seen flying at dusk and feeding on the trees at night. Two dolphins were seen near the shore on the day of our arrival.

Among the birds, the Pied Imperial Pigeon (*Ducula bicolor*) was the commonest and appeared to be feeding mostly on the fruits of the Bulletwood and nesting on the lower branches and on young trees. Its call was heard throughout the island. The flight was amazingly noiseless except while taking off, when the wings clapped loudly over the back, and a buzzing noise while taking sharp turns.

The Koel (*Eudynamys scolopacea*) was seen and heard infrequently. The White-collared Kingfisher (*Halcyon chloris*) was noticed inside the forest as well as out on the coral reef, calling or sitting silently. Only a few Hill Mynas (*Gracula religiosa*) were seen and heard. White-eyes (*Zosterops palpebrosa*) occurred in flocks on mangroves along with Sunbirds (*Nectarinia jugularis*). Three Jungle Crows (*Corvus macrorhynchos*) were seen and heard on two different days. Nicobar Pigeon (*Calaenas nicobarica*) was seen in the jungle, solitary, on the ground. An adult and an immature were collected and their stomachs held hard seeds of Sapotacea and another unidentified variety. A few Thickheads (*Pachycephala cinerea*) and three Whiteheaded Mynas (*Sturnus erythropygius*) were noticed in an area with thick undergrowth.

The sea-snake *Laticauda colubrina* was common on the shore, often coming into the tents at night and causing panic among the men. Several Green Turtles (*Chelonia mydas*) were seen in the lagoon. One of them was shot and was found to have mature eggs. They were quite fearless and could be approached very close. From the trails on different parts of the beach it was evident that many had come ashore to lay.

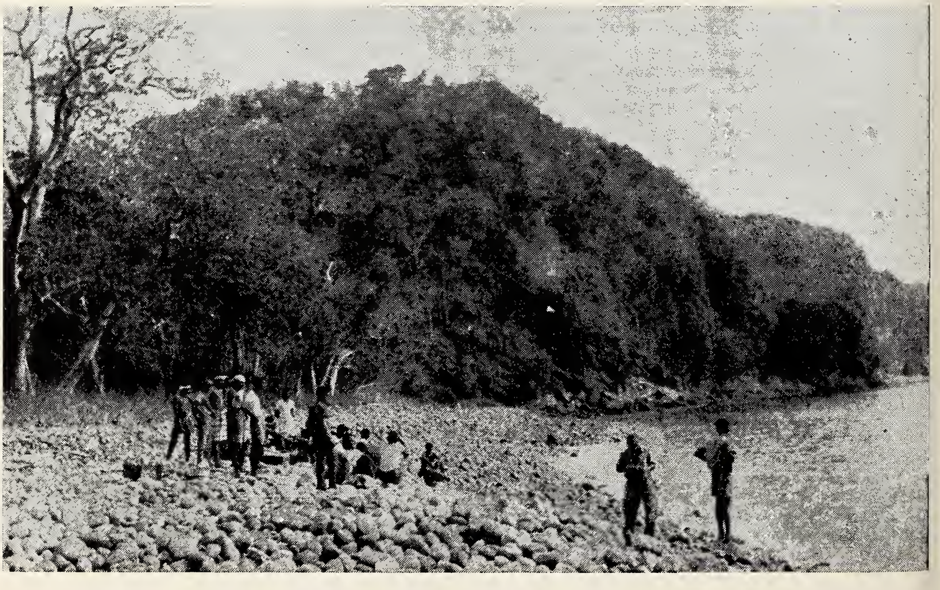
The only terrestrial reptile, the Water Monitor (*Varanus salvator*), was common all over the island. Land crabs found in enormous numbers on the island were possibly their main food, although a dozen were seen feeding together on a dead turtle on the shore and many came to the camp to scavenge. Quite a few were of large size, one specimen being seven feet long. The other two we collected measured 5 ft. 7 inches and 6 ft. 3 inches (tail broken at the tip) respectively. They were impressive to look at and resembled the Komodo Dragon (*Varanus komodoensis*) of Indonesia.

Robber Crabs (*Birgus* sp.) were often seen inside the forest under fallen trees as well as crawling about. The grip of their chela pincers was powerful enough to make a deep dent on the butt of my gun. A Robber Crab was observed to be feeding on a big freshly killed land crab.

Battye Malve 24-25 *March*

Battye Malve is a small, flat, uninhabited coral island 19 miles north of Car Nicobar. It has no fresh water and no shore, the coral reef table rising abruptly about 25 feet above sea-level.

Landing at Battye Malve was difficult. The steep rocks made it inaccessible except at one place where there was a jutting rock at a lower level. The skilful Nicobarese boatmen with their *odi* took us to this landing rock at the right moment between waves, and one or two, sometimes more, people could get on to the rock before the



Above: Barren Island with volcano. *(Photo: Comd. I. S. Bhati, I.N.)*
Below: Landing Bay at Narcondam Island. *(Photo: B. R. Grubh)*

boat fled the next oncoming wave. The danger lay in the huge cavities on the rocks at water level, into which the boat could get sucked in and smashed by the swelling waves. I was on the island for only two hours, an hour in the afternoon and another the next morning.

The immediate land next to the sea is bare, sharp, calcareous rock, impossible to walk on barefoot. This is followed by a thin belt of shrubbery and then comes the bulk of the jungle which is formed of the Andaman Bulletwood trees (*Manilkara littoralis*) seen on South Sentinel. However, there was heavy undergrowth among trees and the trees were covered with creepers. There were some coconut trees planted years ago by the Nicobarese, but they were uniformly emaciated and had no fruit. The agamid lizard (*Goniocephalus subcristatus*) was common, running on the ground and climbing among the vegetation. A skink (*Mabuya tytleri*) also was seen on the ground among litter. No other reptiles or frogs were seen during our short visit.

There was not enough time to look carefully at the birds at Battye Malve. At South Sentinel the Pied Imperial Pigeon was abundant while the Nicobar Pigeon was uncommon. At Battye Malve the Nicobar Pigeon was abundant, even more so than the Pied Pigeon on South Sentinel. Almost every tree had five or six of them sitting alone or sitting on the nest. The nests held a single naked nestling each. No eggs were found. Many young birds flew around and could be easily distinguished from the adults by their green tails (not white) and weak flight. The birds were tame and I could have shot dozens of them in an hour if I had so desired. This island, probably the main nesting place of this magnificent pigeon, was being used by the Navy as a target for shelling. A representation made during one of the recent ornithological trips to the Andamans has resulted in this practice being discontinued.

A pig was seen by a member of the Survey party. The pigs are reported to get water from certain plants on which they feed.

Narcondam Island 23rd April

We had considerable difficulty in obtaining transport for Narcondam Island and a day's visit was possible for me only through the kindness of Capt. V. A. Dhareshwar of the Indian Navy. The naval boat reached the island on the morning of the 23rd April. I met the police head constable who had been advised of my arrival by the Superintendent of Police at Port Blair. As the boat had to start back in the evening I hurriedly collected for half the available time, and spent the rest skinning the birds *on the island.* I did not want the specimens to spoil as had happened at Battye Malve, when I tried to do the skinning on board on a rough sea and was forced to leave the work half-done due to nausea.

Osmaston (*JBNHS* **16**: 620-622) gives a good description of Narcondam Island. Although the surrounding sea is reported to be deep, ships anchor at a safe distance to avoid submerged cliffs. The eastern side of the island slopes gradually into the sea and has a rocky beach of pebbles and boulders. The police outpost is situated on this side. A water tank has been built to store the water brought from Port Blair. However, the police party have tapped a perennial freshwater stream and have conveyed the flow through hollow tree trunks.

I could spend only 8 hours on the island. With two police constables to guide me, I covered a stretch of low rolling hills extending south to north. The Narcondam Hornbill (*Rhyticeros narcondami*) was tame and common. Their call *ka-ka-ka-ka* could be heard very often in all parts of the area covered. They gave easy shots and the report of .12 bore gun did not drive them far. Their stomachs held fruits of *Ficus* sp. and four types of seeds. The police force staying at Narcondam apparently used to eat these birds till recently when the Chief Commissioner of the Andamans and Nicobars declared it a protected species.

A Hill Myna (*Gracula religiosa*) and a Green Imperial Pigeon (*Ducula aenea*) were seen as also a Dark Thrush (*Turdus obscurus*). The other birds seen include a Large Indian Parakeet (*Psittacula eupatria*) and Yellowbreasted Sunbird (*Nectarinia jugularis*). The Koel was seen and heard, and a flight of yellowish wagtails (*Motacilla* sp.) was observed. A Reef Heron (*Egretta sacra*) in dark phase and a *Numenius* sp. were noticed on the shore.

Among the reptiles, the juveniles of the Water Monitor were seen near the police settlement. Two kinds of skinks (*Mabuya tytleri* and *Lygosoma* sp.) were often seen in the forest among dry leaves. A few rats noted in the forest were the only mammals I saw.

I returned to Port Blair on 24th morning and spent the day completing the skinning, and left for Bombay the next day.

ROBERT B. GRUBH

Upon my return to Bombay, I wrote to the Prime Minister telling her the whole story. A reply came soon, where with an expression of regret, she asked me to try again. Grubh and Pimento returned at the end of April with 146 birds of 78 species. In addition, they had obtained 21 lizards, 6 snakes, and various miscellanea like bats, rats, etc.

A preliminary examination of the collections revealed a pair of Crested Bazas (*Aviceda leuphotes*) which, in addition to adding a new species to the Andaman avifauna, were strikingly different from Indian birds (*JBNHS* 67: 137). If the Andamans still hold undiscovered such large and distinctive birds, what may Narcondam not produce?

With the last letter from the Prime Minister, I thought that another effort would be worthwhile and, after the usual negotiations, I arrived at Port Blair via Calcutta and Rangoon on 27th April 1970 and was met by Grubh and my son Akbar (15), who travelling by train to Madras had arrived by boat a day earlier. An immediate check-up with the Chief Commissioner revealed that all was well and that we would leave by the police launch the following night to stay at Narcondam for 2 days. In the middle of our lunch, we were hurriedly summoned by the Chief Commissioner to be informed that, due to various circumstances, the boat was needed back on the morning of 1st May, giving me less than a day on Narcondam! After much argument, an arrangement was arrived at whereby I was to be dropped at Narcondam, and then be picked up by another boat after 4 days. This sounded much better than the original two days and we decided to visit Wimberleygunj in an effort to see if any more Bazas could be located. While this was not seen, we met several old residents like the Emerald Dove (*Chalcophaps indica*), Andaman Swallow Shrike (*Artamus leucorhyncha*), Moorhen (with red on forehead) (*Gallinula chloropus*), Racket-tailed Drongo (*Dicrurus paradiseus*), Chestnut-headed Bee-eater (*Merops leschenaulti*), Green Imperial Pigeon (*Ducula aenea*), Red Turtle Dove (*Streptopelia tranquebarica*) in scattered parties of 15/20 in the fields, Crow Pheasant (*Centropus andamanensis*), Fairy Bluebird (*Irena puella*), Jungle Crow (*Corvus macrorhynchos*), introduced Common Myna (*Acridotheres tristis*) and House Sparrow (*Passer domesticus*), and migrants like

Whimbrel (*Numenius phaeopus*), Spotted Sandpiper (*Tringa glareola*), and Swallow (*Hirundo rustica*).

The M.V. "*Jawahar*" left at 10 p.m. and I had the uncomfortable privilege of occupying the single cabin, while the others slept comfortably on deck! Early the following morning (29th April) we obtained, in mid-ocean, a Migratory Nightjar (*Caprimulgus indicus jotaka* Temm. & Schl.) an addition to the Indian avifauna, which I have already reported (*JBNHS* **67**: 331).

As we anchored off Narcondam, a boat drew alongside and the Captain was handed over a wireless message received at the police outpost. He immediately showed it to me. It required him to be back at Port Blair on 1st May "*with* Abdulali repeat *with* Abdulali." Under the circumstances, there was no alternative but to reshuffle our plans, and after some consultation we decided to stay at Narcondam till about 9 the following morning and then leave for Barren Island which we expected to reach by about 2 p.m.

Immediately after landing (at about 3 p.m.) I walked up along one forest path with Akbar while Grubh went out in the other direction.

Narcondam Hornbills were apparently the commonest or at least the most noticeable birds. In addition to a collection on a peepul (*Ficus* sp.), the loud raucous call was heard in all directions. The Alexandrine Parakeet (*Psittacula eupatria*) was in pairs and their loud *kree-a kree-a* and nasal *tay-ain* were frequently heard. The small sunbird (*N. andamanica*) which Osmaston said was the commonest bird on the island and frequented the coast was only once seen.

It soon began to get dark and we returned to the camp and walked around in the forest near by. Beyond the camp we saw a small dark hawk (*Accipiter* sp.) chasing a Blackheaded Kingfisher (*Halcyon pileata*) and, in trying to make up my mind as to which to shoot, I missed both. The kingfisher was picked up wounded the following morning and must have been hurt by the hawk, which the police said had even attacked a dog.

A Flying Fox (*Pteropus satyrus*) was shot off a *Caryota mitis* palm, and a little later numbers were seen flighting to 2 or 3 large trees near the camp and some specimens obtained. Large rats [*Rattus flexibilis* (Miller)] were seen on the forest floor and on tree trunks both in daylight and at night.

During the night, we collected a few skinks *Lygosoma maculatum* and *Mabuya tytleri* and took possession of 2 snakes (*Laticauda laticauda* and *Chrysopelea paradisi*) collected by the police after Grubh's visit last year and preserved in a jar left behind by him. All these reptiles have been previously recorded from Narcondam in Smith's FAUNA.

The following morning, the first calls were put down to a Koel, but later included almost certainly variations of the Hornbill's *kok-kok-kok kokkok* followed by a cackle not unlike that of a frightened domestic fowl. They were feeding on the berries of a large peepul-like *Ficus* and a male was watched as it flew over quarter of a mile to visit a small hole at the base of a branch high up in a Tipok (*Tetrameles nudiflora*). Here he produced berry after berry and fed the female (?) for 6 minutes in which at least 20 insertions were made. The edges of the hole were stained brownish all around on the whitish bark. No attempt had been made at concealment of the nest which as far as could be judged from about 150 yards appeared to be not more than 3″ in diameter. Though several were seen in pairs, the 2 birds glassed thereafter were both males as also the specimen obtained. Their voices were heard all the time, with that of the parakeet a close second. Several Hornbills were mobbing a Sea Eagle perched in a tree—the latter was whitish below but with a grey head and throat.

We flushed a Pond Heron in dry forest which appeared to be a strange place in which to find this bird. This was later identified as *Ardeola bacchus*. A large swallow/crag martin with whitish under-parts and a longish forked tail soared high over the island, as also a large black swift. Grubh obtained another specimen of *Turdus obscurus* as on the last trip.

With much reluctance we left for Barren Island hoping to get a little more time there. However a foreign cargo boat was seen in the distance and we lost a couple of hours chasing it to no apparent purpose. With this waste of time, we reached Barren Island at 5 p.m. where a cone of ash rose in a ring of hills. Wadia (loc. cit. at pp. 38-39 and 415, describes it as follows:—

" Dormant volcano in Bay of Bengal to east of Andaman Islands 12° 15′ N. lat., 93° 54′ E. long., truncated remnant of a much larger cone. It consists of an outer amphitheatre about 2 miles in diameter, breached at one or two places, the remains of the old cone, surrounding an inner, much smaller, but symmetrical cone, composed of regularly bedded lava-sheets of comparatively recent eruption. At the summit of this newer cone is a crater about 1,000 feet above the level of the sea. But the part of the volcano seen above the waters is quite an insignificant part of its whole volume. The base of the cone lies some thousands of feet below the surface of the sea.

" The last time it was observed to be in eruption was early in the nineteenth century; since then it has been dormant...... Capt. Blair described an eruption in 1795..... another observer in 1803. Holiday J. R. and Mallet F. R. of Geological Survey of India have given a complete account in Memoir, Vol. XXI, pt. 4, 1855.

. . . . . .

" One of the few traces of geological and geographical changes visible in India since the advent of man."

M. S. Krishnan in GEOLOGY OF INDIA AND BURMA (1968) at page 43 says:

> "Central symmetrical cone 305 m. high with sides sloping at about 35° surrounded by eroded remnants of a second large cone 180-300 m. The crater elliptic and 90 metres in diameter some 13 to 15 m. deep in which are hot springs and fumaroles which deposit sulphur and some salts. Vegetation confined to outer slopes of the outer cone."

The lava in rough-shaped blocks formed a gap through the outer ring, and hopping from stone to stone we climbed to the top of a ridge of ash between the inner and outer cones. While approaching the island, we had seen a few goats in the vegetation on the hillside of the outer ring. They were of various colours: white, black, and piebald. It will be remembered that they had been released there in 1891 to provide food to shipwrecked sailors. They had apparently done well and established themselves on the island. Abbott in 1901 thought there were several hundred. We did not see any after landing. Incidentally, Tytler quoted by Hume (1869, ROUGH NOTES, page 260), also refers to pigs, goats, and fowls being released on Narcondam for the same purpose.

As at Narcondam, we saw large rats [here *Rattus atridosum* (Miller)] both by daylight and after dark moving about on the hillside in open country. The low country is covered with a small bushy fig about 10′ high and now in fruit. Large fruit bats appeared after dusk and after much firing by both Akbar and myself we picked up five, 3 black females and 2 brown males, a sexual dimorphism not common among bats. Osmaston's reference to two species of fruit bats at Narcondam possibly refers to this. The bats collected on this trip have been reported upon by Mr. J. E. Hill of the British Museum (Natural History) (*JBNHS* **68**: 1).

It was dark by the time we got back to the shore and we had again reluctantly to pack up and sail to Port Blair. We were fortunate enough to get air passages to India on the morning of the 1st and got back to Bombay via Rangoon and Calcutta the next day. Thus ended another attempt at studying the birds of these far-away islands.

At the 10th General Assembly and 11th Technical Meeting of the International Union for the Conservation of Nature and Natural Resources held at New Delhi in November 1969, a resolution (No. 28) was adopted regarding the great value of oceanic islands, for an up-to-date and worldwide appraisal of conditions on all such islands and that a suitable provisional list be submitted to the Governments of Australia, Ecuador, France, Japan, New Zealand, the United Kingdom, and the United States of America for the purpose of reserving from exploitation or disturbance and making available for long-term research by scientists of all nations certain oceanic islands under their jurisdiction which are not inhabited or in current use for other purposes. I had suggested that the Narcondam and Barren Islands and Battye Malve be so preserved and that the matter be discussed at the 8th Meeting of the Indian Board for Wild Life held in New Delhi on 24th and 25th October 1970. The matter was however not placed on the agenda and there has been some further correspondence in this respect. I do hope that it will be possible to preserve these wonderful islands, not only for immediate research but also for future generations to see what some parts of the world looked like not so long ago.

43 **Ardeola bacchus** (Bonaparte) (Malay Peninsula) Chinese Pond Heron

1 ♂ Sipighat, South Andamans, 1 ♀ Narcondam Island.

	Wing	Bill	Tarsus	Tail
♂ and ♀	220, 225	62, 61	57, 58	82, 83
(♂♀	195-238	61-69	60-64	72-90)[1]

The first bird was obtained in a field among cattle and cattle egrets. The second at Narcondam was flushed off the ground in heavy forest, a most unexpected place for a pond heron. It was noted as *A. grayii* and, had it not a few black feathers on the middle of the back, I would have left it as *grayii*. Both birds have larger wings than the *grayii* available in the Bombay collection

20 ♂♂	195-218 av. 209	10 ♀♀	182-203 av. 193

Sp. No. 21885, a ♀ obtained at Wimberleyganj, South Andamans, and recorded as *grayii*, measuring wing 194, bill 59, tarsus 55, and tail 68, was re-examined and appears to have been correctly identified.

44 **Bubulcus ibis coromandus** (Boddaert) (Coromandel) Cattle Egret

♀ Sipighat, South Andamans, 2 April 1969.

Wing 243; bill from feathers 60 (50-66); tarsus 83 (82-92); tail 85 (83-96).

There are some unfortunate errors in the table of measurements in my Andaman paper (*JBNHS* **61**, p. 502) which, together with the present specimen, should read:

	Bill (from feathers)	Tarsus	Tail
Andamans	60, 60 (50-66)	85, 90 (82-92)	85, 85 (83-96)

A single male from Prome District, Burma, has its bill 68 mm. but the 20 males and females from India are appreciably within the limits indicated in FAUNA (**6**: 350) and IND. HANDBOOK (**1**: 68) i.e. 50-66 mm.

11 ♂♂ 54-61 av. 58	9 ♀♀ 53-60 av. 57.3

[1] The measurements in parentheses throughout this paper are from either Stuart Baker's FAUNA or the INDIAN HANDBOOK.

On 3 March 1969, several with slightly rufous heads were seen near Port Blair, while on 28 April 1970 some were in breeding plumage.

46 **Egretta alba modesta** (J. E. Gray) (India) Eastern Large Egret

1 ♂ Port Blair, South Andamans.

Wing 365 (IH 355-375); bill from feathers 107; tarsus 155 (146-165).

47 **Egretta intermedia intermedia** (Wagler) (Java) Smaller Egret

2 ♂♂ Sipighat, 2 ♀♀ Chauldhari, South Andamans.

	Wing	Bill	Tarsus	Tail
2 ♂♂	315, 320	77, 79	116, 117	120, 124
2 ♀♀	280, 302	63, 73	91, 99	117, 122

In my note on Indian Egrets (*JBNHS* **62**: 554), I had drawn attention to the uncertainty of the earlier records of this species from the Andamans and Nicobars. The present specimens show disintegrated plumes on the breast. The wings and tarsi, though larger than in the Indian specimens measured by me (loc. cit.), are distinctly smaller than in *E. alba modesta*.

These specimens re-establish the earlier records from the Andamans.

49 **Egretta garzetta garzetta** (Linnaeus) (Northeast Italy) Little Egret

1 ♀ Port Blair, Andamans, 3 April 1969.

In my earlier papers, I had withheld the subspecific identity of the Little Egret in the Andamans and Nicobars, for there was some doubt regarding the colour of their feet. In the present specimen the feet were noted as yellow when collected, but were dark and almost concolorous with the tarsus when examined in Bombay after about a month. Though different museum specimens show differences in the extent of yellow in the feet, there would now be no doubt regarding the identity of the Andaman birds.

51 **Egretta sacra** (Gmelin) (Tahiti) Eastern Reef Heron

1 Car Nicobar. White ♂.

Osmaston saw it on Narcondam.

The 8 birds of this species (6 ♂♂ 2 ♀♀) now in our collection include 3 white birds, all of which are males. Excepting one white bird (No. 22557) with traces of grey on the neck and upper parts, from Car Nicobar obtained on 4 April 1966, all have plumes on the back. They do not agree with Graham Pizzey's statement (1966) in ANIMALS AND BIRDS IN AUSTRALIA, page 160, that white birds have yellow bills and slate-grey ones dark bills.

57 **Ixobrychus sinensis** (Gmelin) (China) Yellow Bittern

2 ♂♂ South Andamans.

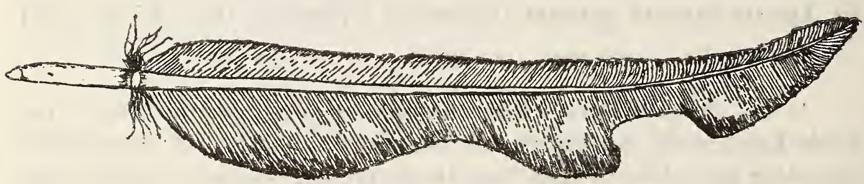
In the Nicobar report (*JBNHS* **64**: 154) I had drawn attention to the absence of birds in adult plumage among the eleven examined from the Andamans and Nicobars. The two fresh ones are also in immature or sub-adult plumage.

88 **Dendrocygna javanica** (Horsfield) (Java) Lesser Whistling Teal

5 ♂♂ 2 ♀♀ South Andamans.

In the general account, I have referred to eight birds being killed in a few moments. One of them has been mounted for the Port Blair Museum. The remaining seven appeared to have consistently pale underparts with almost no chestnut, resembling the few skins in immature plumage available from India. Fortunately, the mounted specimen was available and was found to be as dark as the adults in India! The females are slightly smaller than the males.

While examining these specimens, I was surprised to notice the curious shape of the first primary:



Delacour (1954) THE WATERFOWL OF THE WORLD, **1**: 27, refers to the primaries in *Dendrocygna* being variously notched or emarginate, but I have not seen any reference to this in Indian literature.

128*a* **Aviceda leuphotes andamanica** Abdulali & Grubh (Wrightmyo, South Andamans) Andaman Crested Baza

1 ♂ 1 ♀ Wrightmyo, South Andamans. Type and paratype, wings 224, 220; tails 130, 127.

This race was described in *JBNHS* **67**: 136 from these birds collected on the first trip.

152 **Accipiter virgatus gularis** (Temminck & Schlegel) (Japan) Eastern Sparrow-Hawk

1 ♀ Wrightmyo, South Andamans. Wing 184, tail 130.

173 **Haliaeetus leucogaster** (Gmelin) (St. Prince's Island, Indonesia) Whitebellied Sea Eagle

On Narcondam we saw one being mobbed by several hornbills. Hume (1869) in ROUGH NOTES, page 260, quotes at length from Tytler's notes (unpublished?): "At Port Blair, it is often called the Duck Eagle from the quacking sound it emits . . . . particularly when fighting with another of the same species, about some captured fish." They are said to feed largely on pipe-fish which are caught as they skim the surface. He also adds that they were seen in " great numbers " both at Barren Island and on Narcondam, feeding on Barren Island on the dead and decaying fish almost always strewn on the shores, " a perfect paradise " for sea-eagles.

190 **Circus macrourus** (S. G. Gmelin) (Voronezh, Southern Russia) Pale Harrier

I had referred (*JBNHS* **61**: 508) to the absence of any specimen of this species from the Andamans. Zoological Survey of India Sp. No. 23939, Wimberleyganj, South Andamans, a female collected on 6 February 1930 (outer webs of 2nd, 3rd, and 4th primaries notched, tarsus *c.* 70, wing 332) indicates that this species does visit the Andamans.

200. **Spilornis elgini** (Blyth) (South Andaman Island) Dark Andaman Serpent Eagle

1 ♂ Goracharma, South Andamans. Wing 354.

Blyth's description (1863), in *Journal, Asiatic Society of Bengal*, **32**: 87 is generally accepted as the first publication. This is dated February 1863, while in *Ibis*, January 1863, p. 118 appears a letter from Blyth in which the name and description are given. In the absence of any evidence regarding delay in the publication of this number, this source would have priority.

200*a* **Spilornis cheela davisoni** Hume (South Andamans) Pale Andaman Serpent Eagle

1 ♀ Sipighat, South Andamans. Wing 397.

The two additional specimens support my earlier opinion (*JBNHS* **61**: 509 and **64**: 155) that *elgini* and *davisoni* are two different birds. It is also worth noting that *davisoni* was shot over a tidal creek and contained crabs, while *elgini* was carrying a parakeet in a forested area, confirming the ecological differences mentioned earlier. The parakeet's brain had been completely devoured.

I had overlooked Hume's statement (STRAY FEATHERS **2**: 84) that he saw this bird at Kondal, between Little and Great Nicobar.

211 **Falco peregrinus peregrinator** Sundevall Shahin

In *JBNHS* **61**: 511 I had drawn attention to the incongruity of indicating a type locality " 700 miles off the Nicobars." In IND. HANDBOOK (**1**: 350) this is changed to 700 kilometres, but 434 miles is still too great a distance, and it must be assumed that the original reference (which is not available to me) to 70 Swedish miles is either in error or has been wrongly quoted.

246 **Francolinus pondicerianus pondicerianus** (Gmelin) (Pondicherry, India) Grey Partridge

2: 1 ♂ 1 ♀ South Andamans Wings 145, 141.

This was introduced into the Andamans and the pair collected on 6 March agrees with the nominate race.

345 **Amaurornis phoenicurus insularis** Sharpe (Andamans) White-breasted Waterhen

1 ♂ 1 ♀ South Andamans, 1 ♀ Narcondam Island.

One was seen on South Sentinel Island. Some of the Andaman birds are not jet black below and resemble those from India, but this is possibly a subadult phase.

346 **Gallicrex cinerea cinerea** (Gmelin) (China) Watercock or Kora

1 ♂ 1 ♀ 28 April 1970.

Both birds were put up out of small patches of marshy ground (which also held snipe) along the road 20 to 25 miles from Port Blair. One of them flew about 50 yards across the road and settled in a tangle of vegetation about 30′ up on the edge of the forest.

Among the specimens available (excluding a ♂ with an enlarged 61 mm. crest, and including a male and two females from the Andamans) the bill (from feathers) measures appreciably more than the culmen as in FAUNA repeated in IND. HANDBOOK.

Bill ♂♂ 47-50 av. 47.7 (culmen 37-38)

Bill ♀♀ 37-42 av. 39 (culmen 32-34)

The stomachs held 3 snails [1 *Planaxis* sp. (brackish water), 2 *Neretina* sp. (fresh water)], several grasshoppers (Orthoptera), and the bulbils of an unidentified plant.

347*a* **Gallinula chloropus orientalis** Horsfield (Java) Malay Moorhen

2 ♀♀ 3 and 6 March, 1969. South Andamans.

Wing 165, 166; tail 62, 63; tarsi 47, 48

A bird obtained earlier was identified as of this race by Dr. Ripley, leading to its addition to the list of birds in Indian limits. That specimen has a large red frontal shield 12 mm. broad as against 9 mm. in a ♂ from Simla, but the present two cannot be separated by size or colour, except that they appear to have heavier bills.

349 **Porphyrio porphyrio** subsp. Purple Moorhen

1 ♀ Sipighat, South Andamans. 7 March, 1969.

We saw several birds among the high *Asplenium* ferns alongside a tidal creek and it appeared to be an addition to the Andaman avifauna. On my way back, I stopped for a short period at the Indian Museum and was surprised to see 3 specimens collected at Trinkut, Nicobars. They are very old specimens obtained in 1886 by a Mr. E. N. May (probably E. H. Man, author of THE ANDAMAN ISLANDERS, 1885) and which do not appear to have been referred to in published literature. The Andaman female has its wings 242 mm. which is slightly less than other females from Indian limits (244-254 av. 250), tarsus 90 (88-98 av. 91.6) and hind toe 84 (89-97 av. 93) but does not show any appreciable difference in any other respect. Mr. P. K. Das (*infra* p. 459) is reporting on the Nicobar birds.

374 **Charadrius leschenaultii** Lesson (Pondicherry) Large Sand Plover

1 ♀ Chauldhari, 1 ♀ Port Blair, South Andamans. Wings 135, 147; bills 23, 25.

379 **Charadrius dubius curonicus** Gmelin (Kurland) Little Ringed Plover

1 ♂ Port Blair, Andamans. Wing 120.

384 **Charadrius mongolus atrifrons** Wagler (Bengal) Pamir Lesser Sand Plover

2: 1 ♀ (wing 124) Chauldhari, 1 o? in breeding plumage (wing 127) Port Blair.

398 **Tringa glareola** Linnaeus (Sweden) Wood or Spotted Sandpiper

1 ♀ 28 April 1970. Port Blair, Andamans. Bill 31.

401 **Tringa hypoleucos hypoleucos** Linnaeus (Sweden) Common Sandpiper

Osmaston noted it at Narcondam.

402 **Arenaria interpres interpres** (Linnaeus) (Sweden) Turnstone

1 ♂ 1 ♀ South Sentinel Island. Out of flock on 13 March 1969.

Osmaston noted them on Narcondam.

406 **Gallinago stenura** (Bonaparte) (Sunda Islands) Pintail Snipe

1 South Andamans. 5 March 1969.

418 **Calidris subminutus** (Middendorff) (Stanovoi Mountains and mouth of the Uda) Longtoed Stint

4 ♀♀ Port Blair, Andamans. 1 April 1969.

All four fell to one shot into a large flock at a freshwater pool. Several flocks seen during March and up to 21 April.

468 **Sterna sumatrana sumatrana** Raffles (Sumatra) Blacknaped Tern

A few were seen on rocks as we approached Barren Island.

471 **Sterna anaethetus anaethetus** Scopoli (Panay, Philippines) Brown-winged Tern

1 ♂ off Narcondam Island, 23 April 1969. Wing 251; tail 139.

More white and grey is visible on the upper parts than in other specimens (see *JBNHS* **67**: 111) in the collection.

500*a* **Treron pompadora andamanica** (Richmond) (MacPherson Strait, South Andamans) Greyfronted Green Pigeon

1 ♂ South Andaman.

IND. HANDBOOK **3**: 104 appears to have overlooked the statement in my Nicobar paper (*JBNHS* **64**: 164) where I have confirmed the identity of this subspecies after comparison of series from both places.

508*a* **Ducula aenea andamanica** Abdulali (Betapur, Middle Andamans) Andaman Green Imperial Pigeon

1 ♂ Narcondam Island. April, 1969.
Wing 239; bill 22; tail 157.

The single specimen can be included with those from the Andaman Islands. Grubh saw them (subsp. *nicobarica*) being shot with airguns at Car Nicobar.

509 **Ducula bicolor** (Scopoli) (New Guinea) Pied Imperial Pigeon

3 ♂♂ (1 juv.) 1 ♀ 1o? nestling, South Sentiuel Island, 17 miles off Sothu Andamans.

As recorded by Osmaston some sixty years ago, this bird was still plentiful on this yet uninhabited island, and large numbers were nesting in mid-March, when Grubh and Pimento visited this place. The island was covered with the tree *Manilkara littoralis* which possibly provides its food. As noted by Butler (1899: 688), their pied plumage makes them difficult to spot in the " shifting lights of the thickly-leaved trees". The call often heard from birds seated overhead was a distinct two-syllabled " cru-croo " often repeated and reminiscent of that of the domestic pigeon. The chuckling " hu-hu-hu " recorded by Butler was not heard.

A few were seen on Barren Island.

The observer's movements in the jungle apparently sent them flying from tree to tree constantly but the flight was remarkably noiseless, even in the silent jungle. Sometimes, they would take off so violently that loud " claps " were heard when their wings met over their backs. They would glide away gracefully when high enough. When turning in flight they produced a curious buzzing noise which "I (RBG) have not heard in any other species". In mid-March, many had nests, about the size of a crow's but thinner, flatter, and cruder, with no lining, and between 10 and 15 feet above the ground. Three nests closely examined contained one chick (*c*. 150 gm.) each.

One nestling was preserved. The nestling and juvenile are described in Robinson & Chasen's BIRDS OF THE MALAY PENINSULA (1935, **3**: 53) but as this appears to have been omitted in Indian literature, I may mention that:

(*a*) the nestling has the white feathers of the upper parts tipped broadly with " sandy apricot-buff " (Robinson & Chasen), these feathers having greyish bases. The underparts have a slight wash of this colour, but not prominently on the tips;

(*b*) in the juvenile, the buffish tips are more widely separated making the grey more prominent.

525 **Columba palumboides palumboides** Hume (Port Mouat, Andamans) Andaman Wood Pigeon

1 ♂ South Andamans. Wing 258; tail 153; bill 21.

This specimen must be looked at against the light to differentiate its grey head from the white of the Nicobar birds. The middle toe and claw (44 mm.) is shorter than in *nicobarica*.

527*a* **Macropygia rufipennis andamanica** Abdulali (Betapur, N. Andamans) Andaman Cuckoo-Dove

1 ♂ Calicut, South Andamans. 13 April 1969.
Wing 194; tail 200.

In addition to confirming the colour difference between Andaman and Nicobar birds (*JBNHS* **63**: 421), it would appear that the latter have heavier bills.

536 **Streptopelia tranquebarica humilis** (Temminck) (Bengal & Luzon) Burmese Red Turtle Dove

1 ♂ South Andamans.

544 **Chalcophaps indica maxima** Hartert (Golapabung, South Andamans) Andaman Emerald Dove

1 ♂ Chirria Tapoo, South Andamans, 1 ♂ Car Nicobar.

Though we did not see any, a single feather was picked up and the bird was heard "ghooming" at Narcondam, where Osmaston (*JBNHS* **16**: 621) had obtained a specimen.

544*a* **Calaenas nicobarica** (Linnaeus) (Nicobar Islands) Nicobar Pigeon

5: 2 ♂♂ 2 ♀♀ 1o? (1 chick in spirit) 2 South Sentinel, 3 Battye Malve.

On South Sentinel Island which is about 5 miles in circumference, Grubh estimated a population of 50-75 birds, mostly seen feeding on the ground among dry leaves in a little clearing. When first approached they would rise and settle in trees hardly 20 yards away, but flew further away if disturbed again. At Battye Malve, about 19 miles north of Car Nicobar, they were abundant and many trees, large and small, held nests with birds sitting on single young. Many immature birds, distinguished by their green and not white tails, flew around. A Nicobarese companion said the egg-laying period was over.

The call was a heavy typical pigeon-like *hu-hu* or *hu-hu-hu* which was only heard at Battye Malve. They were also so tame here that one could shoot many one after another with a .22. A flock often fed on the ground 30 feet away.

A member of the Survey of India said that he had seen both adults and young drinking sea-water collected on coral ledges adjoining the sea. Hume (STRAY FEATHERS **2**: 96), who visited this island on 19 March 1873, estimated that there were between 2,000 and 10,000 birds and that here they " fed on the small white albuminous seed, which the undergrowth (and one never met with anything like it elsewhere) here produces in such enormous quantities and with which we found the crops of young and old crammed. . . .".

When writing on Nicobar birds I had referred to this island being shelled by the Navy for target practice. I had then drawn the attention of one of the officers to the damage done to this wonderful pigeon and I understand that this practice has now been suspended.

548 **Psittacula eupatria magnirostris** (Ball) (Andaman Islands) Large Andaman Parakeet

1 ♂ 3 ♀♀ Narcondam Island.

Common at Narcondam where it was also noted by Osmaston.

552 **Psittacula alexandri abbotti** (Oberholser) (South Andaman Island) Andaman Redbreasted Parakeet

1 o? South Andamans.

Juvenile, with red bill, no red on breast, and brownish, not grey head.

576 **Cuculus micropterus micropterus** Gould (Himalayas*) Indian Cuckoo

1 ♂ Mithakhari, South Andamans. 11 April 1969.
Wing 210; tail 160.

580 **Cuculus saturatus saturatus** Blyth (Nepal) Himalayan Cuckoo

1 ♀ South Andamans. 8 March 1969.
Wing 179; tail 133.

592 **Eudynamys scolopacea dolosa** Ripley (Barren Island, Andamans) Andaman Koel

1 o? South Andamans.
Wing and tail in moult, but washed with rufous above.

Osmaston heard and saw a good many on Narcondam in early October and thought they were undoubtedly cold weather visitors. We saw some on Barren Island on 30 April.

603 **Centropus (sinensis) andamanensis** Beavan (Andaman Islands) Andaman Crow-Pheasant

1 ♀ obtained at Sipighat on 6 March had enlarged ovaries. Grubh notes that in addition to its usual hoot, solitary birds were heard to utter an oft-repeated *chur-r-r-ooo*, which is occasionally heard in the mainland form.

607 **Tyto alba deroepstorfii** (Hume) (Aberdeen, South Andamans) Andaman Barn Owl

1 o? South Cinque Island, South Andamans.

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* The type locality is shown to be restricted to the Simla-Almora Districts in Stuart Baker's FAUNA (4: 144).

One of two birds seen among trees on this well-wooded island was obtained.

This bird, which appears to be very rare in collections, agrees with the original description, and is very different from Indian birds. The wing (258 mm.) and tail (110 mm.) are shorter. The Zoological Survey of India also have a ♂ (No. 18666) with a 241 mm. wing collected before 1890 in the Andamans, and with no other data.

613 **Otus balli** (Hume) (South Andaman Island) Andaman Scops Owl

The bird recorded as of this species (*JBNHS* **61**: 534) is *Otus scops modestus* (Walden) as later determined by Dr. Biswas at the British Museum (N.H.).

645 **Ninox scutulata obscura** Hume (Camorta, Nicobars) Brown Hawk-Owl

1 ♂ South Andamans. Wing 222; tail 130.

In the Andaman paper (*JBNHS* **61**: 535) I had referred to specimens obtained by Abbott and Kloss at Car Nicobar, Katchal, and Little Nicobar under *obscura*. It is now noticed that though these were listed as *Ninox scutulata*, they are now under *Ninox affinis* and no specimen of *obscura* from the Nicobars is now traceable. It has therefore yet to be determined if the birds from the Andamans are the same as topotypes. Hume specifically stated that two from the Andamans differed from the type from Camorta, the former being termed " older".

672 **Caprimulgus indicus jotaka** Temm. & Schl. (Japan) Migratory Nightjar

1 ♂ lat. 12° 34′ 30″ N.; long. 93° 38′ 30″ E. *c*. 60 miles north-east of Port Blair.

See *JBNHS* **67**: 331.

679 **Caprimulgus macrurus andamanicus** Hume (Jolly Boys Island, South Andamans) Andaman Longtailed Nightjar

2 ♀♀ 1 Port Blair, 1 Wrightmyo, South Andamans.
Wings 183, 187; tails 126, 134.

The birds taken on 1 and 9 April both had enlarged ovaries. The first had already laid an egg and had another shelled egg in the oviduct. They were found among dry leaves on the ground in thick forest. Also seen on South Cinque Island.

684 **Collocalia brevirostis innominata** Hume (Type from Port Mouat, S. Andamans) Hume's Swiftlet

Osmaston has listed this as seen in numbers around the summit of the mountain at Narcondam and suggested that it bred along the south coast of the island. No specimen was taken and, in view of the great confusion that has dogged the identity of *innominata*, I wonder if it is worthwhile accepting these records as has been done in IND. HANDBOOK.

687 **Collocalia esculenta affinis** Beavan (Port Blair, South Andamans) Whitebreasted Swiftlet

1 ♀ Port Blair, South Andamans. 12 April 1969. Wing 97 mm.

The bird was taken from a nest with 1 egg on the wall of the local jail, near the roof.

723 **Alcedo atthis bengalensis** Gmelin (Bengal) Indian Small Blue Kingfisher

3 ♀♀ 5 March, 3 and 11 April 1969. South Andamans. Wing 71(3).

738 **Halcyon smyrnensis saturatior** Hume (Andaman Islands) Andaman Whitebreasted Kingfisher

This kingfisher has been recorded only from the Andamans, but I notice that one specimen, " Nicobars (R. S. Wimberley) Tweedale Col." is listed in Sharpe's, 1892, CATALOGUE OF BIRDS IN THE BRITISH MUSEUM, p. 227. As it has not been referred to in any of the published reports, I presume that some uncertainty exists.

739 **Halcyon pileata** (Boddaert) (China) Blackcapped Kingfisher

1 ♀ Narcondam Island. 30 April 1970.

Osmaston saw two and thought it rare.

Struck by a hawk on previous evening, picked up near camp.

743. **Halcyon chloris occipitalis** (Blyth) (Nicobars) Whitecollared Kingfisher

In my Nicobar report (*JBNHS* **64**: 175) I referred to differences in plumage, probably linked with sex, overlooking the fact that Richmond (1903, *Proc. U. S. Nat. Mus.* **25**: 301) had already expressed a similar opinion. A re-examination of the material available, in the course of cataloguing the Bombay collection, indicates that Car Nicobar birds are different not only from those from the Andamans (*davisoni* Sharpe) but also from those from further south, i.e. Central Nicobars.

Blyth, 1846 (*J. Asiatic Soc. Bengal* **15**: 23, note; 51) when describing this from the Nicobars compares it with the Andaman race and says " the back is more infuscated than the other and the crown is likewise very dark, with some fulvous lateral edges to the frontal feathers". The rufous feathers do not show in the Car Nicobar birds (7: 4 ♂♂ 3 ♀♀) but appear in those from Central Nicobars, which are also darker on the head and back. I am therefore restricting the type locality of *occipitalis* to Camorta, in Central Nicobars. Peter's CHECKLIST (1945, 5: 207-213) however covers 47 subspecies, mostly from different islands, and I cannot separate the Car Nicobar birds without access even to their descriptions!

745 **Merops leschenaulti andamanensis** Marien (Port Blair) Andaman Chestnutheaded Bee-eater

3: 2 ♂♂ 1 ♀ South Andamans.
♂♂ Wings 113, 115; tails 80, 83.
♀ Wing 111; tail 84.

Common everywhere. The female obtained on 3 April had an unshelled egg in the oviduct.

748 **Merops philippinus philippinus** Linnaeus (Philippine Islands) Bluetailed Bee-eater

1 ♀ South Andamans.

The specimen was obtained on 3 March 1969. Specimens were collected at Trinkut on Central Nicobars on 16 March 1966. I saw it at Port Blair two days later. We have still to determine where it breeds, presumably between the end of March and October when it returns. Osmaston noted them at Narcondam.

762 **Eurystomus orientalis gigas** Stresemann (Rutland Island, South Andamans) Broadbilled Roller

2: 1 ♂ 1 ♀ Wrightmyo, South Andamans.
Wing ♂ 202, ♀ 198; tail 111, 111.

762*a* **Eurystomus orientalis** subsp.

1 ♀ Narcondam Island. Wing 193; tail 93.

This bird, with a very small bill, was sent to Dr. Ripley who (*in epis.*) calls it *cyanocollis* < *deignani*, matching the latter in bill size and overall coloration, and with the large wing and tail of *cyanocollis*.

773. **Rhyticeros (undulatus) narcondami** (Hume) Narcondam Hornbill 4: 293

7: 4 ♂♂ 3 ♀♀ Narcondam Island.

	Wing	Tail	Bill
♂♂	302-316 av. 309 (303-305)	187-199 av. 195 (195-198)	120-129 av. 124 (121-126)
♀♀	283-293 av. 286.5 (285-287)	177-195 av. 188.5 (180-182)	103-111 av. 106

The measurements include those of two old skins in the collection. All the specimens show traces of moult on the belly and the primaries.

On his first visit on 23 April 1969 Grubh obtained 7 specimens all of which had a large amount of fat on the abdomen and rump and were breeding. Presumably arising out of the conversations during this trip, the policemen had been forbidden to shoot any and had confiscated 3 young taken by the Survey of India party; these were eaten up by rats at night. Four types of seeds and fruits including a *Ficus* sp. were obtained in their stomachs, but it has not been possible to identify them. Grubh was also informed that the female was not seated in the nest, but that both parents fed the young, one of the sepoys having caught both mother and nestling after she had entered the hole to feed it.

On the second trip (29 April 1970) we noted this as the commonest bird on the island, constantly attending to a *Ficus* sp. (*religiosa?*). A ♂ collected had the rump and belly covered with fat. The stomach contained green peepul fruit, which all appeared to be broken in half? [See also observations at page 392 above.]

Osmaston who was on Narcondam from 1-6 October said: " I secured altogether 10 specimens which were carefully skinned and preserved. Five times that number might easily have been shot." Stuart Baker referring to Osmaston says: "Standing under the huge fig-trees, the fruit of which they feed upon, he shot 10 specimens and could have killed ten times that number."

831 **Drycopus javensis hodgei** (Blyth) (Andaman Islands) Andaman Black Woodpecker

1 o? Wrightmyo, South Andamans.

846 **Picoides macei andamanensis** (Blyth) (Port Blair, Andaman Islands) Andaman Spottedbreasted Pied Woodpecker

5: 3 ♂♂ 1 ♀ 1 o?

2 Mithakhari, 2 Wrightmyo, 1 South Andamans.

Wings	♂♂ 97, 99, 99	♀ 99	o? 101	(♂♀ 94-101)
Tails	♂♂ 59, 60, 60	♀ 57	o? 61	(♂♀ 55- 60)

One bird was busy drumming and ignored the approach of the collector.

917 **Hirundo rustica gutturalis** Scopoli (Philippines) Swallow

Osmaston noted it at Narcondam.

920 **Hirundo tahitica javanica** Sparrman (Java) House Swallow

1 ♀ South Andamans. Wing 108; tail 48.

950 **Lanius cristatus lucionensis** Linnaeus (Luzon) Brown Shrike

1 ♀ Port Blair, S. Andamans, 30 March 1969.

957 **Oriolus chinensis macrourus** Blyth (Nicobar Islands) Blacknaped Oriole

1 ♀ Battye Malve, 24 March 1969. Wing 151; tail 114.

958*a* **Oriolus xanthornus andamanensis** Abdulali (Wrightmyo, S. Andamans) Blackheaded Oriole

1 ♂ Bambooflats, S. Andamans, 9 March 1969. Wing 131; tail 50.

This is presumably a juvenile in which the yellow is not as deep as in the adult, the black on the chin and head less intense, and with tinges of yellow on the forehead and point of chin.

980 **Dicrurus paradiseus otiosus** (Richmond) (Andamans) Racket-tailed Drongo

1 ♂ Port Blair, S. Andamans, 1 April 1969.

983 **Artamus leucorhynchus humei** Stresemann (Andamans) Ashy Swallow-Shrike

2 ♂♂ Wrightmyo, S. Andamans, 9 April 1969. Both had enlarged testes.

986 **Aplonis panayensis tytleri** Hume (Andamans) Glossy Tree Stare

1 ♂ S. Andamans. Wing 117.

Nesting in tree holes during March/April 1969.

991 **Sturnus erythropygius erythropygius** (Blyth) (Car Nicobar) White-headed Mynah

1 ♂ Car Nicobar, 23 March 1969.

1018 **Gracula religiosa andamanensis** Beavan (Andamans) Hill Myna

1 ♂ Chauldhari, S. Andamans. 1 ♀ Narcondam Island.

Wing ♂ 175, ♀ 169; tail ♂ 82, ♀ 81; bill (from skull) ♂ 27, ♀ 28.

In fresh specimens of both sexes the bill is apple-red except *c.* 10 mm. at tip which is yellow. Within a year the whole bill becomes yellow.

1040 **Dendrocitta bayleyi** Tytler (Andamans) Andaman Tree Pie

2: 1 ♀ Wrightmyo, 1 ♂ S. Andamans.

1075 **Coracina novaehollandiae andamana** (Neumann) (Andaman Islands) Large Cuckoo-Shrike

1 ♀ S. Andamans, 5 March 1969.

Shell-less egg in oviduct, which was distended.

1076 **Lalage nigra** subsp.

See P. K. Das (loc. cit.)

1095*a* **Pericrocotus cinnamomeus** subsp. Little Minivet

4: 2 ♂♂ 2 ♀♀
2 Wrightmyo, 2 S. Andamans.

After the manuscript was handed in, Vol. 6 of IND. HANDBOOK has been published where *thai* Deignan is synonymized with *vividus* Baker, which is said to occur in the Andamans. As this conflicts with my findings, I am withholding them until I have had the opportunity of considering the matter afresh.

1109*a* **Irena puella andamanica** Abdulali (Long Island, Middle Andamans) Fairy Bluebird

2 ♀♀ Chauldhari, S. Andamans.

A re-examination of the material available indicates that though Andaman birds have heavier bills and slightly longer tails (♂♀ 100-110 av. 106 cf. 95-105 av. 101.7 in *sikkimensis* and 95-106 av. 101 in nominate *puella*), they do not represent a very distinct race.

I must also mention that the wing measurements of *sikkimensis* and nominate *puella* overlap to some extent and the former is not as distinctly larger as stated in the original description (*JBNHS* **36**: 582)*

8 ♂♂ nominate *puella*	125-133 av. 128	(*123-131)
8 ♂♂ *sikkimensis*	125-136 av. 133	(*133.5-141)

I notice that INDIAN HANDBOOK (**6**: 63) has synonymized both *sikkimensis* Whistler & Kinnear and *andamanica* with the nominate form.

1113 **Pycnonotus atriceps fuscoflavescens** (Hume) (Port Mouat and Mount Harriet, S. Andamans.) Blackheaded Bulbul

1 Bambooflats, S. Andamans.

1407 **Muscicapa latirostris** Raffles (Sumatra) Brown Flycatcher

2 o? S. Andamans, 4 and 9 April 1969. Wings 71, 71; tails 48, 49.

1467 **Monarcha azurea tytleri** (Beavan) (Port Blair, Andamans) Black-naped Flycatcher

2 ♂♂ (one by plumage) S. Andamans.

1470 **Pachycephala cinerea cinerea** (Blyth) (neighbourhood of Calcutta) Grey Thickhead

3: 1 o? South Sentinel; 1 ♂ Mithakhary, 1 ♂ Port Blair, S. Andamans.

1554 **Acrocephalus orientalis** (Temminck & Schlegel) (Japan) Eastern Great Reed Warbler

4: 3 ♂♂ 1 o? 5th March (2); 8th March (1); 2nd April (1).

No. 23239 does not have the second primary greater than the fifth as required in the FAUNA but conforms with the alternative formula $3 > 2 > 4$ in BIRDS OF U.S.S.R. **6**, p. 328.

1604 **Phylloscopus trochiloides trochiloides** (Sundevall) (Calcutta) Dull Green Leaf Warbler

1 o? Chauldhari, S. Andamans. 5 April 1969.

This specimen (BNHS No. 23450) was identified by Dr. Ripley.

1668 **Copsychus malabaricus albiventris** (Blyth) (Andamans) Shama

1 ♂ Calicut, S. Andamans, 13 April 1969.

Except for Zoological Survey Sp. No. 28363 (Wrightmyo, S. Andamans, 31 March 1964), this is the only one seen or obtained in recent years. Its numbers would appear to have declined appreciably, unless we have missed some very restricted ecological niches occupied by the species.

1735 **Zoothera citrina andamanensis** (Walden) (Andamans) Orange-headed Ground Thrush

1 ♂ South Cinque Island, off South Andamans.

This specimen agrees with one collected on Car Nicobar and is different from others from Camorta and Nancowry, Central Nicobars (*JBNHS* **64**: 186). Hume 1876 (*Stray Feathers* **4**: 289) doubted the validity of *andamanensis*, but did not indicate where his Nicobar specimens were obtained. It is possible that the Car Nicobar population is similar to that from the Andamans, in which case the type locality of *albogularis* (now "Nicobars") may well be restricted to Camorta-Nancowry, Central Nicobars.

My reference (loc. cit.) to the olive-green wash on the back of the Andaman specimens was unnecessary for this was a sexed female, while the Nicobar birds were males.

1762 **Turdus obscurus** Gmelin (Siberia=Lake Baikal) Dark Thrush

2 ♂♂ Narcondam Island—23 April 1969, 30 April 1970.

It is curious that this bird, presumably a winter visitor and of which there are only three records from the Andamans, should have been obtained on both the short visits to Narcondam.

1874 **Motacilla indica** Gmelin (Malabar) Forest Wagtail

Osmaston noted it at Narcondam.

1884 **Motacilla caspica caspica** (Gmelin) (Caspian Sea) Grey Wagtail

1 ♂ South Andamans 9 March 1969. Wing 178; tail 64.

Osmaston noted it at Narcondam.

1903 **Dicaeum concolor virescens** Hume (Neighbourhood of Port Blair) Plaincoloured Flowerpecker

1 ♀ Sipighat, S. Andamans, 20 March 1969, with enlarged ovaries and a distended oviduct.

1913 **Nectarinia jugularis andamanica** (Hume) (Andaman Group) Yellowbreasted Sunbird

2 ♂♂ 1 Narcondam Island; 1 South Sentinel (badly damaged and destroyed).

The Narcondam bird (obtained in 1969) has a 60 mm. wing which is larger than in two from Middle Andamans, 50, 54. The South Sentinel specimen had a 57 mm. wing.

Osmaston noted it as the commonest bird on Narcondam. I only got a glimpse of it during my short visit.

1936 **Zosterops palpebrosa nicobarica** Blyth (Nicobars) White-eye

1 ♂ Bambooflats, 2 ♀♀ South Sentinel Island, S. Andamans.

The male obtained on 9 March had enlarged gonads.

1939 **Passer domesticus** subsp. House Sparrow

1 ♂ Sipighat, 1 ♀ Chauldhari, S. Andamans.

In my Andaman report (*JBNHS* **61**: 569) I had referred to specimens from Port Blair (where the species was introduced in 1895) not quite agreeing with those seen in Bombay and other parts of India. The two specimens obtained do not permit me to comment further but a re-examination enables me to re-confirm that the birds from Shwebo, North Burma, are not the same as those occurring in peninsular India. It would also appear that the large numbers of migratory sparrows with pale-coloured bills, which are ringed at Bharatpur are not *parkini* Whistler as at present accepted, but probably *bactrianus* Zarudny & Kudashev, which are said to migrate to northwestern India (Peter's CHECKLIST OF THE BIRDS OF THE WORLD **6**: 12) but has not been included in the FAUNA or SYNOPSIS.

First Report of the Yale-Bombay Natural History Society studies of Wild Ungulates at the Gir Forest, Gujarat, India

BY

S. H. Berwick[1] and P. A. Jordan[2]

(With a plate)

Introduction

This report covers the first four months, March-June, 1970 of field work in the collaborative research project, "Habitat Relationships, Numbers, and Distribution of Wild Ungulates in the Gir Forest, India", Smithsonian Institution Grant No. SFG-0-1894 funded under the Public Law 480 foreign currency surplus programme.

The Gir Forest in Gujarat State, India, has long attracted the attention of conservationists in India and elsewhere because it holds the last remnant population of the Asiatic Lion, *Panthera leo persica.* The Gir is further valued by ecologists for having the largest and virtually only representation of the original flora and fauna once widespread through semi-arid northwestern India. During a survey of the threatened fauna of southeastern Asia, Talbot (1960) concluded that the Gir lion was in serious jeopardy both from direct killing and from deterioration of the Gir Forest by excessive livestock pressure.

Considering the great difficulty of preserving a natural community of over 400 square miles where exploding population and under-nutrition create a great demand for agricultural development, the Gujarat forest department has done well in holding the Gir as a wildlife sanctuary. It is further encouraging to note that a totally protected 75 square mile national park is being planned within the Sanctuary. The State has received encouragement in these efforts from the Government of India and from conservation groups the world over. Authorities also realise that if large-scale tourism is to be developed, fauna and flora must be preserved. Nevertheless, the continued presence of tens of thousands of livestock depleting vegetation and soils of the Gir plus slow but steady incursions of cultivation around the edges, forces the question of how long can the Gir support the lion and other large wildlife? There are of course both political and ecological questions, all of which must soon be answered if this valuable natural community is to be preserved. The present study addresses a key ecological aspect: what are the requirements and

1 Sasan Gir, Gir Sanctuary, Gujarat.

2 Asst. Professor, School of Forestry, Yale University, U.S.A.

current status of the ungulate species of the Gir—that set of animals which comprise the natural or wild food of the lion.

In October 1968, Jordan submitted for the School of Forestry, Yale University, a proposal to the Smithsonian Institution to study the wild ungulates of the Gir. Simultaneously, Mr. Futehally submitted for the Bombay Natural History Society a parallel proposal to the Indian Screening Committee, in accordance with procedures for involvement of P.L. 480 funds for ecological investigations. In March, 1969, Jordan, accompanied by Dean Francois Mergen and Professor W. R. Burch of the Yale School of Forestry, visited India to meet collaborators and evaluate research opportunities. Both of the above proposals, after some delay and revision, were approved during 1969. Yale's participation involves mainly the full-time field work of Mr. S. H. Berwick, a doctoral candidate doing this research for his dissertation. In addition to collaborating with various Indian scientists, Mr. Berwick will assist several Indian student fellows in independent study related to the overall objectives of the Yale-BNHS programme.

The studies outlined in the proposal and slightly amended in a subsequent document by Berwick, involve censusing and comparing niche relationships among six species of ungulates now extant and one recently extinct within the Gir. These are the wild boar (*Sus scrofa*), chinkara or Indian gazelle (*Gazella gazella bennetti*), four-horned antelope (*Tetracerus quadricornis*), nilgai or blue bull (*Boselephas tragocamelus*), chital or spotted deer (*Axis axis*), and the sambar (*Cervus unicolor*); the locally extinct species is the blackbuck or Indian antelope (*Antilope cervicapra*).

Ungulate populations at the Gir now are apparently far below levels assumed normal for this region were habitat not disturbed. Restoration of ungulate numbers is critical not only to maintaining the original natural community but also to providing enough wild prey for the lions as well as for the other large carnivores here—leopards, wolves, and hyenas. Lions, according to Joslin's studies (1969), now subsist largely on domestic animals, a situation which is neither good for the lions (biologically or politically) nor for the local economy.

The Yale-BNHS research in designed to provide heretofore little known information on the comparative ecology of these large herbivores as they coexist in this part of the world. By field observation and experiments with penned, semi-tame specimens, feeding niches and climatic tolerances are being compared. Numbers, population dynamics, and habitat affinities are being measured and compared. The combined results should reveal the causes of current underpopulation and hence, suggest management strategies for restoring these species to normal levels.

Numbers, Distribution and Composition of Ungulates

A first priority at the Gir was estimation of numbers and distribution of each species of ungulate. A survey for this purpose had been made by Joslin the previous year.

(*a*) *Techniques*

To properly sample a large area such as the 450 square mile Gir, one must use a wide ranging, uniform technique. Fortunately the Gir is covered by a network of roads being rather evenly spaced and traversing all habitats except steep hills. Furthermore, density of vegetation during the dry season, i.e. after the many deciduous trees and shrubs have shed their leaves, affords consistent visibility of animals back 20-200 metres from the road. Thus it was possible to use a strip-count sampling similar to that described by Hirst (1969). From west to east along a gradient of diminishing moisture, the density of vegetation diminishes. The Gir was divided into three regions each characteristically different in dominant vegetation—west, middle, and east. Census sampling was then stratified according to this division.

Extrapolating density from strip counts requires that strip-width be estimated as accurately as the number of animals within the strip. To estimate average maximum distance at which the average sized ungulate is visible, tests were made with cardboard models the size and colour of chitals, the median-sized species and also the most abundant one. For night spot lighting, a model with eye-like reflectors was substituted. From randomly chosen points along the road, one man moved the model away while another, watching from a jeep, indicated when the model could no longer be seen. The disappearance distance was then measured by tape. For both night and daylight visibility, 70 tests each were made to obtain a mean distance. Hirst (1969) compared stationary-observer results with the spotting of randomly placed models from a moving vehicle and found no significant difference between the two methods. Strip-width equals two times disappearance distance since counts are made from both sides of the vehicle. Strip-widths in 1970 were determined only for the mixed teak forest typical of the middle region: there was inadequate time for testing elsewhere. Widths were 128 and 100 metres for daylight and night respectively. It will be possible to test in several other types next spring. If widths are found to be different elsewhere, this year's figures can be subsequently recalculated, since all records are kept by map location.

Above: Acacia Forest, Eastern Gir.

Below: Measuring 'disappearance distance'.

(Photos: Author)

Counts were made between 23 March and 11 May. Daylight runs were confined to the cool, early hours of 6-9 a.m. while the 2-4 hours of night counting started ½ hour after darkness (about 7.45 p.m.). When, for a given area, both day and night counts were made, the same road was run for both counts on the same day. Otherwise there was no repetition of road coverage. For each species in each region, density estimates based on daylight *vs.* darkness counts were compared, and the higher figure was selected for subsequent calculations. It is reasoned that highest counts will result when feeding activity in the species is greatest, i.e. when most animals are on their feed. Since strip-width estimates are based on visibility of standing animals, consistency dictates that counts be made whenever the greatest portion are on their feet.

Densities calculated from the strips are extrapolated for the three regions, and these are then summed for the whole Gir. Areas of the three strata were determined from planimetry of a rather crude map. If and when a better map is available, totals will be recalculated.

(b) *Results and Discussion*

Strip counts were made along some 996 km. of roads: 416 km. in daylight and 580 km. after dark. Considering separately each species estimate in each region, higher density estimates resulted from night counts than day counts in 2 out of 3 cases. Of the most abundant species, chital and nilgai, chital were better represented at night while nilgai results were divided about evenly between day and night counts. Of the four less abundant species, sambar and pig were about evenly represented while four-horned and chinkara were consistently more visible at night. Table 1 shows estimated densities and totals for each region and for the entire Gir.

The results of this survey agree rather well with Joslin's (pers. comm.) survey made one year earlier. His counting was all at night, and his calculations were based on an estimated strip-width of 75 rather than 100 metres. Joslin covered 1,025 km. of roads, but this involved some duplications. He estimated a total of 7,200 ungulates with 5,400 chital as compared to our 6,242 and 4,404 respectively. Had Joslin applied a strip-width of 100 metres, then his total would be 5,400 with 4,050 chital. While the agreement is close for chitals, this year's total of all species is notably larger. It seems reasonable that, by covering the sanctuary more widely this year, a greater diversity of habitat was encompassed, hence the unevenly distributed, rarer species were probably sampled more representatively. Likewise, inclusion of daylight counts probably improved representativeness of some species.

TABLE 1

ESTIMATED DENSITY OF SIX UNGULATES IN THE GIR FOREST BASED ON ROAD STRIP SAMPLING AND CALCULATED SEPARATELY FOR THREE REGIONS OF THE SANCTUARY. THE TOTAL NUMBERS RECORDED DURING THE CENSUS, COMBINING DAY AND NIGHT COUNTS, ARE SHOWN AT THE BOTTOM

Region and its size	Calculated	Species					
		Chital	Nilgai	Sambar	Four-horned	Chinkara	Boar
Western	Number/km² ...	3.05	0.54	0.35	0.31	0.039	0.038
538 km²	Total	1,642	291	186	166	21	21
	Abundance Ratio ...	100	18	11	10	1	1
Middle	Number/km² ...	4.98	0.83	0.26	0.26	...	0.10
348 km²	Total	1,735	289	90	90	...	36
	Abundance Ratio ...	100	17	5	5	...	2
Eastern	Number/km² ...	3.57	1.47	...	...	0.62	0.15
288 km²	Total	1,027	424	...	...	179	45
	Abundance Ratio ...	100	41	0	0	17	4
Gir Forest	Number/km² ...	3.75	0.85	0.24	0.22	0.17	0.09
1,175 km²	Number/mi²	9.7	2.3	0.6	0.6	0.4	0.2
453.5 mi²	Total	4,404	1,004	276	256	200	102 (total 6,242)
	Abundance Ratio ...	100	23	6	6	5	2
	Numbers Counted ...	389	64	26	15	12	5

Chinkara are probably over-estimated. The species prefers the areas where vegetation is most open, hence where the average distance of visibility exceeds the calculated strip-width.

The low figure for wild boar, when contrasted with past observations and reports, suggests a sharp and recent decline in that species. Residents of the Gir claim that boar was the most numerous ungulate but a few years ago. A high frequency of boar among all ungulate skulls now being recovered throughout the forest evidences their recent abundance. While farmers and others are increasing their efforts to eradicate boar from cultivated fields surrounding the Gir, the skulls being picked up for this study are usually well inside the Gir many miles from fields. It is possible the population has suffered a severe epidemic.

The stratified analysis indicates interspecies distributional difference within the Sanctuary. Sambar are most abundant in the west, chinkara in the east, and four-horned antelope in the middle region. Chital and nilgai, the two most numerous species, are more uniformly distributed than the others. Nilgai are notable for existing equally well in the most dense and in the most open of vegetation.

Information gathered on the extirpated black buck indicates that this species was once locally abundant in the flat open areas of the western and eastern margins of the Forest. The disappearance of black buck some 15-25 years ago may well be related to incursions of agriculture across the boundaries of the Sanctuary.

Sex and Age Composition

In travels about the Gir as well as during the census, sex and age are recorded at each sighting of ungulates as long as it is possible to accurately classify every individual sighted at one place and time. During the first months of field work, such classification was impeded by lack of familiarity with growth rates and phenology in the six species. Assuming the necessary criteria will be in hand soon, not only will subsequent classification be more reliable, but some early data can be reanalyzed.

Table 2 summarizes population structure as measured during the first months of this study, the dry season, using provisional criteria of classification. Among limited numbers of four-horned antelope and chinkara classified, no small-sized individuals were recorded. For all species, it is suspected that females are under-represented here. Since groups within which all animals are not classifiable are not recorded, it follows that as size of group increases so also does the probability of that group's not being included in the sample. It appears that females are more likely to predominate large groups than small ones. If so, females are being undersampled. As a direct consequence, young, as a per cent of the total population, would likewise be underestimated. An adjustment in calculations to avoid this bias has been devised and is being tested: it simply requires that group size be recorded in every encounter whether or not complete classification is achieved.

TABLE 2

AGE AND SEX RATIOS IN FIVE UNGULATES ESTIMATED FROM OBSERVATION SAMPLING DURING MARCH-JUNE, 1970

Species	Adult		Young
	Male	Female	
Chital	35 (97)	100 (274)	31 (84)
Nilgai	89 (55)	100 (62)	4 (31)
Sambar	33 (11)	100 (33)	55 (18)
Four-horned	100 (11)	100 (11)	......
Chinkara	100 (11)	100 (11)	......

" Young " is not necessarily year-class I, since criteria of growth and parturition season are not yet available for these species at the Gir. Numbers in parentheses show sample size.

The tendency to aggregate, i.e. display positive social cohesiveness as opposed to mere chance proximity, is measured by the average number seen moving together as a group. Variation in group size can reflect differences in density or in sex or age makeup of the local population as well as reflecting a general tendency within a species to aggregate. Aggregation can vary with feeding habits, time of day, cover, or the point of the annual reproductive cycle. To factor out what regulates grouping tendency requires many types of information. Assuming this information will eventually be uncovered during these investigations, presentation of quantitative results is deferred.

Of all the ungulates, the two most common, chital and nilgai, are the most gregarious, at least during the period March-June. No notable differences in group size appeared for any species by region or habitat type. Unlike chital and nilgai, mixed-sex groupings of sambar, four-horned antelope, and chinkara consistently involved a single adult pair. This suggests breeding behaviour in these last three, but again further information will be required. Pursuing these measurements through the year will be important to determining the timing of mating. In this regard it is noted that chital were dropping antlers just before the monsoon (June), while sambar were in velvet (antlers growing) at that time. It is anticipated the entire picture of phenology of mating and parturition will be defined for the ungulates of the Gir, and this in turn can be related to resource phenologies and climatic tolerances.

Vegetation Surveys and Grazing Measurements

This phase has not yet produced reportable results; however, considerable groundwork has been laid on several phases of investigation. Berwick mastered the identification of the woody flora of the Gir, during which exercise a collection and series of drawings was made of more than 70 species. Familiarization with herbaceous flora was aided by collections prepared and checked by Mr. Hodd. With Mr. Hodd, grasses are being grown free of grazing to assemble a series of tissues representing various growth stages; these will be used in identifying food items from rumen contents or feces.

To gain familiarity with vegetation patterns within the Gir, Berwick made an extensive foot survey across the Forest, recording composition and frequency in 78 types. Each of these types can be relocated on the ground as well as on aerial photographs. Sampling information included stem density, diameter of stems, height of trees, and composition of shrub and herbaceous layers. During the walk, a tally was made of droppings of domestic stock within a 5-foot strip except near herdsmen's villages (nesses). This index will show relationships between livestock distribution during the dry season and vegetation types.

Initial analyses of the survey reveal that tree density is somewhat uniform from the west through the middle of the Gir but from there eastward decreases sharply. The same can be said for the Forest's dominant species of tree, teak (*Tectona grandis*). On the other hand, diversity of woody species increases from west to east.

Grazing-free plots of grass, maintained by fencing out animals, were established in two widely separated locales. Both sites are well removed from nesses, hence from excessive livestock pressure. The production of herbaceous forage will be estimated by clipping samples within the exclosures; differences between inside and outside clippings at selected seasons will provide estimates of grazing removals. Distinction of wild *vs.* domestic grazing will be possible by using exclosures with differential accessibility: one excludes all ungulates, as well as most smaller herbivores, while the other excludes livestock only. Species of wildlife will be distinguished by feces and by direct observation from concealed vantage points. There are 10 plots exclosed, each 20×20 feet, along with an equal number of matched control plots.

In his work with livestock grazing, Mr. Hodd constructed a series of similar exclosures, mostly near nesses. Results from the present study will complement Hodd's in that the most heavily and least heavily used areas by livestock will have been studied. Mr. Hodd suffered considerable loss of data from a variety of disturbances within his exclosures. Based on his experience, we have taken special precautions to prevent these serious misfortunes.

Total Production and Demand for Grass

In order to guide the design of measurements and experiments on grazing capacity at the Gir, a speculative model of grass productivity and usage was constructed. This is but a preliminary exercise; nevertheless it suggests the sorts of results which this work, in conjunction with that of Hodd and Joslin, should produce.

The following calculations are based on best estimates of forage consumption among ungulates — wild and domestic — and early results of Hodd's grass production sampling. Data for the entire forest are simulated as means for estimating the optimal stocking level. Criteria of good range management used here are, unfortunately, those relevant to temperate rather than tropical grasslands.

North American range experts generally agree that grass ranges which are "good" to "excellent" can remain in such condition if no more than 50-60 per cent of annual production is removed by grazing (U.S. Forest Service, 1963; Stoddart & Smith 1955; Jameson 1962). However, ranges in "poor" condition will degrade further or fail to recover if more than 25 per cent of annual production is removed. There is little doubt that range scientists would classify much of the Gir as currently in "poor" condition.

Table 3 lists the estimated numbers of each species of ruminant within the Gir, average live weights, and the calculated live weight biomass of each population. Because this is but a working model and most input data are expressed in English measure, metric equivalents are not shown. Table 4 details the procedure for estimating the amount of grass utilized by each species on a per pound live weight basis. From this is calculated with data from Table 3 the total annual demand for grass.

There are approximately 450 square miles of grazing land within the Gir. Productivity of grass is estimated at 542 pounds (dry weight) per acre (Albertson 1959; Hodd 1969). Domestic animals are given supplements of cottonseed and groundnuts (peanuts) at approximately 1.75 pounds per day. In addition to grass removed by animals or cut by herdsmen for domestic animals within the Gir, some 44×10^5 pounds of grass are cut and removed from the Forest by fodder cutters each year, according to Gujarat Forestry officials.

TABLE 3

POPULATION AND BIOMASS OF UNGULATES IN THE GIR FOREST

Species	Numbers[1]		Average live weight[2]		Species—Average Biomass Lbs. × 10^5
	Adults	Young	Adults	Young	
Zebu Cattle	4,634	2,495	650	200	35.11
Domestic Buffalo	11,806	6,357	900	270	123.42
Nilgai	770	330	500	200	4.50
Sambar	208	52	400	150	0.91
Chital	3,680	920	125	50	5.06
Four-horned	180	45	50	25	.10
Chinkara	160	40	50	25	.09

Subtotals:
Domestic 158.53
Wild 10.66

Total ... 169.19

1 Population estimates based on unpublished work of P. Joslin plus the present study.
2 Schaller 1967; Taylor 1969; Ledger 1969; Prater 1965.

For those livestock not year-round residents the number shown reflects their number multiplied by the fraction of a year they are present.

TABLE 4

CALCULATIONS OF GRASS CONSUMPTION PER ANNUM BY THE UNGULATES OF THE GIR FOREST WITH CERTAIN INTERMEDIATE DATA SHOWN

Species	Per cent diet Grass[1]	Grass consumed (lbs.) per live weight pound per day[2]	Annual consumption by population Lbs. × 10^5
Cattle	90	.023	294.75
Buffalo	85	.022	991.06
Nilgai	20	.005	8.21
Sambar	40	.010	3.32
Chital	95	.023	42.48
Four-horned	40	.010	0.37
Chinkara	80	.016	0.53

Totals:
Domestic 1,285.81
Wild 54.91

Total grazing 1,340.72
Fodder cutting 44.00
Total removal/year 1,384.72
(138,471,000 lbs. or 69,235 T)

1 Schaller, 1967; Ledger, 1969.
2 Stoddart and Smith 1955 ; Odend'hal 1969; Albertson 1959; Bilby 1969; Abrams 1969.

It is calculated that annual production within the Gir is 1.56×10^8 pounds. Our rough calculations of grass removal gives 1.39×10^8 pounds per year or 89 per cent of production. Grazing is heavy at the Gir — perhaps up to 75 per cent overall and approaching 100 per cent in some sectors. It is suspected, however, that the above estimate of annual production is low. There is no allowance for foddeı removed by laga-morphs, rodents, and insects — the total of which might well exceed 10 per cent of annual production[1]. These production estimates were based on sample plots located near nesses where soil and vegetation degradation from long overgrazing and trampling is most severe. On the other hand, Hodd believes that the nes effect extends out 1 to 1½ miles, which for 150 nesses distributed rather uniformly, would mean the nes effect covers the entire Gir.

Based on the above figures, if it is desired just to maintain the present low level of wild ungulates while reducing total grass removal to 25 per cent of annual production, a reduction of 74 per cent of current cattle and buffalo grazing is required[2]. Despite the roughness of these calculations, they offer some notion of how severe is the problem of livestock impact at the Gir. The combined results of Hodd's study and the present one should provide a foundation from which a plan of forage allocation can be devised. Such a plan must be based upon land-use priorities and the need to restore and assure equilibrium in the soil-vegetation complex at the Gir Forest.

References

Abrams, J. T. (1968): Fundamental approach to the nutrition of the captive wild herbivore. *In* Comparative Nutrition of Wild Animals, M. A. Crawford (Ed.). The Zoological Society of London, Academic Press, London.

Albertson, F. W. (1959): Improving grasslands in India. Kansas State College U.S. International Co-operation Administration II CAKSC-1. p. 31.

Bilby, Lorette (1968): A pilot scheme to investigate the diets of some of the mammals at the London Zoo. I. Primate diets. *In* Comparative Nutrition of Wild Animals, M. A. Crawford (Ed.). Academic Press, London. pp. 63-74.

Hirst, S. M. (1969): Road strip census techniques for wild ungulates in African woodland. *J. Wildl. Mgmt* 33 (1): 40-48.

Hodd, K. T. B. (1969): The ecological impact of domestic stock on the Gir Forest. Proc. IUCN 10th General Assembly and 11th Technical Meeting, H. 5 (10 p.).

Jameson, D. A. (1963): Evaluation of the responses of individual plants to grazing. *In* Range Research Methods, U.S.D.A., U. S. Government Printing Office, Washington. pp. 109-116.

Joslin, P. (1969): The Asiatic lion—conservation aspects of its ecology. Proc. IUCN 10th General Assembly and 11th Technical Meeting, I. lb. (16 p.)

Ledger, H. P. (1968): Body composition as a basis for a comparative study of some East African mammals, pp. 289-310. *In* Comparative Nutrition of Wild Animals, M.A. Crawford (Ed.). Academic Press, London.

[1] Also corrections have not been made for increased forage consumption due to lactation in the domestic animals where ghee constitutes a major product.

[2] Less than 4% of the grass removed each year is consumed by wildlife and over 90% is consumed by domestic livestock.

Odend'hal, S. (1969): Proc. IUCN 10th General Assembly and 11th Technical Meeting.

Prater, S. H. (1965): The book of Indian Animals. Bombay Natural History Society, Bombay. p. 323.

Schaller, G. B. (1967): The deer and the tiger. University of Chicago Press, Chicago. p. 370.

Stoddart, L. A. & Smith, A. D. (1945): Range management. McGraw Hill Book Co., Inc., New York. p. 433.

Talbot, L. M. (1960): A look at threatened species. A report on some animals of the Middle East and Southern Asia which are threatened with extermination. *Oryx* 5: 153-293.

Taylor, C. R. (1968): The minimum water requirements of some East African bovids. *In* Comparative Nutrition of Wild Animals, M. A. Crawford (Ed.). Academic Press, London. p. 195-205.

U. S. Forest Service, Region 1. (1963): Range Analysis Field Guide FSH 2212.02 rl. p. 164.

The Pigmy Hog *Sus salvanius* (Hodgson) in Northern Assam

BY

Jeremy J. C. Mallinson

Deputy Director

Jersey Wildlife Preservation Trust

(*With a plate*)

Introduction

The Pigmy Hog *Sus salvanius* was first recorded in 1847 and was described by B. H. Hodgson in his paper " On a new form of Hog Kind or Suidae " in the May edition of the *Journal of the Asiatic Field Society, Bengal.* Hodgson stated that it must seem almost incredible that so tiny an animal should effectually resist men, but considered that the Pigmy Hog entirely escaped all notice due to its being exclusively confined to the deep recesses of primeval forest.

The scarcity of records during the intervening years, and the fact that the species still remains virtually unstudied in the wild state has led some authors to record that the pigmy hog was now possibly extinct. However, Simon (1970) states in the Survival Service Red Data Book that the meagre evidence available suggests that the pigmy hog survives in parts of Assam, and may well be distributed in the Nepalese terai.

The purpose of this paper is to record all the data collected during my visit to Assam, in May, 1971, and in particular the observations made on the fourteen adults and the four young being kept in captivity in the Mangaldai sub-division, of Darrang division, Assam.

Captive Stock

At the time of my visit to Assam there were fourteen adult specimens of pigmy hog comprising three males and eleven females, and four young (one male, three females) kept in three separate locations in the Mangaldai sub-division of Assam. One male, six females, and the four young were kept at the Attareekhat Tea Estate; one male, three females at the Paneery Tea Estate; and one male, two females at the Budlapara Tea Estate.

The first two groups came under the ownership of Mr. Dick Graves but are now under the trusteeship of the newly formed Assam Valley

Wildlife Scheme of which India's Prime Minister, Mrs. Indira Gandhi, is the patron. Regrettably, I was unable to observe the three specimens in the third group at Budlapara although the tea company concerned were participants in the Assam Valley Wildlife Scheme.

Some seventeen specimens were caught in the thatchlands between the Rajagarh Forest Reserve and the Attareekhat Tea Estate on the Bhutan/Assam Border. The reason for the dramatic reappearance and subsequent sightings of this rare and endangered species, was due to an extensive fire amongst the thatch during the twenty-four-hour period 21-22nd March 1971 which is reputed to have covered approximately fifty square miles.

The nearby villages immediately started to catch the pigmy hog to sell them for the pot, and it was then that Mr. Graves intervened and gave the villagers a considerably large sum of money if the specimens were brought to him alive.

This timely intervention was prompted by both Mr. Richard Magor, Director of the Attareekhat Tea Company, and founder of the Assam Valley Wildlife Scheme, who in January 1971 told the staff to make an all-out effort to try and secure some specimens of pigmy hog. Also by Mr. John Tessier-Yandell, Secretary of the Assam Valley Wildlife Scheme, who since 1959 had done a great deal of detective work with regard to the whereabouts of the pigmy hog in Assam.

The first pair arrived on 31st March, two females on 3rd April, and the remainder were brought in, at intervals during April. Out of the seventeen brought in, three specimens, one male and two females, died. It is not known what has happened to the skeleton and skin of the male specimen.

It is interesting to note that Hodgson (1847: 423) refers to the annual clearance of the undergrowth of the forest by fire occasionally revealing the pigmy hogs, and the herd is thus assailed at advantage. The pigmy hogs were at first all accommodated at the Attareekhat Tea Estate, but on 5th May four specimens were sent to Paneery under the supervision of Mr. Robin Wrangham, as it was quite rightly considered to be essential to split up the hogs into at least two separate groups within the species' range in order to minimise the consequences of any virulent infection.

General Description

Adult—The colour of the pigmy hog is blackish brown shaded vaguely with rusty red, the hairs of the specimens examined were quite sparse in comparison to that of a Wild Boar or a Peccary, and the hairs do not exceed 2¼″ in length, the longest of these being at the nape of the neck. Both the tail and ears are short and without hair, and the jaws are shorter than those of the common Hog. The females have only three pairs of teats, half the number possessed by other pigs. Blandford (1888) and Lydekker (1900) state that the young are dark brown, with longitudinal rufous bands above and on the sides, white beneath. The young born at Attareekhat and seen by me at 23 days old had greyish hairs about the snout, forehead, crown of head and ears. The dorsal hairs were blackish brown tinged underneath with rufous. The hairs under the throat and on the stomach were predominantly rufous, the skin having a grey pigmentation. Only on the closest examination could the rufous stripes be observed; the almost absence of any longitudinal bands or stripes at an earlier stage of development was verified by Graves and Singh (*in verbis* 1971) who saw the young soon after birth. The measurements of one at 25 days old can be seen in Table 2. It is doubted whether the stripes of the young pigmy hog could be seen without handling the animal, which is in complete contrast to the obvious striped markings of the young in the Wild Boar of both India and Africa. The young of the New World peccaries do not have any striped markings.

Dimensions

There is little information recorded on the measurements and weights of the Pigmy Hog, as can be seen from the following data:—

Table 1

Dimensions of *Sus salvanius* as quoted in literature

Specimen	Muzzle to base of tail	Shoulder height	Weight	Reference
Sub-adult ♂ ...	18″-20″	8-10″	7-10 lbs.	Hodgson (1847: 423)
Adult ♂	26″	12″	—	Lydekker (1900: 267)

The information given by Blandford (1888 : 563) accredited to Hodgson, of an old male weighing 17 lbs. cannot be traced in the literature cited, and the weight is considered to be highly unlikely.

As it was important for me to examine the majority of the animals in captivity in order to assess their general condition I took this invaluable opportunity in taking the dimensions of eleven of the specimens, when I considered that undue stress would not be caused to them.

Above: Pigmy Hog *Sus salvanius* ♀ young 25 days old. Assam, May 1971.
Below: Pigmy Hog *Sus salvanius*. Assam, May 1971.
(*Photos: Jeremy J. C. Mallinson*)

TABLE 2

DIMENSIONS OF *Sus salvanius* AT ATTAREEKHAT TEA ESTATE TAKEN ON 23RD MAY 1971

Sex	Muzzle to base of tail	Tail	Height of shoulder	Height of ear	Weight	Condition	Pen No.	Code Ref.
ADULT male ...	28″	1¼″	9″	1¾″	—	Good	I	M.1
ADULT female	23½″	1¼″	8½″	1¾″	—	Good	I	F.1
ADULT female ...	23″	1¼″	8½″	1½″	—	Good	I	F.2
ADULT female ...	23½″	1¼″	8½″	1¾″	—	Good	I	F.3
ADULT female ...	22″	1¼″	8″	1¾″	—	Poor left eye missing, very thin	II	F.4
ADULT female ...	24½″	1¼″	8¼″	1¾″	—	Left hind foot amputated skin flaking	III	F.5
ADULT female[1]...	—	—	—	—	—	good	IV	F.6
Infant. f. at 25 days[2]	14¼″	½″	2¼″	¾″	—	Good	IV	F.6 inf.

[1] Sow gave birth to 4 young on 28th April, 1971.
[2] The remaining 3 young were not measured.

TABLE 3

DIMENSIONS OF *Sus salvanius* AT PANEERY TEA ESTATE TAKEN ON 23RD MAY 1971

Sex	Muzzle to base of tail	Tail	Height of shoulder	Height of ear	Weight	Condition	Pen No.	Code Ref.
SUB-ADULT male ...	19½″	1¼″	8½″	1½″	3.700 kgs	Good	I	M.2
ADULT female ...	21¾″	1¼″	8½″	1¾″	3.675 kgs	Poor aborted apr. left hind foot removed.	I	F.7
SUB-ADULT female ...	19½″	1¼″	8″	1¾″	3.400 kgs	Good	I	F.8
SUB-ADULT	19″	1¼″	7¾″	1½″	2.700 kgs	Good left hind foot left toe removed.	I	F.9

It can be seen in Tables 2 and 3 that the muzzle-base of tail measurement of the adult male is 28″, sub-adult male 19½″, and in six adult females the measurements range from 21¾″-24½″. The shoulder height of the adult male is 9″, sub-adult male 8½″, and the six adult female measurements range from 8-8½″. The measurements between the teats taken longitudinally in adult females was found to range from 1¾″-2″.

Behaviour

Hodgson (1847) states that the pigmy hog seems to have the disposition of the peccary (*Tayassu tajacu*) as well as the resemblance. The herds are not large, consisting of five or six, to fifteen or twenty. The males fearlessly attack intruders, charging and cutting the naked legs of their human or other attackers with a speed that baffles the eyesight, and a spirit which their straight sharp laniaries renders really perplexing if not dangerous.

Hamilton (1921), describing a shooting expedition with the Maharajah of Cooch Bihar in 1891, states that they go about in droves of about fifty, and move through the grass with such incredible rapidity that the eye is unable to follow them. The elephants, oddly enough, are scared to death by the pigmy hogs, for the little creatures have tusks as sharp as razors, and gash the elephants' feet with them as they rush past them.

The ten pigmy hogs handled by me on 23rd May 1971 were surprisingly non-aggressive, and from all accounts when the specimens were caught, no real aggression was encountered. When disturbed from their thatch bedding the pigmy hogs have the ability to move like lightning, keeping close together, the females usually following the males, before reaching a further refuge where they would pile on top of each other. Just prior to giving birth the females are said to make a nest within the thatch, this behavioural pattern was observed by Graves (1971) prior to the parturition recorded at Attareekhat Tea Estate.

The literature states that the pigmy hog is nocturnal, however, from my personal observations on the two groups at Attareekhat and Paneery, I saw nothing to support this attribute. The pigmy hog were the most active just after dawn and some two hours before sunset, but on some occasions were seen walking about in their enclosures at Paneery in the middle of the day in the direct sunshine. It is interesting to note that some pigmy hogs were photographed in the Manas sanctuary during the daytime (Jenkins 1971).

Breeding

In the literature consulted there are no references to the pigmy hog being observed with young in the wild state. However, it is considered, as with so many animals, that parturition will take place when environmental conditions are the most favourable, and in all probability breeding seasons are adhered to.

Pigmy hogs were born during the four years 1883, 1884, 1885 and 1886 at the London Zoo (Z.S.L.) but regrettably the only reference to the time of the year that parturition took place was 23rd May 1883. However, it is interesting to note that the 4 young born at Attareekhat Tea Estate, which were conceived in the wild state, were born on 28th April 1971 adhering to a similar time of the year as the former.

Hodgson (1847) states that the grown male perhaps pairs off for a short period in the breeding season, of which there are said to be two in the year, and the litter to consist usually of but 3 or 4 young ones, similar to the number born at Attareekhat.

The records of the Zoological Society of London show that the number of young per litter ranges from 1-4. The South American Collared Peccary in the Jersey Wildlife Preservation Trust's collection, normally produce two litters a year consisting of from one to four young with a gestation period of 110-120 days.

Diet

Hodgson (1847) states that their food is chiefly roots and bulbs, but they also eat eggs, young birds, insects, and reptiles, having a good deal of the omnivorous propensity proper to the whole family (Suidae).

When the pigmy hogs were first taken into captivity, they were fed mainly on rice and vegetable matter, the rice was very much their favourite food. However, in order to provide the specimens with nutritionally adequate and balanced rations, the following foodstuffs were advised.

Papaya — Pumpkin — Tomato — Potato — Egg Plant — Marrow — Cabbage — Corn on the Cob — Banana — Matikali (high in protein)— Pea Nuts — Raw Egg with shell — Unpolished Rice — Skimmed Milk — Insects — Reptiles — Young birds — 'Becadex' (multi-vit preparation including Vits. A, D_2, B_1, B_{12} and C) 2.5 ml. = $\frac{1}{2}$ teaspoon per specimen daily.

Fresh turf with plenty of soil left around roots, and a few branches (to allow the animals to gnaw the bark) to be placed in the outside areas at regular intervals.

It was soon observed that corn on the cob was one of their favourite foods, for they would carry the cob about the paddock nibbling at them until only the husk remained.

Habitat

The jungle and thatchlands of the Himalayan foothills. The majority of the thatch grows up to approximately 12 ft. height during the monsoons from June to October, but then starts to wither down to approximately 5 ft. during January to March, unless the thatch had been fired. The Assamese names for the two chief species of thatch are 'Boranganni kher' and 'Nulgahuri', the latter is the local name given to the pigmy hog. It is considered by the locals, that when the thatch becomes too water-logged during the height of the monsoons, the pigmy hog go into the forested areas of the foothills.

On 23rd May I travelled by jeep through the thatchlands in the Mangaldai sub-division to the north of Attareekhat, and with the permission of the local forest officer, to the Rajagarh Forest Reserve, to study the typical habitat of the pigmy hog.

On 25th May 1971 I flew in a single engine Cessna 180 over the foothills to the east of the Mangaldai sub-division, in the area to the north of Pertabgurh by the Bhutan and N.E.F.A. borders. On the whole the habitat was continuous, although in some areas small patches of forest and thatch had been cleared by Nepalese settlers who are in increasing numbers coming into this area of northern Assam and upsetting the ecology of the pigmy hog's environment.

Possible Distribution

The Himalayan foothills in the west start from the Naini Tal district in the State of Uttar Pradesh and continue eastwards along the northern borders into Bihar State and almost up to the West Bengal border, a distance of approximately 600 miles. This habitat is then broken by a stretch of approximately 150 miles of tea estates in West Bengal, before restarting in the valley of the Manas River, north-west Assam and extending eastwards along the foothills bordering Bhutan and N.E.F.A. up to Lakhimpur district in the north-east border of Assam, a distance of approximately 300 miles. The width of this foothill belt being approximately 5-15 miles.

During March 1971 Jenkins *et al.* photographed what they took to be pigmy hogs in the Manas Sanctuary, north-west Assam (the photographs have since been confirmed as of this species). During March-April, further to the east of the Manas Sanctuary, approximately twenty specimens came to light after the extensive fire in the thatchlands in the Mangaldai sub-division.

Summary and Recommendations

During my mission to Assam valuable information was gathered to supplement the fragmentary data about this, once considered to be possibly extinct species. The description of the markings of the young, and the diurnal behaviour of the adults, are contrary to the accepted published data about this species. The comparative measurements taken of the eleven specimens examined, provides us with a clearer picture as to the pigmy hog's dimensions.

It is generally considered that the pigmy hog is still comparatively numerous in the Himalayan foothill area between Bhutan and North West Assam; and that if the habitat was to remain unmolested, the pigmy hog would probably be able to survive in this part of its range. Regrettably, however, due to the great increase of Nepalese settlement in this area, patches of forest and thatch are being cleared, thus upsetting the ecology of the pigmy hog's environment, and undoubtedly, if the specimens are seen by the settlers they are hunted for the pot.

It is estimated by the numerous people I spoke to, that if the present rate of infiltration continues, the majority of the habitat will have disappeared within the next five to ten years.

In compliance with the I.U.C.N. Survival Service Commission's policy on the capture of Rare or Endangered Animal species, these units should serve the following objectives :—

(*a*) To multiply the species in order to provide a reservoir of animals for stocking scientifically managed sites and reserve areas where sufficient protection can be afforded.

(*b*) To permit study of the species' biology under controlled conditions.

It is recommended that, as the pigmy hog's habitat is threatened by an increasingly intensive human development, steps should be taken when the vegetation is at its lowest, to do a comprehensive evaluation of the habitat to determine what remains of it, and to capture some further specimens. Sufficient animals should be caught in order to strengthen the viability of the two existing captive populations within the species' range; and to provide the opportunity to translocate some to a scientifically managed site, such as at the Jersey Wildlife Preservation Trust. By this means help to ensure the pigmy hog's perpetuation and so prevent the pigmy hog from becoming extinct, before the opportunity is lost forever.

Acknowledgements

In order to consult the majority of the published literature on *Sus salvanius* I am grateful to the following :—Dr. B. S. Kesavan, National

Library, Calcutta; the Bengal Club Library, Calcutta; the Library of the Zoological Society of London; and the Library of Mr. Gerald Durrell.

I am grateful to Mr. John Tessier-Yandell for originally informing the Jersey Wildlife Preservation Trust about the re-occurrence of this species; to Dr. Robin Banerjee for his valuable advice on nutrition; to Mr. Gordon Simpson for allowing me to examine and photograph the skull of *Sus salvanius*; to Mr. Zafar Futehally for showing me a head-mount in the collection of the Bombay Natural History Society, Bombay; and to Mr. Pearson Surita who accompanied me from Calcutta to Assam and gave me his invaluable services throughout. I would like to congratulate Sri P. Barua, Chief Conservator of Forests in Assam, for giving his blessing to these captive units, and to the work being carried out by the Assam Valley Wildlife Scheme.

My thanks to George Williamson & Co., Secretaries to the Attareekhat Tea Co. Ltd., for their co-operation in providing quarters and supervision of the hogs; to Mr. Richard Magor, Director of the aforementioned company and of Williamson Magor & Co., Calcutta, for sponsoring my journey from Calcutta to Assam and the company being my hosts throughout this part of my mission; and finally to the Fauna Preservation Society, London, for sponsoring and making the entire pigmy hog mission possible.

References

Beddard, F. E. (1909): Mammalia. Macmillan & Co. Ltd, London (ill. woodcut p. 276).

Blandford, W. T. (1888): The Fauna of British India. Taylor and Francis, London (text p. 563).

Burke, W. S. (1937): The Indian Shikar Book—Seventh edition. Thacker, Spink & Co. Calcutta (text pp. 151-52).

Edinburgh, H. R. H. The Duke of & Fisher, James (1970): Wildlife Crisis. Hamish Hamilton, London (caption and artist's impression pp. 106-7).

Gee, E. P. (1964): The Wildlife of India. Collins Ltd., London (text pp. 142-43, ill. plate 47).

Graves, Richard (1971): (— *in verbis*).

Hamilton, Frederic Lord (1921): Here, There and Everywhere. Hodder and Stoughton, London (pp. 31-32).

Hodgson, Brian H. (1847): On a New Form of Hog Kind or Suidae. *Journal of the Asiatic Society of Bengal*, Vol. XVI May. (text pp 423-28, ill. plate XII).

Jenkins, D. (1971): Oryx Tour. No. 12 to Qatar and India. (3-25 March). *Oryx*. Journal of the Fauna Preservation Society, Vol. XI. No. 1, London (text p. 15).

Lydekker, R. (1900): The Great and Small Game of India, Burma and Tibet. Rowland Ward Ltd., London (text pp. 266-67, ill. plate, VII, Fig. 8).

Prater, S. H. (1965): The Book of Indian Animals. Bombay Natural History Society and Prince of Wales Museum of Western India. Second edition (text p. 300).

Simon, Noel (1970): Red Data Book Mammalia, Vol. 1. I.U.C.N. Morges, Switzerland (code number MA/114/SUS/SAL June 3).

Singh, (1971): (—*in verbis*).

Sterndale, Robert (1884): Natural History of Indian Mammalia. Thacker, Spink & Co., Calcutta (text pp. 421-22, ill. woodcut).

Walker, E. P. (1964): Mammals of the World. The John Hopkins Press, Baltimore, U.S.A. (no mention of *Sus salvanius*, general inf. on family: Suidae).

Wood, H. S. (1934): Shikar Memories, A Record of Sport & Observations in India & Burma. H. F. & G. Witherby, London (text p. 221).

Wrangham, R, & Wrangham, A. (1971): (—*in lit*. 10: vi: 71 & 21: vii: 71).

Zoological Society of London (1883-86): Annual Reports of the Zoological Society of London (records of breeding *Sus salvanius* at Regents Park).

Footnote

Wrangham (*in lit.* 10: vi: 71) states that female 7 at Paneery died on May 31st with post-mortem findings—T.B. Lymphatic gland. The mother F. 6 at Attareekhat was separated from her four young before they had reached the age of six weeks, as it was considered that the mother had virtually no milk left, and that the young were all but weaned. Female 3 was moved from Attareekhat to Paneery. The male at Budlapara had died.

Wrangham (*in lit.* 21: vii: 71) stated that females 4, 5 and 6 and the male and two of the three female young, had all died at Attareekhat. The number of pigmy hogs in captivity at the end of July 1971 was nine adults and one young, consisting of 2 males, 7 females and the one female young.

Reviews

1. FISHES. By Dr. (Miss) M. Chandy. pp. xi + 166 (20 × 14 cm.) With many illustrations, New Delhi, 1970. National Book Trust, India. Price Rs. 6.00.

The book on " Fishes " written by Dr. M. Chandy of Delhi University, in the series, India—the land and people, is a preliminary account of fishes, useful for general reading. Its first part, dealing with scientific aspect of study of fishes, past and present, their classification, anatomy, adaptations etc. are written fairly satisfactorily. The author has made the difficult task easy for the reader. The language used is simple, understandable and examples and cross references useful. Many would feel happy about this and in this respect the author deserves our compliments. The illustrations given are clear and impressive but they are not always specifically referred to in the text and in some cases typographical mistakes in their captions have remained.

Despite these small deficiencies, the first six chapters are, no doubt, very creditably dealt with. Even in the seventh chapter, the epics of the eel and the Salmon migration have been quite lucidly described. However, the factual account of migrations of the Indian species, leave much to be desired. For instance, while writing about migration of our well-known Chanos, on page 73, it is mentioned " annually they migrate towards river mouth and backwaters of the west coast for spawning. Eggs hatch out and larvae grow into—fingerlings, by which stage they leave for the sea." This account of Chanos migration is not correct as far as the present knowledge goes. Chanos is known to breed in the sea. Its exact location is not yet known but the larvae are collected along the shore.

Similarly, in the case of Bombay Duck the account runs as " its natural home is the Arabian sea along the Bombay coast. It has been reported to wander as far away as Bay of Bengal and into the estuaries of the Ganges." This statement would apparently mean that the same stock of fish as from the Arabian sea wanders right up to the northern boundary of the Bay of Bengal, but this has not been established. As a matter of fact, occurrence of Bombay Duck in the Sunderbans of the Bay of Bengal is sometime cited as a case of discontinuous distribution.

Further, on page 73, it is stated " *Hilsa ilisha* is denizen of the Bay of Bengal." This is not a complete statement of facts, as *Hilsa ilisha* is found on the west coast also and ascends rivers such as Indus, Narmada, Tapi, Ulhas, etc., where it gives rise to regular fisheries which are fairly well known in the respective areas. A lot more can also be said about different stocks, races and their life cycle in inland waters.

As regards part II of the book which deals with "Common Indian Fishes," in chapter VIII, the impression is that the information given is too scanty. It is felt that in view of the extensive information that is now available through research papers published during the past few years, the information furnished could be considerably amplified so as to be of some use to any inquiring mind. This has been a common shortcoming all throughout and hence this is not repeated in the comments on each and every fish. Apart from these omissions, there are several mistakes of factual nature throughout the book. As regards local names I have compared only the Marathi names and have found some mistakes. Other names have not been compared. Several typographical mistakes have also remained. The errors of fact and typography are so many and of such a diverse nature that it does not seem feasible that they can be adequately rectified simply by means of errata slips and without considerable rewriting. It is a pity that lack of attention to vetting the text before publication, and faulty proof-reading should have been permitted to mar this well conceived book. One can only hope that due attention will be paid to removing the defects which the reviewer has listed separately for the guidance of the author and publishers and for the benefit of future users of the book.

C. V. K.

2. AN INTRODUCTION TO PLANT TAXONOMY. By C. Jeffrey. pp. vi + 128 (14×21.5 cm.). With 20 figs., 8 pls., 8 tabs. London, 1968. J. & A. Churchill Ltd. Price 24*s*.

The author who is the Senior Scientific Officer at the famous Royal Botanic Gardens at Kew has indeed made an extremely commendable effort to explain in simple terms how plants are classified and named. This little book is intended for teachers, students, gardeners, amateur naturalists and also professional biologists. It has certainly succeeded in promoting an understanding of plant taxonomy.

The first two chapters explain with the help of diagrams and familiar examples of daily life, the purpose and fundamentals of classification. The author has warned the reader here not to be put off by the seemingly easy and naive manner of these explanations. The next chapters deal with the process of plant classification, the taxonomic hierarchy and its meaning and the scientific naming of plants which explain the fundamental rules of plant nomenclature.

The last three chapters explain the practical use of keys of plant names, systems of classification and scope of plant taxonomy. The book also contains two appendices—one containing a proforma for practical work and the other a list of useful reading and reference works in plant taxonomy.

In this small book is found the essence of plant taxonomy for all practical purposes. It is indeed a very useful, simplified pocket book for any one who wishes to learn the fundamentals of plant taxonomy and nomenclature.

P. V. B.

3. KALIDAS KE PAKSHI—(in Hindi). By Haridutt Vedalankar. pp. iv + 194 (23.5 × 18 cm.). With 12 colour plates, 27 line drawings. U.P., 1964. Gurukul Kangri University, Hardwar. Price Rs. 15.00.

In this scholarly book the author has presented the birds occurring in Kalidasa's poems and plays and he has attempted to identify them. The approach is strictly scientific. An authority is cited even to show that pepper grows in Malabar.

Quoting relevant passages, the author presents each bird as it appears in Kalidasa's works. This in itself makes the book very useful. While it is easy to find out, for example, what the ancient Greeks knew about birds, it is often difficult to find out what the ancient Indians knew about them. Centuries before the migratory habits of birds came to be generally recognized, Kalidasa knew even the route followed by migrating Geese from the plains of India to Manasarowar. His references to birds and their habits agree closely with modern knowledge about them. He recognized the close relationship between breeding season and the calls of birds. KALIDAS KE PAKSHI is a tribute to his keenness of observation.

The task of identifying the birds was not an easy one. It was made more difficult by earlier authors, annotators, translators and lexicographers who identified Kalidasa's birds hastily without weighing the evidence carefully. The author has made an admirable effort to identify them. Nevertheless, considering the fact that mention of some of the birds in Kalidasa's works is limited to a very few occasions, their identity will remain open to debate. How shall we identify a bird when all that is known about it is that its call is a mournful wail or that its feathers are fixed on arrows?

The author has sometimes looked around for additional evidence. It is doubtful whether this was a wise step in identifying Kalidasa's birds. As pointed out by the author himself, not all writers have been as keen observers of nature as Kalidasa. Besides, while looking around for further evidence, where shall we stop? From a study of all the references to the *Crowncha* in the classics two scholars have identified it as the Sarus Crane (*Grus antigone*), whereas Kalidasa's *Crowncha* has been identified by the author as the Common Crane or the Demoiselle Crane. Perhaps we should not try to separate *Crowncha* and *Sarus* into different species but identify them collectively as Cranes.

The book is a very valuable addition to the meagre Hindi literature on birds. Greater attention might have been paid to its editing and printing and the author might have been more discriminating in the use of modern literature on birds.

It is to be hoped that more such authoritative and dependable books on birds will be published in Hindi.

JOSEPH GEORGE

4. POLLEN GRAINS OF WESTERN HIMALAYAN PLANTS. By P. K. K. Nair. pp. viii + 102 (14 × 21.5 cm.). With 54 figs., 15 pls. with 197 microphotographs. Bombay, 1965. Asia Publishing House. Price Rs. 16.00.

This publication forms Asia Monograph No. 5 in a series covering a large variety of subjects without any common denominator.

The monograph embodies pollen morphology of a large majority of plants composing W. Himalayan flora covering 5 families of Gymnosperms, 82 of Dicots and 10 of Monocots supported by photomicrographs of 197 species. It contains palynograms of about 50 species and ectine ornamentation of about 100 more species in the form of 54 text figures.

Of interest is the 10-page ' Hints for identification ' forming a key for the identification of important families and genera of W. Himalayan plants. The pollen/spore characters and their terminology is well explained and is useful.

In the ' prefatory note ' the author states that this is an attempt in the direction of preparing a comprehensive account of the pollen flora of any one vegetation unit of India. Even so, this work is not related to any particular floristic work(s) of the region and in fact none is cited in the references. The plant names given are the same as those which were given on the herbarium sheets from which the pollen material was collected—even so, there is no mention or reference to the herbaria and specimens from which the pollen material was examined. This fact gives the monograph a rather weak foundation and a critical worker is left to make a confirmatory observation with reliably identified material. It is likely that more precise information is available with the author at the Palynological laboratory of the National Botanical Gardens, Lucknow, where the pollen slides and other relevant data are deposited.

It is claimed that this study has presented ample evidence to indicate the significance of pollen morphology in the taxonomy of several families—both Eurypalynous and Stenopalynous. In support, ' unique ' pollen types of *Ephedra foliata, Coriaria nepalense* and *Symplocos* spp. are noted and pollen abnormalities of *Berberis, Taraxacum* and *Stellaria* are described. Some comparative notes are also appended on the pollen of *Trachelospermum* spp. and *Reinwardtia trigyna.*

The format of the book is good and the palynograms are used to advantage, but on the whole the production is rather poor. In spite of some shortcomings this publication is welcome and will no doubt be of help to botanists and workers in related fields in the region of Kashmir. It makes a distinct advance in our knowledge of Botany of W. Himalayan plants.

P. V. B.

5. THE MARVELLOUS ANIMALS : AN INTRODUCTION TO THE PROTOZOA. By Helena Curtis. pp. xvi + 189 (23.5 × 15 cm.). London, 1969. Heinemann Educational Books Ltd. Price 35*s*. £1.75 net.

The ' marvellous animals ' of the title are the protozoa or one-celled animals. Marvellous they certainly are, highly complex, with more than thirty thousand species adapted to every kind of environment, very unlike the mere aggregates of complex molecules within a single surrounding film which are believed to have been the earliest forms of life. Their diversity suggests how the earliest forms had to ' experiment ' to solve the fundamental problems—how to get food, how to assimilate and store it, how to eat another animal without accidentally digesting oneself, how to reproduce.

Evolution has also resulted in an extraordinary range in behaviour. One form, *Stichotricha*, lives in empty cells of pond weed. After cell division there is often not enough room for both the daughter cells and one of them leaves to ' look ' for another plant cell. Before settling down it enters and leaves several cells, as if testing and comparing them. While this cannot be confirmed by experiment, it is surprisingly complex behaviour for a single cell.

Mrs. Curtis knows her animalcules, and writes about them vividly and simply. Consider *Tokophyra*, which has problems in conjugating because it is firmly anchored to the substrate during its adult life. " Recently it has been learned how *Tokophyra* solves this dilemma, and it is presumably by means of some subtle aphrodisiac. When two mating adults are placed close together in the absence of food, their rigid pellicles, which ordinarily look as stiff as glass, begin to waver in shape. Both animals elongate and within several hours begin to develop amoeboid projections. Finally, stretching out pseudopodal arms towards one another, they meet and conjugate. Lest this sound the least bit romantic, it is necessary to add that the entire process can be interrupted instantly by the introduction of an edible ciliate."

A chemical also acts as a signal in one of the slime moulds, a remarkable group of amoebae which respond to lack of food by secreting acrasin, which brings large numbers of amoebae together to form a slug-like body which mushrooms up to form a fruiting body. This bursts, releasing spores which give rise to perfectly normal amoebae.

The beautiful photographs and line drawings add to the value of this excellent introduction to a fascinating group.

R. R.

6. SALINE IRRIGATION FOR AGRICULTURE AND FORESTRY. By Hugo Boyko. pp. xxiv + 326 (24 × 15 cm.), with 42 figs. & 4 plates—Maps. The Hague, 1968. Dr. W. Junk n.v., Publishers. Price Dutch Guilders 35.

This is the fourth of the publication series of World Academy of Arts and Sciences (WAAS) embodying the proceedings of the International Symposium on plant growing with highly saline or sea water, with or without desalination, held in Rome from 5 to 9 September 1965 organised by WAAS in cooperation with Accademia Nazionale di Agricoltura and the Consiglio Nazionale delle Ricerche, Italy, and cosponsored by UNESCO.

The book contains 5 formal opening addresses including one by Professor Guiseppe Medici enunciating the need for the wise use of our water sources and the problem-complex of brackish and sea-water for irrigation.

The bulk of the book contains 23 articles divided in 4 sections : I. Principles, problems and laboratory experiments, II. Field-trials with Saline irrigation, III. Saline soils and Biotopes, and IV. Desalination. The book also contains an appendix giving notes on the symposium and vital information about WAAS and World University.

The articles are prepared by experts in their own fields and are very interesting and informative giving the current position about the progress in each respective speciality. All the articles are written in English with French and Italian résumé. Of direct interest to us in India is the article dealing with utilisation of sea water in coastal sandy soils for growing crops in India—a report of work carried out by the Central Salt and Marine Chemicals Research Institute at Bhavnagar, India.

Several other field projects in Europe (South) and Israel are reported.

The economics of desalination are also carefully worked out and discussed.

After going through the book one does agree with the unanimously expressed resolution at the Symposium that 'They firmly believe that results already achieved by irrigation with highly saline water indicate clearly that those arid areas at least where such a water supply is available, can be rendered capable of crop-production and they therefore strongly recommend to international and national organisations concerned with human welfare that financial provision continue to be made for the necessary expansion of research and field trials.'

P. V. B.

7. ECOLOGICAL ADAPTATIONS FOR BREEDING IN BIRDS. By David Lack. pp. xii + 409 (25 × 17 cm.), with 21 illustrations. London, 1968. Methuen & Co. Ltd. Price 84*s*.

This book is concerned with the evolutionary trends in some features of avian breeding biology, *viz.* nesting dispersion, the pair bond, clutch-size, the egg-size, the incubation and fledging periods and the age of first breeding. The book primarily provides interpretation of the ornithological literature, but, out of necessity, it also reviews the occurrence of these features in birds.

The author has used a semi-quantitative approach in establishing a correlation, or a lack of it, between the features in question. The sub-family is used as a unit and for every sub-family the occurrence of each of the features is tabulated and presented in the numerous appendices. These in turn, provide the basis for correlating one feature with another. The method is open to criticism, for it is impossible to be entirely objective in characterizing a particular feature for a sub-family, when this 'unit' is represented by a large number of species some less extensively studied than the others. To give an instance, for Sturninae the diet is listed as insects and fruits in Appendix 1, while this reviewer would prefer to call the diet omnivorous in the true sense of the word. Inspite of the shortcomings, the method is ideally suited for the purpose it is used. The quantitative data are used only for making broad generalizations on the main evolutionary trends.

The book as a work on adaptation will be useful to zoologists in general. However, my colleagues who are non-ornithologists have complained that the book is difficult to read. Individual readers may find the cost of the book rather high.

If the reviewer is not too optimistic, the book is bound to inject vigour to the field of avian breeding biology. The book is provocative enough to provide field-ornithologists goals other than that of merely collecting data on the breeding biology of individual species. In the light of this book, the account of breeding biology in most ornithology text-books appear sterile. The well-planned and delicately executed pen-drawings by Robert Gillmor are much more meaningful than the glossy photographs one usually finds in an ornithology book.

R. M. NAIK

8. FLOWERS OF EUROPE: A FIELD GUIDE. By Oleg Polunin. pp.1-662 (21.5×14.5 cm.) +192 pages of colour photos (over 1,000). London, 1969. Oxford University Press. Price £4.20.

This is a book that presents a real challenge to any reviewer. The general impression is one of astonishment at the beautiful way many difficult problems have been solved. One of the first problems was the selection of plants for inclusion in the book. There are supposed to be 15,000 to 17,000 species of seed plants both native and naturalised growing in Europe to-day. Roughly, this is the number of plants included in Hooker's FLORA OF BRITISH INDIA for the Indian sub-continent; and Hooker's work covers seven rather fat volumes, without any illustrations. This shows the trouble the author has taken to make a representative selection, which while showing the commoner and more typical plants of Europe, kept the final book within moderate bounds of size, weight and cost. All these details are discussed in detail in the preface. (H.S.)

The book is intended primarily for the layman so that he may recognise the commoner flowers that he comes across and may further profit by this knowledge re. botanical and economic or historical aspects. No effort is spared to make the book most useful and attractive to the layman. The description of the plant emphasises such features as will attract the plant to him. Even the technical terms are explained in a glossary with the help of appropriate figures.

The book includes about 2,600 of the common and more interesting wild flowers found in various natural habitats of Europe. Over 1,900 species are described in detail, their presence or absence in each European country is shown and their uses in healing, as poisons, dyes or vegetables are listed. Keys to families, genera and species are given in a way that facilitates quick identification. Over 1,000 species are shown in colour photographs specially selected to give each species its individuality and natural background. Line drawings of over 280 species accompany the text—in such cases where they have been found to serve a better purpose of easy and correct identification. The appendix of common European names makes the book more useful for anyone who should look for a particular plant or desire its scientific identity.

This is a superb production for which no praise is enough either for the author or the publishers. It is dream book for a nature lover to whom such a wealth of essential information is presented in the most precise and scientifically correct manner with the help of carefully selected photographs and drawings. The loan of excellent photographs, duly acknowledged, has made the book a great success. This book is bound to find a place in all learned institutions and with nature lovers all over the world.

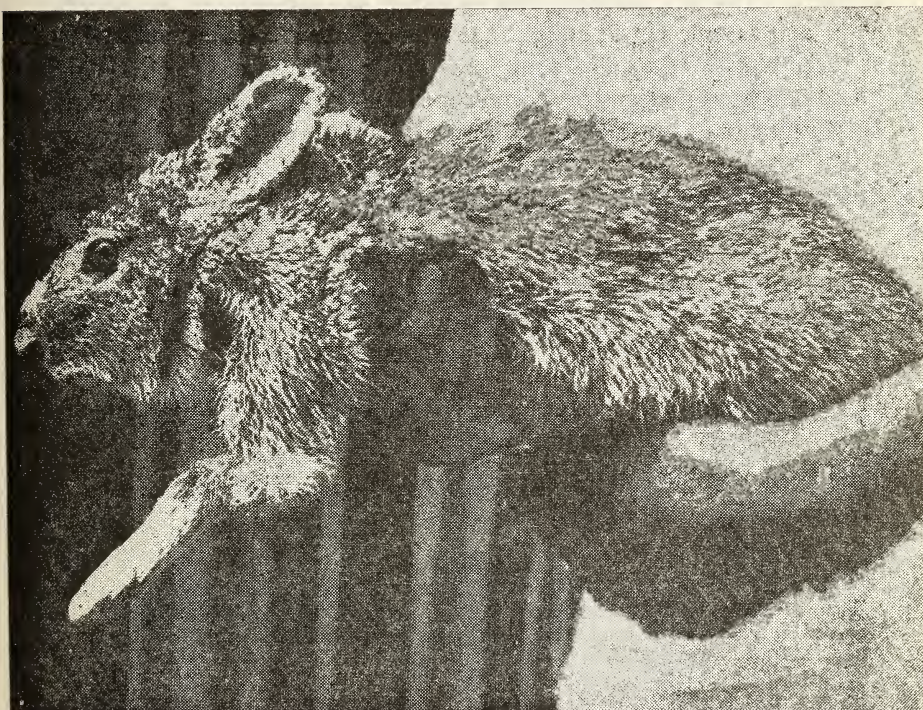
H. S. & P. V. B.

Miscellaneous Notes

1. A NOTE ON THE HISPID HARE *CAPROLAGUS HISPIDUS* (PEARSON 1939)

(*With a photo*)

The Hispid Hare or Harsh-furred Hare had not been noticed since 1956 when a German Zoological team collected one in the Goalpara Division of Assam, and this was examined by Dr. B. Biswas of the Indian Museum, Calcutta. A village headman near Rowta Reserved Forest of Darrang District of Assam, informed the Forest Range Officer that these hares existed in that locality in the winter of 1958-59, but none of these were caught. As Simon (1967) states, the Hispid Hare probably still



Hispid Hare (*Caprolagus hispidus*) Assam, May 1971. (*Photo: Author*)

exists in a few isolated parts of its range in the grassy or scrub-forest areas along the foothills of the Himalayas in U.P., Bihar, West Bengal and Assam.

One adult male of the Hispid Hare was caught on 22nd April, 1971 by Mr. Virenda Singh, in the thatchlands between Rajagarh Forest Reserve and the Attareekhat Tea Estate, in the Mangaldai sub-division of Darrang District, Assam. This was in the same area, and at a similar time that the Pigmy Hogs *Sus salvanius* were caught.

When I examined the Hispid Hare, it had been in captivity for four weeks. The specimen had lost its left hind-leg, but otherwise was in quite good condition. It had been maintained on Dhoob grass, *Cynodon dactylus* with the roots kept on, and soaked dried peas; when offered lettuce, cabbage, carrot or cucumber they had been left untouched.

The most distinguishing characteristic of the Hispid Hare is the small size of the ears. The colour of the pelage is dark brown and blackish with numerous scattered whitish bristly hairs. The dimensions of the adult male examined were as follows:- Nose tip to base of tail 18″; shoulder height 7″; tail ½″; ear 2¼″. The specimen was housed on an earthen floor, and as Tate (1947) states, that although these animals are reputed to make burrows the claws seem to be too long and slender for digging. There had been no signs of the specimen doing any digging in the earth during its month in captivity, although it has proved to be of a nervous disposition, and in keeping with the majority of *Lepus* species has an extreme tendency to flight when alarmed.

If, as advised for *Sus salvanius*, a comprehensive evaluation of the habitat in the Mangaldai foothill area of Assam, and a professional capture programme is embarked upon, it is recommended that the Hispid Hare should be included in this programme.

Deputy Director, JEREMY J. C. MALLINSON
Jersey Wildlife Preservation Trust,
Jersey, Channel Islands,
August, 1971.

References

Simon, Noel (1967): Mammalia, Survival Service Commission Red Data Book. Morges, Switzerland.

Tate, G. H. H. (1947): Mammals of eastern Asia. MacMillan, New York.

2. REACTION OF CHITAL [*AXIS AXIS* (ERXLEBEN)] TO JUNGLE CAT *FELIS CHAUS* GULDENSTAEDT

In March 1970 I had occasion to note the response of Chital to the presence of the Jungle Cat, in Corbett National Park. In the Dhikala area of the sanctuary grazing herds of Chital (30, 25, 25 & 40 in strength), were observed near a ground salt lick on a few occasions (dates: 8/iii, 10/iii, 11/iii & 15/iii). On seeing the cat, the Chital raised their head and with the tail upraised gave the alarm call. A few individuals scratched the ground with their fore legs. Afterwards 3 or 4 Chital, normally headed by a young male walked towards the cat giving periodic calls. More Chital joined the group and gradually drove the cat out of the grazing area. Other members of the herd either pause to see what is happening or continue to graze.

Chital also give the alarm signals: calls, raised tail, and pause from grazing on the approach of the mongoose *Herpestes edwardsi* Hodgson.

ACKNOWLEDGEMENT

I am grateful to the Director, Zoological Survey of India and the Officer in Charge of this Station for providing the opportunity to make the study trip.

NORTHERN REGIONAL STATION,
ZOOLOGICAL SURVEY OF INDIA,
13 SUBHASH ROAD,
DEHRA DUN,
September 26, 1970.

R. K. BHATNAGAR
Assistant Zoologist

3. A FOURSOME OF BARKING DEER, *MUNTIACUS MUNTJAK* (ZIMM.)

Barking deer are by nature solitary animals. Occasionally a pair may be seen with a fawn but association of more than three individuals is seldom seen. It is therefore of interest to note that on March 16, 1969, four adults were seen together in a small area at the edge of a rather sharply circumscribed patch of forest by the side of the palace at Kuttikanum, approximately 4 km. to the southwest of Peermade in the Cardamom Hills (Kottayam District), Kerala State. The time was 7.30 a.m. and they were feeding peacefully, standing about two or three metres apart. Spotting the observer they bolted back into the forest, all in the same general direction. The reason why the four were together is probably because the patch of jungle is totally isolated from other areas with sufficient cover.

ZOOLOGICAL SURVEY OF INDIA,
SOUTHERN REGIONAL STATION,
MADRAS-4,
ebruary 7, 1970.

G. U. KURUP

4. AGE OF SEXUAL MATURITY OF THREE SPECIES OF WILD ANIMALS IN CAPTIVITY

This note is intended to place on record some observations made at Nandankanan Zoo (Orissa) on the age of sexual maturity of the female of three kinds of wild animals.

Sambar (*Cervus unicolor*)

A Sambar doe born at the zoo on 30. viii .1968 gave birth to a fawn for the first time on 27.x.1970 at the age of 2 years, 1 month, 28 days. This was kept along with an adult male throughout this period. Taking the gestation period as about 8 months (Asdell 1964: PATTERNS OF MAMMALIAN REPRODUCTION, pp. 492-581), the age of sexual maturity of this animal can be said to be not more than 1 year, 5 months, 28 days or say 1 year and 6 months.

The period of maturity recorded for Sambar is two years (Prater 965 : THE BOOK OF INDIAN ANIMALS).

Nilgai (*Boselaphus tragocamelus*)

A female Nilgai born here on 13.iii.1968 gave birth to two young for the first time on 31.xii.1970 at the age of 2 years, 9 months, 19 days. This female had remained with an adult male throughout this period. Taking the gestation period as 8 months and 7 days (Asdell, loc. cit.) the age of sexual maturity of this female can be said to be not more than 2 years, 1 month, 12 days or say 2 years and 1 month.

There is no mention of the age of sexual maturity of Nilgai in the available literature.

African Lion (*Panthera leo*)

A lioness born here on 26.iii.1967 gave birth to a cub on 8.ii.1970 for the first time at the age of 2 years, 10 months, 14 days. This lioness was kept along with an adult lion from 1.viii.1967. Taking the gestation period as about 108 days (Asdell, loc. cit.), the age of sexual maturity of this lioness can be said to be not more than 2 years, 6 months, 28 days or 2 years and 7 months.

The lioness breeds at the age of 3 or 4 years (Asdell, loc. cit.).

VETERINARY ASST. SURGEON, L. N. ACHARJYO
NANDANKANAN ZOO,
BARANG (CUTTACK).

WILD LIFE CONSERVATION OFFICER, R. MISRA
ORISSA,
CUTTACK 1,
February 12, 1971.

5. NEW RECORDS OF RODENTS FROM THE RAJASTHAN DESERT

Rodents were trapped in the Rajasthan desert to study their distribution, relative abundance and relationship with the habitat and vegetation types. Trapping was done in eleven districts of the desert. In every district two trap lines, having 30 snap traps each fixed at 10 metres interval, were laid out in every habitat, viz. sandy, gravelly, rocky and ruderal. In all, 449 specimens of rodents were collected. The following species appear to be new records from the desert region.

Rattus cutchicus cutchicus (Wroughton). The Cutch Rock-Rat.

MATERIAL EXAMINED: 2 ♂♂ from Chohtan (Barmer District), December 1968; 4 ♀♀ from Jaisalmer—December 1968; 5 ♂♂ and 4 ♀♀ from Jhunjhunu—December 1968; 8 ♂♂ and 4 ♀♀ and 2 unsexed from Bhopalgarh (Jodhpur District)—April 1969; 7 ♂♂ and 7 ♀♀ from Jalore—January 1969; 2 ♂♂ and 6 ♀♀ from Erinpura (Sirohi District)—January and September 1969 and 2 ♂♂ and 2 ♀♀ from Jadan (Pali District)—January 1969.

Rattus cutchicus has a wide range in India (Ellerman 1961), but the subspecies *R. c. cutchicus* (Wroughton), *R. c. medius* (Thomas) and *R. c. rajput* (Thomas) are found nearest to Rajasthan in Gujarat and *rajput* has been reported from Mt. Abu (Ellerman 1961). During our survey, however, *R. c. cutchicus* was collected westward in the desert in Jodhpur, Barmer and the Jaisalmer districts and in the north up to Jhunjhunu District[1].

One female collected near Jawai Dam, Erinpura, delivered a litter of 2 young on 19.ix.1969 and nearly all males from Bhopalgarh had fully scrotal testes in April, 1969.

Mus booduga booduga (Gray). The Common Indian Field Mouse.

MATERIAL EXAMINED: 2 ♂♂ from Jadan—January 1969; 1 ♂ and 1 ♀ from Bisalpur (Sirohi district)—January and September 1969; and 1 ♀ from Jodhpur—June 1968.

According to Ellerman (1961), this mouse is distributed from Bellary Mysore, Nilgiri to Gujarat State through Bombay; in Madhya Pradesh. Bihar, Orissa and Uttar Pradesh. The present material extends its range into the south-eastern deserts of Rajasthan.

One male collected from Bisalpur, in September, 1969, had fully scrotal testes.

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[1] Some of the *R. cutchicus* were removed by a large male *Herpestes smithi* Gray, a mongoose identified by the black colour at the tip of the tail. Incidentally, this mongoose has also not been reported from the Rajasthan desert.

Mus cervicolor phillipsi (Wroughton). The Fawn-coloured Spiny Mouse.

MATERIAL EXAMINED: 1♂ and 1♀ from Jalore, 1♂ and 4♀♀ from Bisalpur—January 1969.

The subspecies occurs in Central India, Bellary, Balapalli range, Salem District to Gujarat and has been reported from Mt. Abu (Ellerman 1961). At Jalore and Bisalpur, this mouse was collected in association of *Euphorbia caducifolia* bushes in a rocky habitat.

Mus platythrix sadhu (Wroughton). The Brown Spiny Mouse.

MATERIAL EXAMINED: 1♂ from Chohtan—November 1968; 4♂♂ from Bhopalgarh—April 1969; 3♂♂ and 2♀♀ and 1 unsexed from Jadan—January 1969 and 1♂ and 1♀ from Bisalpur—January 1969.

The subspecies has a restricted distribution in Kathiawar, Kutch, Lahore and Virawah in West Pakistan. It was also reported from Mt. Abu (Ellerman 1961). During the present study this rodent was collected from sandy and rocky habitats. It appears that its range in the Rajasthan desert extends into Barmer, Jodhpur, Pali and Sirohi districts.

Golunda ellioti gujerati (Thomas). The Bush Rat.

MATERIAL EXAMINED: 1♀ from Jadan—November 1968; 2♂♂ from Jalore—January 1969; 7♂♂ and 10 ♀♀ from Bisalpur—January 1969 and 1♀ Jodhpur—August 1968.

Golunda e. gujerati is reported from Gujarat and Mt. Abu in Rajasthan. Our collections indicate that its range is further north, up to Jodhpur District. The Bush Rat was usually collected from thorn fences surrounding irrigated crop fields. Wagle (1927) and Biswas & Tiwari (1966) have mentioned that it occurs in parts of Sind. Taber *et al.* (1967), however, did not collect it in the Lyallpur region in West Pakistan.

Nesokia indica indica (Gray). The Short-tailed Mole-rat.

MATERIAL EXAMINED: 1♀ from Sri Ganganagar—January 1969.

The Mole-rat has been reported from east of the Aravalli ranges, from Sambhar and Jaipur (Ellerman 1961). Our collection is, however, from west of Aravallis—from the northernmost part of Rajasthan. The rodent was collected from a sugarcane field but large mounds of earth were noticed on the bunds in orchards and Date Palm fields. It appears that this rat which is usually found in irrigated crop fields is comparatively a recent 'introduction' in the desert region where irrigation is practised and conditions are favourable throughout the year due to the advent of the Ganga Canal.

Recently Agarwal (1967), and Prakash & Jain (1967) reported *Rattus gleadowi, Gerbillus dasyurus indus* and *Rattus meltada pallidior* from Jodhpur. During the present survey we have collected these species from other districts also which indicates that they have a wide range of distribution in the Indian desert.

Gerbillus dasyurus indus[1] (Thomas). Wagner's Gerbil.

MATERIAL EXAMINED: 2♀♀ from Jaisalmer—December 1968; 1♂ and 1♀ from Bikaner—January 1969; 1♂ from Churu—December 1968; 1♀ from Maulasar (Nagaur District)—December 1968; 14 ♂♂ and 21 ♀♀ from Jodhpur during 1967-69.

The Gerbil was earlier reported from Gujarat, Punjab and West Pakistan (Biswas & Tiwari 1966); Taber *et al.* (1967). This gerbil breeds during April-June and December.

Rattus meltada pallidior (Ryley). Soft-furred Field-Rat.

MATERIAL EXAMINED: 6♂♂ and 3♀♀ from Jhunjhunu—December 1968; 1♀ from Churu—December 1968; 1♀ from Bhopalgarh—April 1969; 3♂♂ and 5♀♀ from Maulasar—December 1968; 2♂♂ and 2♀♀ from Jalore—January 1969; 7♂♂ and 7♀♀ from Bisalpur—January 1969; 5♂♂ and 3♀♀ from Sri Ganganagar—January 1969.

Recorded usually from cultivated fields in the Punjab, Haryana, Nepal Terai, parts of Gujarat, Sind (Ellerman 1961) and in the Lyallpur region of West Pakistan (Taber *et al.* 1967). The rat is fairly well distributed in the western Rajasthan. We have collected it from natural grasslands also.

Rattus gleadowi (Murray). Sand-coloured Rat.

MATERIAL EXAMINED: 1♂ and 1♀ from Bikaner—January, 1969; 1♀ from Bhopalgarh—April 1969 and 6♂♂ and 3♀♀ from Pali during 1962.

It is reported from Kathiawar, Palanpur, Sind and South Waziristan (Ellerman 1961). Urs *et al.* (1966) reported it from Mysore.

Three specimens from Pali delivered litters of 2, 2 and 3 respectively, during August and September, 1962.

CENTRAL ARID ZONE RESEARCH INSTITUTE, JODHPUR, *April* 7, 1970.

ISHWAR PRAKASH
A. P. JAIN
B. D. RANA

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[1] Petter (1961) refers *G. dasyurus* to *G. nanus*.

REFERENCES

AGARWAL, V. C. (1967): New mammal records from Rajasthan. *Labdev J. Sci. & Tech.* 5: 342-344.

BISWAS, B. & TIWARI, K. K. (1966): Taxonomy and distribution of common Indian rodents. *Indian Rodent Symposium*, Calcutta. The Johns Hopkins University, CMRT and USAID: 9-45.

ELLERMAN, J. R. (1961): The Fauna of India, Mammalia, vol. III, Pts. 1 & 2. Government of India, Manager of Publ., New Delhi.

PETTER, F. (1961): Repartition geographique et ecologie des rongeurs desertique (du Sahara occidental a l'Iran oriental). *Mammalia* 25 (N. Special): 1-222.

PRAKASH, I. & JAIN, A. P. (1967): Occurrence of *Rattus meltada* and *Gerbillus dasyurus* in the Rajasthan desert. *Ann. Arid Zone* 6(2): 235.

TABER, R. D., SHERI, A. N. & AHMAD, M. S. (1967): Mammals of the Lyallpur region, West Pakistan. *J. Mamm.* 48: 392-407.

URS, Y. L., KRISHNAKUMARI, M. K. & MAJUMDER, S. K. (1966): A report on the burrowing habit of rodents. *Indian Rodent Symposium*, Calcutta. The Johns Hopkins University, CMRT and USAID: 199-203.

WAGLE, P. V. (1927): The rice rats of lower Sind and their control. *J. Bombay nat. Hist. Soc.* 32: 330-338.

6. OCCURRENCE OF EASTERN RINGED PLOVER (*CHARADRIUS HIATICULA TUNDRAE* (LOWE) IN TAMIL NADU

On 22 February 1970, at the Society's bird ringing camp at Muthupet (*c.* 10° 35′ N.; 79° 36′ E.), Thanjavur District, Tamil Nadu, the trappers brought in two plovers that appeared like larger versions of *Charadrius dubius*. One of them was ringed and released after the wing measurement (136 mm.) and weight (57 gm.) were ascertained. The other (wing 123, mltg.; 52 gm. wt.) was taken to the camp for further investigation. From FAUNA OF BRITISH INDIA 6 and HANDBOOK OF BIRDS OF INDIA AND PAKISTAN 2, it appeared to be an Eastern Ringed Plover *Charadrius hiaticula tundrae* (Lowe). In view of the scarceness of Indian records the specimen was preserved by S.A.H.

A closer examination in Bombay revealed a small web between the outer and middle toe, while Vaurie (Systematic Notes on Palaearctic Birds, 1964, *Am. Mus. Novit.* 2177, p. 2) states that the outer and middle toes are *not* webbed in *Charadrius hiaticula* whereas they are webbed in the other species, *semipalmatus*, adding that the difference is not always easy to see in dried skins. Dementiev and Gladkov have described *Charadrius hiaticula* as having " a small swimming web at the base of middle and external toe " (BIRDS OF SOVIET UNION 3: 71). In the absence of suitable material for comparison, the specimen was sent to Dr. Dillon Ripley who has confirmed our identification.

The fact that two birds were obtained at the same time suggests that it is not so rare a straggler as is suggested by existing records for India. The specimen is the first of the species in the collection of the Bombay Natural History Society.

Incidentally, N. G. Smith (*Ibis* 1959: 177-188) in 'Polymorphism in Ring Plovers' has interesting notes on *hiaticula* and *semipalmatus* pairing on Baffin Island, such mixed pairings producing either *hiaticula* or *semipalmatus* with no intermediates.

In the course of this inquiry, we found in the Society's collection a small plover obtained by V. S. La Personne at Duzdap, Seistan, on 4 October 1926, marked as *Charadrius dubius curonicus*, but not registered and omitted in the catalogue. The legs appear to have been originally yellowish but the shafts of all the primaries are white excluding *dubius* and suggesting *hiaticula*. The 107 mm. wing is too small for this species and Dr. Ripley to whom it was sent has identified it as *Charadrius a. alexandrinus*, the colour of the legs apparently being misleading. Attention is drawn to Sharpe (CAT. BDS. BRIT. MUS. **24**: 279) who says: "In one instance I have seen a bird that had one dark leg and one pale one so that apparently the skin of the leg dries in various colours."

75, ABDUL REHMAN STREET, HUMAYUN ABDULALI
BOMBAY-3.

BOMBAY NATURAL HISTORY SOCIETY, S. A. HUSSAIN
BOMBAY-1,
February 3, 1971.

7. A SECOND RECORD OF THE MIGRATORY JUNGLE NIGHTJAR (*CAPRIMULGUS INDICUS JOTAKA* TEMM. & SCHL.) IN INDIAN LIMITS

In *JBNHS* **67**:331, H.A. has recorded the occurrence of the Migratory Jungle Nightjar (*Caprimulgus indicus jotaka* Temm. & Schl.) out at sea 60 miles north-east of Port Blair in the Bay of Bengal. A male of this species collected by Dr. Salim Ali on 7 November 1968 at Phuntsholing, Western Bhutan, wing 214 mm., tail 137 mm., appears to be of the same race, being greyer than *hazarae*. This locality is not far from the area indicated for *jotaka* in the map in INDIAN HANDBOOK (**4**:10) but it has yet to be determined if the population is resident in this area, or migratory as the popular name implies, and as is its habit in the other parts of its range. If migratory, it should be a regular visitor into Indian limits and this would probably account for some of the records of the larger-winged *hazarae* from the Himalayas.

In this specimen the first primary is only 9 mm. longer than the fourth, the difference being less than indicated for *jotaka* by Mayr in "On the Birds of the Vernay-Hopwood Chindwin Expedition" (*Ibis*, 1938, p. 312). The second primary is slightly longer than the third, but though mentioned (loc. cit) as a character of *jotaka*, appears in several *hazarae* available for examination. The relative lengths of the primaries would therefore appear to be inconsistent or intergrading.

75, Abdul Rehman Street, HUMAYUN ABDULALI
Bombay-3.

Bombay Natural History Society, S. A. HUSSAIN
Bombay-1,

April 1, 1971.

8. EXTENSION OF THE BREEDING RANGE OF SYKES'S NIGHTJAR (*CAPRIMULGUS MAHRATTENSIS* SYKES) IN INDIAN LIMITS

A fledgling male nightjar, Reg. No. 11721, with both wings and tail in quill, obtained by Sir Geoffery Archer at Charwa, near Bhuj, Kutch, on 26 July 1939 is marked *Caprimulgus mahrattensis*. The tarsus is naked and, except for some more rufous on the wing coverts, the colour agrees with that of adult male *mahrattensis*, and there can be no doubt it is correctly named.

Caprimulgus mahrattensis is omitted in Sâlim Ali's BIRDS OF KUTCH and, though known as a winter visitor to Gujarat and southwards, this appears to be the southernmost breeding record, the nearest being in Sind.

75, Abdul Rehman Street, HUMAYUN ABDULALI
Bombay-3.

Bombay Natural History Society, S. A. HUSSAIN
Bombay-1,

April 1, 1971.

9. OCCURRENCE OF THE LONG-EARED OWL [*ASIO OTUS OTUS* (LINNAEUS)] IN NORTH BURMA

B. E. Smythies in the second edition (1953) of the BIRDS OF BURMA, page 379, refers to a Short-eared Owl [*Asio flammeus flammeus* (Pontoppidan)] picked up near the Seinghku-Adung confluence in North Burma. In the course of cataloguing the Bombay collection, we find Sp. No. 11810, unsexed, collected on 19 February 1945 by Smythies at 4000′, Saprudam, Upper N'mai Hka (5 miles south of Adung-Seinghku confluence), listed under *flammeus* to be a Long-eared Owl [*Asio otus otus* (Linnaeus)] which is no doubt the specimen referred to by him earlier.

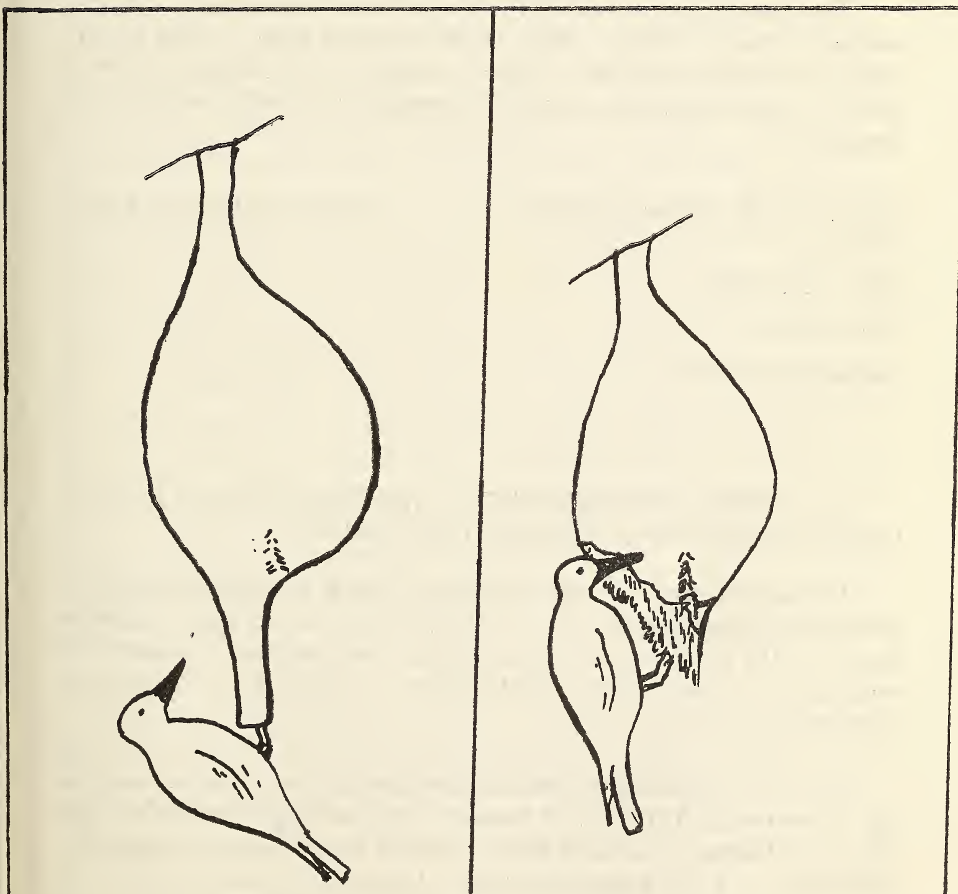
This owl has not been recorded from Burma and adds to its known range of distribution, probably on migration, as suggested by Smythies.

75, ABDUL REHMAN STREET, HUMAYUN ABDULALI
BOMBAY-3.
BOMBAY NATURAL HISTORY SOCIETY, S. A. HUSSAIN
BOMBAY-1,
March 9, 1971.

10. HOUSE CROW, *CORVUS SPLENDENS* VIEILLOT AND BAYA'S, *PLOCEUS PHILIPPINUS* (LINN.), NEST

(*With two text-figures*)

In August 1970 we had a single Baya nest on a coconut tree on the outskirts of our village close to Visakhapatnam, A.P. I could not say



whether the nest was occupied since I had neither heard any sounds of nestlings nor had I seen the parent birds.

A House Crow was seen one afternoon clinging to the entrance tube of the nest (Fig. I) and within 30 mins. it had slowly peeled off the entire tubular projection, bit by bit, taking brief rests of 5 to 8 seconds on a nearby tree for every 7 to 8 mins. of work on the nest. Within half an hour the outer web of the egg chamber was exposed and the crow snatched away the 'contents'. I am unable to say whether they were eggs or nestlings. The point to be noted is, that once the entrance tube is removed and the outer web of the egg chamber exposed, it is very easy for the predator to reach the inner egg chamber by a simple insertion of its beak over the chamber wall (Fig. II). The crow was silent all the while.

The Baya's nest is naturally well protected from predators by its unique shape and location. Even if the entrance tube is tilted to 90° angle the contents will not roll out. I wonder if the method described above is the one normally adopted by predator birds while dealing with Baya's nests.

B.N.H.S. Bird Migration Study Group,
Point Calimere,
Tamil Nadu,
December 12, 1970.

K.S.R. KRISHNA RAJU

11. LITTLE SPIDERHUNTER, *ARACHNOTHERA LONGIROSTRIS* (LATHAM) IN THE EASTERN GHATS

During the banding session of the B.N.H.S. bird migration study project at Lammasingi (*c*. 17° 40′ N., 82° 37′ E.) in the Visakhapatnam section of the Eastern Ghats in April/May this year, we obtained five specimens of the Little Spiderhunter, *Arachnothera longirostris* (Latham).

This is an interesting record as the distribution of the species according to the FAUNA 3 (1929) is " Western Coast of India from Palnis and Nilgiris to Belgaum, East and South Assam, Eastern Bengal in Tipperah, Chittagong and the hills tracts from Manipur to Chin hills . . . ". A similar distributional range is given by the SYNOPSIS (1961) also.

The present record is the first from the Eastern Ghats and adds northern Andhra to its known range.

B.N.H.S. Bird Migration Study Camp,
Forest Rest House,
Lammasingi,
Vizag Dt., A.P.,

K.S.R. KRISHNA RAJU
JUSTUS P. SELVIN

May 28, 1971.

12. NOTES ON SOME INTERESTING BIRDS FROM THE SALT LAKES, NEAR CALCUTTA

(*With two plates*)

The North and South Salt Lakes together constitute a sizable expanse (*c*. 92 sq. km.) of low-lying swampland, skirting the eastern fringes of the city of Calcutta. In the recent past, they were connected with the lower reaches of the Hooghly River basin, were under tidal influence, and contained brackish water; hence the name ' Salt Lakes '. With the severance of the connexion with the Hooghly following silting of the connecting channels, they have become landlocked, freshwater swamps. They are extensively used as fisheries, consisting of a large number of fish-rearing tanks (locally known as ' *bheri* ') of various sizes, separated from each other by narrow dikes ranging in height from a few centimetres to about 60 cm. above the level of water which is seldom more than 1.5 metres deep. The bottom is soft, oozy mud, made chiefly of decaying organic matter of animal and vegetable origin. The most conspicuous among the various aquatic plants growing in the '*bheries*' are the Nal reed (*Phragmites karka*), Hogla bulrush (*Typha angustata*) and the Water Hyacinth (*Eichhornia crassipes*), while various grasses and other herbs and shrubs grow on the dikes (Pl. 1 & Pl. 2, Fig. 1). Small hamlets (locally called ' *ala* ') where the fishery workers live, are dotted here and there, and several species of planted trees of economic importance are grown there.

