

RECORDS

of the

INDIAN MUSEUM

(A JOURNAL OF INDIAN ZOOLOGY)

Vol. XLV, Parts II and III

June & September, 1947

	<i>Page.</i>
Note on Penial Setae in <i>Eutyphoeus quadripapillatus</i> Michaelsen, 1907. By G. E. Gates	111
On a Second Collection of Fish from Iraq. By K. S. Misra	115
Cyclopoides (Crustaceis Copepodis) Nouveaux de l' Inde. By Knut Lindberg	129
Notes on some Helminths in the Collection of the Zoological Survey of India. By B. S. Chauhan	133
On some Species of <i>Acetes</i> (Crustacea, Sergestidae) from Travancore. By S. Nataraj	139
Studies in Intraspecific Variation. III. By M. L. Roonwal	149
Studies in Intraspecific Variation. IV. By M. L. Roonwal	167
Early Embryology of the Desert Locust, <i>Schistocerca gregaria</i> (Forsk.) [Orthoptera, Acrididae]. By V. G. Jhingran	181
Studies on Indian Thysanoptera. II. By Shumsher Singh	211
On the Cervical and Thoracic Arteries in the Northern Indian Green Barbet, <i>Thereiceryx zeylanicus caniceps</i> (Franklin), together with an Anomalous Case of Reversal of the Internal Carotid Artery. By J. L. Bhaduri and B. Biswas	237
Decapoda Crustacea of the Patna State, Orissa. By B. Chopra and K. K. Tiwari ..	213
Notes on a Collection of Birds from the Darrang District, Assam. By Biswamoy Biswas	225
On a Collection of Birds from Rajputana. By Biswamoy Biswas	245
Fish and Fisheries of the Patna State, Orissa. By B. S. Chauhan	267

Edited by the Director, Zoological Survey of India

PUBLISHED BY THE MANAGER OF PUBLICATIONS, DELHI
 PRINTED BY THE GOVERNMENT OF INDIA PRESS, CALCUTTA, INDIA,
 1949

Price Rs. 16 or 25s.

NOTE ON PENIAL SETAE IN *EUTYPHOEUS QUADRIPAPILLATUS*
MICHAELSEN, 1907.

By G. E. GATES, *Ewing College, Allahabad.*

E. quadripapillatus is a little known species, recorded hitherto only from Calcutta, Saraghat (Bengal), and Sirsiah (Bihar). According to Michaelsen (1909, p. 221), penial setae are lacking—no mention is made of setal follicles (penial or otherwise) in association with male terminalia. Gates (1938, p. 108) not only found setal follicles associated with prostatic ducts, but in one of the three follicles examined microscopically, “a complete, sigmoid seta”, and suggested that the presence of sigmoid setae might indicate that *E. quadripapillatus* is more primitive than any other known species (*Idem*, pp. 57 and 108). A recent collection from Gorakhpur district (U.P.) containing a fairly large series of the species has now provided an opportunity to acquire further information with regard to the ventral setae of segment xvii.

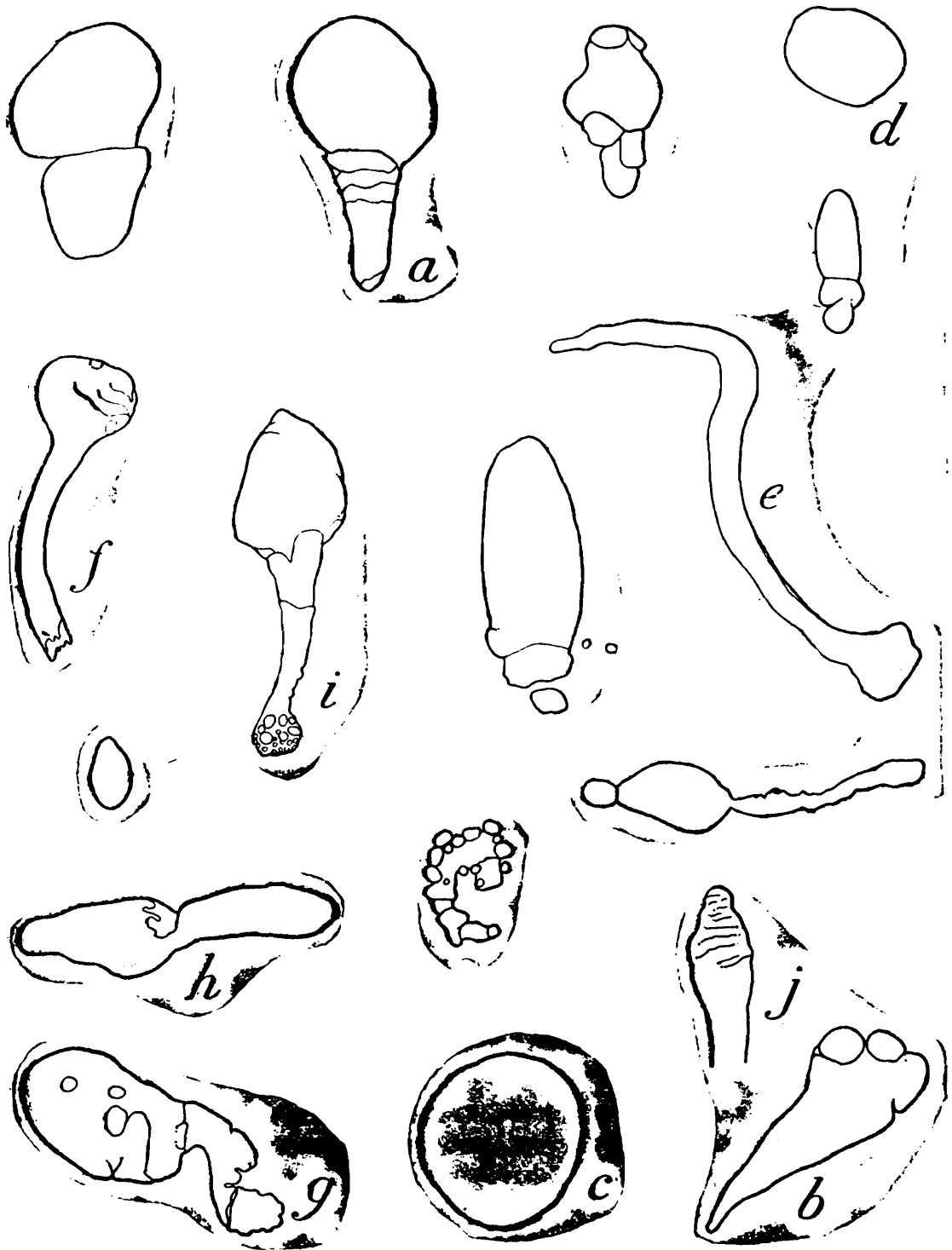
On the median side of each prostatic duct there is always present follicle tissue, which usually protrudes from the parietes only slightly into the coelomic cavity, but which may occasionally reach beyond ental end of bulbus ejaculatorius or even (in one acitellate specimen) to ental end of prostatic duct. Whether this mass of follicle tissue comprises two discrete follicles, of the *a* and *b* setae of xvii, or only a single follicle, and then of *a* or *b*, is unknown. Accordingly, follicle, in this note, as previously, refers to the whole mass of tissue median to a prostatic duct. One hundred follicles from fifty specimens were examined microscopically.

Each follicle always contains pink setal “fragments” of various shapes and sizes. Most common is a topshape (Text-fig. 1, *a* and *b*) and variations thereon. In one follicle five top-shaped fragments are present and in positions similar to those occupied by reserve setae in a normal penisetal follicle. In this as well as many other specimens, pink spots are recognizable, even under the binocular, at ental ends of penisetal follicles just as bases of penisetal shafts are sometimes recognizable, without dissection, at ental ends of penisetal follicles.

Other fragments may be spheroidal (Text-fig. 1, *c*), ovoidal (Text-fig. 1 *d*) or rod-like and then usually curved (Text-fig. 1, *e*). Fragments often are fissured (not cracked, Text-fig. 1, *f*, *g*, and *b*), or knobbed, with irregular “excavations” (Text-fig. 1, *h*), or more regular light spots that look like vacuoles (Text-fig. 1, *g*).

At ectal end of a top-shaped fragment, setal substance often becomes discontinuous, the shaft represented further ectally by discrete granules of variable shape and size. Similar clusters of granules have been found alone or in association with fragments of other shapes.

The impression one gathers in looking at a long series of follicles is that the process of deposition of the setal substance has gone completely away, and that total mass of setal substance is much less than in normal penisetal follicles.



TEXT-FIG. 1.—*Eutypheus quadripapillatus* Michaelsen, 1907. a—j. Different kinds of Penial setae.

In each of three follicles only, a single normal seta is present. By normal, in this connection, is meant a seta without knobs, fissures, grooves, cracks, excavations and vacuoles but with a smooth surface and regular margin. Each normal seta is light yellow, rather than pink, as are usually mature or functional penial setae of penisetal species. One shaft is truncate ectally, the tip without sculpturing. The tip of a second is somewhat irregular (Text-fig. 1, j). The tip of the third is like that of an ordinary sigmoid seta. All three are unornamented, the shafts nearly straight and without nodulus. Lengths ; 0.25, 0.34 and 0.49 mm.

Omitting further details, information now available with regard to ventral setae of xvii may be summarized as follows:—Follicles are larger than those of sigmoid setae of other segments as well as of lateral setae of xvii. Relationships of follicle to male genital terminalia are same as those of a penisetal follicle. Arrangement of fragments within a follicle may be like that of reserve setae in a penisetal follicle. Number of fragments or groups of fragments may be greater than number of reserves usually associated with follicles of ordinary sigmoid setae but may be similar to number of reserves in a penisetal follicle. Normal setae, found occasionally, are usually not sigmoid, even though ornamentation usually characteristic of penial setae is lacking. The single sigmoid seta that has been found (Gates, 1938, p. 108) may have been retained from a juvenile stage.

All this would appear to indicate that *E. quadripapillatus* formerly had penial setae, even though such setae may not have been highly specialized as to size, sculpturing of tip or ornamentation. Penisetal follicles still develop and still have "formative cells" that retain some ability to secrete setal substance while ability to deposit that substance in form of a normal setal shaft has been mostly lost or inhibited.

Further steps in the evolutionary process presumably will be complete loss or inhibition of ability by formative cells to secrete, loss of formative cells themselves and finally loss of the follicles. That last stage apparently has already been reached by two species of the genus, *E. nainianus* Michaelsen, 1907 and *E. quinquepertitus* Gates, 1930. These species do not appear to be closely related to each other, loss of penial setae presumably having arisen independently.

SUMMARY.

E. quadripapillatus, in very rarely having a sigmoid ventral setae in xvii, now appears not to be primitive. On the contrary, the evidence presented that the species once had batteries of penial setae apparently indicates that the species is highly specialized with regard to one characteristic, and in that connection at least is the most highly evolved of the holandtic section of the genus.

REFERENCES.

- Gates, G. E., 1938.—Indian Earthworms. III. The genus *Eutyphoeus*, *Rec. Ind. Mus.* XL, pp. 39—119.
- Michaelsen, W., 1909.—The Oligochaeta of India, Nepal, Ceylon, Burma, and the Andaman Islands. *Mem. Ind. Mus.* I, pp. 103—253.

ON A SECOND COLLECTION OF FISH FROM IRAQ.

By K. S. MISRA, D.Sc., F.Z.S., Assistant Superintendent, Zoological Survey of India, Kaiser Castle, Banaras Cantonment.

(Plates I and II.)

In February, 1943, Dr. Bains Prashad, Director, Zoological Survey of India, received through Dr. S. L. Hora, Director of Fisheries, Bengal, a second collection of fish from Iraq made by Mr. D. D. Belayew, Specialist in Fisheries, Directorate General of Agriculture, Baghdad, for determination. The collection was accompanied by photographs of 16 species and a list of the Arabic names of the fishes.

The material proved to be of great value as most of the freshwater species had been collected from their respective type localities. The earlier descriptions of some of Heckel's species have been amplified, as was done by Hora and Misra¹ in the first article of the series. Illustrations of two of Heckel's species are also included as Heckel's paper is not easily available in this country. The general classification of fishes adopted is according to Jordan².

It has been found that different species have sometimes the same Arabic name and that one species may sometimes have several different Arabic names. So, in specific determination much reliance should not be placed on the vernacular names given to various species as was pointed out by Hora and Misra³ in their studies of the Poona fishes. Limits of distribution of each species are given in order to show the geographical relationship of the fauna.

LIST OF SPECIES.

Super Order TELEOSTEI.

Order ISOSPONDYLI

Family CLUPEIDAE

1. *Ilisha filigera* (V.).

Family DOROSOMIDAE

2. *Nematalosa nasus* (Bl.).

Family ENGRAULIDAE

3. *Thrissocles purava* (C. V.).

Order EVENTOGNATHI

Family CYPRINIDAE

4. *Abramis caeruleus* (Heck.).
5. *Alburnus scheitan* Heck.
6. *Aspius vorax* Heck.
7. *Barbus esocinus* (Heck.).
8. *Barbus xanthopterus* (Heck.).
9. *Barbus (Puntius) luteus* (Heck.).
10. *Barbus (Puntius) sharpeyi* Gthr.
11. *Barbus (Tor) grypus* Heck.

¹ Hora, S. L. and Misra, K. S., *Journ. Roy. As. Soc. Bengal (Sci.)* IX, pp. 1-15 (1943).

² Jordan, D. S., *Classification of Fishes* (Stanford University, California : 1923).

³ Hora, S. L. and Misra, K. S., *Journ. Bombay Nat. Hist. Soc.* XLIII, pp. 218-225 (1942).

Order NEMATOGNATHII

Family TACHYSURIDÆ

12. *Tachysurus thalassinus* (Rüpp.).

Family PAMPIDÆ

16. *Chondrolites chinensis* (Euphras.).

Order SYNENTOGNATHI

17. *Pampus argenteus* (Euphras.).

Family BELONIDÆ

13. *Strongylura strongylura* (van Hass.).

Family POMADASIDÆ

18. *Pomadasyus argyreus* (C. V.)

Order HETEROSOMATA

Family SOLEIDÆ

Family SOLEIDÆ

14. *Synaptura orientalis* (Bl. Schn.).19. *Johnius belengerii* (C. V.).20. *Pseudosciaena sina* (C. V.).

Order GOBIOIDEA

Super Order ACANTHOPTERYGII.

Family GOBIDÆ

Order PERCOMORPHI

21. *Boleophthalmus dussumieri* C. V.

Family MUGILIDÆ

15. *Mugil (Liza) hishni* Misra.

SYSTEMATIC ACCOUNT.

***Ilisha filigera* (V.).**1847. *Pellona filigera*, Valenciennes, *Hist. Nat. Poiss.* XX, p. 332 (type locality Coromandel; Bombay¹).1878. *Pellona filigera*, Day, *Fish. India*, p. 648, pl. clxv, fig. 5.1923. *Ilisha filigera*, Norman, *Ann. Mag. Nat. Hist.* (9) XI, p. 10.Arabic name : *Abou-Avena*.

A single salted and dried specimen, 335 mm. in total length, which has been assigned to *Ilisha filigera*, was collected from the Persian Gulf. Mr. Belayew also sent a photograph of a specimen, 316 mm. in total length to facilitate determination.

Ilisha filigera is distributed in the seas of India, Philippines and Indo-China.

***Nematalosa nasus* (Bl).**1795. *Clupea nasus*, Bloch, *Naturg. ausland. Fische* IX, p. 116, pl. ccccxxix, fig. 1 (type locality : Malabar).1878. *Chatoessus nasus*, Day, *Fish. India*, p. 634, pl. clx, fig. 4.1887. *Chatoessus nasus*, Boulenger, *Proc. Zool. Soc. London*, p. 666 (Muscat).1917. *Nematalosa nasus*, Regan, *Ann. Mag. Nat. Hist.* (8) XIX, p. 313.

¹ Where more than one locality is given by the author, the first one is regarded as the type locality.

Arabi name : *Yaffoud.*

There are 3 specimens, 205 mm., 206 mm. and 210 mm. in total length which were collected from the Hor-el-Hammar Lake. In one specimen the last dorsal ray reaches halfway between the dorsal and caudal fins ; and in other two specimens nearly to the base of the caudal fin. This species is good eating but bony.

Nematalosa nasus is distributed in the seas and estuaries of Sokotra, South Arabia, India, Ceylon, Burma, Malay Peninsula, Malay Archipelago, China, Formosa, New Guinea, Australia.

***Thrissocles purava* (Hàm.).**

1822. *Clupea purava*, Hamilton, *Fish. Ganges*, pp. 238, 382 (type locality : Ganges estuaries).
 1878. *Engraulis purava*, Day, *Fish. India*, p. 628, pl. clvii, fig. 2 (Sind).
 1941. *Thrissocles purava*, Fowler, *Bull. U. S. Nat. Mus.* (100) XIII, p. 677 (Philippines and adjacent seas).

Arabic name : *Shiha.*

There are 2 specimens of *Thrissocles purava* (Hamilton), 163 mm. and 186 mm. in total length, from the Hor-el-Hammar Lake. It attains at least 12 inches in length ; and is distributed in seas and estuaries of India, Malay Peninsula and Malay Archipelago.

***Abramis caeruleus* (Heck.).**

1841. *Alburnus caeruleus*, Heckel, in Russegger's *Reisen in Europa, Asien und Africa* I, p. 1084, pl. xi, fig. 3 (type locality : Aleppo).
 1868. *Abramis caeruleus*, Günther, *Cat. Fish. Brit. Mus.* VII, p. 308.
 1884. *Abramis caeruleus*, Sauvage, *Nouv. Arch. Mus. Nat. Hist.* (2) VII, p. 6 (name only).

Arabic name : *Lassafa.*

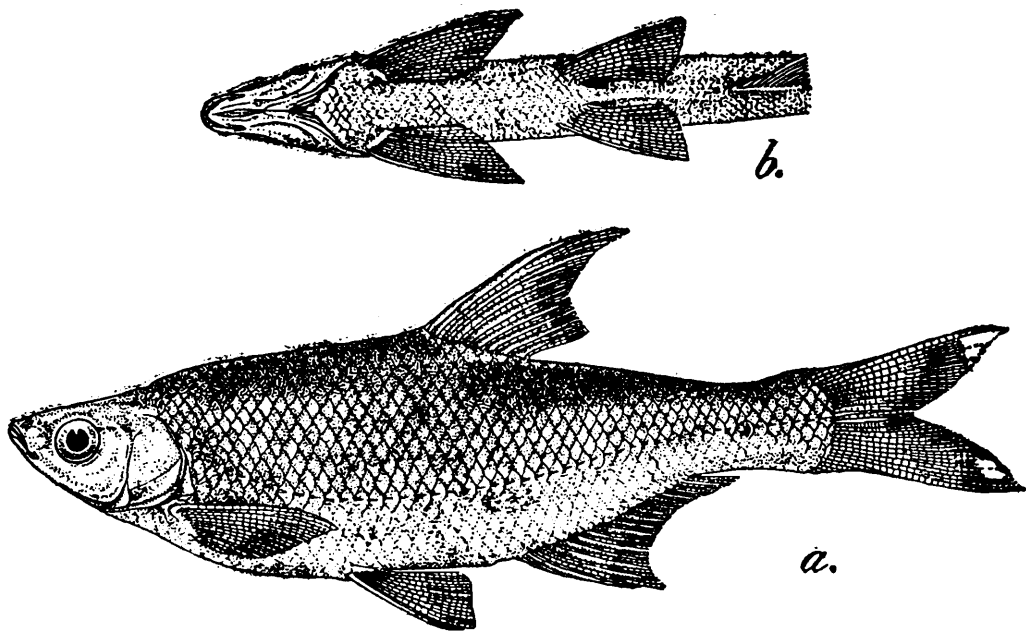
D.3/8 ; A.3/16 ; P.1/14 ; V.1/8 ; L.1.50 ; L.tr.11/6 ; C.19.

There is a single specimen, 176 mm. in total length, which was collected from Hor Abou-Nedjin, Iraq.

The body is elevated. The length of the head is contained 5.5 times in total length and 4.3 times in length without caudal. The depth of body is contained 3.8 times in total length and 2.8 times in length without caudal. The diameter of the eye is contained 3.1 times in the length of the head ; 1.1 times in the interorbital distance ; and 0.8 time in the length of the snout. The cleft of mouth is directed upwards. Both the jaws are equal. The lower labial fold is interrupted at the symphysis of the mandible. The body is covered with scales ; there are 50 scales in longitudinal series along the lateral line ; 4 rows between lateral line and the base of the pelvic fin.

The anal fin originates in advance of the last dorsal ray. The abdomen is round and is not keeled, both preventrally and postventrally. The tip of the dorsal fin is blackish.

Abramis caeruleus was originally described from Aleppo ; and has been recorded for the first time from Hor Abou-Nedjin.

TEXT-FIG. 1.—*Abramis caeruleus* (Heck.).

a. lateral view : $\times 4/7$; b. ventral surface of head and part of body : $\times 4/7$.

Measurements in millimetres and scale counts.

Total length	..	..	..	..	..	176.0
Standard length	..	..	..	..	..	140.0
Length of head	..	..	..	..	..	31.5
Width of head	..	..	..	..	..	17.0
Height of head	..	..	..	..	..	24.0
Diameter of eye	..	..	..	..	..	10.0
Interorbital width	..	..	..	..	..	11.0
Length of snout	..	..	..	..	..	8.0
Depth of body	..	..	..	..	..	46.0
Width of body	..	..	..	..	..	15.0
Length of caudal peduncle	..	..	..	..	..	25.0
Least height of caudal peduncle	..	..	..	..	..	15.0
Length of dorsal spine	..	..	..	..	..	31.5
Longest ray of dorsal fin	..	..	..	..	..	34.5
Longest ray of pectoral fin	..	..	..	..	..	29.0
Longest ray of pelvic fin	..	..	..	..	..	22.0
No. of scales along L. 1	..	..	..	..	..	50
No. of scales between L. 1 and V.	..	..	..	..	..	4

***Alburnus scheitan* Heck.**

1843. *Alburnus scheitan*, Heckel in Russeger's *Reisen in Europa, Asien und Africa* II, p. 264 (type locality : River Araxes).

1868. *Alburnus scheitan*, Günther, *Cat. Fish. Brit. Mus.* VII, p. 317.

Arabic name : *Smnan*.

D.2/8 ; A.3/12 ; P.1/15 ; V.2/7-8 ; L.1.70-72 ; L.tr.11/7 ; C.19.

There are 5 specimens, ranging from 105 mm. to 175 mm. in total length, which were collected from the Tigris River. As no suitable description of *Alburnus scheitan* is available, I fully describe this species,

The body is elongated. The length of the head is contained from 4.8 to 5.0 times in the standard length and from 5.9 to 6.1 times in the total length. The depth of body is nearly equal to the length of head, from 4.8 to 5.6 times in standard length, and from 5.9 to 7.0 times in total length. The diameter of the eye is contained from 2.7 to 3.1 times in length of head from 0.7 to 1.0 time in the interorbital distance, and from 0.77 to 0.88 times in the length of the snout. The cleft of the mouth is directed upwards, the lower jaw projecting beyond the upper. The least height of the caudal peduncle is contained from 2.4 to 2.7 in the length of the caudal peduncle. There are 12 gill-rakers on the lower limb of the anterior arch. They are slender, lanceolate and closely set; and are contained more than two times in the length of gill filaments. The abdomen behind the ventral is compressed into an edge. The body is covered with small scales; there are 70-72 scales in longitudinal series along the lateral line; $4\frac{1}{2}$ rows between the lateral line and base of the ventral fin; $11\frac{1}{7}$ rows in the lateral transverse.

The dorsal fin is situated behind the pelvics. The anterior anal rays are behind the vertical from the last dorsal ray. The longest ray of the pectoral is nearly equal to the dorsal; and terminates at some distances from the root of the pelvics. The dorsal surface of the body above the lateral line is greyish and the lower surface is silvery. A lead-coloured band runs along and above the lateral line.

Alburnus scheitan Heckel which was originally described from the river Araxes, may turn out to be synonymous with *Alburnus mossulensis* Heckel when a large number of specimen of *Alburnus scheitan* is available for study. I do not see any difference of specific importance between them. *Alburnus scheitan* has been recorded for the first time from the river Tigris.

Measurements in millimetres and scale counts.

Total length	..	..	..	105.0	173.0	175.0
Standard length	..	..	..	85.0	140.0	144.0
Length of head	..	..	..	17.5	29.0	28.5
Width of head	..	..	..	8.0	14.0	14.0
Height of head	..	..	..	11.0	19.0	20.0
Diameter of eye	..	..	..	6.5	9.0	9.0
Interorbital width	..	..	..	5.0	9.0	9.0
Length of snout	..	..	..	5.0	7.0	8.0
Depth of body	..	..	..	15.0	29.0	28.0
Width of body	..	..	..	6.5	14.0	14.0
Length of dorsal fin	..	..	..	16.0	23.0	26.0
Longest ray of pectoral fin	..	..	..	15.5	27.0	26.0
Longest ray of pelvic fin	..	..	..	11.5	20.0	18.0
Length of caudal peduncle	..	..	..	19.0	32.0	30.0
Least height of caudal peduncle	..	..	..	7.0	12.5	12.0
No. of scales along L. l.	..	..	..	71	70	72
No. of scales between L. l. and V.	..	..	..	$4\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$

Aspius vorax Heck.

(Plate I, fig. 1).

1841. *Aspius vorax*, Heckel, in Russegger's *Reisen in Europa, Asien und Africa* I, p. 1081, pl. x, fig. 3 (type locality : Tigris).
 1868. *Aspius vorax*, Günther, *Cat. Fish. Brit. Mus.* VII, p. 311.
 1874. *Aspius vorax*, Günther, *Ann. Mag. Nat. Hist.* (4) XIV, p. 37 (name only).
 1884. *Aspius vorax*, Sauvage, *Nouv. Arch. Mus. Nat. Hist.* (2) VII, p. 7 (name only).

Arabic name : *Shillik*.

D.2/9 ; A.2/11 ; P.1/17 ; V.1/8 ; L.1.96 ; L.tr.18/10 ; C.19.

There is only one specimen, 386 mm. in total length which was collected from the Tigris. Mr. Belayew also sent a photograph of a bigger specimen, 454 mm. in total length. The measurements and scale counts of the specimen examined by me are given below.

Aspius vorax has been recorded only from the Tigris river.

Measurements in millimetres and scale counts.

Total length	..	..	..	..	386·0
Standard length	..	..	..	..	335·0
Length of head	..	..	..	..	94·0
Width of head	..	..	..	..	39·0
Height of head	..	..	..	..	49·0
Diameter of eye	..	..	..	..	15·0
Length of snout	..	..	..	..	26·0
Interorbital width	..	..	..	..	20·0
Depth of body	..	..	..	..	74·0
Width of body	..	..	..	..	43·0
Length of dorsal fin	..	..	..	..	41·0
Length of pectoral fin	..	..	..	..	53·0
Length of ventral fin	..	..	..	..	41·0
Length of caudal peduncle	..	..	..	..	65·0
Least height of caudal peduncle	..	..	..	..	31·5
No. of scales along L. 1.	..	..	..	..	96

Barbus esocinus (Heck.).

(Plate I, fig. 2.)

1841. *Luciobarbus esocinus*, Heckel, in Russegger's *Reisen Europa, Asien und Africa* I, p. 1054, pl. iv, fig. 2 (type locality : River Tigris near Mossul).
 1868. *Barbus esocinus*, Günther, *Cat. Fish. Brit. Mus.* VII, p. 86.

Arabic name : *Biz*.

D.3/8 ; A.3/5 ; P.1/18 ; V.2/8 ; L.1.76-78 ; C.19.

Mr. Belayew could not obtain a specimen of 'Biz' of a suitable size for sending to India. Therefore he sent a photograph of a specimen, about 1,150 mm. in total length with its fins and pharyngeal bones to facilitate determination. The photograph of 'Biz' with the help of fins, pharyngeal teeth and scale counts has been assigned to *Barbus esocinus* (Heckel). Pharyngeal teeth are arranged as 4, 3, 2/2, 3, 4,

Barbus esocinus (Heckel) is closely allied to *Barbus subquincunciatus* Gthr., but the two can be distinguished by the following table of characters.

<i>Barbus esocinus</i> (Heckel).	<i>Barbus subquincunciatus</i> Gthr.
1. Lateral line scale 76-78	1. Lateral line scale 82.
2. Lateral transverse scale 12/12.	2. Lateral transverse scale 16/16.

Barbus esocinus (Heckel) has been recorded only from the Tigris river.

***Barbus xanthopterus* (Heck.).**

(Plate II, figs. 1, 2.)

1841. *Luciobarbus xanthopterus*, Heckel, in Russegger's *Reisen in Europa, Asien und Africa* I, p. 1053, pl. iv, fig. 1 (type locality : Tigris near Mossul).
 1841. *Luciobarbus scheich*, Heckel, in Russegger's *Reisen in Europa, Asien und Africa* I, p. (1055 type locality : River Tigris near Mossul).
 1868. *Barbus xanthopterus*, Günther, *Cat. Fish. Brit. Mus.* VII, p. 86.
 1868. *Barbus scheich*, Günther, *Cat. Fish. Brit. Mus.* VII, p. 87.
 1874. *Barbus scheich*, Günther, *Ann. Mag. Nat. Hist.* (4) XIV, p. 37.
 1884. *Barbus xanthopterus*, Sauvage, *Nouv. Arch. Mus. Nat. Hist.* (2) VII, p. 30.

Arabic name : *Gattan* or *Nobbash*.

D.3/8 ; A.3/5 ; L.1.60.

Of the two specimens of *Barbus xanthopterus* which were collected from the Tigris, the larger, 491 mm. in total length, is a deep-bodied form, while the smaller, about 466 mm. in total length, is a shallow-bodied form. The serrated dorsal spine is comparatively more developed in the narrower form than in the other. The labial fold is interrupted in the middle.

In 1874, Günther (*loc. cit.*) thus wrote about *Barbus scheich* : " The examples are the first I have seen ; they vary considerably in the comparative length of the dorsal spine ; and I have no longer any doubt that *Luciobarbus xanthopterus* of Heckel and *Luciobarbus mystaceus* of the same author are founded on individual variations of the same species." In 1884, Sauvage (*loc. cit.*) agreeing with Günther put *Luciobarbus scheich* Heckel and *Luciobarbus mystaceus* Heckel under the synonymy of *Barbus xanthopterus* (Heckel). I have not seen any specimens of *Luciobarbus mystaceus*, but I agree with the views expressed by Günther and Sauvage.

An examination of the gonads of *Barbus xanthopterus* revealed that the deeper and narrower forms are respectively the females and males of *Barbus xanthopterus*. In the male the body is proportionately less deep, and the dorsal fin is more concave. The secondary sexual differences noted above can be made out clearly from a comparison of the drawings of a male and a female specimen reproduced on the plate.

Barbus xanthopterus has been recorded from the rivers Tigris and Euphrates.

Barbus (Puntius) luteus (Heck.).

1841. *Systomus luteus*, Heckel, in Russeger's *Reisen in Europa, Asien und Africa* I, p. 1016, pl. vi, fig. 1 (type locality : Orontes and Tigris).
 1868. *Barbus luteus*, Günther, *Cat. Fish. Brit. Mus.* VII, p. 141.
 1943. *Barbus (Puntius) luteus*, Hora and Misra, *Journ. Roy. As. Soc. Bengal (Sci.)* IX, p. 4, text-fig. 2.

Arabic name : *Binni Hamour* ; *Binni Himri* or *Binni* of *Shifatha*.

D.3/10, P.1/15 ; V.1/8 ; A.2/6 ; L.1.28 ; L.tr. 5/4.

There are 4 specimens ranging between 210 mm. and 260 mm. in total length, which were collected from Shifatha.

Barbus (Puntius) luteus is stated to be found in the Hors and the Rivers Shatt-al-Arab, Tigris, Euphrates and Dialeh.

Barbus (Puntius) sharpeyi Gthr.

1874. *Barbus sharpeyi*, Günther, *Ann. Mag. Nat. Hist.* (4) XIV, p. 38, pl. ix (type locality : Tigris, Baghdad).

Arabic name : *Binni*.

D.3/8 ; P.1/17 ; V.1/8 ; A.3/5 ; L.1.30 ; L.tr.4/5.

There is a single specimen, 295 mm. in total length, which has been assigned to *Barbus (Puntius) sharpeyi* Gthr. Günther (*loc. cit.*) described and figured *Barbus sharpeyi* from Baghdad, on the River Tigris and stated that its vernacular name was "Aradah" I have now examined a specimen of the same species from the river Tigris which was received under a different Arabic name "Binni"; it agrees in all respects with Günther's description of the species. There are few tubercles on the snout and the labial fold is interrupted in the middle. The colouration is uniform but the tips of the pectoral, ventral and caudal fins are dusky.

Barbus (Puntius) sharpeyi is closely allied to *Barbus (Puntius) luteus* Heckel but the two can be distinguished by the following characters.

Barbus (Puntius) sharpeyi (Gthr.)

1. D.11-12
2. Scales along L. 1.30-31
3. 3½ Scales between L. 1. and V.
4. Barbels absent

Barbus (Puntius) luteus (Heck.).

1. D. 13-14
2. Scales along L. 1.28
3. 2½ Scales between L. 1. and V.
4. A pair of short maxillary barbel.

Both *Barbus (Puntius) sharpeyi* and *Barbus (Puntius) luteus* are characterised by having a smooth dorsal spine. *Barbus (Puntius) sharpeyi* has been recorded only from the river Tigris.

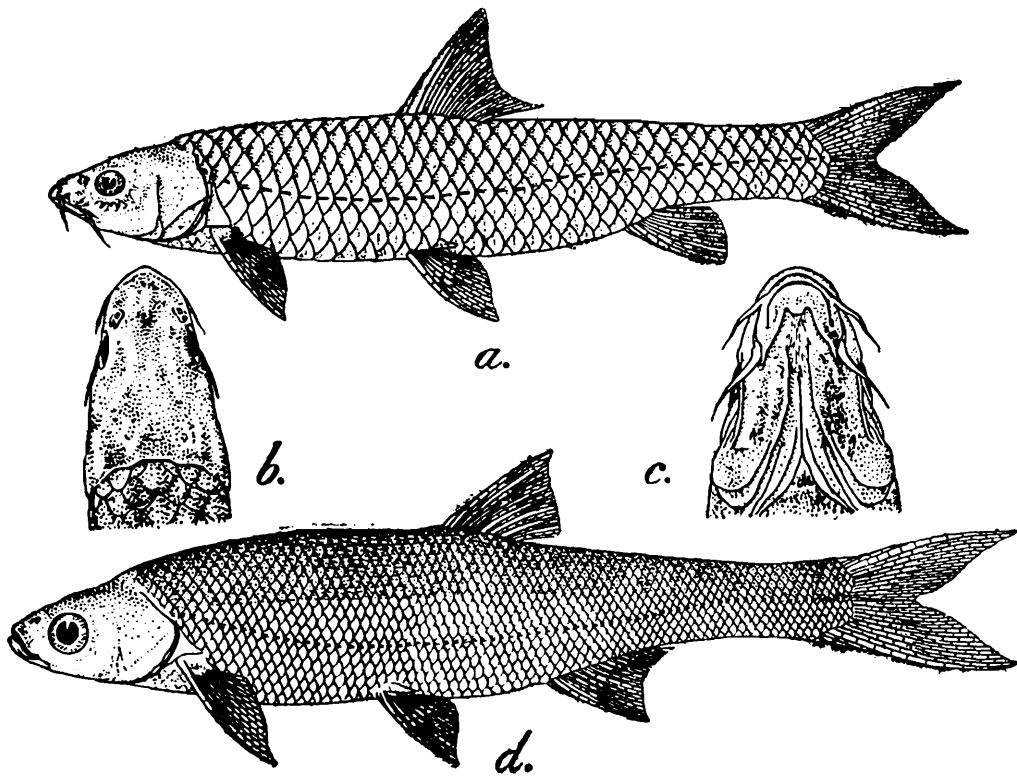
Barbus (Tor) grypus Heck.

1841. *Barbus grypus*, Heckel, in Russeger's *Reisen in Europa, Asien und Africa* I, p. 1048, pl. iii, fig. 1 (type locality : Tigris near Mossul).
 1841. *Labeobarbus kotschyi*, Heckel, in Russeger's *Reisen in Europa, Asien und Africa* I, p. 1049, pl. iii, fig. 2 (type locality : Tigris near Mossul).
 1868. *Barbus grypus*, Günther, *Cat. Fish. Brit. Mus.* VII, p. 109.
 1868. *Barbus kotschyi*, Günther, *Cat. Fish. Brit. Mus.* VII, p. 109.
 1874. *Barbus kotschyi*, Günther, *Ann. Mag. Nat. Hist.* (4) XIV, p. 37.
 1884. *Barbus grypus*, Sauvage, *Nouv. Arch. Mus. Na Hist.* (2) VII, p. 33.

D.3/8 ; A.3/5 ; P.1/13 ; V.1/7 ; L.1·38 ; C.19.

Though in 1868, Günther (*loc. cit.*) recognised *Barbus kotschyi* (Heckel) as a distinct species, he was doubtful about its validity. It is better to quote his words about *Barbus kotschyi* : " This species is so closely allied to *B. grypus*, that we cannot help thinking that the labial lobes may prove to be not a character of specific value." Again in 1874 he (*loc. cit.*) wrote thus : "*Barbus Kotschyi*, Heck., with which most probably *Barbus grypus* (Heck.) is identical." In 1884, Sauvage relegated *Barbus kotschyi* (Heckel) to the synonymy of *Basbus grypus* Heckel.

I have examined a single specimen, 317 mm. in total length, which was collected from the Tigris. Mr. Belayew sent a photograph of a specimen, 857 mm. in total length. I feel certain that the species from the Tigris under report is generically not different from a number of Indian species grouped under *Tor* Gray with *Cyprinus tor* Hamilton as the genotype. A full description of *Barbus grypus* Heckel from its type locality is given here.



TEXT-FIG. 2.—a. Lateral view of *Barbus (Tor) grypus* Heck. : $\times 2/7$; b. dorsal surface of the head of the same : $\times 4/7$; c. ventral surface of the head of the same $\times 4/7$; d. lateral view of *Alburnus scheitan* Heck. : $\times 4/7$.

Barbus grypus is an elongated and subcylindrical fish. The snout is pointed anteriorly and behind the anal fin the caudal peduncle becomes considerably narrow. The length of the head is greater than the depth of the body ; it is contained 5·7 times in the total length and 4·8 times in the standard length. The depth of the body is contained 1·05 times in the length of the head. The diameter of the eye is contained 5 times in the length of head ; 1·3 times in the length of snout ; and 1·8 times in the interorbital distance. The least height of the caudal peduncle is contained 1·8 times in its length.

The mouth is small; its gape does not extend to below the eyes. The lips are fleshy and continuous at the angles of the mouth; the posterior lip is produced into a median lobe and the post labial groove is continuous. There are two pairs of barbels. The rostral barbels are equal to the diameter of the eye. The maxillary barbels are contained 1.2 times in the diameter of the eye. The body is covered with large scales; there are 38 scales in longitudinal series along the lateral line; $2\frac{1}{2}$ rows between the lateral line and the base of the pelvic fin; $4\frac{1}{2}$ rows between the lateral line and the base of the dorsal fin; 12 scales before the dorsal fin and 12 round the caudal peduncle. There is a well developed scaly appendage in the axil of the pelvic fin.

The dorsal fin is slightly in advance of the pelvics and commences slightly nearer to the snout than the base of the caudal fin. The last dorsal spine is very strong, entire and bony; it is contained 1.3 times in the length of the head and 1.2 times in the depth of the body. The longest ray of the pectoral fin is nearly equal to the last dorsal spine. The pectoral fin is separated from the pelvics by a considerable distance. The longest ray of the anal fin is shorter than those of the dorsal, pectoral and pelvic. The caudal fin is deeply emarginate with both the lobes pointed.

Barbus (Tor) grypus Heckel has been recorded from the Tigris and the Euphrates.

Measurements in millimetres and scale counts.

Total length	..	..	..	..	..	317.0
Standard length	..			..	..	266.0
Length of head	..		..	..	..	55.0
Height of head at occipit			..	..	..	34.5
Width of head		..	..	..	..	33.5
Diameter of eye	..	..	..	..	..	11.0
Length of snout	..	..	..	..	..	15.3
Interorbital width	..		..	..	..	20.0
Depth of body	..	..	..	..	..	52.0
Width of body	..	..	..	..	..	32.5
Length of caudal peduncle				..	..	45.0
Least height of caudal peduncle			..	..	..	25.0
Longest ray of dorsal fin	..	..	..	..		44.0
Length of dorsal spine	..			..	..	41.0
Longest ray of pectoral fin	..	..	..	..	..	40.0
Longest ray of pelvic fin			..	..	..	38.0
Longest ray of anal fin	..	..	..	..	..	36.0
Length of rostral barbel	..			..	..	11.0
Length of maxillary barbel	..	..	..	..	..	14.0
No. of scales along L. 1.			..	..	..	38
No. of scales between L. 1. and V.			..	..	..	$2\frac{1}{2}$
No. of predorsal scales	..		..	..	..	12
No. of scales round caudal peduncle			..	..	..	12

Tachysurus thalassinu (Rüpp.).

1837. *Bagrus thalassinus*, Rüppell, *Neue Wirbelth., Fische*, p. 75, pl. 22, fig. (type locality : Massaua, Red Sea).
 1877. *Arius thalassinus*, Day, *Fish-India*, p. 463, pl. civ, fig. 4 and pl. cvi, fig. 1.
 1887. *Arius thalassinus*, Boulenger, *Proc. Zool. Soc. London*, p. 665 (Muscat).
 1938. *Tachysurus thalassinus*, Fowler, *List Fish. Malaya*, p. 50.

Arabic name : *Tchim*.

There is a single specimen, 260 mm. in total length, of *Tachysurus thalassinus* from Hor-el-Hammar Lake. Mr. Belayew sent photographs of two much larger specimens. Besides the produced and pointed snout, this specimen differs from *forma typica* in the shorter maxillary, outer and inner mandibular barbels and the presence of granulations on the snout as had been observed by Boulenger (*loc. cit.*) in his specimens from Muscat. These differences would seem to be sufficiently significant for the recognition of varietal differences, but since I have only a single specimen, I refrain from giving it a new name. The species is said to attain a large size and is distributed from the Red Sea through the Arabian sea, India, to the Malay Archipelago and beyond. It is known to ascend tidal rivers ; and has been recorded for the first time from the Hor-el-Hammar Lake, Iraq.

Strongylura strongylura (van Hass.).

1823. *Belone strongylura*, van Hasselt, *Alegemein Konst-en-Letterb.* I, p. 131 (type locality : Batavia, Java).
 1877. *Belone strongylura*, Day, *Fish. India*, p. 512, pl. cxviii, fig. 6.
 1922. *Tylosurus strongylura*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.* IV, p. 121.
 1938. *Strongylura strongylura*, Fowler, *List Fish. Malaya*, p. 73.

Arabic name : *Mahiyat-en-Nebi*.

Strongylura strongylura is represented by a single specimen, 437 mm. in total length, which was collected from the Hor-el-Hammar Lake. Mr. Belayew sent the photograph of a specimen about 584 mm. in total length. There is a round bluish-black spot in the centre near the root of the caudal fin. This species attains 2 feet or more in length ; and is known from seas, estuaries and tidal rivers of India, Burma, Ceylon, Malay Peninsula, Malay Archipelago, Siam, Cochin China, Formosa and North Australia. The species has been recorded for the first time from Iraq.

Synaptura orientalis (Bl. Schn.).

1801. *Pleuronectes orientalis*, Bloch and Schneider, *Syst. Ichth.*, p. 157 (type locality : Tranquebar).
 1877. *Synaptura orientalis*, Day, *Fish. India*, p. 429, pl. xxiii, fig. 4, pl. xciv, fig. 2.
 1928. *Brachirus orientalis*, Norman, *Rec. Ind. Mus.* XXX, p. 179, text-fig. 3.

Arabic name : *Mislak*.

Synaptura orientalis is represented by a single specimen, 222 mm. in total length, which was collected from that portion of the Hor-el-Hammar Lake which is under tidal influence. The species coming from the Persian Gulf passes the summer in the Hor-el-Hammar Lake and returns in the autumn to the Persian Gulf through the river Shat-el-Arab.

According to Norman (*loc. cit.*), it attains upto 240 mm. in total length. *Synaptura orientalis* is distributed from the Persian Gulf, through the Malay Peninsula and Malay Archipelago to China and Australia.

Mugil (*Liza*) *hishni* Misra.

1943. *Mugil (Liza) hishni*, Misra, *Journ. Roy. As. Soc. Bengal (Sci.)* IX, p. 10, text fig. 5 (type locality : Rivers and Hors Iraq).

Arabic name : *Hishni* or *Hashnoun*.

There are 7 specimens of *Mugil (Liza) hishni* ranging between 96 mm. and 140 mm. in total length which were collected from the channels of Shifatha, which are connected with the Euphrates river through the Habbaniyah Lake and Bahroul-Melah Depression. These agree in all respects with my previous description of the species. The species is distributed in the Rivers and Hors, Iraq.

Chondroplites chinensis (Euphras.).

1788. *Stromateus chinensis*, Euphrasen, *Vat. Akad. Nya Handl. Stockholm* IX, p. 49, pl. ix.
 1876. *Stromateus sinensis*, Day, *Fish. India*, p. 246, pl. liC, fig. 6.
 1938. *Chondroplites chinensis*, Fowler, *List Fish. Malaya*, p. 115.

Arabic name : *Zoubeidae*.

There is a single specimen, 240 mm. in total length, of *Chondroplites chinensis* from the Hor-el-Hammar Lake. This fish is good eating; ascends estuaries; and is found in the seas of India, Malay Archipelago and China. *Chondroplites chinensis* has been recorded for the first time from Iraq.

Pampus argenteus (Euphras.).

1788. *Stromateus argenteus*, Euphrasen, *Vet. Akad. Nya Handl. Stockholm* IX, p. 53, pl. ix.
 1875. *Stromateus cinereus*, Day, *Fish. India*, p. 247, pl. liii, fig. 3.
 1938. *Pampus argenteus*, Fowler, *List Fish. Malaya*, p. 115.

Arabic name : *Zoubeidi*.

There is a single specimen about 225 mm. in total length which has been assigned to *Pampus argenteus* (Euphrasen); this was collected from the portion of Hor-el-Hammar Lake which is under tidal influence. The fish is much esteemed as food, and attains at least a foot in length. *Pampus argenteus* is distributed in the seas of India to the Malay Archipelago and beyond; and has been recorded for the first time from Iraq.

Pomadasys argyreus (C. V.).

1833. *Pristipoma argyreus*, Cuvier and Valenciennes, *Hist. Nat. Poiss.* IX, p. 485 (type locality : Coromandel).
 1875. *Pristipoma guoraca*, Day, *Fish. India*, p. 75, pl. xx, fig. 1.
 1936. *Pomadasys argyreus*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.* VII, p. 406.

Arabic name : *Nagrou*.

There is a single specimen, 207 mm. in total length, from the Persian Gulf, which has been assigned to *Pomadasys argyreus* (C. V.). The species is known from the seas of Portuguese East Africa, Seychelles, India, Ceylon, Andamans, Malay Peninsula, Malay Archipelago and New Hebrides ; and has been recorded for the first time from the Persian Gulf.

***Johnius belengerii* (C.).**

1830. *Corvina belengerii*, Cuvier, *Hist. Nat. Poiss.* V, p. 120 (type locality : Malabar).
 1875. *Sciaena belengeri*, Day, *Fish. India*, p. 191, pl. xliv, fig. 5.
 1936. *Johnius belengeri*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.* VII, p. 535, figs. 98, 99, and 104.

Arabic name : *Tao-Tao*.

There are 3 specimens of *Johnius belengerii*, ranging between 178 mm. and 188 mm. in total length, which were collected from the Persian Gulf. The species is distributed in the seas of Ceylon, India, Malay, the Malay Archipelago, Formosa, New Guinea and North Australia. The present is the first record of the species from the Persian Gulf.

***Pseudosciaena sina* (C.).**

1830. *Corvina sina*, Cuvier, *Hist. Nat. Poiss.* V, p. 122 (type locality : Pondicherry : Malabar : Japan).
 1875. *Sciaena sina*, Day, *Fish. India*, p. 186, pl. xliv, fig. 2.
 1892. *Sciaena sina*, Boulenger, *Proc. Zool. Soc. London*, p. 135 (Muscat).
 1936. *Pseudosciaena sina*, Weber and de Beaufort, *Fish. Indo-Austral. Archipel.* VII, p. 513.

There is a single specimen, 213 mm. in total length from the Persian Gulf, which has been assigned to *Pseudosciaena sina* (C.). The species is found in the seas and brackish waters on the East Coast of Africa from Zanzibar to Natal, Madagascar, Arabia, Baluchistan, India, Ceylon, Malay Peninsula, Malay Archipelago, Southern China and Japan.

***Boleophthalmus dussumierei* C.V.**

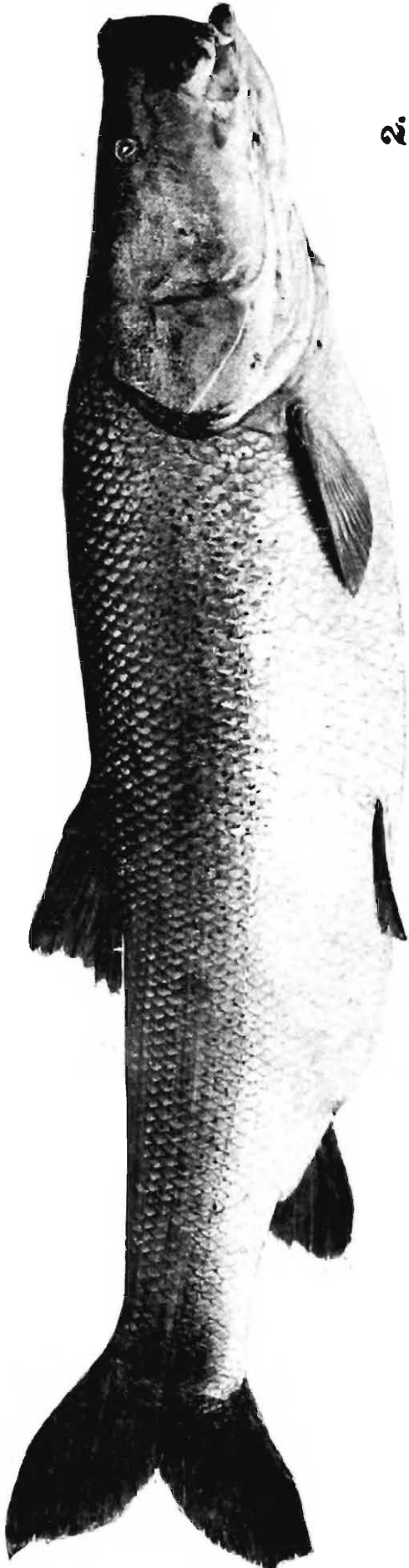
1837. *Boleophthalmus dussumierei*, Cuvier and Valenciennes, *Hist. Nat. Poiss.* XII, p. 207, pl. cccliv (type locality : Bombay).
 1876. *Boleophthalmus dussumierei*, Day, *Fish. India*, p. 305, pl. lxiv, fig. 9.
 1941. *Boleophthalmus dussumierei*, Koumans, *Mem. Ind. Mus.* XIII, p. 282.

Boleophthalmus dussumierei is represented in the collection by a single specimen, 101 mm. in total length, from the Persian Gulf. It grows to 6 inches in length ; and has been recorded from Bombay, Sind and Mesopotamia.

EXPLANATION OF PLATE I.

FIG. 1.—Photograph of lateral view of *Aspius vorax*. Heck., measuring 454 mm. in total length.

FIG. 2.—Photograph of lateral view of *Barbus esocinus* (Heck.), measuring 1,150 mm. in total length.

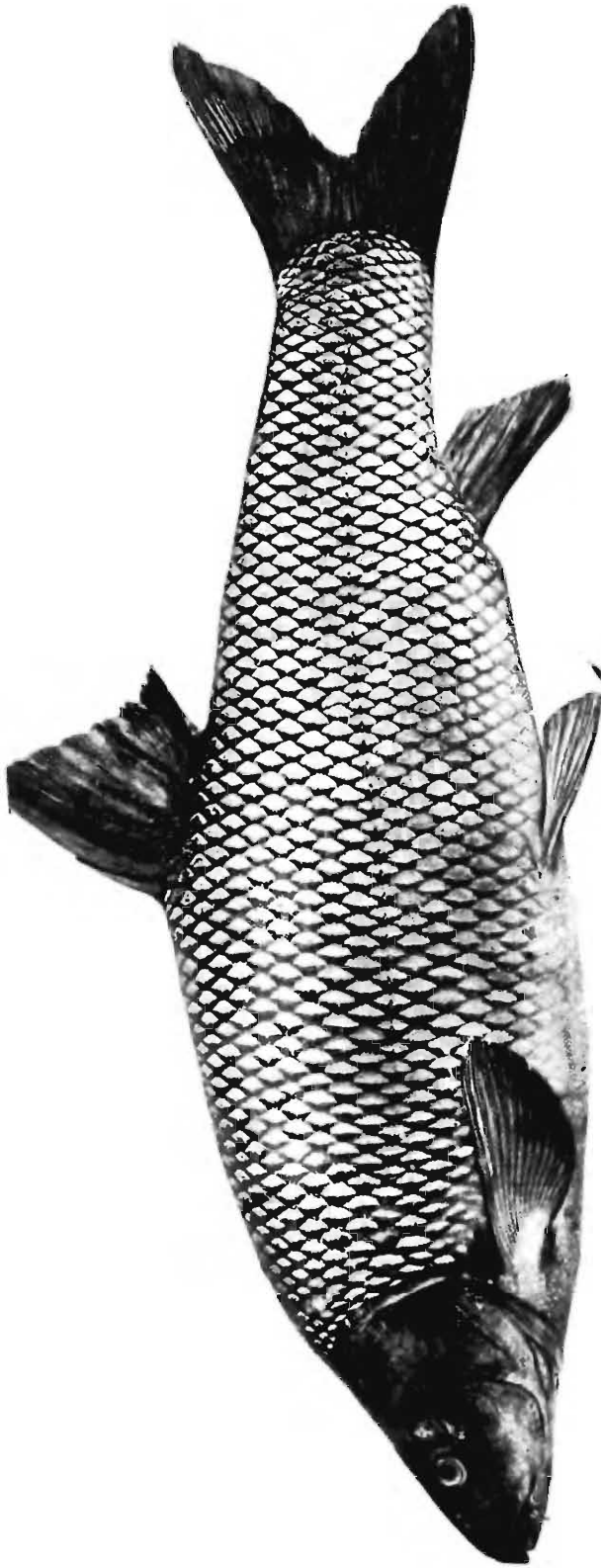


FISH FROM IRAQ.

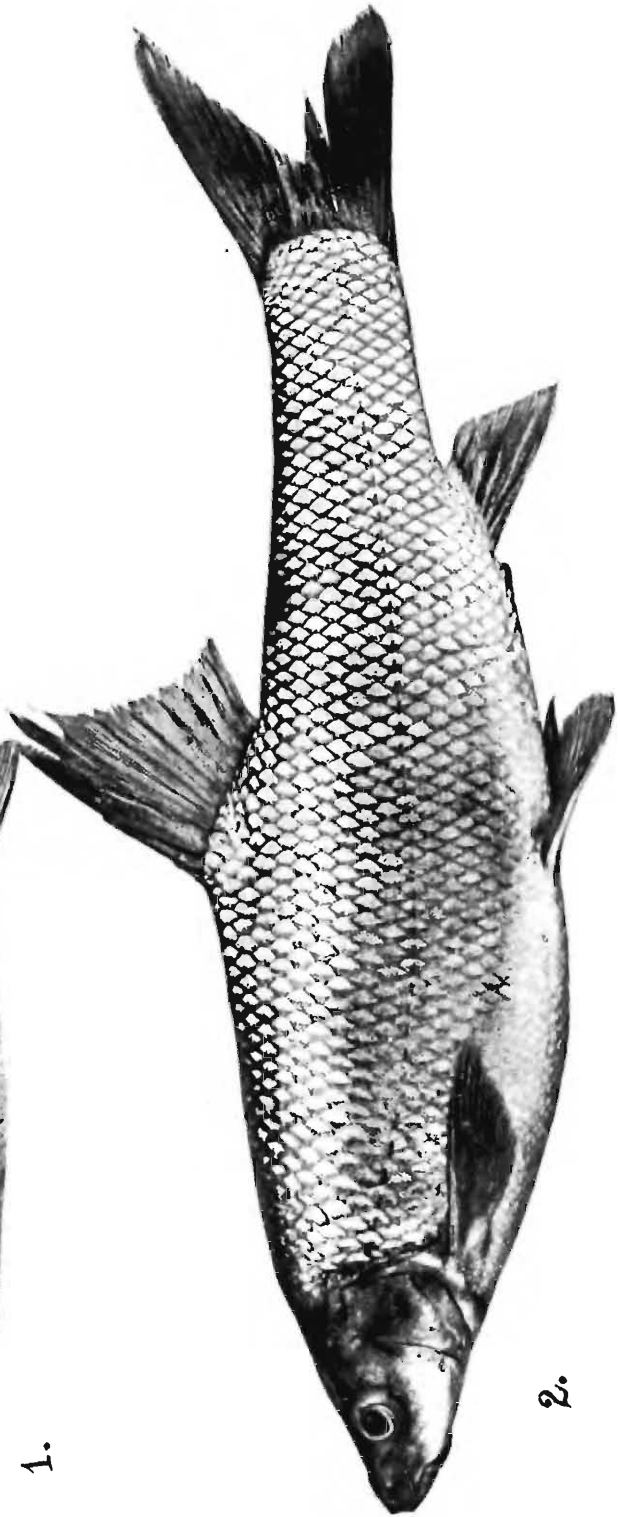
EXPLANATION OF PLATE II.

FIG. 1.—Photograph of lateral view of female specimen of *Barbus xanthopterus* (Heck.), measuring 491 mm. in total length.

FIG. 2.—Photograph of lateral view of male specimen of *Barbus xanthopterus* (Heck.), measuring 466 mm. in total length.



1.



2.

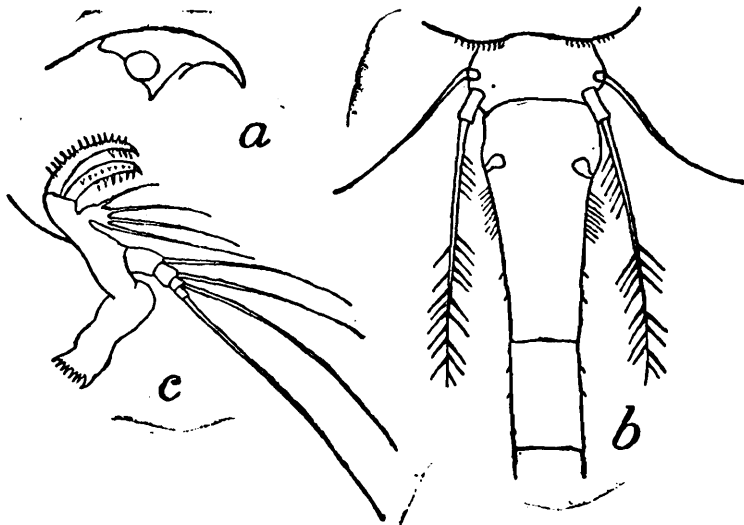
CYCLOPOIDES (CRUSTACÉS COPEPODES) NOUVEAUX DE L'INDE

Par KNUT LINDBERG.

Oithona spinulosa, sp. nov.

