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RECORDS

of the

INDIAN MUSEUM

(A JOURNAL OF INDIAN ZOOLOGY)

Vol. XXXV, 1933.

EDITED BY
THE DIRECTOR,
ZOOLOGICAL SURVEY OF INDIA.

Calcutta
PUBLISHED BY THE DIRECTOR, ZOOLOGICAL SURVEY OF INDIA.
1934.

Price As. 8 or 10d.

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[*N.B.*—An asterisk (*) preceding a line denotes a new variety or sub-species; a daggar (†) indicates a new species: a double daggar (‡) a new genus or sub-genus; a double asterisk (**) a new family or sub-family; synonyms are printed in italics.]

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SUPPLEMENTARY INDEX TO PART III OF VOLUME XXXV OF THE RECORDS OF THE INDIAN MUSEUM.

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MGIPC—M—III-8-19—28-1-35—440.

NOTES ON LAMELLIBRANCHS IN THE INDIAN MUSEUM.

No. 8.—Species of the genus Pisidium from Western Tibet, Yarkand, Persia and Syria.

By B. Prashad, *D.Sc., F.A.S.B., F.R.S.E., Superintendent, Zoological Survey of India.*

(Plate I.)

In his account of the Molluscs of the Second Yarkand Mission Nevill [1] included notes on four species of the genus *Pisidium* collected by Dr. F. Stoliczka and his colleagues. One of the species was identified as *P. obtusale* Pfeiffer, while the other three, though given manuscript names in the collection, were only referred to as new species in the published results. These three species were later recorded under the names *Yarkandense, Bourguignatum* and *appressum* by von Martens [2] with the remarks " Die Artnamen der 3 Pisidien aus Yarkand sind zwar in der gedruckten Arbeit von Nevill nicht gennant, sondern mir nur handschriftlich von demselben mitgetheilt werden ; ich glube aber doch sie hier aufnehmen zu dürfen, da die Arten selbst in Nevill's Werk in derselben Reihenfolge so gut charackterisirt sind, als es in dieser Gattung ohne Abbildung überhaupt geht, Arten ohne Namen aber in Literatur unbequem sind und leicht wieder verloren gehen." In rearranging the Mollusc collections in the Indian Museum I found these specimens and discovered that the names of the species as printed by von Martens do not in all cases agree with Nevill's manuscript names. Further Nevill's notes on the species do not really bring out the specific characters of the species and his comparisons of the Yarkand forms with the previously described species are faulty. I have, therefore, thought it desirable to publish descriptions and figures of the four species collected by the Yarkand Mission.

Sometimes back I received a few specimens of a *Pisidium* from Rev. H. E. J. Biggs from Kerman, Persia, for identification. So far as I can judge from the published descriptions and the named material in the Indian Museum these specimens repre sent a new species, which is described below under the name *P. persicum.*

Notes are also added on a species from Damascus, Syria, in the collections of the Indian Museum.

In view of the greatly scattered literature on the species of the genus *Pisidium* from the areas referred to above it will be useful to preface my notes with a short review of the literature.

The first detailed account of the species from any of the areas under discussion was the description of four new species from Turkestan published by Clessin [3] in an addendum to von Martens' account of the

[1] Nevill, G.—*Scientific Results of the Second Yarkand Mission, etc., Mollusca,* pp. 12, 13 (Calcutta, 1878).

[2] von Martens, E.—*Mém. Acad. Imper. Sci. St.-Petersbourg,* (7) XXX, no. 11, pp. 50-52 (1882).

[3] Clessin, S.—In von Martens' account of Mollusca in *Fedtschenko Reise nach Turkestan,* pp. 36-38, pl. iii, figs. 31-34 (1874).

mollusca of Fedtschenko's collections. The four species described are *P. obliquatum*, *P. acuminatum*, *P. sphaeriiforme* and *P. turanicum*. These species were redescribed and figured in Clessin's monograph [1] in the Conchylien Cabinet in the following year.

These accounts were followed by Nevill's work, cited already, in which, in addition to the three species from Yarkand, a species was recorded under the name *P. obtusale* Pfeiffer from the Pangong Lake, Western Tibet. As noted already, von Martens in 1882 published the manuscript names of Nevill for his new species from the Yarkand area; these names were also mentioned by von Möllendorf [2] in his paper on the Land Molluscs of Western China and Central Asia, and he was of opinion that the shells from Kuko Nor in the collection before him were probably to be referred to one of Nevill's species.

In 1903 Clessin [3] in an appendix to Andreae's paper on the collection of land and freshwater shells from Central and Eastern Asia made by Futterer recorded *P. amnicum* (Müller), and described six new species *P. supinoides*, *P. ovale*, *P. futtereri*, *P. kukenurense*, *P. obliquatum* [4] and *P. lateumbonatum* from North-eastern Tibet and the Gobi Desert. The descriptions of the various species are unfortunately very poor and none of the species were figured. These species must, therefore, remain a stumbling block in the way of any future work on the Pisidia of the area.

In 1909 Preston [5] described a new species, *P. stewarti*, from Tibet, and in the following year *P. zugmayeri* was described from the Pangong Lake, Western Tibet, by Weber [6]; this latter species, as I am able to confirm from an examination of Weber's types and Nevill's specimens, is the same as that recorded as *P. obtusale* Pfeiffer in 1878.

Lindholm [7] in the results of the Pamir Expedition of 1928 recorded *P. casertanum* (Poli) from the Alai Mountain range.

Reference may also be included here to the record of *P. cedrorum* by Germain [8] from Syria; references to earlier literature on this Syrian species will be found in Germain's work (see also further p. 8), but it may be noted that this species was first described by Clessin (1875, *loc. cit.*, p. 42) from springs at Rhedan in Lebanon. Dautzenberg's [9] record of *P. obliquatum* Clessin is, as is shown later, to be referred to *P. cedrorum*.

Pisidium zugmayeri Weber.

(Plate I, figs. 1, 2.)

1878. *Pisidium obtusale*, Nevill (*nec* Pfeiffer *non* Jenyns), *Sci. Res. Second Yarkand Mission, etc., Mollusca*, p. 13.

1910. *Pisidium* (*Fossarina*) *zugmayeri*, Weber, *Zool. Jahrb.* (*Syst., etc.*), XXIX, p. 310.

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[1] Clessin, S.—*Martini-Chemnitz Conch. Cab.* (*n. f.*), IX (3), *Cycladeen*, pp. 43-46, pl. v, figs. 1-12 (1875).

[2] von Möllendorf, C.—*Ann. Mus. Zool. St.-Petersbourg*, VI, p. 401 (1902).

[3] Clessin, S.—In *K. Futterer Durch Asien*, III, *Zoologie*, pp. 81, 82 (Berlin, 1903).

[4] This species should not be confused with the species of the same name described by Clessin in 1874 in Fedtschenko's results from Turkestan.

[5] Preston, H. B.—*Rec. Ind. Mus.*, III, pp. 115, 116 (1909).

[6] Weber, A.—*Zool. Jahrb.* (*Syst. etc.*), XXIX, pp. 310, 311 (1910).

[7] Lindholm, W.—*Abhandl. Pamir-Expedition*, 1928, *Mollusca*, p. 62 (1931).

[8] Germain, L.—*Moll. Terr. Fluv. de Syrie*, II, p. 89 (1922).

[9] Dautzenberg, Ph.—*Rev. Biol. Nord France*, VI, p. 354 (1894).