During a systematic survey of the bird and mammal fauna of the Salt Lakes and bird-ringing commencing from 1961, we have come across some birds which should not be there according to books. Likewise, interesting aspects of behaviour of certain birds have also been noticed there by us. As the detailed report of our observation may take some time to complete, we are taking this opportunity of recording those that may be of interest to the students of bird biology.

Jynx torquilla chinensis Hesse. Chinese Wryneck.

A regular winter visitor in small numbers to the Calcutta area, the Chinese Wryneck prefers the reeds and shrubs in the Salt Lakes, although elsewhere it is generally found on trees and shrubs. We have taken several specimens from reed-beds.

Hirundo rustica tytleri Jerdon. Tytler's Swallow.

Although the standard books on the subject restrict the western limit of the Tytler's Swallow to Dacca and Mymensingh in East Pakistan (Baker 1926, p. 242; Vaurie 1959, p. 10; Ripley 1961, p. 273), we find it as a regular winter visitor in the Salt Lakes. It occurs there along with *H. r. rustica* and *H. r. gutturalis* in mixed flocks. However, its number is not as great as that of the other two subspecies. Unlike its cousins, it comes to the area as late as October and leaves in April.

Acrocephalus bistrigiceps Swinhoe. Blackbrowed Reed Warbler.

Like the Tytler's Swallow, the Blackbrowed Reed Warbler also regularly visits the Salt Lakes in small numbers during the winter, notwithstanding its western limits of distribution in Assam and Manipur according to books (Baker 1924, p. 392; Vaurie 1959, p. 239 ; Ripley 1961, p. 466) It occurs in thick reed-beds, generally associating with the Paddyfield Warbler (*Acrocephalus agricola*), Blyth's Reed Warbler (*A. dumetorum*) and the Grasshopper Warbler (*Locustella certhiola*).

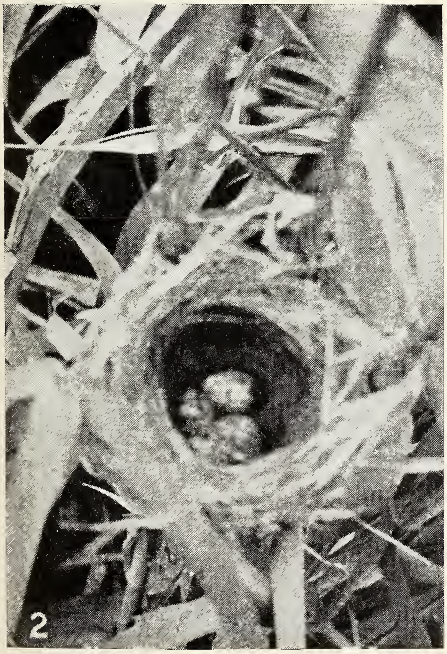
Acrocephalus stentoreus brunnescens (Jerdon). Indian Great Reed Warbler.

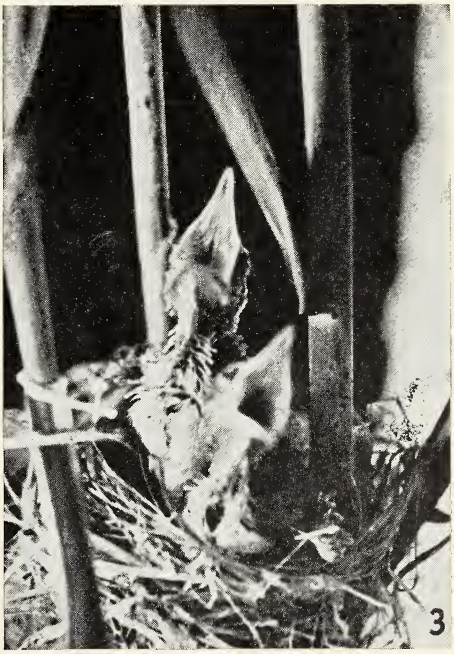
This bird has been referred to as only a winter visitor in Bengal (Baker 1924, p. 389; Vaurie 1959, p. 245; Ripley 1961, p. 465). However, we find it as resident in the Salt Lakes. In winter, the local resident population is greatly augmented by the influx of migrant populations.

The resident population regularly breeds in thick reeds during the monsoon. Occupied nests were observed as early as 31 May and as late as 13 September.

Nests are constructed generally in small colonies, and patches of reeds in the middle of '*bheries*' (that is, surrounded on all sides by an expanse of water) are preferred as nesting sites to the peripheral reed-beds.

The nest is firmly attached to 4-7 (sometimes more) reed-stems standing in 1—1.5 m. deep water, its bottom being about 30-90 cm. above the surface of water. It is a neat, compact, deep cup, made up of coarse-cut leaves of the Hogla bulrush (*Typha angustata*), intermixed





Figs. 1. Principal vegetation of the Salt Lakes; 2. Nest with a clutch of four eggs of the Indian Great Reed Warbler, North Salt Lake, 5 Aug. 1962; 3. Nestlings of the Indian Great Reed Warbler, North Salt Lake, 13 Sep. 1964.

Fig. 1. Hogla bulrush (*Typha angustata*) vegetation in North Salt Lake. A patch of Water Hyacinth (*Eichhornia crassipes*) may be seen at right foreground.

Fig. 2. Thick growth of Nal reed (*Phragmites karka*) in North Salt Lake. There are some Hogla bulrush in the foreground, and a few Cypress grass at left foreground.

with grass and roots of floating vegetation, fastened to the reed-stems by entwined grasses, roots and cobwebs here and there (Pl. 2, Fig. 2). The inner lining is made up of the delicate inflorescence of reed. The cup is about 5-8 cm. deep. Such a depth prevents the eggs from rolling out of the nest when the reeds are violently shaken by the wind during gales which are of frequent occurrence during the breeding season. The nest is on the whole similar to that described by George (1962) in Kerala.

The clutch-size is three to four (Pl. 2, Fig. 2), based on observation of five nests with complete clutches of eggs (3 in three nests and 4 in two). Two more nests were found with only single, freshly laid eggs.

The texture and coloration of the eggs agree with the description given by Baker (op. cit., pp. 389-390) and George (loc. cit.). Thirteen eggs measure : average 20.2×15.1 mm.; maxima 21.3×15.3 and 20.9×15.8 mm.; minima 18.5×15 and 19.8×14.8 mm.

Two nestlings taken on 13 September 1964, were about three or four days old (Pl. 2, Fig. 3). They had down absent, mouth orange, with a pair of somewhat diamond-shaped, glossy, purplish blue directive spots situated on two sides of the base of the tongue; gape yellow, maxilla fleshy horny, mandible fleshy, legs and feet plumbeous, claws horny.

ZOOLOGICAL SURVEY OF INDIA,
INDIAN MUSEUM,
CALCUTTA 13,
January 15, 1971.

S. S. SAHA, P. V. GEORGE,
D. K. GHOSAL, H. P. MOOKERJEE,
A. K. PODDAR, R. K. GHOSE,
P. K. DAS, V. G. GOGATE,
BISWAMOY BISWAS

REFERENCES

BAKER, E. C. S. (1924): The fauna of British India, Birds. 2. Taylor & Francis, London.

———— (1926): The fauna of British India, Birds. 3. Taylor & Francis, London.

GEORGE, P. V. (1962): On the Indian Great Reed Warbler, *Acrocephalus stentoreus* (Hemprich & Ehrenberg), breeding in Kerala. *J. Bombay nat. Hist. Soc.* 58 (for 1961): 797.

RIPLEY, S. D. (1961): A Synopsis of the birds of India and Pakistan. Bombay nat. Hist. Soc., Bombay.

VAURIE, C. (1959): The birds of the palaearctic fauna. Passeriformes. Witherby, London.

13. SOME INTERESTING BIRD RECORDS FROM POINT CALIMERE

The Point Calimere Sanctuary, situated on a low forest-covered promontory on the Coromandel Coast about 300 miles south of Madras city and separated by a bare 30 miles of sea from Ceylon, is an ideal area for the study of birds migrating through India to Ceylon. The Society's bird ringing station maintained at the Sanctuary since June

1969 has proved extremely valuable for obtaining data on the movements of Passerine and non-Passerine migrants. Information on some of the species which have not hitherto been recorded from the area or have been considered absent during summer or rare in Tamil Nadu, is given below :

Limnodromus semipalmatus (Blyth)

Two Snipe-billed Godwit ringed on 13th October 1970, gave the following measurements : Wing 165, 170; Bill (from skull) 79, 81; Tarsus 50, 49. There are no records of this bird from south India after Jerdon obtained a specimen from Madras Market in 1848. It is known as an uncommon straggler in eastern India, south to Chilka Lake, Orissa, where five specimens were ringed by our field team during January 1967.

Chlidonias leucoptera (Temminck)

We have ringed 50 Whitewinged Black Tern at Calimere, most of them in December 1970. Kinnear & Whistler (1937) questioned the statement in the FAUNA that it is common on the east coast, and agreed with the assessment of Blanford (1898) that it has not been identified clearly west of Tipperah. The HANDBOOK (3 : 41) lists the details of its occurrence in India, and gives it as a rare winter visitor to east India and north Ceylon. Wait (1931) found them in fair numbers in the north-central provinces of Ceylon. In the absence of any published record from Tamil Nadu our specimens would suggest the likelihood of this species often being confused with *C. hybrida indica* (Stephens).

Ceyx erithacus erithacus (Linn.)

Four specimens of the Three-toed Forest Kingfisher were ringed between 15th November and 28th December 1970. This is a bird of the moist deciduous and evergreen biotope of the Himalayas, Western Ghats and Ceylon and its occurrence at Point Calimere is intriguing. We cannot be certain whether the specimens were stray vagrants from Ceylon or on passage between Ceylon and their Indian range.

Mirafra erythroptera erythroptera (Blyth)

Seven Redwinged Bush Lark were ringed at Calimere. Ripley (1961 : 261) queries the occurrence of this species in Tamil Nadu, but our birds confirm that it does occur, and is perhaps even not very uncommon.

Zoothera wardii (Blyth)

Five birds of this species were netted and ringed during October 1969. The Pied Ground Thrush which breeds in the Himalayas has previously been recorded at higher elevations on the Eastern Ghats having been obtained on 26th April at Sankrametta, Vizag Hills, apparently on the return migration from its winter quarters in Ceylon to its northern breeding grounds. Its capture at Calimere gives an indication of its migratory movement through the Peninsula. The other records given by Kinnear & Whistler (1932) are evidently also of birds on the northward migration.

Zoothera citrina citrina (Latham)

22 birds of this species were ringed during October/November 1969. This is another record of a passage migrant whose status was not clear as far as Tamil Nadu is concerned.

CAMP,
B.N.H.S. BIRD MIGRATION STUDY PROJECT,
POINT CALIMERE,
TAMIL NADU,
March 22, 1971.

K. S. R. KRISHNA RAJU
P. B. SHEKAR

REFERENCES

ALI, SALIM & RIPLEY, DILLON S. (1969): The Handbook of the Birds of India and Pakistan 3: 41. Bombay.

BAKER, E. C. S. (1929): Fauna of British India. Birds. 6: 114.

BLANFORD, W. T. (1898): Fauna of British India. Birds 4: 308.

KINNEAR, N. B. & WHISTLER, H. (1932): The Vernay Scientific Survey of the Eastern Ghats. Pt. III. *J. Bombay nat. Hist. Soc.* 36: 78.

——— & ——— (1937): The Vernay Scientific Survey of the Eastern Ghats. Pt. XV. ibid. 39: 247.

RIPLEY, S. DILLON (1961): Synopsis of the Birds of India and Pakistan. Bombay.

WAIT, W. E. (1931): Birds of Ceylon, p. 380. London.

14. NEW RECORDS OF BIRDS FROM THE ANDAMAN AND NICOBAR ISLANDS

While working on a collection of birds from the Andaman and Nicobar Islands present in the Zoological Survey of India, I came across four examples of birds belonging to two forms, which according to standard ornithological literature (Baker 1924, 1929; Abdulali 1965, 1967; Ripley 1961; Ali & Ripley 1969) does not occur in this area. They are as follows:—

(1) **Porphyrio porphyrio poliocephalus** (Latham). Indian Purple Moorhen.

Three unsexed specimens bearing Z. S. I. Regd. Nos. 13680, 13681 and 13682, collected from Trinkut Island, Nicobars; donated by late E. H. May to the Asiatic Society of Bengal on 4 March, 1886.

MEASUREMENTS (in mm.)

3 unsexed: Wing 225, 228, 239; tail 78, 81, 83; bill from skull 42, 45, 46; bill from anterior margin of nostril 26(2), 27; length of casque 24, 25, 26.5; width of casque 26, 27(2); tarsus 82, 83, 85, middle toe without claw 88, 90, 93.

All these specimens appear to be young birds after their first moult. They resemble the adult, but are not so brilliant in colour (Sharpe 1894, p. 198). Sides of head, chin, throat and neck are tinged with a little cobalt-blue. One of the specimens has a growth on the left ramus of the lower mandible near the gape.

The Indian Purple Moorhen is known to occur in southern Baluchistan (West Pakistan) north to Kashmir east to East Pakistan and Burma, south to peninsular India and Ceylon. This appears to be the first record of its occurrence in the Nicobar Islands.

(2) **Lalage nigra** ? subsp. Pied Cuckoo-Shrike or Pied Triller.

One male specimen bearing Z. S. I. Regd. No. 28377, collected by Mr. R. V. Sherard of the Zoological Survey of India from Port Blair, South Andaman Island, on 18 March 1952.

MEASUREMENTS (in mm.)

1 ♂: Wing 95+; Tail—; Bill 16.

Since this is a young specimen having a brownish wash on the upper parts (Baker 1924, p 342) and badly damaged tail-feathers, it cannot be identified subspecifically.

Lalage nigra (Forster) is an Indo-Malayan species having four subspecies, three of which are distributed in different islands of this subregion. *Lalage nigra davisoni* Kloss, the fourth subspecies occurs in the Nicobar Islands (Mayr 1960, pp. 197-198), which show closer avi-faunal affinities with this subregion. This is the first authentic record of the occurrence of this species from the Andamans which group of islands are included in the Indo-Chinese subregion (Ali *in* Thomson, 1964, pp. 556-559). In view of the longer wing (Baker, op. cit., p. 341 gives wing measurements of Nicobar birds as 86 to 89 mm.) and immature condition, it can, perhaps, be safely said that it does not belong to the Nicobar population. Until more material is examined, it cannot be determined whether it is a straggler of a known population, or represents an unknown one.

ZOOLOGICAL SURVEY OF INDIA, P. K. DAS
CALCUTTA,
March 15, 1971.

REFERENCES

ABDULALI, H. (1965): The birds of the Andaman and Nicobar Islands. *J. Bombay nat. Hist. Soc.* 61(3): 483-571.

——————— (1967): The birds of the Nicobar Islands, with notes on some Andaman birds. *J. Bombay nat. Hist. Soc.* 64(2): 139-190.

ALI, S. *In* THOMPSON, A. L. [Editor] (1964): A New Dictionary of Birds. London (Nelson) and New York (McGraw-Hill).

ALI, S. & RIPLEY, S. D. (1969): Handbook of the Birds of India and Pakistan, together with those of Nepal, Sikkim, Bhutan and Ceylon. Bombay. Vol. 2.

BAKER, E. C. S. (1924, 1929): Fauna of British India, Birds. ed. 2 & 6. London. (Taylor & Francis).

MAYR, E. (1960): in Peters' Check-list of birds of the World. 9. Cambridge, Massachusetts (Museum of Comparative Zoology).

RIPLEY, S. D. (1961): A Synopsis of the Birds of India and Pakistan, together with those of Nepal, Sikkim, Bhutan and Ceylon. Bombay Natural History Society, Bombay.

SHARPE, R. B. (1894): Catalogue of the Birds in the British Museum. 23. London. British Museum (Natural History).

15. NOTES ON INDIAN SNAKES—1

(*With two plates*)

Albinism in Russell's Sand Boa (*Eryx conicus*)

In October 1969 an unusual specimen of *Eryx conicus* was collected near Madras and given to me. Its length at that time was 275 mm. It was a uniform light cream in colour, the underside being slightly lighter in shade. The only deviation from albinism were the eyes, which were black.

Since capture the snake has lived well on mice and measures about 500 mm. It began to show brown speckled markings on its dorsal scales, and we supposed that the snake was darkening as it approached maturity and some true pigment came through; this action appears to have ceased.

Albinism in snakes is not common but has been observed in a large number of genera including the American rattlesnakes (*Crotalus*), King snakes (*Lampropeltis*), boa constrictors and in India the python (*P. molurus*) and probably others.

Two-headed Snake (*Cerberus rhynchops*)

The Dog-faced Watersnake (*Cerberus rhynchops*) is a rear-fanged estuarine snake common along coastal India. Madras City and environs have many inland waterways where this snake abounds. The specimen in the photo was collected near Madras in 1969 and brought to the office of Mr. Harry Miller, a photographer-naturalist residing in Madras. The specimen was alive and healthy and about 350 mm. long. Unfortunately the owner of the snake was unwilling to part with it and so no observations could be made how it feeds etc. Two-headed snakes usually don't survive long after birth, generally being anatomically defective. It is a rare phenomenon as in other animals. In the United States are records of two-headed rattlesnakes (*Crotalus*), garter snake (*Thamnophis*), and king snake (*Lampropeltis*) and others. In some cases one head is only partially or abnormally developed and the normal head dominates. In others both heads are nearly equal in activity and each tries to control the body. Eventually one head tires out and the other takes over. In this latter case the two heads are sometimes observed fighting over the same mouse (Klauber).

Another Indian snake of which a two-headed example was found is *Natrix piscator*, obtained near Nagercoil (S. India)[1].

Social Behaviour of Common Krait (*Bungarus caeruleus*)

We routinely keep 20 to 30 common kraits at the Madras Snake Park for venom extraction and to study their habits. The krait has some interesting behavioural traits. Being cannibalistic they are extremely wary of each other. When two new males or a male and female are placed together they generally become oblivious of you and carry out a jerking examination of each other. After this familiarization they will not bother the other unless ready to mate. Sometimes though, a new snake will move around causing a commotion among all the snakes in the enclosure. The photograph illustrates a newly introduced male krait (white markings) attacking another large male. The male "combat dance" is observed with this species as with many others but in these rituals (thought to be associated with sexual behaviour) the contest is a harmless 'wrestling match'. The krait here demonstrates an exception with its aggressive biting attacks. The snakes were separated with difficulty, neither suffered ill effects.

Besides this aggressive tendency kraits show a curiosity and sensitivity towards each other most of the time that is observed in other species only at mating time. The nocturnal habits of this snake make it difficult to observe; it appears there is a lot of interesting study to be done on Krait behaviour.

Cannibalism in juvenile Russell's Viper (*Vipera r. russellii*)

A female Russell's Viper commonly gives birth to about 25 young. It is difficult to raise these young, one reason being that they frequently attempt to or succeed in swallowing each other. This habit has been widely observed and reported. The photograph shows an

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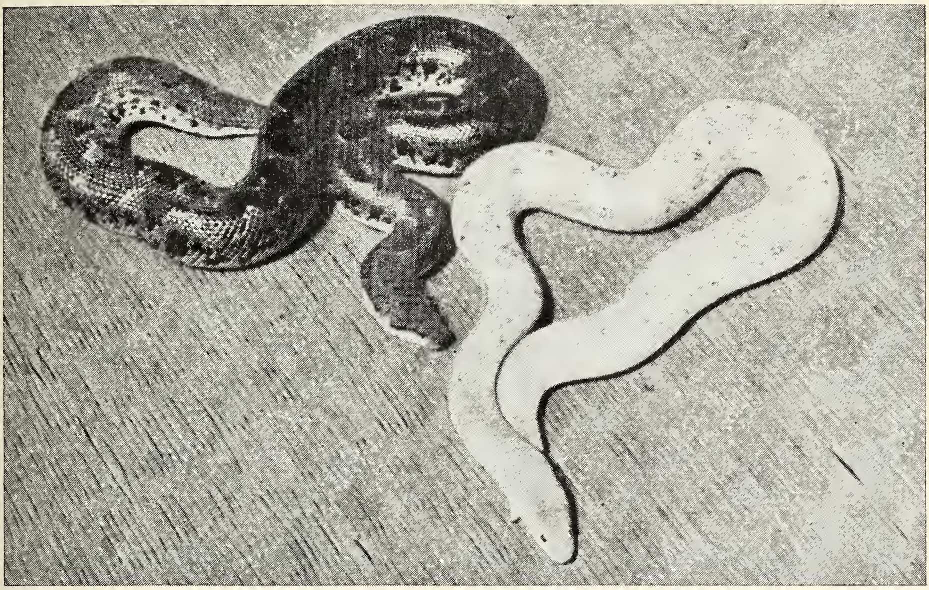
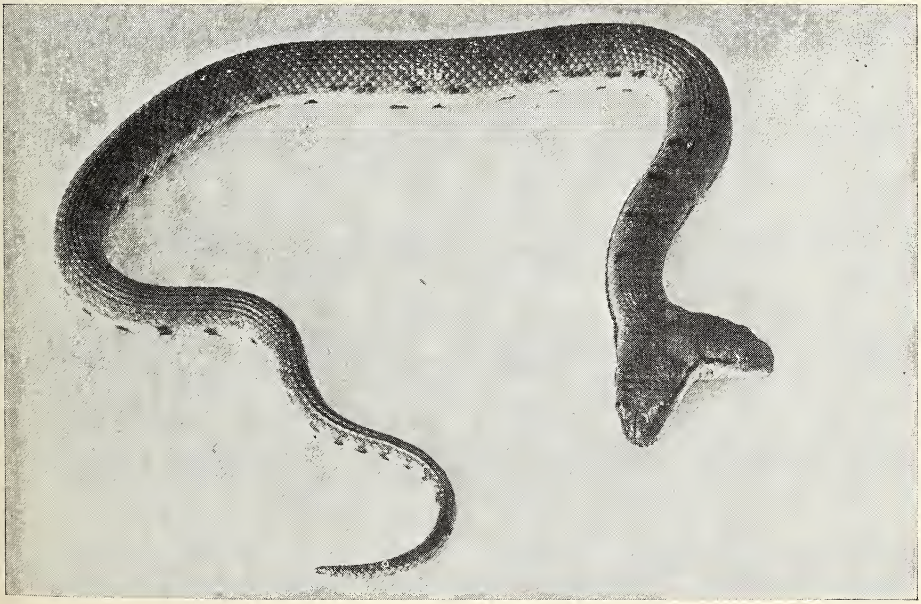
[1] Earlier records of double-headed snakes from India relate to the Wolf Snake (*Lycodon aulicus*), Cobra (*Naja naja*) and Russell's Viper (*Vipera russellii*). In *Zoonooz* 44(3) (1971) of the San Diego Zoo, C. E. Shaw writes of double-headed California King snake (*Lampropeltis gerulus californiae*), one of which lived for 6½ years.—EDS.

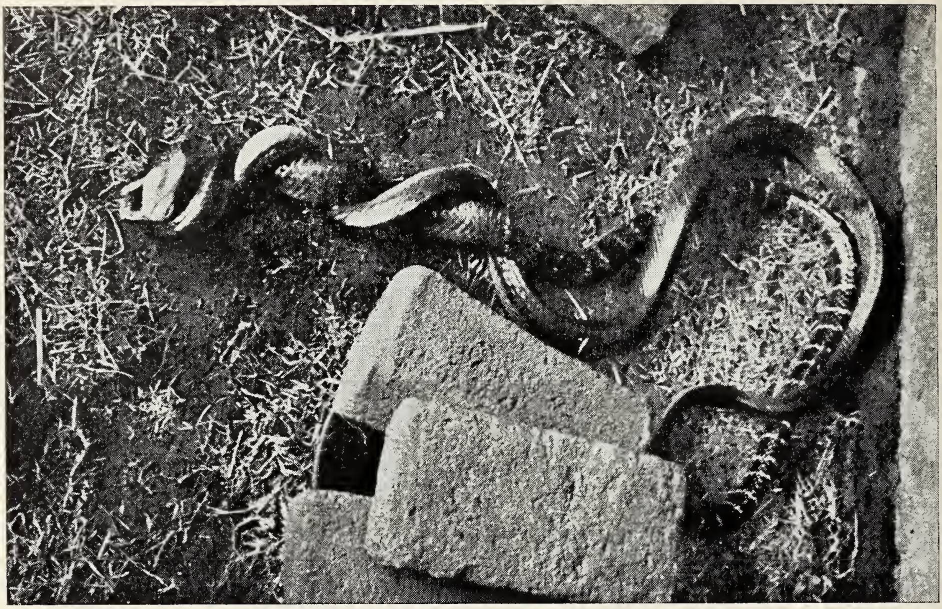


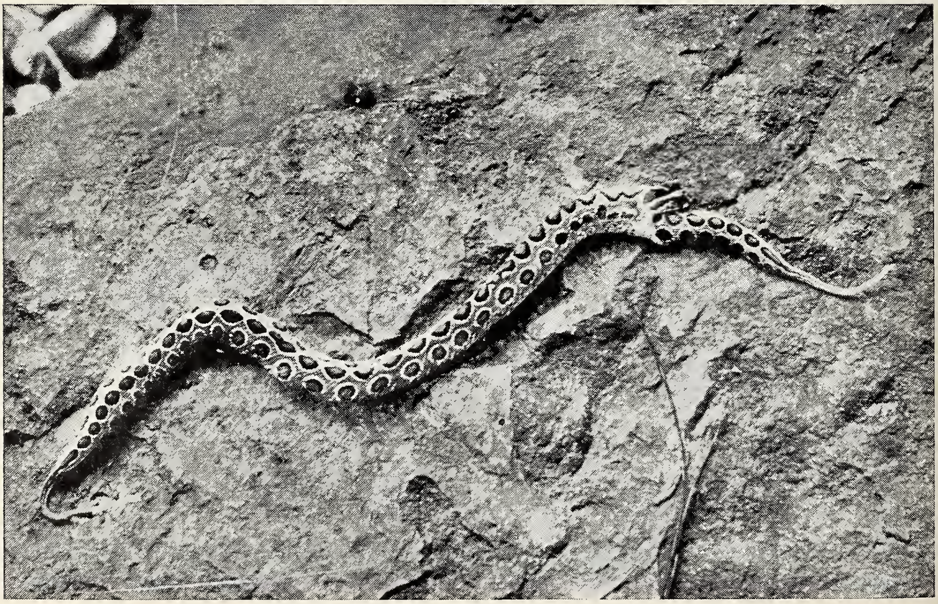


Above : Normal coloured and albino Russell's Sand Boa.

Below : Two-headed Dog-faced Water Snake.

(*Photos: Harry Miller*)





Above: Male Kraits in combat.
Below: Cannibalism in young Russell's Viper.

example of a baby viper that has swallowed another as long as itself. It died shortly afterwards.

MADRAS SNAKE PARK, ROMULUS WHITAKER
180, VELACHERY ROAD,
SELAIYUR,
MADRAS-45,
March, 1971.

16. A SNAKE-FROG INCIDENT

On 20th January 1971, while at the Khodija Falls, some 40 miles out of Karachi, my brother Shumoon picked up a dead 29″ snake *Coluber rhodorhachis* (?) by the side of the flowing stream. A frog's hind leg projected from a tear in the side, 10″ from the snout; a closer examination revealed that the frog (*Rana cyanophlyctis*, 48 mm. from snout to vent) had not been swallowed head first as is usual, but by the hind legs. A couple of inches before the rent where the frog's leg extruded was another smaller tear, indicating that the snake had had a grim struggle.

The Khodija Falls, at the bottom of a deep rocky valley, are visible only at close quarters. The drop is barely 15 feet but the flow of clear water, the pool at the bottom, the green vegetation at the sides, and the high cliff in the background, all present a most delightful scene in an otherwise barren wilderness. Several of the surrounding rocks are embedded with fossil-shells and fossils of starfish and other marine forms appear to be strewn profusely over the area. Our party picked up specimens of starfish and a crenoid during our short visit.

75, ABDUL REHMAN STREET, HUMAYUN ABDULALI
BOMBAY-3,
February 12, 1971.

17. AN ABNORMAL SPECIMEN OF *BRACHIRUS ORIENTALIS* (SCHN.) FROM PULICAT LAKE

Brachirus orientalis (Schn.) is a common sole along the coasts of India (Misra 1959). Recently the species was recorded from Pulicat Lake as a new record (Selvanathan & Kaliyamurthy, in press). It is available in the lake throughout the year and is considered to be a delicacy.

A female *Brachirus orientalis*, measuring 179 mm. in total length, was collected from near the shore of the lake at Arambakkam on

24.xii.1965. This specimen showed abnormal features in the development of the eyes and was slightly larger than the previous records (maximum size 165 mm.) (Misra op. cit.).

Although no differences are apparent in the meristic characters of the fins and scales, the body height, head length and diameter of the eye of the specimen are slightly less when compared to a normal specimen (Table 1). The lower eye is altogether absent and is represented by a white depression covered by a fold of the skin. The upper eye is otherwise normal except for the slightly reduced size and is protruded and tilted towards the mouth. A transparent membrane, resembling an eyelid, is clearly visible close to the lower margin of the upper eye, directed towards the snout, and this is absent in normal specimens. An outgrowth of muscular tissue is also noticed on the dorsal side of the upper eye. In all other features the present specimen resembles the normal form.

TABLE 1

Character	Abnormal specimen	Normal specimen
Total length/head length..	5.88	4.2–5.3
Total length/height of body	2.28	2.0–2.2
Head length/diameter of eye	8.24	5.0–8.0

Abnormal features such as ambicoloration, albinism, arrested rotation of eyes, reversal of sides are well known in flat fishes but the total absence of the lower eye and the peculiar features noticed in the upper eye do not seem to have been reported previously.

The author is thankful to Dr. V. G. Jhingran for his interest and to Dr. V. Gopalakrishnan for kindly going through the manuscript. The author is grateful to Dr. M. Subrahmanyam for revising the manuscript.

PULICAT UNIT OF
CENTRAL INLAND FISHERIES
RESEARCH INSTITUTE,
PONNERI,
TAMIL NADU.

M. KALIYAMURTHY[1]

January 27, 1968.

REFERENCES

MISRA, K. S. (1959): An aid to the identification of the common commercial fishes of India and Pakistan. *Rec. Indian Mus.* 57(1-4): 311.

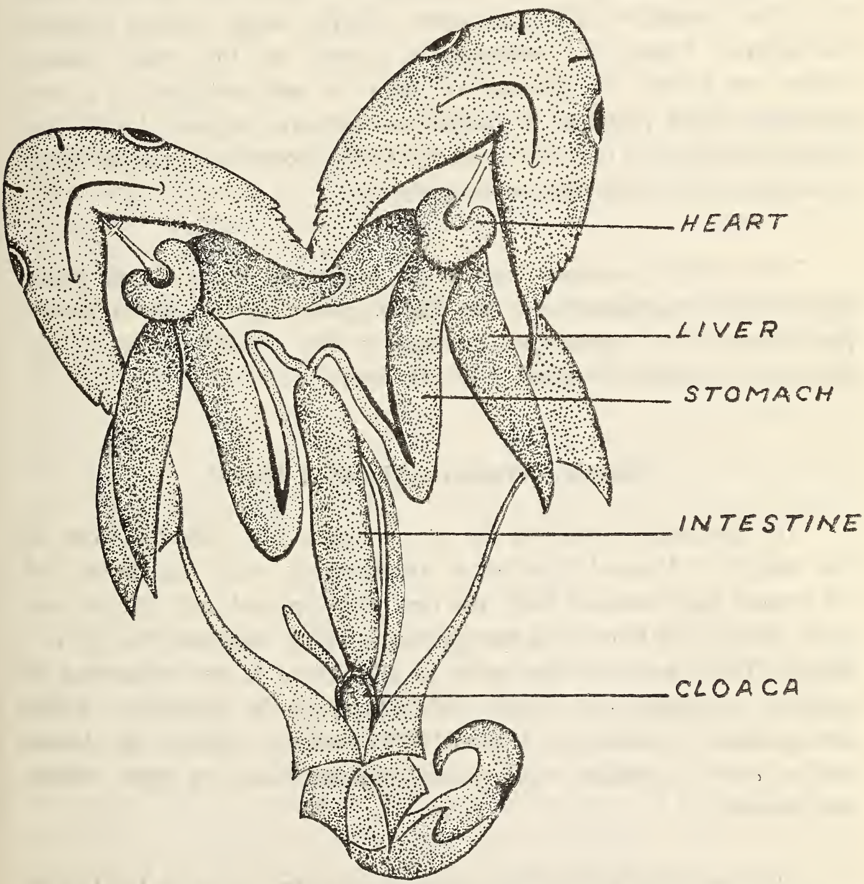
SELVANATHAN, M. & KALIYAMURTHY, M. (1967): New record s of fishes from Pulicat Lake. (In press.)

[1] Present address:— Central Inland Fisheries Research Institute, Perambur, Madras-11.

18. ON TWO ABNORMAL SHARKS FROM GUJARAT

(*With a text-figure*)

The two abnormal sharks which form the subject of this note were collected by me in the course of a fishery investigation on the Gujarat coast. One of them, a double-headed specimen of *Carcharias walbeehmi* (Bleeker), was obtained from landings brought to a fish curing yard at Porbandar in January 1964, and the other, a thumb snouted albino of *Eulamia dussumieri* (Muller & Henle), from Veraval in May 1962. The only previous record of similar specimens from India appears to be that of Menon (1959)[1] from West Hill.



[1] MENON, M. DEVIDAS—(1959): On some abnormal sharks preserved at the Marine Biological Station, West Hill. Fisheries Station Reports and Year Book, April 1955 to March, 1956. Department of Fisheries, Government of Madras. pp. 191-194.

Carcharias walbeehmi (Bleeker)

The specimen measuring 16 cm. in length was obtained from the womb of a mother shark of 80 cm. length. The heads are distinct up to the fifth gill cleft which is common for both at the side of union. Both heads have five normal gill clefts on their free sides. Among the fins, the pectoral, pelvic and caudal are common whereas the first and second dorsal are paired. A single placental chord emerged from between the pectorals.

Among the visceral organs a striking abnormality is exhibited by the alimentary canal where the duodenum of both the partners come from their respective sides and open into the single median intestine (text-figure). Except the urinogenital system, all the other visceral organs are paired. The circulatory system is seen modified as a consequence of the presence of paired and unpaired organs. Liver lobes lying on the side of union are comparatively shorter and less developed than those on the free sides of the embryo.

The vertebral columns meet at the beginning of the caudal region from where they gradually coalesce. The crippled caudal fin curves forward producing a blunt appearance posteriorly. The general pattern of pigmentation indicates the identity of the embryo.

Eulamia dussumieri (Muller & Henle)

The specimen measuring 28 cm. in length was collected from the fish market at Veraval. The fish is conspicuously white due to the lack of normal pigmentation. Both the eyes are displaced and situated ventrally behind the blunt and spongy snout which resembles the tip of a thumb. There are only four pairs of gill clefts. A scar indicating the position of placenta is clearly visible between the pectorals. Unlike the specimen described by Menon (1959) both the eyeballs are distinct in the present specimen with normal pigmentation. All other features are normal.

This work was carried out during the author's tenure in the Department of Fisheries, Gujarat State, and the specimens after the examination have been preserved at the museum of the Survey and Research Centre at Veraval.

ACKNOWLEDGEMENT

The author wishes to express his gratitude to the Director of Fisheries, Gujarat State for the facilities offered during the investigation.

NATIONAL INSTITUTE OF OCEANOGRAPHY, (CSIR), U. K. GOPALAN
PLANNING AND DATA DIVISION,
B-7, HAUZ KHAS,
NEW DELHI,
April 19, 1970.

19. NOTES ON THE BIOMETRIC FEATURES OF *NEMIPTERUS JAPONICUS* (BLOCH)[1]

(*With two text-figures*)

INTRODUCTION

Observations regarding the biometry and biology of *Nemipterus japonicus* from Indian waters are limited to the unpublished data of Amarnath (1961) and the Annual Reports of the Central Marine Fisheries Research Institute. This note deals mainly with some aspects of the biometry of the fish and its food.

At Porto Novo (*c.* 11° 29′ N., 79° 49′ E.), *N. japonicus* occurs in abundance from October to February but stray catches occur in other months also. According to the 1961 report of the Central Marine Fisheries Research Institute, the fish occurs in shoals off Tuticorin during August and September and is also caught in fairly large quantities at 27-31 m. depth off Cochin. *N. japonicus* has a wide distribution and has been recorded from the coastal waters of India, the Red Sea and from the east coast of Africa (Day 1878).

MATERIAL AND METHODS

Since the fishery of *N. japonicus* at Porto Novo is seasonal, it was possible to get adequate samples only for a period of five months (October-February). The fish is generally caught in *Thoori valai* or bag nets, operated from catamarans. Samples were obtained from the main fish landing centres and also from the local fish market. Ninety specimens were examined. The usual methods were used for weight and length measurements and for analysis of stomach contents. Standard length of the fish was used as a basic prerequisite against which regression curves for other parameters were drawn. For estimating the length-weight relationship of the fish, only the total length of the fish was taken into consideration.

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[1] This study formed a part of the dissertation submitted in partial fulfilment of the requirements for the degree of M.Sc., from the Annamalai University, 1965.

Results and Discussion

Body parts: Details of the analysis of the data are presented in Tables 1, 2 and 3. The regression lines based on the degree of angle (*see* Table 3) are delineated in Fig. 1.

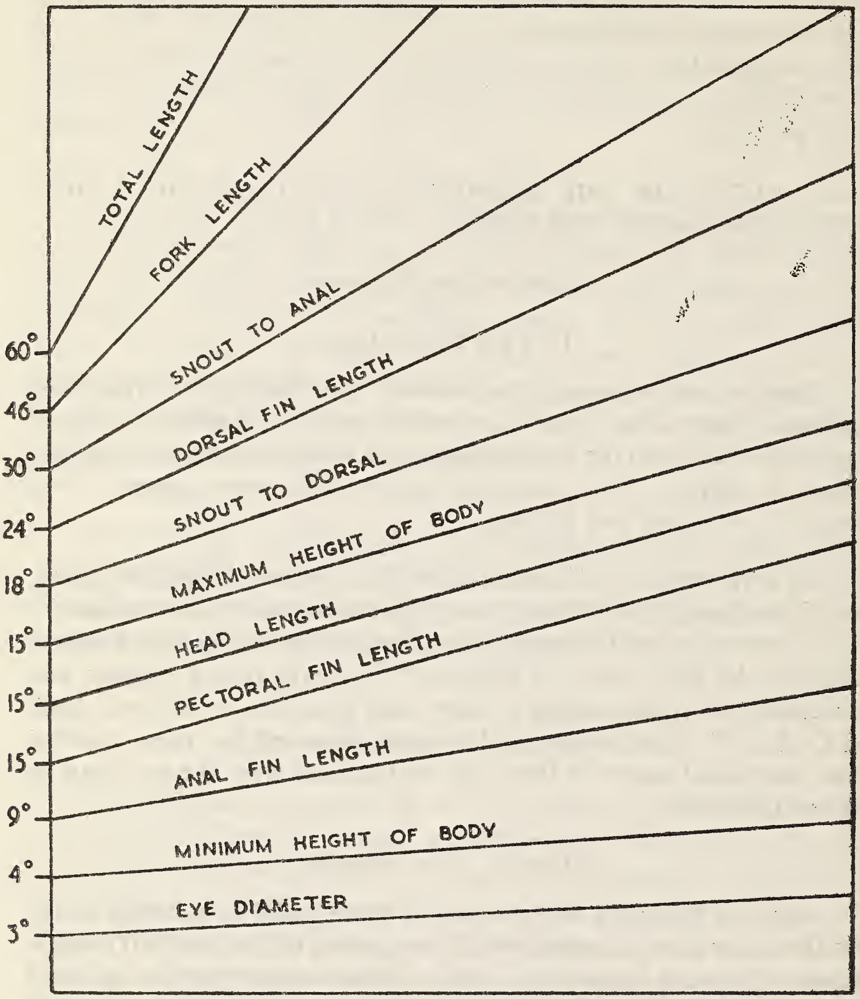

Fig. 1. Regressions of the different measurements of the body on standard length of *Nemipterus japonicus*.

A comparison of different regression lines in Fig. 1 reveals the relative growth of different parts of the body of *N. japonicus*. The regression studies indicate that the total length has a maximum rate of growth. This is followed by the fork length. A comparison of the relative growth of snout to dorsal with snout to anal length indicates that the latter grows

TABLE 1

MEAN VALUES OF DIFFERENT REGIONS OF BODY MEASUREMENTS IN *N. japonicus*

Group No.	Class intervals in cm.	No. of specimens	Total body weight in gm.	Total length in cm.	Standard length in cm.	Fork length in cm.	Maximum height of body in cm.	Minimum height of body in cm.	Head length in cm.	Snout to dorsal in cm.	Snout to anal in cm.	Dorsal fin length in cm.	Pectoral fin length in cm.	Anal fin length in cm.	Eye diameter
1	4.8– 6.8	4	3.5	6.1	4.9	5.7	1.5	0.6	1.5	1.9	3.0	2.5	1.4	0.8	0.7
2	6.9– 8.9	9	5.6	7.4	5.9	6.8	1.8	0.7	1.8	2.3	3.8	3.1	1.7	1.1	0.7
3	9.0–11.0	3	9.9	9.2	7.1	8.3	2.4	0.9	2.1	2.7	4.5	3.8	2.2	1.3	0.8
4	11.1–13.1	3	17.8	11.3	8.8	10.2	2.9	1.0	2.6	3.3	5.6	4.5	2.7	1.6	1.0
5	13.2–15.2	4	43.6	15.0	11.7	13.6	3.8	1.3	3.5	4.4	7.8	6.2	3.6	2.3	1.2
6	15.3–17.3	10	54.2	16.3	12.9	14.7	4.1	1.4	3.9	4.8	8.4	6.7	3.9	2.4	1.2
7	17.4–19.4	11	79.4	18.5	14.6	15.6	4.8	1.6	4.4	5.4	9.5	7.6	4.4	2.7	1.3
8	19.5–21.5	26	102.1	20.3	15.9	18.2	5.2	1.8	4.8	5.9	10.3	8.2	4.7	3.0	1.4
9	21.6–23.6	9	148.4	22.6	17.8	20.4	6.0	2.0	5.5	6.5	11.5	9.4	5.2	3.3	1.6
10	23.7–25.7	4	181.8	24.6	19.3	22.0	6.4	2.1	5.9	7.1	12.7	10.0	5.7	3.8	1.6
11	25.8–27.8	6	236.5	26.9	21.0	23.8	6.9	2.3	6.3	7.8	13.5	10.9	6.3	4.1	1.7
12	27.9–29.9	1	283.0	28.4	22.5	25.2	7.7	2.4	6.8	8.1	13.9	11.9	6.6	4.4	1.7

faster than the former. Similarly the relative growth of different fin lengths suggests that the dorsal fin grows faster than the other fins, namely the pectoral and the anal. The rate of growth of the dorsal fin falls in between those of the snout to anal and snout to dorsal.

TABLE 2

CONSOLIDATED DATA OF DIFFERENT REGIONS OF THE BODY OF THE FISH *N. japonicus* TOGETHER WITH OTHER STATISTICAL INFORMATION

No.	Body regions	Standard length					
		X	Y	XY	X^2	a	b
1	Total length	162.4	206.6	3,297.9	2,592.5	—0.4	1.3
2	Fork length	162.4	185.5	2,951.8	2,592.5	0.6	1.1
3	Max. height of body...	162.4	53.5	859.1	2,592.5	0.4	0.3
4	Min. height of body...	162.4	18.1	285.9	2,592.5	0.2	0.1
5	Head length	162.4	48.9	784.7	2,592.5	0.02	0.3
6	Snout—dorsal ...	162.4	60.2	955.9	2,592.5	—0.4	0.4
7	Snout—anal	162.4	104.5	1,666.5	2,592.5	0.6	0.6
8	Dorsal length ...	162.4	84.8	1,354.4	2,592.5	0.3	0.5
9	Pectoral length ...	162.4	48.4	771.0	2,592.5	—0.03	0.3
10	Anal length	162.4	30.8	495.9	2,592.5	—0.1	0.2
11	Eye diameter ...	162.4	14.9	226.1	2,592.5	0.4	0.06

TABLE 3

TANGENT VALUES OF DIFFERENT BODY REGIONS

No.	Body regions	'b' value	Angle	Tangents
1	Standard length—Total length ...	1.3	60°	1.7321
2	Standard length—Fork length ...	1.1	46°	1.0355
3	Snout to anal fin	0.6	30°	0.5774
4	Dorsal fin length	0.5	24°	0.4452
5	Snout to dorsal fin	0.4	18°	0.3249
6	Maximum height of body	0.3	15°	0.2679
7	Head length	0.3	15°	0.2679
8	Pectoral fin length	0.3	15°	0.2679
9	Anal fin length	0.2	9°	0.1584
10	Minimum height of body	0.1	4°	0.0699
11	Eye diameter	0.06	3°	0.0524

The data also show that the relative rate of growth, delineated from the regression line angle, is similar for the pectoral fin length, the maximum height of the body and for the head length of the fish. The slowest growing body part, however, is the diameter of the eye while next to it is the minimum height of the body which is one degree faster in its growth than that of the diameter of the orbit.

Length-weight Relation : The point of inflation of the curve showing diminution of condition factor with increasing length has been thought to be an indicator of the length at which sexual maturity is attained in fish (Hart 1946). In the present study the modified emperical relationship of $W=CL^n$ (Le Cren 1951) was used where W is the weight of fish, L is the length of fish and C and n are constants to be determined empirically.

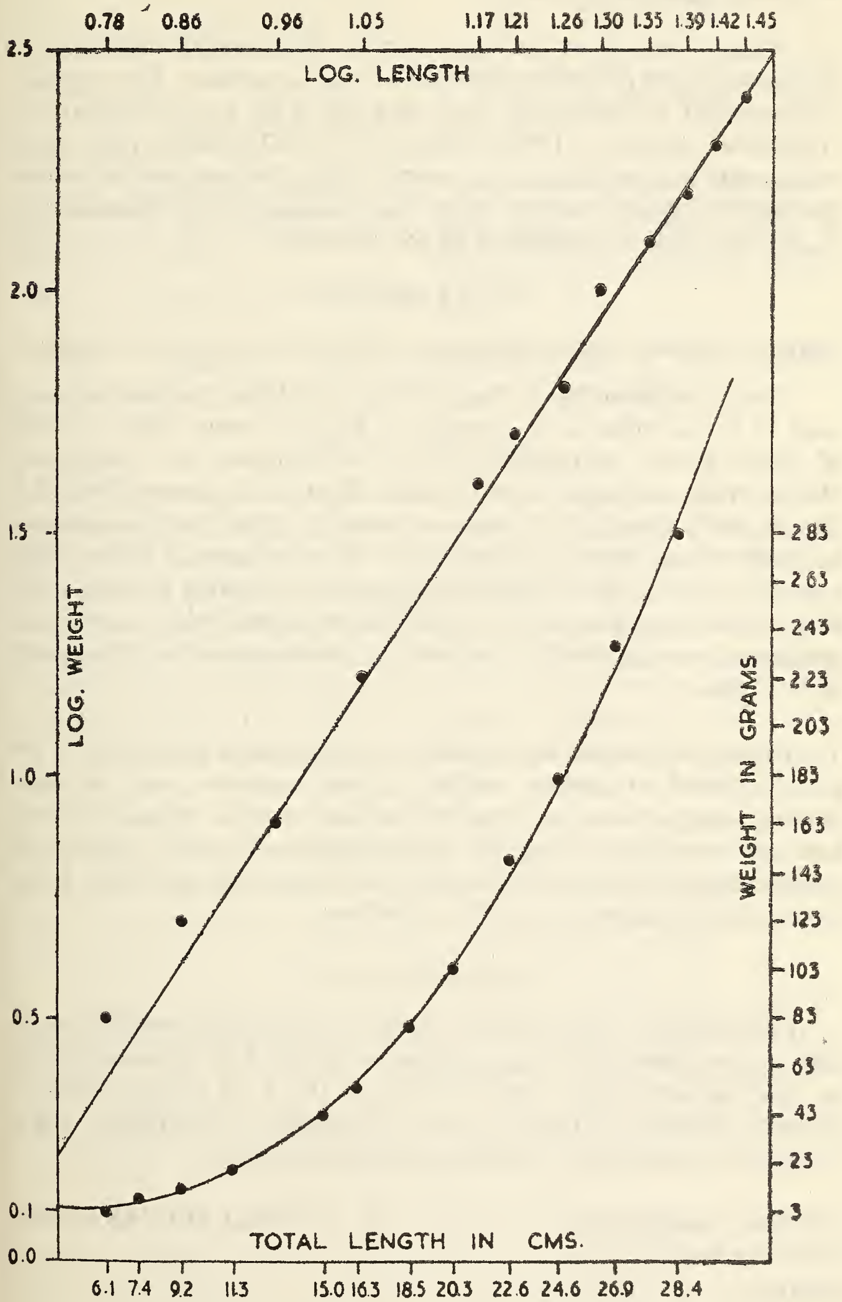

Fig. 2. Length-weight relationship and the logarithmic transformation of length and weight values in *Nemipterus japonicus*.

The data of length-weight relationship are presented in Fig. 2 together with their logarithmic values.

It can be seen from the Fig. 2 that the length-weight relationship in *N. japonicus* is of non-linear type and formed a parabola. The regression of log length on log weight was observed to be linear. Similarly for *Nemipterus virgatus*, Li (1954) reported $W=0.022L^3$ and found a linear relationship for the length range sampled, while the relationship between the observed weight and the length was non-linear. The relationship in *N. japonicus* is best represented by the equation :

$$W=(-2.085)\ L^{3.092}$$

thereby indicating that weight increases at the rate of cube of the length.

Food: Basheeruddin & Nayar (1961) found that the main items of food of the juveniles of *N. japonicus* in Madras waters, chiefly consists of prawn larvae, stomotopod larvae, few copepods and amphipods. Similar studies on the gut content of adults from Cochin waters (CM.F.R.I. Report 1961) show that the main components of the food were prawns and polychaetes, including *Squilla* sp. in large numbers. Chacko (1949) reported that the fish is a plankton feeder but very often browses at the bottom and amongst seaweeds. Li (1954) observed small teleosts, decapods, cephalopods and annelids in that order of abundance in the gut contents of *N. virgatus*.

During the present observation on *N. japonicus* a major part of the gut was found to contain bottom dwelling organisms such as polychaetes, small prawns, fragments of molluscan shells, pieces of hermit crab and occasionally copepods and amphipods. It can, therefore, be concluded that *N. japonicus* is largely a carnivorous fish and feeds at the bottom and occasionally on surface plankton.

Acknowledgements

I am grateful to Professor R. V. Seshaiya, Director, Marine Biological Station, Porto Novo for suggesting the problem and for guidance during the work. Grateful thanks are also due to Dr. S. Z. Qasim, Scientist, National Institute of Oceanography, Ernakulam, for critically going through the manuscript and making valuable suggestions.

R. ALFRED SELVAKUMAR

National Institute of Oceanography,
Panaji,
Goa,

January 24, 1970.

REFERENCES

AMARNATH, D. (1961): A study of the Biology, biometry and fishery of *Nemipterus japonicus* (Block). M.Sc. thesis, Annamalai University, (Unpublished).

BASHEERUDDIN, S. & NAYAR, K. N. (1961): A preliminary study of the fishes of the coastal waters off Madras city. *Indian J. Fish.* **8**: 169-188.

CENTRAL MARINE FISHERIES RESEARCH INSTT. (1961): Annual Report of the Director for the year ending 31st March 1961. *Indian J. Fish.* **8**.

HART, T. J. (1946): Report on trawling surveys on Patagonian continental shelf '*Discovery*'. Rep. **23**: 223-224.

LE CREN, E. D. (1951): The length-weight relationship and seasonal cycle in gonad weight and condition in the Perch (*Perca fluviatilis*). *J. Anim. Ecol.* **20**: 201-219.

LI, KWAN-MING (1954): An Account of the Golden Thread Group Fishery in Hong Kong, and a Preliminary Note on the Biology of *Nemipterus virgatus* (Houttyun). *Hong Kong Univ. Fisheries Journal* **1**: 1-18.

20. A NOTE ON THE TAXONOMY OF A SPECIES OF *TACHYSURUS* LACÉPÈDE (PISCES: TACHYSURIDAE)

(*With a text-figure*)

During a study of the shore fishes of Goa, a specimen of *Tachysurus* Lacépède collected by Dr. S. W. Kemp from Mormugoa Bay in September 1916 was tentatively determined as *T. jatius* (Hamilton 1822). A perusal of the pertinent literature, however, clearly indicates that two species have been confused under the name *jatius* Hamilton. The first species has an edentulous palate and this is clearly the fish named by Hamilton (1822) and later figured by Day (1877, pl. 56, fig. 4) and redescribed by Misra (1959) under the genus *Hemipimelodus* Bleeker. The other related species has two small oval patches of granular palatal teeth and this has up to now apparently been confused by Ichthyologists (Blyth 1860; Day 1877; Munro 1955) with, and accepted as *jatius* Hamilton. This species is described below and is most probably a new species of *Tachysurus* and not congeneric with Hamilton's *jatius*. A new name for this species of *Tachysurus* is not, however, being proposed for the present in view of the limited material available for study.

The type species of the genus *Tachysurus* Lacépède, 1803 is *Tachysurus sinensis* Lacépède which has teeth on the palate; *Pimelodus borneensis* Bleeker, the type species of *Hemipimelodus* Bleeker, 1858, has, however, an edentulous palate. This is the chief taxonomic character for differentiating the two genera (*vide* Weber & de Beaufort 1913; Fowler 1941; Smith 1945; and Misra 1959).

In the collections of the Zoological Survey of India Day's (1877) figured example of *Arius jatius* (Hamilton) corresponding to Plate 56, Fig. 4 (Reg. No. Cat. 473) and another specimen of *A. jatius* (Reg. No. F 13460/1) with an edentulous palate, are available for comparison. Unfortunately, no specimen of Day's *Arius jatius* with palatal teeth are available in the collections for study. A detailed description of the specimen measuring 126 mm. in standard length, from Mormugoa Bay (ZSI Reg. No. F 6045/2) is given below to facilitate further work on this particular species.

Tachysurus sp.

DI. 7 A 19 P I. 10 G.R. 7+1+11, lanceolate.

Depth of body 4.84, head length 3.40; both in standard length. Height of head at occiput 1.44, width of head 1.54; both in head length. Eye diameter 4.11 in head length, 1.50 in interorbital width, 1.50 in snout length. Upper jaw longer than lower jaw, extent of mouth gape

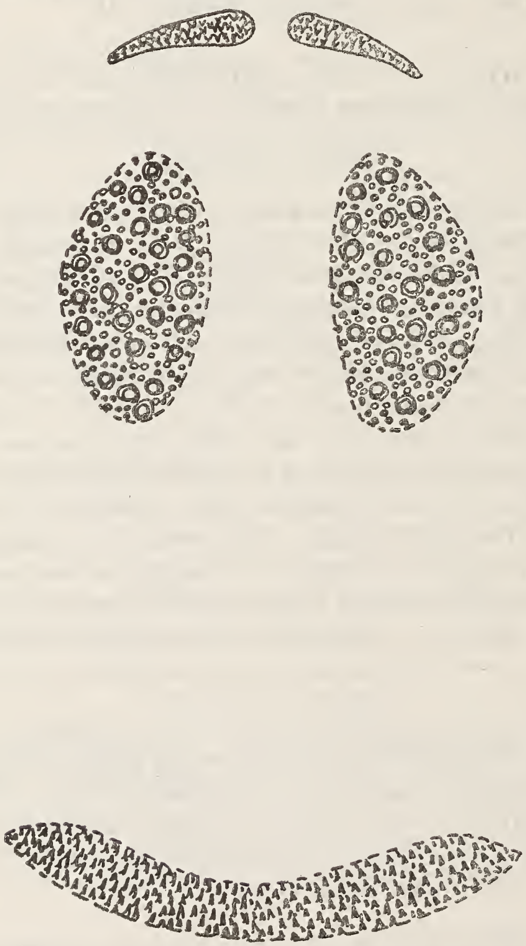

Fig. 1. Dentition in the specimen of *Tachysurus* from Goa (Diagrammatic).

equals one-third of head length. Posterior portion of head sparsely granulated, occipital process more thickly so; median longitudinal groove on head narrow and continued almost to base of occipital process which is keeled and reaches the narrow V-shaped basal bone of dorsal fin.

Barbels—six, maxillary barbels shorter than head, reach slightly beyond base of pectoral fin ; outer mandibular reach gill opening.

Teeth (text-figure)—Villiform in a continuous band on pre-maxillaries, five times as long as wide. Palatal teeth in two small oval groups, globular, separated from jaw teeth by a space equal to one and half times length of patch; length of patch less than half eye-diameter. Vomerine teeth absent.

Fins—Dorsal spine strong, serrated on both sides, as long as head without snout. Pectoral spine slightly shorter than dorsal spine, serrated on both sides. Base of adipose dorsal 4/5 of rayed dorsal. Caudal (broken) forked.

Colour (in alcohol): Light brownish, silvery below. Fins yellowish, upper edge of rayed and adipose dorsals dusky.

Distribution: Goa, estuaries and rivers of Ceylon, and Sitang River (Burma).

Remarks: Day (1877) described the teeth on the palate of *Arius jatius* (Hamilton) as 'globular, in a small oval patch posteriorly, scarcely exceeding half the diameter of the eye ; they may be entirely absent' and figured a specimen from Burma and remarked " The specimen figured has no teeth whatsoever on the palate and is an *Hemipimelodus*, but having closely compared it with four more specimens having teeth as described, I feel convinced of their identity." In our collections we have a specimen registered as *Arius jatius* (Hamilton) collected by Dr. F. Day from Calcutta [ZSI Reg. No. Cat. 187]. The specimen has palatal teeth in two large, semi-ovate patches, about 1.5 times the diameter of the eye and agrees well with Day's figured specimen of *Arius gagora* (Hamilton) (ZSI Reg. No. Cat. 421). This specimen has been correctly redetermined as *Tachysurus gagora* (Hamilton) by Chandy (1953).

Munro (1955) reported *jatius* Hamilton from estuaries and rivers of Ceylon and included the species under the genus *Pseudarius* Bleeker, 1863 as the palatal teeth are globular, in two small oval patches. Misra (1959), however, described *jatius* Hamilton with no palatal teeth and hence referred the species to the genus *Hemipimelodus*.

ACKNOWLEDGEMENTS

The author is grateful to Dr. A. P. Kapur, Director, for encouragement and Dr. A. G. K. Menon, Superintending Zoologist, Zoological

Survey of India, for his sustained help and guidance in the preparation of this paper.

ZOOLOGICAL SURVEY OF INDIA, P. K. TALWAR
CALCUTTA-13,
April 28, 1970.

REFERENCES

BLYTH, E. (1860): Report on some fishes received chiefly from the Sitang river and its tributary streams, Tenasserium provinces. *J. Asiat. Soc. Bengal* **29**: 151-152.

DAY, F. (1877): The Fishes of India. London: 465-466.

CHANDY, M. (1953): A key for the identification of the cat fishes of the genus *Tachysurus* Lacépède, with a Catalogue of the specimens in the collection of the Indian Museum (Zool. Surv.). *Rec. Indian Mus.* **51** (pt. 1): 1-18.

FOWLER, H. W. (1941): Contributions to the biology of the Philippine Archipelago and adjacent regions. *Bull. U.S. Nat. Mus.* (100) **13**: 753-771.

HAMILTON, F. (1822): An account of the fishes found in the river Ganges and its branches. Edinburgh: 171.

MISRA, K. S. (1959): An aid to the identification of the common commercial fishes of India and Pakistan. *Rec. Indian Mus.* **57**: 176.

MUNRO, I. S. R. (1955): The Marine and Freshwater fishes of Ceylon. Canberra: 51-55.

WEBER, M. & BEAUFORT. L. F. DE (1913): The Fishes of the Indo-Australian Archipelago. Leiden **2**: 271-329.

21. SOME NEW FOOD PLANTS OF *DROSICHA MANGIFERAE* (GREEN) IN MADHYA PRADESH (HOMOPTERA: MARGARODIDAE)

Drosicha (*Monophlebus*) *mangiferae* (*stebingi*) (Green), the giant mealy bug, is a widely distributed, sporadic, polyphagous pest, throughout India. During 1959-61, it caused considerable loss to citrus, guava, fig, ber and mango at Gwalior and some other places in Madhya Pradesh. A survey was carried out to investigate its food plants. Rahman and Latif (1944) reviewed the host plants of the pest recorded in India by previous workers and reported sixty-two host plants in the Punjab including twenty-three not previously recorded but found it to be a serious pest of mango only. Wasiual Haque (1955), Sen & Prasad (1956) and Pruthi & Batra (1960) added further lists of host plants of the pest. The author (1968) reported sixty-six food plants of economic importance in M.P. and twenty-eight of them, namely Bael (*Aegle marmelos*), Anwala (*Phyllanthus emblica*), Chikoo (*Achres sapota*), Mahandi (*Lawsonia alba*), *Acalypha* sp., *Zinnia* sp., Quisqualis (*Quisqualis indica*), Poppy (*Papaver* sp.), *Bouganvillea* sp., Madanmasta (*Artabotrys odoratissimus*), Parwal (*Trichosanthes dioica*), Mitha neem (*Melia azedarach*), Amaltas (*Cassia fistula*), Paper flower (*Helicrysum* sp.), Askand (*Withania somanifera*), Dhencha (*Carthamus tinctorius*), Adhasisi (*Xanthium strumatium*), Akua (*Calotropis* sp.), Brinjal (*Solanum melongena*), Badidudhi (*Euphorbia pulcherrima*), Waghata (*Capparis zeylanica*), Mohwa (*Bassia *latifolia*), Kadam (*Anthocephalus cadamba*), Panwar (*Cassia obtusifolia*), Custard apple (*Anona squamosa*), Torai (*Luffa* sp.), Aghada (*Achyranthus aspera*), and *Pennisetum cenchroides*, are new records from India. The author further found *Citrus* sp. and Guava to be the most preferred food plants in Madhya Pradesh as against mango reported by previous workers at other places in India.

Thanks are due to the authorities of the Agriculture Department of M.P. for facilities and to the Director, Zoological Survey of India, Calcutta for the identification.

Department of Entomology, D. K. SAXENA
J. N. Krishi Vishwa Vidyalaya,
Jabalpur, M.P.,
January 24, 1969.

References

Pruthi, H. S. & Batra, H. N. (1960): Some important fruit pests of North-west India. *I.C.A.R. Bull.* 80: 68.

Rahman, K. A. & M. A. Latif, (1944): Description, Bionomics and Control of giant mealy bug, *Drosicha stebbingi* (Green). *Bull. Ent. Res.* 35 (2): 197-209.

Saxena D. K. (1968): Host plants of the Giant mealy bug. *J. Coll .Agri. Gwalior* 8: 45-48.

Sen, A. C. & Prasad, D. (1956): Biology and control of the mango mealy bug *Drosicha mangiferae* (Green). *Indian J. Ent.* 18(2): 127-140.

Wasiual Haque, M. (1955): Some new host plants of *Drosicha stebbingi* (Green) (Rhynchota: Coccidae). *Indian J. Ent.* 17(1): 137-140.

22. SOME OBSERVATIONS DURING OVIPOSITION IN THE LEMON BUTTERFLY, *PAPILIO DEMOLEUS* L.

Generally, an egg-laying female butterfly would be guided by at least two different stimuli while searching for the larval host plant— the odour of the host plant and the coloration of its leaves. The following few observations on the egg-laying behaviour of *Papilio demoleus* are of interest from this point of view.

While experimenting on the role of visual stimuli in the egg-laying behaviour of this insect, it was noticed that the female was not attracted to the characteristic colour alone presented by the blue-green, green or yellow-green papers of the standardized Ostwald series used in the above experiments. When, however, such papers were offered with the odour of Citrus plant, the larval host plant of this insect, was present (the plant being within the large experimental cage but not in direct view of the insects), the females responded strongly to the coloured paper leaves. On these, the females exhibited a characteristic 'drumming response' described previously (Vaidya 1956), which is preliminary to oviposition.

This response consists of approaching a coloured surface in flight and then hammering on it alternately with the front pair of legs. This is often accompanied by the simultaneous fluttering of wings and the ventral curving of the abdomen. Under experimental conditions, this response is usually obtained without its culminating in actual deposition of an egg.

Thus, with respect to the stimuli essential to the egg-laying female of *Papilio demoleus* to evoke a drumming response, it was observed that in addition to a characteristic coloured surface, the odour of the host plant had also to be supplied. Even in the presence of both these stimuli, it could not be successfully induced to lay eggs under experimental conditions, except in a few cases. It was remarkable indeed that none of the females actually seemed to search for the host plant, which was the source of odour. The mere presence of this odour served as a stimulus, which made them respond to the artificial coloured leaves.

A similar observation was made by Knoll (1921-26) on the egg-laying hawkmoth *Macroglossum stellatarum*. A small twig of *Gallium*, the host plant of this insect, was placed vertically in a test tube about 125 mm. long. The twig being shorter than the length of the test tube, it ended about 20 mm. below the mouth of the tube. The female hawkmoth kept flying at the part of the tube through which the leaves of *Gallium* were visible without taking any notice of the opening of the tube through which the scent emanated. It frequently touched the glass sides of the test tube as if to oviposit.

Ilse (1928) has also made a similar observation (described by her as ' Alarmierung durch den Duft '), in connection with the feeding response of certain Vanessid butterflies. She found that the presence of a sweet fruity smell of Amyl acetate made the feeding butterflies visit the artificial coloured flowers more actively.

The observations on *Papilio demoleus* give us a clue to the relative importance of odour and colour during its egg-laying state. There is no doubt that the odour of the host plant is, in this case, of prime importance, while colour plays only a secondary role.

DEPARTMENT OF ZOOLOGY, VIDYADHAR G. VAIDYA
UNIVERSITY OF POONA,
POONA-7,

January 13, 1968.

REFERENCES

ILSE, D. (1928): Uber den Farbensinn der Tagfalter, Z. *vergl. Physiol.* 8: 658-691.

KNOLL, F. (1921-26): Insekten und Blumen, H. 1-6. *Abs. zool. bot. Ges. Wien*, 12.

VAIDYA, V. G. (1956): On the phenomenon of drumming in egg-laying female butterflies, *J. Bombay nat. Hist. Soc.* 54: 216-217.

23. CANNIBALISM IN THE EPILACHNA BEETLE, *HENOSEPILACHNA SPARSA* HERBST. (COLEOPTERA: COCCINELLIDAE)

Cannibalism in phytophagous insects is an interesting phenomenon. The authors, while making ethological studies on the epilachna beetle, *Henosepilachna sparsa* Herbst., a phytophagous beetle, generally feeding on solanaceous plants, made the following observations on its occasional cannibalistic behaviour in the laboratory and in the field.

In the field, the beetles fed on the wild plant, *Datura fastuosa*, the leaves of which were used for rearing them in the laboratory. Under certain conditions, not yet fully understood, all the feeding stages of the beetle develop a transient cannibalistic tendency, even when fresh leaves of the host plant are available. The adults and the larvae then start eating the eggs. In one case, an adult beetle was observed consuming 11 eggs in about 30 minutes, leaving behind only small proximal parts of the chorion attached to the leaf. Laboratory studies also indicate that the female beetle prefers to eat eggs laid by other beetles, if available. The adult also eats all other immature stages. There are four larval instars and the larvae also sometimes feed on the lower instar larvae. In one instance, a late final instar larva fed on a pupa which was attached to the top of the rearing container by its posterior end. The larva attacked the pupa at its cephalic end and consumed most of its soft parts.

Department of Zoology,
Malabar Christian College,
Calicut 1, Kerala,
March 29, 1969.

V. I. EDONA
A. B. SOANS

24. A CONVENIENT METHOD OF COLLECTING THE LARVAE OF TIGER BEETLES (ORDER COLEOPTERA—FAMILY CICINDELIDAE) IN THE FIELD

The larvae of tiger beetles are predaceous creatures, living in burrows in the soil and are highly specialized for their mode of life and feeding. During the day, the larva generally remains at the top end of the burrow, closing its opening with its head and prothorax, and waiting for prey. At the slightest vibration of the surrounding soil or movements of objects or shadows over or around the opening of the burrow, the larva quickly withdraws itself deep down the burrow.

The authors' experience has shown that the collection of the larvae of tiger beetles in the field is indeed a somewhat tricky business for many reasons. For one thing, the larva very rapidly moves down the burrow in reaction to slightest disturbance, mechanical or visual. The burrows run quite deep and are narrow. The collection of larvae by digging does not yield satisfactory results because, in more than seventy-five per cent of the attempts, the larvae either escape notice and are lost or may be crushed and damaged. The burrows do not always take a directly vertical course downwards but may often deviate slightly from the vertical, in all directions and this makes the process of tracing their course particularly difficult. Further, collection by digging takes a long time, as the soil has to be removed bit by bit in order to be able to follow the burrow down to its bottom.

The authors have been able to collect within a relatively short time and with greater success, large numbers of all instars of the larvae of the tiger beetle, *Cicindela cancellata* Dej. in the field, by the following convenient method. First of all, the habitat of the larvae is determined from the presence of neat, circular openings of their burrows in sandy areas during the period of abundance of tiger beetles. A rectangular strip of steel sheet, about 5 centimetres wide, 25 centimetres long and about 0.5 centimetre thick is prepared and the edge of one of its ends is sharpened. The collector sits or squats about half a metre away from the burrow, holding the steel strip, the sharpened end of which is made to rest flat on the ground, between the burrow and the collector and about 5 centimetres away from the opening of the burrow. The larva, on seeing the approach of the collector, quickly withdraws itself. The collector should be watching the opening of the burrow and generally, within a minute, the larva comes to the surface and its dark head and prothoracic parts appear at the opening of the burrow. At this very moment, the collector briskly drives the steel strip into the soil and across the burrow at an angle of about 45 degrees so that the burrow is blocked at about 5-10 centimetres below the soil surface. The larva is now trapped above the steel strip. This part of the operation should almost coincide with the appearance of the head of the larva at the opening of the burrow. Otherwise, even if the action is slightly delayed, the larva may either be damaged by the blade or may even escape by moving deep down.

The soil above the steel strip is slowly raised by levering the end of the strip upwards carefully and the larva is easily spotted and collected.

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A. B. SOANS
J. S. SOANS

Department of Zoology,
Malabar Christian College,
Calicut-1, Kerala,

May 2, 1968.

25. CONTRIBUTIONS TO THE STUDY OF AQUATIC BEETLES (COLEOPTERA) : 8. A NEW SUBGENUS OF *CLYPEODYTES* REGIMBART (DYTISCIDAE)

The genus *Clypeodytes* Regimbart (1894) has about 60 species; nearly 50 per cent of them belong to the Ethiopian region. It is distributed in all the tropical and subtropical zones of the world excepting Europe. Zimmermann (1920) reduced it to a subgenus of *Bidessus* Sharp, but later it was recognised as a genus with three subgenera by Guignot (1959). These subgenera are—*Lioclypeus* Guignot (1950), *Hypoclypeus* Guignot (1950) and *Clypeodytes* (s. str.). I did not divide the genus into various subgenera, as I had not then seen Guignot's (1959) paper, though a key to the species known from India (Vazirani 1969), more or less follows this division. On a reassessment of the position of these species, a new subgenus is proposed for the species *Clypeodytes hemani* Vazirani (1968). Other species, known from India, are also assigned to the various subgenera.

Genus CLYPEODYTES Regimbart

Subgenus **Paraclypeus** subgen. nov.

Type species.—*Clypeodytes hemani* Vazirani (1968).

Diagnosis.—All the characters of genus *Clypeodytes* Regimbart as redefined by Guignot (1959) plus the following characters.

Pronotal striae not continued on the elytra; elytra without any carina or costae.

Distribution.—India.

Genus *Clypeodytes*

KEY TO SUBGENERA (modified from Guignot, 1959)

1.	Laterobasal pronotal striae continued on the elytra	..	2
	Laterobasal pronotal striae not continued on the elytra	..	3
2.	Elytra neither carinate nor with any lateral costae	..	*Lioclypeus*
	Elytra carinate or with lateral costae, though very feeble	..	*Clypeodytes* (s. str.)
3.	Elytra neither carinate nor with any lateral costae	..	*Paraclypeus* subgen. nov.
	Elytra carinate or with lateral costae, though very feeble	..	*Hypoclypeus*

The species known from India are assigned to subgeneric combinations as under—

Clypeodytes (s. str.) *bufo* Sharp

Clypeodytes (*Lioclypeus*) *indicus* (Regimbart)

Clypeodytes (*Lioclypeus*) *orissaensis* Vazirani

Clypeodytes (*Lioclypeus*) *minutus* Vazirani

Clypeodytes (*Lioclypeus*) *horai* Vazirani
Clypeodytes (*Hypoclypeus*) *duodecimaculatus* Regimbart
Clypeodytes (*Hypoclypeus*) *severini* (Regimbart)
Clypeodytes (*Paraclypeus*) *hemani* Vazirani

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May 12, 1969.

T. G. VAZIRANI

REFERENCES

GUIGNOT, F. (1950): Trente-deuxieme note sur les Hydrocanthares—*Rev. franc. Ent. Paris* 17: 97.

———— (1959): Revision des Hydrocanthares d'Afrique—*Ann. Mus. R. Congo Belge* Tervuren, (8) 70: 1-313.

REGIMBART, M. (1894): Voyage de M. E. Simon dans l'Afrique australe.... *Ann. Soc. ent. Fr. Paris*, 63: 227.

VAZIRANI, T. G. (1968): Contributions to the study of Aquatic Beetles (Coleoptera). 1. A collection of Dytiscidae from Western Ghats with descriptions of two new species. *Oriental Ins., New Delhi* 1: 99-112.

———— (1969): Contributions to the study of Aquatic Beetles (Coleoptera). 2. A review of the subfamilies—Noterinae, Laccophilinae, Dytiscinae and Hydroporinae (in part) from India. *Oriental Ins., New Delhi* 2: 221-342.

26. THE ROLE OF VISUAL AND OLFACTORY FACTORS IN THE PREY-HUNTING BEHAVIOUR OF POMPILID WASPS (HYMENOPTERA: POMPILIDAE)

The Pompilid wasps are known to provision their nests in the ground with spiders which are stung and paralysed. The authors made the following observations of the prey-hunting behaviour of a species of Pompilid wasp (unidentified) inside the house during the day. The wasp generally flies into the room, flies close to the ceiling and the corners of the walls and then hovers around a spider's web. It then makes repeated quick approaches to the central hub of the web, finally seizes the spider and flies away with it.

Interestingly enough, the wasp was sometimes found flying around an electric bulb backed by a plate-like shade and mounted on a bracket on the wall. It exhibited for some time, about the same pattern of initial behaviour as that in relation to the spider's web and then flew away. Closer observation revealed that the wasp was repeatedly dashing against the central circular marking at the distal end of the bulb, bearing details of trade mark, voltage, wattage etc. It is quite likely that the wasp mistook this slightly dark, circular part of the bulb for the denser translucent central hub of a spider's web where the spider generally remains at rest, and was looking for its prey.

The authors also came across an instance wherein the wasp accidentally dropped the spider while flying away with it. The dropped spider was slowly moving on the floor and the wasp started hovering over the area, presumably trying to locate its lost prey. The wasp then landed on the floor and started making random movements. Within a few minutes, it appeared to have made out the track of the spider and was found moving approximately along the route taken by the spider. It seemed to follow some kind of trail, moving its antennae in a characteristic manner. The wasp finally reached the spider, seized it and stung it before flying away with it.

The Pompilid wasp, having distinct preference for spiders, would be at an advantage if it can identify its prey with some degree of accuracy and from a distance to avoid waste of time. In the case of its behaviour in relation to the electric bulb, all stimuli except visual are ruled out. It is therefore inferred that the visual factor either through form-vision or skototaxis initially guides the wasp to the hub of the web containing the spider. The final choice and capture of prey may be conditioned by olfactory or tactile factors which may reinforce or destroy the first impressions.

DEPARTMENT OF ZOOLOGY, A. B. SOANS
MALABAR CHRISTIAN COLLEGE, J. S. SOANS
CALICUT, KERALA,
June 4, 1969.

27. ABSENCE OF COLONY-SPECIFIC PHEROMONES IN THE ANT, *TECHNOMYRMEX ALBIPES* SMITH (HYMENOPTERA : FORMICIDAE)

Highly colony-specific pheromones have been well established in the case of colonies of certain ants, honeybees and other social insects and these pheromones enable the insects concerned to distinguish between members of their colonies and also intruders from other colonies of the same species (Butler 1967).

Technomyrmex albipes is a common tramp species occurring in tropical and subtropical countries, with its original home in tropical Asia or Africa (Brown 1964). Colonies of this ant were collected from among the leaf-whorls of bamboo shoots and transferred to an artificial ant-nest in the laboratory. Mixing a few colonies of the ants was also tried by dropping the ants, eggs, larvae and pupae of different colonies into the same nest in the laboratory. It was interesting to see that the ants which moved about in the new environment for some time, soon settled down together in one group and arranged all the eggs and immature stages together, forming what appeared to be a single colonial unit. The ants did not, at any stage, show any sign of intercolonial hostility and this indicates the absence of colony specific odours in *Technomyrmex albipes*. Such a feature has been recorded in a few other ants also (Wilson 1963).

DEPARTMENT OF ZOOLOGY, A. B. SOANS
MALABAR CHRISTIAN COLLEGE, J. S. SOANS
CALICUT, KERALA,
March 11, 1969.

REFERENCES

BROWN, W. L. (1964) : Personal communication.

BUTLER, L. (1967): Insect pheromones. *Biol. Rev.* 42 : 42-87.

WILSON, E. O. (1963): The social biology of ants. *Ann. Rev. Entomol.* 8: 344-368.

28. A NOTE ON *APANTELES PALUDICOLAE* CAMERON (BRACONIDAE; HYMENOPTERA) A PARASITE OF *EXELASTIS ATOMOSA* W.

Bhatnagar (1948) and Usman & Puttarudriah (1955) have reported *Apanteles exelastisae* and *Apanteles* sp. (*Glomeratus* group) as the larval parasites of *Exelastis atomosa.*, a destructive pest of *Cajanus cajan* in Bihar and Mysore. However, they did not mention anything about the biology, period of activity and extent of parasitisation caused by the braconid to the crop pest.

During the course of field observations and laboratory rearing a larval braconid parasite, *Apanteles paludicolae* C. was recorded. Its biology in relation to symptoms of injury to host larvae and extent of parasitisation were studied.

Symptoms of parasitised larva : The third instar larvae of the post were parasitised, and these lose the pinkish colour of the healthy larva changing to a pale white. The size of the parasitised larva was reduced and its feeding activity slowed down. It died soon after the emergence of the parasite.

Biology : The parasite lays one to two eggs in the body of the host which hatch in 4-5 days. The grub feeds for 7-9 days inside the body of the host and when full grown emerges by cutting an irregular hole on the lateral side of the fourth abdominal segment of the host. On an average, the full-grown grub measured 3.5 mm. in length and 0.68 mm. in breadth. Body fleshy, creamy white, covered with very fine short hairs. Some 30 to 45 minutes after emerging, it spins a cocoon and pupates. Cocoon creamy white, oval in shape and on an average measures 3.5 mm. in length and 1.9 mm. in breadth. Pupal period varies from 5-7 days. The adult braconid cuts a hole at the anterior end of the cocoon and emerges. A single life cycle was completed in 18-21 days, and adults lived for 2-5 days. The average duration of each period recorded in 7 cases is summarised in Table 1.

TABLE 1

LIFE CYCLE AND LONGEVITY OF *Apanteles paludicolae* IN DAYS

Month	Incubation period	Larval period	Pupal period	Life cycle period	Adult longevity
October 1965..	4	9	5	18	5
November 1965	5	9	7	21	3
December 1965	5	7	6	18	2

Extent of parasitism and period of activity: Regular collection of the larvae of the pest made to note the extent of braconid parasitism revealed that it was as high as 18% during the month of October but fell to 10% and 7% during November and December 1965.

ACKNOWLEDGEMENTS

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J. N. KRISHI VISHVA VIDYALAYA,
GWALIOR,
April 16, 1969.

B. V. DESHPANDE
S. C. ODAK

REFERENCES

BHATNAGAR, S. P. (1948): Studies on *Apanteles* Forster (Vipionidae; parasitic Hymenoptera) from India. *Indian J. Ent.* **10**: 133-203.

USMAN, S. & PUTTARUDRIAH, M. (1955): A list of insect pests of crops in Mysore including the mites. Dept. Agri. Mysore State Bull. No. 16.

29. LOCALIZED MASS BREEDING OF *HAEMAPHYSALIS BISPINOSA* NEUMANN, 1897 (ACARINA, IXODIDAE) IN KYASANUR FOREST DISEASE AREA, SHIMOGA DISTRICT, MYSORE STATE, INDIA

(*With two plates*)

INTRODUCTION

The tick, *Haemaphysalis bispinosa* Neumann, 1897, has been recorded from different localities in India, parasitizing several species of mammals and birds (Sharif 1928, Rajagopalan 1965, Rajagopalan *et al.* 1968). Outside the Indian continent, the species has been reported to occur in Siberia, Japan, China, Burma, Indonesia, New Zealand and Australia (Nuttall & Warburton 1915, Anastos 1950, and Kohls 1957). However, recent taxonomic studies show that *H. bispinosa* is restricted to India, Pakistan, Burma, Thailand, Malaya and Nepal. Other distribution records refer to several other species (H. Hoogstraal, personal communications).

Though *H. bispinosa* has been known to be a common parasite of domestic animals, information on its bionomics is very scanty. In early studies on the infestation of *Haemaphysalis spinigera* on cattle in Kyasanur Forest disease (KFD) area (Work *et al.* 1957), it was found that cattle were infested by adults and immature stages of nine species of ticks. The predominant species were : *H. spinigera*, *Boophilus microplus*, *H. bispinosa*, *Amblyomma integrum* and *Rhipicephalus haemaphysaloides*. An intensive search made in cattle sheds showed that, of the five predominant species of ticks infesting cattle, only *H. bispinosa* inhabits cattle sheds (Bhat 1968). The present communication deals with some observations on the mass breeding of the species in cattle sheds at Bhimaneri and other nearby villages in the KFD area.

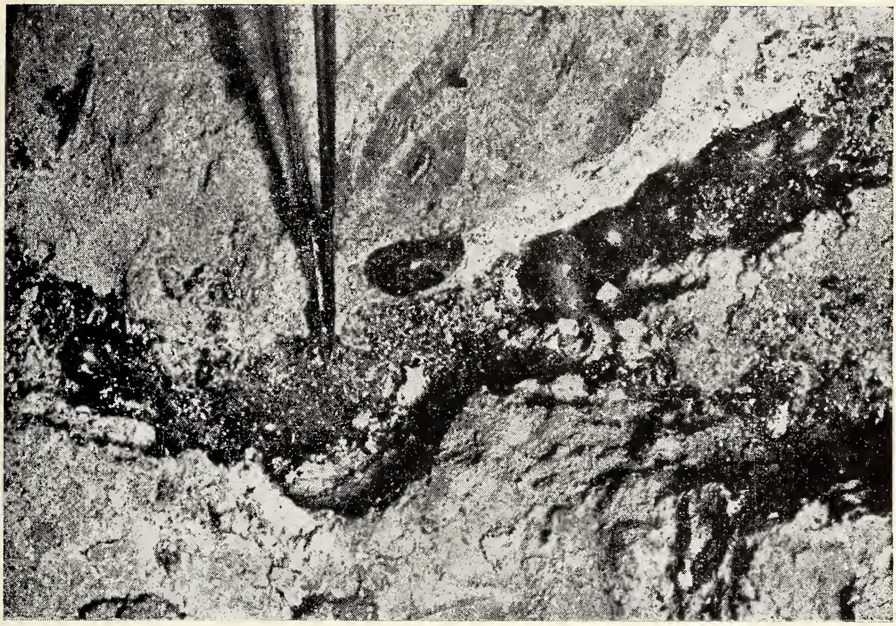
Observations

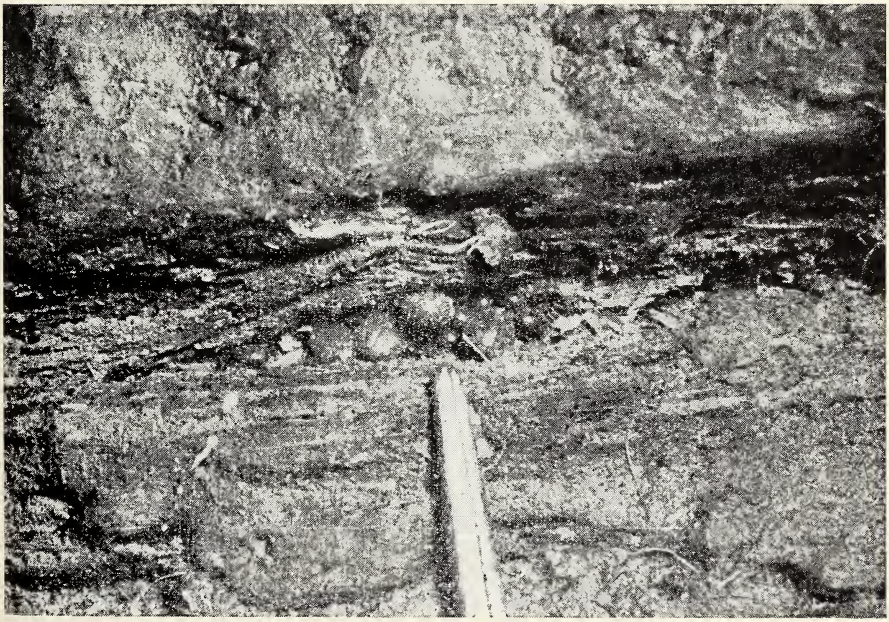
Infestation of *H. bispinosa* in a cattle shed at Bhimaneri was first observed on 14 June 1963. Subsequently the cattle shed was visited once or twice in a fortnight to study the condition of the tick population.

In June 1964, three more cattle sheds with mass breeding of *H. bispinosa* were found at Kalasi and Kamblikoppa villages about four miles from Bhimaneri. The mass breeding in these cattle sheds subsided during the summer months, from April to June 1965. When the study was discontinued in June 1965, two cattle sheds at Kaisodi village, which were clean during the previous years, were found newly infested with ticks.

All cattle sheds in which *H. bispinosa* was found breeding in a mass scale had mud walls and sugarcane leaves thatched roofs or clay tiles. They were without adequate ventilation and were practically dark inside. The other type of cattle sheds in these villages, which were the majority, were open at the sides being without walls. Some were protected with bamboo fencing. These well-ventilated sheds were free from mass breeding, though occasionally a few adults and immature stages were observed.

During the first observation at Bhimaneri in June 1963, the shed

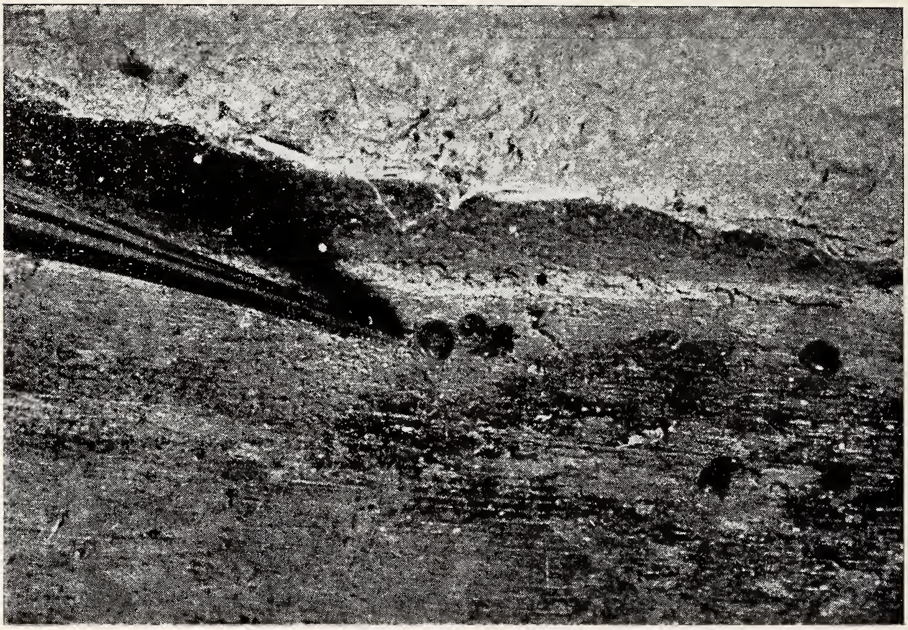




Above : Cluster of gorged females with egg broods in a crevice on a mud-wall Chalky white dots are tick excreta (×4).

Below : Engorged larvae and nymphs in split on wooden pillar (×24).

Bhat: *Haemaphysalis bispinosa*



Above : Engorged nymphs crawling on a wooden pillar (×6).
Below : Engorged larvae and nymphs in a split on a wooden pillar.

was infested by a small number of engorged and unengorged adults. A few engorged immature stages were also seen. In July the population of engorged adults suddenly increased. Freshly dropped and ovipositing females were seen in clusters of fifty to sixty along with egg masses inside the crevices of walls, upto three feet above the floor (Fig. 1). Engorged adults continued to appear till the end of August. From September onwards their number gradually decreased and from December to May, they were almost absent. In the next rainy season from June to September 1964, they reappeared and a similar sequence of events followed. In the rainy season of 1965, the mass breeding subsided in the shed under observation (Table 1).

About a month after the appearance of engorged adults in large numbers, larvae appeared in clusters of a few to several hundred individuals all over the walls and pillars up to five feet above the floor. Engorged larvae, unengorged and engorged nymphs, and unengorged adults appeared in succession with about 10 to 15 day intervals (Table 1). Clusters of engorged larvae and nymphs were observed in grooves and crevices of wooden pillars, walls and ropes (Figs. 4 and 5). Engorged larvae were found up to five feet and nymphs up to eight feet above the floor.

Engorged larvae, nymphs and adults dropped in large number from cattle during early morning hours (6 to 8 a.m.) and the shed was seen teeming with crawling ticks. The crawling activity subsided after about two hours as the ticks gradually settled in the crevices. A considerable number of engorged stages occurred on the hosts when they were leaving the sheds for grazing. These ticks were missing from the body of the hosts when they returned in the evening, indicating that they dropped in the forests and grazing fields.

A large number of the engorged stages were preyed upon by domestic fowls in the shed. Early in the morning fowls were seen devouring a large number of ticks, particularly engorged females, from the body of the hosts as well as from the floor of the shed. The domestic fowls appeared to be partly responsible for keeping the open sheds free from the ticks, where the light permitted them to make a thorough search for the ticks.

Discussion

Unlike other species of ticks infesting cattle in the KFD area, which usually inhabit forest biotope during their nonparasitic phases, *H. bispinosa* inhabits forest, grazing field as well as cattle sheds. The mass breeding of ***H. bispinosa*** inside the cattle sheds appears to be due to the fact that the engorged ticks dropped during the early morning hours, before the cattle were driven out for grazing. In the other species, they normally drop while the cattle are grazing in the forest. Adults and immature stages of other species of ticks infesting cattle were seen in their last stage of engorgement during early morning hours, while the major proportion of adults and immature stages of *H. bispinosa* were dropping inside the sheds. This difference in the time of engorgement appears to determine the dropping of *H. bispinosa* inside the cattle sheds and of the other species in the forests.

For parasitising in the field, each stage has to depend upon a chance encounter of a host, which is comparatively low. On the other hand a continuous availability of the hosts for all the three stages of the tick in the sheds, provides maximum chance for each stage to obtain a blood meal. This enables a maximum number of ticks to complete the life cycle in a minimum period of time, resulting in mass breeding, wherever the physical factors are favourable. A similar observation was made on *Hyalomma anatolicum anatolicum* by Serdyukova (1945) in Tadzhikistan. The mass breeding in *H. bispinosa* reaches its peak during monsoon and post-monsoon months, from June to November, when high humidity prevails. The decrease in population after November is probably due to lack of moisture.

It is apparent that *H. bispinosa* maintains populations in wild as well as in domestic conditions. In the wild, the population is maintained at a low level, due to some unknown limiting factors. But under domestic conditions, the population flares up through a mass breeding, wherever favourable conditions prevail.

TABLE 1

SEASONAL PREVALENCE OF DIFFERENT STAGES OF *H. bispinosa* IN A CATTLE SHED AT BHIMANERI IN KFD AREA

Stages	Unfed adults	Fed adults and eggs	Unfed and fed larvae	Unfed and fed nymphs
January	++	♠	♠	♠
February	++	♠	♠	♠
March	+	♠	♠	♠
April	+	♠	♠	♠
May	+	♠	♠	♠
June	+	+	♠	♠
July	+	+++	+	♠
August	+	+++	+++	+
September	+	++	+++	+++
October	++	+	+++	+++
November	+++	+	++	+++
December ..	+++	♠	+	++

♠ = Extremely rare.
\+ = Present in small numbers.
++ = Present in considerable numbers.
+++ = Present in very large numbers.

ACKNOWLEDGEMENTS

I am grateful to Dr. T. Ramachandra Rao, former Director, Virus Research Centre, Poona, for his valuable suggestions during the work, and to Dr. Harry Hoogstraal, U.S. Naval Medical Research Unit No. 3, Cairo, for his critical appraisal of the manuscript.

VIRUS RESEARCH CENTRE, H. R. BHAT
I.C.M.R., POONA-1,
November 14, 1970.

REFERENCES

ANASTOS, G. (1950): The scutate ticks or Ixodidae of Indonesia. *Ent. Amer.* **30** (1-4): 1-144.

BHAT, H. R. (1968): Studies on the bionomics of *Haemaphysalis spinigera* Neumann, 1897 (Acarina: Ixodidae). Ph.D. thesis (unpublished), University of Poona.

KOHLS, G. M. (1957): Malaysian Parasites—XVIII, Ticks (Ixodoidea) of Borneo and Malaya. *Stud. Instt. Med. Res., Malaya* 28: 65-94.

NUTTALL, G. H. F., and WARBURTON, C. (1915): The genus *Haemaphysalis*. Part 3, p. i—xiii, 349-550. In Nuttall *et al.*, Ticks. A monograph of the Ixodoidea, Cambridge.

RAJAGOPALAN, P. K. (1965) : Studies on the Ixodid ticks (Acarina: Ixodidae) of wild birds of Shimoga district (Mysore State) with notes on the ecology of their distribution and prevalence, Ph.D thesis (unpublished), University of Poona.

RAJAGOPALAN, P. K., PATIL, A. P. and BOSHELL M. JORGE (1968): Ixodid ticks on their mammalian hosts in the Kyasanur Forest disease area of Mysore State, India, 1961-1964, *Ind. Jour. Med. Res.* 56(4): 510-526.

SERDYUKOVA, G. V. (1945): Local mass reproduction of ticks *Hyalomma anatolicum anatolicum* Koch in Tadzhikistan and their causes. *Bull. Tadzhik Branch Acad. Sci.* U.S.S.R. **6**: 60-63.

SHARIF, M. (1928): A revision of the Indian Ixodidae with special reference to the collection in the Indian Museum. *Rec. Ind. Mus.* 30 (3): 217-344.

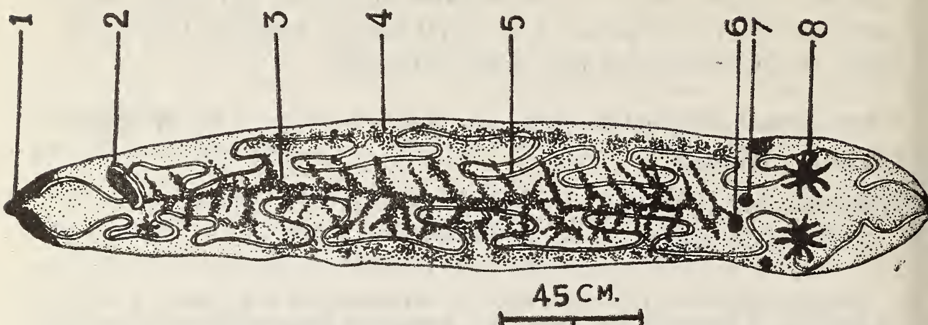
WORK, T. H., TRAPIDO, H., NARASIMHA MURTHY, D. P., LAXMAN RAO, R., BHATT, P. N., and KULKARNI, K. G. (1957): Kyasanur Forest disease III. A preliminary report on the nature of the infection and clinical manifestation in human beings. *Ind. Jour. Med. Sci.* **11** (8): 619-645.

30. OCCURRENCE OF THE DIGENITIC TREMATODE *ASTRORCHIS RENICAPITE* (LEIDY) (FAMILY : PRONOCEPHALIDEA) IN THE LEATHERY TURTLE *DERMOCHELYS CORIACEA* (LINNÉ) FROM THE INDIAN OCEAN

(*With a text-figure*)

In April 1962, a large male leathery turtle *Dermochelys coriacea* (Linné) which had got entangled in the gill nets was discarded by the fishermen near the Pamban landing centre on the Gulf of Mannar side of Rameswaram Island at about 11.00 a.m. The specimen measured 152.5 centimetres from snout to tail.

The turtle was dissected and thirty-one specimens of the intestinal parasite *Astrorchis renicapite* (Leidy 1856) (Fig.) were noticed in the stomach. They were seen among the green algae *Enteromorpha compressa* and fish scales which constituted the bulk of the stomach content of the turtle.



(1) Anterior sucker, (2) Cirrus pouch, (3) Uterine coils, (4) Vitellaria, (5) Caeca, (6) Ootype, (7) Ovary, (8) Testis.

Description: Body slender; head collar not divided. Oral sucker narrow and small. Oesophagus short, caeca narrow waviness terminating at posterior end. Testes branched; cirrus pouch short, oblique, covering part of seminal vesicles. Genital pore near left margin of body just behind the intestinal bifurcation. Ovary anterior to testis; vitellaria consisting of small follicles extends anterio-laterally. Uterine coils extend medially up to cirrus pouch. Eggs numerous.

Some specimens had blood in the caecum indicating their blood-sucking habit.

According to Deraniyagala (1939, P. 44, TETRAPOD REPTILES OF CEYLON) *Astrorchis renicapite* is the only intestinal parasite so far known from *Dermochelys coriacea*. The fact that the same species of parasite infests the leathery turtle of Mediterranean, Atlantic and Indo-Pacific regions may be of interest in view of the divergent opinions (Deraniyagala op. cit.) on the identity of the leathery turtle of different regions.

I am thankful to Dr. R. V. Nair, Deputy Director, Central Marine Fisheries Research Institute, Mandapam Camp for going through this note critically and offering his suggestions.

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE, MANDAPAM CAMP, — R. S. LAL MOHAN
October 6, 1970.

31. A CORAL TREE FROM NEPAL

The coral tree is a popular ornamental tree in gardens all over the world. In Nepal, some years ago one wild-growing species of this plant was collected from Shivpuri mountain (about 8,000 feet), which was identified as *Erythrina arborescens* Roxb. Dr. Roxburgh had made the following observation about this plant in his (1832) FLORA INDICA :

" From Nepal, Dr. Buchanan (later Sir Francis Hamilton and one-time Superintendent of the Honourable East India Company's Botanical Garden) sent seeds to the Botanical Gardens where plants blossomed for the first time in October. In April Dr. B. observed it to be a small tree ten to twelve feet in height; here in seven years they are only five or six feet high and with but few branches."

The plant which is characterised by prickly stem, tri-foliate cordate leaves and flowers borne in packed flaming red arrow-shaped racemes, grows locally more than 40 feet in height. It blossoms during August till middle of October, after which it sheds old leaves. The branches are borne in the form of a crown, which are limited in number.

Its size, ease of cultivation and attractive flowers all make it suitable for growing in gardens.

DEPARTMENT OF BOTANY, DIBYA DEO BHATT
TRI-CHANDRA COLLEGE,
KATHMANDU, NEPAL,
December 28, 1970.

32. ON THE OCCURRENCE OF *AMARANTHUS LIVIDUS* LINN. SSP. *POLYGONOIDES* (MOQ.) PROBST. AND *FIMBRISTYLIS ALBOVIRIDIS* CLARKE IN W. BENGAL

Amaranthus lividus Linn. ssp. **polygonoides** (Moq.) Probst. in Wool Aliens 1949.

Euxolus viridis (Linn.) Moq. var. *polygonoides* Moq. in DC. Prodr. 13(2) : 274. 1849.

Much branched prostrate to suberect herb growing in waste-lands, preferably on heaped soil or tilled ground. Flowering and fruiting in January to April. In Howrah district common at Dumjoor and rare in other places. Regarding the confusion between this taxon and *Amaranthus polygonoides* Linn. see Naik, *Indian Forester* 95 : 415-416. 1969.

Specimens examined : *Bennet* 528.

Fimbristylis alboviridis Clarke in Fl. Brit. Ind. 6 : 638. 1893; Kern in Blumea 8 : 140. 1955.

25-45 cm. high, erect. Umbels lax. Spikelets 3.5-6 mm. long. Grows along the sides of railway lines among bushes and shrubs; prefers shade; rare in Howrah district, collected from Dakshinmaju and Padmapukur. Flowering and fruiting in April to August.

Kern stated, "Considered to be endemic in Assam *F. alboviridis* appears to be rather widely distributed in Malaysia. However, it is rare everywhere."

According to Clarke "the outermost cells of the nut are arranged in 25-30 longitudinal series on each face. This is neither the case in the species determined by Clarke, nor in any of the Malaysian ones. I have always found (12-) 16 vertical rows of cells."

This species has so far not been reported from W. Bengal. In my specimens the nuts have 15-20 vertical rows of cells on each face.

Specimens examined : *Bennet* 724 & 810.

ACKNOWLEDGEMENTS

Thanks are due to the Director of the Royal Botanic Gardens, Kew, for the identification of the *Amaranthus* specimen and to Dr. S. K. Mukerjee, former Keeper of the Central National Herbarium, Calcutta, for the facilities provided for the exploration of Howrah district.

76-ACHARYA JAGADISH BOSE ROAD, S. S. R. BENNET
CALCUTTA-14,
December 9, 1969.

33. NOTES ON *SPERGULA FALLAX* (LOWE), E. H. L. KRAUSE AND *S. VERNALIS* WILLD.

(*With a text-figure*)

This note reports *Spergula fallax* (Lowe) E. H. L. Krause as a new record for erstwhile Bombay State from Khedbrahma, North Gujarat and *Spergula vernalis* Willd. as new record for India from Anand, Kaira District, Central Gujarat and Naka Kalol, Sabarkantha District, North Gujarat.

Spergula fallax (Lowe) E. H. L. Krause in Sturm, Fl. Deutschland (ed. 2) 19, 1901. *Spergularia fallax* Lowe in Hook. Kew. Journ. 8 : 289, 1856. *Spergula pentandra* Edgeworth & Hook. f. Fl. Brit. Ind. 1 : 243, 1872. *Arenaria flaccida* Roxb. Fl. Ind. 2 : 447, 1832.

A slender, annual herb. Leaves fleshy, linear-subulate in false whorls. Stipules small, scarious. Flowers white, in much branched cymes. Capsule ovoid-subglobose, 3-valved. Style 3, persistent, recurved. Seeds winged, as broad as the seed body. Noted as a weed in cultivated fields and on sandy river beds.

Flowering and fruiting : December-February.

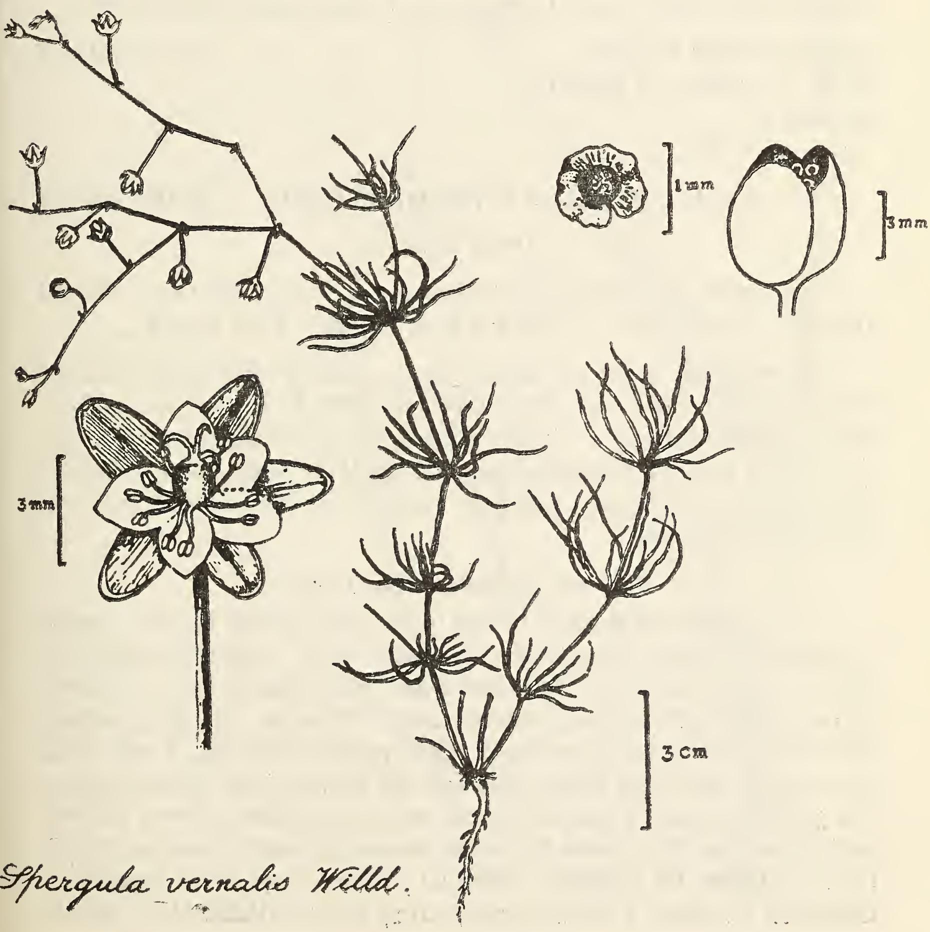
Herbarium specimen nos. : *Bhatt* 2412, 2467; Khedbrahma, North Gujarat. *Shevade* 729; Dwarka, Kathiawar (Saurashtra).

It extends across North Africa from Macronesia to India. In India it extends from Punjab, Bihar and Bengal to Gujarat and Saurashtra.

Santapau in his Flora of Saurashtra (1962) has not mentioned any member of the genus *Spergula* from the Saurashtra region. However, a collection from Dwarka, Kathiawar (Saurashtra) dated 23.iv.1925 made by Prof. S. V. Shevade and housed in the Herbarium of the Department of Botany, the M. S. University of Baroda, on re-investigation is identified as *Spergula fallax* (Lowe) E. H. L. Krause.

Spergula vernalis Willd. in Fl. Berol. Prod. 158, 1787.

The plant is very similar in appearance to the preceding species, but can be differentiated from it by its broad, ovate petals, obtuse at the tips, the stamens with dilated filaments and the seeds with narrower wings, apparently narrower than the seed body. The plants grow in association with *Spergula fallax* as a weed in winter crops, especially near irrigation channels.



Spergula vernalis Willd.

Flowering and fruiting : December-March.

Herbarium specimen nos. : *Bhatt* 2563, Naka Kalol, Sabarkantha District, North Gujarat. *Thaker* 1060, Anand, Kaira District, Central Gujarat.

Widely distributed throughout Europe and North Africa. In India, it is an introduced weed of agriculture. The plant, as far as could be ascertained from the available literature, has not been earlier recorded from any part of India.

ACKNOWLEDGEMENTS

Thanks are due to the Director, Royal Botanic Gardens, Kew, England and Dr. M. Mizushima, of Makino Herbarium, Tokyo, Japan for determination of plants. Thanks are also due to Dr. S. D. Sabnis for his guidance and Dr. S. J. Bedi for going through the manuscript and for useful suggestions. This research is financed in part by grant made by the United States Department of Agriculture under PL 480.

DEPARTMENT OF BOTANY, R. P. BHATT
M. S. UNIVERSITY OF BARODA,
BARODA-2,
October 5, 1970.

34. *PANICUM ELEGANTISSIMUM* HOOK. f. FROM INDIA

(*With a plate*)

The grass *Panicum elegantissimum* was described from Malaya (Hooker, Fl. Brit. Ind. 7: 52), and later reported from Burma.

Recently this grass has been found growing in the Indian Botanic Garden, Howrah [*Banerjee* 4860, 14th July 1967, by the side of the Herbarium building, Botanic Garden (Cal)]. This specimen exactly matches the type of *Panicum elegantissimum* (*Ridley* 3116, 1892, Lumut, State of Perak, Malay Peninsula), which is available in the Central National Herbarium, Calcutta.

Panicum elegantissimum Hooker

A perennial tufted grass, 0.6 to 0.9 m. tall. Stems slender. Leaves numerous from near base, linear acuminate, strict, suberect, softly hairy all over, more than 30 cm. long and 5 mm. wide. Panicle lax, spreading, 23 cm. long, branches very slender, scabrid, filiform. Spikelets solitary or in pairs, few, scattered, ellipsoid, acute, purple at the tips, 4 mm. long, lower glume about half or less than half the length of the spikelet, spikelets gaping. Glume I inserted much below the others. Glume I about half or less than half Glume III, ovate, mucronate and 5-7 nerved. Glume II and Glume III stipitate, subequal, ovate, cuspidately acuminate. Glume II 7 nerved, 5 of the nerves strong above. Glume III 7 nerves,

Panicum elegantissimum Hook. f.

slender, palea small, ovate. Glume IV elliptic-oblong, obtuse as long as glume II, white, shining smooth.

On account of the gaping spikelets, this species is often confused with *P. trypheron* Schult. but *P. elegantissimum* has longer spikelets and long hairy leaves. *P. trypheron* has spikelets about 3 mm. long, gaping widely at anthesis.

ACKNOWLEDGEMENTS

I am grateful to the Director and Joint Director, Botanical Survey of India, for their interest in this study. I am also grateful to Dr. S. K. Jain for his valuable comments on this note. Thanks are due to Shri D. C. Pal for the line drawings.

BOTANICAL SURVEY OF INDIA, DEB KUMAR BANERJEE
CALCUTTA,
October 6, 1970.

35. NOTES ON THE DISTRIBUTION OF *SESAMUM MULAYANUM* NAIR IN MAHARASHTRA

Nair (1963)[1] described *Sesamum mulayanum* from north India and gave its distribution in different parts of Punjab, Rajasthan and Uttar Pradesh.

This species has been collected by the author from different areas of Maharashtra during several field excursions, which show that the species is well represented in this state.

The details of the species represented in the herbarium of Shivaji University, Kolhapur, are:

Herbarium Sheet No.	*Locality*	*Date of collection*	*Remarks*
1125	Kolhapur (Sagarmala)	20.viii.1966	Found along roadsides, in grass and waste lands. Flowering.
1128	Katyayani	9.x.1967	Grows along hilly tracts, flowering and fruiting.
1135	Katrajghats (Poona)	20.ix.1967	,, ,,
1136–37	Ratnagiri	15.x.1968 3.xi.1969	Grows in association with *Pedalium murex*, along sandy coast.
1138–39	Malvan	22.ix.1970 23.x.1970	Along *bundhs* of rice fields.
1140	Vengurla	22.x.1970	Forms pure stands along sandy sea coast, behind *Ipomoea biloba* colonies.

[1] NAIR, N. C. (1963): A new species of *Sesamum* Linn. from northern India. *Bull. Bot. Surv. India* 5: 251-253.

It was interesting to find the plants growing gregariously along the sandy coast at Ratnagiri and Vengurla, suggesting a salt tolerance, a character which could be used in breeding salt-tolerant strains of *Sesamum indicum.*

BOTANY DEPARTMENT, A. R. KULKARNI
SHIVAJI UNIVERSITY,
KOLHAPUR,
December 9, 1970.

36. RECORD OF *GNETUM ULA* BROGN. FROM CENTRAL INDIA

Gnetum, a genus of phylogenetic importance is confined to the tropical, humid regions of the world. Most of its species are endemic to the areas of their distribution. In India the genus is confined to south and eastern India, mainly along the Western Ghats and Malabar Coast. *Gnetum ula* Brogn. is found all along the Western Ghats and some parts of the eastern Coast of India (Maheshwari, P. and V. Vasil, *Gnetum*). Bharadwaj (*J. Ind. bot. soc.* **36**: 408-420, 1957) reported it from Bombay, Mysore, Kerala, Madras, Andhra, Orissa (Mahendragiri) and Andamans. The present record of its occurrence in Central India from Chhindwara District of Madhya Pradesh, far from its natural home in coastal regions.

The specimen is preserved in the Herbarium, State Forest Research Institute, Jabalpur.

Gnetum ula Brogn. (Syn. *G. scandens* Brand.)

Local name: *Gandhela.*

Chhindwara: Sukhabandh. *Shukla* 13022.

NATIONAL BOTANIC GARDENS, H. O. SAXENA
LUCKNOW,
December 2, 1970.

37. A NEW VARIETY OF *SELINUM VAGINATUM* (EDGW.) CL. (APIACEAE) FROM N. W. HIMALAYA

Selinum vaginatum (Edgw.) Cl. var. **garhwalensis** Babu et Chandra, var. nov.

S. vaginatum (Edgw.) Cl. var. *vaginatum* omnino simile, sed a varietate *vaginatum* cum characteribus foliis 2-3 pinnatis, foliorum ultimis segmentis anguste lanceolatis grosse inciso-serratis vel pinnatifidis, var. *garhwalensis* Babu et Chandra differt foliis 1-2 pinnatis, foliorum ultimis segmentis vel foliolis late ovato-lanceolatis acute serratis raro lobulatis.

Erect, perennial herbs, up to 30 cm. tall or more. Rootstock stout, fusiform, clothed with fibrous remains of leaf-sheaths. Stems simple, solitary, terete, striate, fistular, glabrous. Radical leaves none, cauline ones few, reduced to sheaths upwards, imperfectly 1-2-pinnate 6-30 cm. long (incl. petiole); ultimate leaflets or segments sessile, ovate-lanceolate, with a somewhat oblique, rounded base, sharply acute at apex, sharply serrate, nearly glabrous except puberulous nerves, reticulations prominent, 2-3 × 0.7-1.2 (—1.5) cm.; petiole 0-5.8 cm. long; sheaths broad, with ciliolate scarious margins, 2.5-6 cm. long. Inflorescences terminal and axillary, puberulous compound umbels; peduncle stout, terete, striate, puberulous, 3.7 cm. long; involucres 3-5, linear-narrowly oblong, white-margined, ciliate, puberulous, pinnatifid, 0.6-1 cm. long; rays about 20, subequal, striate, puberulous, 2-3 cm. long; involucels 5-6 (—10), oblong, pinnatifid, white-margined, ciliate, puberulous, 1-1.5 cm. long, much exceeding the umbellules; pedicels 15-30, slender, puberulous 0.3-0.5 cm. long; calyx-lobes 5, linear-lanceolate, sharply acuminate, 1-nerved, glabrous, 0.15-0.2 cm. long; petals 5, white, obovate, emarginate through inflexed acuminate tip, 0.15-0.18 cm. long; stamens 5, inflexed in bud, filaments linear, glabrous, 0.2-0.22 cm. long, anthers oblong, 0.08 (—0.1) cm. long; ovary compressed, obovoid-oblong, with 3 prominent winged, primary ridges, lateral ridges broadly winged, glabrous, 0.18-0.2 cm. long, stylodium globose, 0.05×0.1 cm., styles 2, linear, recurved, 0.1 cm. long, stigma simple. Fruits not seen.

INDIA: UTTAR PRADESH: Garhwal, Ramara, alt. 3000 m., 29 Sept. 1958, *Rau* 8728 (CAL-holotype; BSI-isotype).

Flowers: September.

Distribution: Known only from the type locality.

Similar to *S. vaginatum* (Edgw.) Cl. var. *vaginatum* in all respects except that var. *garhwalensis* Babu et Chandra is characterised by 1-2-pinnate leaves with broadly ovato-lanceolate, sharply serrate to rarely lobulate ultimate leaf segments or leaflets in contrast to 2-3 pinnate leaves with narrowly lanceolate, coarsely incised-serrate or pinnatifid ultimate leaf-segments of the former.

CENTRAL NATIONAL HERBARIUM, C. R. BABU
BOTANICAL SURVEY OF INDIA, S. CHANDRA
HOWRAH-3.

July 6, 1970.

38. A NOTE ON THE OCCURRENCE OF *PHALLUS HADRIANII* VENT. EX PERS. IN INDIA

(*With a photo*)

During a survey of mushrooms in the Kashmir valley one interesting Phalloid was collected from Srinagar. The specimen was sent to Dr. D. M. Dring of Royal Botanic Garden, Kew, England, who determined it as *Phallus hadrianii* Vent. ex Pers. Tiwari & Khare (1968)[1] while reporting on two interesting Phalloids from Uttar Pradesh, India, have suggested the study of a large number of collections to establish the range of variation in the species, in this relatively little studied group in India. The description of the specimen which is also a new distribution record for the species in India is being given in this note.

Phallus hadrianii Vent. ex Pers. Syn. Method. Fung.; 246, 1801.

Expanded fructification (Fig. 4) consisting of a gelatinous volva, an elongated stipe and a pileus, 6-10 cm. high; *Pileus* conical and attached round the raised perforated white ring (0.5-1 cm. wide) which terminates the stem; bears the blackish fetid gleba, the exposed surface deeply reticulated with large chambers (3-6 mm. in diam.), white, 2-4 cm. long, covering a thin veil; stipe hollow, white, cylindric, 4-8 cm. tall, 1.5 to 2.5 cm. in diameter at the swollen portion, tapering above and below, spongy, honeycombed (meshes 0.5-1 mm. in diam.); *volva* cup-shaped, thick, wrinkled, and enclosing a thick basal veil; *spores*, smooth, greenish yellow, elliptical, 1.2-1.8 $\times$ 3.3-4μ.

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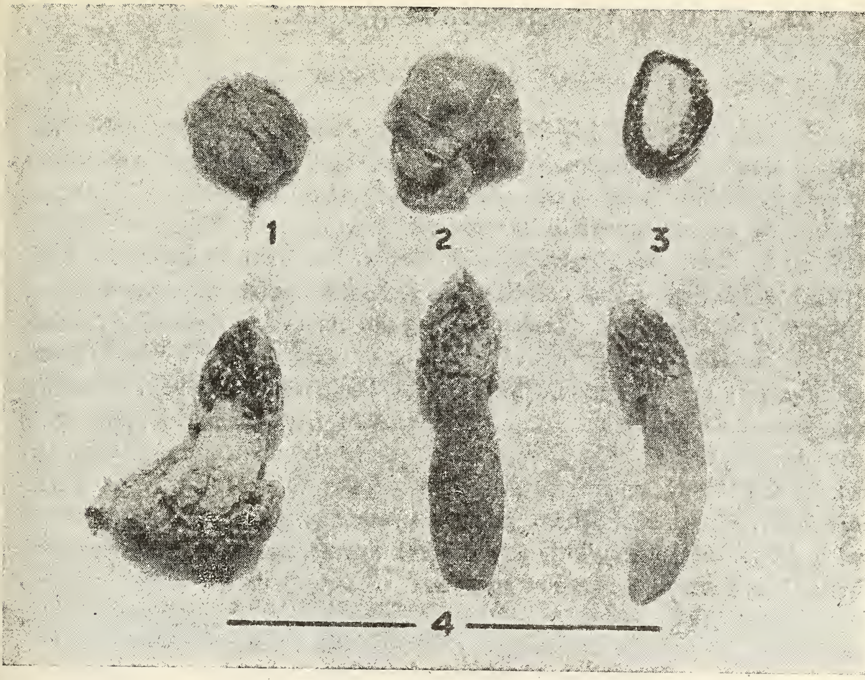
[1] TIWARI, V. P. & KHARE, K. B. (1968): Two interesting Phalloids from Uttar Pradesh. *Ind. Phytopath.* 21 (4): 374-378.



Figs. 1-4: 1. *Phallus hadrianii* Vent. ex-Pers. unexpanded fructification with rhizomorph x ½; 2. Slightly opened fructification x ½; 3. Dissected egg x ½; 4. Expanded plants x ½.

Unexpanded fructification (Figs. 1-3) 2.5-4 cm. in diameter, globose, isolated, pinkish, wrinkled, gelatinous, pliant, with a short pinkish rhizomorph at the base, rupturing in the beginning into a bluish egg-shaped structure.

Collected on wet soil at the base of *Robinia pseudoacacia*, Sanat Nagar, Srinagar (5,200 ft.)

T. N. Kaul and J. L. Kachroo, 28. iv. 1969, RRLS. No. 8.

ACKNOWLEDGEMENTS

We are grateful to Dr. D. M. Dring of Royal Botanic Garden, Kew, for identification and comments. Thanks are due to Dr. K. Ganapathi, Director, for encouragement.

REGIONAL RESEARCH LABORATORY, SANAT NAGAR, SRINAGAR-5, KASHMIR,

T. N. KAUL
J. L. KACHROO

November 4, 1970.

39. STUDIES ON STIGONEMATACEAE

(*With two text-figures*)

Fritsch & Rich (1937-38) figured and described an alga under the name *Haplosiphon fontinalis* (Ag.) Born. having branches with long cells and without cross walls. As pointed out by H. Welsch (1962) this feature is unrepresented in *Haplosiphon fontinalis* of Frémy in Geitler (1932). A form of *Haplosiphon fontinalis* was also reported by Rich (1936) which also differs considerably from the one reported by Geitler. Further, the shortening of cells towards the ends of branches—a characteristic and notable feature of Fremy's drawing in Geitler (1932) and Desikachary (1959) was not indicated by Rich. Welsch (1962) therefore considered Rich's alga as another species of *Haplosiphon*. I agree with the view of Welsch that Fremy's alga where the shortening of cells towards the branch ends is prominently shown is the real *Haplosiphon fontinalis*. Considering these facts the present alga does not agree either with *H. fontinalis* nor with any other known species of the genus and hence it is described as a new species.

Haplosiphon agarkarai sp. nov. (Fig. 1)

Thallus terrestrial, greenish black when old, greenish yellow when young, caespitose, filaments more or less entangled; primary prostrate filaments 8.5-13.5µ broad containing cells in two rows, slightly longer than broad; filaments fairly branched, branching tree; branches arise from the prostrate filaments; more or less irregularly curved, slightly narrower than the main filaments 6.0-7.5µ broad; heterocysts intercalary, cylindrical, common in the main filaments also, 7.5µ broad 8.5µ long; spores not seen.

Partially shaded marshy places in the hospital campus, Jagdalpur.

Haplosiphon agarkarai sp. nov.

Thallus terrestris vestutus, glaucus, novellus viridis, lutens, eaespites, fibrae plus minusque implicatae libre, fibrae primariae jacentes 8.5-13.5µ latae, cum cellibus latibus in duobus seriebus. Fibrae bene ramificatae, ramusque veri, qui emergunt de fibribus prostratis plus minusque inflectae, incompositae, leve angustae quam fibrae principales, 6.0-7.5µ latae, vagina-tenuis, pigmenta subflava ad hyalam. Cellae ramorum prope rotundae 6.8µ latae. Heterocystes intercalares, cylindrici, communes in fibribus principalibus, etiam 7.5µ lati, 8.5µ longi, semina non videbantur.

In locis palustris umbrosisque campi neoscomii, Jagdalpur.

Haplosiphon attenuata sp. nov. (Fig. 2)

Plants look like small greenish yellow gelatinous almost spherical mass. Thallus consists of irregularly interwoven prostrate filaments of 2.5μ broad; cells in one row, longer than broad, 2.0μ broad, sheath thick hyaline; branching lateral, short true, sparse almost regular, nearly as broad as the main filaments containing 3-5 cells of equal size, roughly spherical, apical cell sharply attenuated and cone-like—a feature that distinguishes it from all other known members of the genus. Sheath of the branches indistinct, thin, colourless; heterocysts cylindrical, 2.0-3.0 μ broad, 2.6μ long, intercalory; spores not observed.

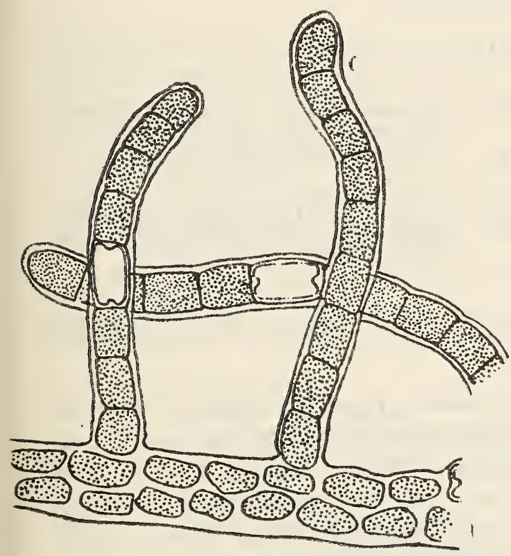
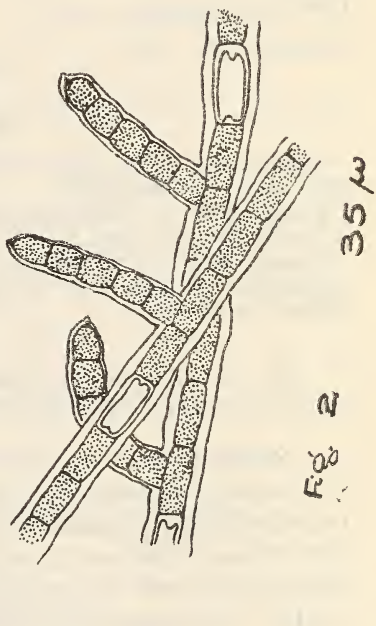


Fig. 1 25 μ

Haplosiphon agarkarai



Haplosiphon attenuata

On tree trunks in the forest office, Jagdalpur.

Haplosiphon attenuata sp. nov.

Fungi videntur tamquam molles virides subflair. Thallus cum fibribus jacentibus incompositae contextae, 2.5μ latae, cellae in seriebus singularibus, latiorae quam latae, vagina, hyala, crassa, rames laterales, veri breves, sparsi fere ordinati. Prope lati quam fibras principles, cum 3-5 cellis similis mensuribus, rauce globoidis, cella apecis attenuata acuta sicut conum-proprietas particularia qui separat hanc speciem abomnibus speciebus genus, vagina ramorum indistincta, tenuis sine colore. Heterocystes cylindrici, 2.3µ lati, 2.6µ longi, intercalares, semina non inveniuntur.

Super stripibus arborum, in domus silvarum, Jagdalpur.

ACKNOWLEDGEMENTS

I thank Dr. J. L. Gnanarethinam of De Nobile College, Poona for providing the latin translation of the species.

B-109, H. A. COLONY, A. SUBRAMANIAM
PIMPRI, POONA-18,
December 28, 1970.

REFERENCES

DESIKACHARY, T. V. (1959): Cyanophyta, I.C.A.R., New Delhi.

FREMY, (1930): Les stigonemataceae de la France. *Rev. Alg. Paris.* 5: 147.

FRITSCH, F. E. (1952): Structure and reproduction of algae. Vol. 2. Myxophyceae, Cambridge.

GONZALVES, E. A. (1949): Observations on the algae of paddy field soils. *J. Univ. Bombay* (18) 3: 51-55.

WELSCH, H. (1962): Some new cyanophytes from South Africa. *Rev. Alg. Paris.* 3: 227-233.

40. A PARASITE (*VISCUM ORIENTALE*) ON ANOTHER (*DENDROPHTHOE FALCATA*)

Normally the host range of parasitic flowering plants is restricted to non-parasitic plants but an interesting case of double parasitism was recorded during botanical collections in Bastar, Madhya Pradesh. *Viscum orientale* Willd. was found growing on *Dendrophthoe falcata* (Linn. f.) Etting which itself was parasitic on *Cleistanthus collinus* (Roxb.) Benth. ex HK. f. and *Anogeissus acuminata* (Roxb.) Wall. ex Bedd.

Herbarium specimens (*Saxena* 1627, 1628, Budra, Bastar, 28.iv.65) have been deposited in the Herbarium, State Forest Research Institute, Jabalpur, M.P.

NATIONAL BOTANIC GARDENS, H. O. SAXENA
LUCKNOW,
March 5, 1971.

Printed By V. K. Joshi for G. Claridge & Co. Ltd., at Shahid Bhagat Singh Road, Bombay 1, and Published by Editors: Zafar Futehally, J. C. Daniel and P. V. Bole for the Bombay Natural History Society, Bombay-1.

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CONTENTS

Journal of the Bombay Natural History Society

Vol. 68, No. 3

Editors

ZAFAR FUTEHALLY
J. C. DANIEL & P. V. BOLE

DECEMBER 1971

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1. Papers which have at the same time been offered for publication to other journals or periodicals, or have already been published elsewhere, should not be submitted.

2. The MS. should be typed (double spacing) on one side of a sheet only, and the sheets properly numbered.

3. All scientific names to be printed in italics should be underlined. Both in zoological and in botanical references only the initial letter of the genus is capitalized. The specific and subspecific names always begin with a small letter even if they refer to a person or a place, e.g. *Anthus hodgsoni hodgsoni* or *Streptopelia chinensis suratensis* or *Dimeria blatteri*.

4. Trinomials referring to subspecies should only be used where identification has been authentically established by comparison of specimens actually collected. In all other cases, or where identification is based merely on sight, binominals should be used.

5. Photographs for reproduction must be clear and show good contrast. Prints must be of a size not smaller than 8·20 × 5·60 cm. (No. 2 Brownie) and on glossy glazed paper.

6. Text-figures, line drawings, and maps should be in Indian ink, preferably on Bristol board.

7. References to literature should be placed at the end of the paper, alphabetically arranged under author's name, with the abridged titles of journals or periodicals underlined (italics) and titles of books *not* underlined (roman type), thus:

Banerji, M. L. (1958): Botanical Exploration in East Nepal. *J. Bombay nat. Hist. Soc.* 55 (2): 243-268.

Prater, S. H. (1948): The Book of Indian Animals. Bombay. Titles of papers should not be underlined.

8. Reference to literature in the text should be made by quoting the author's name and year of publication, thus: (Banerji 1958).

9. *Synopsis :* Each scientific paper should be accompanied by a concise, clearly written synopsis, normally not exceeding 200 words.

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EDITORS,
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Bombay 1-BR.

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CONTENTS

MISCELLANEOUS NOTES :

JOURNAL
OF THE
BOMBAY NATURAL
HISTORY SOCIETY

1971 DECEMBER Vol. 68 No. 3

An ecological Survey of the larger Mammals of Peninsular India

BY

M. Krishnan

(*With eight plates*)

Introduction

This report is based on many years of observation in a great many faunal areas widely distributed over peninsular India. Some of the work was planned, sustained and intensive, the rest of it sporadic and done as opportunity offered. The report is documented by 242 photographs selected from several thousands taken over 12 years, from 1959 to October 1970, and is largely supported by the field notes written up each day during this period (which are appended to the report) and personal experience.

This general statement needs amplification both to indicate adequately the factual records of the report and to expose their limitations. While a considerable body of record (observation notes and photographs) prior to 1959 is available, it was decided to make that year the starting point of this survey, because it was only from then on that photography was regularly employed as part of the field work to supplement and complement observation. The value of photographic documentation (briefly set out in the section on photography, later here) was realised much earlier, but it took years to build the cameras I needed for the work and to develop an adequately versatile photographic technique, largely owing to personal limitations.

All field trips prior to 1959 have been left out of the records of this survey. Many field trips made during the first 10 years of the 12-year period have also been left out because they were to faunal areas outside the region of peninsular India (though a few relevant extracts from trips to the Jaldapara sanctuary of West Bengal, the Kaziranga and Manas sanctuaries of Assam, and the Corbett National Park and the Dudwa preserve of Uttar Pradesh have been included), or because they were mainly floristic or photographic trips, or else because it was not possible to revisit those areas for a check on earlier observation during the last 2 years when intensive work was done on the Jawaharlal Nehru Fellowship. The field notes appended[1] provide full details of the areas visited, the duration of each visit, and seasonal and other particulars. Brief accounts of the terrain and main floristic features of the Periyar, Mudumalai, Point Calimere, Bandipur, Kawal, Hazaribagh and Palamau sanctuaries have been provided later in this report. As far as possible, during the last 2 years, two visits were made at the same time of the year to areas already visited earlier and to new faunal areas. The study locations, in 8 States, are listed below (full details will be found in the field notes and photographs): Kerala: the Periyar Sanctuary (and one isolated record from Quilon); Tamil Nadu: the Mudumalai Sanctuary (which was intensively worked, over years) and the Point Calimere Sanctuary (and selected records from Guindy Park in Madras, Topslip in the Anamalais, and Sholinghur); Mysore: the Bandipur Sanctuary (and one isolated record from the Ranganathittoo Sanctuary); Andhra Pradesh: the Kawal Sanctuary (and passing references to the Pakhal and Eturnagaram Sanctuaries); Orissa: Balimela, Chilka and surroundings, Tickerpara and surroundings, the Usha Kothi Sanctuary in Badrama and the Raigoda Sanctuary, and the Simlipal hills; Bihar: the Hazaribagh and Palamau National Parks, with brief visits to the Baresand area, Tholkobad and Karkatnagar; Madhya Pradesh: the Kanha National Park, with brief visits to Churna (Bori), the Shivpuri National Park, Bastar and Bara Naya Para; Maharashtra: the Taroba National Park.

Some important areas with a distinctive fauna, like Gujarat and Rajasthan, were not visited at all. It was not possible to do so because, during the last 2 years when intensive work could be done, it was decided to do it in areas already known and contiguous tracts so as to obtain reliable records from a series of sample surveys, rather than to break new ground.

Acknowledgements

The grant of a Fellowship for an ecological mammalian survey of peninsular India, by the Jawaharlal Nehru Memorial Fund, enabled me to bring my work until October 1968 to some shape by sustained and continuous field work and photography over the next 2 years, and to complete this report. It was a real privilege to be trusted so entirely to

[1] The field notes are omitted in this publication for reasons of space. However, these notes are available in typescript with the Bombay Natural History Society, and are being held by the Society.

plan and execute an ambitious project. My thanks are also due to the Bombay Natural History Society for suggesting that I might be entrusted with this survey. I can only hope that this report is, in some measure, worthy of the trust reposed in me by the Jawaharlal Nehru Memorial Fund and the Bombay Natural History Society.

It is with pleasure and thankfulness that I acknowledge the generosity of the Governments and Forest Departments of Kerala, Tamil Nadu, Mysore, Andhra Pradesh, Orissa, Bihar, Madhya Pradesh and Maharashtra in providing me with all facilities for work in their forests. Members of the Forest Departments of these States, at all levels, have helped with local guidance and advice, and in other ways, and I am grateful to them for help received.

To my brother professional photographers in Madras and other friends who have responded so unfailingly to my usually exacting and invariably urgent calls upon their time and skills over the past 12 years, I owe such a polymorphic debt that I can only record my thankfulness to them all here generally. However, I am specially indebted to K. Krishnamoorthy, Conservator of Forests, Kerala (now retired) and to Dr. B, G. L. Swamy, Chief Professor of Botany, the Presidency College, Madras, for identifying plants for me and for discussions of forest ecology in India; to B. V. Seshaiah, ace-photographer, for discussions of ways and means for extending the frontiers of photography to suit my field work; to V. H. Sivamani Nadhan and K. Mani for technical help and advice in the devising of my photographic equipment; and to C. Gowrishankar and K. Krishna Murari Rao for aid in many ways. I also acknowledge help received from my son, M. Harikrishnan of the Indian Forest Service, with floral identifications, floristics and stray faunal observations, and am indebted to my wife, Indumati Krishnan, for much help with the typescripts.

The Photographic Record

The main value of a clear photograph in supplementing and complementing visual observation in the field is that the camera's vision is comprehensive and unbiased. Many particulars that the eye might miss for various reasons, such as the confusion resulting from the movement of a number of animals in bush cover, or by the eye being preoccupied with some displayed feature or action of the subject to the exclusion of less flagrant details, are recorded unselectively by the camera, so that study of a clear enlargement of the photograph often reveals details that the observer might have missed. This truth is widely recognised in the copying of documents by photography to ensure total fidelity, but insufficiently appreciated in faunal field work. However, for worthwhile photographic records of wild animals it is necessary that the subject should be truly wild and free—or, to put it in photographic parlance, that the record should be candid. It is conceded generally by students of animal behaviour that the responses and behaviour of wild animals in captivity and in contrived situations are often misleading.

Two practical photographic difficulties arise from this. Obviously, the photographer-cum-observer has his best opportunity when his presence is undisclosed to his subject, as when he is in a hide. Early experiments with ground-hides and more portable camouflage soon exposed their limitations. Apart from the lack of mobility which they inevitably involve, they have major set-backs when employed for the observation of mammals in Indian forests, excellent as they are for bird photography. Most forest mammals depend even more upon smell than on sight, and frequently the photographer inside a ground-hide is discovered by his subject even before he is aware of its proximity, and thereafter naturally never gets even a glimpse of it. Worse still, in elephant country such hides can prove quite dangerous, as I can attest from personal experience. Tree-seats and machans, sited high enough for the human occupant's smell to pass above the animals' questing nose, are much more useful, especially as they can give the watcher a good, overall view, but they are easily detected visually. However, some work was done from such elevated stances.

With free-ranging animals like gaur, deer and predators, it is often possible, when the initial approach has been displayed and casual from a sufficient distance, and has caused no alarm, to get them to accept human beings in a motor vehicle or on elephant back, and it is thereafter possible to edge gradually in for photographs from close up. In this, for some reason, the much quieter sneeze of the Compur shutter seems less acceptable to most animals than the thud of the focal-plane shutter, but undoubtedly a loud thud upsets them, and has to be muffled. It is my experience that animals are much more sensitive to being photographed with an eye-level camera than with a camera held at chest level, where the ground-glass screen can be viewed without looking directly at the animal. Gaur, deer and most predators will not accept men on foot, and though there is a photograph of a gaur and a sambar in the photographic record of this survey, taken on foot, both were photographed not by getting them to accept me but by stealth. Most of the photographs documenting this report were taken from elephant back, a motor vehicle or boat or a tree-seat. Elephants and monkeys are best photographed on foot, though much care is needed in approaching the former in most parts of India. Almost all the elephant and monkey pictures were taken on foot.

The second and less obvious difficulty in wildlife photography in the forests of India is that even where the photographer is mobile, he cannot usually choose his stance or the subject's background, and has to take his pictures as he finds them, so that adequate tonal separation between subject and surroundings and clarity of record (an essential) has to be achieved entirely by photographic technical shifts and not by posing the subject, or by waiting for it to reveal itself in a literally more favourable light—such forbearance usually results in his losing it altogether! This consideration is of much greater consequence than may be imagined, for in our forests the lighting is often extremely contrasting, with hardly any reflectance from the highlights into the shadows. For this reason, a thorough understanding of the colour rendering of the emulsion in use as also of the exploitation of the relationship between exposure and development is necessary for good candid pictures.

Considering how integral a part of this report its photographic record is, two further matters may be briefly set out. An original attempt was made to evaluate the comparative size of the same species (average specimens) in different areas, purely by photography. This failed because of accidental damage to the camera specially constructed for this purpose, but is sufficiently interesting to be retailed here.

In this camera, the rigid parallelism of the lens board to the film plane was ensured by the lens board moving along two tracks set at right angles to each other. The camera was equipped with a 240 mm. telephoto lens of hard definition, with a maximum aperture of f 5.6, and the traverse of this lens from infinity to 15 feet was accurately calibrated. Further, a rigid lock was provided so that the lens could be locked at any desired position on the footage scale. The lens was locked when it was focussed at 100 feet, and a rangefinder right beneath the viewfinder was also locked set at 100 feet. Depth of field tables are calculated on contact prints, so that when the negative is enlarged to 10 or 15 diameters, the depth is very shallow even at 100 feet for a lens of the focal length used at its maximum aperture of f 5.6, only about 8 feet. Preliminary experimental work showed that it was not too difficult to move back or forward a few feet, when one was about 100 feet from chital, gaur and other animals, so as to get the split images in the rangefinder to coincide exactly, though at this distance it was not possible to eliminate errors of a few feet. I hoped to use this camera, set up on a tripod if possible a measured distance of 100 feet from some animal path used by chital and other animals, and to photograph them (by remote control, if necessary, the camera being equipped with a solenoid which could be operated from 100 feet away) at 100 feet, broadside-on, in different areas. Errors in the estimation or measurement of the distance would be immediately shown up when the negative was scrutinised through a highpower magnifier, and it was proposed to mark all successful negatives with code numbers, to indicate the date and area of each picture, and then to evaluate comparative size in different areas by measuring the 15-diameter blow-ups from the successful negatives. Image size, in such a set-up, being directly proportional to subject size and nothing else, it should have been possible to get reliable comparative data by this method. The main difficulty, in fact, would have been not in the photography so much as in the ensuring that the subject and camera were on a plane more or less (otherwise foreshortening and other perspective errors might have complicated matters). Owing to the footage-scale of this camera getting damaged beyond repair in a road accident, soon after it was built, it was not possible to lock the lens at 100 feet and hence the attempt was abandoned. However, since the traverse of the lens was unaffected up to 75 feet (the maximum distance at which pictures could be taken at night with the aid of 2 Metz 502 electronic flashes) it was used exclusively for night photography, and all the night pictures in the record were taken with it.

In many faunal areas (for example in Andhra Pradesh, Orissa and parts of Bihar) animals which are diurnal in less disturbed habitats have turned crepuscular and nocturnal: in fact, in these locations, only at night could any wild mammals be seen, and it was important to my survey that I should get clear pictures of them. The problem here was twofold. The spill of light from the wideangled flash-heads on to the bonnet and other parts of the jeep resulted frequently in reflection-flares that completely ruined the pictures : hoods to narrow the throw of light were devised for the flash-heads, and this also helped in the more even illumination of the field from about 30 feet away. The second problem was that driving along forest roads in an open jeep at night, it was seldom possible to see animals closer than 50 feet away, and inadvisable to open the aperture wider than f 8, as some depth of field was highly desirable—at night the rangefinder could not be used and setting the lens by guessing the distance, the lens had to be stopped down slightly to allow for small errors in the estimation of distances. The guide-number used by professional photographers for taking pictures of open-air processions at night were far too high in the jungle, even though they used the same film and the same electronic flash as I did. Using 2 synchronised flashes, and forced development, I found that printable negatives could be obtained when the subject was 50 feet away, with the lens aperture at f 8, but *not* at 60 feet. Finally and somewhat desperately a new technique of forced development was evolved which solved the problem. The film (Kodak Tri-X Pan) was developed in May & Baker Promicrol at a dilution of 1 : 2½ and development continued till a slight base-fog built up. The time taken for such unobjectionable fogging was noted, and 4 times the tank capacity of the diluted developer was mixed. Then, fixing the time at a little less than the time fixed originally, the used developer was poured out and replaced by fresh developer thrice, at quarter the development time fixed. Successful negatives were obtained even with the subject 75 feet away by this technique.

Scope, Bases and Arrangement of the Report

Being mainly based on a series of repeated sample surveys, in many of the best faunal areas in peninsular India, carried out over a 12-year period, this report has no pretensions to being a study of distribution or a taxonomical natural history of the mammals of the region: it is, in fact, a factually-based ecological mammalian evaluation dependent mainly on the study records specified already, and also on earlier experience and knowledge. All individual faunal assessments, as distinct from the reports of a team of workers, are substantially of this nature, but usually they contain the sum total of the faunal knowledge of the author up to the period of publication. In this report, however, the field records have been limited to a period of 12 years from 1959 for reasons already stated, and even within this period, the observation made during brief trips, unsupported by detailed, on-the-spot field notes, has been left out.

For instance, it will be noticed that the records relating to one of the commonest wild mammals of the region, the bonnet monkey, are quite meagre. I have watched and photographed this monkey in many places where it is the local faunal feature, such as Tirupathi, Courtallam, Papavinasam, Siddharkoil, Jalarpet, Kodaikanal Road, and in and around some suburban towns, but these observations have not been included in the field notes here for chronological reasons, or because there are no detailed notes supporting them, or because they were not made in forest areas. Similarly, no mention at all is made of the commonest diurnal wild mammal of peninsular India, the palm squirrel, for though many photographs and even observation notes of it are available, they are wholly unrelated to the forest areas in which the work on the survey was done.

The field notes[1] have been analysed and the sight-records (varying in duration from a mere glimpse to 3 hours of close watching, and in number from an individual to a herd) of each species mentioned in them separately collected and studied. Since this report is ecological and not on behaviour, the approximate total duration of all observation has not been specified for each species, but other details culled from these field notes have been briefly specified at the commencement of the chapter on each species. In these chapters, as well as in the chapter which provides the overall survey, references are made to photographs and field observations supporting statements and conclusions. For this purpose, the study locations have been prefixed with initials, following their arrangement in the field notes and photographs, as indicated below:

Kerala	K
Tamil Nadu	TN
Mysore	MY

[1] See footnote at p. 504.

Andhra Pradesh	AP
Orissa	O
Bihar	B
Madhya Pradesh	MP
Maharashtra	MR
Other miscellaneous areas	MISC

These initials, followed by the year, month and date of the observation, should be quite adequate for the immediate location of the passage in the field notes to which reference is made. Similarly, the code number of any photograph will suffice to locate it, by reference to the list of photographs provided.

Evidentiary records outside the Report

Thousands of negatives from the field trips made during the 12-year period of this survey (roughly, 6000 negatives) have not been printed for this report for various reasons, though they were all scrutinised and many have been printed in the past for other purposes. The main reason for this, of course, was that some reasonable limit had to be set to the number of illustrations to any text. Many of these negatives are repetitive, being pictures of the same subject taken in sequence at one opportunity; many are of poor quality and are only proof of the subject having been seen in the circumstances set out; a great many have only pictorial and not evidentiary value. Nevertheless, these negatives have been sorted out and stored, so that in the unlikely event of any statement made in this report requiring additional proof, they may be available in case they contain the evidence needed.

During the first 10 years, some of the observation notes and photographs from field trips were used in faunal contributions to newspapers and magazines, and also in survey reports to governments, mainly for my 'Country Notebook' column in *The Statesman*. It is therefore possible to establish that these observation notes were anterior in point of time to those publications and reports.

Nonprovision of Bibliography

The nonprovision of a bibliographic list of the faunal literature consulted or relied upon (as an appendix to this report) may be explained here. I am indebted to booklore for much of my knowledge of Indian wild animals, to some 50 books. These are of 3 main categories, shikar literature, the accounts of naturalists and conservationists, and faunas and specialist studies, compilations and reports.