Description.—*Femelle*: Longueur de 646 à 741 μ . Cephalothorax, y compris Th. 5, considérablement plus long que la queue (abdomen + furca), le rapport variant de 1.48 : à 1.72 : 1 chez cinq échantillons. Forme svelte. Largeur de 152 à 180 μ . Front arrondi, vu de dos. Rostre pointu, recourbé sur la face ventrale. Rebord postérieur de Th. 5 portant une rangée de fins poils. Segment génital égalant ou surpassant un peu le longueur combinée des deux segments suivants ; il est garni de poils vers le milieu et de quelques fines épinules dans son tiers distal ; deuxième segment abdominal également pourvu de quelques épinules. Rebord postérieur du troisième segment abdominal découpé sur la face ventrale en petites denticules. Rangée de petites épinules au niveau du bord postérieur de la face ventrale du segment anal. Branches de la furca divergentes, de 2.37 à 2.82 fois aussi longues que larges, surpassant en longueur celle du segment anal. Soie latérale considérablement plus longue que la furca, insérée près de la base de celle-ci, très forte, portant des cils épais. Soie dorsale nue, longue mais assez faible, un peu inférieure en longueur à celle de la soie apicale médiane externe. Soie apicale externe bien développée, mais plus courte que la soie apicale interne. Soie apicale médiane externe longue. Soie apicale médiane interne apparemment forte et très longue ; elle était cassée chez tous les spécimens. Les quatre soies apicales irrégulièrement garnies de cils épais. Première antenne atteignant le bord postérieur de Th. 2 ou le tiers antérieur de Th. 3, paraissant composée de 11 ou de 12 articles. Deuxième antenne apparemment formée de 4 articles. Basopodite 2 de la mandibule se terminant par deux soies crochues obtuses, extrêmement fortes, de longueur et de structure un peu inégales, armées d'épaisses épinules ; endopodite faible avec 4 soies, exopodite formé de 4 articles, le quatrième ne paraissant porter qu'une seule soie terminale. Branches des pattes natatoires triarticulées. Formule des épines 4.4.4.3. (Épines du rebord externe des trois articles des exp. P 1 à P 4 : 1, 1, 3 1, 1, 3 1, 1, 3 1, 1, 2). Epine apicale de l'article 3 de l'exp. P 4 un peu moins longue que la longueur totale des trois articles de l'exopodite. Rebord externe de l'article 1 de l'exp. P 4 semble dépourvu de poils, le rebord interne de cet article est par contre garni de poils assez longs. Soies des exp. P 1 à P 4 : 1, 1, 4 1, 1, 5 1, 1, 5 1, 1, 5. Soie de l'article 1 de l'exp. P 1 très rudimentaire et celle de l'article 1 de l'exp. P 4 peu développée. Soies des enp. P 1 à P 4 : 1, 1, 6 1, 2, 6 1, 2, 6-1, 2, 5. Au niveau de l'article 3 de l'enp. P 4 les soies sont plus élargies que d'habitude ; en particulier l'élargissement de la soie proximale du rebord interne donne l'impression d'une membrane bordante du côté interne. Cinquième patte représentée par une soie thoracique assez courte et fine ; l'article est fort, allongé et porte une soie apicale puissante garnie

de gros cils ; elle atteint à peu près le milieu on le bord postérieur du deuxième segment abdominal. Les vestiges de la sixième patte ne semblent constitués que par une courte épine recourbée. Aucun des individus ne portait des ovisacs. Les animaux conservés dans de la formaline présentaient une forte teinte jaune au niveau du rostre et des soies de P 5 et de la furca, les cils étant particulièrement bien colorés en jaune or ; des taches pigmentaires bleues se trouvaient irrégulièrement réparties dans les branches de la furca et à l'intérieur des soies furcales.



TEXT-FIG. 1.—*Oithona spinulosa*, sp. nov. ♀, a. Rostre, vue latérale ; b. Th. 5, Abd. 1 et Abd. 2, face ventrale ; c. Mandibule.

Mâle encore inconnu.

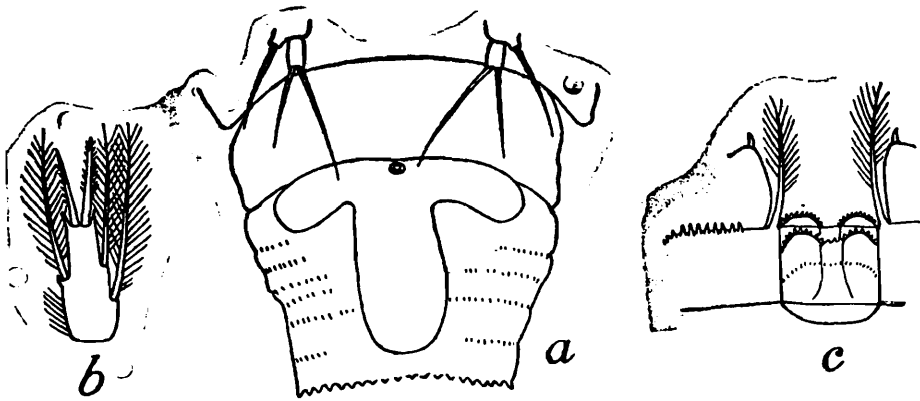
Habitat.—Environ deux kilomètres au large de Madras dans l'échantillon de plancton pêché en août 1945, très obligeamment fourni par le Docteur N. K. Panikkar (5 ♀ ♀).

Remarques.—L'espèce présente se rapproche un peu d'*Oithona brevicornis* Giesbrecht par la configuration du rostre et celle de la mandibule, mais elle en diffère par son segment génital, la longueur et la structure des soies furcales et se distingue aussi par des différences au niveau des pattes natatoires et leurs appendices ainsi qu' au niveau de P 5. C'est une forme bien distincte, aisément reconnaissable et il est étonnant qu'elle n'ait pas encore été remarquée.

Thermocyclops conspicuus, sp. nov.

Description.—*Femelle.* Longueur de 1121 à 1235 μ , Forme grande et très robuste. Ailes latérales de Th. 2 et Th. 3 élargies et prolongées en arrière. Th. 5 un peu plus large que le segment génital. Celui-ci trapu, légèrement moins long que large ; il porte sur les deux faces des rangées de petites dépressions de la cuticule. Bords postérieurs des deux premiers segments abdominaux découpés en petites dents. Celui du segment anal porte sur la face ventrale une rangée d'épinules minuscules. Opercule anal assez grand, de forme un peu trapézoïde. Branches de la furca divergentes, à rebord interne nu, de 3.67 à 3.86 fois plus longues que larges. Dans le tiers proximal du rebord externe se voit une très légère encoche. Soie latérale insérée à peu près à l'union des

deux tiers proximaux avec le tiers distal. Soie dorsale ciliée, beaucoup plus courte que la soie apicale externe. Soie apicale interne dépassant en longueur celle de la soie apicale externe (rapport de trois spécimens 1.15 : 1, 1.24 : 1, 1.36 : 1). Peu de différence de longueur entre les deux soies apicales médianes. A 1 atteignant le milieu de Th. 2, formée de 17 articles, les quatrième, cinquième et septième articles présentant de plus des divisions incomplètes. Cuticule des six premiers articles ornée de petites fossettes. Formule des épines 2.3.3.3. Article 3 de l'emp. P 4 moins de deux fois aussi long que large (55 : 30 μ =1.83 : 1, 57 : 30 μ =1.90 : 1); épine apicale interne bien plus courte que l'article et légèrement plus longue que l'épine apicale externe (article : épine apicale interne 55 : 42 μ =1.31 : 1, 57 : 42 μ =1.36 : 1; épine apicale interne : épine apicale externe 42 : 38 μ =1.10 : 1, 42 : 40 μ 1.05 : 1). Lamelle basilaire de P 4 présentant des élevures latérales arrondies garnies de nombreuses petites épines et faisant saillie au-dessus du rebord libre. P 5 à deuxième article assez allongé armé de deux appendices sétiformes dont l'interne est plus longue que l'externe. Réceptacle séminal à bras latéraux légèrement recourbés et partie postérieure allongée, volumineuse. Ovisacs inconnus.



TEXT-FIG. 2.—*Thermocyclops conspicuus*, sp. nov. ♀. a. P 5 et segment génital; b. Article 3 de l'emp. P 4; c. Lamelle basilaire de P 4.

Male.—Longueur 808 μ largeur, 247 μ . Branches de la furca légèrement divergentes, de 3.77 fois aussi longues que larges. Soie dorsale presque aussi longue que la soie apicale externe. Soie apicale médiane interne considérablement plus longue que la soie apicale médiane externe. Article 3 de l'emp. P 4 longueur : largeur 48 : 23 μ =2.09 : 1; épine apicale interne : épine apicale externe 38 : 32 μ =1.19 : 1. P 6 formée d'une épine interne (42 μ) qui dépasse le bord postérieur de Abd. 2, d'une courte soie médiane (20 μ) et d'une soie externe plus longue que l'épine (55 μ).

Habitat.—Une petite mare à Attakatt (monts Anaimalai), récolté en petit nombre le 10 juillet 1945.

† *Remarques.*—L'espèce remarquable qui vient d'être décrite ressemble à *Th. tinctus* Lindberg mais s'en distingue par l'absence d'excroissances au niveau de Th. 4 et Th. 5, par la soie dorsale de la furca bien plus courte que la soie apicale externe, par l'épine apicale interne de l'article 3 de l'emp. P 4 étant considérablement plus courte que l'article et de longueur presque égale à celle de l'épine apicale externe. On

peut aussi rapprocher la forme présente de *Th. operculifer* Kiefer ; l'opercule anal est cependant moins développé et il y a des différences notables au niveau de l'article 3 de l'enp. P 4; de la lame basilaire de P 4 et de P 5.

NOTES ON SOME HELMINTHS IN THE COLLECTION OF THE ZOOLOGICAL SURVEY OF INDIA

By B. S. CHAUHAN, M.Sc., Ph.D., F.Z.S., *Zoological Survey of India,
Banaras Cantt.*

The present notes deal with some of the Helminth material recently collected or received for identification from different sources and incorporated in the collection of the Zoological Survey of India. Records of only such species are included here as have proved of interest either on account of their structure or distribution, etc. Most of the specimens are poultry worms and fish parasites.

TREMATODA.

Fam. LEPODERMATIDAE.

Ganada clariae, Chatterjee

1933. *Ganada Clariae*, Chatterjee, *Bull. Acad. Sci. U.P. (India)* III, pp. 35-36-

Six specimens of this parasite, along with a few individuals of the unsegmented cestode, *Lytocestus indicus*, were found by Mr. J. J. Dutta (Lecturer in Zoology, College of Science, Nagpur) in the intestines of a fish, *Clarias batrachus*, at Nagpur. This little fluke reveals some interesting variations from the typical specimens. The following differences are particularly noteworthy :—

- (1) Oral sucker is distinctly larger than the ventral.
- (2) Prepharynx is comparatively long.
- (3) Vitellaria may or may not extend beyond the ovary.
- (4) The shape and relative size of the two testes are extremely variable. They are oval to elongate; in some specimens the longitudinal axis of the posterior testis is even slightly more than double its width. The anterior testis is always smaller than the posterior.
- (5) The intertestial space also varies considerably; in some of the specimens the testes are absolutely close together, while in others, there is a wide space between the two.

Fam. ISOPARORCHIDAE.

Isoparorchis hypselobagri (Billet).

1936. *Isoparorchis hypselobagri*, Bhalerao, *J. Helminth.*, XIV, pp. 17-19.

Five specimens were obtained from the liver of a fish, *Wallagonia attu*, caught in the Dhabelbunth tank at Salebhata, in the Patna State (Orissa)* They are of varying sizes. This parasite has been recorded from the neighbouring provinces, but not from this region so far.

The same host also harboured a nematode worm *Porrocaecum* sp. in its intestines.

*Chauhan, B.S. *Rec. Ind. Mus.* XLV, pp. 267-283 (1947).

CESTODA.

Fam. ANOPLOCEPHALIDAE.

Paronia sp.

1930. *Paronia*, Southwell, *Fauna Brit. India*, Cestodes, II, pp. 46-49.

1935. *Paronia*, Bhalerao, *Imp. Counc. Agri. Res. Mono. No. 6*, pp. 129-130.

Paronia columbae is the only species of this genus that has been recorded from India in pigeons from Bengal. The present specimens were collected by Mr. S. L. Zargar, from the intestines of fowls, at Gondia (C.P.) and Khandwa. They were found along with three or four specimens of *Ascaridia galli*, at both the localities. The collection from Khandwa also contained three specimens of *Heterakis gallinae*. Unfortunately, the segments of these parasites are too gravid to render their specific identification possible. In specimens of both the collections the proglottids have two sets of genital organs and the uterus extends beyond the lateral excretory vessels.

Fam. DAVAINIIDAE.

Raillietina (Raillietina) tetragona (Molin).

1930. *Raillietina* (R.) *tetragona*, Southwell, *Fauna Brit. India*, Cestodes, II, pp. 74-75.

1942. *Raillietina tetragona*, Hughes and Schultz, *Bull. Okla. Agri. & Mech. Coll. XXXIX* (8), Res. Mem. No. 2, p. 19.

This parasite, though occurs very commonly in fowls, in the Central Provinces has not so far been recorded. Several specimens of this tapeworm were obtained by Mr. Zargar, from the intestines of a *Deshi* pullet and other fowls, at the Military Poultry Farm, Nagpur.

Raillietina (Raillietina) sp.

Numerous specimens of this worm were collected by Mr. Zargar from the intestines of a dove at Nagpur. Their rostellum has a double row of hooks of uniform size and suckers are also armed with many rows of minute spines, but no definite specific identification of these tapeworms is possible on account of the segments being too gravid.

Cotugnia cuneata var. *nervosa* Meggitt.

1925. *Cotugnia cuneata* var. *nervosa*, Moghe, *Rec. Ind. Mus. XXVII*, p. 431

1930. *Cotugnia cuneata* var. *nervosa*, Southwell, *Fauna Brit. India*, Cestodes, II, p. 107.

About eight specimens of this worm alone were collected by Mr. Zargar from the intestines of a pigeon at Gondia (C.P.). Moghe found these worms in association with *Raillietina (Raillietina) nagpurensis*, in every one of the thirty to forty pigeons, he examined. Southwell puts the species of this genus into two groups, one with "Rostellum, much smaller than suckers" and the other, with the "Rostellum approximating in size to suckers" He includes the species *cuneata* in the latter group. In all the specimens, in the present collection, the rostellum is much larger than the suckers.

Fam. HYMENOLEPIDAE.

Hymenolepis gracilis (Zeder) Cohn.

1930. *Hymenolepis gracilis*, Southwell, *Fauna Brit. India*, Cestodes, II, pp. 130-131.

1940. *Hymenolepis gracilis*, Hughes, *Bull. Okla. Agri. & Mech. Coll.*, No. 8, p. 13.

1941. *Hymenolepis gracilis*, Hughes, *Trans. Amer. Micro. Soc.* LX, p. 412.

Species of the genus *Hymenolepis* have not been recorded from ducks from the Central Provinces. Mr. Zargar obtained two specimens of *H. gracilis* for the first time from this region. He found them in the intestines of a duck in association with another species of the same genus, *Hymenolepis oweni*, at Nagpur. The specimens are contracted and measure about 6-10 mm. in length and 0.5 mm. in width (maximum). The number of rostellar hooks is eight.

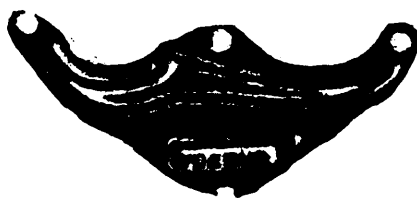
Hymenolepis oweni Moghe.

1933. *Hymenolepis oweni*, Moghe, *Parasit XXV*, pp. 337-39.

Many specimens of this parasite were collected by Mr. Zargar from the intestines of a duck at Nagpur, along with those of *Hymenolepis gracilis*. These are much larger examples than the last species; their length being 29-53 mm. and maximum width about 1.0 mm. Suckers are armed but the number of rostellar hooks is only nine in each of the two scolices that I have in the collection. Moghe had collected his specimens from *Philomachus pugnax* L., from Nagpur.

Hymenolepis sp.

This collection of specimens of the genus *Hymenolepis* has proved of special interest. They have the number of rostellar hooks only six. It is a larger form like *H. oweni*, the size of some of the pieces with me being 30-40 mm. in length and about 1.5 mm. in breadth.



TEXT-FIG. 1.—*Hymenolepis* sp., shape of a rostellar hook.

Other noteworthy points are the presence of a sacculus accessorius, a very long cirrus sac, with a big internal vesicula seminalis and a voluminous receptaculum seminis. Specific identification of specimens has not been made definite as, unfortunately, I have only one scolex at my disposal. The shape of a rostellar hook is as shown in Text-fig. 1. Its length is 58.4 μ , the blade measuring 20.0 μ .

These specimens were also obtained by Mr. Zargar, from the intestines of a duck, at Nagpur.

Cestode sp. (Immature)

Four oval cysts, containing immature cestodes, were collected from the liver of a fish host, *Ophicephalus punctatus* at Salebhata in the Patna State. Their maximum measurements are 6.4 \times 4.0 mm.

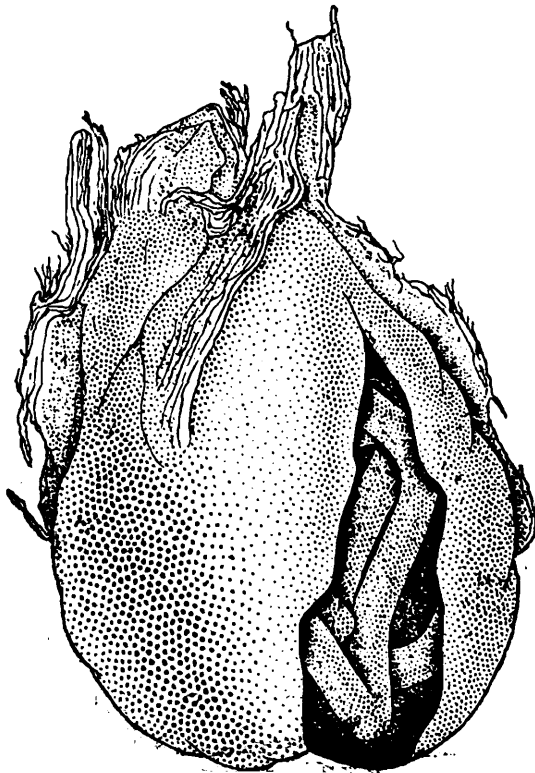
NEMATODA.

Fam. ASCARIDAE.

Sub-family. ANISAKINAE.

Porrocaecum pristis Baylis and Daubney.1922. *Porrocaecum pristis*, Baylis and Daubney, *Mem. Ind. Mus.*, VII, pp. 280-281.

Only two somewhat immature female specimens of this parasite were obtained by Mr. Zargar from a fish, *Wallagonia attu* (locally known as *Paran*), a considerable number of which died in October, 1945, in the tank water reservoir of the Bengal Nagpur Railway, at Gondia (C.P.). One of the parasites was found encysted in the peritoneal tissue of the body cavity of the host (Text-fig. 2). Regarding the fish mortality; the Veterinary Assistant Surgeon, Gondia reports: "... an appreciable



TEXT-FIG. 2.—*Porrocaecum pristis* Baylis and Daubney (encysted).

mortality amongst fish was recorded in a tank situated close to Gondia town. The fish used to jump out of the water and die within a couple of minutes. No exact cause of death has yet been ascertained" It was also reported that the diseased fish had no taste. Further inquiries bring out the fact that *W attu* was the only species of fish, which was affected. For want of sufficient material and detailed information, it is difficult to say whether the nematode parasites were in any way responsible for this fish mortality.

Porrocaecum sp.

A single specimen of this nematode was obtained at Salebhata, in the Patna State, from the intestines of the same host (*Wallagonia attu*) which harboured *Isoparorchis* in its liver. The structure of the anterior portion of this parasite is somewhat interesting. It is roundish in shape and has two broad-based papillae, clearly seen, projecting out. But as there is a single damaged specimen in the collection, it has not been possible to give it a specific name.

Stewart¹ recorded many unidentified nematode larvae from this fish, from various localities in India. Baylis and Daubney² also mention them as unspecified species of the genera *Porrocaecum* and *Contraecaecum*. Their specific identity is still unknown. Therefore any study, leading to the establishment of the specific identity, particularly of the adults of these larvae, may prove of interest especially from the point of view of fisheries.

Sub-Fam. ASCARINAE.

***Polydelphis sewelli* Baylis & Daubney.³**

1922. *Polydelphis sewelli*, Baylis and Daubney, *Mem. Ind Mus.*, VII, pp. 273-274.

Three specimens of this parasite, collected, from the snakes, *Natrix piscators*—chequered keelback, from Deolali, Dist. Nasik (Bombay Precy.) were sent on to the Zoological Survey of India, for study by Mr. H. S. Prater, of the Bombay Natural History Society. One of the parasites was found on a white patch along side the top of the lung of the host and the second on a similar white patch over the heart of the same host. The third worm was collected from the stomach of a second host, reported to have been kept in captivity. This specimen does not easily lend itself much to study.

Fam. HETERAKIDAE.

***Ascaridia galli* (Schrank) Freeborn.**

1936. *Ascaridia galli*, Baylis, *Fauna Brit. India*, Nematode, I, pp. 133-36.

Five specimens of this worm were obtained by Mr. Zargar from the intestines of a fowl at Chanda (C.P.) and eight specimens, from the oesophagus, gizzard and proventriculus of a goose, at Nagpur. This is a very common parasite of Poultry both in the Central Provinces and Central India, although it has not yet been recorded. Its host-record from a goose is interesting.

***Heterakis gallinae* (Gmelin) Freeborn.**

Specimens of this worm were collected, in association with *Parornia* sp. and *Ascaridia galli* from fowls at Khandwa by Mr. S. L. Zargar. They have also been collected from fowls at Nagpur.

My thanks are due to Dr. B. N. Chopra, D.Sc., F.N.I., Director Zoological Survey of India, for going through the Ms. and giving helpful suggestions. I am greatly indebted to Mr. S. E. Zargar, Deputy Director of Veterinary Services, Central Provinces, Nagpur, for the collection of most of the material. I also wish to thank Mr. Zahid Husain, Assist. Fishery Development Officer, Nagpur for supplying me some information.

¹Stewart, *Rec. Ind. Mus.*, X, pp. 179-181 (1914).

²Baylis and Daubney, *Mem. Ind. Mus.*, VII, pp. 280-81 (1922).

³Baylis and Daubney, *Rec. Ind. Mus.*, XXV, pp. 551-578 (1923).

ON SOME SPECIES OF *ACETES* (CRUSTACEA, SERGESTIDAE) FROM TRAVANCORE¹

By S. NATARAJ, M.Sc., Assistant, Zoological Survey of India,
Banaras Cantt.

INTRODUCTION.

The present paper is the outcome of a systematic study of the different species of *Acetes* occurring along the Travancore coast. These are fished on a large scale and are of considerable commercial importance. The work, on which this paper is based, was taken up at the suggestion of Dr. C. C. John, Professor of Marine Biology and Fisheries, and the identification of the specimens was conducted partly in the Marine Biological Laboratory, Trivandrum, and partly in the Zoological Survey of India, Calcutta.

The collection consists of four species, out of which one is a new variety of *Acetes serrulatus* (Kroyer). The remaining three species are *A. erythraeus* Nobili, *A. sibogae* Hansen and *A. dispar* Hansen.

As stated by Kemp (1917), usually two species are found together in most of the collections. The new variety described in the present paper is often found in association with *A. erythraeus*, while in the collection of *A. dispar*, stray specimens of *A. erythraeus* are also seen. This mingling of species renders the isolation of specimens according to species rather a tedious process. But the same difficulty is not experienced in separating the sexes of the various species, since, except in *A. erythraeus*, the males possess an elongated antennular peduncle.

Kemp (1917, p. 45) in describing the characters of the genus *Acetes* says: 'the precise distribution of the red pigment is perhaps different in different species, but on this point nothing precise is known'. In all the specimens I have examined so far the red spots, described as tail-organs by Okada (1928), are present. They could be seen as bright red spots when fresh, but in preserved specimens the red colour fades and disappears, the region of the red spots alone, being distinguishable as dense white patches. In all species there are two pairs of these tail-organs, one pair on each side. One spot is large and more or less circular and is situated on the basal segment, while the other is slightly smaller and occupies the proximal region of the endopodite of the uropod (Text-fig. 2e). The precise location of these spots is the same in all the individuals and in all the species so far examined and hence the presence of the tail-organs may be regarded as a generic character. The function of these organs is unknown, but Okada thinks it may be photogenic.

The clasping spine present on the outer antennular flagellum of the male in all the species (Text-fig. 1d & Text-figs. 2a, b, c & d) is not a regular solid spine as the meaning of the term would imply, but it is grooved longitudinally from apex to base along its inner aspect.

¹ Part of Thesis submitted for the M.Sc. degree of the University of Travancore and published with the permission of the Director, Zoological Survey of India.

The groove becomes broader and shallower towards the tip. The inner surface of this groove is studded with a varying number of spinules or tubercles in the different species. This grooved condition of the clasping spine is visible only under high magnification. In addition, it may also be mentioned that the tip of the clasping spine is somewhat curved in all species, and the degree of curvature varies in different species.

The breeding season of the new variety of *A. serrulatus* and of *A. erythraeus* is from January to April, since all the specimens collected during these months are seen to possess mature gonads. This is further evidenced by the fact that the plankton collections from April to July are rich in the larval forms (Menon, 1933) of *Acetes*. During this breeding season the adults appear in large shoals in the coastal waters drifting with the current, along with *Mysids*, *Alima* larvae of *Squilla* and young forms of *Sepia*, *Loligo* and fish fry. It is during these months that they are invariably found in the stomach contents of the different edible shoal fishes, such as *Lactarius*, Horse-mackerels and *Trichiurus*. Occasionally *Acetes* forms the food of Sardines and Mackerels which are essentially plankton feeders. From June to September *Acetes* forms the chief food of *Lactarius* and *Trichiurus*.

Acetes serrulatus (Kroyer)¹ var. *johni*², nov.

The eye-stalks are about one-third the length of the carapace, and the diameter of the cornea is about half as long as the distal joint of the eye-stalk.

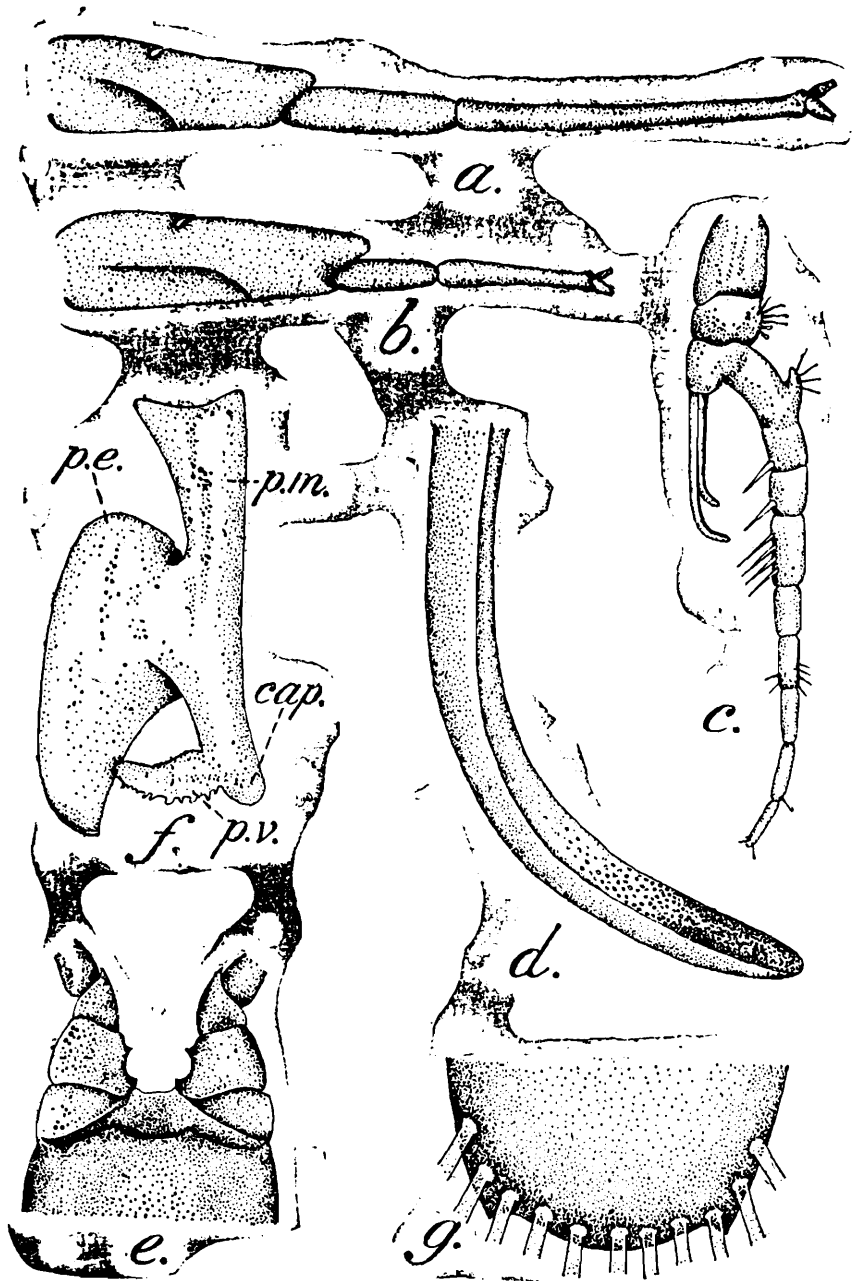
The basal segment of the antennular peduncle of the female is about 1.2 times the length of the two ultimate segments combined; the second segment is about 3.3 to 3.6 times and the third from 6 to 6.5 times as long as broad (Text-fig. 1b). In the male the basal segment is slightly less than half the length of the two ultimate segments combined; the second segment is from 3.2 to 3.5 times as long as broad; the third segment is greatly lengthened and is from 10.5 to 12.5 times as long as broad, and is seldom less than 10 times (Text-fig. 1a).

The outer antennular flagellum of the male (Text-fig. 1c) bears two clasping spines; one longer than the other, and both of them are curved inwards at their tips resembling a hockey stick. On the inner surface of these clasping spines there is a narrow longitudinal groove originating from the base and extending right up to the tip where it becomes broader and shallower. The terminal flattened portion of the groove and the tubercles are visible only under high magnification. The distal basal segment of the flagellum is rather short.

In *A. serrulatus*, Hansen (1919) describes a 'conspicuous protuberance' on the side remote from the clasping spine in the segment in advance of that which bears the two clasping spines. This 'conspicuous protuberance' occurs in the present variety as well, but it is larger and more prominent. As in *A. serrulatus*, it carries a few minute hairs on its angular portion. The segment opposite the tip of the large clasping spine bears 4 to 5 long spinules near its distal end.

¹ *Sergestes serrulatus* Kroyer, *Kgl. D. Vid. Selsk. Skrifter, Math. naturv. Afdeling*, IV, p. 268, Tab. IV, fig. 12a-g. Also see Hansen 1919, p. 41.

² Named after Dr. C. C. John, Professor of Marine Biology and Fisheries, University of Travancore, Trivandrum, under whom the present work was done.



TEXT-FIG. 1.—*Acetes serrulatus* (Kroyer) var. *johni*, nov.

a. antennular peduncle of male (\times ca. 15); *b.* antennular peduncle of female (\times ca. 15); *c.* outer antennular flagellum of male (\times ca. 60); *d.* longer clasp ing spine of the outer antennular flagellum of male (\times ca. 660); *e.* third and fourth thoracic sternite of female (diagrammatic); *f.* right half of petasma of male (\times ca. 40); *g.* tip of telson of male (\times ca. 200).

cap. Capitu-lum; *p.e.* Pars externa; *p.m.* Pars media; *p.v.* Processus ventralis.

The external maxillipeds in the females reach almost to the tip and in some cases even extend beyond the tip of the third antennular segment. In males they reach only to about the middle of the second segment. In both males and females the external maxilliped is always slightly shorter than the third pereopod.

The third thoracic sternite of the female is broadly triangular in shape, it is gently grooved and the anterior margin is slightly depressed. The fourth thoracic sternite, unlike that of the other species of the genus, is acutely pointed at both ends, while the median region is broadly grooved (Text-fig. 1e).

The coxae of the third pair of legs of the male are devoid of any teeth on their distal inner angles.

There is a small bluntly pointed process between the bases of the first pleopods.

The petasma is of the typical simplified form with the two primary divisions, *viz.*, the pars externa and pars media. Pars astringens is absent. The pars externa is a large flat plate, with a greatly expanded proximal end and a slightly narrower distal end, the posterior border of which is conspicuously emarginate. Pars media is somewhat long and slender, with a more or less broad and gently depressed proximal end. Distally the pars media is differentiated into the capitulum and the processus ventralis. The capitulum is hemispherical and devoid of spines. The processus ventralis originates from a little distance above the hemispherical capitulum and is placed at right angles to the long axis of the pars media, with its small and rounded tip directed towards the pars externa. The capitulum and the processus ventralis together have the appearance of a well-defined human foot. The ventral or the external margin of the processus ventralis is beset with a few short modified spines (Text-fig. 1f).

The telson reaches almost to the middle of the inner uropod. The angular termination of the lobe at the proximal end of the inferio-lateral margin is placed almost midway between the base and the apex. The tip is generally straight but sometimes it is slightly convex (Text-fig. 1g), and bears on either side a small tooth. Though both these teeth are present in the majority of the specimens examined, occasionally in some of the specimens the right or the left may be missing.

The ciliated and non-ciliated portions of the external border of the outer uropod are separated by a small tooth, which is longer and more pointed in the females than in the males. In adults the non-ciliated part is from 1.6 to 1.8 times the length of the ciliated part.

Mature males measure from 15 to 20 mm. and the latter appears to be the maximum size of this new variety.

Live specimens are semi-transparent, the only coloured parts being the cornea which is black and the tail-organs which are bright red.

Affinities.—The present variety closely resembles *A. serrulatus* in the possession of a conspicuous protuberance on the outer antennular flagellum of the male, in the shape of the telson and in the presence of a small bluntly pointed process between the bases of the first pleopods. It, however, differs from *A. serrulatus* in the presence of four to five spines opposite the tip of the large clasping spine of the outer antennular flagellum of the male, in the relative measurements of the different joints of the antennular peduncle, in the absence of a tooth on the distal inner angle of the coxa of the third leg in the male, in the shape of the petasma and in the shape of the female genital area.

The 'conspicuous protuberance' on the outer antennular flagellum of the male is a distinctive feature of *A. serrulatus* and is met with in no other species of *Acetes*. Since the specimens under consideration possess this structure, they cannot but be assigned to *A. serrulatus*. At the same time, the differences enumerated above suggest that the present examples represent a variety quite distinct from the typical form.

Locality.—This new variety is found abundantly in the coastal waters of Travancore from the middle of December to the middle of April along with *A. erythraeus*.

Type-specimens.—No. C2554/1 in the Zoological Survey of India.

***Acetes erythraeus* Nobili.**

1917. *Acetes erythraeus*, Kemp, *Rec. Ind. Mus.* XIII, pp. 51-54.

Acetes erythraeus occurs in large quantities along the Trivandrum coast, from the middle of December to the middle of April. It is usually found in association with *A. serrulatus* var. *johni*, nov.

The present specimens agree in all details with the description and figures given by Kemp. Though there are slight differences in the proportions of the antennular segment, with regard to the more important specific characters no marked differences have so far been noticed. But a few minor differences which, though not of any specific importance have been noted and these are:—(1) the tuberculiform eminences on the anterior edge of the third thoracic sternite of the female is rather sharp and pointed and (2) in the male there is a longitudinal groove on the inner surface of the clasping spine when seen under high power of the microscope. This groove becomes wider and shallower towards the curved tip and is studded with numerous tuberculiform processes which become fewer towards the base (Text-fig. 2a).

The proportion of the males to females in the collection is in the ratio of 1 : 3. Large mature males measure about 20 mm. and the females about 24 mm. In all the specimens examined the gonads are well developed. The tail-organs are very distinct and prominent.

Live specimens are semi-transparent, the only coloured parts are the cornea of the eye and the tail-organs. The cornea is black and the tail-organs are bright red.

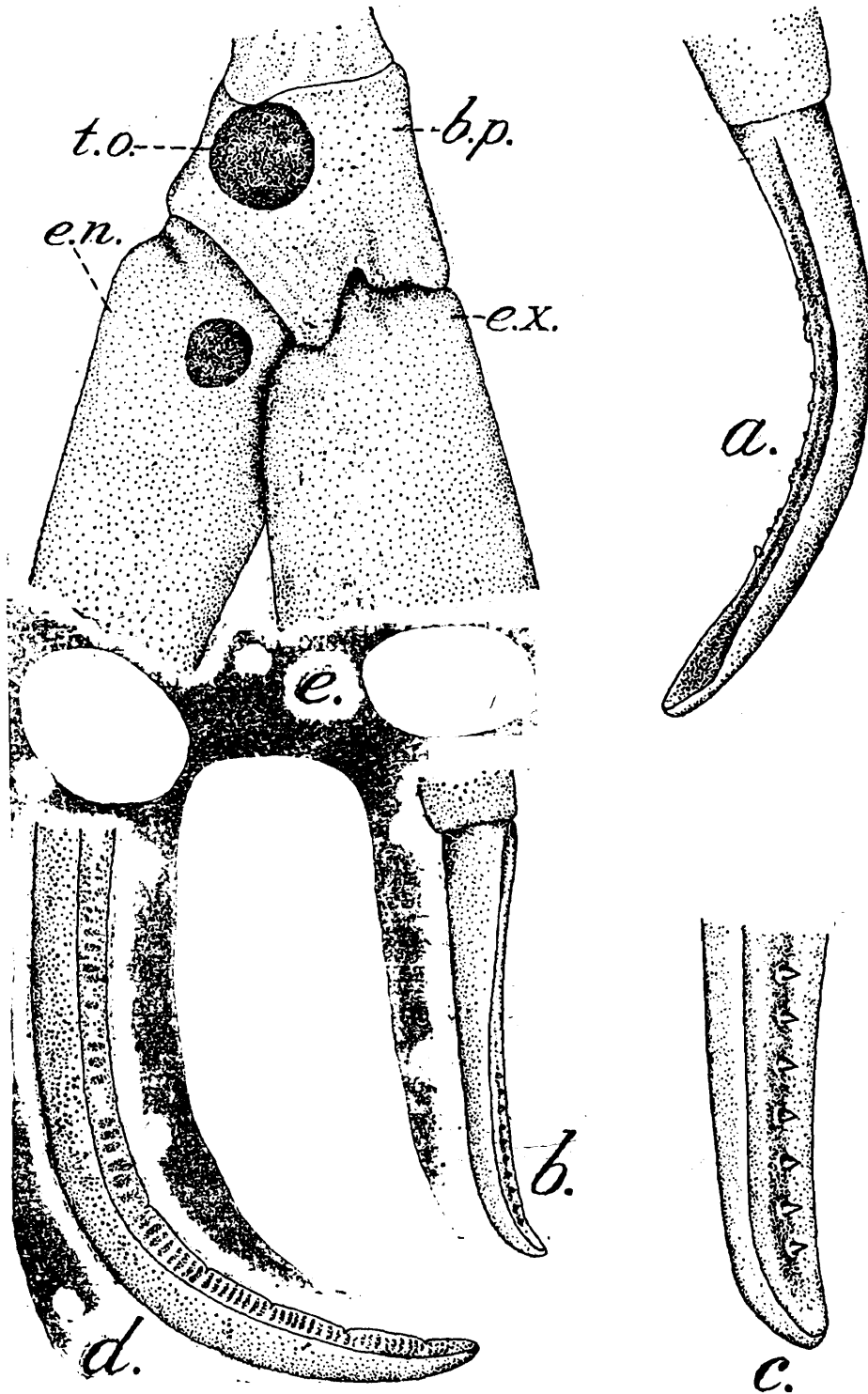
Distribution. Colefax (1940) gives the distribution of the species as Red Sea, western side of the Bay of Bengal, Penang and the Gulf of Siam and French Somaliland.

***Acetes sibogae* Hansen.**

1919. *Acetes sibogae*, Hansen, *Siboga Exped. Rep.* XXXVIII, pp. 38-39, pl. iii, figs. 4a-h.

While engaged in my investigations at Trivandrum, the Professor of Marine biology and Fisheries placed at my disposal a collection of *Acetes* from Quilon, which was in a very good state of preservation. This collection was made at Neendakara near Quilon, some twenty years ago by one of the staff of the Department of Fisheries, posted at that station. The specimens had remained unidentified all these years.

The specimens agree in all details with the description and figures of Hansens' *A. sibogae*. An additional observation made, with regard to the clasping spine of the outer antennular flagellum of the male is, that the inner curved surface of the clasping spine is traversed by a longitudinal groove from the top to the base, with a single median row of prominent spines which could be seen under high magnification (Text-figs. 2 *b* & *c*).



TEXT-FIG. 2.—*Acetes erythraeus* Nobili.

a. clasping spine of male (x ca. 200); *b.* *Acetes sibogae* Hansen, clasping spine of male (x ca. 200); *c.* *Acetes sibogae* Hansen, the distal portion of the clasping spine of male (x ca. 660); *d.* *Acetes dispar* Hansen, the distal portion of the longer clasping spine of male (x ca. 660); *e.* *Acetes dispar* Hansen, portion of uropod showing tail-organs (x ca. 15).

b.p. Basipodite; *e.n.* Eniopodite; *e.x.* Exopodite; *t.o.* Tail-organ.

Forty-five specimens were selected at random from the collection and the following additional measurements were made.

1. The basal segment of the antennular peduncle in the female is from 1.1 to 1.2, and never more than 1.2 times the length of the two terminal segments combined ; in males it is nearly 1.5 times.
2. The second segment in both males and females is from 2.5 to 3.5 times as long as broad.
3. The third segment in males is from 8 to 9 times and in the females from 5 to 6 times as long as broad.
4. The non-ciliated portion of the outer uropod is nearly 1.5 times the length of the ciliated part but never more than 1.5 times.
5. The third maxillipeds in the males reach to about half the length of the terminal segment of the antennular peduncle whereas in the females they extend beyond the terminal segment by about half to three-fourths their length.

Large mature males measure from 14 to 18 mm. The largest female in the collection measures 23.2 mm.

The tail-organs have lost their colour completely, yet they could be seen distinctly as dense white patches and occupy the same relative position as that in the rest of the species recorded in the present paper.

Distribution.—Colefax (1940) in the distribution table of the different species of *Acetes* states that *A. sibogae* occurs in the Bay of Bima, Flores sea and Sangkapura-roads Bawean Islands, Java sea. Now that the species has been recorded from Quilon in Travancore, the range of the species appears to be quite extensive.

Acetes dispar Hansen¹.

1919. *Acetes dispar*, Hansen, *Siboga Exped. Rep.* XXXVIII, pp. 39-41, pl. iii, figs. 5a-f & pl. iv, fig. 1a.

Two Collections of this species were made from the Trivandrum coast in July 1941. My specimens agree fairly closely with Hansen's, but a few additional points which I observed during the examination of the present examples are given below.

The eyes are slightly more than one-third the length of the carapace. The basal region of the eye-stalk is very narrow compared with the other species of the genus.

The basal segment of the antennular peduncle of the female is from 1.2 to 1.4 times (generally 1.3 times) the length of the second and third segments combined ; the second segment, in 16 out of the 21 specimens examined and measured, is either 3 or slightly over 3 times ; and the third about 5.5 times as long as broad. In males the combined length of the two ultimate segments is from 1.8 to 2 times the length of the basal segment ; the second segment is from 2.5 to 3.3 times as long as broad ; and the third segment, in 15 out of the 19 specimens measured, is about 12 times as long as broad.

¹ According to Burkenroad and Colefax (see references at the end of this paper), *A. dispar* Hansen appears to be synonymous with *japonicus* Kishinouye. B. N. Chopra.

The outer antennular flagellum of the male resembles that of *A. japonicus* in the possession of two clasping spines, except in a single individual in which three spines were present. The two clasping spines are grooved longitudinally on their inner margin, the groove becoming broader and shallower towards the tip. The entire groove is studded with closely arranged tubercles which becomes fewer towards the base (Text-fig. 2d). The segments opposite the tip of the clasping spines do not bear any blunt processes.

The external maxilliped is always slightly shorter than the third pereopods and reaches almost to about the tip of the antennal scale.

The third thoracic sternite of the female carries a large backwardly directed plate which posteriorly overlies the fourth sternite. It is depressed in the middle line, its lateral edges are posteriorly convergent and its distal margin is free and emarginate. The posteriorly directed plate is easily visible in a side view. Females of this species could be easily isolated from those of other species of *Acetes* (except *A. japonicus*) by viewing the specimens laterally, when the backwardly directed plate of the third thoracic sternite could be seen distinctly.

There is a small pointed process between the bases of the first pleopods.

The pars media of the petasma is truncate at its proximal end. The capitulum is bulbous at the tip and is set with numerous minute hooks; the processus ventralis is a long and pointed process which usually exceeds the bulbous portion, but occasionally it is seen to be short. The entire petasma agrees with Hansen's description.

The sixth abdominal segment is nearly twice as long as broad.

In males the ciliated and non-ciliated portions of the external border of the outer uropod are more or less equal in length, while in females the non-ciliated portion is always slightly longer than the ciliated part.

Large mature females of this species measure about 22 mm. while adult males reach a maximum length of 16 mm.

In life the entire body is semi-transparent as in the other species of *Acetes*, the only coloured portions being the cornea of the eye which is black and the tail-organs which are bright red.

The seasonal occurrence of *A. dispar* appears to be different from that of the other species which occur along the Trivandrum coast. The several collections of *Acetes* made from this coast from January to April consist only of the two species, *A. erythraeus* and *A. serrulatus* var. *johni*, nov., and there is not a single individual of *A. dispar* found among them. But the July collection from the same coast is mainly composed of *A. dispar*.

Distribution. Hansen (loc. cit.) examined specimens of *A. dispar* from Cheribon, Java and Lem Ngob, Gulf of Siam. It appears from the distribution table given by Colefax (loc. cit.) that this species has not been recorded so far from any other locality. The present is the first record of the species from the Travancore coast.

ACKNOWLEDGMENT.

I am greatly indebted to the University of Travancore for providing me all the facilities for carrying on this work in the Marine Biological

Laboratory, Trivandrum, and for the award of a studentship. My thanks are due to Dr. C. C. John, for suggesting this line of investigation and for all the valuable suggestions and constructive criticism during the entire period of my work at the Marine Biological Laboratory, to Dr. Bains Prasad, O.B.E., for kindly giving me permission to make use of the Library and Laboratory of the Zoological Survey of India, during my stay at Calcutta, and to Dr. B. N. Chopra, Zoological Survey of India, for technical advice and valuable suggestions. My thanks are also due to Mr. K. N. Das, formerly of the Zoological Survey of India, who helped me in identifying some of the species.

REFERENCES.

- Burkenroad, M. D., 1934.—The Penaeidae of Louisiana, with a discussion of their world relationships. *Bull. American Mus. Nat. Hist.*, LXVIII, pp. 126-132.
- Burkenroad, M. D., 1934.—Littoral Penaeidae chiefly from the Bingham Oceanographic collection. *Bull. Bingham Oceanographic Coll.* IV, pp. 99-105.
- Colefax, A. N., 1940.—An Australian species of *Acetes*...with remarks on the distribution and literature of the Genus. *Rec. Australian Mus.* XX., pp. 341-353.
- Hansen, H. J., 1919.—The Sergestidae of the Siboga Expedition. *Siboga Exped. Rep.* XXXVIII, pp. 31-48, pl. iii and iv.
- Kemp, S., 1917.—Notes on Crustacea Decapoda in the Indian Museum. The genus *Acetes*. *Rec. Ind. Mus.* XIII, pp. 43-58.
- Menon, M. K., 1933.—The life histories of Decapod Crustacea from Madras. *Bull. Madras Govt. Mus.* N.H. Section, III, no. 3, pp. 1-45.
- Okada, Yo. K., 1928.—Notes on the tail-organs of *Acetes*. *Ann. Mag. Nat. Hist.* (10) I, pp. 308-310.

STUDIES IN INTRASPECIFIC VARIATION.

III—BODY-SIZE AND BIOMETRICAL RATIOS IN VARIOUS TYPES OF INDIVIDUALS OF THE DESERT LOCUST, *SCHISTOCERCA GREGARIA* (FORSKAL). [ORTHOPTERA, ACRIDIDAE.]¹

By M. L. ROONWAL, *M.Sc., Ph.D. (Cantab.), F.N.I., Hony. Major, Zoological Survey of India, Benares Cantt.*

CONTENTS.

	PAGE.
INTRODUCTION	149
SIZE OF BODY-PARTS	151
SEXUAL DIMORPHISM	160
BIOMETRICAL RATIOS	162
SUMMARY	163
REFERENCES	164

INTRODUCTION.

While attempting to elucidate (Roonwal, 1936-1947a) the various types of intraspecific variations in the Desert Locust, *Schistocerca gregaria* (Forskål), the problem of variation in size and in biometrical ratios in the different types of individuals was taken up, and the results are presented here. Aspects of biometrical differences between *gregaria* and *solitaria* phases have been studied by a number of workers (*vide* Rao, 1937-1942; Murat, 1939; Vayssière and Lepesme, 1939; and Kennedy, 1939), but differences between other major types of intraspecific variations, discovered in recent years, remain unelucidated. These variations are : (i) Eye-stripe and related variations (Roonwal, 1936-1947). Two main types of *solitaria* individuals occur with regard to eye-stripes, *viz.*, 6- and 7-striped. Very rarely, 5- and 8-striped individuals are also encountered. *Gregaria* individuals are always 6-striped. (ii) Two *solitaria* colour-types occur irrespective of the eye-stripe variation. Blue-grey adults and green hoppers occur commonly, while the other and rarer colour type consists of fawn adults and hoppers (Roonwal, 1945a, 1946a).

Several problems, hitherto unsolved, present themselves with regard to body-size and biometrical ratios. For example: What are the degree and the probable causes of the differences, if any, in body-size between *gregaria* and *solitaria* individuals? Among *solitaria* individuals themselves, is there any difference in size between 6- and 7-striped forms? Does sexual dimorphism exist in the biometrical ratios; if so, what is the nature of these differences? In the present account I have attempted to answer these and related questions in respect of three major types of individuals, *viz.*, *gregaria* (6-striped), *solitaria* 6-striped and *solitaria* 7-striped.

¹ For previous parts see *Rec. Indian Mus.*, XLIV, pp. 369-374 (1946) and *Indian J. Ent.*, VII, pp. 77-84 (1946).

The *gregaria* individuals measured were taken mostly from swarms of 1889-1891 and 1930-1931 all over India, with a sprinkling of Iranian specimens. All individuals in which the eye-stripes were clear had 6 stripes. The remainder were assumed to have the same number of stripes, since it has been demonstrated in recent years that *gregaria* individuals are invariably 6-striped (Rao, 1937, 1942; Rao and Gupta, 1939; Roonwal, 1941, 1945). The *solitaria* individuals measured were obtained in Mekran (Baluchistan, W. India) during late 1935-1936, and thus during the middle of the last "*solitaria*" or non-swarmling period which extended from 1932 to 1939, a fresh swarming period having begun in 1940. The year 1936 was in every respect a typical *solitaria* year. Individuals of the blue-grey colour-type (*vide supra*) alone were utilised, though it may be mentioned that no obvious biometrical differences were noticeable between that and the fawn type.

The following data for the fawn type of *solitaria* individuals (southern Baluchistan, November 1935 to August 1936) were obtained and are given here for facility of comparison, even though the samples are small :

Males.

6-striped (8 individuals).—E, 51.0-57.0, mean 53.3 mm.; F, 24.0-28.0, mean 25.9 mm.; E/F, 1.96-2.23, mean 2.06.

7-striped (5 individuals).—E, 49.0-56.5, mean 52.8 mm.; F, 24.0-28.0, mean 25.8 mm.; E/F, 1.97-2.11, mean 2.04.

Females.

6-striped (5 individuals).—E, 59.5-64.2, mean 62.1 mm.; F, 29.3-31.7, mean 30.5 mm.; E/F, 1.96-2.13, mean 2.09.

7-striped (5 individuals).—E, 61.0-66.0, mean 63.8 mm.; F, 29.5-31.5, mean 30.7 mm.; E/F, 2.01-2.12, mean 2.07.

From continuous field observations over a considerable period (1935-1938), including the period under study (late 1935-1936), I could satisfy myself that the "*solitaria*" population studied was genuinely *solitaria*. Throughout that period, the population, though undergoing small fluctuations, was very low, seldom rising above 1000 per square miles. The breeding history was not precisely known. It may be stated that under *solitaria* conditions, with a very low population scattered over a vast area, with the breeding places scattered in tiny patches over an equally extensive area, and, finally, with long-distance *solitaria* migrations from one country or belt to another (*e.g.*, from Arabia and Iran into India, and *vice versa*), it is practically impossible to trace the exact breeding history of small samples of population. Therefore, the population density index, taken in conjunction with the actual morphological characteristics of the individuals themselves, and with the characteristics of the population in that and neighbouring areas during the months immediately preceding and following the period under study, provide the only satisfactory means of judging the nature of field populations.

Measurements were taken with a vernier calliper having dial graduations reading up to 0.1 mm. The mode of measurement was that recommended by the Fourth International Locust Conference (Cairo,

1936)². The body-parts measured were (Tables 1-4): Length of elytron (E); length of hind-femur (F); maximum width of head in the genal region (C); length of pronotum at the keel (P); height of pronotum (H); and width of pronotum at the constriction (M). The biometrical ratios studied were: E/F, P/C, H/C and M/C. The sexes were analysed separately. The approximate number of specimens measured for various purposes was as follows:—Phase *gregaria*: 35-77. Phase *solitaria*: 6-striped, 152; 7-striped, 109-110.

SIZE OF BODY-PARTS.

The mean length of the elytron in males is 53.03 mm. in *gregaria*, 52.2 mm. in 6-striped *solitaria* and 52.4 mm. in 7-striped *solitaria* individuals; in females the mean length is 58.01, 61.6 and 62.9 mm. respectively (Tables 1 and 5).

The mean length of the hind-femur in males is 24.4 mm. in *gregaria*, 25.4 mm. in 6-striped *solitaria* and 26.1 mm. in 7-striped *solitaria* individuals; in females the mean length is 26.4, 29.4 and 30.9 mm. respectively (Tables 2 and 5).

For the head and the pronotum, measurements of *gregaria* individuals only were made (Tables 4*a-g* and 5). The mean figures (in mm.) are: C, ♂ 7.6, ♀ 7.9; P, ♂ 9.9, ♀ 10.5; H, ♂ 8.4, ♀ 8.9; and M, ♂ 5.9, ♀ 6.4.

It will be seen that regarding elytron and hind-femur lengths, the following differences are observable, the sexes being separately analysed (Tables 5 and 6): (i) Among *solitaria*, the 7-striped individuals are slightly larger than the 6-striped. (ii) The *gregaria* (all 6-striped) are considerably smaller than 6-striped *solitaria* and even more so than 7-striped *solitaria* individuals; the male elytron of *gregaria* is, however, exceptional in being longer. Regarding the degree of relative size-differences (Table 6), if the mean length of 6-striped *solitaria* is taken as 100 and the variation in other types calculated as percentages of it, the following points are noticeable:—Elytron length: *Gregaria* ♂♂ are 1.6% longer, and ♀♀ 5.8% shorter; 7-striped *solitaria* ♂♂ are 0.4% and ♀♀ 2.1% longer. Hind-femur length: *Gregaria* ♂♂ are 3.9% and ♀♀ 10.2% shorter; 7-striped *solitaria* ♂♂ are 2.8% and ♀♀ 5.1% longer.

In the Red Locust, *Nomadacris septemfasciata* (Serv.), the value of E in *gregaria* females is much smaller, and in *gregaria* males larger, than in *solitaria* (Lea and Webb, 1939); this condition is similar to that in *Schistocerca*. On the other hand, in the Moroccan Locust, *Dociostaurus maroccanus* (Thunb.) (Jannone, 1938, 1939), and in the Brown Locust, *Locustana pardalina* (Walk.) (Faure, 1932; Smit, 1939; Plessis, 1939), both E and F are longer in phase *gregaria* than in phase *solitaria*, irrespective of sex; this feature is especially pronounced in *Dociostaurus* where *gregaria* individuals are almost one and a half times as large as *solitaria* ones.

The question whether the number of moults undergone is the cause of size-differences in *S. gregaria* may now be considered, but before doing so, the condition known to occur in other Acrididae may be briefly stated. In the Acrididae the males are, as a rule, smaller than females

² The Fifth International Locust Conference (Brussels, 1938) recommended some minor alterations. These, however, do not affect the conclusions presented here.

1.

(E) in Schistocerca gregaria.

Individuals in each category (1 mm.).

54.0-54.9	55.0-55.9	56.0-56.9	57.0-57.9	58.0-58.9	59.0-59.9	60.0-60.9	61.0-61.9	62.0-62.9	63.0-63.9	64.0-64.9	65.0-65.9	66.0-66.9	67.0-67.9	Total.
2	1	1	1	..	..	..	..	..	..	..	..	..	..	14
9	10	1	2	..	..	..	..	..	..	..	..	..	..	89
4	1	2	..	..	..	..	..	..	..	..	..	..	..	25
1	2	2	1	3	2	5	1	1	0	2	0	1	..	26
..	1	2	2	2	6	6	14	11	11	3	2	2	1	63
..	..	2	2	1	3	2	17	9	13	17	7	8	3	84

2.

(F) in Schistocerca gregaria.

Individuals in each category (0.5 mm.).

25.0-25.4	25.5-25.9	26.0-26.4	26.5-26.9	27.0-27.4	27.5-27.9	28.0-28.4	28.5-28.9	29.0-29.4	29.5-29.9	30.0-30.4	30.5-30.9	31.0-31.4	31.5-31.9	32.0-32.4	32.5-32.9	33.0-33.4	Total.
2	3	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	28
12	13	24	10	3	0	1	..	..	..	..	..	..	..	..	..	..	89
4	4	3	6	2	3	1	..	..	..	..	..	..	..	..	..	..	25
4	3	4	0	3	1	4	5	2	1	..	..	..	..	..	..	..	34
1	1	1	1	2	2	3	8	7	10	9	9	6	3	..	..	..	63
..	..	..	..	2	0	1	3	2	6	4	11	20	20	8	7	1	5

TABLE
Variation in the ratio E/F (elytron length/hind-femur

Phase, sex and no. of eye-stripes	Range and mean.		Number of							
	Min.-Max.	Mean.	1.84-1.86	1.87-1.89	1.90-1.92	1.93-1.95	1.96-1.98	1.99-2.01	2.02-2.04	
<i>gregaria</i> : (6-striped)	1. ♂♂	2.04-2.30	2.18	..	..	..	..	..	..	1
	2. ♀♀	2.08-2.43	2.24	..	..	..	..	..	..	..
	3. Both	2.04-2.43	2.22	..	..	..	..	..	..	1
<i>solitaria</i> : (6-striped)	1. ♂♂	1.88-2.23	2.05	..	1	2	0	7	12	17
	2. ♀♀	1.96-2.25	2.09	..	..	..	..	3	3	9
	3. Both	1.88-2.25	2.07	..	1	2	0	10	15	26
<i>solitaria</i> : 7-striped)	1. ♂♂	1.85-2.13	2.004	1	0	2	1	2	9	5
	2. ♀♀	1.93-2.17	2.03	..	..	..	10	6	20	17
	3. Both	1.85-2.17	2.02	1	0	2	11	8	29	22

TABLE
Variation in the width of head (C), length of pronotum (P),
 H/C and M/C in *Schistocerca gregaria*,
(a) Width of

C	Range and mean.		Number of				
	Min.-Max.	Mean.	6.6-6.7	6.8-6.9	7.0-7.1	7.2-7.3	7.4-7.5
♂♂	6.7-8.0	7.6	1	0	0	7	8
♀♀	6.9-8.8	7.9	0	1	3	2	1

(b) Length of

P	Range and mean.		Number of			
	Min.-Max.	Mean.	8.7-8.9	9.0-9.2	9.3-9.5	9.6-9.8
♂♂	8.9-10.7	9.9	1	2	5	5
♀♀	8.7-11.9	10.5	2	0	5	3

3.

length) in Schistocerca gregaria.

individuals in each category (0.03).

2.05-2.07	2.08-2.10	2.11-2.13	2.14-2.16	2.17-2.19	2.20-2.22	2.23-2.25	2.26-2.28	2.29-2.31	2.32-2.34	2.35-2.37	2.38-2.40	2.41-2.43	Total.
0	1	1	1	4	1	1	1	1	..	..	..	..	12
..	1	2	0	1	4	6	5	0	2	1	0	1	23
0	2	3	1	5	5	7	6	1	2	1	0	1	35
17	14	15	1	1	1	1	..	..	..	..	..	..	89
12	6	15	8	3	2	2	..	..	..	..	..	..	63
29	20	30	9	4	3	3	..	..	..	..	..	..	152
3	1	1	..	..	..	..	..	..	..	..	..	..	25
12	5	10	3	3	..	..	..	..	..	..	..	..	34
15	6	11	3	1	..	..	..	..	..	..	..	..	109

4 (a-g).

height of pronotum (H), width of pronotum (M), and the ratios P/C, phase gregaria. (All measurements in mm.).
head (C)

individuals in each category (0.2 mm.).

7.6-7.7	7.8-7.9	8.0-8.1	8.2-8.3	8.4-8.5	8.6-8.7	8.8-8.9	Total.
10	5	3	..	..	..	..	34
9	7	3	9	3	0	2	40

pronotum (P).

individuals in each category (0.3 mm.).