A number of examples of a species of the genus *Pisidium* from the Pangong Lake, Western Tibet, were recorded by Nevill under the name *P. obtusale* Pfeiffer. I have examined the specimens and am of opinion that they are conspecific with the species *P. zugmayeri*, which was described by Weber from the same lake in 1910. This opinion is confirmed by the fact that I was able to examine the types of Weber's species sometime back.

Weber's description of the species is fairly detailed, but it may be noted that his remark " auch die Ecke beim Übergang vom Oberrand zum Hinterrand deutlich bemerkbar ist " does not apply to full-grown specimens. I give a figure of the right valve of a full-grown specimen and figure the hinge-teeth.

The measurements of a full-grown specimen are as follows :—

Length 3·8 mm., height 3·4 mm., thickness 2·4 mm.

The shell of the species is comparatively thick with well developed concentric ridges and the hinge-teeth are very strongly developed.

Attention may also be directed to the fact that the locality of the species as given under the species " lacum Walar in Kaschmir " is, as I was informed by the late Dr. Alois Weber, incorrect; the correct locality is Pangong Lake as given in the concluding remarks on p. 311.

Pisidium yarkandense, sp. nov.

(Plate I, figs. 3, 4.)

The shells of this species in the collection of the Indian Museum bear the manuscript name *P. yarkandense* in Nevill's handwriting, and the species has also been referred to under this name by von Martens; it is No. 28 of Nevill's list.

Nevill's description of this species is very inadequate; he compared the species with *P. pulchellum* Jenyns and Baudon's figures of *P. obtusale* (Lam.) and *P. limosum* Gassies (=*P. casertanum* of Poli), but neither of these comparisons are correct. I, therefore, give below a detailed description of the species and figure the right valve and the hinge-teeth.

Shell of small size, rather thin, almost transparent, of a shining light brownish colour; orbiculate-ovate; not much swollen; regularly concentrically striate, some of the striae more strongly developed; umbones hardly prominent, slightly tumid, placed behind the middle, with very minute striae; anterior and posterior dorsal slopes regularly arched, anterior sloping much more rapidly; anterior margin narrowly rounded; posterior margin rather broader, rounded; ventral margin arched.

Hinge.—More than half the length of the shell, rather narrow but projecting well inwards, strong, greatly arched with two well-marked flexures in the right valve.

R. V. *a. I.*—More than $\frac{1}{3}$ the length of the hinge-line, sharp, curving inwards and upwards; *base* moderately strong; *apex* distal to centre, hardly prominent, distally directed, obtuse; *ridges* slightly rounded, distal sloping slightly, umbonal sharply but gradually and lying at a higher level than the distal.

a. III.—More than $\frac{1}{2}$ the length of *a. I.*, narrow, close to the shell-margin and running almost parallel to it; *apex* slightly distal to centre, hardly marked, broadly rounded; *ridges* rather sharp, subequal, sloping gradually.

R. V. *c. 3.*—Slightly arched, not very thick or prominent, almost reaching the hinge-margin; part corresponding to *b* slightly swollen, *a* sharp, lamelliform.

p. I.—Slightly shorter than *a. I.*, stout, not much curved inwards; *base* strong but not much swollen; *apex* slightly distal to centre, rather sharp, obtuse; *ridges* slightly rounded, umbonal somewhat shorter than distal, latter slightly concave.

p. III.—About ½ the length of *p. I.*, stout, arching up towards the shell-margin; *apex* hardly marked, somewhat obtuse; *ridges* not very sharp, umbonal shorter than distal.

L. V. *a. II.*—About ⅓ the length of the hinge-line, strong, stout, almost straight; *base* stout, swollen; *apex* subcentral, prominent, sharp, acuminate, directed upwards and inwards; *ridges* somewhat angularly sloping, distal more so than umbonal.

c. 2.—Moderately prominent, subsquarish; *apex* directed upwards.

c. 4.—Sharp, lamellar, slightly arched, projecting anteriorly over *c. 2.*

p. II.—Somewhat smaller than *a. II.*, strong, not so sharply pointed; slightly curved; *apex* rounded, subcentral, pointing upwards and inwards; *ridges* rather sharp, distal more angulate than umbonal.

Ligament Pit about ½ the length of the umbo; deep, with its ventral margin markedly sloping.

Measurements (in millimetres).

	Holotype.	2	3
Length	2·5	2·4	2·2
Height	2	2	1·8
Thickness	·2	1·8	1·7

Holotype No. M. $\frac{14257}{2}$ in the collections of the Zoological Survey of India (Indian Museum), Calcutta.

Locality.—A number of specimens of this interesting species were collected by Stoliczka and his colleagues at Yarkand.

Remarks.—In general appearance *P. yarkandense* bears a certain resemblance to *P. lilljeborgi* Clessin,[1] but the hinge is quite different. The hinge-teeth are similar to those of *P. mitchelli* Prashad[2] from Manasbal Lake, Kashmir.

Pisidium appressum, sp. nov.

(Plate I, figs. 5, 6.)

Pisidium appressum is No. 30 of Nevill's list, and the unique shell in the Indian Museum collection bears this name in Nevill's handwriting.

Nevill compared the species with *P. thermale* Dupuy,[3] which as Woodward (*loc. cit.*, p. 32) has shown is synonymous with *P. casertanum* (Poli). The species, however, as I have convinced myself by

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[1] Clessin, S.—*Malak. Blätt.* (n. f.), VIII, p. 119 (1886); also see Woodward, B. B.—*Cat. Brit. Species Pisidium*, pp. 111-116, pls. ii, fig. 8, iv, fig. 2, xxiii, figs. 2, 18, xxviii, figs. 1, 9, 12, 13, 17-26 (1913).

[2] Prashad, B.—*Rec. Ind. Mus.*, XXVIII, pp. 419, 420, pls. vii, fig. 11 a, viii, fig. 10 (1925).

[3] Dupuy, D.—*Hist. Nat. Moll. France*, p. 682, pl. xxx, fig. 6 (1852).

comparison with European specimens of *P. casertanum*, is in no way related to it. It may be described as follows :—

Shell of small size, subtrigonal-ovate, thin, fragile, with well-marked thick, close-set striae all over ; umbones prominent, somewhat tumid, placed well behind the middle ; anterior and posterior dorsal slopes regularly arched, anterior less so than posterior ; anterior margin more compressed than posterior ; ventral margin regularly arched.

Hinge.—About $\frac{2}{3}$ the length of the shell, fairly broad, projecting, with the teeth curving upwards, more so in the left than in the right valve ; arched with two distinct flexures in the right valve.

R. V. *a. I.*—More than $\frac{1}{3}$ the length of the hinge-line, strong, curving inwards and upwards ; *base* strong, somewhat swollen ; *apex* subcentral, obtuse ; *ridges* slightly rounded, sloping about equally.

a. III.—More than $\frac{1}{2}$ the length of *a. I.*, strong, opposed to the shell-margin ; *apex* central, pointed ; *ridges* sharp, equally sloping.

c. 3.—Arcuate, very thin, lamelliform ; portion corresponding to *b* hardly swollen ; portion corresponding to *a* running at a slight angle to hinge-margin.

p. I.—Shorter than but about as broad as *a. I.*, strong, curving upwards ; *base* strong, markedly thickened ; *apex* slightly distal to centre, obtusely rounded ; *ridges* rather sharp, umbonal longer than distal and sloping about equally.

p. III.—Much shorter than *p. I.*, narrow, curved upwards ; *apex* subcentral, acutely pointed ; *ridges* sharp, subequal and sloping sharply.