Among the authors of shikar books I have read, the following may be mentioned, more or less in chronological order : W. Rice, M. H, Shakespear, J. Forsyth, J. Baldwin, E. Braddon, J. Inglis, A. J. O. Pollock, D. Hamilton, G. P. Sanderson, E. F. Burton, R. Sterndale, C. E. M. Russell, A. Mervyn Smith, A. I. R. Glasfurd, the Maharajah of Cooch Behar, S. Eardley Wilmot, E. P. Stebbing and F. W. F. Fletcher (*c.* 1860 to 1912): Best, A. A. Dunbar Brander (his is really much more a valuable natural history than a shikar book), R. G. Burton, Hewett, C. H. Stockley, Musselwhite and Wardrop, between the two World Wars: and thereafter, J. Corbett, K. Anderson, A. Locke, A. Powell, Kesri Singh and H. Allen, most of them writing about tiger hunting.

Among the books of conservationists and naturalists should be mentioned TWO YEARS IN THE JUNGLE by W. T. Hornaday (who came to India in 1877), WITH A CAMERA IN TIGER-LAND and THE JUNGLE IN SUNLIGHT AND SHADOW by F. W. Champion (notable for their magnificent photographs), THE WILD LIFE OF INDIA by E. P. Gee (a sound over-all account with many fine photographs), ELEPHANT GOLD and TIGERS by P. D. Stracey, and THE TWILIGHT OF INDIA'S WILD LIFE by B. Seshadri.

The faunas and specialist studies and publications include MAMMALS OF INDIA by Jerdon, the 2 volumes on mammals in THE FAUNA OF BRITISH INDIA by W. T. Blanford, Sterndale's MAMMALIA OF INDIA revised by F. Finn, THE BOOK OF INDIAN ANIMALS by S. H. Prater (second edition, 1965), THE DEER AND THE TIGER by G. B. Schaller, and notes and articles in the *Journal of the Bombay Natural History Society* (the last two specially valuable). Naturally, other scientific faunal books not dealing specifically with Indian mammals were also read, but are not indicated here.

If this report was primarily concerned, as it is not, with the decline of the country's mammalian wildlife over the past 100 years, an accurate bibliography of all these and some other books would have to be provided. For example, in the Banjar Valley area of Madhya Pradesh, the faunal decline is graphically indicated by what Forsyth, Dunbar Brander and Schaller have written of the local fauna as they knew it in 1861-63, 1900-21, and 1963-65 respectively: Brander further records the decline within the 20-year period of his knowledge of the area. Where such comparative assessments by different observers, spread over different periods of a century, sustain the argument of the text of a report or analysis, the dates and other details of publication of the sources have value and should be furnished in an appendix. In the present report, limited in period and confined largely to a series of repeated visits to widely scattered faunal areas, an added bibliography would serve no useful purpose and can only be pretentious. Further, to be properly done it would entail an enormous amount of work and time—in no book on India's fauna published in the last 3 decades that I have seen is the bibliography complete or wholly free from error.

Wherever it is necessary to refer to the opinion or record of any authority either to corroborate some statement in this report, or because my observation or inference differs from that of others, specific citation of such agreement or difference will be made in the text.

Population Figures: Quantitative Faunal Assessments

In the areas worked, the populations of some free-ranging species, such as elephants and gaur, naturally displayed considerable fluctuations with the seasons; further, even at the same time of the year, there were noticeable fluctuations in their numbers in different years caused, apparently, by climatic or other seasonal variations like drought or unseasonal rainfall. Other species, like chital and muntjac, were widely distributed over many localities either in mobile populations (chital) or individually (muntjac), so that working singlehanded and for a limited period in each area, it was not possible to attempt even a rough count in all localities. Again, the predators were either so largely nocturnal, like tigers and leopards in most places, or so little given to residence in particular localities, like wild dogs, that it was exceedingly difficult to see them, leave alone count their numbers. In many areas where the normally diurnal animals had become furtive creatures of the night owing to sustained disturbance by humanity during the day, drives along forest roads were regularly undertaken, usually both an early drive at nightfall and another late at night, and sometimes predawn drives as well.

In places the sanctuary authorities had conducted a regular census, and where this had been done, close inquiry was made into the methods employed, and the official figures studied. All that is expected of a faunal census is an approximation to the truth, and even where the approximation is wide, if it is adequately representative and if the method employed is sound, a census, enumeration or rough count is better than an educated guess. But where the method is unsound and some of those entrusted with the counts are inept, the census figures obtained, while possessing the verisimilitude of all statistical figures comprehensibly displayed, might be widely misleading. Only in a few instances did the official figures seem substantially true.

Everywhere, but especially in areas where the animals were hard to see, all means other than actual sight records were exploited to determine the presence of wild animals—by exploring nullahs, the edges of pools and water-holes, and forest paths, and noticing and studying footprints (usually with the aid of skilled trackers), forms, fæces, the regurgitated stones of fruits by cud-chewing animals, evidence of feeding offered by the vegetation, and by listening carefully for animal sounds, especially early in the morning and late in the evening. Local inquiry was also made of forest-side villagers and others, but with experience less and less reliance was placed on hearsay.

Summaries of sight records, counts and other observed details are provided at the start of the chapter on each species studied.

Ecological Slants of the Survey

The circumstantial factors influencing the mammalian wildlife of the areas studied, such as terrain and vegetation (as providing cover and food), as well as the habits of the animals, intra- and extra-specific relationships and other details of their life, have been set out in this report based on specific observations as recorded in my field notes, and brief general accounts of certain sanctuaries have been provided in those notes (as already stated). The main features of this report are that it is documented with contemporaneous, on-the-spot photographs, and that both in the field notes and in the report an attempt has been made to study the human biotic factors, generally noticed in ecological reports mainly when they are acutely and overtly hostile (as when poaching or hunting is an appreciable factor), in their entirety, taking all relevant aspects (some insidious or covert) into consideration. The repercussions of forestry and other operations, large-scale projects in and around faunal areas, and of other human activities in and around sanctuaries (such as cattle grazing and the collection of forest produce) on the native uncultivated flora and fauna of the area have been studied and briefly reported. It may be repeated that this is mainly a contemporary report, and that while influences going back to a distant past have not been ignored, prevailing circumstances have been considered.

GENERAL ACCOUNT OF SOME OF THE STUDY AREAS

Kerala

Periyar Sanctuary

Relevant aspects of the history of the sanctuary: In any appraisal where human influences on the native wildlife are taken into consideration, certain aspects of the history of the Periyar Sanctuary become relevant and may be set out briefly. The Periyar River was dammed about 1897 mainly as an irrigation project; it was then considered a unique feat of engineering skill, and the project still remains an achievement of considerable magnitude: the object of the design (conceived and executed by Col. J. Pennycuick, R.E.) was to divert the waters of a montane river (the Periyar) emptying itself into the western sea, through a long subterranean channel, into another river having its origins in these hills and flowing eastwards (the Vaigai), so that a vast tract of barren plains land could be irrigated. Subsequently, the project was also converted into a hydroelectric one, i.e., into an irrigation-cum-hydel project. It was never intended as a sanctuary, *ab initio.*

It was only some 30 years ago that the then Maharaja of Travancore, realizing the great scope of the area as a sanctuary and its magnificent beauty, constituted it as a sanctuary. The authorities who originally built the project, in the British days, took infinite pains to do nothing that would spoil the great natural beauty and floral and faunal wealth of the area. Nothing artificially obtrusive, no modern facilities and no exotic plants, were known in the area in those days. However, it should be noted that since the project was developed as an irrigation-cum-hydel project, as the result of co-operation between the Madras Government and the Maharaja's Government, certain vested human interests, whose influence on the fauna and flora was not even considered, came to establish themselves in the present sanctuary area, and all around it. Inside the sanctuary, the Madras Government has control over the many-armed lake created by the damming of the river (on a 999-year lease) and the Kerala Forest Department over the extensive forests around the lake. These two government authorities are not the only ones with vested interests in the area: several tribals, now organised into a few settlements, had interests here (mainly in its floral and faunal resources) and their interests were, and are, antagonistic to the wildlife. Further, there are some private holdings of land within the sanctuary, and any number of estates and plantations all round.

In recent years another human authority has developed interests inside the sanctuary, the Kerala Tourist Corporation, a public limited company which caters to the tourists, mainly to the foreign tourists. There are also other private agencies.

Location and extent: Periyar Sanctuary (Thekkady) is not far from the borders of Kerala and Tamil Nadu along the Madurai border of the latter. The extent of the sanctuary is 304 sq. miles and of the lake, its main attraction, variable from about 10 to 12 sq. miles. The maximum level of the lake is 2860 feet above MSL.

Terrain and environmental factors: The sanctuary is part of an even vaster mixed deciduous forest with a decided evergreen character in many places, and is hilly, varying in elevation from about 3000′ to 6000′. Rainfall varies but is generally heavy, and there are many creeks and swampy flats. The brief floristic account that follows will be indicative of the edaphic and climatic factors obtaining, and the historical note of its biotic (human) environmental factors. The peripheral forests of the sanctuary have been much depleted in recent years by their exploitation for various purposes. During summer, the lake and its ramifications offer the main source of water to the animals.

Floristics: The most interesting floral feature of the sanctuary is not its actual composition so much as the ecological changes induced by the artificial formation of the reservoir and waterspread, by the pent-up waters banking against the hillslopes which, by their very steepness, could have had no source of water originally except during the rains. No study of these changes has been made but it is apparent that at least certain waterside plants such as *Ochlandra* spp. and some sedges, could not have been found in such profusion on the hillslopes and terraces abutting the water before the formation of the lake.

The introduction of exotics into the area has also considerably affected the floral ecology of the sanctuary in places. Near the dam, the hilltops have been extensively planted up with *Eucalyptus grandis.* Lantana has spread thickly in places, as near Aiyappankurukku. *Eupatorium glandulosum* has, recently, established itself in the area.

However, the integrity of the flora of the inner reaches has changed little in the past few decades. The sholas still retain their peculiar, semi-evergreen nature. Many of the trees found in them are either peculiar to Kerala or attain their best development hereabouts; examples are *Gluta travancorica*, *Dipterocarpus bourdilloni* (other Dipterocarps also occur here—*Hopea parviflora* and *H. wightiana*, & *Vateria indica* should be mentioned), *Xylia xylocarpa*, *Poeciloneuron* sp., *Dysoxylum malabaricum*, (*D. beddomei*, and *D. ficiforme* also). Besides these, other important trees of the area that should be mentioned are: *Artocarpus hirsuta*, *Stereospermum* sp., *Terminalia* spp., in particular a variety of *T. tomentosa* where the bark is not conspicuously fissured, *Adina cordifolia*, *Lagerstroemia lanceolata* and *L. speciosa*, *Messua ferrea*, teak, *Lophopetalum wightianum*, *Mangifera indica*, *Pterocarpus marsupium*, *Calophyllum tomentosum*, and *Tetrameles nudiflora*. Teak is common in the deciduous areas. Most of the tree-stumps that are now to be found in the lake, sound in their wood though deeply pitted by time and the elements, belong to the hardwoods in the list above.

In the shola and other tree forests, the undershrub is often fairly open and seldom thorny. The hilltops are of the peculiar nature, clad mainly with herbaceous plants, termed 'downs' in the Nilgiris. While many grasses, both short and tall, are the dominant components of these downs forests, there are a great many other herbaceous plants besides them, including plants of the order Cyperaceae. The main grasses are: *Apluda mutica*, *Arundinella holcoides*, *Cymbopogon citratus*, *Eragrostis gangetica*, *Hackelochloa granularis*, *Paspalum scrobiculatum*, *Panicum repens* and *P. montanum*, *Themeda cymbaria* and *T. triandra*.

Tamil Nadu

Point Calimere Sanctuary

Location, extent and general character: Point Calimere is on the eastern coastline of the Thanjavur District, where the coast projects in a sharp nose into the sea, so that the sea runs more or less north and south of its pointed tip. The sanctuary consists of the coastal reserved forest, of about 7¼ sq. miles of the 'Kodiakadu Reserved Forest' as per the Government Notification constituting the sanctuary in June 1967.

The English name 'Kodiakadu R.F.' used in official records appears to be a distortion going back to the British days: the Tamil name is 'Kodi-k-kaadu', 'the farthest forest', and in this note the name will be spelled 'Kodikadu'.

The main faunal feature of Point Calimere is its great assemblies of flamingos and other water-birds in the swampy lagoon. This lagoon, called the Great Swamp, is very shallow and miry, and can be traversed by a Masula boat along certain routes. There are a few islands in the lagoon, one at least large enough for the semi-feral ponies to be grazed in. Misled by a report about mammalian predators preying on the water-birds, much time and effort was wasted in trying to trace them, but it now seems clear that the report was without basis.

Apart from its bird life, Point Calimere Sa. (the Kodikadu area) is notable for two main reasons. Agriculture here has been so much frustrated by the animals (pig, horses, cattle and perhaps chital) raiding the crops, that only tobacco, which the animals do not touch, has been raised here. The second point of interest is that most of the mammalian species inhabiting the sanctuary appear to have been introduced. The ponies and cattle are definitely introduced, though some of the cattle have now run wild and are, unlike the ponies, beyond recapture. The chital have been introduced and the pig seem feral. The bonnet monkeys are known to have been brought into the area in April 1965. The truly indigenous mammals of the area (among the larger animals) appear to be the blackbuck, the jackals, and the mongooses on land and the dolphin in the sea around.

There are no large predators. Leopards do not occur in the area. Jackals and mongooses seem to represent the only predators on the land.

The area is sandy along the coast, and in the forest away from the beach, undulating, densely clad with bushes and stunted trees, but with many paths through the forest, and much frequented by humanity grazing cattle: there is a colony of aborigines inside the forest. The commonest animals here are the cattle let loose in the jungle to graze, to fend for themselves; cattle which have become dry or are otherwise unprofitable to their owners are let loose in the forests, and recaptured as needed.

The 'feral ponies' too, are owned and branded (as foals) but appear to be semi-feral, as they are no longer in demand as they were formerly.

Official statistics give the total numbers of blackbuck and chital in the area in several hundreds.

During December, when I visited the sanctuary, there were ample reserves of freshwater to the animals in ponds, ditches and hollows. Being coastal, the forests are exposed to storms and heavy rains. In summer, I understand the water available to the animals is limited to a few ponds inside the forest.

Floristics: The vegetation along the coast is very similar to the vegetation of other sandy beaches on the south-eastern coastline, consisting mainly of the following:

Spinifex squarrosus close to the sea on sand dunes: a few grasses (among which are *Cynodon dactylon, Chloris barbata* and *Eriochloa procera*) on the beach away from the sea; here and there, close to the sea, patches of *Salicornia brachiata* and *Suaeda monoica*; *Cyperus rotundus* on the beach and sandy flats. Herbaceous vegetation of sandy flats: *Launea* sp., *Lippia* sp., *Oldenlandia umbellata*; *Evolvulus alsinoides*, *Ipomoea pes-caprae*; *Prosopis juliflora*, introduced into the area some 20 years ago, has now spread into the forest away from the shore. A casuarina and an eucalyptus plantation have claimed part of the natural forest. Other exotics in the area are *Vinca rosea, Croton sparsiflorus* and *Tribulus terrestris*: in other words, the influence of exotics here is still negligible.

Hedges and brakes of pandanus have been planted, and other species introduced into the area are *Albizzia lebbek* and *A. amara*.

The forest features these tree species: *Mimusops hexandra, Memecylon edule, Zizyphus mauritiana & Z. oenoplia, Pongamia glabra, Dichrostachys cinerea, Atalantia monophylla, Calophyllum inophyllum* (planted probably, in a few places near the sea); *Acacia arabica, Canthium didymum*, near the lagoon *Excoecaria agallocha* and *Avicenna officinalis. Morinda tinctoria, Randia dumetorum* rare. *Thespesia populnea* and *Pithecolobium dulce* (rare).

There are many shrubs, chief among them the following: *Clerodendrum inerme, Cassia auriculata, Carissa* spp., *Toddalia aculeata, Capparis sepiaria, Acacia intsia. Leucas* sp. in patches inside the forest. The flora is similar to that of the coast of Tamil Nadu.

Mudumalai Sanctuary

Location, extent and general character: Occupying a vast undulating hillside on the north-eastern slopes of the Nilgiris, in south-east Wynaad, the Mudumalai Sanctuary is one of the few areas in the country specially blessed by nature with a rich and varied terrain, flora and fauna, and has long been celebrated among hunters (*vide* SPORT IN THE NILGIRIS AND ON THE WYNAAD by F. W. F. Fletcher—1911). It has had a chequered political history, having been held by Kerala and Mysore in the past. For reasons stated in the General Account of the Bandipur Sanctuary, the area of the Mudumalai Sa. (about 125 sq. miles or 320 sq. km.) cannot be considered faunally or florally or territorially distinct from Bandipur, or from the peripheral forested areas of Kerala, Mysore, or of Tamil Nadu itself. The entire area of about 250 sq. miles is one vast and varied stamping ground to the animals and one continuous vegetative tract, in spite of its great variations and political demarcation into the territories of Kerala, Tamil Nadu and Mysore and into the 2 main sanctuaries of the last two States. However, the two sanctuaries hold the major populations of the large wild mammals of the area.

In saying this, it must be remembered that these animal populations are not fixed or entirely resident. Apart from the animals moving around within the 2 sanctuaries to suit seasonal fluctuations and needs, the gaur and the elephants wander over forests outside the 2 sanctuaries as well. The deer are more restricted in their movements and may be considered resident, broadly speaking. The langur and bonnet monkey populations are also probably local, the leopards seem localised, but the tigers and wild dogs probably cover much ground.

Terrain and environmental factors: As said, the sanctuary displays considerable variations of terrain and flora. These differences are not based on differences in elevation so much as on topographical variations, the sanctuary being comprised of hills, hillocks, valleys, ravines, flats, swampy hollows in places, and much cut up by watercourses (rivers, streams and nullahs). The highest elevation is represented by Markundarai Betta, the top of which is 4154′ high; for the rest, the high elevations are all around 3500′ - 3600′: the lowest elevation, at Masinagudi, is around 2900′.

The Benne and Doddakatti Blocks, towards the Kerala border, have a more evergreen complexion than the rest of the sanctuary: the Mudumalai Block consists of rounded hills with hollows in between, the hollows often being swampy, the kind of terrain designated by the local word 'gadde'. Kargudi is more deciduous, but still close tree forest, and moreover the clearings are choked up with tall grass: Theppakkadu, which features natural teak, is more open, with a floor where the undershrub is generally low. Masinagudi is ravine-cut and flat thorn bush forest, with the canals of the Moyar Project supplying perennial water. The entire sanctuary area is well-watered, with the Moyar and subsidiary streams running through. The average rainfall is around 56 inches.

All over the sanctuary, forestry operations are carried on. Selection felling and clear-felling are limited to one coupe per year, but the logging, transport and sale of timber involves considerable forest area. Further, departmental collections of bamboo, and plantation work, are carried on over many areas. Furthermore, minor forest produce collections of many kinds are made on a wide scale both by departmental and extra-departmental agencies, and include the collection of honey, beeswax, myrobalans, bark-lichen, soapnut, tamarind and deer antlers.

The Moyar Project and its working, the activities of the populations living in the many settlements within the sanctuary, or close by it, (such as at Masinagudi, Theppakkadu and Lower Kargudi), and the claims of 14 private holdings within the sanctuary area, add further to the constant disturbance by humanity that the wildlife face here.

The main motor road from Mysore to Ootacamund, runs through the Mudumalai Sanctuary and cattle destined for the slaughter-houses are herded weekly along this road, in hundreds. These are usually decrepit and sick cattle from which infections might well spread to the wild ungulates. Besides this, great numbers of cattle are grazed in many areas in the sanctuary.

Floristics: The floristic variety of the sanctuary is one of its most important features. However, this variety lies not so much in the differences between plant species peculiar to particular areas or Blocks as in the varying stature and dominance that the same species attain in different areas. *Anogeissus latifolia*, found all over the sanctuary, exemplifies the point. In the Benne and Mudumalai Blocks it attains its best growth and is less gregarious than it is in Kargudi and Theppakkadu, and in Masinagudi it is insignificant both in stature and dominance. Again, while *Randia dumetorum* is widespread in the drier areas, it is *R. uliginosa* that is found in moist localities, often along with *Careya arborea*. Along nullahs and streams, brakes of pandanus and *Ardisia solanacea* occur, and along rivers and major watercourses mango, *Syzigium* spp. and other evergreens, and figs. *Phoenix humilis* is common in swampy flats and in clearings, and belts of tall grasses and of bamboo are dominant in certain localities. The bamboo of the sanctuary is *Bambusa arundinacea*.

Among the main tree species of the sanctuary, the following may be mentioned: those typical of particular localities are mentioned under those areas:

Adina cordifolia; *Albizzia procera* & *A. odoratissima*; *Anogeissus latifolia*; *Bauhinia racemosa*; *Bischofia javanica*; *Bombax ceiba*; *Bridelia retusa*; *Buchanania latifolia*; *Canthium parviflorum*; *Careya arborea* in moist localities; *Cassia fistula*; *Cedrela toona* in the elevations; *Dalbergia latifolia*; *Diospyros melanoxylon* & *D. montana*; *Elaeodendron glaucum*; *Emblica* spp. (in the recent revision of the genus, some 4 or 5 species have been assigned to the area, and no taxonomic determination of these by a competent worker has been done so far); *Erythrina indica*; *Ficus* *bengalensis* & *F. mysorensis* ; *Gardenia* spp. ; *Garuga pinnata* ; *Gmelina arborea* ; *Grewia tiliaefolia* ; *Kydia calycina* ; *Lagerstroemia lanceolata* & *L. parviflora* ; *Machilus macrantha* ; *Madhuca latifolia* ; *Mangifera indica* ; *Mitragyna parviflora* along streams ; *Ougeinia dalbergioides* ; *Premna tomentosa*; *Pterocarpus marsupium* ; *Pterospermum rubiginosum* ; *Radermachera xylocarpa* ; *Randia dumetorum* & *R. uliginosa* ; *Santalum album* (Kargudi, Theppakkadu mainly) ; *Schleichera oleosa* ; *Schrebera swietenioides* (distinctive of the Wynaad) ; *Semecarpus anacardium*; *Shorea talura*; *Stereospermum tetragonum*; *Syzigium* spp. ; *Tectona grandis* ; *Terminalia bellerica, T. tomentosa* & *T. chebula* ; *Trewia nudiflora* in moist localities ; *Vitex altissima* ; *Zizyphus mauritiana* ; *Z. oenoplia, Z. trinervia* & *Z. xylopyrus.*

Pandanus sp. and *Phoenix humilis* occur in moist localities and in open flats (usually swampy) respectively. *Dioscorea* spp. and other corms occur all over the sanctuary. Among the twiners may be mentioned *Smilax aspera.*

Among the shrubs of the forest floor should be mentioned : *Abutilon indicum* ; *Ardisia solanacea* ; *Butea parviflora* (more often found as a flat-spread patch on the forest floor than ascending the trees) ; *Desmodium* sp. ; *Flemingia bracteata, F. grahamiana* & *F. wallichii* ; *Grewia hirsuta* and *G. aspera* ; *Helicteres isora* ; *Hibiscus lampas* ; *Indigofera* sp. ; *Limonia alata*; *Pavetta indica*; *Triumfetta pilosa*; *Toddalia aculeata.*

A variety of tall grasses and a few short grasses, and a great many herbs constitute a most valuable source of fodder to the animals. I was unable to get the grasses identified precisely.

A number of epiphytic orchids are found in the Kargudi-Mudumalai area. Mushrooms, puffballs and ledge-fungi of many kinds are found all over the sanctuary, many of them edible.

In the Benne and Mudumalai Blocks the trees attain their best development, and there is a greater admixture of evergreen species in these blocks, though in the north-eastern reaches of Mudumalai the trees are stunted, featuring small-sized *Anogeissus latifolia, Shorea talura, Soymida febrifuga* and *Terminalia chebula.* Elsewhere in the Mudumalai Block, where the tree forests are tall, *Mussaenda tomentosa* is sometimes prominent in the undershrub.

While the giant bamboo (*Bambusa arundinacea*) is widely distributed in the sanctuary, it occurs in large gregarious belts in Benne, and a notable feature of these bamboo belts is that they seeded gregariously in the March of 1959, '63 & '64. *Elaeocarpus serratus* (and other species of the genus), *Sterculia villosa* and *Aporosa lindleyana* are among the trees of Benne, and *Colebrookea oppositifolia* occurs in its undershrub.

The Kargudi Block features many extensive belts of tall grass, rank and choking up the forests in September-October. *Solanum* species are a feature of its undershrub in places (as in C.2) and it is here and in its reaches towards Theppakkadu (as also certain areas in Masinagudi, like the Avarahalla) that lantana flourishes most luxuriously.

The Theppakkadu Block is distinctive in its flora. Natural teak forests, with gregarious patches of *Anogeissus latifolia* in a few places, are the feature of its tree growth. The forest floor is open, and the shrubs, herbs and grasses that clothe it of low stature in the main (except in a few places where lantana has found a footing). A species of the ground orchid, *Habenaria* is found on the forest floor here: other features of the undershrub are procumbent *Butea parviflora*, *Flemingia* spp., and *Desmodium pulchellum*, and, in moist, flat locations a carpet of 'koovai' (*Costus speciosus*, and perhaps also another plant of the Zingiberaceae) —such patches of 'koovai' also occur in places in Kargudi. Apart from teak and *Anogeissus*, no other tree species occurs here gregariously, but among the species typical of the area are *Schrebera swietenioides* and *Eriolaena quinquelocularis* (in fruit in September). Both in Theppakkadu and in Masinagudi, *Argyreia fulgens* is a feature of the undershrub (and in Masinagudi, of open spaces) with its dark purple flowers.

Masinagudi is even more distinctive floristically, featuring a great many spiky shrubs and thorny trees and climbers. *Acacia intsia*, *A. concinna*, *A. ferruginea* and *A. catechu*, all the thorny species of *Zizyphus*, *Capparis* spp., *Gymnosporia montana*, *Toddalia aculeata*, and *Canthium* spp. are features of its flora, as also *Givotia rottleriformis*, and an erect tree-like *Euphorbia*.

Mysore

Bandipur Sanctuary

Location and extent : The Bandipur Sanctuary (23 sq. miles or 60 sq. kms.) of the Gundlupet Taluk of Mysore is the heart of the Venugopal National Park of the old princely State of Mysore and is contiguous with the Mudumalai Sa. of Tamil Nadu along a wide border, along the Kakkanhalla and the Moyar. It lies to the east of the Doddakatti Block of the Mudumalai Sa., to the north-east of its Mudumalai Block and to the north of its Theppakkadu Block. The Moyar and the Kakkanhalla are fordable at many places along the Bandipur-Theppakkadu border, so that the animals commute freely between the two sanctuaries.

Terrain and environmental factors: Bandipur is not much lower in elevation than most places in the Mudumalai Sa.: these figures from the Survey of India topo-sheet No. 58A/10 (one inch to the mile) will prove this statement: Bandipur Sa.: Lodges—3265′; Mulapura Betta: 3768′; Mudumalai Sa. : Upper Kargudi—3270′ ; Lower Kargudi—about 2900′ ; Mudumalai—3285′, Theppakkadu—3050′. However, Bandipur gives the casual visitor the impression of a lower elevation because it is comparatively much less undulating in its topography, and flatter, and its forests are more open and the undershrub less dense and high. It should be appreciated that Masinagudi and its surroundings, set against the backdrop of the Nilgiris, is actually on a lower elevation than Bandipur, and that the Moyar reserved forests extend on both sides of the river into Mysore and into Tamil Nadu. There is not much difference in rainfall (average about 56″ for the Mudumalai Sa.) but apparently edaphic factors differ, and the more uneven ground of the Mudumalai Sa., cut up by many watercourses, is more conducive to tree growth, the same species rarely attaining in Bandipur the stature they do in the Tamil Nadu sanctuary.

A notable feature of Bandipur is its many clearings holding short grass, which, except in summer, have a lawn-like greenness. Bandipur is much less spiky in its underbrush than certain areas of the Mudumalai Sa. (the Masinagudi area in particular) and holds much less tall grass: being only about 1/6 the size of the Tamil Nadu Sanctuary, it is a closer-knit area and more homogenous in character. Moreover, a notable feature of the area is the number of forest pools and tanks, natural and artificial, that it has, such as Tavarakatté, Kollakumalikatté, Kari Gowdana Katté, Aralikatté, Baisnapur Keré and Moolapura Keré. These provide the wild animals (and also the cattle) with water, and attract elephants and gaur when they hold water.

In spite of these differences, both from the point of view of the faunist and of the fauna, the Bandipur Sa. can only be considered a continuation of the Mudumalai Sa. (or the other way around) and territorially and floristically it is closest to the Theppakkadu Block of the Tamil Nadu Sanctuary, though lacking the flow of the Moyar right through it as at Theppakkadu. It also has points of resemblance to Masinagudi in its fauna and flora. A further point of resemblance between Bandipur on the one hand, and Masinagudi and Theppakkadu on the other, which is of importance to any ecological faunal study, is that in both there are abandoned forts, human settlements, and shrines, where the forest has reclaimed human settlements. In Bandipur, the presence of tamarind and banyan trees often marks these locations.

Perhaps the most notable feature of the Bandipur Sa. is that it is almost unique in India in that no forestry operations are permitted in it. To appreciate how vastly this has contributed to the faunal wealth of the sanctuary it is necessary to point out that in spite of privileged shikar being allowed in and around Bandipur, in spite of the extensive grazing of cattle in the sanctuary and the free exercise of village rights, the same animals (chital in particular) are much less shy of humanity in Bandipur than in the Mudumalai Sa.

Floristics: As mentioned, the tree species here do not attain a notable stature and the canopy is generally not too high. The forest floor is fairly open, and the clearings are covered with short grasses : there are also clearings holding tall grasses and hillside flats and slopes covered with herbaceous pasture. The comparatively open nature of the tree forests and the undershrub, are factors that are of great faunal importance.

The main tree species include the following : *Acacia intsia, A. concinna* and *A. ferruginea* (not dominant—nowhere near as common as in Masinagudi in the Mudumalai Sa.) ; *Albizzia lebbek* ; *Anogeissus latifolia* ; *Bauhinia latifolia* ; *Buchanania latifolia* ; *Butea monosperma* ; *Canthium parviflorum*; *Careya arborea* in moist areas; *Cassia fistula*; *Dalbergia latifolia* ; *Diospyros montana* ; *Elaeodendron glaucum* ; *Emblica* spp.; *Ficus bengalensis* and *F. mysorensis* ; *Gardenia* spp. ; *Garuga pinnata* ; *Givotia rottleriformis* (less common than in Masinagudi); *Grewia tiliaefolia* ; *Holarrhena antidysenterica* ; *Kydia calycina* ; *Lagerstroemia parviflora* and less commonly *L. lanceolata* ; *Machilus macrantha* ; *Morinda* spp. ; *Ougeinia dalbergioides* ; *Premna tomentosa* ; *Randia dumetorum* ; *Shorea talura* ; *Syzigium* spp. ; *Terminalia bellerica* and *T. tomentosa* ; *Vitex altissima* ; *Zizyphus xylopyrus, Z. trinervia* and *Z. mauritiana*. Tamarind, mango and wood-apple in places.

The main bamboo of the area is *Bambusa arundinacea* but *Dendrocalamus strictus* is also found. In places *Phoenix acaulis*.

The main shrubs are : *Anona squamosa, Flemingea* sp., *Gymnosporia montana*; *Grewia hirsuta* and *Grewia aspera*; *Helicteres isora*; *Indigofera* spp. ; lantana in places ; *Limonia alata* ; *Pavetta indica* ; *Solanum* spp. ; *Toddalia aculeata*.

The herbaceous vegetation is rich, particularly in September-October. No identification of the grasses was possible.

Andhra Pradesh

Kawal Sanctuary

Terrain and floristics :

The forests around Birsaipet and the surrounding areas are said to be the best in the sanctuary. The ground is undulating, rocky in places, and with a few pools holding water in November. In most areas teak predominates, constituting about 60% of the tree forests ; the other main species noticed were *Chloroxylon swietenia, Terminalia tomentosa, T. bellerica, T. chebula* and *T. arjuna* (the last near water), *Acacia sundra* (*catechu*), *A. leucophloea* and *A. arabica, Albizzia lebbek* and another *Albizzia*, probably *procera, Butea monosperma, Cochlospermum religiosum* and *Sterculia urens*, both in yellow, falling leaf and both with remarkably straight boles, *Careya arborea* here and there, *Zizyphus* *xylopyrus, Z. oenoplia & Z. mauritiana, Lannea grandis* (uncommon), *Boswellia serrata, Madhuca latifolia, Pterocarpus marsupium* (in flower), *Bauhinia racemosa, Dalbergia paniculata,* and *Emblica* spp. (*E. officinalis* & perhaps another species).

In many areas the 'male bamboo', *Dendrocalamus strictus,* grew gregariously or in clumps amidst the trees, and was in a very leafy and lush phase—the culms here are hollow.

In some places teak was sparse or absent, and in such places *Chloroxylon swietenia* and *Boswellia serrata* were prominent; in places *Cleistanthus collinus* grew gregariously and dominated the vegetation.

The undershrub was very thick and luxuriant, and consisted mainly of regenerating teak and gregarious regenerating *T. tomentosa* and other trees—evidently the forests were clearfelled some years ago. *Butea superba* was also prominent in the undershrub. Inside the tree forests there was little grass, though in clearings there was grass, and there were areas where thatching grass grew in abundance.

The forests were dense rather than open, the undershrub in particular being thick. There were paths in a network, overgrown with vegetation in most places in November. I learnt that in summer the forests are much more open and 'negotiable'.

Pakhal Sanctuary

Pakhal Sanctuary features a beautiful lake, which has its own wildlife (mainly birds, and crocodiles in one of its reaches). The forest is fairly thick, of a mixed deciduous nature, and holds trees of faunal importance such as *Emblica* spp., *Gmelina arborea, Careya arborea, Bridelia retusa, Terminalia bellerica,* and mohwa. The undershrub is notable for its comparative scarcity of herbs and grasses and holds many shrubs of faunal importance such as *Helicteres isora,* and *Grewia* spp. Eturnagaram has a richer tree growth and features belts and patches of grasses; the forest floor here is generally less shrubby and more herbaceous.

Both sanctuaries are in the process of being rehabilitated after being much depleted by years of intensive hunting and poaching—indeed, this is true of all sanctuaries in Andhra Pradesh, and while this is true to some extent of all Indian sanctuaries, I feel that the wildlife of Andhra Pradesh is best assessed or investigated after a fair period of the restorative effort. From the point of view of floristic ecology, the floral environment is still quite favourable to mammalian wildlife; however, the biotic (human) environmental factors may change very considerably, after a comparatively recent period of acute hostility.

Bihar

Hazaribagh National Park

History of the recent past.

Hazaribagh today is one of the best-forested districts in Bihar, some 45% of the total area being forested. Nevertheless, its floral history is one of sustained devastation.

Haines, in his BOTANY OF BIHAR AND ORISSA (1925) cites the District Gazetteer of 1917 which contains a note on the flora of Hazaribagh (and Monghyr) by the Rev. S. L. Thompson, formerly Principal of St. Columba's College, Hazaribagh. The following passage from that note of 1917 is significant: 'Unfortunately no report on the Hazaribagh flora can omit the most striking fact about it, i.e., its rapid disappearance. The forest is being most wastefully destroyed, and with it a great number of plants of great botanical and economical value are becoming extinct . . . . where even ten years ago there was considerable jungle.' (p. 70, Introduction, BOTANY OF BIHAR AND ORISSA by H. H. Haines).

Subsequent to 1917 the devastation continued, though certain areas in the present National Park, then the game preserves of the Raja of Ramgarh, were strictly protected and preserved intact. When this zamin forest was taken over about 1948, except for these protected game reserves of the Raja, the rest of the forest was heavily burdened with human rights (right to collect fuel, small timber and mohwa flowers, and to graze cattle), and there were quite a few villages inside the sanctuary area. Those villages are still there, and no doubt they are no singular exception to the stupendous population increase that has overtaken the country during the past 20 years. Considerable tracts of the forest have been ceded to agriculturists following the taking over of the ex-zamin forests, on a Government decision to cede to agriculture all land bearing traces of the plough. Today, even in those areas which were strictly protected prior to 1947, cattle are grazed and fuel collected. Although fuel collection is intended to be limited to dead wood, in actual fact live trees are also cut for fuel, on the sly.

The fauna had also been greatly depleted when the forest was taken over by the Government, and inquiry of many people who knew the forest then reveals that few animals could be seen, even at night.

Terrain and general factors: The extent of the National Park is about 75 sq. m.

Hazaribagh consists of an undulating plateau, of broad, mound-like elevations with broad, shallow depressions in between, cut up by nullahs, and clad in sal and a deciduous tree forest, with an undershrub rich in herbs. The soil is porous, sandy along the nullah, and except in depressed, shallow basins of clay neither the topsoil nor the subsoil is capable of retaining water. Because of this rapid drainage, and not because of poor rainfall, water is a major problem for man and beast during summer.

The climate is cool and dry, and I am told that during the cold weather Hazaribagh is now the coldest place in Bihar, though formerly Ranchi was. Arriving here very early in February when the days were brilliantly sunny, I noticed that even the natives wore shawls and blankets during the day.

A National Highway runs through the National Park, and only the area to one side of it (from Pokharia gate to Rajderwa) has been properly developed as a National Park, though 2 watch-towers have been built on the other side, too.

The most notable biological factor of the area is that during the day there are people all over the forest, collecting firewood, grazing cattle and passing through; man is much the commonest diurnal animal of Hazaribagh, the wild animals being nocturnal and crepuscular, mainly in consequence of this disturbance by men.

Although territorially distinct, it should be realized that the Hazaribagh forest (National Park forest) is only a part of the forest complex around it, and that the forest is very similar in composition and complexion in outlying areas, like Kodarma and Gomia. The animals no doubt commute between the protected and unprotected areas, but tend to concentrate in the former, the incentive for this being mainly the protection they gain here.

Flora

Hazaribagh is mainly a sal forest, but not a sal forest where *Shorea robusta* dominates all else, as in the Simlipal hills of Orissa; the sal at Hazaribagh, cut down in the past, is now in a regenerating phase, and is associated with a number of deciduous species, which grow along with and independently of it, in patches. Besides sal, which occurs in patches rather than in continuous belts, these are the main tree species.

Acacia catechu: Khair. Commoner away from sal, along the nullahs especially, than in the sal patches. Common in clearings; *Adina cordifolia:* Not common. Formerly commoner, as evidenced by old floras; *Aegle marmelos:* more young trees seen than old ones. A tree of great faunal importance; *Ailanthus excelsa:* formerly very common, as evidenced by old floras. I saw very few; *Anogeissus latifolia:* here and there in the interior. Saw no gregarious patches of it, as I have seen elsewhere; seems to have been commoner formerly; *Bauhinia* sp.: Bauhinias are quite a feature of the forest. Among tree species, there seem to be several, none in flower when I saw them. *B. racemosa* and *B. purpurea*, and one or two others occur here. The liana, *Bauhinia vahlii* is very common here; in fact, I cannot recall any other forest area in India where it is so common. I noticed that here, too, it is only rarely or occasionally that it attains to the status of a tree-strangling liana, and that usually it is a harmless, straggling, scandent, low bush, providing lush foliage that is easily accessible ; *Bombax ceiba :* The red silk-cotton. In flower in February-March, and therefore conspicuous. Along the nullahs. Attracts a great many birds ; *Boswellia serrata : Salai.* Much the commonest tree here, after sal. Forms gregarious stands covering the hilltops, and also grows along with sal and other trees. In flower in March. Deciduous and bare in February ; *Bridelia retusa :* Seen occasionally, but probably common in places. Wood seems to be valued as fuel. Saw several branches, with the leaves still on them, being carried by fuel-collecting women on their heads ; *Buchanania latifolia :* Very common. In flower in February-March ; *Butea monosperma :* Palas. The flame of the forest. Not in flower in February. Less common than in other similar forests in Bihar. The liana, *Butea superba,* also occurs, usually as a flat-spread bush; *Cassia fistula :* Not common. I looked for it in the cleared patches where it is often dominant and could not find it commonly there ; *Diospyros melanoxylon :* Sporadic. Said to be common in certain areas. A tree of considerable faunal importance ; *Emblica* sp. : Most probably *E. officinale :* Not uncommon. A tree of considerable faunal importance and definitely *not* a 'sal associate'; *Gardenia* spp. : None in flower, when I saw them ; *Garuga pinnata :* A tree of considerable faunal importance. Sporadic ; *Lagerstroemia parviflora :* Very common. I noticed that all the trees I saw were young ones, and that none had attained to a stature of over 30 feet ; *Madhuca latifolia :* The Mohwa. Common. Beginning to flower in February and in profuse flower in March. The animals do not get a chance to eat the flowers as people camp all night under the tree, with fires lighted, to collect the fallen flowers at dawn. An important item of food to the people here. No reason why they should not, as in the South, plant mohwa groves around villages for human requirements. No such plantations in Bihar ; *Mallotus philippensis :* Very common, especially away from sal along nullahs—also with sal. In fruit in February ; *Nyctanthes arbor-tristis :* Fairly common. Drying up in February ; *Pterocarpus marsupium :* This valuable tree was formerly much less uncommon. Only a few small trees seen ; *Terminalia tomentosa :* Fairly common. Young, bush-sized saplings in clearings. *T. bellerica* (a tree of considerable faunal importance) is uncommon : *T. chebula* (the myrobalan) less so ; *Semecarpus anacardium.* The bamboo of the area is *Dendrocalamus strictus,* which grows in clumps all over. An important plant, faunally.

Shrubs and herbs : The undershrub and clearings are rich in many plants. I did not try to work out the common spp. for I do not have the botanical knowledge, particularly of the grasses needed. A competent field botanist, with a good herbarium and good floras to aid him, should find Hazaribagh very rewarding.

There are many grasses in clearings, in the undershrub, and along nullahs, short or of medium size, still green in February.

Phoenix acaulis (*Phoenix humilis* ?) is common in clearings and along the nullahs : it seems to be *acaulis*, having no stem, or bole, of any height. This is a plant of faunal importance, both the fruit and the young leaves being eaten.

Among the shrubs may be mentioned *Cassia tora*, *Carissa* spp., *Flemingea chappar* and probably another species or two, *Indigofera* sp., and *Holarrhena antidysenterica*.

Betla

Palamau National Park

The Palamau National Park of Bihar is in the western part of the Chotanagpur district of Bihar, and is now about 96 sq. miles in extent. However, since I did most of my work in the Betla area of this park, best developed as a sanctuary and only about 12 sq. miles in extent, this note is confined to that area.

Betla consists of dry deciduous forests (plains forests at the foot of low hills) and is very dry in summer (when I was there), though it is almost enclosed between two rivers, the Koel and the Auranga, in which there is always some water. The animals do not move out of the dry area to the riversides or to the better-watered forests around during summer, when both the drought and the heat are severe—some of them, the elephants for example, do, but even the tiger and the chital and the gaur stay on here, finding such water as they can in drying water-holes, puddles and the few artificially improved hollows. Rainfall averages about 45 inches.

Permanent hides (watch-towers, one, Madhuchuan, a ground-hide) have been built near these sources of water, and observation of the animals, and to a lesser extent photography, is possible from them.

Terrain and floristics : Betla is almost flat, though the hills are close by. The main tree species are *Acacia catechu*, *Adina cordifolia* (in the moister areas), *Aegle marmelos* (quite common), *Anogeissus latifolia* (stunted), *Albizzia lebbek*, *Alangium salvifolium*, *Bauhinia retusa*, *Butea monosperma*, *Buchanania latifolia*, *Boswellia serrata*, *Cochlospermum religiosum*, *Cleistanthus collinus*, *Cassia fistula*, *Chloroxylon swietenia*, *Cordia myxa*, *Diospyros melanoxylon* and *D. montana*, *Emblica* spp., figs., *Garuga pinnata*, *Hymenodictyon excelsum* (in places), *Holarrhena antidysenterica*, *Lagerstroemia parviflora* (stunted), *Madhuca latifolia* (common), *Morinda tinctoria*, *Nyctanthes arbor-tristis*, *Lannea grandis*, *Pterocarpus marsupium* (stunted), *Semecarpus anacardium*, *Syzigium cumini*, *Schleichera oleosa*, *Soymida febrifuga*, *Sterculia urens*, *Terminalia* spp., *Wrightia tomentosa*, *Zizyphus mauritiana*, *Z. xylopyrus* and *Z. oenoplia* figs., and the red silk-cotton, near water.

The forest floor is fairly open, and covered with grass in places. Among the grasses of the area are *Apluda aristata*, *Crysopogon* spp., *Heteropogon contortus*, *Imperata arundinacea* and *Saccharum spontaneum.*

Betla is noted for its bamboo : the bamboo of the area is *Dendrocalamus strictus.*

The grazing of cattle and the collection of thatching grass and firewood is allowed or otherwise indulged in. There are villages around.

The Report of an Ecological Mammalian, Survey of Peninsular India : 1959-70

The factual bases of this report have been fully set out in the field notes, the introduction, and the discussions of each of the 33 mammals observed during the discontinuous 12-year period of the survey, and documented with 242 candid photographs. In the interests of the factual integrity of this study, there has been no attempt at editing or improving the actual record as written up after each day of observation and photography, and pains have been taken to collate the observation notes in the discussion of each species and to correlate them to the interpretation directly without the adventitious aid of graphs, statistical columns and other displayed selective analyses. The photographs have been selected not for their pictorial merit but solely for their evidentiary and record value. Further, brief accounts of the floristic and territorial features of most of the study locations, and references to any climatic factor of special interest, have been provided earlier. When all this has been done, there is neither need nor justification for making the final assessment in this chapter long, and if it seems too brief, it is only because much of what may be detailed here has already been detailed elsewhere in the factual bases specified above, and is not repeated.

The main reason for such a plan is the avoidance, to the extent possible, of personal bias in the assessment of the observation. However, it must be stated that the convictions and experience of many years of faunal and floral observation, and of the factors that influence wildlife in India, have not been ignored, and are also behind this report.

The ecological factors taken into account are not only the climatic, floristic and territorial features, and the inter-relationships of the mammals considered in this report. What is usually termed the biotic factor, i.e., the impact of humanity on wildlife, is of far greater importance than these other circumstantial influences even. This is so overwhelmingly the determining factor in the life of Indian wild animals and plants today, and has been so overwhelmingly so for the past 50 or 60 years, that it must be the main factor taken into consideration in any ecological report on the wildlife of the country. Giving it the importance that is its due, it will be discussed here as the primary factor affecting wild mammals.

Although this is a report of contemporary influences conditioning the life of some of our larger wild mammals, initially it may be noted that some 60 years ago, in the first decade of the century, the repercussions of human activities on the wildlife were not so serious. Not that they had no important impact on the wildlife then—in fact, even then they were the most important conditioning factors, and from all accounts available, even by the middle of the last century hunting, and trapping and snaring, were being indulged in with little inhibition, and the forests were expected (by natural regeneration) to cope with all demands made on them departmentally and by the people. Decline, in the circumstances, would be mainly a measure of the recuperative powers of the wildlife falling short of the depletion by human agency. In those days, apparently, there were many natural forests and other faunal areas not deeply penetrated by men, and the human population was much less dense.

In the twenties, the decline of some wild animals was noticeable and noticed, and more stringent protective steps were taken, resulting, where the habitats of a threatened species were not exploited by men for forest produce, in an improvement in its status: the special protection accorded to the Nilgiri tahr by the Madras Government and the Nilgiri Game Association is an example of such successful conservation. There were failures, too.

The vital, intimate, delicate and complex interdependence of the fauna and the flora, however, was not appreciated, and only in a very few preserves were forestry operations not carried out, and even in them village rights to exploit the forests were ceded. The natural forests were exploited for timber and other produce, clearfelled in coupes, and areas planted up with commercial indigenous species, and exotics like wattle, eucalyptus, casuarina, cashew and rubber. Private plantations, as of tea and coffee, were concurrently developed, and with the population increasing in and around the forests, the demands of the people on the forests for firewood, thatching grass, and other similar produce, and for grazing their cattle, also increased. Between the twenties and the present, the forests have been deeply and systematically invaded by men.

A century ago, Sanderson writing of the Mysore forests referred to thriving human settlements within the forests having been reclaimed by the jungle, and cited instances. Even today, the vestiges of such abandoned settlements survive in ruins in and around the forests he wrote of, such as Eeranamunti and Moolapura in the Bandipur Sanctuary, and Marasuranagudi in the Mudumalai Sanctuary. The position has been completely reversed today. There are few natural forests in the peninsula which have not been deeply penetrated by human enterprise, and apart from the forests having been denuded, or converted into plantations, or having degenerated, they have been occupied and are widely traversed by men. The repercussions on the wild animals of this intensive and deep penetration of their haunts by men, particularly its disturbance value, cannot be overestimated.

Before considering the causes for the decline of forests and wild animals in India briefly, a historical event that has profoundly affected the flora and fauna must be mentioned. After the Constitution of independent India came into force, the Central Government divested itself of such controlling authority as it had over what were, before the event, the provincial forests, and each State gained sovereign authority over its forests. No integrated, mandatory national policy governing the administration of India's forests has been possible, in consequence. Inevitably, in each State the political party in power has not hesitated, within the span of its unrestricted authority, to take steps which seem incapable of being retracted, with regard to its forests. There is little scope for a speculative analysis of motives, and none at all for polemics, in an ecological report, but it may be pointed out, relevantly, that some of these steps, such as the ceding of territorial rights within forests to private parties (as in Bihar and Tamil Nadu), the siting of major projects that affect the area for miles around in or near some of the best faunal areas in the country (as at Parambikulam, Moyar and Ramganga), the increased grant of collection and grazing rights to villagers around sanctuaries and reserved forests, the stepping up of departmental activities within the forests, and similar acts, all have a profoundly depletive influence on the flora and fauna. It is true that these same governments have also set up a number of new sanctuaries and otherwise have shown a consciousness of their responsibilities by the wildlife of their area, but even today there is no recognition of the vital interdependence of the flora and the fauna, and no national wildlife policy that is enforceable, and even in the conferences of the national and State wildlife bodies, the term 'wildlife' is still used mainly to connote the larger wild mammals, or at times these along with the birds and a few other animals, and the flora is considered something quite distinct, a mere setting at best. Further, there is hardly any functional recognition at any level of the prime need for undisturbed living space for the flora and the fauna.

With the enormous growth of the human population and the growth of industries, and the vastly increased and more varied needs of the nation and the people today, the demands made on the forests, wastelands, marshes and other wildlife habitats have also increased and not only in a quantitative manner—these demands have also increased in variety and have a somewhat altered quiddity even when not new. It is no longer only a question of established forestry practices on a more intensive scale and of the forests being more heavily burdened with village rights. Industries and factories have to be supplied with raw materials (such as bamboo and pulp-wood for the paper and rayon industries) from the forests, land within the forests is found for agriculture, human settlements and resettlements (the Dandakarunya project is an example), factories (munitions factories, for example) and industries are located in and around the forests and also major hydroelectric and other projects. All this has naturally resulted in the forests being further opened up and deeper penetrated, cleared and disturbed.

To the extent to which they disturb, alter and destroy the natural flora and environment of the wild animals and affect their interrelationships, these multifarious human demands on the forests are very much the concern of any ecological report, and for many years I have studied them in various parts of India, but it is unnecessary to enumerate and detail them here. For the purpose of this report it will be sufficient to briefly mention the main consequences of these human demands and activities.

The plains forests have disappeared entirely from many parts of south India and in places I have actually watched their disappearance. In the central and northern parts of the peninsula, there are plains forests left still, some of them dry, open jungles, but everywhere they have deteriorated by human exploitation. Even the hill-forests have been opened up, denuded in places, and deeply penetrated by human enterprise: in many areas they have degenerated. No figures to show the extent of this deterioration and denudation, or the increased extent to which human activities have entered the forests, are available in official records: all that official records can specify is the total forest area in each State, (which, paradoxically, has remained the same for the past 50 years, except for political readjustments and minor cedings of territory), the extent planted up with various species, the selection and clearfellings sanctioned, and similar details. I have, naturally, satisfied myself that the position is as stated by personal inquiry of various State Forest Departments, and the offices of the Inspector General of Forests and the Planning Commission, before making this statement. However, though unassessed statistically, all those with an informed interest in the forests of India know that there has been substantial deterioration and diminution of the natural forests by way of denudation, and degeneration caused by many influences (all related to human activities—some directly depletive, like wood-poaching) in the course of the past 50 years, especially the past 30, the probable extent of such deterioration being a matter of personal assessment and differing in different States. A recent depletive factor that may be mentioned in this connection is that in some States (Kerala, for example) there have been illegal encroachments by private parties, which have not been successfully resisted: in others, the tendency to cede rights within the forests to private individuals has been more marked in recent years. The extent of such, and similar, loss of forests is small compared to the total area, and negligible from the point of loss of revenue, but the effects of human occupation, which radiate far outward from small centres, have a powerful depletive influence on the wildlife.

Frequent disturbance by human activities has a most unsettling and unfortunate effect on the wild animals, although these activities are not directed towards them and are mainly concerned with the vegetation and terrain. Because of this, the animals may move out from favourable to unfavourable areas, and from protected haunts to areas where they are actively hunted—as one may observe on the outskirts of sanctuaries. When large enough and sufficiently upset by human interference with their normal activities, the wild animals may turn hostile to men, like elephants in places. It is necessary to point out again the multifaceted depletive potency of disturbance, as it is the least appreciated major factor in wildlife conservation in India.

The increasing growth of human settlements in and around the forests leads directly to an increase (whether officially sanctioned or not) of the exploitation of the forests (even in sanctuaries) by humanity for various reasons, such as the collection of fruits and mohwa flowers (B 68 Apr. 16, 70 Mar. 1), firewood (TN 63 Sep. 25—the General Account of the Hazaribagh N.P.), other forest produce such as thatching grass and bamboos, use for passing through from place to place, and cattle droving and grazing (practically ubiquitous, but reference may be made to TN 63 Sep. 25, 64 Apr. 13, 66 Oct. 7, 68 Dec. 11 and 16, 69 Sep. 22, 69 Dec. 12, 70 Sep. 15 and Oct. 3; K 70 Apr. 20 and AP 68 Nov. 6 to 13). Apart from cattle competing with the wild herbivores for fodder and water, the practice results from time to time in the communication of infections from cattle to the wild herbivores, such as rinderpest and foot-and-mouth disease with disastrous consequences (MY 68 Oct. 5—notes on gaur, sambar and chital).

Officially sanctioned collections of minor forest produce for departmental sale, are most deleterious in their impact on wild animals, and where the collections are intensified (as in Madhya Pradesh), naturally the harm they cause to wild animals is also intensified.

The spread of exotics into the natural forests is directly related to their opening up by human activities, and has in some areas resulted in serious ecological imbalance. Practically all exotics specially cultivated departmentally, such as casuarina, cashew, rubber and *Prosopis juliflora*, serve to deprive the wild animals of territory in long-held homes, but none of these is as inhibiting in this regard as the species of Australian wattle and eucalyptus assiduously cultivated departmentally. Curiously enough, some of the exotics accidentally introduced into the forests and countryside do not have an adverse effect on the wild animals. The most notable of these today is the lantana which, in places, offers congenial cover to the animals (TN 62 Sep. 12), though as fodder it is of much less importance—elephants, gaur and chital eat it desultorily when it is in fresh leaf. Iodine-rich *Eichhornia crassipes*, eaten in small quantities by some animals (MISC 68 Feb. 4) may, or may not, have some ultimate effect on those animals. Many plants of the Compositae have entered deep into the forests and appear to be only a hindrance to the wild mammals.

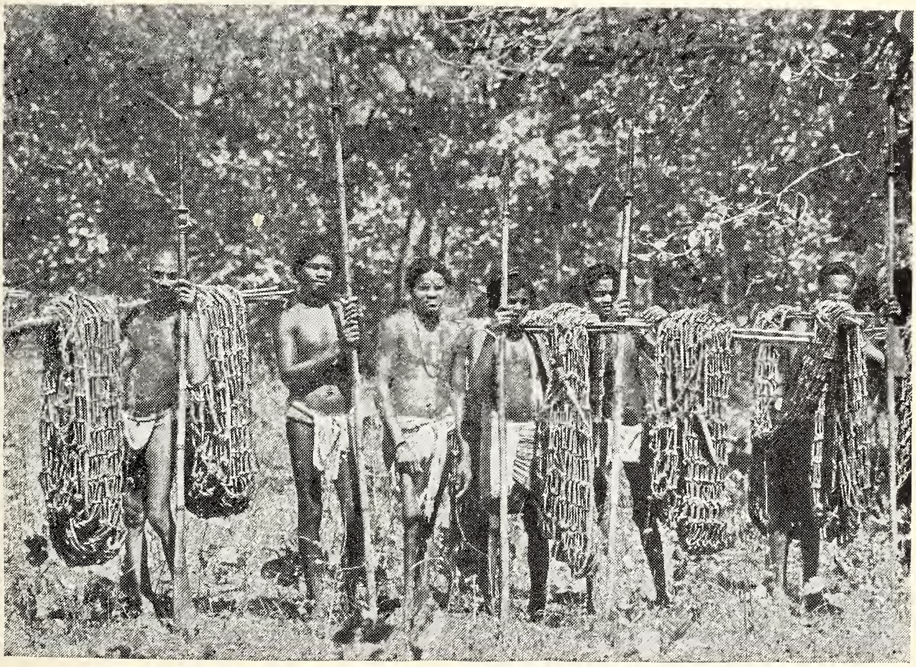
The harm from pollution, where factories are located close to faunal areas, and the lethal effects of insecticides on animal life, have been widely appreciated in the West,' and it is possible this realisation might spread to India, too.

The main depletive factors have been mentioned. For two reasons, they have gained increased potency in recent times, first, because the increase in human population has led to greater human demands on wildlife habitats, second, because the decrease in the flora and fauna progressively limits the recuperative powers of the wildlife. For this second reason, I think that it is not the comparatively recently developed depletive factors that are currently most hostile to wild animals, but the oldest factor, going back to prehistoric times, hunting.

By hunting is meant, here, all modes of encompassing the death of wild animals, by licenced shooting, unlicensed shooting, snaring, netting, baiting, trapping, and organised hunting with bows and arrows, or spears, or both. Because the forests have been opened up and there are few inaccessibly remote retreats left for the wild animals, because the animals have less living space and are therefore easier located, and because protection (however justified the cause of its poverty) is poor, hunting has increasingly assumed a quite menacing depletive potency. No evidence can be adduced in support of my view, but I have studied this problem for years and in many places, making inquiries of poachers, trappers, and many tribals, and I think professional meat-hunters, tribals indulging in regular orgies of hunting (MP 70 Mar. 27—photograph MP 40) and amateur poachers (many of them high-placed in status) are doing much greater damage to the wild animals today than is generally appreciated.

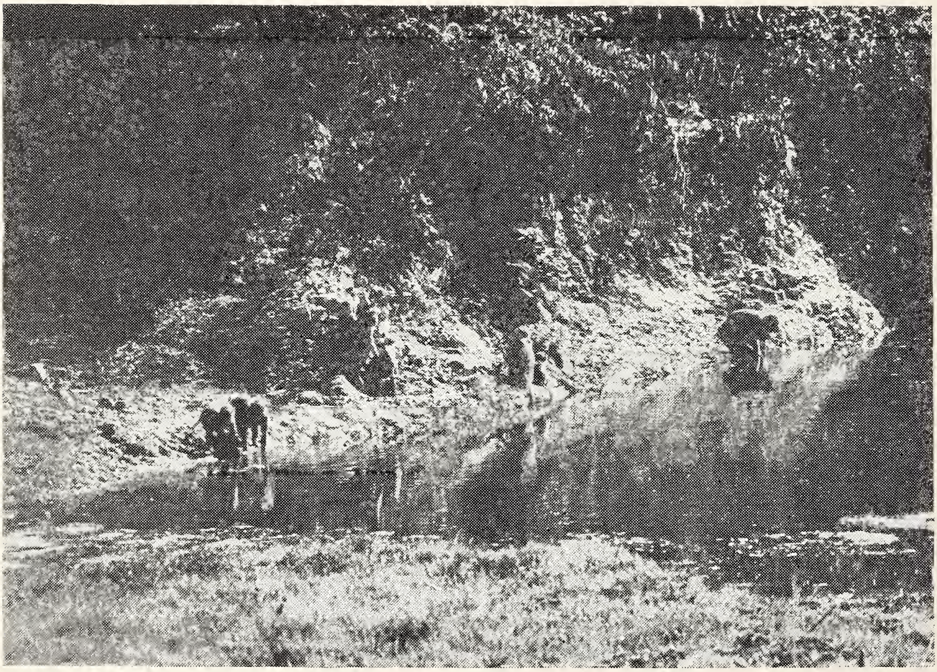
From inquiry made, the main cause for the notable decline of wild animals in areas formerly celebrated for their fauna (in Andhra Pradesh, Orissa and Madhya Pradesh, for example) seems to have been poaching by shikaris with guns and tribal hunting with less sophisticated but still lethal weapons and nets. Among tribals, hunting is mainly dependent on the traditions of each tribe ; the tuber-eating Khadias of Orissa, for instance, do little hunting, while in the same State, Kols and Gonds indulge avidly in it. In general it may be said that tribals in the south of

Krishnan : Mammals



Above: BIHAR 1968: HAZARIBAGH N. P.: April 16—dawn: Men picking fallen flowers from under a mohwa tree—B.1; *Below:* M. P. 1970: BASTAR: March 27: About 9 a. m. at Mukhaveli: Muria hunters, with nets and spears—MP. 40.

(*Photos: M. Krishnan*)



Above: TAMIL NADU 1969 : PT. CALIMERE : December 18 — p.m. : Feral ponies — TN. 58 ; *Below:* BIHAR 1970 : BETLA : PALAMAU N. P. : February 22 — 1 p.m. : Rhesus at Madhuchuan — B. 32.

(*Photos : M. Krishnan*)

the peninsula are less given to hunting than those in the north, but no such regional bias governs poaching. It is practised everywhere.

The most obvious reaction of wild animals to sustained disturbance by humanity (and especially to hunting, which panics and unsettles them even when it does not succeed in killing them) is to convert them into shy, fugitive creatures of the night, and to cause them a greater degree of nervous tension than is normal in their lives. Animals which are normally abroad by day, like gaur, sambar and pig, retreat into cover with dawn and stay in hiding till near sunset: the difference between the behaviour of gaur in the Mudumalai and Bandipur Sas. and in Kanha N.P. is significant. Disturbance also leads to loss of the best feeding grounds and of safe waters (poachers usually sit up over the only available water within miles—MP 70 Mar. 27 and 31) and generally to a decline in animal populations.

Many animals have declined dangerously or become locally extinct within the past 20 years. Only the decline of one of them, the tiger, has excited popular interest here and abroad and been widely publicised. It is not as if the tiger became rare in India overnight: experienced men like Corbett predicted its decline over 20 years ago. When even the decline of the tiger, which has captured human imagination in India for some 2000 years, was noticed only at the last stage, it is only logical that the decline of less glamorous animals like the liontailed monkey, the sloth bear, the hyena, the wolf and the dinky little Indian fox has gone largely unnoticed, and even the local extinction of some of these, and the blackbuck and the leopard in areas. In fact, all the mammals mentioned in this report (and a good few comparatively rarer mammals not mentioned here) have declined noticeably in numbers excepting the elephant, the chital and the pig : of these three, the seeming thriving status of the elephant is almost certainly illusory, as pointed out in the note on the animal, and though it is protected today (and has been so protected for years) all over India, I predict that within a generation elephants, dispossessed of territory, are likely to be so much in men's way that in many areas they will be proscribed and destroyed.

This apathy to the dwindling of wildlife till the last stages of decline are reached is by no means peculiar to our country. In America and Europe, too, the people and the administrations awoke to the imperative need to preserve wildlife only after having lost much of it (more than we have), some species, like the American bison, by active hunting. Whether we will benefit from the experience of the West and save and revive what is left of our wildlife is a question to which no definite or succinct answer can be provided, and anyway the answer is clearly beyond the scope of this report. However, it may be said that in our national culture there is no scientific interest in nature. In our languages we do not have specific names for many plants and animals, and not even terms to distinguish the antelopes from the very different deer. Further, being preoccupied with national development and the many pressing consequences of overpopulation many people find it hard to appreciate the importance of something that offers no immediate, tangible benefit. Even in the West (where natural history had its origin and growth), it was only after the disillusionment and shattering of normal human values by war, that people came to realise that wildlife provides something much greater than recreation or aesthetic satisfaction, that it provides a fascinatingly varied, entirely natural and authentic, and vital interest in human life. Further, as pointed out already, we have the problem of national integration of the country's wildlife effort.

The next ten years are critical.

GENERAL ACCOUNT OF THE MAMMALS STUDIED

The order of arrangement follows the BOOK OF INDIAN ANIMALS by S. H. Prater (2nd edition, 1965) and the nomenclature, following that book, the CHECKLIST OF PALAEARCTIC AND INDIAN ANIMALS, 1758 to 1946, by Ellerman and Morrison-Scott (1951).

THE BONNET MONKEY

Macaca radiata (Geoffroy)

(Summary of field notes: Observation records: 22.

Locations: Forests 19: Mudumalai Sa., Ranganathittoo Sa., Bandipur, Point Calimere. Temple—3, Sholinghur.

Photographs: MISC 1, TN 47A, TN 60.)

This is much the commonest monkey of what used to be termed the Deccan, and south India, and commoner in and around rural and suburban areas (in scrub jungles, around villages and towns, and around certain shrines and railway stations) than in interior forests. However, the meagre record of it in the field notes exaggerates this comparative scarcity inside forests, and is partly due to my having ignored bonnet monkeys seen in tree forests, on occasion, in the preoccupation with some other animal. It is found in deciduous forests (MY 68 Oct. 6 & 18, 69 Oct. 9 and TN 70 Sep. 29) and I have seen it in the tall tree forests of Karwar and also in semi-evergreen forests, as in Courtallam. C. G. Webb-Peploe (*JBNHS*, Vol. 46—No. 4, p. 629 *et seq.*) reports its occurrence in the semi-evergreen forests of Naraikkadu in South Tirunelveli, along with the liontailed macaque. However, it is not a typical forest animal, and is rare or unknown in many montane forests.

Size: Morphological characters

As in other macaques, adult size is extremely variable. Prater gives the weight of a full-grown male at 13-19 lb. and of a female between 7 and 8 lb. The superior size of the male is more evident in macaques than in langurs, but in no troop of this monkey seen was a dominant male so much bulkier than the largest female that its weight could have been more than twice the female's; further, even in animals of fair average size, the difference in weight between adult females is often greater than 1 lb.

Though the male is considerably larger than the female in adulthood, in this macaque variations in size independent of sex but based on locality and genetical factors can be even more pronounced. This difference in adult size between troops in different area does not seem to be dependent entirely on environment, but to be more complex.

It is not in dense forests, but in comparatively open country, in low-elevation hills and around shrines and human settlements, that the bonnet macaque attains its best development. The food advantages of such locations are obvious and probably the sustained intake, over generations, of more nourishing food than is available naturally in the forests has contributed to the physical superiority of this monkey where it is, in a large measure, dependent on humanity for its sustenance, but such a logical explanation does not account for the fact that where it is dependent on humanity, it is smaller in some areas than in others: for example, the size attained in Tirupathi, Papavinasam and Jalarpet is not reached at other shrines and railroad communities in the same region. Forest-living monkeys are generally smaller than those in rural and urban areas, and they seem to reach a larger size in the eastern regions of their range than in their western range.

What is specially interesting about this macaque is that even in the same area, it may display considerable variations in size from troop to troop. In the Mudumalai sanctuary of Tamil Nadu Wynaad, the bonnet monkey is mainly found in a few troops in the Theppakkadu-Kargudi areas, and is typically the smallish, rather furry forest-living kind. Typical specimens are shown in photograph TN 60. However, in the interior forests, a miniature bonnet monkey was noticed, hardly half the size of the commoner specimens around the human settlement at Theppakkadu, so fugitive in its response to humanity that it was not possible to observe it closely or for any length of time, and that only one clear picture of it could be taken (TN 59 Mar. 23, 1963 Sep. 28, 66 Sep. 27 and 69 Oct, 5). An adult female was seen carrying an infant only the size of a loris (TN 62 Mar. 25). The photograph (TN 47 A) shows the small size of 2 'miniature' bonnet macaques in relation to the fresh leaves on the culms of the giant bamboo.

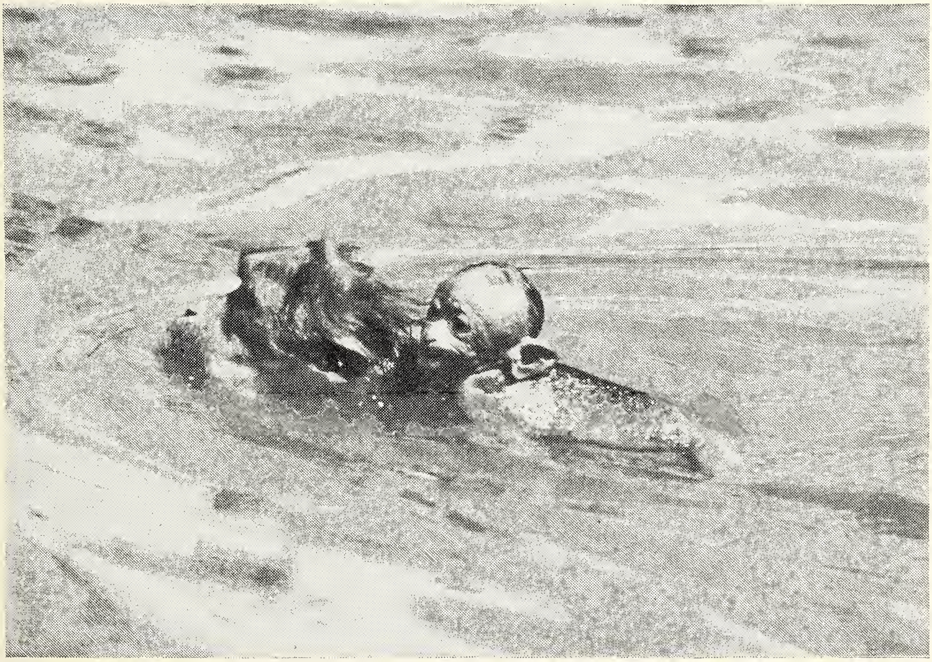
Distribution

The distribution is limited to peninsular India well south of the Gangetic plain. Prater gives the northern limits of the bonnet macaque as up to Bombay on the west, and the Godavari on the east : it may be added that in the central part of this peninsular wedge, in the northern tracts of Andhra Pradesh, its range does not quite reach the river. Within the vast area of this peninsular wedge, its distribution is somewhat discontinuous : it is absent in some natural forests (and also in some rural areas). Although less likely to be deprived of territory by human occupation of the plains forests than most other animals, since it adapts so readily to life around human settlements, it seems to have lost ground in places, but probably this loss has been compensated by the acquisition of new territory elsewhere. An interesting example of such conquest is provided by its introduction, by capture and release, into the coastal forests of Vedaranyam, near Point Calimere. In April 1965 some 30-odd monkeys, captured around Kumbakonam, were brought to the Kodikadu Reserved Forests and liberated : they are thriving in several troops now, with a total population of about 100, and have perhaps been helped in this by the absence of predators in the area.

Habits : Behaviour

A notable feature of the social organisation of the bonnet monkeys of various areas is that in natural forests they are usually to be found in small groups of from 3 or 4 to a dozen or so, and never in large numbers. They are shy of men in the forests, even fugitive, and spend much time in treetops. The big troops are to be seen in specially congenial areas where they are partly or mainly dependent on humanity for food, as around shrines and railway stations. In such places, a number of troops, probably composed of smaller units, live in loose associations where tolerance of one another within limits, and individual displays of threat and dominance, are observable in a complex, rather than in a pattern. It is noteworthy that with the change in feeding habits, from the industrious seeking for small titbits that is typical of life in the natural forests, to plunder and the quick picking up and thrusting into the cheek pouches of scattered human surplus food, they are much more terrestrial and swift-moving, and often gain noticeably in size and power. In the forest they spend much time in finding food, climbing trees to feed on leaf-buds and fruits, patiently combing the seeding heads of grasses with their lips to strip the seeds, hunting insects, or investigating plants growing in the interspaces between rocks for insubstantial fruits and buds ; even when food, such as the tender new leaf of the tamarind, is available in bulk, forestside bonnet macaques feed methodically, filling their cheek-pouches slowly and not stuffing them hurriedly. The vegetarian food includes the leaf-buds of the giant bamboo and the leaf-buds and foliage of many

Krishnan : Mammals



Above: TAMIL NADU 1970: MUDUMALAI SA.: Theppakkadu: September 21 — p.m.: Bonnet monkey grooming young — TN. 60; *Below:* MISCELLANEOUS: Sholinghur, TAMIL NADU: 1960: May 24 — p.m.: Bonnet monkey mother swimming with her young on her back — MISC. 1.

(*Photos: M. Krishnan*)

TAMIL NADU 1966 : MUDUMALAI SA. : September 27 : Bonnet Monkeys — TN. 47A.

(Photo : M. Krishnan)

shrubs and trees, a variety of fruits including green fruits, and the seeds of grasses (TN 62 Mar. 13, 62 Sep. 13, 63 Sep. 13, 69 Dec. 12, 70 Sep. 29). Grubs, insects and other such small prey are also part of the diet, and birds' eggs when available. They eat the eggs rather clumsily. A group of 7 swam across the Kauveri where it was both deep and fast-flowing to a chain of islands on which water-birds were nesting in a packed colony, to raid the eggs from the nests; incidentally, a crocodile was known to frequent the neighbourhood of these islands (MY 67 Aug. 14).

Many distinctive vocalisations, attitudes and gesticulations are used in communication, and expressions of dominance or submissiveness, threats and demonstrations. Among the main vocalisations may be mentioned the rattling, reverberating 'krrrrrr', well-known as the threat and anger call, and a soft short grunt, used in intraspecific communication when the monkeys are on the ground in company and moving through the undergrowth. A vocalisation I have heard on several occasions in the field, but never seen recorded in the literature available to me on this monkey, is a low, bird-like, cooing 'pio', reminiscent of the similar call used by the liontailed macaque. Prater, writing of the Assamese macaque (*Macaca assamensis*) mentions 'a rather plaintive musical call, a low "pio"': never having heard the Assamese macaque, I am unable to say whether this particular vocalisation of the bonnet macaque is similar, but the quotation from Prater would be a good description of this call as well. There is only one mention of the call in my field notes (TN 69 Dec. 12), but as said, I have heard it several times, and outside the period of this survey have also heard the similar call of the liontailed macaque in the wild.

A loud, sustained choking sound, difficult to describe in words except by a contradiction in terms, as a guttural screech, is used in intraspecific combats, and the same sound or a variant as the alarm call. Bonnet macaques come out with this call in frenzied repetition at the sight of a leopard or other predator, but are less unvarying in this than the langur. When up in trees and apparently when confident that they have not been seen, they may remain silent when a predator passes below them, hugging the bole and hiding in foliage.

When walking on the ground, without being excited or alarmed, the distal third of the long tail is trailed: naturally, other Indian macaques, which have short tails, never do this, but on occasion the Common Langur does so: however, the trailing of the tail along the ground in this manner is more usual with the macaque than with the langur.

Although highly arboreal, the bonnet macaque does not bound about the branches, or leap from treetop to treetop, in the manner of the Common Langur. However, in swarming up trees, sheer rock faces and walls, it is even more expert than the langur. At Courtallam, in April 1967, K. Krishnamoorthy showed me a vast, sheer rock-face up which he had seen a troop of some 30 bonnet macaques go swarming, clinging on to minute holds, an impressive performance.

This monkey is a good swimmer and, like the rhesus, takes to the water to get across from one bank of a pool to the other instead of taking the circuitous path around along the bank. It can enter the water very smoothly when it wants to, and swim submerged for short distances. Females carrying infants also take readily to the water, the young shifting from the abdomen to the shoulders to ride piggy-back and keep above the surface of the water (Photographs MISC 1 : notes MISC 60 May 24; MY 67 Aug. 14, 69 Oct. 9; TN 69 Dec. 12).

In biting their opponents (especially during intraspecific combats), the bonnet macaque, like all monkeys, seizes its adversary with both hands and pushes it at the moment of biting, thereby inflicting a quick, tearing wound that can be quite grievous (MISC 60 May 24).

Forest-living bonnet macaques favour the neighbourhood of large rivers and waterfalls.

There seems to be no defined breeding season in the wild and infants are seen both in summer and in September-October. An adult female with 2 infants is seen occasionally, but in such cases it is not known whether these are twins, or one is an adopted infant whose mother is no longer with it. The usual rule is one young at a birth.

THE RHESUS MONKEY

Macaca mulatta (Zimmermann)

(Summary of field notes : Observation records : 10.

Locations : West Bengal—Jaldapara Sa. : Orissa—around Balimela : Bihar—Palamau, Karkatnagar.

Photographs—B 32.)

The rhesus replaces the bonnet macaque as the commonest monkey of the country north of the Godavari. In places it is to be found in large numbers around shrines, railway stations and human settlements, but all records in the field notes are of forest-dwelling rhesus.

Size : Morphological characters

As in the bonnet macaque, size varies considerably with locality, and in adulthood the male is considerably larger than the female. It is easily distinguished from the bonnet monkey by the hair on the crown having a backward slant with no parting, instead of being arranged in a radiating 'bonnet', the shorter tail, and the more chunky build; the burnt sienna to brownish orange colour of the pelage on the rump and lower back is distinctive—for the rest, the coat is an olive-grey, and the skin of the face and ears pink, as in the bonnet monkey. The two are of more or less the same size, and Prater gives the weight of the rhesus at from 10-14 lb. Within peninsular India, the rhesus also seems to attain its best physical development in areas where it is dependent on humanity for food. It is said to reach its maximum size in the sub-Himalayan region. Rhesus observed in Bihar were small-sized and almost olive-brown in colour (B 68 Apr. 22, 68 Apr. 25, 69 Feb. 20, 69 Mar. 2).

Forest-living rhesus are generally small, and in certain forests a few seem to decline to a miniature size, as in the bonnet macaque. In the Jaldapara sanctuary I saw a group of 4 such miniature rhesus (MISC. 65 Oct. 23).

Distribution

The rhesus has a wide distribution outside peninsular India, in the sub-Himalayan forests, Uttar Pradesh, West Bengal and Assam, and farther east into Burma and beyond. Prater gives the southern limits of its territory in peninsular India as the Tapti on the west and the Godavari on the east. In northern Andhra Pradesh it is to be found a little further south than the Godavari. In Orissa, Bihar and Madhya Pradesh the distribution of the rhesus is widely discontinuous. For example it is not to be found in the Hazaribagh and Kanha parks of Bihar and Madhya Pradesh. One probable explanation for this is that with the exception of the liontailed macaque and the Nilgiri langur, the macaques and langurs of peninsular India are all creatures of the deciduous forests and do not occur in evergreen tracts. For this reason the rhesus will not be found where sal dominates the flora. It is true that neither in Hazaribagh nor in Kanha does sal occur in dense continuous belts, as it does in the Simlipal hills of Orissa; I have not seen the rhesus in the Simlipal hills either, but my acquaintance with their sal forests is limited to 7 days spread over 3 years.

Habits: Behaviour

Although it climbs trees and rocky escarpments expertly, the rhesus is much more terrestrial than the bonnet macaque, especially when feeding. It takes readily to water and is a powerful swimmer. A troop of 19 was observed in the Palamau N.P. (Bihar), clinging on to the low steep banks of a pool, using one hand to fish out an alga from the water, and eating it (B 70 Feb. 22; photograph B 32). Forest-living rhesus spend much of their day searching for food assiduously, eating leaves, buds and insects, and similar insubstantial morsels. In their feeding habits they are similar to bonnet macaques, but noticeably less arboreal.

In their vocalisations, too, they are somewhat similar, though except when screeching and grunting during intraspecific fights and disputes (bonnet monkeys also indulge in this while fighting) they seem to be less vocal. They do not have the low, musical 'pio' call, used by bonnet monkeys in treetops. Breeding is not limited to a defined season,

THE LIONTAILED MONKEY

Macaca silenus (Linnaeus)

(Summary of field notes: Observation record: 1
Location: Varagaliyar, Anamalais.
No photographs.)

The liontailed macaque has the most restricted distribution of all Indian monkeys, being confined to a few evergreen forests of the Western Ghats in Tamil Nadu and Kerala. It has been much depleted over the past 50 years by systematic poaching for the sake of the pelage and flesh of the adult, and the capture of the young for sale as live specimens. In hunting this monkey and capturing the young, slings and bows are usually used; the mother is killed or wounded so severely as to be incapable of flight, and the infant then captured.

Some 35 years ago I have seen it, and observed it closely, in the evergreen forests of the Thirunelveli district around Courtallam : it is no longer to be found in this location, or in some other locations where it was known then. Its current status is adequately described by the word ' precarious '.

Size : Morphological characters

The size of this forest-living monkey is approximately that of the other two macaques of the peninsular area, the bonnet macaque and the rhesus, but is even more variable among adult individuals; the superior size of the male in adulthood is noticeable in this species also. The build, especially in adults, is more thickset than in the other macaques.

The sleek black coat and the luxuriant ruff of long, warm grey hair around the black face, forming almost a mane, are the distinctive features of this monkey; the short tail is not leonine, ending only in an inconspicuous tuft.

The only other black monkey of India (excluding the only ape of the country), the Nilgiri langur, is also usually found in evergreen forests inhabited by the liontailed macaque. Both are arboreal, and the langur also has a warm grey ruff, more brownish grey and less luxuriant, but these details are hard to distinguish in the treetops, as also the more reachy build of the langur. The much shorter tail of the macaque, and its quieter movements, serve to distinguish it from the langur.

Distribution

Prater gives the distribution as the Western Ghats from North Kanara southwards to Kerala. It seems to have died out in its northern range and to be now limited to its southern reaches, as already said. It is essentially a seclusive monkey of the deeper evergreen forests.

Habits : Behaviour

The liontailed macaque is found well away from human settlements, in small parties of from half-a-dozen to a dozen or more. It feeds both in treetops and on the ground, and is similar in its feeding habits to the bonnet macaque. It is more deliberate in its movements and notably less vocal. The only sounds heard in the wild were a rather bird-like intraspecific call (also heard in the Calcutta and Madras Zoological gardens), louder than the musical 'pio' of arboreal bonnet macaques but similar to it (MISC 60 Apr. 30), and a soft grunt. I have heard these calls on several occasions, long prior to the period of the present survey, in the wild : they can also be heard where a number of these monkeys are housed together in a zoo. Webb-Peploe (*JBNHS* **46** : 4, 629 *et seq.*) reported that in the evergreen forests of Naraikkadu, South Thirunelveli, these monkeys were seen in a troop of about 20, that they were shy of men and deliberate in their movements, and descended from one tree to climb another instead of proceeding along the tree-tops, and that they were feared by the langurs (presumably the Nilgiri langur) and bonnet monkeys ; he records two calls, a subdued grunt and a loud, pigeon-like 'coo'. Prater (whose book is mainly a compilation), presumably following Webb-Peploe in part, gives this account of vocalisations: 'The call of the male is said to resemble the human voice. It is compared to the "coyeh" of a man trying to get in touch with his lost companions in the jungle, and again to the loud "coo" of a pigeon'. It seems extremely unlikely that a highly gregarious animal like this macaque should have occasion for a penetrating 'coyeh' as of a man calling to lost companions, and I have never heard this call, but in view of the narrow limitation of my personal knowledge of this monkey, made diligent inquiry of tribals in the Anamalais, and the Periyar area of Kerala, who knew it in the wild much better, being those who poached it for pecuniary gain, and they, too, said they had never heard the call, but only the bird-like 'pio'—in fact they locate their quarry when hunting it mainly by this call. As to this call being like the loud 'coo' of a pigeon, the question is which particular pigeon's 'coo' it resembles : if it is the polysyllabic modulated call of a green pigeon of the genus *Treron*, the further qualification may be added that the macaque's call is also modulated and less polysyllabic, being like a phrase of the bird's call rather than the entire call.

THE COMMON LANGUR

Presbytis entellus (Dufresne)

(Summary of field notes : Observation records : 76.

Locations : Tamil Nadu—Mudumalai Sa. ; Mysore—Bandipur ; Orissa—Balimela, Raigoda Sa. ; Bihar—Palamau N.P.; Madhya Pradesh—Kanha N.P. ; Churna ; Maharashtra—Taroba N.P. ; Uttar Pradesh—along the Sharada canal.

Photographs—TN 17, 43 ; MP 8, 33 ; MR 1, 2, 4, 15.)

The grey langur (Common Langur) is the only Indian monkey with a distribution all over India, from the Himalayas to Kanyakumari. Taxonomists have recognized a dozen territorial races within the peninsula, based, among other considerations, on the colour of the hands and feet. Summing up these distinctions, Prater says that the contrast between the white ruff around the face and the darker hair of the body, vivid in Himalayan specimens, is less apparent in peninsular animals, but that 'among them there is variation in the colouring of the hands and feet' which, 'are almost black in langurs from the plains of northern India, become paler as one travels southwards to the Deccan, and are almost white in the dry zone of south-east India'. Perhaps this entire question of races is due for a revision by competent taxonomists. A search for one of the white-handed races described in Blanford's fauna, in the locality of his type-specimens, proved infructuous, the langur seen being black-handed. Further, the darkest grey I have seen in the pelage of this monkey was a langur seen along the Sharada canal in Uttar Pradesh (MISC 68 May 21).

Size : Morphological characters

This langur attains its maximum size and richness of pelage in the Himalayan region. Prater gives the weight of peninsular animals as from 20 to 35 lb.

The grey langur is much taller and heavier than any of the macaques of the peninsula, with the comparatively slim, long-limbed build of its tribe, and a long tail ending in a white-haired tuft, usually in a conspicuous tuft. The difference in size between the adult male and female is much less obvious than in macaques, and size variations among adults in a troop are also less flagrant.

The question of size in comparison to other species of the genus is interesting, the race occurring in or around each of these other species being taken into account. The grey langur is relatively larger than the golden langur (MISC 68 February 15) and perhaps longer than the Nilgiri langur, but slimmer built.

The basal third of the tail is muscular, and the tail is often carried gaily, though the distal half of it is lax and pendent. In adulthood the tail is not prehensile, but in infancy it is, and the infant being carried clinging to the abdomen of its mother loops its tail around the base of its mother's for an additional hold when being carried at a run (MR 68 November 18). The infant langur is black or a very dark grey at birth, but the hair on its coat turns to a pale grey in the first month of its life : apparently the transition is swift, for though I have looked for it, I have not seen young animals in an intermediate stage of this change of colour (TN 59 April 3, 66 April 2, 5, 6 ; MP 69 March 9, 21, 70 March 15, 20). In the bonnet macaque, too, the newborn young is dusky or black. Has this dark colour of the infant changing abruptly to pale grey any phylogenetic significance or is it purely an ontogenetic change? (Photograph MP 33).

The grey langur is typically the monkey of deciduous forests and the total number of observation records of it, exceeding twice the sum total of such records of all three macaques mentioned, in the field notes, is a true reflection of its commoner occurrence in the forests, for it was ignored even oftener than those macaques.

Prater, following faunas, mentions that it is to be found throughout India 'except the western deserts'. This statement needs amplification and addition. Not only is the langur not found in desert regions, but it is also absent from the indeterminate peripheral scrub that has become such a feature of human occupation of the plains forests in India over the past three decades, being essentially a forest monkey.

A further factor conditioning its distribution, also caused by human agency, is that in places it has been killed out, or so harried by men that it has left the area. Tribals hunt the grey langur for its flesh, and its flesh is also in demand for the sake of the therapeutic potency attributed to it superstitiously. In Sholinghur, where this langur was common, it was wiped out by hunting within half-a-dozen years (MISC 60 May 24).

A purely natural factor, also limiting the distribution of the grey langur, is that it is essentially an inhabitant of deciduous forests (including dry deciduous forests, like Betla in Bihar) and does not enter true evergreen forests. In northern peninsular India, where sal is practically the only evergreen species of ecological importance, such forests occur in sizeable belts rather than in patches, and there is no monkey peculiar to the evergreen tracts. In areas where sal occurs in patches, as in the Kanha N.P., the grey langur is common in the areas around, but not in the Hazaribagh park.

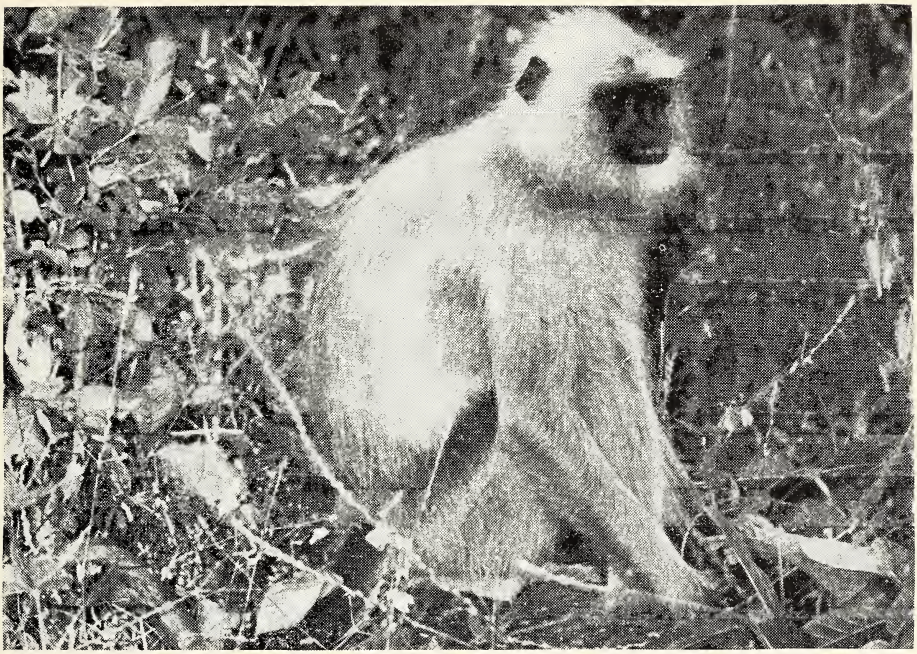
South of the sal areas of the peninsula, the floristic ecology is quite different. A great number of evergreen tree species, not totally unmixed with deciduous species (in fact, in places sal grows so gregariously that the deciduous 'sal associates' are much less common than in southern evergreen forests), form patches and belts of evergreen and semi-evergreen forests, some of them of comparatively low stature and at comparatively low elevations, dependent largely on rainfall and edaphic factors—we have sholas and patches of evergreen forest. The grey langur is not found in them, though the Nilgiri langur is quite frequently. A fuller account of this interesting question of floristic ecology determining distribution is provided in the note on the Nilgiri langur, but it may be said here that in peninsular India today all the man-imposed and natural factors mentioned serve to render the distribution of the grey langur highly discontinuous.

Habits: Behaviour

Like all Indian monkeys, the langur is gregarious. In the forest areas selected for this survey, it was seen in parties of from 4 to 18. On occasion, large troops of from 18 to 36 were seen feeding together in the treetops on the sprouting leaf-buds or on fruits, or feeding on the ground, but these were obviously composite troops of 2 or more parties, and split into parties in their getaway on being approached (TN 66 April 9, 69 October 4; MY 68 October 24; MR 68 November 29). At other times, a single langur, or 2 or 3 together, were seen, but presumably there were other langur not far away (TN 62 April 4; O 69 January 14 & 21).

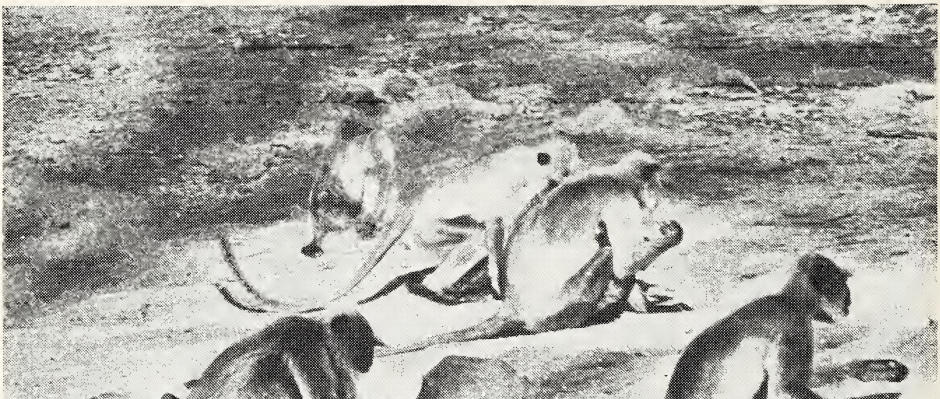
3 separate parties of langur more or less resident in Lower Kargudi (Mudumalai Sanctuary) were noticed from time to time during April 1966; these kept apart and did not mingle, though at times they were very close to one another—it was possible to identify these parties easily by the difference in age between the young in them, and by one containing 2 adult males, another 1, and the third none (the field notes provided here do not contain a detailed record: TN 66 April 2, 3 & 6). A party of 15 observed in the Taroba N.P. in November 1968 was still together a year later, though increased to 19 by new births (MR 68 November 18 & 69 November 26).

In parties with a more or less fixed composition, no defined pattern of dominance by one adult male was evident unvaryingly. A party of 9 observed consisted of an adult dominant male, 5 adult females two of which had months' old grey young with them, and another adult male which was of the party but not in it, keeping to the periphery and avoiding the proximity of the dominant male; this second male was restive and aggressive, and made several threatening advances towards the groups of females and young. The dominant male ignored him, not even indulging in a threat gesture, but on one occasion when this 'rogue male' threatened one of them, 4 adult females joined together and chased him away (TN 66 April 2 & 12: Photograph TN 43). In another party of 11, the dominant male, a big langur with a kinked tail, was relaxed in the fork of a teak, while up another teak a pair of young adults sat very close, a male hugging a female, using both hands and a leg to hold her; for over an hour he just sat there hugging the female, with no overt sign of sexual desire, hardly moving (TN 62 March 30).



Above: MAHARASHTRA 1968 : TAROBA N. P. : November 16 — about 11 a.m. : Adult female langur — MR. 1 ; *Below:* MAHARASHTRA 1968 : TAROBA N. P. : November 18 — a.m. : A langur mother nursing her young — MR. 2.

(*Photos : M. Krishnan*)



Above: MAHARASHTRA 1968 : TAROBA N. P. : November 22 — around noon : Langur drinking — MR. 4 ; *Below:* M. P. 1970 : KANHA N. P. : March 15 — p.m. : Langur at Sravantal lick. Note black baby — MP. 33.

(*Photos : M. Krishnan*)

The young langur stays close to its mother even after it is half-grown, and even when well able to run and climb, rushes to its mother at the least alarm and is carried by her, clinging to her abdomen. Mother langur suckle their young for quite a long time—one infant was suckled for nearly 11 minutes (MR 68 November 18 : Photograph MR 2). When they do not want their young to stray from their side, females restrain their young by holding on to their tails, just above the tip : I have seen a mother langur drinking at a puddle, while holding the tip of her progeny's tail in one hand. Bonnet macaques, which also have long tails, use the same hold to restrain their young.

The normal walk is leisurely and easy, and at times langur even creep silently through the undershrub. But when bolting in alarm, their bounding run has a somewhat laboured and exaggerated action, with the palms, and the soles of the feet, slapping the ground audibly. They are very much at home in trees and can move along branches and climb smoothly, but when scaling a steep rock or going up the bole of a tree, usually go up in a few bounds, and often bound along the boughs with sure-footed, energetic speed, shaking the foliage and twigs with the exuberance of their progress. No doubt their size and weight account for this in part, but for the rest it is the exuberance of their movements.

Their acrobatic leaps from treetop to treetop have been commented upon by every observer. To gain momentum for the leap, they run along the bough with a down-pressing action, so that the upward lash of the branch at the moment of taking off adds propulsion to their leap. Many observers have commented on the predisposition of the grey langur (and other monkeys) to leave the safety of the treetops and descend to the ground, where it can be overtaken, when pursued by an enemy. This might be due to the desire for concealment as an escape. This langur will, when closely watched, draw the foliage of the tree it is sitting on around itself, to hide its face, an action that seems peculiar to it. Langur sitting in a tree bare of foliage will leave it at once when approached by a man, whereas where the tree has a leafy crown, they may stay on (TN 66 April 9).

The thick, calloused skin on the palms and the soles, and the sitting pads beneath the tail, enable langur to climb trees and run on the ground energetically, as well as to sprawl at ease in repose. The attitudes assumed by them during their midday siesta in treetops are often extremely relaxed, and both on the ground and up a tree a favourite rest-position is to sit on the subcaudal pads, with the tail hanging limp or stretched on the ground behind, with both hind legs stretched out in front and elevated, resting on some support (such as a branch or a stump) at the level of the shoulder, with the arms resting on the legs (TN 62 March 30; MR 68 November 27).

Their roosting behaviour is interesting. A suitable tall tree is selected, probably one already used many times, in the vicinity of where they have been feeding in the evening, and towards sunset the langur repair to it singly and in twos and threes, and climb up to a stout, leafy lateral branch on high. There is much vigorous agitation of the boughs during this ascent to roost, but not many noisy wranglings—the agitation of the branches is, presumably, a territorial staking of claim, but it does serve to dislodge debris and dead leaves and twigs from the tree, and possibly unwelcome earlier occupants, though it is a purely instinctive action. All the langur have ascended by nightfall and thereafter they roost in tight company, in one or two groups, on the selected branch or branches. They are so completely hidden by foliage that only their pendent tails, hanging like clustered aerial roots, are visible from below. A tall mango, and a *Lagerstroemia lanceolata* in thick leaf were the trees selected in the instances observed, and if a tall tree in leaf is available, it is chosen (TN 64 March 30; MR 68 November 25, 26; 69 November 19, 20, 26). Prater mentions that a troop returns to the same roosting tree night after night; this has not been my experience.

In the Taroba N.P. I noticed that an iora had built its nest in the mango tree in which the langur roosted, and a number of roseringed parakeets were also roosting in the top branches, and they seemed in no way affected by the violent shaking to which the langur subjected the tree. Langur seem to be late risers and the roosting party watched in Taroba did not descend till 7 a.m.: prior to descent, too, the tree is shaken.

When it rains langur seek the shelter of trees with leafy crowns, especially when there are young in the party. During sustained downpours, when the drip from the leaves is heavy, they continue to stay in treetops, in huddled immobile groups, some of them little protected by the canopy, with the rainwater cascading from their pendent tails. When the rains stops, they shake themselves like wet dogs, and bound about the larger branches not too energetically to dry themselves—considering that the wet surfaces of these branches are prone to be slippery, this restraint on their exuberance is understandable (TN 66 April 11 & 18).

The violent shaking of boughs and foliage, and the display of teeth in a silent snarl, are the main intimidatory gestures. The tail is highly expressive in repose and action. While sitting in a tree in repose, it hangs straight down, at times loosely draped around a branch below, and while resting on the forest floor is laid full length along the ground. Moving at leisure on the ground, it is often trailed, and when walking faster or running, is elevated, with the distal half pendent in a bold loop or flowing behind, depending on the pace of the animal: when about to take a leap, the tail is often raised high and flung so far forward that the tip is above the head of the monkey (Photographs: MP 8; MR 1).

The two main vocalisations, the normal, loud, joyous-sounding whoops and the repeated, frenzied swearing at the sight of a predator, have been described by many observers. Regarding the latter, it may be said that it seems to be a compulsive instinctive response to the sight of danger or suspected danger, and also an expression of aggressive intent; as remarked by all observers, it is sustained only so long as the object of alarm or hatred is in sight. It is indulged in from a treetop or similar elevated stance—langur on the ground run away in silence when a predator approaches, and it is significant that on such occasions their run is much less exuberant than usual, more of a hasty sneaking away than a bounding along, and that the ground is not slapped sharply by the palms and soles. In spite of its keen daytime vision (the main perceptive faculty of the monkey) it swears not only at a live predator but also at the carcass of a leopard or tiger being carried through the forest, and also at any object reminiscent of the pelage of the dreaded predators, the swearing being an instinctive, and not a reasoned response. Years ago, while proceeding in an open jeep along a forest road in Ramgad in Sandur, our passage was marked by the vociferous swearing of every group of langur up trees we passed, which swore hysterically at my wife, who was wearing a saree with a chrome yellow ground patterned with black in a somewhat pantherine pattern! Bonnet monkeys seem more discriminate in swearing at predators.

During such vocal demonstrations, langur violently agitate the treetops they are in. Both the frenzied swearing and the agitation of boughs and foliage is freely indulged in during aggressive displays between adult males (MY 68 Oct. 7, 13 & 18).

Subadults indulging in rough-and-tumbles screech and squeal. A fear-call oftener heard from very young langur than from adults is a low, tremulous whimper.

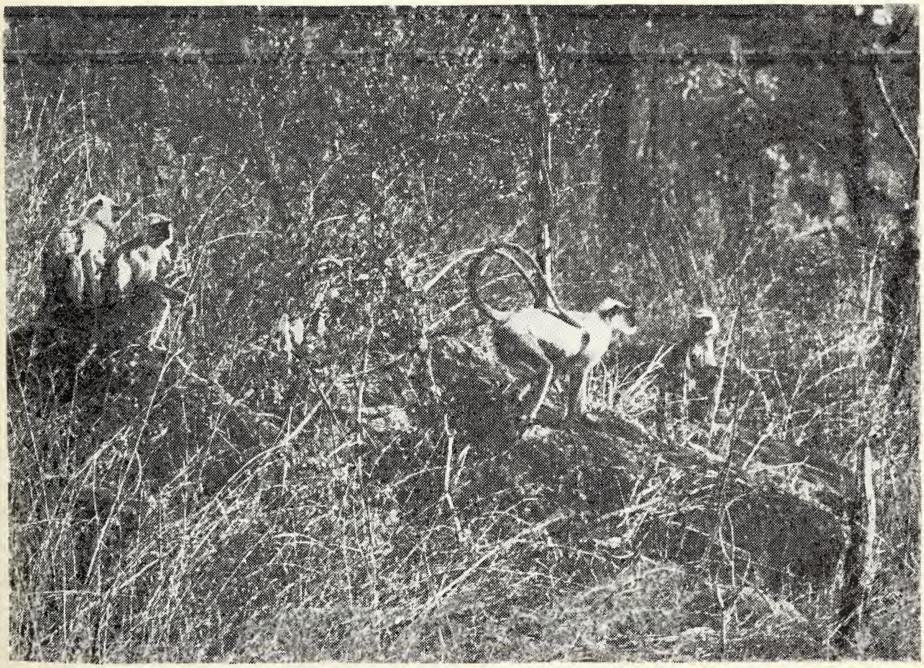
Grooming activity is similar to that of other monkeys. A display of affection by hugging the object of affection is also noticeable in this monkey, as already detailed, and is probably a common feature of the behaviour of all primates.

Like other langurs, it is a strict vegetarian in its diet. Twice, grey langur were observed snatching at swarming termites issuing from the earth after early summer rains (TN 62 March 15, 66 April 18). These were probably aberrant specimens, and if they were not, their haphazard, fumbling attempts at catching the winged insect in the air seemed good evidence of their vegetarianism.

The most notable thing about their feeding habits is that unlike other Indian monkeys, their gregariousness while feeding is not almost exclusively intraspecific. At times rhesus and bonnet macaques may unwillingly share pickings with other animals, as with dogs at railway stations; they are then scavenging in competition with other animals rather than feeding in company with them, and it is not mutual tolerance but a fear of each other that sustains the uneasy truce between them, and even so in the heat of competition for scraps there are frequent quarrels. In other forest-living monkeys, 2 or more different parties do not feed together ; the dominant party drives away the literally more recessive one. But grey langur, in an entirely unforced forest setting, frequently feed amicably in a large composite troop of several parties, both in treetops and on the ground (TN 66 April 9, 69 October 4 ; MY 68 October 24 ; MR 68 Nov. 29). At such times, and when a group is feeding by itself also, an adult (especially a dominant male) will threaten an actual intruder on its feeding, and a dominant animal may occasionally usurp the feeding site occupied by a subordinate, but langur feeding in company are remarkably quiet and peaceable compared to macaques. Further, besides feeding amicably along with their own kind, grey langur feed in company with rhesus and bonnet monkeys, and with chital too, on the ground—up trees, they are not seen in company with other monkeys. Both in the Mudumalai Sanctuary and in Kanha N.P. I have seen langur feeding on the forest floor along with chital, but only one instance has been noted down (MP 70 March 20) : on that occasion, the mothers of 2 black infants, usually so anxious for the safety of their progeny, were quite unconcerned as the infants pranced about on unsteady limbs among the chital hinds sharing the parched gram at Sravantal lick with the monkeys.

Langur feed on a wide variety of vegetarian fare, leaf-buds and leaves, flowers, fruits and seeds, and twigs : I am told they also eat some (unspecified) roots or stolons, and bulbs, and although I have no proof I strongly suspect them of feeding on edible mushrooms and puffballs. In summer, when the deciduous trees are bare of leaf and the leaf-buds are sprouting, they often crowd the treetops in large parties to pick the buds ; fresh, tender leaves are also eaten in quantities,not choosily picked as buds are, but guzzled. In this they may use their hands to strip boughs of foliage, but more often bend the leafy twigs to their mouths with their hands and bite off mouthfuls. In feeding on the buds of the giant bamboo, the monkeys are generally seen singly atop the culms (which cannot support numbers of them). Quite a few herbs, including the basal, succulent parts of certain grasses, are eaten. Eating buds and small fruit, they feed laboriously and over long periods picking each bud or fruit individually and conveying it to their mouth before picking the next : sometimes both hands are used to speed up the process, but economy of movement is not effected by several morsels being picked and then conveyed in a substantial mouthful to the lips. Feeding in this manner in exposed locations, their gregariousness has obvious survival value. At the sight of anything alarming, the individual that is alarmed bolts silently and the others follow it swiftly : there is no sounding of an alarm call.

Among the plants eaten, the following may be mentioned : the field notes contain records of the eating of many of these: besides these, a great many other species are also eaten. Food varies with the season.



Above: TAMIL NADU 1966 : MUDUMALAI SA. : Kargudi : April 2 — p.m. : 'Rogue' male langur — TN. 43 ; *Below:* M. P. 1968 : KANHA N. P. : May 7 — a.m. : Langur near the rest-house — MP. 8.

(*Photos : M. Krishnan*)

Krishnan : Mammals

Above: TAMIL NADU 1962 : MUDUMALAI SA. : Kargudi : March 30 — p.m. : Langur eating flowers of *Radermachera xylocarpa* — TN. 17 ; *Below :* MAHARASHTRA 1969 : TAROBA N. P. : November 29 — 5.45 p.m. : Langur eating neem foliage — MR. 15.

(*Photos : M. Krishnan*)

Leaf buds: *Anogeissus latifolia, Bambusa arundinacea, Butea monosperma, Dendrocalamus strictus, Grewia aspera* and *G. tiliaefolia, Garuga pinnata, Zizyphus mauritiana* (TN 66 March 28, 66 April 9, 66 September 30 ; MP 69 March 7 & 14).

Twigs : *Grewia tiliaefolia* (TN 62 April 4).

Leaves and fresh shoots: Lantana, mango, neem, tamarind, teak. *Albizzia odoratissima* and other spp., *Anogeissus latifolia, Emblica* spp., *Garuga pinnata, Grewia tiliaefolia, Terminalia tomentosa* (young leaves), *T. arjuna* and *T. chebula, Wrightia tinctoria* and *W. tomentosa, Zizyphus trinervia* (TN 62 March 30, 64 March 28, 66 October 7; MR 68 November 26 & 27, 69 November 27 & 29 : photograph MR 15). Foliage is usually guzzled in bulk, and after a spell of feeding the stomach bulges prominently. The leaves and shoots of a number of cultivated plants in the ornamental garden at Taroba N.P. were also eaten eagerly—in fact, it was this garden that drew the langur to the rest-house area (MR 68 November 17 & 18).

Flowers : Mohwa, *Bauhinia racemosa* (unopened buds mainly), *Butea monosperma* (buds), *Bombax ceiba, Hibiscus lampas, Radermachera xylocarpa* (full-blown flowers eaten with avid zest) : (TN 59 March 6, a.m. & p.m., & 13, 66 April 10 & 12 ; MP 69 March 14 : photograph TN 17).

Fruits : Mango, neem, jamun, custard apple. *Aegle marmelos, Aporosa lindleyana, Bombax ceiba* (immature fruit), *Carissa carandas* and *C. spinarum, Cordia myxa, Diospyros melanoxylon, Emblica* spp., *Ficus glomerata, Grewia tiliaefolia* and *G. hirsuta, Terminalia bellerica, Santalum album, Zizyphus mauritiana* (TN 63 March 30, 63 September 14 and 22 ; MY 68 October 18 ; MP 69 March 10 ; MR 68 November 29 ; B 70 February 24).

Langur were seen digging and picking up something small from the forest floor and eating it, but it could not be identified (TN 62 March 26 ; MY 68 October 18).

Earlier observation of the drinking habits of langur was checked at the Mudumalai Sanctuary and Taroba N.P. (MR 68 November 22 : photograph MR 4). I have seen bonnet macaques scooping up the water in their palms and drinking it, when they were up trees and the water was in a hollow between the main forks of the tree. Langur invariably come down to drink, and while drinking crouch low, with the body close to the ground, and bend over to reach the surface of the water with their lips. They seem to distrust large sheets of water or deep rivers, and where possible prefer to drink from a pool of clear water in a hollow in a rock or ground, but will not drink muddy water. Apparently they do not enter the water to bathe or swim, though in heavy rains they get comprehensively drenched. Langur seen in the Moyar area of the Mudumalai Sanctuary, along either bank of the Maravakandy canal, invariably used the many bridges across the narrow canal to cross it.

There does not appear to be any defined breeding season, and young were seen in various stages of development to subadulthood from infancy both during summer and in the cold weather. Prater says that 'while mating may and does take place in any month of the year there is apparently a marked breeding season' and adds that 'in peninsular India most of the young are born between January and March'. Since it is not known on what evidence he came to this conclusion, it is difficult to differ from this guarded opinion, particularly as he was a careful and well-informed naturalist, but the personal and hearsay evidence at my disposal does not warrant such a conclusion.

THE NILGIRI LANGUR

Presbytis johni (Fischer)

(Summary of field notes : Observation records: 6.

Locations : Tamil Nadu—Topslip in the Anamalais : sholas along the road from Ootacamund to Gudalur. Kerala—Periyar Sa.

No Photograph.)

This is the only mammal whose position has improved during the period of this survey. Prior to 1959, sustained hunting for the sake of the handsome pelage and the flesh (credited with rejuvenating and therapeutic powers by superstition) had rendered it extremely fugitive, and driven it deeper into the remote evergreen sholas. Determined poachers pursued it into these retreats, where the chances of detection were much less. A combination of 3 factors seems to have contributed to the improvement in status of the black langur in recent years. Apparently poachers are finding the game increasingly less worth the candle, protection seems to be better organised, and in places the monkey seems to have taken to living in the deciduous forests around human settlements, where it is difficult to poach it furtively. Whatever the reason, the fact remains that this langur, threatened with local extinction in many locations, is now less rare, and less fugitive in places. My field notes show them as shy and hard to see in Topslip in 1960 (MISC 60 April 26 & 30) today it is almost common in the area.

Size : Morphological characters

The Nilgiri langur is more or less the size of the grey langur, shorter in the tail and slightly heavier in the body. The difference in adult size between the male and female and between members of a party is not great. The coat is sleek and glossy, black or a warm black, with the hair on the crown and the ruff around the black face a brownish grey. The young are a warm black : J. C. Daniel and Poirer specify the colour of the infant pelage as a reddish brown.

Distribution

This is exclusively a monkey of south India, like the liontailed macaque (with which it is found in places) and essentially a monkey of the sholas, though it may also be found in deciduous forests around. At present its range is restricted to the central and southern reaches of the Western Ghats and connected hills in Tamil Nadu and Kerala including the Palnis and other high elevations, and in these hills follows the discontinuous distribution of the sholas. Since these sholas have their own floristic variations and occur in comparatively small patches (mainly in the creases between hill slopes), and further since the black langur is not found in all these hill ranges (for example, it is absent from Kodaikanal), a comparison of the typical semi-evergreen and evergreen sholas where it is found may lead to a better understanding of the langur's ecology.

Straightaway it may be said that it seems to prefer sholas in which is an admixture of deciduous species to the purer evergreen sholas.

In the Nilgiris, human activities have ousted it from many of its former haunts. The conversion of the shola forests in and immediately around Ootacamund into commercial plantations of exotics has shifted it farther out, but it is still there in the peripheral sholas, for example along the road from Ootacamund to Pykara, and from Pykara to Gudalur; after Gudalur, there are no evergreen patches, and the black langur so not to be found. The following trees are among those typical of these sholas of the Nilgiris: *Cinnamomum wightii, Cryptocarya neilgherrensis, Elaeocarpus munroii, Euonymis crenulata, Eurya japonica, Fragaea obovata, Ilex wightiana, Isonandra perrottetiana, Michelia nilagirica, Meliosma wightii, Photinia notoniana, Schefflera racemosa, Syzigium montanum, Viburnum hebanthum.*

This langur occurs in the sholas of the higher elevations of the Bolampatti range in Coimbatore, where the forests are little affected by human activities, and at my request M. Harikrishnan has provided the following brief account of the range.

'Bolampatti range: eastern slopes of the Western Ghats in the Coimbatore Dt. Elevation varies from about 300 to 1800 m. Rainfall increases sharply with elevation from about 850 to 5000 mm. Soil conditions are not uniform, though there is a general improvement with increase in rainfall and elevation. Patches of poor soil, however, occur at all elevations. The main peaks are Kunjaramalai (± 1800 m.) and Velingiri (± 1740 m.) and the ascent is achieved in about 12 km. At lower elevations there are rocky, dry deciduous patches containing *Sterculia urens, Cochlospermum religiosum, Givotia rottleriformis* &c. *Anogeissus latifolia* occurs on the fringes of such patches, and extends into the deciduous forests that form the predominant type of forest below approximately 750 m., where it reaches a large size. Other species of these deciduous forests are *Pterocarpus marsupium, Grewia tiliaefolia,* *Wrightia tinctoria*, *Dalbergia latifolia*, *Lagerstroemia lanceolata* &c. Around 900 m., the deciduous forests give way to a semi-evergreen to evergreen type of forest. Some of the trees here reach a height of 30 m., but most are smaller. The top canopy consists of *Toona ciliata*, *Artocarpus hirsuta*, *Hydnocarpus laurifolia*, *Elaeocarpus serratus*, *Mesua ferrea*, *Alstonia scholaris*, and *Bischofia javanica*, *Syzigium cumini* and *Mangifera indica* on stream banks. *Calophyllum elatum* and *Mesua ferrea* are the commonest species around 1200 m. Above 1200 m., *Mesua ferrea* forms almost pure patches in which the trees have short boles and large crowns. The lower canopy is almost exclusively evergreen with *Murraya exotica*, *Neolitsea zeylanica*, *Flacourtia montana*, *Schleichera oleosa*, *Cinnamomum wightii*, *Syzigium montana*, *Garcinia* sp., *Diospyros* sp. & *Actinodaphne lanata* among the main components. Above 1500 m., montane sholas similar to the Nilgiri sholas make their appearance—short trees, all evergreen, with stunted boles and spreading crowns ; among the main species of this elevation are *Eurya japonica*, *Eugenia* spp., *Litsea* sp., *Meliosma simplicifolia*, *Memecylon malabaricum*, *Isonandra perrottetiana*, *Cryptocarya* sp. and *Euonymus crenulata*. The peaks are mainly herbaceous, with a few shrubs, among them *Hypericum mysorense*, *Rhodomyrtus tomentosa*, *Oldenlandia* sp., *Osbeckia* sp. &c. *Ochlandra* sp. occurs in moist patches between 800 and 1500 m. Elephants and the Nilgiri langur are said to be the main animals of these forests'.

Habits : Behaviour

The Nilgiri langur lives in comparatively small groups of from half-a-dozen to a dozen, and is much more arboreal than the other monkeys of peninsular India. It feeds mainly in the treetops, but descends to the ground to drink, and may occasionally feed on the berries and buds of the plants of the forest floor (K 70 Apr. 29). It does not associate with other animals in the treetops, and several groups do not unite into a large foraging party like the Common Langur. It seems to be exclusive, and in areas where it has taken up residence in the deciduous forests (as at Topslip), the grey langur seems to concede the locality to it. It is said to have much the same feeding habits as other langurs.

While feeding in the treetops, it was noticed, the members of a party did not keep more or less together, but were loosely dispersed (K 60 Apr., 70 Apr. 26). It was heard indulging in a rasping whoop, basically similar to the grey langur's whoop but different in tone: probably this helps members of a group to keep in touch with one another while feeding spread out. Inquiry of those who knew it in numbers in certain localities in the past does not show that it was socially more gregarious then. Fleeing from men in the tree forests, it did not descend to the ground in the manner of grey langur, but sought escape along the treetops (MISC 60 Apr. 26). However, it is said that where the forests are not extensive and the crowns of the trees close, it descends to run along the ground from one clump of trees to another. Besides men, leopards and wild dogs are the predators that hunt it, and both apparently catch it on the ground when opportunity offers.

Infant black langur were observed in March in the Nilgiris, and in April in the Periyar Sa. of Kerala (TN 56 Mar. 5, 66 Mar. 27 ; K 60 Apr. 7, 70 Apr. 26).

(*to be continued*)

Studies on the Biology of some Freshwater Fishes

Part V. *Mystus vittatus* (Bloch)

BY

V. S. Bhatt
National Institute of Oceanography, Panaji (Goa)

(With nine text-figures)

Introduction

Mystus vittatus (Bloch) is one of the commonest Indian catfishes. It is abundant in all types of freshwater environments. The serrated pectoral spine, unless held carefully can cause injury and for this reason, the species is locally known as 'Katua' or 'Katia', meaning thorny. The fish is small sized—the largest specimens recorded by Day (1878) were 18·8 cm. to 21·3 cm. long. Estuarine specimens measured by Prabhu (1956), were of 16·5 to 17·5 cm. in length. At Aligarh the largest specimen recorded by the author during the 16 months observations, was only 15·4 cm. long. The colour of the fish differs in different environments and Day (1878) has figured two varieties. He says about the colours:

> Silvery or golden, old specimens at Madras have a light bluish band along the middle of the side, and a narrow light one above and below it, a dark shoulder spot, and sometimes another near the base of the caudal fin. More to the eastward as Orissa and Bengal the colours are more vivid, usually of a golden hue, with a black shoulder spot, a narrow black band along either side of the lateral-line, a lighter parallel one below, and two wider ones above. Sometimes these fish appear to be dark, with 5 longitudinal silvery bands. Tips of fins usually dark.

At Aligarh the specimens were of both types. Those which came from rivers, particularly from the River Ganga and its irrigation channels, were dull coloured with lighter bands; but those which came from the weedy ponds were brightly coloured with darker bands. The light coloured fishes when kept in aquaria developed dark bands after some days. *Mystus vittatus* has a wide distribution and occurs throughout India, Burma, Siam and Ceylon (Day 1878).

Little attention has been given towards the biology of this fish and barring a few comments on its spawning season (Prabhu 1956; Qasim & Qayyum 1961), there is no other information available.

Material and Methods

Samples were collected in the second half of each month, from the Aligarh fish market, and the investigation was spread over a period of 16 months, from September 1962 to December 1963. The fish were preserved in 10% formalin and examined as soon as possible. The techniques of examination were the same as described earlier (Bhatt 1970).

Length Frequency Distribution

Since the fish has no scales, and no other hard structure of the body had annulations as growth checks, the length frequency distribution alone was used to get some information on the growth rate (Fig. 1).

From Fig. 1 it is difficult to identify the various modes, excepting perhaps from the histogram of January-March, where two modes can be seen, and from the histogram of April-June, where three modes can be distinguished. This probably indicates that the maximum longevity of this fish is about 2 to 3 years. The progression of various modes in different quarters could not be followed.

Breeding

Like other species, in this fish also, the classification of gonads into 5 maturity stages was made according to the scheme adopted by Qayyum & Qasim (1964) which is arbitrarily based on the shape, colour, size and weight of the gonads.

Size of fish at first maturity

The various size groups falling in different maturity stages have been given in Table 1. It is clear from the table that in males higher stages of maturity appear at 8·0 cm. and in females at 8·5 cm. All the males below 8·0 cm. and females below 8·5 cm. were immature.

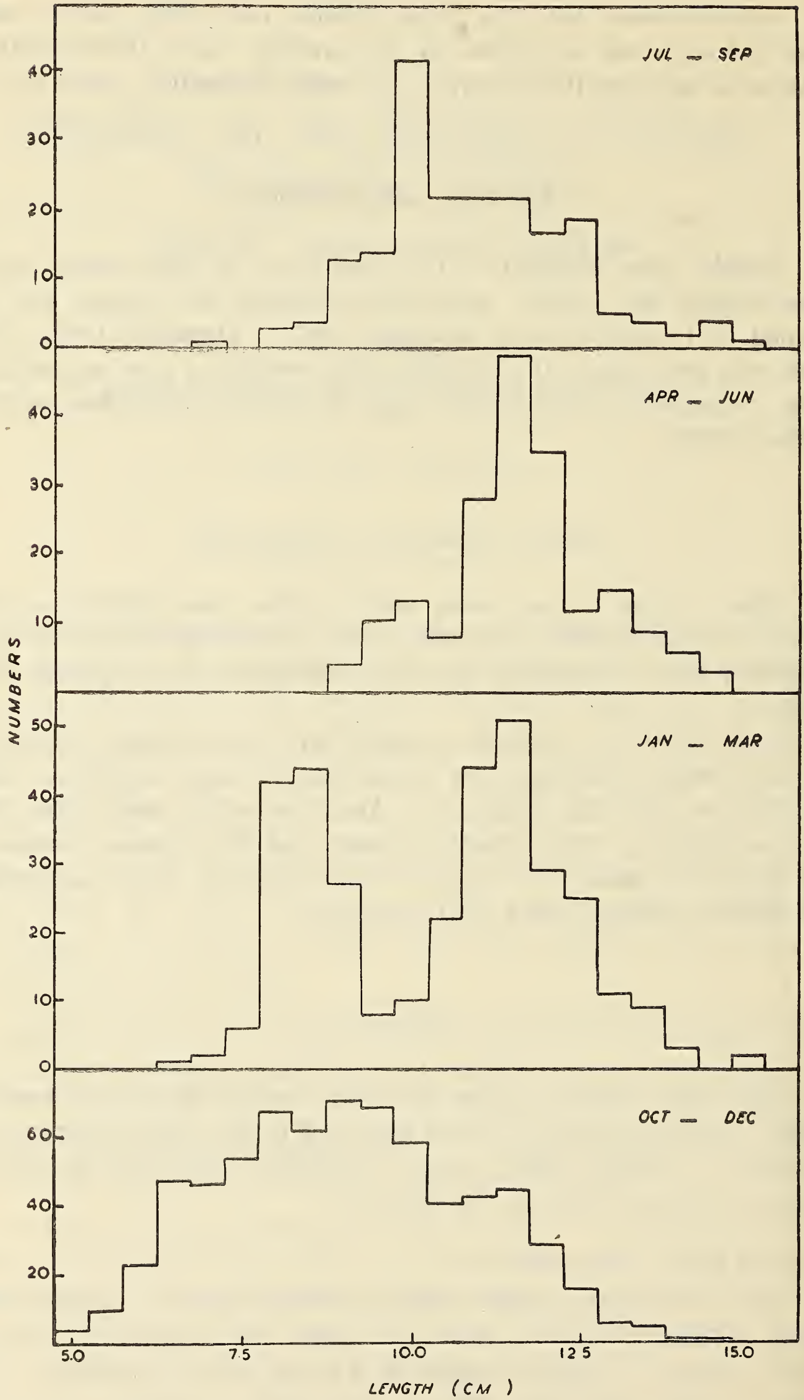


FIG. 1. Length frequency distribution of *M. vittatus*. Each histogram is based on the pooled samples of three months.

TABLE 1

MATURITY STAGES OF *M. vittatus* IN VARIOUS LENGTH GROUPS

Maturity stages	Length in cm.	5·0	5·5	6·0	6·5	7·0	7·5	8·0	8·5	9·0	9·5	10·0	10·5	11·0	11·5	12·0	12·5	13·0	13·5	14·0	14·5	15·0	Total
Male I	..	—	—	1	5	10	8	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	25
II	..	—	—	—	—	—	—	17	25	17	25	18	13	35	51	34	6	5	5	—	—	—	251
III	..	—	—	—	—	—	—	—	—	1	1	6	7	3	12	6	2	—	—	—	—	—	38
IV	..	—	—	—	—	—	—	1	1	6	5	4	3	2	2	5	4	1	—	1	—	—	35
V	..	—	—	—	—	—	—	—	1	4	3	4	2	2	4	1	—	1	—	—	—	—	22
Total	..	—	—	1	5	10	8	19	27	28	34	32	25	42	69	46	12	7	5	1	—	—	371
Female I	..	—	2	1	8	7	8	11	1	—	—	—	—	—	—	—	—	—	—	—	—	—	38
II	..	—	—	—	—	—	—	—	26	42	40	50	33	41	33	21	24	15	12	8	3	—	348
III	..	—	—	—	—	—	—	—	—	—	2	13	8	6	17	14	8	4	—	1	2	—	75
IV	..	—	—	—	—	—	—	—	1	—	4	—	2	7	10	8	15	5	4	2	4	—	62
V	..	—	—	—	—	—	—	—	—	—	6	—	8	6	15	5	—	1	1	—	—	—	42
Total	..	—	2	1	8	7	8	11	28	42	52	63	51	60	75	48	47	25	17	11	9	—	565

Sex-ratio and sex-dimorphism

During the period of investigation about 1420 specimens were sexed by internal examination. Of this, 594 were males and 826 females. Thus the ratio of males to females was about 1:1·5.

Some size difference between males and females was also noticed. The maximum size of the male was found to be 14·2 cm. while the largest female was 15·4 cm. in length. Females in general were usually bigger and more abundant in the samples than the males.

Unlike *Mystus seenghala* (Bhatt 1970), sexual dimorphism in *Mystus vittatus* is of a permanent nature and can be easily seen in the males in the form of a genital papilla. This papilla is a projection of the genital aperture and varies from 2 mm. to almost 1 cm. in length. The genital papilla is prominent throughout the year and gets more enlarged during the spawning season. Although its function is not yet known, its presence probably helps in sex recognition during the spawning congregation. Since females lack this structure, it can be utilized for the identification of the two sexes with absolute certainty.

Cycle of maturation and depletion of gonads

Fig. 2 shows the five maturity stages occurring in different months of the year. It can be seen from the figure that the immature fishes (stage I) do not occur throughout the year. This indicates that the fish matures in the first year of its life and that the immature fishes advance towards the next maturity stage (stage II) in March, when they are hardly six months old. The ripening fishes (stage III) appear first in March and their percentage reaches maximum in June and July. No ripening fish is seen after July.

The ripe fishes (stage IV) of both sexes were first seen in June, and their maximum number occurred in August.

The spent males (stage V) were observed, for the first time, in August but the spent females were seen only in September. The maximum number of spent fishes in both sexes occurred in the month of September (Fig. 2). These spent fishes found in September and October are probably late spawners. The males in the spent condition continued to occur till November and December. The occurrence of only spent males in November and December show that recovery in males starts very late. The spent testes continue to remain in a shrunken state having a dull grey colour for a longer time.

From the cycle given above, it can be concluded that the spawning season in this species starts late in August and continues till about September, and is almost over by October. Peak spawning probably occurs in September.

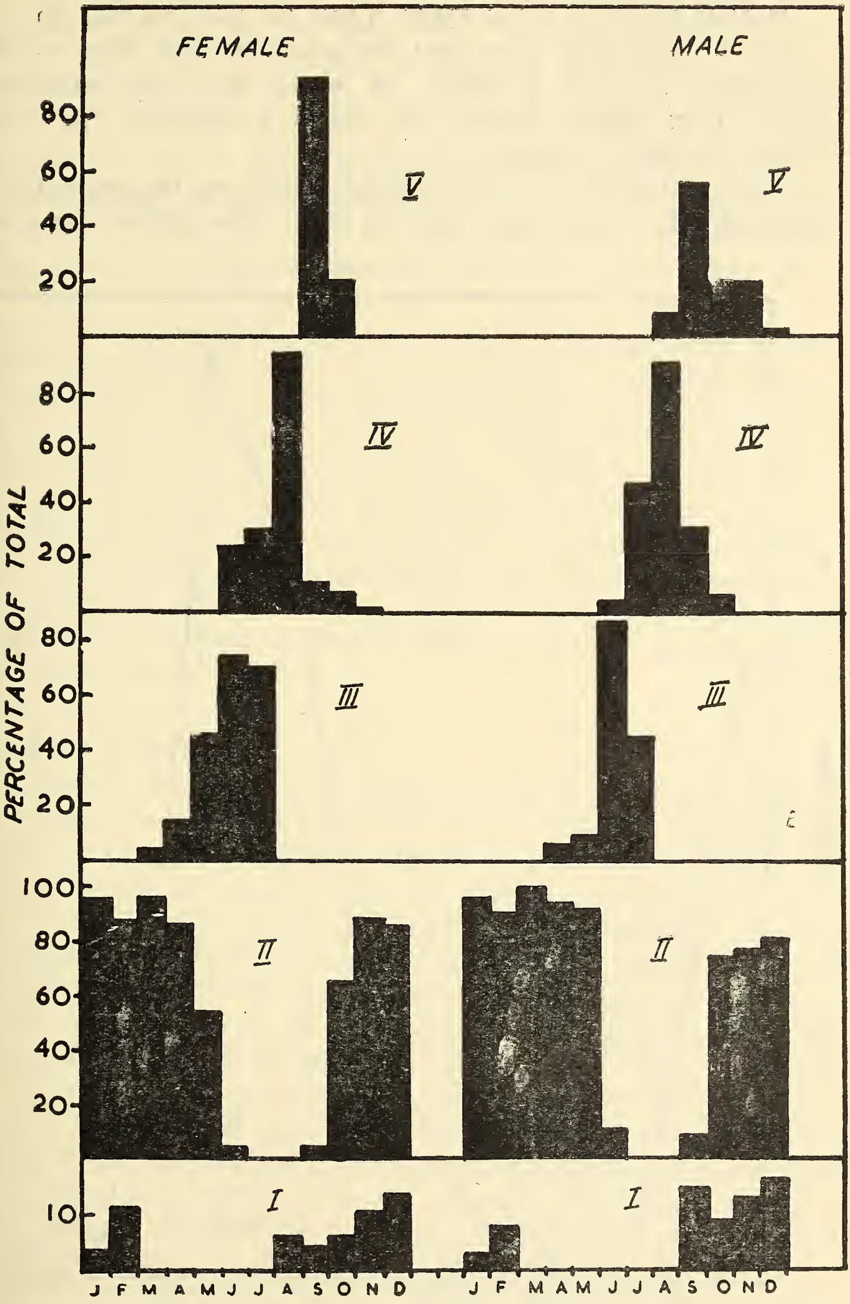


FIG. 2. Percentage of *M. vittatus* at each of the five stages of maturity in different months of the year.

Seasonal changes in gonad weight

Monthly records of gonad weight in both the sexes has been shown in Fig. 3. The figure shows that the gonads of both sexes record an increase in weight in March. In August they reach maximum values. From August onwards they register a rapid fall. This fall seems to be due to spawning.

The gonad weight recorded in October 1962 was far greater than that recorded for the same month in 1963. This indicates that in

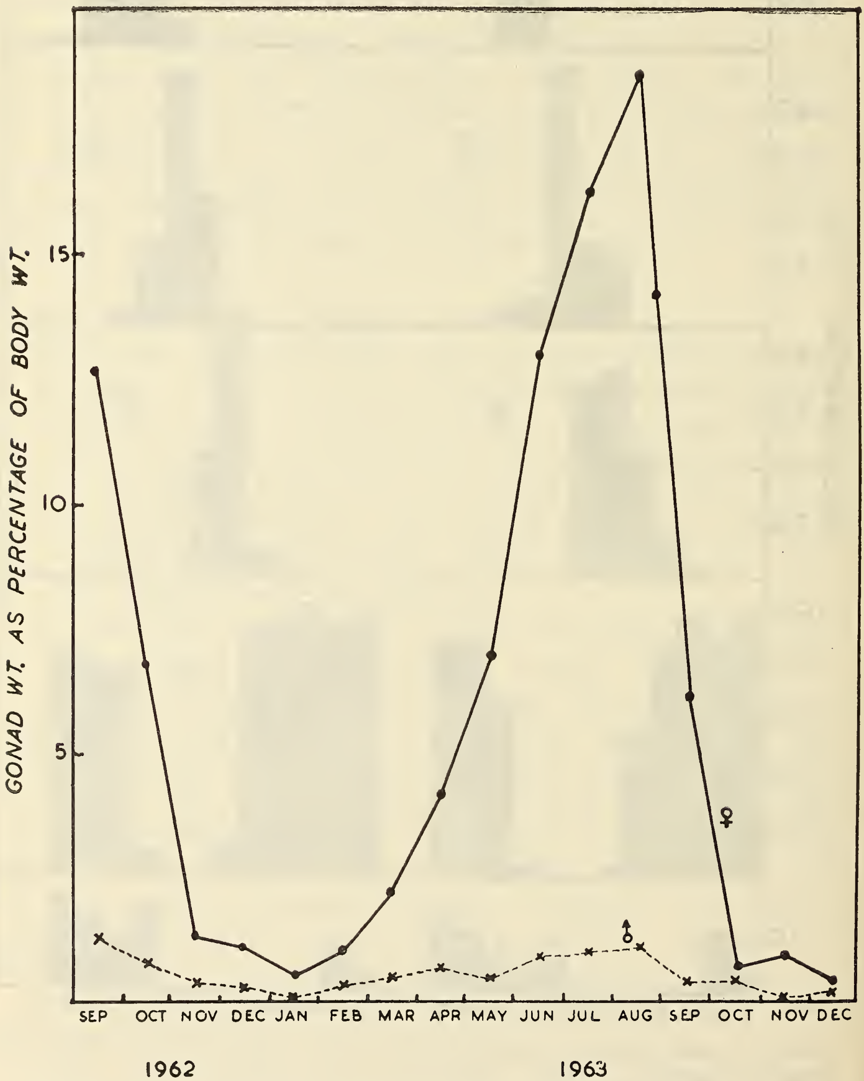


FIG. 3. Seasonal variation in gonad weight as percentage of body weight of *M. vittatus* of males (broken line), of females (continuous line).

1962 the spawning season probably continued till October; but in 1963 was more or less over in September. The second possibility which could lead to such a variation in the gonad weight during the two years of investigation may be because of an inhibition of spawning in a large number of females in October 1962, which probably did not occur to that extent in October 1963. The statement that 'in catfishes too, due to varying conditions of food and shelter prevailing in different ponds, there occurs in some ponds either a delayed spawning or its total inhibition', made by Qasim & Qayyum (1961) seems to be true in this particular species.

While summing up the spawning season of *Mystus vittatus* at Aligarh from the observations on the maturation cycle and the seasonal changes in the gonad weight, it seems important to point out that the months when maximum spawning occurs are August-September. This conclusion differs from the deduction made by Qasim & Qayyum (1961) in the same locality that the time of maximum breeding in this fish is July-August and the probable duration of breeding is June-September. The author did not observe any spent fish in the months of June or July. The spawning season of this species also differs somewhat from that given by Prabhu (1956) as October and November in brackish water.

Spawning periodicity

The ova diameter frequencies were studied from March to August and have been shown in Fig. 4. The figure shows that the maturing batch of eggs gets separated from the original stock in April and forms a mode at 0·60 mm. The maximum size of the eggs in this month is 0·75 mm. In May (Fig. 4 C) there is no increase in the size of eggs and the mode does not shift any further. However, there is a clear increase in the frequency of large-sized eggs. In July the stock of eggs likely to be spawned gets widely separated from the yolkless eggs and the size of eggs becomes uniformly large (Fig. 4 E). In August (Fig. 4 F) more or less the same condition prevails, but in September no eggs are left in the ovaries. It is, therefore, evident that each individual spawns only once during the season and that there is no periodicity in the spawning. This agrees with the deductions made on the frequency of spawning of this fish by earlier workers (Prabhu 1956; Qasim & Qayyum 1961).

Condition factor

The condition factor of 1420 fishes belonging to both sexes was determined by the formula $K = 100/L^3$. The mean 'K' value of adult

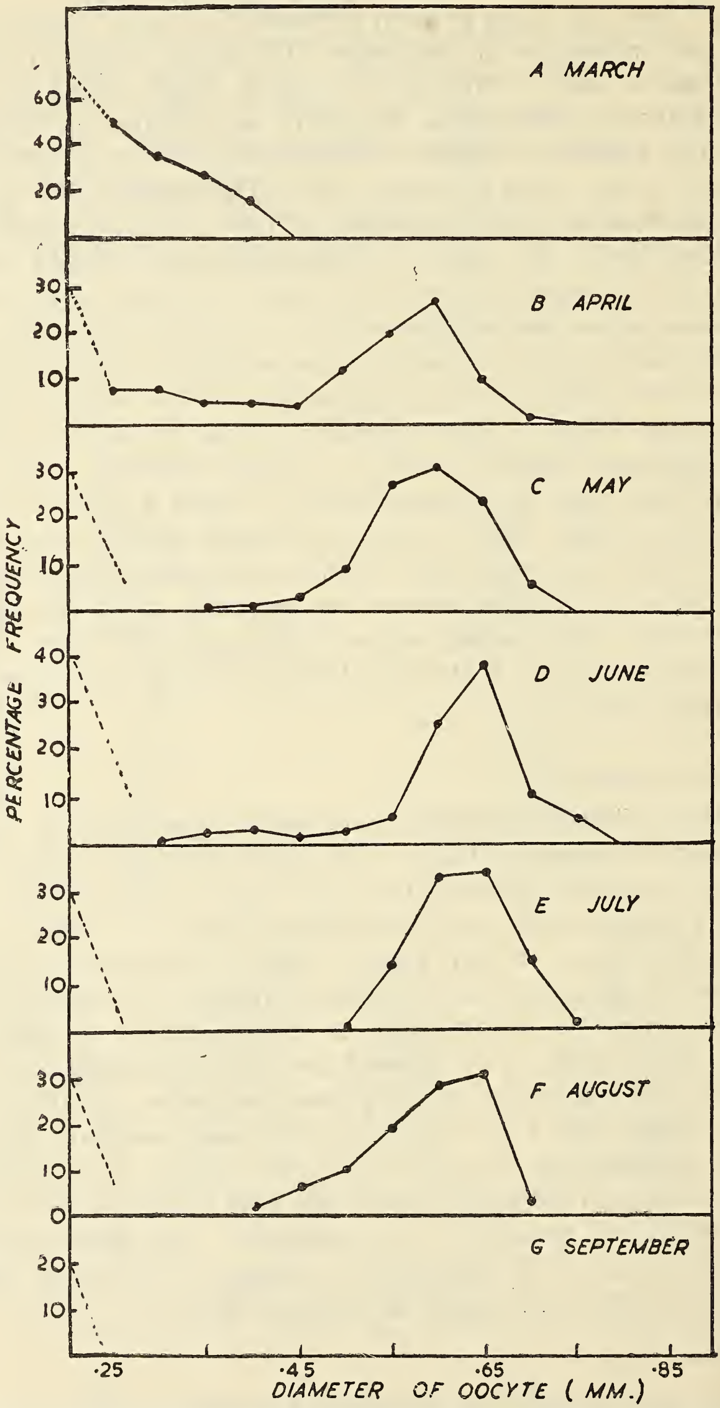


FIG. 4. Size frequency distribution of intra-ovarian eggs of *M. vittatus* from March to September. Broken line indicates the area of small immature eggs which were not measured.

fish (excluding the immature fishes) in different months have been shown in Fig. 5.

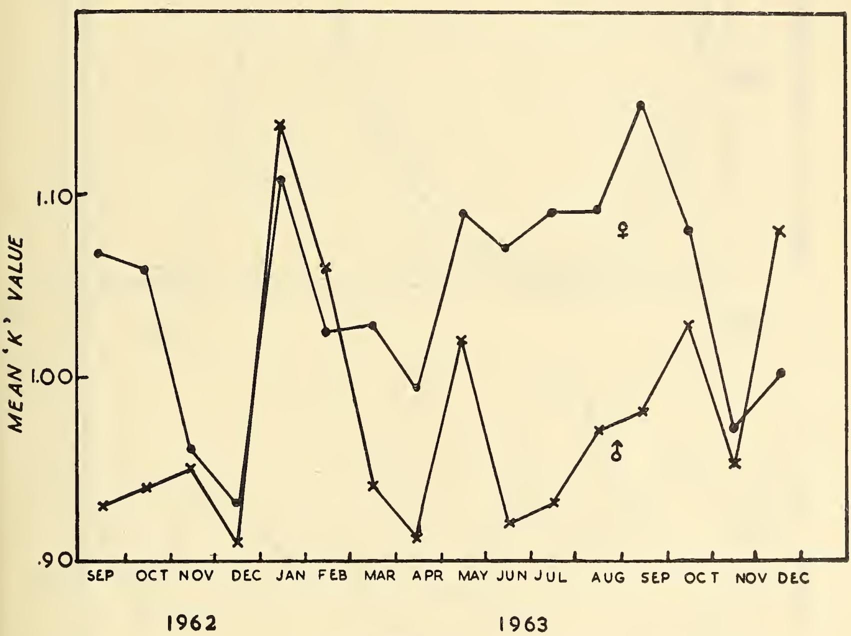


Fig. 5. Seasonal changes in the condition factor 'K' of both sexes of *M. vittatus*, of males x———x, of females •———•.

A comparison of the seasonal changes in the condition factor with the feeding intensity (Fig. 6 b & c) reveals a high degree of correlation between the two. High feeding rate in January corresponds with the high 'K' value in the same month. In other months also the fluctuations in the feeding rhythm are in close agreement with the 'K' values. It is, therefore, evident that the changes in the 'condition factor' are directly related to the rate of feeding.

A comparison of the 'K' values with the seasonal changes in gonad weight will reveal an entirely different picture (Fig. 6 a & c). The rise and fall in the gonad weight does not seem to be strictly connected with the fluctuations in the condition factor.

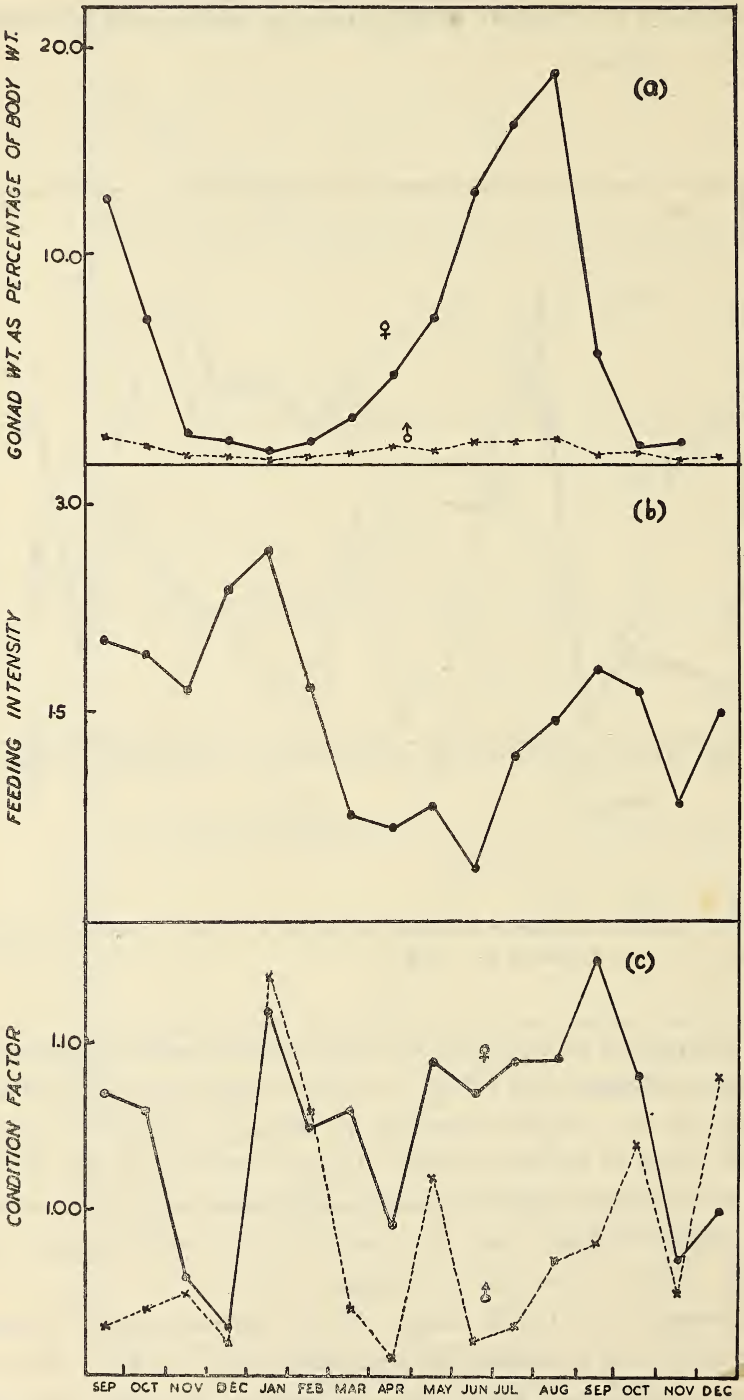


FIG. 6. Seasonal variation in (a) Gonad weight, (b) Feeding rhythm and (c) Condition factor 'K' of *M. vittatus*.