9.9-10.1	10.2-10.4	10.5-10.7	10.8-11.0	11.1-11.3	11.4-11.6	11.7-11.9	Total.
8	7	3	..	..	..	..	31
5	3	3	7	5	4	3	40

TABLE 4
 Variation in the width of head (C), length of pronotum (P)
 H/C and M/C in *Schistocerca gregaria*,
 (c) Height of

H	Range and mean.		Number			
	Min.-Max.	Mean.	7.5-7.6	7.7-7.8	7.9-8.0	8.1-8.2
♂♂	7.8-8.9	8.4	..	2	5	
♀♀	7.5-10.0	8.9	1	2	2	3

(d) Width of

M	Range and mean.		Number				
	Min.-Max.	Mean.	5.0-5.1	5.2-5.3	5.4-5.5	5.6-5.7	5.8-5.9
♂♂	5.3-6.5	5.9	..	1	3	6	11
♀♀	5.0-7.3	6.4	1	0	2	1	5

(e) Ratio

P/C	Range and mean.		Number			
	Min.-Max.	Mean.	1.17-1.19	1.20-1.22	1.23-1.25	1.26-1.28
♂♂	1.17-1.49	1.31	2	0	3	5
♀♀	1.21-1.42	1.32	..	1	2	9

(f) Ratio

H/C	Range and mean.		Number	
	Min.-Max.	Mean.	1.03-1.05	1.06-1.08
♂♂	1.04-1.19	1.11	4	5
♀♀	1.03-1.29	1.13	3	4

(g) Ratio

M/C	Range and mean.		Number	
	Min.-Max.	Mean.	0.71-0.72	0.73-0.74
♂♂	0.71-0.86	0.78	2	3
♀♀	0.71-0.88	0.81	1	1

(continued).

height of pronotum (H), width of pronotum (M), and the ratios P/C, phase gregaria. (All measurements in mm.).

pronotum (H).

of individuals in each category (0.2 mm.).

8.3- 8.4	8.5- 8.6	8.7- 8.8	8.9- 9.0	9.1- 9.2	9.3- 9.4	9.5- 9.6	9.7- 9.8	9.9- 10.0	Total.
5	12	3	4	..	..	..	..	..	34
1	4	6	7	2	4	6	3	2	43

pronotum (M).

of individuals in each category (0.2 mm.).

6.0- 6.1	6.2- 6.3	6.4- 6.5	6.6- 6.7	6.8- 6.9	7.0- 7.1	7.2- 7.3	Total.
8	3	2	..	..	..	..	34
3	7	7	8	3	4	1	42

P/C.

of individuals in each category (0.03).

1.29- 1.31	1.32- 1.34	1.35- 1.37	1.38- 1.40	1.41- 1.43	1.44- 1.46	1.47- 1.49	Total.
8	9	0	3	0	0	1	31
6	7	4	5	3	..	..	37

H/C.

of individuals in each category (0.03).

1.09- 1.11	1.12- 1.14	1.15- 1.17	1.18- 1.20	1.21- 1.23	1.24- 1.26	1.27- 1.29	Total.
9	9	3	4	..	..	..	34
10	11	7	2	2	0	1	40

M/C.

of individuals in each category (0.02).

0.75- 0.76	0.77- 0.78	0.79- 0.80	0.81- 0.82	0.83- 0.84	0.85- 0.86	0.87- 0.88	Total.
5	13	5	3	1	2	..	34
2	9	7	9	6	3	2	40

even in those species in which both the sexes undergo the same number of moults. The size-difference in such cases may possibly be due to the males having a faster rate of development than the females. The number of moults is only one of the causes of size-differences within the species. When an extra-moult is peculiar to the females only, the adults of that sex are usually considerably larger than the males, as in the Rice Grasshopper, *Hieroglyphus banian* (Coleman and Kuhn Kannan, 1911). In *Colemania sphenarioides*, where Coleman (1911) showed that about one-half the number of individuals in each sex undergo an extra-moult, the size of the adults is very variable, the body-length being 23-40 mm. in males and 25-40 mm. in females; the females are, on the average, larger.

Mathur (1938) stated for *S. gregaria* that difference in the number of moults is the cause of the slight size-superiority of *solitaria* over *gregaria* individuals. No comparative measurements were, however, given, nor evidently were eye-stripe variations and their developmental causes taken into account. When this is done, as shown below, Mathur's statement does not receive support. For the present discussion the length of the hind-femur alone will be considered, as this character is generally regarded as a good indicator of body-size in the Acrididae. The main conclusions thus arrived at, however, apply equally well to the elytron, except in *gregaria* males.

Comparing first the 6-striped *solitaria* with *gregaria* (6-striped), it is seen that the latter are smaller by 3.9-10.2%. Both these types are known to undergo the same number of moults, viz., five (*vide* Roonwal, 1937, 1946c; and others,) so that the size-difference that exists in this case cannot be attributed to an extra-moult but must be caused by some other factor probably connected with phases. Within the *solitaria* phase, the 7-striped individuals are larger than 6-striped ones by 2.8-5.1%. How far is this size-superiority due to an extra-moult which is known to occur in some 7-striped individuals? In the absence of measurements of 7-striped individuals with and without an extra-moult, I shall take into consideration some indirect evidence for comparison.

It is generally recognized that the growth quotient or Przibram's quotient, Q, i.e., $\frac{\text{length in one instar}}{\text{length in previous instar}}$, for growth in length of the various body-parts of insects is governed by the progression factor $\sqrt[3]{1.26}$ or 1.26. Bodenheimer (1927) has shown that *Schistocerca gregaria* conforms to this rule, the increase with each moult being either 1.26 or a multiple of this figure, viz., 1.26² (or 1.6), 1.26³ (or 2), and so on. Later, Spett (1934) showed that while in some Acrididae, e.g., *Acridium bipunctatum* Linn. and *A. subulatum* Linn., Q closely approximates 1.26, in others, e.g., *Chorthippus parallelus* Zett., *C. albomarginatus* (De Geer); *Doclostaurus maroccanus* Thunb., *Locusta migratoria* Linn.³ and *Oedipoda coerulescens* (Linn.), it is considerably higher, being about 1.31-1.44. It will thus be seen that a moult in these Acrididae results

³ Spett dealt with the typical subspecies, *L. m. migratoria* Linn., since he was dealing with Russian material. For the African subspecies, *L. migratoria migratorioides* (R. and F.), Duarte (1939) stated that Q approximates the Przibram value of 1.26; he makes no reference to Spett's work.

in a linear increase of not appreciably less than about 1.26-1.44 times or 26.44%. In the *solitaria* phase of *S. gregaria* the maximum superiority, in regard to hind-femur length, of 7-striped over 6-striped individuals is not more than about 5.1%, which is much less than would be expected as a result of an extra-moult in *all* 7-striped individuals. Taking the normal increase due to a moult as at least 26%, it would appear that not more than about 5.1/26% or about one-fifth of the total number of 7-striped individuals undergo an extra-moult⁴.

If this conclusion is correct, it is to be expected that as regards size the 7-striped *solitaria* individuals will fall into two groups: (i) Those which have undergone an extra-moult and are at least about 1.26 times or 26% larger than 6-striped *solitaria*; these constitute a certain proportion of the population. (ii) Those which have not undergone an extra-moult and are about the same size as 6-striped *solitaria*; these constitute the remainder. (*Vide* also Roonwal, 1947, for additional proof of the existence of these two types of 7-striped individuals.)

TABLE 5.

Summary of means of biometrical data (Tables 1-4) on S. gregaria.

Phase, sex and number of eye-stripes.	E	F	E/F	C	P	H	M	P/C	H/C	M/C
<i>greg.</i> ♂♂ : (6-striped)	53.03	24.4	2.18	7.6	9.9	8.4	5.9	1.31	1.11	0.86
<i>sol.</i> ♂♂ : (6-striped)	52.2	25.4	2.05	..	..	..	..	..	..	..
<i>sol.</i> ♂♂ : (7-striped)	52.4	26.1	2.004	..	..	..	..	..	..	..
<i>greg.</i> ♀♀ : (6-striped)	58.01	26.4	2.24	7.9	10.5	8.9	6.4	1.32	1.13	0.88
<i>sol.</i> ♀♀ : (6-striped)	61.6	29.4	2.09	..	..	..	..	..	..	..
<i>sol.</i> ♀♀ : (7-striped)	62.9	30.9	2.03	..	..	..	..	..	..	..

TABLE 6.

Percentage of mean size-differences in E and F in S. gregaria, taking 6-striped solitaria as 100.

Phase, sex and number of eye-stripes.	E	F
<i>greg.</i> ♂♂ : (6-striped)	+1.6%	-3.9%
<i>sol.</i> ♂♂ : (6-striped)	100	100
<i>sol.</i> ♂♂ : (7-striped)	+0.4%	+2.8%
<i>greg.</i> ♀♀ : (6-striped)	-5.8%	-10.2%
<i>sol.</i> ♀♀ : (6-striped)	100	100
<i>sol.</i> ♀♀ : (7-striped)	+2.1%	+5.1%

⁴ This, of course, assumes that the size-superiority under discussion is due entirely to an extra-moult.

SEXUAL DIMORPHISM.

As in other Acrididae, the females in *S. gregaria* are larger than males of that type and phase; this is evident from the mean dimensions given in Tables 1-5. The degree of sexual dimorphism was calculated as a percentage by which the mean length in females is greater than the mean length in males (Table 7). This figure may be termed the *sexual dimorphism percentage*. Thus, for the elytron-length (E) of a population, the percentage will be obtained by the expression $\frac{E_{\text{♀}}}{E_{\text{♂}}} \times 100$.

TABLE 7.

Mean sexual dimorphism percentages in *S. gregaria*.

Type of individuals.	Sexual dimorphism percentage.					
	E	F	C	P	H	M
<i>gregaria</i> (6-striped)	9.4	8.2	3.9	6.1	5.95	8.5
<i>solitaria</i> (6-striped)	18.01	15.7	..	..	..	..
<i>solitaria</i> (7-striped)	20.04	18.4	..	..	..	..

It will be noticed (Table 7) that in regard to both elytron and hind-femur lengths the sexual dimorphism percentage in *solitaria* individuals is nearly double that in *gregaria*. Among *solitaria* individuals themselves, sexual dimorphism is more marked (by about 2% regarding E and 2.7% regarding F) in 7-striped than in 6-striped individuals.

Murat (1939) had already observed in W. Africa that sexual dimorphism in elytron-length is more marked in *solitaria* than in *gregaria* individuals; he was, however, unaware of eye-stripe variations. As an index for the elytron Murat had employed the "sexual dimorphism ratio", viz., $E_{\text{♀}}/E_{\text{♂}}$, his figures being 1.09 for *gregaria* and about 1.18-1.26 for *solitaria* individuals. If my measurements for E and F are analysed in that way, the following ratios are obtained (Table 8):—

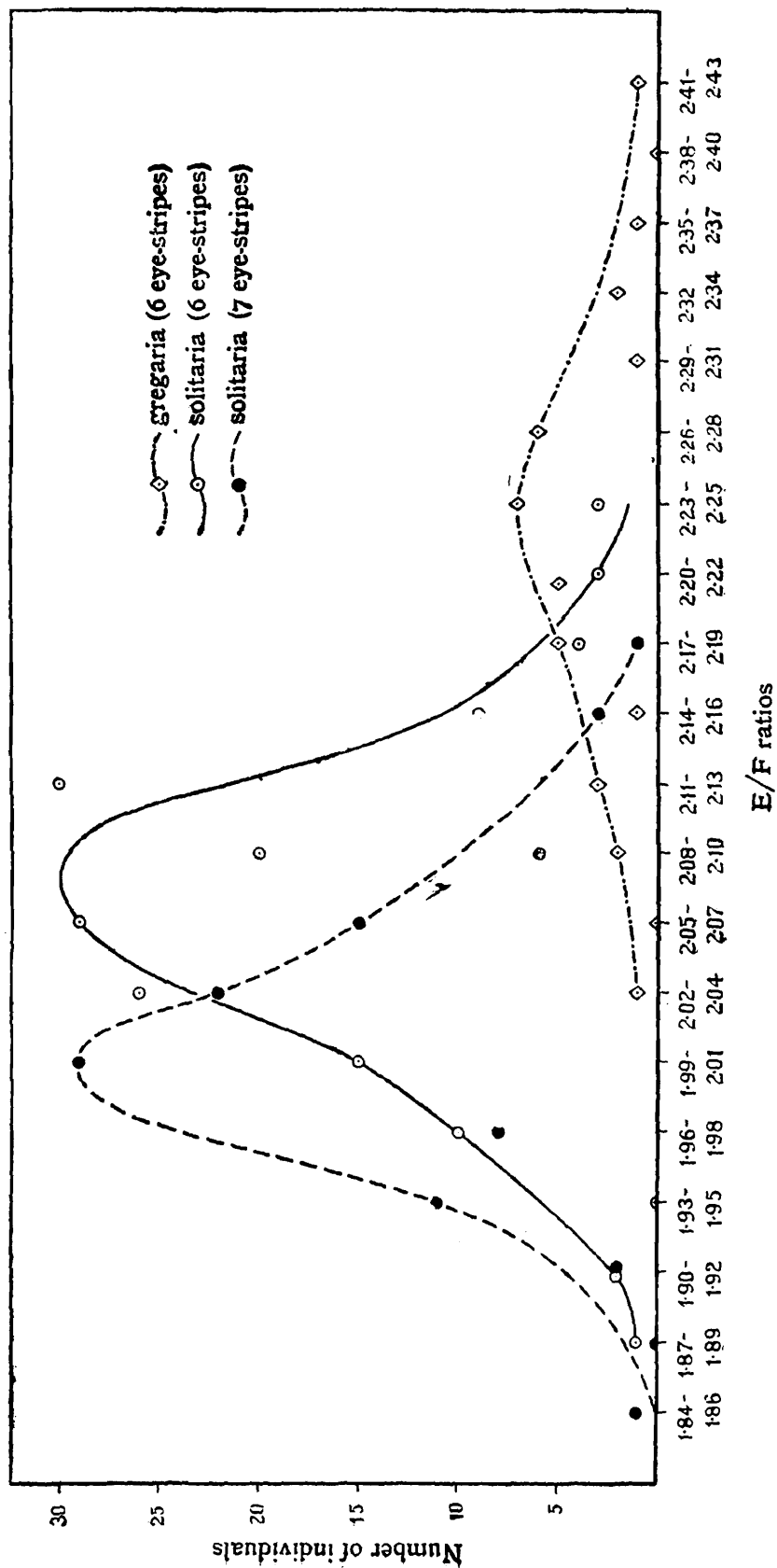
TABLE 8.

Mean sexual dimorphism ratios in *S. gregaria*.

Ratio	<i>gregaria</i> (6-striped)	<i>solitaria</i> (6-striped)	<i>solitaria</i> (7-striped)
$E_{\text{♀}}/E_{\text{♂}}$	1.09	1.18	1.2
$F_{\text{♀}}/F_{\text{♂}}$	1.08	1.16	1.18

A similar variation in the sexual dimorphism ratio was noticed in *Nomadacris septemfasciata* by Lea and Webb (1939) and in *Locustana pardalina* by Faure (1932) and Plessis (1939). That ratio was found to be a more valuable index of phase than the commonly employed E/F ratio.

The use of sexual dimorphism, expressed either as ratio or as percentage—preferably the latter because of the larger figures obtained and the consequent ease of comparison—is recommended here for the assessment of phase in populations of *S. gregaria* in the field.



TEXT-FIG. 1.—Graph of E/F ratios of various types of individuals of *Schistocerca gregaria*, namely, phase *gregaria* 6-striped, *solitaria* 6-striped and *solitaria* 7-striped. (From data in Table 3.)

BIOMETRICAL RATIOS.

E/F ratio.

The analysis of the *E/F* ratios (Text-fig. 1) shows (Tables 3, 5 and 9-11) that, irrespective of sexual variation within each group, the 6-striped *solitaria* individuals have a higher mean ratio (*E/F* 2.07) than 7-striped *solitaria* (*E/F* 2.02). The *gregaria* individuals of course have, as is well-known, a much higher mean ratio (*E/F* 2.22, from the measurements given here) than the *solitaria*.

TABLE 9.

E/F ratios (both sexes together) in *S. gregaria*. (From Table 3.)

Phase and number of eye-stripes	<i>E/F</i>	
	Range	Mean
<i>gregaria</i> (6-striped)	2.04-2.43	2.22
<i>solitaria</i> (6-striped)	1.88-2.25	2.07
<i>solitaria</i> (7-striped)	1.85-2.17	2.02

The figures given in Tables 3 and 5 may be analysed in another way, *viz.*, by comparing the percentage of individuals belonging to each phase-group among 6- and 7-striped *solitaria* forms, assuming the limits of each group as follows :

solitaria : *E/F* 2.05 and below (to about 1.85).

transiens ⁵ : *E/F* 2.06-2.15.

gregaria : *E/F* 2.16 and above (to about 2.43).

It will be seen (Table 10) that in both the 6- and 7-striped *solitaria* group under study there is a sprinkling of high ratio or "*gregaria*" individuals. The proportion of the latter is, however, much higher (8.6%) in the 6-striped than in the 7-striped (0.9%) group.

TABLE 10.

Distribution of *solitaria* populations of *S. gregaria* by *E/F* phase-groups.

Nature of population	% of population in each <i>E/F</i> phase-group		
	<i>solitaria</i>	<i>transiens</i>	<i>gregaria</i>
<i>solitaria</i> (6-striped)	39.5	51.9	8.6
<i>solitaria</i> (7-striped)	67	32.1	0.9

⁵ The reality of the intermediate phase-group, *transiens*, is, in my experience, highly doubtful, although some authors repeatedly use this term to designate intermediate and, supposedly, at least partially distinguishable individuals. Its retention, however, as a purely arbitrary intermediate group may sometimes be desirable for convenience of the statistical analysis of quantitative data.

The E/F ratios also display sexual dimorphism (Tables 3 and 11). Within each phase- and eye-stripe group, the mean E/F ratio is higher in females than in males by 1.3-2.8%. The difference is lowest (1.3%) in the group with the lowest E/F ratio (7-striped *solitaria*) and highest (2.8%) in the group with the highest ratio (*gregaria*). In other words, the degree of sexual dimorphism increases with the progress towards higher ratios; this is the opposite of what occurs with regard to the size of the body-parts, *e.g.*, length of elytron and hind-femur.

TABLE 11.
Sexual dimorphism in E/F ratios in S. gregaria.

Phase and number of eye-stripes	Mean E/F		% mean superiority of ♀ over ♂
	♂	♀	
<i>gregaria</i> (6-striped) . . .	2.18	2.24	2.8%
<i>solitaria</i> (6-striped) . . .	2.05	2.09	1.95%
<i>solitaria</i> (7-striped) . . .	2.004	2.03	1.3%

In *Nomadacris septemfasciata* (Lea, 1938) and *Locustana pardalina* (Plessis, 1939; Smit, 1939) also the E/F ratio within each phase is higher in females than in males.

Other ratios.

With regard to other ratios, I have figures only for *gregaria* individuals (Tables 4e-g and 5). Here again, females tend to have higher ratios than males, the means being as follows:—P/C : ♂♂ 1.31, ♀♀ 1.32; H/C : ♂♂ 1.11, ♀♀ 1.13; M/C : ♂♂ 0.78, ♀♀ 0.81.

SUMMARY.

1. The size and biometrical ratios of the body-parts were studied in the three major types of individuals of the Desert Locust, *viz.*, phase *gregaria* 6-eye-striped, and phase *solitaria* 6- and 7-striped.

2. Regarding the length of the elytron (E) and that of the hind-femur (F), *gregaria* individuals are the smallest (except in male E), 6-striped *solitaria* larger, and 7-striped *solitaria* the largest.

3. The cause of the size-differences between the 6-striped *gregaria* and 6-striped *solitaria* forms is not the difference in the number of moults (both have 5 moults), but some other factor probably connected with phase. The difference between 6- and 7-striped *solitaria* is attributable in part only to the difference in the number of moults—a small proportion of the 7-striped individuals undergo 6 moults; the remaining 7-striped and all the 6-striped individuals undergo only 5 moults.

4. Within each group, the females are larger than males in respect of all the body-parts, the sexual dimorphism being greatest in 7-striped *solitaria* and least in *gregaria*. The use of the "sexual dimorphism percentage", *i.e.*, the percentage by which females are larger than males in a population-group, provides a convenient method for the determination of phase in the field.

5. The mean E/F ratio is lowest in 7-striped *solitaria* (2.02), higher in 6-striped *solitaria* (2.07), and highest in *gregaria* (2.22). It also exhibits sexual dimorphism, being higher in females than in males; the dimorphism is greatest in *gregaria*, and least in 7-striped *solitaria*.

REFERENCES.

[For other references quoted in the text, see Parts I and II of this series.]

- Bodenheimer, F.S. 1927. Über Regelmässigkeiten in dem Wachstums von Insekten. I. Das Längswachstum. *Deutsch. ent. Z.* (1927), pp. 33-57.
- Duarte, A.J. 1939. Problems of growth of the African Migratory Locust. *Bull. ent. Res.* XXIX, pp. 425-456.
- International Locust Conference. 1937. *Proc. 4th int. Locust Conf., Cairo, 1936*, ix+96 pp. +51 appendices. Cairo.
- 1938. *C.R. V^e Conf. int. Res. anti-acridienne, Bruxelles 1938*, 445 pp. Brussels.
- Jannone, G. 1938. Aspetti bio-morfologici e somatometrici del problema delle fasi nel *Dociostaurus maroccanus* Thunb. in Italia e fuori, con particolare riguardo alla provincia di Napoli. (Secondo contributo.) *Boll. R. Lab. Ent. agrar. Portici I*, pp. 261-328.
- 1939. Studio morfologico, anatomico e istologico del *Dociostaurus maroccanus* (Thunb.) nelle sue fasi *transiens congregans, gregaria* e *solitaria*. (Terzo contributo.) *Boll. R. Lab. Ent. agrar. Portici IV*, pp. 3-443.
- Lea, A. 1938. Investigations on the Red Locust, *Nomadacris septemfasciata* (Serv.) in Portugese East Africa and Nyasaland in 1935. *Sci. Bull. Dept. Agric. & For. Un. S. Africa*, No. 176. (*Locust Res. Ser. No. 1*), pp. 1-29.
- Lea, A. and Webb, D. van V. 1939. Field observations on the Red Locust at Lake Rukwa in 1936 and 1937. *Sci. Bull. Dept. Agric. & For. Un. S. Africa*, No. 189. (*Locust Res. Ser. No. 4*), pp. 1-81.
- Murat, M. 1939. Recherches sur le criquet pèlerin (*Schistocerca gregaria* Forsk., Acrididae) en Mauritanie occidentale (A.O.F.) et au Sahara Espagnol, années 1937-1938. Deuxième rapport sur les recherches de la Mission d'Études de la Biologie des Acridiens au Sahara occidentale, précédés d'une descriptions générale de la contrée. *Bull. Soc. Hist. nat. Afr. Nord.* XXX pp. 105-204.
- Plessis, C. du. 1939. The incipient outbreaks of the Brown Locust in 1937-38, with special reference to biometrical analysis. *Sci. Bull. Dept. Agric. & For. Un. S. Africa*, No. 209 (*Locust Res. Ser. No. 6*), pp. 1-69.
- Rao, Y. R. 1937. A study of migration among the solitaries of the Desert Locust (*Schistocerca gregaria* Forsk.). *Proc. 4th int. Locust Conf. Cairo, 1936*, App. 10, pp. 1-14.
- 1938. A further note on studies of migration among the solitaries of locusts in N. W. India in 1936-1938. *C. R. V^e Conf. int. Res. anti-acridienne, Bruxelles, 1938*, pp. 238-247.
- 1942. Some results of studies on the Desert Locust (*Schistocerca gregaria*, Forsk.) in India. *Bull. ent. Res.* XXXIII, pp. 241-265.

- Roonwal, M.L. 1946. On a new phase character, the metasternal interspace, in the Desert Locust. *Proc. roy. ent. Soc. London* (A) XXI, pp. 13-15.
- 1946a. Studies in intraspecific variation. I. On the existence of two colour-types in the adults and hoppers of the *solitaria* phase in the Desert Locust, *Schistocerca gregaria* (Forskål) [Orthoptera, Acrididae]. *Rec. Indian Mus.* XLIV, pp. 369-374.
- 1946b. On variation in the number of ovarioles and its probable origin in the Desert Locust, *Schistocerca gregaria* (Forskål) [Orthoptera, Acrididae]. *Rec. Indian Mus.* XLIV, pp. 375-384.
- 1946c. Studies in intraspecific variation. II. New rules governing the correlation between normal and extra-moulting and directional reversal of the elytron-wing complex in the Desert Locust and other Acrididae (Orthoptera). *Indian J. Ent.* VII (1945), pp. 77-84.
- 1947. Variation and structure of the eyes in Desert Locust, *Schistocerca gregaria* (Forskål). *Proc. roy. Soc. London* (B) CXXXIV, pp. 245-272, 3 pls.
- 1947a. Evolutionary significance of periodicity of variation-intensity and population-flux in the Desert Locust. *Nature* CLIX, pp. 872-873.
- Smit, C.J.B. 1939. Field observations on the Brown Locust in an outbreak centre. *Sci. Bull. Dept. Agric. & For. Un. S. Africa* No. 190 (*Locust Res. Ser. No. 5*), pp. 1-143.
- Spett, G. (Shpett, G.). 1934. On the problem of insect growth. [In Russian.]—*Zool. Zh., Moscow* XIII, pp. 195-205.

STUDIES IN INTRASPECIFIC VARIATION.

IV.—THE ROLE OF SOME VARIATIONS, *E.G.*, EYE-STRIPES, ETC., AS “POPULATION INDICATORS” IN THE DESERT LOCUST, AND THEIR PRACTICAL IMPORTANCE.¹

By M. L. ROONWAL, *M. Sc., Ph. D. (Cantab.), F.N.I., Hony. Major, Zoological Survey of India, Benares Cantt.*

CONTENTS.

	PAGE.
INTRODUCTION	167
TWO NEW CONCEPTIONS : E/F SHIFT FIGURE <i>g</i> , AND EYE-STRIFE FIGURE <i>e</i>	171
ROLE OF “POPULATION INDICATORS” : CORRELATION BETWEEN <i>e</i> AND <i>g</i> ..	175
PRACTICAL UTILITY OF THE “POPULATION INDICATORS”	178
SUMMARY	178
REFERENCES	178

INTRODUCTION.

A certain irregular periodicity in population fluctuation in certain species of locusts is well-known. In the Desert Locust, *Schistocerca gregaria* (Forskål), there is evident, *on the average*, a rough 11-year periodicity in the plague years, though the individual plague periods may last from 2-10 years and may be separated by non-plague periods lasting from 1-8 years (Uvarov, 1928 ; Rao, 1941). In the plague years swarming occurs in enormous numbers and the population may run into several-thousands (usually considerably over 10,000) per square mile. In the non-plague or “solitary” years the population does not go far beyond about 1,000 per square mile, and is usually less, as is clear from the study of several workers (including my own field observations in the western Indian Desert and Baluchistan) in almost the entire belt of the dry, hot desert areas from N. Africa to India. It further strikes the observer that even this low population, when studied in a restricted area, is in a continual state of fluctuation, varying from month to month.

The Phase Theory (Uvarov, 1921-1928) marked a great advance in the understanding of locust fluctuations. Attempts at what may be called “generalizations” or “large-scale explanations” of periodicity, however, continue to be made. Two recent instances concerning the Desert Locust may be cited. Bodenheimer (1937) has attempted to explain periodicity on the basis of a difference in the number of annual generations between the migration and the non-migration periods, potential increase, environmental resistance, and so on. Bodenheimer’s account contains some interesting ideas. Most of his conclusions, however, are poorly supported by facts, or are based on incorrect assumptions. His scheme of the building up of outbreaks runs in the following sequence : Population ebb ; preparatory years (2-6 generations) ; prodromal years (1-3 generations) ; eruption (2-10 generations) ; crisis (1-2 generations) ; and population ebb (a few to many generations).

¹ Previous parts as follows :—I, *Rec. Indian Mus.* XLIV, pp. 369-374 (1946) ; II, *Indian J. Ent.* VII, pp. 77-84 (1946) ; III, *Rec. Indian Mus.* XLV, pp. 149-165 (1947).

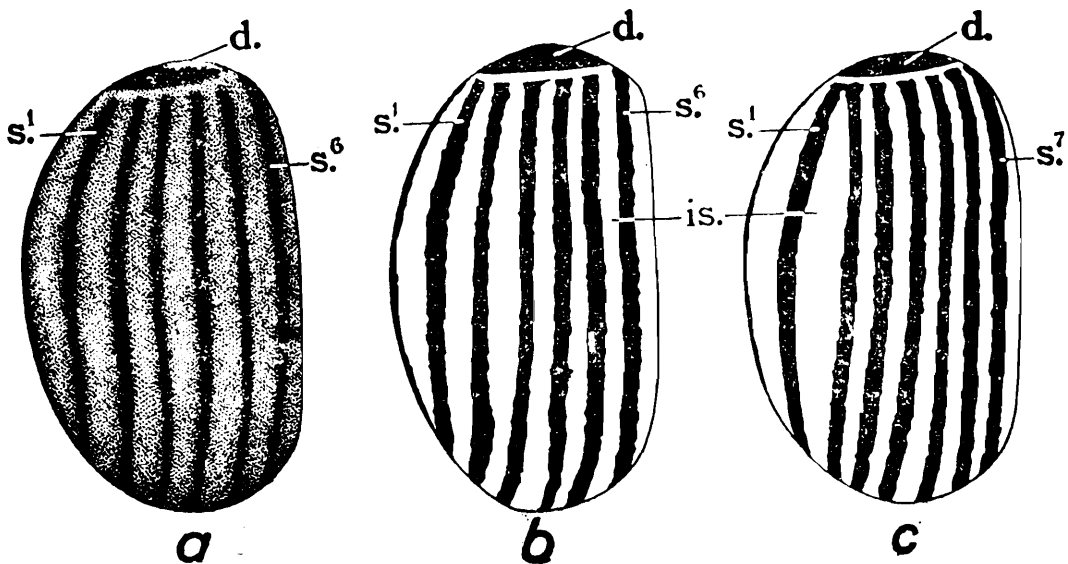
The precise meanings of the terms "preparatory", "prodromal", "eruption" and "crisis" are left unexplained. But even if we give an approximate meaning to them, field experience shows such differentiation to be devoid of any significance. All that can be distinguished are the plague years (usually showing a peak) with high population, and the non-plague years with a low but fluctuating population. The number of generations assigned by Bodenheimer to each period has no basis in fact. Regarding the inaccuracy of the other assumptions on which Bodenheimer proceeds, three examples will suffice. Firstly, he writes that all the species of locusts, such as those of the genera *Schistocerca*, *Locusta*, *Calliptamus* and *Dociostaurus*, which migrate extensively are able to develop more than one annual generation in their gregarious phase, while the solitary phase has only one generation. So far as *Schistocerca gregaria* is concerned, we know that both the *solitaria* and *gregaria* phases have 2-3 annual generations. Secondly, Bodenheimer considers the "Sudano-Deccanian" region (extending from Sudan in N. Africa to the Deccan in India) as the permanent home of the Desert Locust. We know definitely that the Deccan is not the permanent home—the locusts reaching the Deccan only in very exceptional swarming years and never breeding there (Rao, 1945). Thirdly, his statement that the mortality of adults during the so-called imaginal diapause is certainly very great cannot be substantiated. There is no diapause in any stage in the Desert Locust; only, during the cold months, as compared to the summer months, development is very much slowed down and the life-duration prolonged. Nor is there any evidence in support of his assertion that the mortality is greater in the winter than in summer months.

The second instance of a "large-scale explanation" is the interesting attempt of Rao (1938) to correlate Desert Locust periodicity with the sun-spot cycles in India. Rao concluded that a negative correlation subsists between locust cycles and sun-spot numbers. An examination of his numerical data and graph, however, shows that, as in so many previous attempts on locusts and other animals, the supposed correlation is so approximate and breaks down at so many points that the few points where the correlation does occur would seem to be fortuitous rather than real.

These two instances demonstrate the great limitations of such large-scale explanations. The more fruitful, though tedious, procedure then is to make a close study of population dynamics, character by character, from samples obtained periodically in the field. This procedure resolves itself into two methods of approach: (i) *Direct counting*: This involves the periodic counting of actual numbers in a given area. For the Desert Locust, this has been done during approximately the last 15 years in India and Africa by several workers. To start with, it is the only sure method. (ii) *Indirect assessment*: In locusts the morphological and other characters change with population density. So that, if the changes in these characters can first satisfactorily be correlated with actual population figures obtained by the first procedure, they can then be employed as "population indicators", thus obviating the necessity of direct counting. The value of the second procedure depends entirely

on the ease and accuracy of determination of the population indicators. In the present account the value of some of the indicators in the study of Desert Locust populations is discussed.

Biometrical ratios, especially E/F (elytron-length/hind-femur-length), have for many years been the stand-by for population studies of locusts, and the accumulated evidence from several species of locusts tended to show that E/F is quite a sensitive guide to phase. Recently, however, Kennedy (1939, pp. 400-405), from a study of Desert Locust population in an outbreak centre on the Sudanese coast of the Red Sea, found that the E/F ratio alone is not a safe guide. He concluded as follows (p. 404): "Thus it seems that the E/F ratio and other biometric features are unsafe criteria of phase unless account be taken of the stage of given individuals in the whole cycle of outbreak and non-outbreak years, covering many generations. A population which appears a fully gregarious swarm may be biometrically *solitaria* if it comes among the early swarms of an outbreak and *vice versa*, apparently solitary locusts may be biometrically 'gregarious' if they appear at the end of an outbreak period." It, therefore, becomes necessary to seek also the aid of other characters besides the biometrical ratios for the study of phase and population dynamics.



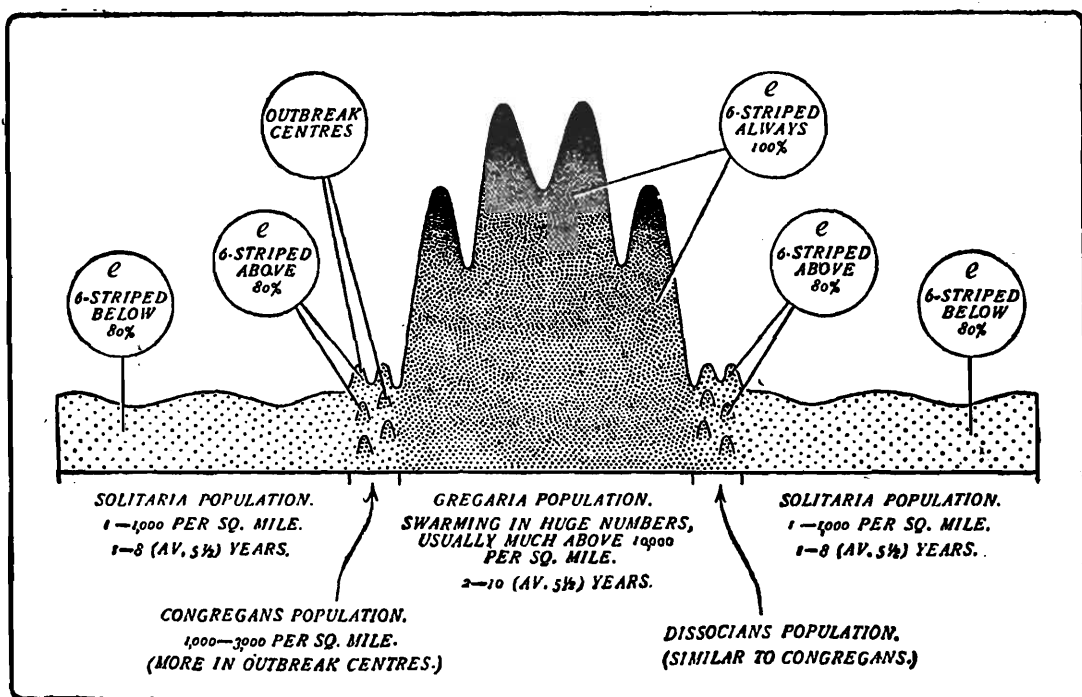
TEXT-FIG. 1.—Compound eyes of the Desert Locust, *Schistocerca gregaria* (Forskål). \times about 10. Anterior margin of eye is on the right. (a), in phase *gregaria* (6-striped). (b) and (c), phase *solitaria*, 6- and 7-striped respectively. [(b) and (c) after Roonwal, 1936.]

d., dorsal pigment spot of eye; is., interstripe; s¹, first or most posterior stripe; s⁶, s⁷, sixth and seventh stripes respectively.

Some years ago, I reported (Roonwal, 1936) on another character, *viz.*, the presence of a variable number of eye-stripes (usually 6 and 7) (Text-fig. 1b, c) in a *solitaria* population of the Desert Locust, which has proved to be of considerable importance in population study, *vide* Rao (1937, p. 41). Further work followed rapidly and the development of the eye-stripes was studied first by Roonwal (1937, 1947) and later by others (Volkonsky, 1938; Mukerji and Batra, 1938). It was found that a vertical stripe first develops in the first stage hopper, and subsequently, one stripe (rarely two or none) is usually added at each moult. In the course of my later work, it was found that the eye-pigment in

the Desert Locust first appears in the embryo shortly before blastokinesis as a faint orange-red pigment at the posterior border of the compound eyes, and soon turns brownish.² The same thing had been noticed earlier (Roonwal, 1936a, p. 415) in the African Migratory Locust, *Locusta migratoria migratorioides* (R. & F.), in which, however, the eyes are unstriped. It was also shown (Rao, 1937; Rao & Gupta, 1939; Roonwal, 1941) that *gregaria* individuals of the Desert Locust from swarms always have 6-striped eyes³ (Text-fig. 1a).

From a comparative study of eye-stripes in *solitaria* and *gregaria* populations over a number of years, three tentative hypotheses were advanced (Roonwal, 1945) for the determination of population fluctuation. The First Hypothesis is as follows: "If in a sufficiently large sample of a *solitaria* population the proportion of the 6-eye-striped individuals (in relation to 7-striped ones) rises above about 80 per cent (maximum figure; average 70.4 per cent) and tends towards 100 per cent, that population is rapidly on its way towards swarming. Conversely, if in a *gregaria* population the proportion of 6-striped individuals falls below 100 per cent and tends towards 80 per cent, that population is on its way towards the acquisition of *solitaria* or non-swarming characters" (Text-fig. 2).



TEXT-FIG. 2.—Diagrammatic representation of the periodical population fluctuation in the Desert Locust, and its relation to the eye-stripe figure *e*.

The number of peaks and valleys in the figure has no exact quantitative significance. The papillae in the region of the *congregans* population (left) represent "outbreak centres", while similar papillae in the *dissocians* population (right) represent isolated pockets of high population before the dispersal leading to low populations (characteristic of the *solitaria* periods) occurs.

² For a study of early embryos of the Desert Locust, *vide* Jhingran, 1947.

³ Formerly it was believed that in *gregaria* individuals the eyes are unstriped owing to the interstripe region being invaded by brown pigment. Actually, the stripes can be seen in several specimens, though they are usually less sharply contrasted than in *solitaria* individuals—*vide* Roonwal, 1947.

In the present account a more detailed analysis has been attempted of the available data in terms of the First Hypothesis. The analysis supports the essential points of that hypothesis, and further shows that the eye-stripes provide an excellent "indicator" for the study of population dynamics. Two new theoretical conceptions—one that of the E/F shift figure g , and the other of the eye-stripe figure e —are put forward; these are likely to be of considerable help in the study of populations. Finally, the practical importance of the eye-stripe "population indicator" in anti-locust work is explained.

I am greatly obliged to Dr. B. N. Chopra for helpful criticism of this paper, and to Dr. B. S. Chauhan for assistance in correcting the proofs.

TWO NEW CONCEPTIONS: E/F SHIFT FIGURE g AND EYE-STRIPE FIGURE e .

E/F shift figure g .

The ratio E/F increases with increasing population density, being higher in phase *gregaria* and lower in *solitaria*. In this regard a population is customarily (Rao, 1936-1942; Roonwal, 1947*b*; and others) grouped into three categories, namely, *solitaria* (S), *transiens* (T) and *gregaria* (G), with the following limits:—

S: E/F 2.05 and below to about 1.85.

T: E/F 2.06-2.15.

G: E/F 2.16 and above to about 2.43.

The number of individuals in each category gives an idea of the character of the population. Rao (1942) has used the following percentage form for expressing the population character in terms of the three classes, S, T and G, based on E/F ratios, and also in terms of the proportion of 6- and 7- eye-striped forms:—S:T:G :: (6) : (7). By the side of each item is given the number or percentage of individuals in each category in the population sample, *e.g.*, 62S : 29T : 9G :: 67(6) : 33(7). As, however, *transiens* is a category which it is impossible to distinguish satisfactorily, in so far as coloration and general facies are concerned (*vide* also Part III, Roonwal, 1947*b*), it seems desirable to divide a population sample into two categories only, namely, *solitaria* (S₁) and *gregaria* (G₁), with the following limits:—

S₁: E/F 2.10 and below.

G₁: E/F 2.11 and above.

Where a population is expressed in terms of S, T and G, it can be converted into S₁ and G₁ by dividing T equally between S and G, thus:

$$S_1 = S + \frac{T}{2}; \text{ and } G_1 = G + \frac{T}{2}$$

The numbers in the categories S₁ and G₁ are then converted into percentages s and g respectively, of the total number of individuals. These percentages indicate how far the population sample is removed from either the *solitaria* or the *gregaria* end. In other words, they express the *shift* (towards *gregaria* or *solitaria*) of a population, so that they may, for brevity, be called *E/F shift figures s and g* . Since s and g are complementary to each other ($s=100-g$), it is necessary to mention only

TABLE

Periodical analysis of Desert Locust populations with regard to field observations) in solitaria periods (except the July 1935

Abbreviations : e, eye-stripe figure for 6-striped

g, E/F shift figure towards gregaria phase ;

S, solitaria ; T, transiens ; and

Sol., solitaria ; and Gr., gregaria population, as judged by

Dominating phase ; and population per sq. mile	Serial num- ber of sample	Region and period	Number of individuals					
			Total	Eye-stripes		E/F		
				6	7	S	T	G
INDIA.								
<i>Mekran Coast.</i>								
Sol. (100)	1	Jan.—Mar., 1935	..	..	..	..	..	..
Sol. (460)	2	Apr.—May, 1935	..	..	..	..	..	..
Gr. (13,000)	3	July 1935 (incursion)	..	..	..	..	..	..
<i>Sind-Rajputana.</i>								
Gr. (40,000)	4	July 1935 (incursion)	..	..	..	..	..	..
<i>Lasbela.</i>								
Sol. (Low)†	5	Oct.—Nov., 1935 (new brood).	..	..	..	..	..	..
Sol. (720)	6	Dec. 1935	..	..	..	..	..	..
INDIA.								
<i>S. Mekran.</i>								
Sol. (120)	7	Mar. 1936	58	21	37	33	22	3
Sol. (30)	8	Apr. 1936	14	4	10	7	7	0
Sol. (550)	9	May 1936	61	43	18	28	30	3
Sol. (660)	10	June 1936	96	59	37	51	39	6
Sol. (480)	11	July 1936	27	18	9	11	16	0
Sol. (190)	12	Aug.-Sept., 1936	30	22	8	13	15	2
Gr. (Swarms)	13	<i>Indo-Iranian region .</i> (1889-91 ; and 1930-31)	41	41	0	1	4	36
N. AFRICA.								
<i>Central Sahara.</i>								
(Periods not stated.)								
Sol. (Probably low).	14	In Salah (Tidikelt) ..	70	24	46	..	..	..
Sol. (Probably low).	15	Reggan (Touat).	82	28	54	..	..	..

† The new brood population figures for October-November 1935 in the Sind-Rajputana desert area outside, as indicated by sudden increases ; and (ii) by its rapidly declining density from October onward. (iii) in October, but rapidly declined in November to barely a few hundred per square mile ; in some in the succeeding one or two months. The population in question must, therefore, be considered

1.

eye-stripes and phase (as judged from E/F, together with actual incursion of gregaria forms in India).

individuals ; e_1 , same for 7-striped individuals.

s , same towards *solitaria* phase.

G, *gregaria* range of E/F.

actual field observations as well as on other criteria.

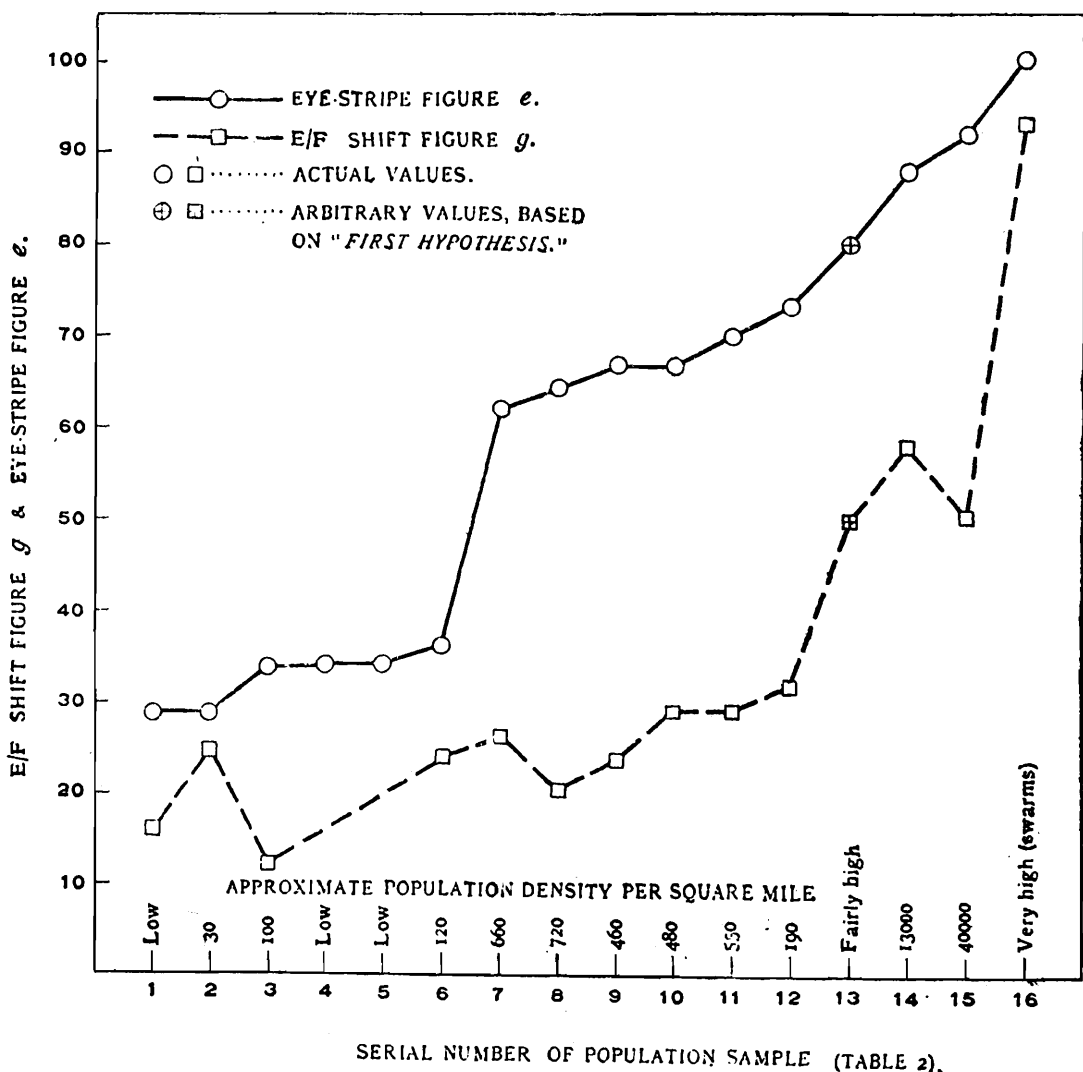
% of individuals					E/F shift figure		Source
Eye-stripes		E/F			s	g	
6 (e)	7 (e_1)	S	T	G			
34	66	76	28	1	87.5	12.5		Rao, 1936a, 1937, 1942. (E/F shift figures calculated by me.)
67	33	62	29	9	76.5	23.5	
88	12	24	35	41	41.5	58.5	
92	8	28	43	29	49.5	50.5	
29	71	69	30	1	84.0	16.0	
64	36	59	41	0	79.5	20.5	
36	64	57	38	5	76	24	Original.
29	71	50	50	0	75	25	
70	30	46	49	5	70.5	29.5	
62	38	53	41	6	73.5	26.5	
67	33	41	59	0	70.5	29.5	
73	27	43	50	7	68	32	
100	0	2	10	88	7	93	
34	66	Phase <i>solitaria</i>	} Volkonsky, 1938.
34	66	Phase <i>solitaria</i>.			..	..

are complicated by two factors : (i) By probable immigration from Thus, the population was rather high (several thousands per square places hardly any locust was found in the last week of November and essentially of a low density, a conclusion borne out by the low g and e_1 ,

one of them for a population sample—the adoption of *g* (shift towards *gregaria*) is proposed. Theoretically, in a wholly *gregaria* population (swarms), $g=100$ and $s=0$; while in a wholly *solitaria* population (middle of non-swarmering period), $g=0$, and $s=100$. In actual practice, these ideal conditions are not met with. Thus, in a small sample of Desert Locust population from actual swarms in the Indo-Iranian region, the figures were: g 93, s 7. Similarly, in a typical *solitaria* period, as for example in Southern Baluchistan in January-March 1935 and during 1936, the figures for the population sample with the lowest g were: g 12.5, s 87.5.

The already mentioned criticism made by Kennedy (1939) is here relevant. But it is of great theoretical interest to know that even in the "peak" or middle years of each swarming or non-swarmering period, a certain small percentage of individuals belong to the phase-group which is characteristic of the other period.

It may be tentatively assumed that the dividing line between *solitaria* and *gregaria* populations is at $g=50$. Actually, perhaps, this figure may prove to be a little too high, but it may be adopted until more data are available.



TEXT-FIG. 3.—Graph showing the correlation between the E/F shift figure *g* and the eye-stripe figure *e* in several population samples (Table 2) of the Desert Locust.

Eye-stripe figure e.

Since only 6- and 7-eye-striped individuals concern us in any sample of Desert Locust population (the 5- and 8-striped individuals occurring far too rarely to be of much practical importance), it is convenient to reduce the number in each category to percentages. The term *eye-stripe figure* may be used for these percentages—abbreviated to e for 6-striped and e_1 for 7-striped forms. Since in a population sample, e and e_1 are complementary ($e=100-e_1$), it is necessary to mention only one of them—the adoption of e is proposed. In a typical *gregaria* population (swarms), e always equals 100, and e_1 equals 0. In typical *solitaria* populations, as for example those mentioned above under g , the minimum value reached by e is about 29.

Thus, if a population sample is expressed as: g 23.5, e 67, we will know that in this sample 23.5 per cent. individuals have *gregaria* E/F ratios, and the remainder *solitaria*; further, 67 per cent. individuals have 6 eye-stripes, and the remainder 7 stripes. The use of the simplified conceptions g and e for the Desert Locust will become evident from what follows. They are also likely to prove helpful in the study of those of the other species which, like the Desert Locust, have striped eyes.

ROLE OF "POPULATION INDICATORS": CORRELATION BETWEEN e AND g .

In 1935 in Western India the June *solitaria* population of about 500 adults per sq. mile suddenly rose, in middle July and August, to about 20,000, and in some places even up to 40,000 (Rao, 1936). This was due to an incursion from the west (Iran or Arabia) of *gregaria*-like individuals and it looked as if a new swarming period was on. The incursion, however, fizzled out, and by December the population was again about 300 per sq. mile. In this change, the E/F was found to be a sensitive guide to the population-character (density), the immigrating individuals in July having mostly high or *gregaria* ratios, while the *solitaria* population preceding and following (next generation) the immigration having low or *solitaria* ratios (Rao, 1936). As will be shown below, in this change in population character, the eye-stripe figure e is correlated with the E/F or shift figure g , and is, like the latter, an excellent indicator of the population dynamics.

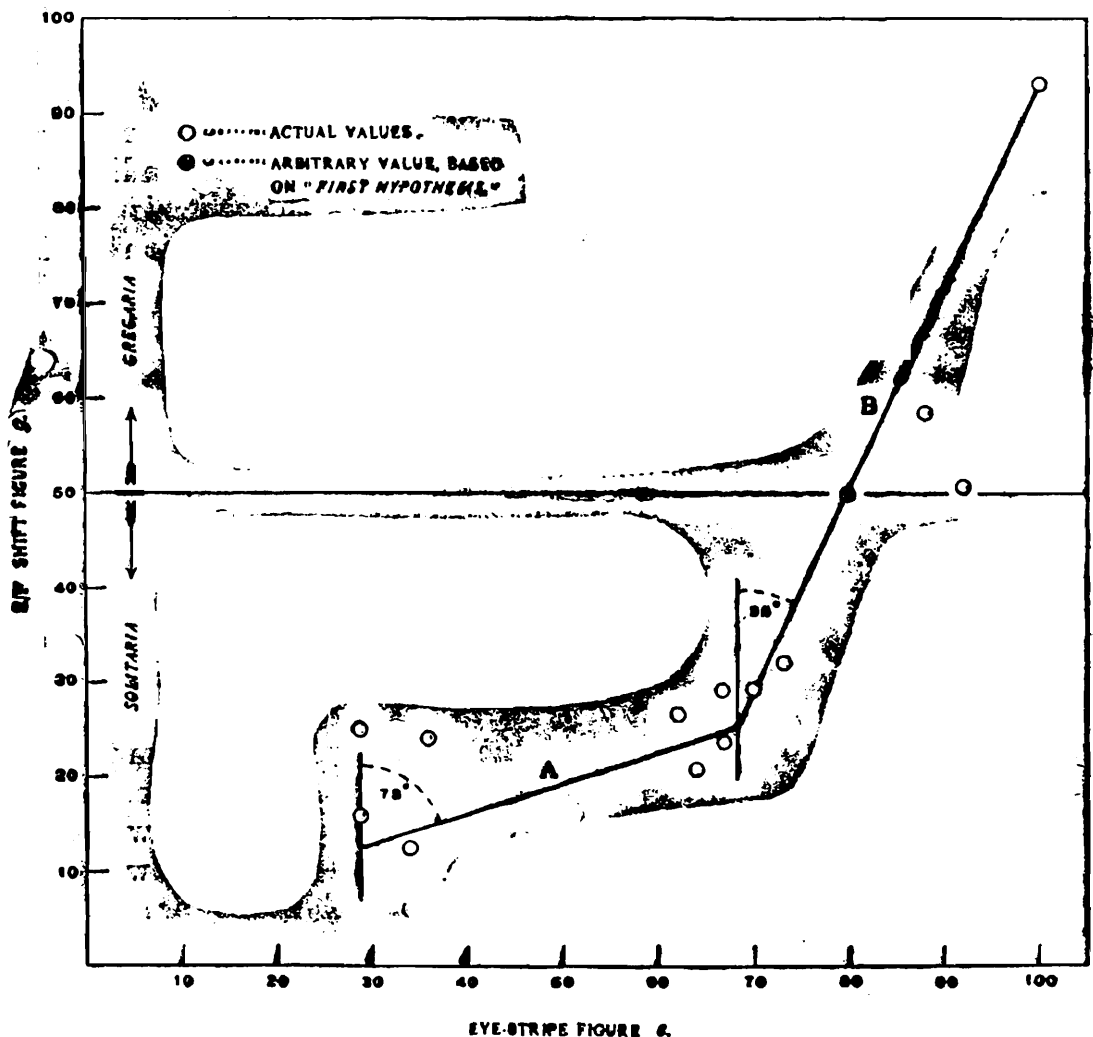
In Table 1 are given the published E/F shift-figure g and eye-stripe figure e from the data of Volkonsky (1938) and Rao (1942), together with my own figures for *solitaria* populations in S. Mekran (Baluchistan) in 1936 and of a *gregaria* population from the Indo-Iranian swarms of older cycles. In the case of Rao's data, S, T and G were given, from these I have calculated the E/F shift figures s and g by the method already described. With the exception of Sample Nos. 3 and 4 which refer to the July 1935 incursion of *gregaria* individuals (*vide supra*), and No. 13 which refers to true swarms, all the other samples are from typical *solitaria* populations, known to be so from actual field experience and belonging mostly to the middle year (1936) of the last non-swarming period which lasted in India from 1932 to 1939—the new swarming period started in 1940. In Nos. 14 and 15, no E/F ratios are given, but Volkonsky states that the populations were *solitaria*, and we may assume that g was below 50.

Regarding g , three points will be noticed: (i) In *solitaria* populations g varies from 12.5-32, i.e., its value lies definitely below 50; (ii) in the July 1935 incursion (Sample Nos. 3 and 4) g definitely rose above 50; it varied between 50.5-58.5; (iii) in swarms (Sample No. 13) g was 93, i.e., close to 100. Regarding e also, we notice three points: (a) In *solitaria* populations it varies from 29-73; (b) in the July 1935 incursion it rose to 88-92; (c) in swarms it is always 100.

In Table 2 the data of Table 1 are arranged in the order of increasing e , along with the corresponding g , in order to show the correlation between e and g . From Table 2 and Text-fig. 3 it will be seen that g generally increases with e . Although this does not happen in every case, the general tendency is perfectly clear, and may be summarized thus:

1. <i>solitaria</i> or very low population	..	..	..	e 29-73	g 12.5-32
2. July 1935 incursion (population about 10,000 to 40,000 per sq. mile)	..	..	..	88-92	50.5-58.5
3. <i>gregaria</i> or very high populations (swarms)	..	..	..	100	About 93.

When e is plotted as a function of g (Text-fig. 4), it is possible to discern two separate trends of correlation (lines A and B) between e and g . In *solitaria* or low populations (lower one-third of the figure), g increases slowly in respect of e , the line A sustaining an angle of roughly 73° with the ordinate. In the upper two-thirds of the figure, i.e., as we move toward the *gregaria* belt of high population, g increases very steeply in respect of e , the line B sustaining an angle of only about 26° with the ordinate.



TEXT-FIG. 4.—Graph obtained when the eye-stripe figure e is plotted as a function of the E/F shift figure g in the Desert Locust.

TABLE 2.

Values of e and the corresponding g (from Table 1) arranged in the order of increasing e .

Serial number.	1	2	3	4	5	6	7	8	9	10	11	12	13*	14	15	16
e	29	29	34	34	34	36	62	64	67	67	70	73	(80)	88	92	100
g	16	25	12.5	..	..	24	26.5	20.5	23.5	29.5	29.5	32	(50)	58.5	50.5	93
Approximate population density per sq. mile	Low	30	100	Low	Low	120	660	720	460	480	550	190	Fairly high.	13,000	40,000	Very high. (Swarms.)
General character of population	<i>Solitaria</i> . Very low population.												<i>Gregaria</i> predominating. Fairly high population.		Almost entirely <i>gregaria</i> . Very high population (Swarms).	

* Figures in this column are arbitrary, the e being based on the *First Hypothesis* (Roonwal, 1945), and g on considerations discussed in the text.

The results of the detailed analysis given above substantiates my *First Hypothesis* already referred to.

PRACTICAL UTILITY OF THE "POPULATION INDICATORS"

The problem of Desert Locust control is such that vast continental areas from India to N. Africa, mostly deserts, have to be kept under observation by means of periodical field surveys. A considerable proportion of field reporting has to be done by the non-scientific personnel, the scientific personnel doing mainly the supervisory work in the field and the study of all the incoming data at the Central Headquarters of a country or area. The field reports usually indicate, in addition to the information on breeding, etc., the number of locusts caught or observed in a day's survey, the distance covered and the number of individuals taking part in the survey. From these data the density of locust population is obtained by means of certain well-tried formulae (Rao, 1936, p. 1036 ; 1936*a*, p. 3 ; 1942, p. 252).

If, however, the field reports were also to contain particulars about the "population indicators" (E/F and eye-stripes), they would become considerably more useful. The determination of E/F and its shift figure g requires accurate measurements of E and F with a vernier calliper which the non-scientific field staff may not be able to do satisfactorily. On the other hand, the number of eye-stripes can be accurately counted with ease by means of a hand-lens, and the eye-stripe figure e calculated. If e goes above 80, incipient swarming is indicated and the Central Headquarters must be warned at once. It is, therefore, suggested that eye-stripe counts should become a routine procedure in Desert Locust surveys. Since the eye-stripes sometimes get distorted after death, it is desirable that their number should be recorded in the fresh specimen.

SUMMARY.

1. The role of the eye-stripes as "population indicators" in the study of the population dynamics of the Desert Locust is discussed.
2. Two new theoretical conceptions, viz., that of the "E/F shift figure" g and of the "eye-stripe figure" e , are given, and their importance in the study of Desert Locust populations explained.
3. The correlation between e and g has been established by a detailed analysis of the available data from various population samples.
4. The practical utility of the eye-stripes as "population indicators" in the scouting work carried out by anti-locust organizations is explained. The need for the adoption of this "indicator" as a routine method of population study in Desert Locust surveys is stressed.

REFERENCES.

[Also see Parts I—III of this series.]