L. V. *a. II.*—More than $\frac{1}{3}$ the length of the hinge-line, stout, strongly curving upwards ; *base* strong ; *apex* distal to centre, obtusely rounded ; *ridges* sharp, umbonal sloping suddenly and then running in almost a straight line, less slanting than the distal.

c. 2.—Prominent, obtusely triangular ; *apex* directed outwards ; *base* almost merging into shell-margin.

c. 4.—Prominent, rather thick, lamellar, arising from near the shell-margin and running to almost the margin of the hinge-plate.

p. II.—About the same size and shape as *a. II.* ; *apex* more broadly rounded ; distal ridge shorter than umbonal and more steep.

Ligament Pit is less than half the length of the umbo. It arises about the middle of the umbo and extends to less than half of the middle of the hinge-plate.

The measurements of the *holotype* are :—

Length 2·8 mm., height 2·2 mm., thickness *ca.* 1 mm.

Holotype No. M. $\frac{14258}{2}$ in the collections of the Zoological Survey of India (Indian Museum), Calcutta.

Locality.—The unique holotype was collected at Yarkand.

Remarks.—*P. appressum* is allied to *P. yarkandense* described above, but the shells are more elongate, not so ovate and with the umbones more prominent ; the hinge is markedly different.

Pisidium stoliczkanum, sp. nov.

(Plate I, figs. 7, 8.)

This species is referred under the manuscript name *Bourguignatum* in von Martens' list, but bears the name *stoliczkanum* in the Indian Museum collection. In memory of Dr. F Stoliczka, the leader of the Second Yarkand Expedition, I propose associating this species with his name ; it is No. 29 of Nevill's list.

Shell of small size, subcircular to ovate, subequilateral, somewhat tumid, thin; of a light brownish or horny colour; striae fine, strong, concentric; umbones slightly swollen, prominent, subcentral; dorsal margins sloping almost equally; ventral margin greatly arcuate; rounded anteriorly and posteriorly.

Hinge.—About $\frac{3}{4}$ the length of the shell, rather narrow and not greatly projecting, moderately arched, much more so in the right than in the left valve.

R. V. *a. I.*—More than $\frac{1}{3}$ the length of the hinge-line, moderately strong and thick, curving inwards; *apex* prominent, centrally situated, anteriorly directed, obtuse; *ridges* rounded, distal somewhat more sloping than umbonal.

a. III.—More than $\frac{1}{2}$ the length of *a. I.*, narrow, opposed to shell-margin and running almost parallel to it; *apex* subcentral, somewhat pointed; *ridges* sharp, subequal.

c. 3.—Somewhat arched, comma-shaped, lower part corresponding to *b* not much swollen.

p. I.—Longer than *a. I.*, stronger and stouter; *base* strong but not much swollen; *apex* proximal to centre, obtusely rounded; *ridges* not very sharp, distal longer than umbonal and more sloping.

p. III.—Shorter than *a. III.*, feeble, sharply pointed; *apex* distal to centre, pointed; *ridges* sharp, umbonal slightly longer than distal.

L. V. *a. II.*—Longer than *a. I.*, fairly strong, stout, greatly curved; *base* very stout, thickened; *apex* proximal to centre, sharp; *ridges* moderately sharp, umbonal shorter and not so arched as distal.

c. 2.—Subquadrate, slightly arched, its upper margin lying almost parallel to *c. 4.*

c. 4.—Lamellar, a little more than $\frac{1}{2}$ the length of *c. 2.*

p. II.—A little shorter than *a. II.*, and not so strongly developed; *base* moderately swollen; *apex* distal to centre, pointed; *ridges* sharp, umbonal greatly arched, distal sloping suddenly to base and running almost parallel to it.

Ligament Pit about $\frac{1}{2}$ the length of the umbo; deep, with its ventral margin sloping.

Measurements (in millimetres).

	Holotype.	2	3
Length	2·3	2·2	2
Height	2	1·9	1·7
Thickness	1·5	1·5	1·3

Holotype No. M. $\frac{13825}{2}$ in the collections of the Zoological Survey of India (Indian Museum), Calcutta.

Locality.—About a dozen examples of this species were collected at Yarkand.

Remarks.—*C. stoliczkanum* is allied to *C. yarkandense* described above, but the shell is more equilateral and more tumid, the umbones more prominent and centrally situated, and the hinge is more strongly developed.

Pisidium persicum, sp. nov.

(Plate I, figs. 9, 10.)

So far as I can find from the literature on the subject no species of the genus *Pisidium* has so far been recorded from Persia—noneis

mentioned by Issel,[1] Mousson,[2] von Martens [3] or Clessin.[4] In the old collections of the Indian Museum there are a few shells from Shiraz labelled *Pisidium* sp. nov., labelled by the talented curator of the Mollusc collection, Mr. G. Nevill, while I recently received from Rev. H. E. J. Biggs some shells of the same species collected at Kerman.

This new species may be described as follows :—

Species of a moderate size, elongate-ovate, subrostrate anteriorly, subrotundate posteriorly, moderately ventricose, thick-shelled ; anterior dorsal slope more sloping than posterior ; regularly concentrically striate, some of the striae more strongly developed ; umbones hardly prominent, situated behind the middle ; ventral margin regularly arched ; of a horny colour.

Hinge.—Almost $\frac{3}{4}$ the length of the shell, strong, projecting well inwards, moderately arched with two distinct flexures in the right valve.

R. V. *a. I.*—Less than $\frac{1}{2}$ the length of the hinge-line, very strong, inclined inwards ; *base* very strong, thick ; *apex* subcentral, prominent, obtusely rounded, pointing backwards and upwards ; *ridges* rounded, distal steep, umbonal slightly arched and descending to a lower level than the distal.

a. III.—More than $\frac{1}{3}$ the length of *a. I.*, straight, narrow, erect, lying parallel to hinge-margin ; *apex* central, pointed, prominent ; *ridges* somewhat sharp, sloping about equally.

c. 3.—Prominent, arcuate, inverted comma-shaped ; part corresponding to *b* greatly swollen, *a* thin, curving diagonally across the hinge-plate.

p. I.—Shorter than *a. I.*, strong, compressed ; *base* thickened, almost straight ; *apex* distal to centre, slightly marked, obtuse ; *ridges* rounded, sloping steeply, distal more so than umbonal.

p. III.—Slightly shorter than *p. I.*, straight, erect ; *apex* distal to centre, hardly marked: *ridges* compressed, distal sloping more steeply than umbonal.

L. V. *a. II.*—Slightly longer than *a. I.*, narrow, greatly curved in its umbonal end ; *base* strong, more swollen than that of *a. I.*, *apex* distal of centre, projecting upwards, sharp, acuminate ; *ridges* rather sharp, umbonal sloping gradually at first and then suddenly curving upwards to the umbo, distal very steep.

c. 2.—Prominent, arcuate, with the outer limb running diagonally across hinge-plate.

c. 4.—Sharp, lamelliform, running at an angle to the outer limb of *c. 2.*

p. II.—About $\frac{2}{3}$ the length of *a. II.*, narrow, strong ; *base* strong, but not so thickened as of *a. II.*; *apex* near distal end, sharp, acuminate ; *ridges* sharp, umbonal longer and descending more steeply than distal.

Ligament Pit.—It starts from about the middle of the umbo and extends to a little behind its posterior limit.

The measurements of the *holotype* are :—

Length 5·2 mm., height 4·1 mm., thickness 3·2 mm.

Holotype No. M. $\frac{14259}{2}$ in the collections of the Zoological Survey of India (Indian Museum), Calcutta.

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[1] Issel, A.—*Die Moll. della missione Italiana in Persia* (Turin, 1865).
[2] Mousson, A.—*Journ. Conchyliol.*, XXII, pp. 1-60 (1874).
[3] von Martens, E.—*Ueber vorderasiatische Conchylien*, p. 69 (Cassel, 1874).
[4] Clessin, S.—*Martini-Chemnitz Conch. Cab. (n. f.)*, IX (3), *Cycladeen*, pp. 1-74 (1874-77).