The mean 'K' values of various length groups have been shown in Fig. 7. It can be seen from the figure that there are many points of

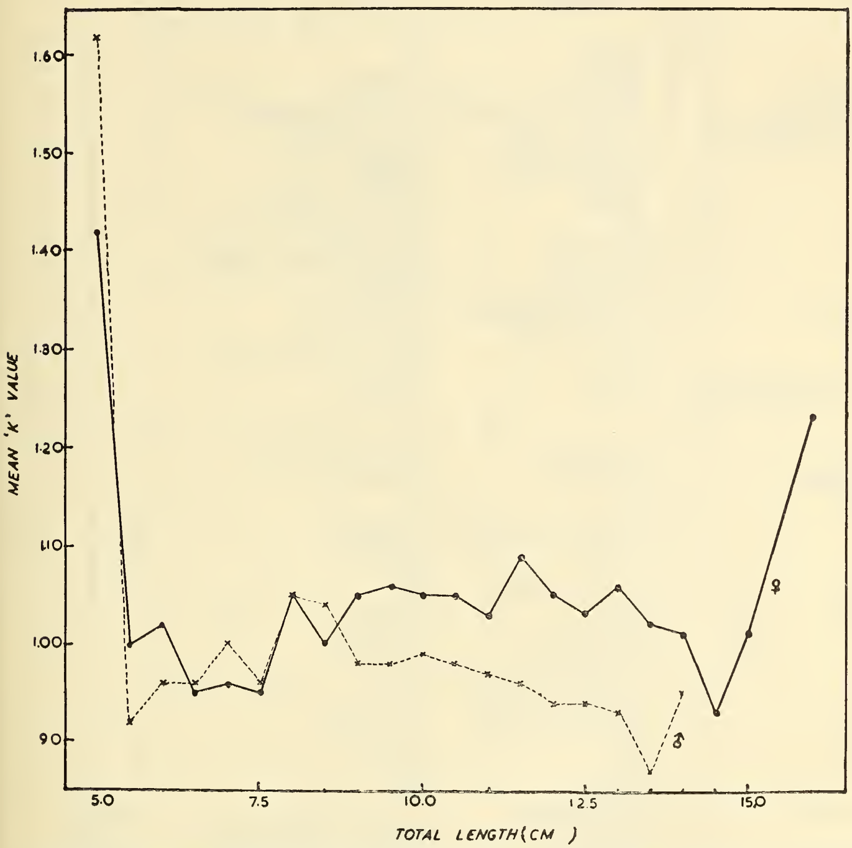


FIG. 7. Mean condition factor 'K' of *M. vittatus* at different lengths of males (broken line) and of females (continuous line).

inflection in the curve and none of these correspond to the size of the fish at first maturity as has been determined by a more direct method (Table 1).

The abovementioned observations on the condition factor of *Mystus vittatus* agree well with those recorded earlier in *Mystus seenghala* (Bhatt 1970).

FOOD AND FEEDING HABITS

Food of *M. vittatus* was analysed over a period of 16 months. During this period 948 guts were examined; of which, 751 were found to contain food and the rest (197 guts) were empty. The monthly

TABLE 2

PERCENTAGE OCCURRENCE OF VARIOUS CATEGORIES OF FOOD IN THE GUTS OF ADOLESCENT AND OLDER FISHES (*Mystus vittatus*)

Food item	Month															
	1962				1963											
	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Insect ..	39·5	25·9	25·8	5·5	5·0	8·0	6·6	3·3	—	—	3·3	13·3	5·6	4·5	3·3	15·1
Insect larvae ..	50·0	44·4	45·1	26·6	13·3	66·6	61·6	76·6	43·3	8·2	58·3	17·7	64·0	9·1	40·0	31·8
Copepods ..	94·7	82·7	79·0	82·2	64·8	95·0	56·6	68·3	63·3	54·0	85·0	48·8	60·0	9·1	58·3	66·7
Daphnids ..	89·5	77·7	45·1	12·2	21·6	36·6	11·6	21·6	33·3	24·5	11·6	28·8	36·0	3·0	30·0	62·1
Fish-fry ..	15·7	6·1	20·9	3·3	1·6	1·6	—	—	1·6	1·6	5·0	2·2	16·0	21·2	20·0	12·1
Rotifers ..	28·9	69·1	27·1	48·8	20·0	81·6	45·0	60·0	25·0	50·8	70·0	26·6	8·0	3·0	33·3	51·5
Crust. larvae ..	—	7·5	12·9	—	—	—	—	33·3	8·3	44·2	70·0	15·5	12·0	10·6	15·0	53·0
Eggs of invertebrates ..	18·4	14·8	46·7	67·7	36·6	33·3	15·0	25·0	48·3	50·8	73·3	33·3	24·0	—	40·0	51·5
Water mites ..	—	18·5	16·1	15·5	8·3	—	—	—	—	—	5·0	6·6	4·0	—	—	—
Algae ..	21·0	12·3	16·1	63·3	10·0	1·6	21·6	5·0	8·3	1·6	8·3	13·3	4·0	13·6	30·0	39·4
Cypris ..	71·0	17·2	20·9	27·7	—	13·3	5·0	—	8·3	68·8	46·6	28·8	—	12·1	15·0	15·2
Sand & mud ..	36·8	4·9	35·4	3·3	21·6	23·3	—	18·3	—	19·7	23·3	13·3	—	21·2	31·6	15·2
Prawn & Shrimps ..	—	—	8·1	7·7	8·3	—	—	—	—	—	—	—	—	18·2	3·3	1·5
Debris (unidentified food) ..	42·1	65·4	45·1	83·3	46·6	71·6	61·6	50·0	40·0	45·9	56·6	44·4	20·0	48·5	46·5	65·2
Higher aquatic plants ..	—	—	—	—	—	—	—	—	13·3	—	1·6	6·6	12·0	9·1	23·3	10·6
Molluscs ..	—	—	—	—	—	—	—	—	—	—	—	20·0	—	1·5	—	—

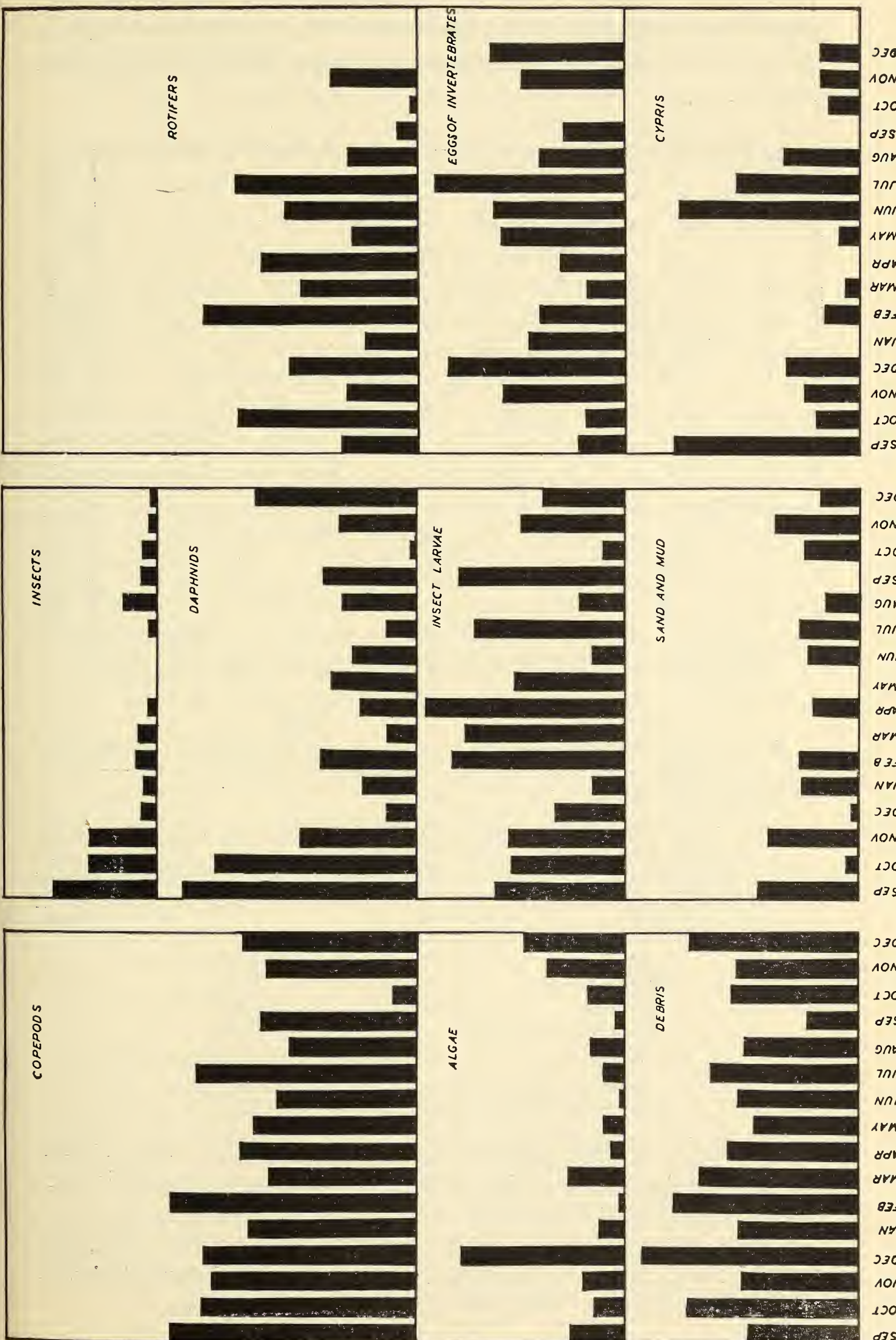


FIG. 8. Histogram showing the percentage occurrence of various categories of food items of *M. vittatus* in different months.

percentages of various categories have been given in Table 2 and the main food items have been illustrated in Fig. 8. The total food as percentage of body weight along with the empty guts have been shown in Fig. 9.

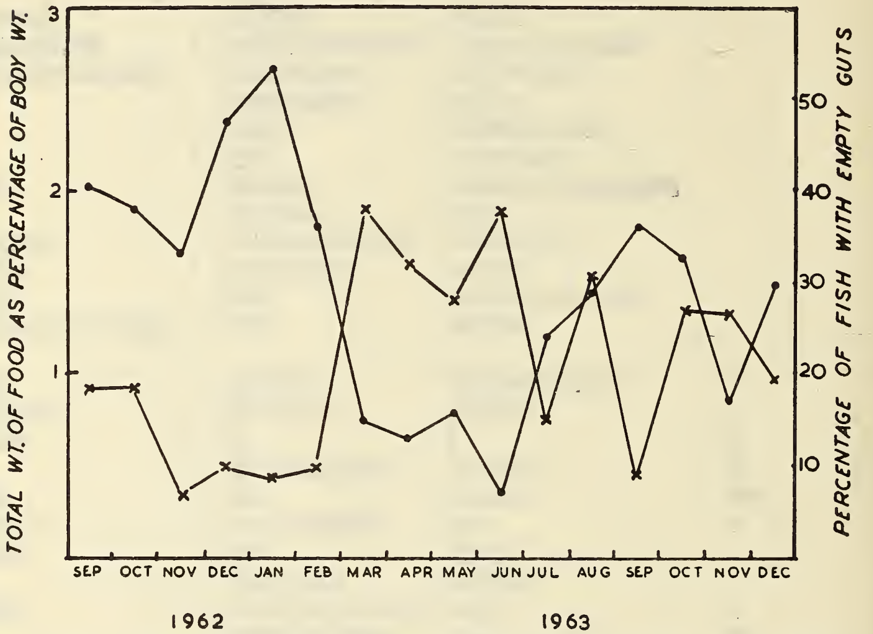


FIG. 9. Seasonal variation in the rate of feeding of *M. vittatus*. Total weight of food of adolescent and older fishes as percentage of body weight, •———• and percentage of empty guts x———x.

The food items of specific importance were the copepods, insect larvae, daphnids, rotifers, eggs of invertebrates, cypris, algae and debris. These food items occurred in the gut regularly. Their percentages in the total number of guts were as follows:

Copepods	.. 66·2%
Insect larvae	.. 41·4%
Rotifers	.. 40·6%
Eggs of invertebrates	.. 36·2%
Daphnids	.. 34·1%
Cypris	.. 21·8%
Algae	.. 16·8%
Debris & Unidentified food	.. 52·1%

Copepods recorded the maximum percentage (66·2), and occurred throughout the year. Cyclops predominated, and their monthly percentage ranged from 9·1 to 94·7.

Insect larvae occurred in 41·4% guts and their monthly percentage varied from 9·1 to 76·6. The insect larvae were mostly dipteran (chironomid and mosquitoes). Dragonfly nymphs were rarely seen.

Rotifers were also abundant in the gut and their total percentage was 40·6. Daphnids were also very common but these were not as abundant as copepods. The crustacean larvae included mostly nauplii and other developing stages of copepods and daphnids.

The eggs of invertebrates occurred in 36·2% guts. Their presence in each month was more or less constant. Most common eggs were those of daphnids, copepods and chironomids. The eggs of mosquitoes were rarely seen.

Cypris occurred in 21·8% guts. Their occurrence was not very steady and they did not occur in large numbers.

Algae showed a relatively low percentage in the gut (16·8%). These included *Microcystis*, *Spirogyra*, *Ulothrix* and *Oscillatoria*.

Debris and unidentified food items were grouped together and kept separately. The percentage of these was about 52·1.

Other food items included insects, fish-fry, water-mites, shrimps, weeds and small molluscs. These items were not regularly seen but in some months their proportion was quite high. Of these, insects, fish-fry and algae require special mention. Insects were represented mainly by terrestrial forms (Diptera and Ephemeroptera). Aquatic insects (*Nepa*, *Notonecta*, etc.) were rarely seen. Fish-fry showed greater percentage in the post-monsoon months. Scales, spines (in one specimen), muscles of fish, leg of frog (in one specimen) were also found in the guts. Higher aquatic plants were rarely seen. In one specimen a ground-nut was also found. Molluscs, earth-worms, shrimps and water-mites were very rare.

Seasonal variation in the rate of feeding has been shown in Fig. 9. It can be seen from the figure that there are two phases of active feeding. One from July to October and the other from December to February. The period of minimum feeding is during summer, i.e. from March to June which coincides with the gonad maturity and spawning.

SUMMARY

Length frequency distribution of *M. vittatus* gave evidence of 2 to 3 modes. Both sexes mature at the end of first year of life. At maturity the males are 8·0 cm. and the females 8·5 cm. long. Seasonal changes in the gonad maturity revealed that this fish spawns from August to September. Seasonal changes in gonad weight confirmed the spawning season. Each individual spawns only once during the breeding season. The variation in 'K' values seems to be correlated with the feeding intensity of the fish. There seems to be no

correlation between the seasonal changes in gonad weight and the 'K' values.

The main food items of *M. vittatus* are insect larvae, copepods, daphnids, rotifers etc. The food items show little variation from season to season. There are two distinct phases of active feeding. Minimum feeding occurs during summer months, just prior to spawning.

Acknowledgements

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References

Bhatt, V. S. (1970): Studies on the biology of some freshwater fishes. Part IV. *Mystus seenghala* (Sykes). *J. Bombay nat. Hist. Soc.* 67 (2): 194-211.

Day, F. (1878): The fishes of India. Vols. I & II. William Dawson & Sons Ltd., London.

Prabhu, M. S. (1956): Maturation of intra-ovarian eggs and spawning periodicities in some fishes. *Indian J. Fish.* **3**: 59-90.

Qasim, S. Z. & Qayyum, A. (1961): Spawning frequencies and breeding seasons of some freshwater fishes with special reference to those occurring in the plains of northern India. *Indian J. Fish.* **8**: 24-43.

——— (1963): Fecundities of some freshwater fishes. *Proc. natn. Inst. Sci., India* **29** (4): 373-382.

——— (1964): Studies on the biology of some freshwater fishes. Parts I-III. *J. Bombay nat. Hist. Soc.* **61**: 74-98; 330-347; 627-650.

Contribution to the flora of Tirap Frontier Division

BY

D. B. DEB AND R. M. DUTTA
Botanical Survey of India, Calcutta

This paper presents an account of the flora of Tirap Frontier Division, North East Frontier Agency, India, and records higher plants ranging from Pteridophytes to Angiosperms collected in an intensive exploration of the area while covering about 300 km. on foot along the hill tracts. One new genus, *Pauia* Deb et Dutta, three new species, *Pauia belladonna* Deb et Dutta, *Boehmeria tirapensis* Deb et Dutta and *Pternopetalum senii* Deb et Dutta and a variety *Chirita macrophylla* Wall. var. *tirapensis* (Panigr.) Deb et Dutta, Comb. & Stat. nov. have already been described. Besides these, information has been obtained on the distribution of the taxa collected and on the phytogeography of the country. Other collections located in the regional herbarium at Shillong, which were inaccurately published or hitherto unpublished are included. The paper lists 905 species in 503 genera under 157 families. Short notes on the species have been added. The vegetation of the region studied has been described broadly.

INTRODUCTION

Tirap Frontier Division situated in the precipitous Patkoi ranges remained unexplored until recently, as it had no accessible tracks. The Botanical Survey of India after its reorganisation in 1955-56 took up exploration of the region through its Eastern Circle at Shillong. Three explorations were undertaken, the third being by the senior author. The area is still under-explored, and only the western half of the division bounded on the east by a line joining Jairampur with Pangsupass has been explored. However, in view of the importance of the collections made by the senior author during the intensive exploration on foot for about 300 km. along the hill tracts it was thought worthwhile to publish a floristic account. The study was started in June 1961, but the identification of our collection, and the re-examination of specimens gathered during the two previous explorations led to considerable delay. Several specimens had to be sent to the Royal Botanic Gardens, Kew, England, for determination, and we are grateful to the Director, Kew gardens, for assistance. While this note was under preparation, Panigrahi & Joseph (1966) contributed a paper on the former's collections from the area. His material has been excluded from the present paper excepting misidentifications which are corrected here. The area is floristically very rich, as is evident from the fact that the senior author's collection yielded one new genus, three new species, one new variety and a number of interesting records. These are listed separately under the heading 'New species & records'. Some have already been published (Deb & Kataki 1963, Deb & Dutta 1962, 1968). There still remains several interesting specimens which could not be determined due to paucity of material.

The paper deals with 905 species in 503 genera under 157 families from Pteridophytes to Angiosperms. Hutchinson's system (1959) has been followed for the Angiosperms but Elaeocarpaceae and Leeaceae have been kept distinct from Tiliaceae and Vitaceae respectively. For Pteridophytes the system proposed by Mehra (1961) has been followed. Under the family, genera and species have been listed in alphabetical order. Efforts have been made to find out the correct names in accordance with the 'International code of botanical nomenclature' (1967). Short notes on the species have been added. The vegetation of the region has been described broadly.

Physical Features of the Area

Situation: The North East Frontier Agency is bounded by Burma on the east, Tibet on the north and east, and Bhutan on the west. On the south lie Darrang, Lakhimpur and Sibsagar Districts of Assam and Tuensang Division of Nagaland. It covers an area of about 8,142,442 hectares of mountainous country spread like a giant horse-shoe between the Himalayas in the north and the Brahmaputra valley in the south. It includes five Divisions namely Kameng, Subansiri, Siang, Lohit and Tirap.

The Tirap Frontier Division lies between 26° 38′ 24″-27° 21′ 36″ N. and 95° 12′-97° 10′ E. It is bounded by Burma on the east and south, by Lohit on the north and by Lakhimpur District of Assam and Tuensang division of Nagaland on the west. It covers an area of about 7,06,811 hectares. It has a plains area in its foothills and the hilly area rising gradually up to Patkaibum. The altitude varies from 150 m. in the plains to 4578 m. in Daphabum. The rivers and streams originate at the watershed of the hills and flow through the valleys into the Brahmaputra. Amongst these only the River Boral (Tirap) is worth mention. The rivers are shallow and slow in winter. After heavy rains in the Patkoi ranges, the rivers flood suddenly and the current is very swift.

Climate: The climate of the region varies in general with the change in altitude. It is hot and humid in the plains and the foothills. Subtropical climate prevails up to an altitude of 1500 m. above which it is temperate up to about 2700 m. Above this altitude there is heavy snowfall in the winter. The rain fall is very high, and the annual average varies from 3000 to 4000 mm. There is rain almost throughout the summer. Mid-April to mid-July are the wettest months. During our stay at Laju the maximum temperature recorded was 30°C. while the minimum was 18°C. Average relative humidity in June was 89%.

Geology: Geologically the Tirap Frontier Division is of recent origin and owes its formation to the upheaval of the Himalayas in pleiocene period of the Tertiary age.

The river beds are cut through massive boulders of gneiss and comprise sands mixed with pebbles. The hill ranges on the other hand consist of brown black alluvium of lateritic origin while the valleys comprise 'Bhabar' or matured alluvial deposits. The forest floor in the ranges close to Burma is covered by debris of leafy humus, some times 6 cm. or more in depth from accumulations of leaf mould through the centuries.

Exploration

The Tirap Frontier Division was botanically an unexplored area until the recent surveys of the Botanical Survey of India. Dr. R. S. Rao spent two weeks in October 1959 from 8-x-1959 to 22-x-1959 and made collections at Jairampur, Nampong, Pangsupass, Chenglang, Khela and Deomali covering altitudes from 100 to 1130 m. He collected about 500 specimens.

Dr. G. Panigrahi collected in the southern part of the Division for 3 weeks from 19-viii-1958 to 10-ix-1958. He explored Chenglang, Khela, Khonsa, Kheti, Tinchha, Laju, Raho, Wakka, Niausa, Vanu, Banfera and Rusa. He collected about 1000 specimens. D. B. Deb collected for a month from 17-vi-1961 to 16-vii-1961. He studied the vegetation and made collection at Deomali, Chenglang, Khela, Khonsa, Tinchha, Laju, Kothong, Chennhang, Noglo, Raho, Wakka, Nginu, Niausa, Pongchow, Lunwa, Jadua, Banfera and Kanubari. He attempted an intensive study of the forests at Burma border, explored the border at several places for a comprehensive view of the vegetation and collected about 1100 specimens.

Vegetation

The vegetation of the south western part of Tirap is broadly tropical evergreen, up to about 900 m. above sea-level, from where it is gradually replaced by subtropical forest between 900 and 1800 m., which in turn changes to the temperate type of vegetation from 1800 to 3500 m.

Dipterocarpus-Shorea-Mesua hylium occurs at Deomali. It is a dense evergreen forest covering an area of about 16×5 sq. km. *Dipterocarpus macrocarpus* Vesque, *Shorea assamica* Dyer, *Mesua ferrea* L., *Manglietia insignis* Bl., *Talauma hodgsoni* Hook. f. & Th. are the most dominant trees. These form the top canopy, though *Dipterocarpus macrocarpus* Vesque and *Shorea assamica* Dyer rise much above others. Natural regeneration of different ages was observed. *Terminalia myriocarpa* Heurck & Muell. occurs in gorges. *Syzygium fruticosum* (Roxb.) DC., *S. cumini* (Linn.) Skeels, *Saurauia roxburghii* Wall., *S. napaulensis* DC., *Knema angustifolia* (Roxb.) Warb. etc. form the middle storey. *Mussaenda* sp., *Osbeckia* sp., *Melastoma* sp. and many other plants of Verbenaceae, Rubiaceae, Acanthaceae occur in the under storey. *Uncaria sessilifructus* Roxb., *Pothos cathcartii* Schott, *P. scandens* Linn., *Byettneria aspera* Colebr., *Hoya parasitica* Wall., *Adenia trilobata* (Roxb.) Engl., *Myxopyrum smilacifolium* Bl., *Cissus assamica* (Laws.) Craib, *Piper peepuloides* Roxb., *Procris wightiana* Wall., *Vittaria elongata* Sw., *Piper thomsonii* Hook. f., *Dioscorea anguina* Roxb., *Rhaphidophora hookeri* Schott, *Schefflera venulosa* Harms. and other climbers are common. Amongst the orchids *Dendrobium chrysotoxum* Lindl., *Agrostophyllum khasianum* Griff., *Bulbophyllum affine* Lindl., *Coelogyne praecox* Lindl., *Cymbidium devonianum* Paxt., *Sarcanthus subulatus* (Bl.) Reichb. f., *Podochilus cultratus* Lindl., *Eria rufinula* Reichb. f. are most common. The forest is very dense, with places where light scarcely penetrates. Ground cover is thin and grasses are scarce.

Thick evergreen forest lies along the road from Khonsa to Deomali for a stretch of about 25 km. Trees are mostly with umbrageous crown and plank buttresses. Epiphytic orchids are common.

At Kanubari the forest is very much depleted but appears to be basically similar to that at Deomali, *Shorea assamica* Dyer being conspicuously absent. The forest is not so thick and biotic influence is more evident. Deciduous species also occur.

The vegetation along Margarita Chenglang road is a tropical evergreen forest. Trees are infested with lichens, climbers and epiphytes. *Talauma hodgsoni* Hook. f. & T., *Gynocardia odorata* R. Br., *Syzygium cumini* (Linn.) Skeels, *Knema angustifolia* (Roxb.) Warb., *K. linifolia* (Roxb.) Warb., *Saurauja napaulensis* DC., *S. punduana* Wall., *Ardisia griffithii* C. B. Clarke, *Cinnamomum pauciflorum* Nees are the common trees. *Rhaphidophora* sp., *Agapetes* sp., *Aeschynanthus* sp., *Hoya* sp., *Bauhinia* sp. are the common climbers.

At Chenglang *Cinnamomum pauciflorum* Nees, *C. tamala* Nees & Ebern, *Litsea monopetala* Pers., *Syzygium cumini* (L.) Skeels, *Gynocardia odorata* R. Br., *Phoebe lanceolata* Nees, *Terminalia myriocarpa* Hourck & Muell., *Quercus lanceaefolia* Roxb., *Styrax serrulatum* Roxb., *Ardisia griffithii* C. B. Clarke, *Elaeocarpus* sp., are also common. At localities where the forest has been denuded due to biotic influence *Kydia calycina* Roxb., *Vitex heterophylla* Roxb., *Stereospermum personatum* (Hassk.) Chatter., *Duabanga grandiflora* (Roxb.) Walp., *Bischofia javanica* Bl., *Sterculia indica* Merr. are occasionally associated. *Litsea citrata* Bl., *Itea macrophylla* Wall., *Alangium barbatum* R. Br., *Ardisia virens* Kurz, *Psychotria fulva* Buch.-Ham., *Antidesma bunius* Spreng., *Abroma angusta* L., *Mussaenda roxburghii* Hk. f., *Leea umbraculifera* L. etc., are common shrubs. *Costus speciosus* (Koenig) Smith, *Alpinia allughas* Rosc., *Polyura geminata* Hook. f., *Begonia* sp., *Forrestia mollissima* (Bl.)., Koorders var. *hispida* (Less. & Rich.) Backer., *Commelina paludosa* Bl., *Pollia haskarlii* Rolla Rao, *Amomum linguiforme* (Roxb.) Benth., *Phrynium placentarium* (Lour.) Merr., *Elatostema surculosa* Wt., *Spiradiclis biflora* Wall. ex Kurz, *Pratia begonifolia* Lindl., *Boeica filiformis* C. B. Clarke, *Boea multiflora* Bl., are the herbs. *Bauhinia khasiana* Baker, *Piper peepuloides* Roxb., species of *Dioscorea, Stephania, Gymnostemma, Trichosanthes* are common climbers. *Livistona jenkinsiana* Griff., *Wallichia caryotioides* Roxb., *Calamus erectus* Roxb., *Calamus floribundus* Griff. are some of the palms. Wild banana is very common in patches along the slopes of the forest which has been subjected to biotic interference.

At Khela the vegetation indicates a drier climate. *Trema orientalis* Bl. is very common. *Schima wallichii* Choisy, *Garuga pinnata* Roxb., *Stereospermum personatum* (Hassk.) Chatter. *Litsea monopetala* Pers., *Albizzia stipulata* Boiv., *Macaranga denticulata* (Bl.) Muell.-Arg., *Pterospermum* sp., *Baccaurea sapida* (Roxb.) Muell.-Arg., *Bischofia javanica* Bl. are the common trees.

From Tinchha to Laju there is a vast expanse of grass land. Grasses commonly met with are *Imperata cylindrica* Beauv., *Setaria palmifolia* Stapf, *S. glauca* Beauv., *Panicum meleaceum* L., *Arundinella bengalensis* Druce, *Erianthus longischorus* Anders., *Capillipedium assimile* A. Camus. Here and there amongst the grasses are found *Gnaphalium luteo-album* L., *Achyranthes bidentata* Bl., *Alternanthera sessilis* Br. etc.

From Pungchow to Lunwa there is a vast grass land, dominated by *Phragmites karka* Trin., *Arundo donax* L., and *Imperata cylindrica* Beauv. In places *Alpinia allughas* Rosc. grows in pure stands and also in association with *Phragmites karka* Trin. Burnt off stumps of *Schima wallichii* Choisy, stand as witness of human influence in the change of vegetation.

At Raho the forest is almost completely denuded of the woody vegetation and land is utilised in cultivation of agricultural crops. At Wakka the vegetation is of temperate type and is dominated by *Quercus* sp., *Litsea lancifolia* Roxb. ex Wall., *L. thomsonii* Meissn., *Itea chinensis* Hook. & Arn., *Schima wallichii* Choisy, *Rhododendron arboreum* Sm., *R. vaccinioides* Hk. f., *Sambucus javanica* Bl., *Styrax serrulatum* Roxb. *Saurauja roxburghii* Wall. and *Saurauja napaulensis* DC. The vegetation along Niusa-Gnignu tract is much depleted and converted to cultivated lands. River banks and slopes are, however, covered with *Macro-*

panax undulatum Seem., *Pterospermum lanceaefolium* Roxb., *Lithocarpus fenestrata* (Roxb.) Rehder, *Syzygium fruticosum* (Roxb.) DC. and others.

Livistona speciosa Kurz, *Wallichia disticha* T. Anders. etc., form societies in patches. *Dendrocalamus hookeri* Munro is the common bamboo used for different domestic purposes.

Vegetation at the Burma border was studied at Kothong, Chennhang, Noglo and Lunwa. *Swietenia mahagoni* with tall erect bole and umbrageous crown dominates the vegetation at Noglo where as it is absent in other places. *Aucuba himalaica* Hook. f. is very common and forms large consociations in all these places. *Alnus nepalensis* D. Don, *Acer laevigatum* Wall., *Litsea semicarpifolia* (Wall.) Hook. f., *Litsea monopetala* Pers., *L. lancifolia* Roxb. ex Wall., *Brassaiopsis glomerulata* (Bl.) Regel, *Casearia kurzii* C. B. Clarke, *C. vareca* Roxb., *Baliospermum montanum* Muel.-Arg., *Drypetes alata* (Bedd.) Pax & Hoffm., *Myrsine semiserrata* Wall., *Lithocarpus fenestrata* (Roxb.) Rehder are other common trees.

Amongst the shrubs *Lindera neesiana* Benth., *Hydrangea robusta* Hk. f. & Th., *Itea macrophylla* Wall., *Embelia vestita* Roxb., *Dichroa febrifuga* Lour., *Dobinea vulgaris* Buch.-Ham., *Ligustrum robustum* Bl., *Psychotria montana* Bl., *Rourea caudata* Planch., *Merilliopanax listeri* (King) Li, *Viburnum odoratissimum* Ker, *Saurauja macrotricha* Kurz, *Buddleja macrostachya* Benth., *B. asiatica* Lour., *Alangium chinensis* (Lour.) Rehder are most common.

Bauhinia tenuiflora Watt ex C. B. Clarke, *Aristolochia saccata* Wall., *Illigera villosa* C. B. Clarke, *Lonicera macrantha* DC., *Actinidia callosa* Lindl., *Trachelospermum axillare* Hook. f., *Periploca calophylla* Falc., *Dioscorea bulbifera* L., *D. laurifolia* Wall. ex Hook. f., *Chonemorpha griffithii* Hook. f., *Melodinus khasianus* Hook. f., *Rubia sikkimensis* Kurz, *Streptolirion volubile* Edgew., *Smilax zeylanica* L., *Melodinus monogynus* Roxb. are most common climbers. Herbs are abundant. *Oenanthe thomsonii* C. B. Clarke, *Sanicula europaea* L., *Impatiens* sp., *Begonia* sp., *Ophiorhiza* sp., *Lysimachia ferruginea* Edgew., *Ranunculus diffusus* DC., *Cardamine* sp., *Hemiphragma heterophylla* Wall., *Pouzoulzia bennettiana* Wt., *Polygonum* sp., *Hydrocotyle javanica* Thunb., *Calamintha umbrosa* (Fisch. & May) Benth., *Disporum pullum* Salisb., *Paris polyphylla* Smith, *Chirita pumila* D. Don, *Vaccinium serratum* Wt., *Aeschynanthus bracteata* Wall. ex DC., *Aeschynanthus parasiticus* (Roxb.) Wall., *Lysionotus serratus* D. Don, *Pothos* sp., *Rhaphidophora* sp., and a host of orchids are common epiphytes.

New Species and Records

In the course of the exploration of the region the senior author made intensive field studies which resulted in the discovery of several new taxa. One new genus *Pauia* Deb et Dutta under Solanaceae with one species

Pauia belladonna Deb et Dutta was discovered. The genus has been named in honour of Rev. Dr. H. Santapau, Director, Botanical Survey of India. It contains an alkaloid and deserves a thorough chemical investigation for medicinal properties.

Other species discovered and described are *Boehmeria tirapensis* Deb et Dutta (Urticaceae) and *Pternopetalum senii* Deb et Dutta (Umbelliferae). *Deb* 26312 has been treated as paratype in describing *Chirita macrophylla* Wall. subsp. *tirapensis* Panigr. in *Bull. Bot. Soc. Bengal* **21** (2): 32, 1967. Being the only flowering material available for describing the new taxon, it should have been treated as the holotype in place of *Panigrahi* 14795 which does not have any flower. However, this subspecies is reduced here to a variety as *Chirita macrophylla* Wall. var. *tirapensis* (Panigr.) Deb et Dutta, Comb. & Stat. nov. as it does not deserve a higher position on the basis of taxonomic differences from the type variety.

Besides these new taxa a number of other discoveries have been made from this region, which broaden our knowledge on the distribution of the taxa concerned and throw more light on the phytogeography of the country. *Gomphogyne macrocarpa* Cogn. ex Deb et Dutta, known from Manipur, *Fissistigma manubriatum* (Hook. f. & Th.) Merr. known from Burma, *Asarum himalaicum* Hook. f. & Th., var. *bhutanicum* W. W. Smith, known from Bhutan, *Isopyrum adiantifolium* Hook. f., & Th. known from Sikkim and Burma, *Strobilanthes glabratus* Nees known from Khasia and Jaintia Hills, *Passiflora assamica* Chakravarty known from Khasia Hills and Burma, *Galeola falconeri* Hook. f. a rare plant in the E. Himalayas, *Polystachya wightii* Reichb. f. known from Malabar, *Lysimachia congestiflora* Hemsl. and *L. rubiginosa* Hemsl. originally described from China, are some of the interesting taxa discovered in the region.

Cultivated Plants

The people inhabiting the region are Wanchos, Noctes, Tingsas, Shinghows and Khamptis. They are rice eaters, and cultivate rice in the valleys and in the hill slopes, sometimes with much hardship. As an alternate grain, they grow in jhum and terrace system of cultivation, *Zea mays* Linn., *Setaria italica* (L.) P. Beauv., *Eleusine coracana* Gaertn., *Pennisetum typhoideum* Rich. and *Hordeum vulgare* L. In house compounds and rarely in fields they cultivate also *Coix lachrymajobi* L. var. *mayuen* (Romanet) Stapf for use mainly in preparing beverages. For pulses and vegetables they cultivate *Cajanus cajan* (Linn.) Druce, *Canavalia gladiata* (Jacq.) DC., *Cicer arietinum* Linn., *Phaseolus calcaratus* Roxb., *Dolichos lablab* Linn., *Glycine max* Merr., *Solanum tuberosum* Linn., *Ipomoea batatas* Lamk., *Benincasa hispida* (Thunb.) Cogn., *Lage-*

naria leucantha (Duch.) Rusby, *Cucurbita pepo* DC., *Colocasia esculenta* (Linn.) Schott, *Abelmoschus esculentus* (L.) Moench., *Solanum melongena* Linn., *Lycopersicon esculentum* Mill., *Capsicum annuum* Linn. and others.

Sesamum indicum L., *Brassica juncea* Czern. & Coss., *B. rugosa* Prain, *Perilla frutescens* Britt. etc., are cultivated for oil seeds.

Zanthoxylum armatum DC. and *Eryngium foetidum* Linn. are cultivated in house compounds for the leaves used in curries and the fruits used as pepper. *Amomum aromaticum* Roxb. is sometimes cultivated for cardamom, and *Curcuma domestica* Valeton for turmeric.

Many wild plants are used by the local people as vegetables.

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PTERIDOPHYTE

Equisetaceae

Equisetum debile Roxb. ex Vaucher

A tall perennial herb among bushes near streamlets. Cone greenish brown or grey; common. Nampong-Pangsupass, Oct. 1959, *Rao* 20040.

E. diffusum D. Don

A perennial herb in moist shady places or rock crevices. Stiff fertile cones are almost covered by annulus when young; common. Nampong-Pangsupass, March 1958, *Murthy* 13008; Khela, March 1958, *Murthy* 12969; Chenglang, March 1958, *Murthy* 12929; Kothong, June 1961, *Deb* 26103; Khela, June 1961, *Deb* 25940.

Selaginellaceae

Selaginella helferi Wart.

A herb on moist humus. Fertile fronds are fan-like; common. Nampong-Pangsupass, Oct. 1959, *Rao* 20044, 20066; Namchik, Oct. 1959, *Rao* 20179.

S. pallida (Hook. et Grev.) Spring

A herb; common. Chennhang, June 1961, *Deb* 26202.

S. pentagona Spring

An erect herb on moist hill slopes, caudex thin, fertile; fairly common. Chenglang-Khela, Oct. 1959, *Rao* 20269, 20276.

S. picta A. Br. ex Bak.

A herb in shade on rocky soil; not rare. Longseck, June 1961, *Deb* 25768.

S. semicordata (Wall.) Spring

A herb on moist ground among other bushes and grasses, frond fertile; not scarce. Margharita-Jairampur, Oct. 1959, *Rao* 19921; Nampong-Pangsupass, Oct. 1959, *Rao* 20043; Deomali, Oct. 1959, *Rao* 20311.

S. subdiaphana (Wall.) Spring

An annual; frond very thin, membranous, fertile; common. Chenglang-Khela, Oct. 1959, *Rao* 20275.

S. wallichii (Hook. & Grev.) Spring

A herb with fertile frond; common. Kanubari, July 1961, *Deb* 26756.

S. willdenovii (Desv.) Bak.

A climbing herb in moist shady places; common. Nampong-Pangsupass, Oct. 1959, *Rao* 20050.

Lycopodiaceae

Lycopodium cernuum Linn.

A herb among bushes with fertile cones. Sometimes creeping on rock crevices; common. Khela, June 1961, *Deb* 25941; Nampong-Pangsupass, Oct. 1959, *Rao* 20029.

L. clavatum Linn.

A herb with long sporophylls; rare. Noglo, June 1961, *Deb* 26359.

L. squarosum Forst.

An epiphyte; rare. Khonsa-Laju, June 1961, *Deb* 26015.

Psilotaceae

Psilotum nudum (Linn.) P. Beauv.

A lithophyte among tall grasses; rare. Nampong-Pangsupass, Oct. 1959, *Rao* 20146.

Schizaeaceae

Lygodium flexuosum (Linn.) Sw.

A twining fern on shrubs. Sori dirty brown, marginal on every lobe; rare. Khela-Chenglang, March 1958, *Murthy* 12987; Deomali, Oct. 1959, *Rao* 20305.

L. scandens (Linn.) Sw.

A twiner on bushes; rare. Nampong-Pangsupass, Oct. 1959, *Rao* 20036.

Vittariacea

Vittaria elongata Sw.

An epiphyte on trees, frond fertile; common. Deomali, June 1961, *Deb* 25908.

V. ensiformis Sw. var. **latifolia** Holtt.

An epiphyte; frond fertile; sori linear near the margin at the middle of the lamina; rare. Noglo, June 1961, *Deb* 26361.

Antrophyceae

Antrophyum reticulatum (Forst.) Kaulf.

An epiphyte with broad, sessile, fertile frond; sori without indusium; not rare. Khela, March 1958, *Murthy* 12971; Raho-Wakka, July 1961, *Deb* 26450; Chenglang, Oct. 1959, *Rao* 20250.

Cryptogrammaceae

Onychium siliculosum (Desv.) C. Chr.

A terrestrial fern; frond fertile, sori yellow; not rare. Chenglang-Khela, Oct. 1959, *Rao* 20273.

Pteridaceae

Pteris cretica Linn.

A terrestrial fern; sori along the margin of the frond; common. Noglo, June 1961, *Deb* 26305.

P. excelsa Gaud.

In shady moist soil slopes; frond fertile, sori marginal; not rare. Khela, March 1958, *Murthy* 12962.

P. quadriaurita Retz.

A terrestrial fern in humid humus cover; caudex tufted, fertile; not scarce. Khonsa-Laju, June 1961, *Deb* 26019.

P. semipinnata Linn.

A terrestrial fern of sandy areas; caudex tufted; not rare. Nampong-Pangsupass, Oct. 1959, *Rao* 20061; Banfera, July 1961, *Deb* 26723.

HYPOLEPIDACEAE

Pteridium aquilinum (Linn.) Kuhn.

A fern with creeping, under-ground rhizomes; frond fertile; common. Khela, March 1958, *Murthy* 12978.

DAVALLIACEAE

Davallia griffithiana Hook.

An epiphyte on trees; frond fertile, sori oblong; not rare. Kothong, June 1961, *Deb* 26113.

OLEANDRACEAE

Naphrolepis cordifolia (Linn.) Presl

An epiphyte. Caudex tufted, sori crescent-shaped. Very common on wet ever-green forest. Kothong, June 1961, *Deb* 26107; Khonsa-Laju, June 1961, *Deb* 26020.

DICKSONIACEAE

Cibotium barometz (Linn.) J. Smith

A terrestrial fern with fertile frond (Tree fern); common. Banfera, July 1961, *Deb* 26724.

CYATHEACEAE

Alsophila glauca (Bl.) J. Smith

Pinnea bipinnately compound; common. Nampong-Pangsupass, Oct. 1959, *Rao* 20147.

A. ornata Schott

A terrestrial tree fern; frond circinate; common. Chennhang, June 1961, *Deb* 26201.

Aspidiaceae

Heterogonium saxicolum (Bl.) Holtt.

An epiphyte; frond fertile; common. Kothong, June 1961, *Deb* 26033.

Polystichum aculeatum (Linn.) Schott

An epiphyte; caudex tufted. On the wet forest floor near streams; not rare. Langsang, June 1961, *Deb* 26172.

P. lentum (Don) Moore

A terrestrial fern on rocks; frond fertile; common. Chennhang, June 1961, *Deb* 26230.

Tactaria polymorpha (Wall.) Copel.

A terrestrial fern with fertile frond and creeping rhizome; common. Lailongsong, June 1961, *Deb* 25846; Raho, July 1961, *Deb* 26391.

Athyriaceae

Athyrium drepanopterum (Kze.) A. Br. ex Milde

A terrestrial fern; caudex semierect; frond fertile. Growing mostly on rocks; common. Khonsa-Laju, June 1961, *Deb* 26016.

Thelypteridaceae

Cyclosorus acuminatus (Houltt.) Ching var. **glabrum** (Houltt.) Ching

An epiphytic fern with creeping rhizome; frond fertile; rare. Khonsa, June 1961, *Deb* 25915.

C. megaphyllus (Mett.) Ching

An epiphyte; caudex tufted; frond fertile; common. Chegum-Wakka, July 1961, *Deb* 26499.

C. parasiticus (Linn.) Ferwell

A terrestrial herb with erect caudex and fertile frond; common. Tipang, June 1961, *Deb* 25703; Longseck hillock, June 1961, *Deb* 25769.

C. sagittifolius (Bl.) Copel.

A terrestrial fern with erect caudex; basal pair of the pinnae reduced to auricles; common. Kothong, June 1961, *Deb* 26104.

C. sumatranus (V.A.V.R.) Ching

A terrestrial fern with erect caudex; sori along the margin of the pinnae; not rare. Lailongsong, June 1961, *Deb* 25842.

Thelypteris subpubescens (Bl.) K. Iwats.

A terrestrial fern; frond fertile. Khonsa, June 1961, *Deb* 25926.

Aspleniaceae

Asplenium ensiforme Wall. ex Hook. et Grev.

An epiphyte; frond fertile; not rare. Noglo, June 1961, *Deb* 26362.

A. nidus Linn.

An epiphyte; frond fertile, about 1 m. long; common. Namchick, Oct. 1959, *Rao* 20181; Langsang forest, June 1961, *Deb* 26169; Margharita-Jairampur, Oct. 1959, *Rao* 19962.

A. rutaefolium (Berg.) Kuntze

An epiphyte; frond fertile; not scarce. Chennhang, June 1961, *Deb* 26296; Raho-Wakka, July 1961, *Deb* 26451.

A. spathulinum J. Smith

A terrestrial or an epiphyte; frond fertile, not rare. Margharita-Jairampur, Oct. 1959, *Rao* 19955.

Blechnaceae

Blechnum orientale Linn.

A rhizomatous herb with erect caudex; frond fertile; common. Tipang, June 1961, *Deb* 25704; Margharita-Jairampur, Oct. 1959, *Rao* 19944.

Loxogrammaceae

Loxogramme flavescens Presl

An epiphyte on trees; sori arranged acropetally; rare. Khela, March 1958, *Murthy* 12972.

L. lanceolata Presl

An epiphyte on mossy bark, frond fertile; not scarce. Chennhang, June 1961, *Deb* 26297.

Polypodiaceae

Aglaomorpha coronans (Wall. ex Mett.) Copel.

An epiphyte or a lithophyte; frond fertile; not rare. Banfera, July 1961, *Deb* 26725.

Colysis elliptica (Thunb.) Ching var. **pothifolia** (Don) Ching

An epiphyte with rhizome; frond fertile; not rare. Chennhang, June, 1961, *Deb* 26299.

C. pedunculata (Hook. et Grev.) Ching

An epiphyte; frond fertile. Jadua-Banfera, July 1961, *Deb* 26693.

Drynaria propinqua (Wall.) J. Smith

An epiphyte with rhizome; common. Khonsa-Laju, June 1961, *Deb* 26017.

Lemmaphyllum rostratum (Bedd.) Tagawa

An epiphyte with wavy rhizome, frond fertile. Chennhang, June 1961, *Deb* 26298.

Lepisorus excavatus (Bory.) Ching

An epiphyte; not rare. Khonsa-Laju, June 1961, *Deb* 26018.

L. macrosphaerus (Bak.) Ching

An epiphyte with fertile frond. It is so far recorded from China only by Ching. Kothong, June 1961, *Deb* 26036.

L. sordidus (C. Chr.) Ching

An epiphyte; frond fertile. Kothong, June 1961, *Deb* 26035.

Microsorium cuspidatum (D. Don) Tagawa

An epiphyte with creeping rhizome; frond fertile; not rare. Lailongsong, June 1961, *Deb* 25843; Soha village, Oct. 1959, *Rao* 20269.

M. punctatum (Linn.) Copel.

An epiphyte in humid forest; not scarce. Lailongsong, June 1961, *Deb* 25845.

M. zippelii (Bl.) Ching

An epiphyte; frond fertile; common. Kothong, June 1961, *Deb* 26111.

Pleopeltis caudato-attenuata (Takeda) Patnaik

An epiphyte on trees; frond fertile; not rare. Chenglang, Oct. 1959, *Rao* 20249.

P. thunburgiana Kaulf.

An epiphyte; frond fertile; common. Kothong, June 1961, *Deb* 26108.

Polyopodium amoenum Wall. ex Mett.

An epiphyte on mossy bark; frond fertile; common. Kothong, June 1961, *Deb* 26108.

Pyrrosia adnascens (Sw.) Ching

An epiphytic herb; frond fertile. Jangkeng village, June 1961, *Deb* 25875.

P. beddomeana (Gies.) Ching

An epiphyte; caudex tufted, frond fertile; not rare. Lailongsong, June 1961, *Deb* 25844.

P. flocculosa (D. Don) Ching

An epiphyte on mossy bark of trees; frond fertile, not rare. Kothong, June 1961, *Deb* 26106.

P. heteracta (Mett.) Ching

An epiphyte with fertile frond ; rhizomatous; common. Nampong-Soha, Oct. 1959, *Rao* 20351(1); Langsang forest, June 1961, *Deb* 26168; Kothong, June 1961, *Deb* 26112.

P. lanceolata (Linn.) Farwell

An epiphyte, frond fertile; not rare. Chenglang, Oct. 1959, *Rao* 20252.

P. mollis (Kze.) Ching

An epiphyte with fertile fronds; common. A Chinese plant. Noglo, June 1961, *Deb* 26360.

P. mannii (Gies.) Ching

An epiphyte with fertile fronds; not rare. Kothong, June 1961, *Deb* 26034 ; Longseck hillock, June 1961, *Deb* 25771.

P. nummularifolia (Sw.) Ching

An epiphyte, leaves dimorphic; frond fertile; common. Khonsa, June 1961, *Deb* 25927; Raho-Wakka, July 1961, *Deb* 26454; Longseck hillock, June 1961, *Deb* 25770; Namchick, Oct. 1959, *Rao* 20192.

P. stenophylla (Bedd.) Ching

An epiphyte with rhizomes; frond fertile; not rare. Kothong, June 1961, *Deb* 26110.

DICOTYLEDONS

MAGNOLIACEAE

Manglietia insignis Bl.

A lofty tree in fruit; common in the evergreen forest. Deomali, June 1961, *Deb* 25899.

Talauma hodgsoni Hook. f. & Thoms.

A lofty tree; common in the evergreen forest. Chenglang, Oct. 1959, *Rao* 20277; Deomali, Oct. 1959, *Rao* 20325; Lailongsong, 510 m., June 1961, *Deb* 25774.

ANNONACEAE

Goniothalamus sesquipedalis Hook. f. & Thoms.

A shrub, scattered all over the evergreen forest as an undergrowth. Banfera, July 1961, *Deb* 26728; Aug. 1958, *Panigrahi, S.N.*

Fissistigma bicolor (Roxb.) Merr.

A large woody climber, rare. Lailongsong, 510 m., June 1961, *Deb* 25808.

F. manubriatum (Hook. f. & Thoms.) Merr.

A shrub. Noglo (Burma border), June 1961, *Deb* 26321. It has been recorded for India by the authors in *Bull. Bot. Soc. Beng.* **19** (1): 37, 1965.

LAURACEAE

Actinodaphne obovata Bl.

A medium-sized tree; scarce. Banfera, July, 1961, *Deb* 26693.

Cinnamomum pauciflorum Nees

A tree in flower. Longseck hillock, June 1961, *Deb* 25724.

C. tamala F. Nees & Eberm.

A large tree. Deomali, Oct. 1959, *Rao* 20312; Khonsa, June 1961, *Deb* 25952.

Lindera neesiana Benth.

A small tree in flower; common. Kothong, June 1961, *Deb* 26042; Khonsa, June 1961, *Deb* 25956.

Litsea citrata Bl.

A small tree with long spreading branches; fairly common. Chenglang to Khela, Oct. 1959, *Rao* 20300; Longseck hillock, June 1961, *Deb* 25726.

L. kingii Hook. f.

A medium-sized tree, common along the Burma border. Chegum, July 1961, *Deb* 26468.

L. laeta Wall. ex Nees

A small tree in fruit; scarce. Pungchow, July 1961, *Deb* 26606; Langsang, June 1961, *Deb* 26146.

L. lancifolia Roxb. ex Wall.

A large tree dominant in the locality. Chegum, July 1961, *Deb* 26463.

L. monopetala (Roxb.) Pers.

A large tree in flower and fruit; common. Khela, March 1958, *Murthy* 12975; Longseck hillock, 1500 m., June 1961, *Deb* 25730 & 25744; Kothong, June 1961, *Deb* 26030; Khela, June 1961, *Deb* 25928.

L. oblonga (Wall.) Hook. f.

A small tree. Banfera, July 1961, *Deb* 26705.

L. salicifolia (Roxb. ex Wall.) Hook. f. var. **attenuata** Meissn.

A shrub. Wakka, July 1961, *Deb* 26541.

L. semecarpifolia (Wall.) Hook. f.

A large tree. One of the dominant trees of Burma border forests. Noglo, June 1961, *Deb* 26306.

L. thomsoi Mnieissn.

A tree in flower; rare. Wakka, July 1961, *Deb* 26455.

Persea minutiflora Kosterm.

A tree in flower. Khonsa, June 1961, *Deb* 25961.

Phoebe lanceolata Nees

A medium-sized tree. Longseck hillock, June 1961, *Deb* 25725.

HERNANDIACEAE

Illigera villosa C. B. Clarke

A large climber with purple flowers; widely scattered. Chennhang, June 1961, *Deb* 26223; Chegum-Wakka, July 1961, *Deb* 26495; Kothong, June 1961, *Deb* 26053.

MYRISTICACEAE

Knema globularia (Lamk.) Warb.

A medium-sized tree; fairly common in the evergreen forest. Longseck hillock, June 1961, *Deb* 25723.

K. angustifolia (Roxb.) Warb.

A medium-sized tree with blood red sap; fairly common in the evergreen forest. Fruits 2·5-3·8 cm., glaucous, pericarp yellowish, aril purple. Longseck hillock, June 1961, *Deb* 25722.

K. linifolia (Roxb.) Warb.

A medium-sized tree; fairly common in the evergreen forest. Longseck hillock, 1500 m., June 1961, *Deb* 25723 A.

DILLENIACEAE

Dillenia indica Linn.

A large tree up to 35 m. in height in flower and fruit; scattered. Namchik, 152 m., Oct. 1959, *Rao* 20195.

CONNARACEAE

Connarus paniculatus Roxb.

A climber in fruit; scattered near the valleys. Kanubari, July 1961, *Deb* 26758.

Rourea caudata Planch.

A small tree fairly common in subtropical forests. Noglo (Burma border), June 1961, *Deb* 26349.

ROSACEAE

Duchesnea indica (Andr.) Focke

(Syn. *Fragaria indica* Andrews)

A small herb; rare. Nampong, Oct. 1959, *Rao* 20031.

Neillia thyrsiflora D. Don

A shrub in flower and fruit. Tinchha, Aug. 1958, *Panigrahi* 14648; Kothong, June 1961, *Deb* 26063.

Potentilla kleiniana Wight & Arn.

A diffused herb in flower and fruit; scattered. Laju, June 1961, *Deb* 25972.

Prunus acuminata Hook. f.

A small tree in flower; rare. Pungchow, July 1961, *Deb* 26627.

P. persica (L.) Batsch

Cultivated. Soha village, Oct. 1959, *Rao* 20387.

Rubus burkilli Rolfe

A scandent shrub with yellow flowers; scarce. Raho, Aug. 1958, *Panigrahi* 16849; Chegum, July 1961, *Deb* 26476.

R. ferox Wall. ex Kurz

A prickly scandent shrub in flower; rare. Langsang forest (Kothong), June 1961, *Deb* 26155.

R. insignis Hook. f.

A scandent shrub with rose red flowers; scarce. Chenglang, March 1958, *Murthy* 12911.

R. lasiocarpus Smith

A straggling shrub with white flowers and orange red drupelets; scarce. Kothong, June 1961, *Deb* 26094; Khonsa, June 1961, *Deb* 25988.

R. lineatus Reinw.

A shrub with light green flowers; fairly common. Raho, July 1961, *Deb* 26420; Nampong, Oct. 1959, *Rao* 20012; Noglo, June 1961, *Deb* 26332.

R. lucens Focke

A straggling shrub with rose red flowers ; common. Jairampur, Oct. 1959, *Rao* 19924; Nampong, Oct. 1959, *Rao* 20060.

R. moluccanus Linn. var. **macrocarpa** Gard.

A straggling shrub with hooked thorns all over. Flowers white ; scarce. Lailongsong, 510 m., June 1961, *Deb* 25780; Khonsa, June 1961, *Deb* 25973; Kothong, June 1961, *Deb* 26084.

CAESALPINIACEAE

Bauhinia khasiana Baker

A small climber with golden yellow flowers; scarce. Longseck hillock, June 1961, *Deb* 25721.

B. purpurea L.

A tall tree with large white flowers having odd petal pinkish violet ; scarce. Deomali, Oct. 1959, *Rao* 20306 ; Chenglang, March 1968, *Murthy* 12930.

B. tenuiflora Watt ex. C. B. Clarke

A climber with white flowers. Flowers yellowish on drying ; scarce. Noglo, June 1961, *Deb* 26322 ; Chennhang, June 1961, *Deb* 26274.

Mimosaceae

Acacia intsia (L.) Willd.

A tall climber with white flowers; rare. Jairampur, Oct. 1959, *Rao* 19941.

Albizzia gamblei Prain

A shrub in flower; scarce. Chennhang, June 1961, *Deb* 26205.

A. lucida (Roxb.) Benth.

A medium sized tree in white flowers; common. Grows in association with *Macaranga* on slopes.

A. mollis Boiv.

A large tree; scattered. Khonsa, June 1961, *Deb* 25942. Noglo, June 1961, *Deb* 26309.

A. chinensis (Osbeck) Merr.

A tree with brown legumes; scattered. Nagnu, Aug. 1968, *Panigrahi* 14871 ; Kothong, June 1961, *Deb* 26082; Khela, June 1961, *Deb* 25930. Khonsa, June 1961, *Deb* 25985.

Entada pursaetha DC.

A gigantic climber in fruit on the outskirts of the forest; scarce. Banfera, July 1961, *Deb* 26729.

Mimosa pudica L.

Common. Pangsupass, Oct. 1959, *Rao* 20152.

Pithecellobium angulatum Benth.

A small tree in flower ; scarce. Lailongsong, 510 m., June 1961, *Deb* 25789 ; Banfera, July 1961, *Deb* 26744.

Papilionaceae

Cicer arietinum L.

Cultivated herb. Khela, March 1958, *Murthy* 12981.

Crotalaria ferruginea Grah. ex Benth.

An undershrub with yellow flowers; scarce. Pangsupass, 290-1130 m., Oct. 1959, *Rao* 20091; Pungchow, July 1961, *Deb* 26567.

C. tetragona Andrews

A shrub with yellow flowers. Namsang, Oct. 1959, *Rao* 20340.

Desmodium laburnifolium DC.

A herb in flower and fruit; scattered. Jairampur, Oct. 1959, *Rao* 19920.

D. laxiflorum DC.

A small shrubby plant with bluish flowers; fairly common. Pangsu-pass, 290-1130 m., Oct. 1959, *Rao* 20011; Jairampur, 199·3 m., Oct. 1959, *Rao* 11984.

D. heterocarpum (L.) DC.

A small spreading shrub with small pinkish, brownish or bluish violet flowers; common. Jairampur, Oct. 1959, *Rao* 19918 & 19970.

D. sequax Wall.

A shrub with pinkish blue flowers; fairly abundant at places. Khela, Oct. 1959, *Rao* 20285; Noglo, June 1961, *Deb* 26376.

Indigofera cylindrica Grah.

A shrub up to 3 m. in height, in flower and fruit; scarce. Chennhang, June 1961, *Deb* 26213.

I. dosua Buch.-Ham. var. **tomentosa** Baker

A shrub in flower; fairly abundant at places. Wakka, July 1961, *Deb* 26497.

Millettia caudata Baker

A small tree with white flowers; scarce. Lailongsong, 510 m., June 1961, *Deb* 25790.

M. cinerea Benth.

A climber with pink flowers; rare. Pungchow, July 1961, *Deb* 26599.

M. pulchra Benth. ex Baker

A shrub with pink flowers; scarce. Pungchow, July 1961, *Deb* 26646.

M. monosperma DC.

A large climber in flower; scarce. Jairampur, Oct. 1959, *Rao* 19966.

Phaseolus calcaratus Roxb.

A herb with yellow flowers; cultivated. Namsang-Soha, Oct. 1959, *Rao* 20346.

P. mungo L.

A climber about 3 m. in height, flowers yellow; scarce. Bimalpur, Sept. 1958, *Panigrahi* 17033.

Pueraria bella Prain

A climber, flowers pinkish white, calyx yellowish green; Khonsa, Aug. 1958, *Panigrahi* 14490.

P. peduncularis Grah.

A climber up to 10 m. in height; flowers yellowish or bluish white; rare. Tinchha, Aug. 1958, *Panigrahi* 14647.

P. phaseoloides Benth.

A climber with orange yellow or bluish flowers; fairly common in places. Tinchha, Aug. 1958, *Panigrahi* 14633; Pangsupass, Oct. 1959, *Rao* 20009; Namsang, Oct. 1959, *Rao* 20339.

Shuteria vestita Wt. & Arn.

A twiner with small brownish flower; scarce. Khela, March 1958, *Murthy* 12977; Noglo, June 1961, *Deb* 26303.

Smithia ciliata Royle

A herb with sensitive leaves and yellow flowers; scarce. Pangsupass, Oct. 1959, *Rao* 20048 & 20049.

Butea parviflora Roxb.

An extensive climber with purple flowers. Khonsa, June 1961, *Deb* 25965.

Tephrosia candida DC.

A shrub with white flowers and fruits; abundant in places. Namsang, Oct. 1959, *Rao* 20334.

PHILADELPHACEAE

Dichroa febrifuga Lour.

A shrub, flowers blue, fruits pale green to chocolate grey; common. Kothong, June 1961, *Deb* 26060; Khonsa, June 1961, *Deb* 25964; Chennhang, June 1961, *Deb* 26261, 26267 & 26268.

HYDRANGEACEAE

Hydrangea robusta Hook. f. & Thoms.

A shrub with blue violet flowers; abundant in places. Kothong, June 1961, *Deb* 26047; Noglo, June 1961, *Deb* 26320.

H. robusta Hook. f. & Thoms. var. **griffithii** C. B. Clarke

A shrub with blue violet flowers; scarce. Khonsa, June 1961, *Deb* 25982.

Escalloniaceae

Itea chinensis Hook. & Arn.

A small tree in flower and fruit; scarce. Wakka, July 1961, *Deb* 26521.

I. macrophylla Wall.

A shrub of about 8 m., in flower and fruit; common. Kothong, June 1961, *Deb* 26029 & 26083; Longseck hillock, 510 m., June 1961, *Deb* 25733.

Crypteroniaceae

Crypteronia glabra Bl.

A tree with spreading branches; scarce. Namsang, Oct. 1959, *Rao* 20350.

(*to be continued*)

On a collection of Sipunculids from Indian waters

BY

PEACE JOHNSON
(Department of Zoology, Christ College, Irinjalakuda)

(With four plates)

INTRODUCTION

Prashad (1937) reported five sipunculids from Indian waters, namely *Sipunculus nudus* Linn., *S. robustus* Keferstein, *S. porrectus* Selenka, *S. aequabilis* Sluiter and *Siphonosoma australe* (Keferstein). Recently (1964, 1969) I have reported two species of *Aspidosiphon*, *A. homomyarium* Johnson, *A. exostomum* Johnson and a species of *Xenosiphon*, *X. indicus* Johnson. Except for these eight species there have been no other records of sipunculids from Indian Seas. The present paper describes four species of the genus *Phascolosoma* Leuckart of which two are new and a single species of the genus *Phascolopsis* Fisher. Since this is the first record of the species of *Phascolosoma* and *Phascolopsis* from the Indian Seas, all have been described in detail. The diagnostic generic characters are also given.

Genus *PHASCOLOSOMA* Leuckart 1828

Phascolosoma Leuckart, 1828, p. 22; Baird, 1868, p. 82.
Phymosomum Quatrefagus, 1866, p. 621.
Prophymosoma Lambert, 1900, p. 54.
Physconosoma Bather, 1900, p. 78.
Phymosoma Selenka, Bulow & de Man, 1883, p. 54; Ikeda, 1904, p. 20.
Physcosoma Selenka, 1897, p. 460; Shipley, 1903, p. 174; Lanchester, 1905, p. 28; Gerould, 1913, p. 419; Sato, 1939, p. 38.
Phascolosoma Fisher, 1950, p. 551; 1952, p. 422; Wesenberg-Lund, 1954b, pp. 1-18; Edmonds, 1955, p. 28.

Diagnosis :

Moderate as well as very large forms. Tentacles not encircling mouth, forming crown dorsal to mouth opening. Introvert when extended set at same axis as that of body. Skin externally beset with very conspicuous papillae. Papillae usually more crowded and deep in colour at the base of introvert and posterior region of the body. Papillary pore surrounded by chitinous plates of different size and shape. Hooks, when present, arranged in circlets at anterior part of introvert; characterised with bent point and clear streak running through centre, with or without accessory points. In certain cases, besides clear streak, a triangular clear area also present. Longitudinal muscle layer of body wall forms longitudinal bands. Nephridia two in number and retractor muscles four basially, sometimes two, uniting in various ways to form single or double bands. Spindle muscle forming axis for intestinal coils, and attached posteriorly to body wall. Pollian sac generally simple, sometimes with tubercle-like villi projecting into coelom.

Phascolosoma antillarum Grube & Oersted, 1859

(Pl. IV, Figs. 6-11; Pl. II, Figs. 10-12)

Phascolosoma antillarum Grube & Oersted, 1859, p. 117.
Phascolosoma fuscum Keferstein, 1862, p. 67.
Sipunculus (*Phymosomum*) *antillarum* Quatrefagus, 1865, p. 626.
Phascolosoma nigreceps Baird, 1868, p. 90.
Phymosoma antillarum Selenka *et al.* 1883, p. 57; Fischer, 1895, p. 12; Augner 1903, pp. 297-371; Ikeda, 1904, p. 24.
Physcosoma antillarum Gerould, 1913, p. 420.
Phascolosoma antillarum Fisher, 1952, p. 434.

Present record :

Port Blair (Andaman Island).

Distribution :

Florida, West Indies, Columbia, Venezuela, Dutch Guiana, Brazil, Gulf of California, Costa Rica, Panama, Chile, Hawaii, Riukiu Islands & Jamaica.

Description :

Thick-walled, medium-sized sipunculid. The length of the trunk varies from 26 to 29 mm. and that of the introvert from 6 to 9 mm. Maximum width of the body varies from 6 to 8 mm. The shape resembles that of a bottle with a round posterior end (Pl. IV, Fig. 6) and a narrow introvert (Pl. IV, Fig. 7). The colour may be greyish black or dirty dark brown. The body papillae are very conspicuous, dark brown in colour, sparingly scattered all over the body and more crowded at the base of the introvert and at the posterior part of the body. In the middle region of the trunk they are flat and the papillary pore is immediately surrounded by a clear space which is encircled by a ring of large and closely packed chitinous plates of irregular shape (Pl. II, Figs. 10 & 11). At the base of the introvert and at the posterior region of the body the papillae are slightly raised and there are few more rows of closely packed, polygonal and medium-sized chitinous plates circling them besides the ring of larger plates (Pl. II, Fig. 12). These keep the papillary pore slightly raised from the body surface. At the anterior region of the introvert (Pl. IV, Fig. 8), papillae are much raised, conical and spine-like, with a pore at the centre and these are formed of chitin which is homogeneous instead of being in plates. Chitinous granules occur in the skin between papillae. Hooks on the introvert absent. Tentacles numerous, filamentous and form a crown dorsal to the mouth opening. Crown is semicircular and the tentacles are arranged in more than one row. Tentacles are striped with alternating dark and white bands (Pl. IV, Fig. 11). Nuchal organ, if present, is inconspicuously developed. A thickened ridge surrounds the crown as well as the mouth opening. Immediately behind this ridge a small region of the introvert is white in colour and smooth without any papillae.

Longitudinal muscle layer of the body wall separated into bands which frequently anastomose. Anteriorly, the bands number from 13 to 15 and posteriorly from 37 to 40. Retractor muscles four, dorsal and ventral, originating at the same transverse line. Immediately after their origin the dorsal and ventral of one side fuse to form a stout band. Nephridia are long and reach farther than the middle of the trunk. Two-thirds of its length is fixed to the body wall by mesenteries. Oesophagus is short and the intestinal coils vary from 16 to 20 which spiral round a spindle muscle that arises near the anus and is attached to the posterior part of the body. Rectum is long and without a rectal caecum. A single intestinal fastener which arises from the ventral wall, left of the nerve cord, is attached to the last whorl of the intestine. Pollian sac extends along the oesophagus and has small tubercle-like villi (Pl. IV, Fig. 10). Posteriorly the rectum is fixed to the body wall by a well developed wing muscle. Nephridial openings are below the anal opening. In the specimens dissected eggs were present in the coelom.

Remarks:

In Selenka's (1897) account the intestinal fastener is described as attached to the first whorl of the intestine instead of the last whorl of the intestine as in these specimens. Again, Selenka as well as Gerould

(1913) describe the nephridia as fixed to the body wall by their entire length, but in the Indian forms it is fixed only by the two-thirds of their length. Selenka has counted about 50 to 80 tentacles. Fisher (1952) has counted about 200 tentacles arranged in a fashion that is found in *Dendrostomum* species. In all my specimens the tentacles are arranged in more than one row, but in the form of a semicircle above the mouth forming almost the shape of the letter W (Pl. IV, Fig. 9).

Phascolosoma agassizii Keferstein

(Pl. III, Figs. 1 to 5)

Phascolosoma agassizii Keferstein, 1866, p. 218; 1867, p. 46.
Phymosoma agassizii Selenka, 1883, p. 78.
Physcosoma agassizii Chamberlin, 1919, p. 30.
Phascolosoma lordi Baird, 1868, p. 92.

Present Record:

50 specimens from Okha (Gulf of Kutch).

Distribution:

Kodiak Island, Alaska, San Quintin, Baja California, British Columbia, Ceylon, Laccadive and Maldive Islands, Mauritius, Sumatra, Timor, Sharks Bay, Rottnest Island, Western Australia, Sydney, Java Sea, Tahiti, Bermuda and Villefranche.

Description:

Trunk varies in length from 45 to 55 mm. Introvert distinctly narrower than the trunk, 14 to 17 mm. in length (Pl. III, Fig. 1). Skin opaque to translucent, pinkish grey, yellowish grey, reddish brown or dark muddy brown in colour. Introvert carries dark transverse bands, usually over its entire length, sometimes at its distal end only. These do not meet ventrally. Body beset with papillae appearing as dark spots in contrast to the skin colour. Papillae are crowded at the base of the introvert and the posterior region of the body. Papillae are large, conical and greatly raised from the body surface. The papillary pore is surrounded by a few irregular inner rows of large chitinous granules and numerous outer rows of smaller chitinous granules (Pl. III, Fig. 5). Papillae in the middle part of the trunk and the introvert proper are smaller and less conical, though structurally similar to those present at the base of the introvert. Everywhere the size of the papillae gradually decreases from the dorsal to the ventral side of the animal. The introvert at its anterior end carries 15 to 17 circlets of hooks (Pl. III, Fig. 4). Hooks are small and characterised by a slightly curved apex, which is not uniform (Pl. III, Figs. 2 & 3). Also the diameter of the hook-base varies within the same individual. Each hook is provided with a centrally running narrow streak without any expansion at the base. Triangular clear area is absent for the hook. Anterior to these hook-circlets there is a small region on the introvert where hooks or papillae are absent. The introvert ends in a thickened ridge which encircles the mouth and the tentacular crown. Tentacular crown is semicircular and dorsal to the mouth. There are 20 to 35 filiform tentacles (Pl. III, Fig. 4).

Internally the longitudinal muscle layer is separated into longitudinal bands, about 18 to 22 bands anteriorly and 24 to 30 posteriorly. Four retractor muscles, the ventral pair reaching the posterior third of the body. About 6 to 7 longitudinal muscle bands take part in the formation of the ventral while 4 to 7 bands make the dorsal. The attachment of the dorsal pair to the body wall is anterior to that of the ventral pair. Two long nephridia, both opening out ventrally at the same level, a little posterior to the anal opening. They are attached to the body wall by mesenteries along their entire length. The spindle muscle, which takes its origin near the anus, runs along the length of the rectum to pass through the centre of the intestinal coils and is firmly attached to the posterior extremity of the trunk. The oesophagus is fairly long and carries with it at its dorsal side the poorly developed and simple pollian sac. The intestinal coils vary from 14 to 16 and the rectum is a straight tube opening out by the anus. A rectal caecum is absent. The last part of the rectum is fixed to the body wall by the wing muscle. The entire alimentary canal is suspended in the coelom by a single intestinal fastener which arises from the midventral line of the body wall, anterior to the dorsals, by two roots and at its distal end it again bifurcates, one limb being attached to the rectum and the other to the first whorl of the intestine. Eggs are present in the coelom of most of the specimens dissected.

Remarks :

The specimens in my collection resemble the description of the Californian specimens described by Fisher (1952). I could count a maximum 17 rows of hooks only while Fisher has given the maximum number as 25. There are about 35 tentacles in the Indian forms while Fisher has counted only 24 tentacles for the American forms. The variation noticed by Fisher in the curvature of the hooks and the hook base has been noticed in the Indian forms also.

Phascolosoma spinosum sp. nov.

(Pl. II, Figs. 1 to 9)

Present record :

5 specimens from Port Blair (Andaman Islands).

Description :

This species is a cylindrically elongated from with the posterior tip tapering to a point (Pl. II, Fig. 1). Body wall thin enough to show the longitudinal bands. Colour yellowish brown. Introvert shorter and distinctly narrower than the trunk. The trunk varies in length from 57 to 58 mm. and the introvert from 28 to 29 mm. The maximum width of the body varies from 4 to 5 mm.

Skin beset with conspicuous papillae, crowded at the base of the introvert and to a lesser extent at the posterior part of the body. They appear as dark brown spots, rounded in shape and are slightly raised from the body. Papillae at the posterior part of the body are larger. The papillary pore is surrounded by a small clear area and then by numerous small chitinous granules which are closely packed (Pl. II, Figs. 7, 8 & 9). In the middle region of the body the papillae are sparingly distributed and are smaller and less raised. The nature of the papillary structure is the same as present at the posterior part of the body. On the introvert proper they are still smaller, but do not differ in their structure. At the base of the introvert, in between the crowded papillae, there are spine-like papillae which are confined to the dorsal side of the introvert. At the apex of these papillary spines (apices are directed posteriorly) there are papillary openings. About 25 to 30 such papillary spines have been counted. On the introvert there are a number of pigment bands, dark in colour, which do not meet on the ventral side. At the anterior region of the introvert there are 17 to 20 rows of hooks. Hooks are characterised by sharply bent apex (at right angle to the base) with a clear streak which bends strongly towards the inner tip of the base on the concave side of the hook. On the convex side near the base there is a clear triangular area. The base of the hook is comparatively small while the hook is tall and high. Between the hook rows small perforated papillae are present. There are 11 finger-shaped tentacles arranged in a row forming a semicircular crown dorsal to the mouth. This tentacular crown is open dorsally where it accommodates the nuchal organ (Pl. II, Fig. 5). On the inner side of the crown the tentacular bases have a greenish tinge. A thickened ridge encircles the mouth and the tentacular crown. This ridge or collar is broken dorsally where the nuchal organ is present. Posterior to this collar a small region of the introvert is smooth and white where neither hooks nor papillae are present. A thin round membraneous fold of skin projects from the posterior border of this smooth region. The anus is carried on an anal cone.

Internally the longitudinal muscle layer is separated into longitudinal bands which anastomose profusely. There are 16 to 18 bands anteriorly while posteriorly there are 21 to 22 bands. In the middle region the number varies from 23 to 25. There are, therefore, both division and fusion of the bands. Oesophagus is long and about half of it is loosely attached to the retractors by mesenteries (Pl. II, Fig. 2). The pollian sac is simple and extends to about three-fourths of the oesophageal length. There are approximately 35 coils of intestine, the coils being closely wound round a spindle muscle. This spindle muscle originates near the anus and is attached to the body wall posteriorly. Rectum is fairly long without a rectal caecum. There are two intestinal fasteners of which one is bifurcated and attached to the first and second whorls of the intestine. The other is attached to the last whorl of the intestine. There are four retractor muscles which reach the middle of the posterior half of the trunk (Pl. II, Fig. 2). The origin of the dorsal retractors is anterior to that of the ventrals. Immediately after their origin the dorsal and the ventral of one side fuse to form a stout band. The two nephridia are long and reach the base of the retractors. Two-thirds of their length is fixed to the body wall by mesenteries. Nephrostome is small and flower-like and is at the anterior region of the nephridium (Pl. II, Fig. 6). Both the nephridia open at the same level of the trunk, but slightly posterior to the anal opening. Eggs are seen in the coelom.

Systematic position :

P. dentigerum (Selenka & de Man) is perhaps the only species in which there are papillary spines at the base of the introvert. The present species differs from *dentigerum* in the nature of the papillae, retractor muscle and hooks. In *spinosum* the hooks are longer with a comparatively short base and a sharply bent apex. The clear streak is deflected to the inner tip of the base on the concave side of the hook. In *dentigerum* the papillary spines occur at the posterior region of the trunk also while in *spinosum* they are absent at the posterior region of the trunk.

The species is considered to be new on the basis of the hook structure and the nature of the papillae and the retractors.

Holotype and paratypes:

Deposited in the Zoological Museum of B.I.T.S., Pilani, Rajasthan.

Type locality:

Port Blair (Andaman Island).

Phascolosoma andamanensis sp. nov.

(Pl. I, Figs. 1 to 7)

Present record:

160 specimens were collected from Port Blair (Andaman Island).

Description:

A slender, medium-sized, form. The skin may be thick or thin. The posterior tip tapers to a point. The introvert is shorter and narrower than the trunk (Pl. I, Fig. 1). There are dark pigmented bands on the dorsal side of the introvert. Ventrally they are not continuous. The skin may be smooth except at the base of the introvert and the posterior region of the trunk where large, raised and dark brown papillae occur. They are more crowded and coloured at the base of the introvert than at the posterior region. The middle region bear papillae (Pl. I, Fig. 7) which can be observed only under magnification. The papillary pore is at the centre of a clear area which in turn is surrounded by minute chitinous granules. A considerable area in the outer margin of the papilla is devoid of these chitinous granules. Papillae in the middle region of the body do not have any chitinous granules surrounding them. There are hooks which are arranged in circlets at the anterior region of the introvert. These circlets vary in number from 17 to 26. The hook is characterised by broad base and sharply bent apex (at right angle to the base) with a clear streak at the centre which expands at the base considerably and with a triangular clear area at the convex side of the base (Pl. 1, Figs. 5 & 6). In some hooks a characteristic hump can be observed on the concave side, at the bend. In between the hook circlets there are minute perforated papillae arranged in single circular rows. The introvert carries at its tip 11 to 20 fleshy and finger-shaped tentacles which form a horse-shoe-shaped crown placed dorsal to the mouth. This crown encloses at its dorsal side the nuchal organ (Pl. I, Fig. 3). In many specimens a greenish tinge can be observed on the inner side of the tentacles. The ventral mouth and the dorsal tentacular crown are surrounded by a thick ridge in the form of a collar which is broken dorsally by the nuchal organ. Posterior to this collar a small region of the introvert is creamy white in colour and smooth without papillae and hooks (Pl. I, Fig. 4). In between this smooth region and the hook circlets there is another collar which projects out as a membraneous flap.

Internally, the longitudinal muscle layer is separated into bands. There are 16 to 18 bands anteriorly, 19 to 23 in the middle and 18 to 20 posteriorly. The bands, therefore, divide and fuse at different levels. Oesophagus is long and narrow. Intestinal coils vary from 11 to 17. The rectum is comparatively short and without a rectal caecum (Pl. I, Fig. 2). The single intestinal fastener is delicate and it originates from the ventral wall near the nerve cord and is attached to the beginning of the rectum. It will be missed unless the specimen is carefully examined. A spindle muscle takes its origin near the anus and runs posteriorly forming the axis for the intestinal coils. Posteriorly this muscle is attached to the body wall. Well developed wing muscle fixes the last part of the rectum to the body wall. The pollian sac is dorsal to the oesophagus. At certain places it swells up to form tubercles, probably due to concentrations of coelomic corpuscles at those places. Nephridia are long and tubular reaching one-third of the trunk length. The nephridia are fixed to the body wall by mesenteries by two-thirds of their length. The nephrostome is small and is at the anterior region of the nephridium. There are four retractors. The dorsals are slender and emerge from a place anterior to the stout ventrals. The place of origin of ventrals varies in different individuals. Usually they reach the middle part of the body sometimes a little ahead or little behind. At the anus level, the dorsal and the ventral of one side fuse to form a single stout band. In the introvert these fused bands are held together by mesenteries to appear as a single unit. On the dorsal aspect of this retractor-unit the oesophagus runs down. Eggs were present in the coelom of many specimens dissected.

Systematic position:

This species resembles *P. albolineatum* (Baird) in the hook structure and the papillary arrangement. However, the hooks of this species differ from that of *albolineatum* in lacking a bar with warts at the hook base (Sato 1939). The species resembles *P. varians* (Keferstein) in having the hook bent at right angle to the base and also in the papillary structure and distribution. However, in *varians* between the hook circlets there is a zone where hooks and papillae occur together. This zone is wanting in *andamanensis*. The introvert is longer than the trunk in *varians* while it is shorter or equal in *andamanensis*. Again from the diagram given by Sato (1939, p. 392) of the hook of *varians* it appears that the triangular clear area in the hook is on the concave side while it is on the convex side in *andamanensis*. There is difference in the number of hook circlets as well as in the number and attachment of the intestinal fasteners.

Considering the hook structure as well as the distribution and composition of papillae, the individuals in my collection have been referred to a new species.

Holotype and paratypes:

Deposited in the Zoological Museum of B.I.T.S., Pilani, Rajasthan.

Type locality:

Port Blair (Andaman Island).

Genus *PHASCOLOPSIS* Fisher, 1950

Diagnosis:

Large, slender and elegant forms. Tentacles filiform, usually very distinct, surrounding mouth in one or two rows or in series of double rows. Hooks absent on introvert. Nuchal organ well developed. Longitudinal muscle layer of trunk wall separated into longitudinal bands. Four retractor muscles. Pollian sac simple. Spindle muscle not extending beyond intestinal loop. Nephridia two only, hang freely in the coelom.

Phascolopsis gouldii (Pourtales 1851)

(Pl. III, Figs. 6 to 11)

Sipunculus gouldii Pourtales, 1851, p. 40.
Phascolosoma gouldii Diesing, 1851, p.588; Baird, 1868, p. 85; Keferstein, 1865, p. 205.

Present record:

6 specimens were collected from Port Blair (Andaman Island) and 3 from Gulf of Mannar.

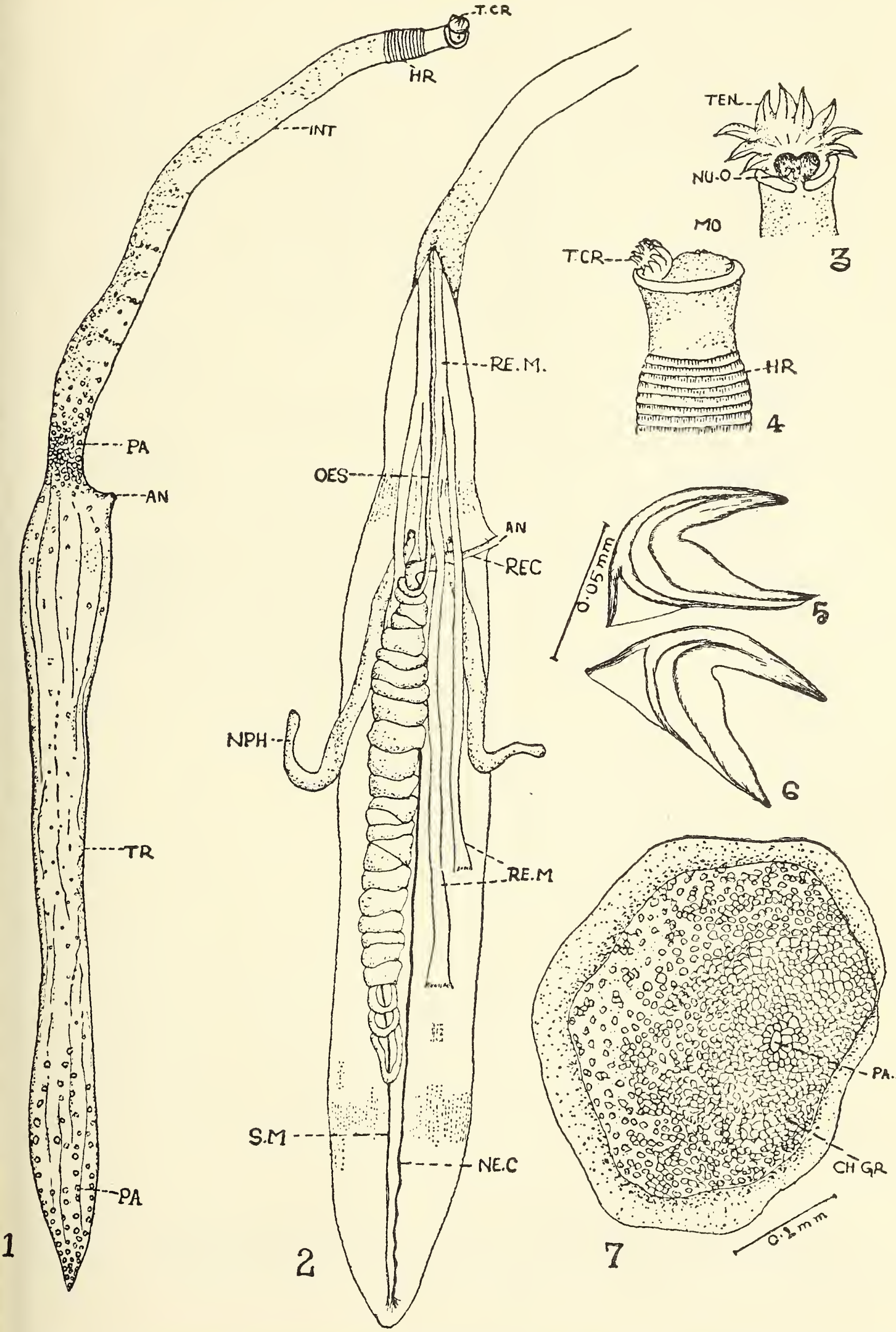
Distribution:

Mediterranean Sea, British Coasts, Coast of New England and Long Island, New York, *Description :*

Slender and elongated forms, the trunk varying in length from 85 to 260 mm. Introvert considerably shorter than the trunk measuring only 15 to 50 mm. in length. The maximum width of the body varies from 6 to 8 mm. (Pl. III, Fig. 6). Body wall thick and opaque, and smooth in appearance. However, under magnification numerous minute and round papillae are seen distributed densely all over the trunk and the introvert. The introvert is not distinctly marked off from the trunk. The anus is located on the dorsal side of the animal about 3 mm. below the base of the introvert. The two nephridial openings can be observed on the ventral side, at the anterior region of the trunk. The introvert carries a well developed tentacular crown at its tip (Pl. III, Fig. 11). The tentacles are numerous and filiform and are arranged in a double series of folds. All the folds are continuous. Each fold contains about 15 to 20 tentacles. The mid-dorsal fold extends nearly to the mouth forming a loop to enclose the well developed nuchal organ. The tentacles are grooved on the oral side.

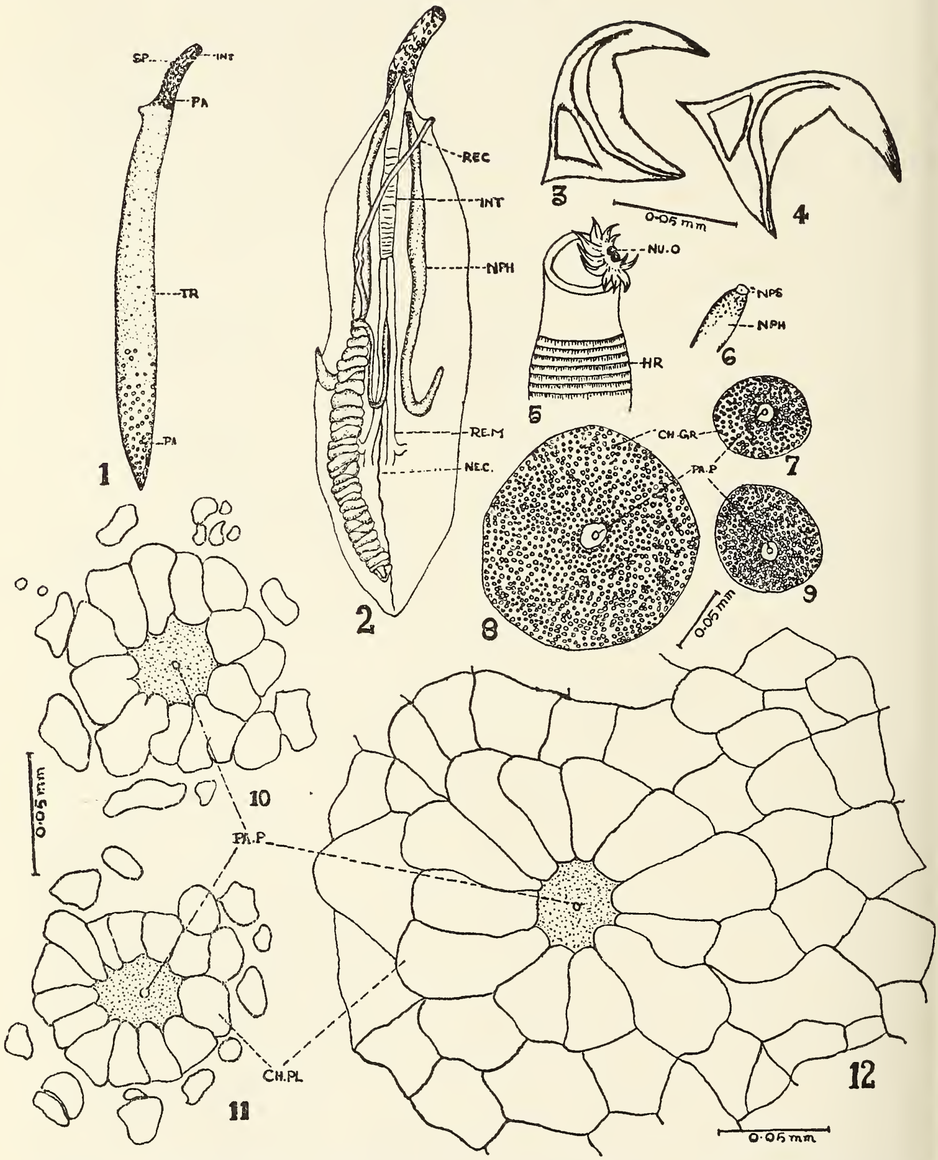
The longitudinal muscle layer of the trunk wall is separated into longitudinal bands. The number of bands varies considerably from specimen to specimen and even in the same specimen at different regions. In a single specimen, it varies from 36 to 42 and it is mainly due to the tendency of the bands to anastomose. In the introvert region the longitudinal muscle layer is continuous. There are four retractor muscles which are thin and slender. The dorsals are attached to the body wall anteriorly to the ventrals, and reach the anterior one-fifth of the trunk-length while the ventrals extend up to two-fifths of the trunk-length. The dorsals merge with the first and fifth longitudinal bands and the ventrals the eighth to fifteenth. At the introvert region, the ventrals and the dorsals fuse to form single bands, which finally fuse again to form a single stout band. On the dorsal aspect of this stout band runs the oesophagus, the latter being attached to it by mesenteries. Nephridia are two in number. They are brownish, long, tubular and free from the body wall in their entire length. The nephrostome is fan-shaped, frilled marginally and comparatively inconspicuous (Pl. III, Fig. 9). The two nephridia open ventrally at the same level, but far anteriorly to the anal opening. The loop of the alimentary canal does not even reach half of the trunk length. The intestinal coils vary from 60 to 64, and coil round a spindle muscle which is not attached to the posterior part of the trunk. The spindle muscle arises near the anus, runs along the rectum, very close to the rectal caecum and enters the intestinal coils as a thin strand and finally merges with the last coil of the intestine. The

Johnson: Sipunculids

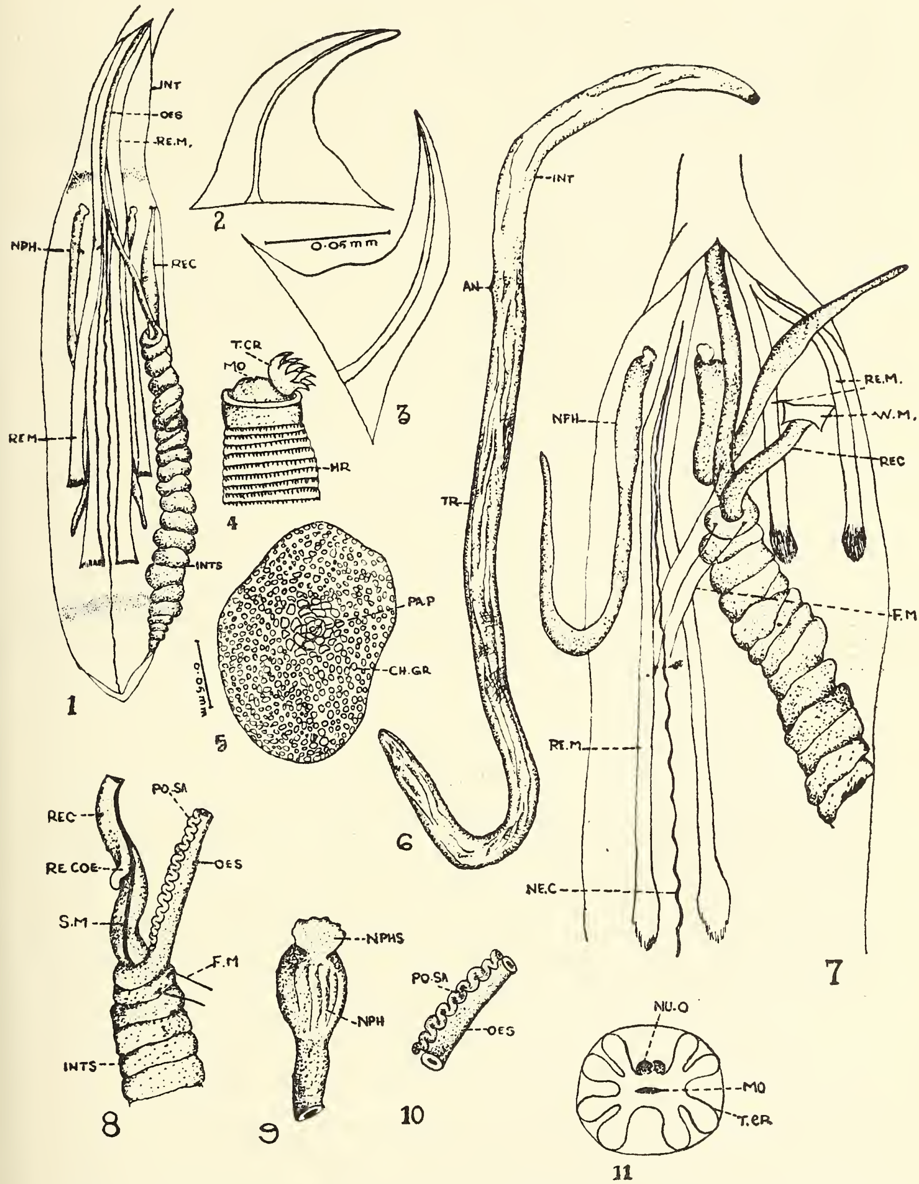


FIGS.: 1. *Phascolosoma andamanensis* sp. nov.; 2. Dissected; 3. Tentacular crown with nuchal organ; 4. Anterior region of the introvert; 5 & 6. Hooks from the introvert; 7. Papillae.

Johnson: Sipunculids

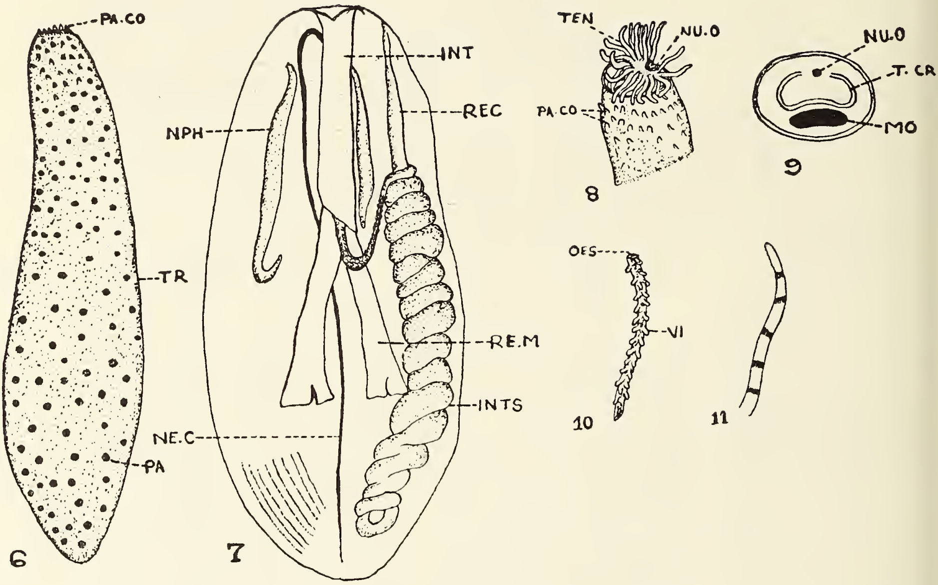


FIGS.: 1. *Phascolosoma spinosum* sp. nov.; 2. Dissected; 3 & 4. Hooks from the introvert; 5. Anterior region of the introvert; 6. Nephridium anterior region; 7, 8 & 9. Papillae; 10, 11 & 12. *Phascolosoma antillarum* Grube & Oersted—Papillae.



Figs.: 1. *Phascolosoma agassizii* Keferstein—Dissected; 2 & 3. Hooks from the introvert; 4. Anterior region of the introvert; 5. Papillae; 6. *Phascolopsis gouldii* (Pourtales); 7. Dissected; 8. Anterior region of intestinal coil; 9. Nephridium anterior region; 10. Part of oesophagus with pollian sac; 11. Tentacular crown-diagrammatic design.

Johnson: Sipunculids



Figs.: 6. *Phascolosoma antillarum* Grube & Oersted; 7. Dissected; 8. Anterior region of introvert; 9. Tentacular crown-diagrammatic design; 10. Part of oesophagus with pollian sac; 11. Tentacle.

Abbreviations

AN: Anus; CH.GR: Chitinous granules; CH.PL: Chitinous plates; F.M.: Intestinal fastener; HR: Hook rings; INT: Introvert; INTS: Intestine; NE.C: Nerve cord; OES: Oesophagus; PA.P: Papillary pore; PA: Papillae; PO.SA: Pollian sac; REC: Rectum; RE.M: Retractor Muscle; RE.COE: Rectal caecum; SP: Spine; TCR: Tentacular crown; TR: Trunk; TEN: Tentacle; VI: Villi; W.M: Wing muscle; NPH: Nephridium; NPS: Nephrostome; MO: Mouth; NU.O: Nuchal organ.

intestinal coils are held close to the spindle muscle by thin membraneous mesenteries. The rectum is short, highly muscular and possesses a rectal caecum. The last part of the rectum is fixed to the body wall by wing muscle (Pl. III, Fig. 7). The pollian sac is very prominent and takes a sinuous course along the dorsal side of the oesophagus and extends far into the first few coils of the intestine. It is simple without any villi and almost equal in diameter to the oesophagus (Pl. III, Fig. 8). There are three intestinal fasteners, all of which arise from the ventral wall close to the nerve cord. Two of them are attached to the first whorl of the intestine while the other is attached to the last part of the oesophagus. The coelom contains eggs.

Remarks:

The specimens in my collection are identified mainly on the nature of the tentacular crown, the simple pollian sac and the longitudinal muscle layer being in bundles. The species may be mistaken to be a *Siphonosoma* Spengel from the external appearance.

Acknowledgements

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References

Baird, W. (1868): Monograph of the species of worms belonging to the subclass Gephyrea. *Proc. Zool. Soc. London*, pp. 76-114.

Bather (1900): Zoological Record, Echinoderms, p. 78.

Chamberlin (1919): Notes on the Sipunculids of Laguna Beach, Pomona Coll. Tour. *Ent. and Zool.* pp. 30-31.

Diesing (1851): System Helminthum, Vol. 2. Vidobonae.

Fischer, W. (1895): Die Gephyreen des naturhistorischen Museum zu Hamburg **13**: 1-24.

Fisher, W. K. (1950): The sipunculid genus *Phascolosoma*. *Ann. Mag. Nat. Hist. London* 3 (12): 547-552.

——— (1952): The sipunculid worms of California and Baja California. *Proc. U.S. Nation. Mus.* **102**: 371-450.

Gerould, J. (1913): The sipunculids of the eastern coast of North America. *Proc. U.S. Nation. Mus.* **44**; 373-437.

GRUBE, E. & OERSTED, A. S. (1859): Annulata Oerstediana. Vid. Medd. naturh. Foren. Kjobenhavn for 1858.

IKEDA, I. (1904): The Gephyrea of Japan. *Jour. College Sci. Uni. Tokyo,* **20** (4): 1-87.

JOHNSON, P. (1964): Two new species of Aspidosiphon (Sipunculoidea). *Ann. Mag. Nat. Hist. London* 7 (13) : 331-335.

——— (1969); A new subgenus of *Xenosiphon* (Sipuncula) and the description of a new species from Indian Waters. *J. Bombay nat. Hist. Soc.* **66**: 43-46.

KEFERSTEIN, W. (1862): Beitrage zur Kenntniss der Gattung *Phascolosoma. Zeit. Wiss. Zool.* **12** : 35-51.

——— (1865a): Beitrage zur anatomischen und systematischen Kenntniss der Sipunculiden. *Zeit. Wiss. Zool.* **15**: 189-209.

——— (1866): Untersuchungen uber einige amerikanichen Sipunculiden. *Nachr. Ges. Wiss. Gottingen,* pp. 215-228.

——— (1867): Untersuchungen uber einige amerikanichen Sipunculiden. *Zeit. Wiss. Zool.* **17** : 44-55.

LAMBERT, J. (1900): Etude sur quelques echinides de l'infralias et du lias. *Bull. Soc. Sci. l'Yonne* **53**: 3-57.

LANCHESTER, W. (1905): The sipunculids and echiurids collected during the Skeet Expedition to the Malay Peninsula. *Proc. Zool. Soc. London* **1** : 35-41.

LEUCKART, F. S. (1828): Breves animalium quorumdum maxima ex parte marinorum descriptions. Heidelberg.

PRASHAD, B. (1937): On the Sipunculoidea from the Indian Waters in the Indian Museum, Calcutta. *Rec. Ind. Mus.* **38**: 231-238.

POURTALES, L. F. (1851): On the Gephyrea of the Atlantic coast of the United States. *Proc. Amer. Asso. Adv. Sci.*, 5th meeting, pp. 39-42.

QUATREFAGUS, J.L.A. (1866): Histoire naturelle des anneles marins et d'eau douce, vol. 2, Paris.

SATO, H. (1939): Studies on the Sipunculids of Japan. *Sci. Rept. Tohuku Univ. Sci.. ser* 4, *Biol.* **14**: 339-460.

SELENKA, E., BULOW, C., & DE MAN, I.G. (1883): Die Sipunculiden. Reisen im Archipel der Philipinen von Dr. C. Semper, Theil 2, Bd. 4; Abth. 1.

SELENKA, E. (1897): Die Sipunculiden-Gattung. *Phymosoma. Zool. Anz.* **20** : 460.

SHIPLEY, A. E. (1903): Report on the Gephyrea collected by Prof. Herdman at Ceylon in 1902. Ceylon Pearl Oyster Fisheries—1903—Supplementary reports No. III, pp. 169-176.

WESENBERG-LUND, ELSE (1954b): Priapuloidea, Sipunculoidea and Echiuroidea. *Bull. Inst. Sci. Nat. Belgium* **30** (16): 1-18.

Spider Fauna of India: Catalogue and Bibliography

BY

B. K. Tikader

Zoological Survey of India, 8, *Lindsay Street*, *Calcutta*-16

[*Continued from Vol.* **67** (2): 221]

Family Oxyopidae

Genus *OXYOPES* Latreille 1806

194. **Oxyopes chittrae** Tikader 1965. *Proc. Indian Acad. Sci.* **62**: 141, fig. 1a-c.

Distribution: India: National Chemical Laboratory Compound, Poona, Maharashtra.

Type: **ZSI.**

195. **Oxyopes hindostanicus** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13**: 482.

Distribution: India: Throughout India and Ceylon.

Type: **BMNH.**

196. **Oxyopes ryvesii** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13**: 482.

Distribution: India: Allahabad, U.P.

Type: **BMNH.**

197. **Oxyopes sushilae** Tikader 1965. *Proc. Indian Acad. Sci.* **62**: 142, fig. 2a, b.

Distribution: India: Poona University Compound, Maharashtra.

Type: **ZSI.**

198. **Oxyopes wroughtoni** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13**: 483.

Distribution: India: Bulsar, Gujarat.

Type: **BMNH.**

Genus *PEUCETIA* Thorell 1869

199. **Peucetia choprai** Tikader 1965. *Proc. Indian Acad. Sci.* **62** : 143, fig. 3a-c.

Distribution: India: Pashan near Poona City, Maharashtra.

Type: **ZSI**.

200. **Peucetia graminea** Pocock 1900. FAUNA BRIT. INDIA *Arachnida*, p. 356.

Distribution: India: Western India, Bulsar in Gujarat.

Type: **BMNH.**

201. **Peucetia viridana** Stoliczka 1869. *J. Asia. Soc. Bengal* **38** : 220, fig. i.

Distribution: India: Madras, Pondicherry, Ootacamund, Travancore, Calcutta. Ceylon.

Type: **ZSI**.

Family PHOLCIDAE

Genus *ARTEMA* Walckenaer 1837

202. **Artema atlanta** Walckenaer 1837. *Ins. Apt.* **1** : 656.

Distribution: India: Travancore, Meerut, Rajasthan, Poona, West Bengal, East Khandesh, Karachi, Calcutta. Burma. Ceylon.

Type: ?

Genus *CROSSOPRIZA* Simon 1893

203. **Crossopriza lyoni** (Blackwall) 1867

Pholcus lyoni Blackwall 1867. *Ann. Mag. Nat. Hist.* **19** : 392.

Distribution: India: Madras, Allahabad, Rajasthan, Meerut, West Bengal. Burma.

Type: **BMNH.**

Genus *SMERINGOPUS* Simon 1890

204. **Smeringopus elongatus** Vinson 1863. *Aran. Reunion, etc.*, p. 135, fig. 5.

Distribution: India: Trivandrum, Pondicherry, Andaman Islands. Burma. Ceylon.

Type : ?

Family PLATORIDAE

Genus *PLATOR* Simon 1880

205. **Plator indicus** Simon 1897. *Mem. Soc. Zool. France* **10** : 256.
Distribution: India: Himalayas, Western India, Poona, Konkan, Mundali, Dalhousie.
Type: MNHN.

206. **Plator ixodinus** Pocock 1899. *J. Bombay nat. Hist. Soc.* **12** : 753.
Distribution: India: Konain and Mundali in the Himalayas.
Type: **BMNH.**

Family PSECHRIDAE

Genus *FECENIA* Simon 1887

207. **Fecenia travancoria** Pocock 1899. *J. Bombay nat. Hist. Soc.* **12** : 750.
Distribution: India: Madatory, Kerala.
Type: **BMNH.**

Genus *PSECHRUS* Thorell 1878

208. **Psechrus alticeps** Pocock 1899. *J. Bombay nat. Hist. Soc.* **12** : 751.
Distribution: India: Trivandrum, Kerala.
Type: **BMNH.**

Family SALTICIDAE

Genus *HARMOCHIRUS* Simon 1885

209. **Harmochirus lloydii** Narayan 1915. *Rec. Indian Mus.* **11** : 394, fig. 1.
Distribution: India: Calcutta.
Type: **ZSI.**

Genus *LYSSOMANES* Hents 1845

210. **Lyssomanes sikkimensis** Tikader 1967. *Proc. Indian Acad. Sci.* **66** : 120, fig. 3a, b.
Distribution: India: Ligship, West Sikkim.
Type: **ZSI.**

Genus *MAEVIA* Koch 1846

211. **Maevia himalaya** Tikader 1967. *Proc. Indian Acad. Sci.* **66** : 118, fig. 2a, b.

Distribution: India: Gezing, W. Sikkim.

Type: **ZSI.**

Genus *MARPISSA* Koch 1846

212. **Marpissa tigrina** Tikader 1965. *Sci. & Cult. Calcutta* **31** : 261, fig. 1a, b.

Distribution: India: Poona, Maharashtra.

Type: **ZSI.**

Genus *MYRMARACHNE* Macleay 1899

213. **Myrmarachne himalayensis** Narayan 1915. *Rec. Indian Mus.* **11** : 399, fig. 2.

Distribution: India: Chumti, Darjeeling district, West Bengal.

Type: **ZSI.**

214. **Myrmarachne incertus** Narayan 1915. *Rec. Indian Mus.* **11** : 396, fig. 2.

Distribution: India: Calcutta, Pusa, Bihar.

Type: **ZSI.**

215. **Myrmarachne laetus** Thorell 1895. SPIDERS OF BURMA, p. 320.

Distribution: India: Calcutta, Madras, Nicobar Islands. Burma.

Type: **BMNH.**

216. **Myrmarachne manducator** (Westwood) 1841.

Salticus manducator Westwood 1841. *Mag. de. Zool.*, pl. 1.

Distribution: India: Siripur, Saran, Bihar. Singapore. Burma.

Type: ?

217. **Myrmarachne paivae** Narayan 1915. *Rec. Indian Mus.* **11** : 403, fig. 3.

Distribution: India: Katihar, Purnea district, Bihar.

Type: **ZSI.**

218. **Myrmarachne plataleoides** (Cambridge) 1869.

Salticus plataleoides Cambridge 1869. *Ann. Mag. Nat. Hist.* **3** : 68.

Distribution: India: Calcutta, Sibpur near Calcutta, Pusa, Bihar. Ceylon.

Type: **BMNH.**

219. **Myrmarachne ramunii** Narayan 1915. *Rec. Indian Mus.* **11** : 400.

Distribution: India: Madras.

Type: **ZSI.**

220. **Myrmarachne satarensis** Narayan 1915. *Rec. Indian Mus.* **11** : 404.

Distribution: India: Koyna, Satara district, Maharashtra.

Type: **ZSI.**

221. **Myrmarachne tristis** Simon 1889. *Ann. Soc. Ent. France*, p. 115.

Distribution: India: Calcutta, Madras.

Type: **MNHN.**

222. **Myrmarachne uniseriatus** Narayan 1915. *Rec. Indian Mus.* **11** : 402.

Distribution: India: Madras.

Type: **ZSI.**

Genus *PLEXIPPUS* Koch 1846

223. **Plexippus paykulli** (Aud.) 1825.

Attus paykulli Aud. 1825. *Savigny's Descr. Egypt Arach.* **1** (4) : 172.

Distribution: India: Rothak, West Sikkim, Shillong, Allahabad. America. Europe. Africa. Burma. Ceylon.

Type: ?

Genus *SALTICUS* Latreille 1804

224. **Salticus ranjitus** Tikader 1967. *Proc. Indian Acad. Sci.* **66** : 117, fig. 1a-e.

Distribution: India: Nayabazar, Sikkim, Gujarat.

Type: **ZSI.**

Family Scytodidae

Genus *LOXOSCELES* Heinecken & Lowe 1832

225. **Loxosceles indrabeles** Tikader 1962. *Proc. Zool. Soc.* **16** : 24, fig. 1a-c.

Distribution: India: Poona, Maharashtra.

Type: **ZSI.**

Genus *SCYTODES* Latreille 1804

226. **Scytodes mawphlongensis** Tikader 1966. *Curr. Sci.* **35** : 627, fig. 1a-d.

Distribution: India: Khasi and Jaintia Hills, Assam.

Type: ZSI.

227. **Scytodes propinqua** Stoliczka 1869. *J. Asia. Soc. Bengal* **38** : 222.

Distribution: India: Calcutta, Poona, Punjab.

Type: ZSI.

228. **Scytodes semipullata** Simon 1908. *Bull. Sci. Fran. Belgigue* **42** : 75.

Distribution: India: Siju cave, Garo Hills, Assam.

Type: MNHN.

229. **Scytodes thoracica** (Latreille) 1802.

Aranea thoracica Latreille 1802. *Hist. Nat. Incrus. Ins.* 7: 249.

Distribution: India, Australia, Europe, America and Africa.

Type: ?

Family Sparassidae

Genus *SPARASSUS* Walckenaer 1805

230. **Sparassus admiratus** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13** : 492.

Distribution: India: Bombay, Maharashtra.

Type: BMNH.

231. **Sparassus impudicus** Thorell 1887. *Ann. Mus. Genova* **25** : 241.

Distribution: India: Andaman Islands, Burma.

Type: BMNH.

232. **Sparassus lamarcki** (Latreille) 1806.

Thomisus lamarcki Latreille 1806. *Gen. Crust. etc.* **1**: 115.

Distribution: India: Chingleput, Coimbatore, Pondicherry. Ceylon. Madagascar.

Type: ?

233. **Sparassus patagiatus** Simon 1897. *Mem. Soc. Zool. France* **10** : 256.

Distribution: India: Dehra Dun.

Type: MNHN.

234. **Sparassus phipsoni** Pocock 1899. *J. Bombay nat. Hist. Soc.* **12** : 752.

Distribution: India: Bombay.

Type: BMNH.

235. **Sparassus stimulator** Simon 1897. *Mem. Soc. Zool. France* **10** : 258.

Distribution: India: Himalayas.

Type: MNHN.

236. **Sparassus tener** Thorell 1891. *K. Sv. Vet. Akad. Hondl.* **24** : 80, fig. 1.

Distribution: India: Assam.

Type: BMNH.

237. **Sparassus wroughtoni** Simon 1897. *Mem. Soc. Zool. France* **10** : 257.

Distribution: India: North Konkan, Maharashtra, Bulsar, Gujarat.

Type: MNHN.

238. **Sparassus milleti** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13** : 494.

Distribution: India: Nasik, Maharashtra.

Type: BMNH.

239. **Sparassus rotundiceps** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13** : 493.

Distribution: India: Ootacamund.

Type: BMNH.

240. **Sparassus obesulus** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13** : 493.

Distribution: India: Poona, Maharashtra.

Type: BMNH.

241. **Sparassus pearsoni** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13** : 492.

Distribution: India: Poona, Eastern Khandesh, Maharashtra.

Type: BMNH.

242. **Sparassus iranii** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13** : 492.

Distribution: India: Poona, Maharashtra.

Type: BMNH.

243. **Sparassus hampsoni** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13** : 491.

Distribution: India: Nilgiri Hills.

Type: **BMNH.**

244. **Sparassus fuligineus** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13** : 491.

Distribution: India: Satara, Maharashtra.

Type: **BMNH.**

Family TETRAGNATHIDAE

Genus *EUCTA* Simon 1881

245. **Eucta javana** Thorell 1895. SPIDERS OF BURMA, p. 146.

Distribution: India: Western Ghats, Travancore, Bangalore, Mysore, Ootacamund, Nilgiri Hills, Chilka Lake, Madras, Nagpur, Bihar, West Bengal, Shillong. Sikkim. Burma.

Type: **BMNH.**

Genus *ORSINOME* Thorell 1890

246. **Orsinome armata** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13**: 480.

Distribution: India: Shillong, Assam.

Type: **BMNH.**

247. **Orsinome listeri** Gravely 1921. *Rec. Indian Mus.* **22**: 449, fig. 7c.

Distribution: India: Pashok, Singla, Darjeeling district, West Bengal.

Type: **ZSI.**

248. **Orsinome marmorea** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13**: 479.

Distribution: India: North Kanara, Nilgiri Hills, Pachmari, in the Satpura Hills, Maharashtra.

Type: **BMNH.**

Genus *TETRAGNATHA* Latreille 1804

249. **Tetragnatha caelestis** Pocock 1901. *J. Bombay nat. Hist. Soc.* 13: 478.

Distribution: India: Shillong, Assam.

Type: **BMNH.**

250. **Tetragnatha cochinensis** Gravely 1921. *Rec. Indian Mus.* **22**: 442, fig. 4a, b.

Distribution: India: Cochin, Bangalore, Nilgiri Hills, Parambikulam.

Type: ZSI.

251. **Tetragnatha delumbis** Thorell 1891. *Sv. Ak. Handl.* **24**: 149.

Distribution: India: Little Nicobar.

Type: ZSI.

252. **Tetragnatha fletcheri** Gravely 1921. *Rec. Indian Mus.* **22**: 440, fig. 3a.

Distribution: India: Shillong, Assam.

Type: ZSI.

253. **Tetragnatha geniculata** Karsch 1892. *Berlin. Ent. Zeit.* **36**: 267.

Distribution: India: Poona, Maharashtra, Nilgiri Hills, Madras.

Type: ?

254. **Tetragnatha gracilis** (Stoliczka) 1869. *J. Asia. Soc. Bengal* **38**: 202.

Distribution: India: Chingleput, Calcutta, Andaman Islands, Bangalore, Madras, Darjeeling, Kalimpong. Ceylon. Burma.

Type: ZSI.

255. **Tetragnatha listeri** Gravely 1921. *Rec. Indian Mus.* **22**: 443, fig. 4c, d.

Distribution: India: Kalimpong, Darjeeling, Ernakulam, Cochin, Shillong. Ceylon. Burma. East Pakistan. Nepal. Siam.

Type: ZSI.

256. **Tetragnatha mackenziei** Gravely 1921. *Rec. Indian Mus.* **22**: 438, fig. 1e, g.

Distribution: India: Western Ghat, Travancore, Mahabaleshwar, Bangalore, Mysore, Siripur, Bihar, Calcutta, Salt Lake.

Type: ZSI.

257. **Tetragnatha mandibulata** Walckenaer 1837. *Hist. Nat. Ins. Apteres* **2**: 211.

Distribution: India: Poona, Shillong, Nicobar Islands. Burma. Austro-Malaysia.

Type: ?

258. **Tetragnatha moulmeinensis** Gravely 1921. *Rec. Indian Mus.* **22**: 439, fig. 2.

Distribution: India: Shillong, Moulmein, Burma.

Type: **ZSI.**

259. **Tetragnatha paradisea** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13**: 479.

Distribution: India: Shillong, Assam.

Type: **BMNH.**

260. **Tetragnatha sutherlandi** Gravely 1921. *Rec. Indian Mus.* **22**: 444, fig. 5a, b.

Distribution: India: Shillong, Cochin, Trichur, Saran, Bihar, Serampore, West Bengal, Kalimpong, Darjeeling.

Type: **ZSI.**

261. **Tetragnatha viridorufa** Gravely 1921. *Rec. Indian Mus.* **22**: 445, fig. 6a, b.

Distribution: India: Barkuda Island in Chilka Lake, Puri, Orissa, Ernakulam.

Type: **ZSI.**

(*to be continued*)

Durgapur Barrage as a Waterbird Habitat

BY

F. M. GAUNTLETT

(*With a map*)

The paper summarises two years observations made in the vicinity of the Durgapur barrage in West Bengal and indicates the importance of this development in providing a waterbird habitat. The area is described and significant variations in the weather during the period are given. Observations are listed of those species which depend wholly or partly on a wetland habitat, and their status given.

GENERAL

When there is so much decrease in wild life due to habitat destruction it is pleasant to record a man-made development that can be shown to be of definite benefit.

In 1955, as part of the development of the Damodar River in W. Bengal and Bihar, a barrage was put across the Damodar at Durgapur for flood control and irrigation purposes. The reservoir so formed also supplies water to the heavy industry development on the north bank. It is located in Burdwan district about 170 km. (110 miles) north west of Calcutta.

DESCRIPTION

The shallow lake formed upstream is about 1.5 km. (1 mile) wide and 3 to 4 km. (2-2.5 miles) long. Due to siltation a large number of islands have formed which have become covered with a dense growth of reeds (*Phragmites*), rushes (*Juncus*) etc. with broad fringes of Water Hyacinth (*Eichhornia crassipes*). Some of the islands are of considerable size (several hectares) and are continuing to grow and new ones appear gradually. One large island adjacent to the south bank supports a small colony of reed cutter's huts, the occupants cutting the reeds for thatch. Cows are also grazed on it. While this activity makes a very small reduction in the total area of reed-bed available for nesting, it provides a feeding area for storks, egrets, plovers, snipe etc. The water level of the lake is kept almost constant throughout the year, varying by about only 50 to 75 cm. (20-30 in.).

An area of *c.* 13 ha. (*c.* 30 acres) enclosed by the south bank efflux bund is used as a fish farm by the state government. The water in the fish farm is clear as distinct from the heavily silt laden river water and its level is more dependent on rainfall.

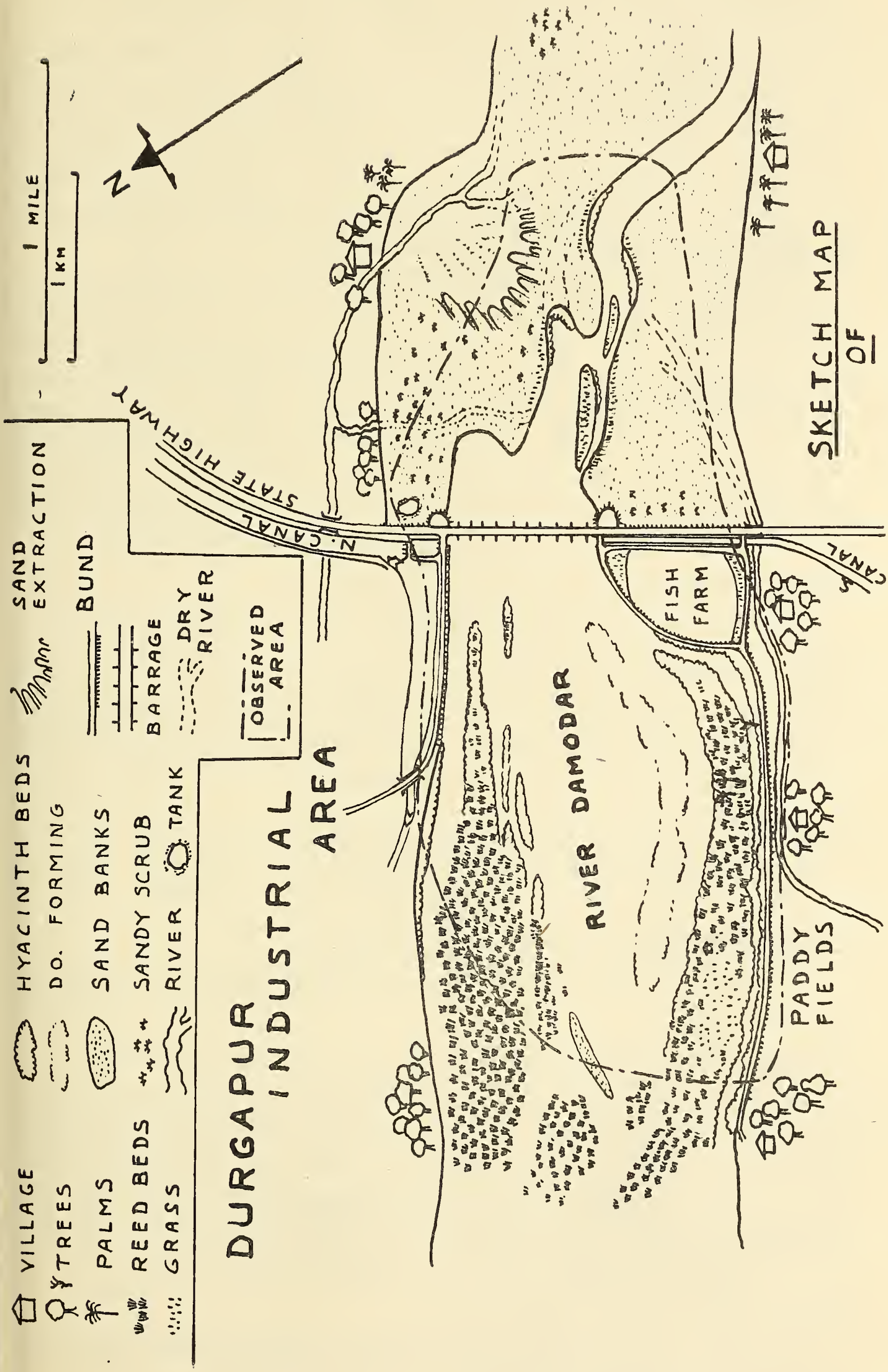
The river bed downstream of the barrage is similar to many of the larger rivers of the N. Indian plains. In the dry season there is a wide expanse of sand through which there is a shallow sluggish flow of water that becomes a raging torrent during the monsoon. However, even during the dry season, some water passes through, bringing with it silt and water plants which produce a rich growth along the water's edge providing a good feeding ground for waders. Occasionally the water level rises due to excess discharge following thunderstorms and as the water level recedes the large areas of wet sand also provide suitable wader feeding ground. During such flashes, large quantities of water hyacinth become stranded at high water mark which slowly rot providing a flourishing breeding ground for insects which attract wagtails, pipits, larks and other insectivorous species.

Sand has been commercially extracted from the sand banks in an area near the north bank, permitting water to seep to the surface giving rise to a growth of short grasses and low plants thus further diversifying the habitat.

Observations began in March 1968 and the present paper summarises two years' activity, which is continuing. The area has been visited two or three times each month except August-October 1969 when the observer was on home leave. Most observations on the upstream side have been made in the afternoon from the south bank bund road which extends further along the river than that on the north. As the river flows from WNW to ESE the light is also better for observations made from this direction. The island with grazing area mentioned above was also readily observed from the south bank. Visits to the downstream side were usually made in the morning and observations made from the water's edge. The area covered downstream extended about 1.5 km. (1 mile) from the barrage.

The fluctuations in bird numbers cannot be considered in isolation from the variations in the weather. March 1968 was in the middle of an unusually dry spell following the poor monsoon of 1967. The 1968 wet season began at the end of May and continued till the beginning of October giving the wettest monsoon in West Bengal for 50 years with rainfall 50% above normal (press report). The following dry season also had excessive rainfall and maximum temperatures were lower than the previous year. The 1969 monsoon began a few days early at the beginning of June but petered out after a few days to return a month later in more normal strength.

The attitude of the Damodar Valley Corporation, the authority



SKETCH MAP OF DURGAPUR BARRAGE

responsible for the barrage and its storage lake, is encouraging from the conservation point of view. Bathing, fishing and shooting are prohibited on the lake and a sanctuary has thereby been created in effect if not in name. It would be gratifying if this state of affairs could be given official recognition so that the immense wealth of bird life which has been created could be considered from the conservation aspect if any changes or developments take place in the future. There can be few places in India, or anywhere else, where 10,000 ducks can be easily seen from a state highway against a backdrop of factory chimneys.

The only disturbance to which birds on the lake are subject are a few villagers fishing in country boats, but neither birds nor men take a great deal of notice of each other. The only imminent threat would be a large scale take over of the islands for agricultural purposes but it seems unlikely that the authorities would tolerate this. There was a press report towards the end of 1969 about the amount of siltation that had taken place and there was a scheme to drain and dredge the lake to restore its storage capacity but no action has been taken so far. Such action would of course mean the loss of breeding habitat for the resident birds.

Podiceps cristatus (Linnaeus) Great crested Grebe

A single record of 2 birds on 8.ii.69.

Podiceps ruficollis (Pallas) Little Grebe

Present throughout the year in varying numbers. A small resident population augmented by a winter influx with a further increase in times of drought elsewhere. Largest flock of about 100 on 11.v.68.

Phalacrocorax fuscicollis Stephens Indian Shag

Possibly overlooked amongst the flocks of the next species, and if so more numerous than the single record on 18.v.68 suggests.

Phalacrocorax niger (Vieillot) Little Cormorant

A common resident, usually between about 10 and 50 but a maximum of 150 on 2.ii.69.

Anhinga rufa (Daudin) Darter

Two or three birds present on almost every visit between March and Nov. 1968 with a juvenile on 25 August indicating possible breeding. However, the only subsequent record was a single bird on 24.v.69. There are two possible reasons for the birds' departure: firstly that the water had become too shallow, and secondly, that the birds have been actively discouraged from the fish farm which was their favourite haunt.

Ardea cinerea Linnæus Grey Heron

Probably resident but not recorded during May-August. Maximum of 10 on 18.i.69 and 12 on 1.ii.70.

Ardea purpurea Linnæus Purple Heron

Probably resident but not recorded during July-Nov. six or 7 was the largest number seen in one day (22.vi.68) but actual numbers are likely to be considerably higher. It is quite possible that both this and the preceding species disperse to the surrounding paddy fields during and after the monsoon.

Butorides striatus (Linnæus) Little Green Heron

Status uncertain. This nocturnal species has been seen in the late afternoon on 5 occasions between Jan. and April, always on or near the piers of the barrage itself.

Ardeola grayii (Sykes) Pond Heron

Very common resident but the total numbers are difficult to estimate and must be several hundred.

Bubulcus ibis (Linnæus) Cattle Egret

Common resident but less aquatic than other herons and egrets. Usually between 50 and 100 in the area.

Egretta alba (Linnæus) Large Egret

Resident. The determination of the actual and relative status of this and the two following species is difficult because it is impossible to count all the egrets in the area at one time and not easy to distinguish between them at long ranges. There are estimated to be 8 or 10 of the present species.

Egretta intermedia (Wagler) Smaller Egret

Resident. About twice as numerous as the previous species.

Egretta garzetta (Linnæus) Little Egret

Very common resident always present in large numbers, probably between 250 and 300.

Nycticorax nycticorax (Linnæus) Night Heron

The status of this species is rather puzzling. Apparently absent for most of the year, it suddenly appears in some numbers (50+) just before and during the monsoon. Recorded from May to August, once April.

Ixobrychus cinnamomeus (Gmelin) Chestnut Bittern

Observed only when active during the monsoon from June to August. At least 6, probably many more in the inaccessible areas.

Ixobrychus sinensis (Gmelin) Yellow Bittern

As above, but at least 12 from April to August.

Dupetor flavicollis (Latham) Black Bittern

This allegedly shy species is also quite active during the monsoon, flying about over the reed beds and visiting nearby paddy fields. Never more than one seen at a time, from May to August.

Ibis leucocephalus (Pennant) Painted Stork

A single immature bird on 17-iii-68 is the only record.

Anastomus oscitans (Boddaert) Openbill Stork

An irregular visitor, occuring in any month in numbers up to 30. (This number has been greatly exceeded just after the scope of the present review ended).

Leptoptilos javanicus (Horsfield) Lesser Adjutant

A single bird settled on the sandbanks on 23-ii-69. The locality and habitat might indicate that the bird was actually. *L. dubius*, but I saw both species in Assam a week later where *javanicus* was much commoner, and in fact was the common stork of the area and I am satisfied that the present designation is correct.

Threskiornis melanocephala (Latham) White Ibis

Scarce monsoon visitor. Two records for June and July.

Anser indicus (Latham) Barheaded Goose

Four birds flying up-river on 17-iii-68.

Dendrocygna javanica (Horsfield) Lesser Whistling Teal

Resident, probably breeding in small numbers, but with large winter influx reaching a peak of about 2,000 on 22-ii-70. It is possible that the Large Whistling Teal *D. bicolor* is also present among the flocks of the smaller species but none have been identified for certain.

Tadorna ferruginea (Pallas) Ruddy Sheld-duck

Common winter visitor with flocks up to 25 on the lake or the sand banks, but 82 on the lake on 11-i-69 was exceptional.

Anas acuta Linnæus Pintail

Winter visitor in huge numbers, outnumbering all other duck together between Dec. and Feb. A few also in Nov. and March, latest 3 on 19-iv-68. Peak numbers were 8,000 on 8-15-ii-69 and an incredible 12,000 to 15,000 on 1-ii-70. These large flock appear to be birds gathering prior to departure because numbers drop rapidly afterwards.

Anas crecca Linnæus Teal

Common winter visitor, up to 500 from Nov. to March.

Anas platyrhynchos Linnæus Mallard

Four birds on 23-xi-69 is the only record.

Anas strepera Linnæus Gadwall

Regular winter visitor in small numbers, sometimes up to 200. Nov. to March.

Anas penelope Linnæus Wigeon

Winter visitor from Dec. to March, maximum 25.

Anas querquedula Linnæus Garganey

Common winter visitor from Nov. to March, most numerous in Feb. to March with maximum of 500 on 15-ii-69.

Anas clypeata Linnæus Shoveller

Regular winter visitor, in numbers up to 60 from Jan. to March.

Netta rufina (Pallas) Redcrested Pochard

Three winter records of up to 12 birds in Dec. and Jan.

Aythya ferina (Linnæus) Pochard

Irregular winter visitor with 4 records of up to 20 birds from Dec. to March.

Aythya fuligula (Linnæus) Tufted Duck

Regular winter visitor from Nov. to April, maximum numbers in March, 100 in 1969, 200 in 1970. One record for 1 bird on 2-vi-68.

Aythya nyroca (Güldenstädt) White-eyed Pochard

Only 2 records, 1 bird on 31-iii-68 and 2 on 15-ii-69. Possibly overlooked amongst female Tufted Duck.

Nettapus coromandelianus (Gmelin) Cotton Teal

Resident, probably breeding in some numbers. Winter flocks of up to 150.

Sarkidiornis melanotos (Pennant) Comb Duck

Not recorded until 11-i-69 but regular from Dec. to April since. Maximum of 70 on 15-ii-69.

Haliastur indus (Boddaert) Brahminy Kite

Irregular visitor at any time of the year. Normally only one bird at a time.

Circus macrourus (S. G. Gmelin) or **C. pygargus** (Linnæus) Pallid Harrier or Montagu's Harrier

A female or immature, a very slender bird hunting over a reed bed. From shape and habitat I am inclined to feel the bird was Montagu's but this would be my only record for W. Bengal, whereas the Pallid Harrier is quite common in winter over dry paddy fields. Seen on 14-xii-68.

Circus melanoleucos (Pennant) Pied Harrier

Six records between Nov. and March.

Circus aeruginosus (Linnæus) Marsh Harrier

Seen very regularly in every month except May-July, usually 2 birds. Very useful as a 'beater' because a harrier passing over a reed bed causes all the otherwise hidden occupants to take flight.

Pandion haliaetus (Linnæus) Osprey

Almost permanent resident, recorded on every visit in 1968 with 2 on 25th August. Frequent, but a little less regular since.

Amaurornis phoenicurus (Pennant) Whitebreasted Waterhen

The comparatively few records of this species must give a false impression of its status. Seen only from March to August. A family party with newly hatched chicks on 25-viii-69.

Gallicrex cinerea (Gmelin) Watercock

Becomes quite active just before and during the monsoon, from May to August, flying about over the reed beds and visiting paddy fields. At least 2 birds, but probably many more in the inaccessible islands.

Gallinula chloropus (Linnæus) Moorhen

Apparently only present from March to August. Up to 7 on one occasion but this can only be a minimum.

Porphyrio porphyrio (Linnæus) Purple Moorhen

Probably resident but seen only when active just before and during the monsoon, from March to August. 7 or 8 at once on the grazing island, probably more elsewhere.

Fulica atra (Linnæus) Coot

Apart from a single bird on 2-vi-68, a small wintering flock of about twelve birds, from Dec. to February.

Hydrophasianus chirurgus (Scopoli) Pheasant-tailed Jaçana

Common in every month except Sept.-Nov. (However, my visits were least frequent at this time), probably breeding in numbers. Flocks of 100 or more in breeding plumage in March.

Metopidius indicus (Latham) Bronzewinged Jaçana

Less numerous but more consistent than the preceding species on the whole. At least 20 pairs, probably many more, seem likely to breed. Recorded in every month except Sept. and Oct. Maximum 50-60 in March.

Vanellus indicus (Boddaert) Redwattled Lapwing

Several pairs present, probably breeding judging by their mobbing behaviour, between Feb. and Oct. Apparently disperses during the cold weather.

Pluvialis squatarola (Linnæus) Grey Plover

One bird on a sand bank just below the barrage on 24-iii-68. (A second record of 1 on some fallow land a few km. away in Bankura district in the period under review may indicate the species is less uncommon on passage inland than is generally supposed).

Pluvialis dominica (P.L.S. Müller) Lesser (or Eastern) Golden Plover

Regular winter flock of about 50 from Dec. to April.

Charadrius hiaticula (Linnæus) or **C. placidus** J. E. & G. R. Gray Ringed Plover or Longbilled Ringed Plover

A typical 'ringed' plover on 16-iii-69 showing a conspicuous wing bar in flight was one species or the other. From their relative status in India as a whole the Longbilled Ringed Plover is the much more likely of the two.

Charadrius dubius Scopoli Little Ringed Plover

Ten to twelve birds on the sand banks from Sept. to April, probably breeding.

Charadrius alexandrinus Linnæus Kentish Plover

Up to 40 from Sept. to April. A few pairs may breed.

Charadrius mongolus Pallas Lesser Sand Plover

Single birds on 7-ix-68, 6-xii-69 and 3-i-70. Possibly overlooked amongst flocks of Kentish Plover.

Numenius phaeopus (Linnaeus) Whimbrel or **N. arquata** (Linnæus) Curlew

Records of 1 and 6 flying over, heading SE, on 4th and 15th August 1968. I thought they were Whimbrel from the shape of the bill, (not a very reliable feature), but Curlew is more likely.

Tringa erythropus (Pallas) Spotted Redshank

Common winter visitor from Jan. to April, maximum 40. Contrary to the statement in Ali & Ripley (1968) it is not less numerous than Redshank *T. totanus*, the latter has not been recorded here, or anywhere in W. Bengal by me.

Tringa stagnatilis (Bechstein) Marsh Sandpiper

Probably regular winter visitor in small numbers. 8 records Sept. to March, maximum 6.

Tringa nebularia (Gunnerus) Greenshank

One of the most regular and consistent of winter visitors between Sept. and April, up to 20. (The similarity of Armstrong's Sandpiper *T. guttifer* has been known for the last winter of the review only but none have been identified despite close attention to all Greenshanks).

Tringa ochropus Linnæus Green Sandpiper

Common winter visitor in small numbers from Sept. to April. The total number of individuals and small groups hard to assess, but probably about 20.

Tringa glareola (Linnæus) Wood Sandpiper

Much more numerous than either the previous or next species. From Sept. to March, usually 20-30, sometimes up to 100.

Tringa hypoleucos (Linnæus) Common Sandpiper

Five or six individuals regularly from Sept. to March.

Capella gallinago (Linnæus) Fantail Snipe

Possibly resident, 1 record May, 2 in August. Regular from Nov. to March, maximum 15. All snipe have been assumed to be this species but the possibility of Swinhoe's Snipe *C. megala* and Pintail Snipe *C. stenura* also occurring cannot be ruled out. The only differences so far as is known is the number of tail feathers which cannot be discerned in the field.

C. minima (Brünnich) Jack Snipe

One on 3-i-70.

Calidris canutus (Linnæus) Knot

A single bird on 3-i-70 was the most surprising record of all because the species has only two previous records in the sub-continent, one in West Pakistan and one in Ceylon. The greater probability of the bird being an Eastern (or Great) Knot *C. tenuirostris* was considered but that species should be larger than a Lesser Golden Plover, 29 cm. *vs*. 24-25 cm. whereas a Knot should be about the same size, 25 cm. which this bird was. I am familiar with the species from previous experience in U.K.

Calidris minutus (Leisler) Little Stint

Regular in small flocks mixed with larger numbers of the next species. Most numerous in Feb., return migration?, when up to 100 recorded.

Calidris temminckii (Leisler) Temminck's Stint

Easily the most numerous of the wintering waders. 50 counted along about 400 m. of the water's edge formed only a small proportion of the total present. Earliest 9 Sept., latest 19 April. Same dates apply to previous species.

Philomachus pugnax (Linnæus) Ruff

Only 2 records on 15 Feb. and 30 March 1969. However the species has been seen more frequently at another locality 19 km. downstream.

Rostratula benghalensis (Linnæus) Painted Snipe

Only 3 records between 30 March and 27 April 1969, in lush waterside vegetation on the downstream side.

Himantopus himantopus (Linnæus) Blackwinged Stilt

A capricious winter visitor depending on water level between Jan. and March. Quite numerous when conditions are right, up to 50.

Glareola lactea Temminck Small Indian Pratincole

Common but erratic in numbers between Dec. and April, maximum 45.

Larus brunnicephalus Jerdon Brownheaded Gull

One flying up river on an unrecorded date in April 1968.

Chlidonias hybrida (Pallas) Whiskered Tern

Common breeding resident, numbers increase in winter up to 60.

Sterna aurantia J. E. Gray Indian River Tern

One or two birds regularly from March to October.

Sterna hirundo Linnæus Common Tern

Three records of up to 6 birds in Nov. and December.

Sterna acuticauda J. E. Gray Blackbellied Tern

Up to 4 birds regularly from Nov. to April, one record in June.

Sterna albifrons Pallas Little Tern

Six records of 1 or 2 birds between March and June.

Cacomantis merulinus (Scopoli) Plaintive Cuckoo

Hardly a species to include in such a paper, but 6 records between Nov. and Jan. of single birds flying to or from the reed beds could indicate that it is a regular winter visitor in this habitat.

Ceryle rudis (Linnæus) Lesser Pied Kingfisher

At least 2, probably 3, pairs present throughout the year.

Alcedo atthis (Linnæus) Common Kingfisher

Only 2 records, in March in different years.

Halcyon smyrnensis (Linnæus) Whitebreasted Kingfisher

At least 2 birds, probably more, resident.

Merops philippinus (Linnæus) Bluetailed Bee-eater

Common summer visitor from March to Oct. Usually 6-10 birds.

Merops orientalis Latham Green Bee-eater

Very common resident in waterside vegetation along the bund roads.

Jynx torquilla Linnæus Wryneck

Once again, hardly a waterbird, but the vegetation and piles of facing stones along the bund road is one of the most regular winter haunts of this species in the Durgapur area. Up to 3 from Nov. to March.

Eremopterix grisea (Scopoli) Ashycrowned Finch-Lark

Present all the year in small numbers. During the monsoon it is found on the bund road.

Calandrella raytal (Blyth) Sand Lark

Common resident of the sand banks during the dry season, Nov. to April. Nest with eggs on 23 March.

Riparia riparia (Linnæus) Collared Sand Martin

One record of 5 or 6 birds on 14-xii-68. Possibly overlooked amongst the next species.

Riparia paludicola (Vieillot) Plain Sand Martin

Regular in small numbers from Sept. to April. A small colony, about 20 holes, was discovered in Feb. 1970 just downstream of the area.

Hirundo rustica Linnæus Swallow

Regular winter visitor from Oct. to May, usually between 20 and 40, and nearly always flying up river in the late afternoon, presumably going to roost in the reed beds. Numbers rise rapidly to reach a peak of about 3,000 in March, gathering on high tension wires across the north bank canal, and then decline equally quickly.

Hirundo smithii Leach Wiretailed Swallow

The only record was of 2 or 3 birds flying round the DVC power station which is within sight of but just outside the area. Date 24-iv-68.

Hirundo fluvicola Blyth Indian Cliff Swallow

Scarce, but probably overlooked, between March and May. Usually from 1-6, but once exceptionally 300 coincident with peak Swallow numbers on 30-iii-69.

Hirundo daurica (Linnæus) Striated Swallow

Four records of 2 to 10 birds between Oct. and March.

Acrocephalus stentoreus (Hemprich & Ehrenberg) Indian Great Reed Warbler

Regular in water-side vegetation between Nov. and March. Probably more numerous than the 8 records indicate.

Erythacus svecicus (Linnæus) Bluethroat

Regular visitor along the bank of the bund road from Dec. to March.

Anthus novaeseelandiae Gmelin Paddyfield Pipit

The Indian Pipit *A. n. rufulus* is the resident form present in small numbers. The large, heavily marked Richards Pipit *A. n. richardi* has occurred twice in March.

Anthus campestris (Linnæus) Tawny Pipit

Two records in Nov. and Dec. of 3 and 1 bird on the sand banks.

Anthus pelopus J. E. Gray Hodgson's Pipit

A single bird on 14-iv-68 showing a distinctly pinkish throat was thought to be this species but the possibility of Redthroated Pipit *A. cervinus* cannot be ruled out.

Motacilla flava Linnæus Yellow Wagtail

Very common winter visitor from Nov. to April. All those identified appeared to be the race *M. f. beema*.

Motacilla citreola Pallas Yellowheaded Wagtail

Very common winter visitor from Dec. to April.

Motacilla caspica (Gmelin) Grey Wagtail

One bird in the barrage sluices on 13-ii-70. May occur more frequently.

Motacilla alba Linnæus Pied Wagtail

Very common winter visitor from Nov. to April in various races. A mixed flock of the three commoner wagtails numbered between 200-300.

Motacilla maderaspatensis Gmelin Large Pied Wagtail

Two birds first seen on 1-ix-68 and fairly regularly since on or around the barrage itself. May be a resident pair.

Ploceus philippinus (Linnæus) Baya

Very common resident, flying to roost in the reed beds in large numbers.

Ploceus benghalensis (Linnæus) Blackthroated Weaver Bird

Probably not always differentiated from the preceding species. A few definite records of a flock of about 30.

Estrilda amandava (Linnæus) Red Munia

Resident flock of about 30 birds.

The foregoing list does not purport to be a comprehensive list of all the birds recorded in the area, but only of those which rely wholly or partly on the habitats of river, sand bank, lake or reed bed which constitute the area covered. In addition to the above most of the common plains species have also been seen in or around the area.

When interpreting the numbers quoted, the difficulties should be realised in trying to give an accurate estimate of those species which do not form compact flocks out in the open. For secretive reed bed species such as bitterns and rails, their exact status and numbers must be largely conjecture.

References

Ali, Sálim, (1964): The Book of Indian Birds 7th ed. Bombay Natural History Society, Bombay.

——— & Ripley, S. D. (1968): Handbook of the Birds of India and Pakistan, Vol. I, Bombay.

Ripley, S. D. (1961): A Synopsis of the Birds of India and Pakistan. Bombay Natural History Society, Bombay.

New Taxa, chiefly of Copepoda described by the late R. B. Seymour Sewell, between 1912 and 1960[1]

By

E. G. SILAS[2]

Central Marine Fisheries Research Institute

INTRODUCTION

IN the course of nearly fifty years of work on the aquatic fauna of India and adjacent countries, and the seas around India, the late Dr. Seymour Sewell[3] described several new taxa of marine, brackishwater and freshwater organisms chiefly belonging to the Class Copepoda. Based on the R.I.M.S. *Investigator* collections, the John Murray Expedition material, and other collections from Indian waters, Sewell described several new genera, subgenera, and about 170 new species, subspecies, varieties and forms of Copepoda. This represents only a small fraction of the species dealt with by him in the course of his extensive faunistic and biogeographic investigations. His published papers also contain descriptions with illustrations of scores of new distributional records of Copepoda to the Indian Seas (species previously known from the Atlantic or Pacific Oceans), redescriptions, and data on the developmental stages of several species of Copepoda.