- Bodenheimer, F. S. 1937. Factors controlling locust populations, *Proc. 4th int. Locust Conf., Cairo, 1936*, Cairo, App. 9, 11 pp.
- Jhingran, V G. 1947. Early embryology of the Desert Locust, *Schistocerca gregaria* (Forskål) [Orthoptera, Acrididae]. *Rec. Indian Mus.* XLV, pp. 181-200.

- Kennedy, J. S. 1939. The behaviour of the Desert Locust (*Schistocerca gregaria* Forsk.) (Orthop.) in an outbreak centre. *Trans. roy. ent. Soc. London* LXXXIX, pp. 385-542.
- Mukerji, S. and Batra, R. N. 1938. A note on the post-embryonic development of eye-stripes and their correlation with the number of larval instars and the antennal segments in the life-cycle of *Schistocerca gregaria* Forsk. *C. R. Ve Conf. int. Rech. antiacridienne, Bruxelles, 1938*, Brussels, pp. 410-415.
- Rao, Y. R. 1936. The locust incursion of 1935 in North-West India—its significance in the study of locust problem. *Indian J. agric. Sci.* VI, pp. 1031-1053.
- 1936a. *A Report of the Work done by the Research Staff under the Locust Research Entomologist to the Imperial Council of Agricultural Research at Karachi during the year 1935.* 103 pp. New Delhi.
- 1937 Ditto. *Report for 1936.* 161 pp. Simla.
- 1938. A preliminary note on a study of locust infestations in North-West India since 1863 in relation to sunspot cycles. *C. R. Ve Conf. int. Res. antiacridienne, Bruxelles, 1938*, Brussels, pp. 252-257.
- 1941. Some observations on the periodicity of locust invasions in India. *Proc. 28th Indian Sci. Congr., Part II, Presid. Address, Sec. Entom.*, pp. 211-237.
- 1942. Some results of studies on the Desert Locust (*Schistocerca gregaria*, Forsk.) in India. *Bull. ent. Res.* XXXIII, pp. 241-265.
- 1945. The areas of origin of locust flights in different parts of India with reference to the question of their control. *Current Sci.* XIV, pp. 31-33.
- Rao, Y. R. and Gupta, R. L. 1939. Some notes on eye-stripes in Acrididae. *Indian J. agric. Sci.* IX, pp. 727-729.
- Roonwal, M. L. 1936. On the existence of two different types of striped eyes among solitary type specimens of the Desert Locust, *Schistocerca gregaria* Forsk. *Current Sci.* V, p. 24.
- 1936a. Studies on the embryology of the African Migratory Locust, *Locusta migratoria migratorioides* R. & F.—I. The early development, with a new theory of multi-phased gastrulation among insects. *Philos. Trans. roy. Soc. London* (B) CCXXVI, pp. 391-421.
- 1937 [Development of eye-stripes in the Desert Locust.] In Y. R. Rao's *Report for 1936 (vide supra)*, pp. 25-26 ; and 150-151.
- 1941. Sex ratios and eye-stripes in a swarm of the Desert Locust. *Indian J. Ent.* III, pp. 340-341.
- 1945. New hypotheses for the prediction of the swarming of the Desert Locust. *Bull. ent. Res.* XXXV, pp. 391-393.

- Roonwal, M. L. 1945a. [Remarks on variation in the eye-stripes, etc., in the Desert Locust, and the species-problem.] *Proc. 31st Indian Sci. Congr. Pt. IV, Discussions*, p. 33.
- 1946. On a new phase character, the metasternal interspace, in the Desert Locust, *Schistocerca gregaria* (Forskål) (Orthoptera, Acrididae). *Proc. roy. ent. Soc. London* (A) XXI, pp. 13-15.
- 1946a. Studies in intraspecific variation. I. On the existence of two colour-types in the adults and hoppers of the *solitaria* phase in the Desert Locust, *Schistocerca gregaria* (Forskål) [Orthoptera, Acrididae]. *Rec. Indian Mus.* XLIV, pp. 369-374.
- 1946b. Studies in intraspecific variation. II. New rules governing the correlation between normal and extra-moulting and directional reversal of the elytron-wing complex in the Desert Locust and other Acrididae [Orthoptera]. *Indian J. Ent.* VII, pp. 77-84.
- 1947. Variation and structure of the eyes in the Desert Locust, *Schistocerca gregaria* (Forskål). *Proc. roy. Soc. London* (B) CXXXIV, pp. 245-272, 3 pls.
- 1947a. Evolutionary significance of periodicity of variation-intensity and population-flux in the Desert Locust. *Nature* CLIX, pp. 872-873.
- 1947b. Studies in intraspecific variation. III. Body-size and biometrical ratios in various types of individuals of the Desert Locust, *Schistocerca gregaria* (Forskål) [Orthoptera, Acrididae]. *Rec. Indian Mus.* XLV, pp. 149-165.
- Uvarov, B. P. 1921. A revision of the genus *Locusta* L. (= *Pachytylus* Fieb.), with a new theory as to the periodicity and migrations of locusts. *Bull. ent. Res.* XII, pp. 135-163.
- 1923. Notes on locusts of economic importance, with some data on the periodicity of locust invasions. *Bull. ent. Res.* XIV, pp. 31-39.
- 1928. *Locusts and Grasshoppers*. London.
- Volkonsky, M. 1938. Stries oculaires et âges larvaires chez les acridiens. *Arch. Inst. Pasteur Algérie* XVI, pp. 523-532.

EARLY EMBRYOLOGY OF THE DESERT LOCUST, *SCHISTOCERCA GREGARIA* (FORSKÅL). [ORTHOPTERA, ACRIDIDAE.]

By V G. JHINGRAN, *M. Sc.*, Department of Zoology, Lucknow University, Lucknow.

(Plates III-VI.)

CONTENTS.

	PAGE.
INTRODUCTION	181
MATERIAL AND METHODS	182
REFERENCE SCALE OF EMBRYONIC STAGES	183
LAW OF MEDIAL SHIFTING OF CEPHALIC APPENDAGES	186
FORMATION AND EARLY DEVELOPMENT OF COELOM	188
SUMMARY	195
REFERENCES	196

INTRODUCTION.

The embryology of the Orthoptera, which are among the most primitive of the living Pterygota, is of considerable importance in throwing light upon the many disputed questions of insect development. The Desert Locust, *Schistocerca gregaria* (Forskål) (Fam. Acrididae), was chosen as the subject of study firstly, because of the ready availability of material; and secondly, because of the great economic importance of this insect.

The embryology of only two species of Acrididae, namely, *Stenobothrus* sp. (Graber 1888-1891a) and the African Migratory Locust, *Locusta migratoria migratorioides* (R. & F.) (Roonwal, 1935-1939b) has been studied more or less fully. In a third species, viz., the Differential Grasshopper of N. America, *Melanoplus differentialis* Uhl., certain aspects of embryology have been studied by a number of workers thus: Sex differentiation and development of the gonads by Nelsen (1931-1934a); external morphology of the embryo, blastokinesis and the function of pleuropodia by Slifer (1931-1938a); egg-maturation and cleavage by Slifer and King (1934); the development of the male genitalia by Else (1934); the development of the mid-gut by Stuart (1935); and the development of the nervous system by Baden (1936). Packard (1883) had long ago studied a few aspects of the embryology of the Rocky Mountain Locust, *Melanoplus spretus* Walsh. The development of the external form of embryos has been recently described by Jannone (1940) in the Moroccan Locust, *Dociostaurus maroccanus* (Thunb.), and by Steele [Andrewartha] (1941) in the Australian grasshopper, *Austroicetes cruciata* Sauss. Husain and Roonwal (1933) have studied the structure of the egg-wall and the micropylar apparatus in *Schistocerca gregaria* and a number of other Acrididae.

In the present paper on *Schistocerca gregaria* I have described firstly, the external form of the embryos from the moment of the first formation of the germ band until hatching, recognizing, in all, 18 stages for convenience of reference. Secondly, the peculiar bi-triangular concentration of the cephalic appendages towards the medial line is described and the law recently given by Roonwal (1939) concerning that phenomenon is confirmed. Finally, the origin and early development of the coelom is described. The ultimate fate of the coelomic cavities and other aspects of organogeny will be presented in a subsequent paper. Cleavage and gastrulation were not studied, as suitable developmental stages were not available.

This work was carried out in the Department of Zoology, Lucknow University, Lucknow, during the author's tenure of a University Research Fellowship for the years 1943 and 1944. I am deeply grateful to Prof. K. N. Bahl for working facilities and every form of encouragement. To Major M. L. Roonwal of the Zoological Survey of India I am grateful for placing at my disposal his entire material of fixed eggs and embryos that he had collected earlier and for valuable help and suggestions in the course of my work. My thanks are also due to Dr. B. N. Chopra, Offg. Director, Zoological Survey of India, for library and other facilities on many occasions, and to Dr. G. B. Banerjea, Principal, Government College, Sambalpur, Orissa, for various facilities during the latter part of this work.

MATERIAL AND METHODS.

The material for this work consisted of a large collection of well fixed eggs and embryos of various stages made several years ago in Baluchistan by Major M. L. Roonwal who also kindly supplied the following information regarding them: "The eggs were laid in sand in laboratory cages and were allowed to develop under semi-natural conditions; individual eggs were removed from the pod at desired intervals, and the embryos dissected out and fixed. The fixatives employed were hot alcoholic Bouin's fluid for the younger eggs, aqueous Bouin's fluid for the younger embryos, and Carnoy's fluid (Formula No. 2) for the older eggs and embryos. The fixed material was preserved in 90-95 per cent. alcohol." When examined for study after nearly 7 years, it was found to have undergone no deterioration, and whole embryos and sections stained excellently. Up to blastokinesis, the age of the embryos in the original material was indicated in days. Since however, the eggs were incubated under varying conditions, a reference scale of embryos, with 18 stages in all, was drawn up from selected whole mounts, in order to obtain comparable stages. In the post-blastokinesis period, when differentiation is comparatively slow, the age is also referred to in terms of the number of days from the moment of blastokinesis, as indicated in the original material. Embryos were embedded in paraffin wax (M. P. 52° C.) for 2 to 10 minutes, depending on size, and sections 8 to 10 μ thick were cut. The sections were stained with Delafield's haematoxylin and orange G,

REFERENCE SCALE OF EMBRYONIC STAGES.

(Plate III, Figs. 14-22 ; and Pl. IV, Figs. 23-31.)

Eighteen stages were recognized from the early formation of the germ band until hatching. The actual specimens in the reference scale consisted of stained whole mounts of embryos up to blastokinesis (Stages 1-12), and, thereafter, of spirit specimens, each stage being represented by a single embryo. All other embryos, whether for section-cutting or any other purpose, were referred to this standard scale. The distinguishing morphological characteristics, especially external, of the various stages are briefly described below ; some measurements are also given in Table I.

Stage 1 (Pl. III, Fig. 14). The germ band is differentiated into a protocephalon and a protocorm only, and is about 0·8 mm. long.

Stage 2 (Pl. III, Fig. 15). The embryo is similar to Stage 1, but is now about 1·3 mm. long.

Stage 3 (Pl. III, Fig. 16). The protocorm is now differentiated into 3 apparent segments—the anterior, posterior and middle—, thus making, along with the protocephalon, 4 segments in the embryo. This segmentation evidently corresponds to the primary segmentation in *Locusta* (Roonwal, 1936a), and later leads to the definitive body segmentation. The embryo is about 1·6 mm. long.

Stage 4 (Pl. III, Fig. 17). The mesodermal rudiments of the labrum and the antennae, and the rudiments of the eyes and the stomodaeum are developed on the protocephalon. The protocorm is now divisible into two parts—a broad anterior half comprising the 3 jaw and the 3 thoracic segments ; and a narrow posterior half comprising the abdomen. In the former the rudiments of the mandibles, the first and second maxillae and the three thoracic legs are seen, while in the latter the rudiments of the first two abdominal appendages are visible. The embryo is about 1·7 mm. long.

Stage 5 (Pl. III, Fig. 18). The rudiments of the various appendages of Stage 4 have now grown into lateral evaginations, and the early rudiments of the third and fourth abdominal appendages are seen. The stomodaeum first appears in this stage. The embryo is about 2 mm. long.

Stage 6 (Pl. III, Fig. 19). The stomodaeal invagination is deepened and is about 0·08 mm. long. The early rudiments of the fifth and sixth abdominal appendages are now visible. The embryo is about 2·4 mm. long.

Stage 7 (Pl. III, Fig. 20). The stomodaeum is about 0·12 mm. long. The first six abdominal appendages are now in the form of lateral outgrowths, and the early rudiments of the seventh and eighth abdominal appendages are visible. The proctodaeal invagination makes its appearance. The embryo is about 2·5 mm. long.

Stage 8 (Pl. III, Fig. 21). The stomodaeum is about 0·14 mm. long. The body appendages are considerably elongated but not yet segmented. The first pair of abdominal appendages or pleuropodia are now much larger than the remaining abdominal appendages. The rudiments of

the seventh, eighth, and ninth pair of abdominal appendages now appear. The proctodaeum elongates and is about 0.16 mm. long. The embryo is about 2.6 mm. long.

Stage 9 (Pl. III, Fig. 22). The labrum has now shifted to the ventral side and covers the oral aperture. The stomodaeum measures about 0.32 mm. and the proctodaeum about 0.26 mm. in length. The jaw and thoracic appendages exhibit segmentation. In the first maxillae the rudiments of the lacina, galea and maxillary palps are differentiated; in the second maxillae the palps are distinguishable; the thoracic legs show differentiation into 5 joints, thus: joint representing the combined segments of the subcoxa, coxa and trochanter; femur; tibia; tarsus; and the terminal joint. All the eleven abdominal appendages are now developed. The embryo is about 2.9 mm. long.

Stage 10 (Pl. IV, Fig. 23). The stomodaeum measures about 0.38 mm. and the proctodaeum about 0.36 mm. in length. The thoracic appendages, especially the metathoracic ones, have grown considerably. The embryo is stouter and broader and measures about 3 mm. in length.

Stage 11 (Pl. IV, Fig. 24). The stomodaeum is about 0.44 mm. and the proctodaeum 0.5 mm. long. The two labial appendages have shifted close to each other in the median line prior to complete fusion. The pleuropodia are considerably enlarged. The embryo measures about 3.1 mm. in length.

Stage 12 (Pl. IV, Fig. 25). Blastokinesis occurs in this stage, and the embryo is bent double into a U-shape before turning round completely. The mouth-parts tend to concentrate around the oral aperture. The embryo is about 3.5 mm. long.

The remaining stages are timed in days after blastokinesis.

Stage 13 (Pl. IV, Fig. 26), one day after blastokinesis. The head thorax and abdomen are clearly demarcated from one another. The two compound eyes are very large and prominent and show the beginning of pigmentation (*vide* Roonwal, 1947a, p. 170). The tarsal joint of the thoracic legs becomes differentiated into its components. All the abdominal appendages disappear with the exception of the pleuropodia (1st), the 7th and those forming the genitalia (8th and 9th in females; and 9th and 10th in males) and the cerci (11th in both sexes). All along the anterior part of the abdomen a pair of closely apposed nerve cords with ganglia can be seen through the translucent wall of the embryo. The embryo is about 4 mm. long.

Stage 14 (Pl. IV, Fig. 27), two days after blastokinesis. The ganglionic rudiments of the ventral nerve cord can be clearly seen up to the posterior end of the abdomen. It is possible at this stage to easily differentiate the sexes by means of differences in the genitalia. The embryo measures about 5.2 mm. in length.

Stage 15 (Pl. IV, Fig. 28), three days after blastokinesis. The terminal tarsal joint of the thoracic legs develops a pair of claws. The genitalia become better defined. The embryo measures about 5.6 mm. in length.

Stage 16 (Pl. IV, Fig. 29), six days after blastokinesis. The embryo has grown considerably and now measures about 7.2 mm. in length. The hind-femur is greatly elongated and the genitalia are prominent.

TABLE I.
Measurements of embryos, in mm.

Stage No.	1	2	3	4	5	6	7	8	9	10	11	12*	13	14	15	16	17	18
Total length of embryo	0.8	1.3	1.6	1.7	2.0	2.4	2.5	2.6	2.9	3.0	3.1	3.5	4.0	5.2	5.6	7.2	8.7	9.0
Width of protocephalon (later, head in level of eyes).	0.5	0.6	0.7	0.6	0.5	0.6	0.7	0.7	0.9	1.1	0.8	1.4	1.5	1.6	1.4	1.3	1.4	1.4
Length of protocorm (later, thorax plus abdomen)	0.6	0.9	1.2	1.5	1.7	2.2	2.3	2.3	2.4	2.6	2.8	2.7	3.2	4.2	4.4	5.5	6.9	7.0
Length of thorax .. .. .	..	..	..	0.6	0.8	0.8	0.8	1.1	1.0	1.1	1.1	0.8	0.8	1.0	1.0	1.0	1.1	1.5
Length of abdomen .. .. .	..	..	..	0.8	0.9	1.4	1.4	1.2	1.4	1.5	1.7	1.9	2.4	3.2	3.4	4.5	5.7	5.5
Width of anterior region of protocorm (just posterior to 2nd thoracic legs).	0.3†	0.3†	0.36†	0.4	0.2	0.3	0.3	0.5	0.7	0.8	0.8	1.0	1.2	1.4	1.4	1.5	1.9	2.0
Width of posterior region of protocorm (in level of 4th abdominal segment).	0.3†	0.3†	0.36†	0.2	0.2	0.2	0.2	0.4	0.7	0.7	0.6	0.8	1.0	1.6	1.4	1.6	1.7	1.7
Vertical length of eye .. ..	..	..	..	..	..	..	..	..	..	..	..	0.57	0.63	0.65	0.65	0.7	0.95	1.3
Length of hind-femur .. .. .	..	..	..	..	..	..	..	..	..	..	..	0.5	0.96	1.1	1.1	2.5	2.9	3.3

*Blastokinesis.

†In stages 1-3, these two regions are not distinguishable.

Stage 17 (Pl. IV, Fig. 30), eight days after blastokinesis. The embryo measures about 8.7 mm. in length. Spines appear on the metathoracic tarsi.

Stage 18 (Pl. IV, Fig. 31), hatching. The embryo is about 9.0 mm. long.

LAW OF MEDIAL SHIFTING OF CEPHALIC APPENDAGES.

Some years ago Roonwal (1939) gave a new law of the bi-triangular medial concentration of the cephalic appendages in the Chilopoda and the Insecta, which runs as follows (p. 7):—

“The cephalic appendages lying in front of and behind the intercalary pair of appendages undergo a concentration,¹ both in phylogeny and in ontogeny, towards the median line. In this way, two hypothetical triangles, termed the ‘anterior or procephalic triangle’ and the ‘posterior or gnathocephalic triangle’ are formed, having a common base in the level of the intercalary appendages. The cephalic appendages occupy roughly either the sides or the apices of the triangles and *the degree of their final medial concentration is in direct proportion to their distance from the triangular base*. Before the final bi-triangular condition is achieved by the appendages, varying types of transitory shiftings are passed through.”

Observations on positions at the time of the first appearance and subsequent shifting of the cephalic appendages in the embryonic development of *Schistocerca gregaria* has shown (Pl. III, Figs. 1-13; Text-figs. 1 and 2; and Table 2) that Roonwal's Law is fully applicable to this insect.

Thirteen embryonic stages² (Pl. III, Figs. 1-13) from the time of the first appearance of the cephalic appendages until hatching were compared with regard to the position of these appendages. The bases or exact points of attachment of the appendages were determined by dissecting them out at the base. In the last three stages (Pl. III, Figs. 11-13) the clypeus, labrum and antennae were removed so as to fully expose the remaining cephalic appendages.

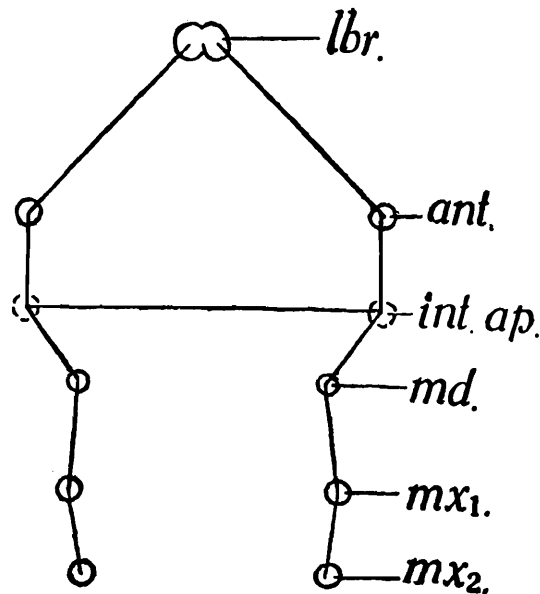
If the centres of the bases of the cephalic appendages, as they make their first appearance in the early embryo (Pl. III, Fig. 1), are joined, an outline diagrammatically represented in Text-fig. 1 is obtained; this is a modified H-position of Roonwal. The intercalary appendages are not quite clear in *Schistocerca*³, but their position is indicated by

¹ This concentration in *Schistocera gregaria*, as will be noticed in Table 2, is at first only *relative* to the increasing size of the embryo; the absolute distance between the appendicular bases of a segmental pair at first actually increases. Finally, of course, a decrease even in the absolute distance occurs towards the triangular apices, but not in those appendages which lie towards the triangular base. These points are implied in Roonwal's law, but need reemphasis.

² These “stages” are not synonymous with Stages 1-18 of the Reference Scale of embryos (Pl. III, Figs. 14-22; and Pl. IV) described above, but refer to the figures 1-13 on Pl. III.

³ In Stage 8 a pair of small appendage-like evaginations is seen (Text-fig. 3a) between the antennae and the mandibles in longitudinal sections; they could not, however, be demonstrated in surface views of embryos. In *Locusta* (Roonwal, 1937) intercalary appendages are marked by mere thickenings of the body-wall and develop rather late.

that of the intercalary mesoderm masses representing modified coelom sacs. Starting from that position, the antennae are the first pair of



TEXT-FIG. 1.—Diagrammatic representation of the cephalic appendages of *Schistocerca gregaria* as they first appear in the embryo.

ant., antennae; *int. ap.*, probable intercalary appendages; *lbr.*, labrum; *md.*, mandibles; *mx₁*, first maxillae; *mx₂*, second maxillae.

TABLE 2.

Distance (in mm.) between the centres of the bases of the two rudiments of each segmental pair of cephalic appendages.

(Figs. 1—8 before blastokinesis; Figs. 9—13, after blastokinesis.)

Stage (Fig. number in Pl. III).	Distance.			
	Antennae.	Mandibles.	First maxillae.	Second maxillae.
Fig. 1	0.26	0.18	0.20	0.18
Fig. 2	0.20	0.18	0.20	0.20
Fig. 3	0.33	0.23	0.20	0.20
Fig. 4	0.38	0.33	0.33	0.33
Fig. 5	0.28	0.46	0.48	0.48
Fig. 6	0.45	0.52	0.39	0.28
Fig. 7	0.52	0.66	0.50	0.38
Fig. 8. (Just before blastokinesis.)	0.42	0.51	0.38	0.31
Fig. 9. (One day after blastokinesis.)	0.50	0.80	0.80	0.50
Fig. 10. (Two days after blastokinesis.)	0.48	0.72	0.90	0.40
Fig. 11. (Four days after blastokinesis.)	0.48	0.62	0.86	Fused
Fig. 12. (Eight days after blastokinesis.)	0.75	0.90	0.96	Fused
Fig. 13. (Hatching.)	0.75	1.0	0.75	Fused

appendages on the procephalic side (Pl. III, Fig. 1); the preantennar appendages are absent in *Schistocerca*. The apex of the "procephalic triangle" is occupied by the labrum. On the gnathocephalic side (Pl. III, Fig. 2), the mandibles and the first and second maxillae follow in the order stated. The distances between the two members of each pair of appendages, as they vary from stage to stage (Pl. III, Figs. 1-13), are given in Table 2. It will be noticed that the three gnathocephalic appendages are almost equidistant from the median line at the moment of their first appearance (Pl. III, Fig. 1). During further development Pl. III, Figs. 2-11 and Text-fig. 2), the second maxillae, which are the farthest from the triangular base, undergo the greatest degree of *final*

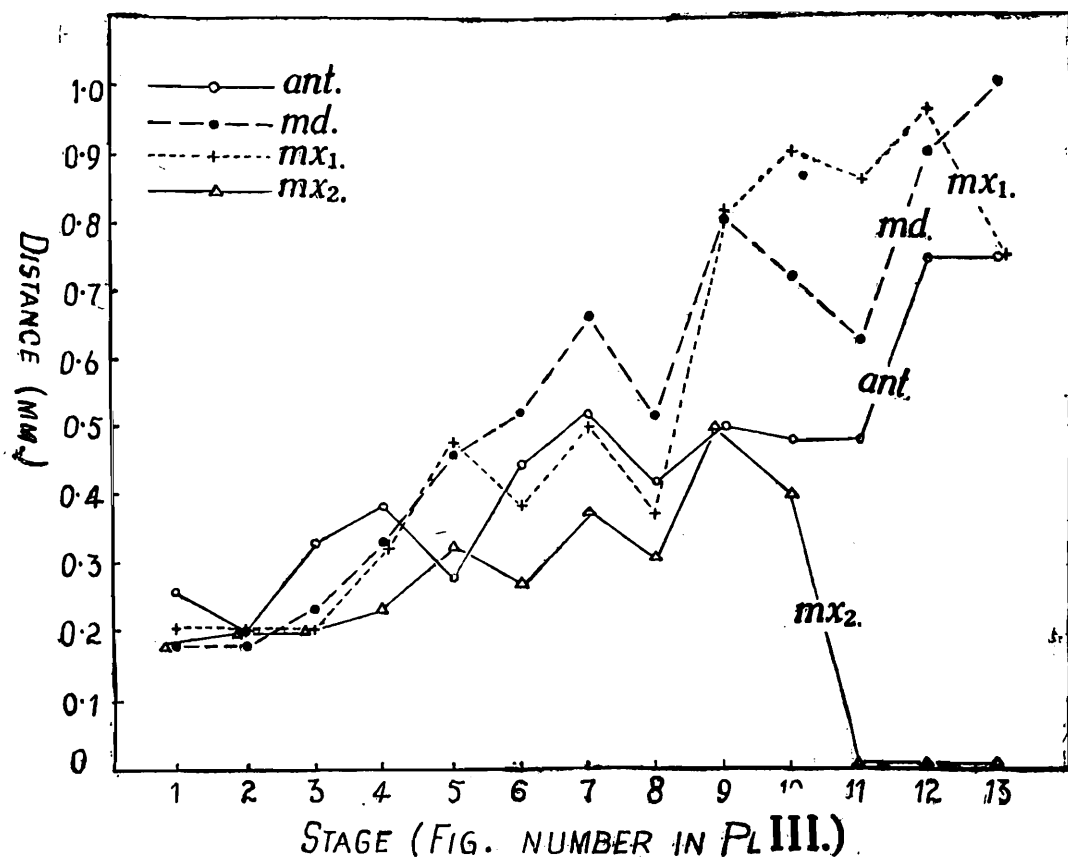
medial concentration and the two rudiments ultimately fuse together to form the labium (Pl. III, Fig. 11). The degree of final medial concentration of the first maxillae is less than that of the second maxillae, and that of the mandibles the least (Pl. III, Figs. 11-13), this being in accord with their respective distances from the triangular base.

In the procephalon the labral rudiments have evidently undergone a considerable degree of medial concentration in phylogeny as is indicated by their earliest rudiments appearing close to the median line (Pl. III, Figs. 1 and 17). The antennae, which are closer to the triangular base, undergo a lesser degree of medial concentration than the labrum.

FORMATION AND EARLY DEVELOPMENT OF COELOM.

Origin and Mode of First Formation of Coelomic Cavities.

The formation of coelom in *Schistocerca* first takes place in Stage 4. The germ band in Stage 3 (Pl. III, Fig. 16) is more or less semilunar in transverse section and measures about 0.7 mm. broad in the protocephalonic region and about 0.36 mm. in the protocormic. Soon after-



TEXT-FIG. 2.—Graph showing the developmental changes in the distance (in (mm.)) between the bases of a segmental pair of cephalic appendages in *Schistocerca gregaria* from the moment of their first appearance until hatching. The numerals on the abscissa correspond to stage of embryo as indicated by corresponding figure number in Plate III.

ant., antennae; md., mandibles; mx₁., first maxillae; mx₂., second maxillae.

wards (Stage 4), the germ band develops an outpushing in the mid-ventral area (Pl. V, Fig. 32) extending from a point slightly posterior

to the protocephalon to almost the tip of the protocorm. This outpushing quickly assumes the shape of a dorso-ventrally flattened pouch (Pl. V, Fig. 33). It enlarges with further development and, at the same time, its mouth widens. Both the ectoderm and the inner layer¹ are involved in the pouching. After the completion of pouching, one sees, along the lateral edges of the germ band, an incomplete tube open medially and composed of inner layer cells (Pl. V, Fig. 33). Soon afterwards, the two tubes close medially, and thus arise the coelom sacs (Pl. V, Figs. 34 and 35) of the jaw segments and of those that follow them.

Hitherto two modes of formation of coelom sacs have been known among insects. These are: (i) By the appearance of clefts in the solid inner layer, as in *Gryllus* (Heymons, 1895), *Gryllotalpa* (Graber, 1888, 1890, 1891b), *Calandra oryzae* (Mansour, 1927; Tiegs and Murray, 1938), *Formica* (Graber, 1888, Strindberg, 1913), and in all the abdominal segments, except the first, in *Locusta* (Roonwal, 1937). (ii) By the lateral margins of the germ band bending inward and dorsalward, the inner layer cells thus enclosing a cavity which forms the coelom, as in *Blatella* [= *Phyllodromia*, *Blatta*] *germanica* (Heymons, 1892, 1895), *Eutermes* (Strindberg, 1913), *Sialis* (Strindberg, 1915), *Diacrisia* (Johannsen, 1929), *Calandra callosa* (Wray, 1937), and in the cephalic, thoracic and the first abdominal segments in *Locusta* (Roonwal, 1937). *Schistocerca* shows an entirely new mode of coelom formation. In the jaw segments and those that follow them the coelom sacs arise before the body segmentation and as a result of the mid-ventral pouching of the germ band. In the remaining segments the coelom sacs arise by the first method described above.

Early Development of Coelom.

Nineteen pairs of coelom sacs are developed in *Schistocerca gregaria*—5 in the cephalic region, 3 in the thorax, and 11 in the abdomen. Their early development proceeds as follows.

Cephalic coelom sacs.

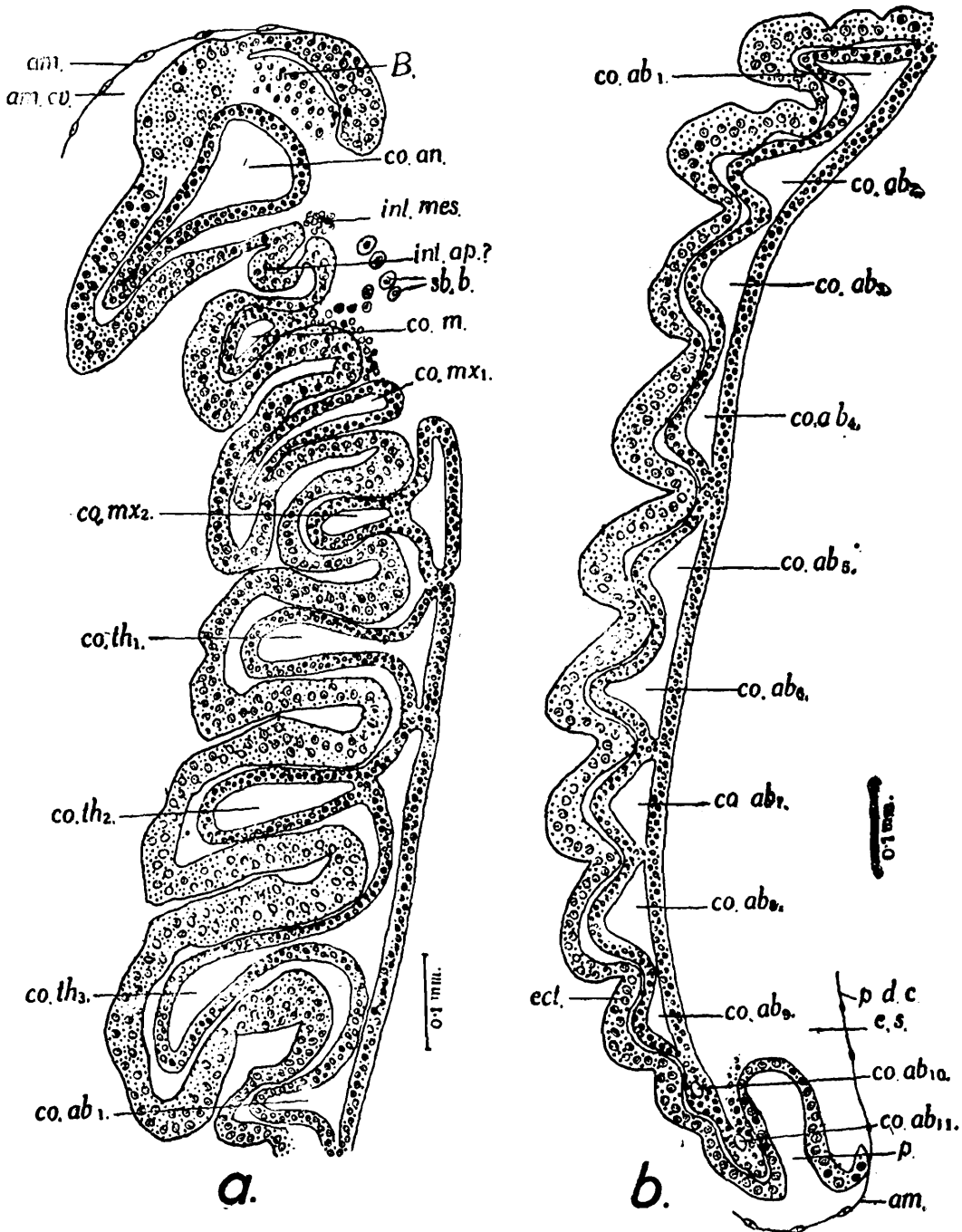
The five pairs of cephalic coelom sacs belong to the labral, antennary, mandibular, first maxillary and labial segments.

Labral coelom sacs (Pl. V, Figs. 36 and 37). A distinct pair of small and short-lived labral coelomic sacs arises in *Schistocerca* and are best developed in Stage 8. The labral mesoderm mass first makes its appearance in Stage 4 by the migration of cells from the stomodaeal mesoderm. In Stages 5-7 it becomes paired, but no cavities are as yet visible. These latter appear in Stage 8 (Pl. V, Figs. 36 and 37), and by Stage 9 they have disappeared. In Stage 8 a few mesoderm cells are seen lying in between the two labral coelom sacs and probably connecting them. In the same stage it is seen that the labral mesoderm is also connected with the stomodaeal mesoderm by means of loose cells lying between the two structures. In these features *Schistocerca* differs

¹ See Roonwal (1936a, 1937, 1939a) for a discussion of the terminology of the various germ layers in insects and other Arthropods.

from *Locusta* in which, according to Roonwal (1937), the labral coelom sacs are neither connected with each other medially nor with the stomodaeal mesoderm. In *Schistocerca*, even after the obliteration of the labral coelom sacs, the labral mesoderm remains connected with the stomodaeal mesoderm.

Clearly defined labral coelom sacs have hitherto been found only in four other insects, viz., *Carausius* (Wiesmann, 1926), *Rhodinus*, (Mellanby, 1935, 1936), *Locusta* (Roonwal, 1937, 1939b) and *Pteronarcys*



TEXT-FIG. 3.—Reconstruction, from camera lucida drawings, of several longitudinal-vertical sections of an embryo near Stage 9, showing the various coelomic cavities, etc.

(a), anterior half; and (b) posterior half of embryo. (Explanation of lettering as in Plates, p. 200.)

(Miller, 1940). In agreement with these authors, I am of the opinion that these sacs in *Schistocerca* represent true coelom sacs belonging to

the labrum. They are not mere extensions of the supposedly preantennary coelom, as opined by Manton (1928) for *Carausius*. Nor can they be regarded, as Snodgrass (1938) suggests, as unsegmental in nature merely by virtue of their acquiring a radial instead of a bilateral symmetry.

Antennary coelom sacs (Pl. V, Figs. 38, 39, 41 and 43). The antennary mesoderm first appears in Stage 4 as a pair of mesodermal cell-masses immediately posterior to the stomodaeal invagination and near the junction of the protocephalon with the protocorm. Soon afterwards, each of these masses develops a cavity, thus giving rise to the antennary coelom sacs. They first lie (Pl. V, Fig. 38) in the appendicular outgrowths which forms the antennae. From the time of its first appearance, the antennary mesoderm is connected with the stomodaeal mesoderm by loose mesodermal cell-strands. As in *Locusta* (Roonwal, 1937), the antennary coelom sacs are at first subcircular in shape, but with the growth of the antennae they elongate. Though composed throughout of a single layer of cells, the sac-walls do not remain uniformly thick. The ventro-median portions are considerably thickened, while the dorso-lateral portions are thinned down. By Stage 8 (Pl. V, Figs. 39 and 42) each antennary coelom sac has developed a large dorso-rostral pouch and a comparatively small dorso-anal pouch—for terminology of these pouches *vide* Wiesmann (1926) and Roonwal (1937). The antennary coelom thus has three pouches, *viz.*, a ventral, a dorso-rostral and a dorso-anal. The ventral pouch lies in the hollow of the antenna. The dorsal pouches occupy an extensive area in the head—the dorso-rostral reaching almost up to the labrum, and the dorso-anal up to the mandibles. Gradually, the two dorso-rostral pouches move towards each other and ultimately, by Stages 9-10 (Pl. V, Figs. 42 and 43), unite over the stomodaeum.

Intercalary mesoderm. Well defined intercalary coelom sacs do not occur in *Schistocerca*, but are represented, near Stage 9, by a pair of solid mesodermal cell-masses (Text-fig. 3a). In *Locusta* (Roonwal 1937), on the other hand, there occurs a distinct pair of intercalary coelom sacs.

Mandibular coelom sacs (Pl. VI, Fig. 44; and Text-fig. 3a). The mandibular coelom sacs first appear in Stage 4 as a pair of very small cavities in the mandibular segment. They gradually increase in size until they become quite large. They do not develop dorsal pouches which are characteristic of the coelom sacs of the antennary and some other segments—the mandibular coelom sacs correspond to the ventral pouches of these segments. From the dorsal wall of the mandibular coelom sacs certain cells move off medially, congregate in the middle below the oesophagus and thus constitute the suboesophageal body. The mandibular coelom sacs are connected with the maxillary sacs by means of mesodermal cell-strands, as in *Carausius* (Wiesmann, 1926) and *Locusta* (Roonwal, 1937).

First maxillary coelom sacs (Pl. VI, Fig. 48; and Text-fig. 3a). Like the mandibular coelom, the coelom of the first maxillary segment arises as a pair of very small cavities in the first maxillary mesoderm.

These cavities subsequently become considerably enlarged. The coelom sac of each side develops a small dorsal outgrowth which probably represents, in a rudimentary form, the well-developed dorsal pouches of the antennary coelom; this outgrowth does not develop any further. In *Locusta* (Roonwal, 1937) the dorsal pouch is not developed at all. The walls of the first maxillary coelom sacs are connected with those of the mandibular segment by means of a pair of mesodermal cell-strands.

Second maxillary or labial coelom sacs (Pl. V, Figs. 48-50; and Text-fig. 3a). The labial coelom first makes its appearance in Stage 4 as a pair of mesodermal sacs in the hollow of the second maxillary appendages. These sacs grow rapidly, and by Stage 7 they develop extensive dorso-rostral and rather smaller dorso-anal pouches. The former extend almost up to the first maxillary segment, while the latter extend towards the prothoracic legs but without reaching them. In the intersegmental area between the first and second maxillary segments, as well as in the latter segment itself, the dorso-rostral pouches of the labial coelom send down mesodermal cells towards the mid-ventral line where, in Stages 8-9, they meet. In this way a layer of median mesoderm connecting the two sacs is formed just above the ectoderm (Pl. VI, Fig. 49).

At the junction of the ventral pouch with the dorsal there develops, in Stage 8, a furrow which deepens and ultimately separates the two pouches (Pl. VI, Fig. 50).

Discussion : Segmentation of the head. In recent years Hanström (1927-1930), on the basis of the morphology of the brain, has revived Holmgren's (1916) view of a 4-segmental insect head. The value of this view is greatly reduced by the fact that Hanström completely ignores the embryological evidence not only as regards coelom sacs and appendages but also as regards neuromeres. Apart from this highly improbable view, the insect head is most commonly regarded as either 6- or 7-segmental. The evidence in support of these two views has been discussed by a number of authors, e.g., Wiesmann (1926), Eastham (1930), Imms (1937), Roonwal (1937, 1939b), Snodgrass (1935, 1938) and Weber (1938). Eastham, Imms and Weber support the 6-segmental view, and Wiesmann and Roonwal the 7-segmental view. The existence of the last five segments, viz., the antennary, intercalary or pre-mandibular, mandibular, first maxillary and second maxillary, is accepted by both groups of authors. In front of the antennary segment, however, some authors accept the existence of only one oral segment (given a variety of names), while others accept two, viz., preantennary and labral. Until recent years the evidence for the oral segment was based only on the presence of its neuromere, viz., the protocerebrum; no coelom sacs were known. Since the discovery of the labral and preantennary pairs of coelomic cavities by Wiesmann (1926) in *Carausius*, and the demonstration of the former alone in a number of other insects (*vide supra*), the evidence for the existence of 1 to 2 segments became stronger. Evidence for 2 segments based on the presence of 2 pairs of coelom sacs and 2 pairs of appendages (labral and preantennary in *Carausius*) was available, but the evidence from the neuromeres

was lacking as only one neuromere, the protocerebrum, had until recently been demonstrated. Recently, however, Roonwal (1939*b*, pp. 27-44), has provided a new interpretation of the composition of the protocerebrum. He has conclusively demonstrated, from developmental evidence in *Locusta* and other insects, that the protocerebrum is composite in nature and is composed of two pairs of neuromeres, and not of one. As will be shown in a subsequent paper, the protocerebrum in *Schistocerca* develops in the same way as in *Locusta*. Judging from these three pieces of evidence, the head of *Schistocerca* must be regarded as 7-segmental (Table 3).

TABLE 3.

Evidence for the composition of Schistocerca gregaria head.

+ present ; — absent.

Segment.	Coelom.	Neuromere.	Appendages.
1. Labral	+	+	+
2. Preantennary	—	+	—
3. Antennary	+	+	+
4. Intercalary	—*	+	+
5. Mandibular	+	+	+
6. First maxillary	+	+	+
7. Labial	+	+	+

*Doubtful.

Thoracic coelom sacs.

(Pl. VI, Figs. 45 and 52 ; and Text-fig. 3*a*.)

Each of the three thoracic segments, the pro-, meso-, and metothorax, develops a pair of coelomic cavities. These cavities first appear in Stage 4 as small sacs in the hollow of the appendages of each segment. Soon they develop dorso-rostral and dorso-anal pouches. These attain considerable development by Stage 8 when they extend lengthwise such that the posterior end of the dorso-anal pouch of one coelom sac abuts, in the intersegmental area, on the anterior end of the dorso-rostral pouch of the following segment (Pl. VI, Fig. 45). In *Locusta* (Roonwal, 1937), in the intersegmental areas, the distal tip of the rostral pouch of one segment lies beneath the proximal tip of the anal pouch of the preceding segment. In *Schistocerca* such an overlapping does not occur,

When the coelomic cavities first develop in Stage 4, the ventral wall of the mesoderm of each side extends towards the median line in the intersegmental area. These extensions later, in Stages 7 and 8, unite in the mid-ventral position and form the median mesoderm or blood cell-lamellae lying immediately above the ectoderm. In the segmental areas this change occurs in a later stage.

In Stage 8 a furrow develops at the junction of the dorso-rostral pouch with the ventral one. It gradually deepens and ultimately separates the two pouches in the same way as in the labial coelom. There thus come to exist in the labial and the three thoracic segments four pairs of dorsal pouches arranged serially, one set on either side of the mid-ventral line (Pl. VI, Fig. 45).

In Stage 12 there develops a horizontal partition in the dorsal pouch (in both the rostral and anal divisions) of the coelom, thus dividing this portion into upper and lower chambers. Graber (1888) had already recorded it in *Stenobothrus*, and Roonwal (1937) described it in *Locusta*. The later author has suggested that this partition is characteristic of the family Acrididae.

Abdominal coelom sacs.

(Pl. V, Fig. 40 ; Pl. VI, Figs. 51, 53 and 54 ; and Text-fig. 3.)

Eleven pairs of abdominal coelomic cavities are developed in *Schistocerca*, one pair in each segment. Their development proceeds from the anterior to the posterior end simultaneously with the differentiation of the respective abdominal segments. By Stage 9 all the abdominal coelom sacs are formed. As in the thorax, the abdominal coelomic cavities are differentiated into dorsal and ventral pouches. The latter are the first to appear and lie in the hollow of the appendages of their respective segments. Soon afterwards, dorsal pouches appear which quickly differentiate into dorso-rostral and dorso-anal portions. The dorsal pouches extend lengthwise from one end of the abdomen to the other (Text-fig. 3). Unlike the thoracic coelom sacs, the ventral pouches here do not get cut off from the dorsal pouches. The abdominal coelomic cavities become smaller as we proceed towards the posterior end of the abdomen, the cavities of the eleventh segment being the smallest (Pl. VI, Fig. 54). In *Locusta* (Roonwal, 1937) the eleventh abdominal coelom sacs differs from the others ; they consist of a pair of long, narrow cavities running dorsally along the proctodaeum. In *Schistocerca* this is not the case and the cavities are essentially similar to the other abdominal sacs, except in being smaller.

It will be seen that the dorsal pouches of the coelom form a continuous chain of cavities from the labium to the posterior tip of the abdomen. Later, with the disappearance of the intervening cellular walls between the dorso-rostral pouch of one coelom sac and the dorso-anal pouch of the preceding sac, these cavities are converted into a pair of mesodermal tubes running from the labium to almost the tip of the last abdominal segment.

Segmentation of the Body.

From developmental evidence, the body of *Schistocerca gregaria* is to be regarded as composed of 21 segments, thus : Cephalic 7, thoracic 3 and abdominal 11. The same has been shown for *Locusta* by Roonwal (1937, 1939b).

The 7-segmental nature of the head has been discussed above. No acron is developed in *Schistocerca*. Snodgrass (1938, p. 94) has suggested a new definition of the acron as meaning " a primarily unsegmented archicephalon corresponding with the annelid prostomium " Such an acron, according to Snodgrass, is represented in the Arthropod embryos by the cephalic lobes bearing the eyes, labrum, preantennae and first antennae. Snodgrass has not brought forward any considerable evidence in favour of this view. To me there appears to be no justification for altering the usually accepted definition of the acron as meaning the unpaired apical part of the Arthropod head lying in front of the first true segment. Such an acron is seen in the embryos of certain insects and Myriapods.

The three thoracic segments are clear and call for no comment.

The existence of eleven abdominal segments is supported by the presence of a corresponding number of paired coelom sacs, appendages and neuromeres, one set in each segment. The telson, found in some insect embryos, is absent in *Schistocerca*.

SUMMARY.

1. The external form of the embryos of the Desert Locust, *Schistocerca gregaria* (Forskål), from the time of the first formation of the germ band until hatching, is described. For convenience, a reference scale of 18 embryonic stages, whose characteristics are described, was made.

2. The first origin and the subsequent medial shifting of the cephalic appendages has been studied. It is shown that this shifting occurs in accordance with Roonwal's Law (1939) of " bi-triangular medial concentration ".

3. Three pairs of thoracic and eleven pairs of abdominal appendages are developed. The first three form the legs, while the majority of the latter are transitory.

4. The formation and early development of the coelom is described. A new mode of coelom formation, not hitherto described in insects, occurs in *Schistocerca*.

5. In the head the following five pairs of coelom sacs are developed : the labral, antennary, mandibular and first and second maxillary. Intercalary and preantennary coelom sacs are absent. The question of head segmentation is discussed and the *Schistocerca* head shown to be 7-segmented.

6. Three pairs of thoracic and eleven pairs of abdominal coelom sacs are developed, one pair to each segment.

7. The suboesophageal body arises from the dorsal wall of the mandibular coelom sacs.

8. The body of *Schistocerca* is regarded as composed of 21 segments --7 cephalic, 3 thoracic and 11 abdominal. Neither the acron nor the telson are developed.

REFERENCES.

- Andrewartha, H. G. 1941. See Steele, H. V.
- Baden, V 1936. Embryology of the nervous system in the grasshopper, *Melanoplus differentialis* (Acrididae, Orthoptera). *J. Morph.* LX, pp. 159-188.
- Eastham, L. E. S. 1930. The embryology of *Pieris rapae*. Organogeny. *Philos. Trans. roy. Soc. London (B)* CCXIX, pp. 1-50.
- Else, F. L. 1934. The developmental anatomy of male genitalia in *Melanoplus differentialis* [Locustidae (Acrididae), Orthoptera]. *J. Morph.* LXV, pp. 577-609.
- Graber, V 1888. Vergleichende Studien über die Keimhüllen und Rückbildung der Insekten. *Denkschr. Acad. Wiss. Wien* LV, pp. 109-162.
- 1888a. Über die Polypodie der Insektenembryonen. *Morph. Jahrb.* XIII, pp. 586-613.
- 1888b. Über die primäre Segmentierung des Keimstreife der Insekten. *Morph. Jahrb.* XIV, pp. 345-386.
- 1890. Vergleichende Studien am Keimstreifen der Insekten. *Denkschr. Acad. Wiss. Wien* LVII, pp. 622-734.
- 1891. Beiträge zur vergleichenden Embryologie der Insekten. *Denkschr. Acad. Wiss. Wien* LVIII, pp. 803-866.
- 1891a. Über die embryonale Anlage des Blut- und Fettgewebes der Insekten. *Biol. Centralbl.* XI, pp. 212-224.
- 1891b. Zur Embryologie der Insekten (*Meloe, Hydrophilus* und *Gryllotalpa*). *Zool. Anz.* XIV, pp. 286-291.
- Hanström, B. 1927. Das zentrale und periphere Nervensystem des Kopflappens einiger Polychäten. *Z. Morph. Ökol. Tiere* VII, pp. 543-596.
- 1928. *Vergleichende Anatomie des Nervensystems der wirbellosen Tiere unter Berücksichtigung seiner Funktion.* 628 pp. Berlin.
- 1928a. Die Beziehung zwischen dem Gehirn der Polychäten und dem der Arthropoden. *Z. Morph. Ökol. Tiere* XI, pp. 151-160.
- 1929. Weitere Beiträge zur Kenntnis des Gehirns und der Sinnesorgane der Polychäten. *Z. Morph. Ökol. Tiere* XIII, pp. 329-358.
- 1930. Über das Gehirn von *Termops nevadensis* und *Phyllium pulchrifolium*, nebst Beiträgen zur Phylogenie der Corpora pedunculata der Arthropoden. *Z. Morph. Ökol. Tiere* XIX, pp. 732-773.

- Heymons, R. 1892. Die Entwicklung der Cölomsäcke von *Phyllodromia (Blatta) germanica*. *Verhand. deutsch. zool. Gesell.*, pp. 139-141.
- 1895. *Die Embryonalentwicklung von Dermapteren und Orthopteren, unter besonder Berücksichtigung der Keimblätterbildung. Monographisch bearbeitet.* 136, pp. Jena.
- Hirschler, J. 1909. Die Embryonalentwicklung von *Donacia crassipes* L. *Z. wiss. Zool.* XCII, pp. 627-744.
- 1924-1927. *Embryogenese der Insekten.* In Schröder's *Handb. d. Ent.*, Bd. I, Kapital 10, pp. 570-752. Jena.
- Holmgren, N. 1916. Zur vergleichenden Anatomie des Gehirns von Polychaeten, Onycophoren, Xiphosuren, Arachniden, Crustaceen, Myriapoden und Insekten. *Kungl. Svenska Vetensk. Akad. Handl.* LVI (1), pp. 1-303.
- Husain, M.A. and Roonwal, M. L. 1933. Studies in *Schistocerca gregaria* Forsk. I. The micropyle in *Schistocerca gregaria* and some other Acridiidae. *Indian J. agric. Sci.* III, pp. 639-645.
- Imms, A. D. 1937. *Recent Advances in Entomology.* (2nd ed.). London.
- Jannone, G. 1940. Studio morfologico, anatomico e istologico del *Dociostaurus maroccanus* (Thunb.) nelle sue fasi *transiens congregans, gregaria e solitaria*. Terzo contributo. *Boll. Lab. Ent. agraria Portici* IV, pp. 1-443.
- Johannsen, O. A. 1929. Some phases in the embryonic development of *Diacrisia virginica* Fabr. (Lepidoptera). *J. Morph.* XLVIII, pp. 493-542.
- Johannsen, O. A. and Butt, F. H. 1941. *Embryology of Insects and Myriapods.* New York and London.
- Mansour, K. 1927. The development of the larval and adult mid-gut of *Calandra oryzae* Linn., the rice weevil. *Quart. J. micr. Sci.* LXXI, pp. 313-352.
- Manton, S. M. 1928. On the embryology of a Mysid Crustacean, *Hemimysis lamornae*. *Philos. Trans. roy. Soc. London* (B) CCXVI, pp. 363-463.
- Mellanby, H. 1935. The early embryonic development of *Rhodinus prolixus* (Hemiptera, Homoptera). *Quart. J. micr. Sci.* LXXVIII, pp. 71-90.
- 1936. The later embryology of *Rhodinus prolixus*. *Quart. J. micr. Sci.* LXXIX, pp. 1-42.
- Miller, A. 1939. The egg and early development of the stonefly, *Pteronarcys proteus* Newman (Plecoptera). *J. Morph.* LXIV, pp. 555-609.
- 1940. Embryonic membranes, yolk cells and morphogenesis of the stonefly, *Pteronarcys proteus* Newman (Plecoptera, Pteronarcidae). *Ann. ent. Soc. Amer.* XXXIII, pp. 437-477

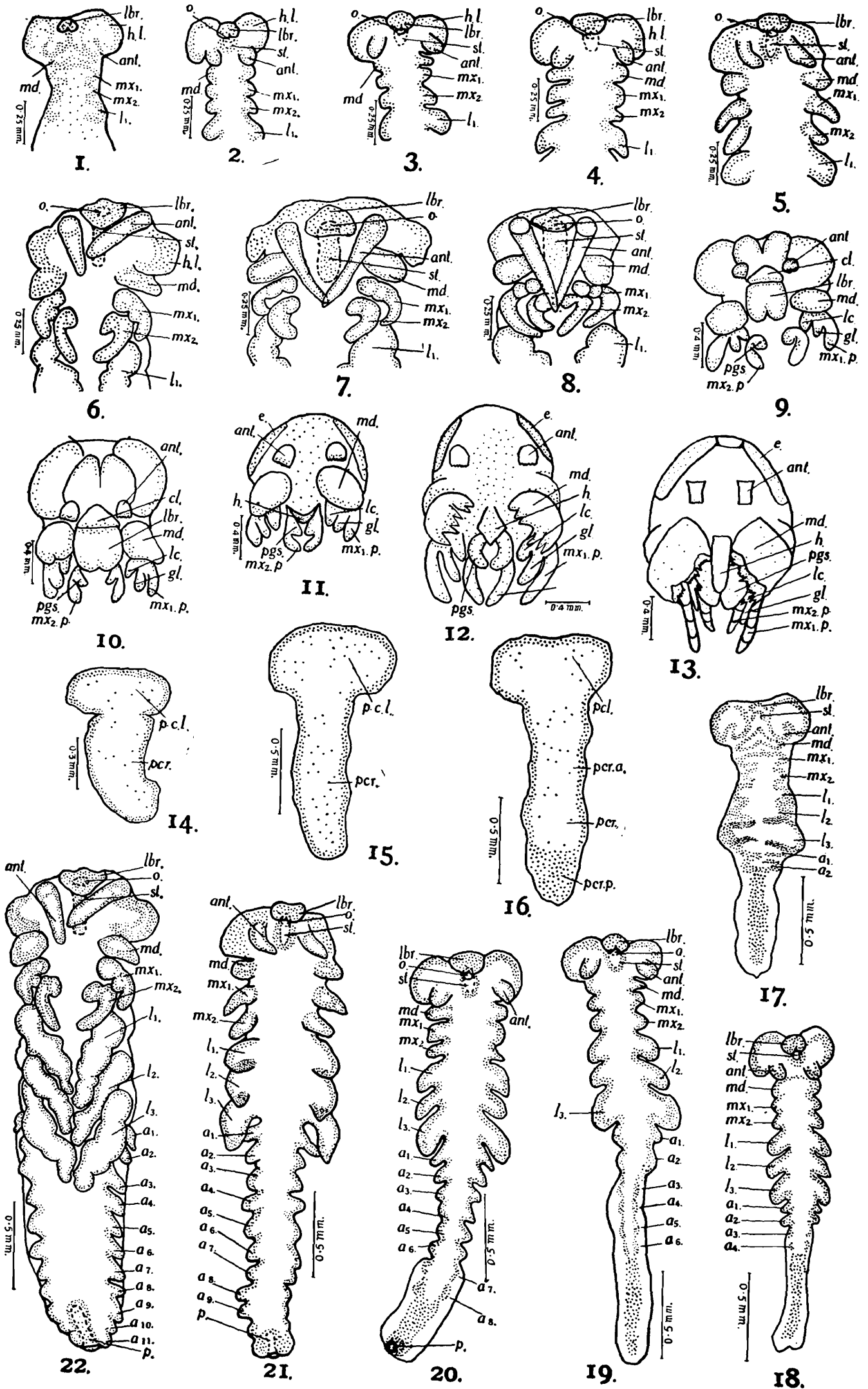
- Nelsen, O. E. 1931. Life cycle, sex differentiation and testis development in *Melanoplus differentialis* (Acridiidae, Orthoptera). *J. Morph.* LI, pp. 467-526.
- 1934. The development of the ovary in the grasshopper, *Melanoplus differentialis* (Acridiidae, Orthoptera). *J. Morph.* LV, pp. 515-543.
- 1934a. The segregation of the germ cells in the grasshopper, *Melanoplus differentialis* (Acridiidae, Orthoptera). *J. Morph.* LV, pp. 544-575.
- Packard, A. S. 1883. The embryological development of the locust. *Third Rept. U. S. ent. Commiss.*, pp. 263-286.
- Roonwal, M. L. 1935. Über das Schneiden dotterreicher Eier. *Zool. Anz.* CX, pp. 17-18.
- 1935a. Fate of the embryonic membranes in insects. *Curr. Sci.* IV, pp. 317-318. [Correction in *Curr. Sci.* IV, p. 779 (1936).]
- 1936. The growth-changes and structure of the egg of the African Migratory Locust, *Locusta migratoria migratorioides* R. & F. (Orthoptera, Acrididae). *Bull. ent. Res.* XXVII, pp. 1-14.
- 1936a. Studies on the embryology of the African Migratory Locust, *Locusta migratoria migratorioides* R. and F. (Orthoptera, Acrididae). I. The early development, with a new theory of multi-phased gastrulation among insects. *Philos. Trans. roy. Soc. London (B)* CCXXVI, pp. 391-421.
- 1937. Studies on the embryology of the African Migratory Locust, *Locusta migratoria migratorioides* Reiche and Fm. II. Organogeny. *Philos. Trans. roy. Soc. London (B)* CCXXVII, pp. 175-244.
- 1939. On a new law of the bi-triangular medial concentration of the cephalic appendages in the Chilopoda and the Insecta. *J. Morph.* LXIV, pp. 1-8.
- 1939a. Amplification of the theory of multi-phased gastrulation among insects, and its applicability to some other Arthropods. *Trans. nation. Inst. Sci. India* II, pp. 1-37.
- 1939b. Some recent advances in insect embryology, with a complete bibliography of the subject. *J. roy. Asiat. Soc. Bengal (Science)* (N. S.) IV (1938), pp. 17-105.
- 1942. Earliest observation on the swelling of insect eggs after oviposition. A historical note. *Indian J. Ent.* IV, pp. 145-151.
- 1947. Variation and structure of the eyes in the Desert Locust, *Schistocerca gregaria* (Forskål). *Proc. roy. Soc. London (B)* CXXXIV, pp. 245-272, 3 pls.