Locality.—A number of specimens from Shiraz, Persia, were found amongst the old collections of the Indian Museum, while a few young shells were, as noted above, recently received from Kerman.

Remarks.—*P. persicum* appears to be allied to *P. casertanum* (Poli), but the form, texture and sculpture are different. The hinge of the two species also differs materially.

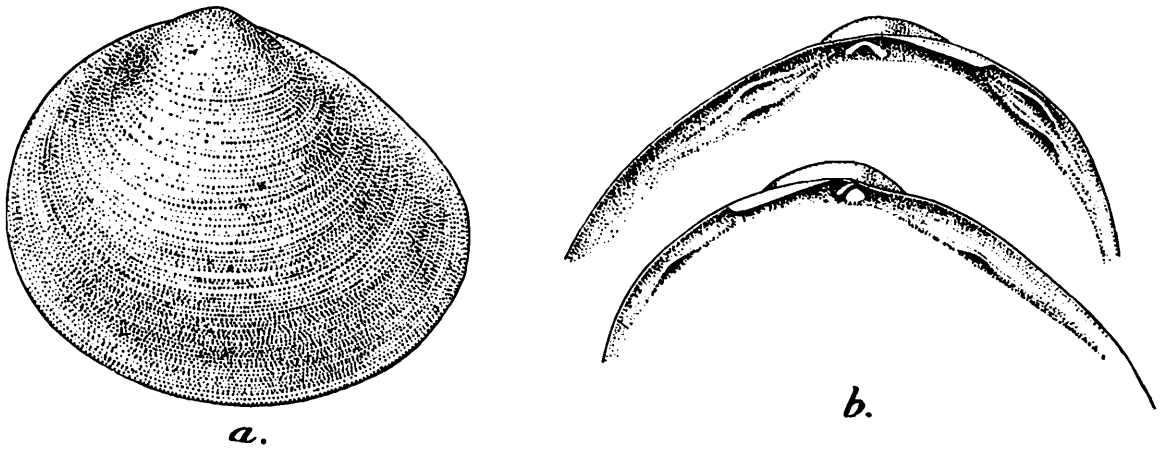
Pisidium cedrorum, Clessin.

1875. *Pisidium cedrorum,* Clessin, *Martini-Chemn. Conch. Cab.* (*n. f.*), IX (3), *Cycladeen,* p. 42, pl. iv, figs. 22, 23.

1922. *Pisidium* (*Fossarina*) *cedrorum,* Germain, *Moll. Terr. Fluv. de Syrie,* II, p. 89.

In view of the fairly detailed descriptions of this species by Clessin and Germain it is not necessary to redescribe the species, I, however, for comparison figure the right valve and the hinge of the species.

Attention may also be directed to the fact that Germain in his account has confused the anterior and posterior sides of the valves for he says " région antérieure courte, tronquée, region postérieure allongée, deux fois aussi développée que l'antérieure."



Pisidium cedrorum, Clessin.

a, right valve of a specimen from Damascus, Syria ; *b,* hinge-teeth of the two valves.

I have also little doubt that the species recorded as *Pisidium* (*Fossarina*) *obliquatum* Clessin by Dautzenberg [1] from various localities in the same area is probably *P. cedrorum.*

In the Indian Museum this species is represented by a number of specimens from Damascus.

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[1] Dautzenberg, Ph.—*Rev. Biol. Nord. France,* VI, p. 354 (1894).

EXPLANATION OF PLATE I.

Pisidium zugmayori Weber.

FIG. 1.—Right valve of a full-grown specimen from the Pangong Lake, Western Tibet.
FIG. 2.—Hinge-teeth of the two valves.

Pisidium yarkandense, sp. nov.

FIG. 3.—Right valve of the holotype from Yarkand.
FIG. 4.—Hinge-teeth of the two valves.

Pisidium appressum, sp. nov.

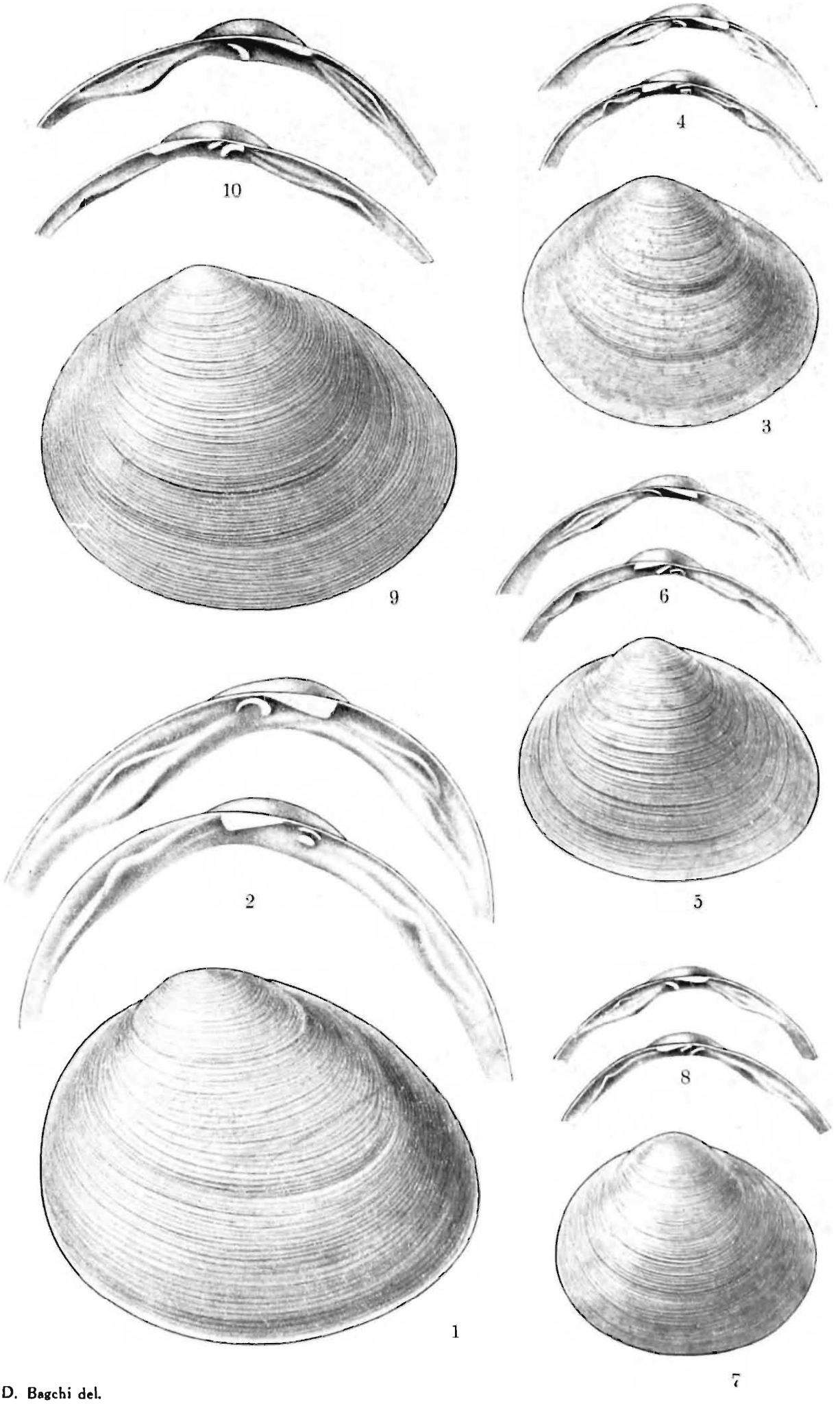
FIG. 5.—Right valve of the holotype from Yarkand.
FIG. 6.—Hinge-teeth of the two valves.