Sewell's pioneering work on Copepoda of the Indian Seas has assumed greater importance in recent years in view of the currently concluded intensive faunistic exploration of the Indian Ocean. Since the descriptions of his new taxa are distributed in several publications which may not be readily available for reference, a list of all the new taxa described by him including those belonging to non-Copepoda groups is given here to facilitate easy reference. In order to make the list useful, information as to the correct paginations of the original descriptions, details of illustrations, number of type specimens, sex on which the description is based (especially for Copepoda), and type localities are in-

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[1] Published with the permission of the Director, Central Marine Fisheries Research Institute, Mandapam Camp.

[2] Present address: C.M.F.R.I., Gopala Prabhu Cross Road, Ernakulam, Cochin-11, Kerala.

[3] Dr. R. B. Seymour Sewell died on February 11, 1964.

cluded. In addition, any subsequent reference made by Sewell to the species, etc., is also given as on many occasions his descriptions of new copepods were based on a single male or female specimen but he had a tendency to add to the descriptions in his later works based on fresh collections. The classification followed here for the general arrangement of the Copepoda is that adopted by him in 1947.

In addition to Copepoda, Sewell's contributions cover various other fields, especially oceanography, parasitology (Helminthology), anthropology, malacology, zoogeography, organic evolution, etc. He pioneered oceanographic investigations in Indian Seas and being of topical interest, a bibliography of his works (excluding Anthropology) is given at the end.

NEW TAXA DESCRIBED BY R.B. SEWELL

SUCTORIA (Epibionts)

Family ACINETIDAE

Genus *Acineta* Ehrenberg, emend Collin

Acineta euchaetae Sewell, 1951, pp. 278-281, text-figure 7 a-g. [Host and Type locality : From several specimens of *Euchaeta wolfendeni* A. Scott, and *E. marina* (Prestand.) from surface haul at 'John Murray Expedition' station No. 61].

Family PODOPHRYIDAE

Genus *Paracineta* Collin

Paracineta goetani Sewell, 1951, pp. 281-284, text-figures 8 a-e, and 9 a-f. [Host and Type locality: From *Goetanus antarcticus* Wolfenden and *G. curvicornis* Sars from 'John Murray Expedition' station No. 61 in haul from 1500-0 m.].

Genus *Hallezia* Sand.

Hallezia scottocalani Sewell, 1951, pp. 284-285, text-figure 10 a-f. [Host and Type locality : From *Scottocalanus dauglishi* Sewell (both sexes) from 'John Murray Expedition' station No. 145 D, in haul from 500-0 m.].

PERIDINIENS (Parasites)

Family BLASTODINIIDAE

Genus *Blastodinium* Chatton

Blastodinium apsteini Sewell, 1951, pp. 330-332, text-figure 31 a-e. [Host and Type locality : *Paracalanus aculeatus* Giesbrecht and *Clausocalanus furcatus* (Brady) from Arabian Sea; also earlier reported from *Clausocalanus arcuicornis* (Dana) from the Mediterranean by Chatton (1920) as *B. contortum hyalinum* (in part)].

Blastodinium chattoni Sewell, 1951, pp. 332-337, text-figures 32 a-f, 33 a-c, and 34 a-d. [Host and Type locality : From *Nannocalanus minor* (Claus), *Undinula darwini* (Lubbock), *Paracalanus aculeatus* Giesbrecht, *P. denudatus* Sewell, *P. parvus* (Claus), *Clausocalanus arcuicornis* (Dana), and *C. furcatus* (Brady) from 'John Murray Expedition' from Arabian Sea. Earlier reported by Chatton (1920) from the Mediterranean as *B. contortum hyalinum* (in part)].

COPEPODA : CYCLOPOIDA

Section GNATHOSTOMA

Family CYCLOPINIDAE

Subfamily Cyclopininae

Genus *Cyclopina* Claus

Cyclopina intermedia Sewell, 1924b, pp. 792-793, plate 47, fig. 1. [Several examples of both sexes including ovigerous females from stations B, 133, and 166 in Chilka Lake].

Cyclopina longifurca Sewell, 1924b, pp. 794-795, plate 47, fig. 2. [Several ovigerous females (no males) from stations C and 128 in Chilka Lake].

Cyclopina minuta Sewell, 1934a, pp. 85-86, text-figure 5 a-f. [Type locality: Hooghly River, from freshwater].

Family OITHONIDAE

Subfamily Oithoninae

Genus *Oithona* Baird

Oithona horai Sewell, 1934a, pp. 82-84, text-figure 4 a-j. [Type locality: Hooghly River, from freshwater].

Family ONCAEIDAE

Genus *Oncaea* Philippi

Oncaea media Giesbrecht forma **major** Sewell, 1947, p. 261. [Type locality: Several examples of females from 'John Murray Expedition' station No. 61C, from Northern Arabian Sea].

Oncaea media Giesbrecht forma **minor** Sewell, 1947, pp. 261-262. [Type locality : Few examples of both sexes from 'John Murray Expedition' station No. 61C from Northern Arabian Sea].

Family CYCLOPIDAE

Genus *Euryte* Philippi

Euryte brevicauda Sewell, 1949, pp. 33-35, fig. 3 a-j. [Type locality: One female in weed-washings from Addu Atoll, Maldive Archipelago].

Genus *Halicyclops* Norman

Halicyclops tenuispina Sewell, 1924b, pp. 796-797, plate 47, fig. 3. [Type locality: Two females from Chilka Lake].

Genus *Eurycyclops* Sewell, 1949, pp. 36-39.

[The genus was created to accommodate two new species *E. magna* Sewell (1949), and *E. parva* Sewell (1949). The genotype is not indicated, but the first described species, *E. magna* may be considered so. Sewell also drew attention to the possibility that these two species could represent stages in the life-history of one species (p. 39). On p. 38, line 1, Sewell remarks that '. . . . in one specimen of the smaller form, which I have named *Eurycyclops minor*, there appeared to be indications. . . .' This is apparently an error as there is no subsequent reference to a new species *E. minor*. In all probability Sewell meant *E. parva*, the female of which with a total length of 0·68 mm. is smaller in size than the female of *E. magna* which measures 0·96 mm.].

Eurycyclops magna Sewell, 1949, p. 39, text-figure 5 a-k. [Type locality : Several examples (?) ; description based on one female taken in weed-washings from Addu Atoll, Maldive Archipelago].

Eurycyclops parva Sewell, 1949, pp. 39-41, text-figure 6 a-h. [Type locality : Several examples (?) ; description based on one female taken in weed-washings from Addu Atoll, Maldive Archipelago].

Genus *Mesocyclops* Sars

Subgenus *Thermocyclops* Kiefer

Mesocyclops (Thermocyclops) schmeili Poppe and Mrazek forma **marmagoensis** Sewell, 1957, pp. 89-116, text-figures 1 i-j ; 3 a-n ; 4 a-e ; and 5 a-d. [Type locality : Several adults and copepodid stages from a freshwater pool about a mile off the coast of Marmagoa, Goa].

Section SIPHONOSTOMA

Family ASTEROCHERIDAE (=ASCOMYZONTIDAE)

Genus *Asterocheres* Boeck (=*Ascomyzon* Thorell)

Asterocheres indicus Sewell, 1949, pp. 53-56, text-figure 10 a-g. [Type locality : One female in weed-washings from Alcyonarians from 'John Murray Expedition' station No. 45].

Asterocheres orientalis Sewell, 1949, pp. 51-53, text-figure 9 a-j. [Type locality : Three females in weed-washings from Addu Atoll, Maldive Archipelago].

Asterocheres ovalis Sewell, 1949, pp. 56-58, text-figure 11 a-i. [Type locality : One male in washings from Ascidians from 'John Murray Expedition' station No. 10].

Family ACONTIOPHORIDAE

Genus *Acontiophorus* Brady

Acontiophorus maldivensis Sewell, 1949, pp. 60-62, text-figure 13 a-h. [Type locality : Two females in weed-washings from Addu Atoll, Maldive Archipelago].

Genus *Asteropontius* Thompson & A. Scott

Asteropontius nicobaricus Sewell, 1949, pp. 58-60, text-figure 12 a-e. [Type locality : Two females in weed-washings from Nankauri Harbour, Nicobar Islands].

Family DYSPONTIIDAE

Genus *Pteropontius* Giesbrecht

Pteropontius quartus Sewell, 1949, pp. 63-65, text-figure 14 a-j. [Type locality : One female from 'John Murray Expedition' station No. 24—in debris from 73-220 m. depth, from Gulf of Aden].

Section POECILOSTOMA

Family CLAUSIDIIDAE

Genus *Hemicyclops* Boeck

Hemicyclops indicus Sewell, 1949, pp. 69-72, text-figure 16 a-i. [Type locality : Several females and one male in weed-washings from Nankauri Harbour, Nicobar Islands].

Genus *Saphirella* T. Scott

Saphirella indica Sewell, 1924b, pp. 800-803, plate 59, fig. 1. [Type locality: A few immature examples from Chilka Lake Stations K, 89 and 148; 1949, p. 66].

Saphirella nicobarica Sewell, 1949, p. 66, text-figure 15 a-b. [Type locality: One immature example from Nankauri Harbour, Nicobar Islands].

Family LICHOMOLGIDAE

Genus *Anthessius* Della Valle (=*Pseudomolgus* Sars)

Anthessius brevifurca Sewell, 1949, pp. 76-78, text-figure 17 a-k. [Type locality: One female in weed-washings from Addu Atoll, Maldive Archipelago].

Anthessius investigatoris Sewell, 1949, pp. 80-81, text-figure 18 a-e. (on p. 79). [Type locality: One male in weed-washings from R.I.M.S. *Investigator* station No. 664, Henry Lawrence Island, Andaman Islands].

Genus *Preherrmannella* Sewell, 1949, p. 82.

[The genus was created to accommodate eight species of which three were described as new by Sewell. According to Sewell, 'In this genus I include *Preherrmannella prehensilis* (Sars), *robusta* (Thompson and A. Scott), *serendibica* (Thompson and A. Scott) and two new species *nicobarica* sp. nov. and *adduensis* sp. nov., all with a prehensile second antenna, and *finmarchica* (T. Scott), *tenuicaudis* (Sars) and *brevicauda* sp. nov. with a non-prehensile 2nd antenna.' The genotype is not indicated, but the species first described under the new genus is *P. brevicauda* Sewell].

Preherrmannella adduensis Sewell, 1949, pp. 85-89, text-figures 20 a-g, and 21 a-i. [Type locality: One female and two males from Addu Atoll, Maldive Archipelago; Also one female from Nankauri Harbour, Nicobar Islands].

Preherrmannella brevicauda Sewell, 1949, pp. 82-85, text-figure 19 a-o. [Type locality: One female and one male in weed-washings from Addu Atoll, Maldive Archipelago].

Preherrmannella nicobarica Sewell, 1949, pp. 89-91, text-figure 22 a-g. [Type locality: One female in weed-washings from Nankauri Harbour, Nicobar Islands].

Genus *Lichomolgus* Thorell

Lichomolgus rotundus Sewell, 1949, pp. 97-99, text-figure 23 a-h. [On pages 19 and 97 the specific name is indicated as *L. rotundus*, but on pages 93, 98, and 167 it is given as *L. rotundatus*. However, the earlier given spelling is followed here. (Type locality: One female in weed-washings from Addu Atoll, Maldive Archipelago)].

Genus *Macrochiron* Brady

Subgenus *Macrochiron* s.str.

Macrochiron (Macrochiron) longipes Sewell, 1949, pp. 104-105, text-figure 26 a-i. [Type locality: One female in weed-washings from Addu Atoll, Maldive Archipelago].

Macrochiron (Macrochiron) spinipes Sewell, 1949, pp. 106-108, text-figure 27 a-i. [Type locality: One female in weed-washings from Nankauri Harbour, Nicobar Islands].

Subgenus **Paramacrochiron** Sewell, 1949, p. 108.

[The subgenus was erected to accommodate the species *Pseudanthessius maximus* Thompson and A. Scott, *P. chelifer* Thompson and A. Scott, *P. parvus* A. Scott, *P. fucicolus* T. Scott, and a new species *Macrochiron* (*Paramacrochiron*) *malayense* Sewell. No subgenotype is designated, but the first species to be dealt with under the new subgenus is *Macrochiron* (*Paramacrochiron*) *maximus* (Thompson and A. Scott)].

Macrochiron (Paramacrochiron) malayense Sewell, 1949, pp. 109-111, text-figure 28 a-f. [Type locality: Two females, both taken at surface in tow-net, one from Kurau River, Perak, Federated Malay States, and the second from off Viper Island, Port Blair, Andaman Islands].

Genus *Kelleria* Gurney

Kelleria andamanensis Sewell, 1949, pp. 112-114, text-figure 9 a-i. [Type locality: One female from surface tow-net collection, Macpherson Strait, Andaman Islands].

Kelleria camortensis Sewell, 1949, pp. 114-117, text-figure 30 a-m. [Type locality: Several females from Nankauri Harbour, Nicobar Islands; and one male and one female in weed-washings from Addu Atoll, Maldive Archipelago].

Kelleria gurneyi Sewell, 1949, pp. 117-119, text-figure 31 a-h. [Type locality: Two females in surface tow-net from Kurau River, Perak, Federated Malay States].

Genus *Pseudanthessius* Claus

Pseudanthessius gracilioides Sewell, 1949, pp. 123-125, text-figure 34 a-f. [Type locality: One female in weed-washings from Addu Atoll, Maldive Archipelago].

Genus *Nasomolgus* Sewell, 1949, pp. 125-126.

[Monotypic for *N. cristatus* Sewell, 1949].

Nasomolgus cristatus Sewell, 1949, pp. 126-127, text-figure 35 a-e. [Type locality: One female from 'John Murray Expedition' station No. 45 along South Arabian Coast—from debris from 38 m. depth].

COPEPODA : MONSTRILLOIDEA

Section CYCLOIPMORPHA

Family THESPESIOPSYLLIDAE

Genus *Orientopsyllus* Sewell, 1949, pp. 128-129.

[Monotypic for *Orientopsyllus investigatoris* Sewell, 1949].

Orientopsyllus investigatoris Sewell, 1949, pp. 129-131, text-figure 36 a-h. [Type locality: Two females taken in surface tow-net from Nankauri Harbour, Nicobar Islands].

Section MONSTRILLOIDA GENUINA

Family MONSTRILLIDAE

Genus *Monstrilla* Dana

Monstrilla investigatoris Sewell, 1949, pp. 140-141, text-figure 39 c-e. [Type locality: One female in surface tow-net from Nankauri Harbour, Nicobar Islands].

Genus *Cymbasoma* Thompson

Cymbasoma nicobarica Sewell, 1949, pp. 142-144, text-figure 40 a-d. [Type locality: One male in surface tow-net from Nankauri Harbour, Nicobar Islands].

COPEPODA : NOTODELPHYOIDEA

Family Doropygidae

Genus *Botryllophilus* Hesse

Botryllophilus indicus Sewell, 1949, pp. 146-148, text-figure 41 a-g. [Type locality: One female in weed-washings from Nankauri Harbour, Nicobar Islands].

COPEPODA : HARPACTICOIDA

Family Longipediidae

Genus *Canuella* T. Scott and A. Scott

Subgenus *Canuella* s.str.

Canuella (Canuella) scotti nom. nov., Sewell, 1940c, p. 136, text-figure 2 a-h. [Substitute name for *Canuella curticauda* A. Scott, 1909, p. 197, pl. lxiv, figs. 1-6—nec *Canuella curticauda* (Thompson and A. Scott) (1893). Species known from Malay Archipelago and Nicobar Islands].

Subgenus *Ellucana* Sewell, 1940c, p. 136.

[Subgenotype not indicated. The two species recognised under the subgenus are: *C.* (*E.*) *curticauda* Thompson and A. Scott, and *C.* (*E.*) *longicauda* Sewell 1904c].

Canuella (Ellucana) longicauda Sewell, 1940c, pp. 136-139, text-figure 3 a-j. [Type locality: From weed-washings from Nankauri Harbour, Nicobar Islands. Number of specimens in the type series is not indicated].

Family Peltidiidae

Genus *Peltidium* Philippi

Peltidium maldivianum Sewell, 1940c, pp. 144-146, text-figure 6 a-h. [Type locality: One female in weed-washings from Addu Atoll, Maldive Archipelago].

Family Tegastidae

Genus *Tegastes* Norman

Tegastes minutus Sewell, 1940c, pp. 147-148, text-figure 7 a-g. [Type locality; One female in weed-washings from Addu Atoll, Maldive Archipelago].

Genus *Parategastes* Sars

Parategastes sphaericus (Claus) var. **similis** Sewell, 1924b, pp. 815-817, plate 51, fig. 2; plate 52, fig. 2. [Type locality: Several examples of both sexes from Chilka Lake, station Nos. B, E, F, G, 37, and 133].

Genus *Syngastes* Monard

Syngastes indicus Sewell, 1940c, pp. 149-150, text-figure 8 a-g. [Type locality: One female in weed-washings from Addu Atoll, Maldive Archipelago].

Family HARPACTICIDAE

Genus *Harpacticus* M. Edwards

Harpacticus gracilis Claus var. **orientalis** Sewell, 1924b, pp. 811-813, plate 50, fig. 2. [Type locality: One male from Chilka Lake; 1940c, p. 153. (Few examples of both sexes from Nankauri Harbour, Nicobar Islands)].

Genus *Harpacticella* Sars

Harpacticella lacustris Sewell, 1924b, pp. 813-815, plate 51, fig. 1. [Type locality: Several examples of both sexes from Chilka Lake, stations B, D 101, 133, and 142 and also in weed-washings from Barkuda].

Family IDYIDAE

Genus *Tisbe* Lilljeborg

Tisbe ensifera (Fischer) var. **indica** (Sewell, 1924b). [=*Idyaea ensifera* var. *indica* Sewell, 1924b, pp. 817-819, plate 52, fig. 1. Type locality: Two females from Chilka Lake; 1940c, p. 160 (from Nankauri Harbour, Nicobar Islands, in tow-netting 12 fathoms near bottom. Number of specimens (?)].

Genus *Tisbintra* Sewell, 1940c, p. 161.

[Monotypic. For *Tisbintra nankaurica* Sewell, 1940c].

Tisbintra nankaurica Sewell, 1940c, pp. 161-162, text-figure 12 a-k. [Type locality: One female in tow-netting at surface, Nankauri Harbour, Nicobar Islands].

Genus *Paraidya* Sewell, 1940c, pp. 163-164.

[Genotype not indicated. Genus erected to accommodate two new species, namely *Paraidya major* Sewell, 1940c, and *P. minor* Sewell, 1940c].

Paraidya major Sewell, 1940c, pp. 164-167, text-figure 13 a-m. [Type locality: Several examples of both sexes in weed-washings from Nankauri Harbour, Nicobar Islands].

Paraidya minor Sewell, 1940c, pp. 167-169, text-figure 14 a-l. [Type locality: Several examples of both sexes in weed-washings from Nankauri Harbour, Nicobar Islands].

Family THALESTRIDAE

Genus *Phyllothalestris* Sars

Phyllothalestris orientalis Sewell, 1940c, pp. 177-180, text-figures 19 a-h (female); 20 a-f (juv. female). [Type locality: Two females, one adult and one in copepodid stage-V in weed-washings from Addu Atoll, Maldive Archipelago].

Phyllothalestris sarsi Sewell, 1940c, pp. 180-184, text-figures 21 a-e (female); 22 a-f (male); and 23 a-f (Juv. male). [Type locality: Two females and two males (one immature) in weed-washings from Addu Atoll, Maldive Archipelago; and one female from Nankauri Harbour, Nicobar Islands].

Genus *Parastenhelia* Thompson and A. Scott

Parastenhelia littoralis (Claus) forma **scotti** nom. nov., Sewell, 1940c, pp. 195-196, text-figure 28 a-e. [For *Thalestris forficula* T. Scott, 1894, p. 100, pl. 12, figs. 33-41. (One female)].

Genus *Xouthous* Thompson (=*Megarthrum* Norman and T. Scott)

Xouthous maldiviae Sewell, 1940c, pp. 198-200, text-figure 30 a-e. [Type locality: One female in weed-washings from Addu Atoll, Maldive Archipelago].

Genus *Eudactylopus* A. Scott

Eudactylopus anomala Sewell, 1940c, pp. 219-221, text-figure 40 a-j. [Type locality : One male in weed-washings from Addu Atoll, Maldive Archipelago].

Eudactylopus fasciatus Sewell, 1940c, pp. 215-219, text-figures 38 b-j. (female); 38a ; 39 a-j (male adult and stage-V). [Type locality : Several examples of both sexes and juvenile male in stage-V in weed-washings from Nankauri Harbour, Nicobar Islands ; and from colonies of stag's horn coral from Addu Atoll, Maldive Archipelago].

Eudactylopus opima (Brian) forma **major** Sewell, 1940c, pp. 207-209, text-figure 34 a-g. [Type locality : Several examples of both sexes in weed-washings from Nankauri Harbour, Nicobar Islands; and Addu Atoll, Maldive Archipelago].

Eudactylopus opima (Brian) forma **minor** Sewell, 1940c, p. 209-211, text-figure 35 a-l. [Type locality : Several examples of both sexes from same localities as forma *major*].

Eudactylopus striatus Sewell, 1940c, pp. 211-215, text-figures 36 a-j (male); and 37 a-k (female stage-V). [Type locality: Several males and immature females from Nankauri Harbour, Nicobar Islands].

Genus *Dactylopusia* Norman

Dactylopusia falcifera Willey forma **violacea** Sewell, 1940c, pp. 223-226, text-figure 41 a-n. [Type locality : Several examples of males and females in weed-washings from Nankauri Harbour, Nicobar Islands].

Dactylopusia tropica Sewell, 1940c, pp. 227-229, text-figure 43 a-i. [Type locality : Females (no.?) in weed-washings from Addu Atoll, Maldive Archipelago].

Genus *Jalysus* Brian

Jalysus investigatoris Sewell, 1940c, pp. 230-233, text-figures 44 a-k (female) ; and 45 a-h (male). [Type locality : Several examples of males and females in weed-washings from Addu Atoll, Maldive Archipelago].

Jalysus proximus Sewell, 1940c, pp. 234-236, text-figure 46 a-g. [Type locality : Males (no. ?) in weed-washings from Addu Atoll, Maldive Archipelago].

Family Diosaccidae

Genus *Diosaccus* Boeck

Diosaccus monardi Sewell, 1940c, pp. 244-246, text-figure 49 a-j. [Type locality : Females (no. ?) in weed-washings from Perseus Reef, Camorta Island, Nicobar Islands].

Genus *Amphiascus* Sars

Amphiascus calcarifer Sewell, 1940c, p. 270.

[Two forms of this species given below are described by Sewell, 1940c].

(a) **Amphiascus calcarifer** Sewell forma **major** Sewell, 1940c, pp 273-274, text-figure 60 f-g. [Type locality : Three females in weed-washings from Addu Atoll, Maldive Archipelago].

(b) **Amphiascus calcarifer** Sewell forma **minor** Sewell, 1940c, pp. 270-273, text-figures 59 a-i ; and 60 a-e. [Type locality : Several examples of males and females in weed-washings from Addu Atoll, Maldive Archipelago].

Amphiascus coralicola Sewell, 1940c, pp. 263-265, text-figure 57 a-h. [Type locality: Examples of both sexes in coral washings from Henry Lawrence Island, Andaman Islands; and in weed-washings from Addu Atoll, Maldive Archipelago].

Amphiascus inermis Sewell, 1940c, pp. 277-280, text-figure 62 a-g. [Type locality: One male in tow-netting from 20 fathoms at Nankauri Harbour, Nicobar Islands].

Amphiascus nicobaricus Sewell, 1940c, pp. 252-256, text-figures 52 a-h (female); and 53 a-g (male). [Type locality: Several examples of both sexes in weed-washings from Nankauri Harbour, Nicobar Islands, and Addu Atoll, Maldive Archipelago].

Amphiascus rebus Sewell, 1940c, pp. 260-262, text-figure 56 a-h. [Type locality: Several adult females from Addu Atoll, Maldive Archipelago; and one female in stage-V in weed-washings from Nankauri Harbour, Nicobar Islands].

Amphiascus scotti Sewell, 1924b (nom. nov.), pp. 819-823, plate 54, fig. 1. [Substitute name for *Dactylopus propinquus* T. Scott, 1894, p. 99, pl. 10, figs. 44-52; pl. 11, figs. 1-3 (=*Amphiascus propinquus* (T. Scott) name preoccupied. Several examples from Chilka Lake)].

Genus *Teissierella* Monard

Teissierella adduensis Sewell, 1940c, pp. 291-293, text-figure 65 a-j. [Type locality: Females in weed-washings from Addu Atoll, Maldive Archipelago].

Genus *Stenhelia* Boeck

Subgenus *Delavalia* Brady

Stenhelia (Delavalia) latisetosa Sewell, 1940c, pp. 297-300, text-figure 68 a-e. [Type locality: One female in weed-washings from Addu Atoll, Maldive Archipelago].

Stenhelia (Delavalia) longifurca Sewell, 1934a, pp. 94-96, text-figure 8 a-j. [Type locality: Examples from pools at Uttarbhag, Chingrighatta, and Piali River, Bengal].

Stenhelia (Delavalia) truncatipes Sewell, 1940c, pp. 295-297, text-figure 67 a-e. [Type locality: One female from Addu Atoll, Maldive Archipelago].

Family Ameiridae

Genus *Nitocra* Boeck

Nitocra spinipes Boeck var. **orientalis** Sewell, 1924b, pp. 827-828, plate 56, fig. 1. [Type locality: Several examples of both sexes from Chilka Lake].

Nitocra typica Boeck var. **lacustris** Sewell, 1924b, pp. 828-829, plate 55, fig. 3, plate 56, fig. 2. [Type locality: Two males and one female from Chilka Lake].

Family Canthocamptidae

Genus *Leptomesochra* Sars

Leptomesochra nasuta Sewell, 1940c, pp. 301-304, text-figure 69 a-h. [Type locality: One female in weed-washings from Addu Atoll, Maldive Archipelago].

Family Laophontidae

Genus *Laophonte* Philippi

Laophonte adduensis Sewell, 1940c, pp. 314-317, text-figure 71 a-j. [Type locality: Two females in weed-washings from Addu Atoll, Maldive Archipelago].

Laophonte bengalensis Sewell, 1934a, pp. 98-100, text-figure 10 a-k. [Type locality : Several examples from Chingrighatta in Salt Lake Canal ; pool at Uttarbhag ; and Piali River at Uttarbhag].

Laophonte macani Sewell, 1940c, pp. 319-322, text-figure 73 a-f. [Type locality : One female from 'John Murray Expedition' station No. 45 along South Arabian Coast from 40 m. depth].

Laophonte quinquespinosa Sewell, 1924b, pp. 832-834, plate 58, fig. 1. [Type locality : Several examples of both sexes from Chilka Lake, Stations C, 128 and 166].

Laophonte trispinosa Sewell, 1940c, pp. 326-328, text-figure 76 a-f. [Type locality : One female in weed-washings from Addu Atoll, Maldive Archipelago].

Genus *Cleta* Claus

Cleta secunda Sewell, 1924b, p. 835, plate 59, fig. 2. [Type Locality : One female in tow-netting off Satpara in outer channel, Chilka Lake].

Family Cletodidae

Genus *Laophontella* Thompson and A. Scott

Laophontella armata (Willey) var. **indica** Sewell, 1940c, pp. 337-341, text-figures 82 a-m (female) ; and 83 a-g (male). [Type locality : Two females from Addu Atoll, Maldive Archipelago; and one male from Camorta Island, Nicobar Islands—all taken in weed-washings].

Genus *Limnocletodes* Borutzky

Limnocletodes secundus Sewell, 1934a, pp. 101-102, text-figure 11 a-h. [Type locality : Examples from road-side shallow pool at 4 miles from Baruipur on way to Uttarbhag, Bengal].

Genus *Enhydrosoma* Boeck

Enhydrosoma nicobarica Sewell, 1940c, pp. 344-346, text-figure 85 a-j. [Type locality : One female in weed-washings from Nankauri Harbour, Nicobar Islands].

Family Ceyloniellidae

Genus *Ceyloniella* Wilson

Ceyloniella armata (Claus) forma **major** Sewell, 1940c, pp. 329-331, text-figures 77 a-g (female) and 78 a-f (male). [Type locality : Several examples of both sexes in weed-washings from Nankauri Harbour, Nicobar Islands and Addu Atoll, Maldive Archipelago].

Ceyloniella armata (Claus) forma **minor** Sewell, 1940c, pp. 331-332, text-figure 79 a-f. [Type locality : Several examples of both sexes from same localities as forma *major*].

Ceyloniella nicobarica Sewell, 1940c, pp. 332-336, text-figure 80 a-j. [Type locality : Several examples of both sexes from R.I.M.S. *Investigator* station No. 630 west of Nankauri Island, Nicobars, in weed-washings].

(a) **Ceyloniella nicobarica** Sewell var. (?) Sewell, 1940c, p. 336, text-figure 81 a-i. [Variety unnamed. Description based on several females from Nankauri Harbour, Nicobar Islands; and a few females from Addu Atoll, Maldive Archipelago].

Family METIDAE

Genus *Metis* Philippi

Metis jusseaumei (Richard) forma **major** Sewell, 1940c, pp. 349-350, text-figures 87 a-f (female) and 88 a-f (male). [Type locality: Several examples of both sexes from east side of Camorta Island, Nicobar Islands].

Metis jusseaumei (Richard) forma **minor** Sewell, 1940c, pp. 346-349, text-figure 86 a-j. [Type locality: Several examples of males and females in weed-washings from Nankauri Harbour, Nicobar Islands and Addu Atoll, Maldive Archipelago].

COPEPODA: CALANOIDA

Tribe AMPHASKANDRIA

Family CALANIDAE

Genus *Canthocalanus* A. Scott

Canthocalanus pauper (Giesbrecht) var. **plumulosus** Sewell, 1912d, p. 355. (Examples from: 13°51·5′-13°55·5′ N, 97°57·5′-98°2′ E; 13°50′-13°45′ N, 97°59·5′-97°55′E; 13°44.5′N, 98°0.5′E); 1914a, p. 193. [Sewell, 1914a, p. 193 showed that the variety *plumulosus* based on the dichotomous branching of some or all of the furcal setae is merely an abnormality due most probably to injury and subsequent regeneration of the setae].

Genus *Undinula* A. Scott

Undinula caroli (Giesbrecht) var. **plumulosus** Sewell, 1912d, p. 357. [Examples from 13°50′-13°45′N, 97°59.5′-98°00′ E].

Undinula darwini (Lubbock) var. **intermedia** Sewell, 1929a, pp. 45-46, text-figure 12 a-d. [Examples from *R.I.M.S. Investigator* Collections].

Undinula darwini (Lubbock) var. **symmetricus** Sewell, 1929a, p. 45. [Examples from *R.I.M.S. Investigator* Collections].

Undinula vulgaris (Dana) var. **giesbrechti** Sewell, 1929a, p. 31. [Type locality: same as var. *typica*].

Undinula vulgaris (Dana) var. **plumulosus** Sewell, 1912d, p. 356; 1929a, p. 31.

Undinula vulgaris (Dana) var. **typica** Sewell, 1929a, p. 31. Syn. *U.v.* forma **minor**. [Examples from *R.I.M.S. Investigator* stations 540, 541, 542, 552, 555, 556, 558, 577, 582 and 614].

Undinula vulgaris (Dana) var. **zeylanica** Sewell, 1929a, p. 32. [Syn. *U.v.* forma *major* ?].

Genus *Neocalanus* Sars

Neocalanus minor (Claus) forma **major** Sewell, 1929a, pp. 21-22, text-figure 2 a-d. [Type locality: *R.I.M.S. Investigator* station No. 614—from Nankauri Harbour, Nicobar Islands].

Neocalanus minor (Claus) forma **minor** Sewell, 1929a, pp. 22-25, text-figure 3 a-d. [Type locality: Same as forma *major*].

Family MEGACALANIDAE nov. Sewell, 1947, pp. 20-25.

[To include the genera *Megacalanus* Wolfenden, *Bathycalanus* Sars, and *Bradycalanus* A. Scott].

Genus *Megacalanus* Wolfenden

Megacalanus princeps Wolfenden var. **inermis** Sewell, 1947, pp. 25-27, text-figure 2 a-g. [Type locality: One female from 'John Murray Expedition' Station No. 98, Central Area, Arabian Sea. The variety is based on a single specimen showing '... an interesting abnormality'].

Genus *Bradycalanus* A. Scott

Bradycalanus gigas Sewell, 1947, pp. 28-30, text-figure 3 a-d. [Type locality: One female from 'John Murray Expedition' Station No. 120, Zanzibar Area].

Family EUCALANIDAE

Genus *Eucalanus* Dana

Eucalanus pseudattenuatus Sewell, 1947, pp. 40-43, text-figures 7a, and 8 a-f. [Type locality: Several examples of both sexes and a few stage-V males from 'John Murray Expedition' Stations 61A, 61C, 96, 145, and 172].

Genus *Rhincalanus* Dana

Rhincalanus gigas Sewell, 1914a, p. 203 (*nec* T. Scott, 1912, p. 530). [By clerical error the name is given as *R. gigas* instead of *R. cornutus* Dana. The correction is made by Sewell, 1929a, p. 58].

Family PARACALANIDAE

Genus *Paracalanus* Boeck

Paracalanus aculeatus Giesbrecht forma **major** Sewell, 1912d, pp. 326-327 (male); 1929a, pp. 62-64 (female); text-figure 20 a-f. [Examples from *R.I.M.S. Investigator* Stations 540-545, 547, 552, 555, 556, 558, 561, 562, 574, 578, 581-583, 587, 589, 590, 591, 614, and Expedition Harbour, Central Group of Nicobar Islands].

Paracalanus aculeatus Giesbrecht forma **minor** Sewell, 1912d, pp. 326-327; 1929a pp. 64-66, text-figure 21 a-g. [Areas of occurrence same as for forma **major**].

Paracalanus denudatus Sewell, 1929a, pp. 66-68, text-figure 23 a-h. [Type locality: Female examples in surface tow-net at *R.I.M.S. Investigator* Station 614 (Nankauri Harbour, and in Macpherson Strait, Andaman Islands); 1947, p. 51].

Paracalanus dubia Sewell, 1912d, pp. 330-332, plate 15, figs. 1-5. [Type locality: Examples from Mouth of Rangoon River, Burma; 1929a, p. 76, text-figure 29 a, b].

Paracalanus nudus Sewell, 1929a, pp. 76-78, text-figure 30 a-i. [Type locality: not given. Description based on female].

Paracalanus serratipes Sewell, 1912d, pp. 332-334, plate 15, figs. 6-10. [Type locality: Chittagong Region and Rangoon River Estuary; 1914a, p. 208; 1929a, p. 66, text-figure 22 a-b].

Genus *Acrocalanus* Giesbrecht

Acrocalanus inermis Sewell, 1912d, pp. 334-336, plate 16, figs. 1-9. [Type locality: Rangoon River mouth, Burma; 1914a, pp. 211-213, plate 17, figs. 3-5; 1924b, p. 781; 1929a, pp. 81-82. *Acrocalanus similis* Sewell, 1914a was made a synonym of this species by Sewell, 1929a].

Acrocalanus similis Sewell, 1914a, pp. 211-213, plate 17, figs. 3-5. [Type locality: Gulf of Mannar. Synonym of *A. inermis* Sewell, 1912d].

Acrocalanus longicornis Giesbrecht, var. **plumulosus** Sewell, 1912d, p. 359. [Type locality: 13°49·5′N 97°58·5′E].

Family PSEUDOCALANIDAE

Genus *Clausocalanus* Giesbrecht

Clausocalanus arcuicornis (Dana) var. **plumulosus** Sewell, 1913b, p. 367. [Type locality: *R.I.M.S. Investigator* station 393 (7°21′06″N 85°07′15″ E) in surface tow-net. Later considered by Sewell (1929a, p. 91) as an absolute synonym of *Clausocalanus arcuicornis* (Dana)].

Clausocalanus farrani Sewell, 1929a, pp. 94-95, text-figure 38 a-g. [Type locality: Several females from *R.I.M.S. Investigator* station 555, taken in tow-net; 1947, p. 55 ('John Murray Expedition' station 61. Several examples)].

Family AETIDEIDAE

Genus *Euchirella* Giesbrecht

Euchirella orientalis Sewell, 1929a, pp. 115-119, text-figure 44 a-f. [Type locality: Several examples of both sexes from *R.I.M.S. Investigator* station 393; 1947, pp. 76-80, text-figure 15 b-h (Numerous examples of both sexes from 'John Murray Expedition' stations 61C, 96, 145C, 172, and 186)].

Genus *Chirundina* Giesbrecht

Chirundina indica Sewell, 1929a, pp. 119-123, text-figures 45 a-b; and 46 a-j. [Type locality: Several examples of both sexes from *R.I.M.S. Investigator* station 670; 1947, pp. 92-95, text-figure 20 a-e (Numerous examples of both sexes from 'John Murray Expedition' stations 96, 131D, 145C, 145D, 172 and 186)].

Genus *Valdiviella* Steuer

Valdiviella ignota Sewell, 1929a, pp. 137-138, text-figure 52 a-b. [Type locality: One male from *R.I.M.S. Investigator* station 393].

Family EUCHAETIDAE

Genus *Euchaeta* Philippi

Euchaeta murrayi Sewell, 1947, pp. 117-119, text-figure 26 a-i. [Type locality: Nine females from 'John Murray Expedition' stations 61A (1 female), 61C (7 females), and 76 (1 female) in northern part of Arabian Sea and Gulf of Oman].

Genus *Paraeuchaeta* A. Scott

Paraeuchaeta investigatoris Sewell, 1929a, pp. 158-160, text-figure 60 a-d. [Type locality: Three males from *R.I.M.S. Investigator* station 393; 1947, pp. 125-127 (several examples of both sexes from 'John Murray Expedition' station 96, 172 and 186)].

Paraeuchaeta malayensis nom. nov., Sewell, 1929a, pp. 160-168, text-figure 62 a-j. [For *Paraeuchaeta barbata* A. Scott, 1909, nec *Euchaeta barbata* Brady, 1883; 1947, pp. 121-123, text-figure 27 a-f].

Paraeuchaeta withi Sewell, 1947, pp. 131-132, text-figure 30 a-c. [Type locality: One male from 'John Murray Expedition' station 131D in Central part of Arabian Sea in 1500-0 m. *Euchaeta sarsi* (male) With, 1915, p. 178, pl. 6, fig. 7b from the North Atlantic is considered by Sewell to be identical with his new species. (nec *Euchaeta sarsi* Farran)].

FAMILY PHAENNIDAE

Genus *Cornucalanus* Wolfenden

Cornucalanus indicus Sewell, 1929a, pp. 179-183, text-figure 66 a-g. [Type locality : One female from *R.I.M.S. Investigator* station 393].

Family SCOLECITHRICIDAE

Genus *Scottocalanus* Sars

Scottocalanus dauglishi Sewell, 1929a, pp. 189-193, text-figures 68 a-l, and 69 a-c. [Type locality : A large number of females and one male from *R.I.M.S. Investigator* stations 373 and 670 ; 1947, pp. 142-143 (several examples of both sexes from 'John Murray Expedition' stations 96, 145C, 145D, 172 and 186 from Central part of Arabian Sea, Maldive Area, and Gulf of Aden)].

Scottocalanus investigatoris Sewell, 1929a, pp. 187-189, text-figure 67 a-f. [Type locality : One male from *R.I.M.S. Investigator* station 670].

Genus *Lophothrix* Giesbrecht

Lophothrix frontalis Giesbrecht, forma **major** Sewell, 1929a, pp. 193-196, text-figures 70 (part), and 71 a-n. [Type locality : Numerous examples of both sexes from *R.I.M.S. Investigator* collections ; 1947, pp. 149-150, text-figures 37 c-d, and 38 a-f (a few examples from the Arabian Sea taken during 'John Murray Expedition')].

Lophothrix frontalis Giesbrecht, forma **minor** Sewell, 1929a, pp. 196-200, text-figures 70 (part), 72 a-j, and 73 a-c. [Type locality : Several examples of both sexes from *R.I.M.S. Investigator* collections ; 1947, p. 149, text-figure 37 a-b (Arabian Sea and Gulf of Aden—'John Murray Expedition')].

Genus *Macandrewella* A. Scott

Macandrewella scotti Sewell, 1929a, pp. 202-205, text-figure 76 a-j. [Type locality : A number of examples of both sexes including developmental stages collected at *R.I.M.S. Investigator* Station 614].

Genus *Scolecithrix* Brady

Scolecithrix nicobarica Sewell, 1929a, pp. 209-211, text-figure 78 a-g. [Type locality : Examples of both sexes from Nankauri Harbour, Nicobar Islands].

Genus *Scolecithricella* Sars

Scolecithricella pearsoni Sewell, 1914, p. 217, plates 17, figs. 6-7, and 18, figs. 1-4. [Type locality : Examples taken in surface tow from Pearl Banks of Ceylon, Gulf of Mannar; 1929a, p. 215].

Genus *Scaphocalanus* Sars

Scaphocalanus magnus (T. Scott) forma **major** Sewell, 1947, pp. 144-145, text-figure 35 a-i. [Type locality : Descriptions based on seven females and one juvenile male taken at 'John Murray Expedition' stations 96 and 136. The species has a world wide distribution].

Scaphocalanus magnus (T. Scott) forma **minor** Sewell, 1947, pp. 146-147, text-figure 36 a-h. [Type locality : Twelve females from 'John Murray Expedition' stations 76 and 172 in the Gulf of Oman and the Arabian Sea].

Genus *Amallothrix* Sars

Amallothrix indica Sewell, 1929a, pp. 219-221, text-figure 81 a-g. [Type locality : Several female examples from *R.I.M.S. Investigator* station 670 in the

Laccadive Sea ; 1947, pp. 161-162 (seven females from 'John Murray Expedition' stations 61C, 96, and 172 in Northern and Central Arabian Sea].

Tribe HETERARTHRANDRIA

Family CENTROPAGIDAE

Genus *Centropages* Kroyer

Centropages alcocki Sewell, 1912d, pp. 338-339, plate 17, figs. 1-7. [Type locality : Mouth of Rangoon River, Burma ; 1929a, p. 228].

Centropages trispinosus Sewell, 1914a, p. 223, plate 18, figs. 5-8. [Type locality : Kilakarai, Ramnad Coast, Gulf of Mannar ; 1932a, p. 232].

Genus *Isias* Boeck

Isias tropica Sewell, 1924b, pp. 782-784, plate 44, fig. 1. [Type locality : Examples of both sexes from Chilka Lake stations E, 15, and 48 ; 1932a, p. 233].

Family DIAPTOMIDAE

Genus *Diaptomus* Westwood

Diaptomus indicus Sewell, 1934a, pp. 73-75, text-figure 2 b-g. [Type locality : Examples from Hooghly River, Station Naihati, 16 miles above Howrah bridge (freshwater) and Tank in P.W.D. Bungalow compound, Ghorawal, Mirzapore (freshwater)].

Family PSEUDODIAPTOMIDAE

Genus *Pseudodiaptomus* Herrick

[*Schmackeria* Poppe and Richard, 1890, has been relegated as a subgenus of *Pseudodiaptomus* Herrick by Sewell (1956), while earlier (Sewell, 1947, p. 164) he recognised it as a distinct genus of the family Pseudodiaptomidae. Of the species of *Pseudodiaptomus* described as new to science by Sewell (1912d, 1924a, 1932a), the following species—*P. annandalei*, *P. binghami*, *P. dauglishi*, and *P. tollingeri* would belong to the subgenus *Schmackeria*, while *P. hickmani* and possibly *P. burckhardti* and *P. masoni* belong to *Pseudodiaptomus* s. str.].

Pseudodiaptomus annandalei Sewell, 1919a, pp. 5-7, plate 10, fig. 9. [Type locality : Examples from Chilka Lake ; 1924a, p. 787, plate 44, fig. 2 ; 1932a, p. 240].

Pseudodiaptomus binghami Sewell, 1912d, pp. 337-338, plate 17, figs. 8-11. [Type locality : Rangoon River Estuary, Burma ; 1919a, p. 7 ; 1924a, p. 786, plate 45, fig. 2 ; 1932a, pp. 240-241].

Pseudodiaptomus burckhardti Sewell, 1932a, pp. 235-237, text-figure 83 a-e. [Type locality : One female from *R.I.M.S. Investigator* station 614, Nankauri Harbour, Nicobar Islands ; and a few females from Macpherson Strait, Andaman Islands].

Pseudodiaptomus dauglishi Sewell, 1932a, pp. 241-244, text-figure 86 a-h. [Type locality : Several examples of both sexes from Kuala Kuran, Perak, Malaya in surface tow-net collections].

Pseudodiaptomus hickmani Sewell, 1912d, pp. 364-365, plate 22, figs. 1-7. [Type locality: Hinze Basin, 14°41′05″ N and 97°53′E; 1924a, p. 786; 1932a, p. 235].

Pseudodiaptomus masoni Sewell, 1932a, pp. 237-240, text-figure 84 a-j. [Type locality : Several females and copepodid stages from Port Blair Harbour and Macpherson Strait, Andaman Islands].

Pseudodiaptomus tollingeri Sewell, 1919a, pp. 2-5, plate 10, fig. 8. [Type locality : Chilka Lake and Port Canning in Gangetic Delta ; 1924a, p. 787, plate 45, fig. 3 ; 1932a, p. 241].

Family LUCICUTIIDAE

Genus *Lucicutia* Giesbrecht

Lucicutia challengeri Sewell, 1932a, pp. 290-294, text-figure 95 a-j. [Type locality : Several examples of both sexes from *R.I.M.S. Investigator* stations 393, and 682. Sewell also gives *Leuckartia flavicornis* Brady, 1883, p. 50, plate 15, figs. 1-6, 16 (nec *Lucicutia flavicornis* Claus) as a synonym ; 1947, p. 174].

Family AUGAPTILIDAE

Genus *Euaugaptilus* Sars

Euaugaptilus indicus Sewell, 1932a, pp. 319-321, text-figure 105 a-j. [Type locality : Two females from *R.I.M.S. Investigator* stations 670 and 680 ; 1947, pp. 201-203, text-figure 51 a-c (one juvenile male—stage V—from 'John Murray Expedition' station 172 in Central Arabian Sea].

Family PSEUDOCYCLOPIDAE

Genus *Pseudocyclops* Brady

Pseudocyclops obtusatus Brady and Robertson, var. **latisetosus** Sewell, 1932a, pp. 330-331, text-figure 108 a-f. [Type locality : Male (no ?) ; locality not given].

Pseudocyclops simplex Sewell, 1932a, pp. 332-333, text-figure 109 a-l. [Type locality : Examples of both sexes ; locality not given].

Family CANDACIIDAE

Genus *Candacia* Dana

Candacia magna Sewell, 1932a, pp. 338-340, text-figure 111 a-h. [Type locality : One female and one male from *R.I.M.S. Investigator* stations 393 and 670].

Candacia norvegica Boeck var. **tropica** Sewell 1932a, pp. 336-337, text-figure 110 a-d. [Type locality : Two females from *R.I.M.S. Investigator* station 682].

Family PONTELLIDAE

Genus *Labidocera* Lubbock

Labidocera euchaeta Giesbrecht forma **major** Sewell, 1932a, pp. 361-362. [Same as *L. euchaeta* Giesbrecht Stage-I, Sewell, 1912a, p. 339, plate 18, figs. 1-9. (Male ; no. of specimens ?). (See under *Labidocera gangetica* Sewell)].

Labidocera euchaeta Giesbrecht forma **minor** Sewell, 1932a, p. 362. [Same as *L. euchaeta* Giesbrecht Stage-II, Sewell, 1912d, p. 341, plate 19, figs. 1-3. (Females)].

Labidocera gangetica Sewell, 1934a, pp. 79-80. [For *L. euchaeta* Giesbrecht Stage-I of Sewell, 1912d, and *L. euchaeta* Giesbrecht forma **major** Sewell, 1932a].

Labidocera kroyeri (Brady) var. **bidens** Sewell, 1912d, p. 369, plate 24, fig. 8. [Type locality : Mouth of Tavoy River, Burma].

Labidocera kroyeri (Brady) var. **burmanica** Sewell, 1912d, p. 369, plate 23, figs. 4-5. [Type locality : Mouth of Tavoy River, Burma ; 1914a, p. 233 ; 1932a, p. 363].

Genus *Pontella* Dana

Pontella andersoni Sewell, 1912d, pp. 344-346, plate 20, figs. 1-6. [Type locality : Coast of Burma ; 1932a, p. 375].

Pontella investigatoris Sewell, 1912d, pp. 371-372, plate 23, figs. 1-3. [Type locality : Coast of Burma ; 1914a, p. 236 ; 1932a, p. 382].

Genus *Pontellopsis* Brady

Pontellopsis scotti Sewell, 1932a, pp. 388-390, text-figure 129 a-f. [Type locality : Several examples of both sexes from several *R.I.M.S. Investigator* stations along the Burma Coast].

Family Acartiidae

Genus *Acartia* Dana

Group-I. Acartiae arostratae

Subgenus *Acartiella* Sewell, 1914a

[Sewell (1914a) erected the genus *Acartiella* for *A. kempi* Sewell, but later (Sewell, 1932a) relegated *Acartiella* as a subgenus of genus *Acartia* Dana].

Acartia (Acartiella) gravelyi Sewell, 1919a, p. 10, plates 9, fig. 7, and 10, figs. 1-5. [First described as *Acartiella gravelyi* Sewell. Type locality : Examples from Cochin backwaters) ; 1932a, p. 393].

Acartia (Acartiella) kempi Sewell, 1914a, p. 246, plate 20, figs. 1-5, and plate 21, fig. 4. [First described as *Acartiella kempi* Sewell (Type locality : Gulf of Mannar) ; 1932a, p. 393].

Acartia (Acartiella) major Sewell, 1919a, p. 13, plates 9, fig. 8, and 10, figs. 2-6. [First described as *Acartiella major* Sewell (Type locality : Examples from Chilka Lake) ; 1924a, p. 791, plate 46, fig. 1 ; 1932a, p. 393].

Acartia (Acartiella) minor Sewell, 1919a, p. 15, plates 9, fig. 6, 10, fig. 7. [First described as *Acartiella minor* Sewell (Type locality : Examples from Chilka Lake ; 1924a, p. 791, plate 46, fig. 2 ; 1932a, p. 393)].

Acartia (Acartiella) tortaniformis Sewell, 1912d, pp. 346-348, plate 21, figs. 1-10. [First described as *Acartia tortaniformis* (Type locality : Examples from the mouth of Rangoon River, Burma) ; 1932a, p. 393].

Group-II. Acartiae rostrae

Subgenus *Euacartia* Steuer

Acartia (Euacartia) southwelli Sewell, 1914a, p. 244, plate 19, figs. 8-9. [First described as *Acartia southwelli* Sewell. (Type locality : Examples from Ceylon Pearl Banks, Gulf of Mannar) ; 1924a, p. 790, plate 45, fig. 6 ; 1932a, pp. 393-394, text-figure 130].

Subgenus *Acanthacartia* Steuer

Acartia (Acanthacartia) chilkaensis Sewell, 1919a, pp. 9-10, plate 9, figs. 1-5. First described as *Acartia chilkaensis* Sewell. [Type locality : Examples from Chilka Lake ; 1924a, p. 790 ; 1932a, p. 395].

Family TORTANIDAE

Genus *Tortanus* Giesbrecht

Subgenus *Atortus* Sewell, 1932a, p. 400.

[Monotypic, known only from *Tortanus* (*Atortus*) *tropicus* Sewell, 1932a].

Tortanus (Atortus) tropicus Sewell, 1932a, pp. 400-402, text-figure 131 a-g. [Type locality : Examples of both sexes from *R.I.M.S. Investigator* station 614—taken in surface tow-net].

CRUSTACEA : DECAPODA

Family HYPPOLYTIDAE

Genus *Merhippolyte* Bate

Merhippolyte calmani Kemp and Sewell, 1912e, pp. 20-22, plate 1, figs. 1-4. [Type locality : Obtained during *R.I.M.S. Investigator* Survey Season 1910-11].

Class PISCES

Order PERCIFORMES

Suborder Gobioidei

Family GOBIIDAE

Genus *Cryptocentrus* (Ehrenberg) Valenciennes, 1837

Cryptocentrus rubropunctatus Sewell, 1914b, pp. 134-135, plate 8, fig. 3. [Type locality : One example from *R.I.M.S. Investigator* station 414, Tavoy Island, Coast of Burma].

DETAILS OF STATION POSITIONS MENTIONED AS TYPE LOCALITIES

I. CHILKA LAKE :

Station No.	B.	At Satpara on 16-12-1913.
,, ,,	C.	Weed-washings from Rambha on 27-12-1913.
,, ,,	D.	Rambha Bay on 22-1-1914.
,, ,,	E.	South side of Maludaikadu on 12-4-1914.
,, ,,	F.	Off Barkuda Island on 13-4-1914.
,, ,,	G.	Between Cherriakuda and Breakfast Island on 15-4-1914.
,, ,,	K.	Off Gantasila, Rambha Bay in April 1914.
,, ,,	15.	Rambha Bay, off Boat Harbour on 15-2-1914.
,, ,,	48.	2·9 miles east of Barkul Bungalow on 3-3-1914.
,, ,,	89.	Between Mahosa and Satpara in main channel on 18-3-1914.
,, ,,	101.	Between Cherria and Mainland on 20-7-1914.
,, ,,	128.	Off southernmost island of Manikpatna series on 10-3-1914.
,, ,,	133.	Off Mahosa, main channel on 12-9-1914.
,, ,,	142.	Along Barkuda Island on 23-9-1914.
,, ,,	148.	Chiriya Island to near Barkuda Island on 19-11-1914.
,, ,,	166.	Anchorage at Barkul due east on 29-11-1914.

II. JOHN MURRAY EXPEDITION—1933-1934 :

Station No.	10.	Red Sea, 55 m.
,, ,,	24.	Gulf of Aden, 73-220 m.
,, ,,	45.	South Arabian Coast, 38 m.
,, ,,	61.	Northern part of Arabian Sea, surface.
,, ,,	61A.	Northern area of Arabian Sea, 1500-0 m.
,, ,,	61C.	Northern area of Arabian Sea, 1000-0 m.; 1500-0 m.
,, ,,	76.	Gulf of Oman, 600-0 m.; 1500-0 m.

Station No.	96.	Central part of Arabian Sea, 645-400 m.
,, ,,	98.	Central area of Arabian Sea, 2800-0 m.
,, ,,	120.	Zanzibar area, 2926-0 m.
,, ,,	131D.	Southern area of Arabian Sea, 1500-0 m.
,, ,,	145.	Maldive area, 300-0 m.; 500-0 m.
,, ,,	145C.	Maldive area, 300-0 m.
,, ,,	145D.	Maldive area, 500-0 m.
,, ,,	172.	Central area of Arabian Sea, 400-0 m.; 850-0 m.; 2091-0 m.
,, ,,	186.	Gulf of Aden, 600-0 m.; 500-700 m.; 250-0 m.

III. R.I.M.S. 'INVESTIGATOR' STATIONS :

St. No.	Date	Position	Depth (fms.)	Depth of haul (fms.)
373	19-xii-1906	15° 59′ 10″N, 93° 30′ 45°E	195	195
393	21-x-1911	7° 21′ 6″N, 85° 7′ 15″E	2000	400
414	27-x-1913	Fisher Bay, Port Owen, Tavoy Island	..	Littoral
540	11-12-x-1913	12° 55′ 15″N, 98° 27′ 00″E	12	1
541	12-13-x-1913 13-14-x-1913 24-25-x-1913	12° 29′ 57″N, 98° 34′ 38″E	8	Surface
542	14-15-x-1913	12° 45′ 15″N, 98° 22′ 00″E	12	,,
543	15-x-1913	12° 51′ 30″N, 98° 30′ 45″E	8	,,
544	15-16-x-1913	13° 01′ 15″N, 98° 29′ 30″E	7	,,
545	16-17-x-1913	12° 40′ 00″N, 98° 27′ 00″E	9	,,
552	22-xi-1913	12° 44′ 00″N, 98° 08′ 30″E (3 miles NNW of Brown Rock)	25	25
555	23-24-xi-1913	12° 45′ 50″N, 98° 17′ 54″E	12	Surface
556	31-xi-1913	12° 40′ 00″N, 98° 26′ 30″E	10	,,
558	2-3-xi-1913	Port Maria, Elphinstone Id.	9	,,
561	4-5-xi-1913	12° 00′ 10″N, 98° 20′ 30″E	7½	,,
562	6-7-xi-1913	11° 53′ 45″N, 98° 20′ 45″E	5	,,
574	17-18-xii-1913	11° 53′ 45″N, 98° 25′ 00″E	7	,,
577	27-28-xii-1913	11° 58′ 20″N, 98° 18′ 15″E	8	,,
578	30-31-xii-1913	11° 48′ 52″N, 98° 23′ 23″E	5½	,,
581	1914	Mergui Harbour	6	,,
583	2-3-ii-1914	11° 28′ 34″N, 98° 34′ 27″E	11	,,
587	7-8-ii-1914	11° 35′ 00″N, 98° 34′ 15″E	11	,,
589	11-12-ii-1914	11° 23′ 33″N, 98° 33′ 45″E	6	,,
590	12-16-ii-1914	11° 34′ 45″N, 98° 34′ 30″E	..	,,
591	16-17-ii-1914	11° 16′ 15″N, 98° 38′ 30″E	8	,,
613	1-2-v-1914	15° 51′ 45″N, 73° 31′ 40″E	..	,,
614	26-27-x-1914	Octavia Bay, Nankauri Harbour.	13	Surface and 9½ fathoms. Also weed-washings.
664	4-ii-1915	Henry Lawrence Island (From sandy beach and coral reef at south end)	..	Weed-washings.
670	23-iv-1915	5° 56′ 00″N, 76° 22′ 00″E	..	Approx. 200 fms. to surface, and from surface.
680	10-iv-1915	South of Chinese fishing village, Kachal Island	..	Littoral; Weed-washings.
682	28-iv-1915	10° 26′ 00″N, 74° 32′ 30″E	..	700 fms. to surface and from surface.

List of Scientific Publications of the late Dr. R. B. S. Sewell[1]

1912a. Notes on the deep-sea fish obtained by *R.I.M.S. Investigator* during the Survey Season 1910-11. *Rec. Indian Mus.* 7(1) : 1-14.

[Based on deep-sea trawls made off the south-west coast of India from *Investigator* stations 388 to 391. Includes descriptions and details of 19 species and a detailed illustrated account of the egg capsule and embryo of *Rhinochimaera* sp. (Holocephali)].

1912b. Capture of *Limulus* on the surface.

Rec. Indian Mus. 7(1) : 87-88.

[On an adult specimen of *Limulus muluccanus* Latreille (=*Tachypleus gigas* (Müller)] measuring 39 cm. captured in surface tow-net by *R.I.M.S. Investigator* at 18·30 hours on 19-12-1911 close to 97° 45½'E, 14° 43½'N in 10 fathoms].

1912c. Notes on the development of larva of *Lingula*.

Rec. Indian Mus. 7(1) : 88-90.

[Larvae presumably that of *Lingula anatina* from Hinzé Basin, Burma Coast obtained in plankton during months of December and February 1911. Description, body measurements and comparison with earlier descriptions as regards (*a*) the stage of formation and protrusion of the peduncle; and (*b*) the stage at which change in shape of shell takes place].

1912d. Notes on the surface-living copepoda of the Bay of Bengal I, and II.

Rec. Indian Mus. 7 : 313-382, pls. xiv-xxiv.

[I. The Gymnoplea of the Chittagong and Rangoon River Estuaries ; with notes on the application of 'Brook's Law' to the Copepoda and evidence of dimorphism in this group of Crustacea. pp. 313-348. II. The Gymnoplea of the South Burma Coast and Moscos Island. pp. 349-382. The account also contains descriptions of 8 new species, 6 new varieties and two new forms of Copepoda].

1912e. Notes on Decapoda in the Indian Museum. III. Species obtained by *R.I.M.S. Investigator* during the Survey Season 1910-11.

Rec. Indian Mus. 7(1) : 15-32, pl. i (With S. Kemp).

[Contains descriptions and notes on 31 species and varieties including a new species—*Merhippolyte calmani* (Family Hyppolytidae)].

1912f. Indian fish of proved utility as mosquito destroyers.

Thacker, Spink & Co., Calcutta, pp. 1-24 (and B. L. Chudhuri).

[Has an 'Introductory note' by Dr. N. Annandale. Eleven species are dealt with and Sewell gives 'Additional notes' on these fish in their natural surroundings].

1913a. Note on plankton from Chilka Lake.

Rec. Indian Mus. 9 : 338-340.

[General notes on plankton with descriptions of three species of Copepoda, namely *Paracalanus crassirostris* Dahl, *Acartia centrura* Giesbrecht, and *Oithona* sp.].

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[1] Excluding papers on Anthropology.

1913b. Notes on the Biological work of the *R.I.M.S. Investigator* during Survey Seasons 1910-11 and 1911-12.

Journ. & Proc. Asiatic Soc. Bengal (*n.s.*) **9** (8 & 9) : 339-390.

[Brief history of the Marine Survey of India; notes on observations made during two seasons; shore collecting ; bottom trawling ; midwater trawling ; observations on surface plankton; succession of planktonic organisms along the Burma coast—from Hinzé Basin to Tavoy Island—for the months of November to April ; a list of 134 species of molluscs collected at various shore collecting stations in Burmese waters ; tables giving station data including data on plankton volume, copepod catch per hour, etc.].

1913c. Notes on the fish fauna of certain tanks in Bengal.

Special Bulletin No. 1, *Dept. Agric. Bihar and Orissa, Ranchi,* (with T. Southwell).

1914a. Notes on surface Copepoda of the Gulf of Mannar.

Spolia zeylanica **9**(35) : 191-263.

[Includes descriptions of one new genus and five new species].

1914b. Notes on Indian fish. I-II.

Rec. Indian Mus. **10**(2) : 131-135, pl. 1.

[I. On the genus *Malthopsis* Wood-Mason and Alcock, and species ; II. Descriptions of a new goby *Cryptocentrus rubropunctatus* from Tavoy Island, Burma].

1914c. Some observations on the development of the Copepoda.

IXth Congrês International de Zoologie Monaco, p. 492.

1919a. A preliminary note on some new species of Copepoda.

Rec. Indian Mus. **16** : 1-18, with 2 plates.

[Includes descriptions of six new species collected from Chilka Lake, Port Canning, and Cochin backwaters. A key for the identification of the species of the genus *Acartiella* Sewell is also given].

1919b. The possible occurrence of *Schistosoma japonicum* Katsurada in India.

Rec. Indian Mus. **16** : 426-429, with 1 plate.

[Description and figures of a true *Schistosoma* (Cercariae Indicae xxx) almost identical to that of *S. japonicum* found for the first time from a tank in Russa Road, South Tollygunge, Calcutta, from the hosts *Planorbus exustus* Desh., or in a form of *Limnaea amygdalum* Troschel].

1920a. On *Mesocoelium sociale* (Lühe).

Rec. Indian Mus. **19**(3) : 81-96.

[Description of the trematode *M. sociale* from the host *Bufo melanostictus* from Calcutta. Notes on the development of the trematode and comments on the systematic position of the species are also dealt with].

1920b. Notes on Mr. Charles' specimen (Filaria).

Indian Medical Gazette **55** : 378, Calcutta.

1920c. 'Progress Report on a Survey of the Freshwater Gastropod Molluscs of the Indian Empire and their Trematode Parasites.'

Indian J. Med. Res. **8** : 93-124 (with N. Annandale).

1921. The Banded Pond-snail of India (*Vivipara bengalensis*).

Rec. Indian Mus. **22**(3) : 215-292, with 3 plates (with N. Annandale).

[Part I—Anatomical, and Part IV—'Bionomics' (pp. 217-242 and 279-292) are dealt with by Sewell, while Part II—'The edge of the mantle and the external ornamentation of the shell' (pp. 243-266), and Part III—'Systematics' (pp. 267-278) are dealt with by Annandale].

1922a. The Fauna of the Chilka Lake. The Hydrography and invertebrate fauna of Rambha Bay in an abnormal year.

Mem. Indian Mus. **5** : 677-710 (with N. Annandale).

1922b. A survey season in the Nicobar Islands on the *R.I.M.S. Investigator*, October, 1921, to March, 1922.

J. Bombay nat. Hist. Soc. **28**(4) : 970-989, with 4 plates.

[Natural history observations ; also descriptions of fringing reef, with notes on distribution of corals].

1922c. Cercariae Indicae.

Indian J. Med. Res. **10** (Supplement) : 1-327, Calcutta.

1924a. Observations on growth in certain molluscs and changes correlated with growth in the radula of *Pyrazus palustris*.

Rec. Indian Mus. **26** : 529-548.

[In continuation of work on rate of growth and other correlated changes in the structure and life-history of Indian Molluscs, data is given here on I. Fresh-water inhabitants (*Acrostoma variabile* (Benson), *Melanoides lineatus* (Gray), *M. tuberculatus* (Müller), *Limnaea acuminata* (Lamarck) var. *gracilior* (V. Martens), and *Indoplanorbis exusta* (Deshayes) ; and II. Marine and Brackish-water forms *Littorina scabra* (Linn.), *L. obesa* Say, *Pyrazus palustris* (Linn.), and *Mytilus variabilis* Krss.].

1924b. The Fauna of Chilka Lake. Crustacea, Copepoda.

Mem. Indian Mus. **5** (12) : 771-852, with 15 plates.

[Out of a total number of 57 species, varieties and forms dealt with, 9 species and 5 varieties are described as new, and most of the species given in the account are illustrated].

1925a. Geographic and Oceanographic research in Indian waters. Part I. Introduction, and The Geography of the Andaman Sea Basin.

Mem. Asiatic Soc. Bengal **9** : 1-28, with 3 text-figures and 5 plates.

1925b. Geographic and Oceanographic research in Indian waters. Part II.

A study of the nature of the sea-bed and of the deep-sea deposits of the Andaman Sea and Bay of Bengal.

Mem. Asiatic Soc. Bengal **9** : 29-49, with 1 text-figure, 1 chart and 2 plates.

1926a. The Salps of the Indian Seas.

Rec. Indian Mus. **28** : 65-126.

[Records 17 species, subspecies and forms ; most of the species are illustrated, with taxonomic notes added ; also given are, month-wise occurrence of species in Indian waters; salinity in relation to occurrence of *Salpa cylindrica* on the surface along the Burma Coast in 1911 ; same for *Thalia democratica* in Burmese waters in 1914 and for Nankauri Harbour in 1922].

1926b. A study of *Lithotyra nicobarica* Reinhardt.
Rec. Indian Mus. **28** : 296-330, with 2 plates.
[On cryptozoic (lodged in shells, corals, coral conglomerate, solid limestone rock, etc.) pedunculate cirripedes of the genus *Lithotyra*, especially the species *L. nicobarica*. Topics dealt with include taxonomic discussions having a bearing on the species problem in this genus; detailed anatomical description of *L. nicobarica* as well as table of measurements of 60 specimens].

1927a. The study of zoology in India in the Future.
Proc. 14*th Indian Sci. Congr., Lahore*, 1927, pp. 177-187.

1927b. Geographic and Oceanographic research in Indian waters. III. Maritime Meteorology in Indian Seas.
Mem. Asiatic Soc. Bengal **9** : 53-129.

1928. Geographic and Oceanographic research in Indian waters. IV. The temperature and salinity of the coastal water of the Andaman Sea.
Mem. Asiatic Soc. Bengal **9** : 133-205.

1929a. The Copepoda of Indian Seas. Calanoida. Tribe Amphaskandria.
Mem. Indian Mus. **10**(1) : 1-221, with 81 text-figures.
[Out of 171 species and varieties, 13 species are described as new. In addition, various copepodid stages are described and figured for 14 species].

1929b. Geographic and Oceanographic research in Indian waters. V. The temperature and salinity of the surface-waters of the Bay of Bengal and Andaman Sea, with references to the Laccadive Sea.
Mem. Asiatic Soc. Bengal **9** : 207-355.

1929c. The history and progress of the Zoological Survey of India. Introduction.
J. Bombay nat. Hist. Soc. **33**(4) : 922-926.

1930. The evolution of the Excretory system in certain groups of the Furcocercous Cercariae.
Rec. Indian Mus. **32** : 357-383, with 4 plates.
[The systematic grouping of the various species of the furcocercous cercariae based on characters of their excretory system. An attempt is made to trace the evolution of the excretory system in certain groups].

1931a. The Problem of Evolution. I. Experimental modification of bodily structure.
Presidential Address : 18*th Indian Science Congress, Nagpur*, January 2, 1931 : 1-19.

1931b. The Problem of Evolution. II. The trend of evolution under natural conditions.
Annual Presidential Address ; 1930-1931 : *Asiatic Soc. Bengal, Calcutta*, February 2, 1931 : 1-14.

1931c. The problem of Evolution. Part I.
J. Bombay nat. Hist. Soc. **35** (1) : 115-131 (June 1931).

1931d. The problem of Evolution. Part II.
J. Bombay nat. Hist. Soc. **35** (2) : 347-358 (October 1931).

1932a. The Copepoda of the Indian Seas. Calanoida. Tribe Heterarthrandria.
Mem. Indian Mus. **10**(2) : 223-407, with 40 text-figures and 6 plates.
[Out of a total of 206 species, varieties and forms, 8 species are described as new. Various copepoda stages are described for 12 species].

1932b. Marine Biological Research in India.
Curr. Sci. **1** : 155-157.

1932c. The Zoological Survey of India.
Nature, Lond. **129** : 530-532.

1932d. The coral coasts of India.
Geographical Journal **79** : 449-462.
[Descriptive accounts of the coral reefs in the Nicobar Islands, and reef processes].

1932e. Geographic and Oceanographic research in Indian waters. VI. The temperature and salinity of the deeper waters of the Bay of Bengal and Andaman Sea.
Mem. Asiatic Soc. Bengal **9** : 357-423.

1933. Notes on a small collection of Copepoda from the Malay States.
Bull. Raffles Mus. **8** : 25-31.

1934a. A study of the fauna of the Salt Lakes, Calcutta.
Rec. Indian Mus. **36**(1) : 45-121.
[Geography of the area; salinity and other observations on salt-water lakes near Calcutta; an account of the plankton with special reference to Copepoda and a systematic account of the Copepoda including descriptions of 7 new species].

1934b. The John Murray Expedition to the Arabian Sea.
Nature, Lond. **133** : 86-89, 669-672 ; **134** : 685-688.

1934c. Studies on the bionomics of fresh-waters in India. II.
Internat. Rev. d. ges. Hydrobiol. u Hydrogr. **31**.

1935a. Geographic and Oceanographic research in Indian waters. VII. The topography and bottom deposits of the Laccadive Sea.
Mem. Asiatic Soc. Bengal **9** : 425-460.

1935b. Geographic and Oceanographic research in Indian waters. VIII. Studies on coral and coral formation in Indian waters.
Mem. Asiatic Soc. Bengal **9** : 461-539.

1935c. Introduction and list of Stations.
Scientific Reports : John Murray Expedition 1933-1934, **1** : 1-41, with 1 map.
[John Murray Expedition Committee; Scientific staff; ship's staff; a brief narrative of the voyage; ship and scientific equipment; methods of preservation of collections ; station list and map showing track of voyage of *H.E.M.S. Mabahiss*].

1936a. An account of Addu Atoll.
Scientific Reports : John Murray Expedition 1933-1934, **1** : 63-93, with 1 text-figure and 8 plates.

1936b. An account of Horsburgh or Goifurfehendu Atoll.
Scientific Reports : John Murray Expedition 1933-1934, **1** : 109-125, with 1 text-figure and 6 plates.

1937a. The Oceans around India. *In* : An Outline of the Field Sciences of India.
Indian Sci. Congr. Assoc. Silver Jubilee Session, pp. 17-41.

1937b. The Floor of the Arabian Sea.

Geological Magazine **74** : 219-230 (with J. D. H. Wiseman).

1940a. The Indian Ocean.

Union Géodésique et Géophysique Internationale, Assoc. d' Oceanographic Physique Publication Scientifique **8** : 81-86.

1940b. The extent to which the distribution of marine organisms can be explained by and is depended on the hydrographic conditions present in the great oceans, with special reference to the plankton.

Proc. Linn. Soc. London, Session 152, pt. 3, (1939-40).

1940c. Copepoda, Harpacticoida.

Scientific Reports : John Murray Expedition 1933-1934, **7** : 117-382, with 88 text-figures and 1 chart.

[Out of a total of 116 species, varieties and forms belonging to 42 genera, 2 genera, 1 subgenus, 30 species, 1 variety and 11 forms are described as new. The account is also partly based on *R.I.M.S. Investigator* collections from other areas of the Indian waters].

1942. The Theory of Continental Drift.

Proc. Linn. Soc. London, **155** :

1946. Oceanographical problems in the Indian Ocean.

British Commonwealth Scientific Official Conference—Committee on Oceanography and Fisheries, London, DS 80442/1, pp. 4-6 (Mimeo.).

1947. The Free-swimming planktonic Copepoda. Systematic Account.

Scientific Reports: John Murray Expedition 1933-1934, **8** : 1-303, with 71 text-figures.

[The account is also partly based on *R.I.M.S. Investigator* collections from parts of the Indian Seas. Of the 230 species, varieties, and forms belonging to 73 genera of Calanoida, Cyclopoida, and Harpacticoida, 1 family, 4 species, 1 variety and 4 forms are described as new].

1948a. The Free-swimming planktonic Copepoda. Geographical Distribution. *Scientific Reports : John Murray Expedition* 1933-1934, **8** : 317-592, with 24 text-figures and 2 charts.

1948b. Minimum Oxygen layer in the Ocean.

Nature, Lond. **162** : 949-951 (and L. Fage).

1949. Littoral and Semi-Parasitic Cyclopoida : Monstrilloida and Notodelphyoida.

Scientific Reports: John Murray Expedition 1933-1934, **9** : 17-199, with 41 text-figures and 1 chart.

[The account consists of 44 species belonging to 22 genera. Of these, 3 genera, 1 subgenus, and 25 species are described as new. The account is also partly based on material collected from *R.I.M.S. Investigator* from Indian waters].

1950. Dr. Thomas Nelson Annandale's work in India.

Rec. Indian Mus. **47**(2) : 173-182.

1951. The Epibionts and Parasites of the Planktonic Copepoda of the Arabian Sea. *Scientific Reports : John Murray Expedition* 1933-1934, **9** : 255-394, with 61 text-figures.

[The account also includes descriptions of three new Suctoria which are epibionts on Copepods (*Acineta euchaetae* sp. nov., *Paracineta gaetani* sp. nov., and *Hallezia scottocalani* sp. nov.), and two new species of *Blastodinium* (*B. apsteini* sp. nov., and *B. chattoni* sp. nov.) which are parasitic on certain copepods].

1952a. Deep-Sea Oceanographical Exploration in Indian Waters. *J. Bombay nat. Hist. Soc.* **50** (4) : 705-717.

1952b. Oceanographic Exploration, 1851-1951. Paper read before the Association of British Zoologists on January 6, 1951, and published in *Science Progress*, 1952, p. 16.

1953a. The Pelagic Tunicata. *Scientific Reports : John Murray Expedition* 1933-1934, **10**(1) : 1-90, with 32 text-figures and 1 plate.

[25 species, varieties and forms are dealt with. The species problem, especially in Pyrosomatidae is discussed at length].

1953b. A note on the Productivity of the waters of the northern region of the Indian Ocean. *Proc. 8th Pacif. Sci. Congr.*, 3 A : 1138-1144.

1955. A study of the sea coast of Southern Arabia. *Proc. Linn. Soc. London*, Session 165, 1952-53, pt. 2 (June 1955 *Presidential Address*) : 188-210.

1956. The Continental Drift Theory and the distribution of Copepoda. *Proc. Linn. Soc. London*, Session 166, 1953-54, pts. 1 & 2 (January 1956) : 149-177.

1957. A review of the subgenus *Thermocyclops* Kiefer of the genus *Mesocyclops* Sars, with a description of a new form of *Mesocyclops* (*Thermocyclops*) *schmeili* Poppe and Mrazek forma *marmagoensis* nov. *Rec. Indian Mus.* **55** : 69-119.

1958. Evolution : The Taxonomer's Approach. Parts I & II. *J. Bombay nat. His. Soc.* 55(1) : 17-36 (Part I) ; ibid. 55(2) : 269-286 (Part II).

UNPUBLISHED AND MISCELLANEOUS WORKS :

'Copepoda' in '*The Fauna of India*' Series (Under Publication).

The Invertebrate Gallery in the Indian Museum. pp. 187-194 (Published by the Indian Museum in the late Twenties).

'Oceanographic Studies in Indian Waters.' Extracts from four letters of Dr. R. B. S. Sewell included in the Presidential Address: 1950, delivered before the Zoological Society of India at its Annual Meeting held at Poona on January 4, 1950 by Dr. Sunder Lal Hora. *J. Zool. Soc. India* **2**(2) : 73-85 (Sewell's letters and one map reprinted on pp. 78-83).

J. Bombay Nat. Hist. Soc. 68(3). 1971

Orchids of Nepal—5

BY

M. L. BANERJI[1] AND B. B. THAPA[2]

(With two text-figures)

[*Continued from Vol.* 68 (1):36]

In this instalment on the Orchids of Nepal, some of the genera that fall under the series *Acranthae* of tribe *Kerosphaeroideae* are dealt with, namely *Agrostophyllum* Bl., *Cryptochilus* Wall., *Otochilus* Lindl., and *Pholidota* Lindl. ex Hk.; the subtribe in each case is also indicated.

KEY TO THE GENERA

Lateral sepals united in a mentum. Column dilated at apex—
- Tufted, flattened leafy stem.................... *Agrostophyllum* (Glomereae)
- Pseudobulbs crowded, 1-2 leaved.............. *Cryptochilus* (Dendrobieae)

Lateral sepals not united—
- Column short with broad wings round the anther.... *Pholidota* (Coelogyneae)
- Column elongate.................................. *Otochilus* (Coelogyneae)

Agrostophyllum Bl.

The genus gets its name from the grass-like leaves of most of the species. It is placed under the subtribe Glomereae by Schultes and Pease, but Hawkes calls the subtribe as Glomerinae. The plants have a leafy stem with leaves distichous and linear, persistent flattened sheaths. Flowers are very small crowded in terminal heads, bracts long and paleaceous. Lateral sepals broader and adnate to the foot of the column. Lip adnate to the foot of the column which is stout and more thickened above.

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[1] University of Kalyani, Kalyani, W. Bengal.

[2] Horticultural Assistant, Indian Co-operation Mission, Kathmandu.

Agrostophyllum callosum Reichb. f. in Seem. Fl. Vit. 296, 1865-68; F.B.I. 5:824, 1890; King & Pantl. 155, t. 212, 1898; Hara, 425, 1966.

Plants without pseudobulbs, stem flat. Leaves linear with an apical notch. Flowers dull reddish-green; sepals 5-7-nerved, petals broad, many-nerved. Lip broadly ovate or oblong, obscurely 3-lobed, sometimes the lobes are distinct, midlobe orbicular. *Flowering* during July and August. Collected from Mahadeophedi to Katonje; Lebang to Tenkhu; Bagdoar; Sheopuri. Distributed mostly at 1370 m.

Cryptochilus Wall.

Low epiphytes with crowded pseudobulbs; leaves 1-2, coriaceous. Flowers in a terminal scape, densely and distichously arranged, smaller than the persistent bracts. Sepals connate into an urceolate or gibbous tube, petals narrow; lip included, column erect, apex dilated and toothed.

Artificial key to the species of *Cryptochilus*

Flowers yellow, calyx-tube urceolate; petals oblique; pollinia yellow.......... *lutea*

Flowers orange at base, red above; calyx-tube gibbous; petals obovate; pollinia green .... *sanguinea*

Cryptochilus lutea Lindl, Journ. Linn. Soc. 3:21, 1859; F.B.I. 5: 827, 1890; King & Pantl. 163, t. 221, 1898; Hara, 430, 1966.

An epiphyte with crowded pseudobulbs. Flowers glabrous, yellow; calyx-tube urceolate; petals obliquely lanceolate. Lip obtuse; pollinia yellowish. *Flowering* during July. Collected from Sheopuri, at 1820 m. It appears to be a rare orchid.

C. sanguinea Wall. Tent. Fl. Nep. 36, t. 26, 1826; Lindl. Gen. et Spec. Orch. 193, 1833; F.B.I. 5: 827, 1890; King & Pantl. 163, t. 220, 1898. Hara, 430, 1966.

Epiphytic. Flowers pubescent, bright red or orange at base, and red above; calyx-tube gibbous; petals obovate; lip also obovate; pollinia green. *Flowering* during July and August. Collected from Lebang to Tenkhu, also at Sundarijal where it is also rare as the previous species. Distributed at c. 1675 m.

Otochilus Lindl.

Epiphytic with articulate branched stems, formed by elongated superimposed pseudobulbs; leaves on the uppermost pseudobulb, in pairs, elliptic or lanceolate. Flowers small, bracteate, in racemes; bracts scarious with sides rolled inwards. Sepals and petals spreading, free, subequal. Lip short, sessile on base of column, base saccate, lateral lobes short, erect, midlobe entire; column long and slender, foot absent.

ARTIFICIAL KEY TO THE SPECIES OF *Otochilus*

Lateral lobes of labellum large, midlobe lanceolate. Racemes drooping ; bracts broad, acute...*porrecta*

Lateral lobes of labellum very small, midlobe linear—

Racemes drooping: flowers white: sepals and petals acute ; bracts acuminate. Flowering during May & June......................................*alba*

Racemes short: flowers pink; sepals and petals obtuse; bracts truncate. Flowering during December & January......................................*fusca*

(We must admit that flowering time is not very reliable, yet it can possibly be of some secondary importance.)

Otochilus alba Lindl. Gen. et Spec. Orch. 35, 1830; F.B.I. 5:843, 1890.

Flowers white with a pink or even greenish column, sepals and petals acute; lateral lobes of lip very small, obtuse, yellow or white, midlobe linear, oblong, acuminate. *Flowering* during May and June. Collected from Suparitar; Cheesapanigarhi; Sheopuri. Distributed at 1500 to 1800 m.

O. fusca Lindl. Gen. et Spec. Orch. 35, 1830; F.B.I. 5:844, 1890; King & Pantl. 143, t. 199, 1898; Hara, 447, 1966.

Flowers pale-pink; sepals linear-oblong, petals narrower, dilated upwards. Lip concave, lateral lobes as small teeth, midlobe linear, oblong; column red. Possibly flowering time is during December and January. Collected from Namsaling to Gorkha; Lamidanda; foot of Sundarijal. Distributed at 1350 m. The material collected Namsaling to Gorkha during June had ruptured pods, and as such it is presumed that the flowering time is during the cold months, however, the Lamidanda material had flowers during the cold months.

O. porrecta Lindl. Gen. et Spec. Orch. 36, 1830. F.B.I. 5:844, 1890; King & Pantl. 142, t. 198, 1898; Hara, 447, 1966.

Flowers white or pale pink; sepals linear, acuminate, petals linear; lateral lobes of lip falcate, obtuse, midlobe lanceolate. *Flowering* during October and November. Collected from below Sheopuri; Godavari; Mulkharka. Distributed at 1500 to 1650 m.

Burkill collected an unidentified *Otochilus* from Hitaura. We have not been able to trace the sheet in the Central National Herbarium,

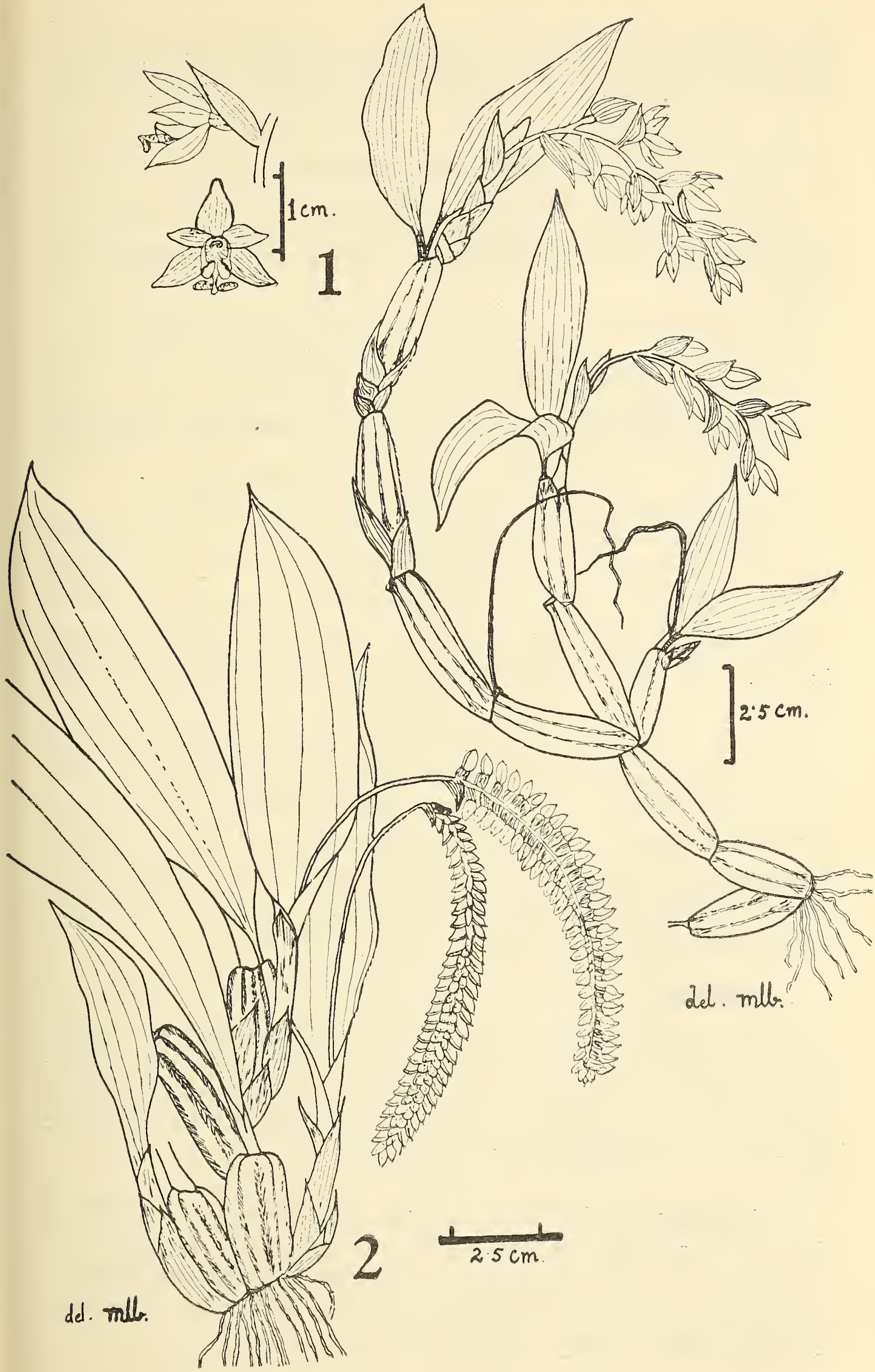


Fig. 1. *Pholidota articulata* Lindl.
Fig. 2. *Pholidota imbricata* (Roxb.) Lindl.

Calcutta, as such we are unable to make any comments on that material. Nor have we been able to collect any *Otochilus* from Hittaura, although *O. alba* has been collected by us from that area (Supari Tar).

Pholidota Lindl. ex Hook.

Habit of *Otochilus*. Rachis of raceme flexous; flowers small and bracteate, bracts stiff and distichous. Column very short, with wide wings.

ARTIFICIAL KEY TO THE SPECIES OF *Pholidota*

Pseudobulbs uninodal; flowering scapes from top of pseudobulbs; inflorescence rachis thickened, not zigzag .... *imbricata*

Stem elongate, branched and formed of pseudobulbus internodes—

- Flowering scape from top of pseudobulbs; dorsal sepal suborbicular—
  - Inflorescence rachis flexous, zigzag .... *griffithii*
  - Inflorescence rachis not flexous, zigzag .... *articulata*
- Flowering scape from the sheath of the internodes .... *protracta*

Pholidota articulata Lindl. Gen. et Spec. Orch. 38, 1830; F.B.I. 5: 844, 1890; King & Pantl. 146, t. 205, 1898; Holttum 233, 1953. (Fig. 1).

Flowers *c.* 1·2 to 1·5 cm. wide, cream coloured; sepals and petals nearly equalling and widely spreading, dorsal sepal suborbicular, lateral sepals ovate, keeled. Lip cymbiform with a didymous midlobe, which is yellowish at the tip. *Flowering* during April and May. Collected from Sheopuri; Godavari; Chandragiri; Hatia to Gola; Papung; West Nepal (Parker); locality unknown (Herklotts). A common epiphytic orchid widely distributed between 1500 to 2400 m.

P. griffithii Hk. f. Ic. Pl. t. 1881, 1890; F.B.I. 5:845, 1890.

Dorsal sepal broadly ovate or suborbicular, lateral sepals ovate-lanceolate, acute, 5-nerved, keeled; petals elliptic-lanceolate, 3-5-nerved. Lip cymbiform with a didymous midlobe; no lateral lobes. *Flowering* time during May and June. Collected from Godavari; Chandragiri; Dhunibesi. Distributed at 300 to 1800 m.

P. imbricata (Roxb.) Lindl. in Hook. Exot. Fl. 2, t. 138, 1825, et Gen. et Spec. Orch. 38, 1830; F.B.I. 5: 845, 1890; Holttum, 234, 1953; Hara, 447, 1966. *Cymbidium imbricatum* Roxb. Hort. Beng. 63, 1814 (nom. nud.) et Fl. Ind. 3: 460, 1832. *Ptilocnema bracteatum* D. Don, Prodr. Fl. Nep. 33, 1825. (Fig. 2).

Flowers 6-7 mm. wide, faintly pink; sepals 7 mm. long, dorsal sepal orbicular, 3-nerved, lateral sepals cymbiform, connate at the base; petals linear-oblong, falcate. Lip 4-lobed, lateral lobes broad, rounded, midlobe deeply bilobed, with a deep or light yellow spot. *Flowering* during June and July. Collected from Murra to Dhupu; Sundarijal; Chandragiri; Godavari. Distributed at 900 to 1500 m.

P. protracta Hk. f. Ic. Pl. t. 1877, 1889; F.B.I. 5:845, 1890; Hara, 448, 1966.

Flowers pale yellow; sepals ovate, obtuse, not keeled, very concave; petals elliptic, obtuse, 3-nerved. Lip cymbiform, midlobe suborbicular, gibbous above the base, orange within. *Flowering* during May and June. Collected from Godavari; Mulkharka. Distributed at 1500 m.

(to be continued)

Parturition in the Indian Vespertilionid Bat, *Pipistrellus ceylonicus chrysothrix* (Wroughton)

BY

A. Gopalakrishna and A. Madhavan
Department of Zoology, Institute of Science, Nagpur

(*With nine figures in two plates*)

Details of parturition were observed in several females of *Pipistrellus ceylonicus chrysothrix* (Wroughton) kept in cages. Before delivery the mother assumes a peculiar posture by hooking the claws of her toes and thumbs to the wire mesh in the ceiling of the cage with her belly facing the ceiling. The wings and the tail patagia are curled to form a cradle-like structure into which the young are delivered. Two young are born. Breech presentation was noticed and each young takes about 15 to 20 minutes to emerge. There is an interval of about 15 to 20 minutes between deliveries. The umbilical cords of the two young remain attached to the placenta until both placental discs come out 35 to 40 minutes after the delivery of the second young. The mother eats the placenta. At birth the eyelids of the young are adherent, and skin naked without much pigmentation. The young accidentally separated from the mothers, are not retrieved.

Introduction

The process of delivery of the young in bats is of considerable interest to zoologists and to naturalists because of the peculiar resting posture of these animals, and because of their many anatomical specializations. Further, the newly born young is relatively enormous in size, and weighs between 15% to 25% of the adult body weight (Gopalakrishna 1969).

Details of parturition are available with respect to only a few species of bats, and even amongst these there seem to be marked differences in the process of delivery. The posture that the female assumes during delivery varies among the different species. *Cynopterus* and *Hipposideros* (Ramakrishna 1950) deliver their young while they are in their natural posture. On the other hand the female of *Myotis lucifugus lucifugus* (Wimsatt 1945, 1960) assumes an inverted position (that is, head up for the bats) during delivery. In *Corynorhinus* *rafinesquei* (Pearson *et al.* 1952) the mother during labour assumes a peculiar cradle-like posture by hooking the claws of the thumbs and the toes to projections in the ceiling. With regard to the emergence of the young at birth, whereas the young emerges with breech presentation in the vespertilionids (Wimsatt 1945, 1960; Pearson *et al.* 1952), delivery occurs with head presentation in *Cynopterus*, *Hipposideros* (Ramakrishna 1950) and in *Rhinopoma kinneari* (Anand Kumar 1965).

Pipistrellus ceylonicus chrysothrix is a small bat with an adult body weight of 7 to 8 gm. and a wing span of about 25 cm. It occurs in small colonies ranging from 24 to 200. The species inhabits old houses and dilapidated buildings and the bats roost between wooden rafters, and inside cracks in the walls and ceiling. The specimens for the present study were collected from old buildings in and around Nanded in Marathwada, Maharashtra.

Pipistrellus ceylonicus chrysothrix has a sharply marked breeding period (Madhavan, unpublished). Pregnant specimens in progressively advanced stages of gestation occur from about the second week of July to about the middle of September. Deliveries take place during the first two weeks of September after a gestation of 50 to 55 days. Normally each female bears two embryos in each pregnancy and brings forth two young in each litter. In very rare cases a single embryo or triplets are borne. The young at birth weighs about 1·25 gm.

Material and Methods

Several females in late pregnancy, were kept in cages between the 4th and the 13th of September 1968. Although many deliveries were actually observed, in 23 specimens the entire birth sequence was studied and almost minute to minute record kept of the various events during parturition. It is noteworthy that all deliveries took place during day between 6 a.m. and 7 p.m.

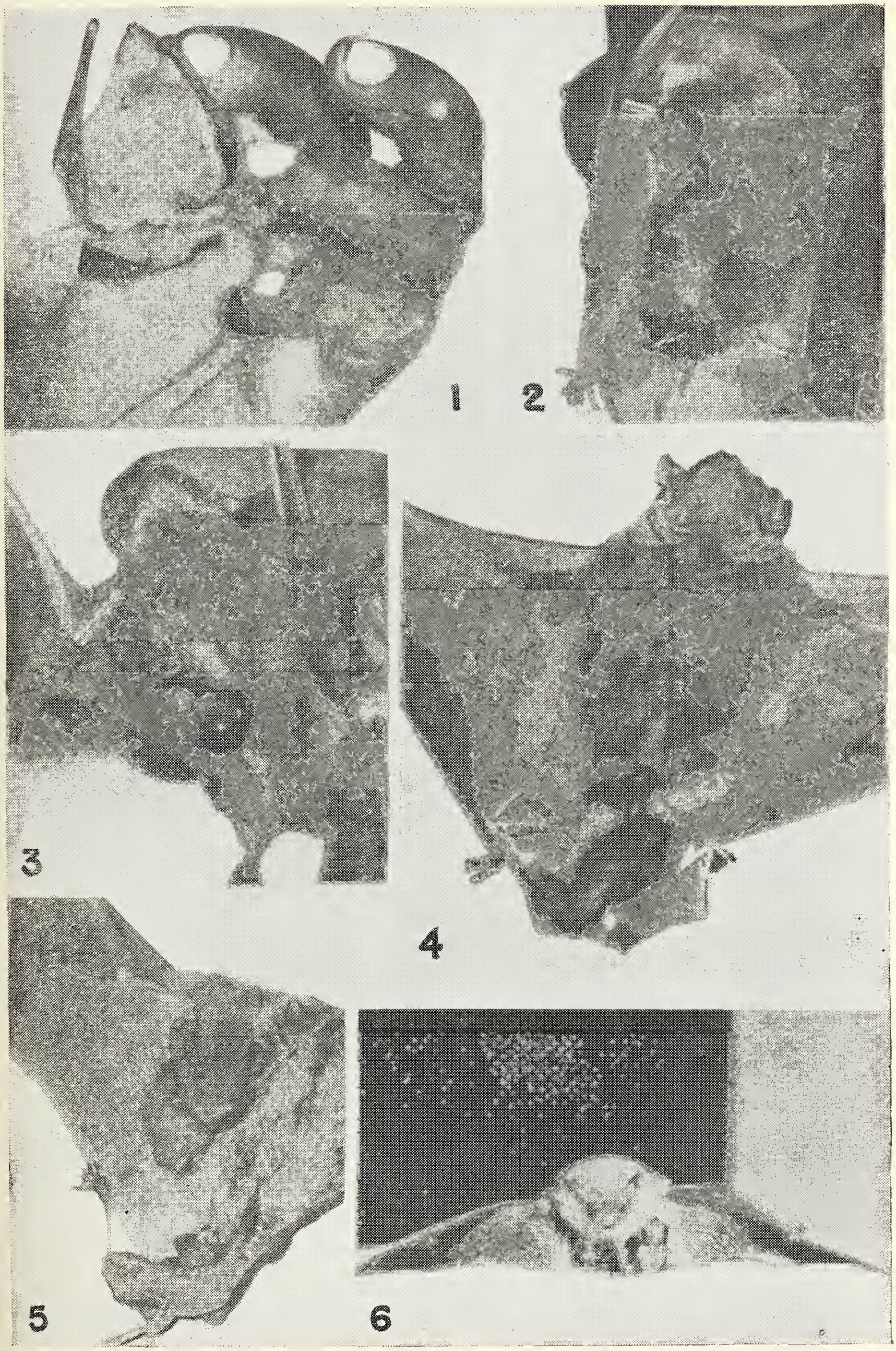
Detailed observations were made of many deliveries without handling the animals and without disturbing them in any way. But on some occasions the females exhibiting pre-parturitional activities were removed from the cages and kept on the laboratory table or held in the hand to note the details of parturition. Since it was impossible to take the photographs of the animals within the cages because of the peculiar posture of the mother in labour, the female under observation was removed from the cage for a few seconds and photographed while either holding her in the hand or after placing her on the laboratory table. She was returned to the cage immediately after taking the photograph.

Observations

The female which is about to deliver can easily be recognized amongst the caged specimens by her restless movements, frequent micturitions, and constant licking of vaginal orifice. She appears irritable, and on many occasions was seen to bite her own patagia. For about 15 to 20 minutes before the first young one begins to come out of the vaginal opening, the abdominal wall of the mother at approximately two to four minutes intervals seems to have a series of paroxysms of contractions, each lasting a fraction of a second. During this period the fœtus appears to be moving inside the uterus, and this impression is created as the flanks of the mother show the presence of two longitudinal bulges as if the body wall was being pushed from within by two hard objects. These are the two fœtuses pressed against the body wall of the mother from within. A few minutes before the young begins to emerge the mother moves to the top of the cage and assumes a characteristic posture, with the legs widely separated and hooked to the wire mesh of the top of the cage. The wings are widely spread out and the thumbs hooked to the wire mesh. The uropatagium and the wing patagia are curled backwards so that the body of the mother, along with the patagium membranes, forms a cradle-like structure with the belly of the mother acting as a cushion. Since the ventral surface of the mother faces the ceiling of the cage all details of parturition can be easily observed by looking through the top of the cage. After assuming this posture the mother becomes very quiet and remains still. This is an indication that the young will soon emerge.

A clear fluid oozes out of the vagina about a minute before the young begins to emerge, and the posterior part of the abdomen of the mother appears to be puffed up. The pubic symphysis stretches accentuating the swollen appearance of the posterior part of the abdomen. As the young emerges, the uropatagium is strongly curved up, and the wing patagia are also brought close together as if to form a receptacle to prevent the young from dropping off. During the emergence of the young the mother constantly bends her neck towards the vaginal opening, and continuously licks the body of the emerging young. To one watching the process of parturition in this bat, it appears as if the mother, by repeatedly curling the body in a ventral flexure, is trying to apply some pressure on her own belly to facilitate the ejection of the young from the uterus. The young normally comes out in breech presentation. From the time the body of the young is first seen it takes about 15 to 20 minutes for the entire body to come out of the vagina. Only in one case, out of the so many deliveries observed, did the wing patagium of the young come out first. This was in the second young delivered by the mother, the first having been

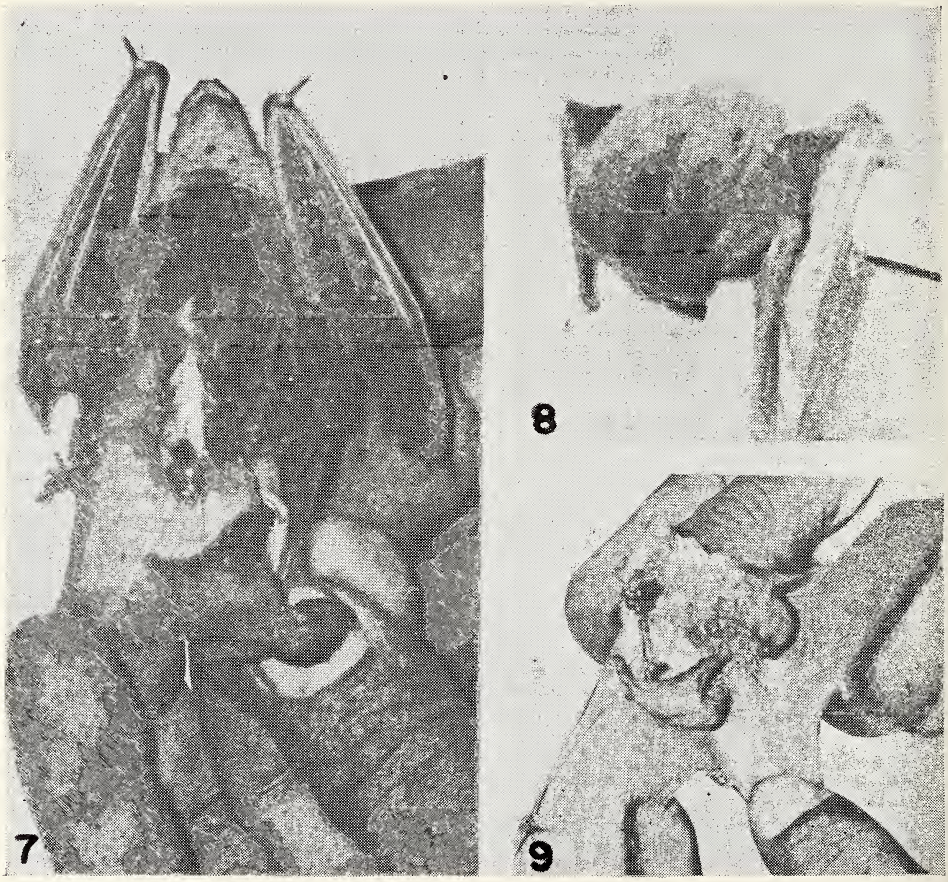
Gopalakrishna & Madhavan : *Pipistrellus c. chrysothrix*



Parturition in *Pipistrellus ceylonicus chrysothrix*

(For details see Plate II)

Gopalakrishna & Madhavan : *Pipistrellus c. chrysothrix*



Parturition in *Pipistrellus ceylonicus chrysothrix*

FIGS. 1. The mother a few minutes before parturition; 2. First young emerging. Note the breech presentation; 3. First young delivered and attached to the nipple of the mother. Second young emerging; 4. An instance of abnormal delivery. Second young being delivered with the wing emerging first. First young is dangling with umbilical cord still attached to the placenta inside the mother; 5. Both young have been delivered. The mother is pulling the first young towards her breast. Note the persistent umbilical cords; 6. Delivery while the mother is lying on the table. The first young delivered and attached to the breast. Second emerging; 7. Both young delivered; one is on breast and the other crawling on inter-femoral membrane. Placenta emerging with umbilical cords still attached; 8. Posture of the mother when delivery occurs while she is hanging to a vertical surface; 9. The mother eating the placenta.

delivered in the normal manner. The mother was seen in this instance to manipulate the young by slowly pulling the wing patagium with her mouth. The actual process of delivery in this abnormal case took $4\frac{1}{2}$ hours.

As soon as the young comes out of the vagina the mother draws the young to her nipples. Within a minute or two the young becomes firmly attached to the mother's nipple. However, its umbilical cord remains intact and remains connected to the placenta, which remains inside the uterus. Usually about 15 to 20 minutes elapse before the second young starts coming out. In one case there was a gap of 40 minutes between the first delivery and the commencement of the second. During the gap between the delivery of the two young the mother is engaged alternately in vigorously licking the body of the first delivered young and licking her own vaginal opening. During this period between the delivery of the first young and the commencement of the delivery of the second young, the abdominal wall contracts intermittently. The contractions of the abdominal wall seem to increase both in intensity and in frequency a few minutes before the second young emerges. The delivery of the second young is similar to that of the first, and the young comes out breech first. The second young is also promptly pulled to the breast and is vigorously licked by the mother. The umbilical cord of the second young is also attached to the placenta, which remains inside the uterus of the mother for some time. After the second young is delivered the mother intermittantly puffs up her abdomen and strains her abdomen as if she is attempting to eject the placenta. Usually there is a gap of about 35 to 40 minutes between the delivery of the second young and the ejection of the placental discs. In two cases, however, the placental discs came out $2\frac{1}{2}$ hours after the delivery of the second young. As soon as the placental discs start emerging the mother holds them with her teeth and pulls them out and eats up the placenta within a few minutes. The umbilical cords of the young ones are not eaten by the mother, but they dry up and become shrivelled within about an hour after the placenta is eaten by the mother. The mother does not normally alter her posture until her second young comes out and is firmly anchored to the nipple. In most cases the mother assumed her normal (head down) posture after the placenta came out.

In its natural haunts also the mother assumes the posture noted in caged animals during delivery. The claws of the toes and the thumbs are firmly hooked to some projection or crevice in the ceiling. On two occasions deliveries were noticed while the mothers were hanging to the wall or to a wooden rafter outside their natural haunts where there was no ceiling. In such cases the mother kept her normal head-down posture although her legs were kept wider apart than at other times. At such times the wing membranes and the mothers' head are bent inwards so that the bent head and the closer folding of the wings prevent the young from dropping off during delivery. Some deliveries were observed with the mothers left on the table. Under such a condition the delivering mother lies on her belly and keeps her wings bent inwards. In all these cases the sequence of events during parturition is, however, as described for caged animals. It was, however, impossible to photograph the details of parturition while the mother was hanging on a wall or rafter or while she was lying on the table. Figures 1 to 9 illustrate the various stages of parturition in *Pipistrellus ceylonicus chrysothrix*.

On many occasions young ones at various stages of growth had dropped off from their mothers. In a few cases freshly delivered young had accidentally dropped from their mothers, sometimes with the umbilical cord and the placenta attached. The mothers do not make any attempt to recover such young.

The newly-born young one has adherent eyelids, is flesh-coloured and is completely naked. The skin starts darkening within 24 hours after the birth and becomes completely dark when the young is about 48 hours old. The eyelids open about 72 hours after birth. As the young one grows, hair appears first on the ventral surface of the body, and spreads progressively towards the neck and the sides of the body. The dorsal surface of the body is the last to become hairy. After sprouting, the hair on the dorsal surface quickly outgrow those on the ventral surface of the body. Hence, when the young is about 6 to 8 days old it appears to be more hairy dorsally than ventrally.

References

Anand Kumar, T. (1965): Reproduction in the rat-tailed bat, *Rhinopoma kinneari*. *Jour. Zool. London.* **147**: 147-155.

Gopalakrishna, A. (1969): Gestation period in some Indian bats. *J. Bombay nat. Hist. Soc.* **66**: 317-322.

Madhavan, A. (1968): Breeding habits and sex-cycle in the vespertilionid bat, *Pipistrellus ceylonicus chrysothrix* (Wroughton). Thesis submitted to Nagpur University.

Pearson, O. P., Koford, M. R. & Pearson, A. K. (1952): Reproduction of the lump-nosed bat, *Corynorhinus rafinesquei* in California. *Jour. Mammal.* **33**: 273-320.

Ramakrishna, P. A. (1950): Parturition in certain Indian bats. *Jour. Mammal.* **31**: 274-278.

Wimsatt, W. A. (1945): Notes on breeding behaviour, pregnancy and parturition in some vespertilionid bats of Eastern United States. *Jour. Mammal.* **26**: 23-33.

——— (1960): An analysis of parturition in Chiroptera including new observations on *Myotis lucifugus lucifugus*. *Jour. Mammal.* **41**: 183-200.

The Thalassinoidea (Crustacea, Anomura) of Maharashtra

BY

K. N. SANKOLLI [1]
Marine Biological Research Station, Ratnagiri

(*With two text-figures*)

[*Continued from Vol.* **68** (1): 106]

Sub-family: Upogebiinae

Remarks: In Maharashtra, this sub-family is represented by a single genus *Upogebia* Leach.

4. **Upogebia (Upogebia) kempi** n.sp. (Figs. 9 & 10)

Description: (Fig. 9, a and b)

Rostrum fairly large, bluntly triangular, its length being slightly larger than its breadth at base and reaches more than half way or just falls short of reaching the distal end of the penultimate joint of the antennal peduncle. Length twice that of the ocular peduncle. Each lateral margin of the rostrum armed with two strong, upstanding, more or less conical spines of which the anterior ones are closely situated near the tip. Distance between the two anterior spines less than that between anterior and posterior spines of each side. Dorsal surface of rostrum, anterior portion of the dorso-median region and the latero-frontal margin of the carapace beset with tufted hairs and tubercles. Hairs densely arranged in anterior part, almost encircling the tubercles and posteriorly present much less densely, along the lateral margin leaving the mid-dorsal region more or less plain. Tubercles arranged in about 4-5 indistinct longitudinal rows, the number of the rows gradually increasing posteriorly but becoming a bit oblique. Also the tubercles and hairs become less and less sharp and prominent. Hairs arise from inner angles of the tubercles and especially in the posterior part of this tuberculated area, the hairs are arranged in a sort of semicircle in front of the bases of the tubercles. Lateral frontal margin anteriorly

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[1] Present address: Marine Zoology and Fisheries Div., Dept. of Zoology, Karnatak University, Dharwar-3, Mysore.

extends just beyond the base of the rostrum and posteriorly by more than the distal $\frac{3}{4}$ length of the carapace; ridged with longitudinal row of 13-14 tubercles, of which the anterior ones are strong and more spine-like and the posterior ones low and less prominent. This row of tubercles is separated from the tubercles of the post-rostral median region by a smooth groove which fades away posteriorly near the proximal $\frac{1}{4}$ distance from the cervical groove. Cervical groove deep and well defined, with several, minute transverse rugae on the inner side. No spinules or tubercles present behind the cervical groove, only a few tufts of setae. The *linea thalassinica*, is quite distinct. Ventral surface of rostrum unarmed. A well developed ocular spine present on the anterior margin of carapace at the level of the ocular peduncle. About 4-5 granular tubercles on antennal margin below ocular spine; generally rudimentary in smaller specimens (32 mm).

The ocular peduncle extends more or less to the middle of the rostrum ; corneal portion fairly large and latero-distally situated.

Antennule (Fig. 9, c): Peduncle extends beyond rostrum by more than $\frac{1}{2}$ the length of its terminal segment. Basal segment swollen, in length slightly less than the third segment and bears distally a slender, rudimentary tooth on the lower border. Median tooth of the upper margin absent in all specimens examined so far, unlike as in *U.* (*U.*) *carinicauda* where it is present. Third segment about 3 times the length of the second.

Antenna (Fig. 9, d) : Distinctly longer than antennule. Antennal gland-opening clearly seen on the coxopodite. Second segment has the scaphocerite situated distally on the upper margin and an accuminate thorn at the distal end of the ventral border. Scaphocerite or the scale roughly oval, terminating in a sharp but minute tooth-like point. Third segment $1\frac{1}{2}$ times the second, widening out a bit distally; fourth segment more slender than second though it is more or less of the same length. Scaphocerite and thorn present in all specimens examined.

Mandible (Fig. 9, e) : With segmented palp; cutting edge armed with one large and eight minute teeth. Below cutting edge are two large teeth visible from above.

First maxilla (Fig. 9, f) : Consists of two endites—lower and upper—and a well developed palp. Lower endite large; upper endite narrow with its distal part rounded. Tip of the palp bent or deflexed.

Second maxilla (Fig. 9, g) : It has two bilobed endites. Upper lobe of the lower endite is very small and narrow. Endopodite well developed, slightly broad at base, narrowing distally. Scaphognathite larger with the lateral notch situated at 3/5 the distance from the anterior end.

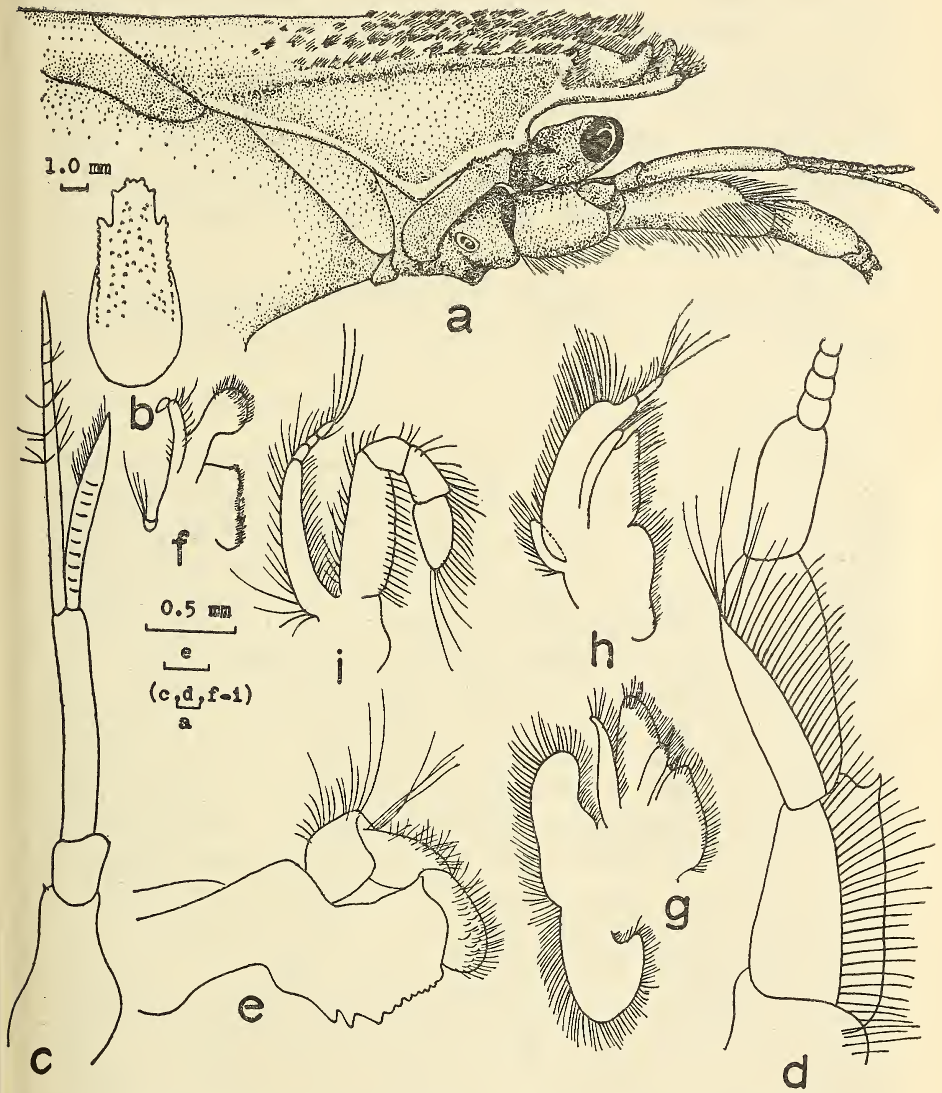

FIG. 9. *Upogebia* (*Upogebia*) *kempi* n. sp. a—lateral view of the anterior part of the body, b—anterior part of carapace (dorsal view, denuded), c—antennule, d—antenna, e—mandible, f—first maxilla, g—second maxilla, h—first maxilliped, i—second maxilliped.

First maxilliped (Fig. 9, h) : The two endites are separated by a notch. Distal part of upper endite rather pointed and that of lower endite more or less rounded. Palp well developed but narrow.

Flagellum of the exopodite is much narrower and shorter than the basal part. Epipod small and oval.

Second maxilliped (Fig. 9, i): Flagellum of exopodite sub-divided into four joints. A small but slightly elongated epipod is present.

Third maxilliped (Fig. 10, a): Dactylus of endopodite more or less as long as the propodus and nearly $2\frac{1}{2}$ times the length of the carpus. Merus slightly smaller than the ischium which in turn is as long as the dactylus. Exopod jointed in the distal part and reaches nearly to half the length of the merus. A small narrow epipod is present.

Pereipods :

First pair (Fig. 10, b and c): Heavy and well-formed, similar in size and shape. Distal end of the merus just extends beyond the rostral tip.

Ischium bears 2-3 spines on lower margin, the middle spine is generally large.

Merus slightly less than the propodus in length and its upper margin at some distance behind the distal end bears a distinct, anteriorly directed spine which is sometimes broken. Outer lower margin proximally armed with 3-5 spine-like, well-spaced teeth ; rest of the margin smooth; the inner lower margin bears about 12-18 minute tubercle-like distinct teeth of which the proximal 4-5 are well-spaced, these two margins meet near the proximal most tooth of the inner margin.

Carpus slightly more than half the length of the palm and narrows proximally. It has at the middle of the outer surface a longitudinal groove. In the upper half of its outer surface, there is an oblique row of hairs which originate from the inner surface near the meral articulation and then continue on the proximal part of the upper border from where it slopes down to meet the longitudinal groove distally on the outer surface. Upper margin in the proximal part, i.e., behind the oblique row of hairs, plain and then onwards with 6-8 distinct, anteriorly curved spines which increase in size distally. In males and smaller specimens of both sexes the teeth are much less pronounced. The distal margin in the upper half of the outer surface bears 5-6 unequal small spines of which the upper 3 are well-spaced. In a few specimens, near the middle of the lower half of the external surface, there is a longitudinal ridge-like elevation provided with a few minute, low tubercles at random. Outer lower margin shows about 6 very low, flat tubercle-like elevations from the inner angles of which the setae arise. The inner lower margin distally bears, near the propodal articulation, 2 distinct spines of which the distal one is very small. The distal margin of the inner surface, almost dorsally, bears a large spine which is as large as those of the dorsal and ventral surfaces.

The propodus is half as high as long. The upper outer border of palm is armed with small spine-like teeth all along the border. These are quite sharp and pointed in the proximal half and lose their sharpness distally and are interspersed throughout with long setae. Upper inner border often provided with very minute, flat tubercle-like elevations from the base of which the long setae arise. This border is proximally armed with 3 long, slightly curved spines. Between the borders and near the carpal articulation, there is sometimes a distinct spine-like tubercle. The outer surface has distally just near the articulation with the dactylus a small but distinct elevation which is generally tipped with a tooth-like tubercle. Distal margin of the inner surface bears a spine-like tooth on an elevated ridge, at the articulation of the dactylus, and 3-4 smaller closely arranged tubercles just below the elevation. Proximal margin of inner surface has compactly beaded tubercles, thicker, in the upper middle half and continuing with the upper inner tuberculated ridge. Lower margin, bears a long, curved spine on the inner side away from the fixed finger as in *carinicauda.* Inner lower surface proximally has a faint thin and shallow groove fringed with setae, which in its basal part bears 3-4 minute, granular tubercles. In males and small specimens of both the sexes, the tubercular proximal margin and the tubercles of the groove of the inner surface, are very pronounced. The lower half of the inner surface near its ventral spine, has 3-5 equal sized sharp spines, often much smaller than the ventral one and 2-5 similar spines along the middle, near the fixed finger. Tufts of hairs arise, from the inner angles of these spines. These spines often appear to be situated almost in a longitudinal row, parallel to the lower margin, except the 1-2 spines near the large ventral spine. These spines are usually absent in males and are very few in number in small females. On the outer surface of the palm, there is an oblique row of setae running downwards from the upper proximal margin to join the outer lower fringed border.

Dactylus nearly twice the length of the fixed finger and slightly longer than or as long as, carpus or a little more than one-half the length of palm. Outer cutting edge has 10-12 tubercle-like teeth of which the proximal most is the largest and is separated from the rest which decrease in size distally; the inner edge is provided with about 12 blunt but round tubercles which are larger than those on the outer edge. There are 3 longitudinal crests, one near and along the upper margin, the second along the middle of the outer surface and the third which is the shortest of the three, situated between the second and the outer cutting edge but in the proximal part only. These crests are followed by 3 rows of tufted hairs. The cutting edge of the fixed finger bears 6-9 tubercular teeth of which the proximal 3-5 are larger than the remaining ones.

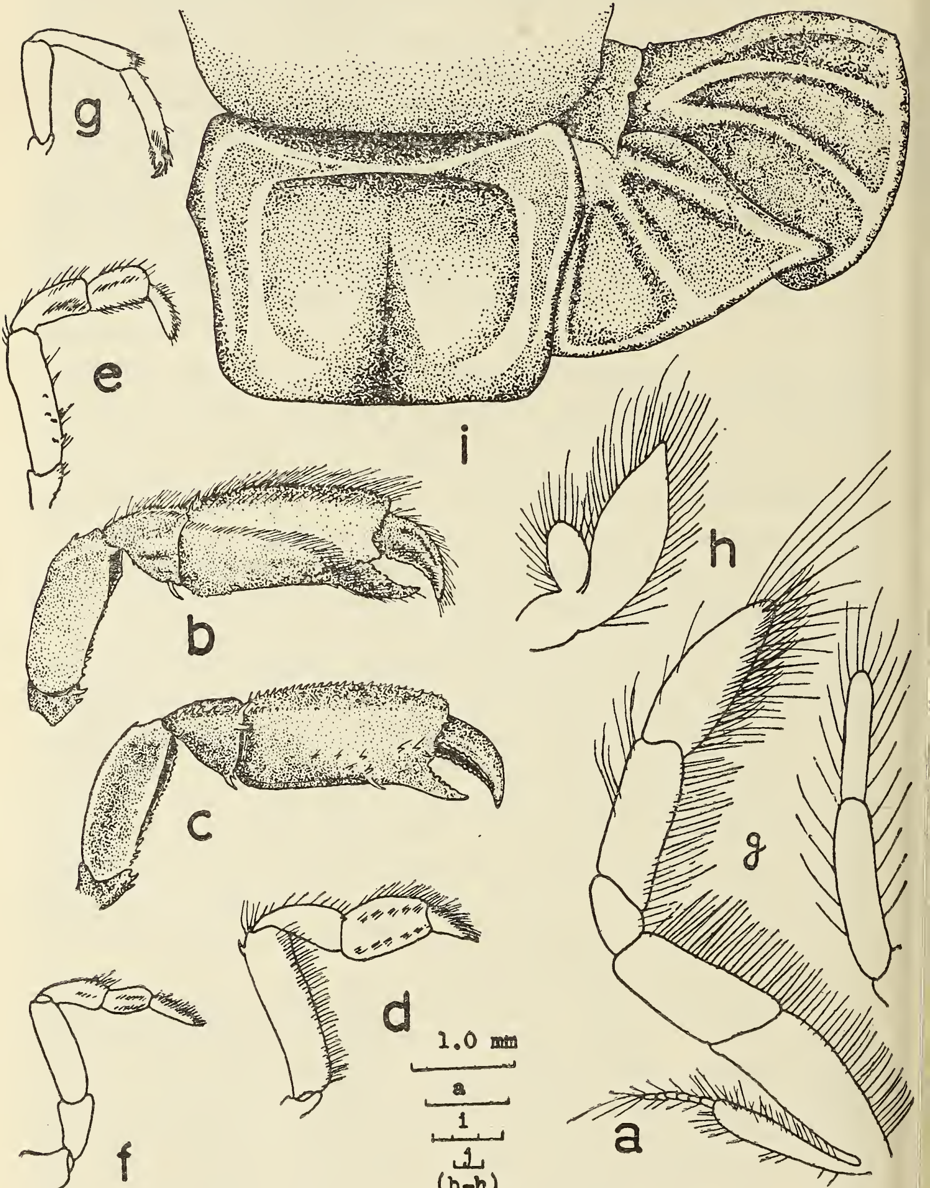

FIG. 10. *Upogebia* (*Upogebia*) *kempi* n. sp. a—third maxilliped, b—outer view of cheliped, c—inner view of cheliped, d—second leg, e—third leg, f—fourth leg, g—fifth leg, h—first pleopod of male, i—telson with uropod magnified, j—first pleopod of female.

Second pair (Fig. 10, d): Simple and equal; the distal end of its merus, almost reaches the level of the rostrum. Merus twice the length of the propodus and bears a sharp tooth on the anterior margin at some distance behind the distal margin. Carpus slightly shorter than propodus but slightly larger than the dactylus, narrowing proximally; with a spine situated almost dorsally on the distal margin of its external surface. Inner distal margin bears a spine ventrally, which is not visible dorsally. Propodus roughly quadrangular, broadening proximally.

Third pair (Fig. 10, e): Distal end of carpus just extends beyond the rostrum. Dactylus as long as propodus; propodus broader than the dactylus, its outer surface with 3 distinct longitudinal rows of hairs; carpus almost of the same length as propodus; the merus is slightly more than twice the length of the carpus and has two distinct spines in the proximal part of the posterior margin and a few tubercles on the lower half of outer lateral surface, in groups of 1-3, 2-4 and 2-3 in line with the spines of the posterior margin.

Fourth pair (Fig. 10, f): More or less similar to the third pair. Dactylus longer than propodus; carpus $1\frac{1}{2}$ times the length of the propodus; merus almost as long as carpus and propodus combined. There are no tubercles on any of the segments.

Fifth pair (Fig. 10, g): Dactylus slender, curved and spoon-shaped. Propodus nearly 5 times the length of the dactylus and its anterior portion is produced to form a process resembling a fixed finger which reaches almost the middle of the dactylus. The carpus is slightly smaller than the propodus and the merus in turn, is also smaller than the propodus.

The coxopodite of the first leg generally bears one spine-like tubercle, that of the second two—one proximal and the other distal, whereas on the third leg, there is a single proximal tubercle which in case of females, is situated above the gonadial aperture.

The thoracic sternite of the fourth pair of legs is little concave and posteriorly incised.

Abdomen:

It is normal in shape; the furrows dividing the tergal and pleural portions are quite deep and well-formed, even in the smaller individuals. Pleuron of the first segment is elongated and bluntly triangular, that of the second roughly elongatedly rectangular, those of the third and fourth parallelogram-shaped and that of the fifth broadly triangular with rounded angles. The sixth segment is peculiarly shaped. Dense pubescence on the lower margin extends, from the first to the fifth segments, but in second to fourth it extends also to the posterior margin and the distal half of the lower margin of the fifth pleuron. Slight pubescence is also present on the lower margin of the sixth segment. The abdominal terga are slightly broader in females than in the males examined so far.

Pleopods: In males, 4 biramous pairs (Fig. 10, h) present from 2nd to 5th abdominal segments. The basal stalk is slightly smaller than the endopod which in turn, is less than $\frac{1}{2}$ the length of the exopod. Both the endo-and exo-pods are membranous and leaf-like. All the pleopods are similar in size and shape.

In females, 5 pairs (Fig. 10, j) on 1st-5th abdominal segments, the 1st pair being uniramous and styliform. The remaining pairs are more or less similar to the pleopods of the male. The eggs are borne on 1st to 4th pleopods and that too, on the endopods only in 2nd to 4th, whereas eggs are not borne on either rami of the 5th pleopods.

Telson (Fig. 10, i): It is somewhat broader than long and generally widens slightly just before the middle and then narrows posteriorly to end in a broad posterior margin, which is more or less straight. There is a shallow longitudinal furrow in the middle, from about the middle of the telson to almost the posterior margin. A high and distinct carina of the shape as shown in the figure is present on the anterior raised portion of the telson. There is also an indistinct crest-like elevation on either side of the mid-dorsal furrow, just near and along the lateral margin.

Uropods (Fig. 10, i): Protopodite of the uropod with a well developed spine-like tooth extending to the base of the endopod. The basal part of the exopod has a small, blunt tubercle. Anterior margin more or less straight in the basal as well in the distal parts except about the middle where it is convex; distal margin is convex bearing several teeth-like tubercles along the margin. There are 3 distinct longitudinal carinae on the dorsal surface, 2 about the middle and the 3rd along the anterior margin of the exopod. The anterior margin of the endopod is angular with rounded or blunt angle in the basal part and is slightly concave in the distal part. The antero-distal corner is not rounded but is drawn out and angular and the distal margin bears about one-half the number of teeth-like tubercles borne on that of the exopod. The dorsal surface has two longitudinal carinae, one about the middle and the other along the anterior margin.

Material examined:

Several specimens were collected from Bombay (Chowpatty and Cuffe-parade) and one from Ratnagiri.

The holotype (female; type-locality—Chowpatty, Bombay) and paratype specimens will, in due course, be deposited in the Zoological Survey of India, Museum, Calcutta.

Measurements:

Of the material examined for the present study, the males ranged from 27 to 58 mm., non-ovigerous females from 30 to 56 mm. and ovigerous females from 47 to 58 mm., in length.

Ecology:

An intertidal species commonly found in the admixture of sand, mud and stones in the intertidal zone of Chowpatty and Cuffe-parade Bays in Bombay. The burrows are generally found under loose stones, their openings measuring about *c.* 10 mm. in diameter. These are quite characteristic since their inner wall is finely cemented and quite rigid and has a smooth, shiny surface. The burrows run more or less obliquely downwards among and in between the stones and have generally 3-4 side-tunnels and 2-3 blind, broad, semi-circular ends where the animal turns. These are also usually observed to run closely and almost parallel to the tubes of the tube-worm *Loimia medusa* (Savigny).

The ovigerous females could be collected from September to December.

So far no commensals have been noticed.

Discussion:

The new species, differs from *Upogebia* (*U.*) *carinicauda* (Stimps.), in the following characters.

1. *Rostrum*: Short, reaching but little beyond the ocular peduncle in *carinicauda* whereas in *kempi* it is fairly large reaching well beyond the ocular peduncle and measures twice the length of the ocular peduncles. In smaller specimens, however, the rostrum extends a little beyond the ocular peduncle as in *carinicauda*.

2. *Carapace*: The two species agree but for the presence of 4-5 granular tubercles on the antennal margin in *kempi* which is neither mentioned (de Man 1928 b) nor present in *carinicauda* (ovigerous specimen, Siboga Station 213).

3. *Antennule*: In *carinicauda*, the peduncle extends beyond the rostrum by only $\frac{1}{2}$ its terminal joint and the first joint has a distal spine and a much smaller acute tooth in the middle of its lower border. In *kempi* the peduncle extends by more than $\frac{1}{2}$ its terminal joint and the first joint bears only a minute and rudimentary distal tooth; the median tooth of the lower margin is invariably absent.

4. *Cheliped*:

Merus: With 10-12 teeth on the lower border in *carinicauda* and in *kempi* there are 12-18 on the inner lower and 2-3 on the outer lower borders.

Carpus: Upper border is smooth except for a single, strong distal spine in *carinicauda*, whereas in *kempi* species, it is edged with 6-8 curved spines which increase in size distally.

Propodus: In *carinicauda*, the upper border and the inner lateral surface are not armed but smooth; cutting edge of fixed finger with 6 unequal small teeth in the proximal half only; in *kempi*, the upper border is dentate and the inner surface is armed with 7-10 sharp spines in its lower half. The cutting edge of the fixed finger has 6-9 tubercular teeth, the proximal 3-5 being larger. The proximal margin of the inner surface also bears bead-like tubercles.

Upogebia (*U.*) *kempi* exhibits the following variations, sexual dimorphisms and size variations unknown in *carinicauda*.

Chelipeds:

Carpus: The teeth on the upper border are well pronounced in larger females only. In males and smaller females, these teeth are much less pronounced i.e., smaller in size and less in number, but *invariably at least* 3-4 *are present.*

Propodus: (a) Upper border: The teeth are well developed in larger females, but very small in males of all sizes and smaller females.

(b) Lower half of inner lateral surface: The spine-like teeth are well developed in larger females, but practically absent in males and very few in number (1-3) in smaller females.

(c) Proximal margin of inner lateral surface: The bead-like granules are more prominent in males than in females.

My observations on *carinicauda* are based on the descriptions given by Stimpson (1860), Miers (1884b), de Man (1888, 1927 a & b) etc. and on actual examination of one ovigerous specimen of Siboga Station 213 sent to me by Dr. Stock from the Amsterdam Museum.

The only apparent resemblance of *carinicauda* (ovigerous specimen 22·5 mm., Siboga Station 213, Amsterdam Museum) to the smaller specimens (28-30 mm.) of *kempi* is in respect of the relative length of the ocular peduncle and rostrum, and absence of granular tubercles on the antennal margin of the carapace.

Although, the two species are identical in possessing a spine at some distance from the fixed finger on the lower margin of propodus of chelipeds, the new species can be easily distinguished by its dentate upper border. I, however, recommend that specimens larger than

40 mm., especially the females, of *carinicauda* may be examined in greater detail with reference to the characters of *kempi*, since I have no access to the larger material of *carinicauda*.

Remarks:

In the Indian Museum at the Zoological Survey of India, Calcutta, there is a jar containing several vials of *Upogebia* specimens, ranging from 22 to 60 mm., collected by 'Investigator' (shore collection, Stn. 414, locality—Fisher Bay, Port Owen, Tavoy Island and Stn. 593, locality Paye or Paway Island, 11°, 25′ 00″ N, 98°, 51′ .00″ E). The jar carries a printed label of *carinicauda* and unfortunately this material has not been published. The material almost tallies with *U. kempi*, especially the two non-ovigerous females (58 and 60 mm.) kept in a separate vial. I understand from Dr. K. K. Tiwari of the Zoological Survey of India, Calcutta, that judging from the handwriting of the locality label, that the late Dr. Stanley Kemp, probably wanted to study this 'Investigator' material and hence these two females could have been kept separately by him for future study. Hence, I take pleasure in naming the new species as *U.* (*U.*) *kempi* n. sp., in honour of Dr. Kemp who contributed so much to the study of Indian carcinology.

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References

Alcock, A. & Anderson, A. R. S. (1894): An account of recent collection of Deep Sea Crustacea from the Bay of Bengal and Laccadive Sea. *Journ. Asiatic Soc., Bengal* **LXIII**: 162-164.

Alcock, A. (1901): A descriptive catalogue of the Indian Deep Sea Crustacea, Decapoda, Macrura and Anomala in the Indian Museum, Calcutta: 186-286.

Anderson, A. R. S. (1896): An account of the Deep Sea Crustacea collected during the seasons 1894-95. *J. Asiatic Soc., Bengal* LXV: 97-102.

*Blass, H. (1927): Bericht liber die Crustacea Decapoda (Natantia and Anomura). *Trans. Zool. Soc. Lond.* **XXI**: 224-225.

——— (1957): Bronn's Klassen Ordn. Tier. Vol. 5, pt. 1. no. 7, fasc. **12**: 1575-1599.

Barnard, K. H. (1950): Descriptive Catalogue of South African Decapod Crustacea. *Ann. South African Mus.* **38**: 400-524, text figs. 76-97.

Borradaile, L. A. (1903): On the classification of the Thalassinidea. *Ann. Mag. Nat. Hist. Ser.* 7, **12**: 534-551.

——— (1906): Marine Crustaceans. XIII, The Hippidea, Thalassinidea and Scylaridea. Gardiner's Fauna and Geography of the Maldive and Laccadive Archipelago. II: 750-754.

——— (1907): On the classification of Decapod Crustaceans. *Ann. Mag. Nat. Hist.* (7) **XIX**: 457-486.

Calman, W. T. (1909): 'Crustacea' Lankaster's Treatise on Zoology. (Oxford Nat. Hist.) **VII** (3): 253-316.

Chopra, B. (1933): Further notes on Crustacea Decapoda in the Indian Museum, V. On *Entrichocheles modestus* (Herbst) (Family: Axiidæ). *Rec. Ind. Mus.* **XXXV**: 277.

Gravely, F. H. (1927): The littoral fauna of Krusadai Island in the Gulf of Mannar. Orders Decapoda (except Paguridea) and Stomatopoda. *Bull. Madras Govt. Mus.*, (n. ser.) (nat. hist. sect.) 1(1): 135-155, text figs. 1, 2, pls. 19-26.

Gurney, R. (1938): Larvæ of Decapod Crustacea. V. Nephropsidea and Thalassinidea. Discovery Report **XVII**: 291-344.

Haan, W., de, (1833-50): In P.F. von. Siebold, Fauna Japonica, Crustacea, pp. (xvi), (xxxi), 1-244, pls. 1-55, A-Q. Lugduni Batavorum.

Henderson, J. R. (1893): A contribution to Indian Carcinology. *Trans. Linn. Soc. London* (2), *Zool.* **V**: 325-458.

*Herbst, J. F. W. (1804): Versuch einer Naturgeschichte der. Krabben und Krebse, **III**: 45.

Holthuis, L. B. (1956): Notes on a collection of Crustacea Decapoda from the Great Bitter Lake, Egypt, with a list of the species of Decapoda known from the Suez Canal. *Zool. Meded. Leiden* **34**: 325.

Kamita, T. (1957): Studies on the decapod Crustaceans of Corea, II. Scientific Reports of the Shimene Univ. **7**: 105-106.

Kemp, S. (1915): 'Fauna of the Chilka lake—Crustacea Decapoda.' *Mem. Ind. Mus.* **V**: 249-260.

Man, J. G., de, (1888a): Report on the Podophthalmous Crustacea of the Mergui Archipelago, collected for the Trustees of the Indian Museum, Calcutta, by Dr. J. Anderson, F.R.S., Superintendent of the Museum, part 4. *J. Linn. Soc. London* **22**: 177-256.

——— (1915): Zoolog. Jahrb. (Spengel), Abt. fur Systematik, Geographie and Biologie der Tiers, Bd. 38, Heft. 6: 445, Taf. 29, fig. 16-166.

——— (1925): Axiidæ collected by the Siboga Expedition, Siboga Expd. pt. VI, mongr. 39 a 5.

——— (1927a): A contribution to the knowledge of twenty one species of the genus *Upogebia* Leach. *Capita Zoologica* Decl II, Afl. **5**: 1-58.

——— (1927b): *Upogebia* (*Upogebia*) *carinicauda* var. Mitterlungen aus dem Zoolog. Museum in Berlin. 12, Bd. 2, Heft. 1927. p. 343-345.

——— (1928a): A contribution to the knowledge of twenty two species and three varieties of the genus *Callianassa* Leach. *Capita Zoologica*, Decl II, Afl. **6**: 1-56.

——— (1928b). The Decapoda of the Siboga Exped. VII. The Thalassinidæ and Callianassidæ collected by the Siboga Expedition with some remarks on the Laomediidæ. *Siboga Exped. mongr.* 39 a6: 1-187, fib. 1-31.

Miers, E. J. (1884a): 'On some Crustacea from Mauritius.' *Proc. Zool. Soc. London* **13**: 10-17, pl. I, fig. 1.

——— (1884): Crustacea. Rep. Zool. Coll. made in the Indo-West Pacific Ocean during the voyage of H.M.S. 'Alert' 1881-1882 (London), Brit. Mus. 1884: 259-283. pl. XVIII-XVIV.

*Ortmann, (1892a): Die Decapoden-Kerbe des Strassburger Museums. IV. Theil. Die Abtheilungon Galatheidea and Paguridea. *Zool. Jahrb. Syst.*, **IV**: 241-326, pls. 11-12.

Pillai, N. K. (1954): A note on *Callianassa maxima* M. Edwards (Decapoda). *Bull. Cent. Res. Inst. Univ.* Travancore, 30, 1: 23-26.

Sakai, K. (1962): Systematic studies on Thalassinidea—1. *Laomedia astacina* De Haan. *Publ. Seto. Mar. Biol. Lab.* (I): 27-34, pls. 5-7.

Sankolli, K. N. (1963): On the occurrence of *Thalassina anomala* (Herbst), a burrowing crustacean in Bombay waters, and its burrowing methods. *J. Bombay nat. Hist. Soc.* **60** (3): 600-605, pls. 2, text fig. 1.

Shenoy, Shakuntala (1965): Larval development of the Thalassinid, *Upogebia* (*Upogebia*) *kempi* n. sp. in the laboratory. Symposium on Crustacea (1965), organised by the Marine Biological Association of India. (in press).

Southwell, T. (1906): 'Anomura' Herdman's Rep. Ceylon Pearl oyster Fisheries V: 211-224, 2 text-figs.

*Not referred to in original.

Emergence periods of two beetles, *Oryzaephilus surinamensis* (Cucujidae) and *Tribolium castaneum* (Tenebrionidae), from dum nuts, *Hyphaene thebaica*, in India

BY

M. L. Roonwal

Emeritus Scientist, (CSIR), Desert Regional Station, Zoological Survey of India, Jodhpur

(*With two text-figures*)

Introduction

The dum nut is the seed of the dum palm, *Hyphaene thebaica* Mart., of the Sudan, Africa, and is imported into India for manufacturing buttons and beads. The nut has a pear-shaped, brown-coated body, *c.* 4-5 cm. in diameter. It has a hard, 7-15 mm. thick white kernel or 'ivory,' the centre of the seed being hollow. It is the 'ivory' which is made into buttons and beads. The nuts are frequently infested by three species of beetles, viz., *Coccotrypes dactyliperda* (Fabricius) (Scolytidae), *Oryzaephilus surinamensis* (Linnaeus) (Cucujidae) and *Tribolium castaneum* (Herbst) (Tenebrionidae). The infection spoils the 'ivory' due to the excavation of galleries and emergence holes, and causes considerable loss to industry.

Infested nuts and pieces were obtained from Coimbatore (southern India), a manufacturing centre, and observed in cages in unconditioned rooms at Dehra Dun during 1951-52 and 1955-56. Here the summer (April to mid-June) is moderately warm, the monsoon rains (mid-June to September) heavy and the winter (November to February) severe, with frequent frost but as a rule no snow. The average monthly room temperature and relative atmospheric humidity during the hot and cold months were as follows :—

Item	*May-June*	*December-January*
1. Average minimum temperature ..	26°-27°C	8°-10°C
2. Average maximum temperature ..	31°-32°C	12°-15°C
3. Average relative humidity (%) at 9.30 hrs. ..	56-60%	78-83%
4. Average relative humidity (%) at 16.30 hrs.	42-55%	69-75%

The heaviest infection was by *Coccotrypes* (18,655 beetles emerged from the entire material, *vide infra*), while infection by the other two species was relatively small (emergences : 55 beetles of *Oryzaephilus* and 110 of *Tribolium*).

Five lots (A,B,C,D,E), comprising 55 whole nuts, 142 pieces and 118 buttons, were obtained at various periods during 1951 (Lot A) and 1955 (Lots B-E) and were kept under almost daily observation until all emergence had ceased. The nuts and pieces were then broken and examined for any remaining beetles or larvae. Some relevant details of each lot are given below.

Lot A.—4 whole nuts. Caged on 16 October 1951.

Lot B.—22 whole nuts and 83 pieces. Were *en route* from 12 February to 17 March, 1955 ; caged on 18 March 1955.

Lot C.—19 whole nuts and 4 pieces. Were *en route* from end June to early July 1955 ; caged on 8 July 1955.

Lot D.—6 whole nuts, 45 pieces and 118 buttons. Were *en route* in early November 1955 ; caged on 18 November 1955.

Lot E.—4 whole nuts and 10 pieces. Were *en route* in December 1955 ; caged on 28 December 1955.

As no information on emergences of the last two species from dum nuts in India is available, the details observed here are given below. Emergences of *Coccotrypes dactyliperda* will be discussed separately (Roonwal, *in press*).

Observations

1. **Oryzaephilus surinamensis** (Linnaeus)

(The Saw-Toothed Grain Beetle)

(Text-fig. 1)

Emergence of beetles from the five above mentioned lots of dum nuts are discussed below. Emergence occurs from tiny, round holes, *c.* 1 mm. or less in diameter, on the surface of the nut.

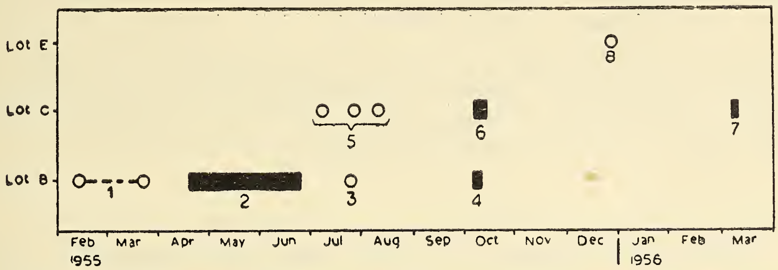
Lot A

No *Oryzaephilus* emerged, though some 5347 *Coccotrypes* came out.

Lot B

The monthly distribution of the 44 beetles which emerged was as follows :—February and March, 3 (*en route*) (6·8%) ; April, 14 (31·8%); May, 20 (45·5 %); June, 2 (4·6%) ; July—September, 0 ; and October, 5 (11·3 %).

Grouping emergences into active and inactive periods (Table 1) is more instructive. After the scanty emergence *en route* (from Coimbatore : 3 beetles) during the period 12 February to 17 March, there was no emergence until 18 April. For the following 39 days, from 19 April



TEXT-FIG. 1. *Oryzaephilus surinamensis.* Diagram showing emergence periods of beetles from dum nuts, *Hyphaene thebaica*, at Dehra Dun. Main or heavy emergences (Nos. 2, 4, 6 and 7) are shown in thick solid rectangles; and odd emergences (Nos. 3 and 5) in small circles. Emergences at Nos. 1 and 8 occurred *en route.* (*See* Table 1 for fuller details.)