- 1947a. Studies in intraspecific variation. IV The role of some variations, *e.g.*, eye-stripes, etc., as "population indicators" in the Desert Locust, and their practical importance. *Rec. Indian. Mus.* XLV, pp. 167-180.
- Slifer, E. H. 1931. Insect development. II. Mitotic activity in the grasshopper embryo. *J. Morph.* LI, pp. 613-618.
- 1932. Insect development. III. Blastokinesis in the living grasshopper egg. *Biol. Centralbl.* LII, pp. 224-229.
- 1932a. Insect development. IV External morphology of the grasshopper embryos of known age and with a known temperature history. *J. Morph.* LIII, pp. 1-23.
- 1938. The formation and structure of a special water-absorbing area in the membrane covering the grasshopper egg. *Quart. J. micr. Sci.* LXXX, pp. 437-457
- 1938a. A cytological study of the pleuropodia of *Melanoplus differentialis* (Orthoptera, Acrididae) which furnishes new evidence that they produce the hatching enzyme. *J. Morph.* LXIII, pp. 181-205.
- Slifer, E. H. and King, R. L. 1934. Insect development. VII. Early stages in the development of the grasshopper eggs of known age and with a known temperature history. *J. Morph.* LVI, pp. 593-601.
- Snodgrass, R. E. 1935. *Principles of Insect Morphology.* New York.
- 1938. Evolution of the Annelida, Onychophora and Arthropoda. *Smiths. misc. Coll.* XCVII, pp. 1-159.
- Steele, H. V [Mrs. H. G. Andrewartha.] 1941. Some observations on the embryonic development of *Austroicetes cruciata* Sauss. (Acrididae) in the field. *Trans. roy. Soc. S. Australia* LXV, pp. 329-332.
- Strindberg, H. 1913. Embryologische Studien an Insekten. *Z. wiss. Zool.* CVI, pp. 1-227.
- 1915. Hauptzüge der Entwicklungsgeschichte von *Sialis lutaria*. *Zool. Anz.* XLVI, pp. 167-185.
- Stuart, R. R. 1935. The development of the mid-intestine in *Melanoplus differentialis* (Acrididae, Orthoptera). *J. Morph.* LVIII pp. 419-438.
- Tiegs, O. W and Murray, F. V 1938. The embryonic development of *Calandra oryzae*. *Quart. J. micr. Sci.* LXXX, pp. 159-284.
- Uvarov, B. P. 1928. *Locusts and Grasshoppers.* London.
- Weber, H. 1938. Morphologie und Entwicklungsgeschichte der Arthropoden. *Fortschr. Zool.* (Neue Folge) III, pp. 55-92.
- Wheeler, W. M. 1893. A contribution to insect embryology. *J. Morph.* VIII, pp. 1-160.

- Wiesmann, R. 1926. Zur Kenntnis der Anatomie und Entwicklungsgeschichte von *Carausius morosus* Br. IV. Entwicklung und Organogenese der Cölomblasen von *Carausius morosus* Br. (Inaugural Dissertation.) Pp. 123-328. Jena.
- Wray, D. L. 1937. The embryology of *Calandra callosa* Olivier, the Southern Corn Billbug (Coleoptera, Rhynchophoridae). *Ann. ent. Soc. Amer.* XXX, pp. 361-409.

EXPLANATION OF LETTERING IN PLATES III TO VI.

a_1 - a_{11} , 1st to 11th abdominal appendages; ab_1 - ab_{11} , 1st to 11th abdominal segments; *am.*, amnion; *am. cv.*, amniotic cavity; *ant.*, antenna; *B.*, Brain; *b.c.*, blood cells; *cbl.*, cardioblasts; *cer.*, cercus; *cl.*, clypeus; *co.*, coelom; *co. ab₁-co. ab₁₁*, 1st to 11th abdominal coelomic cavities; *co. an.*, antennary coelom; *co. lb.*, labral coelom; *co. m.*, mandibular coelom; *co. mx₁*, first maxillary coelom; *co. mx₂*, second maxillary or labial coelom; *co. th₁-co. th₃*, 1st to 3rd thoracic coelomic cavities; *da.co.*, dorso-anal pouch of coelom; *d. co₁*, *d. co₂*, upper and lower portions of the dorsal coelomic pouches; *d. co. mx₂*, dorsal pouch of second maxillary coelom; *dr.co.*, dorso-rostral pouch of coelom; *dr.co.an.*, dorso-rostral pouch of antennary coelom; *dr. co.mx₂*, dorso-rostral pouch of 2nd maxillary coelom; *d.y.c.*, degenerating yolk cells; *e.*, eye; *ect.*, ectoderm; *ect.lbr.*, labral ectoderm; *e.s.*, epineural sinus; *f.*, furrow between dorsal and ventral pouches; *gl.*, galea; *h.l.*, head lobes; *h.s.*, horizontal septum; *in. l.*, inner layer; *int. ap.?*, probable rudiments of intercalary appendages; *int. mes.*, intercalary mesoderm; *l₁-l₃*, 1st to 3rd thoracic legs; *lbr.*, labrum; *lbs₁*, *lbs₂*, 1st and 2nd lateral blood sinuses. *lc.*, lacinia; *l.mb.*, lateral myoblast plate; *md.*, mandible; *mes. lbr.*, labral mesoderm; *mm.*, median mesoderm; *mx₁*, *mx₂*, 1st and 2nd maxillae; *mx₁.p.*, *mx₂.p.*, 1st and 2nd maxillary palps; *nb.*, neuroblasts; *n.gr.*, neural groove; *n.c.*, nerve cells; *o.*, oral aperture; *ovp₈*, *ovp₉*, lower and upper ovipositor valves; *P.*, mid-ventral pouch of germ band, leading to coelom formation; *p.*, proctodaeum; *pcl.*, protocephalon; *pcr.*, protocorm; *pcr.a.*, anterior portion of protocorm; *pcr. m.*, middle portion of protocorm; *pcr. p.*, posterior portion of protocorm; *p.d.c.*, provisional dorsal closure; *p. ect.*, proctodaeal ectoderm; *pgs.*, paraglossa; *p.mes.*, proctodaeal mesoderm; *sb.b.*, suboesophageal body; *spl.m.*, splanchnic mesoderm; *st.*, stomodaeum; *st.m.*, stomodaeal mesoderm; *t₁*, anterior tentorial invagination; *v.co.*, ventral pouch of coelom; *v.co.an.*, ventral pouch of antennary coelom; *v.co.mx₂*, ventral pouch of second maxillary coelom; *v.w.*, ventral wall of coelom; *y.*, yolk.



EXPLANATION OF PLATE III.

FIGS. 1—13.

Camera-lucida drawings of anterior portions of embryos of *Schistocerca gregaria*, to illustrate the medial shifting of the cephalic appendages. In Figs. 9 and 10 the antennae, and in Figs. 11-13 the antennae, clypeus and labrum have been cut away at the base to expose the other appendages.

FIG. 1.—Embryo at the time of the first appearance of the cephalic appendages (about Stage 4). Note the modified H-position (*vide* Text-fig. 1).

FIGS. 2-8.—Embryos in progressive stages of development until shortly before blastokinesis (Fig. 8).

FIG. 9.—Embryo one day after blastokinesis.

FIG. 10.—Embryo two days after blastokinesis.

FIG. 11.—Embryo four days after blastokinesis.

FIG. 12.—Embryo eight days after blastokinesis.

FIG. 13.—Embryo at the time of hatching.

FIGS. 14—22.

Camera-lucida drawings of embryos of *Schistocerca gregaria*, showing developmental stages Nos. 1-9 of the Reference Scale.

FIG. 14.—Embryo in Stage 1.

FIG. 15.—Embryo in Stage 2.

FIG. 16.—Embryo in Stage 3.

FIG. 17.—Embryo in Stage 4.

FIG. 18.—Embryo in Stage 5.

FIG. 19.—Embryo in Stage 6.

FIG. 20.—Embryo in Stage 7.

FIG. 21.—Embryo in Stage 8.

FIG. 22.—Embryo in Stage 9.

EXPLANATION OF PLATE IV.

Camera-lucida drawings of embryos of *Schistocerca gregaria*, showing developmental stages Nos. 10-18 of the Reference Scale.

FIG. 23.—Embryo in Stage 10.

FIG. 24.—Embryo in Stage 11.

FIG. 25.—Embryo in Stage 12. During blastokinesis. The two arms of the bent embryo are shown here separately.

FIG. 26.—Embryo in Stage 13. One day after blastokinesis.

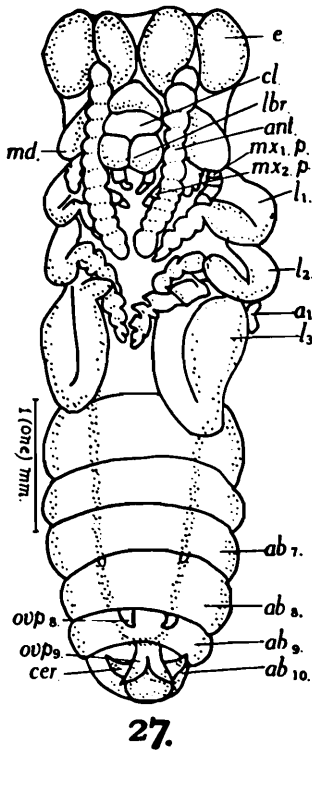
FIG. 27.—Embryo in Stage 14. Two days after blastokinesis.

FIG. 28.—Embryo in Stage 15. Three days after blastokinesis.

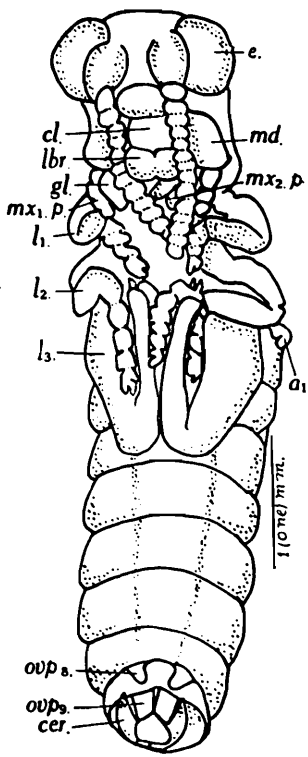
FIG. 29.—Embryo in Stage 16. Six days after blastokinesis.

FIG. 30.—Embryo in Stage 17. Eight days after blastokinesis.

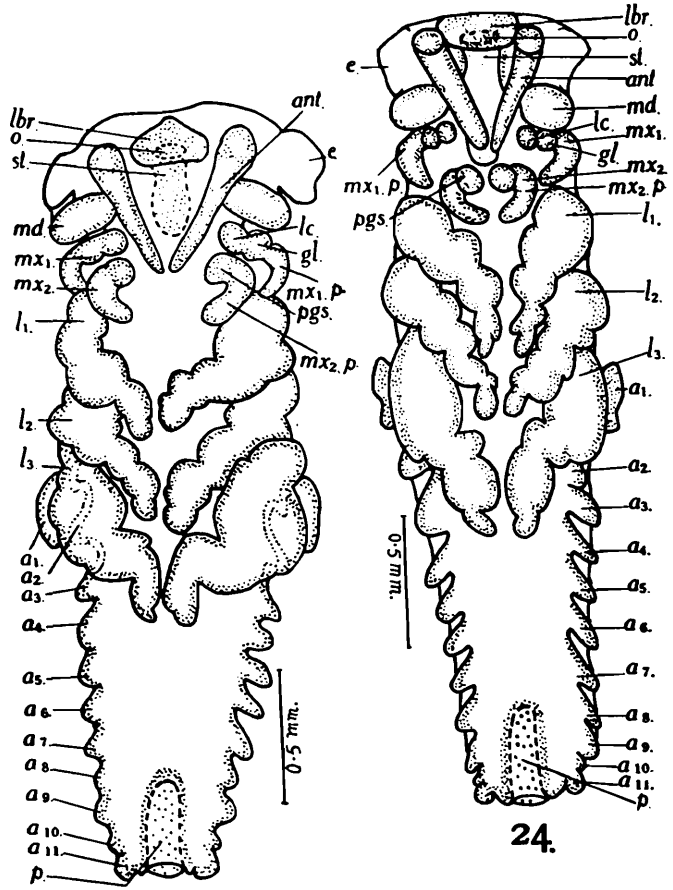
FIG. 31.—Embryo in Stage 18. Hatching.



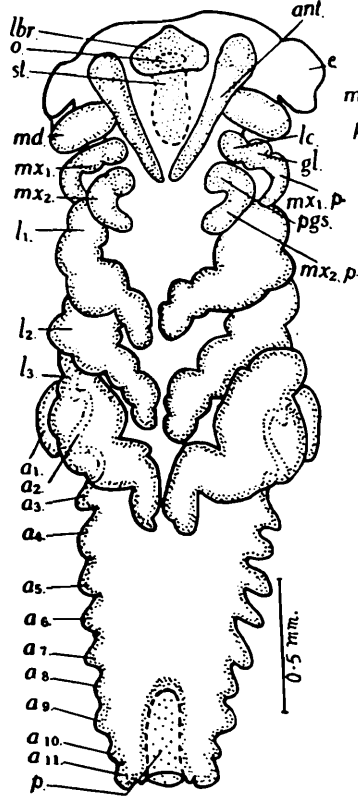
27.



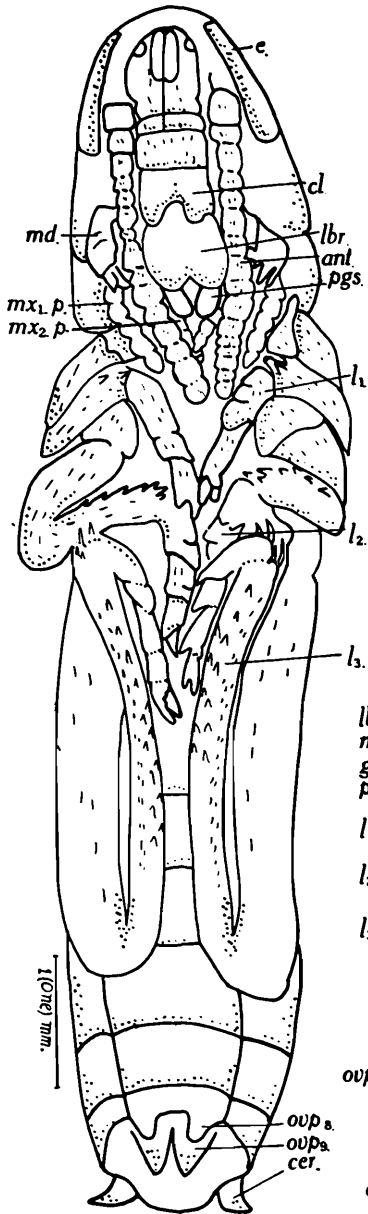
28.



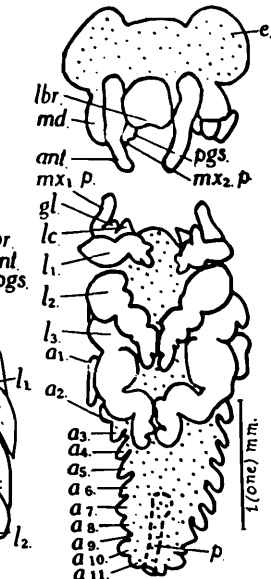
24.



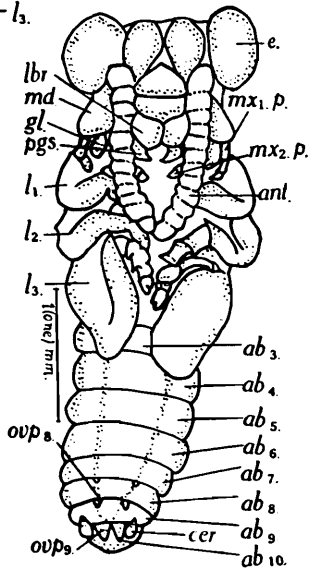
23.



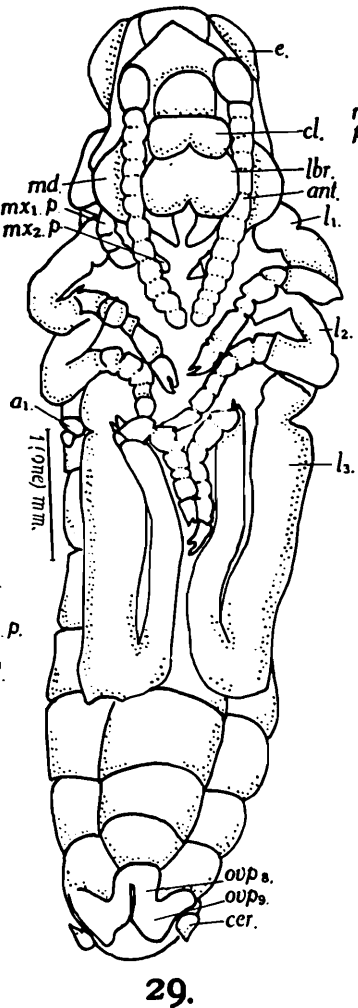
31.



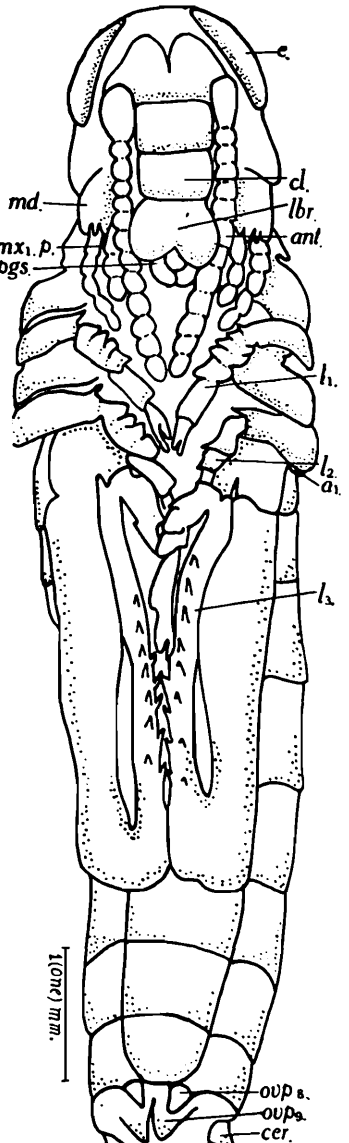
25.



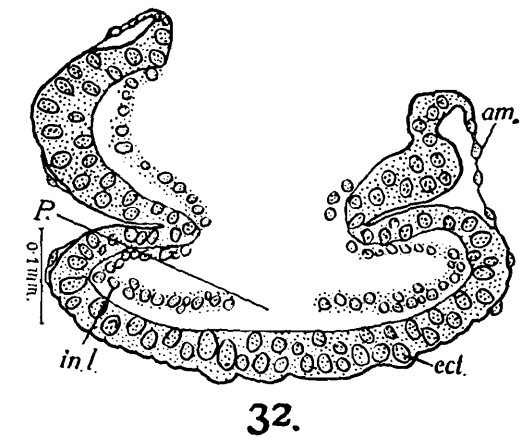
26.



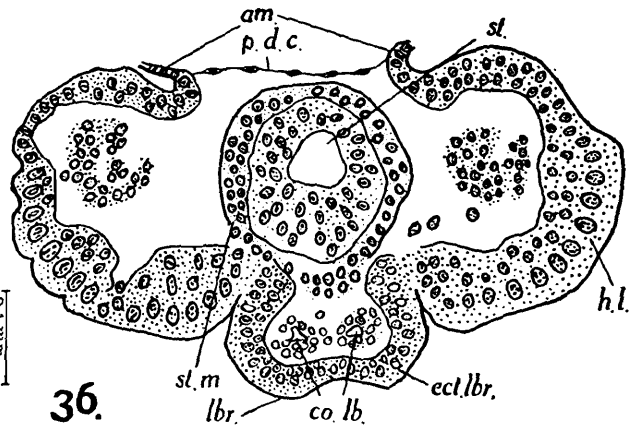
29.



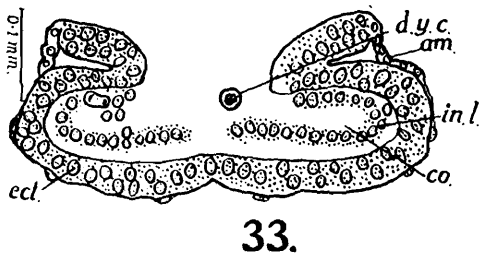
30.



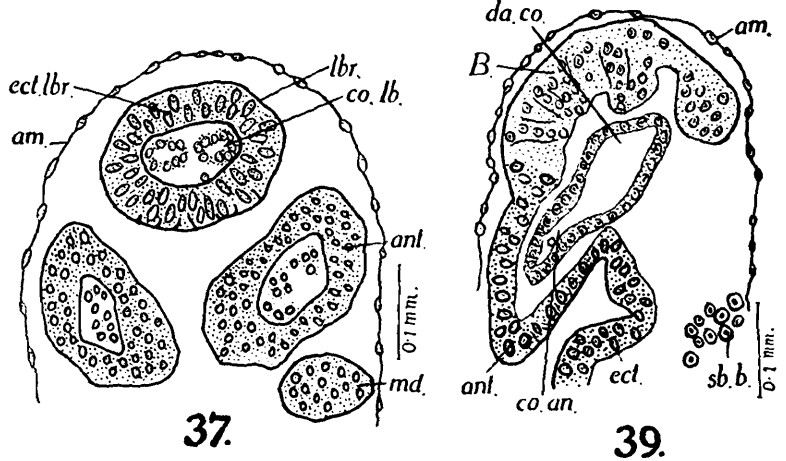
32.



36.

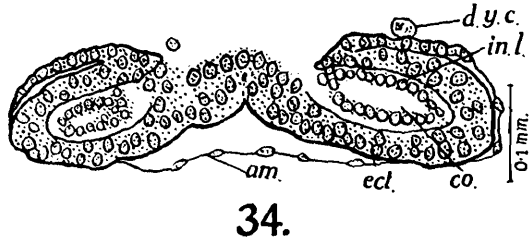


33.

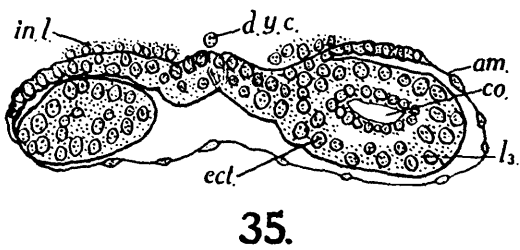


37.

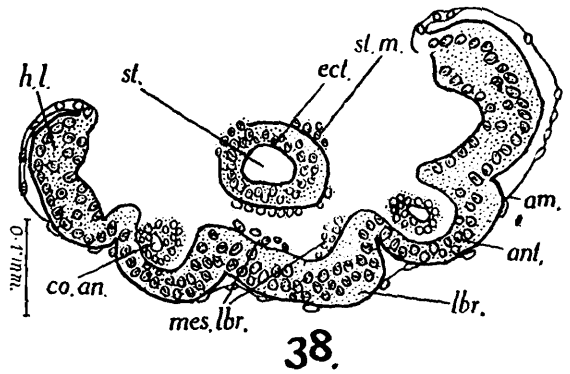
39.



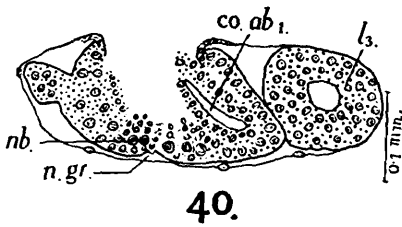
34.



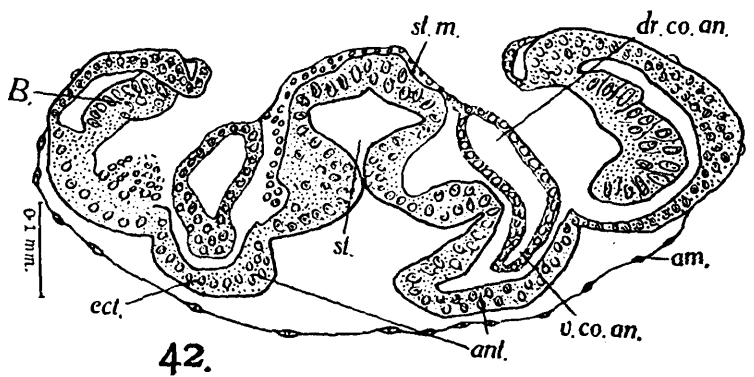
35.



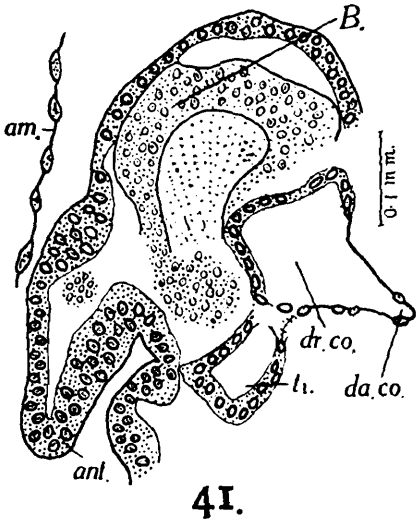
38.



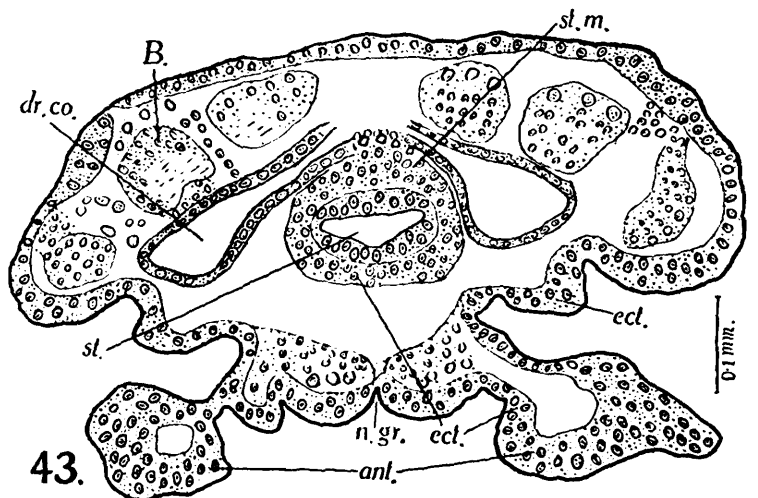
40.



42.



41.



43.

EXPLANATION OF PLATE V.

Camera-lucida drawings of portions of sections of embryos of *Schistocerca gregaria*, showing the early development of some of the coelomic cavities. (T. S., transverse section.)

FIG. 32.—T. S. of an embryo near Stage 3 across the protocorm, showing the ventral pouch leading to the formation of coelom.

FIG. 33.—Same, but across region slightly anterior to above, showing the coelomic pouches still open medianally.

FIG. 34.—T. S. of an embryo near Stage 4 across the metathoracic segment, showing the coelomic cavity of that segment.

FIG. 35.—Same, but across region slightly posterior to above, showing the ventral pouch of the coelom of the metathoracic segment; the pouch is seen extending into the appendage of that segment.

FIG. 36.—T. S. of an embryo in Stage 8 across the labrum, showing the labral coelomic cavities.

FIG. 37.—Portion of a longitudinal-horizontal section of an embryo in Stage 8 across the labrum, showing the paired labral coelomic cavities.

FIG. 38.—T. S. across the head lobes of an embryo near Stage 4, showing the antennary coelom when it is first formed.

FIG. 39.—Portion of a longitudinal-vertical section of an embryo in Stage 8, showing the ventral and dorso-rostral pouches of the antennary coelom.

FIG. 40.—T. S. (slightly oblique) of an embryo in Stage 4 across the first abdominal segment, showing the coelomic cavity of that segment.

FIG. 41.—Portion of a longitudinal-vertical section of an embryo in Stage 10 across the antennary segment, showing the dorso-rostral and dorso-anal pouches of the antennary coelom.

FIG. 42.—T. S. of an embryo in Stage 8 across the antennary segment, showing the ventral and the dorso-rostral pouches of the antennary coelom.

FIG. 43.—T. S. of an embryo in Stage 9 across the antennary segment, showing the union of the dorso-rostral pouches of the antennary coelom above the stomodaeum.

EXPLANATION OF PLATE VI.

Camera-lucida drawings of portions of sections of embryos of *Schistocerca gregaria*, showing the early development of coelomic cavities and other organs. (T. S., transverse section.)

FIG. 44.—T. S. of an embryo in Stage 8 across the mandibular segment, showing the origin of the suboesophageal body from the walls of the mandibular coelom sacs.

FIG. 45.—Portion of a longitudinal-horizontal section of an embryo^o in Stage 8, showing the dorsal coelomic pouches of the labial and the three thoracic segments. The dorso-rostral end of each pouch is seen abutting against the dorso-anal end of the one preceding it.

FIG. 46.—Portion of a longitudinal-horizontal section (slightly slanting) of an embryo in Stage 9, showing the ventral coelomic pouches of the first three abdominal appendages on the right and the dorsal pouches on the left.

FIG. 47.—T. S. (slightly oblique) of an embryo in Stage 8 across the seventh abdominal segment, showing the coelomic cavity of that segment.

FIG. 48.—T. S. of an embryo in Stage 8 across the first maxillary segment, showing the first maxillary coelom and the dorso-rostral pouch of the labial coelom.

FIG. 49.—T. S. of an embryo in Stage 8 across the intersegmental area between the first and second maxillary segments.

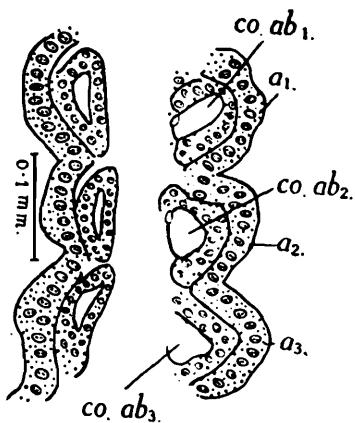
FIG. 50.—T. S. of an embryo in Stage 8 across the second maxillary segment, showing the ventral and dorsal pouches of the second maxillary coelom.

FIG. 51.—T. S. of an embryo in Stage 12 (during blastokinesis) across the third abdominal segment showing the horizontal septum in the dorsal pouch of the coelom of the abdominal segments. As the embryo is bent double, portions of 4th and 5th abdominal terga are also seen.

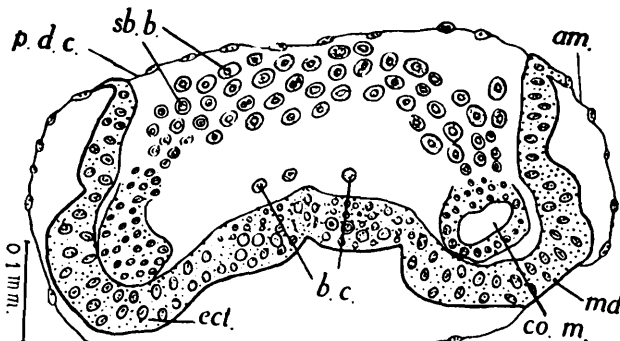
FIG. 52.—Portion of a longitudinal-horizontal section of an embryo in Stage 8, showing the dorsal coelomic pouches of the second maxillae and those of the three pairs of thoracic legs.

FIG. 53.—Longitudinal-horizontal section of an embryo in Stage 9 across the posterior end, showing the coelomic cavities of the tenth and eleventh abdominal segments.

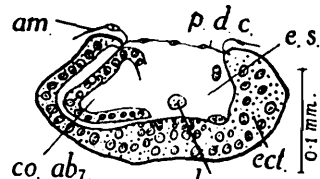
FIG. 54.—T. S. (slightly oblique) of an embryo in Stage 9 across the posterior end, showing the coelomic cavity of the eleventh abdominal segment.



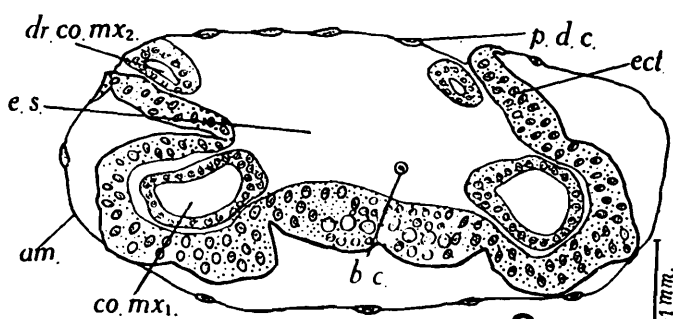
46.



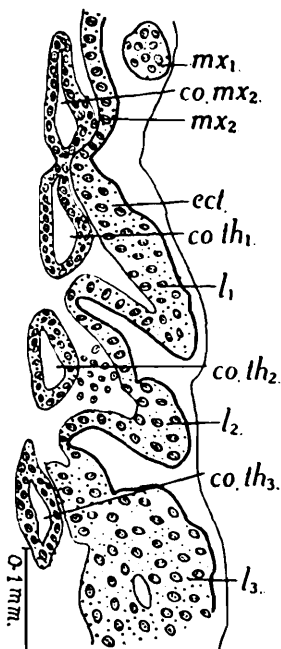
44.



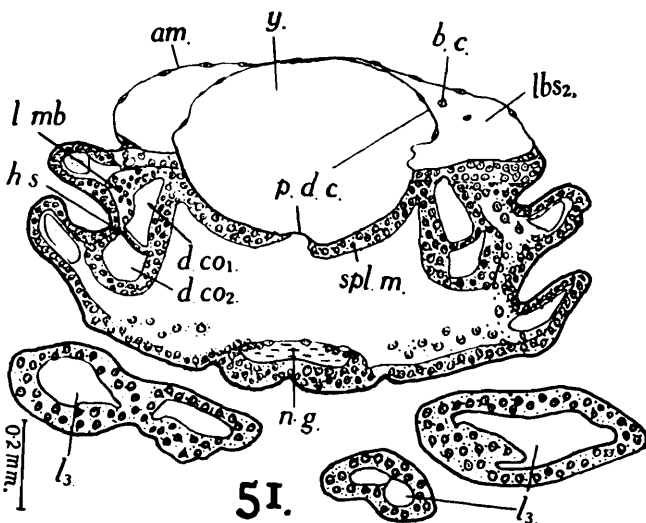
47.



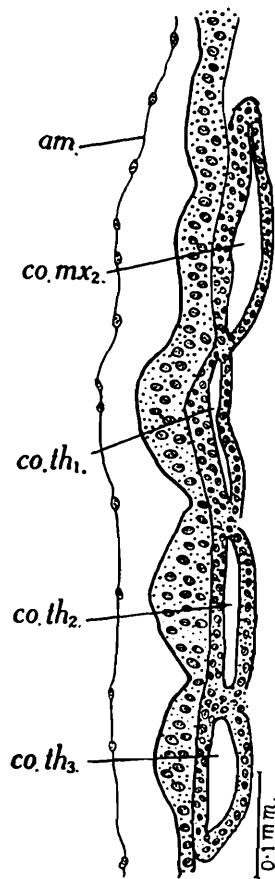
48.



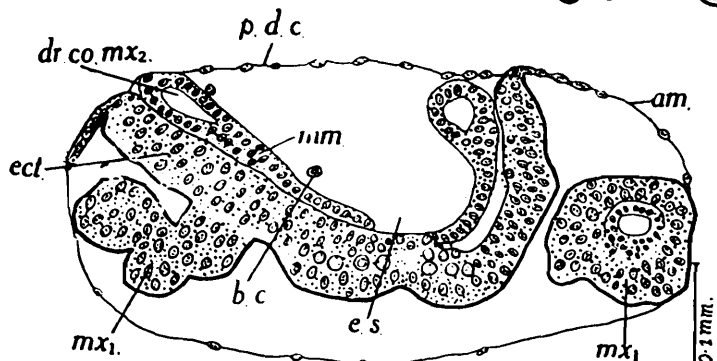
52.



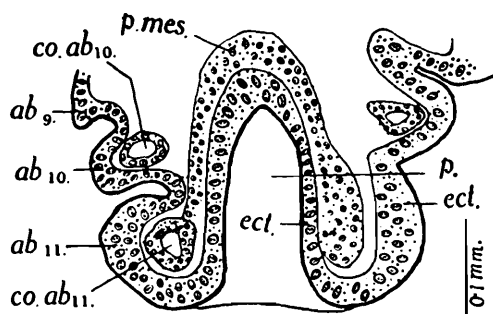
51.



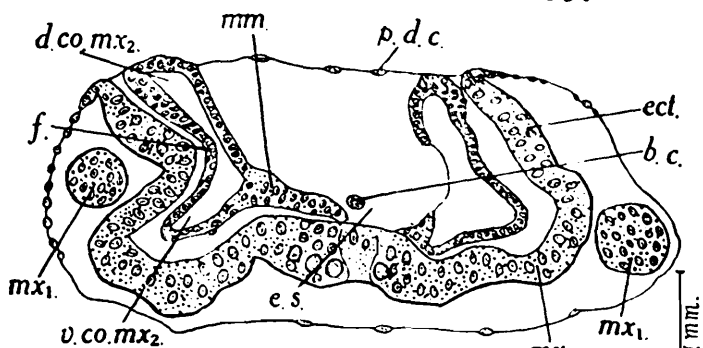
45.



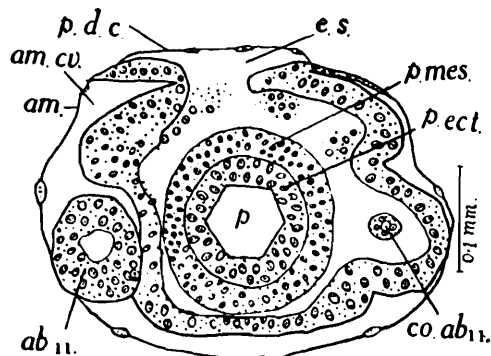
49.



53.



50.



54.

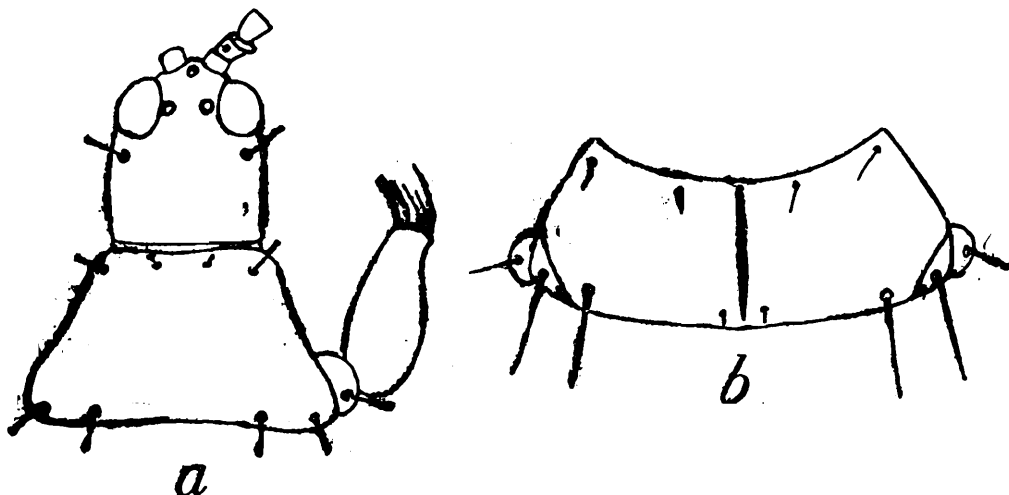
STUDIES ON INDIAN THYSANOPTERA. II.*

By SHUMSHER SINGH, B.Sc. Hons., Assoc. A.I.R.I.

My recent study of the collection of the Zoological Survey of India, Benares Cantonment, and the Imperial Pusa Collection, Indian Agricultural Research Institute, New Delhi, has enabled me, among other things, to record new food plants of some species or additional information on their geographic distribution; to discuss the systematic position of some species and to redescribe two species, wrongly or inadequately described previously.

I express my thanks to Dr. B. N. Chopra and Dr. H. A. Hafiz of the Zoological Survey of India and to Dr. Taskhir Ahmad of the Indian Agricultural Research Institute, New Delhi, for facilities to study the collections.

The species dealt with in the paper are:—*Thrips bambusae* Shumsher, *Hindsiana apicalis* Bagn., *Neoheegeria citripes* Bagn., *Podothrips aegypticus* Pr., *Chiridothrips indicus* (Ramk. & Marga), *Dichaetothrips gloveri* (Ramk. & Marga.), *Mallothrips indica* Ramk. and *Liothrips bosei* Moulton.



TEXT-FIG. 1.

- a. *Chiridothrips indicus* Ramk. & Marga. Head and prothorax-dorsal view.
b. *Dichaetothrips gloveri* (Ramk. & Marga.). Pronotum-dorsal view.

***Thrips bambusae* Shumsher**

1945. *Thrips bambusae*, Shumsher, *Indian J. Ent.*, VII, pp. 182-184.

Originally described from bamboo leaves, Mandalay (Burma) 26th November 1941. Now found on the same host, Coimbatore (S. India) 1st August 1944 (Shumsher Coll.!) along with *Limothrips* (*Neolimothrips*) *brachycephalus* Shumsher.

***Hindsiana apicalis* Bagn.**

1915. *Hindsiana apicalis*, Bagnall, *Ann. Mag. Nat. Hist.* (8), XV, p. 323.

1928. *Hindsiana apicalis*, Ramakrishna, *Mem. Dep. Agric. India* (Ent. ser.), X (7), p. 290.

1928. *Haplothrips ceylonicus* var. *veroniae*, Ramakrishna, *Mem. Dep. Agric. India* (Ent. ser.), X(7), p. 291 (*nec* Priesner).

1940. *Hindsiana apicalis*, Ramakrishna & Margabandhu, *Catalogue of Indian Insects*, Pt. 25, p. 35.

*Part I in *Proc. R. Ent. Soc. London* (B), XIII, 1944, pp. 139-144.

Along with many apterous males, females and nymphs collected by W. Kerr on *Cyanodon dactylon* in Ajmer on 29-9-1941, are found one male and two females with fully developed wings. The wings are rather feebly constricted in the middle, provided with a sparse fringe and no duplicate cilia. Wing lamina is transparent, colorless; scale brown. The three basal setae on costa of fore-wing are hyaline and clavate.

It is interesting that the absence of wings in either sex is not accompanied by any other modification, not even absence of or diminution in size of ocelli.

Hitherto recorded by Ramakrishna on grass and some wild flowers in Coimbatore and on a jungle plant in Almora (N. India). Now recorded from within leafsheath of *Zea mays* in Delhi 25th August 1940 (Shumsher Coll.) along with *Anaphothrips flavicinctus* Karny; on *dub* grass (*Cyanodon dactylon*) at Ajmer 29th September 1941 (W. Kerr Coll.) along with *Chirothrips manicatus* Haliday; and on grass in Karnal (Punjab) 11th August 1942 (Shumsher Coll.). Also collected in Delhi in very small numbers on *Tephrosia purpurea* flowers and *Capsicum annum* flowers and leaves, 11th September 1940 (Shumsher Coll.); and on flowers of *Phaseolus radiatus* 14th September 1940 (Niranjan Singh Coll.). Probably a graminivorous species wandering to these non-graminaceous plants from the surrounding grass.

Neoheegeria citripes Bagn.

1921. *Neoheegeria citripes*, Bagnall, *Ann. Mag. Nat. Hist.* (9), VII, pp. 360-361.

1928. *Neoheegeria citripes*, Ramakrishna, *Mem. Dept. Agric. India* (Ent. ser.), X(7), p. 288.

Recorded previously on *Abutilon indicum* in Pusa, Behar (C. S. Misra Coll.) and Coimbatore (Y. R. Rao Coll.). Now found on the same plant near Rupar, Punjab 12th October 1940 (Shumsher Coll.). Apparently a widely distributed monophagus species.

Podothrips aegypticus Pr.

1929. *Podothrips aegypticus*, Priesner, *Bull. Soc. Roy. Ent. Egypte* (New ser.), XIII, pp. 59-61.

In the above publication Priesner also provides a key for separating six species of *Podothrips* Hood, including *aegypticus*.

Originally described from millet in Gezirah (Egypt) F. C. Willcock Coll. Now recorded from bamboo leafsheath in Mandalay, Burma 26th November 1941 (Shumsher Coll.): apparently a subtropical graminivorous species.

Chiridothrips Ramk. & Marga.

1939. *Chiridothrips*, Ramakrishna & Margabandhu, *Rec. Ind. Mus.* XLI, p. 32.

On examination of the holotype in the collection of the Zoological Survey of India, the original characterisation of the genus is found inadequate. Hence it is recharacterised below:

Head longer than broad, dome-shaped. Vertex produced in front of eyes a little (as in *Leeuwenia* Karny). Cheeks faintly arched, without

seta bearing tubercles, smooth. Eyes small. Front ocellus on cephalic projection, hind ocelli contiguous to middle of eyes. Postocular seta swollen at tip. Antennae 8-segmented¹: 2nd segment with an external beak-like process at tip as in *Chirothrips* Haliday; segments 2-7 almost of equal length, segment 8 longer than 7. Mouth-cone roundly pointed at tip, just surpassing middle of prosternum.

Prothorax shorter than head, trapezoidal with front margin shorter and nearly straight and hind margin longer and concave, sides constricted in the middle. Fore femora strongly incrassate. Fore wings constricted in the middle. Tube about as long as head.

The "tooth-like projections" or "1 or 2 teeth" on the legs, emphasised by the protologists, were not seen.

The type species is redescribed below from the holotype as the original description is neither adequate nor free from ambiguity in many points.

***Chiridothrips indicus* Ramk. & Marga.**

1939. *Chiridothrips indicus*, Ramakrishna & Margabandhu, *Rec. Ind. Mus.*, XLI, pp. 32, 33.

Female holotype. (Text-fig. 1a)

General color yellowish brown. Thorax and abdomen with some pink hypodermal coagulations. The 1st antennal segment, base of 2nd, fore femora externally and mid and hind legs concolorous with body. Tip of antenna, fore femora (specially internally) and fore tibiae brownish yellow. Tip of abdomen blackish. All body setae slightly swollen at tip, those at tip of abdomen pointed.

Head as described for the genus. Eyes black, small, not protruding. Ocelli equidistant from one another. Postocular seta removed by about half the length of the eye from the front end of cheek. Antennae as described for the genus: 2nd segment asymmetrical due to the external beak, the remaining segments symmetrical: 1st segment short and broad like the base of a cone; 3rd obconical with a narrow basal style; 4th pear shaped with a shorter and broader style; 5th and 6th slightly elongate-pear shaped with a similar style; 7th narrow at base, gradually widening to middle then parallel sided, slightly constricted near the tip; 8th pointed at tip, parallel sided near middle and constricted basally. Segments 3-6 with a pair of stout, short, simple sense-cones.

Prothorax as described for the genus. A seta at each front angle, two long ones at each hind angle, one on each fore coxa. Fore femora strongly incrassate slightly pointed in a beak like manner externo-distally. Pterothorax very broad. Wings well developed reaching the 8th abdominal segment; constricted in the middle.

¹Antennae in the type asymmetrical. The right antenna apparently 7-segmented the left one clearly 8-segmented: in the right antenna the 6th segment appearing altogether abbreviated in the form of a "ring joint" at the base of the 7th, there being no corresponding ring joint on the left. Hence the 8-segmented left antenna is taken as normal for the species.

Abdomen with short, wide segments: 1-8 with long lateral spines directed backwards and curved inwards, those of 9th segment not thickened at tip. Tube as long as head, about a third as wide at base as long.

Measurements.

	I	II	III	IV	V	VI	VII	VIII
Antennal segments	..							
Length in microns	..	20	36	36	36	36	36	48
Width in microns	..	36	36	28	30	26	20	12

Length of head 176 μ ; width 160 μ . Length of pronotum 168 μ ; width 290 μ . Length of pterothorax 240 μ ; width 330 μ . Length of tube 176 μ ; width at tip 30 μ , width at base 60 μ ; width at one-sixth length from tip 42 μ . Width of interocular dorsal space 56 μ . Width of eyes 40 μ ; length 60 μ . Length of cephalic projection in front of eyes 22 μ . Length of cheeks about 100 μ . Length of wing lamina 330 μ . Length of postocular seta 40 μ . Length of setae at tip of abdomen about 80 μ ; on 9th abdominal segment 48 μ ; on hind angles of pronotum 64 μ ; on front angles of pronotum 30 μ . Length of body 1.229 mm.

Dichaetothrips gloveri (Ramk. & Marga.) (Text-fig. 1b)

1939. *Neosmerithothrips gloveri*, Ramakrishna & Margabandhu, *Rec. Ind. Mus.*, XLI, pp. 31, 32.

The species is redescribed from holotype in the collection of the Zoological Survey of India, in view of the inadequate original description.

Female.

General color dark grey-brown, with portions here and there brownish yellow. Isolated patches of reddish hypodermal coagulations in thorax and abdomen. Tube black; abdomen paler basally. Antennal segments 1 and 5-8 concolorous with head, 3rd yellow, very faintly brownish infusate; 2 and 4 paler than 1 but more brownish than 3. 1st segment of maxillary palpi yellow, 2nd dark brown. All setae of body hyaline yellow. Eyes velvety red in reflected light and black by transmitted light. Fore femora and mid and hind legs concolorous with thorax; the margins of fore tibiae and the 2nd tarsal segment of a similar color, but the remaining part of the fore tarsi and fore tibiae yellow. Wings colorless, with faintly yellow margins and grey-brown fringes.

Head longer than broad; cheeks almost parallel, *very slightly* converging at base, smooth, with two small spines one behind the other just a little behind the eyes. Eyes small, even less than a third as long as cheeks and about a third as wide as head, triangular in shape, with angles rounded. A conspicuously long dorsal seta arises about $\frac{1}{3}$ length of eye behind each eye. Due to split along vertex, ocelli and post-ocellar setae not clear. Mouth-cone rounded; much shorter than wide at base. Maxillary palpi very stout, 2-segmented, basal segment slightly tapering towards base. Antennae arising from frontal pits; 8-segmented: 1st segment cylindrical, slightly tapering apically; 2nd gradually widening towards the tip, provided with a raised rim projecting forwards from the tip; segments 3-6 similar but elongate and narrowed in distal quarter; 7th roughly barrel-shaped; 8th conical.

Pronotum (Text fig. 1b) much broader than long, less than half as long as head, much broader behind. Front margin deeply concave,

hind margin convex; front angles acute, hind angles rounded. Two long setae at each hind angle, a minute seta mesad to the outer postangular; two long anteromarginals; one long mid-lateral and one minute seta near the middle of posterior margin on each side. One long seta on each fore coxa. A thin black mid-dorsal streak not reaching the front and hind margins of pronotum.

Pterothorax broader than prothorax, shorter than broad, longer than head. Sides strongly arched in front, very weakly behind.

Fore femora strongly incrassate; fore tibiae slender; fore tarsi armed with a very powerful tooth. Mid and hind legs simple; hind legs the longer, about as long as the fore legs. Mid and hind tibiae on the outside at about $\frac{1}{3}$ their length from the tip provided with a long seta; fore tibiae with a slender short seta in similar position.

Wings well developed. Fore wings almost parallel-sided, slightly expanded apically; 15 duplicate cilia.

Abdomen elongate, almost uniformly broad upto the 6th segment, thence gradually tapering. Wing retaining spines on segments 3-7 and two long setae on each side outside the wing retaining spines. Sides of tube feebly arched. Setae on 9th abdominal segment longer than the tube, those at the tip of the tube shorter than it. Two setae on each side of the 9th segment very stout.

Measurements.

Antennal segments	..	I	II	III	IV	V	VI	VII	VIII
Length in microns	..	52	64	92	88	76	68	48	40
Width in microns	..	44	44	34	36	33	30	28	14

Length of antenna 530 μ . Head 340 μ long 280 μ wide. Cheeks 260 μ long. Eyes 80 μ long 92 μ wide. Postocular seta 120 μ long. Pronotum along mid-dorsum 140 μ , (along side) 160 μ long; (across fore coxae) 420 μ , (across front margin) 280 μ wide. Fore femora 300 μ long, 160 μ wide. Pronotal setae: inner postangular 100 μ , outer postangular 100 μ , coxal 48 μ , mid-lateral 60 μ , anteromarginal 25 μ long. Pterothorax 440 μ long, 540 μ wide. Abdomen 0.6 mm. wide. Tube 320 μ long; (at base) 152 μ , (at apex) 62 μ wide. 9th abdominal segment 120 μ long, 8th 120 μ long. Long setae of 9th segment 360 μ long, those of tube 220 μ long. Maxillary palpal segment I: 20 μ long and 16 μ wide, II: 44 μ long and 12 μ wide. Total body length 2.933 mm.

This insect differs from *Neosmerinthothrips* Schmutz, in which genus its protologists placed it, in (1) not having a short head, strongly converging posteriorly, (2) not having a pointed mouthcone, (3) not having the wings narrow in the apical half but rather wider, and (4) having very long antennae.

Dichaetothrips besoni Moulton (1928. *Indian For. Rec.* (Ent. ser.) XIII, p. 289) appears a very close ally of this species differing only in small details like measurements; *gloveri* Ramk & Marga. is the larger and has 15 duplicate cilia (*besoni* Moulton has 13).

Mallothrips indica Ramk.

1928. *Mallothrips indica*, Ramakrishna, *Mem. Dep. Agric. India* (Ent. ser.), X(7), pp. 308-310.

1934. *Mallothrips indica*, Ramakrishna, *Rec. Ind. Mus.*, XXXVI, p. 498.

So far recorded in leaf galls of *Eugenia jambolana* in Marudamalai Hills, Coimbatore and from fruit of the same tree in Cawnpore. Now recorded from Cawnpore on garden flowers and cucurbitaceous flowers (Coll ?) date ?.

Liothrips bosei Moulton

1928. *Liothrips bosei*, Moulton, *Indian For. Rec.* (Ent. ser.), XIII, pp. 286, 287.

Originally recorded from leaf galls of *Mallotus philippinensis* in Dehra Dun. Now recorded as occurring in large numbers on under-surface of leaves of a wild plant in Tangmarg, Kashmir, 7,500 ft. (A.P. Kapur Coll.) 6th October 1940.

ON THE CERVICAL AND THORACIC ARTERIES IN THE NORTHERN INDIAN GREEN BARBET, *THEREICERYX ZEYLANICUS CANICEPS* (FRANKLIN), TOGETHER WITH AN ANOMALOUS CASE OF REVERSAL OF THE INTERNAL CAROTID ARTERY

By J. L. BHADURI and B. BISWAS, *Zoology Department, Calcutta University.*

INTRODUCTION.

In the course of studies on the cervical and thoracic arteries of birds, we have come across a unique reversed arrangement of the internal carotid artery in a specimen of the Northern Indian Green Barbet, *Thereiceryx zeylanicus caniceps* (Frankl.). So far as we are aware no such case has previously been recorded in any bird (*vide* Biswas, 1946, for a recent review of abnormal cases). Some species of Capitonidae have been studied by Garrard (1873), Glenny (1943*b*) and Bhaduri and Biswas (1945), but *Thereiceryx* is not in their list. We have, therefore, included an account of the normal arrangement of the anterior arteries in *T. z. caniceps*.

The terminology used by Bhaduri and Biswas (1945) is followed here with the exception of the syringeo-bronchial artery, which, especially its bronchial portion, represents Glenny's 'ductus shawi.'

The arterial system was injected in four specimens of *T. I. z. caniceps* in the usual way, and the observations are set forth in the following pages.

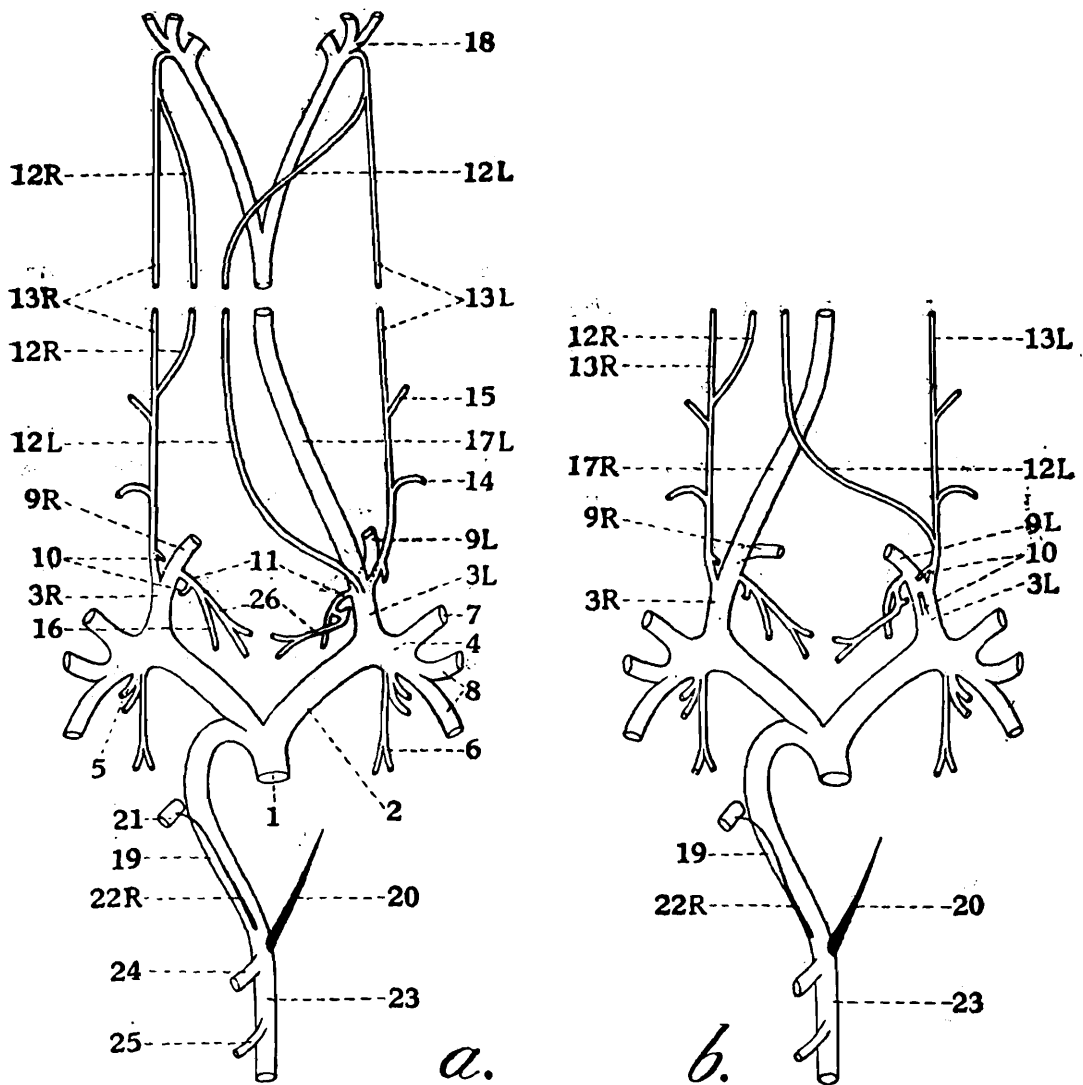
We take this opportunity of thanking Dr. M. L. Roonwal, M.Sc., Ph.D. (Cantab.), F.N.I., of the Zoological Survey of India, for kindly reading the manuscript and making some helpful suggestions.

OBSERVATIONS.

In *Thereiceryx zeylanicus caniceps* the right and left innominate arteries (Text-fig. 1*a*, 2) arise from the aortic root (1) and pass on anteriorly and laterally to give rise to the common carotid (3) and subclavian (4) arteries. Each subclavian gives off the juxtaposed sterno-clavicular (5) and internal mammary (6) arteries and the axillary (7) and two pectoral (8) arteries in that order as in other Capitonids.

The left common carotid (3L) runs forward and in the region of the thyroid gland, gives off a vertebral (9L) from the dorsal side, a comes nervi vagi (13L) from the outer side, an ascending oesophageal (12L) from the ventral side and a syringeo-bronchial (11) from the inner side. The thyroid gland receives a small twig from the syringeo-bronchial stem. The left internal carotid artery (17L) alone enters the hypapophysial canal and proceeds cephalad, bifurcating eventually into right and left branches. The comes nervi vagi artery courses anteriorly, giving rise to the subscapular (14) and the cervical cutaneous (15) branches. The ascending oesophageal passes along the oesophagus towards the head.

On the right side, the common carotid (3R), in the region of the thyroid gland, passes on dorsally to become the vertebral artery (9R). The



TEXT-FIG. 1.—Diagrammatic representation of the main cervical and thoracic arteries in *Thereiceryx zeylanicus caniceps*.

a, normal condition; *b*, abnormal case. (Ventral views.)

1, Aortic root; 2, Innominate artery; 3, Common carotid artery; 4, Subclavian artery; 5, Sterno-clavicular artery; 6, Internal mammary artery; 7, Axillary artery; 8, Pectoral arteries; 9, Vertebral artery; 10, Thyroidean artery; 11, Syringeo-bronchial artery; 12, Ascending oesophageal artery; 13, Comes nervi vagi artery; 14, Subscapular artery; 15, Cervical cutaneous artery; 16, Bronchial artery; 17, Internal carotid artery; 18, External carotid artery; 19, Descending aortic arch; 20, Ligamentous vestige of left radix aorta; 21, Pulmonary artery; 22, Ligamentum botalli; 23, Dorsal aorta; 24, Coeliac artery; 25, Superior mesenteric artery; 26, Syringeal artery. R=Right; L=Left.

syringeo-bronchial artery (11), in disposition and branching, is just like its fellow of the opposite side. The comes nervi vagi artery (13R) courses cephalad in a similar fashion to the left. The ascending oesophageal (12R), unlike that in other Capitonids, arises by a common stem with the comes nervi vagi artery and separates from it a little anterior to the origin of the cervical cutaneous artery.