Pisidium stoliczkanum, sp. nov.

FIG. 7.—Right valve of the holotype from Yarkand.
FIG. 8.—Hinge-teeth of the two valves.

Pisidium persicum, sp. nov.

FIG. 9.—Right valve of the holotype from Shiraz, Persia.
FIG. 10.—Hinge-teeth of the two valves.



D. Bagchi del.

ASIATIC PISIDIA.

REMARKS ON SOME OLD WORLD GECKOES.

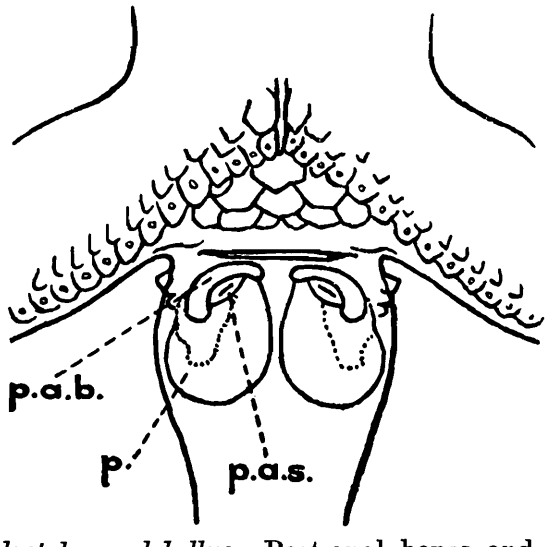
By MALCOLM A. SMITH.

In reviewing the Oriental Gekkonidae for the forthcoming Volume on the Lizards in the Fauna of British India series, it has been found necessary to make certain changes in taxonomy and nomenclature with regard to the Family. To have included all the changes in that Volume would have been out of place, for some of the genera and species concerned do not occur in the area covered by that work. In the present article certain structural characters which concern the family as a whole are considered, the status of four genera and of the Uroplatidae are discussed, and two species from the Indian Empire are described as new. The text-figures are by Miss Joyce Townend.

The post-anal bones and sacs.

These structures, which appear to be peculiar to the Gekkonidae, have so far escaped the notice of anatomists. Noble mentioned the bones briefly in 1921, but I can find nothing in the literature concerning the sacs. Most of the Geckoes, under which I include the Eublepharidae and Uroplatidae, possess them.

They are paired structures, lying one on each side of the base of the tail just behind the vent. The sac is present in both sexes, but the bone only in the male ; in those species in which the sac is absent, the bone also is absent. The bone is short, and curved or angular in shape ; it lies free just under the skin. It can be easily recognised without dissection, by inserting the point of a needle into the opening of the sac and lifting the bone upwards. The opening of the sac lies within the curve of the bone ; it varies from an elongated and conspicuous slit, to a minute aperture hardly visible to the naked eye. Its position with regard to the vent is variable ; in some species it is closer to that opening



TEXT-FIG. 1.—*Gymnodactylus pulchellus.* Post-anal bones and sacs. *p.*penis; *p. a. b.* post-anal bone ; *p. a. s.* opening of post-anal sac ; The outline of the sac itself is shewn as a dotted line.

than in others. The sac itself runs backwards and outwards; it is loosely attached to the surrounding tissues, and in life, in large species, can be partly evaginated. It is larger in the male than in the female.

Mr. M. A. C. Hinton junr. has kindly made microscopic sections of the sac wall for me and glandular cells are certainly present. At the same time I have so far failed to discover any secretion in the sac, although I have examined many individuals both in the living state—in captivity—and preserved. Possibly the secretion is periodic, occurring only during the mating season. The attention of naturalists in India is directed to this point.

The above description of the bones and sacs is as I have found them in all the Oriental Geckoes. Some of the material used has been stained by the Alazarin method, and in that case the whole skeleton could be very completely examined. For the rest I have relied upon dissection and the information gained is therefore not so exact. A complete series of stained specimens may shew that the shape of the post-anal bones is not always as stated, for they are variable, at any rate in Geckoes outside the Oriental Region. The American *Coleonyx variegatus* has two post-anal bones on each side, the outer one projecting through the skin (Noble 1921); the same author states that in the African *Pachydactylus maculatus* " in addition to a broad fenestrated median bone lying transversely across the anterior lip of the cloaca, there is a pair of irregularly shaped bones posterior to either corner of the cloacal slit" I have failed to find this median bone in the one stained specimen of this species in the British Museum collection, and its post-anal bones are angular, as in some of the Oriental Geckoes, and not irregularly shaped as he states.

Post-anal bones and sacs are present in all the Indian and Indo-Chinese Geckoes, except *Pristurus*. They are not present in any member of the genus *Pristurus*. On the other hand they are present in all the species of *Phyllodactylus* in the British Museum collection except *P. riebeckii* from Socotra and *P. elisae* from Persia; they are present in all the Old World species of *Gonatodes* (as Boulenger recognized the genus), but absent in all the New World species.

Genus **Cnemaspis.**

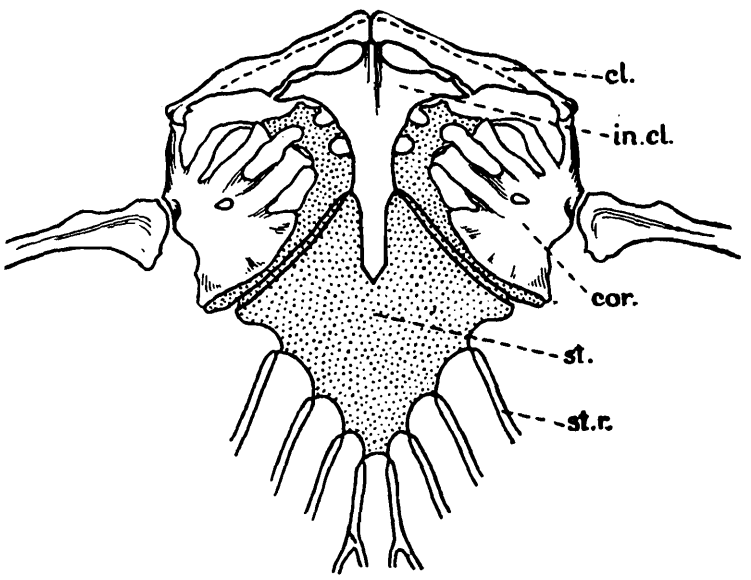
The *Gonatodes* of Boulenger had a wide distribution over the Oriental Region, Africa and tropical America. In external characters all the species agreed well, but as shewn by Noble (1921) there are considerable skeletal differences between the American *Gonatodes* (genotype *albogularis* from the West Indies) and *Gonatodes dickersoni* Schmidt from Africa; he therefore erected a new genus, *Paragonatodes*, for the African species My examination of the Oriental forms shews that they agree in the majority of their characters with *Paragonatodes*. Noble's examination of the African species (3 in number) was limited to *G. dickersoni*, and I have made a partial examination of *G. africanus*†. Of the Indian species I have examined *G. indicus**, *G. mysorensis**, *G. ornatus*†, *G. sisparensis*† and *G. beddomei*† (=*marmoratus*); of the Indo-Chinese and Malayan, *G. kendallii*†, *G. nigridius**, *G. affinis*†, *G. siamensis** and *G. boulengeri** (=*Gonatodes glaucus* Smith). Those marked with an

asterisk are stained specimens, those with a cross have had the pectoral girdle only dissected.