TABLE 1

EMERGENCES OF BEETLES OF *Oryzaephilus surinamensis* FROM DUM NUTS, *Hyphaene thebaica*, at DEHRA DUN DURING 1955, GROUPED INTO ACTIVE AND INACTIVE PERIODS

Period (1955)	No. of days	Beetles emerged: Number	Beetles emerged: % of total emergence
LOT B (1955)			
(1) 12 Feb.—17 Mar. (*en route*) ..	34	3	6·8
(2) 18 Mar.-18 Apr. ..	32	0	0
(3) 19 Apr.-27 May ..	39	34	77·3
(4) 28 May-23 June ..	27	0	0
(5) 24 June ..	1	2	4·5
(6) 25 June-5 Oct. ..	103	0	0
(7 6-13 Oct.	8	5	11·4
No further emergence up to 18 May 1956.			
Total ..	244	44	—
LOT C (1955)			
(1) 8-17 July ..	10	0	0
(2) 18 July-24 Aug. ..	38	9	90
(3) 25 Aug.-12 Oct. ..	49	0	0
(4) 13 Oct. ..	1	1	10
No further emergence up to 18 May 1956.			
Total ..	98	10	—

to 27 May, there was active emergence and 34 beetles (77·3%) emerged. Thereafter, there was a gap of nearly 4½ months, from 28 May to 5 October,

during which there was no emergence except for two beetles on 24 June. This lull was then followed by a short 8-day period (6-13 October) of activity during which 5 beetles (11·3%) emerged, after which emergence ceased and no insects were left in the nuts. Thus, leaving aside the odd emergence on 24 June, there were three emergence periods, viz., February to about middle March, third week April to end May and a few days in the first half of October ; of these, the middle period, of about a month and a half in summer, was the most active.

Lot C

Of the small emergence of 10 beetles, the heaviest (9 beetles) occurred during the 38-day period from 18 July to 24 August, and one on 13 October.

Lot D

No *Oryzaephilus* emerged though some 89 *Coccotrypes* came out.

Lot E

Only one *Oryzaephilus* emerged, in late December *en route* ; none emerged later in the cage.

Conclusions

From the data discussed above it will be seen that under Dehra Dun conditions, with its severe winter (November to February), there are two main periods of emergence, both in the warm months, viz., one in April-May for about 5 weeks (*c*. 19 April to 27 May) and the other in July-August, also for about 5 weeks (*c*. 18 July to 24 August). A third period, of relatively weak emergence, is observable in the first half of October (*c*. 6-13 October). Some emergence *en route* from Coimbatore occurred during 12 February-17 March and in December, and an odd emergence occurred on 24 June.

The beetle is a world-wide pest of grain and other such stored products, and also occurs in bark and twigs in forests in India. Brief accounts of its life-history and control will be found in Beeson (1941). Mookherjee (1964) and Kushwaha and Sharma (1968). According to Beeson the life-cycle in flour in India may be completed in 7 weeks ; and emergences from bark continues throughout the year. Kushwaha and Sharma have provided some more details : Ovipositing females live for 6-10 months ; a single female lays 45-285 eggs ; the incubation period of eggs is 3-5 days, the larval period 2-10 weeks, and the prepupal and pupal periods 1-4 weeks ; the total life-cycle takes 27-315 days.

2. **Tribolium castaneum** (Herbst)

(The Red Flour Beetle)

(Text-fig. 2)

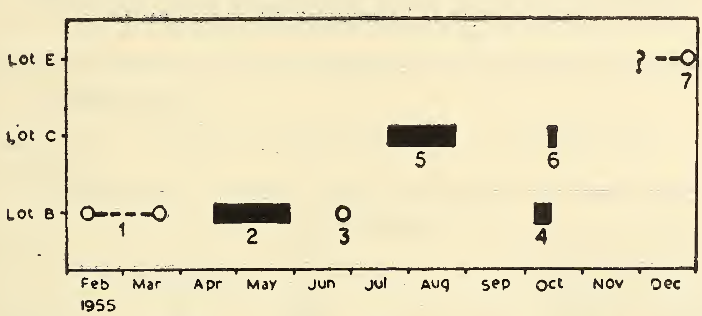
Emergences of beetles from the five lots of dum nuts (*vide supra*) is discussed below. Emergence occurs from tiny, round holes, *c*. 1 mm. or less in diameter, on the surface of the nut.

Lot A

No *Tribolium* emerged though some 5347 *Coccotrypes* came out.

Lot B

The monthly distribution of the 62 beetles which emerged during 1955, was as follows :—February and March, 3 *en route* (4·8%); April, 10 (16·2%); May, 18 (29%); June, 26 (41·9%); July, 1 (1·6%); August and September, 0; and October, 4 (6·5%).



TEXT-FIG. 2. *Tribolium castaneum*. Diagram showing emergence periods of beetles from dum nuts, *Hyphaene thebaica*, at Dehra Dun. Main or heavy emergences (Nos. 2, 4, 5 and 6) are shown in thick solid rectangles; and odd emergences (Nos. 3 and 7) in small circles. Emergence at Nos. 1 and 7 occurred *en route*. (*See* Table 2 for fuller details.)

When grouped into active and inactive periods, the following trend is seen :—After the scanty emergence *en route* from Coimbatore (3 beetles) during the period 12 February to 17 March, there was no emergence for 32 days (18 March to 18 April). Then there was a spurt of emergence (54 beetles or 87·1%) for 67 days, from 19 April to 24 June, followed by a long lull of nearly 30 months (25 June to 5 October) during which there was no emergence except for an odd beetle on 23 July. A weak emergence (4 beetles or 6·5%) occurred on 6 October after which there was no emergence, and nuts and pieces examined on 18 May 1956 showed no insects except 2 odd larvae.

Lot C

The monthly distribution of the 47 beetles which emerged during 1955-56 was as follows :—July, 2 (4·3%); August, 2 (4·3%); September, 0; October, 28 (59·6%); November-February next, 0; and March, 15 (31·9%).

When grouped into active and inactive periods, the following trend is seen:—After scanty emergence (4 beetles or 8·5%) for a little over a month (8 July to 8 August) there was complete lull for some 2 months (10 August to 4 October). This was followed by a spurt of emergence (28 beetles or 59·6%) on October 5 and 6, followed again by a long lull of nearly 5 months (7 October 1955 to 6 March 1956). Then there was another spurt of emergence (15 beetles or 31·9%) on 7 March 1956, after which emergence ceased. The nuts, when examined on 18 May, showed no more insects.

Lot D

No *Tribolium* emerged though some 89 *Coccotrypes* came out.

TABLE 2

EMERGENCE OF BEETLES OF *Tribolium castaneum* FROM DUM NUTS, *Hyphaene thebaica*, AT DEHRA DUN DURING 1955-56, GROUPED INTO ACTIVE AND INACTIVE PERIODS

Period 1955-56	No. of days	Beetles emerged: Number	Beetles emerged: % of total emergence
LOT B (1955)			
(1) 12 Feb.-17 March ..	34	3 (*en route*)	4·8
(2) 18 Mar.-18 Apr. ..	32	0	0
(3) 19 Apr.-24 June ..	67	54	87·1
(4) 25 June-22 July ..	28	0	0
(5) 23 July ..	1	1	1·6
(6) 24 July-5 Oct. ..	74	0	0
(7) 6 Oct. ..	1	4	6·5
No further emergence up to 18 May 1956.			
Total ..	237	62	—
LOT C (1955-56)			
(1) 8 July ..	1	1	2·1
(2) 9-25 July ..	17	0	0
(3) 26 July ..	1	1	2·1
(4) 27 July - 8 Aug. ..	13	0	0
(5) 9 Aug. ..	1	2	4·3
(6) 10 Aug. - 4 Oct. ..	56	0	0
(7) 5-6 Oct. ..	2	28	59·6
(8) 7 Oct. -6 Mar. ..	151	0	0
(9) 7 Mar. ..	1	15	31·9
No further emergence up to 18 May 1956.			
Total ..	243	47	—

Lot E

One beetle emerged *en route* from Coimbatore up to 28 December 1955. No further emergences occurred though the material was kept under observation until 18 May 1956.

Conclusions

There would appear to be three principal periods of emergence at Dehra Dun, as follows :—(i) Early March (*c.* March 7) ; (ii) the third week April to last week June (*c.* 19 April to 24 June) ; and (iii) the first week October (5-6 October). Besides these, weak emergences of odd beetles occurred during July and August. Some emergence occurred *en route* from Coimbatore during 12 February to 17 March and in December.

The beetle is widely distributed the world over in flour, and also occurs abundantly throughout India and the East in timber, wooden articles, bamboos, seeds, dried fruit and cereals. According to Kushwaha and Sharma (1968), the life-cycle takes about 6 weeks in August-September, and may be prolonged in winter ; a female lays *c.* 400-500 eggs ; the incubation period is 5-12 days, the larval period 4 weeks and the pupal period 6-9 days.

Summary

1. The dum nut, *Hyphaene thebaica* Mart., is imported into India from the Sudan, Africa, for manufacturing buttons and beads. The nuts are frequently infested with three species of beetles, viz., *Coccotrypes dactyliperda* (F.) (Scolytidae), *Oryzaephilus surinamensis* (L.) (Cucujidae) and *Tribolium castaneum* (Herbst) (Tenebrionidae). The heaviest infection is by *Coccotrypes*, that by the other two being much milder.

2. Hitherto, no information was available about the periods of emergence of these beetles from dum nuts. Observations on the last two species are given here. The infected nuts were obtained from Coimbatore (southern India) which is a manufacturing centre, and emergences observed in cages in unconditioned rooms at Dehra Dun where the summer (April to mid-June) is mild, the rains (mid-June to September) heavy and the winter (November to February) severe.

3. Five lots of infected nuts, consisting of 55 whole nuts, 142 pieces and 118 buttons, were caged at various intervals. The emergence periods of the beetles at Dehra Dun were as follows :—

(*a*) *Oryzaephilus surinamensis*—There were two main periods of emergence, viz., one in April-May (19 April—27 May) and the other in July-August (18 July—24 August). A third period of relatively weak emergence occurred in the first half of October (6-13 October). Some emergence *en route* from Coimbatore occurred during 12 February—17 March and in December, and an odd emergence occurred on 24 June.

(*b*) *Tribolium castaneum*—Three principal periods of emergence occurred, viz : (i) Early March (*c*. March 7) ; (ii) the third week April to last week June (*c*. 19 April—24 June) ; and (iii) the first week October (*c*. 5-6 October). In addition, weak emergences of odd specimens occurred during July and August. Some emergence *en route* from Coimbatore occurred during 12 February-17 March, and December.

References

Beeson, C. F. C. (1941): The Ecology and Control of Forest Insects in India and the Neighbouring Countries. ii+1007 pp., many figs.—Dehra Dun (Vasant Press). (Reprint 1961, 8+5 (*errata*)+4+767 pp., Govt. of India, Delhi).

Kushwaha, K. S. & Sharma, J. C. (1968): Safe storage of grains and other products from insect pests and rats *Tech. Farm. Bull. Univ. Udaipur*, Udaipur, No. 1, 8+59 pp.

Mookherjee, P. B. (1964): Stored grains pests. pp. 317-330. In: Entomology in India 1938-1963. New Delhi (Ent. Soc. India).

Roonwal, M. L. (*in press*): Observations on the biology of the Date Stone or Dum Nut Beetle, *Coccotrypes dactyliperda* (Scolytidae), from dum nuts, *Hyphaene thebaica*, in India. *J. Zool. Soc. India* **23** (1).

Food-Habits of water-birds of the Sundarban, 24-Parganas District, West Bengal, India—III

Egrets

BY

AJIT KUMAR MUKHERJEE

Zoologist, Zoological Survey of India, Calcutta

(*With three text-figures*)

[*Continued from Vol.* **68** (1) : 64]

Bubulcus ibis coromandus (Boddaert), Cattle Egret

The Cattle Egret, *Bubulcus ibis coromandus* (Boddaert), is found in the reclaimed area, usually in the cultivated and pasture tracts of the Sundarban. It is the commonest of all egrets but has not been seen in the forests or on tidal mud-flats.

Jerdon (1864, p. 750) states : 'It always attends cattle whilst grazing, and picks up grasshoppers and their larvae disturbed by them. Now and then it varies its food with small fish, tadpoles, and aquatic insect.' Blanford (1898, p. 389) wrote : 'This egret is a constant attendant on cattle, either oxen or buffaloes, frequently perching on their backs and feeding mainly on the insects that are attracted by cattle, and on grasshoppers.' Mason and Maxwell-Lefroy (1912, p. 285) examined three birds, and found 166 insects of which three were beneficial, three neutral and 160 injurious. Whistler (1928, p. 396) stated : 'For though it feeds sometimes on small fish, tadpoles and aquatic insects, its chief food consists of grasshoppers and flies, and these it obtains in plenty while attending the cattle, pecking them off the grass, and off the animals themselves. It also performs a definite service by ridding their skins of leeches, ticks and other parasites.' Baker (1929, p. 350) remarked : 'This egret differs from other members of the family in being almost entirely an insect-eater, spending most of its time wandering about cattle pastures, feeding on the insects and grasshoppers which they disturb and also picking off ticks from the backs of cattle. The birds, of course, also eat frogs, worms, fish and mollusca as well.' Ali

(1955, p. 104) mentions that its food comprises chiefly of grasshoppers, bluebottle flies and other insects ; also frogs, lizards, etc. According to Voous (1960, p. 18) its food is mainly large insects which have been disturbed in the grass by grazing mammals. In addition, it independently catches grasshoppers, beetles and other insects and even to a lesser extent various small aquatic animals. The number of parasitic ticks and insects caught by Cattle Egrets from the skin of large grazing mammals is probably small.

The detailed analysis of the stomach contents of 318 adult specimens that the author collected in the Sundarban is given in Table 8.

TABLE 8

ANALYSIS OF THE STOMACH-CONTENTS OF THE CATTLE EGRET

Items of diet	No.	Wt.(g.)	%(Wt.)	Remarks
Phylum Chordata				
Class Amphibia				
Family RANIDAE				
Rana sp. (tadpoles)	18			
Family BUFONIDAE				
Bufo melanostictus Schneider	40			Mainly subadults.
Total:	58	250	7.94	
Phylum Arthropoda				
Order Orthoptera				
Family LOCUSTIDAE				
Hieroglyphus banian Fabricius	95			Pest of paddy.
Acantholobus sp.	12			
Criotettix spinilobus Hancock	35			
Euparatettix sp.	27			
Paratettix sp.	19			
Ergatettix sp.	13			
Coptotettix sp.	26			
Acrida sp.	21			Pest of cultivated plants.
Acrotylus sp.	127			Surface grasshopper. Pest of paddy nurseries.
Attractomorpha crenulata Fabricius	87			Pest of tobacco, etc.
Aiolopus tamulus Fabricius	23			Groundhopper.
Chrotogonus sp.	89			Pest of cotton and other young crops.
Lefroya sp.	16			Pest of cotton and other young crops.
Catantops humilis Serville	25			Pest of cotton.
Heteracaris capensis Thunberg	37			Pest of cotton.
Locusta danica Linnaeus	28			Pest of paddy nurseries.
Loxilobus sp.	5			Pest of paddy nurseries.

Items of diet	No.	Wt.(g.)	%(Wt.)	Remarks
Family TETTIGIDAE				
Scelimena sp.	10			
Acrydium sp.	76			Pest of cultivated plants.
Family GRYLLIDAE				
Gryllus sp.	17			
Gryllus bimaculatus De Geer	34			Burrowers feeding on roots and tender shoots of some crops.
Liogryllus sp.	22			Burrowers feeding on roots and tender shoots of some crops.
Family GRYLLOTALPIDAE				
Gryllotalpa sp.	28			Burrowers feeding on roots and tender shoots of some crops.
Fragments of Orthoptera				Head, tarsus and part of abdomen. Not identifiable.
Order Phasmida				
Family PHASMIDAE				
Phasmids	6			Partially digested. Unidentifiable.
Order Mantodea				
Family MANTIDAE				
Mantis religiosa Linnaeus ?	35			A beneficial insect, being a predator.
Order Dermaptera				
Family LABIDURIDAE				
Labidura sp.	18			Inhabits decaying leaves and decaying wood.
Family LABIIDAE				
Labia minor (Linnaeus)	11			Inhabits damp ground.
Order Odonata				
Sub-order Anisoptera				
Family LIBELLULIDAE				
Crocothemis sp.	21			
Pantala sp.	13			
Sub-order Zygoptera				
Family COENAGRIIDAE				
Ceriagrion sp.	27			
Ischneura sp. ?	40			
Order Hemiptera				
Family PENTATOMIDAE				
Nezara viridula Linnaeus	44			Pest of castor, potato and other plants.
Coptosoma sp.	9			Pest of pulses.
Tetroda sp.	10			Pest of paddy.

Items of diet	No.	Wt.(g.)	%(Wt.)	Remarks
Podops lurida Burmeister	42			Pest of paddy.
Menida histrio Fabricius	12			Pest of paddy.
Aspongopus sp.	18			
Family Coreidae				
Leptocorisa acuta Thunberg	156			Pest of paddy-ears.
Family Pyrrhocoridae				
Dysdercus cingulatus Fabricius	72			Pest of Malvaceae.
Family Jassidae				
Tettigoniella sp.	19			Pest of paddy.
Nephotettix bipunctatus Fabricius	32			Pest of paddy.
Deltocephalus sp.	7			Pest of paddy.
Order Coleoptera				
Family Dynastidae				
Phyllognathus dionysius (Fabricius)	61			Pest of paddy.
Family Meloidae				
Mylabris pustulata Thunberg	13			Pest of flowers of various plants.
Mylabris sp. ?	15			Pest of grass and paddy.
Gnathospastoides rouxi Castalenau	6			Pest of earheads of paddy.
Cylindrothorax ruficollis (Fabricius)	3			Pest of earheads of paddy.
Epicauta sp.	8			Pest of earheads of paddy.
Cantharis sp.	6			Pest of earheads of paddy.
Family Chrysomelidae				
Oides affinis Jacoby	1			Affects rice plants.
Aulacophora sp.	17			Pest of Cucurbitaceae.
Haltica cyanea Weber	35			Pest of paddy.
Dicladispa armigera Oliver	191			Pest of paddy.
Leptispa pygmoea Baly	10			Pest of paddy.
Family Curculionidae				
Myllocerus sp.	6			Pest of paddy.
Acactogaster sp.	12			Pest of Malvaceae.
Athesapeuta oryzae Marshall	16			Pest of paddy.
Echinocnemus oryzae Marshall	16			Pest of paddy.
Order Lepidoptera				
Family Noctuidae				
Spodoptera mauritia Boisduval (Larva)	84			Swarming caterpillar. Pest of paddy.
Cirphis sp. (Larva)	26			Swarming caterpillar. Pest of paddy.
Agrotis sp. (Larva)	15			Pest of paddy, millets, and Cruciferae.

Items of diet	No.	Wt.(g.)	%(Wt.)	Remarks
Family PYRALIDAE				
Nymphula sp. (Larva)	19			Pest of paddy.
Family HESPERIADAE				
Pelopidas mathias (Fabricius) (Larva)	22			Pest of paddy.
Order Hymenoptera				
Family FORMICIDAE				
Dorylus sp.	16			Badly mutilated.
Aenictus sp.	10			Badly mutilated.
Camponotus sp.	52			Badly mutilated.
Family COLLETIDAE				
Prosopis sp.	6			
Family APIDAE				
Anthidium sp.	12			
Xylocopa sp.	10			
Apis indica Fabricius	32			Beneficial.
Order Diptera				
Suborder Nematocera				
Family TIPULIDAE				
Tipulid Fly				Mutilated.
Suborder Brachycera				
Family BOMBYLIIDAE				
Bombylius sp. ?	3			
Family SCENOPINIDAE				
Scenopinus sp. ?	6			Carnivorous larvae feeding on other insects.
Family MYDAIDAE				
Mydaid fly				Mutilated.
Family CALLIPHORIDAE				
Sarcophaga sp.	9			
Miscellaneous insect fragments				Unidentifiable.
Total :	2202	2220	69·84	
Class Arachnida				
Order Araneae				
Family ERESIDAE				
Stegodyphus sp. ?	19			
Family ARGYOPIDAE				
Leucage decorata (Blackwall) ?	25			Common in grass and paddy fields.
Araneus mitifica (Thorell)	66			Common in grass and paddy fields.
Cyclosa sp.	92			Common in bushes.

Items of diet	No.	Wt.(g.)	%(Wt.)	Remarks
Family THERIDIIDAE				
Thereodon sp. ?	14			
Family OXYOPIDAE				
Oxyopus sp.	126			Grass-spider. Common.
Family LYCOSIDAE				
Lycosa sp.	152			
Hippasa sp. ?	91			
Family TETRAGNATHIDAE				
Acuta javana Thorell	52			Very common in paddy and grass.
Order Acarina				
Family IXODIDAE				
Hyalomma sp.	33			Common on cattle.
Total :	670	350	11·11	
Phylum Annelida				
Class Chaetopoda				
Order Oligochaeta				
Family MEGASCOLECIDAE				
Pheritima sp. ?				Badly mutilated.
Eutyphoeus sp. ?				Partially digested, unidentifiable.
Total :		350	11·11	

The Cattle Egret feeds mainly on insects (69·84 per cent) of which grasshoppers and crickets form the bulk. It devours hard insects (Coleoptera) as well as soft-bodied Lepidoptera larvae. Besides, it takes other insects, such as earwigs, bugs, Diptera, Hymenoptera, etc. Out of 2202 insects found in the stomachs of 318 birds, 1757 are pests of crops and garden vegetables, 191 are beneficial insects since these are either predators or parasites of other insect pests or produce substances of economic value. The other arthropods that form a part of its food are spiders and ticks (11·11 per cent). Oligochaeta (11·11 per cent) and Amphibia (7·94 per cent) such as tadpoles, frogs and toads are also added to its diet. No fish has been obtained.

It is a highly beneficial bird, since it consumes many insects injurious to agriculture.

Egretta alba modesta (J. E. Gray), Eastern Large Egret

The Eastern Large Egret, *Egretta alba modesta* (J. E. Gray) occurs singly, generally on river banks at the edge of water and sometimes in the inundated fields during monsoon. In the Sundarban it generally inhabits estuaries where it is seen on the undisturbed broad mud-flats of tidal rivers.

Very little information is available on the food-habits of the Eastern Large Egret. About the food of the Large Egret, *Egretta alba alba* (Linnaeus) Baker (1929, p. 346) states: 'It feeds principally on fish, frogs, tadpoles, and freshwater mollusca etc., but like most herons, will also devour young and sickly birds, mice etc. and it also feeds constantly on grasshoppers, Coleoptera etc. Witherby *et al.* (1939, p. 138) mention that its food varies to some extent according to season : in wet year mainly fish, aquatic insects and larvae, frogs, tadpoles, etc., but in dry seasons takes small mammals (chiefly field-mice and voles), land insects, lizards and probably young birds. Freshwater Mollusca and worms, are also recorded. Insects taken are chiefly Orthoptera, Hemiptera and Coleoptera. Voous (1960, p. 16) mentions that its food is composed of a large number of small water and marsh animals, especially aquatic insects and small fish, also frogs and toads, grasshoppers and mice.

The detailed analysis of the stomach contents of 70 adult specimens that the author collected in the Sundarban is given in Table 9.

TABLE 9

ANALYSIS OF THE STOMACH-CONTENTS OF THE LARGE EGRET

Items of diet	No.	Wt.(g.)	%(Wt.)	Remarks
Phylum Chordata				
Class Reptilia				
Order Squamata				
Suborder Serpentes				
Family COLUBRIDAE				
Acrochordus granulatus (Schneider)	8			Estuarine.
Natrix stolata (Linnaeus)	21			Freshwater and Estuarine. Common in stomachs.
Total :	29	555	2	
Series Pisces				
Class Teleostomi				
Order Cypriniformes				
Family SCHILBEIDAE				
Pangasius pangasius (Hamilton)	28			Freshwater but descends tidal waters.
Family BAGRIDAE				
Mystus gulio (Hamilton)	190			Length 5-30 mm. Partially digested. Invariably present in stomachs.
Mystus ? sp.	60			Partially digested.

Items of diet	No.	Wt.(g.)	%(Wt.)	Remarks
Order Cyprinodontiformes				
Family CYPRINODONTIDAE				
Aplocheilus panchax (Hamilton)	106			Common in inundated fields and fresh and brackish water ponds. Invariably present in stomachs.
Order Anguilliformes				
Family ANGUILLIDAE				
Anguilla bengalensis (Gray)	90			Length 60-120 mm. Invariably present in stomachs.
Muraena tile (Hamilton)	27			Length 70-100 mm. Estuarine.
Family MURAENESOCIDAE				
Muraenesox cinereus (Forskål)	14			Length 50-100 mm. Estuarine.
Order Beloniformes				
Family BELONIDAE				
Strongylura strongylura (van Hasselt)	22			Estuarine.
Order Mugiliformes				
Family SPHYRAENIDAE				
Sphyraena sp. ?	6			Estuarine. Partially digested, unidentifiable.
Family MUGILIDAE				
Chelon sp.	25			Length 30-110 mm. Estuarine.
Mugil tade Forskål	106			Length 45-100 mm. Quite common in stomachs.
Order Polynemiformes				
Family POLYNEMIDAE				
Polynemus heptadactylus Cuvier & Valenciennes	70			Length 60-175 mm. Estuarine.
Polydactylus indicus (Shaw)	26			Estuarine.
Polynemus paradiseus Linnaeus	45			Length 100-170 mm.
Order Perciformes				
Family AMBASSIDAE				
Ambassis commersoni Cuvier & Valenciennes	62			Length 5-30 mm. Freshwater. Common in stomachs.
Ambassis gymnocephalus (Lacépède)	70			Length 10·35 mm. Freshwater. Common in stomachs.
Family MULLIDAE				
Upeneus sp. ?	3			Partly digested.
Family SCATOPHAGIDAE				
Scatophagus argus (Linnaeus)	6			Estuarine.

Items of diet	No.	Wt.(g.)	%(Wt.)	Remarks
Family CICHLIDAE				
Etroplus suratensis (Bloch)	4			Estuarine.
Family CYBIIDAE				
Scomberomorus commersoni (Lacépède)	6			Marine.
Scomberomorus guttatus (Schneider)	10			Estuarine.
Family ANABANTIDAE				
Anabas testudineus (Bloch)	22			Length 30-60 mm. Fresh and brackish water.
Family GOBIIDAE				
Glossogobius giuris (Hamilton)	18			Length 40-90 mm. Brackish water.
Family PERIOPTHALMIDAE				
Periopthalmus sp.	109			Inhabits mud flats of tidal rivers. Quite common in the stomachs.
Boleopthalmus boddaerti (Pallas)	41			
Fish remains				Not identifiable.
Total:	1166	9935	80	
Phylum Mollusca				
Class Gastropoda				
Order Basommatophora				
Family LYMNAEIDAE				
Lymnaea sp.	80			Freshwater.
Order Archaeogastropoda				
Family NERITIDAE				
Nerita sp.	15			Brackish water.
Order Mesogastropoda				
Family VIVIPARIDAE				
Viviparus bengalensis (Lamarck)	77			Freshwater. Invariably present in stomachs.
Family MELANIIDAE				
Melanoides sp.	82			Freshwater. Invariably present in stomachs.
Family PILIDAE				
Pila sp.	25			
Miscellaneous shell remains				Not identifiable.
Total:	279	1130	6·00	

Items of diet	No.	Wt.(g.)	%(Wt.)	Remarks
Phylum Arthropoda				
Class Crustacea				
Order Decapoda				
Family PENAEIDAE				
Metapenaeus sp.	18			Brackish water.
Family PORTUNIDAE				
Scylla serrata (Forskål)	67			Brackish water. Invariably present in stomachs.
Portunus sp.	17			Brackish water. Invariably present in stomachs.
Family GRAPSIDAE				
Varuna litterata (Fabricius)	108			Brackish water. Invariably present in stomachs.
Family OCYPODIDAE				
Uca sp.	29			
Miscellaneous Crustacean fragments				Not identifiable.
Total:	239	1610	5·00	
Class Insecta				
Order Odonata				
Suborder Zygoptera				
Family COENAGRIIDAE				
Ceriagrion sp. (Naiads)	100+			Aquatic.
Suborder Anisoptera				
Family AESCHNIDAE				
Crocothemis sp. (Naiads)	100+			Aquatic.
Pantala sp. (Naiads)	50+			Aquatic.
Order Coleoptera				
Family DYTISCIDAE				
Eretes stictus Linnaeus	60			Aquatic.
Laccophilus sp.	110			Aquatic.
Canthydrus sp.	40			Aquatic.
Family GYRINIDAE				
Dineutes sp.	32			Aquatic.
Family HYDROPHILIDAE				
Hydrophilus olivaceous Fabricius	20			Aquatic.
Miscellaneous insect fragments				Not identifiable.
Total:	512+	815	4·00	
Miscellaneous Vegetable matter		125	1·00	

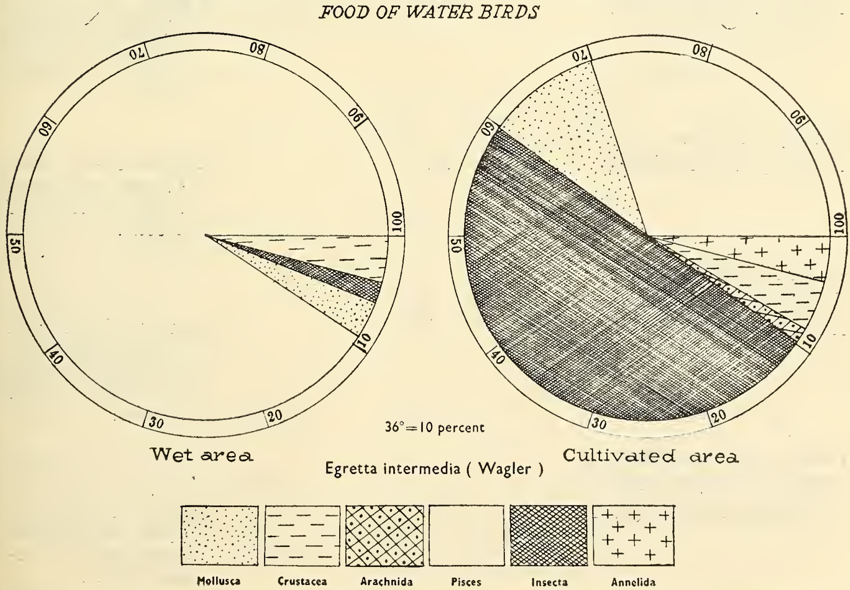
The food of the bird is chiefly fishes (80 per cent). Altogether 1166 examples of fishes were found in the 70 stomachs examined. They represent 26 species of which three are freshwater species and the rest are brackish water estuarine species. With the exception of three species of mud fishes, all have commercial value. The fishes found in stomachs vary from 5-175 mm. in standard length. Next to fishes, Mollusca are consumed (6 per cent). They are mostly freshwater forms. Brackish water crustaceans which consist more of crabs than shrimps are taken in small proportion (5 per cent). These have commercial value except two species. Small quantity of brackish water snakes (2 per cent), aquatic insects (4 per cent) are also taken. It is interesting to note that no Amphibia or bugs has been found in the stomachs.

Since the bird feeds to a great extent on fish, fish-fry and crustaceans of commercial value, it appears to have an appreciable effect upon fishery. The bird may therefore be regarded as injurious to fishery.

Egretta intermedia intermedia (Wagler), Smaller Egret

The Smaller Egret, *Egretta intermedia intermedia* (Wagler), is the commonest of all true Egrets in the Sundarban area. It is very common in the reclaimed area, in the grasslands and cultivation, and in the very shallow inundated paddy-fields or drying pools, mostly associated with

DIAGRAMMATIC REPRESENTATION OF THE PERCENTAGES OF FOOD OF WATER BIRDS



the Cattle Egret and the Little Egret. It is basically a gregarious bird, occurring in flocks of about six to eighteen individuals. When it visits tidal waters, it prefers smaller creeks which are practically drained out during the ebb tide, and this apparently helps easy location of food in mud and shallow water. In the Sundarban it is more a landbird with almost similar habits to that of the Cattle Egret, following cattle or boats that are punted through reeds and grass across fields which get flooded during monsoon. This habit helps it to catch insects and spiders, etc., inhabiting reeds and grass disturbed by the boat's passage.

Practically nothing is known about the food-habits of the Smaller Egret. Baker (1929, p. 347) states that the Smaller Egret feeds very much on insects specially on Coleoptera and grasshoppers and may sometime feed with Cattle Egrets among cattle.

The detailed analysis of the stomach contents of 220 adult specimens that the author collected in the Sundarban is given in Table 10.

TABLE 10

ANALYSIS OF THE STOMACH-CONTENTS OF THE SMALLER EGRET

Items of diet	No.	Wt.(g.)	%(Wt.)	Remarks
Phylum Chordata				
Series Pisces				
Class Teleostomi				
Order Cypriniformes				
Family CYPRINIDAE				
Puntius ticto (Hamilton)	92			Length 20-50 mm. Fairly common in stomachs of birds of cultivated tracts.
Family BAGRIDAE				
Mystus gulio (Hamilton)	183			Length 30-60 mm. Quite common food of birds of creeks.
Order Anguilliformes				
Family ANGUILLIDAE				
Anguilla bengalensis (Gray)	66			Length 70-110 mm. Not uncommon in stomachs of birds of creeks and *bheries*.
Order Cyprinodontiformes				
Family CYPRINODONTIDAE				
Oryzias melastigmus (McClelland)	202			Length 25-40 mm. Quite common in stomachs of inland birds.

Items of diet	No.	Wt.(g.)	%(Wt.)	Remarks
Order Perciformes				
Family AMBASSIDAE				
Ambassis sp.	49			Length 25-40 mm. Quite common in stomachs of inland birds.
Family SCIAENIDAE				
Pseudosciaena diacanthus (Lacépède)	22			Length 50-80 mm.
Pseudosciaena coibor (Hamilton)?	15			Length 55-90 mm.
Family NANDIDAE				
Nandus nandus (Hamilton)	30			Length 40-70 mm.
Family ANABANTIDAE				
Anabas testudineus (Bloch)	108			Length 60-80 mm. Quite common in stomachs of estuarine and inland birds.
Family GOBIIDAE				
Gobius gutum Hamilton	66			All these mud-fishes are quite common in stomachs of estuarine birds.
Periopthalmus koelreuteri (Pallas)	225			
Boleopthalmus viridis (Hamilton)	100			
Boleopthalmus boddaerti (Pallas)	67			
Gobids (in bits)				Digested not identifiable.
Order Mastocembeliformes				
Family MASTOCEMBELIDAE				
Mastocembelus armatus (Lacépède)	19			Length 80-120 mm.
Mastocembelus pancalus (Hamilton)	32			Length 70-110 mm.
Macrognathus aculeatum (Bloch)	16			Length 70-100 mm.
Miscellaneous fish remains				Unidentifiable.
Total:	1292	6187	82·50	
Phylum Mollusca				
Class G a s t r o p o d a				
Order Basommatophora				
Family LYMNAEIDAE				
Lymnaea sp.	52			Freshwater form.
Indoplanorbis sp.	28			Land-snail.
Order Mesogastropoda				
Family VIVIPARIDAE				
Viviparus bengalensis (Lamarck)	43			Freshwater form.
Family MELANIIDAE				
Melanoides tuberculatus (Müller)	31			Freshwater form.
Total:	154	562	7·50	

Items of diet	No.	Wt.(g)	%(Wt.)	Remarks
Phylum Arthropoda				
Class Crustacea				
Order Decapoda				
Family PENAEIDAE				
Metapenaeus brevicornis Milne-Edward	23			Brackish water form. Very common in creeks and also in flooded paddy-fields.
Metapenaeus monoceros Fabricius	17			Brackish water form. Very common in creeks and also in flooded paddy-fields.
Family PALAEMONIDAE				
Macrobrachium lamaerrei (Milne-Edward)	28			Freshwater form found in ponds. Common.
Macrobrachium rude (Heller)	19			Freshwater form.
Palaemon styliferus Milne-Edward	35			Freshwater form found in ponds. Common.
Family ATYIDAE				
Caridina gracilipes de Man	48			Freshwater form.
Family PORTUNIDAE				
Scylla serrata (Forskål)	11			Brackish water form.
Portunus pelagicus (Linnaeus)	6			Brackish water form.
Family GRAPSIDAE				
Varuna litterata (Fabricius)	31			Brackish water form.
Miscellaneous crustacean fragments				Not identifiable.
Total :	218	300	4	
Class Insecta				
Order Orthoptera				
Family LOCUSTIDAE				
Hieroglyphus banian Fabricius	25			Pest of paddy.
Criotettix sp.	2			Minor pest of paddy nurseries.
Loxilobus sp.	5			Minor pest of paddy nurseries.
Acrotylus sp.	4			Minor pest of paddy nurseries.
Attractomorpha crenulata Fabricius	10			Pest of paddy.
Chrotogonus sp.	4			Pest of cotton, etc.
Migratoria migratorides (Reiche & Fairmaire)				

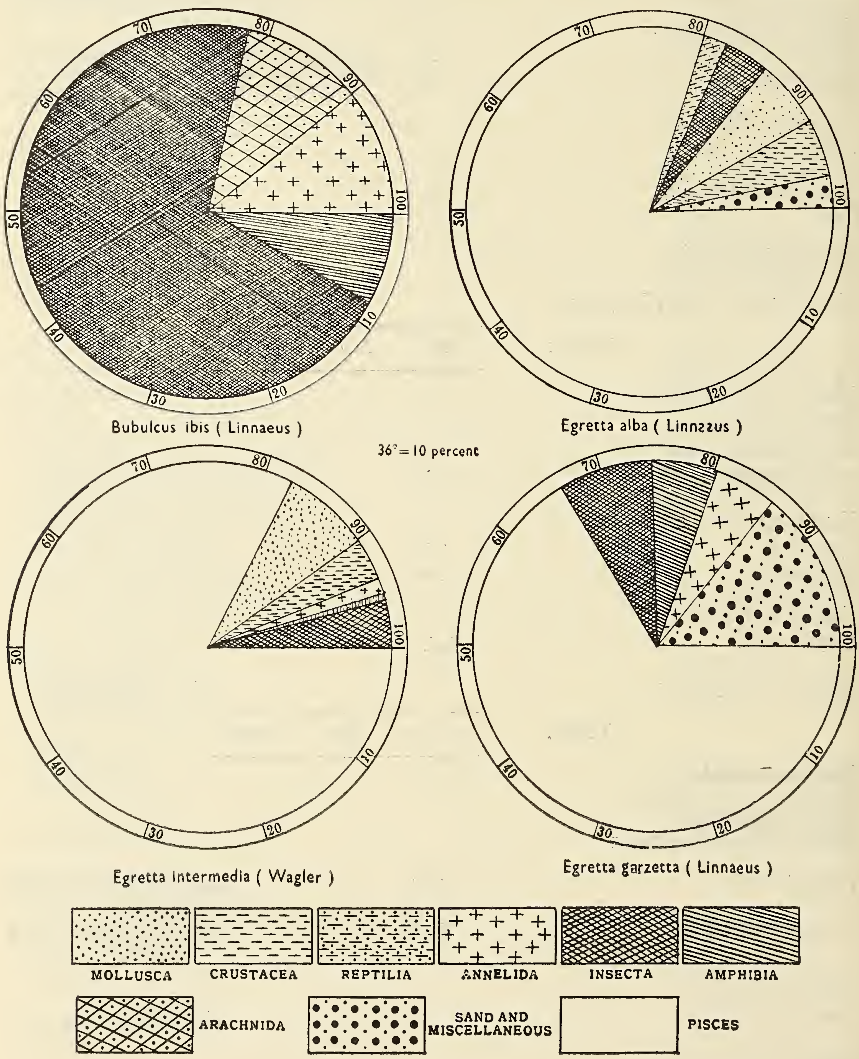
Items of diet	No.	Wt.(g)	(Wt.)	Remarks
Family GRYLLIDAE				
Gryllus bimaculatus De Geer	14			Burrowers, feeding on vegetation and damaging nursery plants.
Gryllus melanocephalus Serville	6			Burrowers, feeding on vegetation and damaging nursery plants.
Family GRYLLOTALPIDAE				
Gryllotalpa sp.				Burrowers, feeding on vegetation and damaging nursery plants.
Orthoptera fragments				Not identifiable.
Order Odonata				
Suborder Zygoptera ? sp. (Naiads)	21			Aquatic form. Partially digested, unidentifiable.
Suborder Anisoptera				
Family LIBELLULIDAE				
Pantala sp.	6			
Order Lepidoptera				
Family NOCTUIDAE				
Spodoptera mauritia Boisduval (Larvae)	22			Pest of paddy.
Agrotis sp. (Larvae)	3			Pest of paddy.
Cirphis sp. (Larvae)	5			Pest of paddy.
Family PYRALIDAE				
Schoenobius incertellus Walker (Larvae)	8			Pest of paddy.
Nymphula depunctalis Guenee (Larvae)	7			Pest of paddy.
Lepidopterous larvae				Mutilated.
Order Coleoptera				
Family RUTELIDAE				
Anomala elata (Fabricius)	6			Pest of garden plants.
Family SCARABAEIDAE				
Heliocopris bucephalus Fabricius	7			Scavenger.
Gymnopleurus sp.	5			Scavenger.
Catharsius pithecius (Fabricius)	6			Scavenger.
Family MELOLONTHIDAE				
Apogonia carunata Brenske	6			Root-feeder.
Family DYNASTIDAE				
Phyllognathus dionysius Fabricius	3			Pest of paddy.
Family COCCINELLIDAE				
Epilachna sp.	7			Pest of brinjal and Cucurbitaceae.
Epilachna vigintiocto-punctata Fabricius	5			Pest of potato. Also a predatory insect.

Items of diet	No.	Wt.(g.)	%(Wt.)	Remarks
Family TENEBRIONIDAE				
Gonocephalum sp.	2			
Opaterum sp.	2			
Family MELOIDAE				
Mylabris pustulata Thunberg	7			Pest of flowers of various plants.
Gnathospastoides rouxi Castalenau	8			Pest of ears of paddy.
Cylindrothorax ruficollis (Fabricius)				
Epicuta sp.	1			Pest of ears of paddy.
Family CHRYSOMELIDAE				
Podagria sp.	3			Pest of *Hibiscus*.
Oides affinis Jacoby	18			Pest of paddy.
Aulacophora sp.	12			Pest of Cucurbitaceae.
Haltica cyanea Weber	9			Pest of paddy.
Leptispa pygmoea Baly	1			Pest of paddy.
Dicladispa armigera (Oliver)	3			Pest of paddy.
Family CURCULIONIDAE				
Myllocerus sp.	6			Pest of paddy.
Paramecops sp.	6			Pest of paddy and brinjal.
Alcides sp.	2			Pest of lablab.
Calandra stigmaticollis Guenne	7			Pest of palms.
Athesapeuta oryzae Marshall				Pest of paddy.
Echinocnemus oryzae Marshall	3			Pest of paddy.
Order Hymenoptera				
Family TENTHREDINIDAE				
Athalia proxima Kirby	4			Pest of Cruciferae.
Family SCOLIIDAE				
Scoliid wasp				Mutilated.
Family FORMICIDAE				
Cataulacus sp.	6			
Dorylus sp.	13			
Camponotus sp.	16			Pest of sugarcane.
Ant fragments				Not identifiable.
Family VESPIDAE				
Vespa orientalis Linnaeus	3			
Family APIDAE				
Apis indica Linnaeus	2			Beneficial insect.
Family CHRYSIDAE				
Chrysis sp.	1			
Family EUMENIDAE				
Wasp	3			Mutilated.
Family SPHEGIDAE				
? sp.				Mutilated.

Items of diet	No.	Wt.(g.)	%(Wt.)	Remarks
Order Diptera				
Family CECIDOMYIDAE				
Pachydiplosis oryzae Marshall	5			Pest of paddy.
Family ANTHOMIDAE				
Atherigona sp.	2			Pest of paddy.
Family MUSCIDAE				
Lucila sp.?	2			
Stomoxys sp.	4			
Family TABANIDAE				
? sp.				Digested, unidentifiable.
Family TIPULIDAE				
? sp.				Digested, unidentifiable.
Diptera fragments				Not identifiable.
Miscellaneous insect fragments				Not identifiable.
Total:	338	319	4·25	
Class Arachnida				
Order Araneae				
Family ARGIOPIDAE				
Araneus mitifica (Thorell)	25			
Family LYCOSIDAE				
Lycosa sp.	85			
Hippasa sp.	19			
Family OXYOPIDAE				
Oxyopus sp.	102			
Spiders in fragments				Not identifiable.
Total:	231	38	0·50	
Phylum Annelida				
Class Chaetopoda				
Order Oligochaeta				
Family MEGASCOLECIDAE				
Pheretima sp.	17+			Partly digested and in bits.
Eutyphoeus sp.	19+			Partly digested and in bits.
Family NAIDIDAE				
Limnodrilus sp.				Tangled mass.
Order Polychaeta				
Family SERPULIDAE				
Mercierella ? sp.	6+			Partly digested.
Miscellaneous annelid fragments				Not identifiable.
Total:	42+	94	1·25	

The Smaller Egret is principally a fish-eating bird, but when it is in cultivated fields in company with Cattle Egret, it shares the food of the latter, which is mostly insects.

DIAGRAMMATIC REPRESENTATION OF THE PERCENTAGES OF FOOD OF WATER BIRDS



Fishes form the principal diet (82.5 per cent). The total number of fishes taken by 220 birds is 1292, representing 16 species and comprising mostly of commercial fishes. With the exception of eight freshwater forms, the others are marine and estuarine fishes. The length of fishes vary from 10 mm. to 120 mm. The next item of food is freshwater Mollusca (7.50 per cent). Insects taken are mostly grasshoppers, beetles, Diptera and Lepidoptera larvae and naiads of dragonflies and damselflies. Of the 338 examples of insects representing 58 species, 257 examples representing 39 species are pests of agriculture. No bugs have been found in the stomachs of this egret. Crustaceans are consumed in small quantities (4 per cent), and they are of commercial value. A small quantity of spiders (0.50 per cent) and Annelida (1.25 per cent) are also taken.

Out of the 220 birds collected, 102 were from tidal creeks and the rest were from cultivated fields, and fallow lands about villages of the reclaimed area. The food-habits of the birds that were obtained from the cultivated areas differ to an appreciable extent from those found in the tidal creeks. The analysis of the food of ten specimens from each area represent two different ecological niches :

		Mud-flats (Tidal creeks & rivers)	Cultivated tracts (Reclaimed area)
Pisces	..	95%	
Mollusca	..	—	7.50%
Insecta	..	—	87.0%
Arachnida	..	—	0.50%
Crustacea	..	4.50%	3.0%
Annelida	..	0.50%	2.0%

From the foregoing analysis and general observation it may be said that on grassland and cultivated tracts it behaves as an insectivorous bird doing immense good to agriculture by destroying insect pests of crop and cultivated vegetables. While foraging in the creeks and river flats, however, it feeds on fishes and crustacea which are mostly of commercial value, and hence may be regarded as harmful to fishery there.

Egretta garzetta garzetta (Linnaeus), Little Egret

The Little Egret, *Egretta garzetta garzetta* (Linnaeus), is a bird of the marshes. In Sundarban, it is found not only in shallow waters and on mud-flats of estuaries, but also on wet land in company of the Cattle and the Smaller Egret. It ventures in cultivated field and grasslands in search of insects, hunting in association with other egrets. The birds forage, in small flocks of up to a dozen or so, moving in shallow water puddles, mud-flats, and in mangrove swamps.

About the food of Little Egret, Whistler (1928, p. 394) wrote: 'Their food consists very largely of fish and frogs, but lizards, worms, grasshoppers, locusts, aquatic insects, freshwater Mollusca and Crustacea are all eaten'. According to Baker (1929, p. 349) the Little Egret, feeds more on insects than the larger species, but small reptiles, frogs, etc., form its staple diet. Ali (1955, p. 103) states that the food of the Little Egret is insects, frogs and small reptiles. Voous (1960, p. 16) mentions that its food is composed of various water and marsh animals mostly of small size: large aquatic and marsh insects (dragonflies and water beetles), small fishes, frogs, newts, worms, and other crustaceans.

The detailed analysis of the stomach contents of 138 adult specimens that the author collected in the Sundarban is given in Table 11.

DIAGRAMMATIC REPRESENTATION OF THE PERCENTAGES OF FOOD OF WATER BIRDS.

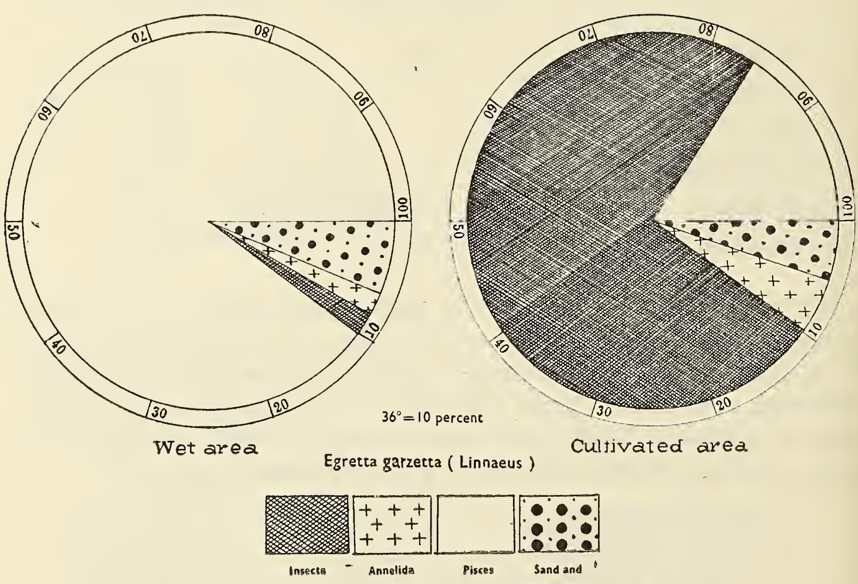


TABLE 11

ANALYSIS OF THE STOMACH-CONTENTS OF THE LITTLE EGRET

Items of diet	No.	Wt.(g.)	%(Wt.)	Remarks
Phylum Chordata				
Class Amphibia				
Order Anura				
Family RANIDAE				
Rana sp. (tadpoles)	102			Partially digested.
Family BUFONIDAE				
Bufo melanostictus Schneider	26			8 tadpoles and 18 sub-adults.
Microhyla sp.?	7			Partially digested, unidentifiable.
Total:	135	300	5·5	
Series Pisces				
Class Teleostomi				
Order Clupeiformes				
Family CLUPEIDAE				
Raconda russelliana Gray	48			Length 20-60 mm.
Nematolosa nasus (Bloch)	9			Brackish water form.
Anodontostoma chacunda (Hamilton)	26			Brackish water form.
Order Cypriniformes				
Family CYPRINIDAE				
Puntius sarana (Hamilton)	52			Length 10-30 mm. Freshwater form.
Puntius ticto (Hamilton)	91			Length 15-65 mm.
Family PLOTOSIDAE				
Plotosus sp.	5			Estuarine form.
Family BAGRIDAE				
Mystus gulio (Hamilton)	212			Length 40-70 mm. Very common in estuaries, invariably present in stomach.
Order Anguilliformes				
Family ANGUILLIDAE				
Anguilla bengalensis (Gray)	45			Length 50-90 mm. Common in tidal rivers.
Family MURAENIDAE				
Muraena tile (Hamilton)	18			Length 40-70 mm. Common in tidal creeks.
Order Cyprinodontiformes				
Family CYPRINODONTIDAE				
Oryzias melastigmus (McClelland)	53			Common in inundated fields.

Items of diet	No.	Wt.(g)	%(Wt.)	Remarks
Order Mugiliformes				
Mugil parsia Hamilton	29			Length 60-90 mm. Brackish water form.
Mugil tade Forskål	77			
Chelon macrolepis (Smith)	13			Length 70-100 mm.
Chelon oligolepis (Bleeker)	6			Length 50-80 mm.
Rhinomugil corsula (Hamilton)	27			Length 60-90 mm.
Order Symbranchiformes				
Family SYMBRANCHIDAE				
Symbranchus bengalensis (McClelland)	29			Length 70-100 mm. Estuarine form.
Order Perciformes				
Family AMBASSIDAE				
Ambassis sp.	86			Length 15-40 mm. Freshwater form.
Family THERAPONIDAE	3			Coastal fish.
Family SCATOPHAGIDAE				
Scatophagus argus (Linnaeus)	6			Coastal fish. Also enters brackish water.
Family NANDIDAE				
Nandus nandus (Hamilton)	10			Fresh and brackish water form.
Family ANABANTIDAE				
Anabas testudineus (Bloch)	10			Length 30-70 mm. Fresh and brackish water form.
Family GOBIIDAE				
Glossogobius giuris (Hamilton)	7			Brackish water form. Partially digested.
Goboides cirratus (Blyth)	17			Tidal, shallow water fish. Partially digested.
Goboides rubicundus (Swainson)	13			Tidal, shallow water fish. Partially digested.
Periopthalmus koelreuteri (Pallas)	95			Tidal, shallow water fish. Partially digested.
Boleopthalmus boddaerti (Pallas)	86			Tidal, shallow water fish. Partially digested.
Miscellaneous fish remains				Not identifiable.
Total:	1073	3600	66·6	

Items of diet	No.	Wt.(g.)	%(Wt.)	Remarks
Phylum Arthropoda				
Class Insecta				
Order Orthoptera				
Family LOCUSTIDAE				
Hieroglyphus banian Fabricius	135			Pest of paddy.
Cirotettix sp.	16			
Acrydium sp.	22			Pest of paddy nurseries.
Attractomorpha crenulata Fabricius	29			Pest of brinjal and tobacco.
Chrotogonus sp.	76			Pest of vegetables and paddy.
Migratoria migratorides (Reiche & Fairmaire)	7			Pest of paddy nurseries.
Family GRYLLIDAE				
Gryllus bimaculatus De Geer	14			Burrowers, feed on vegetation and damage nurseries.
Gryllus melanocephalus Serville	6			Burrowers, feed on vegetation and damage nurseries.
Family GRYLLOTALPIDAE				
Gryllotalpa sp.	5			Burrowers, root-feeders.
Order Odonata				
Suborder Zygoptera				
? sp. (Naiads)	21			Aquatic form. Partially digested. Unidentifiable.
Suborder Anisoptera				
Family LIBELLULIDAE				
Pantala sp. (Naiads)	6			
Order Lepidoptera				
Family NOCTUIDAE				
Spodoptera mauritia Boisduval (Larvae)	22			Pest of paddy.
Agrotis sp. (Larvae)	3			Pest of paddy.
Cirphis sp. (Larvae)	5			Pest of paddy.
Family PYRALIDAE				
Schoenobius incertellus Walker	8			Pest of paddy.
Nymphula depunctalis Guenee (Larvae)				Pest of paddy.
Lepidopterus larvae (mutilated)				Not identifiable.
Order Coleoptera				
Family RUTELIDAE				
Anomala elata (Fabricius)	6			Pest of garden plants.
Family SCARABAEIDAE				
Heliocopris bucephalus Fabricius	7			Scavenger.
Gymnopleurus sp.	5			Scavenger.
Catharsius pithecius (Fabricius)	6			Scavenger.

Items of diet	No.	Wt.(g)	%(Wt)	Remarks
Family MELOLONTHIDAE				
Apogonia carinata Brenske	6			Root-feeder.
Family DYNASTIDAE				
Phyllognathus dionysius Fabricius	3			Pest of paddy.
Family COCCINELLIDAE				
Epilachna sp.	17			Pest of brinjal, potato, Cucurbitaceae, etc.
Family MELOIDAE				
Gnathospastoides rouxi Castalenau	29			Pest of ears of paddy.
Cylindrothorax ruficollis (Fabricius)	24			Pest of ears of paddy.
Family CHRYSOMELIDAE				
Aulacophora sp.	15			Pest of Cucurbitaceae.
Oides affinis Jacoby	29			Pest of paddy.
Haltica cyanea Weber	42			Pest of paddy.
Leptispa pygmoea Baly	6			Pest of paddy.
Dicladispa armigera Oliver	56			Pest of paddy.
Family CURCULIONIDAE				
Myllocerus sp.	10			Pest of brinjal and other vegetables.
Atactogaster sp.	18			Pest of cotton.
Family DYTISCIDAE				
Eretes stictus Linnaeus	9			Aquatic.
Family CYRINIDAE				
Dineutes sp.	4			
Gyrinus sp.	6			Aquatic.
Family HYDROPHILIDAE				
Berosus sp.	5			Aquatic.
Hydrophilus sp.	4			Aquatic.
Order Hymenoptera				
Family FORMICIDAE				
Camponotus sp.	2			
Acantholepis sp.	16			
Dorylus sp.	92			
Phidole sp.	52			
Polyrachis sp.	7			
Family APIDAE				
Apis indica Fabricius	28			Beneficial insect. Flower pollinator.
Family CHRYSIDAE				
Eumenes sp.	13			Parasitic insect of lepidopterous larvae.
Total:	892	450	8·3	

Items of diet	No.	Wt.(g.)	%(Wt.)	Remarks
Phylum Annelida				
Class Chaetopoda				
Order Oligochaeta				
Family MEGASCOLECIDAE				
Pheretima sp.	20+			In bits.
Eutyphoeus sp.	50+			In bits.
Chaetogaster sp.	10+			In bits.
Order Polychaeta				
Mercierella sp.	10+			In bits.
Total :	90+	300	5·5	
Sand and miscellaneous animal fragments and vegetable etc.		750	13·8	

The food of the Little Egret is chiefly composed of fishes (66.6 per cent) altogether 1073 examples of fishes were found.

In the stomachs of 138 specimens of birds altogether 1073 examples of fishes were found representing 28 species, of which 20 are sea and estuarine forms and eight are freshwater forms. With the exception of four species all are fishes of commercial value. The fish found in the stomachs vary from 5-100 mm. in standard length. Insects form the next large bulk (8.3 per cent) of the 892 examples of insects representing 44 species, 630 examples comprising 31 species are pests of cultivated plants, five are neutral, three are beneficial and eight are scavengers. A small quantity of Annelida of freshwater, moist soil and brackish water are taken. A good quantity of sand fragments (13.8 per cent) have also been found. It is interesting to note that the stomachs did not contain either Hemiptera (bugs) or Crustacea.

Out of 138 birds collected, 58 were from tidal mud-flats and the rest were from well-watered cultivated tracts. The food of the bird collected from the two different habitats vary to a great extent. The analysis of the food of ten birds representing each of the habitats in the wet season, are as follows :

	Tidal Mud-flats (Estuaries)	Cultivated tracts (Reclaimed area)
Pisces ..	90%	16%
Insecta ..	2%	74%
Annelida ..	2%	5%
Sand and Vegetable ..	6%	5%

From the foregoing analysis and general observation it may be said that on grassland and cultivated tracts in company of the Cattle Egret it picks up a lot of insects comprising of noxious pests, mainly of paddy and local cultivated vegetables that are raised in that area, and is a beneficial bird. However, while foraging on estuaries, it destroys a lot of food-fishes, thereby proving to be destructive to fishery. The proportion of fish and fish-fry it devours is very high and the fish loss far excels the good it does as an insect-controller, so that the bird appears to do more harm to fishery than good to agriculture.

(*to be continued*)

Eco-toxicology and control of the Indian Desert Gerbil, *Meriones hurrianae* (Jerdon)

VIII. Body weights, sex ratio and age structure in the population

By

Ishwar Prakash

Animal Ecologist, Animal Studies Division, Central Arid Zone Research Institute, Jodhpur

Introduction

Live Desert Gerbils, *Meriones hurrianae* (Jerdon) were collected from the field for our toxicological work during 1963-64 and 1966-67. Records were maintained with respect to their body weights, sex, and age. During both the periods the site of collection was the same and, therefore, an attempt has been made here to deal with the body weight, sex ratio and age structure found in the desert gerbil population during the two years. Interesting facts about the population structure have come to light.

Methods

During 1963-64, merion gerbils were collected by flooding their burrows with water. No sooner the rodents rushed out, they were scooped with butterfly nets and transferred to cages. During 1966-67, however, they were collected by trapping in Sherman live traps. During both the years they were collected from natural grasslands comprising mainly of *Cenchrus biflorus*, *C. setigerus*, *C. ciliaris*, *Aristida adscensionis* and *Cyperus rotundus*. The site of collection was the Central Research Farm of the Institute situated at Jodhpur. Body weights of gerbils were taken on a triple-beam scale (accuracy 1/10 gm.) soon after their capture. They were sexed. With respect to age, the gerbils were classed into two groups : those weighing below 40 gm. were regarded as subadults and the rest as adults. This categorisation was made following Ghosh (1968) who observed that sexual maturity is attained by them around the body weight of 40 gm.

Observations and Discussion

BODY WEIGHT OF ADULT GERBILS

Body weight trend through the year : The mean monthly body weights of adult desert gerbils fluctuate around 60 gm. during 1963-64 and around 70 gm. during 1966-67 (Table 1). Body weights tend to decline after winter and reach a low in summer, thereafter they increase. A steep peak is, however, observed in June, the hottest month during which climatic conditions are very hostile and there is severe paucity of food. Such a peak has also been observed by my co-worker in the Indian Gerbil, *Tatera indica indica* which were collected from Bikaner (Jain 1970) during 1968. It is difficult to assign any definite reason for this sudden increase in the body weight of adult merion gerbils but in both the species (Prakash 1963 & Jain 1970) a peak is also shown in the reproductive activity in both the sexes. Whether the peaks in reproductive activity and body weights are independent characteristics or whether there is a cause and effect relationship between the two can be ascertained only when further work is done. On the whole, the trend of variations in mean monthly body weights of adult gerbils appear to be parallel to the availability of food in the desert tract. Minimum food is available in natural condition during summer months when all the vegetation dries and, therefore, the body weights are also minimum during these months. During the monsoon and post-monsoon seasons when vegetation is green, the rodents gain body weight. During winter when the vegetation starts drying, the gerbils also start losing body weight and it continues till summer.

Differences between sexes : Male desert gerbils are found to be heavier than the females in all the months except in October, 1966. This difference, however, reached the level of significance (Table 1), only in January, August and September during 1963-64 and in February and August during 1966-67.

Differences between years : The mean monthly body weights of male desert gerbils collected during 1966-67 were higher as compared to those of male gerbils collected during 1963-64 except in January (1963-64) but the difference was statistically significant only during August. Similar was the trend in the body weights of adult female gerbils between the two periods, significant differences (Table 1) being observed in the months of March, July and August. It is noteworthy, that significant differences in the body weight of both the sexes were observed during monsoon season, body weights being heavier in 1966-67 during which year the total precipitation (280 mm.) was more as compared to that in 1963-64 (184 mm.). It may indicate that a greater availability

TABLE 1

MEAN MONTHLY BODY WEIGHTS OF ADULT DESERT GERBILS DURING 1963-64 AND 1966-67 WITH STANDARD ERROR

Month	1963-64		1966-67		't' between					
	Male	Female	Male	Female						
	1	2	3	4	1 & 2	1 & 3	1 & 4	2 & 3	2 & 4	3 & 4
January	79·15 ± 2·14	59·57 ± 3·43	71·04 ± 3·98	66·14 ± 3·16	4·51*	1·81	3·42*	1·80	1·40	0·87
February	68·46 ± 6·75	56·24 ± 2·97	75·61 ± 4·97	62·48 ± 2·31	1·67	1·86	0·84	3·38*	1·68	2·41*
March	63·90 ± 3·83	52·41 ± 1·98	70·67 ± 3·01	68·50 ± 2·54	2·67	0·43	1·00	5·12*	5·05*	0·54
April	54·50 ± 8·94	53·12 ± 2·64	—	—	0·15	—	—	—	—	—
May	59·00 ± 6·40	47·5	—	—	—	—	—	—	—	—
June	75·33 ± 9·47	72·66 ± 11·7	—	—	0·17	—	—	—	—	—
July	46·10 ± 1·00	50·75 ± 2·71	65·80 ± 2·29	66·81 ± 2·10	0·45	1·94	1.93	4·13	4·72*	0·26
August	62·54 ± 1·58	51·71 ± 1·41	73·63 ± 1·75	63·76 ± 2·05	4·53*	4·33*	0·08	9·87*	5·04*	3·71*
September	69·11 ± 2·25	57·34 ± 1·77	79·18 ± 5·41	65·99 ± 5·36	4·17*	1·74	0·54	3·89*	1·54	1·74
October	—	—	74·63 ± 3·35	78·49 ± 2·37	—	—	—	—	—	0·83
December	65·51 ± 3·27	64·05 ± 2·95	74·41 ± 4·28	65·67 ± 3·14	0·33	1·65	0·03	2·00*	0·38	1·65

* Significant at 5 per cent level.

of green food directly influences the health of the rodents resulting in an increased prevalence of pregnancy and in an increase in the litter size (Prakash 1963).

Distribution of body weights in the samples: In Table 2, the body weights of the desert gerbil are classed at 20 gm. intervals. The two classes, up to 20 gm. and 20·1-40 gm. represent subadult gerbils. It is observed that these two classes are not distributed uniformly in the population during 1963-64 whereas during 1966-67, their distribution is more or less regular. Noteworthy is the poor representation of these classes during monsoon which is reported (Prakash 1963) to be the period of their peak littering activity. The weight classes 40·1-60·0 gm. and 60·1 to 80·0 gm. are distributed almost throughout the year in both the sexes during 1963-64, and these two and the 80·1 to 100 gm. class are distributed similarly during 1966-67. It is interesting to note that the 80·1-100 gm. class is very poorly represented during 1963-64. Moreover, the 100·1-120 gm. and 120·1-140 gm. classes are completely absent in both the sexes during 1963-64 whereas they are represented during 1966-67. These observations indicate that during the earlier year the older (heavier) gerbils were not present in the population although the chances of their collection, if they were present, were much more as they were being collected by flooding their tunnels and chances of their escape were minimal. This may be related to the poor feeding conditions available to desert gerbils during the previous year when the rainfall was poor (184 mm.) as compared to 1966-67 (280 mm.).

Age Structure

Adult-subadult ratio : The proportion of subadult gerbils in the population of desert gerbils in 1963-64 was significantly higher than ($d = 4 \cdot 03$) those in the population of 1966-67. It is rather difficult to visualise the possible reasons for this significant difference as it is expected that the number of subadult gerbils should be more during 1966-67 when there was a comparatively larger population of heavier animals and during which year the feeding conditions were also superior to 1963-64. This paradoxical situation may perhaps be explained on the basis of the difference in the modes of collection of the animals during the two years. During 1963-64, they were collected by flooding their warrens with water and, therefore, even those young ones which had not weaned and which did not usually venture out of burrows were also forced to move out and collected. Hence a higher representation of younger animals (20 gms. and below) was found in the population of 1963-64 as compared to that 1966-67 (34 as against 19).

TABLE 2

MONTHLY DISTRIBUTION OF WEIGHT CLASSES OF MALE AND FEMALE DESERT GERBILS DURING 1963-64 AND 1966-67 EXPRESSED AS PER CENT OF MONTHLY COLLECTION

Wt. class/Months	1963-64										1966-67							
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Dec.	Jan.	Feb.	Mar.	July	Aug.	Sept.	Oct.	Dec.
♂♂																		
Up to 20 gm.	—	5·2	7·1	25	12·5	—	—	—	—	—	3·7	7·7	2·3	—	—	—	2·5	—
20·1— 40·0	—	52·6	42·8	—	37·5	—	—	2·5	—	—	33·9	23·0	11·9	2·8	—	17·3	15·0	7·9
40·1— 60·0	—	15·8	50·0	50	25·0	33.3	66·6	42·5	24·0	46·1	20·7	19·2	26·1	38·2	12·0	13·0	27·5	28·9
60·1— 80·0	100	15·8	—	25	25·0	33.3	33·3	52·5	52·0	46·1	20·7	15·3	33·3	38·2	62·0	34·6	20·0	26·3
80·1—100·0	—	10·4	—	—	—	33.3	—	2·5	24·0	7·7	18·8	27·0	21·4	20·6	22·0	21·7	30·0	31·5
100·1—120·0	—	—	—	—	—	—	—	—	—	—	—	7·7	4·6	—	4·0	8·7	5·0	2·6
120·1 & above	—	—	—	—	—	—	—	—	—	—	1·8	—	—	—	—	4·3	—	2·6
♀♀																		
Up to 20 gm.	41·3	7·7	16·3	—	—	—	—	—	—	22·2	—	9·1	11·7	—	—	—	1·8	—
20.1— 40·0	27·5	46·0	32·6	45·4	87·5	16·6	—	8·6	—	16·1	23·7	22·7	23·4	—	—	5·5	12·9	20·4
40.1— 60·0	17·2	27·0	38·1	45·4	12·5	16·6	100	80·0	66·6	22·2	37·2	30·0	17·6	32·3	46·4	50·0	7·3	36·7
60.1— 80·0	13·7	19·2	12·7	9·1	—	33·2	—	11·4	33·3	29·0	22·1	28·7	27·4	58·0	42·8	27·7	38·8	22·4
80.1—100·0	—	—	—	—	—	33·2	—	—	—	9·5	13·5	7·5	19·6	6·4	10·7	11·1	33·3	16·3
100.1—120·0	—	—	—	—	—	—	—	—	—	—	1.6	1·3	—	3·2	—	—	5·5	4·1
120.1 & above	—	—	—	—	—	—	—	—	—	—	1.6	—	—	—	—	5·5	—	—

Table 4 also indicates that the number of male subadult gerbils collected during both the years was significantly less as compared to female subadult gerbils [1963-64—$x^2(1)=28{\cdot}8$, $P < {\cdot}01$; 1966-67—$x^2(1)=16{\cdot}93$, $P < {\cdot}01$].

It is further clear from Table 3 that the numbers of subadult male and female desert gerbils, during both the years, collected during the first half of the year (January to June) is significantly higher than those collected during the second half of the year (July to December). This would suggest that the rate of reproduction in desert gerbils is higher during the first half of the year as compared to that in the latter half.

TABLE 3

ADULT AND SUBADULT DESERT GERBILS IN THE 1963-64 AND 1966-67 POPULATIONS

—	Jan.-June Adult	Jan.-June Subadult	July-December Adult	July-December Subadult	d =normal deviate between subadult population in the two halves of year
			Male		
1963-64 ..	36	17	83	1	4·76*
1966-67 ..	87	34	170	15	4·44*
			Female		
1963-64 ..	67	79	77	15	6·75**
1966-67 ..	123	53	161	19	4·78*

*Significant at 5 per cent level of probability.
** Significant at 1 per cent level of probability.

SEX RATIO

Table 4 shows the monthly and yearly sex ratios observed in the two samples. For purposes of comparison, the sex ratio observed in collection made earlier (Prakash 1962) have also been included. It can be seen from the Table that the numbers of male in the 1953-55 collection was slightly more than 50 per cent but in the latter collections, it never reached the 50 per cent level. The yearly ratios in the 1953-55 and 1966-67 samples do not depart from the hypothetical 50 : 50 male-female ratio but during 1963-64 the male desert gerbils are significantly [$x^2(1)= 27{\cdot}4$, $P < {\cdot}01$] less in number in the yearly sample, being only 36·5 per cent of the total. During both the years the numbers of male subadult gerbils was also significantly less than that of female subadult gerbils

TABLE 4

SEX RATIO IN THE DESERT GERBIL DURING 1953-55, 1963-64 AND 1966-67

—	1953-55			1963-64									1966-67								
	Adult & Subadult			Adult			Subadult			Total			Adult			Subadult			Total		
	♂	♀	% ♂	♂	♀	% ♂	♂	♀	% ♂	♂	♀	% ♂	♂	♀	% ♂	♂	♀	% ♂	♂	♀	% ♂
January	22	26	45·8	2	9	18·1	0	20	0	2	29	6·4	33	45	42·3	20	14	58·8	53	59	47·3
February	8	9	47·0	8	12	40·0	11	14	44·0	19	26	42·2	18	45	28·5	8	21	27·5	26	66	28·2
March	8	11	42·1	13	28	31·6	1	27	3·5	14	55	20·2	36	33	52·1	6	18	25·0	42	51	45·1
April	5	4	55·5	3	12	20·0	1	10	9·1	4	22	15·3	—	—	—	—	—	—	—	—	—
May	4	4	50·0	4	1	80·0	4	7	36·3	8	8	50·0	—	—	—	—	—	—	—	—	—
June	2	2	50·0	6	5	54·5	0	1	0	6	6	50·0	—	—	—	—	—	—	—	—	—
July	5	6	45·4	6	2	75·0	—	—	—	6	2	75·0	33	31	51·5	1	0	100·0	34	31	52·3
August	10	7	58·8	39	32	54·9	1	3	25·0	40	35	53·3	50	28	64·1	0	0	0	50	28	64·1
September	13	12	52·0	25	24	50·2	—	—	—	25	24	50·2	19	17	52·7	4	1	80.0	23	18	56·1
October	9	4	69·2	—	—	—	—	—	—	—	—	—	33	46	41·7	7	8	46.6	40	54	42·5
December	8	8	50·0	13	19	40.6	0	12	0	13	31	29.5	35	39	47·3	3	10	23·1	38	49	43·6
Total	94	93	50·2	119	144	45·2	18	94	16·1	137	238	36·5	257	284	47·5	49	72	40·5	306	356	46·2

in respective populations (1963-64, $P < \cdot 01$; 1966-67 $P < \cdot 05$). This poor representation of subadult male gerbils could possibly be due to three reasons : the number of males was very low among the new born, trap reaction was different with respect to male and female subadult gerbils, and mortality of male subadults was more as compared to that of female subadults.

It is very unlikely that the number of males was lower at the newborn stage. This view is supported by the observed sex ratios of newborn in the northern palm squirrel, *Funambulus pennanti* Wroughton and Indian gerbil, *Tatera indica indica* Hardwicke which inhabit the same locality. The male to female ratios of these species have been reported as 1·1 : 1 (Purohit *et al.* 1966) and 1·1 : 1 (Jain 1970) respectively. In young desert gerbil also, it is quite likely that both the sexes would be represented in equal numbers.

If trapability of male and female young was different, it may be the reason of poor representation of male subadults in the population of 1966-67, but during 1963-64 the desert gerbils were collected by flooding their warrens and, therefore, their trap response cannot be a factor responsible for the low number of male subadults.

It is quite likely that mortality rate in male subadults is much more than that in females. A low number of male subadults have also been observed in the palm squirrel (Purohit *et al.* 1966), and in the Indian gerbil (Jain 1970). Since the male desert gerbil increases its home range when it attains sexual maturity and during the breeding season (Fitzwater & Prakash 1969), the maturing male gerbils have to, therefore, encounter hostile behaviour from other territorial adult males and it can be expected that in the process a substantial number of young perish. In addition to the mortality caused by social interactions, some subadult male desert gerbils may also die as they are less adaptable to xeric conditions as compared to female gerbils (Ghosh, Pers. Comm.). A higher rate of mortality may be the possible reason of the poorer representation of male subadult gerbils in the populations as compared to that of female subadult gerbils.

Summary

During 1963-64, the Indian desert gerbils, *Meriones hurrianae* Jerdon were collected by flooding their burrows whereas during 1966-67 they were trapped in Sherman live trap at the Research Farm of the Institute at Jodhpur.

The mean monthly body weights of adult desert gerbils fluctuated around 60 gm. during 1963-64 and around 70 gm. in the period 1966-67. The body weight trend through the years apparently ran parallel to the availability of food in the desert, the minimum weight being during

summer when food available is also minimal and the maximum weight corresponding to the period of monsoon when abundant green food is available. Male adult desert gerbils were found to be heavier than female adult gerbils.

The proportion of subadult gerbils in the population during 1963-64 was significantly higher ($P < \cdot 01$) than those in the 1966-67 population. It is attributed to different modes of collection. Due to flooding action even those young gerbils were collected during 1963-64 which do not venture out of burrows. During 1966-67, however, these were absent as they were not available for trapping. The male subadult gerbils were significantly ($P < \cdot 01$) less than subadult females during both the years. The distribution of subadult gerbils in various months indicate that the reproductive rate of desert gerbil is higher in the first six months of the year as compared to the later six months.

During 1966-67 the male-female ratio did not deviate from the hypothetical 50 : 50 ratio but in the 1963-64 population it was 1 : 1·74, the difference being significant ($P < \cdot 01$). Similar was the case with subadult gerbils. The poor representation of male sub-adults in the population is attributed to their higher rate of mortality mainly due to hostile intra-specific interactions and due to their lesser adaptability to the xeric environment, as compared to female merion gerbils.

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References

Fitzwater, W. D. & Prakash, I. (1969): Burrows, behaviour and home range of the Indian desert gerbil, *Meriones hurrianae* Jerdon. *Mammalia* **33** : 598-606.

Ghosh, P. K. (1968): Unpublished report of C.A.Z.R.I., Jodhpur.

Jain, A. P. (1970): Body weights, sex ratio, age structure and some aspects of reproduction in the Indian gerbil, *Tatera indica indica* Hardwicke in the Rajasthan desert, India. *Mammalia* **34** : 415-432.

Prakash, I. (1962): Ecology of gerbils of the Rajasthan desert, India. *Mammalia* **26**: 311-331.

——— (1963): Eco-toxicology and control of Indian desert gerbil, *Meriones hurrianae* (Jerdon). Pt. 2. Breeding season, litter size, and post-natal development. *J. Bombay nat. Hist. Soc.* **61**: 142-149.

Purohit, K. G., Kametkar, L. R. & Prakash, I. (1966): Reproduction biology and post-natal development of the Indian palm squirrel, *Funambulus pennanti* Wroughton. *Mammalia* **30**: 538-546.

Polychaetes from Maharashtra and Goa

BY

ARUN H. PARULEKAR[1]

Senior Research Fellow, (C.S.I.R.), Bombay Natural History Society, Bombay-1

(*With a map and four plates*)

A collection, of polychaetes from the intertidal region of 16 localities of the coast of Maharashtra and Goa, is described. For each species, the habit and preferred habitat, size, coloration, distinguishing external features, association and distribution are given. Out of 54 species, 11 are new records for West Coast and 4 new records for India.

In course of studies on the 'Sea Anemones of Maharashtra and Goa' during 1965-68, a number of polychaetes were collected from the intertidal region of this part of the West Coast of India. The localities (*see* map) of collection were Gholvad, Dahanu, Tarapur, Arnala, Bombay, Alibag, Ratnagiri, Vijaydurg, Devgad, Malvan, Vengurla and Redi in Maharashtra State and Kalangut, Miramar, Dona Paula and Marmgao Harbour in the Union territories of Goa. These localities represent different ecological habitat, such as, sandy beaches, rocky foreshores, mud flats, marshes, mangrove swamps, etc.

Fauvel (1932, 1940 and 1953) has reported 14 species from Bombay and Marmgao Bay. Bhatt (1959) recorded 35 species and 4 varieties from 9 localities within the Bombay City limit. The collection of polychaetes, in this study, is quite rich, both in quantity and quality. It consists of 54 species and 8 varieties, belonging to 36 genera and 16 families. The group-wise composition is 43 species and 8 varieties of Errant polychaetes from 9 families and the remaining 11 species are sedentaria from 7 families. In fact the present collection consists of many more species, some of which may prove to be new.

Eleven out of 54 species, described here, are recorded from West Coast of India for the first time. *Nereis talehsapensis* Fauvel; *Nereis* (*Ceratonereis*) *costae* Grube ; *Eunice savignyi* Grube and *Spirographis spallanzanii* Viviani, are first records for India. *Nereis burmensis* Monro, recorded by Fauvel (1932, 1953) from this part of the West Coast, is not represented in the present collection.

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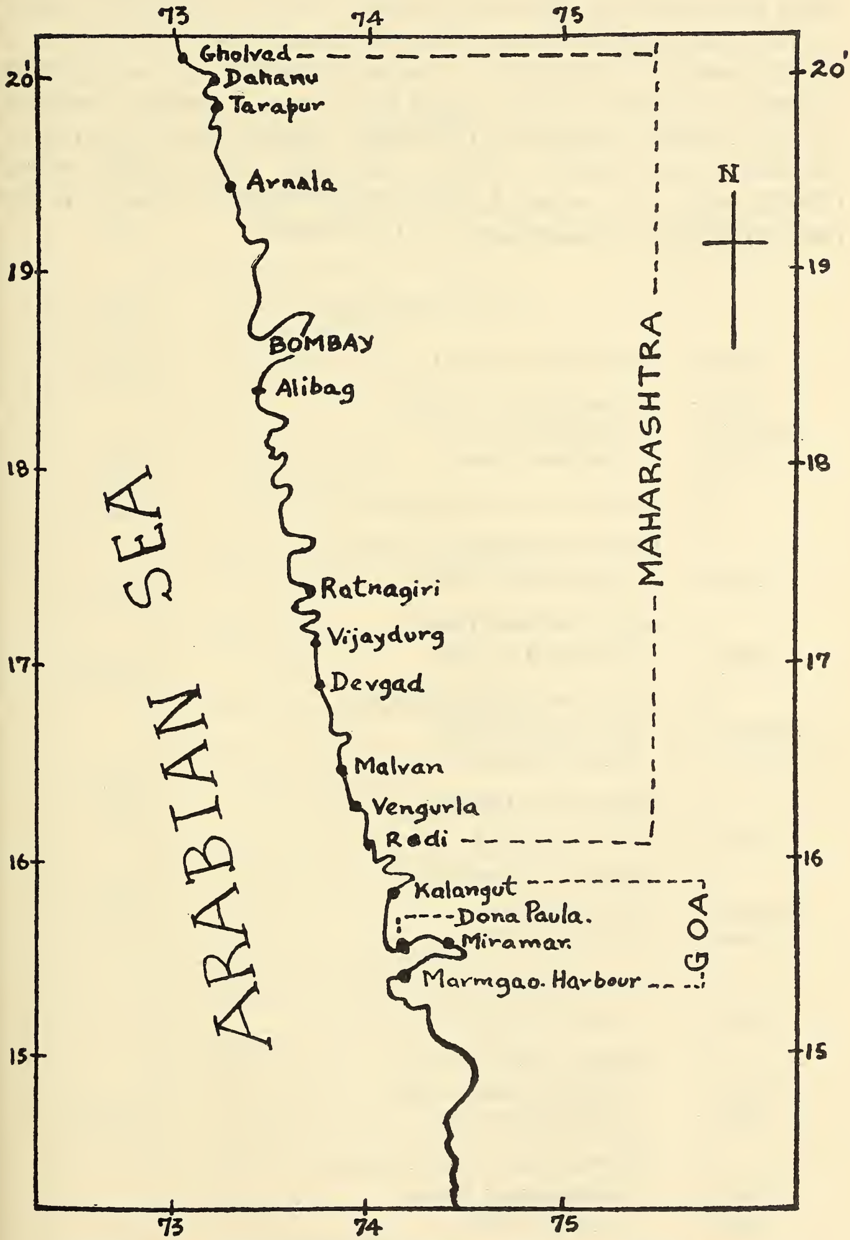
[1] Present Address : National Institute of Oceanography, Miramar, Panaji, Goa.



Map of Maharashtra and Goa Coast showing localities of Collection.

As Fauvel (1953) remarks, many of the Polychaeta are really cosmopolitan and most of the species are common to the Indo-Pacific Coasts. Many forms have a world-wide distribution and the intertropical species are the same in all the Oceans. Thus the distribution of Polychaetes is mainly limited by temperature. The distribution is also not regulated by depth or pressure as many abyssal forms found in deep-sea dredgings are also collected between the tide-marks. *Leanira japonica* McIntosh, *Panthalis oerstedi* Kinberg, *Chloeia rosea* Potts, and *Leocratides ehlersi* (Horst), were so far recorded from deep-sea but were obtained in the intertidal region of Maharashtra and Goa Coast.

LIST OF SPECIES

Group I— POLYCHAETA ERRANTIA

Family : APHRODITIDAE Savigny
Subfamily : POLYNOINAE Grube
Genus : *Lepidonotus* Leach

1. *Lepidonotus carinulatus* Grube

2. *Lepidonotus tenuisetosus* (Gravier)

Genus : *Gattyana* McIntosh

3. *Gattyana deludens* Fauvel

Genus : *Harmothoë* Kinberg

4. *Harmothoë ampullifera* (Grube)

Subfamily : SIGALIONINAE Grube
Genus : *Sthenelais* Kinberg

5. *Sthenelais boa* (Johnston)

Genus : *Leanira* Kinberg

6. *Leanira japonica* McIntosh

Subfamily : ACOETINAE Grube
Genus : *Polyodontes* Renier

7. *Polyodontes melanonotus* (Grube)

Genus : *Panthalis* Kinberg

8. *Panthalis oerstedi* Kinberg

Family : CHRYSOPETALIDAE Ehlers
Genus : *Bhawania* Schmarda

9. *Bhawania cryptocephala* Gravier

Family : AMPHINOMIDAE Savigny
Genus : *Eurythoë* Kinberg

10. *Eurythoë complanata* (Pallas)

11. *Eurythoë parvecarunculata* Horst

Genus : *Chloeia* Savigny

12. *Chloeia rosea* Potts

Family : HESIONIDAE Grube
Genus : *Hesione* Savigny

13. *Hesione pantherina* Risso

Genus : *Leocrates* Kinberg

14. *Leocrates claparedii* (Costa)

Genus : *Leocratides* Ehlers

15. *Leocratides ehlersi* (Horst)

Genus : *Podarke* Ehlers

16. *Podarke angustifrons* (Grube)

Family : PHYLLODOCIDAE Grube
Subfamily : PHYLLODOCINAE
Genus : *Phyllodoce* Savigny
Subgenus : *Anaitides* Czerniavsky

17. *Phyllodoce* (*Anaitides*) *madeirensis* Langerhans

Family : SYLLIDAE Grube
Genus : *Syllis* Savigny
Subgenus : *Haplosyllis*

18. *Syllis* (*Haplosyllis*) *spongicola* Grube

Subgenus : *Syllis* s.str.

19. *Syllis* (*Syllis*) *gracilis* Grube

Subgenus : *Typosyllis*

20. *Syllis* (*Typosyllis*) *variegata* Grube

21. *Syllis* (*Typosyllis*) *closterobranchia* Schmarda

Family : NEREIDAE Johnston
Genus : *Dendronereides* Southern

22. *Dendronereides heteropoda* Southern

Genus : *Nereis* Cuvier
Subgenus : *Nereis* s.str. Kinberg

23. *Nereis* (*Nereis*) *chingrighattensis* Fauvel

24. *Nereis* (*Nereis*) *talehsapensis* Fauvel

25. *Nereis* (*Nereis*) *chilkaensis* Southern

26. *Nereis* (*Nereis*) *zonata* var. *persica* Fauvel

Subgenus : *Ceratonereis* Kinberg

27. *Nereis* (*Ceratonereis*) *costae* Grube

28. *Nereis* (*Ceratonereis*) *mirabilis* Kinberg

Genus : *Perinereis* Kinberg

29. *Perinereis vancaurica* (Ehlers)
   a. var. *typica* Fauvel
   b. var. *indica* Bhatt

30. *Perinereis cultrifera* Grube
a. var. *typica* Grube
b. var. *helleri* Grube

31. *Perinereis aibuhitensis* Grube

32. *Perinereis nigro-punctata* Horst

33. *Perinereis nuntia* (Savigny)
a. var. *typica* (Savigny)
b. var. *brevicirris* (Grube)
c. var. *vallata* Grube
d. var. *bombayensis* Bhatt

Family : EUNICIDAE Grube
Subfamily : EUNICINAE Kinberg
Genus : *Eunice* Cuvier

34. *Eunice tentaculata* Quatrefages

35. *Eunice savignyi* Grube

36. *Eunice antennata* Savigny

Genus : *Marphysa* Quatrefages

37. *Marphysa sanguinea* Montagu

38. *Marphysa mossambica* Peters

Subfamily : ONUPHIDINAE Levinsen
Genus : *Diopatra* Aud. & M. Edw.

39. *Diopatra neapolitana* Delle Chiaje

Genus : *Onuphis* Aud. & M. Edw.

40. *Onuphis* sp.

Subfamily : LUMBRICONEREINAE Grube
Genus : *Lumbriconereis* Blainville

41. *Lumbriconereis heteropoda* Marenzeller

Genus : *Arabella* Grube

42. *Arabella iricolor* (Montagu)

Family : GLYCERIDAE Grube
Subfamily : GLYCERINAE Arwidsson
Genus : *Glycera* Savigny

43. *Glycera alba* Rathke

GROUP II—POLYCHAETA SEDENTARIA

Family : SPIONIDAE Sars
Genus : *Polydora* Bosc
Subgenus : *Polydora* Bosc

44. *Polydora* (*Polydora*) *coeca* Oersted

Family : CIRRATULIDAE Carus
Genus : *Cirriformia* Hartman (*Audouinia* Quatrefages)

45. *Cirriformia limnoricola* Kirkegaard & Santhakumaran

Family : CHAETOPTERIDAE Aud. & M. Edw.
Genus : *Phyllochaetopterus* Grube

46. *Phyllochaetopterus socialis* Claparède

Family : SABELLARIIDAE Johnston
Genus : *Sabellaria* Lamarck

47. *Sabellaria* sp.

Family : TEREBELLIDAE Grube
Subfamily : AMPHITRITINAE Malmgren
Genus: *Pista* Malmgren

48. *Pista* sp.

Family : SABELLIDAE Malmgren
Genus : *Spirographis* Viviani

49. *Spirographis spallanzanii* Viviani

Genus : *Dasychone* Sars

50. *Dasychone cingulata* Grube

51. *Dasychone serratibranchis* Grube

Genus : *Potamilla* Malmgren

52. *Potamilla leptochaeta* Southern

Family : SERPULIDAE Burmeister
Genus : *Vermiliopsis* Saint-Joseph

53. *Vermiliopsis glandigerus* Gravier

Genus : *Spirobis* Daudin

54. *Spirobis foraminosus* Moore

Description of Species

Group I: POLYCHAETA ERRANTIA

1. **Lepidonotus carinulatus** Grube (Plate I: Fig. 1A & B)

Occurrence: Found in sand between rocks, or crevices of rock at Alibag, Malvan and Dona Paula.

Remarks: Elytra round to oval, fringed and covered with carinulate tubercles. Slender, spinulose dorsal setae ; stout, bidentate ventral setae (Fig. 1 A & B). Length : 10-22 mm. Uncommon to rare.

Distribution: Red Sea, Persian Gulf, Madagascar, Ceylon, Indian Ocean, Philippines, and Japan.

INDIA: Pamban bridge, Shingle Is., Tuticorin, Kilakarai (Tamil Nadu); Alibag and Malvan (Maharashtra); Dona Paula (Goa).

2. **Lepidonotus tenuisetosus** (Gravier) (Plate I: Fig. 2 A & B)

Occurrence: In sand or from crevices of rocks at almost all the localities of this study, except Dahanu and Miramar.

Remarks: Elytra oval, slightly reniform, with a small fringe and few large and many small rounded papillae. Slender, spinulose dorsal setae (Fig. 2 A) and unidentate ventral setae (Fig. 2B). Length: 5-12 mm. Common.

Distribution: Red Sea, Persian Gulf, Jack & Una Is., Madagascar, Indian Ocean, Mergui Archipelago.

INDIA: Tamil Nadu; Port Canning; Orissa; Maharashtra and Goa Coast.

3. **Gattyana deludens** Fauvel (Plate I: Fig. 3)

Occurrence: Generally found under stones in rocky and sandy areas. Also, present in the apical whorl of a gastropod shell (*Babylonia spirata*), inhabited by a hermit-crab (*Diogenes custus*) with a sea Anemone (*Neoaiptasia commensali*) on the outer surface of the shell. Collected from Bombay, Ratnagiri and Malvan. Uncommon to rare.

Remarks: Much flattened body, tapering posteriorly and fully covered by elytra. The first elytron is orbicular while the others, reniform. Elytra divided into polygonal areas (Fig 3). Size: 10-20 × 6-7 mm.

Distribution: Annam, Poulo Condore, Mergui Archipelago.

INDIA: Gangetic Delta, Ghandipore; Pondicherry, Madras (Tamil Nadu); Balasore (Orissa); Bombay, Ratnagiri, Malvan (Maharashtra).

4. **Harmothoë ampullifera** (Grube) (Plate I: Fig. 4)

Occurrence: Found in rock pools or undersurface of rock or from dead corals. Almost all localities except, Gholvad, Tarapur and Miramar.

Remarks: Largest and commonest polynoid, found associated with *Diodora* sp. and chitons on dead corals. Elytra, fringed with conical tubercles and large posterior vesicles, not divided into polygonal areas (Fig. 4). Numerous verticillate and spinulose dorsal setae. Size: 10-30 × 1-10 mm.

Distribution: Red Sea, Persian Gulf, Singapore, Camorta Is., Philippines, Annam.

INDIA: Rameswaram, Pamban, Coral reefs (Tamil Nadu); Maharashtra and Goa.

5. **Sthenelais boa** (Johnston) (Plate I: Fig. 5)

Occurrence: Burrowing in sand, also on the undersurface of rock. Rarely observed in soft mud. Collected at Gholvad, Bombay, Alibag, Malvan and Miramar.

Remarks : Rusty black elytra, convex dorsally, are reniform, fimbriated with numerous minute papillae (Fig. 5). Uncommon to rare. Size : 40-70 × 3-8 mm.

Distribution : Indian and Atlantic Oceans, Mediterranean Sea, Israel, English Channel, Ceylon, Dry Tortugas (Florida), Amiranti Is.

INDIA : Cape Comorin, Krusadai Is. (Tamil Nadu) ; Maharashtra and Goa.

6. **Leanira japonica** McIntosh

Occurrence : Usually a deep-sea inhabitant, but the specimens, in the present collection are from intertidal area of Bombay, Malvan, Vengurla and Kalangut.

Remarks : Body very long and slender. Prostomium with four black eyes. Elytra variable in shape, unfimbriated, and overlapping. Size : 30-54 × 2-3 mm. Uncommon to rare.

Distribution : Gulf of Oman, Indian Ocean. Ceylon, Japan, Annam, Malay seas, Mergui.

INDIA : Bay of Bengal ; Arabian Sea ; Andamans ; Gulf of Mannar ; Bombay, Malvan, Vengurla (Maharashtra) ; Kalangut (Goa).

7. **Polyodontes melanonotus** (Grube)

Occurrence : Deep-sea inhabitant, but two specimens, one each from Bombay and Malvan, respectively, were collected between tide-marks. Burrowing in admixture of sand and mud.

Remarks : Large first pair of elytra, crossing and overlapping in front, flat, smooth without fringe or pouch. Pigmented spots on tentacles and palps. Size : 50 × 9 mm. Rare.

Distribution : Philippine Is., Malay Archipelago, Ceylon, Gulf of Oman, Madagascar, Jamaica, Burma, off Tenasserim and Arakan Coast, Indian Ocean.

INDIA : Andamans ; Rameswaram (Tamil Nadu) ; Bombay and Malvan (Maharashtra).

8. **Panthalis oerstedi** Kinberg (Plate I : Fig. 6A, B, C & D)

Occurrence : Collected from muddy sand at Bombay, Malvan, Dona Paula, and Marmgao Harbour.

Remarks : First elytron large, rounded, smooth and unfringed. Posterior elytron (Fig. 6A), having margin folded in a pocket-like manner, Branchia absent. Ventral setae of three different kinds : (1) Bipennato-penicillate (Fig. 6B) ; (2) Aristate bristles (Fig. 6C) and (3) Serrulate Sub-spiral setae (Fig. 6D). Size : 40-50 × 2-5 mm. Rare.

Distribution : Pacific, Indian and Atlantic Oceans, Mediterranean and Arabian seas, off Burma, Laccadive sea.

INDIA : Bay of Bengal; Andamans ; Maharashtra and Goa.

9. **Bhawania cryptocephala** Gravier (Plate II : Fig. 7)

Occurrence : A single specimen, associated with sponges, was collected at Malvan in April 1967.

Remarks : Elongated and slightly twisted body, measuring 70 × 3 mm. in size. Light-yellow in colour. Body fully covered by dense transverse rows of brown palae (Fig. 7). Rare.

Distribution : Red Sea, Indian Ocean, Philippine Is., Pacific Ocean, New Caledonia, Laccadive and Maldive Archipelago, Burma Coast, Camorta Is., Ceylon.

INDIA : Port Blair (Andamans) ; Nankauri Harbour (Nicobar Is.) ; Malvan (Maharashtra).

10. **Eurythoë complanata** (Pallas)

Occurrence : A number of specimens were collected among rocks, from almost all the localities, of the present study.

Remarks : Branchiae commencing on 2nd Segment. Dorsal setae, finely serrated, calcareous and very brittle. Light-red in life. Size : 80-100 × 5-10 mm. Common.

Distribution : Tropical waters of Pacific, Indian and Atlantic Oceans, Mergui, Ceylon, Arabian Sea, Red Sea, Mediterranean Sea, Persian Gulf, Karachi, Great Barrier Reef, Florida, West Indies, Australia, Zanzibar.

INDIA : Andaman and Nicobar Is. ; Kilakarai, Cape Comorin, Turicorin, Krusadai, Pamban (Tamil Nadu) ; Maharashtra and Goa Coast.

11. **Eurythoë parvecarunculata** Horst (Plate II : Fig. 8)

Occurrence : A single specimen was collected from Bombay in February 1968. Burrowing in sand.

Remarks : Branchiae beginning on the third segment. Rounded cephalic lobe, with a large heart-shaped palpar and a long unpaired antenna, posteriorly (Fig. 8). Two types of dorsal setae. Size : 40 × 3 mm, *Distribution :* Malay Archipelago, Bay of Bengal, Atlantic Ocean, Cameroon, Guiana, Red Sea, Maldives.

INDIA : Off Chilka Lake (Orissa) ; Port Blair (Andamans) ; Bombay (Maharashtra).

12. **Chloeia rosea** Potts

Occurrence : This species which has so far been recorded only from deep-seas, is represented in the present collection, by a single specimen, found in the intertidal mud, at Malvan.

Remarks : Moderately elongated worm, having uniform reddish pink colour. This species closely resembles, *C. fusca* but differs in coloration, structure and arrangement of branchiae (Potts 1909). Size : 10×4 mm. Rare.

Distribution : Amirante Is., Persian Gulf, Bay of Bengal, Arabian Sea, Burma.

INDIA : Malvan (Maharashtra).

13. **Hesione pantherina** Risso

Occurrence : One specimen each from Dahanu and Malvan, respectively. Worms found on the undersurface of rocks, in association with a sea anemone (*Anthopleura midori*).

Remarks : When alive, the specimen has black transverse bands on a yellowish-white body. Number of brown spots in the anterior region. Moderately elongated with slight posterior tapering. Long dorsal cirri. Size : 10×3 mm. Uncommon.

Distribution : Atlantic, Pacific and Indian Oceans, Mediterranean Sea, Ceylon, Banka Strait.

INDIA : Andamans ; Nankauri Harbour (Nicobar Is.,) ; Chilka Lake (Orissa) ; Krusadai, Rameswaram (Tamil Nadu) ; Dahanu and Malvan (Maharashtra).

14. **Leocrates claparedii** (Costa) (Plate II : Fig. 9)

Occurrence : Collected from gravel and sandy mud at Bombay, Ratnagiri, Malvan and Dona Paula.

Remarks : Lateral tentacles longer than the palps. Biramous parapodia (Fig. 9), with a long articulate, dorsal cirrus. Dorsal ramus simple, capillary dorsal setae are reduced. Well developed ventral ramus. Size : $15\text{-}22 \times 2\text{-}4$ mm. Uncommon to rare.

Distribution : Japan, Indo-China, Singapore, Ceylon, Persian Gulf, Red Sea, Mediterranean Sea, Indian Ocean.

INDIA : Andaman and Nicobar Is.; Bay of Bengal; Gulf of Mannar; Maharashtra and Goa Coast.

15. **Leocratides ehlersi** (Horst) (Plate II : Fig. 10)

Occurrence : Found among loose rocks and boulders at Gholvad, Bombay, Ratnagiri and Malvan.

Remarks : Proboscis armed. Parapodia (Fig. 10) sesqiramous, the dorsal lobe reduced to an aciculum only at the base of the dorsal cirrus. Size 20×2 mm. Uncommon to rare.

Distribution : Saleh Bay, Sumbawa, Andaman Sea and Maharashtra Coast.

16. **Podarke angustifrons** (Grube)

Occurrence : A single specimen, associated with a sea cucumber was collected from Malvan in April 1967.

Remarks : Width of the body more than three times the length. Brown with white rings, when alive. Prostomium almost rectangular. Dorsal cirri, long, smooth or faintly ringed. Short, subulate ventral cirrus. Furcate setae. Rare.

Distribution : Philippine Is., Celebes, Bay of Bengal, Ceylon, Persian Gulf, Red Sea, Australia, New Zealand.

INDIA : Pamban (Tamil Nadu); Nicobar Island; Malvan (Maharashtra).

17. **Phyllodoce (Anaitides) madeirensis** Langerhans (Plate II : Fig. 11)

Occurrence : One specimen among the green alga *Cladopora* sp. from Bombay, in December 1966. Two more specimens, from rocks covered with unidentified green algae at Alibag in February 1966.

Remarks : Worm brilliantly iridescent green in life. Tentacles and tentacular cirri, subulate. Dorsal cirri (Fig. 11) very variable in shape, usually lanceolate-falcate. Rare.

Distribution : Pacific, Atlantic and Indian Oceans, Red and Mediterranean Seas, Persian Gulf, China, Annam, Philippine Is., Australia, W. Mexico, Bermuda, Malay Archipelago, Malacca Strait, Mergui, Ceylon.

INDIA : Andaman Is.; Laccadive Sea; Bombay and Alibag (Maharashtra).

18. **Syllis (Haplosyllis) spongicola** Grube

Occurrence : Only four specimens, one each from Ratnagiri and Dona Paula and two from Malvan, collected from the undersurface of rocks.

Remarks : Elongated, slender body with short, cylindrical dorsal cirri and compound anterior and posterior setae Reddish-brown in colour. Size: 9-17 × 2-3 mm.

Distribution : Cosmopolitan. Atlantic, Pacific and Indian Oceans, Mediterranean and Red Seas, Ceylon, Maldive Archipelago.

INDIA : Tuticorin (Tamil Nadu); Ratnagiri and Malvan (Maharashtra); Dona Paula (Goa).

19. **Syllis (Syllis) gracilis** Grube

Occurrence : Collected from all localities, in rock crevices. Occasionally associated with *Dasychone* or *Membranipora.*

Remarks : Short, cylindrical or fusiform dorsal cirri. Compound anterior and posterior setae. Dirty-brown in colour. Size 8-21 × 1-3 mm. Common.

Distribution : Cosmopolitan. Indian, Pacific and Atlantic Oceans, Persian Gulf, Maldive Archipelago, Israel, Ceylon and Marshall Is.

INDIA: Andamans; Gulf of Mannar, Tuticorin (Tamil Nadu); Maharashtra and Goa Coast.

20. **Syllis (Typosyllis) variegata** Grube

Occurrence : Very common, as it was collected from all the localities except Redi and Marmgao Harbour.

Remarks : Elongated and slender form. Pharynx very long, with an anterior tooth. All compound setae alike, with a falcate bidentate terminal piece. Size: 8-17 × 1-3 mm.

Distribution : Indian, Atlantic and Pacific Oceans, Persian Gulf, Mediterranean and Arabian Seas, Israel, Ceylon, Dry Tortugos (Florida), South Africa, New Zealand and Marshall Is.

INDIA : Gulf of Mannar ; Maharashtra and Goa Coast.

21. **Syllis (Typosyllis) closterobranchia** Schmarda

Occurrence : Common form, generally found in rock pools or under rocks and boulders at all the localities, except Gholvad, Tarapur and Marmgao Harbour.

Remarks : Short, fusiform dorsal cirri. Reddish-brown with black spots in the anterior part of the body. Size : 5-9 × 1-3 mm.

Distribution : Japan, Australia, New Zealand, New Caledonia, Indian Ocean, Red Sea.

INDIA : Diamond Is.; Andamans; Gulf of Mannar; Maharashtra and Goa Coast.

22. **Dendronereides heteropoda** Southern

Occurrence : Two specimens, one each from Tarapur and Bombay, respectively. Found in soft mud in March 1966.

Remarks : Quite elongated, with broad prostomium and tapering posterior part. Blunt, ovoid palps and four eyes. Black spots on a yellowish-white body. Size 28-34 × 1 mm. Rare.

Distribution : Indian Ocean and Persian Gulf.

INDIA : Calcutta (West Bengal); Tarapur and Bombay (Maharashtra).

23. **Nereis (Nereis) chingrighattensis** Fauvel (Plate II : Fig. 12 A & B).

Occurrence : A single, intact, specimen and a few, cut off, segments were collected from Malvan in April 1968.

Remarks : Numerous, very slender and transparent, spinigerous setae (Fig. 12 A & B) on a brownish body. Size : 40 × 12 mm. Rare.

Distribution : INDIA : Chingrighatta and Maharashtra (Malvan).

24. **Nereis (Nereis) talehsapensis** Fauvel (Plate II : Fig. 13)

Occurrence : Bhatt (1959) has recorded this species from Bombay. In the present collection, there are specimens from Bombay, Ratnagiri, Vijaydurg and Devgad. Generally found in rocks, along with Oysters and barnacles. Occasionally in loose sand.

Remarks : Small, thin worms, tapering posteriorly. Anterior feet (Fig. 13) with a long dorsal cirrus and three dorsal ligules, the inferior two borne on a common elongated base. Acicula, black in colour. Size : 30 × 2 mm. Uncommon.

Distribution : Taleh-sap (Gulf of Siam).

INDIA : Bombay, Ratnagiri, Vijaydurg and Devgad (Maharashtra).

25. **Nereis (Nereis) chilkaensis** Southern

Occurrence : Common on the southern part of this coast, especially at Vijaydurg, Devgad, Malvan, Vengurla, Kalangut, Miramar and Marmgao Harbour. Found burrowing in sand, *Remarks :* Dorsum deeply coloured with purplish brown pigment, dark in front and pale behind. Head narrower in front than behind. Large and stout palps. Size: 50-80×2-4 mm.

Distribution : INDIA : Madras Coast, Ennur Backwaters, Pamban, (Tamil Nadu); Chilka Lake, Travancore, Maharashtra and Goa Coast.

26. **Nereis (Nereis) zonata** var. **persica** Fauvel

Occurrence : Five specimens, one each from Miramar, and Dona Paula, and three from Marmgao Harbour, respectively.

Remarks : Body rounded. Proboscis: Groups—I, 0-1; II-IV, crescentic clusters ; III, transverse cluster of 2-3 rows; V, 0; VI, a rounded or oval cluster 6-10, on each side ; VII-VIII, an anterior row of rather large denticles and 2-5 irregular rows of small and numerous denticles. Size : 15×2 mm. Rare.

Distribution : Red Sea, Persian Gulf, New Caledonia, Indo-China, Indian Ocean.

INDIA : Pamban (Tamil Nadu), Miramar, Dona Paula and Marmgao Harbour (Goa).

27. **Nereis (Ceratonereis) costae** Grube (Plate III : Fig. 14)

Occurrence : Two specimens, one each from Bombay and Malvan, respectively. Burrowing in mud.

Remarks : Prostomium not cleft (Fig. 14). Proboscis : Groups—I, 0; II, 2 crescentic rows; III, 3 set in a triangle; IV, square clusters. Three dorsal ligules, with the median one shorter, in the anterior feet. Dorsal cirrus long and ventral short. Falcigerous bristles present, throughout. Colour Pink. Size : 50×2 mm. Rare.

Distribution : Australia, Philippine Islands, Indo-China, Malay Archipelago, Indian and Atlantic Oceans, Red Sea, Persian Gulf, Ceylon, Israel, Marshall Is.

INDIA : Bombay and Malvan (Maharashtra).

28. **Nereis (Ceratonereis) mirabilis** Kinberg (Plate III ; Fig. 15)

Occurrence : Collected from localities Gholvad, Arnala, Bombay, Ratnagiri, Malvan, Miramar and Marmgao Harbour.

Remarks : Prostomium, deeply cleft (Fig. 15). Proboscis : Groups—I, 0 ; II & IV, triangular clusters ; III, a transverse cluster of several rows. Dorsal ramus, with two long, slender, subequal ligules. Colour white with rounded black dots. Size : 40×2 mm. Common.

Distribution : Red Sea, Persian Gulf, Indian and Atlantic Oceans, Amboina, New Caledonia, New Zealand, Honolulu, Australia, Brazil, West Indies.

INDIA : Krusadai and Shingle Is., Pamban, Kilakarai (Tamil Nadu) ; Andamans ; Maharashtra and Goa Coast.

29 (a). **Perinereis vancaurica** (Ehlers) var. **typica** Fauvel

Occurrence : Commonly found in the crevices of rock at all the localities, except Dahanu and Kalangut.

Remarks : Yellowish-brown body with a brown prostomium. No dark stripes on the anterior segments. Proboscis : Groups I, 1-2; II, crescentic clusters; III, a square cluster, with sometimes, 2-4 teeth in a vertical line; IV, a cluster of small denticles; V, 3 large teeth, set in a triangle; VI, two transverse, broad, flattened and elongated paragnaths on each side; VII-VIII, 3 rows, first row regular and made up of large teeth. Size : 57-72×2-3 mm.

Distribution : Philippines, Indo-China, Great Barrier Reef, New Zealand, Singapore, Mergui, Red Sea, Atlantic Ocean, French Guiana.

INDIA : Nankauri (Nicobar Is.) ; Maharashtra and Goa Coast.

29 (b). **Perinereis vancaurica** (Ehlers) var. **indica** Bhatt

Occurrence : Bhatt (1959) has described this new variety from Bombay. In the present collection, there are a number of specimens obtained from crevices of rocks as well as from mud, at all the localities, except Dahanu, Tarapur and Kalangut.

Remarks : Proboscis : Groups—I, 4 ; II, in crescentic clusters; III, square or rectangular patch, generally with many denticles on either side; IV, triangular clusters; V, 3 big denticles, arranged in a triangle; VI, two transverse, broad and flattened paragnaths on either side, the outer being noticeably shorter than the two inner ones, which are elongated; VII-VIII, 3 rows. Size : 40×2 mm. Common.

Distribution : Bombay. Coast of Maharashtra and Goa.

30 (a). **Perinereis cultrifera** Grube var. **typica** Grube

Occurrence : Found among stones at Arnala, and Bombay.

Remarks : Tentacular cirri, reaching back to 5th-6th segment. Groups—I, 2 in a line (1-3); V, a triangle of 3 paragnaths. Size: 27-32×1-2 mm. Uncommon to rare.

Distribution : Cosmopolitan. Indian, Pacific and Atlantic Oceans, Mediterranean Sea, Israel, Japan, Burma, Diamond Is., Carmorta Is.

INDIA: Nicobar and Andaman Is.; Travancore; Cape Comorin (Tamil Nadu); Maharashtra.

30 (b). **Perinereis cultrifera** Grube var. **helleri** Grube

Occurrence: Collected, along with *P. cultrifera* var. *typica*, from the same localities.

Remarks: Tentacular cirri, reaching back to 7th-9th segment. Groups—I, normally there are 2 teeth, one behind the other, but in a few specimens, only one tooth was noticed; V, a triangle of 3 paragnaths. Size : 40×3.5 mm. Uncommon to rare.

Distribution: Pacific and Atlantic Oceans, Philippine Is., Mergui Archipelago, Great Barrier Reef, New Zealand and Costa Rica.

INDIA: Gulf of Mannar and Maharashtra.

31. **Perinereis aibuhitensis** Grube (Plate III : Fig. 16)

Occurrence: Common at most of the localities. Found in mud, rock crevices, undersurface of stones or cement structures.

Remarks: Proboscis (Fig. 16): Groups—I, 2 in a longitudinal line (rarely three); II, a cluster of 6-7 teeth; III, a rectangular patch with 1-4 in a line on each side; IV, a cluster of 8-10 teeth; V, 3 in a triangle; VI, two stout, obtusely conical narrow teeth, on each side; VII-VIII, 3 rows, the anterior teeth, being smaller. Size : 80×4 mm.

Distribution: Philippines, Batavia, China, Macassar.

INDIA: Andamans; Vishakhapatnam (A.P.); Maharashtra; Goa.

32. **Perinereis nigro-punctata** Horst (Plate III: Fig. 17)

Occurrence: Common at all the localities. Found among barnacles and Oysters, also in rock crevices at ebb-tide.

Remarks: Proboscis (Fig. 17): Groups—I, 5-12 paragnaths in a cluster; II & IV, clusters; III, a rectangular cluster; V, 3 large denticles in a triangle; VI, one flat and semi-circular tooth on each side; VII-VIII, two rows. Greatly enlarged dorsal ligule in the posterior feet. Size : 50×2 mm.

Distribution: Malay Archipelago, Great Barrier Reef.

INDIA: Andaman and Nicobar Is.; Chilka Lake (Orissa); Cape Comorin (Tamil Nadu), Maharashtra; Goa Coast.

33 (a). **Perinereis nuntia** (Savigny) var. **typica** (Savigny)

Occurrence: Commonly found in sand at almost all the localities, except, Gholvad, Devgad, Redi and Dona Paula.

Remarks : Proboscis: Groups—I, 0, 1 or 2; II-IV, clusters; III rectangular patch; V, 3 set in a triangle; VI, on each side, a curved row of 5-12, conical; VII-VIII, 2 anterior rows of large ones and 2-3 rows of smaller ones. Tentacular cirri and dorsal cirri, long. Size 60-210 × 3-6 mm.

Distribution : Red Sea, Persian Gulf, Indian Ocean.

INDIA : Tuticorin, Pamban Backwaters (Tamil Nadu); Chandipore (Orissa); Nankauri Is. (Nicobars); Maharashtra and Goa Coast.

33 (b). **Perinereis nuntia** (Savigny) var. **brevicirris** (Grube)

Occurrence : Largest and the commonest nereid worm, observed at all the localities of the present study. Always found in coarse sand.

Remarks : Proboscis : Groups—I, 1-3; but in a few specimens 4 teeth are present; II-IV, crescentic and triangular clusters; III, a rectangular patch, often with 2-3 on each side; V, 3 in a triangle; VI, 8-10 flattened or mixed teeth, arranged transversely; VII-VIII, 3 irregular rows. Tentacular cirri are short, reaching only up to 5th-8th segment.

Distribution : Japan, Australia, New Zealand, New Caledonia, Malay Archipelago, Indian Ocean, Saint Paul Is., Red Sea.

INDIA : Gulf of Mannar, Tuticorin, Cape Comorin (Tamil Nadu); Nankauri (Nicobar Is.); Maharashtra and Goa Coast.

33 (c). **Perinereis nuntia** (Savigny) var. **vallata** Grube

Occurrence : Two epitokous specimens were collected from Bombay in March 1966. Few more specimens were obtained from Ratnagiri, Malvan and Miramar in April-May 1968. Found in sand, under rocks.

Remarks : Proboscis: Groups—I, 1 to 3; II-III-IV, clusters; V-1, set far back; VI, 8-15 (in the present specimens, 11 on each side); VII-VIII, 5 to 6 irregular rows of small teeth (3 rows, according to previous description). Tentacular cirri reaching to 3rd-6th segments. Size: 22 × 2 mm. Rare.

Distribution : Chile, New Zealand, Australia, Philippines, Red Sea, Madagascar, Cape of Good Hope.

INDIA : Maharashtra and Goa Coast.

33 (d). **Perinereis nuntia** (Savigny) var. **bombayensis** Bhatt

Occurrence : This new variety has been described by Bhatt (1959) from Bombay. In the present collection there are two atokous specimens one each from Bombay and Alibag. Found in crevices of trachyte rocks.

Remarks : Proboscis: Groups—I, 2 or 3, one behind another; II, oblique close-set clusters; III, square patch of 12 teeth; IV, round cluster of many teeth; V, 0; VI, 4 conical teeth on each side; VII-VIII, 2 rows, the anterior of large teeth. Size : $45\text{-}52 \times 3\text{-}4{\cdot}5$ mm. Rare.

Distribution : INDIA : Bombay and Alibag (Maharashtra).

34. **Eunice tentaculata** Quatrefages

Occurrence : Only two specimens, one each from Gholvad and Malvan, respectively. Found in mud.

Remarks : Long, annulated tentacles, with articulated cirri. Black acicula and acicular setae. Branchiae, begin about 3rd-6th segment, and continue to the hind part of the body. Colour brown with black spots. Size : 18×2 mm. Rare.

Distribution : Australia, New Zealand, Malay Sea, Indian Ocean, Ceylon.

INDIA : Laccadive Is.; Nankauri Harbour (Nicobars); Port Blair (Andamans); Tuticorin, Krusadai, Pamban (Tamil Nadu); and Maharashtra.

35. **Eunice savignyi** Grube

Occurrence : Only one specimen from Bombay. Found in a tube of mud. Bhatt (1959) has also recorded it from the same locality.

Remarks : Tentacles articulate. Gills beginning on the 3rd or 4th feet and disappear from about 80th segment. Yellow, bidentate acicular setae. Size : $23 \times 1{\cdot}5$ mm. Rare.

Distribution : Philippines, Ceylon, Persian Gulf, Agulhas current and Cape Town (S. Africa).

INDIA : Bombay (Maharashtra).

36. **Eunice antennata** Savigny

Occurrence : Three specimens, two from Malvan and one from Bombay. Found in coarse mud tubes.

Remarks : Deeply annulated tentacles. Branchiae beginning about 4th-6th feet and continued to near the anus. Yellow, tridentate acicular setae. Size : 20×2 mm. Rare.

Distribution : Red Sea, Persian Gulf, Indian Ocean, Philippine Islands, Pacific Ocean, Indo-China, Ceylon.

INDIA : Pamban, Krusadai and Shingle Is., Tuticorin (Tamil Nadu); Andamans; and Maharashtra Coast.

37. **Marphysa sanguinea** Montagu (Plate III : Fig. 18)

Occurrence : Two specimens collected from Marmgao Harbour in April 1967. One more specimen obtained at Malvan in March 1968. Found in admixture of sand and mud or in association with a sea Anemone, *Paracondylactis indicus.*

Remarks : Bilobed prostomium. Tentacles shorter than head.

Presence of compound ventral setae (Fig. 18). Size : 18×5 mm. Rare.

Distribution : Indian and Atlantic Oceans, Mediterranean and Red Sea, Australia, New Caledonia.

INDIA : Krusadai Island, Pamban Backwaters, Pondicherry, Tuticorin, Gulf of Mannar (Tamil Nadu); Travancore; Marmgao Bay (Goa); Malvan (Maharashtra); Vishakapatnam (A.P.).

38. **Marphysa mossambica** Peters

Occurrence : Only one specimen, from Bombay, burrowing in sand.

Remarks : Body flattened, with a rounded anterior end. Tentacles longer than head. Absence of compound setae. Size : 80×4·5 mm. Rare.

Distribution : Philippines, Australia, Singapore, Red Sea, East Africa.

INDIA : Nankauri (Nicobar Is.); Pondicherry, Kilakarai (Tamil Nadu); Bay of Bengal; Gulf of Mannar; Bombay (Maharashtra).

39. **Diopatra neapolitana** Delle Chiaje

Occurrence: Commonly found on the sandy parts of the shore of all the localities.

Remarks : Large-sized (100-250 mm.), iridiscent worms, living in membranous tubes, partly buried in sand. Most abundant in a substratum of mixed sand and mud.

Distribution : Pacific, Atlantic and Indian Oceans, Gulf of Oman, Gulf of Siam, Persian Gulf, China, Arabian, Red and Mediterranean Seas, Japan, Australia, Burma, Mergui, Ceylon, Maldive Archipelago.

INDIA : Chilka Lake (Orissa); Madras Coast (Tamil Nadu); Maharashtra and Goa Coast.

40. **Onuphis** sp.

Occurrence: Found living in association with a sea anemone, *Anemonia indicus* at Bombay, Ratnagiri, Malvan, Vengurla and Redi.

Remarks: So far, seven species have been recorded from India, however, it is not possible to assign the forms, from the present collection, to any of the seven species. Worms attain a maximum length of 60 mm., resemble *Diopatra neapolitana* in appearance but are smaller. Their tubes are also similar and are found in mud deposited between the rocks.

41. **Lumbriconereis heteropoda** Marenzeller

Occurrence: Fauvel (1932) has reported this species from Chaupatty, Bombay. Specimens, in the present collection, are from Bombay as well as from all other localities, except, Vijaydurg, Redi, Kalangut and Miramar. Found in sand, mud or crevices of rock.

Remarks: Small, thin and cylindrical worms, with feet increasing in length, posteriorly. Size : $14\text{-}50 \times 1\text{-}3$ mm. Common.

Distribution: Red Sea, Persian Gulf, Indo-China, Japan, California.

INDIA: Marmgao Bay (Goa); Doorakara (Sunderbans); Chaupatty, Bombay (Maharashtra); and Goa Coast.

42. **Arabella iricolor** (Montagu) (Plate III: Fig. 19 A & B).

Occurrence: Common, in mud, at Arnala, Bombay, Alibag, Ratnagiri, Malvan, Vengurla and Marmgao Harbour.

Remarks: Blunt, conical proboscis with four eyes (Fig. 19 A). Parapodia (Fig. 19 B) with dorsal cirrus reduced to a bent knob. Seta simple, stout and geniculate. Size: $32\text{-}57 \times 1\text{-}4$ mm. Common.

Distribution: Pacific, Atlantic and Indian Oceans, Japan, Marshall Is., Samoa, W. Indies, Mediterranean Sea, British Channel.

INDIA: Nicobar; Vishakapatnam (A.P.); Madras Coast, Gulf of Mannar, Krusadai, Pamban, Shingle Is. (Tamil Nadu); Maharashtra and Goa Coast.

43. **Glycera alba** Rathke (Plate III: Fig. 20)

Occurrence: Found in mud at Gholvad, Bombay, Alibag, Ratnagiri, Vijaydurg, Malvan, Dona Paula and Marmgao Harbour. Previously recorded from Marmgao Bay (1932).

Remarks: Body rounded, tapering at both the ends. Simple, long branchiae inserted on the dorsal edge of the foot. Feet with acute lobes

(Fig. 20). Colour red in life, dark-brown or black in spirit. Size : 150×4 mm.

Distribution : Indian and Atlantic Oceans, Red Sea.

INDIA : Ganjam Coast (Orissa); Cochin Backwaters (Kerala); Marmgao Bay (Goa); Maharashtra.

Group II : POLYCHAETA SEDENTARIA

44. **Polydora (Polydora) coeca** Oersted (Plate III : Fig. 21)

Occurrence : Found in mud or attached to stones, at Arnala, Bombay, Alibag, Ratnagiri, Devgad, Malvan, Vengurla, Miramar and Marmgao Harbour.

Remarks : Prostomium, deeply notched and prolonged backwards over the first two segments (Fig. 21). Long slender tentacles. Though this species is mentioned as eyeless, but in majority of the specimens, four eyes are noticed. Size: 10×1 mm. Common.

Distribution : Atlantic and Indian Oceans, Mediterranean, Arctic and North Seas.

INDIA : Gulf of Mannar; Krusadai, Shingle Is. (Tamil Nadu); Maharashtra and Goa Coast.

45. **Cirriformia limnoricola** Kirkegaard & Santhakumaran

Occurrence : Recently, Kirkegaard & Santhakumaran (1967) have described this worm from Bombay Harbour. A number of specimens, always found in the tunnels of the wood-borer, *Limnoria* (*Limnoria*) *bombayensis* Pillai, were collected from Arnala, Bombay, Ratnagiri, Malvan, Vengurla and Marmgao Harbour.

Remarks : Slender, Cylindrical body with a long, cone-shaped prostomium. Gills from 1st-29th setigerous segments. Colour: Reddish-brown, when alive, and dark brown to black, in formalin preserved specimens. Size : $10\text{-}15 \times 1\text{-}1\frac{1}{2}$ mm. Common.

Distribution : INDIA : Maharashtra and Goa Coast.

46. **Phyllochaetopterus socialis** Claparède

Occurrence : Single specimen from Malvan. Fauvel (1932) has recorded this species from Bombay. Found in horny tubes.

Remarks : Worm, having slender body, divided into three regions. Two long palps anteriorly and two small posterior tentacles. Middle region with numerous segments fitted with biramous feet. Size : 30×3 mm.

Distribution: Atlantic and Indian Oceans, Mediterranean and Arabian Seas, Australia, Falkland Is., Gulf of Oman.

INDIA : Hooghly River (W. Bengal); Chandipore (Orissa); Bombay and Malvan (Maharashtra).

47. **Sabellaria** sp.

Occurrence : Commonly found at Arnala, Bombay, Alibag, Ratnagiri, Devgad, Malvan, Vengurla and Dona Paula. The tubes built by these worms are of firmly cemented sand grains and small shell pieces, forming dense reef-like masses on the stones. Occasionally found on the surface of oysters and barnacles.

Remarks : Outer palae, without spines. Dorsal acicular setae with a peduncle. Size : 10-30 mm.

48. **Pista** sp.

Occurrence : Occasionally found in coarse mud or sand, below gravel or stones at Bombay, Ratnagiri, Malvan, Dona Paula and Marmgao Harbour.

Remarks : Short, stout body with swollen anterior end. Two branchiae and 6 ventral scutes. Size : 20-50 × 5-12 mm.

49. **Spirographis spallanzanii** Viviani (Plate IV: Fig. 22 A & B)

Occurrence : Bhatt (1959) recorded the worm for the first time in India, from Chaupatty Rocks and Cuffe Parade, Bombay. In addition to the above mentioned localities, specimens were also collected from Dahanu, Arnala, Alibag, Ratnagiri, Devgad, Malvan, Kalangut and Marmgao Harbour. These worms live in long tubes embedded in soft mud, near or in between rocks in sheltered or semi-sheltered areas.

Remarks : Moderately elongated worm abruptly tapering behind. Two dorsal and two ventral lobes of the collar. Intermittent brown streaks on the branchial filaments. Abdomen with only dorsal uncini (Fig. 22 A) and ventral winged capillary setae (Fig. 22 B). Tube of the worm, tough, erect and mud-coloured. Size : 35-50 × 2-3·5 mm. Common.

Distribution : Indo-China, Malay Archipelago, Ceylon, Indian and Atlantic Oceans, Mediterranean Sea.

INDIA : Maharashtra and Goa Coast.

50. **Dasychone cingulata** Grube (Plate IV : Fig. 23)

Occurrence : Few tubes, of these worms, were collected from Malvan in April 1967. Tubes found attached to rocks.

Remarks : Presence of long slender dorsal stylodes (Fig. 23). Dark scattered spots on the body. Size: 40×3 mm. Rare.

Distribution : Red Sea, Arabian Sea, Burma Coast, Mergui, Persian Gulf, Indian and Pacific Oceans.

INDIA : Madras, Gulf of Mannar, Pamban (Tamil Nadu); Andamans; Malvan (Maharashtra).

51. **Dasychone serratibranchis** Grube (Plate IV : Fig. 24)

Occurrence : Found in sheltered parts of the coast of Bombay, Ratnagiri, and Malvan. Tubes, attached to rocks, in association with Oysters, Polyzoans or rarely attached to the shell of *Placenta placenta.*

Remarks : Dorsal stylodes (Fig. 24), small, short and oppressed, giving a serrated appearance to the gill filaments. Bands of white, purple or yellow colour on the gill filaments. Size : 15·50×1-5 mm. (excluding gill-tuft). Uncommon to rare.

Distribution : Mergui, Philippines, Indo-China, New Zealand, Australia.

INDIA : Andaman ; Pamban (Tamil Nadu); Maharashtra Coast.

52. **Potamilla leptochaeta** Southern (Plate IV: Fig. 25 A, B & C)

Occurrence : This species was so far known from brackish-water only but in the present study, specimens were collected during low ebb-tides, at Arnala, Bombay and Miramar. These small worms are found together with *Dasychone* and *Polyzoa.*

Remarks : Thorax with dorsal spatulate (Fig. 25a) and limbate setae and ventral pick-axe-shaped setae (Fig. 25b) and hooks (Fig. 25c). Size : 5-9 mm. Rare.

Distribution : Malay Archipelago.

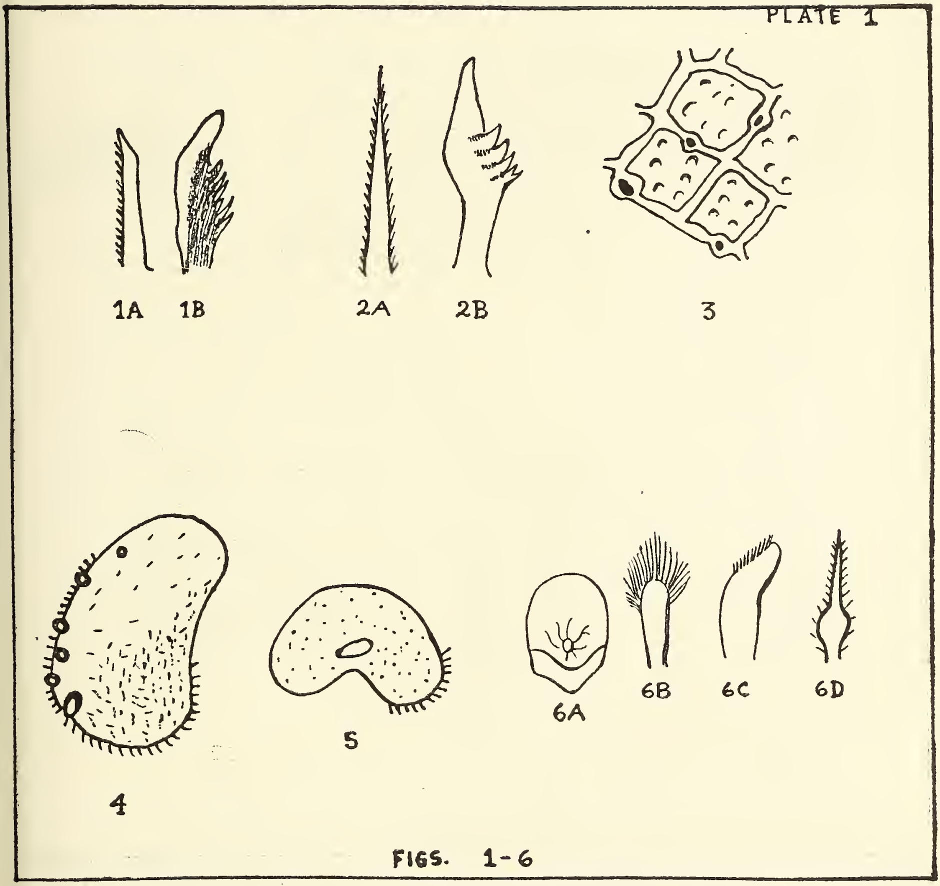
INDIA : Chingrighatta (near Calcutta); Vishakapatnam, Port Canning (A.P.), Arnala and Bombay (Maharashtra), Miramar (Goa).

53. **Vemiliopsis glandigerus** Gravier (Plate IV: Fig. 26)

Occurrence : Collected from Bombay and Malvan. Found attached to the underside of stones. Tubes pink in colour.

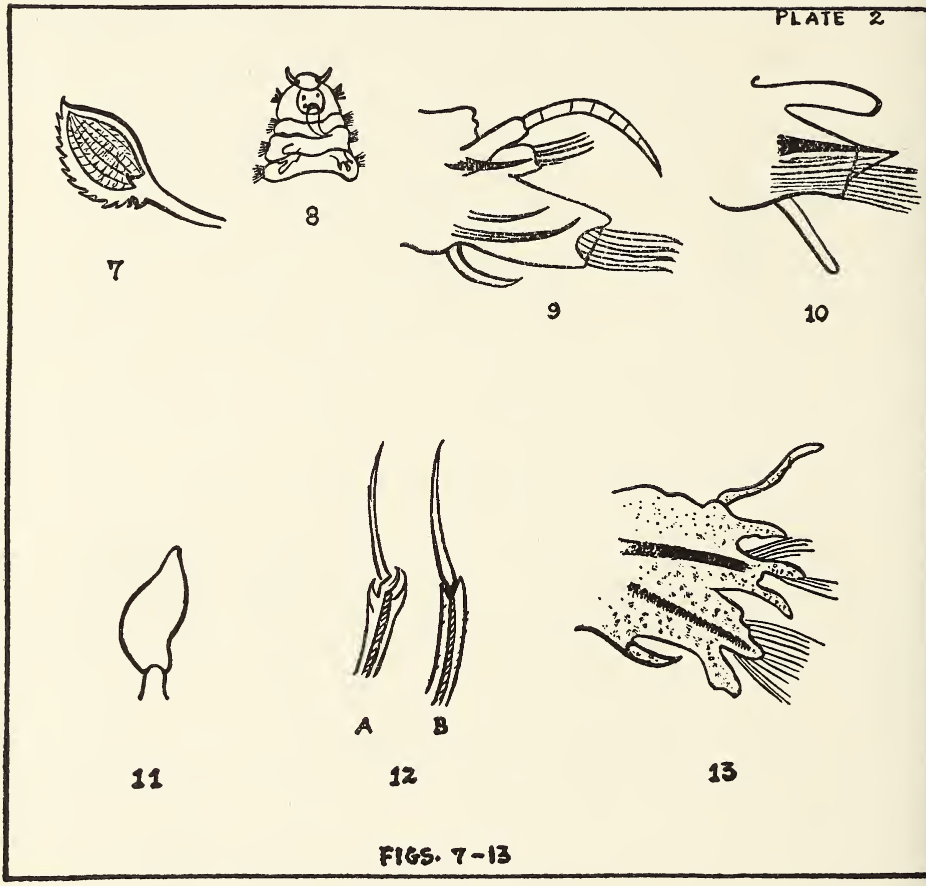
Remarks : Tube of the worm is wrinkled, with 4-5 long keels and peristomial ridges. Operculum (Fig. 26) having a wrinkled stalk and is divided into partitions. Size : 20×1·5 mm. Rare.

Parulekar : Polychaetes



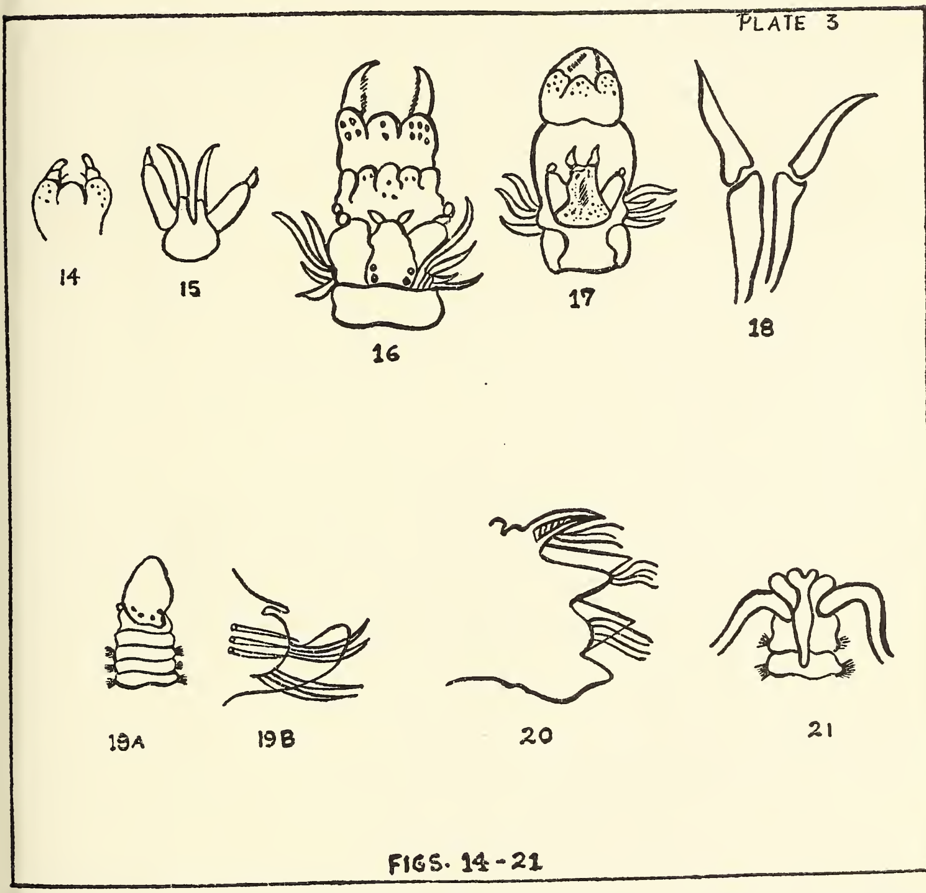
FIGS. 1. *Lepidonotus carinulatus* Grube : *A*—dorsal seta; *B*—Ventral seta ; 2. *Lepidonotus tenuisetosus* (Gravier) : *A*—dorsal seta; *B*—Ventral seta ; 3. *Gattyana deludens* Fauvel : elytra ; 4. *Harmothoë ampullifera* (Grube) : elytra ; 5. *Sthenelais boa* (Johnston) ; elytra ; 6. *Panthalis oerstedi* Kinberg ; *A*—elytra; *B*, *C* & *D*—seta

Parulekar : Polychaetes

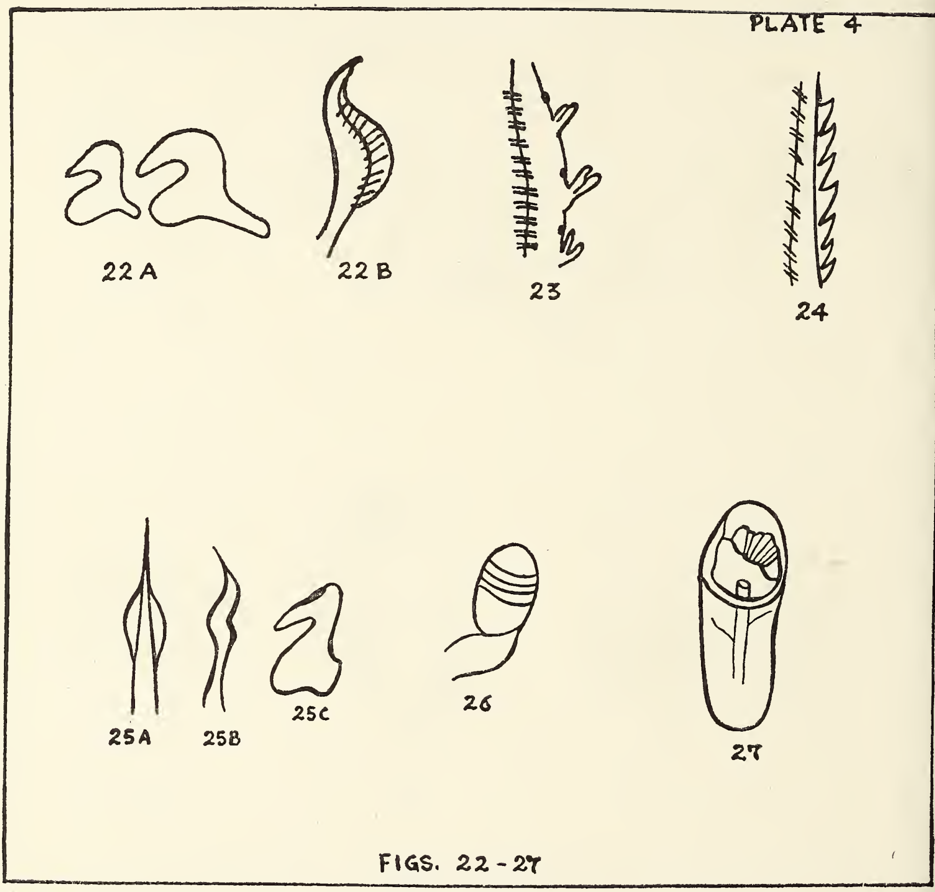


FIGS. 7. *Bhawania cryptocephala* Gravier : palae ; 8. *Eurythoë parvecarunculata* Horst : head ; 9. *Leocrates claparedii* (Costa) : feet ; 10. *Leocratides ehlersi* (Horst) : feet ; 11. *Phyllodoce* (*Anaitides*) *madeirensis* Langerhans : dorsal cirri ; 12. *Nereis* (*Nereis*) *chingrighattensis* Fauvel : *A* & *B*—Spinigerous setae ; 13. *Nereis* (*Nereis*) *talehsapensis* Fauvel : anterior feet

Parulekar : Polychaetes



FIGS. 14. *Nereis (Ceratonereis) 'costae* Grube : prostomium ; 15. *Nereis (Ceratonereis) mirabilis* Kinberg : prostomium ; 16. *Perinereis aibuhitensis* Grube : proboscis ; 17. *Perinereis nigro-punctata* Horst : proboscis ; 18. *Marphysa sanguinea* Montagu : compound ventral seta ; 19. *Arabella iricolor* (Montagu) : *A*—probosics; *B*—parapodia ; 20. *Glycera alba* Rathke : feet ; 21. *Polydora (Polydora) coeca* Oersted : head



FIGS. 22. *Spirographis spallanzanii* Viviani : *A*—uncini seta ; *B*—capillary seta ; 23. *Dasychone cingulata* Grube : dorsal stylode ; 24. *Dasychone serratibranchis* Grube : dorsal stylode ; 25. *Potamilla leptochaeta* Southern : *A*—spatulate seta ; *B*—pick-axe-shaped seta ; *C*—hook ; 26. *Vermiliopsis glandigerus* Gravier : operculum ; 27. *Spirobis foraminosus* Moore : operculum

Distribution : Panama, Atlantic Ocean, Gulf of Guinea, Madagascar, West Africa, Red and Arabian Seas.

INDIA : Gulf of Mannar; Krusadai, Shingle Is., Rameswaram (Tamil Nadu); Bombay and Malvan (Maharashtra).

54. **Spirobis foraminosus** Moore (Plate IV : Fig. 27)

Occurrence : Specimens from Bombay and Vengurla. Found mixed with different algae or attached to the undersurface of stones in shallow rock-pools.

Remarks : Tube wrinkled and small in size (about 1 mm.). Operculum (Fig. 27) with longitudinal grated plates. Three thoracic segments. Rare.

Distribution : Pacific Ocean, Ceylon and Japan.

INDIA : Nankauri Harbour (Nicobar Is.); Gulf of Mannar, Krusadai Is., Rameswaram Beach (Tamil Nadu); Bombay and Vengurla (Maharashtra).

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I am grateful to Mr. J. C. Daniel, Curator, Bombay Natural History Society, for providing research facilities and taking interest in this work. Acknowledgements are made to C.S.I.R. for awarding a Post-Doctoral Research Fellowship for continuing the study.

REFERENCES

BHATT, Y. M. (1959) : A Study of Intertidal Organisms of Bombay. Ph.D. Thesis, Univ. of Bombay (Unpublished).

KIRKEGAARD, J. B. & SANTHAKUMARAN, L. N. (1967) : On a new species of Annelid associate of marine wood borers : *Cirriformia limnoricola* n. sp. (Polychaeta). *Vid. Medd. Dansk. natu. Forening* **130** : 213-216.

FAUVEL, P. (1932): Annelida Polychaeta of the Indian Museum, Calcutta. *Mem. Indian Mus.* **XII** : 1-262. pls. I-IX.

——— (1940) : On a small collection of Annelida Polychaeta of the Indian Museum. *Rec. Indian Mus.* 1940, **XLII**, Pt. II : 253-268.

——— (1953) : Annelida Polychaeta. The Fauna of India, including Pakistan, Ceylon, Burma and Malaya, Pp. 1-507. Published by The Indian Press Ltd., Allahabad.

POTTS, F. A. (1909-10) : Polychaeta of the Indian Ocean. Part I. The Amphinomidae. *Trans. Linn. Soc. London* (*Zool.*) 2nd series. **XII** : 355-371, Pls. XLV-XLVII ; Part II, The Palmyrdae, Aphroditidae, Polynoidae, Acoetidae, and Sigalionidae, ibid. **XII** : 325-353, pls. XVIII-XXI.

SOUTHERN, R. (1921) : Polychaeta of the Chilka Lake, and also of fresh and brackish waters in other parts of India. *Mem. Indian Mus.* V: 563-659, pls. XIX-XXXI.

Aquatic and Marshy Angiosperms of Roorkee Sub-division

BY

UDAI SINGH CHAUHAN

Division of Genetics, I.A.R.I., New Delhi

AND

A. C. DEY [1]

In this paper the authors have enumerated 78 species belonging to 46 genera and 31 families. The family Cyperaceae is dominant in the area.

INTRODUCTION

Aquatic plants constitute a peculiar form of plant life. In India the hydrophytes have attracted the attention of a good number of workers. Subramanyam's AQUATIC ANGIOSPERMS (1962) gives a detailed account of the study of this group. But there is little data on the vegetation found in and near running water.

We, therefore, undertook the study of the vegetation along the banks of ponds, lakes and streams.

Roorkee, in the sub-Himalayan tract, has climate marked by both dry and rainy seasons. During the monsoons, the water level is usually high and banks are flooded. After the monsoon, the water level goes down, exposing extensive areas of the banks. In the month of October the banks are muddy, and have sparse vegetation.

During the course of the survey of medicinal plants of Roorkee Sub-Division a collection of aquatic and marshy plants was also made. The habitat, flowering period, distribution, were studied. The plants were identified and later confirmed at the F.R.I. herbarium, Dehra Dun. The herbarium sheets were deposited in the Herbarium, Survey of Medicinal Plants, Gurukul Kangri (Hardwar).

The order of families followed in this paper is that of Duthie in the FLORA OF THE UPPER GANGETIC PLAIN. Hutchinson (1959)[2] has been followed in splitting of families. An attempt has been made to bring the nomenclature up-to-date as far as possible. The plants marked with an asterisk (*) have not been recorded in Duthie's flora but were reported by subsequent workers from the Upper Gangetic Plain.

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[1] S. M. P., Gurukul Kangri.

[2] HUTCHINSON, J. (1959) The Families of Flowering Plants. 2 vols, Oxford.

Geography of the Area

Roorkee Sub-Division occupies an area of 1425 sq. km. The approximate bearings of Roorkee are 29° 58′N. and 78° 13′E.; it has an elevation of 290 m. above sea level and is bounded by Dehra Dun in the North and by Muzaffarnagar, Ganga River, and Saharanpur in the South, East and West respectively.

Topography and Soils

Roorkee, a part of the Indo-Gangetic Plain of north India, slopes gradually from North to South. The Ganga River flows through the area. In addition, there are a large number of temporary swamps and ditches that are full of water during the rainy season but become shallow marshes or even arable land in the winter or summer.

The soil of the area is generally loam but clay and sandy loam are also common. The pH of the soil varies between 6 and 8.

Climate

Roorkee has a dry sub-humid climate characterized by low rainfall and extremes of temperature. There are three well marked seasons: Summer from March to June; Rains from July to September; and Winter from October to February. The average rainfall of Roorkee is 1092 mm. 85% of which falls during July to September. Maximum temperature rises up to 43°C in June.