It is of interest to note that the comes nervi vagi and the ascending oesophageal arteries of each side fuse together before anastomosing with the external carotid artery (18).

The ligamentous vestige of the left radix aorta (20) is present but without the ligamentum-botalli, which is fully represented on the right side (22R). The coeliac (24) and superior mesenteric (25) arteries are much apart from each other in their origins from the dorsal aorta (23).

The abnormal case.

In one of the four specimens dissected by us, the internal carotid artery is present on the right side instead of the left (Text-fig. 1b). The right internal carotid artery (17R) alone enters the hypapophysial canal and follows the same course and has the same fate as the left internal carotid of the normal birds. The left common carotid (3L) instead of continuing forwards as the internal carotid becomes the vertebral (9L) of that side, and there is no trace of the left internal carotid, not even of its ligamentous vestige. The origin and disposition of other arteries are essentially the same as in the normal specimens.

No reversal was noticed in the visceral organs, which appeared to be normal in every respect.

DISCUSSION.

According to the left-handed disposition of the internal carotid artery, the Capitonidae belongs to the '*aves laevo-carotidinae*' group (Garrord, 1873; Glenny, 1943b; Bhaduri and Biswas, 1945), and *Thereiceryx* is no exception to this. By comparison, the general basic pattern of the main arteries in this species appears essentially to be the same as in other Capitonids, but in some respects the condition in each species is to be regarded as characteristic, especially in the origin and fate of the ascending oesophageal and comes nervi vagi arteries. Between the two major Capitonidae groupings, as suggested by Glenny (*op. cit.*), *Thereiceryx* appears to fall in *Xantholaema*-group.

In view of the abnormal case it seems pertinent to introduce here a brief discussion on the origin of the paired and unpaired condition of the internal carotid artery.

Various explanations have been put forward by earlier authors. Bauer (1825) thought that the smaller species should have single carotids. Meckel (1826) at first thought that there was some correlation between the length of the neck and the simplicity of the carotids, but later withdrew that view. Owen (1866) stated that those birds which sleep with their necks twisted on one side lose the carotid of that side. Garrord (1873) has critically reviewed the above explanations as unsatisfactory. He, however, assumes that there is a blending of the left with the right (internal) carotid in early life of the bird in the manner of *Botaurus stellaris* and *Cacatua sulphurea*, and considers that the decreased flow of blood in the right carotid as compared with the left, owing to the right systemic arch sharing a portion of the blood from the former side, is responsible for the obliteration of the right carotid. In this connection the analogy of the mechanical principle which he draws from Wheatstone's Bridge in order to explain the disappearance of the right carotid does not seem to be very convincing. Lastly, Glenny (1943-1944 a) assumes that the anterior cervical portions of the internal carotids anastomose and the posterior

proximal portion of the right internal carotid remains as a superficial artery which appears to be functionally modified to serve as the ascending oesophageal in all the *laevo-carotidinae* birds. This may not be the true picture, since the ascending oesophageals are normally present on both the sides in the '*aves bicarotidinae normales*' as well as '*aves laevo-carotidinae*' (Bhaduri and Biswas, 1945). He is, however, forced to conclude in one of his latest papers (1945 a, p. 453): "The probable answer to the wide differences in the arteries of the neck and thorax, especially with regard to the anastomosis of the internal carotid (trunk) arteries may be found through embryological studies." A similar conclusion was also arrived at in one of his previous papers (Glenny, 1943c, p. 51). It is indeed true that we have some embryological data of the '*aves bicarotidinae normales*', but unfortunately there is none so far of the '*aves laevo-carotidinae*'

Now, the abnormal condition in *T. z. caniceps* is not a case of *situs inversus viscerum*, since the visceral organs were quite normal. It is evidently a case of partial mirror image or reversal of the asymmetrical left internal carotid artery. As a result the condition resembles that in the '*aves dextro-carotidinae*' group of Garrord (1873) and Glenny (1945 a). The explanation of the occurrence of reversal should, as in all cases, be sought in the embryonic history. It would appear that in the normal development of either a *laevo-* or *dextro-carotidinae* bird, two internal carotids are originally laid down the anterior portions of which probably fuse with each other at some time during embryonic life. Later, the proximal part of the right internal carotid disappears in the adults in Passeriformes, Piciformes, etc. The corresponding portion of the left one atrophies only in a few birds, e.g., *Eupodotis* (Garrord, 1873) and *Ixobrychus* (Glenny, 1945 a). In the present instance the left internal carotid artery has atrophied totally. This reversal of asymmetry may be regarded as due to some abnormal condition resulting from developmental arrest.

REFERENCES.

- Bauer, F. 1825. *Disquisitiones circa nonnullarum Avium systema arteriosum*. Berolini. (Not seen in original.)
- Bhaduri, J. L. and B. Biswas 1945. The main cervical and thoracic arteries of birds. Sr. I. Coraciiformes—Pt. 1. *Proc. nat. Inst. Sci. India*, IX, pp. 236-245.
- Biswas, B. 1946. On a case of persistence of the left systemic arch in a weaver bird, *Ploceus philippinus philippinus* (Linné). *Curr. Sci.*, XV, pp. 309-311.
- Garrord, A. H. 1873. On the carotid arteries of birds. *Proc. zool. Soc. London*, pp. 457-472.
- Glenny, F. H. 1940. A systemic study of the main arteries in the region of the heart. Aves. *Anat. Rec.*, LXXVI, pp. 371-380.
- 1943. A systemic study of the main arteries in the region of the heart. Aves VI. Trogoniformes. Pt. 1. *Auk*, LX, pp. 235-239.

- Glenny F. H. 1943a. Main arteries in the neck and thorax of *Rhea* embryo. *Canad. J. Res.*, XXI, pp. 189-193.
- 1943b. A systemic study of the main arteries in the region of the heart. Aves : Piciformes. *Proc. zool. Soc. London*, (B) CXXIII, pp. 179-192.
- 1943c. A systemic study of the main arteries in the region of the heart. Aves VII. Coraciiformes. Pt. 1. *Trans. roy. Soc. Canada* XXXVII, pp. 35-53.
- 1944. A systemic study of the main arteries in the region of the heart. Aves XXIII. Passeriformes (Compsophilidae). *Canad. J. Res.*, (D) XXII, pp. 126-129.
- 1944a. Concerning some changes in the aortic arches and their derivatives, with reference to their ultimate fate in birds. *Trans. roy. Canad. Inst.*, XXV, pp. 21-28.
- 1945. A systemic study of the main arteries in the region of the heart. Aves XXI. Passeriformes (Paridae—Pt. 1). *Ohio J. Sci.*, XLV, pp. 19-21.
- 1945a. A systemic study of the main arteries in the region of the heart. Aves XIII. Ciconiiformes. Pt. 1. *Amer-Midl. Nat.*, XXXIII, pp. 449-454. (Contains all previous references to his papers.)
- Meckel, J. F. 1826. Beitrag zur Geschichte des Gefässsystems der Vögel, *Meckel's Arch. f. Anat. u.-Physiol.*, pp. 19-20.
- Owen, R. 1866. *Anatomy of Vertebrates*, London, II, p. 190.

DECAPODA CRUSTACEA OF THE PATNA STATE, ORISSA.

By B. CHOPRA, D.Sc., F.N.I., Offg. Director and KRISHNA KANT TIWARI, M.Sc., Research Scholar, Zoological Survey of India, Benares Cantt.

The material dealt with in the present paper was mostly collected in March 1945, in various localities in the Patna State, Orissa. The physical features of the state, and a brief description of the localities in which collections were made, are given by Dr. B. S. Chauhan in another place of this publication. (p. 267)

The following species of Decapoda were collected in the State :—

Family Potamonidae

1. *Paratelphusa (Barytelphusa) jacquemontii* (Rathbun)
2. *Paratelphusa (Oziotelphusa) hydrodromus* (Herbst)

Family Palaemonidae

3. *Palaemon malcolmsonii* H.M.-Edw.
4. *Palaemon lamarrei* H.M.-Edw.
5. *Palaemon dayanus* Henderson

Family Atyidae

6. *Caridina nilotica* var. *chauhani*, nov.
7. *Caridina weberi* prox. var. *sumatrensis* deMan

Of the two crabs obtained, *P. (Barytelphusa) jacquemontii* appears to be a common species in the Patna State, while *P. (Oziotelphusa) hydrodromus* was obtained only at one locality, viz., a tank at Patnagarh.

In the Palaemonidae, *Palaemon lamarrei* was collected in large numbers at all the stations visited. This species appears to form an important item of food of the local population. *Palaemon malcolmsonii* was obtained only twice, in the Ang River at Agalpur (one male specimen) and in the Tel River at Belgaon (four young male specimens). *Palaemon dayanus* was found in great abundance in, and below, a hillstream at Harishanker. Of the representatives of the family Atyidae, *Caridina nilotica* var. *chauhani* was obtained from nearly all stations along with *Palaemon lamarrei*, although not in large numbers. *Caridina weberi* prox. var. *sumatrensis* was found in abundance in the hillstream at Harishanker.

As *Palaemon dayanus* was found to exhibit a wide range of structural variations, opportunity has been taken to study two other collections of this species also. As a result of our study of these three fairly large series of specimens, we are able to give a fuller description of the species, than that originally given by Henderson. It is somewhat surprising that there are very few references in literature to this widely distributed species.

Family POTAMONIDAE

Sub-family GECARCINUCINAE.

Paratelphusa (Barytelphusa) jacquemontii (Rathbun).

1910. *Paratelphusa (Barytelphusa) jacquemontii*, Alcock, *Cat. Ind. Dec. Crust.*, Part 1, Brachyura, p. 79, pl. xii, fig. 55.

Ang River, Salebhata	..	Patna State Survey Party,	1♂
		March 1946.	
Ang River, Agalpur	--	Do.	1♂, 1♀
Hill Stream, Harishanker	--	Do.	11 juvenile specimens, 12.8—34.0 mm. in maximum breadth.

Paratelphusa (Oziotelphusa) hydrodromus (Herbst).

1910. *Paratelphusa (Oziotelphusa) hydrodromus*, Alcock, *Cat. Ind. Dec. Crust.* Part 1, Brachyura, pp. 97-100, pl. xiii, fig. 60.

We have examined eight specimens of this species, four males and four females, collected in the Rani Sar, a tank at Patnagarh. The female specimens were sent to us by Mr. B. L. Choudhari, Agriculture Officer, Patna State. Although the Patna State examples are typical in nearly all respects, sometimes the post orbital crests are not trenchant, and are corroded on their inner aspect. The shape of the sixth abdominal segment of the males also does not agree exactly with Alcock's description. This segment, according to Alcock, is nearly as long as broad, but in the Patna State specimens the proximal breadth of the sixth abdominal segment is greater than its length. The sides of the segment are strongly biconcave. We have examined a large number of examples of this species from various localities, in the Collection of the Zoological Survey of India, and have found that the shape of the sixth abdominal segment of the male is, in most cases, as in the Patna State specimens.

Family PALAEMONIDAE.

Sub-family PALAEMONINAE.

Palaemon malcolmsonii H. Milne-Edw.

1910. *Palaemon malcolmsonii*, Henderson and Matthai, *Rec. Ind. Mus.* V, pp. 283-285, pl. xv, figs. 2 a-f.

1915. *Palaemon malcolmsonii*, Kemp, *Mem. Ind. Mus.* V, pp. 266-268.

Ang River, Agalpur Patna State Survey Party, 1♂
March 1946.

Tel River, Belgaon Do. 4 juvenile.

The Patna State specimens are typical in every respect. The specimens from the Tel River were caught during night fishing, which is briefly described by Dr. B. S. Chauhan in another paper.

Palaemon lamarrei H. Milne-Edw.

1908. *Palaemon (Eupalaemon) lamarrei*, de Man, *Rec. Ind. Mus.* II, pp. 222-226, pl. xix, fig. 4.

1915. *Palaemon lamarrei*, Kemp, *Mem. Ind. Mus.* V, pp. 265-266.

A large number of specimens of this species were collected from all the localities visited in the state, from young ones to fully grown males, and egg-bearing females. The rostrum is typical in all cases. De Man has given the ratio of chela to carpus in the first cheliped as 4 : 9, but in the specimens examined by us this ratio is as 4 : 11. According to de Man the carpus of the second cheliped is almost twice as long as the chela and three times as long as the palm; in the Patna State specimens the proportions are practically the same. In examples from the Chilka lake, examined by Kemp, however, "the carpus, though still decidedly longer than the chela is proportionately shorter"

Palaemon lamarrei is widely distributed in many parts of India and shows considerable variation in the number of its rostral teeth and other characters.

The following table gives measurements (in millimeters) of five specimens from the Patna State.

No.	Sex.	Total length of body.	I Cheliped.				II Cheliped.				
			Ischi-um	Merus	Carpus	Chela	Ischi-um	Merus	Carpus	Palm	Finger
1	♀ egg-bearing ..	68.5	3.8	5.4	7.1	2.1	6.5	6.3	9.3	2.8	2.5
2	♀ „ ..	57.3	3.0	4.2	5.4	1.9	5.0	5.0	7.7	2.3	1.9
3	♀ — ..	45.3	2.6	3.5	4.1	1.5	..	..	..	..	..
4	♀ egg-bearing ..	45.5	2.5	3.5	4.4	1.6	4.2	4.2	6.2	1.9	1.5
5	♀ „ ..	44.8	2.5	3.2	4.3	1.7	4.2	3.9	5.9	1.4	1.7

Palaemon dayanus Henderson.

1893. *Palaemon Dayanus*, Henderson, *Trans. Linn. Soc. London* (2) V, pp. 443-444, pl. xl., figs. 7-13.

Henderson described *Palaemon dayanus* from a large series of specimens collected in various localities in Northern India. Though this species appears to have a wide range of distribution in India and Henderson's description is adequate enough for its identification, it is somewhat surprising that there are very few references to it in literature, and the only record of its occurrence since Henderson's time, that we have come across, is by Nataraj¹ from Travancore.

We have before us three series of specimens from (1) the Patna State in Orissa, (ii) the Varuna River (a small tributary of the Ganges) at Benares, U. P., and (iii) Sonarpur, near Calcutta in Bengal. The specimens agree in nearly all characters with the description given by Henderson, and though they show a considerable range of variation in certain characters, they are undoubtedly referable to this species.

Males.—The shape of the rostrum is variable as illustrated by Henderson in his figs. 7-10 on plate xl. In most of our specimens the rostrum is straight, but in those from Sonarpur, it is distinctly upturned at its distal end. In length also the rostrum may fall short of the antennal scales by from one-fifth to one-fourth of its length. The antennal scale is rounded at its distal extremity.

The rostral teeth show considerable variation in their numbers. Henderson has given the rostral formula as $\frac{7.9}{5.6}$ though the range of variation may be from $\frac{5.10}{5.7}$. In the material that we have examined the number of teeth commonly found on the rostrum, as shown in the table below, may be represented by the formula $\frac{8.9}{5.6}$, and the range of variation as $\frac{7.11}{4.7}$. Though we have not seen any specimen with less than seven teeth on the upper border of the rostrum, taking Henderson's figures also, the range of variation in the number of teeth in the species appears to be $\frac{5.11}{4.7}$.

¹Nataraj, S., *Current Science* XI, pp. 467, 468 (1942).

Rostral formula in *Palaemon dayanus* Hend.

Rostral formula.	Number of specimens.			Total.
	Patna State.	Varuna River.	Sonarpur.	
7/4	1	nil	nil	1
8/4	3	3	nil	6
8/5	6	13	1	20
8/6	2	5	4	11
8/7	nil	1	1	2
9/4	1	1	nil	2
9/5	6	24	4	34
9/6	1	8	12	21
9/7	nil	3	5	8
10/5	1	1	nil	2
10/6	nil	5	2	7
10/7	nil	nil	3	3
11/7	nil	nil	1	1
Total no. of specimens	21	64	33	118

It is thus seen that out of the 118 specimens examined, 39 have eight upper rostral teeth, 65 have nine, 12 have 10, while one example each has seven or 11 teeth. Similarly, in these 118 examples, there are nine with four lower teeth, 56 with five, 39 with six and 14 with seven teeth.

Henderson has stated that the number of teeth on the rostrum varies according to its length. A study of the above table seems to confirm this view. The Patna State specimens with a comparatively short rostrum show the lowest formula 7/4, while the long rostrum forms from Sonarpur show the other extreme, viz., 11/7. The Varuna River specimens, which are intermediate with regard to the length of the rostrum, show the middle range.

The arrangement of the teeth on the rostrum agrees with the description of Henderson. There are two or three teeth on the carapace, and usually the third tooth is placed just above the orbital border.

The carapace is smooth, with the hepatic spine rather small and behind it there is a sulcus, as described by Henderson.

The first legs are equal, slender and exceed the antennal spine by the length of the fingers and half the length of the palm. They are less than one-third the length of the body.

The following are the measurements (in mm.) of the first chelipeds of three male examples of about the same size.

Locality.	Total length of body.	Ischium.	Merus.	Carpus.	Chela.	Total length of cheliped.
Patna ..	60.8	3.6	5.1	6.5	2.9	18.1
Varuna ..	59.7	3.5	5.4	6.2	2.9	18.0
Sonarapur	63.2	4.3	5.6	6.8	3.0	19.7

The Merus is cylindrical, of uniform thickness, measuring slightly more than a fourth of the cheliped. The carpus is the longest segment measuring one-third or more of the entire cheliped; it is thickened distally. The chela is very short, less than half the length of the carpus. The fingers are either equal to or slightly longer than the palm. The ischium and fingers are covered with tufts of setae, while on the rest of the cheliped the hairs are very sparsely distributed.

The second chelipeds are moderately stout, slightly scabrous, equal or subequal and about half the length of the body (including rostrum) in smaller examples. In large and mature males they are considerably longer, in some cases measuring about two-thirds of the body length. The ischium is cylindrical. The carpus, which is generally slightly longer than the merus, is thickened distally. The chela is distinctly longer than the carpus. Henderson has described the palm as equal to the carpus, but we find this to be the case in only three or four large male specimens from Sonarapur. In all the remaining specimens, more than hundred in number, the palm is slightly shorter than the carpus. The fingers are about two-thirds the length of the palm and densely pubescent. The palm is slightly compressed laterally.

The following are the measurements (in mm.) of the second cheliped in three male specimens, one from each of the three localities :

Locality.	Total length of body.	Ischium.	Merus.	Carpus.	Palm.	Finger.	Total length of cheliped.
Patna ..	60.8	7.1	7.4	8.4	7.6	6.2	36.7
Varuna	59.7	6.9	8.0	9.0	8.8	5.7	38.4
Sonarapur	65.0	6.7	7.3	8.0	7.1	5.0	34.1

The fingers (Text-fig. 1, *a*) on removal of hairs, are seen to be conspicuously ridged longitudinally on all sides, as stated by Henderson and Kemp¹. The fixed finger has one conical tooth, followed proximally by three or four small tubercles. The mobile finger has two large conical teeth, so placed that the tooth on the fixed finger lies just in front of the proximal tooth on the mobile finger when the fingers are apposed. The rest of the cutting edge is sharp and smooth.

¹Kemp, S., *Rec. Ind. Mus.* VIII, p. 304 (1913).

The telson (Text-fig. 1, *b*) is as described by Henderson. The outer sub-terminal spinules are very small, being much less than half the length



TEXT-FIG. 1.—*Palaemon dayanus* Henderson. *a*. Chela, after removal of hairs ($\times 3\frac{1}{2}$); *b*. Telson, dorsal view ($\times 4\frac{2}{3}$).

of the inner spinules. The inner terminal spines are long, and have a tuft of setae between them. There are two pairs of dorsal spinules situated on the posterior half of the telson; these are not shown in Henderson's illustration.

Females.—Many egg-bearing females are present in the collection. The second chelipeds, as is usually the case, are shorter, less-stout and less scabrous than those of males. The eggs are large, measuring between 1.7 to 1.9 mm.

Size.—The specimens in the series that we have examined show considerable variation in size, the smallest egg-bearing female being 43.8 mm. long (including rostrum) while the largest male measures 75.0 mm.

Coloration.—In living specimens the chelipeds were prominently banded with stripes of dark brown pigment, and the carapace was densely mottled with the same colour. The antennular and antennal flagella were also banded. On the rest of the body the pigment was irregularly and sparsely distributed.

Hill Stream at Harishanker, Patna State, Orissa.	Patna State Survey Party, March 1946.	Large number of males (37.4— 60.8 mm.) and females (39.3— 52.6 mm.).
The Varuna River at Benares, U. P.	Zoological Collector (P. N. Mitter), July, 1946.	Males (35.2—70 mm.) and females (51.0—62.00 mm.).
Sonarpur, near Calcutta, Bengal.	?	Males (32.2—75.0 mm.) and female with maximum body length 59.2 mm.

Distribution.—*Palaemon dayanus* was recorded by Henderson from a large number of localities in Northern India—Orissa, Jubbulpur, Calcutta, Beerbhoom, Debroo (probably river Dibru in Assam), Delhi, Roorkee, Hardwar, Loodhiana, River Jumna and Lahore. Our records of the species are from within the range given by Henderson. Nataraj (*op. cit.*) has, however, recorded the occurrence of *P. dayanus* in Travancore in South India also.

It is interesting to note that *Palaemon dayanus* was collected only in one hill-stream in the Patna State, and attempts to obtain it from the rivers and the large number of tanks that were visited in the State proved unsuccessful. Similarly it is remarkable that whereas the species appears to be fairly common in the Varuna river, we have so far been unable to get any specimen from the Ganges river close by.

Like most other species of *Palaemon*, *P. dayanus* also shows considerable variations in several characters. This is clearly seen in the series of specimens examined by us. The Patna State specimens are small in size, the largest male being only 60.8 mm. in total length; the rostrum is short, not reaching the antennal scale, is straight and not particularly deep; the rostral formula is $\frac{7-10}{4-6}$, and the second chelipeds are comparatively slender. The Varuna River examples are larger in size than those from the Patna State, the largest male being 70.0 mm. in total length; the rostrum reaches the tip of the antennal scales and is distally upturned; the rostral formula is $\frac{8-10}{4-7}$; and the chelipeds are shorter. The Sonarpur specimens are the largest, the longest male example in the collection being 75.0 mm.; the rostrum is also the longest exceeding the antennal scales by one-fifth to one-fourth of its length; is noticeably deep and considerably upturned distally; the rostral formula is $\frac{8-11}{5-7}$, and the second chelipeds are also long and comparatively stout. The amount of pubescence on the fingers is also variable. As suggested by Henderson, the variation in the number of teeth on the rostrum appears to be correlated with its length.

Family ATYIDAE.

Caridina nilotica (Roux).

1908. *Caridina nilotica* (typical form) de Man, *Rec. Ind. Mus.* II, pp. 259-62, pl. xx, figs. 1, 1a, 1b.

var. *chauhani* nov.¹

A large number of specimens collected from various localities in the Patna State, appear to represent a new variety of *Caridina nilotica*. This variety bears a somewhat close resemblance to *Caridina nilotica* var. *brachydactyla* form *peninsularis*,² described by Kemp³ from Patani in Siamese Malay States and Penang, but it differs from it, as also from other varieties of *Caridina nilotica* in certain well-defined characters.

¹Named after Dr. B. S. Chauhan, Asstt. Spudt., Zoological Survey of India.

²Edmondson, C. H., *Occ. Pap. Bishop Mus. Honolulu* LXI, No. 3, pp. 1-19 (1935-36).

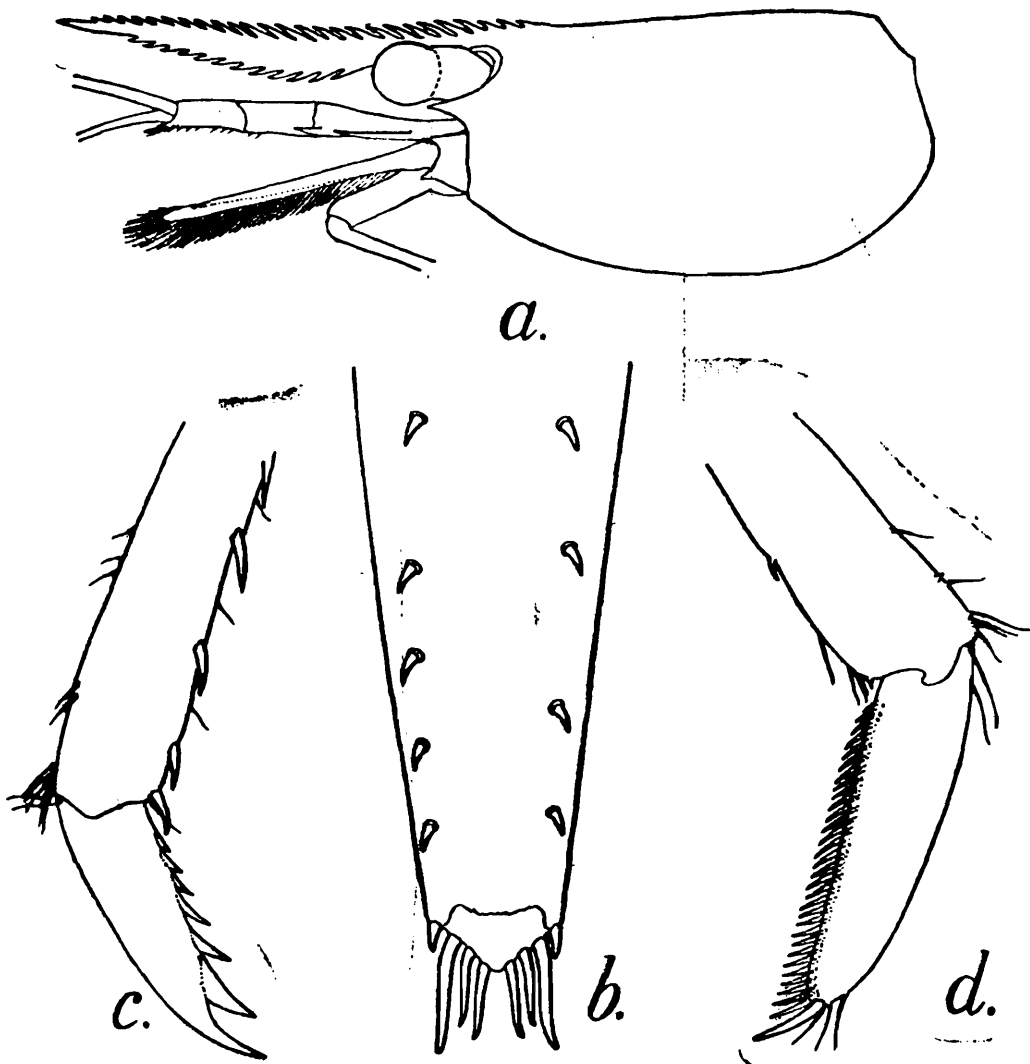
³Kemp, S., *Mem. As. Soc. Bengal* VI, pp. 279-82.

The rostrum (Text-fig. 2, *a*) usually exceeds the length of the antennular peduncle, and in some cases extends a little beyond the antennal scale. It is generally straight, sometimes slightly upturned distally, and is armed above with a series of 24 to 40 (usually 26 to 33) teeth, of which two to four are situated on the carapace behind the orbital notch. The number of rostral teeth in 61 examples from the Patna State are shown below.

Number of dorsal teeth.	Number of examples.	Number of ventral teeth.	Number of examples.
24	1	4	1
25	2	5	2
26	6	6	3
27	6	7	7
28	8	8	10
29	13	9	6
30	5	10	9
31	4	11	12
32	2	12	5
33	6	13	5
34	2	14	1
35	2		TOTAL 61
36	2		
37	0		
38	1		
39	0		
40	1		
	TOTAL 61		

In all the specimens, except one, the teeth are continuous nearly up to the apex of the rostrum (Text-fig. 2, *a*) without any break, there being no, or very short, unarmed distal part. One specimen, however, presents an interesting condition. Proximally it bears 26 continuous teeth, followed by two small ones, then a short gap, at the end of which one tooth is placed. This condition agrees with that described by Kemp in some examples of *peninsularis* (*op. cit.*), in which there is a distinct break distally, followed by a number of sub-terminal teeth. The teeth at the base of the rostrum are usually small in size. They are crowded, when more numerous, but in specimens with a smaller number of teeth, the interspaces between them increase as they approach the tip. In many cases the rostrum presents a convexity just above the orbital

border, with the result that the entire rostrum appears to be bent slightly downwards. The lower border of the rostrum bears from four



TEXT-FIG. 2.—*Caridina nilotica* var. *chauhani*, nov. **a.** Anterior portion of the body: $\times 8$; **b.** Posterior end of telson: $\times 33$; **c.** Dactylus of third peraeopod: $\times 66$; **d.** Dactylus of fifth peraeopod: $\times 66$.

to 14 (usually six to 13) teeth, which, when numerous, may extend throughout the anterior two-thirds of the lower border.

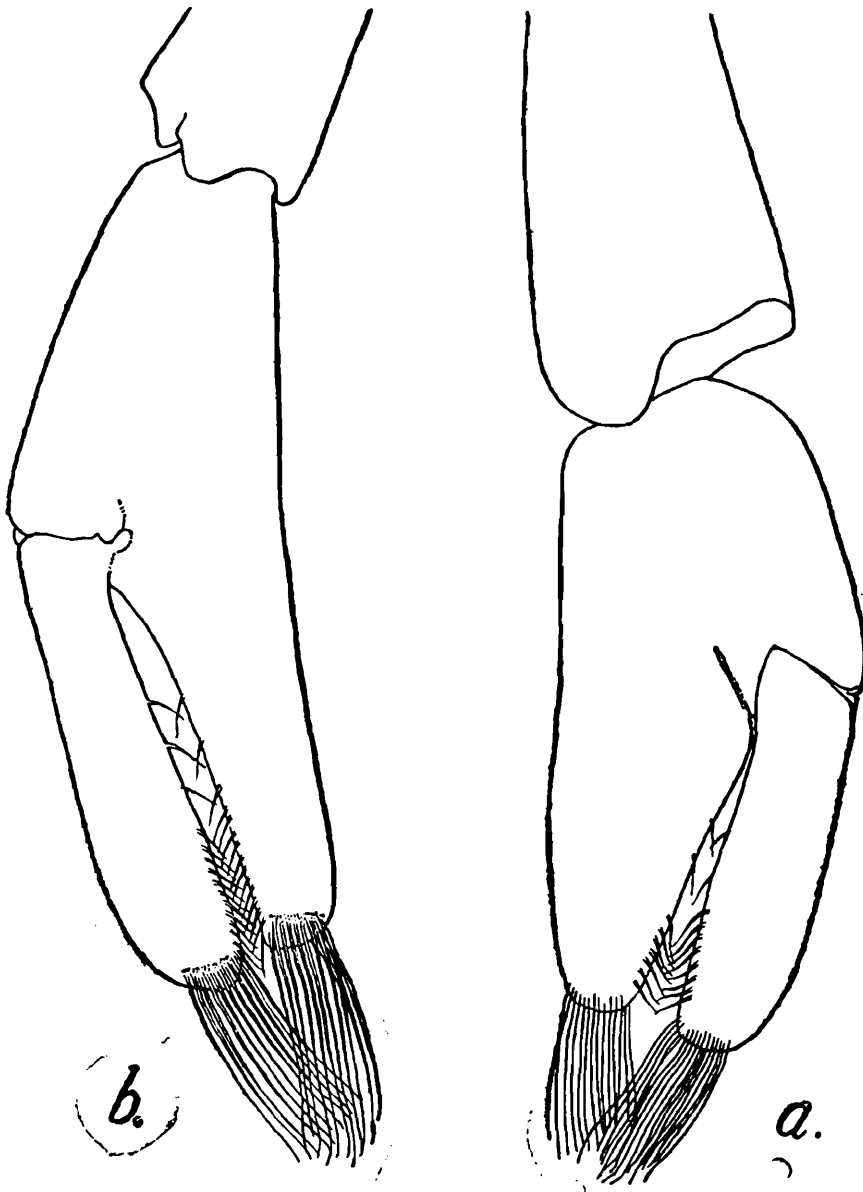
The cornea in dorsal view is shorter than the stalk, whereas in Kemp's *peninsularis* the reverse is the case.

The pre-ocular length of the antennular peduncle is from 0.83 to 0.89 times the post-orbital length of the carapace. The antennal scale is about 3.5 times as long as broad.

The antero-inferior angle of the carapace is bluntly obtuse and does not bear a pterygostomian spine. The second segment of the antennal peduncle is produced distally into a spine immediately below the insertion of the scale.

The carpus of the first peraeopods (Text-fig. 3, *b*) is from 2.0 to 2.5 times as long as broad. The length of the chela is from 2.1 to 2.6 times its breadth. The finger is 1.5 or more times longer than the palm.

In the second peraeopods (Text-fig. 3, *a*) the carpus is 4·6 to 6·7 times as long as broad. The length of the finger is generally less than



TEXT-FIG. 3.—*C. nilotica* var. *chauhani* nov. *a*. Chela of second peraeopod: x 66; *b*. Chela of first peraeopod: x 66.

1·5 times the length of the palm.¹

In the proportions of the third and fifth peraeopods this variety shows conspicuous differences from other forms. The dactylus in both these peraeopods (Text-fig. 2 *c*, *d*) is proportionately longer, and sub-parallel in shape. The merus in both peraeopods bears 3 or 4 spines on its lower edge. The propodus of the third pair is 2·6 to 4·0 (exceptionally up to 5·0) times as long as the dactylus (Text-fig. 2, *c*). The length of the dactylus is from 3·1 to 5·0 times its breadth (excluding the terminal spine). It bears from 5 to 7 (usually 6) spines, including the terminal. In the fifth peraeopods (Text-fig. 2, *d*) the propodus is 2·7 to 3·5 times as long as the dactylus, the length of the dactylus is 4·0 to 6·3 (rarely 3·0) times its maximum breadth; and it bears from 27 to 43 (usually 34 to 41) spinules.

¹ This ratio is in most cases between 1·17 to 1·44 but in a few exceptional cases it is as much as 1·7.

There are from five to six pairs of dorsal spines on the telson (Text-fig. 2, *b*) and from five to seven spines on the apex. The telson is long and narrow. The outer uropod bears from 8 to 15 movable spines.

The eggs vary from 0.62 to 0.69 mm. in length and from 0.36 to 0.4 mm. in breadth.

The largest egg-bearing female measures 29.0 mm. In the majority of examples the rostrum is longer than the carapace, but in some cases, it is equal to, or even a little shorter.

The present variety differs from all other varieties of *C. nilotica* in the rostrum bearing continuous teeth up to the tip, and in the dimensions of the peraeopods. It bears the closest resemblance to *C. nilotica* var. *brachydactyla* in the dimensions of the first and second peraeopods. The form *peninsularis* of *C. nilotica* var. *brachydactyla* has a rostrum similar to that of var. *chauhani* but in the new variety *chauhani* the dactyli of the third and fifth peraeopods are proportionately longer and broader and sub-parallel in shape, the cornea is shorter than the ocular stalk in dorsal view, and the eggs are larger.

Locality.—Most of the specimens were obtained from tanks at Salebhata, Chandanbhati, Bolangir, Salepali and Titilagarh and a few were collected in weeds in the Ang River at Salebhata. This form appears to inhabit mostly muddy waters. No specimens of this variety were found in the hill-stream at Harishanker, though *Caridina weberi* prox. var. *sumatrensis* (*vide infra*) was quite abundant.

Type specimens.—C $\frac{2534}{1}$ Zoological Survey of India.

***Caridina weberi* prox. var. *sumatrensis* de Man.**

1918. *Caridina weberi* prox. var. *sumatrensis*, Kemp, *Rec. Ind. Mus.* XIV, pp. 99-101.

A large series of specimens, collected in the hill-stream at Harishanker and in other localities in the Patna State, appears to belong to *Caridina weberi* prox. var. *sumatrensis* de Man, described by Kemp from the Inlé Lake in Southern Shan States, Burma.

In most of the examples examined by us the antero-inferior margin of the carapace is produced into a spine, a character which was noticed by Kemp in examples from the Inlé Lake. The rostrum is short and deep, reaching up to the middle or the end of the second segment of the antennular peduncle. The upper border of the rostrum bears from 11 to 23 teeth of which three to eight are placed on the carapace behind the orbit. In this respect, however, these examples are more like var. *sumatrensis* described by de Man¹ from *Flores*. The specimens from the Inlé Lake bear only three or four teeth behind the orbit on the carapace.

¹ De Man, J. G., *Weber's Zool. Ergebn. Reise Nied. Ost.-Ind.* II, p. 375, pl. xxii, fig. 23g (1892).

The number of rostral teeth in the Patna State specimens is shown below.

No. of Dorsal teeth.	No. of examples.	No. of Ventral teeth.	No. of examples.
11	2	3	9
12	2	4	16
13	3	5	6
14	1	6	3
15	4	7	1
16	2	8	1
17	3		
18	5		
19	3		
20	4		
21	2		
22	2		
23	3		
	TOTAL 36		TOTAL 36

The peraeopods agree with Kemp's description.

The telson carries from four to five pairs of dorsal spinules and six to nine terminal spines. The outer uropods bear 14 to 21 movable spines.

This variety, according to Kemp, appears to be widely distributed in India. In the specimens from Kobo, Dibrugarh and Darrang Districts, in Northern Assam, referred to by Kemp² as *Caridina weberi* var., no mention is made of the spine on the antero-inferior angle of the carapace which is so characteristic of the Patna State specimens and also of specimens from the Inlé Lake.

Caridina weberi prox. var. *sumatrensis* was found in abundance in the hill stream at Harishanker and in a tank connected with a river at Salepali. Three specimens were obtained from the Ang River at Salebhata, and a few examples were also collected in tanks at Bolangir and Titilagarh. This form appears to live chiefly in streams and small rivers, but may occasionally be found in tanks with muddy water.

The present form appears to represent a distinct variety of *Caridina weberi*, but we have refrained from giving it a name, as our knowledge of Indian Caridinas is still very limited.

²Kemp, S., *Rec. Ind. Mus.* VIII, pp. 395-96, pl. xix, figs. 24, 25 and pl. xx, figs. 26-28 (1913).

NOTES ON A COLLECTION OF BIRDS FROM THE DARRANG DISTRICT, ASSAM.

By BISWAMOY BISWAS, *M.Sc., Research Scholar, Zoological Survey of India.*

INTRODUCTION.

In November 1939, a party of the Zoological Survey of India, consisting of Dr. B. Prashad, Dr. S. L. Hora, Dr. M. L. Roonwal, and a taxidermist, made a small collection of about 73 bird skins from the Darrang District, northern Assam. The following is a report on that collection along with some systematic notes based on comparison with specimens in the collections of the Zoological Survey of India.

*Physiography, etc., of the Darrang District*¹.—The Darrang District (Text-fig. 1) consists of a narrow strip of land lying between the base of the Himalayas and the Brahmaputra river. It lies between the lat. 26° 12' and 27°N., and long. 91° 42' and 93° 47'E. The district is a level plain, the only hills being a few low *tilás* along the edge of the Brahmaputra and an outlying spur of the Himalayas north of Balipara. The land slopes from north to south. The foot-hills are clothed with forest, while the banks of the Brahmaputra are covered with jungle. The district is cut across by a large number of rivers and rivulets, which form the tributaries of the Brahmaputra.

The average temperature of the year is 66°F. (min.) to 82°F. (max.). The period from November to February is the coldest, during this period the minimum temperature being 51°F. and the maximum 76°F. The average rainfall near the Brahmaputra region is about 70 inches a year, and in the northern parts about 100 inches.

Ornithology of the Darrang District.—The published accounts of the birds of the Darrang district are few. Godwin-Austen (1876) gave a list of birds of the Aka and Dafla hills, including the north-eastern corner of the Darrang district, while Milburne (1939) presented a list of birds observed in a garden on the north bank of the Brahmaputra, within two miles of the Balipara Frontier Tract.

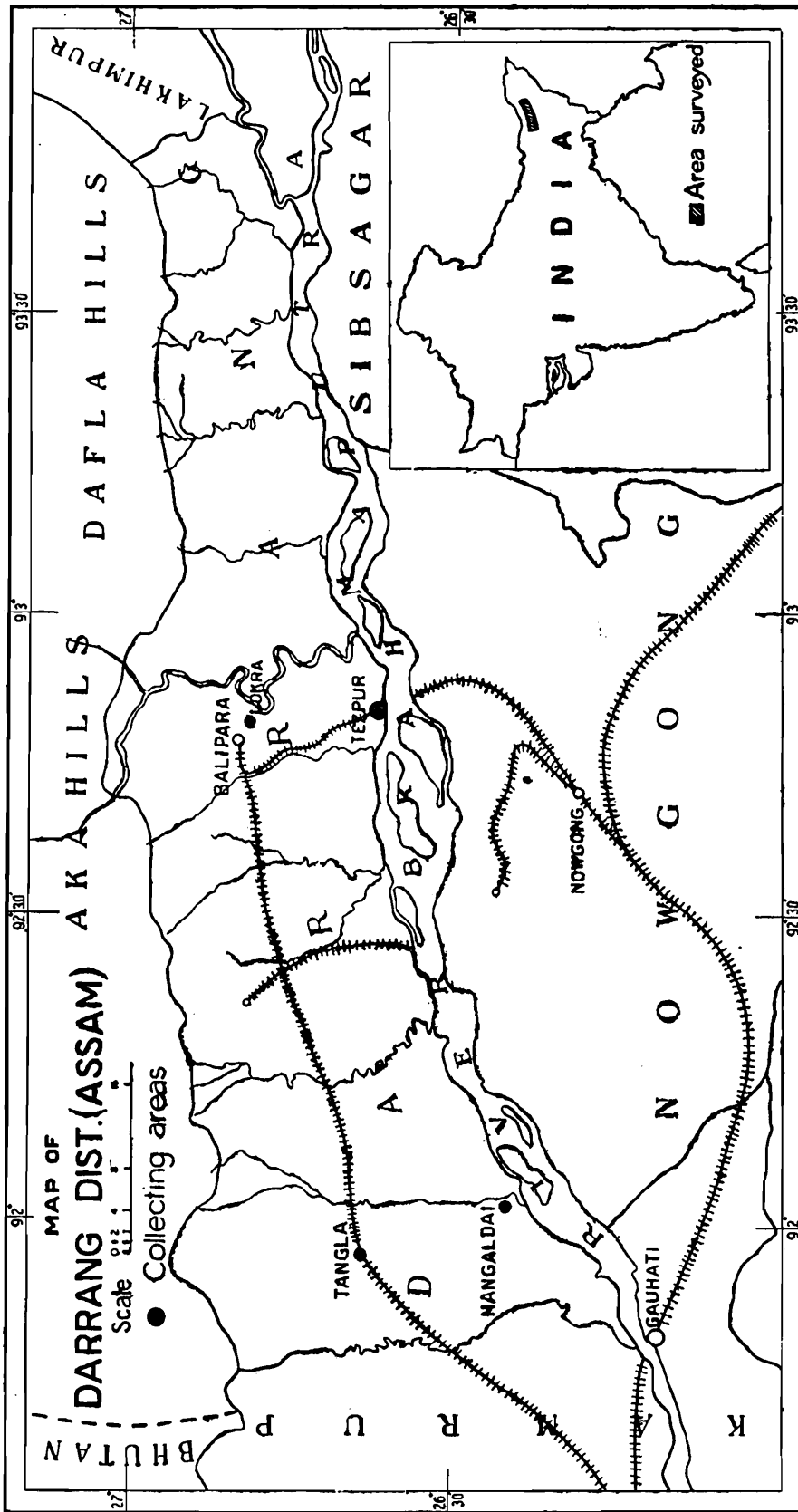
Mention may be made of the papers by Stevens (1914-15), who worked in the Lakhimpur district which adjoins the Darrang district.

Measurements, etc.—Measurements (in mm.) of the skins were taken as follows: *Wing* (W.): Chord from the bend of the wing to the tip of the longest primary, the wing being flattened. *Tail* (Tl.): From the insertion of the median rectrices to the tip of the longest tail-feather. *Tarsus* (Tr.): From the middle point of the joint between tibio-tarsus and tarso-metatarsus behind to the middle of the metatarso-digital joint in front. *Bill* (B.): From the junction of the bill with the skull to the tip.

The sex was determined in the field by an examination of the gonads, In some cases, however, sex was determined only from plumage, when it is indicated in brackets, e.g. (♂) or (♀).

¹ Adapted from the Imperial Gazetteer of India.

The weights (in gms.) were taken in the field within a few hours after the birds were killed.



Text-figure 1.—Map of the Darrang District, Assam, showing the localities where collections were made. (The scale is in English miles.)

The colours of soft parts were noted in the field, but they are omitted in this report as they are similar to those described by Baker in his volumes on Birds in the Fauna of British India series.

Local names were ascertained from local sources in the field.

The specimen numbers refer to the Registration numbers in the Zoological Survey of India collections.

For complete synonymies of the various species dealt with in the present paper, Baker's volumes (VII and VIII) of Fauna of British India (Birds) may be referred to.

ACKNOWLEDGMENTS.

I am grateful to Dr. B. N. Chopra, D.Sc., F.N.I., the Director, and Dr. M. L. Roonwal, M.Sc., Ph.D. (Cantab.), F.N.I., Asstt. Superintendent, Zoological Survey of India, for permitting me to examine the entire collection from the Darrang District. To Dr. Roonwal I am further indebted for checking the identifications and for constant guidance throughout the preparation of this report.

SYSTEMATIC ACCOUNT.

Order PASSERIFORMES.

Family CORVIDAE.

Dendrocitta vagabunda vagabunda (Latham).

(The Eastern Indian Tree-pie.)

1922. *Dendrocitta rufa vagabunda* (Lath.), Baker, *Faun. Brit. India, Birds* (2nd ed.) I, p. 50.

1932. *Dendrocitta vagabunda vagabunda* (Lath.), Whistler and Kinnear, *J. Bombay nat. Hist. Soc.* XXXV, p. 514.

Specimens collected.—Nos. 26860, ♂, and 26861, ♀, Tangla, November 14, 1939.

	Measurements (mm).	W.	Tl.	Tr.	B.
1 ♂	144	237	34	?
1 ♀	143	227	33	33

Weight.—No. 26861, ♀, 116.0 gms.

Systematic note.—The number of subspecies of *Dendrocitta vagabunda* is a somewhat disputed question. Baker (1922, pp. 48-51) recognizes five subspecies from India and Burma, viz., *rufa*, *vagabunda*, *sclateri*, *kinneari* and *saturator*. Whistler and Kinnear (1932, pp. 514-516) have critically studied this question, and have recognized four subspecies, viz., *pallida*, *vagabunda*, *vernayi* and *parvula*. My examination of 39 specimens in the Zoological Survey of India collections upholds their conclusion. The measurements of these specimens are given in Table 1.

TABLE 1.

Table showing the measurements in mm. of the different subspecies of *Dendrocitta vagabunda* in the Zoological Survey of India collections.

Subspecies	Localities	No. of specimens	Sex	Measurements			
				W.	Tl.	Tr.	B.
<i>Dendrocitta vagabunda pallida</i> (Blyth).	Punjab (Kangra valley)	2	?	165—170	274 (One specimen)	34—35	30—31
	Rajputana (Mt. Aho)	1	?	166	?	34	29
	TOTAL	3	?	105—167 167	274	34—35 34	29—31 30
<i>Dendrocitta Vagabunda Vagabunna</i> (Lathan).	Burma (all over the country)	2	♀♀	155—157	252—264	32—35	29—31
		13		140—167	200—310	26—35	27—30
				148·5	241·5	31	29
<i>Dendrocitta Vagabunda Vagabunna</i> (Lathan).	Assam (including the Darrang Dist. specimens).	1	♂	144	237	34	?
		2	♀♀	143—146	227 (One specimen)	31—33	28—33
		1	?	146	282	31	29

<i>Dendrocitta vagabunda vagabunda</i> (Latham)	Bengal (mostly in or around Calcutta, one from Duars and one from Nadia Dist.).	7	♂♂	144—153 149	224—262 247	30—34 32	27—29 28
		3	♀♀	147—150	250—254	33—34	26—27
		3	??	148·5 143—153 149	251 214	34 30—34 33	28·5 28—29 (Two specimens) 28·5
	Bihar (Purnea Dist.)	1	♀	148	?	33	28
	Central India (Baroda)	1	?	150	262	31	?
<i>Dendrocitta vagabunda vernayi</i> Kinnear and Whistler.		8	♂♂	144—153 148	224—262 243·5	30—34 32	27—29 (Seven specimens) 28
	TOTAL	8	♀♀	143—157 149	227—264 (Six specimens) 249·5	31—35 33	26—33 29
		18	??	140—167 149	200—310 (Sixteen specimens) 240·5	26—35 31	27—30 (Sixteen specimens) 28
	Mysore (Bangalore).	1	♀	132	?	31	?
<i>Dendrocitta vagabunda parvula</i> (Latham).	Travancore (Trivandrum)	..	1	♂ 145	221	30	28

Thick figures indicate average measurements.

Family PARIDAE.

Parus major nipalensis Hodgson.

(The Eastern Grey-Tit.)

1922. *Parus major cinereus* Vieil. (part), Baker, *Faun. Brit. India, Birds* (2nd ed.) I, p. 14.1932. *Parus major nipalensis* Hodgson, Whistler and Kinnear, *J. Bombay nat. Hist. Soc.* XXXV, pp. 518-519.*Specimen collected*.—No. 26862, ♂, Tangla, November 14, 1939.*Measurements*.—1 ♂: W. 68; Tl. 60; Tr. 17.5; B. 12.*Weight*.—13.4 gms.

Family TIMALIIDAE.

Pellorneum ruficeps mandellii Blanford.

(Mandelli's Spotted Babbler.)

Specimen collected.—No. 26863, ♂, Lokra, November 9, 1939.*Measurements*.—1 ♂: W. 65; Tl. 63; Tr. 26; B. 17 mm.*Weight*.—27.0 gms.**Aegithina tiphia tiphia** (Linné).

(The Common Iora.)

Specimen collected.—No. 26864, ♀, Lokra, November 9, 1939.*Measurements*.—1 ♀: W. 62; Tl. 53; Tr. 23; B. 17 mm.*Weight*.—15.1 gms.**Chloropsis aurifrons aurifrons** (Temminck & Laugier).

(The Gold-fronted Chloropsis)

Specimen collected.—No. 26865, ♀, Lokra, November 7, 1939.*Measurements*.—1 ♀: W. 89; Tl. 68; Tr. 21; B. 23 mm.*Weight*.—29.4 gms.

Family PYCNONOTIDAE.

Criniger gularis flaveolus (Gould).

(The Indian White-throated Bulbul.)

Specimen collected.—No. 26866, ♂, Lokra, November 9, 1939.*Measurements*.—1 ♂: W. 100; Tl. 92; Tr. 22; B. 21 mm.*Weight*.—54.5 gms.**Molpastes cafer bengalensis** (Blyth).

(The Bengal Red-vented Bulbul.)

Specimen collected.—No. 26867, ♀, Lokra, November 7, 1939.*Measurements*.—1 ♀: W. 97; Tl. 100; Tr. 26; B. 16 mm.*Weight*.—41.0 gms.

Otocompsa jocosa emeria (Linné).

(The Bengal Red-whiskered Bulbul.)

Specimen collected.—No. 26868, ♀, Lokra, November 8, 1939.*Measurements.*—1 ♀ : W. 87 ; Tl. 90 ; Tr. 20 ; B. 16 mm.**Otocompsa flaviventris flaviventris** (Tickell).

(The Black-crested Yellow Bulbul.)

Specimen collected.—No. 26869, ♀, Lokra, November 10, 1939.*Measurements.*—1 ♀ : W. 79 ; Tl. 83 ; Tr. 19 ; B. 14 mm.*Weight.*—28·0 gms.

Family TURDIDAE.

Saxicola torquata (subspecies ?).*Specimens collected.*—Nos. 26870 and 26871 (♂♂), Lokra, November 10 ; No. 26872, ♂, Tangla, November 14, 1939.*Measurements.*—3 ♂♂ : W. 71-76 ; Tl. 59-61 ; Tr. 23-27 ; B. 14-15 mm.*Weights.*—♂♂ : Nos. 26870, 14·2 ; 26871, 14·4 ; 26872, 13·7 gms.*Field note.*—Common all over.**Copsychus saularis saularis** (Linné).

(The Indian Magpie-Robin.)

Specimen collected.—No. 26873, ♂, Lokra, November 12, 1939.*Measurements.*—1 ♂ : W. 94 ; Tl. 90 ; Tr. 33 ; B. 21 mm.

Family MUSCICAPIDAE.

Culicicapa ceylonensis ceylonensis (Swainson).

(The Grey-headed Flycatcher.)

Specimens collected.—Nos. 26874 and 26875, ♂♂, Tangla, November 14 ; Nos. 26876 and 26877, ♂♂, Tezpur, November 18, 1939.

	<i>Measurements (mm).</i>	W.	Tl.	Tr.	B.
4 ♂♂	59—64	51—54	14—16	12—13
Av.	61	53	15	12

Weights.—♂♂ : Nos. 26875, 7·3 ; 26877, 7·0 gms.

Family DICRURIDAE.

Dicrurus macrocercus albirictus Hodgson.

(The Black Drongo.)

1924. *Dicrurus macrocercus macrocercus* Vieill., Baker, *Faun. Brit. India, Birds* (2nd ed.) II, p. 356.1924. *Dicrurus macrocercus albirictus* Hodgs., Baker, *Ibid.*, p. 357.*Specimen collected*.—No. 26878, ♂, Lokra, November 9, 1939.*Measurements*.—1 ♂ : W. 148 ; Tl. 170 ; Tr. 24 ; B. 27 mm.

Family SYLVIIDAE.

Abroscopus superciliaris flaviventris (Jerdon).

(The Yellow-bellied Flycatcher-Warbler.)

Specimens collected.—Nos. 26879 and 26880, ♂♂, Lokra, November 11, Nos. 26881 and 26882, ♂♂, Tezpur, November 18, 1939.

	<i>Measurements (mm).</i>	W.	Tl.	Tr.	B.
4 ♂♂	.	52—60	39—49	18—21	10—11
Av.	.	56	43.5	20	10

Weights.—♂♂ : Nos. 26879, 7.1 ; 26880, 6.0 ; 26881, 5.5 ; 26882, 5.5 gms.

Family ORIOLIDAE.

Oriolus xanthornus xanthornus (Linné).

(The Indian Black-headed Oriole.)

1926. *Oriolus xanthornus xanthornus* (Linn.), Baker, *Faun. Brit. India, Birds* (2nd ed.) III, p. 11.1933. *Oriolus xanthornus maderaspatanus* Frankl., Whistler and Kinnear, *J. Bombay nat. Hist. Soc.* XXXVI, p. 584.*Specimen collected*.—No. 26883, ♂, Lokra, November 10, 1939.*Measurements*.—1 ♂ : W 131 ; Tl. 85 ; Tr. 24 ; B. 29 mm.

In the Zoological Survey of India collections there are three other specimens from the Darrang district collected by Maj. Godwin-Austen in the winter of 1874-75. Their measurements are as follows :

	<i>Measurements (mm).</i>	W.	Tl.	Tr.
2 ♂♂	.	140—143	90—94	25—27
1 ♀	.	139	85	27

The bills in all these specimens are broken.

Weight.—55.0 gms.*Local name*.—*Patmāḍé*.*Field note*.—Not common.

Systematic note.—There is some controversy regarding the subspecies of *Oriolus xanthornus* in India. Baker (1926, pp. 11-13) recognizes two subspecies—*xanthornus* Linn. and *ceylonensis* Bonap., but Whistler and Kinnear (1933, pp. 584-585) split up the former into *xanthornus* and *maderaspatanus* Frankl. They confine *xanthornus* to the north of the Gangetic plain and *maderaspatanus* to its south. Their basis of differentiating *maderaspatanus* from the typical race are smaller size and narrower extension of the yellow colour on the tips of the secondary wing feathers, together with a small difference in the colours of the first year birds. From *ceylonensis* it (*maderaspatanus*) is said to differ in its larger size and wider extension of the yellow on the tips of the secondaries, and in the colour of the first year birds; so that, *maderaspatanus* forms an intermediate race between *xanthornus* and *ceylonensis*.

I have carefully examined 46 skins of *O. xanthornus* collected from all over India excluding Burma, Andamans, south Travancore and Ceylon. Their measurements are given in Table 2 below:

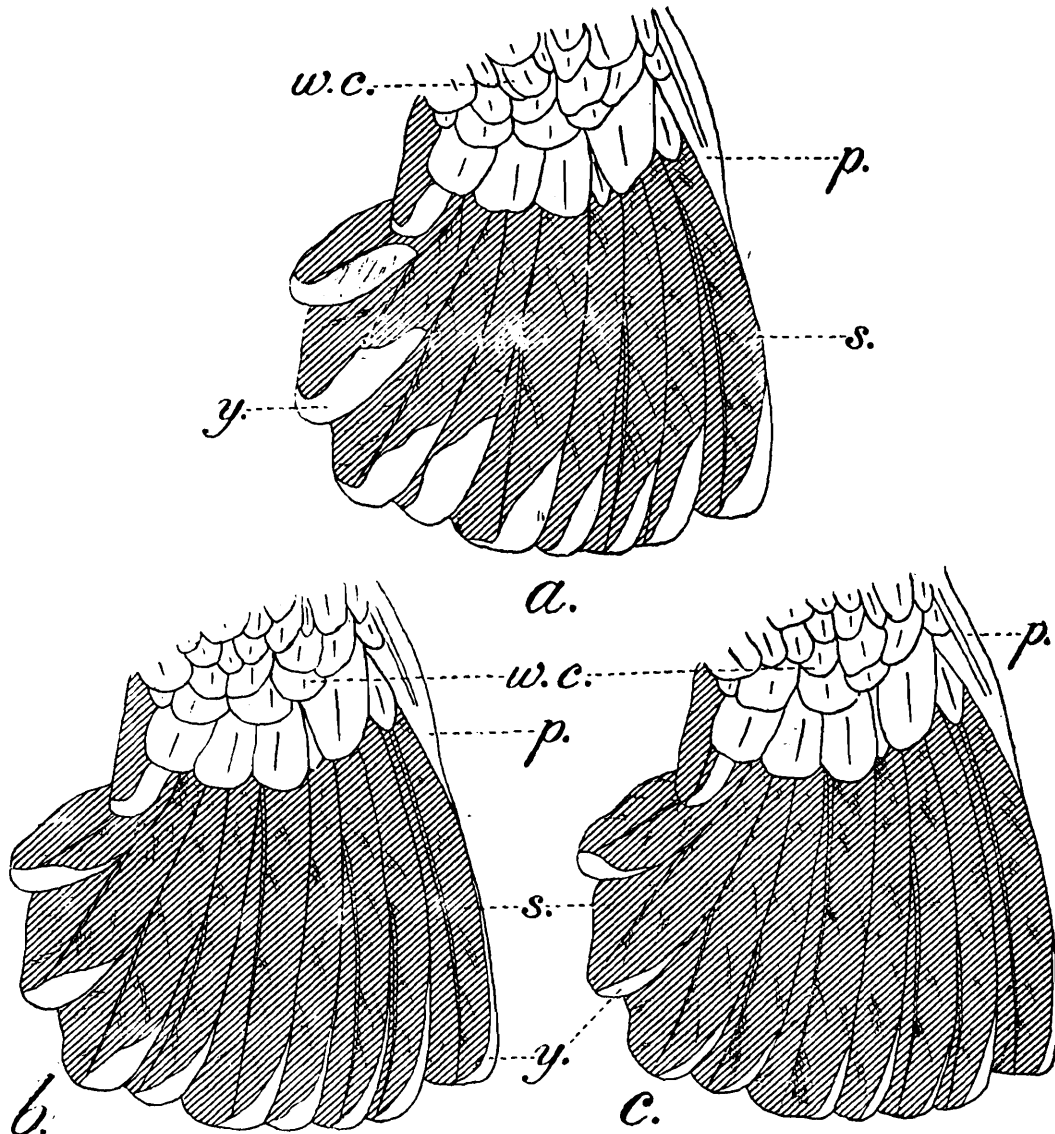
TABLE 2

Region	No. of specimens.	Sex	Measurements (mm)			
			W.	Tl.	Tr.	B.
Sub-himalayan Region (Lat. 26°—30° N.)	7	♂♂	132—146 139	87—100 93·5	22—27 25	30—31 30
	1	♀	139	85	26	?
	2	??	138—144	91—92	25—28	30 (one specimen)
Indo-gangetic Plain and adjacent southern land mass. (Lat. 22°—25° N.)	12	♂♂	127—142 137·5	82—100 92	22—27 24	27—31 28·5
	1	♀	128	91	28	25
	8	??	133—140 138·5	89—99 93	23—26 24·5	29—31 29
Central Peninsular India (Lat. 16°—18° N.)	8	♂♂	127—142 134	88—104 94·5	25—27 25·5	27—31 28
Southern India (Lat. 11°—12° N.)	2	♂♂	131—135	88	24—25	27—28
	1	♀	137	87	24	?
	4	??	131—138 135	84—89 86·5	23—25 23·5	28—29 28·5

Thick figures indicate average measurements.