The characters stressed by Noble as distinguishing his *Paragonatodes* from the American *Gonatodes*, are as follows :—

Gonatodes	*Paragonatodes*
1. Clavicle slightly dilated, not perforated.	1. Clavicle slightly dilated, not perforated.
2. Interclavicle cruciform.	2. Interclavicle dagger-shaped.
3. Four sternal ribs.	3. Three sternal ribs.
4. No hypo-ischium.	4. A hypo-ischium.
5. No post-anal bones.	5. Post-anal bones.
6. Two pairs of basi-branchials.	6. One pair of basi-branchials.

As regards 4, 5 and 6 the Oriental forms agree with *Paragonatodes*. They have a well-developed hypo-ischium, post-anal bones and sacs, and a reduced hyoid apparatus, there being only one pair of basi-branchials. Four sternal ribs are present in all the Oriental species, as well as in



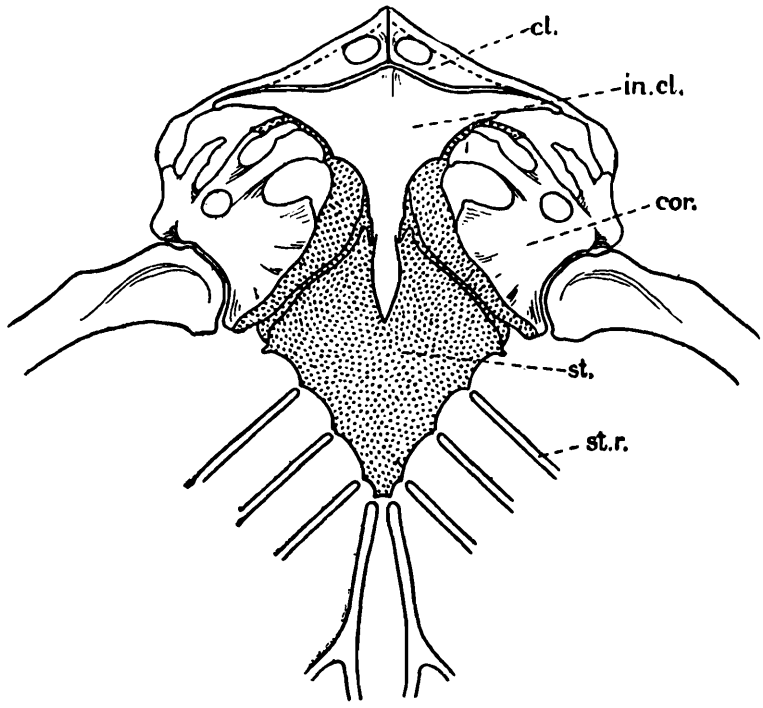
TEXT-FIG. 2.—*Cnemaspis mysorensis*. Sternal apparatus.
cl. clavicle ; *in. cl.* interclavicle ; *cor.* coracoid ; *st.* sternum ; *st. r.* sternal ribs.

Gonatodes africanus. The interclavicle is well developed and cruciform in the Oriental forms, but much reduced and with only very small transverse arms in *africanus*, in which respect it agrees with *dickersoni*. In *africanus* the whole of the sternal apparatus appears to be poorly ossified.

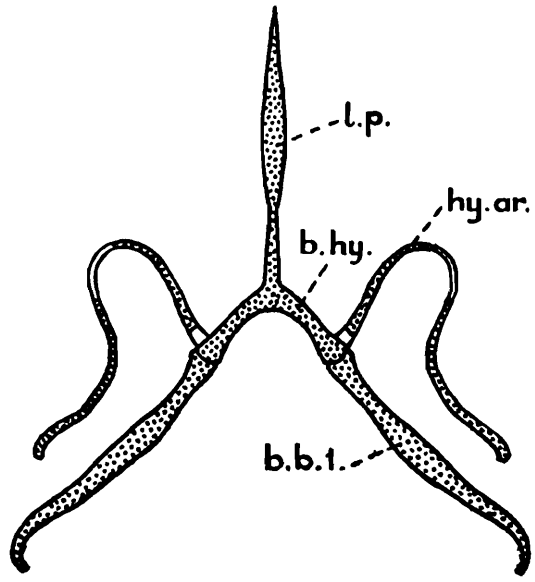
The greatest variation in form is in the clavicle. In the Indian *mysorensis*, *indicus* and *beddomei* it is dilated and thinned but not perforated as figured in *mysorensis* (text-fig. 2) ; in the Indo-Chinese and Malayan species and in the Indian *ornatus* and *sisparensis* it is dilated, thinned and perforated as figured in *boulengeri* (text-fig. 3). The perforation of the clavicle is but the final stage in the thinning process of the bone, and it may vary in size in different species from a small hole to a comparatively large opening. It cannot therefore be regarded as having any phylogenetic significance.

My observations then confirm Noble's view that the American species of *Gonatodes* are generically distinct from the Oriental. All the Old World species appear to be sufficiently nearly related to one another

to be regarded as congeneric, and for them *Cnemaspis* Strauch 1896, type *boulengeri*, from Pulo Condor off the coast of Cochin-China, is avail-



TEXT-FIG. 3.—*Cnemaspis boulengeri. cl.* clavicle ; *cor.* coracoid ; *in. cl.* interclavicle ; *st.* sternum ; *st. r.* sternal ribs.



TEXT-FIG. 4.—*Cnemaspis mysorensis. b. b. i.* basi-branchial 1 ; *b. hy.* body of hyoid ; *hy. ar.* hyoid arch ; *l. p.* lingual process.

able. Strauch recognised the affinities of his species with *Gonatodes* but considered that its enlarged post-tibial scales were sufficient to merit generic distinction. I am not of that opinion.

Genera **Gehyra** *and* **Hoplodactylus.**

The actual specimens which Gray had before him when he framed his genus *Gehyra*, type *pacifica*, cannot now be traced and the combination—*Gehyra specifica*—does not occur again in literature. He mentions three specimens, and presumably they belonged to two genera, for in revising his genus in 1842 he made *Gecko oceanicus* Lesson 1830, the type of *Gehyra* and gave the name *pacificus* to a new genus which he called

Naultinus. This conclusion was confirmed in 1845 and a specimen of *Gehyra oceanica* (Lesson) is mentioned as being in the British Museum. That specimen also cannot now be traced. Whether he recognized in 1842 that his *Gehyra pacifica* was identical with *Gecko oceanicus* but omitted to include it in the synonymy we do not know, but it is significant that both his *pacifica* and his specimen of *oceanica* are from the same locality, namely "Islands of the Pacific" His original description of the genus "Digiti 5-5, ad basin dilati, serie unica squamarum transversalium integrarum tecti, ad apicem compressi, liberi, omnes (praeter pollices) unguiculati" as well as his confirmation of it in 1842, are quite in agreement with the *Gehyra* of Boulenger or *Peropus* of later authors, and *Gehyra* 1834, type *pacifica* =*oceanica*, therefore, is the correct name for the genus and not *Peropus* Wiegmann which did not appear until 1835. The only point that remains to be considered is the place of the unidentifiable *G. pacifica* in literature. On the argument put forward it would be correct to include it in the synonymy of *oceanica*.

The synonymies of *Gehyra*, *Naultinus* (which Gray also confused with *Hoplodactylus*) and *Hoplodactylus* will now stand as follows :—

Genus **Gehyra.**

Gehyra (in part) Gray, Proc. Zool. Soc. 1834, p. 100, and Zool Misc. 1842, p. 57 (type *pacifica*=*oceanica*).