Habitats

There are many permanent ponds and jheels within the area that retain water throughout the year and are rich in hydrophytic vegetation. Besides, there are large number of temporary ponds and ditches which are full of water during rainy season but dry up during summer. The banks of the rivers and canals are also rich in marshy vegetation. The free floating aquatic herbs include: *Eichhornia crassipes* Solms, *Lemna paucicosta* Hegel., *Spirodela polyrrhiza* Schleid., *Utricularia stellaris* L.f., and *Wolffia microscopica* Kurz; the common submerged species are: *Ceratophyllum demersum* L., *Hydrilla verticillata* Royle, *Potamogeton crispus* L., *Vallisneria spiralis* L., and *Zannichellia palustris* L. The attached floating herbs include: *Aponogeton natans* (L.) Engl. & Krause, *Aponogeton crispum* Thunb., *Nymphaea nouchali* Burm. f., *Nymphaea stellata* Willd., *Monochoria vaginalis* Presl, *Potamogeton indicus* L., and *Sagittaria guayanensis* H.B. & K. The common species that occur in marshy places are *Typha elephantina* Roxb., *Arundo donax* L., *Caesulia* *axillaris* Roxb., *Echinochloa crus-galli* Beauv., *Eleocharis plantaginea* R. Br., *Fimbristylis* spp., *Cyperus* spp., *Juncellus* spp., *Scirpus* spp., *Ipomoea reptans* Poir, and *Ranunculus sceleratus* L.

LIST OF SPECIES

Ranunculaceae

Ranunculus aquatalis Linn.
Fl. Nov.-January, Kankhal; *Singh* 4977.

R. sceleratus Linn.
Fl. Jan.-March, Jagdishpur; *Singh* 4979.

Nymphaeaceae

Nymphaea nouchali Burm. f.
Fl. July-Sept., Pathri; *Dey* 4973.

N. stellata Willd.
Fl. July-September, Pathri; *Dey & Singh* 4972.

Elatinaceae

Bergia ammanioides Roxb.
Fl. Oct.-Dec., Panjnerhi; *Singh* 4962.

Papilionaceae

Aeschynomene indica Linn.
Fl. Aug.-Oct., Lakshar; *Singh.* 4953.

Lythraceae

Rotala densiflora (Roth.) Koehne
Fl. Feb.-March, Jagdishpur; *Singh* 4983.

R. leptopetala Koehne.
Fl. July-Jan., Jagdishpur; *Singh* 4959.

Ammania baccifera Linn.
Fl. Rainy season, Panjnerhi; *Dey* 4958.

A. senegalensis Lamk.
Fl. July-Sept. Jagdishpur; *Dey & Singh* 4971.

Onagraceae

Jussiaea repens Linn.
Fl. Sept.-Nov., Pathri; *Singh* 4966.

J. suffructicosa Linn.
Fl. Sept.-Dec., Ranipur; *Singh* 4965.

J. perennis (Linn.) Drenan.
Fl. Sept.-Nov., Roorkee; *Dey* 5976.

Epilobium hirsutum Linn.
Fl. Sept.-Nov., Jawalapur; *Singh* 4988.

Trapaceae

Trapa bispinosa Roxb.
Fl. Sept.-Dec., Kankhal; *Dey & Singh* 1966.

Umbelliferae

Centella asiatica (Linn.) Urban.
Fl. Sept.-Dec., Gurukul Kangri; *Dey* 4993.

Hydrocotyle sibthorpoides Lamk.

Fl. Sept.-Jan., Gurukul Kangri; *Dey* 4991.

Oenanthe javanica (Bil.) DC.

Fl. April-May, Jawalapur; *Singh* 4983.

COMPOSITAE

Caesulia axillaris Roxb.

Fl. Sept.-Dec., Jawalapur; *Singh* 4986.

CAMPANULACEAE

Sphenoclea zeylanica Gaertn.

Fl. Aug.-Oct., Lashashar; *Singh* 4968.

HYDROPHYLLACEAE

Hydrolea zeylanica (Linn.) Vahl

Fl. Sept.-Oct., Bahadrabad; *Singh* 4956.

CONVOLVULACEAE

Ipomoea reptans Poir.

Fl. Most part of the year. Dhanori; *Singh* 4964.

SCROPHULARIACEAE

Limnophila gratioloides R.Br.

Fl. Oct.-Nov., Roorkee; *Singh* 4955.

Dopatrium junceum Buch.-Ham.

Fl. Aug.-Sept., Panjnerhi; *Dey & Singh* 4990.

Veronica anagallis Linn.

Fl. Feb.-May, Gurukul Kangri; *Dey & Singh* 4978.

LENTIBULARIACEAE

Utricularia stellaris Linn.

Fl. Sept.-Nov., Dhanori; *Dey & Singh* 4961.

U. aurea Lour.

Fl. Oct.-Nov., Dhanori; *Dey & Singh* 4982.

ACANTHACEAE

Hygrophila auriculata (Schumach.) Heine.

Fl. Sept.-Nov., *Dey & Singh* 4987.

POLYGONACEAE

Polygonum barbatum Linn.

Fl. Most part of the year. *Dey & Singh* 4991.

P. hydropiper Linn.

Fl. Aug.-Feb., Mayapur; *Dey & Singh* 4992.

P. lanigerum R.Br.

Fl. Sept.-Nov., Kankhal (Hardwar); *Dey & Singh* 4995.

P. glabrum Willd.

Fl. Aug.-Dec., Kankhal; *Dey & Singh* 4996.

URTICACEAE

Pouzolzia pentandra Benn.

Fl. Sept.-Dec., Panjnerhi ; *Singh* 4963.

SALICACEAE

Salix tetrasperma Roxb.

Fl. Feb.-May, *Singh* 4984.

Ceratophyllaceae

Ceratophyllum demersum Linn.
Fl. Sept.-Nov., Manglor; *Dey & Singh* 4997.

Hydrocharitaceae

Hydrilla verticillata Royle
Fl. Nov.-Dec., Jawalapur; *Dey & Singh* 4960.

Vallisneria spiralis Linn.
Dey & Singh 4906.

Pontederiaceae

***Eichhornia crassipes** (Mart.) Solms
Fl. Sept.-Nov., Gurukul Kangri; *Dey & Singh* 4910.

Monochoria vaginalis Presl
Fl. Aug.-Nov., Lakshar; *Dey & Singh* 4957.

Thyphaceae

Typha elephantina Roxb.
Fl. July-Sept., Lakshar; *Dey & Singh* 4998.

Lemnaceae

Spirodela polyrrhiza Schleid.
Panjnerhi; *Singh* 4999.

Lemna paucicostata Hegelm.
Fl. Not seen. Jagdishpur; *Dey & Singh* 4991.

Wolffia microscopica Kurz
Jagdishpur; *Dey & Singh* 5000.

Alismaceae

Sagittaria guayanensis H.B.K.
Fl. Aug.-Oct., Lakshar; *Singh* 4974.

Aponogetonaceae

***Aponogeton natans** (Linn.) Engl. & Krause
Fl. Aug.-Nov., Bahadrabad; *Singh* 4970.

A. crispum Thunb.
Fl. Aug.-Nov., Pathri; *Dey & Singh* 4960.

Potamogetonaceae

Potamogeton indicus Roxb.
Fl. Feb.-June, Jawalapur; *Dey* 4980.

P. crispus Linn.
Fl. Feb.-May, Jawalapur; *Dey & Singh* 4974.

P. pectinatus Linn.
Fl. Feb.-May, Jawalapur; *Dey & Singh* 4913.

Zannichelliaceae

Zannichellia palustris Linn.
Fl. Feb.-March, Danpur; *Dey & Singh* 4921.

Naidaceae

Naias minor All.
Fl. Aug.-Oct., Kankhal; *Dey & Singh* 4881.

Ericaulaceae

Eriocaulon sieboldianum Seib.
Fl. Oct.-Nov., Ajitpur; *Dey & Singh* 4915.

Cyperaceae

Cyperus iria Linn.
Fl. Aug.-Oct., Panjnerhi; *Dey & Singh* 4945.

C. eleusinoides Kunth
Fl. Aug.-Nov., Panjnerhi; *Dey & Singh* 4941.

C. exaltatus Retz.
Fl. Aug.-Nov., Panjnerhi; *Dey & Singh* 4940.

C. globosus All.
Fl. Aug.-Nov., Panjnerhi; *Dey & Singh* 4944.

Juncellus laevigatus C. B. Clarke
Fl. Aug.-Sept., Kankhal; *Dey & Singh* 4951.

Mariscus dilutus Nees
Fl. July-Sept., Misharpur; *Dey & Singh* 4948.

Eleocharis plantaginea R.Br.
Fl. Sept.-Nov., Bahadrabad; *Dey & Singh* 4947.

Fimbristylis dichotoma (Linn.) Vahl
Fl. July-Oct., Kankhal; *Dey & Singh* 4953.

F. monostachya Hassk.
Fl. July-Sept., Jagdishpur; *Dey & Singh* 4954.

F. miliacea Vahl
Fl. July-Sept., Panjnerhi; *Dey & Singh* 4942.

Scirpus mucronatus Linn.
Fl. Oct.-Nov., Panjnerhi; *Dey & Singh* 4948.

S. maritimus Linn.
Fl. Dec.-Feb., Kankhal; *Dey & Singh* 4989.

Gramineae

Phragmites karka (Retz.) Trin. ex Steud.
Fl. Oct.-Dec., Kankhal; *Dey & Singh* 4920.

Echinochloa crus-galli (Linn.)Beauv.
Fl. Aug.-Nov., Jawalapur; *Dey & Singh* 4949.

Oryza sativa Linn.
Fl. Sept.-Nov., Bahadrabad; *Dey & Singh* 1966.

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A Catalogue of the Birds in the Collection of the Bombay Natural History Society—10

Cuculidae

BY

HUMAYUN ABDULALI

[*Continued from Vol.* **68** (2): 338]

This part deals with 435 specimens of 36 species and subspecies up to No. 605 in IND. HANDBOOK (**3** : 246) up to Reg. No. 23591. Mr. S. A. Hussain assisted with measurements and other work.

569 **Clamator coromandus** (Linnaeus) (Coromandel—Pondicherry) Redwinged Crested Cuckoo **4** : 170

9 : 4 ♂♂ 4 ♀♀(2 imm.) 1 o ?

1 Savantwadi, Maharashtra ; 1 Point Calimere, Tamil Nadu ; 1 Darjeeling ; 1 Goalpara, 2 Dibrugarh, 2 Assam ; 1 *Monywa, Burma.*

	Wing	Bill	Tarsus	Tail
4 ♂♂	158, 159, 161, 166	20, 21, 22, 24	25, 26(2), 27	218, 222, 226, 235
2 ♀♀	158, 171*	23, 24	26, 27*	236, 260*
(IH♂♀	157-166	*c.* 24-25	*c.* 27-28	231-245)

The female from Point Calimere* is the largest, the measurements of the wing and tail exceeding the limits in the FAUNA. It also differs from all the others in having dark instead of pale coloured legs and feet.

570 **Clamator jacobinus serratus** (Sparrman) (Cape Peninsula, Cape Province, S. Africa) Pied Crested Cuckoo **4** : 167

30 : 11 ♂♂ 10 ♀♀(1 juv.) 9 o ?(1 juv.)

1 Baghat State, 1 Chili, Patiala State, 1 Simla, 1 NW. Himalayas (H.P.) ; 1 Karachi ; 1 Bhujia Fort, Kutch, 1 Bhavnagar, 1 Bodeli, Baroda, 1 Gir Forest ; 1 Mandu, Dhar State, C.I. ; 1 Bassein, Thana, 8 Bombay City ; 1 Talewadi, Belgaum ; 1 Vizagapatam ; 4 Anark, Darbhanga, Bihar ; 1 Meerut, 1 Cawnpur, 1 Almora, 1 Nainital, Kumaon, U.P. ; 1 Karung ?.

	Wing	Bill	Tarsus	Tail
11 ♂♂	145-152 av. 149	18-20	25-27 av. 25·8	163-179 av. 168·4
	(IH 146-155)	(20-22)	(27-28)	(IH 158-176)
9 ♀♀	142-150 av. 146	18-20	24-28 av. 26	149-172 av. 164
	(IH 144-151)	(20-22)	(27-28)	(IH 156-169)

Two females from Darbhanga, Bihar, and Cawnpur, U.P., have their wings 142 and 143 mm. All the specimens, including the juveniles, have been collected between ? April in Gir and 8 November (a juvenile on 11 November) in Bombay. A male from Talewadi, Belgaum (wing 147) is the southernmost specimen. IND. HANDBOOK (**3** : 195) putatively accepts this as wintering in Africa south of the Sahara, but wing measurements of 20 ♂♀ from Africa and Arabia quoted from Ticehurst (loc. cit., p. 197) 147-162 (once 167) apparently refer to a different race. The dates of the specimens available give no indication of a movement in any direction. Can any significance be attached to Inglis's statement that at Jalpaiguri, E. Bengal, it is common in the plains from April to November, while it is said to arrive at the end of May in almost every other place ?

571 **Clamator jacobinus jacobinus** (Boddaert) (Coromandel Coast) Ceylon Pied Crested Cuckoo **4** : 169

4 : 1 ♂ juv. 3 ♀♀

1 Mercara, Coorg ; 1 Kurumbapatti, 1 Tirthamalai, Salem Dist. ; 1 Seshachalam Hills, S. Cuddapah.

	Wing	Bill	Tarsus	Tail
1 ♂ juv.	140	18	26	153
3 ♀♀	142(2), 143	18, 19, 20	25, 27(2)	155, 160, 166
	(IH ♂♀ 136-144	—	—	147-163)

This race is generally accepted as the resident southern population though IND. HANDBOOK (**3** : 197) adds that 'its rainy season migrations and dispersal are restricted within our limits'. It is significant that the specimens available are dated 20 April (breeding), 23 June, 13 September and 26 October (juvenile), while the Eastern Ghats Ornithological Survey, which was continuously in the field between 8 April 1929 and 15 May 1930, obtained 9 specimens, but all between 20 April and 8 November. There are admittedly a few records outside this period (Sálim Ali, Cape Comorin, 7 April, Seringapatam, Mysore, 8 December; Pillay, Trivandrum, 28 February) but a closer inquiry is required for both races.

572 **Cuculus sparverioides sparverioides** Vigors (Himalayas) Large Hawk-Cuckoo **4** : 146

8 : 5 ♂♂ (2 juv.) 2 ♀♀ 1o ?

1 Koti State, 1 Simla ; 2 Kurseong, 1 Darjeeling ; 1 Temi, 1 Richingpong, Sikkim ; 1 Cachar.

	Wing	Bill	Tarsus	Tail
♂♂ (2 juv.)	222, 226, 229, 237(2)	29(2), 29(2)	25, 26(3), 27	193, 198(2), 204
♀♀	224, 234	29, 30	27, 28	195, 205
o ?	236	29	27	216
	(IH ♂♀ 213-236	28-30	25-27	175-220)

Two ♂♂ (both February), which differ from the others in lacking the rufous patch on the upper breast and in having slight traces of light rufous barring on the upper parts, are presumably young of the year.

The key in IND. HANDBOOK (3 : 198) requires a tail over 197 mm. while later (p. 200) it is measured as 175-220.

573 **Cuculus varius varius** Vahl (Tranquebar) Common Hawk-Cuckoo **4** : 148

23 : 15 ♂♂ (3 juv.) 8 ♀♀ (3 juv.)

1 Baghat State, 1 Ambala, 2 Delhi ; 1 Gwalior ; 1 Gondia, 1 Kankar, C.P. ; 3 Bombay ; 1 Karwar ; 1 Peermade, 1 Rajampara, Panthalam Hills, Kerala ; 1 Nallamalai, S. Kurnool ; 1 Sankrametta, Vizagapatam ; 1 Bhaspur, Devkand, Orissa ; 3 Darbhanga, 1 Bagha, 1 Tirhut ; 1 Bankulwa, Morang, Nepal ; 1 Goalpara, Assam.

	Wing	Bill	Tarsus	Tail
8 ♂♂	193-202 av. 197·5	20-23 av. 21·3	22-24 av. 23·2	160-179 av. 168
	(IH 193-213	—	21-23	157-188)
5 ♀♀	183-196 av. 191	20-22 av. 20·8	23-24 av. 23·8	157-169 av. 163·5.
	(IH 192-207	—	23-26	156-180)

It will be noticed that the measurements are smaller than indicated in IND. HANDBOOK. The young have bold streaks on the breast and the upper parts are washed with rufous indicating an indistinct barring.

574 **Cuculus varius ciceliae** (Phillips) (Caledonia Estate, 4000 ft. Lindula, Dimbula, Ceylon) Ceylon Hawk-Cuckoo

nil.

575 **Cuculus fugax nisicolor** Blyth (Nepal) Hodgson's Hawk-Cuckoo **4** : 150

nil.

576 **Cuculus micropterus micropterus** Gould (Himalayas) Indian Cuckoo **4** : 144

11 : 8 ♂♂ 3 ♀♀ (1 juv., 1 pull.)

1 Bhaji State, 2 Simla ; 1 Powai, Bombay ; 1 Rajampara, Panthalam Hills, Kerala ; 1 Puttocku, N. Arcot ; 1 Monna Khal, U.P. ; 1 Ramshai, Jalpaiguri, Bengal ; 1 Hathiban, Nepal ; 1 Duars, Assam ; 1 Mithakhary, S. Andamans.

	Wing	Bill	Tarsus	Tail
7 ♂♂	198-210	24-26	18-20	149-166
	av. 203·4	av. 25	av. 19·5	av. 155
2 ♀♀	190, 209	22	21(2)	144, 159
	[IH ♂♀ 190-207	(22-24)	20-21	142-161]

The females do not differ from the males in colour.

The black band almost at the end of the tail and the white edge to wings are good characters for the identification of this species, but the heavy bill appears to be a reliable, and sometimes necessary, supplementary character to separate it from *C. canorus*, specimens of which were mixed up with this species. All the specimens were obtained between 17 March (breeding ♀, Rajampara) and 26th July (juvenile), but this may be due to its silence and unobtrusiveness at other seasons. The pullet was obtained in the Duars on 31st May, while the ♀ from Rajampara, Kerala (17 March) held soft eggs and a distended oviduct. One male (Simla 26 May) marked adult has a slight trace of rufous barring on the upper back.

Sp. No. 23173 from the Andamans differs from the others in having white tips to the wing coverts, forming two bars across the wing, in which respect it resembles the juvenile and may represent a subadult plumage.

577 **Cuculus canorus subtelephonus** Zarudny (Turkestan) Asiatic Cuckoo

8 : 4 ♂♂ (1 juv.) 2 ♀♀ (1 hepatic, 1 juv.) 2 o ? (juv.)

1 *Felujah, R. Euphrates,* 1 *Shaiba,* 1 *Shatt-el-Adhain, R. Tigris ;* 2 *Bahm-e-Shur,* 2 *Mishun, Persian Gulf ;* 1 *Shiraz, Persia.*

The subspecies of *C. canorus* are extremely difficult to tell apart. The three adult males are paler above than the others, but the 4 juveniles vary among themselves, and are only separated on geographical grounds.

Specimen No. 20925 a hepatic female (adult, 23rd March) from Bahm-e-Shur, wing 201, tail 147, is rufous all over and has a foxy chestnut tail with a very distinct black spot/bar preceding the small white tips, a character shared only with two rufous juveniles under the next subspecies (q.v.). No. 20929 a juvenile male (which was caught and died in captivity) has its primaries only a little longer than the secondaries, a rufous wash on the upper parts, and a large white patch on the nape.

The measurements are under serial 579.

578 **Cuculus canorus canorus** Linnaeus (Sweden) Cuckoo 4 : 135

29 : 14 ♂♂ (7 juv.) 10 ♀♀ (3 juv.) 5 o ? (juv.)

3 Chitral ; 2 Kashmir ; 1 Keonthal State, 1 Bhagat State, 2 Mashobra, 8 Simla, H.P. ; 1 Dharamshala*, 1 Patiala ; 1 Bikanir ; 1 Bhuj Fort, Kutch ; 1 Dhari, Kathiawar ; 1 Rewas, Kolaba ; 4 Baghownie, Tirhut, Bihar ; 1 Nannakhat ; 1 Yumaniti, Garhwal. *missing.

The rufous tinge on the upper breast referred to and illustrated in BRIT. HANDBOOK (II, p. 300 and Plate 56) is very poorly exhibited and the females can hardly be picked out from the males.

Juvenile female No. 18706 (wing 177, tail 132) from Simla (5th May, 'Skull incompletely ossified') is strongly rufous and has bold bands across the breast, broader than in any of the others, including *bakeri*, a character approached by No. 18707 (Simla o? juvenile). Both these resemble the hepatic female of *subtelephonus* in having a black spot/bar before the end of the tail.

Most of the juveniles have varying degrees of rufous all over. Measurements are under serial 579.

579 **Cuculus canorus bakeri** Hartert (Shillong, Assam) Khasi Hills Cuckoo 4 : 149

16 : 11 ♂♂ (2 pull., 2 juv.) 3 ♀♀ 2 o ?

1 Yusmarg, Kashmir; 1 Bhandardara, Ahmednagar; 1 Lamasinghi, Vizagapatam Dist.; 1 Yoshimathi, 1 Chamoli, Garhwal; 1 Sipuri, 1 Bankulwa, Morang, Nepal; 3 Darjeeling, 1 Longview T.E., Punkabari, 2 Goalpara, 2 Khasi Hills, Shillong, Assam; 1 *Maymyo, Burma.*

The nine adults are slightly darker above than those listed as nominate *canorus* and there is no other character which would appear to justify this separation. Specimen No. 20627 from Yusmarg, Kashmir, is distinctly greyer than all the others and D. Goodwin at the British Museum, to whom it was sent in 1968, suggested that it may be *bakeri.* If this is correct and a constant character, the others would all be nominate *canorus.* All the specimens listed under 578 and 579 were obtained between 19th March (Nepal) and 20th October (Amreli, Gujarat) which does not support the statement in IND. HAND. (3 : 209) that they are dispersed throughout Peninsular India 'between early August and mid-March'.

If these identifications are correct the specimen from Lamasinghi, Eastern Ghats, is the second record of this race from Peninsular India, the first being from Ahmednagar.

The specimens measure as follows :—

MALES	Wing	Bill	Tarsus	Tail
3 ad. *subtelephonus*	211, 214, 233	(1) 20	21(2), 22	163, 171, 182
	(IH 204-220	—	—	—
1 juv. ,,	mltg.	15	19	155
7 ad. nominate *canorus*	210-224 av. 219·5	19-21 av. 20	20-22 av. 21	160-173 av. 167
	(IH ♂♂ 209-243	(20-22)	c. 21-24	152-183)
7 juv. do. ,,	177-213 av. 200	18-23	18-24 av. 21	145-178 av. 159·5
7 ad. *bakeri*	208-234 av. 225	19-20 av. 19·3	20-23 av. 21	158-184 av. 174
2. juv. ,,	193, 215	19, 20	21, 22	156, 162
	(IH ♂♀ 208-240	—	—	—)
FEMALES				
2 juv. *subtelephonus*	201, 216	19(2)	21(2)	147-158
	(IH ♀♀ 184-216	—	—	—)
7 ad. nominate *canorus*	193-225 av. 212	18-20 av. 19	19-23 av. 21	155-170 av. 163
	[IH ♀♀ 213-230	(20-22)	23-24	157-170]
2 juv. do.	177, 205	19(1)	22(2)	132(1)
3 ad. *bakeri*	198, 217(2)	18, 19	18, 20	156, 157, 165
	(IH ♂♀ 208-240	—	—	—)

580 **Cuculus saturatus saturatus** Blyth (Nepal) Himalayan Cuckoo **4** : 140

12 : 6 ♂♂ 5 ♀♀(1 juv., 2 pull.) 1 o ? (pull.)

1 Koti State, 4 Simla ; 1 Deoband ?, 1 Kanaur ?, 2 Tumseong Tea Estate, Darjeeling ; 1 Khasi Hills, Assam ; 1 S. Andamans (8th March 1969).

	Wing	Bill	Tarsus	Tail
6 ♂♂	188-194 av. 191	—	—	150-163 av. 157
3 ♀♀	176, 179, 186	—	—	140, 144, 146
	(IH ♂♀ 179-192	—	—	144-159)

The two females from Kanaur(?) and S. Andamans (Nos. 10622 and 23180) have some rufous on the breast. The former (juvenile ?) also has traces of rufous barring on the hind neck, upper wing coverts and the tail.

581 **Cuculus poliocephalus poliocephalus** Latham (India) Small Cuckoo **4** :12

18 : 13 ♂♂(4 juv.) 4 ♀♀ (2 juv.) 1 o ?

1 Bagi, Bashar State, Punjab ; 1 Khandala; 2 Mercara, Coorg ; 1 Dakuri, Danpur, U.P. ; 1 Chalna-Khel, Nepal ; 5 Darjeeling ; 2 Sikkim ; 1 Shillong, 2 Dibrugarh, Assam ; 2 no data.

	Wing	Tail
10 ♂♂	150-173 av. 157	119-138 av. 128
2 hepatic ♂♂	145, 151	108, 124
2 ♀♀	150, 168	125, 119
3 hepatic ♀♀	144, 147, 148	123(2), 124
	(IH ♂♀ 142-162, once 171)	(IH 126-137)

All 5 hepatic birds (3 of which are marked *Cacomantis merulinus* by Stuart Baker !) have the upper breast and chin barred and I wonder if this is not a sub-adult phase, a suggestion supported by the measurements above. No. 10637 (Sikkim), which is the larger of the two hepatic males, has a rich chestnut unbarred head, the rest of the plumage being grey as in the adult and with almost no rufous elsewhere. No. 10638 (Mercara 10 Oct. 1918, wing 143, tail 120) shows no rufous but is marked as a juvenile of this species by Whistler.

After these notes were completed, Dr. D. R. Wells of the School of Biological Sciences, University of Malaya, Kuala Lumpur, Malaysia, passed through Bombay. He has been making a special study of *Cuculus saturatus* in south-east Asia, and has examined a large number of specimens at the British Museum (Natural History) and in the Natural History Collections at Leyden. He thought that specimens No. 10627 (♀ Sikkim) and 12636 (♂ no data), wings 171 and 172, which have their bills heavier than in other *poliocephalus*, are nominate *saturatus*.

Both however have their tails 130 mm. which is closer to *poliocephalus* and, pending publication of Dr. Wells's paper on this subject, I am making no alterations in my groupings.

582 **Cacomantis sonneratii sonneratii** (Latham) (India) Indian Bay-banded Cuckoo **4** : 157

13 : 7 ♂♂ 4 ♀♀ 2 o ?

1 Galkund, 1 Pandwa, Surat Dangs ; 1 Andheri, Bombay, 1 Ratnagiri, Maharashtra ; 1 Santgal, 1 Bakemani, 1 North Kanara ; 2 Darba, Bastar ; 1 Kutri, Daspalla, Orissa ; 1 Kumaon, U.P. ; 1 *North Shan States*, 1 *Hsipau, Burma.*

	Wing	Bill	Tarsus	Tail
7 ♂♂	121-125 av. 123	19-21 av. 20	16-18 av. 17·2	110-121 av. 114·5
4 ♀♀	121, 122, 123, 125	20-21	17(2), 18(2)	112, 114, 116, 125
	(IH ♂♀ 116-128	from skull 23-26	17-18	112-118)

583 **Cacomantis sonneratii waiti** (Baker) (Ceylon) Ceylon Baybanded Cuckoo **4** : 159

nil.

584 **Cacomantis merulinus passerinus** (Vahl) (Tranquebar) Indian Plaintive Cuckoo **4** : 159

21 : 15 ♂♂ (1*pull.) 2 ♀♀ (1 rufous) 4 o ?(1 pull., 1 rufous)

1 Keonthal, Simla ; 1 Kumaon ; 1* Bhyander, 1 Salsette ; 3 Karwar, 1 Dharwar, 1 Cassimode (?), 2 Kanara, 1 Talguppa, Sagar, Mysore, 1 Palni Foothills ; 1 Pt. Calimere ; 1 Seshachalam Hills ; 1 Lamasinghi, 2500′, Vizagapatam Dist.; 1 Hyderabad ; 1 Nilgiri, 1 Chilka Lake, Orissa ; 1 Sikkim.

	Wing	Bill	Tarsus	Tail
14 ♂♂	112-122 av. 116	17-20 av. 18	16-19 av. 17·6	104-118 av. 109
2 ♀♀	113, 114	17, 17	17, 18	104, 109
	(IH ♂♀ 113-120	—	17-19	105-115)

The 14 sexed grey specimens are males. Two hepatic specimens are superficially not unlike the females of *querulus*, but differ in having no bars on the similarly rufous tails and being much brighter chestnut above; one is sexed as a female, indicating one of the dimorphic forms mentioned by Whistler (AVIFAUNAL SURVEY OF CEYLON, p. 213). The other ♀ (No. 23272, Pt. Calimere, 26 Sept.) is like the male except that it has traces of rufous on the cheeks and upper breast, suggesting that it has moulted from a hepatic plumage. Two from Kanara (1 ♂ 1 o ?) are darker and show no white on the lower belly.

One pullet in (now) much-faded grey plumage, collected at Hyderabad, Deccan, bears the following note over Stuart Baker's signature: 'The extraordinary melanistic juvenile plumage sometimes found in this (*querulus* ? HA) and *merulinus*. Bird brought up from egg of red type in nest of *P. socialis*'. This only confirms that the earlier records of *querulus* (q.v.) have to be treated with circumspection. The second pullet is smaller, and resembles the adult in plumage except for faint traces of white (barring ?) all over the underparts.

♂ No. 10675 collected in Kanara on 7 May 1891 differs from the others in lacking both the white patch on the edge of the wing and all traces of white on the undertail coverts and tail. The underparts are also dark and not greyish.

585 **Cacomantis merulinus querulus** Heine (Lower Bengal, Assam, Sylhet, Burma, and China) Burmese Plaintive Cuckoo 4 : 156

10 : 4 ♂♂ 4 ♀♀ 2 o?

1 S. Sylhet, 3 Cachar, 1 2600′ Moirang, Manipur, Assam ; 1 *Taunggyi*, 1 *Paunkkaung*, 3 *Prome Dist., Burma.*

	Wing	Bill	Tarsus	Tail
5 ad. ♂♀	108-117 av. 113·4	17	16-19 av. 17·4	113-115 av. 114·2
5 juv. ♂♀	111-118 av. 113	16-18	17-18 av. 17·8	100-122
(IH ♂♀	109-119	15-17	17-18	112-125)

Of the 5 in adult plumage two (1 ♂ 1 o? Nos. 10681 & 10677) have their underparts paler rufous and also show slight traces of the juvenile barring on the wing coverts in one and on the head in the other. The three with darker underparts are 2 ♂♂, 1 o?.

♂ Sp. No. 21718 from Moirang is in an intermediate plumage, showing irregular traces of rufous barring and the paler rufous on the underparts.

With the material available it is not possible to comment upon the races and plumages except to draw attention to the following :—

(*a*) All included under *querulus* are east/south of the Brahmaputra and I have seen no evidence of the re-examination of the specimen from Cumbum, A.P., said to be of this form (Biswas 1951, *Ibis* p. 597).

(*b*) The single ♂ and 3 ♀♀ in rufous plumage have their tails barred with black, which is quite different from those of hepatic *passerinus*, in which the brighter chestnut of the tail (as also the upper parts) is not marked by cross-bars but only has a more or less straight black line along the central shaft.

(*c*) In all reference to earlier literature it must be remembered that Stuart Baker collected 3 hepatic specimens of *C. poliocephalus* one of which (with no data regarding time or place) is particularly marked 'Rufousbellied Cuckoo, *Cacomantis merulinus* ♀. The bird was caught by a noose round the neck in the act of placing its egg in the nest of *Suya khasiana*. This skin though rough should be kept—ECSB'. Curiously 3 other adult *querulus* (including one in the same year, 1904) are correctly named by Stuart Baker, the difference in size having been overlooked.

586 **Chalcites maculatus** (Gmelin) (Ceylon) Emerald Cuckoo 4 : 162

7 : 2 ♂♂ (1 juv.) 4 ♀♀ 1 o?

1 Karia Bustee, 4000′, Darjeeling ; 1 Goalpara, 1 Cachar, 2 Dibrugarh, Assam ; 1 Teressa, Nicobars ; 1 *Bangkok, Siam.*

The wings are 102-108 against 105-114 in the FAUNA, repeated in IND. HANDBOOK.

Only one ♂ from Karia Bustee, Darjeeling, is in adult plumage, with the neck and upperbreast as green as the back. The collector Rev. N. A. Fuller had obtained birds both in Darjeeling and in the Palnis, and the latter name was wrongly added on to the label, leading to its being quoted of this origin in IND. HANDBOOK (**3** : 222). The other ♂ has the green on the upper parts mixed with coppery, the front half of the head barred black and the similar markings on the underparts extending up to the chin.

In my Nicobar paper (*JBNHS* **64** : 171) I have referred to the female from Teressa having its upperparts green as in Emerald Dove but turning coppery in 3 days. The juvenile, bred from an egg taken in the nest of *Aethopygia seheriae* by Stuart Baker, does not agree with his description in the FAUNA, not being barred above and with no elongate marks on the head. The underparts are completely barred black and white with the breast and chin washed with rufous. The females are all similarly marked below (3 without rufous wash) and show a varying amount of emerald green on the upper parts.

The Teressa ♀ resembles the sub-adult ♂ in having traces of barring on the forecrown. The plumages do not appear to be understood.

The unsexed specimen has a rufous wash over the head, chin, and upperbreast, which appears to be a juvenile character, showing in two of the females.

587 **Chalcites xanthorhynchus** (Horsfield) (Nepal) Violet Cuckoo

1 ♂ Cachar. Wing 104 (95-105), tail 73 (64-72). **4** : 165

588 **Surniculus lugubris dicruroides** (Hodgson) (Mountains of Nepal) Indian Drongo-Cuckoo **4** : 165

16 : 5 ♂♂ (1 juv.) 10 ♀♀ 1 o ?

2 Simla Hills ; 1 Powai Lake, 1 Trombay, 1 Thana, Bombay ; 1 N. Kanara ; 1 Kurseong ; 1 Goalpara, 4 Dibrugarh, 1 Cachar, 1 Lakhimpur, 1 Laitkensew, Khasia Hills, Assam ; 1 *Toungoo, Burma*.

The males have wings 137, 142(2), 144 and tails 137, 143, 157 which are slightly larger than in the females 129-146 av. 135 and 117-157 av. 132 (IH♂♀ wing 135-148; tail 128-152). Three from the Bombay area in which the tails are perhaps more distinctly forked (fully grown ?) have them 148, 157, and 158, which is appreciably longer than in the others. The white spot on the nape is visible in one male and eight females. The juvenile male from Dibrugarh (8th August) has small white spots on the head and underparts and also a few on the wing coverts. These spots are not terminal as stated in FAUNA and IND. HANDBOOK.

589 **Surniculus lugubris stewarti** Baker (Ceylon) Ceylon Drongo-Cuckoo **4** : 166

1 ♂ Maha Oya, Ceylon

Wing 130 ; bill 18 ; tail 135

590 **Eudynamys scolopacea scolopacea** (Linnaeus) (Malabar) Indian Koel 4 : 172

45 : 20 ♂♂ (7 juv.) 24 ♀♀ (1 pull., 3 juv.) 1 o ?(albino)

1 Kalka, Simla Hills; 2 Nawashahr, Jullundur; 1 Deesa, Palanpur, 2 Kutch, 2 Gir Forest, 1 Tapkeshwari, Bhuj, 1 Bulsar; 1 Madmeshwar, 1 Nasik, 1 Thana, 7 Bombay, 1 Rewas, Kolaba, 1 Panchgani, 1 Ratnagiri; 1 Bhatkal, North Kanara; 1 Balgod, 1 Kugwe, 1 Murgi-Metta, 3 Sorab, Sagar, 1 Bangalore, Mysore; 1 Seshachalam Hills, 1 Palkonda Hills; 1 Cassimode, S.I.; 2 Baghownie, 1 Darbhanga, Bihar; 2 Benares; 1 Raipur, Dehra Dun; 1 Thankot, 2 Hathiban, Nepal; 2 Latiguri, Jalpaiguri.

Measurements are under serial 592.

♂ No. 18730 (Kalka, NW. Himalayas, 23 August 1924) with both wing and tail not fully grown, has dark head, chin, and upper breast, the rest of the underparts being barred as in adult ♀. The upper parts are not so prominently marked with white and the bars on the tail are rufous.

No ♂ pullet is available but there is a subadult plumage in which the upperparts, wing and tail are brown and not glossy black, 6 such ♂♂ are dated February, April, June, July, August, and October (2) the earlier birds perhaps from eggs laid in the nest of the Jungle Crow. No. 21814 (23 Feb., Mysore) has white tips to the primary coverts, white bars on the inner webs of the primaries, and traces of barring on the two pairs of outer tail feathers.

591 **Eudynamys scolopacea malayana** Cabanis & Heine (Sunda Islands and Sumatra) Malay Koel 4 : 174

7 : 4 ♂♂ (1 juv.) 3 ♀♀

3 Dibrugarh, Assam; 1 *Sandoway*, 2 *Prome Dist.*; 1 *Upper Burma.*

Measurements are under serial 592.

The juvenile ♂ (28th July, Dibrugarh) which does not have a fully grown tail resembles those of the nominate race having the wing coverts and primaries tipped with white.

592 **Eudynamys scolopacea dolosa** Ripley (Barren Island, Andamans) Andaman Koel

5 : 2 ♂♂ 3 ♀♀

1 Port Blair, 1 Humphryganj, 1 South Andaman; 1 Nancowry, Central Nicobar, 1 Great Nicobar.

IND. HANDBOOK (**3** : 230) errs in quoting my measurements of the bill (*JBNHS* **64** : 171) as '27-34 from skull' for these measurements are from the feathers of the forehead.

E. s. scolopacea	Wing	Bill	Tarsus	Tail
12 adult ♂♂	183-203 av. 194	28-31 av. 28·7	29-32 av. 31	169-205 av. 184
	[IH 182-205	(28-31)	32-35	186-205]
20 adult ♀♀	174-203 av. 187	27-29 av. 28	29-32 av. 29	168-197 av. 178
	[IH 179-203	(28-31)	31-35	171-189]

E. s. malayana				
3 ♂♂	199, 205, 206	31(2), 32	33(2), 34	180, 181, 190
3 ♀♀	198, 200, 206	30(2), 31	33, 35(2)	145, 175, 188
	(IH ♂♀ 190-221	32-34	35-37	181-203)
E. s. dolosa				
2 ♂♂	209, 224	32, 33	31, 33	201-213
	(IH 203-235	—	—	189-221)
3 ♀♀	192, 200, 209	31, 32 (2)	32(2), 33	178, 183, 199
	(IH 201-216	—	—	184-197)

593 **Rhopodytes tristis tristis** (Lesson) (Sumatra *errore*=Bengal) Large Greenbilled Malkoha **4** : 178

20 : 10 ♂♂ (4 juv.) 7 ♀♀ (3 juv.) 3 o ?

1 Bhopalpatnam, 1 Kotamsar, Bastar Dt.; 1 Bamra, 1 Hazaria, Pattargatta; 1 Longview T.E., Darjeeling; 1 Sikkim; 1 Bankulwa, Morang, 1 Sagang, Nepal; 2 Goalpara, 2 Roopchena, Cachar, 1 Golaghat, 1 Dibrugarh, 1 Buxa, 1 Abor Country, Assam; 1 *Nkang*, 1 *Kani*, 1 *Moungkan, E. Bank, L. Chindwin*, 1 *Dimlo, Chin Hills, Burma.*

	Wing	Bill	Tarsus	Tail
6 ♂♂	162-172 av. 167	32-33 av. 32	41-42 av. 41	312-394 av. 367
4 ♀♀	162, 162, 165, 173	31, 32, 33	40, 41, 43, 44	326, 344, 354

According to IND. HANDBOOK the fledgling is like the adult but the juvenile undescribed. Some birds have a few of the wing- and tail-quills brown without any gloss, as in the juvenile *Eudynamys scolopacea* referred to above, and no doubt represent the same phase.

Though some of the specimens are from the accepted range of *R. t. saliens* Mayr, I am unable to separate them. The 3 from continental India (2 Bastar, 1 Orissa) are not unlike *R. t. longicaudatus* (Blyth) from Southern Burma.

IND. HANDBOOK (**3** : 234) holds that *R. tristis* differs from *R. viridirostris* (Jerdon) in not having the feathers of the chin and throat bifurcate. The specimens of *tristis* show this character very distinctly and their range in peninsular India appears to be clearly divided, suggesting a subspecific and not specific difference.

594 **Rhopodytes tristis saliens** Mayr (Chapa, Tonkin) Burma Large Greenbilled Malkoha

nil.

EL **Rhopodytes tristis longicaudatus** (Blyth) (Moulmein) Large Malay Greenbilled Malkoha **4** : 179

4 : 3 ♀♀ 1o ?

1 *Taunggyi, S. Shan States*, 1 *Sadon Chaung, Thayetmyo*; 1 *Sandoway*; 1 *Ateran, Burma.*

These birds differ from nominate *tristis* in their greyer throats and breasts which lack the ochraceous wash.

	Wing	Bill	Tarsus	Tail
3 ♀♀	158, 160, 173	30, 31, 32	40, 41, 42	354, 365

595 **Rhopodytes viridirostris** (Jerdon) (Bottom of the Coonoor Pass) Small Greenbilled Malkoha 4 : 177

15 : 10 ♂♂ (2 juv.) 4 ♀♀ (1 juv.) 1 o ?

1 Karwar, 3 North Kanara ; 2 Palni Foothills, 1 Kowenuth, Travancore ; 1 Jamestown, Kanyakumari Dt., 1 Thirthamalai, 2 Chetteri Range, Salem Dt.; 1 Palkonda Hills, Cuddapah ; 1 Nallamalai Hills, South Kurnool, 1 Bhusandpur, Chilka Lake, 1 Daspalla, Orissa.

	Wing	Bill	Tarsus	Tail
8 ♂♂	130-142 av. 134·5	27-29 av.28	32-35 av. 33·7	214-246 av. 226·6
	[IH 131-143	(c. 27-29)	32-36	202-246]
3 ♀♀	132(2), 136	28(3)	34, 35(2)	228-229, 245
	[IH 129-140	(c. 27·29)	32-34	218-240]

The three juveniles obtained in May (2) and June do not have gloss, on the upper parts and, as in the Koel and *Rhopodytes tristis*, have brown feathers in the wing and tail.

EL **Rhamphococcyx curvirostris erythrognathus** (Bonaparte) (Sumatra) Malay Chestnut-breasted Malkoha 4 : 181

2 : 1 ♂ 1 o ?

1 *Bankachon, South Tenasserim*, 1 *Thitkado, Burma*.

Wing	Bill	Tarsus	Tail
168, 170	42	42, 43	270, 276
(158-177	39-42	41-42	239-270)

The specimen from Thitkado was collected by Sálim Ali in 1920 and has been lying under the name of *Rhopodytes sumatranus* Raffles.

596 **Taccocua leschenaultii sirkee** (J. E. Gray) (Cawnpore) Western Sirkeer Cuckoo 4 : 187

9 : 4 ♂♂ 4 ♀♀ 1 o ?

1 Chandigarh, 1 Jagadhri ; 1 Meerut ; 3 Delhi ; 2 Gwalior, C.I.; 1 Baghowni, Bihar.

	Wing	Bill	Tarsus	Tail
♂♀	157-164 av. 157	c. 26	41-44	236-259 av. 245
	[IH (once 148) 153-168]	(24-26)	—	—

597 **Taccocua leschenaultii infuscata** Blyth (Sub-Himalayan region ; type from near Darjeeling) Eastern Sirkeer Cuckoo 4 : 187

9 : 4 ♂♂ 4 ♀♀ 1 o ?

1 Sonawani, Balaghat Div., 2 Bastar, M.P ; 1 Daspalla, 1 Nilgiri, 1 Keonjhar 1 Mahendragiri, 1 Bonai, Orissa ; 1 no data.

	Wing	Bill	Tarsus	Tail
♂♀	147-157 av. 152·7	26-27	40-42	236-2 63
	(IH 148-167	from skull 31-35	—	—)

These birds some of them so marked by Sálim Ali are listed under *infuscata* following the arrangement in IND. HANDBOOK, but the identity of *affinis*, as also of *infuscata*, is not very clear. None of the specimens have the large 165 mm. wing referred to in the original description of *infuscata*, and again by Whistler (*JBNHS* **37** : 527) when he recorded a specimen from Sankrametta in the Eastern Ghats (wing 153·5 ; tail 233) as *affinis* and referred to its being smaller than *infuscata* from the Eastern Terai. He also suggested that the wing measurements in FAUNA 153-186 were in error for 153-168.

Blyth (*JASB* 1846, p. 19), describing *affinis* from Rajmahal and Monghyr Hills, stated that the tibial plumes are brownish and concolorous with the back, and not rufous as in all the others. This character does not show in any of the specimens available.

In the absence of topotypical or any northern *infuscata* with *large* wings, it was not possible to express any opinion, and I borrowed from the American Museum of Natural History their specimen No. 462156, a ♂ collected at Amlekhganj, Nepal, on 7 March, 1947, by Koelz, which is generally accepted as *infuscata*. This specimen (wing 156 ; bill 26 ; tarsus 40 ; tail 201) generally resembles in size and colour the series from eastern M.P. and Orissa and, if supported by a matching series, could well be separated by the greyer upperparts, the paler rufous on the belly, and a more clearly distinct grey on the throat, neck, and upper breast, in which there is no trace of rufous.

There is suggestive evidence that some birds from the north have their wings 164 mm. and larger, and it is possible that in the hills a larger form is present to which the name *infuscata* would apply. If so, we would still have to determine how to classify (i) the smaller bird from Nepal, (ii) the rufouswashed specimens listed above, and (iii) the existence or otherwise of *affinis* as described.

598 **Taccocua leschenaultii leschenaultii** Lesson (Madras) Southern Sirkeer Cuckoo **4** : 185

9 : 4♂♂ 4 ♀♀ 1 o ?

1 Mehsana, 1 Nadiad, 1 Surat Dangs, Gujerat ; 1 Bhopal C.I. ; 1 Kumili, High Range, Kerala ; 3 Palni Foothills ; 1 Seshachalam, S. Cuddapah.

The birds from Gujerat are slightly paler on the upper parts, and have less grey on the throat and upperbreast, but with the material available Koelz's *vantynei* (1954, *Contrib., Inst. Regional Exploration* **1,** p. 24) does not appear worth separating.

	Wing	Bill	Tarsus	Tail
♂♀	150-160 av. 156	26	39-42	235-261 av. 245

Three from the Palni Foothills (2 ♀♀ 1 o ?) are darker above and below and show more grey on the throat than the others, showing a tendency towards *infuscata/affinis* (q.v.). They are also smaller :

Wing	Bill	Tarsus	Tail
138, 148	25, 26(2)	36, 38(2)	215(2), 225

599 **Phaenicophaeus pyrrhocephalus** (Pennant) (Ceylon) Redfaced Malkoha 4 : 182

2 : 1 ♂ 1 ♀

1 Balangoda, 1 Rygamkorale, Ceylon.

	Wing	Bill	Tarsus	Tail
1 ♂	148	35	33	261
1 ♀	151	36	32	265

600 **Centropus sinensis sinensis** (Stephens) [Ning Po (now Ninghsien), China] Common Crow-Pheasant or Coucal 4 : 189

10 : 2 ♂♂ (1 juv.) 5 ♀♀ (2 juv.) 3 o ? (2 juv., 1 pull.)

1 Jagadhri, Ambala, 1 Bahawalpur State ; 1 Keoladeo, Bharatpur ; 1 Okhla Delhi ; 1 Meerut, 1 Bhimtal, Kumaon, U.P.; 3 Baghowni, Darbhanga, Bihar ; 1 Nepal.

		Wing	Tarsus	Tail
4 adults	1 ♂	212	62	245
	3 ♀♀	223, 233, 237	62, 64, 65	272, 275, 287
		(IH ♂♀ 205-232, one 239, one 242	58-66	220-262)

I have recently had occasion to examine at the Zoological Survey of Pakistan, Karachi, a series of specimens from East and West Pakistan. Though they show no differences in colour, their measurements are almost exclusive :

	Wing	Tarsus	Tail
Western ♂♂ (11)	210-235 av. 220	53, 58, 60(2)	250, 260(2), 289, 296
Western ♀♀ (7)	206-235 av. 222	55(2), 58	285, 290(2)
Eastern ♂♂ (7)	196-212 av. 204	50-64 av. 56·5	233-262 av. 241
Eastern ♀♀ (4)	200-208 av. 206	49, 55, 57	230-262 av. 244·5

The 18 western birds are, from Mirpur Sakru, Sangar, Thatta, Kotri, and Karachi, all in Sind. The 13 including 2 unsexed eastern birds were obtained west (1 Gopalpur, 1 Rajshahi, 1 Mohanganj, 3 Dinajpur, 1 Gailabanda, Rangpur) and east or south (2 Sylhet ; 2 Dohazari, 1 Harbans, Chittagong ; 1 Cox's Bazar) of the Brahmaputra and show no differences in size or colour. None show any degree of duskiness.

La Touche in HANDBOOK OF BIRDS OF EASTERN CHINA refers to nominate *sinensis* extending into South Yunnan, while Peter's CHECKLIST (**4** : 70) states that birds from Manipur, Assam, south of the Brahmaputra, are the same. In IND. HANDBOOK (**3** : 243) both the places are attributed to *intermedius*. Biswas's measurements from Nepal (loc. cit.), 5 ♂♀ : wing 193-210, tail 222-245, are smaller than of western birds and agree with those from further east and south, i.e. *intermedius*, of which the type localities were originally Dhoon, Dacca, and Thayetmyo, later restricted by Stresemann in 1913 (NOV. ZOOL. **20** : 322) to Thayetmyo. The restriction was accepted by Stuart Baker (**4** : 192) but is ignored in IND. HANDBOOK. If *intermedius* is accepted from Nepal, there would be two populations of nominate *sinensis* occurring in two distant areas separated by *intermedius*. Blanford (FAUNA **3** : 241) presumably with access to topotypical material held there was no difference between *sinensis* and *intermedius* and accepted Hume's *maximus* as the larger form from Sind and northern India. Pending an opportunity to examine material from China, I am grouping them largely in accordance with the distribution in IND. HANDBOOK. If *maximus* is accepted, I suggest that Hume's type locality, 'Sindh and Sikim', be restricted to Sind. The species is not mentioned in Sâlim Ali's BIRDS OF SIKKIM, and Hume's reference may be to another place.

Smith's *Centropus fasciatus* (*JASB* 1841, p. 658/9) from Gorrukpur is no doubt based on a barred juvenile of this species.

601 **Centropus sinensis intermedius** (Hume) (Thayetmyo) East Pakistan Crow-Pheasant **4** : 192

4 : 3 ♂♂ (2 juv.) 1 ♀ juv.

1 Goalpara, Assam; 1 *North Shan States;* 1 *Thayetmyo*, 1 *Prome District, Burma*.

	Wing	Tarsus	Tail
1 adult ♂	193	55	225

Both *intermedius* and *sinensis* differ from *parroti* in the adults having a purple and not greenish gloss, and in the young being barred.

See also remarks under 600.

602 **Centropus sinensis parroti** Stresemann (Ceylon) Southern Crow-Pheasant **4** : 192

40 : 16 ♂♂ (1 juv.) 21 ♀♀ 3 o ?

1 Ambala, Punjab*; 1 Delhi*; 1 Saitanwara, Gwalior; 1 Chadav, Bhuj, Kutch, 2 Pimpri, Surat Dangs; 1 Kymore, M.P.; 2 Nasik, 1 Kalyan, 2 Thana, 3 Bombay, 3 Khandala, Maharashtra; 1 Castle Rock, 1 North Kanara, 3 Hosur, 2 Sagar, Mysore; 1 Kodaikanal, 1 Billigirirangan Hills, 1 Edanad, 1 Madura, 2 Chitteri Range, Salem; 1 Palkonda, 2 Nellore, 1 Koduru, South Cuddapah Dt., A.P.; 2 Bastar, 1 Barkot, 1 Keonjargarh, 1 Badrama, Orissa.

	Wing	Bill	Tarsus	Tail
15 ♂♂	180-200 av. 190·6	34-39 av. 36	50-57 av. 53·2	233-284 av. 255·6
21 ♀♀	185-209 av. 196	34-38 av. 36	51-57 av. 52·3	224-320 av. 268

In an earlier note (*JBNHS* **54** : 183) I have referred to the young of *sinensis* (*maximus* ?) and *intermedius* being barred. Barred young are available from Ambala and Delhi, while adults from the same place have black backs and shorter wings and tarsi, which would make them *parroti*, leaving them in an area presumably also inhabited by nominate *sinensis* (*maximus* ?).

Of 18 dusky birds examined, including specimens borrowed from Zoological Survey, only 4 are males. The birds are from Ambala (1), Delhi (1), Kutch (1), Surat (1), Nasik (1), Thana (1), Bombay (2), Madhya

Pradesh (6), Bastar (1), and Orissa (3) the character being found throughout the year, and most pronounced in Bastar and Orissa. The non-dusky birds include 13 males and 10 females.

Except that the duskiness appears to be more frequent in the females, it is not possible to indicate what it signifies.

4 males and 1 female from Mysore show an exceptional amount of green gloss on the upper parts, a character shared only with a specimen from Kerala.

It will be noticed that birds from Ambala and Delhi are included under both *parroti* and *sinensis* (*maximus*). The specimens listed as *parroti* are two females No. 18740 from Delhi and 18739 from Ambala, which have their wings 195 and 198, black backs, and a slight trace of duskiness, all characteristic of this species. Of the two others from Okhla, Delhi (o ? No. 21758) and Ambala (♂ No. 18738) the former is a completely barred juvenile, and the latter has a rufous back and purplish head, though a small 212 mm. wing. Stresemann (*Nov. Zool.* 1933, **20** : 324) when describing *parroti* includes a specimen from Ambala.

The relationships and association of the two or three subspecies meeting around Delhi leave room for an interesting study.

603 **Centropus (sinensis) andamanensis** Beavan (Andaman) Andaman Crow-Pheasant 4 : 193

5 ♀♀

2 Wimberleyganj, 1 Wrightmyo, 1 Long Island, 1 Sipighat, South Andamans.

604 **Centropus chlororhynchus** Blyth (Ceylon) Ceylon Coucal 4 : 193

nil.

605 **Centropus toulou bengalensis** (Gmelin) (Bengal) Lesser Coucal 4 : 194

12 : 2 ♂♂ (1 ad., 1 subad.) 4 ♀♀ (3 subad., 1 juv.) 6 o ? (1 ad., 2 subad., 2 juv., 1 pull.)

1 Baghowni, 1 Sepaya, Saran, 1 Darbhanga, Bihar ; 2 Goalpara, 1 Surma T. E., Sylhet, 1 Bagho-Bahar, 1 Roopchena, Cachar, 1 Dibrugarh, Assam ; 1* Ceylon ; 1 *Ngawphaw, Prome Dt., Burma* ; 1 no data.

	Wing	Bill	Tarsus	Tail
2 ad. (1♂ 1 o ?)	155, 155	24, 26	42, 45	190
5 subad. ♂♀	144-174 av. 160	21-29 av. 22.4	36-44 av. 90	160-195 av. 179·2
4 juv.	147(2), 153, 165	20, 21, 22, 23	37, 39, 40, 41	160, 175(2), 193
	(♂♀ 137-174	22-26	36-37	156-211)

The juveniles differ from the subadults in having one, or more, primaries barred, a character absent in the phase marked subadult. The pullet differs from the juvenile in the almost complete absence of pale shaft streaks to the feathers of the head and upper parts. The few feathers on the back with slight traces of the pale shaft are rufous, banded with black, presenting a barred appearance lacking in all the others.

A similar sequence of several plumages is described for the Philippine Coucal (*Centropus viridis*) by K. C. Parker, *Ibis*, 1957, pp. 518-520. The NEW DICTIONARY OF BIRDS, page 129, shows a colour plate of the African nominate *toulou* in which the streaked plumage is said to indicate a non-breeding and the other a breeding plumage.

Biswas (*JBNHS* **57** : 546) has measured 5 ♂♂ (wing 137-148 ; tail 163-181) and 5 ♀♀ (wing 161-169 ; tail 180-200). The present series contains several unsexed birds which are intermediate in size ; but though the few sexed specimens indicate that the females are larger (wing 153, 164, 165, 174 ; tail 170, 175, 190, 195) than the males (wing 155, 155, tail 190) the measurements are not exclusive.

The bills are black in the two in adult plumage and yellowish horny in the others.

*Sp. No. 10863 obtained by A. L. Butler in Ceylon (no other data) is presumably the bird referred to by Whistler (*Spolia Zeylanica, Av. Survey of Ceylon*, **23**: 219) as obtained by Butler from a native dealer in 1896, and not admissible to the Ceylon list.

There is no material from southern India, and I can only draw attention to Whistler's statement (*JBNHS* **37** : 528) that the six specimens in the British Museum said to be from Peermade ' do not belong to the typical race '.

(*to be continued*)

A Contribution to the Flora of Gangolihat Block in Pithoragarh District[1]

BY

V. Singh and H. Singh

School of Plant Morphology, Meerut College, Meerut

Introduction

The flora of the Kumaon hills is known through the collections of Strachey and Winterbottom made in the years 1846-49. The original catalogue was revised and supplemented by Duthie (1906). In 1927 Osmaston published the Forest Flora for Kumaon which enumerates only woody elements. Raizada (1934, 1941) also made some additions to the flora of Kumaon. More recently Jain (1956) and Bhargava & Gupta (1958) listed the plants of Nainital. The present work deals with the flora of Gangolihat block in Pithoragarh district studied by the authors during 1968.

Geography of the Area

The Pithoragarh district is divided into two tehsils, Pithoragarh and Didihat. Gangolihat block is one of the two blocks of Pithoragarh tehsil. It occupies an area of about 1367 sq. km. and has mountains varying in elevation from 1200 to 2750 metres. The approximate bearings of Gangolihat are 29°50′ N and 80°E. The rivers Ram Ganga and Saryu make the boundary of the Gangolihat block in east and south respectively.

Soil and Climate

Limestones and quartzites and shales form the principal types of soils met within the area. The floor of the forest is rich in humus and organic contents and the soil is black in colour. On the slopes red loamy soil is prevalent.

The climate of Gangolihat is monsoonic temperate. Since no climatic data are available for Gangolihat, the information given here is

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[1] Research contribution No. 92 from the School of Plant Morphology, Meerut College, Meerut.

based on the climatic data of Askote, the nearest place with a meteorological station. The average annual rainfall is about 2200 mm.; June, July and August are the wettest months, having three-fourth of the total precipitation. The remaining one-fourth is distributed throughout the year.

April, May and early part of June are the hottest months with maximum temperatures up to 30°C. During winter, beginning from November, the temperature drops until January and February, which are the coldest months, the average temperature ranges from 6 to 14° C, but frequently drops to freezing point or below. Snow comes from December to February and is heavy on the higher hills.

The humidity is highest during monsoon months, mid-June to mid-September being 70-90%. It gradually decreases until January, then again it increases lightly in the months of February and March and finally drops to an average of 40% until the advent of the rainy season.

Vegetation

About three-fourths of the area of the Gangolihat block is covered with forest. The nature of the forest varies considerably with the exposure and with the quality of the soil. The northern slopes with black soil are more rich in vegetation. The valleys of Ram Ganga and Saryu rivers are covered with sal (*Shorea robusta*) forests. At higher altitudes up to 1000 metres, *Shorea robusta* and *Pinus roxburghii* form mixed communities. At elevations from 1000 to 1700 m. conifers become dominant, *Pinus roxburghii* forming pure communities. The areas from 1700 to 2700 m. are covered by forests of oaks with *Cedrus deodara* growing in some pockets particularly on northern slopes. *Quercus incana* and *Q. lanuginosa* are the dominant species in the oak forests. *Rhododendron arboreum* is the most common tree associated with oak forests and *Myrica fraquhaniana*, *Lyonia ovalifolia*, *Dendrobenthamidia capitata* and *Alnus nepalensis* are other common species.

In the forest of oak and deodar there is little undershrub. On dry exposures *Berberis aristata*, *B. asiatica*, *Desmodium tiliaefolium*, *Spiraea vaccinifolia*, *Elsholtzia polystachya* and *Plectranthus rugosus* are characteristic. On the cooler and wetter slopes, besides some of the above mentioned shrubs, species of *Salix* and *Viburnum* are common. In the undergrowth of ravines, species of *Indigofera*, *Sarcococca pruniformis*, *Myrsine africana*, *Osbeckia stellata* and *Prinsepia utilis* are prominent.

The more open glades of the forest are covered with *Boenninghausenia albiflora*, *Pimpinella diversifolia*, *Valeriana wallichii*, *V. hardwickii*, *Dipsacus manjitis*, *Bupleurum tenue*, species of *Anaphalis* and *Plectranthus*, etc.

The grassy slopes are covered with a luxuriant growth of *Potentilla, Gentiana, Polygonum, Anemone, Swertia, Ranunculus, Pedicularis, Eplobium, Polygala*, etc.

The oak forests have a rich growth of orchids. The epiphytic species occur on northern slopes which are damp and cool. *Dendrobium amoenum, D. alpestre, Cymbidium giganteum, Vanda cristata* and *Pholidota articulata* are the common epiphytic orchids of the oak forests. The terrestrial species include *Eria alba, Microstylis wallichii, Coelogyne cristata, Habenaria edgeworthi, Satyrium nepalense* and *Herminum angustifolium.*

Taxillus vestitus, Viscum nepalense, V. japonicum and *Korthalsella opuntia* commonly parasitise oak trees.

Enumeration of Species

The present work is primarily a record of the plants collected during three trips made in 1968. In this work Bentham and Hooker's system of classification has been followed. Hutchinson (1959) has been followed in splitting of the families. An attempt has been made to incorporate nomenclatural changes. Local names of the plants, where available, have also been given after the botanical names. Brief description of plants have been given followed by the localities of collections and their approximate altitude. Field numbers of each species are given in brackets after their description.

A total of 366 species of Angiosperms and 2 species of Gymnosperms representing 279 genera and 100 families have been listed in the following pages. The specimens cited in this work are deposited in the Herbarium of the School of Plant Morphology, Meerut College, Meerut.

DICOTYLEDONS

Ranunculaceae

Clematis buchananiana DC.

Climbing shrub with pale yellow flowers. Nandan hill, 2330 m. (5130).

Anemone obtusilobus D. Don

Herb with white flowers. Daula hill, 2230 m. (5381).

Thalictrum javanicum Blume

Herb with white flowers. Mallagarkha, 1660 m. (5282).

Ranunculus hyperboreus Rotteb. var. **radicans** Meyer

Creeping herb with yellow flowers. Goptari, 2000 m. (5448).

R. hirtellus Royle

Herb with bright yellow flowers. Daula hill, 2230 m. (5156).

R. sceleratus L.

Herb with pale yellow flowers. Mallagarkha, 1660 m. (5014).

R. laetus Wall.

Herb with bright yellow flowers. Mallagarkha, 1660 m. (5048).

Delphinium denudatum Wall.

Herb with spurred blue flowers. Daula hill, 2230 m. (5158).

Menispermaceae

Stephania elegans Hook. f. & Thoms.

Climbing shrub with red purple flowers. Gangolihat, 2000 m. (5427).

S. glabra (Roxb.) Miers. (Loc. Gargee ganh)

Climbing shrub with green yellow flowers. Mallagarkha, 1660 m. (5308).

Cissampelos pareira L.

Climbing shrub with greenish yellow flowers. Gangolihat, 1800 m. (5234).

Berberidaceae

Berberis chitria Ham. ex Ker. (Loc. Chuttar)

Spiny shrub with bright yellow flowers. Daula hill, 2230 m. (5148).

B. asiatica Roxb. (Loc. Kinmour)

Shrub with yellow flowers. Gangolihat, 1800 m. (5056).

Fumariaceae

Fumaria indica (Haussk.) Pugsley

Herb with pink flowers. Mallagarkha, 1660 m. (5017).

Cruciferae

Sisymbrium wallichii Hook. f. & Thoms.

Herb with white flowers. Mallagarkha, 1660 m. (5025).

Capsella bursa-pastoris Medic.

Herb with white flowers. Mallagarkha, 1660 m. (5016).

Lepidium sativum L. (Loc. Halim)

Herb with white flowers. Mallagarkha, 1660 m. (5026).

VIOLACEAE

Viola canescens Wall.

Herb with lilac flowers. Daula hill, 2230 m. (5041).

POLYGALACEAE

Polygala tatrinowii Hegel.

Small herb with deep pink flowers. Goptari, 2000 m. (5435).

P. crotalarioides Buch.-Ham.

Perennial herb with purple flowers. Goptari, 2230 m. (5454).

P. chinensis Linn.

Herb with yellow flowers. Mallagarkha, 1660 m. (5268).

CARYOPHYLLACEAE

Silene conoidea L. (Loc. Tumaria)

Herb with pink flowers. Mallagarkha, 1660 m. (5015).

Cerastium glomeratum Thuill.

Viscid-pubescent herb with white flowers. Daula hill, 2230 m. (5076).

Stellaria media (L.) Vill. (Loc. Khusania)

Herb with white flowers. Mallagarkha, 1660 m. (5063).

Drymaria diandra Blume

Procumbent herb with white flowers. Mallagarkha, 1660 m. (5391).

HYPERICACEAE

Hypericum oblongifolium Choisy

Small shrub with yellow flowers. Daula hill, 2230 m. (5029).

H. uralum Buch.—Ham.

Shrub with yellow flowers. Mallagarkha, 1660 m. (5241).

H. japonicum Thunb.

Perennial herb with yellow flowers. Goptari, 2230 m. (5407).

THEACEAE

Camellia sinensis (L.) O. Ktze. (Loc. Chai)

Bushy shrub with white flowers (planted). Jhaltora, 2200 m. (5324).

DIPTEROCARPACEAE

Shorea robusta Gaertn. f. (Loc. Sal)

Large resinous tree with yellowish flowers. Banks of Ramganga, 880 m. (5444).

MALVACEAE

Malva sylvestris L.

Herb with pink-purple flowers. Gangolihat, 2000 m. (5343).

Sida cordata (Burm. f.) Borss

Trailing herb with yellow flowers. Mallagarkha, 1660 m. (5273).

Urena lobata L.

Erect undershrub with pink flowers. Mallagarkha, 1660 m. (5442).

Hibiscus cancellatus Roxb. (Loc. Kapasua)

Perennial herb with pale yellow flowers. Mallagarkha, 1660 m. (5295).

BOMBACACEAE

Bombax ceiba L.

Large handsome tree with crimson flowers. Mallagarkha, 1700 m. (5172).

STERCULIACEAE

Sterculia villosa Roxb.

Medium sized tree with yellow flowers. Daula hill, 2230 m. (5379).

TILIACEAE

Triumfetta pilosa Roth

Tall bristly herb with yellow flowers. Mallagarkha, 1660 m. (5296).

Linaceae

Linum usitatissimum L. (Loc. Alsi)

Herb with blue flowers (naturalized). Mallagarkha, 1660 m. (5076).

Reinwardtia trigyna Planch. (Loc. Pyaoli)

Trailing undershrub with bright yellow flowers. Mallagarkha, 1660 m. (5023).

Geraniaceae

Geranium nepalense Sweet

Herb with pale purple flowers. Mallagarkha, 1660 m. (5155).

G. ocellatum Camb.

Herb with pink flowers. Mallagarkha, 1660 m. (5047).

Oxalidaceae

Oxalis corniculata L.

Herb with yellow flowers. Mallagarkha, 1660 m. (5164).

O. latifolia H.B. & K.

Herb with pink purple flowers. Mallagarkha, 1660 m. (5133).

Balsaminaceae

Impatiens thomsoni Hook. f. & Thoms.

Herb with pale pink spurred flowers. Mallagarkha, 1660 m. (5084).

Rutaceae

Boenninghausenia albiflora Reichb.

Herb with white flowers. Daula hill, 2230 m. (5375).

Zanthoxylum armatum DC. (Loc. Timoor)

Small spinous tree with yellow flowers. Mallagarkha, 1660 m. (5119).

Murraya paniculata (L.) Jacq. (Loc. Chandanee)

Evergreen shrub with fragrant white flowers (planted). Gangolihat, 2000 m. (5213).

Citrus medica L. (Loc. Chookh)

Small tree with purplish white flowers (planted). Gangolihat, 2000 m. (5306).

C. sinensis L. (Loc. Narangi)

Moderate sized tree with white flowers (planted). Gangolihat, 2000 m. (5351).

C. aurantifolia (Christ.) Swingle (Loc. Nimbu)

Small tree with white flowers (planted). Gangolihat, 2000 m. (5307).

Aegle marmelos (L.) Correa (Loc. Bel)

Small deciduous tree with white flowers (planted). Ganayee, 1800 m. (5326).

Meliaceae

Azadirachta indica Juss. (Loc. Neem)

Large tree with white flowers. Gangolihat, 1750 m. (5237).

Toona ciliata (L.) Roem (Loc. Tooni)

Large handsome tree with cream coloured flowers (planted). Gangolihat, 1750 m. (5203).

Celastraceae

Euonymus pendulus Wall.

Small evergreen tree with white flowers. Daula hill, 2230 m. (5117).

Maytenus royleanus (Laws.) M. A. Rau

Spinous shrub with white flowers. Daula hill, 2230 m. (5176).

Rhamnaceae

Zizyphus mauritiana Lamk. (Loc. Ber)

Spinous shrub with greenish flowers. Pali, 1200 m. (5216).

Vitaceae

Vitis vinifera L. (Loc. Angoor)

Woody climber with green flowers (planted). Gangolihat, 1750 m. (5046).

Ampelocissus rugosus (Wall.) Planch.

Climbing shrub with yellow green flowers. Mallagarkha, 1660 m. (5200).

Tetrastigma serrulatum (Roxb.) Planch.

Creeping shrub with yellow green flowers. Mallagarkha, 1700 m. (5322).

Sapindaceae

Sapindus mukorossi Gaertn. (Loc. Reetha)

Tall evergreen tree with purple flowers (planted). Mallagarkha 1660 m. (5202).

Anacardiaceae

Cotinus coggyria Scop.

Small tree with pale-purple flowers. Goptari, 2000 m. (5078).

Rhus parviflora Roxb.

Shrub with yellow green flowers. Nandan hill, 2400 m. (5305).

Mangifera indica L. (Loc. Aam)

Evergreen tree with pale yellow flowers (planted). (5166).

Coriariaceae

Coriaria nepalensis Wall.

Shrub with green flowers. Daula hill, 2230 m. (5096).

Papilionaceae (Fabaceae)

Crotalaria prostrata L.

Herb with yellow flowers. Goptari, 2000 m. (5444).

C. albida Heyne

Herb with pale yellow flowers. Goptari, 2000 m. (5456).

C. calycina Schrank

Herb with yellow flowers. Goptari, 2000 m. (5447).

Trifolium repens L.

Procumbent herb with pinkish flowers. Mallagarkha, 1660 m. (5210).

Indigofera gerardiana Wall.

Herb with pink flowers. Daula hill, 2230 m. (5138).

I. dosua Buch.—Ham.

Shrub with red flowers. Daula hill, 2230 m. (5140).

Lespedeza cuneata G.Don

Erect undershrub with pale yellow flowers. Bhrugtam hill, 2660 m. (5167).

L. eriocarpa DC.

Small shrub with deep purple flowers. Daula hill, 2230 m. (5376).

Zornia gibbosa Span.

Grass-like herb with yellow flowers. Mallagarkha, 1660 m. (5244).

Smithia ciliata Royle

Herb with pale-blue flowers. Jeebal, 2000 m. (5414).

Alysicarpus glumaceus (Vahl) DC.

Diffuse herb with pale-pink flowers. Mallagarkha, 1660 m. (5270).

Desmodium tiliaefolium Don

Shrub with pale pink flowers. Gangolihat, 2000 m. (5429).

D. concinnum DC.

Pubescent shrub with purple-blue flowers. Gangolihat, 2000 m. (5432).

D. heterocarpum (L.) DC.

Under-shrub with purple flowers. Daula hill, 2220 m. (5310).

D. microphyllum DC.

Trailing herb with purple-blue flowers. Mallagarkha, 1600 m. (5272).

Vicia angustifolia L.

Suberect herb with pinkish flowers. Mallagarkha, 1600 m. (5022).

Lathyrus aphaca L.

Trailing herb with yellow flowers. Mallagarkha, 1660 m. (5030).

Shuteria involucrata W. & A.

Twining herb with pinkish-white flowers. Goptari, 2000 m. (5421).

Rhynchosia rothii Benth. ex Ait.

Trailing or climbing herb with dark red flowers. Goptari, 2000 m. (5449).

Moghania fruticosa (Wall.) Mukerjee

Small procumbent shrub with pink flowers. Goptari, 2000 m. (5290).

Atylosia scarabaeoides Benth.

Twining herb with yellow flowers. Mallagarkha, 1660 m. (5269).

Caesalpinaceae

Cassia sophera L. var. **purpurea** Roxb.

Tall herb with bright yellow flowers. Mallagarkha, 1660 m. (5199).

C. mimosoides L.

Procumbent herb with yellow flowers. Mallagarkha, 1660 m. (5309).

Phanera vahlii (W. & A.) Benth. (Loc. Malu)

Climbing shrub with white flowers. Daula hill, 2230 m. (5163).

Rosaceae

Prunus persica (L.) Stokes (Loc. Aru)

Small tree with pink flowers (planted). Gangolihat, 2000 m. (5123).

P. armeniaca L. (Loc. Khumani)

Small tree with white flowers (planted). Gangolihat, 2000 m. (5123).

P. domestica L. subsp. **institia** Hk. f. (Loc. Alubukhara)

Small tree with white flowers (planted). Gangolihat, 2000 m. (5211).

Prinsepia utilis Royle

Spiny shrub with white flowers. Mallagarkha, 1660 m. (5093).

Spiraea vaccinifolia Don

Shrub with white flowers. Daula hill, 2230 m. (5137).

Rubus paniculatus Smith (Loc. Kala Hisaloo)

Rambling shrub with white flowers. Daula hill, 2230 m. (5139).

R. ellipticus Smith var. **hirtus** Roxb. (Loc. Hisaloo)

Trailing shrub with white flowers. Daula hill, 2230 m. (5074).

R. niveus Thunb.

Shrub with dark pink flowers. Daula hill, 2230 m. (5151).

Potentilla indica (Andr.) Wolf. (Loc. Bhi-ka-phal)

Creeping herb with yellow flowers. Mallagarkha, 1660 m. (5012).

P. kleiniana W. & A.
Spreading herb with yellow flowers. Daula hill, 2230 m. (5060).

Agrimonia eupatoria L.
Herb with small yellow flowers. Daula hill, 2230 m. (5046).

Rosa moschata Mill.
Prickly climber with white flowers. Mallagarkha, 1660 m. (5152).

Pyrus sylvestris Mill. (Loc. Sabe)
Small tree with pink flowers (planted). Gangolihat, 2000 m. (5334).

P. communis L. (Loc. Naspati)
Small tree with white flowers (planted). Gangolihat, 2000 m. (5204).

P. pashia Buch.-Ham. ex D.Don (Loc. Mahle)
Spiny tree with pinkish flowers. Gangolihat, 2000 m. (5105).

Crataegus crenulata Roxb. (Loc. Gheengaroo)
Spiny shrub with white flowers. Mallagarkha, 1660 m. (5147).

Saxifragaceae

Bergenia ciliata (Royle) Raizada (Loc. Bansupari)
Herb with pink flowers. Daula hill, 2230 m. (5104).

Crassulaceae

Kalanchoë integra (Medik.) O.Ktze.
Fleshy herb with yellow flowers. Mallagarkha, 1700 m. (5366).

Sedum adenotrichum Wall.
Glandular herb with pinkish white flowers. Daula hill, 2220 m. (5170).

Bryophyllum calycinum Salisb.
Fleshy herb with pinkish flowers. Mallagarkha, 1700 m. (5171).

Droseraceae

Drosera peltata Smith
Herb with lunate leaves and pinkish-white flowers. Mallagarkha, 1660 m. (5329).

Combretaceae

Terminalia chebula Retz. (Loc. Harh)

Large deciduous tree with yellowish flowers. Gangolihat, 2000 m. (5231).

Myrtaceae

Psidium guajava L. (Loc. Amrood)

Small tree with white flowers (planted). Mallagarkha, 1660 m. (5286).

Syzygium cumini (L.) Skeels (Loc. Jamun)

Tree with greenish flowers (planted). Gangolihat, 2000 m. (5230).

Melastomaceae

Osbeckia stellata Wall.

Bristly undershrub with pink-purple flowers. Goptari, 2230 m. (5168).

Punicaceae

Punica granatum L. (Loc. Darim)

Small tree with bright red flowers (planted). Gangolihat, 2000 m. (5088).

Onagraceae

Hertmannia rosea G.Don

Herb with pink flowers. Mallagarkha, 1660 m. (5050).

Samydaceae

Casearia graveolens Dalz.

Small tree with greenish yellow flowers. Mallagarkha, 1660 m. (5246).

C. elliptica Willd. (Loc. Kukari)

Small tree with greenish flowers. Mallagarkha, 1660 m. (5220).

Cucurbitaceae

Trichosanthes bracteata (Lamk.) Voigt

Perennial climber with white flowers. Mallagarkha, 1660 m. (5132).

Zehneria umbellata Thw.

Climbing herb with pale yellow flowers. Mallagarkha, 1660 m. (5196).

BEGONIACEAE

Begonia picta Smith

Succulent herb with pale-pink flowers. Daula hill, 2230 m. (5332).

CACTIACEAE

Opuntia dillenii Haw.

Phylloclade with yellow flowers. Mallagarkha, 1600 m. (5451).

UMBELLIFERAE

Centella asiatica (L.) Urban

Prostrate herb with purple white flowers. Goptari, 2000 m. (5436).

Sanicula elata Buch.-Ham. ex D. Don

Herb with white flowers. Daula hill, 2000 m. (5137).

Bupleurum tenue Don

Herb with yellow flowers. Mallagarkha, 1660 m. (5297).

Pimpinella diversifolia DC.

Herb with white flowers. Daula hill, 2220 m. (5289).

Heracleum candicaus Wall.

Tall pubescent herb with white flowers. Bhragtam hill, 2660 m. (5173).

ARALIACEAE

Hedera helix C. B. Clarke

Climbing shrub with yellow-green flowers. Jeebal, 2000 m. (5401).

CORNACEAE

Dendrobenthamia capitata (Wall.) Hutch. (Loc. Bamour)

Small tree. Bhuvaneshwar, 2200 m. (5260).

CAPRIFOLIACEAE

Viburnum cotinifolium Don (Loc. Gui)

Shrub with white flowers. Goptari, 2000 m. (5143).

Rubiaceae

Hedyotis lindleyana Hook. ex W. & A.
Decumbent herb with white flowers. Goptari, 2000 m. (5198).

Oldenlandia corymbosa L.
Herb with white flowers. Goptari, 2000 m. (5191).

O. gracilis DC.
Grass-like herb with dark purple flowers. Mallagarkha, 1660 m. (5135).

O. coccinea Royle
Herb with bright red flowers. Goptari, 2000 m. (5252).

Pavetta crassicaulis Bremek.
Small shrub with white flowers. Salikhate, 880 m. (5223).

Leptodermis lanceolata Wall.
Shrub with white flowers. Mallagarkha, 1660 m. (5358).

Borreria articularis (Linn. f.) F.N.Wils.
Herb with white flowers. Mallagarkha, 1660 m. (5311).

Rubia cordifolia L.
Rambling herb with dark red flowers. Gangolihat, 2000 m. (5327).

Galium rotundifolium L.
Trailing herb with white flowers. Mallagarkha, 1660 m. (5331).

G. aparine L.
Herb with white flowers. Gangolihat, 2000 m. (5008).

G. mollugo subsp. **asperifolium** (Wall.) Kitamura
Diffuse herb with red flowers. Gangolihat, 2000 m. (5361).

G. hirtiflorum Ref.
Trailing herb with red flowers. Goptari, 2000 m. (5394).

Valerianaceae

Valeriana jatamansi Jones
Herb with pinkish white flowers. Bhuvaneshwar, 2500 m. (5110).

V. hardwickii Wall.
Herb with white flowers. Daula hill, 2230 m. (5368).

DIPSACEAE

Dipsacus mitis D.Don
Robust herb with white flowers. Goptari, 2000 m. (5419).

COMPOSITAE (ASTERACEAE)

Vernonia cinerea Less.
Herb with pink-purple heads. Jeebal, 2000 m. (5403).

Adenostemma lavenia (L.) O.Ktze.
Viscid herb with white heads. Boyal, 1200 m. (5301).

Ageratum conyzoides L.
Herb with pale-blue heads. Mallagarkha, 1660 m. (5028).

Eupatorium reevesii Wall.
Shrub with pale-purple heads. Daula hill, 2230 m. (5400).

Dicrocephala integrifolia (L.f.) O.Ktze.
Herb with yellowish-white heads. Gangolihat, 2230 m. (5053).

Aster molliusculus Wall.
Herb with lilac heads. Goptari, 2000 m. (5160).

A. asperulus Nees
Herb with purple heads. Daula hill, 2230 m. (5420).

Conyza stricta Willd.
Herb with pale yellow heads. Mallagarkha, 1660 m. (5038).

Blumea fistulosa (Roxb.) Kurz
Herb with yellow heads. Mallagarkha, 1500 m. (5042).

B. lacera (Burm.f.) DC.
Herb with yellow heads. Mallagarkha, 1500 m. (5201).

Anaphalis triplinervis C. B. Clarke
Cottony herb with white heads. Goptari, 2000 m. (5417).

A. cinnamomea C. B. Clarke
Woolly herb with white heads. Goptari, 2000 m. (5396).

A. busua (Buch.-Ham.) Hand.-Maz.
Woolly herb with white heads. Mallagarkha, 1660 m. (5083).

A. contorta Hk.f.

Cottony herb with pale-yellow heads. Goptari, 2000 m. (5416).

Gnaphalium luteo-album L. subsp. **affine** (D.Don) Koster

Herb with white heads. Jeebal, 2000 m. (5103).

Inula cappa DC.

Aromatic shrub with pinkish heads. Nandan hill, 2250 m. (5108).

Carpesium cernuum L.

Herb with yellow heads. Daula hill, 2230 m. (5424).

C. trachelifolium Less.

Herb with yellow heads. Bhuvaneshwar, 2500 m. (5378).

Xanthium strumarium L.

Coarse herb with unisexual heads. Mallagarkha, 1660 m. (5265).

Siegesbeckia orientalis L.

Herb with yellow heads. Daula hill, 2230 m. (5325).

Eclipta prostrata (L.) L.

Herb with white heads. Mallagarkha, 1660 m. (5240).

Bidens biternata (Lour.) Merr. & Sherff

Herb with yellowish white heads. Gangolihat, 2000 m. (5101).

Galinsoga parviflora Cav.

Herb with white heads. Mallagarkha, 1660 m. (5020).

Artemisia vulgaris L. (Loc. Patii)

Aromatic undershrub with yellow heads. Mallagarkha, 1660 m. (5293).

Emilia sonchifolia DC.

Herb with purple heads. Mallagarkha, 1660 m. (5031).

Echinops niveus Wall. (Loc. Kanya)

Herb with purple spiny heads. Goptari, 2000 m. (5439).

Saussurea candicans C. B. Clarke

Erect herb with pale-red heads. Mallagarkha, 1660 m. (5082).

Youngia japonica (L.) DC.

Herb with pale-yellow heads. Mallagarkha, 1660 m. (5111).

Taraxacum officinale Wigg.

Herb with solitary yellow heads. Goptari, 2000 m. (5127).

Lactuca dissecta Don

Herb with pale-blue heads. Goptari, 2000 m. (5024).

Sonchus brachyotus DC.

Succulent herb with yellow heads. Mallagarkha, 1660 m. (5044).

(*to be continued*)

Medicinal and Aromatic Plants of Bhandal Range, Churah Forest Division, Chamba District, Himachal Pradesh

BY

RAJENDRA GUPTA[1]

Central Indian Medicinal Plants Organisation, Lucknow

A systematic survey of Bhandal Forest Range of Churah Forest Division, Chamba Dt., H.P. reveals that some 15 plant species are regularly exploited in varying quantities for export outside the district; an additional 44 species are collected on a limited scale either on orders from outside or for local use. The edapho-climatic conditions available in the district are suitable for commercial cultivation of a large number of drugs and perfumery raw materials, which continue to be imported into the country.

INTRODUCTION

Chamba district, located in the extreme North-West of Himachal Pradesh amidst the Western Himalayas, is one of the traditionally rich districts for vegetable raw materials, where a sizable quantity of drugs and perfumery raw materials are collected and marketed annually. The whole district is hilly, traversed by two parallel lofty ranges of the Dhauladhar and Zanskar, forming narrow valleys, that are criss-crossed by fast running streams. The district has hitherto remained largely inaccessible because of difficult terrain and lack of communications. A few well known plant taxonomists (Watt, G. in 1881; Gammie, G. A. in 1898; Burkill, I. H. and others) have travelled in the district, mostly on plant collection trips, but the distribution and occurrence of medicinal and aromatic plants have usually been dealt by them in very general terms. A need for detailed survey has long been felt and the Himachal Pradesh Administration formulated a programme of resources survey work under the aegis of the State Forest Deptt. in its second Five Year Plan. This survey work was conducted by the author. The district, for convenience of the Forest Administration, is divided into two units, Chamba and Churah Forest Divisions, while a third one called Pangi-Lahoul Division, has recently been created out of the latter. The first survey report covering Chamba Forest Division has been published

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[1]Formerly Minor Forest Produce Officer, Chamba Circle, Himachal Pradesh, Dalhousie.

(Rajendra Gupta 1964). The Bhandal Forest Range is the richest range of the Churah Forest Division and its survey report is presented here.

The Bhandal Forest Range is of comparatively easy terrain, 241 sq. km. in area and abounding in magnificent pine forests. It is a narrow strip of mountainous land running from south-west to north-east of the district and rising up to 4500 m. above sea level. It forms the North and North Western part of the Chamba district, bordering the Bhadarwah district of Jammu and Kashmir State; Tissa, Tikri and Lower Chamba Forest Ranges form its north-east, east and south-east boundaries, while its southern boundary runs along the Ravi River. The whole range is traversed by perennial, fast running streams in narrow valleys and the drainage is directed mainly towards south-east in the Siul River, which joins the Ravi, only a few miles north-west of Chamba town. A fair weather 'jeepable' road runs from Chamba to Kilor, a distance of about 35 km., the rest of the area is served by bridle and foot-paths.

The structural features of the area fall in line with the geological characteristics of the North-Western Himalayas. Siwalik zone is absent. The mountain ranges are an extension of Dhauladhar Range, a part of Archean system of geological formation. The parent rock is both of igneous and sedimentary origin with massive granitic intrusions. The important rocks are gneisses, shales and schists; slate-stone is quarried at several places. Soil is deep, moist, clayey to clay-loam with abundant forest litter on easy northern slopes. Southern exposed slopes are usually dry, rather steep and with sparse vegetational cover.

Climate and Vegetation

As most of the area falls between 1000 and 3000 m. above sea level, the climate of the range could be described as varying from sub-tropical to temperate. Spring months are cool and pleasant, summers are mild while winters are severely cold. Monsoon usually commences by the middle of July and continues till late September; the average rainfall is about 1500 mm. mostly during monsoon months. Above this zone, the climate is subalpine, where the average rainfall is over 2000 mm., a major portion of the precipitation here is received in winter months in the form of snow, which remains on the ground for about 5 months in a year; none of the peaks in the area remain snow-bound throughout the year.

According to vegetation types the range may be divided into three distinct zones :

(i) **Sub-tropical Pine Forests**

This type of vegetation is found in valleys up to 1200 m. elevation and constitutes only a negligible ten per cent area of the whole range.

Chil Pine (*Pinus roxburghii* Sargent) is the principal timber species and is mixed with a number of associate brush-wood species such as *Dodonaea viscosa* Linn., *Adhatoda vasica* Nees, *Prinsepia utilis* Royle, *Murraya koenigii* Spreng., *Punica granatum* Linn. etc. Tree species such as *Quercus glauca* Thunb., *Celtis australis* Linn., *Grevia oppositifolia* Roxb., *Ficus glomerata* Roxb., *F. roxburghii* Wall., *Cedrela toona* Roxb., and *Lannea grandis* Engl. occurs most frequently and are lopped heavily near habitations for feeding cattle.

(ii) **Moist Temperate Forests**

Higher above the sub-tropical pine forests and up to 3600 m. above sea-level is found the moist temperate forests. It consists of 35 reserved and 70 demarcated protected forests and thus covers a large portion of about seventy per cent area of the range. The reserved and protected forests are an important source of valuable coniferous timber species. It has deodar [*Cedrus deodara* (Roxb.) Loud.] Kail or Blue Pine (*Pinus wallichiana* A. B. Jackson), Fir [*Abies pindrow* Spach. and *A. spectabilis* (D. Don) Spach.] Tosh (*Picea morinda* Link), in abundance. Two species of Oak, Moru Oak (*Quercus dilatata* Lindl.) at the lower height and Kharsu Oak (*Quercus semicarpifolia* Smith) in the higher zone are fairly common. Mixed with the pine and oak forests are found scattered broad-leaf tree species of *Acer*, *Aesculus*, *Alnus*, *Ilex*, *Taxus*, *Fraxinus*, *Cornus*, *Prunus*, *Pieris* (*ovalifolia*), *Rhododendron* etc. *Betula utilis* D. Don forms the tree line. The ground canopy is rich and composed of a number of shrub species; some of the more common genera are *Berberis*, *Myrsine*, *Spirea*, *Indigofera*, *Buddleia*, *Lonicera*, *Viburnum*, *Cotoneaster*, *Desmodium*, *Rosa*, *Impatiens*, *Echinops*, *Strobilanthes*, *Polystachya*, *Plectranthus* and *Artemisia* etc. Plants of *Bergenia*, *Platystemma* and *Begonia* are abundant on moist rocky slopes. The herbal flora is equally rich and varied, and completely covers the ground, more particularly during and after the rains.

(iii) **Sub-Alpine Grass-Lands**

The sub-alpine grass-lands or *dhars* lie just above the tree line and constitute a fairly large and important part of the range. During summer and till late September this region supports large herds of cattle. The flora of these pastures is far more varied and colourful. Shrub species are comparatively rare, of which *Rosa*, *Rhododendron*, *Spirea*, *Cotoneaster*, and *Salix* are the common ones—all of which show a spreading habit. The common herbal flora is dominantly made of species belonging to *Aconitum*, *Geranium*, *Gentiana*, *Trifolium*, *Swertia*, *Rumex*, *Podophyllum*, *Polygonum*, *Polygonatum*, *Artemisia*, *Arisaema*, *Anemone*, *Potentilla*, *Impatiens*, *Ranunculus*, *Caltha*, *Codonopsis*, *Corydalis*, *Viola*, *Valeriana*, *Fragaria*, *Elsholtzia*, *Achillea*, *Anaphalis*, *Gnaphalium*, *Delphinium*, *Meconopsis*, *Sedum*, *Spiranthes*, *Pedicularis*, *Primula*, *Lilium*,

TABLE 1

CHEMICAL ASSAY OF SOME DRUGS AND AROMATIC PLANTS OCCURRING IN BHANDAL RANGE

Name	Locality and time of collection	Drug part	Active principle* (at zero moisture)
Atropa acuminata	Bhaint Reserve, September 1960	Leaves and root	Total alkaloids: Leaves 0.38% Roots 0.6%
Aconitum chasmanthum	Gumgul, Sept. 1960	Tuber	Total alkaloids 4%
Dioscorea deltoidea	(1) Bhaint Reserve (2) Langera Reserve, Sept. 1960	Tuber	3 to 6% diosgenin content.
Podophyllum hexandrum	(1) Bhadroh-nalla (2) Bhandal Reserve, Sept. 1960	Rhizome & roots	Total resin: 9 to 11%
Cedrus deodara	Kilor Reserve, September 1960	Wood-chips	Essential oil 0·2% w/w (Fresh material)
Jurinea macrocephala	Ban-da-got, October 1959	Rhizome	Chloroform extractive 58%
Skimea laureola	Kilor beat, September 1960	Leaves	Essential oil 2·10%
Salvia moorcroftiana	Bhandal beat, September 1960	Root	Essential oil 1%
Selinium veginatum	Gumgul, September 1960	Rhizome & roots	Essential oil 1·3 to 1·8%
Valeriana wallichii	Bhandal beat, October 1959	Rhizome and roots	Essential oil 1 to 1·2%

*Range of the active principle is given wherever two or more samples are examined.

Jurinea and *Taraxacum* including those belonging to sedges and grasses. A large number of other herb species, too, are found either scattered or localised at some places in the range. A number of medicinal and aromatic plant species grow abundantly in this region some of which are regularly collected and exported outside the State. The collection, sale and export of medicinal and aromatic plant material is governed by Chamba Minor Forests Produce Act 2003(S).

Floristics

The floral composition of the range compares favourably with the species recorded under similar ecological conditions of the North-Western Himalayas. Deodar, fir and spruce form almost single species plant communities. The growth of deodar is exceedingly good; lofty large trees are a common feature of the reserve forests. The ground canopy is thick and varied. Compositae, Labiatae, Ranunculaceae, Scropulariaceae, Berberidaceae and Liliaceae are well distributed in the range, each represented by a large number of species. With the melting of snow the sub-alpine grass-lands resume vegetative activity and the whole ground is covered with green in about a month's time. As these plants complete their life cycle in a few months, they come to bloom early adding brilliant, very colourful touches to the landscape. Yellow in all its shades, followed by pink are the dominant colours, a spectacular contrast to the green surroundings.

The medicinal and aromatic plants of the region are described in this report under two categories, based upon their market demand and value. While the survey work has been done catchment-wise, the names of forest-beats and dhars have been given in the report to facilitate easy location for later collection. Marketable drugs are treated in some detail so far as their locality and distribution is concerned while for the remaining plant species only the frequency of occurrence, zonal distribution and local uses are recorded.

Marketable Drugs and Aromatic Plants

In all 15 plant species are found to grow in this range which possess consistent market demand and fetch a fair price. These are described below alphabetically. Forty-four plant species are found to be collected on a limited scale; uses and distribution are incorporated in Table 2 appended to this paper. Representative samples of a few of the drug and aromatic plant species from areas, where they are commercially collected or where commercial collection is possible, have been analysed chemically for active principles. The result of the assay is reproduced in Table 1.

TABLE 2

PLANTS HAVING LIMITED OR LOCAL DEMAND

S. No.	Latin Name	Local name	Distribution
1.	*Abies webbiana* Linn.	Talispatra	Frequents higher reaches of moist temperate forests.
2.	*Abutilon indicum* (Linn.) Sw.	Kanghi	Common, sub-tropical pine forests.
3.	*Achillea millefolium* Linn.	Gandhana	Abundant, sub-alpine dhars.
4.	*Achyranthes aspera* Linn.	Putkanda	Common, sub-tropical pine forests.
5.	*Adhatoda vasica* Nees	Basuti	Abundant, sub-tropical pine forests.
6.	*Agave angustifolia* Haw.	Ramban	Frequent, sub-tropical pine forests.
7.	*Ajuga bracteosa* Wall. ex Benth.	Nilkanthı	Abundant, moist temperate forests.
8.	*Arisaema flavum* Schott	Sarp-chalii	Common, in moist temperate forests.
9.	*Artemisia vulgaris* Linn.	Charmari	Abundant, moist temperate forests.
10.	*Asparagus racemosus* Willd.	Sansarpod	Common, sub-tropical pine forests.
11.	*Berberis aristata* DC., and other sp.	Rasaunt	Common in moist temperate forests. Roots yield 'rasaunt' of commerce.
12.	*Betula utilis* D.Don	Bhojpatra	Common, forms last tree line in moist temperate zone.
13.	*Boerhaavia diffusa* Linn.	Punarnava	Frequent, sub-tropical pine forests.

14. *Boenninghausenia albiflora* Reichb.	Pissumar	Common in moist temperate forests.
15. *Cassia occidentalis* Linn.	Pawar	Common in village waste lands.
16. *Celastrus paniculatus* Willd.	Malkangni	Rare, sub-tropical pine forests.
17. *Cissampelos pareira* Linn.	Patha	Common, sub-tropical pine forests.
18. *Cymbopogon nardus* (Linn.) Rendle	Makira-ghas	Frequent, sub-tropical pine forests.
19. *Datura metel* Linn.	Kala dhatura	Rare, sub-tropical pine forests.
20. *Fumaria parviflora* Linn.	Pitpapra	Common on agricultural lands or near villages.
21. *Geranium wallichianum* D.Don	Ratmundi	Abundant, moist temperate forests.
22. *Inula royleana* DC.	Puskar mool	Rare in sub-alpine dhars.
23. *Juniperus communis* Linn.	Bithar	Common, sub-alpine dhars.
24. *Litsea glutinosa* (Lour.) Robbins	Hadran	Rare, moist temperate forests.
25. *Murraya koenigii* Spreng.	Gandhelu	Common, sub-tropical pine forests.
26. *Myrsine africana* Linn.	Baibidang	Rare, sub-tropical pine forests.
27. *Nasturtium fontanum* Aschers.	Nalachu	Common in running water. Plant possesses fatty oil.
28. *Origanum vulgare* Linn.	Mirjanjosh	Rare, lower sub-alpine dhars. Possesses essential oil.
29. *Pedalium murex* Linn.	Bara gokhru	Rare, sub-tropical pine forests.
30. *Peristrophe bicalyculata* Nees	Kak-jangha	Common, sub-tropical pine forests.

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30.	*Peristrophe bicalyculata* Nees	Kak-jangha	Common, sub-tropical pine forests.

S. No.	Latin Name	Local name	Distribution
31.	*Plumbago zeylanica* Linn.	Safed Chitrak	Common, sub-tropical pine forests.
32.	*Punica granatum* Linn.	Anar	Common, sub-tropical pine forests. The dried ripe fruits are marketed for use as spices.
33.	*Roylea elegans* Wall.	Kaur	Rare, sub-tropical pine forests.
34.	*Rubia cordifolia* Linn.	Majitha	Frequent, moist temperate forests.
35.	*Selinium vaginatum* Linn.	Bhutkesi	Common, moist temperate forests.
36.	*Skimmia laureola* S. & Z. ex Walp.	Kastura Pati	Common in shade in moist temperate forests. Leaves possesses an aromatic oil. According to local belief the plant is eaten by musk-deer.
37.	*Rhododendron campanulatum* Linn.	Chue	Common, sub-alpine dhars, leaves used as nasbar.
38.	*Solanum indicum* Linn.	Kandyan	Common, sub-tropical pine forests. Root enters into Dashmool—a widely used prescription in Ayurvedic medicine.
39.	*S. nigrum* Linn.	Makoi	
40.	*S. xanthocarpum* Schrad. & Wendl.	Badikateri	
41.	*Taraxacum officinale* Wigg.	Dudhli	Common, sub-alpine dhars.
42.	*Thalicturum foliolosum* DC.	Mamiri	Common, moist temperate forests.
43.	*Vitex negundo* Linn.	Nirgundi	Abundant, sub-tropical pine forests. Leaves contain an essential oil.
44.	*Zanthoxylum alatum* Roxb.	Titiri	Rare, along streams and most localities in sub-tropical pine forests. Seed aromatic, contains an essential oil.

1. **Aconitum heterophyllum** Wall. (*Mitha Patis*, Ind. baz. *Atis*).

A small perennial herb with orbicular to reniform leaves and blue flowers. Tuber medicinal, used as a febrifuge and bitter tonic in indigenous medicine. It is common in sub-alpine grass-lands and is collected on a small scale from Kihar-Madrala, Nakru, Khornu-Talai, Desot, Gulu-ki-Mandi, Ban-da-got, Raja-da-dera dhars.

2. **A. chasmanthum** Stapf ex Holmes (*Kaura-Patis* Ind. baz. *Patisa*).

A small perennial herb with orbicular to reniform leaves and blue flowers. The plant is found in sub-alpine grass-lands. Tuber is medicinal, regarded as substitute of English Aconite. It is collected on a small scale from areas listed above.

3. **Atropa acuminata** Royle ex Lindley (*Jharka*, Ind. Baz. *Belladonna*).

A tall, branched perennial herb with dull yellow flowers and purple berries. The leaves and roots are official drugs and yield belladonna alkaloids having a large market demand. It is found sporadically distributed in deodar forests, but regular commercial collections, are now not possible, because the areas have been heavily and regularly exploited in past years.

The temperate deodar forests are ideally suited for its large scale introduction in the range. Experiments done on raising plantations by the author (1968) elsewhere in the district, have given very encouraging results both in respect to yield of crude drugs as well as the percentage of active principles contained in the cultivated plants.

4. **Bergenia ligulata** (Wall.) Engl. (*Saprotri*, Ind. baz. *Pashan bhed*, *Abe-hayat*).

A spreading, shade loving creeper on moist rocky localities. In Ayurvedic and Unani medicines, its root is used in pulmonary affections and also as a medicine for removing stones from affected kidneys. It has *bergenin* as its active principle.

The plant is abundant in upper reaches of the moist temperate forests but no commercial collections of the roots are made.

5. **Cedrus deodara** (Roxb.) Loud.

Deodar trees, a valuable timber species, are abundantly found in the range in its reserve and protected demarcated forests. These are annually auctioned and timber is extracted. The wood-chips and shavings that are left at site are not put to any use. The fresh wood-chips and saw-dust from this species, on steam distillation, yield an aromatic oil which resembles in essential characteristics the Atlas Cedar-wood oil marketed in Europe and America. The Cedar-wood oil is employed in soap perfumery and a small quantity of this oil is produced in Kashmir only. The Bhandal Range could be profitably exploited for production of this oil and movable distillation units could be fabricated and employed to distill the wood-chips and shavings at site where timber exploitation work is in progress so as to keep the cost of production low.

Chamba district in general is in a position to support a small scale industry for production of the Himalayan cedar-wood oil at competitive price in the State.

6. **Dioscorea deltoidea** Wall. (Kniss)

A climbing perennial herb, bearing small white flowers in June-July, is found to grow between 1600 and 2500 m. above sea level. Its tubers yield *diosgenin*—a starting raw material for production of cortisone. There is an ever increasing demand of this raw material by the Pharmaceutical industry. The plant is available in commercial quantities in reserve and protected temperate forests of Baint and Langera beats.

The medicinal virtues of this plant are not known to the local population, who use it for washing their woollen garments because of the presence of *Saponins* in the tuber.

7. **Gentiana kurroo** Royle (Kaur)

A small perennial herb with tufted stem and sky blue flowers, common in alpine grass-lands. Root-stock is cylindrical, used in medicine, sometimes as a substitute of Gentian root of the British Pharmacopoeia. Collections on a small scale are made from Bhandal, Kilor and Langera beats.

8. **Jurinea macrocephala** Benth. (Dhoop).

A small perennial herb, devoid of stem and with large radical raddish-like leaves, that lie on the ground forming a rosette. The flowers are borne in composite heads, purple to purplish white in colour and arising almost in the centre of the rosette. As the peduncle is shortened to the extent of being almost absent, the inflorescence appears as a bunch of rosy flowers arranged on a green oval plate. The plant is found in open alpine grass-lands, at an elevation of 3500 m. or above, and is gregarious wherever it grows.

Roots large, cylindrical and contain a sticky substance, which is chemically a catechu like material. It yields the famous *dhoop* material which is burnt as incense at ceremonies and in temples. Commercial collections of roots are made regularly from Supa-Cholu, Kihar Madrala, Khirnu-Talai, Maral, That-Kihar, Sawan-Tith, Ban-da-got and Dhangi dhars.

9. **Pinus roxburghii** Sargent (Chil pine).
P. wallichiana A. B. Jackson (Blue pine, Khail).
Picea morinda Link (Tosh).

These species are so abundant, that each constitutes a dominant part of important reserve forests; the leaves contain a sweet smelling, aromatic oil easily extractable on steam distillation. Like deodar oil, the pine needle oil too could be produced on commercial scale from the raw materials available in this range. This oil is used and marketed mainly as a deodorant. However, it is not produced anywhere in India on a sizable scale.

10. **Podophyllum hexandrum** Royle (Ban kakru, Ind. Baz. *Ban-kakri*).

An erect perennial herb with two large radical leaves and solitary fugitive white flower. The plant is common in moist temperate forests. Its rhizome and roots yield a resin, used in medicine. Lately, it is regarded to have anti-cancer properties and some firms have been organising cultivation of this species in Kashmir and Nilgiri Hills in India.

Commercial collections are regularly made from Bhadroh nalla area, Chandi-dhar in Kilor beat, Matanu dhar and Supa Cholu dhar in Langera beat, as also on small scale in Gumgul, Ban-da-got and Madrala dhars in Bhandal beat.

11. **Polygonum verticillatum** All. and **P. multiflorum** A. (*Salam misra*).

Small erect perennial herbs, with star-like flowers and cylindrical, white root, which is sweet in taste. Root medicinal, a well known nerve tonic in Ayurvedic medicine. It is collected on a small scale from areas given under item 10 above.

12. **Swertia chirata** Buch.-Ham. (*Chirata*, Ind. Baz. *Chirayata*).

A large branched, annual herb with greenish yellow flowers. It is common on alpine grass-lands. The extract of aerial part is a reputed Ayurvedic medicine against periodical fever.

The collection of genuine plant material is not feasible economically as allied species, (*S. angustifolia* Buch.-Ham., *S. alata* Royle etc.) medicinally inferior to it, are very frequently found mixed with it and are not easily distinguishable in the field. So the material generally sold in the market, is a mixture of a number of *Swertia* species.

13. **Salvia moorcroftiana** Wall. (Thuth).

A small perennial herb with cylindrical root and lilac flowers. It is common throughout the moist temperate forests. Despite the fact that the plant is available in commercial quantities in most of the beats, its market price is neither consistent nor good enough to attract large scale collection. The root is aromatic and yields a spicy oil on steam distillation.

14. **Valeriana wallichii** DC. (*Samak*, Ind. baz. *Musk-bala*).

A small erect herb with small lilac-white flowers. The plant is common in partial shade and is available in commercial quantities throughout the moist temperate forests. The rhizome and roots emit a pleasant, sweet aroma, and on steam distillation yield an essential oil. Its rhizome and roots form an important constituent of '*Havan Samigri*' and the oil could be employed in perfumery industry. It is also reported to be useful in treatment of neurosis and epilepsy (Chopra *et al* 1958).

The rhizome and roots are collected regularly but not on a very large scale as the oil of this species is regarded as inferior to its European counterpart *V. officinalis* L. The oil from the Indian plant develops an unpleasant odour on storage. The wide occurrence of this species in North-Western Himalayas deserves detailed chemical investigation including working-out a simple, cheap and effective method for removal of the undesirable constituents.

15. **Viola serpens** Wall. (*Banafsa*).

A small shade-loving herb up to 10 cm. in height with few leaves and lilac flowers. The plant is very common all over the moist temperate forests and its flowers are employed as a household remedy against common cold, bronchitis and fever. The flowers are plucked on a large scale, and marketed.

To sum up the information gathered from this survey work, including examination of records of herb collectors, local herb-dealers and that maintained in the Forest Range, reveals that those localities traditionally known as rich are exploited heavily and this has adversely affected the availability of the drug plant species. Further, this regular collection of the drug and perfumery raw material in an area without periodical resting time and lack of maintenance have lately increased their cost of collection. It is now desirable that suitable working plans be drawn up for selected demarcated areas to provide protection, rotational and regulated exploitation, to permit their natural regeneration. This would enable the Forest Department to maintain a constant supply of the raw material to the industry.

The soil and climatic conditions of the range, and Chamba district in general, are conducive for large scale cultivation of certain plant species, which are either official in pharmacopoeias or used extensively in perfume industry. Experiments conducted on raising a number of exotic species in the district such as Belladonna, Foxglove, Pyrethrum and Hops by the author have yielded very encouraging results (Rajendra Gupta 1965, 1967, 1968, 1969). It is now time that this experimental work is followed by commercial cultivation either by the Government or user industries in an effort to develop the vegetable resources of the newly formed State of Himachal Pradesh.

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References

Chopra, R. N., Chopra, I. C., Handa, K. L. & Kapoor, L. D. (1958): Indigenous Drugs of India, Calcutta.

Gupta, Rajendra, Sethi, M. L. & Atal, C. K. (1961): *Jurinea macrocephala* Benth. The commercial source of Dhoop. (Part I). *Indian For.* **87**: 104-115. Part II (1964). ibid., **90**: 288-291.

Gupta, Rajendra (1964): Survey Record of Medicinal & Aromatic Plants of Chamba Forest Division, Himachal Pradesh. ibid **90**: 454-468.

——— (1965): Introduction of *Hops* cultivation in Himachal Pradesh. *Indian Perf.* **9**: 81-85.

——— (1967): Cultivation of *Digitalis lanata* Ehrh. in Chamba Hills, Himachal Pradesh. *Indian For.* **93**: 33-40.

——— (1968): Cultivation of *Belladonna* in India. *Indian Drugs & Pharm. Industry* 3 (5): 29-34.

——— (1969): Prospects & Problems of *Pyrethrum* cultivation in India with special reference to trials conducted in Himachal Pradesh. *Indian Drugs & Pharm. Industry* (in press).

Güenther, E. (1949): *The Essential Oils.* **6**: 33-34.

Gammie, G. A. (1898): A botanical tour of Chamba and Kangra. *J. Bombay nat. Hist. Soc.* **1**: 183-214.

Hooker, J. D. (1875-97): Flora of British India. Vols. **1-7**.

Jain, M. K. & Gupta, Rajendra (1962): Isolation of Bergenin from *Saxifraga ligulata. Ind. Journ. Chem. Soc.* **39** (10): 2-14.

Nadkarni, K. M. (1954): Indian Materia Medica. Vols. **1** & **2**.

Watt, George (1881): Notes on the vegetation of Chamba State and British Lahoul with description of new species. *J. Proc. Linn. Soc.* **18**: 368-382.

——— (1889-96): A dictionary of Economic Products of India. Vols. **1-14**.

Reviews

1. THE ECOSYSTEM CONCEPT IN NATURAL RESOURCE MANAGEMENT. By George M. Van Dyne. pp. 383 (23 × 15·5 cm.) New York, 1969. Academic Press. Price $ 16·50.

If you are in the habit, as I am, of first thumbing through a technical book before reading, it is soon clear that this melange of offerings by 13 authors is as varied in both content and quality as most such collations. However, the thread which binds the four major sections and ten articles is a strong one—the ecosystem concept—and one which has not, until this book, been properly exploited. There are many collations of ecologically orientated literature such as Hazen's READINGS IN ECOLOGY and Shepard's SUBVERSIVE SCIENCE. However interesting, no such systematically developed analytical approach to confronting technical problems encountered in field studies had been published. Credit is due to editor and contributor George Van Dyne for a stimulating job of selection and synthesis.

The theme is the utility of systems analysis techniques to the unravelling of the inter-relationships within the functional unit of ecology. The arbitrarily defined but topologically discrete ecosystem.

It is unlikely that this book will be intelligable to the complete layman. However a brief grounding in the theory and jargon of ecology from an introductory text such as Odums will be sufficient for a fuller appreciation of the book.

S. Spurr and Jack Major present us with the necessary definitions and review the historical development of the ecosystem concept in the introductory section. Van Dyne in the final chapter and in the sectional introductions ties the differing approaches to the various elements of the system together within the ecosystem framework. To the point of necessary redundancy the case is made for the systems approach—breaking the ecosytem into comprehensible, manageable compartments analysing each, then synthesizing these elements with the assistance of electronic computational machines, eventually producing such resource management tools as the predictive model with which the effects of altering a characteristic can be quantitatively predicted for the entire system. This is the approach advocated for sorting out complex integrated phenomena which use the constituent parts of an ecosystem.

Such an approach can be demanding in terms of commitment. As illustrated in Chapter III (Coupland *et al.*) dealing with the

Matador grassland ecosystem research project of the Canadian International Biological Programme, entire ecosystems cannot be realistically approached within the usual time-frame of projects funded for a couple of years. The individual gives way to the team approach (80 to 100 scientists in the case of the Matador Project), which demands novel adjustments on the part of participants who must work together under new sets of administrative scientific and personal constraints—problems not adequately discussed in this chapter. I should think that there is a potentially productive study for a social scientist willing to monitor developing social configurations of such team efforts by using the systems approaches referred to in the context of the natural sciences.

The second of four sections (Chapters III-V) treats working examples of research and development projects employing the ecosystem concept. In addition to the Matador Project and a study of an artic tundra ecosytem reported by A. Schultz, a particularly elegant study of nutrient cycling in a small, temperate deciduous forest watershed is presented.

F. H. Bormann and G. E. Likens assessed the input of water and minerals from such sources as precipitation aerosols and weathering of the substrat and measured losses of water and minerals with a small weir constructed in the drainage. Even in this catchment characterized by steep gradients (26%) about 90% of the nutrients (macronutrients such as Ca-Mg, N, Na, K, Su) were lost in solution rather than as particulate matter—evidence of the effectiveness of the vegetation and its decomposition products in mitigating mechanical erosion. The effects of an experimental treatment (clear felling) followed by herbicides were dramatic. The loss of important cations was increased by 10-20 times over that of the undisturbed system primarily because of reduced uptake in the vegetation and an accelerated through—put of water (a 40% increase in run off). Water was no longer cycled by the transpiration of living plants, root systems died and a more direct impact of erosive elements was observed. These effects have important implications for planning in wildland use—for particularly in forest harvest methods. A revealing practical analogy of management goals in land use systems with those of a factory—i.e. maximizing production minimizing costs, diversification of products etc., is given. Similar work on Indian systems might prove a valuable investment in conserving, the vital nutrient capital necessary for productive forests and grasslands.

The third section carrys the use of the ecosystem concept to several traditional land use disciplines—range, forestry, wildlife and watershed management. The chapters on range ecology and management by J. K. Lewis, and wildlife ecology and management by F. H. Wagner constitute the real reason for shelling out the money for this book.

Both articles constitute rather complete reviews of their respective fields, provide exhaustive and up to date bibliographies and are germinal in their impact. They are too comprehensive to adequately discuss here and simply have to be read. Because both range and wildlife ecology can look forward to considerable development in Asia and because they deal with central positions in the trophic structure of ecosystems these are particularly instructive chapters for workers in this region.

Because of my interest in Prof. Wagner's subject a few brief comments will be offered. He has successfully fused theoretical concepts in ecology which deal with the nature of animal populations such as growth, exploitation, competition and diversity with their practical application in the management of these populations. Prof. Wagner discusses the importance of ecosystem studies in tropical regions which are characterized by a higher species diversity to clarify the implications which the niche specificity and energy flow characteristics of these systems have for using wild herbivores in various conservation schemes—for example game ranching. We should not attempt the traditional single species study used in temperature zones. This extremely interesting chapter will have a long shelf life.

Editor Van Dyne closes the offerings by redefining the proferred problem solving approach and undergraduate and graduate curriculae for training ecosystems analysts at two basic levels: (1) one emphasizing experimental ecology; and (2) the other intended for theoretical ecologists who would be more involved in modelling and analysis than in the conduct of field research. It would prove difficult to separate individual responsibility for the planning, execution and analysis of ecological research, however I do not read this as Prof. Van Dyne's intent—and educational emphasis which would serve to show a students proclivity for a compass or a computer to the mutual exclusion of neither. I feel uneasy about the rather rigidly structured 'block' approach to coursework and the added emphasis of journal coursework at the expense of research, even at the Ph.D. level. Courses tend to concentrate on a slice of the pie and others tend to fragment what is essentially a holistic integrative discipline (as is frequently pointed out in this book). A research project tends to bring it all together and make a natural system in fact live for the first time in the students career. To defer these insights and rewards too long may prove counter productive no matter how much there is to learn. Also, the proposed curriculum seems to offer little room for adjustment and experimentation. The freedom to pursue newly discovered concepts or interests should not be programmed out of the University level experience. Having done so in the past has often turned off or antagonized the inquisitive or experimental student who may be the ideal type to tackle the complex and changing situations encountered in the study of natural systems.

The mix of coursework proposed with the emphasis on a firmer grounding in basic courses, particularly mathematics surely seems called for.

It appears that we are at a point in time when human ecology should be more rigorously defined, integrated with the more traditional resource disciplines and approached with similar tools. Such a chapter would, I feel, have been appropriate in this volume. The direct effects of primitive, modern and future cultures on natural systems and the effects such systems on these cultures can be fruitfully studied by ecologists. Many attempts in these directions have been made by sociologists, anthropologists and archaeologists who have subsequently found the need to pick up some background in ecological theories and field methods (viz. Rappaport's PIGS FOR ANCESTORS) few ecologists have worked the other way around. An exception who comes to mind is C. S. Holling at British Columbia who is finding cultural-ecological analogues in study of realator-real estate (Predator-prey) systems using systems analysis techniques. Interesting computer generated cyclic oscillations nearly identical to natural cycles have been derived from these studies of human economic systems with ecological formulae. But then new dimensions emerging in human ecology and the universality of ecological theories to the extent that there is any, might require a book in itself.

S. BERWICK

2. BIRD SONG: ACCOUSTICS AND PHYSIOLOGY. By Crawford H. Greenewalt. pp. viii+194 (27×20 cm.). With 168 figures in black and white, and 2 gramophone records. City of Washington, 1968. Smithsonian Institution Press.

The anatomy of avian vocal organs has been fully investigated and described. How they work, on the other hand, is only partially understood, and much in the available literature is mere speculation. This is hardly surprising, as direct observation of the mechanism in action is virtually impossible. The difficulties which would face anyone trying, say, to film a bird's syrinx at work during song must surely be, and will probably remain, insuperable. Investigators must lean heavily on the circumstantial evidence of the songs themselves. Fortunately techniques of measuring and analysing sound electronically have now attained a very high level of efficiency and precision. With their aid it is therefore reasonable to expect that the study of the structure of bird songs can throw light on the functions and characteristics of the organs which produce them more readily than any purely anatomical investigation. This is Mr. Greenewalt's view, and the premise behind the research he describes in this elegant and enthralling book. Quite properly he is at some pains to stress that his evidence 'must be given less weight than direct experimental proof', and that the inferences he makes are no more than inferences. He is being realistic here, not just modest; but there is no doubt that the exercise has been worthwhile, and even if his case is not proven it is a good one—presented, it must be said, with much, finesse and expertise.

Using such devices as the Sonagraph, oscilloscope, writing oscillograph and wave analyser Greenewalt has examined fragments of the songs of a number of (mostly American) birds representative of different stages of evolutionary development. In this book he publishes the time-amplitude and time-frequency graphs thus produced and his analyses of them. He goes on to make tentative deductions as to the acoustical and anatomical mechanisms which they imply.

The chief of these deductions and the most interesting, contradicts the two principle theories postulated by earlier investigators which liken birdsong to playing a wind instrument or to human speech. Both attach importance to the function of the trachea. The first presumes that the frequency of sounds generated in the syrinx is controlled by the trachea which behaves like a tube, as if it were the body of a flute or an oboe. The second holds that the syrinx is analogous to the human glottis while the trachea plays the part of a modulator, like the oral cavities. Greenewalt imputes no significant role to the trachea at all. The typical syringeal complex contains two separate acoustical sources, one in each bronchus (Greenewalt does not agree with the theory that there are more than two), his analysis shows not only that each can act independently and produce separate harmonically unrelated notes, as has long been recognised, but that they can do this *simultaneously*. This is a fact one has often suspected from one's own listening, and it is heartening to see it substantiated by the studies in this book. Such internal duets would obviously be impossible if each source was forced to conform to the resonances of a single tube, the trachea. As for the second theory, Greenewalt's searches reveal no sign of pulses generated in the syrinx being modified or amplified by tracheal resonances. Modulation appears to be effected by movable mechanisms within the syrinx itself. Nor indeed are harmonics produced by the trachea. They arise in the syrinx as a result of 'mechanical constraints imposed on the vibrating tympanic membrane by the opposing bronchial wall'. The trachea would appear to be virtually without influence. It is little more than a passage through which the sounds produced by the syrinx pass unchanged to the listening world outside.

A further conclusion is not without interest to Indian Ornithologists as it particularly concerns the Grackle and its ability to 'talk'. Among birds *Gracula religiosa* is by far the most convincing talker. Greenewalt has compared 'words' spoken by a Grackle with the same words uttered by himself and his wife, and concludes that although the physical similarities in the performances of bird and human are remarkable the bird is not endowed with any abnormal anatomical features, nor does it employ acoustical techniques which are neglected in its natural song. There is no evidence in the Grackle's speech of modulating resonances; even its vowels are wholly syrinx-generated and controlled. If this makes the bird's skill as an imitator seem even more astonishing, it is nonetheless also remarked that the human ear is relatively insensitive, and can recognise and be satisfied with wave forms which are no more than rough approximations to those we produce ourselves. 'The Grackle's task in imitating speech sounds is not as difficult as might be supposed.'

Mr. Greenewalt's approach is scholarly and vigorous. This is not a book for the general reader; nor will it be easy reading for the ornithologist who is primarily concerned with the behavioural aspects of song. It will, however, be of the greatest interest to all serious students of the acoustics of song and of bird physiology, and they should not overlook it.

R. A. MELLUISH

3. A GUIDE BOOK TO THE BIRDS OF CEYLON. By G. M. Henry. Second Edition. pp. xl-457 (21 × 13.5 cm.). With 27 coloured, 3 black and white and 136 monochrome drawings by the author, London, 1971. Oxford University Press. Price £2.75 net.

Bird lovers will welcome the appearance of the second edition of this comprehensive, and beautifully illustrated book, the first edition of which was reviewed in the *Journal* in 1955 (**53**: 451-453). The main part of the present edition remains unchanged. As before it describes 403 forms of resident and migrant birds of Ceylon including no less than 80 species and subspecies endemic to the island, some of which have even developed wet country and dry country forms. 309 of these are illustrated, mostly in colour and the plates are of the quality and excellence that have brought the artist well deserved renown. The addition of an extra 25 pages has enabled this edition to be suitably updated by the provision of an appendix containing additions and amendments to the distribution and nomenclature of many birds which have accrued during the interval. For convenience, the sequence of families followed in both editions is juxtaposed with that in W. W. A.

Philips's (1952), *A Revised Checklist of the Birds of Ceylon* which follows the system now generally adopted in publications on birds of India and SE Asian countries—in fact more or less universally. A welcome feature is the addition of 10 monochrome plates at the end, depicting several of the more interesting nests and nesting sites of Ceylon birds. As the reviewer observed in the case of the earlier edition, the Guide will be equally helpful to bird students in India considering the great overall similarity in the avifauna of the two countries. Its handy form and attractive get-up make the book a pleasure to handle, and the modest price—as prices of such books go these days—makes added appeal to bird lover and book lover alike.

S.A.

4. FIRST CATCH YOUR TIGER. By Oliver Graham-Jones. pp. 223 (21.5 × 13.5 cm.). London, 1970. Collins. Price 36*s*. net.

A questing curiosity about animals which persisted from childhood through the school years brought young Oliver Graham-Jones, against the cherished wishes of his parents, to the Royal Veterinary College, London, where after a nearly disastrous beginning in his first year he achieved the degree which entitled him to practise as a veterinary surgeon. Invalided out from the army after a spell of war-service in Italy as a vet in a mule corps, he set up a lucrative private practice. After a time, feeling that there must be something more worthwhile than merely making money in this fashion, he spent his savings in establishing an animal hospital with the latest facilities for diagnosis and surgery. This venture, however, left him equally dissatisfied, for his chief patrons were farmers who had no interest in keeping alive animals which had gone past their working value and rich persons seeking his services for their over-fed under-exercised pets. In despair he turned to human medicine and registered for admission in a medical college, but during his period of waiting a professor of his R. V. C. days told him of a vacancy at the Zoological Gardens in Regent's Park where, after an interview which lasted for two-and-a-half hours and a further wait of six weeks, he found a job after his heart as Resident Veterinary Officer responsible for the well-being and medical care of more than 6,000 animals of various species. For a time he combined with this the post of Curator of Mammals.

From now on his book is of absorbing interest. Thrills are there in plenty—for instance when, alone at night in the Zoo grounds, he came face to face with an escaped and angry bear and had only a garden broom to defend himself with ; or when he sheltered in an escape tunnel with two enraged elephants, one at each and of the tunnel, feeling inside with their trunks and missing him by inches. These are only two out of several equally thrilling experiences, within and without the Zoo.

But to me the interest lay in his account of the medical side of his work, the problems that arose, the difficulties he experienced, the lack of guidance in the text-books, his own initial ignorance about wild animals, his devices to keep up the morale of his patients their will to live, the initial hostility of the other Zoo staff this being the first appointment of its kind, how he gradually got over these difficulties and ended up with the different departments working harmoniously with him. It was also interesting to see how readily persons outside the profession came to his help when called on. Sir Benjamin Ryecroft, a leading London ophthalmologist, operated on the eye of an anaesthetised tigress, an American visitor an expert in dental pathology helped with an operation on a pregnant lioness, a dental surgeon helped in piecing together the lower half of a toucan's bill—this last operation is of interest as it helped the bird to live and to grow a completely new replacement.

Strange as it may sound, when the author entered the service of the Zoo in October 1958, the facilities for the medical treatment of animals, were of the most primitive. The Sanatorium, 'Sanny' as it was generally called, 'was probably among the oldest of the Zoo's very old buildings, and appeared to have been created out of a row of haylofts, cart sheds and stables . . . . The long-ranging haylofts had been converted into accommodation for "small animals" in cages, and what had once formed the grooms' cramped quarters had been turned into an office together with another small room which acted as clinic cum-dressing room, cum-operating theatre . . . . the ground floor was given over to "large animals" who—lions included—were housed in ex-horse boxes, or in dens which, in many cases, still had stable doors . . . There was little or no provision for a keeper's entry—or escape! . . . In the main, the animals could only be approached by way of the front door, which meant that, for the purpose of effective examination, let alone treatment, they could hardly be approached at all! . . . Radiography facilities . . . were nil. There was no X-ray machine. Medical records . . . were grotesquely incomplete . . . . At the time, the Zoo's only method of getting an animal to the operating table was to carry it there, enmeshed in a capture-net . . . . To cater for the population of the world's largest collection of captive animals we had only one old leather face-mask, of the type once employed on race-horses, and a single bottle of chloroform.' By the time the author left the Zoo in 1968 for another post, 'Sanny' had given place to a modern well-equipped hospital worthy of a Zoo of the standing of the London Zoo.

The author ends with a question as to the purpose of a Zoo, a question that requires a considerable amount of re-thinking: 'Educational . . .

conservational . . . a medium of entertainment, or a laboratory in which to study comparative medicine . . . certainly there is no shortage of ideas as to what a Zoo's purpose should be . . .'

This is a book that everyone, inside or outside a Zoo, who has animals in his charge should read.

D.E.R.

5. INNOCENT KILLERS. By Hugo & Jane Van Lawick-Goodall. pp. 222 (17 × 24.5 cm.). With many illustrations. London, 1970. Collins. Price 45*s*.

Perhaps the most singular achievement of INNOCENT KILLERS is that three of the most maligned creatures, the wild dog, the jackal, and the hyena are projected in an altogether different light. Sportsmen and naturalists alike hitherto have passed only uncomplimentary remarks about them, though the former are mainly to blame for propagating their alleged cruelty and uselessness for anything other than scavenging. The Lawick-Goodall book is refreshingly different, giving us new, interesting and even charming facts on an old subject, thus restoring our faith in even the allegedly lowliest of the animal kingdom.

The accomplishment of their book is not confined to endearing three disliked species to the readers. It is an objective, detailed and an impartial study, scientific yet not pedantic. Notwithstanding its scientific bias it is a very well-written readable and entertaining book, appealing to the specialist and animal lover alike. Special mention must also be made of the exceptional quality of camera-work. Besides accuracy of detail and unusual poses, the photographs with very apt captions, give the viewer amusing similarity with their human counterparts.

Finally one can hardly wait for little 'Grublin' to grow up and follow the footsteps of his illustrious parents. I am sure all of us look forward to a total family of naturalists.

C.C.A.

6. THE LIFE AND ORGANIZATION OF BIRDS. By W. B. Yapp. pp. 246 (14 × 21.5 cm.). London. Edward Arnold (Publishers) Ltd. Price 70*s*. net.

That near-classic of an earlier generation, THE BIOLOGY OF BIRDS by J. A. Thomson published in 1923, has now been out of print for many years. In the interval there has been nothing comparable to it in the English language to quite take its place as an introduction to ornithology, despite the several excellent American publications of this type that have appeared from time to time. The present work is therefore specially welcome. Its comprehensive selection of topics covers all that a serious amateur or college student of biology should know about birds in order to enjoy them as they should be enjoyed, and give him the proper perspective for interpreting his observations in a meaningful and scientific way.

Nine main chapters comprise the book, as follows : Reptiles with Feathers, Flight, Classification and Adaptive Radiation, Physiology, The Endocrine Control of Reproduction, The Higher Life, Maintenance Activities of Reproduction, Other Complex Behaviour, and Distribution and Dispersion. The chapters are further divided and subdivided into sections, and all the topics treated with admirable conciseness and clarity. References are provided at the end of the book to most of the important recent advances in knowledge concerning the various facets of the life of birds, for further reading. One example of the divisions and subdivisions of the main chapters will suffice to convey a clearer idea of their wide-ranging coverage. The theme of Physiology, is subdivided into Nutrition, Metabolism, Temperature Control, Nervous System and Sense Organs. Each of these subdivisions is further split into sections covering the entire gamut of relevant topics such as Food, The alimentary canal, Digestion, Biochemistry of carbon, Biochemistry of nitrogen, The kidney, Production of energy, The physiology of diving, Control of loss of heat, Contrcl of production of heat, Ontogeny of temperature control, Torpidity, Nervous system, Simple sense organs, Chemical senses (Taste, Smell), Sight, Hearing. Most of the other chapters are similarly divided, subdivided and sectioned.

For teachers of modern biology—with increasing accent on ecology and animal behaviour—and for university biology students alike, the book should prove completely adequate as a basic manual of ornithology. It fills a long-felt gap and is to be warmly welcomed. Incidentally, it is good to find that no special effort has been made to avoid the use of accepted technical terminology in the text. This is a distinct advantage since the sooner the serious student can familiarize himself with a modicum of the prevailing 'jargon' the better will he be able to profit from his more specialized reading.

S. A.

7. FAUNA OF INDIA AND THE ADJACENT COUNTRIES—ORTHOPTERA, VOL. 2, GRYLLOIDEA. By L. Chopard. pp. xviii+421 (24×16 cm.), Calcutta, 1969. Published by the Manager of Publications, Government of India, Delhi and issued by the Zoological Survey of India.

The first volume of the FAUNA OF INDIA on Orthoptera dealing with the family Acridiidae appeared in 1914. For over 50 years after that, information on the other families of this order remained desultory. Prof. L. Chopard, who is an authority on the crickets of this region has published a number of papers on the subject and other authors have contributed a good many articles on the family but the literature remained scattered. It is fortunate that Government of India could get the services of Prof. Chopard to put all this information together and bring forth the present volume, second in the series on Orthoptera.

Study of the fauna of the different regions bring to light some interesting points. According to the author of this volume, though the crickets are supposed to be universal, no Palaearctic material is found in the region of study. Only one species of a genus very common in America is found in India scattered in different tracts and another species of a common Australian genus is met with, though rarely, in some parts of the country. They were probably introduced here with their host plants which are often imported.

The book is nicely printed and profusely illustrated with at least one figure of the adult insect of each genus and genitalia of almost all the species, making identification easy. Footnotes regarding their habits and special characters under some of the species are very useful and interesting. Such notes in all or at least the majority of species could have been possible if information on the basis of a full survey of the whole country was available to the author with reference to their ecology. Such studies have not been done in India and therefore information on these aspects is wanting. Since the survey is not complete the distribution of different species as given now cannot be taken as final. A full survey and study of the habits of these insects is, therefore necessary.

N. T. N.

8. ANIMAL TRAPS AND TRAPPING. By James A. Bateman. pp. 286 (21 × 14 cm.). Newton Abbot Devon, 1971. David & Charles (Publishers) Ltd. Price £3.50.

A well written book on the various types of traps and trapping methods employed by men through different ages to catch insects, fish, birds, and mammals for food, protection, sale or research.

The book begins with an outline of the historical development of traps and then, before going on to the man made traps and trapping, mentions the traps used in nature by animals and plants. The closing chapters deal with the ethics of trapping and trap legislation in America and Europe.

Persons associated with wild animals and pests, especially farmers and field biologists will find this book interesting and useful. It explains numerous ways to control agricultural pests without using currently controversial pesticides, and describes simple devices for capturing animals for field studies. The variety of traps perspicuously illustrated in line drawings and half-tones aids in selecting the right traps. With each category of traps is furnished relevant information on the habits of the animals sought, which helps non-professional trappers. Conservationists offended by such publicity for trapping methods would be convinced of the fact that poachers never lacked in ideas.

Enhancing the value of the book are the accounts on the history of traps, traps of nature, and the ethical aspects of trapping with an emphasis on the unfolding trend to avoid inhumane methods for capture and disposal of animals. The excellent compilation of trap legislation in western countries should help in making conservation oriented laws on trapping elsewhere.

But the conspicuous dearth of traps used in Asian countries deprives this book of its claimed comprehensiveness. The author's reference literature covers mostly English publications, resulting in the inclusion of too many European and American traps. Perhaps the situation could be rectified by a second edition incorporating sufficient examples of traps from the rest of the world, or by suitably qualifying the title.

R. B. G.

9. OWLS. By John Sparks and Tony Soper. Illustrated by Robert Gillmor. pp. 206 (21.5×15 cm.). With eighteen photographs and many illustrations. Newton Abbot, 1970. David & Charles (Publishers) Limited. Price 50*s*. (£2.50) net.

Owls are particularly difficult birds to see and study. Most of them spend the day hidden away inside the crevices of trees and rafters and emerge only at night to hunt for food. Yet the authors have succeeded in delving into the most intimate secrets of their lives and have written a book where the scientific facts are charmingly presented. The numerous photographs and illustrations help greatly in both clarifying and in enlivening the text.

The owl ' is a cat with wings ' and the book explains how well these birds are designed for darkness. They fly noiselessly on their large soft wings giving no hint of approach to their prey ; because they must judge distances unerringly to be able to pounce on their victims their eyes are more forward facing than of most birds : the overlapping of sight or binocular vision is one method by which distances can be judged. Experiments conducted in Cornel University revealed the extraordinary fact that owls have such sensitive ears that they can determine both distance and direction accurately from sound signals alone. The high pitched squeaks of rodents even when they are partially covered by leaf litter on the ground enables the owl to find its mark with uncanny accuracy.

The droppings of owls accumulated below their nests and roosts provide invaluable clues not only about the food of these birds but simultaneously indicate to the naturalist the presence of many species of life in the locality of which there is no visual evidence, and may be wrongly presumed not to exist.

Owls swallow their victims as a whole and rely on their strong digestive juices to dissolve the nourishing soft parts after which the undigestable fur, bones, teeth are ejected in the form of tightly packed pellets. These tell tale packages contain a whole lot of interesting data for those who can unravel the secrets from these casts.

It is wellknown that in many cases predator populations vary proportionately to the number of their prey species. Likewise the densities of owls is proportionate to the availability of food. Studies in specific areas show that when there is a shortage of mice and rodents no attempt is made by the owls even to nest. In some cases nests are abandoned after the clutch is laid. The female owl alone incubates and the dutiful male feeds her on the nest. In those years when food supply is short he fails to be so self abnegating as to feed his mate in the nest while remaining hungry himself. Feeling hungry the female soon abandons the nest and the eggs and the young are saved the misery of arriving in a starving world. The owl is a wise bird and how one wishes that this attitude of relating population to food supply would transmit itself to human beings.

Z. F.

Miscellaneous Notes

1. NOTES ON THE YELLOW BELLIED WEASEL, *MUSTELA KATHIAH* HODGSON (MUSTELIDAE) FROM KHASI HILLS, ASSAM

All that is known of the habits of this weasel is that it is tamed and kept by the Nepalese as a ratter and trained to kill small game. In Nepalese it is known as *Kathia nyal* from which its specific name has been derived. In Khasi Hills it is known by the local name *Ksish*. Seven specimens were obtained by the Survey in the Khasi Hills.

The long body and short limbs, are particularly suited to enter holes to prey on borrowing animals. The sharp claws are used for climbing trees. One example reared in a cage was observed to climb on dry branches with agility and ease. Although habitually a creature of jungles haunting the vicinity of streams, they approach human habitations in extremely cold weather rummaging about in the garden for food and venturing occasionally into houses. It preys predominantly on small rodents. The stomach contents of some specimens examined by us revealed a mass of hairs and partly digested flesh, presumably that of rats or mice. No remains of insects or other invertebrates were noticed. A foul smell emanating from the anal glands is characteristic of many of the genera of Mustelidae and *Mustela kathiah* could be smelled and its presence established without sighting it. As in the Grey Musk Shrew, *Suncus murinus* an unpleasant odour persists even after the culprit has left the premises. In captivity this weasel makes low whining noises like a puppy. When irritated it makes a louder *chew-crew—chick-chick* noise. A female collected on 15-xii-1967 had well developed mammae. But the glands did not show any milk secretion, neither was any foetus found inside the uterus. The fact that a mature male was also caught from the same place after three days suggests that they cohabit. The colour of the belly is at its brightest in animals collected in the month of December.

Khasis attribute certain magical properties to the teeth of this weasel. It is alleged that the discomfort and pain arising out of a fish bone stuck in the throat are instantly removed by touching the persons' throat with a weasel's tooth.

It may be of interest to add here that a skin of the Burmese Ferret-Badger, *Melogale personata* Geoffroy, another member of the family Mustelidae was obtained from a shop in Cherrapunji on 31-iii-1971 where it was exhibited for sale. The animal had been killed about three weeks earlier at Mawblang, near Cherrapunji where it had been trapped in a poultry shed at night while trying to get at the chickens. We have seen similar skins from other localities at Cherrapunji and also at Nongpo, both in the Khasi and Jaintia Hills, Meghalaya.

We are thankful to the Director, Zoological Survey of India, Calcutta for facilities.

EASTERN REGIONAL STATION,
ZOOLOGICAL SURVEY OF INDIA,
SHILLONG,
July 31, 1971.

R. S. PILLAI
S. BISWAS

2. HABITS OF A SMALL INDIAN CIVET [*VIVERRICULA INDICA* (DESMAREST)]

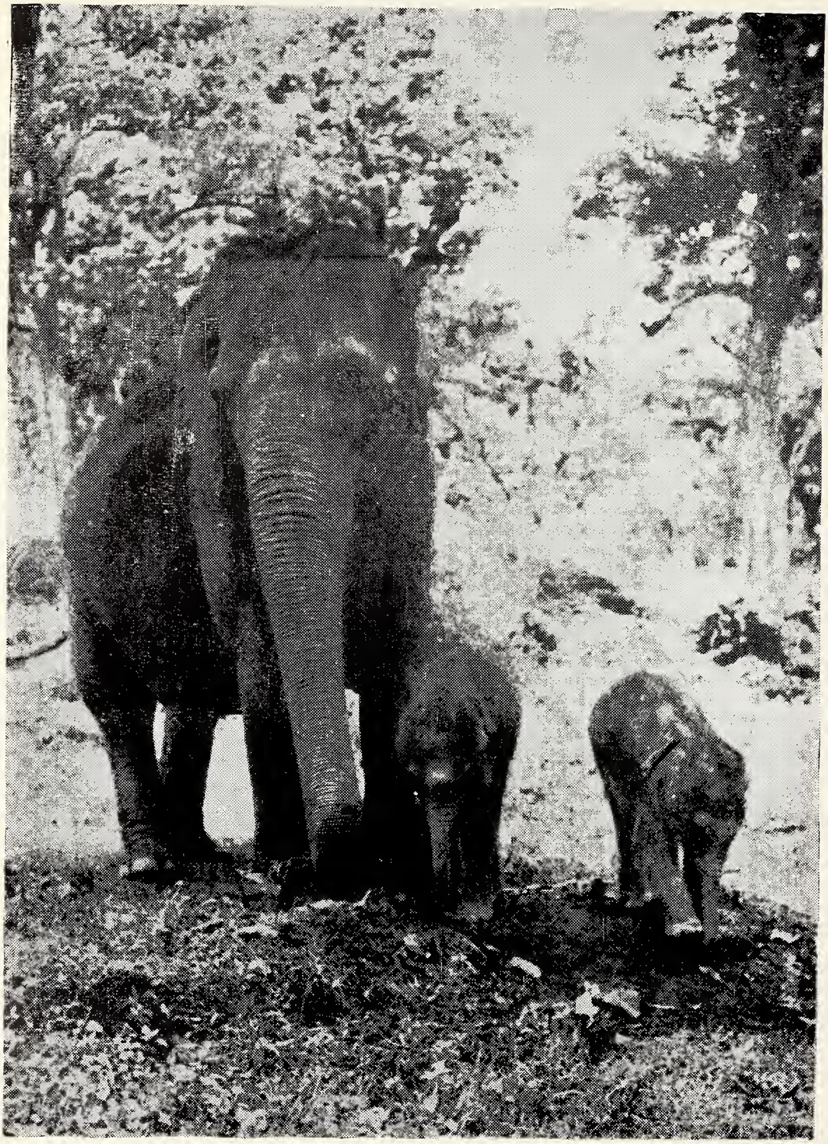
Recently a villager brought a young Small Indian Civet (*Viverricula indica*) to me. The animal was completely tame and we have had it as a pet for more than two months at the time of writing.

A week ago another villager cutting rice in a small field not far from my house found a litter of five baby civets, of the same species, in the middle of the field and brought them to me after the mother had run away. We are now rearing these by hand on Largactil and they appear to be flourishing.

On consulting Prater's BOOK OF INDIAN ANIMALS, I find two statements in it concerning *Viverricula indica* which do not conform to my observations of the six animals mentioned.

Prater states (page 87) that civets are mute, but the larger civet I have constantly makes a tick-tick-tick sound when agitated in any way, either by pleasure, alarm or merely *Joie de vivre.* The five baby civets also make this tick-tick-tick noise and, in addition, utter extremely loud and piercing cat-like miaows occasionally, apparently as an expression of hunger.

Of *Viverricula indica* specifically, Prater says, 'Though it climbs well and can scale a vertical trunk with ease . . . .'. I find that my large tame specimen is not a climber at all. Indeed, when placed on my shoulder, on a wall, or on a tree, he appears to be most unsteady and unable to hold on in any way and quite often tumbles awkwardly down. The animal is in perfect health and is quite without any kind



Twin Elephant Calves

of injury which might account for this fact. The claws of this species are, of course, small short and non-retractile so that it has nothing to grip with except its soft small pads, and even from the examination of a dead specimen this would have led me to suppose that the animal was unable to climb. The behaviour of my living pet specimen therefore confirms this.

The litter of five babies cannot be more than two or three weeks old at the time of writing, so that we are not able to confirm this from observations of their behaviour yet.

'THE FROGS', HARRY MILLER
TIRUMULLAIVAYAL,
VIA AVADI,
MADRAS,
March 2, 1971.

3. THE TEPPAKADU TWINS

(With a plate)

The elephant camp at Teppakadu situated in the middle of Mudumalai Wild Life Sanctuary in Tamil Nadu enjoys the reputation of having produced the largest number of elephant calves in captivity. But this record would have been incomplete had not Devaki, the 40 year old cow given birth to twins recently. Twin births and even triplets are not unknown. But they are distinctly rare. The chances both calves surviving are rarer still.

Sanderson the well-known authority on the Indian elephant and the father of the Mysore Khedda did not come across a single case of twin births in his thirteen years in India. He, however, acknowledges that this is possible and writes 'I have heard of what appears to be a well authenticated case of a female, elephant having two calves at birth'. Birth of triplets in Siam and two pairs of twins in Burma are recorded in this *Journal.*

The fact that Devaki was pregnant was known at the camp. She was given progressively lighter tasks and special rations like all expectant mothers. She looked normal and none suspected that she was carrying twins. On 20th May 1971 at 6.45 p.m. after all the camp elephants were assembled and fed, it was noticed that she was in distress. She bit her trunk, sat on her haunches and showed other signs of discomfort. This first spell of pains lasted 5 minutes. At this stage Forester Selvaraj who is in-charge of the elephants took charge. Instead of letting Devaki go out into the jungle at night as usual he had her secured on the outskirts of the camp.

The second bout of pains set in at 8.40 p.m. and at 8.45 p.m. the first calf arrived—a normal birth, head first.

Devaki set to work cleaning the calf of the amniotic fluid with earth gathered from the area, and in 10 minutes the calf was able to get up.

At 9.00 p.m. the 2nd calf was born, also a normal birth. To Devaki who had given birth to four calves before this was something new and she kicked the calf aside, perhaps mistaking it for the placenta. The calf fell into a depression and Forester Selvaraj and his assistants dragged it aside and cleaned it of the birth fluid. This calf took half an hour to stand up. It took Devaki considerable time to get reconciled to the fact that the second calf was hers.

The calves were not weighed, but their weight, according to the Forester, was normal. They stood 2′ 11″ and 3′ at the shoulder—the average height at birth being 3′.

Tara, another cow elephant at the camp gave birth to twins some five years previously. Only one of the calves survived and the other was presumed to be a still birth. These calves were born in the jungle as in the majority of cases.

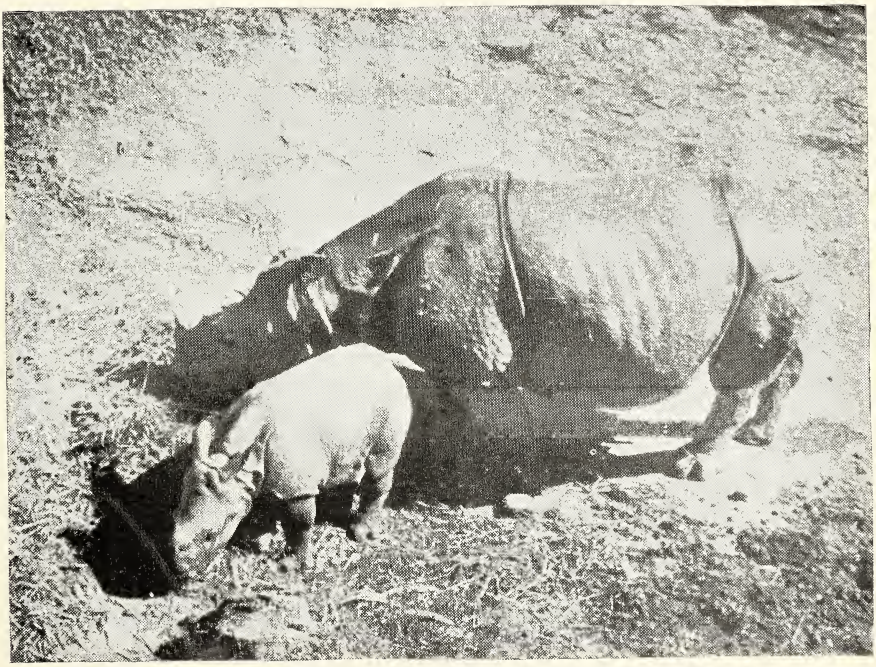
But for Forester Selvaraj's initiative and the care and attention he and his staff bestowed on Devaki; the 2nd calf would have surely been trampled and written off as a still birth if it had been discovered at all in the jungle. This may, perhaps, be the reason why twins are thought to be so rare among elephants.