Again as to the extension of yellow on the tips of the secondaries, I find that it varies greatly, even in birds from the same or adjoining

localities (Text-fig. 2), and it is, therefore, impossible to regard this as a subspecific character.



Text-figure 2.—Secondary wing feathers of *Oriolus x. xanthornus* to show the extent of yellow on their tips. *a*, WIDE in No. 8187, ♂, Darrang Dist., Assam; *b*, MEDIUM in No. 8188, ♀, Darrang Dist., Assam; *c*, NARROW in No. 5742 (sex ?), Samaguting, Naga Hills, Assam.

p., primaries; *s.*, secondaries; *w.c.*, wing-coverts; *y.*, yellow on the tips of secondaries.

On these grounds, *maderaspatanus* cannot be accepted as a valid subspecies.

Family STURNIDAE.

Sturnia malabarica malabarica (Gmelin).

(The Grey-headed Myna.)

Specimens collected.—Nos. 26884, ♀, and 26885, ♂, Lokra, November 7 and 12, 1939, respectively.

	<i>Measurements(mm).</i>					<i>W.</i>	<i>Tl.</i>	<i>Tr.</i>	<i>B.</i>
1 ♂	:	:	:	:	:	102	73	26	21
1 ♀	:	:	:	:	:	99	66	27	20

Weights.—♂ : No. 26885, 44.5; ♀ : 26884, 40.4 gms.

Acridotheres tristis tristis (Linné).

(The Common Myna.)

Specimen collected.—No. 26886, ♂, Lokra, November 9, 1939.*Measurements.*—1 ♂ : W. 143 ; Tl. 100 ; Tr. 40 ; B. 22 mm.*Weight.*—138.7 gms.*Local name.*—*Hâlîkâ.***Sturnopastor contra contra**(Linné).

(The Indian Pied Myna.)

Specimens collected.—No. 26887, ♂, Tezpur, November 4 ; No. 26888, ♂, Tangla, November 14, 1939.*Measurements.*—2 ♂♂ : W. 116-119 ; Tl. 72-80 ; Tr. 39-41 ; B. 31 mm. (one specimen).*Weights.*—♂♂ : Nos. 26887, 87.0 ; 26888, 82.5 gms.

Family FRINGILLIDAE.

Passer domesticus indicus Jardine and Selby.

(The Indian House-Sparrow.)

1926. *Passer domesticus indicus* Jard. and Selby, Baker, *Faun. Brit. India, Birds* (2nd ed.) III, p. 170.1928. *Passer domesticus nigricollis* Burt., Baker, *Faun. Brit. India, Birds* (2nd ed.) VIII, p. 656.*Specimens collected.*—Nos. 26889 and 26890, ♂♂, Lokra, November 12, 1939.*Measurements.*—2 ♂♂ : W. 71-74 ; Tl. 56-58 ; Tr. 20-22, B. 11 mm.*Weights.*—♂♂ : No. 26889, 23.3 ; 26890, 22.2 gms.*Systematic note.*—From an examination of all the specimens of *Passer domesticus* in the Zoological Survey of India collections, I could not find any difference between the supposed subspecies *indica* and *nigricollis*, as maintained by Baker (1926, pp. 170-172). A similar conclusion was also arrived at by Whistler and Kinnear (1933a, p. 838).**Passer montanus malaccensis** Dubois.

(The Malay Tree-Sparrow.)

Specimen collected.—No. 26891, ♂, Lokra, November 10, 1939.*Measurements.*—1 ♂ : W. 68 ; Tl. 56 ; Tr. 19 ; B. 11 mm.*Weight.*—20.5 gms.*Local name.*—*Konchikâ.**Field note.*—Common in houses.

Family HIRUNDINIDÆ.

Riparia paludicola brevicaudata (Horsfield).

(The Indian Sand-Martin.)

Specimen collected.—No. 26892 (sex ?), Tezpur (on the bank of R. Brahmaputra), November 6, 1939.

Measurements.—1 (sex ?) : W. 92 ; Tl. 43 ; Tr. 10 ; B. 6 mm.

Weight.—8.2 gms.

Local name.—*Tâltâpi*.

Family MOTACILLIDÆ.

Motacilla alba dukhunensis Sykes.

(The Indian White Wagtail.)

Specimen collected.—No. 26893, ♀, Tezpur (on the bank of R. Brahmaputra), November 6, 1939.

Measurements.—1 ♀ : W. 88 ; Tl. 93 ; Tr. 23 mm.

Weight.—16.5 gms.

Local name.—*Bâlimâti*.

Motacilla alboides Hodgson.

(Hodgson's Pied Wagtail.)

Specimens collected.—No. 26894, ♀, Tezpur (on the bank of R. Brahmaputra), November 6 ; No. 26895, ♀, on the bank of R. Bhareli, about 4 miles from Lokra, November 7, 1939.

Measurements.—2 ♀♀ : W 87 ; Tl. 87-92 ; Tr. 23-24 ; B. 16-17 mm.

Weights.—♀♀ : Nos. 26894, 21.5 ; 26895, 20.7 gms.

Local name.—*Tiposi*.

Motacilla cinerea caspica (Gmelin).

(The Eastern Grey Wagtail.)

Specimen collected.—No. 26896, ♂, Lokra (on the bank of stagnant streamlet in forest), November 12, 1939.

Measurements.—1 ♂ : W. 81.5 ; Tl. 93 ; Tr. 22 ; B. 15 mm.

The tail length of "under 75 mm." given by Baker (1926, p. 266) is incorrect, as already pointed out by Ticehurst (1927, p. 351).

Weight.—16.6 gms.

Motacilla citreola citreola Pallas.

(The Yellow-headed Wagtail.)

Specimens collected.—Nos. 26897, ♀, and 26898, ♂, Lokra, November 7 and 11, 1939, respectively.

	<i>Measurements (mm).</i>	W.	Tl.	Tr.	B.
1 ♂	.	88	81	27	14
1 ♀	.	83	80	25	15

Weights.—♂ : No. 26898, 18.2 ; ♀ : No. 26897, 17.9 gms.

Local name.—*Tooni*.

Field note.—Common in flocks of about 20-30 in the vicinity of water.

Anthus hodgsoni hodgsoni Richmond.

(The Indian Tree-Pipit.)

Specimens collected.—Nos. 26899, ♂, and 26900, ♀, Lokra, November 8, 1939.

	<i>Measurements (mm).</i>	W.	Tl.	Tr.	B.
1 ♂	.	83	64	23	14
1 ♀	.	85	67	22	14

Anthus richardi rufulus Vieillot.

(The Indian Pipit.)

Specimen collected.—No. 26901, ♂, Tangla, November 14, 1939.

Measurements.—1 ♂ : W 81 ; Tl. 65 ; Tr. 26 ; B. 14 mm.

Weight.—20.8 gms.

Family NECTARINIIDAE.

Aethopyga siparaja seheriæ (Tickell).

(The Indian Yellow-backed Sunbird.)

Specimens collected.—Nos. 26902, ♂, and 26903, ♂ (juv.), Lokra, November 12 ; No. 26904 (sex ?) (juv.), Tangla, November 15, 1939.

Measurements.—1 ad. ♂ : W 55 ; Tl. 67 ; Tr. 16 ; B. 21 mm.

Weight.—No. 26902, ad. ♂, 7.5 gms.

Order PICIFORMES.

Family CAPITONIDAE.

Thereiceryx lineatus hodgsoni (Bonaparte).

(The Assam Lineated Barbet.)

Specimens collected.—Nos. 26906, ♀, and 26905, ♂, Tangla, November 10 and 14, 1939, respectively.

	<i>Measurements (mm).</i>	W.	Tl.	Tr.	B.
1 ♂	126	86	30	33
1 ♀	128	87	30	34

Weights.—♂: No. 26905, 128.9; ♀: No. 26906, 140.0 gms.

Cyanops asiatica asiatica (Latham).

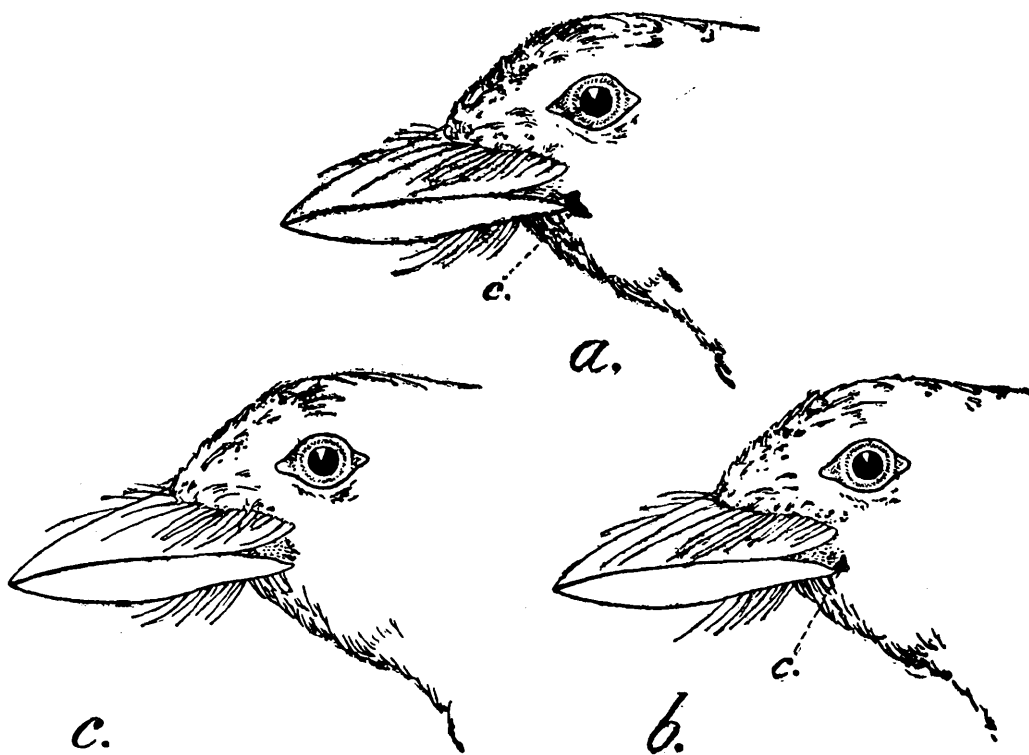
(The Blue-throated Barbet.)

Specimen collected.—No. 26907, ♂, Lokra, November 11, 1939.

Measurements.—1 ♂: W. 103; Tl. 67; Tr. 28; B. 27 mm.

Weight.—84.7 gms.

Systematic note.—The crimson specks at the base of the lower mandible, which Baker (1927, p. 116) mentions as a general character of the subspecies, was long ago considered by Godwin-Austen (1874, pp. 176-177) and Hume (1888, pp. 67-68) to be characteristic of the birds of



Text-figure 3.—Variation of crimson patches at the base of the lower mandible in *Cyanops a. asiatica*. *a*, in No. 26907, ♂, Lokra (Darrang Dist., Assam); *b*, in No. 15245 (sex ?), Nepal; *c*, in No. 688 of Mr. King's collections, ♂, Dehra Dun (U. P.).
c, crimson patch at base of lower mandible.

the Assam hills. My examination of 12 specimens in the Zoological Survey of India collections corroborates this conclusion. I find that in the Dehra Dun (U. P.) birds they are absent; of the four Nepal specimens one lacks them altogether and the other three have only slight traces of crimson patches; in Bengal specimens they are present as very small specks; while the Assam and Burma birds have them quite conspicuously (Text-fig. 3).

Order PSITTACIFORMES.

Family PSITTACIDAE.

Psittacula krameri borealis Neumann.

(The Northern Indian Rose-ringed Paroquet.)

Specimen collected.—No. 26908, ♀, Mangaldai, November 16, 1939.

Measurements.—1 ♀: W. 162; Tl. 183; Tr. 17; B. 25 mm.

Weight.—135.0 gms.

Systematic note.—Baker (1927, p. 204) gives the colour of the lower bill in this subspecies as wholly red; but in the present specimen its colour is mixed dusky red and black. Whistler and Kinnear (1935, p. 752) have already pointed out the nature of mixed coloration of the lower bill in this subspecies, and they did not attach any subspecific value to the colour of the lower bill.

Order CORACIIFORMES.

Family CORACIDAE.

Coracias benghalensis affinis Horsfield.

(The Burmese Roller.)

Specimen collected.—No. 26909, ♂, Mangaldai, November 15, 1939.

Measurements.—1 ♂: W. 193; Tl. 140; Tr. 27; B. 47 mm.

Weight.—192.0 gms.

Family MEROPIIDAE.

Merops orientalis birmanus Neumann.

(The Burmese Green Bee-eater.)

Specimen collected.—No. 26910, ♂, Lokra, November 11, 1939

Measurements.—1 ♂: W. 92; Tl. 124; Tr. 10; B. 33 mm

Weight.—11.4 gms.

Family ALCEDINIDAE.

Ceryle rudis leucomelanura Reichenbach.

(The Indian Pied Kingfisher.)

Specimen collected.—No. 26911, ♂, Tezpur (on the bank of R. Brahmaputra), November 6, 1939.

Measurements.—1 ♂ : W. 135 ; Tl. 76 ; Tr. 11 ; B. 68 mm.

Weight.—89.5 gms.

Local name.—*Hanumān*.

Alcedo atthis bengalensis Gmelin.

(The Common Indian Kingfisher.)

Specimen collected.—No. 26912, ♂, Kenduguri Bhil (Lake), a few miles from Mangaldai, November 16, 1939.

Measurements.—1 ♂ : W. 69 ; Tl. 35 ; Tr. 7 ; B. 41 mm.

Weight.—25.5 gms.

Local name.—*Hanumān*. (Same as above.)

Alcedo hercules Laubmann.

(Blyth's Kingfisher.)

Specimen collected.—No. 26913, ♂, Lokra, November 9, 1939.

Measurements.—1 ♂ : W. 95 ; Tl. 48 ; Tr. 12 ; B. 59 mm.

Weight.—59.7 gms.

Local name.—*Masrokhá*.

Remarks.—The name of this species has suffered a variety of changes within recent years. Blyth's *grandis*, being preoccupied, was changed to *hercules* by Laubmann. Kinnear (1929, p. 121) changed it to *megalia* without assigning any reason, and this was supported by Ticehurst (1930, p. 472). Later Ticehurst and Stanford (1939, p. 25) revived *hercules*.

Halcyon smyrnensis fusca (Boddaert).

The Indian White-breasted Kingfisher.)

Specimens collected.—Nos. 26914 and 26915, ♂♂, Tezpur (on the bank of R. Brahmaputra), November 4 and 6, respectively ; No. 26916, ♂, Mangaldai, November 15, 1939.

Measurements.—3 ♂♂ : W. 117-123 ; Tl. 87-93 ; Tr. 15-17 ; B. 62-63 mm.

Weights.—♂♂ : Nos. 26914, 86.4 ; 26915 73.0 gms.

Order COLUMBIFORMES.

Family COLUMBIDAE.

***Dendrophasa pompadora phayrei* (Blyth).**

(The Ashy-headed Green Pigeon.)

Specimen collected.—No. 26917, ♂, Lokra, November 11, 1939.*Measurements.*—1 ♂; W. 156; Tl. 92; Tr. 24; B. 16 mm.***Streptopelia chinensis suratensis* (Gmelin).**

(The Indian Spotted Dove.)

Specimens collected.—Nos. 26918, ♂, and 26919, ♀, Lokra, November 9, 1939.

	<i>Measurements(mm).</i>	W	Tl.	Tr.	B.
1 ♂	.	135	134	22	20
1 ♀	.	138	136	22	18

Weights.—♂: No. 26918, 119.0; ♀: Nos. 26919, 115.7 gms.*Local name.*—*Kaposrā*.

Systematic note.—These specimens are somewhat intermediate between the Indian subspecies *suratensis* and the Burmese *tigrina*, but close to the former. From specimens from western India they differ in having their backs, wing-coverts, scapulars and secondaries less heavily spotted with rufous, and in having the outer webs of the median wing coverts more ashy. In the under-parts there is no appreciable difference

Order CHARADRIIFORMES.

Family JACANIDAE.

***Metopidius indicus* (Latham).**

(The Bronze-winged Jacana.)

Specimens collected.—Nos. 26920 and 26921, ♀♀, Kenduguri Bhil (Lake), a few miles from Mangaldai, November 16, 1939.*Measurements.*—2 ♀♀: W. 178-181; Tl. 50-51; Tr. 71-77; B. 39-40 mm.

Family STERNIDAE.

Sterna melanogaster Temminck and Laugier.

(The Black-bellied Tern.)

Specimens collected.—Nos. 26922, ♂, and 26923, ♀, Tezpur (on the bank of R. Brahmaputra), November 4 and 6, 1939, respectively.

	<i>Measurements(mm).</i>	W.	Tl.	Tr.	B.
1 ♂	. .	226	160	15	41
1 ♀		223	110	15	37

(Outer tail-feathers not properly developed).

Weights.—♂ : No. 26922, 65.2 ; ♀ : No. 26923, 63.0 gms.

Local name.—*Siloni* and *Gangāsiloni*.

Remarks.—In No. 26923, ♀, it appears from the coloration that the specimen has not yet assumed the winter plumage.

Family CHARADRIIDAE.

Leucopoliu alexandrinu alexandrinu (Linné).

(The Kentish Plover.)

Specimen collected.—No. 26924, ♀, Tezpur (on the bank of R. Brahmaputra), November 6, 1939.

Measurements.—1 ♀ : W. 105 ; Tl. 47 ; Tr. 26 ; B. 19 mm.

Weight.—36.0 gms.

Local name.—*Titiāli*.

Family SCOLOPACIDAE.

Tringa hypoleucos Linné.

(The Common Sandpiper.)

Specimens collected.—Nos. 26925 and 26926, ♀♀, Tezpur (on the bank of R. Brahmaputra), November 4, 1939.

Measurements.—2 ♀♀ : W. 111 ; Tl. 57-61 ; Tr. 23-26 ; B. 26-27 mm.

Weights.—♀♀ : Nos. 26925, 49.0 ; 26926, 52.0 gms.

Tringa glareola Linné.

(The Wood Sandpiper.)

Specimen collected.—No. 26927, ♂, Kenduguri Bhil (Lake), a few miles from Mangaldai, November 16, 1939.

Measurements.—1 ♂ : W. 118 ; Tl. 48 ; Tr. 36 ; B. 31 mm.

Weight.—56.4 gms.

Order CICONIIFORMES.

Family ARDEIDAE.

***Egretta garzetta garzetta* (Linné).**

(The Little Egret.)

Specimen collected.—No. 26928, ♀, Tezpur (on the bank of R. Brahmaputra), November 4, 1939.

Measurements.—1 ♀: W. 261; Tl. 95; Tr. 94; B. 84 mm.

Local name.—*Bogulá.*

***Ardeola grayii* (Sykes).**

(The Pond Heron.)

Specimens collected.—Nos. 26929, ♀, and 26930, ♂, Tezpur (on the bank of R. Brahmaputra), November 4 and 6 respectively; No. 26931, ♂, Kenduguri Bhil (Lake), a few miles from Mangaldai, November 16, 1939.

	<i>Measurements (mm).</i>	W.	Tl.	Tr.	B.
2 ♂♂		215—227	84—94	62	72—73
1 ♀		210	82	60	65

Local name.—*Kânámoshûri.*

***Butorides striatus javanicus* (Horsfield).**

(The Indian Little Green Heron.)

Specimens collected.—Nos. 26932, ♂, and 26933, ♀, Tezpur (on the bank of R. Brahmaputra), November 6, 1939.

	<i>Measurements (mm).</i>	W.	Tl.	Tr.	B.
1 ♂		181	70	49	65
1 ♀		174	64	48	71

Local name.—*Wák.*

REFERENCES.

- Baker, E. C. S. 1922-1927. *Fauna of British India, Birds*, London, (2nd ed.) I-IV.
- Godwin-Austen, H. H. 1874. 'Fourth list of birds from the Naga Hills and Manipur, including others from the Khasi, Garo, and Tipperah Hills. *J. Asiat. Soc. Bengal* XLIII, pp. 151-180.

- Godwin-Austen, H. H. 1876. List of birds collected on the expedition into the Daffa Hills, Assam, together with those obtained in adjacent Darrang Terai. *Ibid.*, XLV, pp. 64-85.
- Hume, A. O. 1888. The birds of Manipur, Assam, Sylhet and Cachar. *Str. Feath.* XI, pp. 1-353.
- Kinnear, N. B. 1929. On birds collected by Mr. H. Stevens in Northern Tonkin in 1923-24. *Ibid.* (12) V, pp. 107-149.
- Milburne, D. 1939. Birds of another Assamese garden. *J. Darjeeling nat. Hist. Soc.* XIII, pp. 100-104.
- Stevens, H. 1914-1915. Notes on the birds of Upper Assam. *J. Bombay nat. Hist. Soc.* XXIII, pp. 234-268, 547-570 and 721-736.
- Ticehurst, C. B. 1926. Some notes on the second edition of the *Fauna of British India—Birds*, vols. I and II. *Ibid.*, XXXI, pp. 490-499.
- 1927. Some further notes on the second edition of the *Fauna of British India—Birds*, vol. III. *Ibid.*, XXXII, pp. 344-356.
- 1930. Notes on the *Fauna of British India—Birds*, vols. IV, V and VI (*New edition*). *Ibid.*, XXXIV, pp. 468-490.
- Ticehurst, C., B. and Stanford, J. K. 1939. On the birds of Northern Burma, Pt. V. *Ibid.* (14) III, pp. 1-45.
- Whistler, H. and N. B. Kinnear 1932. The Vernay Scientific Survey of the Eastern Ghats (Ornithological Section).—Pt. I. *J. Bombay nat. Hist. Soc.* XXXV, pp. 505-524.
- 1933. The Vernay Scientific Survey of the Eastern Ghats (Ornithological Section). Pt. V. *Ibid.*, XXXVI, pp. 561-590.
- 1933 a.—The Vernay Scientific Survey of the Eastern Ghats (Ornithological Section). Pt. VI. *Ibid.*, XXXVI, pp. 832-844.
- 1934. The Vernay Scientific Survey of the Eastern Ghats (Ornithological Section). Pt. VII. *Ibid.*, XXXVII, pp. 96-105.
- 1935. The Vernay Scientific Survey of the Eastern Ghats (Ornithological Section). Pt. X. *Ibid.*, XXXVII, pp. 751-763.

ON A COLLECTION OF BIRDS FROM RAJPUTANA

By BISWAMOY BISWAS, *M.Sc., Research Scholar, Zoological Survey of India*

INTRODUCTION

A party of the Zoological Survey of India, consisting of Dr. B. N. Chopra, Dr. M. L. Roonwal and a taxidermist made a short collecting trip to Rajputana in October-November, 1941. The collections made by them include about 100 bird skins from Ajmer-Merwara, and the Mewar (Udaipur) and Dungarpur States.

The physiography¹, etc., of the areas visited are briefly described below.

(a) *Ajmer-Merwara*—Collections were made in and around Ajmer City, which lies at the foot of the Târagârh Hill. The average mean temperature of the year is about 76°F., and in October-November about 68°F. The rainfall is low, the annual average being about 21 inches.

(b) *Mewar State*—The northern and eastern portions of the State consist of an elevated plateau of fine open country sloping to the north-east, while the southern and western portions are entirely covered with rocks, hills and dense jungle. The hill tract embraces the wildest portion of the Arâvalli range. Moreover, to the east of Chitorgarh is a series of hills running north and south forming narrow parallel valleys.

The country is arid. There are only a few rivers flowing through this State. The average annual rainfall at Udaipur is about 24 inches. There is usually more rain in the south-west. The climate is not severe. The average mean annual temperature at Udaipur is about 77°F.

In this State collections were made at the following places :—
Chitorgarh—in and around the town; also on the banks of the adjacent Berach river.

Udaipur—the capital of the State. Collected around the city.

Udaisagar Lake—7 miles from Udaipur.

Barapal—about 15 miles south of Udaipur.

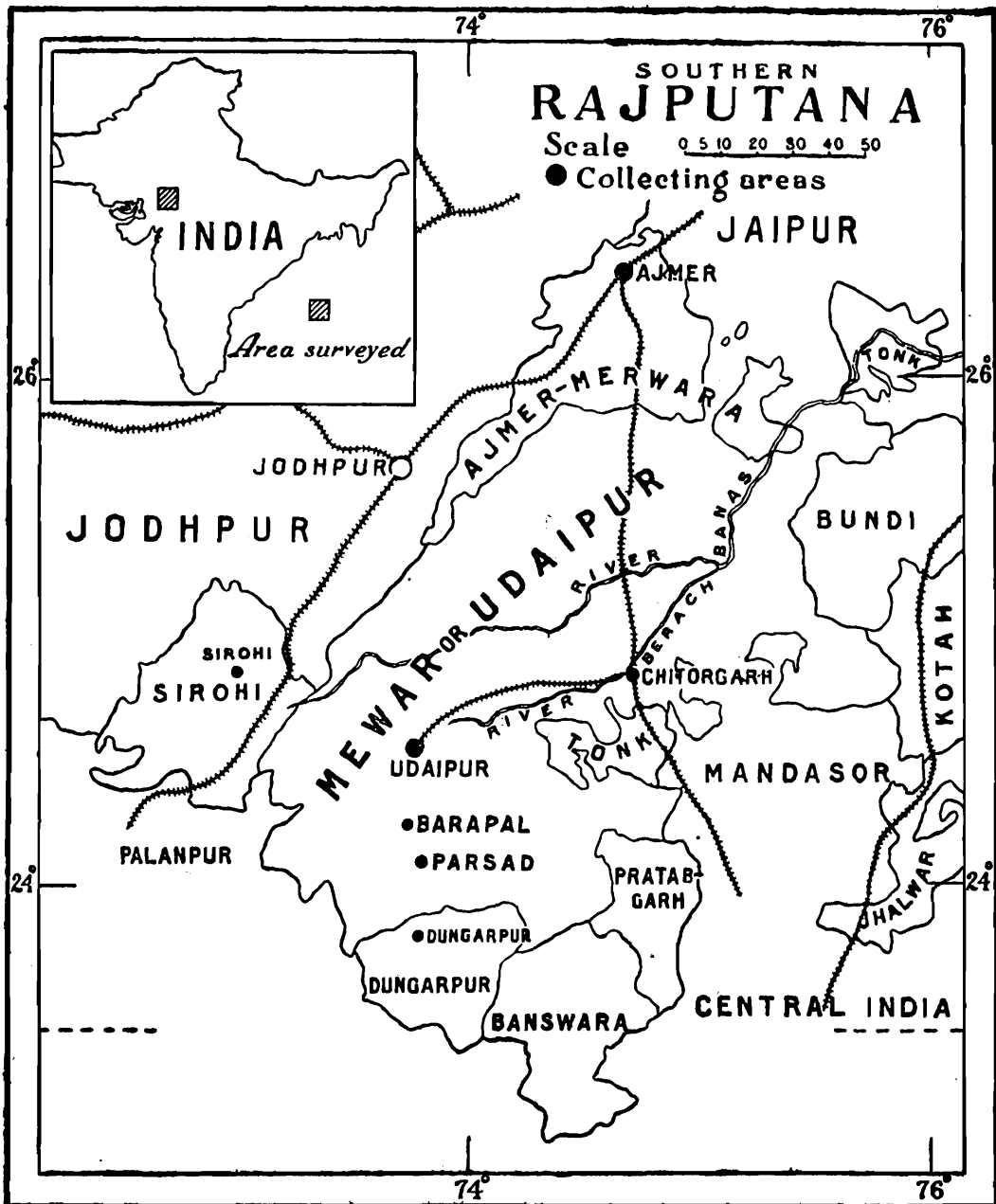
Parsad—about 30 miles south of Udaipur. Collected in the surrounding jungle and adjacent streamlets.

(c) *Dungarpur State*—In this, the southernmost State of Rajputana, collections were made around Dungarpur town. The climate is temperate and dry. The mean annual temperature is about 75°F., and the annual rainfall averages about 27 inches.

The accompanying map (Text-fig. 1) shows the positions of the different localities surveyed.

¹ Adapted from the Imperial Gazetteer of India.

Ornithology of Rajputana—The avifauna of Rajputana is imperfectly known. The only noteworthy reports on the birds of Rajputana are



TEXT-FIGURE 1.—Map of the southern part of Rajputana to show the area surveyed. The scale is in English miles. (Sirohi has been wrongly indicated as a collecting locality; no collecting was done there.)

from the Sambhar Lake and its vicinity by Adam (1873-74), the Mount Aboo region by Butler (1875-76), and the Jodhpur State by Hume (1878) and Whistler (1938).

Measurements, etc.—For the methods of taking measurements and determination of sex, weight, local names, etc., my previous paper (Biswas, 1947) may be referred to. When sex was determined from plumage and not by an actual examination of the gonads, it is indicated in brackets, e.g., (♂) or (♀).

The specimen numbers refer to the Registration numbers in the Zoological Survey of India collections.

Brief synonyms are given in controversial cases only. For a more complete list of synonyms reference may be made to Baker's volumes (VII-VIII) on Birds in the Fauna of British India series,

ACKNOWLEDGEMENTS

I wish to express my indebtedness to Dr. B. N. Chopra, D.Sc., F.N.I., the Director, and Dr. M. L. Roonwal, M.Sc., Ph.D. (Cantab.), F.N.I., Asstt. Superintendent, Zoological Survey of India, for their kindness in putting the entire collection of birds from Rajputana at my disposal. I owe a special debt of thanks to Dr. Roonwal for checking the identifications and many valuable suggestions in the preparation of this report.

SYSTEMATIC ACCOUNT

Order PASSERIFORMES

Family CORVIDAE

Corvus macrorhynchus culminatus Sykes

(The Indian Jungle-Crow)

1930. *Corvus levaillanti levaillanti* Less., Baker, *Faun. Brit. India Birds* (2nd. ed.) VIII, p. 593.

1930. *Corvus levaillanti culminatus* Sykes, Baker, *Ibid.*, p. 594.

1932. *Corvus macrorhynchus culminatus* Sykes, Whistler and Kinnear, *J. Bombay nat. Hist. Soc.* XXXV, p. 512.

Specimen collected : No. 26738, ♂, Barapal, October 15, 1941.

Measurements : 1 ♂ : W 282 ; Tl. 160 ; Tr. 54 ; B. 58 mm.

Local (Bhil) name : Kagwad.

Field note : The testes were in the non-breeding condition, measuring approximately 4.0×2.5 mm.

Remarks : Adam (1873-74), Hume (1878) and Whistler (1938) did not record this species from the Sambhar Lake area or the Jodhpur State, but Butler (1875) found it to be common in Mount Aboo region.

Family PARIDAE

Parus major marhattarum Hartert

(The Southern Grey Tit)

Specimen collected : No. 26739, (sex ?), Parsad, October 20, 1941.

Measurements : 1 (sex ?) : W 64 ; Tl. 56 ; Tr. 17 ; B. 11 mm.

Weight : 11.9 gms.

Family TIMALIIDAE

Turdoides somervillei terricolor (Blyth)

(The Bengal Jungle-Babbler)

1844. *Malacocercus terricolor*, Blyth, *J. Asiat. Soc. Bengal* XIII, p. 367 (Nepal).
(ex *Maina Terricolor*, Hodgson (1836), *J. Asiat. Soc. Bengal* V, p. 771.
Nom. nud.)
1922. *Turdoides terricolor terricolor* Hodgs., Baker, *Faun. Brit. India, Birds*
(2nd. ed.) I, p. 191.
1932. *Turdoides somervillei terricolor* (Blyth), Whistler and Kinnear, *J. Bombay
nat. Hist. Soc.* XXXV, p. 738.

Specimens collected : No. 26742, ♀, Chitorgarh, October 7, 1941 ;
Nos. 26741, ♂, and 26740, (sex ?), Parsad, October 19, 1941.

	Measurements (mm.).	W.	Tl.	Tr.	B.
1 ♂	: : : : .	106	110	34	22
1 ♀	: : : : .	105	100	35	21
1 (sex ?)	: : : : .	102	107	34	22

Weights (gms.) : No. 26741, ♂, 65.7 ; No. 26742, ♀, 68.2 ; No. 26740,
(sex ?) 59.0.

Local (Bhil) name : *Nelô* and *Kaugô*.

Argya caudata huttoni (Blyth)

(The Afghan Babbler)

Specimens collected : Nos. 26743, ♀, and 26744, (sex ?), Ajmer, October
31, 1941.

	Measurements (mm.).	W.	Tl.	Tr.	B.
1 ♀	: : : : .	86	111	28	18
1 (sex ?)	: : : : .	79	120	28	18

Weights (gms.) : No. 26743, ♀, 38.2 ; No. 26744, (sex ?), 31.2.

Systematic note : These specimens are somewhat intermediate between
the subspecies *caudata* and *huttoni* but nearer the latter. In Rajputana
caudata has been recorded by Adam (1873, p. 378) in the Sambhar Lake
area, by Butler (1875, p. 472) in Deesa (south-western Rajputana), and
by Hume (1878, p. 55) and Whistler (1938, p. 216) in Jodhpur State.
Ticehurst (1922, p. 540) found both *caudata* and *huttoni* in Sind. It
seems, therefore, that both the subspecies possibly occur in Rajputana.

Aegithina tiphia tiphia (Linné)

(The Common Iora)

Specimens collected : Nos. 26745, ♂, and 26746, (sex ?), Dungarpur,
October 26 and 28, 1941, respectively.

	Measurements (mm.).	W.	Tl.	Tr.	B.
1 ♂	: : : : .	64	49	18	16
1 (sex ?)	: : : : .	63	51	21	16

Weight (gms.) : No. 26745, ♂, 11.8 ; No. 26746, (sex ?), 12.4.

Field notes : Only a few pairs were seen.

Adam (1873) also found this species to be very rare in the Sambhar Lake area.

In No. 26745 the testes were in the non-breeding condition, measuring approximately 2.0×1.0 mm.

Family PYCNONOTIDÆ

Molpastes cafer pallidus Baker

(The Central Indian Red-vented Bulbul)

Specimens collected : No. 26747, ♂, Barapal, October 14 ; No. 26748, ♂, Parsad, October 19 ; Nos. 26749, ♀, and 26750, ♂, Ajmer, November 1, 1941.

	Measurements (mm.).	W.	Tl.	Tr.	B.
3 ♂♂	: : :	90—97	82—90	23—24	16
1 ♀	: : :	89	83	23	16

Weights (gms.) : ♂♂ : Nos. 26747, 36.2 ; 26748, 41.7 ; 26750, 33.9.

♀ : No. 26749, 28.7.

Field notes : Very common.

The testes in No. 26748 were in the non-breeding condition and measured about 2.0×1.5 mm.

Local (Bhil) name : *Peetrôlyô*.

Family TURD DÆ

Oenanthe picata (Blyth)

(The Pied Chat)

Specimen collected : No. 26758, ♂, on R. Berach near Chitorgarh, October 8, 1941.

Measurements (mm.) : 1 ♂ : W. 94 ; Tl. 72 ; Tr. 22 ; B. 17.

Weight (gms.) : 21.1.

Cercomela fusca (Blyth)

(The Brown Rock-Chat)

Specimen collected : No. 26756, ♀, Parsad, October 20, 1941.

Measurements (mm.) : 1 ♀ : W. 85 ; Tl. 68 ; Tr. 22 ; B. 17.

Weight : 12.7 (gms.).

Field note : Only a pair seen on river.

Saxicola fulicata cambaiensis (Latham)

(The Brown-backed Indian Robin)

Specimens collected : Nos. 26751 and 26752, ♂ (♂), Chitorgarh, October 9 ; No. 26753, ♀, around Udaisagar Lake, October 11 ; Nos. 26754, (♂), and 26755, (♀), Parsad, October 17 and 20, 1941, respectively.

Measurements (mm.).		W.	Tl.	Tr.	B.
3 ♂♂	:	72—76	65—69	25—27	15—16
2 ♀♀	:	70—71	63—69	26	14—16

Weights (gms.) : ♂♂ : Nos. 26751 and 26754, 20.0 and 17.0 respectively ; ♀♀ : Nos. 26753 and 26755, 18.6 and 19.0 respectively.

Local (Bhil) name : Dachkô.

Field notes : They were common all over.

In No. 26753 the ovary was in the non-breeding condition, measuring approximately 3.0 × 2.5 mm.

Copsychus saularis saularis (Linné)

(The Indian Magpie-Robin)

Specimen collected : No. 26757, ♂, Parsad, October 19, 1941.

Measurements (mm.) : 1 ♂ W. 99 ; Tl. 90 ; Tr. 27 ; B. 21.

Weight : 31.2 (gms.).

Local (Bhil) name : Kabrô.

Field note : A few seen.

Family MUSCICAPIDAE

Tchitrea paradisi paradisi (Linné)

(The Indian Paradise Flycatcher)

Specimen collected : No. 26762, ♂, (in black and white plumage), Barapal, October 14, 1941.

Measurements (mm.) : 1 ♂ : W. 96 ; Tl. 134 ; Tr. 19 ; B. 26.

Weight : 19.5 (gms.).

Field notes : Only one seen.

The testes were in the non-breeding condition and measured about 2.0 × 1.5 mm.

Leucocirca aureola aureola (Lesson)

(The White-browed Fantail Flycatcher)

Specimens collected : No. 26759, ♂, Barapal, October 15 ; No. 26761 (sex ?), Dungarpur, October 26 ; No. 26760, ♀, Ajmer (in scrub jungle close to the town), November 1, 1941.

	Measurements. (mm.)	W.	Tl.	Tr.	B.
1 ♂	84	90	18	16
1 ♀	88	95	18	14
1 (sex ?)	86	94	18	15

Weights (gms.) : ♂ : No. 26759, 12.0 ; ♀ : No. 26760, 10.0 ; (sex ?) No. 26761, 11.5.

Field notes : At Barapal it was not found to be common, while in the scrub jungles near Ajmer it was common in certain patches. Hume (1878) found it to be rare in the Jodhpur State.

In No. 26759 the testes were in the non-breeding condition measuring about 2.5 × 1.5 mm.

Family LANIIDAE

Lanius excubitor lahtora (Sykes)

(The Indian Grey Shrike)

Specimen collected : No. 26763, ♀, Chitorgarh, October 7, 1941.

Measurements (mm.) : 1 ♀ : W 105 ; Tl. 117 ; Tr. 31 ; B. 23.

Weight : 62.0 (gms.).

Field note : Two or three seen.

Lanius excubitor pallidirostris Cassin

(The Allied Grey Shrike)

Specimen collected : No. 26764, ♀, Ajmer (in the scrub jungle close to the town), October 31, 1941.

Measurements (mm.) : 1 ♀ : W 108 ; Tl. 109 ; Tr. 31 ; B. 33.

Weight : 60.0 (gms.).

Field note : One seen in the scrub jungle.

Remarks : This is a palaeartic race breeding in Baluchistan, but rarely recorded from the rest of India—once in the Punjab (Baker, 1924, p. 288) and twice in Sind (Ticehurst, 1922, p. 606). There is also in the Zoological Survey of India collections one specimen from Shahasan, Sind (No. 25701, ♀, Manchar Survey Party, November 1927) belonging to this race. The present one is, I believe, the first record from Rajputana.

Lanius vittatus Valenciennes

(The Bay-backed Shrike)

Specimens collected: Nos. 26766 and 26768, ♂♂; 26767, (sex ?),
Dungarpur, October 26, 1941.

	Measurements (mm.).	W.	Tl.	Tr.	B.
♂♂	: : : : :	84—85	87—88	23—25	14
1 (sex ?)	: : : : :	84	92	23	15

Weights (gms.): ♂♂: Nos. 26766, 21.9, and 26768, 21.9; (sex ?):
No. 26767, 21.7.

Field notes: Fairly common.

In Nos. 26766 and 26768 the testes were in the non-breeding condition and measured 2.0-2.5 × 1.0-2.0 mm.

Lanius schach erythronotus (Vigors)

(The Rufous-backed Shrike)

Specimens collected: Nos. 26765, ♂, and 26769, ♂ (juv.), Barapal,
October 14, 1941.

Measurements (mm.): 1 ad. ♂: W. 88; Tl. 105; Tr. 27; B. 19.

Local (Bhil) name: Monalyô.

Field note: Not uncommon.

Systematic note: The adult ♂ specimen shows a faint rufous tinge in patches on the upper back, and in this character it resembles the allied southern subspecies *caniceps*.

Family PERICROCOTIDAE

Pericrocotus peregrinus pallidus Baker

(The Sind Small Minivet)

Specimens collected: No. 26770, ♂, Parsad, October 19; No. 26771,
♂, Ajmer, October 31, 1941.

Measurements (mm.): 2 ♂♂: W. 68—70; Tl. 72—73; Tr. 15; B.
11—12.

Weights (gms.): ♂♂: Nos. 26770, 8.5; 26771, 8.3.

Field notes: Only a few seen.

In both the specimens the testes were in the non-breeding condition; measuring approximately 0.75-1.0 × 0.75-1.0 mm.

Systematic note: The specimens are somewhat intermediate between the subspecies *peregrinus* and *pallidus*, but closer to the latter. On the abdomen there is a very faint tinge of yellow; in this character they approach *peregrinus*. The lateral tail-feathers are tipped neither with scarlet-cream nor brick-pink, but with orange.

Family DICURURIDAE

Dicrurus macrocercus macrocercus Vieillot

(The Black Drongo)

Specimens collected : No. 26779, ♂, Barapal, October 14; No. 26778 (sex ?) (juv.), Parsad, October 17, 1941.

Measurements (mm.) : 1 ad. ♂ : W. 133 ; Tl. 124 ; Tr. 20 ; B. 21.

Local (Bhil) name : Kalyô.

Field note : Not uncommon.

Family STURNIDAE

Temenuchus pagodarum (Gmelin)

(The Black-headed Myna)

Specimens collected : Nos. 26772 and 26773, ♂♂, Dungarpur, October 25 and 26, 1941, respectively.

Measurements (mm.) : 2 ♂♂ : W 99—107 ; Tl. 70—72 ; Tr. 26—28 ; B. 18—19.

Weights : No. 26773, ♂, 44.4 gms.

Field notes : Common in the jungle close to Dungarpur.

In No. 26772 the testes were in the non-breeding condition and measured about 1.5×1.0 mm.

Acridotheres tristis tristis (Linné)

(The Common Myna)

Specimens collected : No. 26776, (sex ?), Chitorgarh, October 8 ; Nos. 26774, ♀, and 26775, ♂, Dungarpur, October 26, 1941. All are juveniles.

Local (Bhil) name : Kābar.

Remarks : Nos. 26774, ♀, and 26775, ♂, appear to be in moulting condition, the nape showing some small newly emerged feathers, and the crown with almost fully developed ones, with naked spaces here and there. No. 26776 (sex ?) appears to have completed moulting, the feathers being fresh.

Acridotheres ginginianus (Latham)

(The Bank Myna)

Specimen collected : No. 26777, ♀, Udaipur, October 11, 1941.

Measurements (mm.) : 1 ♀ : W 114 ; Tl. 76 ; Tr. 35 ; B. 22.

Local (Bhil) name : Gurkal (?)

Field note : The ovary was in the non-breeding condition, measuring approximately 4.0×4.0 mm.

Remarks : From plumage this specimen appears to have just completed moulting, the nape and posterior crown showing some newly developed feathers.

Family PLOCEIDAE

Uroloncha malabarica (Linné)

(The White-throated Munia)

Specimens collected : No. 26780, ♀, Chitorgarh, October 7 ; Nos. 26781 ♀, 26782, (sex ?), and 26783, ♂, Ajmer, November 1, 1941.

	Measurements (mm.).	W.	Tl.	Tr.	B.
1 ♂	.	57	51	14	10
2 ♀♀	:	52—55	49—50	13—14	10
1 (sex ?)	55	52	13	10

Weights (gms.) : ♂ : No. 26783, 11.3 ; ♀♀ : Nos. 26780, 12.5, and 26781, 11.4 ; (sex ?) : No. 26782, 10.6.

Field notes : Common all over.

In No. 26783 the testes were in the breeding condition, and measured 5.0×3.0 mm.

Family FRINGILLIDAE

Passer domesticus indicus Jardine & Selby

(The Indian House-Sparrow)

Specimens collected : Nos. 26784, ♂, 26785 and 26786, ♀♀, Barapal, October 13, 1941.

	Measurements (mm.).	W.	Tl.	Tr.	B.
1 ♂	:	76	58	19	12
2 ♀♀	:	69—70	53	17—18	10—11

Weights (gms.) : ♂ : No. 26784, 21.7 ; ♀♀ : Nos. 26785, 20.5 ; 26786, 21.3.

Local (Bhil) name : Charkalpe (for ♂♂ only).

Field notes : Fairly common near habitation.

The gonads were in the non-breeding condition. The testes in No. 26784 measured 1.0×0.75 mm., and the ovary in No. 26785, 3.0×3.0 mm.

Remarks : In the Jodhpur State Whistler (1938) found *P. d. parkini*, and not *P. d. indicus*.

Family HIRUNDINIIDAE

Hirundo daurica erythrogyia Sykes

(Sykes's Striated Swallow)

Specimen collected : No. 26787, ♂, Dungarpur, October 28, 1941.*Measurements* (mm.) : 1 ♂ : W 106 ; Tl. ? ; Tr. 14 ; B. 7.5.*Weight* : 17.5 gms.*Field note* : Very common, especially in the vicinity of water.**Hirundo daurica temmincki** (Hume)

(The European Striated Swallow)

Specimen collected : No. 26788, ♂, Chitorgarh, October 8, 1941.*Measurements* (mm.) : 1 ♂ : W 118 ; Tl. 116 ; Tr. 13 ; B. 10.*Weight* : 17.8 gms.*Local (Bhil) name* : *Chami chodalyô*.*Field note* : The specimen was shot from a flock of 100 or more which might possibly have been a mixed one of *H. d. erythrogyia* and *H. d. temmincki*. They were seen either soaring high up or sitting in flocks on telegraph wires, etc.*Remarks* : This palaeartic race occurs as a rare straggler in N. W. India, Gilgit, Kashmir and Nepal, and has once been recorded from Sind. The present one is probably the first record from Rajputana.

Family MOTACILLIDAE

Motacilla alba dukhunensis Sykes

(The Indian White Wagtail)

Specimen collected : No. 26789, ♀, on R. Berach near Chitongarh. October 8, 1941.*Measurements* (mm.) : 1 ♀ : W. 92 ; Tl. 91 ; Tr. 23 ; B. 17.*Weight* : 20.4 gms.*Local (Bhil) name* : *Náchangôl*.*Field notes* : Not common.

The ovary was in the non-breeding condition, measuring about 2.0×2.0 mm.

Motacilla maderaspatensis Gmelin

(The Large Pied Wagtail)

Specimen collected : No. 26790, ♂, on R. Berach near Chitongarh, October 8, 1941.

Measurements (mm.): 1 ♂: W. 95; Tl. 98; Tr. 26; B. 20.

Weight: 29.5 gms.

Local (Bhil) name: Náchangól.

Field note: A few seen on river.

Anthus trivialis trivialis (Linné)

(The Tree-Pipit)

Specimen collected: No. 26791, ♂, Chitorgarh, October 8, 1941.

Measurements (mm.): 1 ♂: W. 86; Tl. 66; Tr. 21; B. 14.5.

Weight: 20.9 gms.

Field note: The testes were in the non-breeding condition and measured approximately 0.75×0.50 mm.

Family ALAUDIDAE

Mirafra erythroptera erythroptera Blyth

(The Red-winged Bush-Lark)

Specimen collected: No. 26792, ♂, Chitorgarh, October 7, 1941.

Measurements (mm.): 1 ♂: W. 78; Tl. 53; Tr. 22; B. 12.

Weight: 21.1 gms.

Field notes: A few seen.

The testes appeared to be in the breeding condition, measuring about 6.0×3.5 mm.

Family ZOSTEROPIDAE

Zosterops palpebrosa occidentis Ticehurst

(The North-Western White-Eye)

Specimen collected: No. 26793, ♀, Dungarpur, October 27, 1941.

Measurements (mm.): 1 ♀: W. 55; Tl. 37; Tr. 15; B. 12.

Weight: 7.8 gms.

Order CUCULIFORMES

Family CUCULIDAE

Cuculus canorus (subspecies ?)

Specimen collected: No. 26794, ♀ (subadult), Parsad, October 21, 1941.

Measurements (mm.): 1 subad. ♀: W. 207; Tl. 172; Tr. 23; B. 28.

Weight: 104.0 gms.

Field notes: Only one seen.

Clamator jacobinus jacobinus (Boddaert)

(The Pied Crested Cuckoo)

Specimen collected : No. 26795, ♀, Parsad, October 22, 1941.*Measurements* (mm.) : 1 ♀ : W. 148 ; Tl. (165) ; Tr. 27 ; B. 14.
(Tip of tail abraded)*Weight* : 70.9 gms.*Field notes* : A few seen.

The ovary was quite large, measuring about 9.0×10.0 mm, and suggesting nearness to breeding.

Order CORACIIFORMES

Family CORACIIDAE

Coracias benghalensis benghalensis (Linné)

(The Indian Roller)

Specimens collected : No. 26797, ♂, Barapal, October 13 ; No. 26796, ♂, Parsad, October 22, 1941.*Measurements* (mm.) : 2 ♂♂ : W. 178—195 ; Tl. 124—142 ; Tr. 26—28 ; B. 42—48.*Weights* (gms.) : ♂♂ : Nos. 26796, 152.5 ; 26797, 130.0.*Field notes* : The testes were in the non-breeding condition, measuring approximately 2.0-2.5×2.0 mm.

Family MEROPIIDAE.

Merops orientalis orientalis Latham

(The Common Indian Bee-eater)

Specimens collected : Nos. 26798, ♂, and 26799, (sex ?), Barapal, October 13 ; No. 26800, ♂, Parsad, October 20, 1941.

Measurements (mm.).				W.	Tl.	Tr.	B.
2 ♂♂	:	:	:	90—92	115—118	9.5—11	30
1 (sex ?)	:	:	:	91	118	10	29

Weights (gms.) : ♂ : No. 26800, 14.6 ; (sex ?) : No. 26799, 15.5.*Field notes* : Common.

The testes were in the non-breeding condition, and measured about 1.5-2.5×1.25-1.5 mm.

Family ALCEDINIDAE

Alcedo atthis bengalensis Gmelin

(The Common Indian Kingfisher)

Specimen collected : No. 26801, ♂, on R. Berach near Chitorgarh, October 8, 1941.

Measurements (mm.) : 1 ♂ : W. 68 ; Tl. 34 ; Tr. 7 ; B. 44.

Weight. 25.0 gms.

Local (Bhil) name : Karkilô.

Remarks : Whistler (1938) did not find this subspecies in the Jodhpur State ; he found *pallasii* instead. But *bengalensis* was recorded by Adam (1873) in the Sambhar Lake area, and by Butler (1875) in Mount Aboo region.

Halcyon smyrnesis fusca (Boddaret)

(The Indian White-breasted Kingfisher)

Specimens collected : No. 26804, ♂, Barapal, October 14 ; Nos. 26802, ♀, and 26803, ♂, Parsad, October 20 and 21, 1941, respectively.

	Measurements (mm.).	W.	Tl.	Tr.	B.
2 ♂♂		121—125	84—85	16	62—63
1 ♀		123	87	16	67

Weights (gms.) : ♂♂ : Nos. 26803, 81.7 ; 26804, 74.5 ; ♀ : No. 26802, 86.5.

Local (Bhil) name : Karkilô.

Field notes : A few seen.

The gonads were in the non-breeding condition. In No. 26803, the testes measured about 2.0×1.0 mm. ; and in No. 26802, the ovary was about 5.0×6.0 mm.

Family UPUPIDAE

Upupa epops epops (Linné)

(The European Hoopoe)

Specimens collected : Nos. 26805, ♂, and 26806, ♀, Parsad, October 22, 1941.

	Measurements (mm.).	W.	Tl.	Tr.	B.
1 ♂	:	144	105	23	58
1 ♀	:	136	100	22	51

Weight : No. 26805, ♂, 66.7 gms.

Field notes : The gonads were in the non-breeding condition ; in No. 26805, the testes measured about 3.0×2.5 mm., and in No. 26806, the ovary was about 6.0×5.0 mm.

Remarks : The birds were evidently immigrants.

Upupa epops orientalis Baker

(The Indian Hoopoe)

Specimens collected : Nos. 26807 and 26808, ♂♂ : 26809, ♀, Parsad, October 22, 1941.

Measurements (mm.).	W.	Tl.	Tr.	B.
2 ♂♂	134—135	96—98	21—22	55—61
1 ♀	130	100	20	51

Weights (gms.) : ♂♂ : Nos. 26807, 54.5 ; 26808, 53.0 ; ♀ : No. 26809, 41.7.

Field notes : Not uncommon.

The gonads were in the non-breeding condition ; the testes were approximately $3.0-3.25 \times 2.0-3.0$ mm., and the ovary 5.0×4.0 mm.

Order STRIGIFORMES

Family ASIIONIDAE

39. **Athene brama brama** (Temminck and Laugier)

(The Spotted Owlet)

1927. *Athene brama brama* (Temm. & Laug.), Baker, *Faun. Brit. India, Birds* (2nd. ed.) IV, p. 439.

1927. *Athene brama indica* (Frankl.), Baker, *Ibid.*, p. 440.

Specimens collected : Nos. 26810, (sex ?), and 26811, ♂, Parsad, October 19 and 22, 1941, respectively.

Measurements (mm.).	W.	Tl.	Tr.	B.
1 ♂	151	78	28	20
1 (sex ?)	149	75	27	19

Weights (gms.) : ♂ : No. 26811, 114.0 ; (sex ?) : No. 26810, 105.0.

Field notes : Not common.

In No. 26811, the testes were in the non-breeding condition, measuring about 3.0×2.0 mm.

Systematic note : Baker (1927, pp. 439-440) recognises two subspecies of *Athene brama* in India, viz., *brama* (South Indian) and *indica* (North Indian). From the descriptions of these two subspecies as given by Baker, it was difficult to place the Rajputana specimens subspecifically. He differentiates them on the degree of coloration of the upper side and spotting on the under side, together with very slight

differences in their sizes. He restricts *brama* to the south of lat. 14°N. Whistler and Kinnear (1935, p. 237) maintain this division into two subspecies and give measurements of several specimens to show the differences, but these measurements largely overlap. Moreover, they recognize lat. 20°N. as the dividing line. Peters (1940, p. 150) also upholds this division.

I have examined all the specimens (36 in all) of *Athene brama* in the Zoological Survey of India collections from all over India. I find that in coloration the northern birds are generally slightly paler than the southern ones, but with all degrees of intergradations between them. In sizes, the southern birds tend to be slightly smaller but with much overlapping. The same conclusion was also arrived at by Whistler and Kinnear (*loc. cit.*) in spite of their recognition of the two subspecies as valid. They concluded: "There is, of course, complete intergradation between the two forms, both in colour and size, and there is a further complication that individual birds may vary considerably in colour. A Punjab bird . . ., for instance, is as dark as any specimen from Travancore." And conversely, I may add, in the Zoological Survey of India collections there is a specimen from Shevroy hills (Madras Presidency) which is so pale that it could not be differentiated when placed with the Dehra Dun (United Provinces) birds. The intergradation of the sizes will be clear from the following table (Table 1).

TABLE 1.

Measurements of the specimens of Athene brama in the Zoological Survey of India collections. Arranged from north to south.

Localities.	No. of specimens.	Sex.	MEASUREMENTS (mm.).			
			W.	Tl.	Tr.	B.
Punjab (Simla) Lat. ca. 31°N.	1	?	155	80	29	20
United Provinces (Dehra Dun and Agra Dt. Lat. ca. 27°—30°N.	1	♂	153	79	29	20
	1	♀	162	80	30	20
	2	??	155—157	80—85	29—30	21—21.5
Baluchistan. Lat. ca. 28°N.	1	♀	150	77	29	19.5
Bengal (Siliguri, Calcutta and its suburbs, Canning). Lat. ca. 22°—26°N.	2	♂♂	167—170	84—90	32	21—22
	7	??	157—170	80—86	28—32	21—23
			Av. 164.5	82	30	22
Assam (Gauhati and Cachar). Lat. ca. 25°—26°N.	1	♂	158	83	29	22
	2	??	168—171	81—90	29—32	21—22
Rajputana (Parsad) Lat. ca. 24°N.	1	♂	151	78	28	20
	1	?	149	75	27	19

TABLE 1—*cont l.*

Localities.	No. of specimens.	Sex.	MEASUREMENTS (mm.).				
			W	Tl.	Tr.	B.	
Bihar (Manbhum and Ranchi Dts.). Lat. ca. 23°N.	3	♂♂	151—162	78—82	30—32	20—21	
	1	♀	150	78	28	21	
	4	??	155—163	80—89	30—32	20—22	
			<i>Av. 159</i>	<i>84</i>	<i>31</i>	<i>21</i>	
Central Provinces (Pipariya). Lat. ca. 23°N.	1	♂	150	79	32	21	
Bombay Presy. {	Ahmedabad. Lat. ca. 23°N.	1	?	151	76	30	20
	Batnagiri Dt. Lat. ca. 17°N.	2	♂♂	147—156	74—77	30	21—22
South India (Bangalore, Mangalore, Shevroy hills and Trivandrum). Lat. ca. 8°—13°N.	2	♀♀	148—154	73—74	27	18.5—19	
	2	??	155—157	70—75	28	18—21	

It would appear from the table that there is a very small and hardly significant reduction in size from north to south, and it is impossible to fix a dividing line between northern and southern birds.

The above facts would lead to infer that only one subspecies (*viz.*, *brama*) of *Athene brama* should be recognized in India.

Order FALCONIFORMES

Family FALCONIDAE

Astur badius dussumieri (Temminck and Laugier)

(The Indian Shikra)

Specimen collected : No. 26812, ♂, Barapal, October 14, 1941.

Measurements (mm.) : 1 ♂ : W. 194 ; Tl. 151 ; Tr. 50 ; B. 20.

Weight : 140.0 gms.

Local (Bhil) name : *Richhadnyô*.

Order COLUMBIFORMES

Family COLUMBIDAE

Columba livia intermedia Strickland

(The Indian Blue Rock-Pigeon)

Specimen collected : No. 26813, ♂, Parsad, October 17, 1941.

Measurements (mm.) : 1 ♂ : W. 232 ; Tl. 124 ; Tr. 30 ; B. 22.

Streptopelia chinensis suratensis (Gmelin)

(The Indian Spotted Dove)

Specimen collected : No. 26814, ♂, Parsad, October 21, 1941.*Measurements* (mm.) : 1 ♂ : W. 140 ; Tl. 141 ; Tr. 23 ; B. 20.*Weight* : 103.5 gms.*Field notes* : Common only in certain localities.

The testes were in breeding condition, and measured approximately 8.0 × 6.0 mm.

Streptopelia senegalensis cambayensis (Gmelin)

(The Little Brown Dove)

Specimen collected : No. 26815, ♂, Barapal, October 13, 1941.*Measurements* (mm.) : 1 ♂ : W. 126 ; Tl. 120 ; Tr. 19 ; B. 18.*Weight* : 72.7 gms.*Local (Bhil) name* : Hôlu.*Field note* : The testes were in the non-breeding condition, measuring about 2.5 × 1.75 mm.**Streptopelia decaocto decaocto** (Frisvaldszky)

(The Indian Ring Dove)

Specimens collected : No. 26817, ♂, Chitorgarh, October 8 ; No. 26818, ♂, around Udaisagar Lake, October 12 ; No. 26816, ♂, Barapal, October 13, 1941.*Measurements* (mm.) : 3 ♂♂ : W. 161—170 ; Tl. 130—142 ; Tr. 22—23 ; B. 20.*Weights* (gms.) : ♂♂ : Nos. 26816, 132.2 ; 26817, 147.0 ; 26818, 139.7.*Local (Bhil) name* : Hôlu or Alyô.*Field notes* : Common.

In Nos. 26816 and 26817 the testes were in the non-breeding condition, measuring approximately 2.0—3.0 × 1.5—2.0 mm.

Remarks : As already reported by Roonwal (1943), in No. 26817, ♂, the bare orbital skin is pale grey with a distinct bright lemon yellow in patches ; and the edges of the eyelids are yellowish white.

Family PTEROCLIDIDAE

Pterocles indicus (Gmelin)

(The Painted Sand-Grouse)

*Specimens collected*² : Nos. 26572 and 26574, ♂♂, 26573, ♀, Parsad, October 23, 1941.