Genus **Naultinus.**

Naultinus (in part) Gray, Zool. Misc. 1842, pp. 58 and 72, and Cat. Liz. Brit. Mus. 1845, p. 169 (type by elimination *elegans*).

Genus **Hoplodactylus.**

Hoplodactylus Fitzinger, Syst. Rept. 1843, pp. 19 and 100 (type *Platydactylus duvaucelii* D. & B.).

Gehyra 1834 is in part *Gehyra* and in part *Naultinus*, whereas *Naultinus* 1842 is in part *Naultinus* and in part *Hoplodactylus*.

Hoplodactylus, as recognized by Boulenger (Cat. Liz. Brit. Mus. I, 1885, p. 171) contained five species. Three of these were said to inhabit New Zealand, one India, and the fifth, namely *H. duvaucelii*, which was stated to have come from Bengal, but which has never since been found in any part of India, now turns out to be very closely allied to, if not a race of, one of the New Zealand forms. I have recently compared a specimen of *H. pacificus* with the types and only known specimens of *duvaucelii* and except for a difference in size, and the number of subdigital lamellae the two are identical. The largest specimen (♀) of *pacificus* in the British Museum collection measures 70 mm. from snout to vent, the largest example of *duvaucelii* 120 mm. There can be little doubt that the types of *duvaucelii* did not come from India, and that some error must have occurred in the labelling of the specimens. This places the genus *Hoplodactylus* in a more satisfactory position, for

the faunas of New Zealand and India have nothing in common with one another. The true *Hoplodactylus* is confined to New Zealand, and the one Indian species, which can be distinguished from it by several small but distinct characters, should be placed in a separate genus. I propose for it *Dravidogecko*, gen. nov., monotype *Gecko annamallensis* Günther. The similarity which the two genera bear to one another in external characters is due no doubt to parallel evolution and not to phylogenetic relationship. The material available does not permit me to examine the internal structure of *Dravidogecko*.

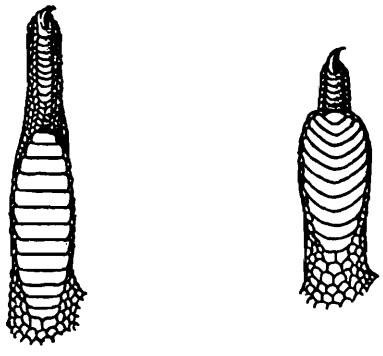
The following characters will serve to distinguish the two :—

Free terminal phalanges rising from the end of the expanded portion of the digit; inner digit with a minute claw, or the claw concealed; male pores in multiple series .	*Hoplodactylus.*
Free terminal phalanges rising from within the expanded portion of the digit; inner digit with distinct claw; male pores in single series	*Dravidogecko.*

Boulenger's Key for the species of *Hoplodactylus* unfortunately breaks down when a large number of specimens are examined; the four forms however can be readily distinguished from one another if attention is paid to the following characters :—

A. 10 to 14 lamellae (the posterior usually divided) beneath the free terminal phalanges of the outer 4 digits.	
Ten to 12 curved lamellae beneath the dilated portion of the digit .	*pacificus.*
Sixteen to 18 curved lamellae beneath the dilated portion of the digit	*duvaucelii.*
Lamellae beneath the dilated portion of the digit straight, transverse .	*granulatus.*
B. 4 to 6 lamellae beneath the terminal phalanges of outer 4 digits, which are not more than half the length of the dilated portion.	
Lamellae beneath the dilated portion of the digit curved . .	*maculatus.*

Colour pattern and the number of pores in the male vary greatly in different individuals. In two specimens of *maculatus* in the same bottle



TEXT-FIG. 5.—*Hoplodactylus granulatus* and *H. maculatus*. Fourth toes.

in the British Museum collection there are 39 pores in one example, 102 in the other. Lucas and Frost state that *duvaucelii* has no pores, but this is not so.

The synonymy of the species will run as follows :—

1. Hoplodactylus pacificus.

Naultinus pacificus, Gray, Zool. Misc. 1842, pp. 58 and 72 and in Diffenbach's Travels in New Zealand, 1843, p. 203; *id.*, Cat. Liz. Brit. Mus. 1845, p. 169 (in part).—*Hoplodactylus pacificus*, Boulenger, Cat. Liz. Brit. Mus. I, 1885, p. 173; Lucas and Frost, Tr. N. Zealand Inst., XXIX, 1897, p. 264.

2. Hoplodactylus duvaucelii.

Platydactylus duvaucelii Dum. and Bib. Erp. Gen. III, 1836, p. 312 (type loc. "Bengal"; Mus. Nat. Hist. Paris).—*Hoplodactylus duvaucelii*, Boulenger, Cat. Liz. Brit. Mus., p. 172.

3. Hoplodactylus granulatus.

Naultinus granulatus Gray, Cat. Liz. Brit. Mus., 1845, p. 273 (type loc. New Zealand; Brit. Mus.).—*Hoplodactylus granulatus*, Boulenger, Cat. Liz. Brit. Mus., 1885, p. 174; Lucas and Frost, Tr. New Zealand Inst., XXIX, 1897, p. 264.

4. Hoplodactylus maculatus.

Naultinus pacificus (*N. maculatus*) Gray, Cat. Liz. Brit. Mus., 1845, p. 273 (type loc. New Zealand; Brit. Mus.).—*Hoplodactylus maculatus*, Boulenger, Cat. Liz. Brit. Mus., I, 1885, p. 171; Lucas and Frost, Tr. N. Zealand Inst., XXIX, 1897, p. 264.—*Naultinus pacificus* (*N. brevidactylus*)[1] Gray, l. c. s., p. 273.

The genus is definitely known from New Zealand. The old collections of the British Museum and Paris contain specimens of *H. pacificus* from Tasmania and of *H. maculatus* from Tasmania and the Marquesas Is. As far as I am aware they have not been since met with in those localities.

Genus **Hemiphyllodactylus.**

Bleeker's *Hemiphyllodactylus*, 1860, appears to have given rise to considerable confusion in the past. Boulenger in his Catalogue, 1885, limited it to a single species (under *Spathoscalabotes*), overlooking the fact that three of the species included by him in that work under *Lepidodactylus*, namely *ceylonensis*, *aurantiacus* and *crepuscularis* had the generic characters of *Hemiphyllodactylus*, the chief of which is the vestigial first digit. This was put right by Stejneger in 1899. Later Boulenger described under *Gehyra*, two species, namely *larutensis*, 1900, and *yunnanensis*, 1903, that again have the digital characters of *Hemiphyllodactylus*. The latter was made by Barbour in 1924 the type of a new genus, namely, *Cainodactylus*. I cannot help thinking that he overlooked *Hemiphyllodactylus* at the time, for I can find nothing in his description, or in the species, the types of which are in the British Museum, to separate it from that genus. *Hemiphyllodactylus* and *Gehyra* are no doubt very closely allied, and both are possibly derived from *Hemidactylus* by gradual reduction of the first digit. Whether their retention as three separate genera represents their true phylogeny is doubtful. *Lepidodactylus* on the other hand appears more closely allied to *Gekko*.

The genus *Hemiphyllodactylus* may be defined as follows :—

Digits free, subcylindrical at the base, the penultimate joint bearing a strong expansion furnished beneath with lamellae, which are more or less divided in two by a median fissure; terminal phalanges of outer four digits short, compressed, clawed, free, rising angularly from within the

[1] These specimens cannot now be traced.

expansion ; inner digit vestigial, without free distal phalanx, sometimes with a minute claw. Dorsal scales small, granular. Pupil vertical. Males with preanal and femoral pores.