'CANOWIE', PRIYA DAVIDAR
COONOOR-1,
NILGIRIS,
August 11, 1971.

4. BREEDING OF THE INDIAN RHINOCEROS (*RHINOCEROS UNICORNIS*) AT DELHI ZOOLOGICAL PARK

(With a plate)

The Great Indian One-horned Rhinoceros (*Rhinoceros unicornis*), like all rhinoceroses, does not breed readily in captivity. Till 1960, only five calves were born in captivity. One reason for few rhino births in captivity might be the violent battles that take place between the sexes



Above: The Parents.
Below: Rhino Baby and Mother at Delhi Zoological Park.

which discourages zoo authorities from keeping them together. During the last ten years, however, more Indian rhinos have been bred in captivity. The International Zoo Yearbook, Volume 10, published in 1970 by the Zoological Society of London, lists twelve births of Indian rhinoceros in captivity.

The Delhi Zoological Park obtained 'Mohan' a male Great Indian Rhinoceros in December, 1965. It was three and a half years old when it came to the zoo. Later in March, 1968, a female 'Rongi' of about six years of age was brought to the Zoo from Gauhati, Assam.

The rhino enclosure at the Park is an open air enclosure of about an acre in area. The enclosure has a luxuriant growth of naturally growing trees and undergrowth of *Prosopis juliflora*. In the centre of the enclosure, a wallow has been provided. The enclosure has a few cells and a large enclosed paddock where the animals could be kept separately.

Rongi, arrived at the zoo in the evening of 28th March, 1968, and was kept in the paddock. 'Mohan' was at that time kept in the outer enclosure. It was observed that Mohan was very interested in Rongi but she was very restless for the first few days. Later both used to smell and see each other. It was then decided to introduce her to Mohan. However, it was not without anxiety as it was known that rhinoceros did not readily live together in captivity. In fact, a pair at Whipsnade Zoo had fought and the female was eventually removed to Regent's Park, London. A pair at Chicago, USA, had never became reconciled to each other.

Precautions were therefore taken to avert any possible trouble. In the early morning hours of April 14, 1968, about 20 keepers and attendants stood by with crackers, tin cans and bamboo sticks. The partition door between the paddocks and the main enclosure was gradually opened. At 7.00 a.m. Mohan and Rongi met for the first time in the middle of the enclosure. The male was more interested in mounting but the female kept him at a distance. She looked apprehensive, broke off and ran away several times. After about an hour, both settled down, the male went to the mud wallow and the female was seen eating green fodder. Fortunately, there was no fight and the two settled down in course of time.

The female came into oestrus on 4th January, 1969 for the first time but the male remained indifferent and mating did not take place. She again came in oestrus on 22nd September, 1969. This time, the male was continuously seen chasing the female in the enclosure and also in the moat. The female, however, broke off and ran away several times. At about 1.00 p.m. a very fierce fight took place between the two, and both were injured. Later the male was shut in the paddock to avoid one of them being very seriously injured. Two days later the male was released, again with due precautions and there was no fight. On 1 October, 1969, hard blowing and shrill whistling noises were heard from both as they ran about in the enclosure and in through the water in the moat. Several sharp skirmishes also took place between the two but this time one of them was not shut inside. At 2.40 p.m. first mating took place. The whole act lasted for about 30 minutes. In the afternoon another mating was observed. No mating was observed from 2nd October, 1969 onwards and both became quiet. It was hoped that successful mating had taken place, and in the late winter it became apparent that the female was pregnant.

Both the rhinos were, however, kept together in the same enclosure till July, 1970 when Mohan was shut into the paddock. The female was now definitely in calf. Her mammary glands increased in size and became active. She also stopped showing any interest in the male in the adjoining paddock.

On 27th January, 1971, she took her usual food at 11.30 hrs. and retired into the bushes. At about 15.00 hrs. she became very restless and emitted bleating sounds on and off. It was apparent that she was in labour pains. At 16.00 hrs. she went to the far corner of the enclosure, away from the public, and sat in a small wet depression. A watery discharge was seen and she stood up at 16.15 hrs. when birth became imminent. The front legs and head emerged while she was standing and at 16.20 hrs. she exerted a little and the calf was born. She was totally exhausted and sat down and showed little interest in the calf for the first five minutes and then started licking it. The duration of gestation in this case was 484 days as calculated from the day of last mating to the day of birth.

The baby was pink coloured at birth. At 17.05 hrs. the calf made attempts to stand up but could not succeed. However, by 18.15 hrs. the baby was standing.

The last observation of the mother and calf was made at 19.00 hrs. on 27th January, 1971 and till then she had not nursed the calf. Next day, in the early morning hours, the calf was seen suckling. The vulva of the baby appeared very prominent and it was possible to sex her on the 28th January, 1971. The colour of the skin also appeared to be slightly darker than on previous day. The mother was very protective of the calf and even did not come for feeding during the daytime. She, however, came at about 19.00 hrs. for feeding along with the calf. She first made the calf sit down on the straw padding in the enclosure and then went for feeding. This procedure was followed till the middle of February, 1971. On 20th February, she came out of the bush with the baby in broad day-light at about 13.00 hrs.

On 27th February, evening the calf was seen nibbling green fodder for the first time. She took some fodder leaves in her mouth and attempted to chew and continued to play like this for about 15 minutes. From 17th March, 1971, the calf started to take some green fodder. The calf has now grown considerably stronger and bigger.

DELHI ZOOLOGICAL PARK, C. L. BHATIA
NEW DELHI, J. H. DESAI
June 16, 1971.

5. WHITE BISON OF MANJAMPATTI

With reference to Mr. Davidar's note on the 'White Bison' in the Vol. 67 (3) of the *Journal*, your readers might be interested to know that there is a mounted specimen of the head of a cow 'white bison' in the High Range Club in Munnar. This was, I think presented by a Mr. Ranicar and was obtained from the Talanji area prior to 1939. The pelage is fawn, and was originally almost cream coloured, but has darkened somewhat with age and dust. Though I have never seen the 'white bison' in this area myself I have spoken to many planters, all of whom have since retired, who, like Mr. Ranicar, saw the herd on many occasions. I gather that in those days the pale coloured variation was confined to the animals in one herd only. Over the past twenty years I have frequently asked the Pulyars, as well as the Muduvans who occasionally visit the area, whether there are any 'white bison' left, and have always been told that they have not seen any for many years. On my many trips during that period along the Munnar-Udumalpet road, although I have occasionally seen the normal-coloured Gaur. I have never seen any of the pale variety, and my information from the above-mentioned planters was that in the old days the herd was never seen west of the Pambar-Amaravathi River.

LOWER VAGAVURRAI ESTATE, J. C. GOULDSBURY
TALLIAR P.O.,
KERALA,
July 2, 1971.

6. NOTES ON THE NILGIRI TAHR *(HEMITRAGUS HYLOCRIUS)*

I was most interested in the two articles on Nilgiri Tahr on pages 365 and 535 of the December 1970 issue of the *Journal* Vol. **67** (3). It is sad to think how the herds of Tahr have been thinned out, but it is encouraging to know that they are still holding out in some areas.

I arrived in the Anamallai Planting District as a green junior assistant in 1924, and I left the district for a job in our head office in Coimbatore in 1939. Until 1956, when I retired from India, I travelled over most of the planting districts in S. India and got to know them well.

Between 1924 and 1939 I spent nearly all my local leave in jungle trips, and I can claim to know the Nelliampathi Hills, Mount Stewart and Top Slip, and all the hill country between the Anamallai Planting District and the High Range, very well indeed. I spent many camps in the Gundrow area on the NE slope of the Anamallais, and I also know the Kundah and Muhkerti Peak areas of the Nilgiris. I have made a number of camping trips to the White Bison country in the Manjampatti/Talanji area. All these areas used to carry herds of Tahr and the following notes may be of interest—if only now—unfortunately of historical interest.

The Anamallai grass hills between the Anamallai Planting District and the High Range over the Travancore boundary supported huge herds of Tahr between the years 1924 and 1937. They were to be found in quantity on all the main peaks and ridges from as low down as what is now Akkamallai Tea Estate, over the Koramparai ridge, the Kornellar Valley, Oosimallai and all the peaks out to Peratamallai. Outliers from these herds probably spread through the heavy forest over the ridge to the North-East as Tahr were often, but not always to be found on Pachaipalmallai over what is now Waterfall Estate, and on the rocky slopes above and near Waverley Estate and right down to the Velloni angle station on the old Ropeway. The record Tahr head for the Anamallais was shot on the twin rocky hills at the foot of the old Anamallai Ghat Road—Tadaganachimallai. P. T. French and I one Sunday morning found a fine saddleback in a wire snare on one of the rocky pinnacles overlooking the ghat road, and within a few yards of the road just below Attakatti. The wire had bitten so deep that we had to kill it.

Tahr meat is very highly flavoured and has a very strong smell. Probably for these reasons it has a reputation of medicinal value. It was always in great demand and commanded a good price per pound. Large inroads into all this territory have been made by forestry planting, Cinchona planting, and irrigation schemes. Even before I left the Anamallais in 1939 there was extensive poaching most week ends by gangs of labourers from these schemes. By that time there were few tahr left even on Oosimallai and Koramparai.

It is sometimes said that tahr do not travel in heavy evergreen forest, but this is certainly not true in this area. They make quite long treks through heavy forest to graze on small rocky outcrops of grass which are found here and there in this area. On the western side of the old Vellonie bridle-path there is a ridge of rocky peaks running down towards Perambakulam. These all held large numbers of tahr, but as they were terribly difficult to get over they were seldom visited. These areas have remained comparatively undisturbed and they probably still hold tahr.

Brownbacks and Saddlebacks were seldom seen in or near the large herds of does during the dry winter months. From about the end of November until mid or late April they would be found living singly or in small troops, usually in the scrub on the edge of grassy slopes, in contrast to the does and kids which kept to the tops and open grass.

About the end of April, after the first pre-monsoon thunder showers, the bucks started coming back into the herds, and they stayed with them throughout the S.W. Monsoon months and through till the end of October. The S.W. Monsoon is very severe in this area and even now the tahr are probably pretty safe during this period. There is no incentive for anyone to even camp up there then.

I well remember watching some tahr coming up a steep khud on the edge of the Kornellar Valley one year in mid May. It was misty in patches, and a violent thunder storm was working up towards the Valley. No less than 12 Saddlebacks and 4 Brownbacks came up that track in single file, and spread out on the grass in the Valley to join a large herd of does at the foot of Oosimallai.

On another occasion during a short break in the S.W. Monsoon in July I shot two saddlebacks in 20 minutes on the open grass at the top of the Koramparai ridge, and there were several more saddlebacks and brownbacks with this large herd.

It was not at all uncommon to see herds of from 50 to 150 strong in this area. These large herds, or congregations, were most common in the dry weather and were nearly always composed of does and kids.

In the course of many years wandering on these hills I came to believe that the bucks stay brownbacked for the first three years or so of their lives. About the third or fourth year they develop a light saddle in the breeding season, but they often lose this again for a year after the season is over. From then onwards the white saddle is permanent and it becomes whiter and more grizzled as the years go by. This may well be a local characteristic.

It has been said that wild dog seldom hunt tahr. This again is certainly not true in this area. They very frequently hunt them here. I have watched a pack hunt a tahr right through the middle of a herd. The herd itself paid very little attention except to give the hunted animal plenty of room to pass through, and none of the dogs turned aside after any other animal. There used to be a lot of hill panther on these hills—many of them black. These lived largely on the tahr as their staple food.

A herd of tahr once turned up in a newly felled clearing of forest in Anaimudi Estate in the Mudis Group on the Anamallais. They were a very long way inside forest, and far from any grass, and they had probably been chased there by wild dogs.

In the Nilgiris there used to be fair number of tahr all along the edge of the escarpment from Mukerti Peak to behind the Bangitappal Forest Rest House, on the steep slopes overlooking the Silent Valley, and right out to Sispara. It is good to know that some of them are still there. All this area gets a very heavy S.W. Monsoon with gale winds and torrential rain, and as it is well off any beaten track it seems probable that the tahr may survive there for some time yet. In addition to these herds there were small herds on the precipitous slopes falling into the Bhavani Valley where the Chembar River topples off the plateau. These tahr used to graze the open grass around the Chembar River, but this may have become too dangerous for them. The herds ranged all along the steep slopes overlooking the Bhavani Valley, and I have seen them on the open grass hills below Carrington Estate and on all the other steep hills around the bottom of the Peermund River where that topples over the edge of the plateau. I visited this area in 1969/70. The character of the country has been greatly changed by hydroelectric schemes and the planting of wattle and gum trees. It has also been extensively roaded where few foot tracks existed before. It seems likely therefore that the game, including the tahr, have been driven out to less frequented areas. There are plenty of these still in the Attapadi area, and in Manarghat, and I think it is quite likely that tahr may survive in some of these isolated spots. As I have mentioned in connection with the Anamallais they will travel considerable distances through forests between isolated grass patches.

Incidentally all the Kundah Range in the Nilgiris used to carry large packs of wild dogs. Their main source of food supply were the large number of sambar and pig that used to abound, but I have no doubt that they killed the odd tahr too.

The company for whom I worked opened up the Tea Estates on the High Wavys and I know this area well. There are still a few tahr there but the herds are very small. Like some of the tahr in the Anamallais they travel considerable distances through dense and heavy forest from grass patch to grass patch. There is a huge area of unopened virgin forest here right down to the Periyar Game Reserve, and it is quite likely that a survey would discover that there were still small herds of ibex throughout the area.

I have not been in the Nelliampathi hills since 1942. Then there were a fair number of tahr there in the Contengady Estate area. But there has been a lot of development in this district since then, and all game may well have been driven out.

I was very interested to read that small herds still survive further south in the more isolated areas of forest. I think it is very probable that a search in areas I have described above might reveal other herds in isolated areas of which there are many suitable ones.

The Nilgiri Tahr is an adaptable animal, and might quite possibly adapt itself to a safer way of living than the great herds of the Anamallais and the High Range which used to live almost entirely in open grass land. The smallness of the bands that lived in the more isolated areas was probably due to the fact that they had to wander considerable distances to find suitable grazing. I have seen tahr nibble at browse. I do not think that they browse habitually where grazing is plentiful, but is possible that they might become habitual browsers if good grazing areas were restricted.

BOYNARDS MANOR HOUSE, JAMES L. H. WILLIAMS
RUDGWICK,
HARSHAM RH2 3AD,
SUSSEX, ENGLAND,
July 24, 1971.

7. AN ALBINISTIC GADWALL FROM INDIA

(*With two plates*)

Through the kindness of Mr. J. C. Daniel of the Bombay Natural History Society we have been invited to examine and comment on an albinistic example of the Gadwall, *Anas strepera* Linnaeus. This bird was collected on November 25th, 1967, at Bharatpur, Rajasthan, India; Museum No. 127-68 and is a female.

Description :

Upperparts: these are generally off white with a yellowish tinge; the rump, however, is pale sooty-brown with upper tail coverts of the same colour, but much paler.

Underparts: from root of neck to lower edge of breast shield off white, but whiter than upperparts, with typical distribution of the palest Gadwall spotting on the breast shield and down both flanks. Belly and under tail coverts white, with very faint spotting on lower belly and under tail coverts.

Wings: above as upperparts, below whiter. Greater wing coverts on both sides, dark sooty-brown, while the longest secondaries are a purer white. Rectrices off white. Head and neck whitish with full distribution of Gadwall marking, but much diluted. Irides brown, bill and legs brownish-yellow. The bill shows the typical strong lamellae of the Gadwall.

Measurements in mm.

Wing (chord)	.. 263
Bill length (from feather margin)	.. 40
Bill width (at nostrils)	.. 17
Tarsus	.. 40

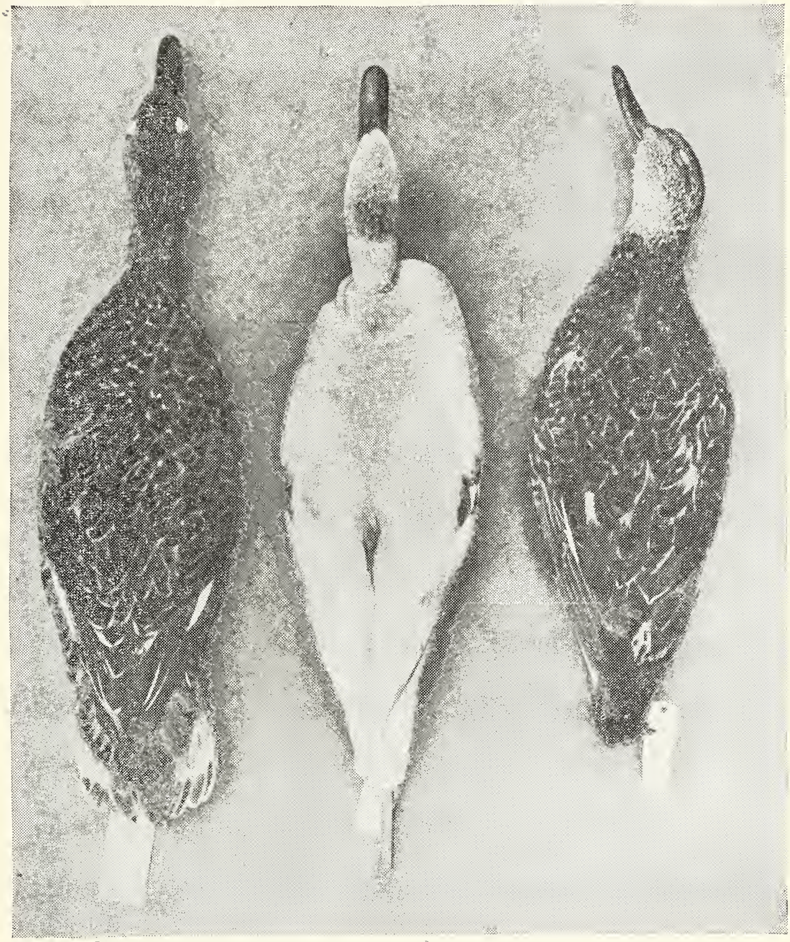
Discussion: the specimen appears to be a bird of the year judging by the narrow pointed tail feathers and the elongated and more pointed wing coverts. Like all albinistic individuals this specimen shows excessive wear of its plumage generally, but particularly of the flight feathers.

Albinistic Gadwall appear rare. There are two types of female normal winter plumage—a white-breasted and a spotted type, the former being the more usual. From the standard works, the dark spotted type does not appear to have been described. However, the specimen now described is best classified as showing a normally distributed 'ghost' pattern, and the bird is therefore an example of marked hypochromatism, in which all the pigments are present, but in much reduced amount, thus conforming in its characters to chlorochroism (Rensch 1925)[1].

Sage (*in litt.* 1971) informs us that the only record of albinism in the Gadwall known to him was an immature which was entirely pale creamy-fawn, with many slightly darker frecklings on the body and wings, trapped at Ministi Lake, near Edmonton, Alberta, Canada, on

[1] Rensch, B. (1925): Die Farbaberrationen der Vögel. *J.f.o.* 73 (4): 514-539

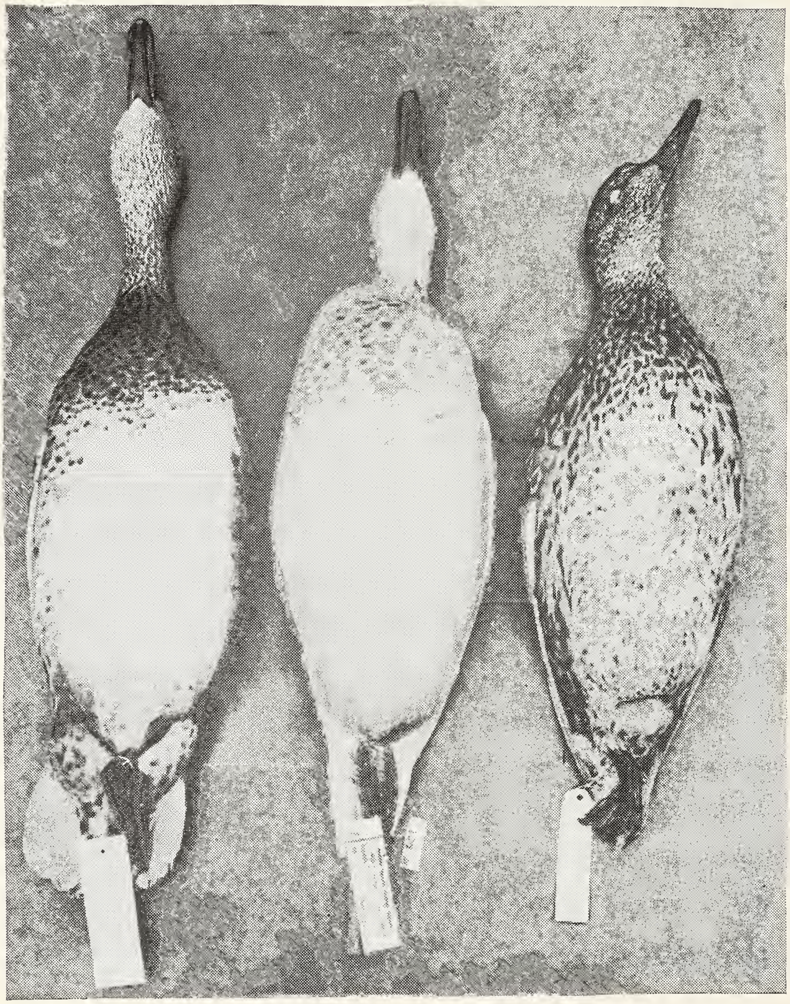
Harrison : *Gadwall*



Upperparts

The albinistic Gadwall from India between the two types of female.

Harrison : *Gadwall*



Underparts

The albinistic Gadwall from India
between the two types of female.

July 21st, 1940. Hawkes (*in litt.* 1971) informs us also that he has seen a drake Gadwall on the Island of Sheppey (Kent, England) in the three winters of 1969-71, with a creamy white nape and neck.

ACKNOWLEDGEMENTS

For the loan of the specimen, we are grateful to Mr. J. C. Daniel. For information of the other examples, both previously unpublished, we are indebted to Mr. Brain Hawkes and Mr. Bryan Sage, and for the photographs to Dr. Pamela Harrison.

HARRISON ZOOLOGICAL MUSEUM,
BOWERWOOD HOUSE,
SEVENOAKS, KENT,
ENGLAND,
June 1, 1971.

JAMES M. HARRISON
JEFFREY G. HARRISON

8. ON THE VALIDITY OF *OTUS BAKKAMOENA STEWARTI* KOELZ

While cataloguing the specimens of *Otus bakkamoena* in the Bombay collection, we sorted out a group of seven individuals (4 ♂♂ 2 ♀♀ 1 o? : 1 Simla Hills; 2 Chandigarh, 1 Karnal, Punjab; 1 Delhi; 1 Sironj, Tonk, Rajasthan; 1 Balaghat, C.P.) which, though intruding according to IND. HANDBOOK upon the range of four other races, could be well separated from them—darker than *deserticolor* Ticehurst (Type locality: Hyderabad, Sind), larger than *marathae* Ticehurst (Raipur, C.P.), darker than and not earthy brown as *gangeticus* Ticehurst (Fategarh, U.P.), and with the feathering of the tarsus not extending on to the toes as in *plumipes* (Hume) (Murree, Punjab).

In IND. HANDBOOK, Koelz's *stewarti* (1939, *Proc. Biol. Soc. Washington* **52**: 80. Type locality: Baijnath, Kangra, Punjab) is synonymised with *gangeticus* but as the specimen from Karnal which is not very far from the type locality was very different from *gangeticus*, we thought we would examine the original description, of which Dr. Dillon Ripley very kindly sent us a copy.

Koelz measures the wing of the type and paratype, both males, as 163 and 160 mm. In his description he does not compare it with *gangeticus* but separates it very clearly from *deserticolor* and *plumipes*, adding that the dark markings on the underparts when compared with *plumipes*, from 8000 feet in the same district, are greatly reduced, the shaft streaks narrower, and the barring broken into dots much as in *O. brucei*.

The wings and tail measurements are compared below with those of *marathae*, which these seven specimens resemble most in colour.

	Wing	Tail
Otus b. stewarti	156-175 av. 163	70-82 av. 80
Otus b. marathae	143, 145, 147, 148	66(2), 67, 71

The larger wing '152-162, once 165 (41 measured)' indicated for *marathae* in IND. HANDBOOK, ex Ticehurst, is no doubt due to these two subspecies being measured together.

There can be no doubt that another of Koelz's buried races needs resuscitation and we do so in this instance.

75, Abdul Rehman Street, Bombay-3. — HUMAYUN ABDULALI

Bombay Natural History Society, Bombay-1, — S. A. HUSSAIN

June 25, 1971.

9. CALLS OF THE MALABAR JUNGLE OWLET *(GLAUCIDIUM RADIATUM MALABARICUM)*

The Jungle Owlet is the commonest owlet of North Malabar. When it has young to feed, it can be seen as often during the day as any diurnal bird. Young birds are either diurnal or must be getting fed all the 24 hours of the day. The very peculiar food-call of the juvenile does not appear to have been recorded.

For about three months from the time they have developed into downy young, juvenile Jungle Owlets incessantly utter a note that could easily be mistaken for the voice of the Tickell's Flowerpecker *(Dicaeum erythrorhynchos)*. In fact, during April and May, 1969, though I heard it frequently at Dharmadam, Tellicherry Taluk, Kerala State, I did not pay much attention thinking that the author was a flowerpecker. On one or two occasions I saw a flowerpecker mobbing a jungle owlet and this made me ignore the fact that very often the sound seemed to issue from the place where an owlet was perched. On 10-vi-1969, however, I observed an owlet closely and found that the sounds were actually produced by it. It was a young bird and was being fed by an adult. When alone the juvenile went on uttering a series of *chick-chick-chick* (or *tchlik-tchlik*) notes at the rate of one 'chick' per second. When approached by the adult the rate increased until it became a rapid, harsh chatter during the actual feeding. In 1969 almost every day from 10th June to 3rd July I saw and heard the juvenile owlet.

On 6-iv-1970 at 2.20 p.m. I saw a Jungle Owlet flying with a large brown insect to its nest in one of the hollows in a dead coconut tree. The nest was some 30 feet above the ground. A young bird was peeping out and uttering the food-call continuously. The adult just passed on the food to the young bird and flew off. Only one young bird's head was seen at the nest entrance. Till the 16th of April the young were fed in the nest by the adults. They left the nest on the 17th and (unless they were replaced by other juveniles) were regularly seen and heard uttering the food-call till the 30th of June, 1970. After that date I do not seem to have heard the food-call. I think at least two young were raised by the pair that bred in the coconut tree. Their nest was found occupied by Roseringed Parakeets on 2-v-1970. In a hole lower down a pair of Goldenbacked Woodpeckers was raising a family at the time the owlets were nesting there.

In the HANDBOOK OF THE BIRDS OF INDIA & PAKISTAN, 3 (1969) the adult Jungle Owlet is said to utter two sorts of call: one that 'begins with a loud and slow "kāo" repeated 2 or 3 times, followed by "kāo-kūk (or kookūk), kāo-kūk, kāo-kūk, kāo-kūk etc. of about five seconds duration, quickening in tempo and fading off at the end"; the other, 'an occasional pleasant bubbling continuous *woi oioioioioi......keek,* the final *keek* in a much higher key'. THE BIRDS OF KERALA (Sálim Ali 1969) gives an almost identical description, but the first type of call is described as 'ending abruptly'. This is perfectly correct, whereas the HANDBOOK's 'fading off at the end' is definitely misleading.

Though the Jungle Owlet was very common at Dharmadam, I do not remember to have heard the bubbling *woi oioioioioi......keek* call at any time. However, I heard certain other notes not mentioned in the literature.

On 21-ix-69 at 5.45 a.m. more than 2 Jungle Owlets were calling. To quote from my diary, 'Two uttered the normal call of *kwār-kwār-kwār-kāokūk-kāokūk-kāokūk...*, but one that was very close to our house began with three *kwār's* and then broke into a rapid *quack-kekekekekek*. This call it uttered at least 4 times, each time seemingly in reply to the normal calls of another bird in the adjacent compound. Every time this "unorthodox" call was repeated, it was the same in quantity, quality and rhythm.'

On 24-ix-69 at 6.45 p.m. two Jungle Owlets began a duet. They uttered 4 different sorts of notes. One was a low *toor-toor-toor-toor-toor*, often followed by the regular *kaokuk-kaokuk-kaokuk* refrain or a variant of it that sounded like *kwārk-kwōr-kwōr-kwārkwarkwarkwark*!; the second a *quōr-quōr-quōr*; the third a *croo-croo-croo-croo-croo-croo*, the final note sharply stressed; and last, a rapid *quack-wack-wack-wack-wack.* These owlets went on calling throughout the night and one of them was heard repeating a *kwoi-kwoi-kekekekeke-kweee* which may be a variant of the note described in the HANDBOOK as a bubbling *woi-oioioioioioi . . . keek.*

On 25-ix-69 also the owlets were noisy all night; and, in addition to the calls described above, were often heard uttering a *kyow-kyow-kyow-queck-queck-queck-queck...* which, like the normal call, was always abruptly terminated. 25-ix-69 was fullmoon night but the sky was rather cloudy.

As all these unusual sounds were produced late in September, they were probably part of courtship-rivalry displays.

UNIVERSITY COLLEGE, K. K. NEELAKANTAN
TRIVANDRUM,
April 16, 1971.

10. TIBETAN TWITE (*ACANTHIS FLAVIROSTRIS*) IN NEPAL

The present observation, mentioned incidentally in the *Ibis* 1965:400, appears to be the only record of the Twite in Nepal. Between the 15th and the 18th of June 1964, Twites were heard daily on both sides of the Gosainkund Pass at *c.* 4200 to 4500 m. in pure alpine zone, i.e. boulderstrewn meadows well above the scrub zone. The birds were in pairs, feeding on the ground or flying overhead, uttering a characteristic *dje-dje-djet.* In habits and voice, this species is much more like a redpoll than a linnet; its call-note differs only from that of the redpoll in being a triple note while that of A. *flammea* is usually a double-note. The nearest observations are from Sikkim (in winter), Mt. Everest region (summer—Kinnear, N.B., 1922, *Ibis*: 520) and upper Karnal and Sutlej Rivers north of the Kumaon border, *c.* 81° long. east (Sálim Ali, *JBNHS* **46**: 300 and Lavkumar, K.S., *JBNHS* **52**: 928). The population inhabiting southern Tibet is named *A. f. rufostrigata.*

MUSEUM OF NATURAL HISTORY, M. DESFAYES
SMITHSONIAN INSTITUTION,
WASHINGTON, D.C.,
August 4, 1971.

11. SOME BIRDS FROM NEPAL

During the past seven years, the senior author has had an opportunity of collecting birds in various parts of Nepal. The Nepali collection now numbers 552 birds of about 250 species. From these data we extracted the most significant finds for this paper.

Birds were collected with 32, 410 and 12 gauge shotguns; specimens are now in Chetrapati, Kathmandu. Scientific terminology follows that given by Ripley (1961).

Botaurus stellaris (Linnaeus)

Specimens examined: 1. Kathmandu Valley, Changu Dole, 10 km. NE. Kathmandu, 1340 m. Sex undetermined; wing 330 mm.

Remarks. The Bittern has not been recorded in Nepal since Hodgson's time (*see* Biswas 1960:298). A single Bittern standing in a rice field on 9 November 1968. No others were seen.

Amaurornis fuscus (Linnaeus)

Specimens examined: 4. Kathmandu Valley, 3 to 4 km. N. Kathmandu, 1340 m. All adult males in breeding condition; wings 101, 102, 103 and 107 mm.

Remarks. The Ruddy Crake, although recently reported from Nepal (*see* Fleming & Traylor 1964:518-519; Fleming & Fleming 1970:2), is not a well-known species here. Apparently this is a breeding bird in Kathmandu. According to our local informants, the birds nest in rice paddies where the young hatch in about mid-August. All our birds were taken from 1 to 9 July 1970.

Streptopelia senegalensis (Linnaeus)

Specimens examined: 1. Kathmandu Valley, Balaju, 3 km. N. Kathmandu, 1340 m. Female; wing 115 mm., tail 98 mm.

Remarks. This is the first record of the Little Brown Dove from Nepal. Although it is frequent in parts of western and central India, this species does not appear to be common here. Only one individual was seen and then collected from a fruit tree on 2 December 1967. Numbers of Spotted Doves (*Streptopelia chinensis*) were also in the neighbourhood at that time.

Lanius excubitor Linnaeus

Specimens examined: 1. Bardiya District, Gauhna Village, 20 km. W. Nepalganj, 120 m. Female; wing 109 mm.

Remarks. The migratory Great Grey Shrike has not been taken in Nepal before. Our individual, the only one seen, was perched on a bush top near Gauhna Village. Collected on 8 February 1969.

Sturnus pagodarum (Gmelin)

Specimens examined: 1. Bardiya District, Semra Village, 20 km. E. Galuria, 120 m.

Remarks. Since Hodgson's time, the Brahminy Myna now has been collected twice in Nepal. The first specimen was from the extreme SW. corner of Nepal (*see* Fleming & Traylor 1968: 169) so our bird extends the range of this species eastwards to near Nepalganj in the Nepal Tarai. Our specimen was one of a flock of 15 or 16 birds feeding in low thorn bushes. 9 February 1969.

Acrocephalus stentoreus (Jerdon)

Specimens examined: 1. Kathmandu Valley, Balaju, 3 km. N. Kathmandu, 1340 m. Male; wing 81 mm.

Remarks. This is the first notation of the migratory Indian Great Reed Warbler in the Kathmandu Valley; it is the second find since Hodgson (*see* Fleming & Traylor 1968: 179). Our specimen was solitary, in bushes bordering rice fields on 26 December 1966.

Lonchura malacca (Linnaeus)

Specimens examined: 1. Kathmandu Valley, Sangala Khola, 8 km. N. Kathmandu, 1525 m. Male; wing 55 mm.

Remarks. The Chestnut Mannikin is not common in Nepal. Our specimen, collected on 14 December 1969, is the first from Kathmandu since the 1870's (*see* Biswas 1963: 389). This bird was one of a small flock associating with Nutmeg Mannikins (*Lonchura punctulata*).

Emberiza melanocephala Scopoli

Specimens examined: 1. Kathmandu Valley, Balaju, 5 km. N. Kathmandu, 1340 m. Male; wing 96 mm., tail 69 mm.

Remarks. The Blackheaded Bunting, although a common migratory bird in western India, has not been found before in Nepal. Our individual was with a large (*c.* 200 birds) flock of Yellowbreasted Buntings (*E. aureola*) that had settled in bushes and hedges around rice fields. This bird appeared larger than the others and was collected on 17 November 1969.

Emberiza spodocephala Pallas

Specimens examined: 1. Kathmandu Valley, Balaju, 3 km. N. Kathmandu, 1340 m. Male; wing 76 mm., tail 65 mm.

Remarks. Several times small parties (3 to 4 birds) of these Blackfaced Buntings were seen flying into 'Nilkanta' bushes just at dusk, Apparently they roosted here at the edge of the fields. This species has not been reported in Nepal since Hodgson's time (*see* Biswas 1963: 192). Our specimen was taken on 12 January 1967.

ACKNOWLEDGEMENTS

We would like to thank the following people for their assistance and help during the development of this collection: Capt. A. J. Tamang, Capt. S. M. Sakya, Shri K. L. Dhalli, and Shri M. Bhattacharya. Kirthi M. Tamang was most helpful during the senior author's visit to Nepalganj. Dr. Robert L. Fleming, Sr. was always a valuable source of information and guidance. We also wish to thank the Forest Department, HMG, for granting permission to collect birds.

CHETRAPATI, KATHMANDU. — HARI S. NEPALI

P.O. BOX 229, KATHMANDU, — ROBERT L. FLEMING, JR.

August 8, 1970.

REFERENCES

BISWAS, B. (1960-1963): The Birds of Nepal. *J. Bombay nat. Hist. Soc.* **57** (2): 278-308; **60** (1): 173-200; **60** (2): 388-399.

FLEMING, R. L. SR. & FLEMING, R. L. JR. (1970): Birds of Kathmandu Valley and Surrounding Hills—a check list. Jore Ganesh Press, Kathmandu.

FLEMING, R. L. & TRAYLOR, M. A. (1964): Further notes on Nepal Birds. *Fieldiana*: Zoology **35** (9): 495-558.

——— & ——— (1968): Distributional notes on Nepal Birds. *Fieldiana*: Zoology **53** (3): 147-203.

RIPLEY, S. D. (1961): Asynopsis of the Birds of India and Pakistan, xxxvi+703 p. Bombay nat. Hist. Soc., Bombay.

12. CROCODILE (*CROCODILUS PALUSTRIS*) BREEDING AT THE JAIPUR ZOO

Thirty-three eggs, oval in shape and hard-shelled were laid by the female crocodile at the Jaipur Zoo on 5th May, 1971. Two young ones were found dead in the eggs and four eggs were sterile. Thus 27 young ones survived, which gives a hatching success of 82 per cent. The female laid eggs in the dry portion of the cage. The eggs were buried by the mother in a 2 feet deep pit. Leaves and plant debris were used by her to cover the pit.

The average weight of the eggs was 115 gm. and diameter 70 mm.

The female crocodile sat at the place where the eggs were concealed once or twice in a day for half to 2 hours. Occasionally the mother looked around to make sure that the brooding place was un-

TABLE

STATEMENT SHOWING BREEDING DATA OF CROCODILES AT JAIPUR ZOO

Year	Date of Egg laying	Clutch size	Date of Hatching	Incubation period	No. of young Hatched and survived	No. of spoiled Eggs	Hatching success percentage
1967	9-v-1967	41	3-vii-1967	55 days	29	12	71%
1968	18-v-1968	22	6-vii-1968	49 days	12	10	55%
1969	22-v-1969	28	5-vii-1969	44 days	24	4	86%
1970	25-iv-1970	35	2-vii-1970	68 days	31	4	89%
1971	5-v-1971	33	26-vi-1971	52 days	27	6	82%

disturbed. She would run to the site if some one came near. At times she rushed towards the sweeper if he went near the eggs while cleaning the enclosure.

The hatching started on the morning of 26th June and was complete by 15 hrs. the same day. 14 young escaped into the water but were soon captured with the help of nets and along with the other young were kept in a separate cage.

If the young are not separated from the parents soon after hatching, there is the danger of their being devoured by them. They were removed from the cage of their parents very cautiously as the mother furiously attacked intruders.

The young reptile soon after hatching measured between 28 and 30 cm. with their weight ranging from 90 to 100 gm. The young ones could see, bite and swim with ease.

The young ones do not accept any feed for about a month but depend on sand particles and small insects available in their cage. After this they are given minced-meat and minced-fish once a day which they readily devour.

Crocodiles in the Jaipur Zoo have been breeding regularly for the last 12 years. The data has also been published in the year book of the London Zoological Society, Volume 9.

Mating occurs during December and January and the eggs are laid in April and May. The mating takes place in water in an overlapped position and lasts half to two hours, during which period they are silent and motionless.

By the time this note was written in the third week of July, all the 27 young crocodiles were doing well in their small cage in the Jaipur Zoo.

CONSERVATOR OF FORESTS, MAHENDRA PRAKASH
RAJASTHAN,
JAIPUR,
July 26, 1971.

13. A RECORD OF THE GHARIAL, *GAVIALIS GANGETICUS* (GMELIN) FROM PATNA (BIHAR)

On 21-xi-1970 night a single specimen of *Gavialis gangeticus* (Gmelin) was caught by a fisherman, from the Badar Ghat (Patna), at the confluence of the River Gandak with the River Ganges. It was collected in a fishing net, locally called 'Gochai'. The specimen measured 247 cm. and its approximate weight was 100 Kg.

The measurements of the specimen were as follows:

Total length	..	247 cm.
Maximum girth	..	99 ,,
Tail length	..	144 ,,
Distance from snout to eye	..	38 ,,
Diameter of the eye	..	4 ,,
Lower teeth on each side	..	26 Nos.
Upper teeth on each side	..	27 ,,

The dorsal surface was olive brown and ventral surface whitish yellow. There were six cross-bands on the body. From its size it appeared to be a young animal.

It appears that the specimen might have migrated in the rainy season from River Gandak. Biswas (1970)[1] states that in rainy season the Gharials migrate up to Allahabad in River Ganges.

The fisherman, Dholan Choudhury, who caught the Gharial, stated that he had in 1968, caught 3 specimens from the same spot on the River Ganges.

The specimen was alive in his possession for 5 days.

GANGETIC PLAINS REGIONAL STATION,
ZOOLOGICAL SURVEY OF INDIA,
RAJENDRANAGAR, PATNA-16,
June 25, 1971.

T. VENKATESWARLU
BHOLANATH
D. P. SANYAL

14. COBRA AND MONITOR LIZARD

On the morning of July 2nd I witnessed a fight between a cobra and a monitor lizard. The incident took place on the sloping bank of an overgrown ditch about twenty feet wide in a small piece of wild land at the back of the Safdarjang airfield. While birdwatching in this area I suddenly came across a cobra (a black one) coiled around a stone with a charge of reeds behind it, its head raised about a foot from the ground, its hood about six inches wide with a binocellate mark. About a yard in front of it a three foot long monitor lizard stood facing it. The lizard moved from side to side probably trying to get a opening for attack while the snake followed its movements carefully. As the lizard moved to one side and came forward, the cobra struck but missed, the monitor jumped on its back, but whipping round, the snake struck once more but missed again as the lizard jumped off. They resumed their old positions watching each other

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[1] BISWAS, S. (1970). A preliminary survey of Gharial in the Kosi River. *Indian Forester* **96** (9): 705-710.

warily. Suddenly the cobra made a break for it and darted up the opposite slope of the ditch and disappeared with the lizard in hot pursuit. I do not know what followed. The whole scene was watched from about fifteen feet and lasted three or four minutes.

DI/43, SATYA MARG, E. BHARATAN
CHANAKYAPURI,
NEW DELHI-11,
July 4, 1971.

15. STRIKING BEHAVIOUR IN THE COMMON GREEN WHIP SNAKE (*AHAETULLA NASUTUS*)

In a recent contribution in this *Journal* (**67**: 113; 1970) Romulus Whitaker noted the effects of *Ahaetulla nasutus* bite. I have several times been bitten by Thailand specimens of this snake, with symptoms of bleeding, itchiness, and only slight swelling deriving exactly as those described by Mr. Whitaker. Several individuals made feinting lunges, although one struck and bit with such determination that it required my aid to free its teeth from my hand. My own experience also confirms M. Smith's statement (1943, FAUNA OF BRITISH INDIA Reptilia and Amphibia 3) that, 'when handled it has the peculiar habit of watching one's face and suddenly making a dart at it, aiming usually for the eyes.' The snake is called 'Eye Snake' in parts of its range.

Ahaetulla nasutus has from birth a propensity for striking. On 8 June 1962, in Bangkok, I caught a 65 inch long female, which soon gave birth to eleven young, of which two did not survive birth. Each of these was about ten inches long. Immediately after birth the young were very active, striking at each other and at me.

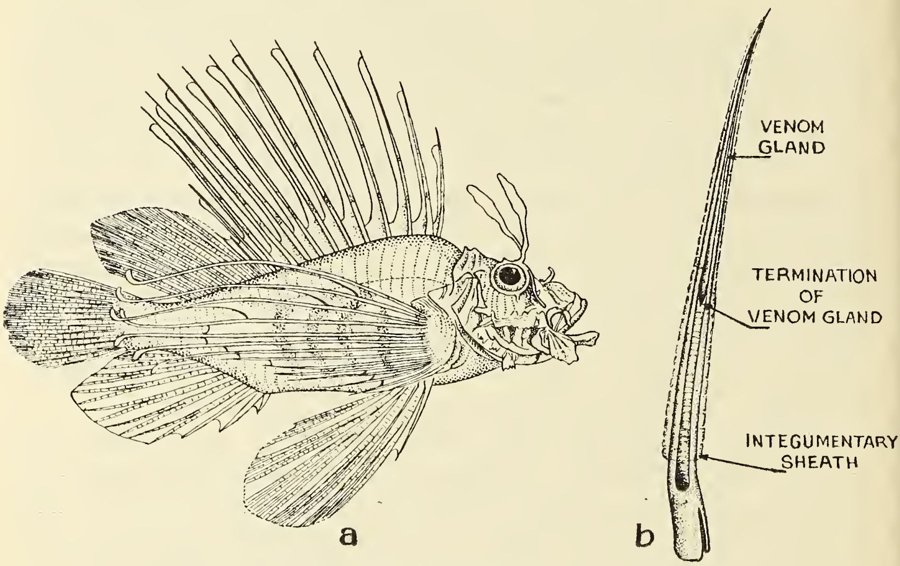
I noted that specimens of the less common *Ahaetulla prasinus* from southern Thailand were, as a rule, more prone to strike than *Ahaetulla nasutus*. The former were remarkable for the rapidity with which they would whip into the 'S'-shaped striking posture, inflate the neck to reveal the black and white interstitial pattern, flicker the tongue, hiss, and rapidly vibrate the tail. I saw several individuals so excited strike at inorganic objects; one, turning and seeing its own tail vibrating, struck at it!

949 E. LA JOLLA DRIVE, PAUL S. SODERBERG
TEMPE, ARIZONA,
USA—85281,
January 1, 1971.

16. THE USE OF SCORPIONFISH (*PTEROIS* SPP.) SPINES AS A STIMULANT (?) IN COCK FIGHTS

(With a text-figure)

During a recent collection trip to Andaman Islands, from January to March, 1970, the authors were surprised to see a few scorpion-fishes belonging to the genus *Pterois* (Fig. a) kept for sale at a fishing village near Diglipur, North Andamans. On enquiry, the local fishermen informed us that these stinging fishes are known locally as 'Murgi machi' and are generally purchased by the locals in connection with cock fights. The venomous dorsal spines (Fig. b) of these



a. *Pterois volitans* (Linnaeus).
b. *Pterois* sp. venom organs of dorsal spine.

fishes are regularly stuck into the body of the cock for a week before the fight. It is likely that during the process the dried venom containing dehydrated toxin gets dissolved in the body fluids or blood serum and acts as stimulant in the fight. This interesting folklore, however, needs further investigation.

The 'Murgi machi' (*Pterois* spp.) are venomous fishes and are characterised by 12-13 dorsal spines, 2-3 anal spines and 2 ventral spines. These spines are generally long, slender and straight. The sides of the spines are grooved and the grooves consist of a glandular tissue covered over by a thin integumentary sheath which is coloured and banded. The scorpionfishes, as the name implies are known for their venomous nature. They are also known as zebrafishes, turkeyfishes, lionfishes, etc. They are brightly coloured and occur in shallow waters around coral reefs and rocky areas near the shores of tropical seas.

ZOOLOGICAL SURVEY OF INDIA, CALCUTTA, June 9, 1971.

A. G. K. MENON
K. V. RAMA RAO

17. ON THE OCCURRENCE OF *ICHTHYSCOPUS INERMIS* (SWAINSON) OFF VIZHINGAM, KERALA

The only available information regarding the occurrence of *Ichthyscopus inermis* (Family Uranoscopidae) is from Day (1878)[1] who had described a male specimen of 12″ length from the Kanara Coast. No further report is available regarding the distribution of this species from the east and west coast of India.

On March 13th, 1969, a female specimen of *Ichthyscopus inermis* measuring 390 mm., weighing 1373 gms. was collected from a 'Karamadi or Kamba vala' (Shore-seine) operated in the Vizhingam Bay.

Distinguishing Characters

Body elongate with a single dorsal fin; head covered with bony plates; mouth large with a cleft projecting upwards; small teeth on palate and jaws; eyes dorsal; anterior nostrils round, situated in front of the centre of eye and surrounded with papillae; an elongated angular flap edged with papillae behind the shoulder; lateral line close to the dorsal base; canary-yellow with pure white, round, irregular and oval spots on the body and white spots on the pectoral and dorsal fins; lateral portion below the eye black and soft; ventral and opercular portion light red.

The meristic counts and morphometric measurements are presented in the Table.

Analysis of the stomach contents (30 c.c.) showed that fish formed the main bulk of the food representing 90 per cent of the stomach contents. A single fish (*Pseudorhombus* sp.) of length 120 mm. was found in the stomach along with bottom mud mixed with sand particles which suggests a bottom feeding habit. Day (1878) in his account of this species has reported that the fish has a peculiar habit of bury-

[1] DAY, F. (1878) : Fishes of India.

ing itself in the mud with only cleft of mouth and eyes projecting while a constant current is kept through its gills. If lifted out of the water it squirted fluid from its mouth for some distance. While in the mud it resembled a frog. It made a curious noise, half snapping and half croaking when removed from the water.

TABLE

Meristic counts B VIII D3 16, A. 16; V. 1/5; C 11-12; P. 18

Morphometric measurements (mm.)

Total length : 390	Caudal spread : 90
Standard length : 310	Length of angular flap : 65
Head length : 120	Maximum body height : 120
Snout to Vent : 170	Height of caudal peduncle : 35
Vent to Caudal Peduncle : 140	Height at head : 110
Snout to dorsal : 125	Lateral depth: 100
Snout to pectoral : 125	Diameter of eye: 10
Snout to Ventral : 110	Interorbital : 30
Snout to Anal : 185	Interspiracle : 25
Dorsal base : 135	Cleft of mouth : 45
Anal base : 155	Projection of mouth : 15
Length of pectoral : 105	Average length of papillae : 10-12
Length of ventral : 55	Height of dorsal : 40
Length of caudal : 80	

CENTRAL MARINE FISHERIES RESEARCH UNIT,
VIZHINGAM,
VIA TRIVANDRUM,
June 17, 1970.

M. D. K. KUTHALINGAM

18. TWO NEW RECORDS OF BRYOZOANS FROM INDIAN WATERS

(With three text-figures)

Studies on the fouling bryozoans of Bombay harbour and its vicinity have brought to light the existence of a good number of species. In a recent collection of fouling bryozoans from the intertidal region at Cuffe Parade (Bombay), two species hitherto unknown from Indian waters, have been encountered. These specimens were found attached on stones and shells obtained from enclaves of shallow waters, found trapped during low tide, all along the area which is exposed to atmospheric air, at least for two hours, twice in a day, during low tide. A brief account of these two species is given in this note.

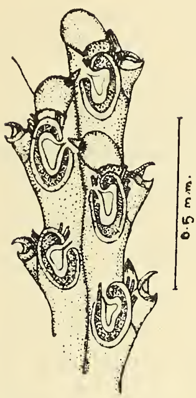


Fig. 1. *Scrupocellaria harmeri* (Osburn) Frontal view

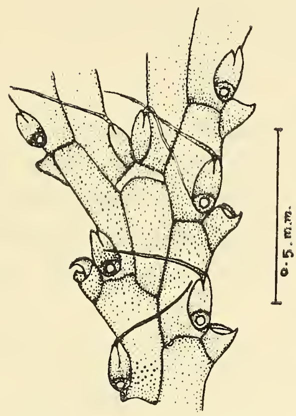


Fig. 2. *Scrupocellaria harmeri* (Osburn) Basal view

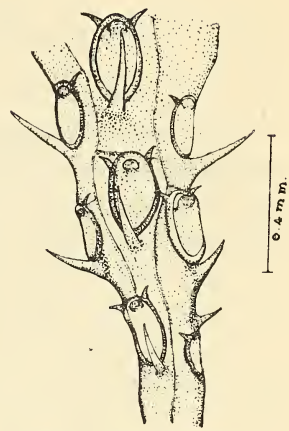


Fig. 3. *Electra bellula* (Hincks.)

Scrupocellaria harmeri (Osburn)

(Figs. 1 & 2)

Spreading, branched, whitish colonies, with stiff joints, attached to substratum by rootlets. Branches composed of alternating zooecia in two series, and mostly having 7-9 zooids between bifurcations. Zooecia narrowest proximally, with the oval opesia occupying less than half its length. Zooecia measure from 325-360 μ in length and 160-180μ in width. Cryptocyst present. Ovate scutum, with a small upper lobe, attached well above the middle of the opesia. Four spines normally present on the outer distal corner and two on the inner angle of the zooecium.

Lateral avicularia large and prominent, with mandible similar to the beak of a bird. Frontal avicularia small with triangular mandible and associated with ovicells only. Basal surface bear vibracula, with simple seta, slightly longer than the zooid. Two axial vibracula present in the axil of a bifurcation.

Ovicells almost spherical, measuring about 125 μ in diameter; smooth, imperforate with distal and inclined towards the axis of the internode.

These specimens agree with the Atlantic and Pacific specimens described by Osburn, (1947, 1950) in all features, except that they possess slightly shorter and wider zooecia and more or less spherical ovicells. The specimens were collected in June. This species was first recorded from the Atlantic coast of America and subsequently from the Pacific coast of America by Osburn.

Electra bellula (Hincks)

(Fig. 3)

Erect colony, attaining a length of 4 to 6 mm., branching dichotomously. Zooecia elongate, with the oval opesia occupying the distal half, and measure from 360-400 μ in length and 140-180 μ in width. Proximal median spine stout and attains a length from 200 to 325 μ. A few zooecia with branched spines on the opesial margin. Gymnocyst well developed.

These specimens are erect and have unbranched proximal spine like those figured by Marcus (1937) in specimens from Brazil and by Cook (1968) in specimens from Lagos. The number of opesial spines is reported to vary widely and the colony can be both encrusting and erect (Cook, op. cit.). It appears to have considerable tolerance to low salinity also as specimens were collected during the monsoon period when salinity of water at the area may drop to 16%.

Acknowledgements

The authors are grateful to Shri K. H. Alikunhi, Director & Research Guide, Central Institute of Fisheries Education, Bombay, for his guidance and valuable suggestions during the preparation of this note. Grateful thanks are also due to Miss Patricia L. Cook of the British Museum (Natural History) for her valuable comments on the species.

S. R. MADHAVAN PILLAI

Wood Preservation Centre of
Forest Research Institute,
(Dehra Dun).

L. N. SANTHAKUMARAN

Central Institute of
Fisheries Education,
Bombay-58 AS,
January 6, 1971.

References

Cook, P. L. (1968): *Polyzoa* from West Africa, the Malacostega, pt. I. *Bull. Br. Mus. nat. Hist.* (*Zool.*) **16** (3): 134.

Marcus, E. (1937): Bryozoarios Marinhos Brasileiros I. *Bol. Fac. Filos. Cienc. S. Paulo. Zool.* **1**: 1-244.

Osburn, R. C. (1947): *Bryozoa* of the Allan Hancock Atlantic Expeditions 1939. Report No. 5, 1-66.

——— (1950): *Bryozoa* of the Allan Hancock Pacific Expeditions 1933-1942. **14** (1): 1-269.

19. ON A NEW HOST RECORD OF *TARAGAMA SIVA* (LEF.) (LEPIDOPTERA: LASIOCAMPIDAE) FROM WEST BENGAL

The present note records *Taragama siva* (Lef.) for the first time from the tamarind tree. On 21 August, 1968, I found green leaves of a small tamarind tree in Eden Gardens, Calcutta being eaten by caterpillars. Tracing the caterpillars was difficult as their body colour was almost similar to the colour of the branches. Some caterpillars were brought to the laboratory and reared in a glass jar containing dry sandy soil. They pupated on the surface of the cloth used for covering the mouth of the jar. The moths that emerged were identified as *Taragama siva* (Lef.)

ACKNOWLEDGEMENT

I am thankful to Sri D. K. Mondal, Zoological Survey of India, Calcutta, for confirming the species.

ZOOLOGICAL SURVEY OF INDIA, P. PARUI
CALCUTTA-12,
May 14, 1969.

20. SUBTERRANEAN HABITATS OF SANDFLIES (DIPTERA: PSYCHODIDAE) IN AURANGABAD AND BHIR DISTRICTS, MAHARASHTRA, INDIA

Studies on Indian sandflies have so far remained confined mainly to domestic and peridomestic habitats. The significance of certain other types of habitats, particularly the subterranean ones is well known in the epidemiology of 'termite-hill Kala-azar' in Kenya (Wijers & Minter 1962; Minter 1963) and cutaneous Leishmaniasis in Uzbekistan, U.S.S.R. (Dergacheva & Dolmatova 1962; Dolmatova & Dergacheva 1961). Subterranean habitats of sandflies have also been reported from Sudan (Quate 1964; Qutubuddin 1961), Brazil (Martin *et al.* 1964), Ghana and Pakistan (Lewis 1967). In the present communication, sandflies have been recorded for the first time from subterranean habitats in India.

Following the isolation of a virus of sandfly fever group from the sera of two febrile cases in Aurangabad, Maharashtra State, India (Bhatt *et al.*, in preparation), and the isolation of Chandipura virus from wild caught sandflies from the same area (Dhanda *et al.*, 1970), extensive studies on the distribution and habitat of sandflies in this region were undertaken. During a recent survey trip to Aurangabad and Bhir districts during May/June 1970, several termite-hills and rodent burrows were searched for sandflies, and as many as seven species were collected from these habitats as shown below.

TABLE

SANDFLIES COLLECTED FROM TERMITE-HILLS AND RODENT BURROWS

Sandfly species	Termite-hills 24/25*		Rodent burrows 13/18*		Total 37/43*	
	♂	♀	♂	♀	♂	♀
Phlebotomus argentipes ..	0	1	0	0	0	1
Phlebotomus colabaensis ..	2	0	0	0	2	0
Sergentomyia babu ..	55	144	19	22	74	166
Sergentomyia bailyi ..	84	101	7	6	91	107
Sergentomyia clydei ..	60	4	15	6	75	10
Sergentomyia punjabensis ..	11	5	3	1	14	6
Sergentomyia squamipleuris ..	0	0	0	1	0	1
Total ..	212	255	44	36	256	291

*Number of habitats positive/total number searched.

Out of a total of 25 termite-hills searched, 24 were positive. In all 15·5 man-hours were actually spent in making the collection, and a total of 467 sandflies, belonging to six species were collected. *Sergentomyia babu* (Annandale 1910) and *S. bailyi* (Sinton 1931) were the predominant species in the termite-hills. Some gravid specimens and some with fresh blood meal were also present in the collection. Out of 18 rodent burrows searched, 13 had sandflies. Although actually only 2·5 man-hours were spent in making these collections, as many as 80 specimens belonging to five species were collected. *S. babu* and *S. clydei* (Sinton 1928) formed majority of the collection. Some gravid and freshly fed specimens were also present in the collection.

Vertebrates such as rodents, shrews, snakes and lizards are often found inside these subterranean habitats, and may serve as hosts for the sandflies living there. Whether these habitats play a role in the epidemiology of sandfly borne diseases in India remains to be investigated.

We are grateful to Dr. T. Ramachandra Rao, former Director of the Virus Research Centre, for his keen interest and helpful sugges-

tions during our studies on the sandflies of Marathwada region. The technical assistance of Mr. S. N. Guttikar is also gratefully acknowledged.

VIRUS RESEARCH CENTRE,
INDIAN COUNCIL OF MEDICAL RESEARCH,
POONA, INDIA,
September 24, 1970.

G. B. MODI
VIJAI DHANDA

REFERENCES

BHATT, P. N., DANDAWATE, C. N. & RODRIGUES, F. M. (in preparation): Isolation of a virus belonging to the Phlebotomus Fever group, from febrile cases in Aurangabad, India.

DERGACHEVA, T. I. & DOLMATOVA, A. V. (1962): On the epidemiology and epizootology of cutaneous leishmaniasis of the rural type in the Karshi Oasis, Uzbekistan, IV. *Medskaya Parazit.*, **31**: 206-211.

DHANDA, V., RODRIGUES, F. M. & GHOSH, S. N. (1970): Isolation of Chandipura virus from sandflies in Aurangabad. *Indian J. Med. Res.*, **58**: 179-180.

DOLMATOVA, A. V. & DERGACHEVA, T. I. (1961): On the epidemiology and epizootology of cutaneous leishmaniasis of the rural type in the Karshi Oasis, Uzbekistan, I. *Medskaya Parazit* **30**: 584-591.

LEWIS, D. J. (1967): The phlebotomine sandflies of West Pakistan (Diptera: Psychodidae). *Bull. Brit. Mus. (Nat. Hist.) Entomology*, **19**: 1-57.

MARTINS, A. V. FALCAO, A. L. & DA SILVA, J. E. (1964): Estudos sobre os flebotomos do Estado de Minais Gerais. VI. *Revta bras. Biol.* **24**: 309-315.

MINTER, D. M. (1963): Studies on the vector of Kala-azar in Kenya. III. Distributional evidence. *Ann. Trop. Med. Parasitol.* **57**: 19-23.

QUATE, L. W. (1964): Phlebotomus sandflies of the Paloich area in the Sudan. *J. Med. Ent.* **1**: 213-268.

QUTUBUDDIN, M. (1962): Notes on the Phlebotomine of the Sudan Republic with description of a new species and subspecies. *Ann. Mag. Nat. Hist. Ser.* 13, **4**: 593-611.

WIJERS, D. J. B. & MINTER, D. M. (1962): Studies on the vector of Kala-azar in Kenya. I. Entomological evidence. *Ann. Trop. Med. Parasitol.* **56**: 462-472.

21. A NOTE ON THE OCCURRENCE OF *DISCOMYZA MACULIPENNIS* WIEDMANN (DIPTERA: EPHYDRIDAE) ON DRIED FISH

The ephydrid flies are generally known to inhabit marshy, damp and filthy areas. A recent survey by the authors, of the insect pests attacking stored dried fish in Malabar area has revealed the occurrence of large numbers of adult and immature stages of the ephydrid fly, *Discomyza maculipennis* Wiedmann on dried fish in Calicut, particularly under inadequate conditions of processing and storage. This is generally, a filth inhabiting fly and dried fish, which is not properly processed and stored is likely to undergo a certain degree of decomposition, thus attracting these flies to lay their eggs. The larvae feed on the decomposing tissues, and their presence on fish appears to accelerate the process of deterioration of the fish. Though these flies are not found on properly cured and stored fish, their occurrence on dried fish under the conditions explained above is being recorded for the first time.

DEPARTMENT OF ZOOLOGY,
MALABAR CHRISTIAN COLLEGE,
CALICUT-1, KERALA STATE,
June 12, 1969.

A. B. SOANS
CLEMENT ADOLPH

22. FURTHER COLLECTION OF THE SYRPHIDAE (DIPTERA) FROM CENTRAL INDIA

Anand *et al.* (1967)[1] have reported that the hoverflies or sunflies (Syrphidae) play an important part in checking aphids which are important insect pests of cultivated crops and have recorded nine hosts of these flies from Delhi and its adjoining areas. The following fourteen syrphids were collected from central Madhya Pradesh, while they were hovering over aphid attacked plants. Except the species marked with asterisk, the rest were collected for the first time from the locality.

1. *Asarcina aegrota* Fab.
2. *Baccha sapphirina* Wied.
*3. *Eristalis quinquestriatus* Fab.
4. *Eristalis aenea* Scop.
*5. *Eristalis arvorum* Fab.
6. *Eumerus* sp.
7. *Megaspis argyrocephalus* Maeq.
8. *Megaspis crassus* Fab.
9. *Microdon auricinctus* Brun.
10. *Paragus* sp.
11. *Paragus* sp. ? *yerburiensis* Stuck.
12. *Syritta pipiens* L.
*13. *Syrphus balteatus* De Geer.
*14. *Xanthogramma* sp.

ACKNOWLEDGEMENTS

Thanks are due to Dr. G. S. Misra and Dr. A. Bhattacharya, Director and Entomologist of the Institute respectively for providing facilities to work. The author is also thankful to Mr. R. W. Crosskey, Commonwealth Institute of Entomology, London for determining the syrphids.

INDIAN LAC RESEARCH INSTITUTE,
NAMKUM, RANCHI, BIHAR,
July 4, 1969.

R. S. GOKULPURE

[1] ANAND, R. K.; RAI, SAMARJIT & SHARMA, V. K. (1967): Notes on the hoverflies (Diptera: Syrphidae) from Delhi and adjoining areas. *Indian J. Ent.* **29** (3): 301-308.

23. COLONY-FISSION IN THE ANT, *MONOMORIUM GRACILLIMUM* SMITH (HYMENOPTERA: FORMICIDAE)

Reproduction of colonies by fission is known to take place in pleometrotic ants in which old colonies grow and may break up into new daughter ones (Brian 1965). Details of this process in a few species of ants have been recorded by workers (Elton 1932; Ledoux 1950; Gosswald 1951; Duncan-Weatherly 1953; Vanderplank 1960; Soulie 1962). The authors happened to make the following observations on the fission of colony in the ant *Monomorium gracillimum* Smith in the verandah of a building in the Malabar Christian College compound at about 18 hrs. on June 30, 1969. At that time, the sky was cloudy and there was a break in the first rains of the season. The temperature was 27·5°C and the relative humidity was 92%. It is to be noted that the initial part of the observations could be interpreted only after it was definitely known that the colony of the ant was undergoing fission.

The workers of *M. gracillimum* were first seen leaving their nest and coming out in fairly large numbers through the opening of the nest on the cemented floor, and going to a point about seven metres away where they had found another opening at the base of a wall, presumably leading to a suitable nesting site. The workers moved back and forth between the old nest and the new site, probably laying the trail for others to follow. During the course of about one hour, large numbers of workers emigrated and entered the new nesting site and then a queen emerged out of the opening of the parent nest and started moving slowly along the trail, with the workers. The queen was in the dealated stage and must have been fertilized. It could hardly walk and was virtually being dragged by its legs and antennae, by the workers towards the new nest-site. No immature stages were being carried by the emigrating workers. The queen finally reached the new nest into which it entered. The emigration of workers continued till about 20 hrs. though their number gradually decreased. All the workers which came out of the parent colony did not necessarily move into the new nest, as some of them returned to the old nest after moving along the trail for some distance. A few workers even appeared to be moving from the new colony-site towards the old nest. For some time there was a certain degree of intermixing of workers of the two colonies along the trail but on the following morning, no ants were found moving along the old trail between the two nests and the two colonies had apparently become well separated and established. As the forms involved in this process are apterous, the extent of dispersal of daughter colonies arising from such fissions of the old colony, is obviously limited.

DEPARTMENT OF ZOOLOGY,
MALABAR CHRISTIAN COLLEGE,
CALICUT-1, KERALA,
July 8, 1969.

A. B. SOANS
J. S. SOANS

REFERENCES

BRIAN, M. V. (1965): Social Insect Populations. Academic Press, London—New York.

DUNCAN-WEATHERLY, A. H. (1953): Some aspects of the biology of the mound ant, *Iridomyrmex detectus* Smith. *Australian J. Zool.* **1**: 178-192.

ELTON, C. (1932): Territory among wood ants (*Formica rufa* L.) at Picket Hill. *J. Anim. Ecol.* **1**: 69-76.

GOSSWALD, K. (1951): Uber den Lebensablauf von Kolonien der Roten Waldameise. *Zool. Jb.* **80**: 27-63.

LEDOUX, A. (1950): Recherche sur la biologie de la fourmi fileuse *Oecophylla longinoda* (Latr.). *Ann. Sci. nat. Zool.* (11) **12**: 313-461.

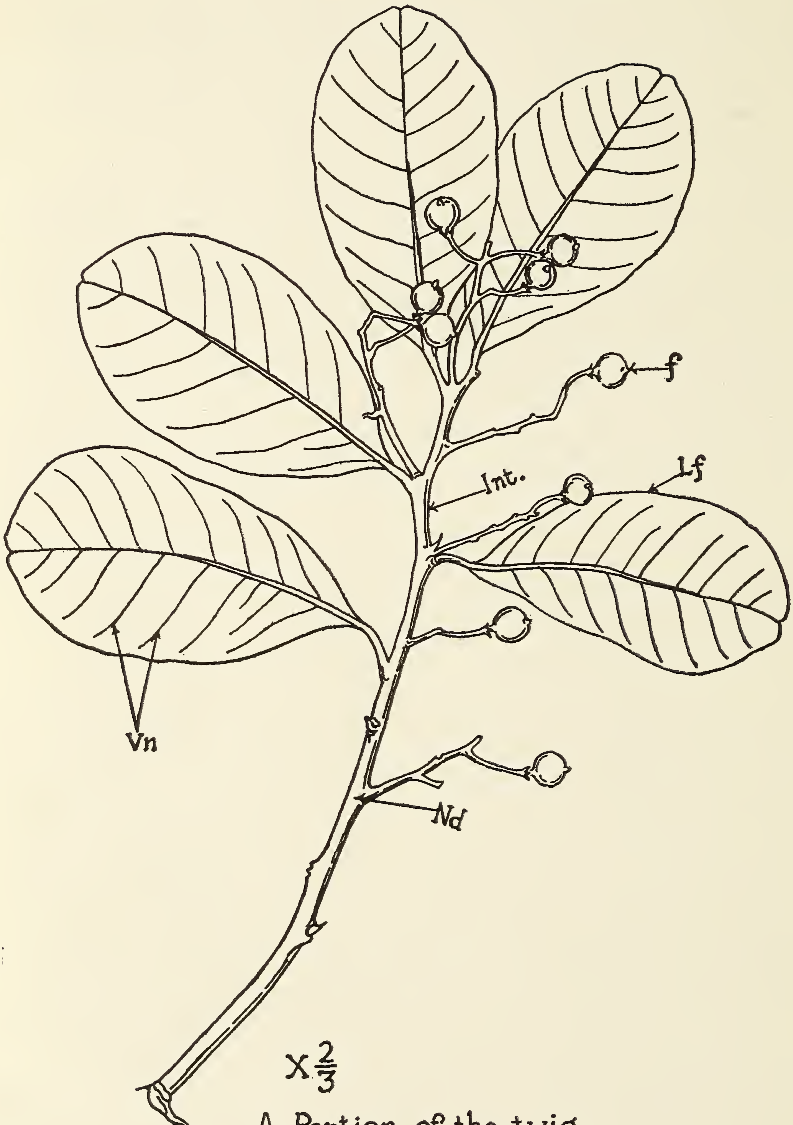
SOULIE, J. (1962): Recherche ecologique sur quelques especes de fourmis du genre *Crematogaster* de l'ancien monde (Europe, Afrique du Nord, Asie du Sud-Est). *Ann. Sci. nat. Zool.* **4**: 669-826.

VANDERPLANK, F. L. (1960): The bionomics and ecology of the red tree ant, *Oecophylla* sp., and its relationship to the coconut bug *Pseudotheraptus wayi* (Brown) (Coreidae). *J. Anim. Ecol.* **29**: 15-33.

24. PROXIMITY OF THE COLONIES OF THE TENDING ANT SPECIES AS A FACTOR DETERMINING THE OCCURRENCE OF APHIDS

Aphis craccivora Koch. is a common aphid and is found periodically infesting the tender newly sprouted shoots of the plant, *Glyricidia maculata* in Calicut, soon after the first rains. The area of observation reported below is a square compound on the Malabar Christian College campus and it is fringed on all sides with *G. maculata*. In this area, at present, the aphids are actively tended almost exclusively by the ant, *Anoplolepis longipes* Jerdon which nests in bare soil. It is known that in this kind of beneficial association or mutualism, the ants obtain honeydew from the aphids while the aphids are protected to some extent from their enemies by their attendant ants.

It was noted with interest that while the plants on two continuous sides of the compound were heavily infested with aphids, those on the other two sides were virtually free from them. This part of the compound was flooded with stagnant water during the rainy season making it impossible for *A. longipes* to nest in the soil. The plants along these two sides were not infested with aphids. In the remaining part of the compound where there is better drainage, the soil was more favourable to the ant and about fifteen nests were counted in the area.



A Portion of the twig

Atalantia missionis Oliv.

The plants along the two sides bordering this area showed heavy infestation of aphids. This observation shows that the occurrence of the aphid *A. craccivora* depends on or is determined by the proximity of the nests of its tending ant species which in this area is *A. longipes*.

DEPARTMENT OF ZOOLOGY,
MALABAR CHRISTIAN COLLEGE,
CALICUT, KERALA,
July 14, 1969.

A. B. SOANS
J. S. SOANS

25. ON THE OCCURRENCE OF *ATALANTIA MISSIONIS* OLIV. IN THE DISTRICT OF BURDWAN IN WEST BENGAL

(With a plate)

In course of a collection trip to the district of Burdwan, a tree was noticed on the roadside at Jaugram, which was later identified as *Atalantia missionis* Oliv., (family Rutaceae).

The occurrence of *Atalantia missionis* Oliv., in this remote part of rural Bengal is very interesting. The available literature and herbarium sheets, reveal that the plant is distributed in the western Peninsula, Red Hills, Madras, Deccan Hills and eastern slopes of Nilgiris and Anamalais. Prain, Duthie, Haine, Das & Kanjilal, as well as many other botanists of India who especially worked on the floristic survey of Eastern, Northern and Central India did not collect or record this species, so its occurrence in Jaugram is rather intriguing from the distributional point of view.

Atalantia missionis Oliv.—In Journ. Linn. Soc. Suppl. 25; F.B.I. 1:513 (1872); Cooke, Fl. Bomb. Presidency 1:188 (1903); Gamble Fl. of Madras Presi. 1:114 (Reprinted edition, 1957).

A small very thorny citrus like tree with yellowish-white hard wood. Leaves alternate, 1-foliate, leaflet coriaceous, entire or crenulate, stipulelike scales often present. Flowers in axillary, rarely terminal, fascicles, racemes or panicles, rarely solitary, calyx 3-5 lobed or partite sometimes irregularly split. Petals 3-5 free or adnate to the stamens and united with them in a tube, imbricate. Disk—annular or capsular.

Deposited in Herb. (CAL) No. 1. S. K. Bhattacharyya.

Herbarium sheets examined:

Peninsular India, *Wight*, 375.
Mamandar, Chittoor district, 11-3-1918, *C.E.C. Fischer*, 4279.
Nilgiri, 1891, Dr. Shahl, s.n. (4) Quilon, A. *Meebold*, 12678.

BOTANICAL SURVEY OF INDIA, INDIAN BOTANIC GARDEN, SHIBPORE, HOWRAH.
March 19, 1971.

R. B. GHOSH
D. N. GUHA BAKSHI
K. D. MUKHERJEE
S. K. MONDAL

26. *EUPHORBIA SERPENS* H.B.K. (EUPHORBIACEAE): A HITHERTO UNRECOGNISED SPECIES IN INDIA[1]

(With a text-figure)

Euphorbia microphylla Heyne, as understood in FLORA OF BRITISH INDIA, is a mixture of two species: *E. microphylla* Heyne and *E. serpens* H.B.K. This was observed, while ascertaining the correct identity of a weed in Bengal, commonly known as '*E. bombaiensis* Santapau (=*E. microphylla* Heyne)'; in fact, these plants represented the true *E. serpens* H.B.K., a tropical American weed.

Santapau (Bull. bot. Soc. Beng. 8: 17, 1955) proposed *E. bombaiensis*, as an avowed substitute for *E. microphylla* Heyne (in Roth, Nov. Pl. Sp. 229, 1821, non Lamk. 1786); subsequently Rajagopal & Panigrahi (Taxon 17: 547, 1968) treated *E. bombaiensis* Santapau conspecific with *E. orbiculata* H.B.K. (Nov. Gen. Sp. 2: 52, 1817); however, the above species does not seem to occur in Bengal.

Euphorbia serpens H.B.K., though long since naturalized in some parts of India, has not been recognised so far in any Indian Flora, apparently being not easily distinguishable from '*E. microphylla* Heyne'. Thus J. D. Hooker in Fl. Brit. India 5: 253, 1887, while treating *E. microphylla* Heyne states: 'It is certainly very near indeed to the *E. serpens*......'; also he combines the diagnostic characters of both the species: 'stipules minute, triangular, *2-partite* (*E. microphylla*) or *laciniately toothed* (*E. serpens*).' (parenthesis and italics mine). A. T. Gage, on the other hand identified the two entities as *E. serpens* H.B.K., in Herb. CAL.

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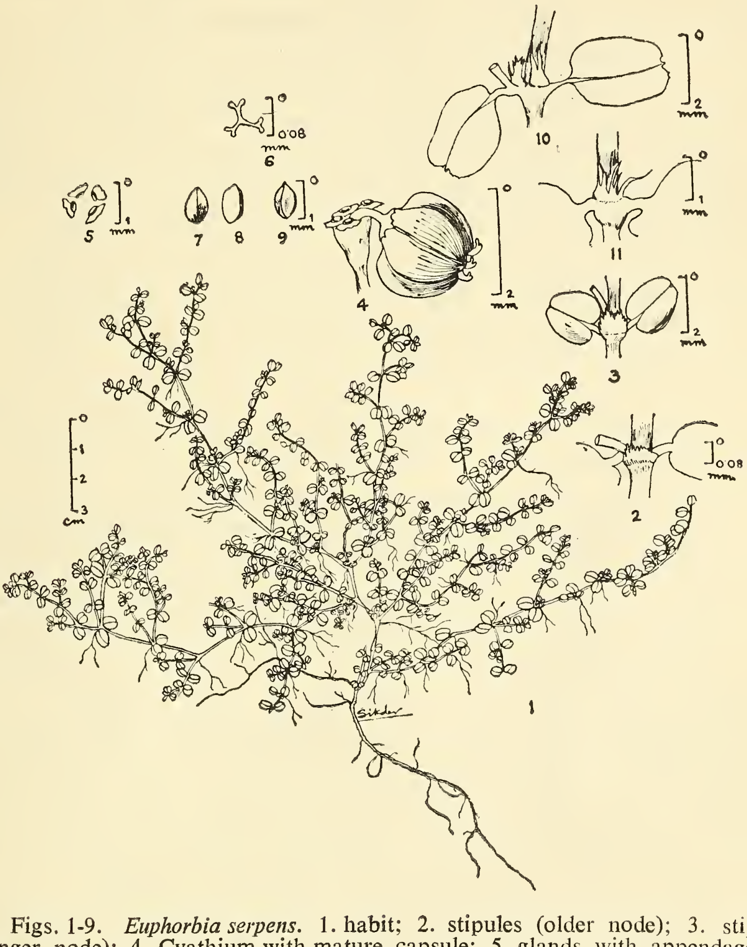
[1] Communicated by Prof. P. V. Bole.

At one stage of study, the plant was identified as *E. makinoi* Hayata. In J. Coll. Sci. Tokyo 30:262, 1911, Hayata described *Eu-*



Figs. 1-9. *Euphorbia serpens*. 1. habit; 2. stipules (older node); 3. stipules (younger node); 4. Cyathium with mature capsule; 5. glands with appendages; 6. styles; 7-9. seeds. Figs. 10 & 11. *Euphorbia orbiculata*. 10. stipules (upper side); 11. stipules (lower side).

phorbia makinoi from Formosa, with the following remarks (p. 263): 'The present plant was identified with *E. microphylla* Heyne by myself, only by the description given in Hook. f. Fl. Brit. Ind. V. p. 252, without seeing any specimen of it. Since coming to Kew, I have compared my plant with Heyne's type and found that they are not exactly identical......'. However, on further scrutiny, *E. makinoi* Hayata was proved to be conspecific with *E. serpens* H.B.K.

The specimens studied in Herb. CAL include one authentic sheet of *E. makinoi* Hayata, from Taiwan and three sheets of *E. serpens*

H.B.K. from North America. The North American sheets include '*Lindheimer* 300' from Texas, cited by Boissier [DC. Prodr. 15(2): 29, 1862] in his treatment of *E. serpens* H.B.K. However, the identity of this weed in Bengal was further confirmed by comparing the herbarium specimens (*Mitra* 665), with the types of *E. makinoi* Hayata (*T. Makino* 1896, MAK) and *E. serpens* H.B.K. (*Bonpland* 407, P).

While this study was in progress, Rajagopal & Panigrahi in Taxon 17:547, 1968, described a new variety: *E. orbiculata* var. *jawaharii*, from Allahabad; examination of one of the isotypes (*Panigrahi & Rajagopal* 2491/A, BSA), proved it to be only *E. serpens* H.B.K.

Datta in Taxon 16:348, 1967, and also in Sci. & Cult. 34:398, 1968, reported the chromosome number of *E. bombaiensis* Santapau as n=12 & 2n=24; the voucher specimens, *Datta* 2443 & 2459 in Herb. CAL (CBLH belongs to CAL), however represent *E. serpens* H.B.K.

E. serpens H.B.K. can be differentiated from *E. orbiculata* H.B.K. (=*E. bombaiensis* Santapau; *E. microphylla* Heyne) as follows:

Plants rooted at nodes (at least root primordia present); leaf apex retuse, mucronulate. Stipules on both sides united, broad, scale-like, membranous, margin shallowly incised or toothed irregularly........................*E. serpens*

Plants not rooted at nodes; leaf apex notched, mucronulate, obscurely denticulate. Stipules on upper side distinct, deeply laciniate; lower united, bilobed, each lobe deeply laciniate....................................*E. orbiculata*

Euphorbia serpens H.B.K. Nov. Gen. 2:52, 1817; Boissier in DC. Prodr. 15(2):29, 1862; Wheeler in Rhodora 43:198, 1941; Hutch. & Dalziel, Fl. W. Trop. Afr. 1:421, 1958 (ed. 2—revised by R.W.J. Keay).—*Anisophyllum serpens* (H.B.K.) Klotzch & Grake, Abh. Akad Berlin, Phys. 1859:23, 1860.—*Chamaesyce serpens* (H.B.K.) Small, Fl. Southeast U.S. 709, 1903.—*Euphorbia makinoi* Hayata in J. Coll. Sci. Tokyo 30:262, 1911, SYNON. NOV.; Merr. in Philip. J. Sci. 16:578, 1920.—*Chamaesyce makinoi* (Hayata) Hara in J. Jap. Bot. 14:356, 1938; Hurusawa in J. Fac. Sci. Univ. Tokyo 3, 6:291, 1954.—*Euphorbia orbiculata* var. *jawaharii* Rajagopal & Panigrahi in Taxon 17:547, 1968, SYNON. NOV.—*E. microphylla* auct. non Heyne: Hook. f. Fl. Brit. India 5:252, 1887, *p.p.*; Prain, Bengal Pl. 2:692, 1963 (rep. ed.) *p.p.*

Glabrous, annual or perennial herbs, prostrate, occasionally ascending or clambering amidst grasses. Stems slender, profusely branched, spreading, rooted at nodes, often forming mats up to 70 cm. across; internodes up to 5 cm. long, usually much shorter (1 mm. long) in smaller branches. Leaves 2-8×1-6 mm., opposite, obliquely ovate-oblong, subquadrate or suborbicular, entire, cordate or subcordate at base, shallowly retuse, and mucronulate at apex; stipules on both sides united, broad, scale-like, membranous, margin shallowly incised or toothed irregularly. Cyathia solitary, axillary at leafy nodes, particularly of short suberect condensed leafy laterals; peduncles slender, short. Involucres broadly campanulate; lobes triangular, exceeding the glands, minutely hairy at base within; glands transversely oblong, concave, maroon in colour; appendages of glands white, entire or obsoletely lobed. Capsules $1{\cdot}2 \times 0{\cdot}8-1{\cdot}5$ mm., broadly ovoid, 3-angled, glabrous, cocci slightly keeled dorsally. Seeds smooth, oblong, 4-angular, with shallow depressions on two faces; coat microreticulate, white.

Distribution: Native of Tropical America; naturalised in tropics of Africa and Asia.

Specimens examined:

INDIA. West Bengal, Birbhum: Santiniketan, 15 May 1965, *Guha* 172 (CAL). Calcutta: Belgachia Milk Colony, 19 Aug. 1969, *Mitra* 881 (CAL). Ballygunge Science College Campus,—?, *Datta* 2459 (CAL). Howrah: Howrah, 4 July 1963, *Shetty* 52 (CAL). Midnapur: Haldia, 21 Apr. 1965, *Rao* 4205, 4259 & 4260 (CAL); Hijili, 25 Aug. 1966, *Mukherjee* 4486 (CAL); Junput, 24 Feb. 1965, *Rao* 4062 (CAL). Nadia: Kalyani, 18 Feb. 1966, *Dutta* 2443 (CAL). 24-Parganas: Bansdroni, 31 May 1965, *Mitra* 148 (CAL); Briji, Garia, 4 Dec. 1965, *Mitra* 415 (CAL); Baghajatin, Jadavpur, 28 Aug. 1966, *Mitra* 619 (CAL); 24 Nov. 1968, *Mitra* 665 (CAL); Boral, Garia, 11 May 1969, *Mitra* 760 (CAL); 1 Aug. 1969, *Mitra* 856 (CAL); Bamanghata, 3 May 1962, *Ghosh* 1392 (CAL); Falta, 29 June 1963, *Ghosh* 898 (CAL); Namkhana, 3 June 1965, *Mukherjee* 4351 (CAL); Frazergunj, 30 May 1966, *Mukherjee* 5374 (CAL); Gangasagar, 29 Apr. 1967, *Mukherjee* 5916 (CAL); Kakdwip, 19 Sept. 1968, *Mukherjee* 7083 (CAL). Uttar Pradesh, Allahabad: Baxiband Rd., 16 Aug. 1965, *Panigrahi & Rajagopal* 2491/A (BSA).—Andhra Pradesh, E. Godavari: Sirivaka, 1 Jan. 1902, *Bourne* 3356 (CAL). W. Godavari: Gobanapalam, 25 Jan. 1958, *Subramanyam* 5152 (MH).—Madras, Ramnad: Tirupachetti, 23 Aug. 1964, *Ramamurthy* 21066 (MH).

FORMOSA. Taiwan, 15 June 1932, *Tanaka & Shimada* 11116 (CAL).

UNITED STATES. Texas, 1897, *Lindheimer* 300 (CAL); Dallas, 3 July 1955, *Schinners* 20460 (BLATT); Corpus Christ Bay, Newces County, S. Texas, 21 Mar. 1894, *Heller* 1467 (CAL). Florida: Ballast ground, Pensacola, 2 July 1897, *Curtiss* 5920 (CAL).

BRAZIL.—?, *Claussen* 2022 (KW): examined by my colleague Mr. A. N. Henry.

ACKNOWLEDGEMENTS

I thank Dr. K. Subramanyam for facilities and encouragement and Prof. P. V. Bole for helpful suggestions; Dr. M. Mizushima, Makino Herbarium, Tokyo and Dr. G. Aymonin, Museum National d' Histoire Naturelle, Paris, for comparing my specimens with the type materials available in their respective herbaria; and Messrs A. N. Henry and C. P. Sreemadhavan for making suggestions to improve the manuscript.

CALCUTTA, R. L. MITRA
March 23, 1971.

27. PLANT RECORDS FOR MAHARASHTRA

The following species collected from Chandrapur district (Maharashtra) in September-October, 1970 are considered interesting records for the State. The specimens are deposited in the herbarium of the Botanical Survey of India, Western Circle, Poona (BSI).

Distemon indicum Wedd. Monogr. 551, t. 20A; Fl. Brit. India 5: 588, 1888.

Fl. & frts.:— August-November. *Loc.*:—Chorampalli (Allapalli Division), *Malhotra* 123129.

The present record of the species from Chandrapur district (Maharashtra) is interesting as it links up the earlier known distribution in upper Godavari area (Gamble, Fl. Pres. Madras 3:1304, 1956, rep. ed.), Ranchi (Haines, Botany Bih. and Orissa 3:858, 1961 rep. ed.) and Assam (Kanjilal, Fl. Assam 4:292, 1940). It is quite possible that this species occurs in the deciduous forests of Orissa, Bengal and lower Assam.

Utricularia scandens Benj. subs. **scandens** P. Taylor in Kew Bull. 18:46, 1964. *U. wallichiana* Wt.: Fl. Brit. India 4:332, 1884.

Fl. & frts.:— September-October. *Loc.*:— Bhramapuri (West Chandrapur Division), *Malhotra* 122536.

This record from the Chandrapur dist. indicates specific occurrence of the species in such dry deciduous zones and further supports the possibility of locating this taxon in the surrounding deciduous forests and hilly tracts of Central India.

ACKNOWLEDGEMENTS

We are thankful to Dr. R. S. Rao, Regional Botanist, Botanical Survey of India, Western Circle, Poona for encouragement and suggestions.

BOTANICAL SURVEY OF INDIA,
WESTERN CIRCLE,
POONA-1,
March 26, 1971.

S. K. MALHOTRA
S. MOORTHY

28. THE GENUS *FUIRENA* (CYPERACEAE) IN GUJARAT[1]

(With a plate)

The genus *Fuirena* was so far represented in Gujarat by only one species namely *F. ciliaris* (L.) Roxb. (Sabnis 1962). Recently Deshpande and Shah (1968) have described *F. tuwensis* from Tuwa, eastern Gujarat.

In this note, the authors present their field observations on the two plants, their distribution in Gujarat, supplementary morphological description of *F. tuwensis*, key to identification based on important, stable characters and line drawings to scale (Plate).

Fuirena ciliaris (L.) Roxb. Hort. Beng. 81, 1814; Blatt. & McC. in JBNHS. 37:772; Sabnis in Bull. Bot. Surv. India 4:196, 1962.

An annual. Stems 10-40 cm. high, leafy throughout. Leaves linear-lanceolate, provided with ligules at the mouth of the sheath. Sheaths closed, striate, hairy. Spikelets ovoid, green or brown, in axillary and terminal clusters Glumes 1·88×1·24 mm., keeled, with a 0·66 mm. long awn. Hypogynous scales 0·85×0·52 mm. with a stalk 0·34 mm. long, petaloid, quadrate, with a conspicuous mucro. Nut 0·74×0·59 mm., broadly obovoid to elliptic, trigonous, yellowish white to brown.

The plants are observed usually near dry ditches on open plateau of the forests as well as on the plains.

Flowering and Fruiting:— September-January.

Sonasan, in rice fields (Sedgwick 330); Godhra (Woodrow ex Cooke); Ratanmahal hills (Bedi, Sabnis 377-79); Swargavahini river, Dharampur (Bedi 5846); Pongarbari (B 5945); Kosambi river, Padhara, N. Gujarat (Bhatt 1451); Parosda, Naka Kalol, N. Gujarat (Bhatt 2007); Ummarkoi, Nagar Haveli (Sabnis & Bedi B 7165).

Fuirena tuwensis Deshpande & Shah in Bull. Bot. Surv. India 10(2): 239-240, 1968.

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[1] This research has been financed in part by a grant made by the United States Department of Agriculture under PL 480.

The plant resembles the preceding species in its vegetative and inflorescence characters. For a full description, reference may be made to Deshpande & Shah, (loc. cit.) However, the following few points of morphological description are supplementary:

1. Leaves hairy on both the surfaces, more on the lower,
2. Ligule scale-like, membranous, densely ciliate on the margin,
3. Spikelets green or dull brown on maturity, in axillary and terminal subpaniculate clusters,
4. Glumes strongly keeled and 3-nerved ending in a 1·17 mm. long, hispidulous awn,
5. Hypogynous scales 0·81×0·66 mm. with a stalk 0·34 mm. long, petaloid, oblong with an obtuse or rounded apex, auriculate at the base. The margins and especially the apex showing a cushion-like thickening,
6. Hypogynous bristles 3, retrorsely scabrid,
7. Nut 0·92×0·55 mm., triquetrous, smooth, shortly beaked.

'Occasional among grasses growing in association of *Cyperus difformis* L. and *Fuirena ciliaris* (L.) Roxb. in moist ground along margins of ditches by road sides' (Deshpande & Shah, loc cit.). We observed the plants growing by the side of fallow fields in association with *Bergia ammannioides* Heyne ex Roth, *Centaurium roxburghii* Druce and *Stemodia viscosa* Roxb.

Flowering and Fruiting:— October-November.

Tuwa, Panchamahal District, Gujarat State (Deshpande 1726, Holotype — 23-x-66); Athal, Nagar Haveli (Sabnis & Bedi B 7215, 13-xi-70).

The peculiar pattern of distribution of this plant in Gujarat warrants a careful reappraisal of the *Fuirena* material from the entire Indian subcontinent.

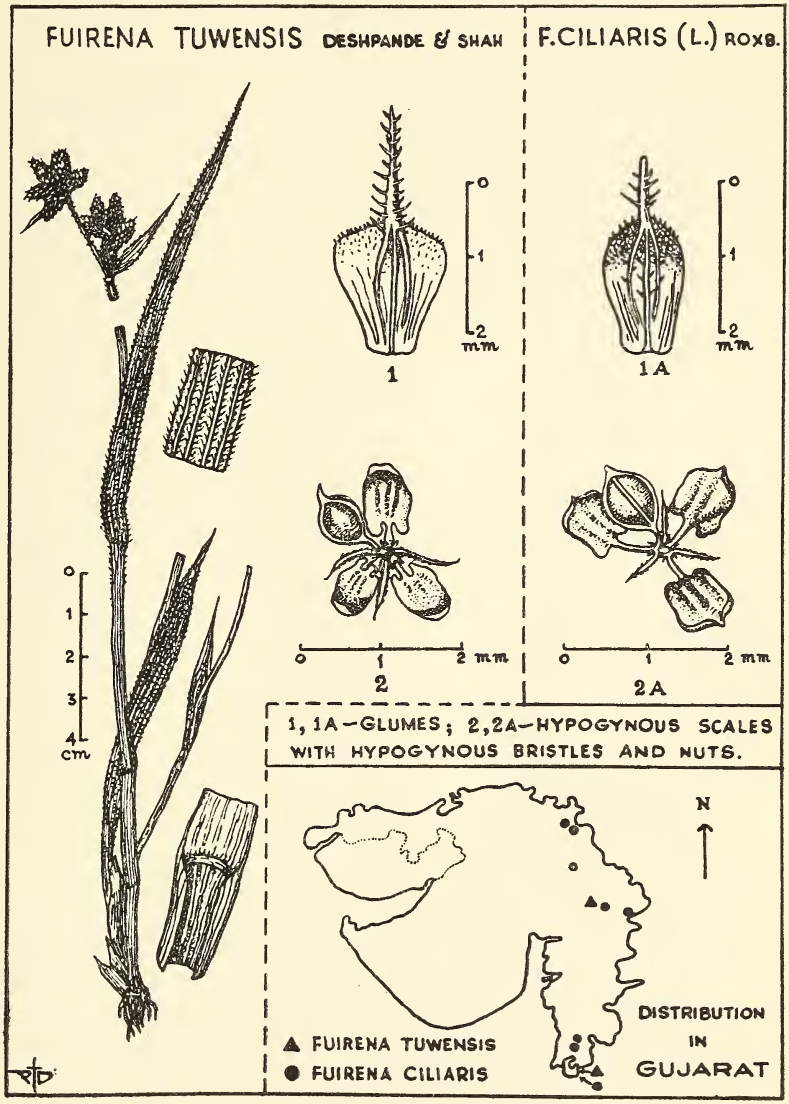
For easy separation of these apparently similar plants, the following key should prove useful.

Hypogynous scales clawed, quadrate, prominently ribbed on the back with a conspicuous mucro. Awn shorter.................................*F. ciliaris*

Hypogynous scales clawed, oblong, obtuse or rounded at the apex, auriculate at base; margins and apex showing cushion-like thickening. Awn longer.... ....*F. tuwensis*

Taxonomy Laboratory,
Department of Botany,
M. S. University of Baroda,
Baroda-2,
February 1, 1971.

S. D. SABNIS
S. J. BEDI



Genus *Fuirena* (Cyperaceae) in Gujarat.

29. ENDOGENOUS RHYTHM IN OPENING AND CLOSING OF FLOWERS IN *PORTULACA* SPECIES

(With a text-figure)

Portulaca is the commonest genus of the family Portulacaceae with varying shades of yellow or red coloured flowers which in nature open and close at certain fixed times of the day. It has been stated that the flowers remain closed in bad weather (Willis 1966). The opening and closing of flowers of *Cestrum nocturnum* have been found to occur in a cyclic manner both in constant light and constant darkness at constant temperature (Overland 1960).

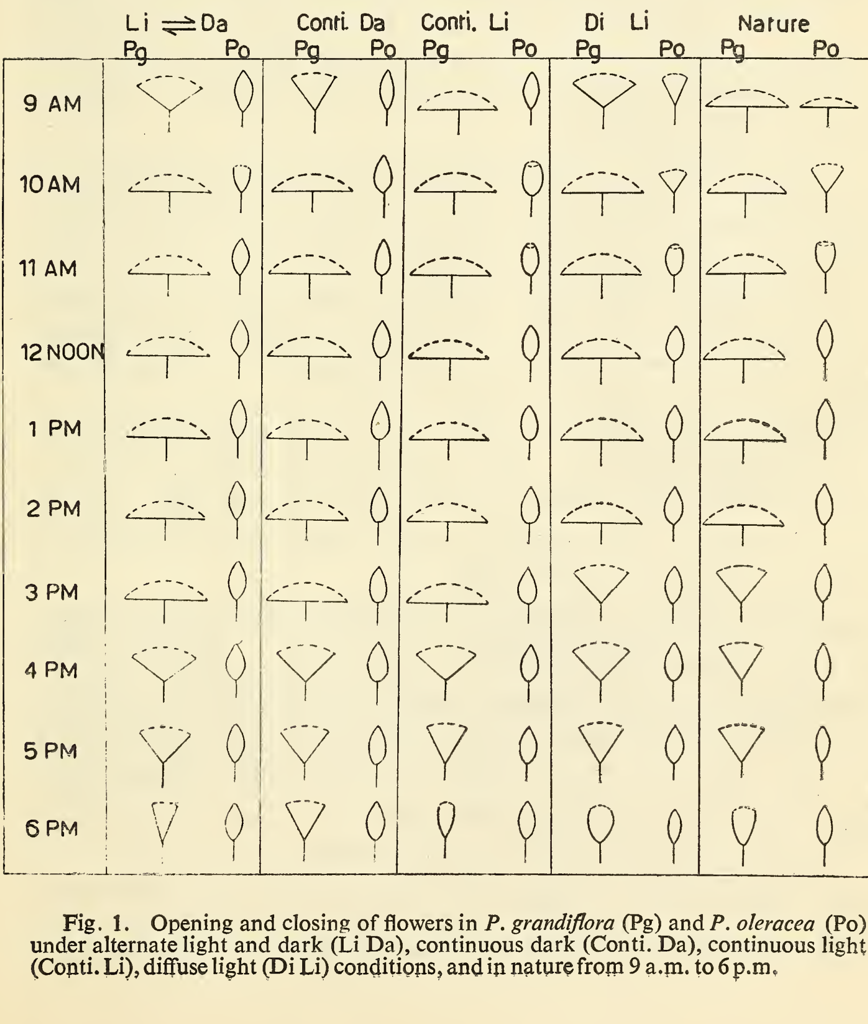


Fig. 1. Opening and closing of flowers in *P. grandiflora* (Pg) and *P. oleracea* (Po) under alternate light and dark (Li Da), continuous dark (Conti. Da), continuous light (Conti. Li), diffuse light (Di Li) conditions, and in nature from 9 a.m. to 6 p.m.

The present investigation on the behaviour of flowers in *Portulaca* under controlled and environmental conditions were undertaken in order to determine the possibility of the association of flower opening and closing with endogenous rhythms. It has been stated that the 'endogenous rhythm' refers to a biological process which alters periodically in a pendulum-like manner although external conditions remain constant (Bünning 1956).

The materials used in the present experiments performed in the month of August 1970 were flowers and bud bearing twigs of *P. grandiflora* and *P. oleracea.* These twigs were kept in beakers containing tap water and were exposed to continuous total darkness or continuous light. A set was put in dark before sun rise, and another after opening of the flowers at 9 a.m. A set of plants were alternately exposed to artificial light and total darkness for one hour each. A set each was exposed to red light for 5 minutes and another to far-red, and still a third one first to far-red followed by red light. A set of each was kept in total darkness and another in artificial light of 40 f.c., intensity.

The opening and closing of floral buds were observed from 9 in the morning till 6 in the evening at each hour. The sequence of opening and closing of the flowers during different hours of the day under varying conditions are shown in Fig. 1.

It is apparent from figure 1 that the opening of the floral buds do not depend on light alone. In case of *P. grandiflora* the opening and closing of flowers appeared nearly independent of light/dark conditions, although complete opening of flowers took place earliest by 9 or 9.15 in the morning in nature and also in twigs transferred to continuous light condition. They remained open longest in the continuous illumination, although flowers started closing after 3 in the afternoon under all the conditions. On a cloudy day the opening of buds was delayed to a large extent.

The opening and closing of flowers in case of *P. oleracea* was more distinct and sharp as compared to *P. grandiflora.* The floral buds in nature opened fully about 9 and closed nearly completely by 11 in the morning. In cut twigs the rhythm appeared to be discontinuous, as the buds did not open at all in those which were kept in total darkness. They very slightly opened at 10 a.m., under alternate light and dark and also in continuous light conditions. The behaviour under diffuse light was nearly similar to that in nature.

The opening and closing of floral buds in the above mentioned plants, believed to be a direct result of light and darkness, has been found to exist as an endogenous rhythm independent of outer environment. It was found to occur in an entirely constant condition of light/dark and temperature. However, in nature, in a very clouded and drizzling weather, the old flowers will open but attain an intermediate position which is neither completely closed nor open. This would suggest that opening and closing of flowers is initiated and controlled by an endogenous rhythm, but the completion of the act is supported by prevailing environmental conditions, mainly light.

Most of the flower buds exposed to far-red or far-red/red did not exhibit any effect on plants as a whole. Those exposed to red and kept in dark had an effect on the opening of flowers. This suggests that the phytochrome system is not responsible for opening and closing of flowers in *P. grandiflora*. Extremely low concentrations (·01-·05 ppm) of kinetin and 2ip were supplied to the twigs bearing flowers from their cut ends. There has been no appreciable effect on the opening and closing of the flowers. In diffuse light ·05 ppm of 2ip solution hastened flower opening as compared to kinetin.

The movements in some African plants were also studied under conditions of natural light to determine their opening and closing by Cesaire *et al.*, (1966). Besides other plants *P. grandiflora* and *P. oleracea* were reported to be opened 90 minutes to 3 hours after sunrise and closed their flowers at noon or soon afterwards. They have reported that each species had a characteristic rhythm and some flowers even reacted normally to light when separated from the plant. Temperature, humidity and barometric pressure are reported to exert an influence.

BOTANY DEPARTMENT,
UNIVERSITY OF JODHPUR,
JODHPUR, (RAJ.),
March 16, 1971.

D. N. SEN
K. D. SHARMA
M. C. BHANDARI

REFERENCES

BÜNNING, E. (1956): Endogenous rhythm in plants. *Ann. Rev. Plant Physiol.* 7: 71-90.

CESAIRE, O. G., BRESSON, Y., BELLOSSI, A. & LEDUC, Y. (1966): Recherches sur la movements d'ouverture et de fermeture des fleurs de certaines plantes Africaines. *Bull. Mem. Fac. Pharm. Dakar.* **14**: 159-163.

OVERLAND, L. (1960): Endogenous rhythm in opening and odor of flowers of *Cestrum nocturnum. Amer. Jour. Bot.* **47**: 378-382.

WILLIS, J. C. (1966): A dictionary of flowering plants and ferns. Camb. Univ. Press. 7th ed., revised by H. K. Airy Shaw.

Gleanings

Leonard Woolf in GROWING: AN AUTOBIOGRAPHY OF THE YEARS, 1904-1911, tells the story of his experiences in Ceylon as a member of the Colonial Civil Service. One of them will be of interest to all who have ever had anything to do with that pest, the flea:

> ' One day I had been away for over twenty-four hours from Jaffna on an enquiry. When I got back in the late afternoon and walked into my room I was wearing a pair of white flannel trousers. Three minutes later I looked down and saw that the trousers half-a-way to the knee had turned black with thousands of fleas. I dashed into the compound, tore off the trousers and shouted to my boy to bring me a clean pair. Then I wandered out on to the beach and stood there in the depths of gloom . . . As I stood there, a very old, bent Tamil woman of the fisher caste hobbled by. To my immense surprise she stopped, came up to me, and said: Why is your honour so sad?' ' I am sad ', I said, ' because I have just come back to my bungalow after being away out there for a day or two, and now I find the floor of my room black with thousands of fleas.' . . . She hobbled away and after five or ten minutes reappeared with a hand-full of some herb. She told me to take it and make my boy spread it on newspaper on the floor of the bungalow and set fire to the paper . . . I thanked her and did what she said. To my great astonishment, the thing worked; the miracle was accomplished; half an hour later there was not a flea in the place.'

Has any of our readers had such an experience? And what is the wonder-working herb that the old lady gave to the writer?

ANNUAL REPORT OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR 1970-71

Executive Committee

President

Nawab Ali Yavar Jung, *Governor of Maharashtra*

Vice-Presidents

Major-General Sir Sahib Singh Sokhey, I.M.S. (Retd.)
Dr. Sálim Ali, D.SC., F.N.I.
Mr. R. E. Hawkins

Hon. Secretary

Mr. Zafar Futehally

Hon. Treasurer

Mr. J. D. Kapadia, I.C.S. (Retd.)

Member

Secretary, Ministry of Education, Govt. of India

ex-officio

Elected Members

Mr. Humayun Abdulali
Mr. G. V. Bedekar, I.C.S. (Retd.)
Prof. P. V. Bole
Mr. S. Chaudhuri
Dr. C. V. Kulkarni, M.SC., PH.D.
Mr. Duleep Matthai
Dr. A. N. D. Nanavati, M.D.
Mr. D. J. Panday
Mr. G. S. Ranganathan
Mr. D. E. Reuben, I.C.S. (Retd.)

Advisory Committee

Mr. H. G. Acharya	*Ahmedabad*
Mrs. Jamal Ara	*Ranchi*
Mr. F. C. Badhwar, O.B.E.	*New Delhi*
Sir Chintaman Deshmukh, KT., C.I.E., I.C.S. (Retd.)	*Hyderabad*
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Dr. S. K. Mukherjee	*Calcutta*
Dr. N. K. Panikkar, M.A., D.SC., F.N.I.	*Panaji*
Mr. R. C. Soni, I.F.S.	*New Delhi*
Mr. P. D. Stracey, I.F.S. (Retd.)	*New Delhi*

HONORARY SECRETARY'S REPORT FOR THE YEAR 1970

Membership

The number of members which any Society has is a good indication of its vitality, and we have to admit regretfully as we have done for some years now that the membership position is unsatisfactory. This is particularly so taking into account the fact that the wide ranging activities of the Society and its concern with the environment as a whole should now attract the interest of not merely the specialist naturalist, but the citizen at large. There was a slight favourable trend in 1969, which seems to have flattened out, and we solicit again your energetic cooperation in enrolling new members. The total membership on our Register as on 31st December, 1970 was as follows :

	31-12-1970	31-12-1969
Life Members	174	163
Ordinary Members	703	823
Forest Department nominees ..	78	68
Student Members	5	4
Honorary Members	3	2
	963	1060

However after the closing of accounts for 1970, we have received subscription for that year from 35 members bringing the total to 998. We have to receive subscription from 123 members on the roll. Efforts are being made to persuade them to continue their membership.

The Society's Publications

Journal : Three issues of the Journal were published during the year—Volume 66 (3) ; 67 (1 & 2). The 586 pages included 12 articles on Botany, 6 on Mammals, 4 each on Birds and Insects, and articles of general interest ; 3 on fishes and 2 on Crustacea and other invertebrates. The ninety Miscellaneous Notes covered all aspects of natural history. As the leading publication of Natural History in Asia the Journal must necessarily continue to be scientific as opposed to popular. But there is a legitimate complaint that very few articles in it are of general interest and while the Editors can take shelter behind the apathy of Indians, by and large, in Natural History, and the non-availability of the type of popular scientific articles which filled the Journal 30 years ago, an attempt will be made to improve this situation by including a larger selection of articles of general interest in future.

The articles published during the year which were of unusual interest were: the note on the Black and Spotted Leopards by Ray Robinson which discussed polymorphism in these animals ; Starkel's article discussing the cause and effect of heavy rainfall in the Eastern Himalayas ; George Schaller's survey of the Nilgiri Tahr ; Dr. M. S. Swaminathan's article on Agricultural productivity in this country.

Books : The 3rd edition of the BOOK OF INDIAN ANIMALS by S. H. Prater has been published recently and this was made possible mainly due to the very kind financial assistance by Lady McNiece, sister of the late Loke Wan Tho, and who like him has been remarkably generous to the Society. It is unfortunate that we have been unable to find funds for reprinting SOME BEAUTIFUL INDIAN TREES by Blatter & Millard, BUTTERFLIES OF THE INDIAN REGION by M. A. Wynter-Blyth and SOME BEAUTIFUL INDIAN CLIMBERS AND SHRUBS by Bor and Raizada. These books are all in a class of their own, and must not be allowed to be permanently out of circulation. We are also certain that CIRCUMVENTING THE MAHSEER AND OTHER SPORTING FISHES IN INDIA AND BURMA by Macdonald would be welcomed by the large number of anglers in India whose numbers will grow with the increasing facilities being provided in Kashmir and elsewhere for trout and mahseer fishing. We have in spite of some investigations not yet succeeded in finding a sponsor.

Dr. Sálim Ali continues to work relentlessly on the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, and the 4th Volume dealing with species of *Frogmouths* to *Pittas* was published during the year.

With the financial assistance from the World Wildlife Fund, Switzerland, the Society was able to bring out as a single volume the five booklets in the GLIMPSES OF NATURE series, and this publication has been welcomed in educational circles.

Conservation and Surveys

The Society has been anxious to see that the several resolutions that were passed at the Tenth General Assembly of the International Union for Conservation of Nature and Natural Resources in November, 1969 are followed up adequately ; and the closest contact is maintained with the Central and State Governments through its representatives on the Indian Board for Wildlife as well as on the State Wildlife Advisory Boards.

Among our endangered animals the position of the Tiger particularly has been a cause for growing concern, and the assessment of the tiger population made by the Society on the basis of reports received from Forest Officers in India has been a useful basic document which has been welcomed in conservation circles. The Society is in close touch with the Inspector General of Forests in connection with the proposed all-India census of tigers in which both IUCN, and Smithsonian Institution are deeply interested. The Society feels that there is need for much stricter control over the illegal export of tiger and panther skins and representations continue to be made and useful advice offered from time to time to the authorities concerned.

With the assistance of a grant from the World Wildlife Fund, India, the Curator, J. C. Daniel, made a survey of the Nilgiri Tahr. His report has been published in the Journal. A survey of the White Bison in Tamil Nadu was carried out by E. R. C. Davidar with a grant from the Society. It is proposed to make a survey of the Salt Water Crocodile off Orissa coast for this too is a gravely threatened species. The Society has made recommendations for establishing a floral sanctuary at Khandala in memory of Fr. H. Santapau, who had studied the area intensively and was greatly impressed by its floral richness.

The Society assisted the Expert Committee set up by the Government of India to make recommendations for establishing National Parks and Sanctuaries, and the Policy Statement incorporated in the Report is based largely on the draft presented by the Society.

The Society continues to take great interest in the Borivli National Park and has organised a Leopard Study Group with the principal objective of studying the status of the animal in the Park and making recommendations for its protection.

On the recommendation of the Society, the Maharashtra Government has revised its Game Schedules and have removed Birds of Prey from the List of Vermin. This is an important step, for Birds of Prey play a significant role in maintaining the balance of the environment, and their numbers have been declining on a worldwide basis, at an alarming rate.

Bird Migration Study

An activity which has brought the Society a great deal of credit and publicity is the Bird Migration Study which is in progress under the direction of Dr. Sálim Ali in collaboration with Dr. S. D. Ripley of the Smithsonian Institution, Washington. During 1970, camps were established at Bharatpur in Rajasthan, Point Calimere and Yercaud in Tamil Nadu, at Daulatabad and Mahableshwar in Maharashtra and in Hingolgadh and Kutch in Gujarat State. Exploratory trips were made to Assam, and the possibility of having a camp in Ceylon was examined, Many interesting recoveries were made during the year of which the following need to be specifically mentioned :

Species	*Ringed at*	*Date*	*Recovered at*	*Date*
Spotbill Duck (*Anas poecilorhyncha*)	Bharatpur, Rajasthan	5th Dec. 1969	Novosibirsk, nr. Bagon (*c.* 54°06′N; 75°38′E)	August 1970
Common Pochard (*Aythya ferina*)	Bharatpur, Rajasthan	22nd Dec. 1967	Somme, France	23rd July 1969
*Redvented Bulbul (*Pycnonotus cafer*)	Hingolgadh, Jasdan	20th Sept. 1960	Hingolgadh, Jasdan, Gujarat	29th Aug. 1970

*Recaptured and released

The Gir Project

In collaboration with the Smithsonian Institution, Washington, the Yale University, Connecticut, and the Government of Gujarat, research is being undertaken in the Gir Sanctuary to understand the factors which are adversely affecting the survival of the Asiatic Lion. It is evident that habitat destruction and the intrusion of maldharis within the Sanctuary is the principal cause. Studies are also being carried out to determine the food requirements of the several species of herbivores in the Gir. One researcher is engaged in finding out the role of vultures in the Gir to determine the extent to which they deprive the Lion of its legitimate kill. The Gir Project is funded up to the end of 1971 and the future of this research will depend upon whether or not further funds are available and also on whether or not the Society is able to put up a permanent station for housing the equipment and the personnel. In view of the fact that there is great need for Wildlife Research of this kind in India and also because the Forest Officers of various States have been greatly stimulated by what they have seen of the research activities in the Gir it would appear that the effort to establish a permanent station would be justified.

Sálim Ali—Loke Wan Tho
Ornithological Research Fund

During the year we received a further grant of Rs. 13,000 as donation from Dr. Sálim Ali, and at the end of the year the corpus of the Fund amounted to Rs. 64,606.48.

Field Work Grant

A grant of Rs. 10,000 was made by Mr. Humayun Abdulali for field work in vertebrate zoology.

Nature Education Scheme

The Nature Education Organiser visited several schools in the Bombay and Poona region and lectured to students. He also organised field trips for students and teachers and arranged seminars for Nature Education teachers in Poona, Kosbad and Matheran.

Library

During the year 92 books were added to the Library, of which 10 were purchased, 59 were donated and 23 received as review copies for the Journal.

Additions to the Collections

During the year 456 specimens were added to the collection :

Mammals	17
Birds	347
Reptiles	52
Amphibians	40

Interesting additions to the collections are :

Mammals

Narcondam Flying Fox (*Pteropus melanotus satyrus*)

Andaman Flying Fox (*Pteropus melanotus tytleri*)

Birds

Knot — *Calidris canutus*

Eastern Knot — *Calidris tenuirostris*

Ringed Plover — *Charadrius hiaticula*

Reptiles

Leiolopisma palnicum

Cyrtodactylus wynadensis

Meetings/Exhibitions

January	:	Prof. P. V. Bole spoke on Gardens and Flowers of Western Europe.
February	:	Cactus Club Show.
		Snakes I have known—Talk R. Whitaker.
March	:	Dr. F. Kurt on ' Ceylon Elephants '.
June	:	Some Ecological Problems of India and America, by Peter Jordan.
		Natural History of our World—Film Show.
July	:	Indian Wildlife in Texas and prospectus of ranching in India—James Teer.
		Tiger—K. S. Sankhala.
August	:	R. H. Waller on Indian Wildlife.
September	:	Environmental Problems in India—Prof. Seshachar.
		Orchid Club Show of Flowering Orchids.
November	:	Film Show ' Great Barrier Reef and Feathered Fishers'.
December	:	Film Show ' Shelduck Migration '.
		Snakes by P. J. Deoras.
		Film Show ' Elsa the Lioness '.

Revenue and Accounts

The financial position of the Society shows considerable improvement over the last year due largely to the fact that its overheads were partially absorbed by the different field projects which it now handles.

Staff

The Committee wishes to record its appreciation at the willing co-operation of the staff in the entire activities of the Society.

Acknowledgements

Committee's thanks are due to Mr. M. J. Dickins who looked after the Society's affairs in the U.K., and to the members and others who gave help in its field projects and other activities.

Registered No. F. 244 (BOM)

BOMBAY NATURAL HISTORY SOCIETY

THE BOMBAY PUBLIC TRUST ACT, 1950

SCHEDULE VIII [VIDE RULE 17(1)]

BALANCE SHEET AS AT 31 *DECEMBER*, 1970

FUNDS AND LIABILITIES	Rs. P	Rs. P.	ASSETS	Rs. P.	Rs. P.
Trust Funds or Corpus :			*Immovable Properties :*		
Life Membership Fund :			*Motor Cars and Motor Cycle :*		
Balance as per last Balance Sheet ..	56,192·46		Balance as per last Balance Sheet ..	45,996·86	
Add : Amount received during the year	5,180·33		Additions during the year ..	1,625·00	
		61,372·79		47,621·86	
			Less : Depreciation during the year ..	9,199·37	
Fixed Assets Fund :					38,422·49
Balance as per last Balance Sheet ..	89,514·15		*Furniture, Fixtures and Equipment :*		
Add : Grants and donations received ..	1,923·83		Balance as per last Balance Sheet ..	50,081·66	
Transferred from building fund	9,906·08		Additions during the year ..	3,640·54	
	1,01,344·06			53,722·20	
			Less : Depreciation during the year ..	6,715·27	
Less : Transferred to Income and Expenditure Account on account of Depreciation for the year ..	15,914·64				47,006·93
		85,429·42	*Investments:* (At cost)		
			Shares—Quoted		
			107 'A' Equity Shares of Rs. 50 each in Bank of India, fully paid ..	7,541·00	
General Reserve Fund :			95 Equity Shares of Rs. 100 each in Bank of India, Rs. 50 per Share paid up	6,669·00	
Balance as per last Balance Sheet ..		34,015·40			
Carried forward ..		1,80,817·61	Carried forward .	14,210·00	85,429·42

BALANCE SHEET AS AT 31 *DECEMBER*, 1970—(*continued*)

FUNDS AND LIABILITIES	Rs. P.	Rs. P.	ASSETS	Rs. P.	Rs. P.
Brought forward ..		1,80,817·61	Brought forward ..		85,429·42
Building Fund:			*Investments*: (At cost) Brought forward	14,210·00	
Balance as per last Balance Sheet ..	19,150·76		*Government Securities*—Quoted		
Less: Transferred to fixed assets fund	9,906·08	9,244·68	Rs. 25,000 3% Conversion Loan 1946/86. ..	25,000·00	
			Rs. 2,000 5½% Government of India Loan 2,000 ..	2,000·00	
Publication Fund:					
Balance as per last Balance Sheet ..		30,725·00	(Market value Rs. 43,160) ..	41,210·00	
Other Earmarked Funds:			*Unquoted:*		
(As per Schedule 'A') ..		2,06,953·95	Rs. 3,000 12 Year National Defence Certificates	3,000·00	44,210·00
Provision for Capital Losses:					
Balance as per last Balance Sheet ..		4,528·38	*Loans*: (Unsecured, considered good)		
			Loan Scholarships ..	—	
			Other Loans (to staff) ..	75·00	75·00
Provision for Depreciation on Investments:					
Balance as per last Balance Sheet ..	6,750·00				
Add: Transferred from Income and Expenditure Account ..	51·25	6,801·25			
Carried forward ..		4,39,070·87	Carried forward ..		1,29,714·42

BALANCE SHEET AS AT 31 DECEMBER, 1970—(*continued*)

FUNDS AND LIABILITIES	Rs. P.	Rs. P.
Brought forward ..		4,39,070·87
Liabilities :		
For Expenses	33,865·56	
,, Advance Subscriptions ..	2,253·29	
,, Sundry Credit Balances ..	18,765·28	54,884·13
Carried forward ..		4,93,955·00

Notes :—

(1) Included in the Fixed Assets is an auto cycle amounting to Rs. 1,625·00 purchased out of the Grants from the Smithsonian Institution, U.S.A., for Bird Migration Study during 1970.

(2) All expenses incurred on the various activities for which grants and donations are received have been directly debited to the relevant Fund Account.

(3) Annual subscriptions are accounted for on a cash basis. The amount due as at 31st December 1970, from Members is not ascertainable.

ASSETS	Rs. P.	Rs. P.
Brought forward ..		1,29,714·42
Advances : (Unsecured, considered good)		
To Trustees ..	—	
,, Employees (for camp expenses)	12,103·90	
,, Others ..	12,402·52	24,506·42
Stocks : (At cost or under)		22,762·38
Income Outstanding :		
Rent	—	
Interest (Accrued)	9,204·61	
Other Income:		
Supplies and Services .. (including Rs. 3,105 considered doubtful) ..	28,005·89	
Government of India :		
Grant for Journal Expenses 1970-71	10,000·00	
National Science Academy :		
Grant for Journal Expenses 1970-71	3,000·00	50,210·50
Cash and Bank Balances :		
(*a*) In Current Account with :		
National & Grindlays Bank Ltd., Bombay ..	11,342·98	
National & Grindlays Bank Ltd., London (£364-4-5) ..	6,555·97	
Chartered Bank, Bombay ..	37,241·74	
Carried forward ..	55,140·69	2,27,193·72

BALANCE SHEET AS AT 31 *DECEMBER*, 1970—(*continued*)

FUNDS AND LIABILITIES	Rs. P	Rs. P.	ASSETS	Rs. P.	Rs. P.
Brought forward ..		4,93,955·00	Brought forward ..	55,140·69	2,27,193·72
(4) There is a contingent liability for calls on partly paid shares Rs. 4,750.			*Cash and Bank Balances*: (Contd.)		
			In fixed Deposit with :		
			Bank of India Ltd., Bombay (including Rs. 36,000 for Sálim Ali/Loke Wan Tho Ornithological Research Fund and Rs. 3,000 for Col. Burton's Nature Conservation Fund) ..	39,000·00	
			National & Grindlays Bank Ltd., Bombay	60,000·00	
			Chartered Bank, Bombay ..	60,000·00	
			Bank of Bhutan, Phuntsholing ..	11,131·00	
			M/s. Mukund Iron & Steel Works Ltd., Bombay	10,000·00	
			(*b*) With the Trustees	—	
			(*c*) With the Cashier	—	2,35,271·69
			Income and Expenditure Account		
			Balance as per last Balance Sheet ..	51,099·31	
			Less : Excess from Income and Expenditure Account ..	19,609·72	31,489·59
Total ..		4,93,955·00	Total ..		4,93,955·00

As per our report of even date
(Sd.) A. F. FERGUSON & Co.,
Chartered Accountants

For Bombay Natural History Society
(Sd.) ZAFAR FUTEHALLY,
Honorary Secretary

(Sd.) R. E. HAWKINS,
Chairman, Executive Committee

(Sd.) SÁLIM ALI,
Vice-President

The above balance sheet to the best of our belief contains a true account of the funds and liabilities and the property and assets of the trust.

BOMBAY, 28*th August* 1971

Registered No. F. 244 (BOM)

THE BOMBAY NATURAL HISTORY SOCIETY

THE BOMBAY PUBLIC TRUST ACT, 1950

SCHEDULE IX [VIDE RULE 17(1)]

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER, 1970

EXPENDITURE	Rs. P.	Rs. P.	INCOME	Rs. P.	Rs. P.
To Expenses in respect of properties :			*By Rent :*		
			Accrued	Nil	
			Realised	Nil	Nil
Rates, Taxes & Cess ..		Nil	,, *Interest* (Accrued and Realised) (excluding items directly credited to grants)		
Repairs and Maintenance ..		Nil	On Securities	1,030·41	
Salaries		Nil	On Bank Account (Fixed Deposits) ..	8,616·30	9,646·71
Insurance		Nil	,, *Dividends* (Net)		630·00
Depreciation (by way of provision or adjustments)		Nil	,, *Donations :*		
,, *Expenditure from Grants—Government of Maharashtra :*			In cash	Nil	
			In kind	Nil	Nil
For 1969-70 : Salaries, including Dearness Allowance (Per contra) ..	9,012·00		,, *Grants :* *Government of Maharashtra :* For 1969-70 (Expended as per contra)	9,012·00	
For 1970-71 : Salaries, including Dearness Allowance (Per contra) ..	25,283·80		For 1970-71 (Expended as per contra)	25,283·80	
For 1969-70 : Building Maintenance (Per contra)	1,655·06		For 1969-70 (Expended as per contra)	1,655·06	
For 1970-71 : Building Maintenance (per contra)	4,476·15	40,427·01			
Carried forward ..		40,427·01	Carried forward ..	35,950·86	10,276·71

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER, 1970—(*continued*)

Expenditure	Rs. P.	Rs. P.
Brought forward ..		40,427·01
To Establishment Expenses :		
Salaries including Dearness Allowance	53,846·60	
Society's contribution to Staff Provident Fund	2,704·00	
Postages	2,517·66	
Printing and Stationery	3,138·94	
Advertisements	243·76	
Telephone Charges	1,112·80	
Bank Charges	550·20	
Meeting Expenses	1,232·70	
Motor Car Charges	527·18	
Conveyance, Travelling and field trip Expenses	196·55	
Interest on overdraft	164·68	
		66,235·07
To Miscellaneous Expenses :		
General Charges	1,442·59	
Fire and Equipment Insurance ..	286·14	
Repairs to Furniture	591·00	
I.U.C.N. Conference Expenses ..	150·00	
		2,469·73
,, Remuneration to Trustees ..	Nil	
,, Remuneration (In the case of Math) Legal Expenses	Nil	
Audit Fees	1,000·00	
Contribution and Fees	Nil	
		1,000·00
Carried forward ..		1,10,131·81

Income	Rs. P.	Rs. P.
Brought forward ..		10,276·71
By Grants: (contd.) Brought forward	35,950·86	
For 1970-71 (Expended as per contra)	4,476·15	
Educational Activity Grant 1970-71 ..	4,000·00	
Government of India :		
For Journal Publication Expenses 1970-71	10,000·00	
National Science Academy :		
For Journal Publication Expenses 1970-71	3,000·00	
		57,427·01
,, *Income from Other Sources :*		
Membership Subscriptions ..	31,255·46	
Subscribers (non-members) ..	11,097·61	
Student membership subscriptions ..	100·00	
Entrance Fees	605·00	
		43,058·07
,, *Publications :*		
Journal Sales	1,027·41	
,, *Profit on sale of Books :*		
Book of Indian Birds ..	8,117·75	
Book of Indian Animals ..	12·50	
Identification of Poisonous snake charts	251·50	
Other Publications	4,164·16	
Nature Calendars	6,107·08	
Carried forward ..	19,680·40	1,10,761·79

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 *DECEMBER*, 1970—(*continued*)

EXPENDITURE	Rs. P.	Rs. P.
Brought forward ..		1,10,131·81
To Amounts Written off :		
(*a*) Bad Debts	19·56	
(*b*) Loan Scholarships	Nil	
(*c*) Irrecoverable Rent	Nil	
(*d*) Other Items	Nil	
		19·56
,, *Depreciation :*		
On Investments	Nil	
On Furniture	6,715·27	
On Motor Cars	9,199·37	
		15,914·64
,, *Expenditure on Objects of the Trust :*		
(*a*) Religious	Nil	
(*b*) Educational—Journal Expenses	34,773·76	
Library Account :		
Subscription to other Societies .. 1,529·04		
Purchase of Books .. 1,017·17		
Periodicals and binding charges .. .. 646·00		
	3,192·21	
,, *Maintenance of Reference Collections* ..	1,749·55	
		39,715·52
,, *Excess of income over expenditure* ..		19,609·72
Total ..		1,85,391·25

INCOME	Rs. P.	Rs. P.
Brought forward ..		1,10,761·79
Profit on sale of Books (contd.) B./f.	19,680·40	
Add : Profit on packing and forwarding charges ..	766·93	
		20,447·33
By Miscellaneous Receipts: (including Rs. 6,000 compensation from World Wildlife Regional Office, Bombay)		13,284·97
Administrative fees for handling various project grants during the year, debited to the respective grants/fund		24,982·52
,, Profit on redemption of investments	51·25	
Less : Transferred to provision for depreciation on investments	51·25	Nil
,, *Transfers :* From Fixed Assets Fund on account of Depreciation (as per contra)		15,914·64
Total ..		1,85,391·25

As per our report of even date.

(Sd.) A. F. FERGUSON & CO.,
Chartered Accountants

(Sd.) ZAFAR FUTEHALLY,
Honorary Secretary

(Sd.) R. E. HAWKINS,
Chairman, Executive Committee

(Sd.) SÁLIM ALI,
Vice-President

BOMBAY, 28*th August* 1971

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING THE PART OF THE BALANCE SHEET AS AT 31 *DECEMBER*, 1970

Name of the Fund/Grant (1)	*Balance as per last Balance Sheet* (2)	*Additions/ Amounts received during the year* (3)	*Transfers from other Funds* (4)	*Total of columns* 2, 3, & 4 (5)	*Spent/ Refunded* [1] *during the year* (6)	*Transfers to other Funds* (7)	*Total of columns* 6 & 7 (8)	*Balance as at 31st December* 1970 (*minus*) (5-8) (9)
(1) Field Work Fund ..	789·64	..	..	789·64	500·60	..	500·60	289·04
(2) Staff Welfare Fund ..	500·00	1,720·69	..	2,220.69	..	..	..	2,220·69
(3) Dr. Sálim Ali/Loke Wan Tho Ornithological Research Fund	49,089·50	15,516·98 (including interest Rs. 2,516·98)	..	64,606·48	..	..	..	64,606·48
(4) Col. Burton's Nature Conservation Fund ..	3,811·88	209·02 (interest)	..	4,020·90	..	..	..	4,020.90
(5) Grant from California Academy of Sciences for Herpetological Survey ..	1,386·83	..	..	1,386.83	80·10	..	80·10	1,306·73
(6) Vertebrate Zoology Field Work Fund (By Shri Humayun Abdulali) ..	9,107·21	11,476·11 (including interest Rs.806·29)	..	20,583·32	5,643·62	..	5,643·62	14,939·70
(7) Grant from Smithsonian Institution for the Secretarial Assistance to Dr. Sálim Ali on the Publication of Handbook of the Birds of India and Pakistan in Ten Volumes ..	12,667·21	..	..	12,667·21	12,475·29	..	12,475·29	191·92
(8) Grant from Seth Purushottamdas Thakurdas and Divaliba Charitable Trust for the Publication of Nature Study booklets for Free Distribution ..	1,344·16	..	813·00[2]	2,157·16	2,143·00	..	2,143·00	14·16
Carried forward ..	78,696·43	28,922·80	813·00	1,08,432·23	20,842·61	..	20,842·61	87,589·62

Name of the Fund/Grant (1)	*Balance as per last Balance Sheet* (2)	*Additions/ Amounts received during the year* (3)	*Transfers from other Funds* (4)	*Total of columns 2, 3, & 4* (5)	*Spent/ Refunded*[1] *during the year* (6)	*Transfers to other Funds* (7)	*Total of columns 6 & 7* (8)	*Balance as at 31st December, 1970 (minus) (5-8)* (9)
Brought forward Rs. ..	78,696·43	28,922.80	813·00	1,08,432·23	20,842·61	..	20,842·61	87,589·62
(9) Grant from Smithsonian Institution for the Bird Migration Study Survey ..	..	1,75,560·00	146·28[2]	1,75,706·28	1,50,339·17[3]	25,367·11[4]	1,75,706·28	..
(10) Grant (Supplementary) from U.S. Government (Army) for Migratory Animal Pathological Survey in Eastern India	6,043·07	..	..	6,043·07	6,043·07	..	6,043·07	..
(11) Grant from His Majesty King of Bhutan for the publication of Birds of Bhutan by Dr. Sálim Ali ..	10,637·43	602·59 (interest)	..	11,240·02	..	..	..	11,240·02
(12) Grant from Smithsonian Institution for Gir Forest Ecological Research Programme .	86,032·00	..	..	86,032·00	67,957·62	..	67,957·62	18,074·38
(13) Grant from Yale School of Forestry for the Gir Forest Ecological Research Programme ..	1,32,698.70	1,16,029·20	..	2,48,727·90	1,90,682·02	..	1,90,682·02	58,045·88
(14) Grant from World Wildlife Fund for the publication of a Booklet on Conservation for distribution to Schools ..	2 0,000·00	..	..	20,000·00	..	..	..	20,000·00
Carried forward ..	3,34,107·63	3,21,114·59	959·28	6,56,181·50	4,35,864·49	25,367.11	4,61,231.60	1,94,949·90

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Brought forward Rs. ..	3,34,107·63	3,21,114·59	959·28	6,56,181·50	4,35,864·49	25,367·11	4,61,231·60	1,94,949·90
(15) *Grant from Government of Maharashtra :*								
(1) Grant of 1969-70 :								
(*a*) For Establishment expenses ..	9,727·13	..	..	9,727·13	9,012·50 714·63 [1]	..	9,727·13	..
(*b*) For Building Maintenance ..	1,794·71	..	..	1,794·71	1,655·06 139·65 [1]	..	1,794·71	..
(2) Grant for the year 1970-71 :								
(*a*) For Establishment expenses ..	..	35,764·00	..	35,764·00	25,283·80	..	25,283·80	10,480·20
(*b*) For Building Maintenance ..	..	6,000·00	..	6,000·00	4,476·15	..	4,476·15	1,523·85
Total ..	3,45,629·47	3,62,878·59	959·28	7,09,467·34	4,77,146·28	25,367·11	5,02,513·39	2,06,953·95

[1] The above amounts being unspent have been refunded to the relevant Grantee/Government Authorities.

[2] Includes amount spent by Bombay Natural History Society, since recovered.

[3] Including Rs. 1,625, being the cost of an auto cycle transferred to Fixed Assets Fund.

[4] Amount refunded to Bombay Natural History Society in respect of amount spent by them in the previous year.

BOMBAY, 28*th August*, 1971

BOMBAY NATURAL HISTORY SOCIETY

NATURE EDUCATION SCHEME

Receipts and Payments Account for the Year ended 31 *December* 1970

RECEIPTS	Rs. P.	Rs. P.	PAYMENTS	Rs. P.	Rs. P.
To Balance as at 1st January, 1970			By Salary of Nature Education Organiser		7,467·00
National & Grindlays Bank Ltd., Bombay, on Current Account ..		10,018·05	,, Printing and Stationery ..		1,015·81
			,, General Charges		1,196·70
,, Grant from Government of Maharashtra for 1970-71		9,236·00	,, Postages		195·65
,, Sales of Nature Study Booklets ..		220·65	,, Refund of Grant for 1969-70 Government of Maharashtra (unspent)		413·68
			,, Balance as at 31st December, 1970 National & Grindlays Bank Ltd., Bombay, on Current Account ..		9,185·86
Total ..		19,474·70	Total ..		19,474·70

(Sd.) SÁLIM ALI, *Vice-President*

(Sd.) R. E. HAWKINS, *Chairman, Executive Committee*

(Sd.) ZAFAR FUTEHALLY, *Honorary Secretary*

BOMBAY NATURAL HISTORY SOCIETY

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH GRANT-IN-AID

Receipts and Payments Account for the Year ended 31 *December* 1970

RECEIPTS		Rs. P.
To Balance as at 1st January, 1970 :		
With National & Grindlays Bank Ltd., Bombay, on Savings Account ..	1,921·59	
With Junior Fellow (Mr. D. N. Mathew)	500·00	2,421·59
,, Grant for Study of the Ecology of Avian Species of importance to Indian Agricultural Economics 1970-71		4,454·47
,, Interest on Bank Account		47·00
Total ..		6,923·06

PAYMENTS	Rs. P.	Rs. P.
By Grant for Study of the Ecology of Avian Species of importance to Indian Agricultural Economics 1970-71 :		
Salaries	3,600·00	
Miscellaneous	1,493·29	5,093·29
,, Balance as at 31st December, 1970 :		
With National & Grindlays Bank Ltd., Bombay, on Savings Account	1,329·77	
With Junior Fellow (Mr. D. N. Mathew) ..	500·00	1,829·77
Total ..		6,923·06

(Sd.) SÁLIM ALI,
Vice-President

(Sd.) R. E. HAWKINS,
Chairman, Executive Committee

(Sd.) ZAFAR FUTEHALLY,
Honorary Secretary

MINUTES OF THE ANNUAL GENERAL MEETING OF THE BOMBAY NATURAL HISTORY SOCIETY HELD AT HORNBILL HOUSE, SHAHID BHAGAT SINGH ROAD, BOMBAY 1, ON FRIDAY, 3RD SEPTEMBER, 1971, AT 6-30 P.M., WITH H.E. NAWAB ALI YAVAR JUNG, GOVERNOR OF MAHARASHTRA AND PRESIDENT OF THE SOCIETY, IN THE CHAIR. APPROXIMATELY 50 MEMBERS WERE PRESENT

Proceedings :

1. The President asked the Honorary Secretary to present the report for the year 1970. The Honorary Secretary, welcoming the Governor, said that his presence at the meeting was of great significance as indicating to the public at large the importance of natural history, conservation and ecology to the State as well as to the nation as a whole. He hoped that, in spite of his busy schedule and his heavy social and political commitments, the Governor would be in a position to attend not only the Annual General Meeting but occasionally the Executive Committee meetings of the Society as well, as had been the practice of the Governors in the past.

The Honorary Secretary drew attention to some of the more salient features of the report. He pointed out that, from the records of the last 50 years, it was seen that the highest membership was reached in 1929 when Sir Frederick Sykes was the President of the Society and Sir Reginald Spence was the Honorary Secretary. At that time the total number of members was 1,359, but while the same Committee was in office the membership declined to 1,121 in 1931. The Committee then reduced the entrance fee drastically, and also made it possible for members to pay their subscriptions in two instalments. In spite of this the decline continued, and in 1941 when Sir Roger Lumley was the President and H. M. McGusty was the Honorary Secretary, the membership had declined to a low figure of 810. Since then the position has improved somewhat and on the day of the meeting the total number of members in good standing was 982.

From the accounts it would be seen that the reason why the Society was in a satisfactory position financially was due to the fact that a sum of Rs. 24,982.52 accrued as administrative fees for handling various projects from grants received from the Smithsonian Institution, Washington, Yale University and other sources. The Honorary Secretary said that since it was not certain that the projects would continue, it was essential for the Society to at least double its membership, so that it would be able to stand on its own feet. This could be done by the simple expedient of each member bringing in one new member during the course of the year.

With regard to the Journal, the Honorary Secretary said that it retained its high standard but the Committee was aware of the desirability of producing a more popular magazine or newsletter which would go out frequently to members and make it possible for the Society to keep in close-touch with its membership.

The Honorary Secretary touched briefly on the various aspects of the Society's work, and referred to the bird banding scheme which had brought the Society a great deal of credit and publicity. It was most interesting to receive reports of recoveries of birds ringed in camps in India from places thousands of miles away. Recently, the President of the Shaheen Shooting Club, Gujranwala, West Pakistan, wrote 'I am very proud that by reporting the recovery of the fourth bird my Club is helping mankind through your Society.'

The President then asked the members if they had any comments to make on the report.

Dr. P. J. Deoras said that there was a feeling among some members that the fact of the Honorary Secretary being also Secretary of World Wildlife Fund and of the Birdwatchers Field Club of India was detrimental to the interests of the Bombay Natural History Society. Members of World Wildlife, for example, paid only Rs. 10 annually and were invited to the meetings of the Society. Why should they then become members of the Society? He said that it was desirable to appoint a Committee to go into the matter. Supporting this proposal Mr. Humayun Abdulali said that the Committee should study not only this aspect of the matter but several others; among these, he drew attention to certain alleged irregularities.

The Honorary Secretary explained that the World Wildlife Fund was an international organisation and existed in many countries, where too there were many other organisations like the Bombay Natural History Society functioning simultaneously. It was not a disadvantage but an advantage to have parallel organisations catering to different needs and getting the support of different groups of people.

The President ruled that as no notice of a resolution demanding a committee of enquiry had been sent, he could not allow the motion to institute a committee of enquiry. Mr. Abdulali then moved a motion of adjournment which was seconded by Dr. Deoras. The motion was put to the vote and lost by 6 votes—13 for and 19 against. The President then asked for a vote on the adoption of the report, and the report was adopted by a majority of 21 to 9.

2. The next item of business was the adoption of the Statement of accounts. Mr. Humayun Abdulali raised a point of order on the grounds that the statement was invalid because it had not been signed

by all members of the Committee as suggested by the Auditors. The Vice-President stated his impression was that the Auditors had not made such a suggestion, but the Honorary Secretary mentioned that they did make the suggestion, but that, at the Committee meeting, all the members barring Mr. Humayun Abdulali were ready to sign the accounts and some had in fact signed them. As at the foot of the statement submitted by the Auditors, however, the word ' Trustee ' appeared, and the Committee members could not be described as Trustees, only the two Vice-Presidents—Dr. Sálim Ali and Mr. R. E. Hawkins—and the Honorary Secretary, the Honorary Treasurer being absent, had signed the accounts.

The President accepted this explanation, but pointed out that, in future, it was necessary that the Auditors' directions should be scrupulously followed ; also that, in the absence of the Honorary Treasurer from station for long periods, a Deputy should be appointed. He then put the statement of accounts to the vote, and it was adopted by a majority of 22 to 6.

At this point the President, Nawab Ali Yavar Jung, left the meeting as he had another engagement. Mr. R. E. Hawkins, Vice-President, then took the Chair.

3. The Chairman explained that, as there were eleven nominations for the ten vacancies on the Executive Committee, an election would have to be held in accordance with Rule 32 of the Society, and the voting papers would be sent to all members resident in India shortly.

By show of hands the other nominations to the Executive and Advisory Committees were accepted. They were as follows :

President :

Nawab Ali Yavar Jung, *Governor of Maharashtra*

Vice-Presidents :

Major-Gen. Sir Sahib Singh Sokhey, I.M.S. (Retd.)
Dr. Sálim Ali, D.SC., F.N.A.
Mr. R. E. Hawkins

Honorary Secretary :

Mr. Zafar Futehally

Honorary Treasurer :

Mr. J. D. Kapadia, I.C.S. (Retd.)

4. The Chairman withdrew the proposal to amend the rules.

The meeting terminated with a vote of thanks to the Chair, and, thereafter, Dr. Sálim Ali displayed his films on the Baya Weaver Bird which were greatly appreciated.

Executive Committee

President

Nawab Ali Yavar Jung, *Governor of Maharashtra*

Vice-Presidents

Major-General Sir Sahib Singh Sokhey, I.M.S. (Retd.)
Dr. Sálim Ali, D.SC., F.N.A.
Mr. R. E. Hawkins

Hon. Secretary

Mr. Zafar Futehally

Hon. Treasurer

Mr. J. D. Kapadia, I.C.S. (Retd.)

Member

Secretary, Ministry of Education, Govt. of India

ex-officio

ELECTION TO THE EXECUTIVE COMMITTEE 1971-72

As more than ten nominations had been received for the Executive Committee, an election was held in accordance with Rules 32 & 33 of the Rules and Regulations of the Society. The following ten members were declared elected to the Executive Committee.

Elected Members

Mr. G. V. Bedekar, I.C.S. (Retd.)
Prof. P. V. Bole
Dr. E. B. Fanibunda, F.D.S.R.C.S. (Eng.), F.R.P.S.
Dr. C. V. Kulkarni, M.SC., Ph.D.
Mr. Surendr Lall, F.C.I.I., F.F.I.I.
Dr. A. N. D. Nanavati, M.D.
Mr. D. J. Panday
Mr. G. S. Ranganathan
Mr. D. E. Reuben, I.C.S. (Retd.)
Mr. Sandip Thakore

Advisory Committee

Mr. H. G. Acharya .. .. .. *Ahmedabad*
Mrs. Jamal Ara .. .. .. *Ranchi*
Mr. F. C. Badhwar, O.B.E. .. .. .. *New Delhi*

Mr. S. Chaudhuri	*Calcutta*
Sir Chintaman Deshmukh, KT., C.I.E., I.C.S. (Retd.) ..	*Hyderabad*
Dr. A. P. Kapur	*Calcutta*
Mr. M. Krishnan	*Madras*
Mr. Duleep Matthai	*New Delhi*
Dr. S. K. Mukherjee	*Calcutta*
Mr. R. C. Soni, I.F.S.	*New Delhi*

Field Work Grant

The Society is in a position to financially assist individual projects in field work in Vertebrate Zoology, including collecting, and would be glad to consider applications for specific proposals. Apply in detail to the Honorary Secretary.

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THE SOCIETY'S PUBLICATIONS

Mammals

The Book of Indian Animals, by S. H. Prater. 3rd (revised) edition. 28 plates in colour by Paul Barruel and many other monochrome illustrations. Rs. 30

(*Price to members Rs.* 25)

Birds

The Book of Indian Birds, by Sálim Ali. 8th (revised) edition. 66 coloured and many monochrome plates. **Rs. 25**

(*Price to members Rs.* 20)

Snakes

Identification of Poisonous Snakes. Wall chart in English, Gujarati, and Marathi. **Rs. 10**

(*Price to members Rs.* 8)

Miscellaneous

Picture Postcards of 12 representative Indian Birds (In colour) per set **Rs. 2·50**

Glimpses of Nature Series Booklets :

1. Our Birds I (with 8 coloured plates) in Hindi, and Marathi, **Rs. 0·80**
   Kannada. **Rs. 0·62**
2. Our Birds II (with 8 coloured plates) in Hindi. **Rs. 0·62**
3. Our Beautiful Trees (with 8 coloured plates) in Hindi and Marathi. **Rs. 0·62**
4. Our Monsoon Plants (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **Rs. 0·80**
5. Our Animals (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **Rs. 1·25**

Back numbers of the Society's Journal. Rates on application.

Correspond with :

The Honorary Secretary,
Bombay Natural History Society,
Hornbill House, Shahid Bhagat Singh Road, Bombay 1-BR.

Agents in England :

Messrs Wheldon & Wesley Ltd.,
Lytton Lodge, Codicote, Near Hitchin,
Herts, England.

The Society will gratefully accept back numbers of the *Journal*, particularly numbers prior to Vol. 45, from members who may not wish to preserve them.

TERMS OF MEMBERSHIP

Life Members pay an entrance fee of Rs. 5 (25*p*.) and a life membership fee of Rs. 600 (Inland), £45·50 (Foreign).

Ordinary Members pay an entrance fee of Rs. 5 (25*p*.) and an annual subscription of Rs. 36 (Inland), £3 (Foreign).

Members residing outside India should pay their subscription by means of orders on their Bankers to pay the amount of the subscription to the Society in Bombay on the 1st January in each year. If this cannot be done, then the sum of £3·00 should be paid annually to the Society's London Bankers—The National & Grindlays Bank Ltd., 23 Fenchurch Street, London E.C. 3.

The subscription of members elected in October, November, and December covers the period from the date of their election to the end of the following year.

CONTENTS