Measurements (mm.).	W.	Tl.	Tr.	B.
2 ♂♂	178—180	77—85	26—27	19
1 ♀	170	85	28	?

² These specimens have been studied by Roonwal (1947) in connection with his *Catalogue of Pterocletes*.

Field notes. Common among grass on hill-sides, usually in pairs. Shot at a pool where they come in large numbers every evening to drink.

In Nos. 26572 and 26574 the testes were in the non-breeding condition, and measured about 2.0×1.5 mm.

Order GALLIFORMES

Family PHASIANIDAE

Perdica asiatica asiatica (Latham)

(The Jungle Bush-Quail).

Specimen collected : No. 26819, ♀, Barapal, October 15, 1941.

Measurements (mm.) : 1 ♀ : W. 81 ; Tl. 40 ; Tr. 25 ; B. 13.

Weight : 40.8 gms.

Local (Bhil) name : *Labdee*.

Field note : Fairly common.

Francolinus pondicerianus interpositus Hartert

(The Northern Grey Partridge)

Specimens collected : Nos. 26820, ♀ (juv.), and 26821, ♀, Barapal, October 14 and 15 respectively ; No. 26822, ♀, Parsad, October 22, 1941.

Measurements (mm.) : 2 ad. ♀♀ : W 137 ; Tl. 84—87 ; Tr. 36—37 ; B. 21—22.

Local (Bhil) name : *Titar*.

Field notes : Very common at Parsad, but not so at Barapal.

The ovaries were of very large size, measuring in No. 26821, 9.0×7.0 mm., and in No. 26822, 12.0×8.0 mm., both with several conspicuous ova (some measuring about 2.5 mm. in diameter), suggesting proximity to breeding.

Order CHARADRIIFORMES

Family CHARADRIIDAE

Lobivanellus indicus indicus (Boddaert)

(The Indian Red-wattled Lapwing)

Specimen collected : No. 26823, (sex ?), on R. Berach near Chitorgarh, October 8, 1941.

Measurements (mm.) : 1 (sex ?) : W. 220 ; Tl. 120 ; Tr. 87 ; B. 38.

Weight : 197.2 gms.

Field notes : Very common.

Himantopus himantopus himantopus (Linné)

(The Black-winged Stilt)

Specimen collected : No. 26824, ♂, Barapal, October 14, 1941.*Measurements* (mm.) : 1 ♂ : W. 238 ; Tl. 88 ; Tr. 117 ; B. 59.*Field notes* : The testes were in the non-breeding condition and measured about 3.0×1.5 mm.

Family SCOLOPACIDAE

Tringa ocropus Linné

(The Green Sandpiper)

Specimen collected : No. 26825, ♂, Barapal, October 14, 1941.*Measurements* (mm.) : 1 ♂ : W. 142 ; Tl. 65 ; Tr. 34 ; B. 38.*Field notes* : Common.The testes were in the non-breeding condition, measuring approximately 2.0×1.5 mm.

Order CICONIIFORMES

Family PLEGADIDAE

Plegadis falcinellus falcinellus (Linné)

(The Glossy Ibis)

Specimens collected : Nos. 26827, 26828, 26829, ♂♂, Barapal, October 12, 13 and 14, 1941 respectively.*Measurements* (mm.) : 3 ♂♂ : W 275—287 ; Tl. 110—113 ; Tr. 89—107 ; B. 112—145.*Local (Bhil) name* : Kôylee.*Field notes* : Not very common.The testes were in the non-breeding condition, and measured approximately $7.0-8.0 \times 4.0-5.0$ mm.

Order PODICIPIFORMES

Family PODICEPIDAE

Podiceps ruficollis capensis Salvadori

(The Indian Little Grebe)

Specimens collected : Nos. 26830, ♂, and 26831, ♀ (juv.), Barapal, October 14, 1941.*Measurements* (mm.) : 1 ad. ♂ : W. 101 ; Tr. 37 ; B. 21.

Field notes : Common.

In No. 26830, the testes were in the non-breeding condition, measuring about 3.5×2.0 mm.

REFERENCES.

- Adam, R. M. 1873. Notes on the birds of the Sambhar Lake and its vicinity. *Str. Feath.* I, pp. 361-404.
- 1874. Additional notes on the birds of the Sambhar Lake and its vicinity. *Ibid.*, II, pp. 337-341, and 456-466.
- Baker, E. C. S. 1924. *Fauna of British India, Birds* (2nd. edition), London, II.
- 1927. *Ibid.*, IV
- 1930. *Ibid.*, VIII.
- Biswas, B. 1947. Notes on a collection of birds from the Darrang District, Assam. *Rec. Indian Mus.* XLV, pp. 225-244.
- Butler, E. A. 1875. Notes on avifauna of Mount Aboo and northern Gujerat. *Str. Feath.* III, pp. 437-500.
- 1876. Notes on avifauna of Mount Aboo and northern Gujerat. *Ibid.*, IV, pp. 1-41.
- Hume, A. O. 1878. The birds of a drought. *Ibid.*, VII, pp. 52-68.
- Peters, J. L. 1940. *Check-list of the Birds of the World*, Cambridge, U. S. A., IV
- Roonwal, M. L. 1943. Note on the colour of iris, of the bare orbital skin around the eyes and of the edges of the eyelids in the Indian Ring-Dove. *J. Roy. Asiat. Soc. Bengal* IX, p. 17.
- 1947. Catalogue of birds in the Indian Museum, Calcutta. II. Pterocletes (Sand-Grouse or Pigeon-Grouse). *Rec. Indian Mus.* XLV, pp. 57-73.
- Ticehurst, C. B. 1922. The birds of Sind, Pt. i. *Ibis* (11) IV, pp. 526-572.
- 1922. The birds of Sind, Pt. ii. *Ibis* (11) IV, pp. 605-662.
- Whistler, H. 1938. The ornithological survey of Jodhpur State. *J. Bombay nat. Hist. Soc.* XL, pp. 213-235.
- Whistler, H. and Kinnear, N. B. 1935. The Vernay scientific survey of the Eastern Ghats (Ornithological section), Pt. X. *Ibid.*, XXXVII, pp. 751-763.

FISH AND FISHERIES OF THE PATNA STATE, ORISSA.

By B. S. Chauhan, M.Sc., Ph.D., F.Z.S., Zoological Survey of India, Kaiser Castle, Banaras Cantt.

(Plates VII—IX.)

CONTENTS.

	Page.
Introduction	267
Water resources of the State	268
Fish Fauna of the State—	
(i) Salebhata	268
(ii) Agalpur	271
(iii) Balangir	271
(iv) Chandanbhati	273
(v) Patnagarh	273
(vi) Harishanker	274
(vii) Jarasingha	275
(viii) Salepali	275
(ix) Belgaon	275
(x) Titilagarh	276
Fishing implements used in the State—	
I. Nets—	
(a) Plunge nets	277
(b) Fixed nets	278
(c) Drag nets	278
(d) Cast nets	279
(e) Fry nets	279
II. Traps—	
(a) Basket traps	279
(b) Floating traps	280
III. Lines	280
IV. Fishing Boats	281
General	281
Acknowledgments	282

INTRODUCTION.

In March 1946, a party of the Zoological Survey of India, headed by me was deputed to the Patna State, in Orissa to conduct a fish and fisheries survey of the State. The work was undertaken specially at the instance of Rai Bahadur Dr. S. L. Hora, Director of Fisheries, Bengal, who had been requested by the state authorities to advise them on the development of the State Fisheries. As the fauna of this state and the country in its immediate vicinity has not yet received any attention, at the hands of the Systematists, this opportunity was availed of to collect and study as many other types of animals also, as could possibly be done.

The Patna State is situated between 20° 9' and 22° 4' N. and 82° 41' and 83° 40' E. and lies in the valley of the Mahanadi. It consists mostly of an undulating plain broken up by numerous small ranges and isolated

peaks. The average yearly rainfall is between 50 to 60 inches. For details of the physical features, etc., of the state a reference may be made to the following publications :—

Bengal Gazetteers, Feudatory States of Orissa, XIX, pp. 281-303 (Calcutta : 1910).
The Imperial Gazetteer of India, XX, pp. 70-73 (New Edition : 1908).

WATER RESOURCES OF THE STATE.

The water area of the State is about 18,000 acres and there are about 8,000 tanks, *Kathas* and *Mundas*.

The principal river of the state is the Tel river, a tributary of the Mahanadi. Almost the entire state is drained by the tributaries of the Tel, principals of which are the Ang river, Suktel, Lant, Sungad, Rahul, Khadang and Under. The Suktel and Barabait rivers traverse the centre of the State. Subarnrekha, Mayabati, Singodi, Solen, Chilari, Tong, Nimuruti and Luchimi are the other important smaller rivers of the state. Besides these rivers, there are some big streams or *Nallas*, known as *Jores*, in the state.

From the point of pisciculture, the state is particularly lucky in having many tanks, *Kathas* and *Mundas* which may prove useful provided necessary repairs and improvements are carried out. Sometimes, many as three or four tanks or *bundhs* exist in a single village and most of the cultivation fields, specially of paddy, which is the staple crop of the state are also terraced. These tanks are mostly irrigational tanks but with few alterations could probably be used for fish culture also. A very typical tank, in the state (Plate I, fig. 4) is a more or less square enclosure with high embankments, occasionally with a light house like tower, or a stone or a wooden pole in its centre perhaps to indicate water level. In addition to irrigation, these tanks are usually used for other purposes also, such as bathing, washing and taking drinking water for men and animals alike. Their areas vary from half an acre to ten or even more each. The tanks are dug deeper than *Kathas* and *Mundas*; an average depth of a tank being six to twelve feet and that of a *Katha* or *Munda* two to eight feet only.

There are in the state about 19 *Sars* or water reservoirs, which get connected with the rivers in the rainy season. We visited only two of them. There are in addition three very large water reservoirs in the state, known as *Sagars*. Each of these covers an area of more than 100 acres.

There is only one hill stream, with almost a perennial supply of water, at Harishanker, about 2,500 feet above sea level.

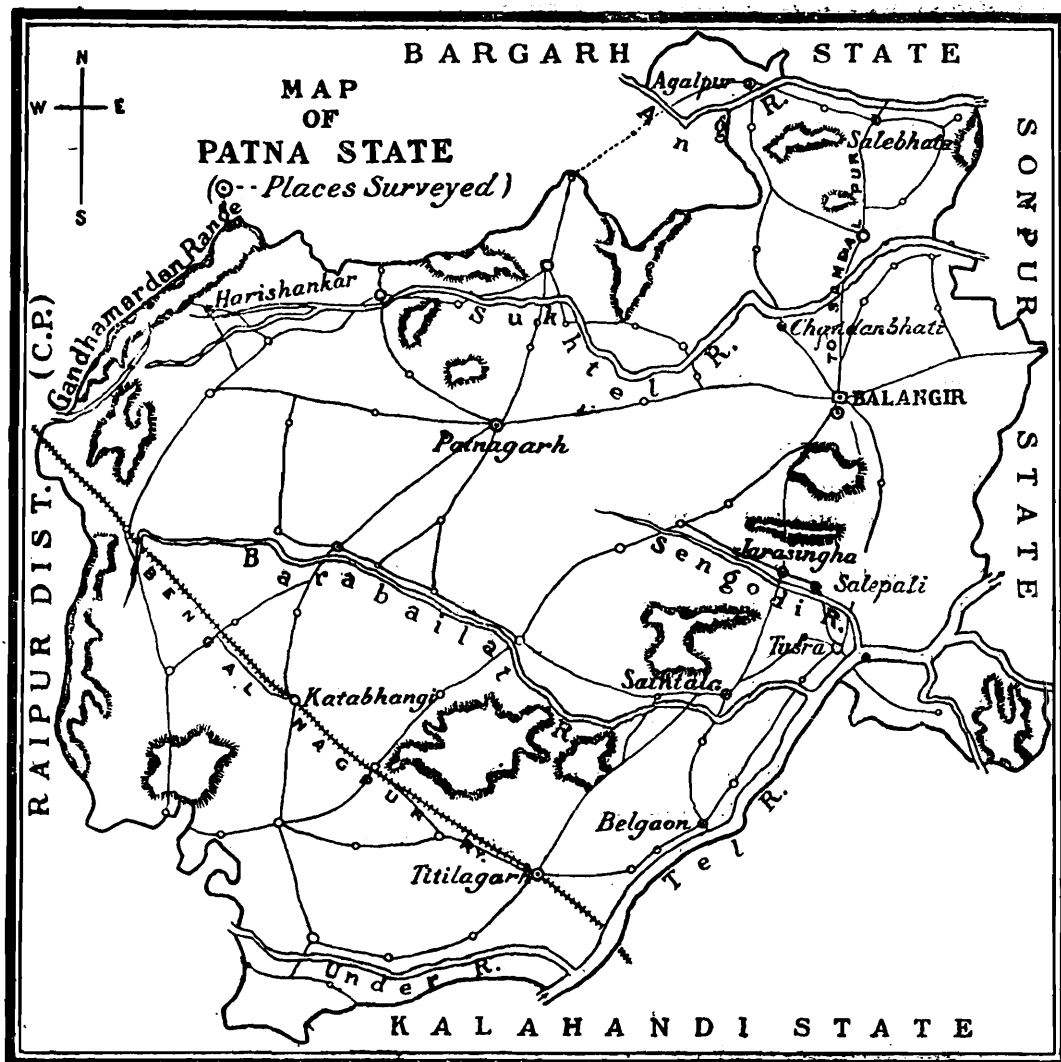
FISH FAUNA OF THE STATE.

A few localities, representing the different types of habitats in the state were selected and surveyed. The localities are shown in the accompanying map (Text-fig. 1) and descriptions of the tanks, etc., that were surveyed and the names of fishes found in them are given below:—

(i) *Salebhata*.—The following water resources were surveyed at this place :—

Jhitri bundh.—(Plate I, fig. 1). This is a small, roadside irrigational tank. The water area is about half an acre and increases in the

rainy season to about two and a half acres. It is a shallow tank and the vegetation consists mostly of *Hydrilla*, *Nymphia*, *Ceratophyllum*



etc. It is manured from the washings of the cattle sheds situated on its south-west bank and is very much silted.

- Ambasis baculis* (Ham.)¹
- Amblypharyngodon mola* (Ham.)
- Barbus (Puntius) sophore* (Ham.)
- Lepidocephalichthys guntea* (Ham.)
- Ophicephalus gachua* Ham.
- Rasbora daniconius* (Ham.)

Dhubel bundh.—This is a large perennial tank, about five feet in depth, with high embankments and over-shadowing trees, particularly on western side. It is full of vegetation, mostly *Nelumbium Pistia*, *Hydrilla* and other weeds. The water is greenish in colour. The tank is heavily silted and netting for fish is difficult. Its water is used for drinking and bathing. It has a large catchment area, mostly covered by paddy fields, the manure of which is probably washed off into this tank. It is also an irrigational tank and is reported to have many cat-fishes. A specimen of *Wallagonia attu*. from this tank was found to harbour an

¹ I am obliged to Dr. K. S. Misra, Assistant Superintendent, Zoological Survey of India for the identification of the fishes of this collection. A paper, dealing with the systematics of these fishes, along with their local names, is being published by him separately.

immature nematode, *Porrocaucum* sp. in its intestine and in its liver, half a dozen specimens, of the trematode fish parasite, *Isoparorchis hypselobagri* (Billet) which is believed to cause often serious fish mortality.¹

Ambassis ranga (Ham.)
Amblypharyngodon mola (Ham.)
Barbus (Puntius) sarana (Ham.)
 " " *sophore* Ham.
Clarias batrachus (L.)
Chela clupeoides (Bl.)
Esomus danricus (Ham.)
Labeo boggut (Sykes)
 " *fimbriatus* (Bl.)
Ophicephalus gachua Ham.
 " *punctatus* Bl.
 " *striatus* Bl.
Rasbora daniconius (Ham.)
Wallagonia attu (Bl. Schn.)

Baijal Sagar.—This has a water area of about one and a half acres and a catchment area of about three to four square miles. The tank is about two and a half to three feet deep, clean and with mostly reed vegetation. It dries up in summer. *Chela clupeoides* was found to be the most abundant fish in this tank.

Purni bundh.—This is a seasonal tank but has so much vegetation that no satisfactory netting of fish is possible.

The fish fauna of the above two tanks was found to consist of the following fishes :—

Ambassis ranga (Ham.)
Amblypharyngodon mola (Ham.)
Barbus (Puntius) sarana (Ham.)
 " " *sophore* Ham.
Chela clupeoides (Bl.)
Esomus danricus (Ham.)
Labeo boggut (Sykes)
 " *fimbriatus* (Bl.)
Lepidocephalichthys guntea (Ham.)
Ophicephalus gachua Ham.
 " *punctatus* Bl.
 " *striatus* Bl.
Rasbora daniconius (Ham.)

The Ang River.—The river Ang is a tributary of the Mahanadi. Vegetation in this river at this place is not very thick and consists of ordinary water weeds, reeds, etc. The nature of the bottom is sandy, there is clay on one bank and the bottom near about muddy; current is slow and water clear; and not deep. The river, just behind the state Inspection Bangalow, was surveyed twice up to the road bridge and the Sar.

Barbus (Puntius) ticto (Ham.)
 " (*Tor*) *khudree*² ? Sykes.
Barilius bendelisis (Ham.)
 " *vagra* (Ham.)
Brachydanio rerio (Ham.)
Labeo boggut (Sykes).
Rasbora daniconius (Ham.)

¹ Chauhan, B. S. *Rec. Ind. Mus.* XLV, pp. 133 and 136 (1947).

² The specimens are too young to be determined with any certainty.

Chandi Sar.—This is a long and deep *Sar*, a blind arm of the river Ang, just by the side of the bridge, on its right side. The place is shady. The bottom of the reservoir is muddy, with rich organic matter. The water is clear and has almost no current.

Ambassis baculis Ham.

„ *ranga* (Ham.)

Barbus (Puntius) ticto Ham.

Gadusia chapra (Ham.)

Xenentodon cancila (Ham.)

(ii) *Agalpur.*—The Ang river at Agalpur, about 11 miles from Salebhata, has a long and deep pool. The nature of the river bed here is sandy and at places rocky. One bank of the river is sandy, with shallow water and the other is high with deep water and is cut through earth. The water is clear, cool and the current slow, vegetation is scanty, except on the bank composed of clay where there are some high reeds and other water plants.

It was hoped that adult specimens of *Barbus (Tor) khudree?* and *Labeo boggut*, many fingerlings of which were seen in shoals at Salebhata, would be found at Agalpur. We however failed to get any adults of these two species. The following fishes were collected:—

Ambassis ranga (Ham.)

Callichrons bimaculatus (Bl.)

Chela boopis Day.

„ *gora* (Ham.)

Cirrhina reba (Ham.)

Danio devario (Ham.)

Gonialosa manmina (Ham.)

Labeo fimbriatus (Bl.)

Mastacembelus pancalus (Ham.)

Mystus bleekeri (Day)

„ *seenghala* (Sykes)

Ophicephalus gachua Ham.

Rasbora daniconius (Ham.)

Rohtee vigorsii Sykes.

(iii) *Balangir.*—This town is the capital of the State. The following tanks were visited here.

The Rajendra Agricultural Farm tanks.—This state agricultural farm has a chain of about five extensive tanks, almost in a continuous line, with a catchment area extending over miles, extending right from down the neighbouring hills: The tanks are surrounded by paddy fields and have something like a natural “lock-system” arrangement of drainage and control of water level. Although all of these tanks are not perennial, probably with a comparatively small investment, they

could be used for fish culture, and specially for rearing and stocking.—

Amblypharyngodon mola (Ham.)
Barbus (Puntius) amphibius (C. V.)
 " " *sarans* (Ham.)
 " " *sophore* Ham.
Chela clupeoides (Bl.)
Labeo boggut (Sykes)
Rasbora daniconius (Ham.)

Naya bundh.—This is comparatively a newly constructed small tank, about 10-12 feet deep, with high embankments and is used both for bathing and washing. The bottom consists of gravel and rocks and there is almost no vegetation. Size of the fishes is also comparatively small, due to lack of sufficient food as pointed out for such tanks by Hora (1943).¹ It is reported that a mortality of fishes in this tank often occurs on a large scale in the hot months of May and June. The water, in this tank was comparatively warm also.

Amblypharyngodon mola (Ham.)
Barbus (Puntius) sophore Ham.
 " " *ticto* Ham.
Chela bacaila (Ham.)
Esomus danricus (Ham.)
Glossogobius giuris (Ham.)
Mastacembelus pancalus (Ham.)

Jubilee tank.—This tank is about six feet deep. It has trees on its western side and has little aquatic vegetation.

Amblypharyngodon mola (Ham.)
Barbus (Puntius) sophore Ham.
Chela bacaila (Ham.)
 " *clupeoides* (Bl.)
Lepidocephalichthys guntea (Ham.)
Mastacembelus pancalus (Ham.)
Ophicephalus punctatus Bl.
Rasbora daniconius (Ham.)

Gait sarobar.—The following fishes were obtained to us from this tank.

Amblypharyngodon mola (Ham.)
Chela clupeoides (Bl.)
Mastacembelus pancalus (Ham.)
Ophicephalus punctatus Bl.
Rasbora daniconius (Ham.)

Maharani sagar.—A collection consisting of the following fishes was made for us from this tank.

Ambassis nama (Ham.)
Barbus (Puntius) sophore Ham.
 " " *ticto* Ham.
Lepidocephalichthys guntea (Ham.)
Mastacembelus armatus (Lac.)
Nandus nandus (Ham.)

Talpali Katha.—This reservoir is located near the Jubilee tank. It dries up completely in summer.

¹Hora, S. L. Tank for Fish-Culture. *Indian Farming* IV (8), p. 389 (1943).

Other fishes found in different tanks at Balangir are.—

Labeo boggut (Sykes)
 „ *fimbriatus* (Bl.)
Notopterus notopterus (Pallas)
Rohtee vigorsii Sykes

(iv) *Chandanbhati*.—This place is situated on the banks of the river Suktel. The river and its *Sar* and some tanks were surveyed here.

The Suktel river.—This river here is deep and its current slow. The bottom is sandy and at places there is silt. The water is not very clear and contains much decaying organic matter. The insect fauna is rich and the vegetation, specially algae growth is considerable.

Barilius bendelisis (Ham.)
Barilius vagra Ham.
Brachydanio rerio (Ham.)
Labeo boggut (Sykes)
Lepidocephalichthys guntea (Ham.)

Dhamna Sar.—This reservoir is a blind arm of the river Suktel. It is deeper than the river, and the water is almost stagnant. The bottom is sandy or muddy. There is thick growth of submerged vegetation.

Amblypharyngodon mola (Ham.)
Barbus (Puntius) ticto Ham.
 „ „ *sophore* Ham.^f
Gadusia chapra (Ham.)
Rohtes cotio var. *cunma* Day.

Nimuhi tank.—This is a clean tank, vegetation is not considerable and the bottom is made of ordinary clay.

Barbus (Puntius) amphibiis (C. V.)
 „ „ *sarana* (Ham.)
 „ „ *sophore* Ham.
 „ „ *ticto* Ham.^g
Chela clupeoides (Bl.)
Glossogobius giuris (Ham.)
Rasbora daniconius (Ham.)

(v) *Patnagarh*.—This place is the old capital of the State. It has a large number of tanks, but most of them are not in good condition. The place is said to be rather malarious. The following water areas were surveyed here.

Bhusagar.—This is a rather deep tank, being about 12 feet in depth, has an area of about four acres, and at the time of our visit, the water was dirty and greenish. It is full of mosquito larvae and is used for bathing and washing. *Glossogobius giuris* was found to be breeding and *Barbus (P.) sophore* was very abundant in this tank.

Amblypharyngodon mola (Ham.)
Barbus (Puntius) sophore Ham.
 „ „ *ticto* Ham.
Glossogobius giuris (Ham.)
Mastacembelus pancalus (Ham.)
Mystus sp.
Notopterus notopterus (Pallas)
Rasbora daniconius (Ham.)

Mena bundh.—This is a deep tank, about three to four acres in area. It has *pucca* ghats, clear water and profuse vegetation. The bottom soil is alluvial. The tank is also used for bathing. *Barbus (P.) ticto* was most abundant here. A large number of frogs were also observed.

Barbus (Puntius) ticto (Ham.)

Glossogobius giuris (Ham.)

Ophicephalus punctatus Bl.

Notopterus notopterus (Pallas)

Rasbora daniconius (Ham.)

Tahsil bundh.—It has an area of about two acres ; water is muddy and there is hardly any aquatic vegetation.

Barbus (Puntius) sophore Ham.

Ophicephalus punctatus Bl.

Rasbora daniconius (Ham.)

Markand bundh.—This is a small tank, with an area of about only half an acre, water is dirty and the tank has little vegetation.

Notopterus notopterus (Pallas)

Rasbora daniconius (Ham.)

Other fishes found in tanks at Patnagarh are.—

Barbus (Puntius) chola Ham.

” ” *conchonius* Ham.

Esomus danricus (Ham.)

Lepidocephalichthys guntea (Ham.)

The following fishes were noticed to be on sale, in the local market at this place.—

Barbus (Puntius) sophore Ham.

” ” *ticto* Ham.

Glossogobius giuris (Ham.)

Mastacembelus pancalus (Ham.)

Rasbora daniconius (Ham.)

(vi) *Harishanker.*—(Plate I, figs. 2 and 3). This place is at an altitude of about 2,500 feet above sea level and has the advantage of a profuse, perennial water supply from a hill stream ; which ultimately makes up the Suktel river. The water is distinctly alkaline and its temperature was found to be 18°C in the morning and 20°C in the afternoon in the middle of the month of March. The place is said to be very malarious. Collections were made in the hill stream, from the top of the neighbouring hill up to the base, where the village Nandupala is situated. The water is clear and current swift. The bed of the stream is rocky and soil, where present, is light and reddish in colour ; vegetation in the stream consists of a few reeds and shrubs here and there, and the banks are also occasionally shaded with shrubs, trees, etc.

Brachydanio rerio (Ham.)

Danio malabaricus (Jerdon)

Garra mullya (Sykes)

Glyptothorax lonah (Sykes)

Lepidocephalichthys guntea (Ham.)

Nemachilus dayi Hora.

The following fishes were collected from Makritapar which is a deep pool of Katangi Jore, a continuation of the above stream three miles away from the Harishanker Rest House. This stream is shallow, with

bottom usually muddy or sandy. Its water is somewhat warmer and the current is also slower than that of the hill stream.

Barbus (Puntius) chola Ham.
 „ „ *sarana* (Ham.)
 „ „ *ticto* Ham.
Brachydanio rerio (Ham.)
Callichrons bimaculatus (Bl.)
Garra mullya (Sykes)
Lepidocephalichthys guntea (Ham.)
Nemachilus dayi Hora.
Ophicephalus gachua Ham.

(vii) *Jarasingha.*

Budhai bundh.—The water of this tank is dirty and aquatic vegetation consists of small plants and is profuse. Its bottom is muddy. *Rasbora daniconius* was the most abundant species in this tank and was found to have strikingly brilliant colour band.

Amblypharyngodon mola (Ham.)
Barbus (Puntius) sophore Ham.
 „ „ *ticto* Ham.
Rasbora daniconius (Ham.)

(viii) *Salepali.*—Collections were made at this village in the *De Sar* reservoir of the Sungad river. The water in this reservoir is deep cool and clear. There are almost no currents. Its bottom is made of loamy soil. Vegetation is high but spare.

Ambassis baculis (Ham.)
 „ *ranga* (Ham.)
Amblypharyngodon mola (Ham.)
Barbus (Puntius) sophore Ham.
Chela clupeiodes (Bl.)
Danio chrysops (C. V.)
Ophicephalus punctatus Bl.
Rasbora daniconius (Ham.)
Rohtee cotio var. *cunma* Day.
Xenentodon cancila (Ham.)

Danio and *Xenentodon* were the most abundant fishes here.

(ix) *Belgaon.*—This place is situated on the banks of the river Tel (Plate I, fig. 5). The water of this river, though clear, probably contains some minerals and appears to be oily. Collections were made here in Kudal Darh, which is said to be the deepest pool in the state, and is at places 15-20 feet deep. Its water is cool and the bottom sandy; one bank is made up of sand and the other of poor, red soil; vegetation where present, is high and thick and water current is fairly swift.

Fry and fingerlings, specially of *Chela*, were found to abound here.

Ambassis baculis (Ham.)
 „ *ranga* (Ham.)
Aspidoparia morar (Ham.)
Barbus (Puntius) amphibius (C. V.)
 „ „ *chola* Ham.
 „ „ *sarana* (Ham.)
 „ „ *ticto* Ham.
Barilius bendelisis (Ham.)
 „ *barila* Ham.

Brachydanio rerio (Ham.)
Callichrons bimaculatus (Bl.)
Chela boopis Day.
 " *clupeiodes* (Bl.)
 " *gora* (Ham.)
Cirrhinā reba (Ham.)
Clupisoma garua (Ham.)
Erethistes hara (Ham.)
Eutropichthys vacha (Ham.)
Glossogobius giuris (Ham.)
Labeo ariza (Ham.)
 " *boggut* (Sykes)
 " *calbasu* (Ham.)
 " *gonius* (Ham.)
Lepidocephalichthys guntea (Ham.)
Mastacembelus armatus (Loc.)
Mugil corsula (Ham.)
Mystus cavasius (Ham.)
Nemachilus botia var. *aureus* Day.
 " *botia* (Ham.)
Rasbora daniconius (Ham.)
Rita chrysea Day.
Rohtee cotio (Ham.)
 " *vigorii* Sykes.
Xenentodon cancila (Ham.)

(x) *Titilagarh*.—This small, rapidly growing town with advantages of railway communication has a number of good tanks, like Maharaj Sagar, Nua bundh, Circle bundh, etc., which could perhaps be usefully employed for fish culture.

Trishool bundh.—This is a small tank, about half an acre in area and four feet in depth, situated in the Khazurpara village.

Barbus (Puntius) sophore Ham.
Rasbora daniconius (Ham.)

Nua bundh.—This is a bigger tank about two acres in area, but is full of vegetation. It has the advantage of getting washings from the neighbouring sheds.

Barbus (Puntius) sophore Ham.
Glossogobius giuris (Ham.)
Ophicephalus punctatus Bl.
Rasbora daniconius (Ham.)

Circle bundh.—This is a very clean tank, almost devoid of any vegetation. It is deeper also, about six feet deep.

Amblypharyngodon mola (Ham.)
Barbus (Puntius) conchoniū Ham.
 " " *sophore* Ham.
Glossogobius giuris (Ham.)
Ophicephalus punctatus Bl.

Deo bundh.—This appears to be a deep but dirty tank. It is full of vegetation, especially *Nelumbium*, *Pistia*, etc. and is said to abound in cat-fishes.

Ambassis ranga Ham.
Barbus (Puntius) conchoniū Ham.
 " " *sophore* Ham.
Glossogobius giuris (Ham.)
Mastacembelus pancalus (Ham.)
Nandus nandus (Ham.)
Ophicephalus punctatus Bl.
Rasbora daniconius (Ham.)

Maharaj Sagar.—This is one of the good tanks, with high embankments. Its area is about five acres and depth eight feet. The catchment area is also large.

Barbus (Puntius) sophore Ham.

Nandus nandus (Ham.)

Ophicephalus punctatus Bl.

Rasbora daniconius (Ham.)

Rasbora daniconius was found to be the most abundant fish in this tank.

The following fishes were found on sale in the local market, at this place.

Ambassis ranga (Ham.)

Barbus (Puntius) sophore Ham.

Glossogobius giuris (Ham.)

Nandus nandus (Ham.)

Notopterus notopterus (Ham.)

It was learnt that the state had been purchasing fish fry from Sambalepore for introducing in the tanks all over the state. The fish fauna, as recorded by us here, cannot, therefore be taken as absolutely indigenous to this state. As no experimental and control tanks are maintained, it is difficult to say, which species of fishes were introduced into these different tanks from outside the State.

FISHING IMPLEMENTS USED IN THE STATE.

The various fishing implements, nets, traps, etc. and other special devices used in the state are dealt with in brief below. It will be observed that they are remarkably old and primitive.

NETS.

The different types of nets, met with in the state, have been divided here into five groups—

(a) PLUNGE NETS.—These are light, hand nets operated generally by a single person.

Kural jal.—(Plunge net; Plate I, fig. 6). This net is designed on the model of an umbrella with six wooden ribs loosely tied at the top and carrying the netting at their lower ends. There is a handle at the upper end to operate the net. The netting can be taken out completely and the frame folded like an umbrella. It is evidently, not very useful for catching large fishes.

Tula jal.—(Lifting net; Plate II, figs. 1 and 2). The frame of this net consists of two long and thin bamboo strips crossing each other in the middle and at right angle, with a long bamboo handle attached at the point of crossing. The net is fixed to the four ends of the bamboo strips. This is a large net, a specimen that was measured being 12 feet 10 inches long and 12 feet 6 inches broad. The mesh, as in most of the other nets used in the state, is about half an inch to one inch. The net is lowered in the water and when some fishes, prawns, etc., have been collected into it, the man operating it lifts it out of the water and

collects his catch in a basket that he generally carries on his back. This net very much resembles the *Ilb-jung-thauri* of the Manipuris.¹ Though this net is used during the day also, fishermen of Belgaon and perhaps of Titilagarh side also employ it extensively for night fishing. Forty to fifty of them or even more, stand in pairs, in a row across the river. One man of each pair, operates the net and carries on his back a basket in which the catch is collected, while the other has a *Baingi* over his shoulder. This is a horizontal bar of wood with a basket hanging at each end. In the front basket, is a half earthen pot in which some fuel is kept burning, while in the other basket supply of extra fuel is carried. Fishes are attracted by the light of the fire and are easily caught in the net. Wood of *Sisoo* (*Dalbergia latifolia*) or some such other wood is generally used as fuel, as it is said to contain oil and therefore considered to give a comparatively bright light and also burn for a longer time, while fishing the men keep up moving forward slowly.

Thapi net (*Chingri jal*; Plate III, fig. 3). This is a small, rectangular hand net, designed on the lines of the last one but has no handle. It consists of two thin and elastic bamboo strips, tied down in their middle so as to cross each other at right angles and their four ends carry the netting. Our sample measured about 30 inches in length and 20 inches in width. The size of the mesh is about one third of an inch. This net is used mainly for shrimps and small prawns but is quite effective for fry and small fishes also. It is mostly used in small tanks, pools and perhaps in paddy fields as well.

(b) FIXED NETS.

Fwi jal.—(Fixed or stake net; Plate III, fig. 1). This net is just like the *Sera jal* referred below or any other ordinary drag net of its type. It differs from a common drag net in being smaller in size and in the construction of the upper border, which is formed of small, thin, and hollow pieces of stick, about three to four inches in length, arranged in a continuous chain. This modification makes the operation of the net, as an ordinary drag net, difficult, but renders it perhaps more convenient to handle and also effective in operation, as the sticks serve the purpose of a float. This net is fixed across the stream at night. The size of the mesh varies considerably; it is generally one to three inches. The net is about 20 to 60 feet long and five feet high. It is used in slow running waters, tanks, deep pools, etc.

(c) DRAG NETS.

Khadi jal.—(Plate II, fig. 4.) This net is, perhaps, just a modification of an ordinary drag net, the modifications being that it is narrower, shorter, and is supported by thin transverse wooden sticks. It is very common all over the state, probably on account of its being light and convenient to use. Its length is usually about 80 feet and height 2 feet. It is known as *Khadi Jal*, on account of the local name of the wood, which is used for making its supporting ribs. It is effective for small and shallow waters and can be used only up to two to three feet below the surface of the water. Two men are required to operate this net and generally one or more persons are needed to drive the fishes towards the net.

Sera jal.—This is just an ordinary drag net, common almost all over India. It measures about 30 to 120 feet in length and five to eight feet in height. The size of the mesh is about one and a half inches.

(d) CAST NETS.

Bhaur jal.—This is a typical cast net used all over India. It is circular in shape, with a pull-string in the centre and lead beads all along the margin. Its circumference is about 12 feet, radius six feet and the size of the mesh about a quarter of an inch. In the Patna State, it is specially employed for catching clupeoids, etc.

(e) FRY NETS.

The length of these nets varies from 30 to 60 feet and the height is about five feet. The size of the mesh is about a quarter of an inch.

TRAPS.

Fishermen, in the State, use different types of traps also, mostly made of bamboo. These are generally used in comparatively still waters and can be roughly divided into two groups.

(a) BASKET TRAPS.

The traps included in this group are generally fixed.

Ghani trap.—(Plate II ; fig. 5.) This is a rectangular bamboo basket with a device for allowing the fish to get in and preventing it from escaping easily. There is a hole in one corner, near the bottom and as this is protected on the inside by converging strips of bamboo, fishes can get in easily, but cannot escape. A large door running along the whole height of the trap, in the middle of the front side, is used for taking out the fish. It also serves as an additional trap-gate. Bait, generally consisting of some worms is hung on a string running across, inside the trap. These traps are sometimes used singly but often in groups in one line. One trap that was measured was 25 feet long, 14 feet broad and 23 feet high.

Dhair trap.—(Filter basket ; Plate III, fig. 2.) This trap is also made of bamboo strips. There are three holes on one side and two on the other to allow the fish to get in. The holes, as in the case of *Ghani trap* are provided inside with converging bamboo strips. The outlet for collecting the catch is in one corner on the top. Its length is 77 feet, height 25 feet and width, at the bottom 15 feet. They are used singly or in a row in shallow running waters.

Thapa (Plunge basket ; Plate III, fig. 3). This is just a conical basket, open at both the ends. A person carries it in his hand and if he comes across a fish in the water, he plunges the basket over it, to trap it. If he is successful, the prey is removed out of the basket through the narrow outlet at the top. It is about 22 feet 5 inches high and has a diameter of about 29 inches.

Khaksa, *Putia* and *Chingri Bendas* (Plate II, fig. 6 ; Basket Nos. 1 and 2. *Khaksa Benda* ; 3-6 *Chingri Benda* and 7-8 *Putia Benda*). All

these traps are also rectangular bamboo baskets, made on the model of *Ghani trap* (Plate II, fig. 5), the only difference being in their smaller size and absence of any hole near the bottom. There is similar arrangement for bait and the gate is also identical. It consists of small strips of bamboos fastened together into a mat like structure by three rows of strips; of which the central string is tied down to the top and bottom horizontal supports of the frame of the top in such a way that the middle string acts more or less like a hinge and a fish could get in only but cannot come out again. The distance between the inter-spaces of the bamboo strips of the traps, varies with the size of the game which is sought to be trapped, *Khaksa* (*Ophicephalus*), *Putia* [*Barbus* (*Puntius*) spp.] or *Chingri* (Prawn and Shrimps). Average size of one of these baskets is length nine inches, height nine and a half inches and width five inches. These traps are used only in slow running streams and several of them are used at one time.

Kumna (Back trap; Plate III, fig. 4). This trap consists of two parts, first a piece of straw or bamboo mat folded so as to make a gutter-like channel, leading into the second component, bamboo cone, arranged as shown in the photograph. The whole thing is kept in a flowing stream along the direction of the current. A fish passes along the channel formed by the mat into the cone, and as the space at the farther end of the cone is narrow, it cannot turn back and escape. Its fins are often entangled in the meshes of the trap. The size of the mat is variable, but the cone generally measures about 32 inches in length. This trap is used in somewhat, slow running streams.

(b) FLOATING TRAPS.

The two little fishing devices described below are used in groups at a time either independently or along with the *Dawn*, described below, or *Fui jal*, already referred to.

Floating Sol.—(Plate III, fig. 5, *b*). This trap is made of some light wood, generally pieces of certain climber intertwined, carrying a hook with bait hanging from one end. This floats on water and its increased movements enable a person to detect the catch.

Phas.—(=trap; Plate III, fig. 5, *a*.) This is an elongated, hexagonal cone open at both ends and is made of thin and light branches or strips of certain climbers. There is a ring of a few strips at the narrow end of the cone, carrying a small hook and bait. A fish enters this cone for the bait, and as soon as it swallows the bait and tried to escape the ring closes the narrow end, so that even a small fish cannot easily escape. If a large fish struggles to get out, its fins get entangled or come out of the inter-spaces of the component strips, making its escape almost impossible. This trap also floats on water and like the previous one, is generally used in groups, with floating *sol* or alone. These contrivances are specially used for air breathing fishes, like *Ophicephalus*, *Clarias*, *Heteropusteus*, etc., that come to the surface to take air.

LINES.

(*a*) *Dawn* (Hook and lines). This is a long, cotton cord with about 100-150 hooks, hanging at more or less regular intervals, with bait attached and is used specially for *Ophicephalus* fishing.

(b) *Upher* (Rod and line). This consists of the usual hook, line and a rod as used by anglers everywhere.

FISHING BOATS.

Boats and other crafts appear to be seldom used for fishing in the state. A very primitive type of canoe (Plate III, fig. 6) was seen for the first time in the state, in the river Tel at Belgaon. Four similar boats were subsequently seen at Rigdol village, about four miles from Titilagarh. Their average measurements were : length 11.4 feet, width one foot and depth, on the inside, nine inches. These canoes are dug out from single trunks of *Pipal*, teak or *Sāle* (*Bowsellia serata*) trees, probably prepared by the fishermen themselves and are reported to cost only two or three rupees each. While fishing a canoe is usually manned by two persons, one for paddling and the other for operating a net, generally a lifting net. At the longer end of the canoe where there is a round hole, in which the pole is fixed, when not in use, which is used for paddling, a person sits to paddle it and at the other, the smaller end, the second person operates the net. They also tie two canoes together for fishing purposes.

GENERAL.

The total population of the Patna State is about seven lakhs and the staple food is rice. A vast majority of the population, reported to be about 96 per cent eat or are said to have no objection to eating fish. The communities, which deal in fishes in the state are *Kewat*, *Dhimar*, *Tiyar* and *Gingra* and their population is about 4,500.

There is great demand of fish in the state. At Balangir, the State Fisheries Inspector auctioned a small lot of fingerlings, weighing about a pound, and it fetched nine annas. Similarly a handful of tiny shrimps were sold for six pice and the competition amongst the bidders for both the fish and shrimps was comparatively keen. Fish is also imported into the state from the neighbouring state of Sonapur, on account of scarcity of local fish. Cured, smoked and sun-dried fish, etc., appears to be scarce in the markets all over the state.

The fishing communities of the state appear to be poor and simple folk and their fishing methods and implements are also primitive and crude. Mostly, they use the *Thapi* and *Khadi jals*, which are good only for small, surface feeders. This absence of large nets probably accounts for the absence of most of the familiar bigger varieties of carps, like Catla, Mahaseer, etc., from our list of fishes of the State. During the later part of our tour, we arranged to get large cast and drag nets, from the neighbouring state of Sonapur, but, unfortunately, the local fishermen could not operate them effectively. They do not appear to be familiar with fishing in waters more than a few feet deep and are reluctant to go in even moderately deep waters.

Some of the methods employed by the fishermen are injurious to the development of fisheries. A very common device is the diversion of water courses into blind channels, resulting in the catching and wanton destruction of large quantities of young fishes, fry, etc.

We were also told at Belgaon that the fishing rights in the river Tel, are auctioned by the state every year. This year the rights are said to have been auctioned for Rs. 200 only for the whole year. It is stated that the contractor employs a very large number of people for fishing on particular days and total destruction of fish, irrespective of size, takes place. Fish destruction by poisoning the waters, with fruits, leaves and bark of various jungle trees is also reported.

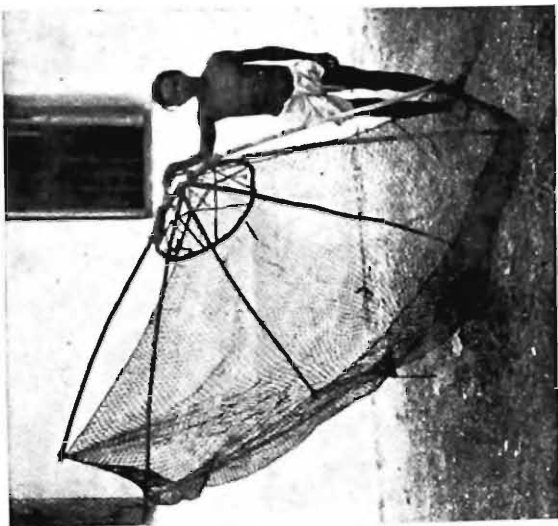
The fishing rights in the state-owned water reservoirs are leased out every year by public auction, approximately at the rate of rupee one per acre. Fishing in the rivers also is permitted under license and for this purpose the various fishing implements used in the state have been classified and the licence fee fixed for each variety at roughly the following rates :

	Rs.	₹.	P.	
Long nets (including <i>Khadi jal</i>)	7	8	0	per year
Cast nets	2	8	0	„
<i>Thapi</i> net	0	8	0	„
Hooks	1	0	0	„
Lifting nets	1	0	0	„
<i>Thapa</i> nets	0	8	0	„
<i>Benda</i> trap	15	0	0	„
<i>Dawn</i> (line)	3	0	0	„

A comprehensive fishing legislation, fixing the size of mesh of the various types of nets and declaring illegal all devices destructive or injurious to fisheries is said to be under preparation by the state authorities.

ACKNOWLEDGMENTS.

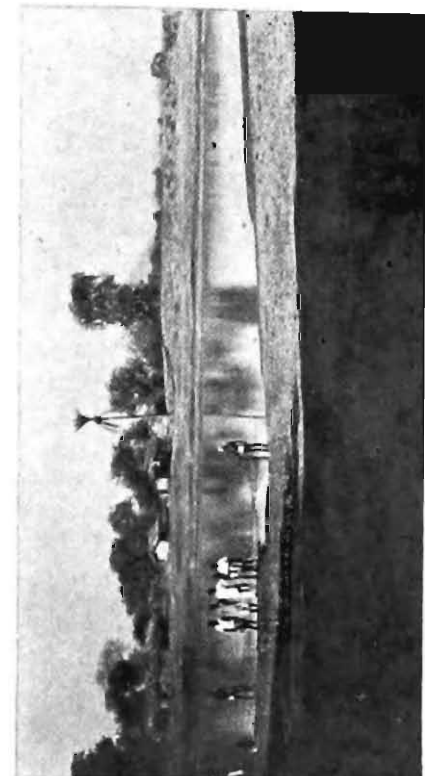
I am grateful to Dr. B. N. Chopra, Director, Zoological Survey of India, for going through the manuscript and helpful suggestions. My thanks are due to H. H. the Maharaja and Ruler, Sir Rajendra Narayan Singh Deo, K.C.I.E., Mr. B. L. Choudhri, State Agriculture and Fisheries Officer and Mr. A. R. Naik, Fishery Inspector. I also wish to thank R. B. Dr. S. L. Hora, for his keen interest and advice.



6.



4.



1.



5.



2.



3.

EXPLANATION OF PLATE VII.

FIG. 1.—Jhitri bundh tank at Salebhata.

Please note the catchment area ; the tank is usually manured from the washings of the Farm sheds of the neighbouring houses.

FIG. 2.—Harishanker hill stream, near the temporary Bamboo Bridge.

FIG. 3.—Harishanker hill stream, a view of the upper stream.

FIG. 4.—*Deol bundh* near Patnagarh, a typical tank, common almost, all over the state.

FIG. 5.—River *Tel*, at Belgaon.

FIG. 6.—*Kural jal*, a plunge net.

EXPLANATION OF PLATE VIII.

FIG. 1.—*Tula jal*, the lifting net ; compare with the *Ilb-jung-thauri* of the Manipuris (Hora, 1921).

FIG. 2.—The same, another view.

FIG. 3.—*Thapi net (Chingri jal)*, mostly used for shrimps, very common in the state.

FIG. 4.—*Khadi jal*, the most common net of the state.

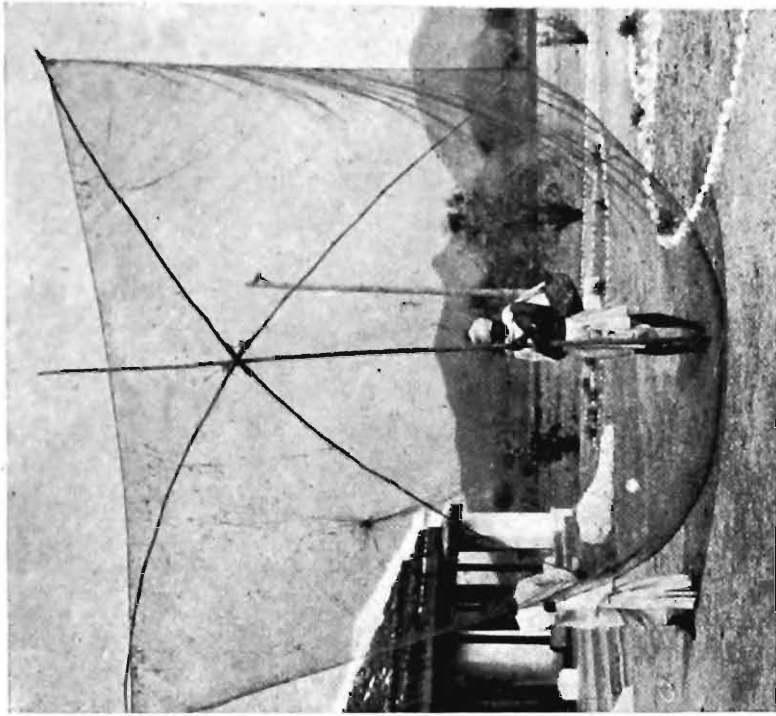
FIG. 5.—*Ghani* (Basket trap).

FIG. 6.—*Bendas* (Basket traps).

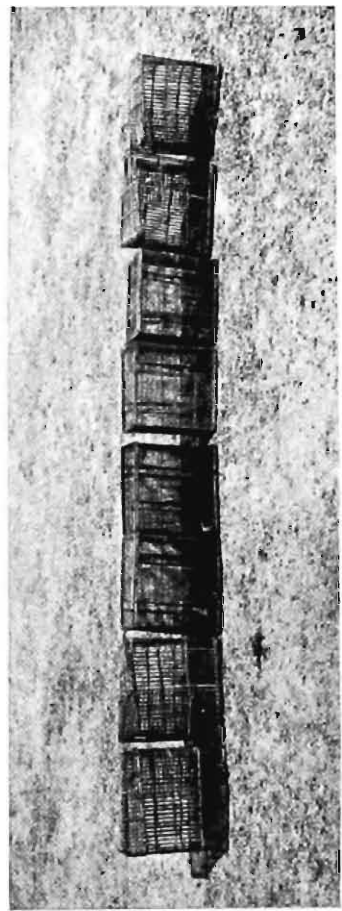
Basket Nos. 1 and 2 *Khaksa Benda*.

„ „ 3—6 *Chingri Benda*.

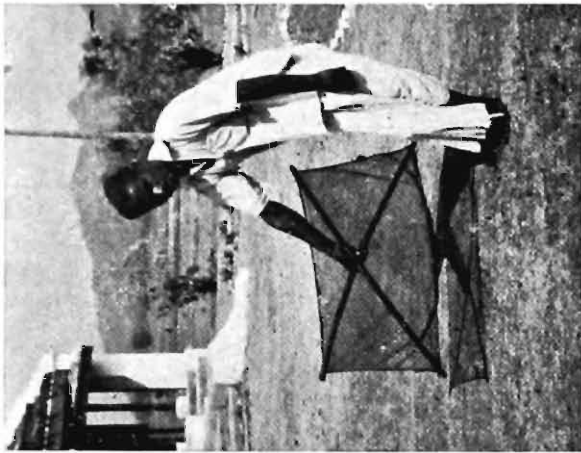
„ „ 7 and 8 *Putia Benda*.



2.



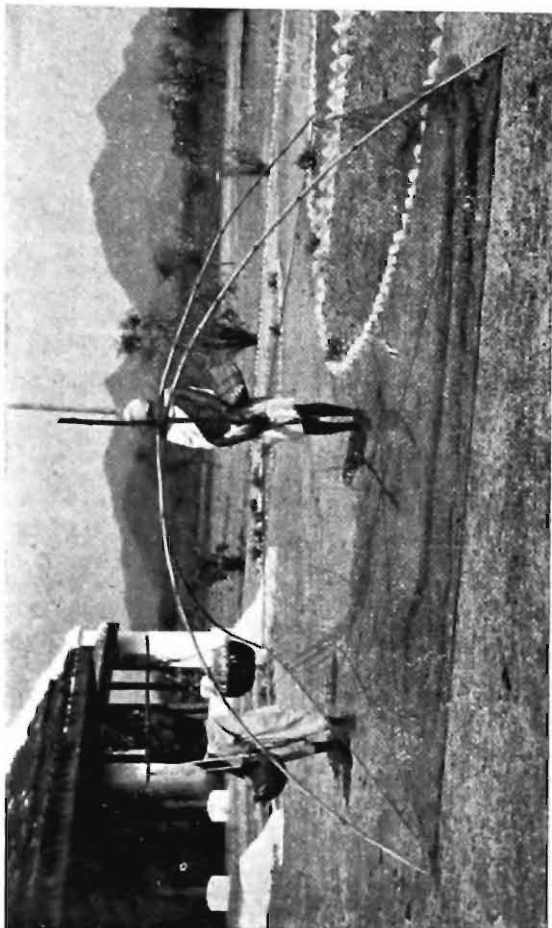
6.



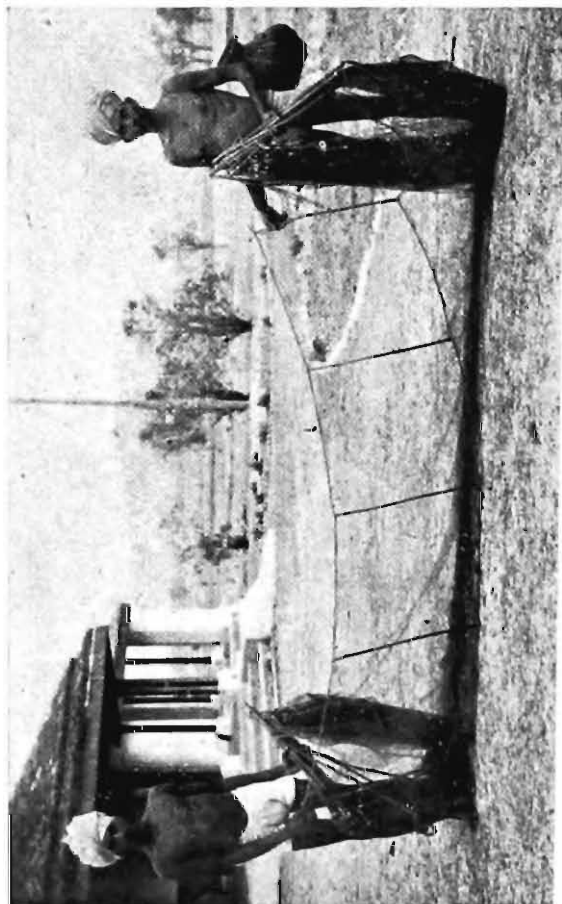
3.



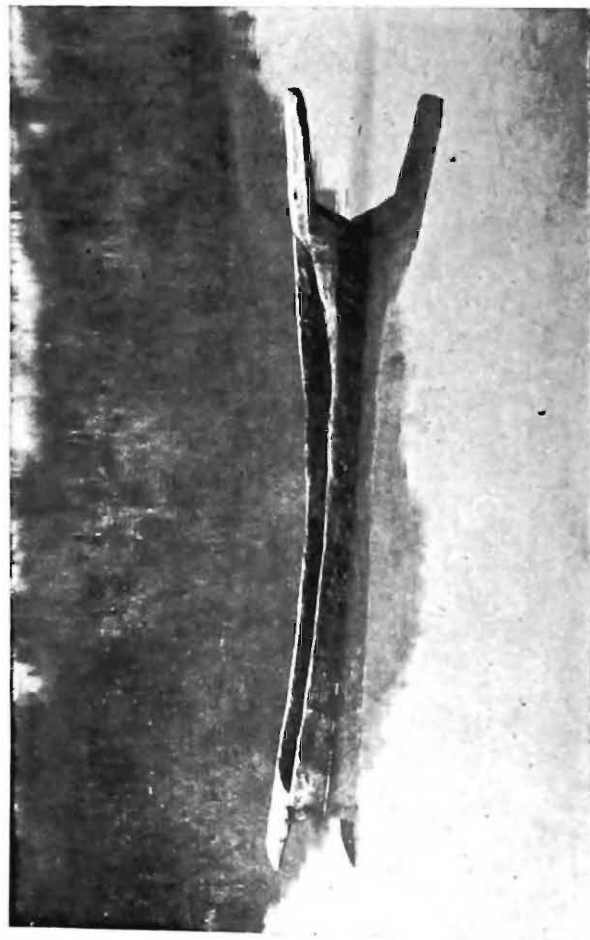
5.



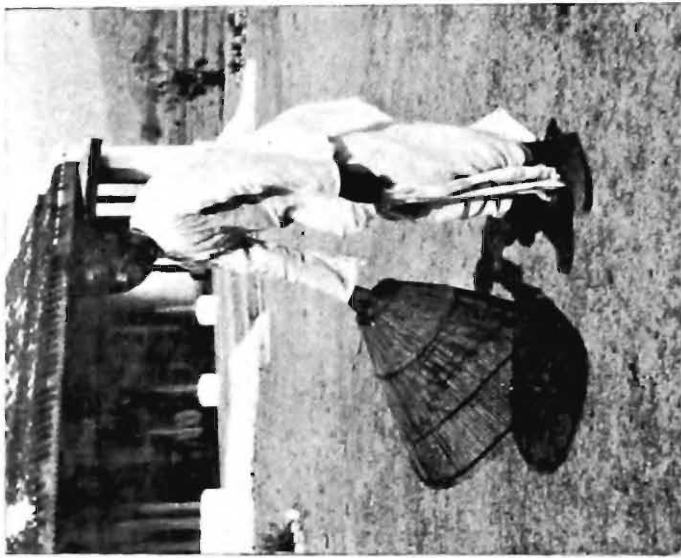
1.



4.



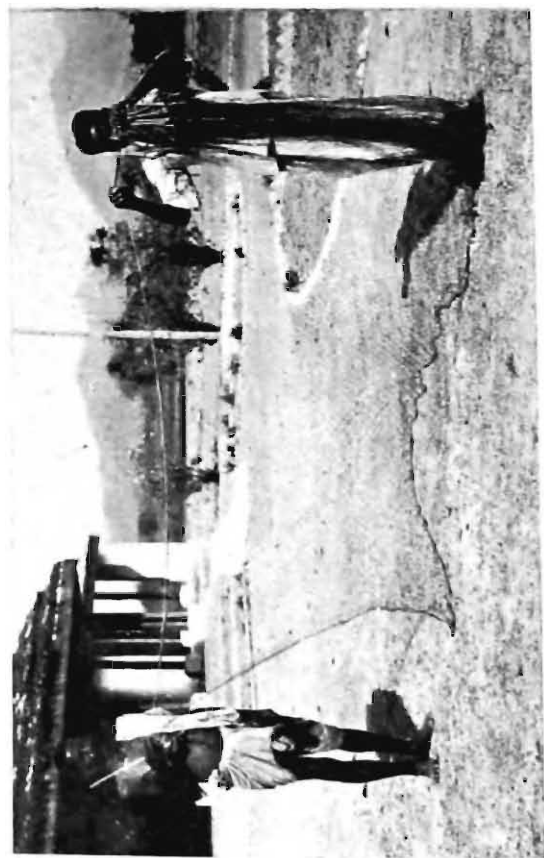
6.



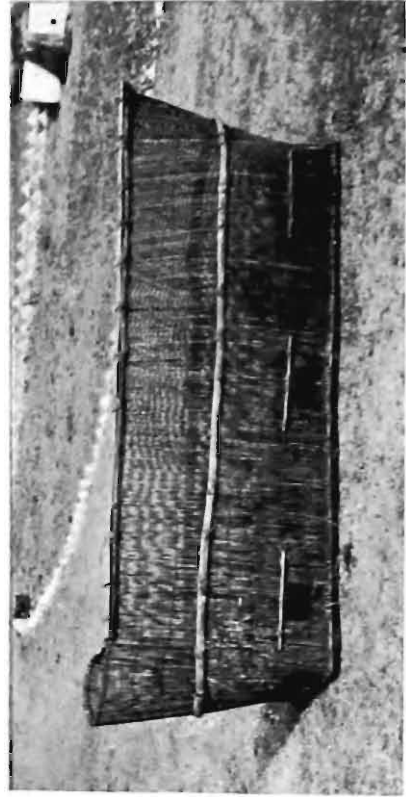
3.



4.



1.



2.



5.

EXPLANATION OF PLATE IX.

FIG. 1.—*Fui jal* (Fixed or stake net).

FIG. 2.—*Dhair trap* (Filter basket).

FIG. 3.—*Thapa* (Plunge basket).

FIG. 4.—*Kumna* (Back trap).

FIG. 5.—Floating traps.

a. *Phas* (=trap).

b. Floating *Sol*.

FIG. 6.—A Fishing canoe.