Range. Ceylon and southern India ; Indo-China ; the East Indies and Islands of Oceania. It contains the following species :—

1. *Hemiphyllodactylus typus*, Bleeker, 1860.

Platydactylus crepuscularis Bavay, 1869.
Spathodactylus mutilatus Gunther, 1872.
Lepidodactylus ceylonensis Boulenger, 1885.
Hemiphyllodactylus leucostictus Stejneger, 1899.
Hemiphyllodactylus insularis Taylor, 1918.
Hemiphyllodactylus margarethae Brongersma, 1931.

2. *Hemiphyllodactylus yunnanensis.*

Gehyra yunnanensis Boulenger, 1903.—*Cainodactylus yunnanensis* Barbour, 1924.

Hemiphyllodactylus harterti.

Lepidodactylus harterti Werner, Zool. Anz. Leipzig, April, 1900.
Gehyra larutensis Boulenger, Ann. Mag. Nat. Hist. August, 1900.

Through the kindness of Dr. Ernst Ahl, Keeper of Reptiles in the Zoological Museum, Berlin, I have recently been able to examine the type and only known specimen of *L. harterti*, and can confirm Boulenger's suspicion (1912) that it is identical with his *larutensis*. The name *harterti* has priority over *larutensis* by four months.

It is satisfactory to find that Dr. L. D. Brongersma (1931), working independently, has reached the same conclusions with regard to *Hemiphyllodactylus typus* as I have.

The Eublepharidae *and* Uroplatidae.

It is usual now to regard the Eublepharidae as of polyphyletic origin, as an assemblage of genera that have developed independently, but along similar lines, from the true Geckoes, in different parts of the world. Boulenger separated them from the Gekkonidae for having procoelous vertebrae, co-ossified parietals and moveable eye-lids, but recent work has shewn that there are exceptions to this definition. The American *Sphaerodactylus* is a Geckonid with procoelous vertebrae ; paired parietals have been found in two species of Eublepharid (Noble, 1921). His statement, however, that the Indo-Chinese *Phyllodactylus siamensis* has fused parietals is not borne out by three specimens examined by me in the British Museum collection. The Malayan *Aeluroscalabotes* is a Geckonid with connivent eye-lids, and no doubt other exceptions to those mentioned will be found when the internal structure of more of the Geckoes is known.

The Uroplatidae differ from the true Geckonids and the Eublepharids in having cylindrical clavicles and a reduced interclavicle. The interclavicle however is not more reduced in them than it is in the two African species of *Cnemaspis* previously mentioned, while the difference between a cylindrical clavicle which is larger at its sternal end, and the clavicle

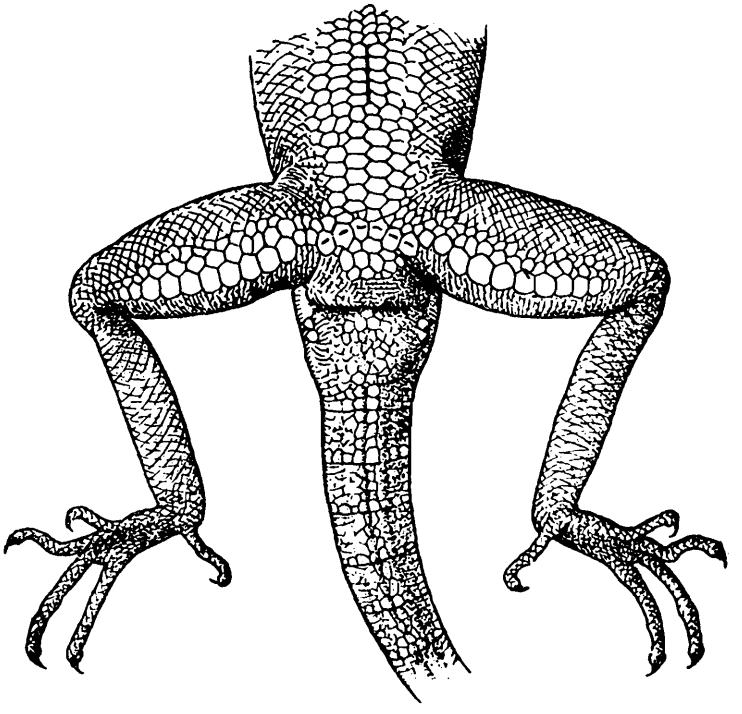
as it is found in some species of *Gonatodes* and *Cnemaspis* is not great. In other respects *Uroplates*, the only genus in the Family, is a typical Geckonid and should be regarded as a member of the Gekkonidae. Mocquard came to this conclusion in 1909 (Nouv. Arch. Mus. Paris). Ángel, on the other hand, has discussed the genus more recently (Mem. Acad. Malg. 1929, fasc. IX) and has regarded the genus as a subfamily of the Gekkonidae.

The following species are described as new to science.

Agamura femoralis, sp. nov.

Head somewhat depressed, about twice as long as broad; snout longer than the distance between the eye and the ear-opening, the diameter of which is less than half that of the eye ; eye moderate, with well-developed upper eye-lid. Rostral pentagonal, as broad as high ; nostril between the first labial and three rather swollen nasals ; 12 upper and 11 lower labials ; mental considerably longer than the adjacent labials, pointed behind ; a pair of well-developed post-mentals with a smaller pair outside ; gular region with small flat granules.

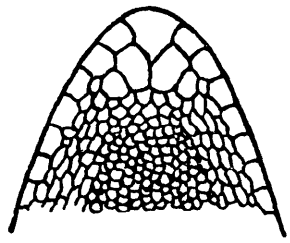
Head covered above with small rounded scales, largest on the snout, intermixed posteriorly with larger tubercles. Body depressed, back with small, rather irregular scales intermixed with numerous larger rounded keeled tubercles ; belly with flat, rounded, feebly imbricate scales. Limbs



TEXT-FIG. 6.—*Agamura femoralis*, From the type.

shorter than in *persica*, the hind limb reaching only to the neck ; a series of much enlarged scales along the under surface of each thigh. Tail cylindrical, becoming suddenly smaller after the basal part but not so markedly as in *persica*, tapering to a point, segmented, with small scales above, four or five in longitudinal series to each segment, below with larger irregular scales, usually three to each segment. Male with 6

preanal pores in a transverse series and a series of greatly enlarged femoral scales.



TEXT-FIG. 7.—*Agamura femoralis*, Ventral view of the Chin. ×3.

Greyish above with indistinct darker cross-bands upon the back and tail ; whitish below.

Head and body 50, tail 55 mm.

The type and only known specimen (B. M. coll. 1912, 3-26-12) was collected by Capt. C. Daukes at Kharan in Baluchistan in 1912. It differs from the only other known species in the genus in having enlarged femoral scales, well-developed postmentals and a pointed tail.

Stenodactylus maynardi, sp. nov.

Stenodactylus orientalis (not of Blanf.) Alcock and Finn, *J. Asiat. Soc. Bengal,* LXV, 1896, p. 554.

Types male and female (Brit. Mus. 1931, 6-14-1, and Ind. Mus., no. 13944).

Head moderate, depressed ; snout longer than the distance between the eye and the ear-opening, the diameter of which is half that of the eye. Nostril between the rostral, first labial, and three or four smaller shields ; rostral quadrangular ; 13-15 upper and 12-13 lower labials ; mental much larger than the adjacent labials, its curved posterior margin projecting well beyond them ; no post-mentals. Head covered above with small, granular scales, largest upon the snout. Body depressed, the back covered with small granular scales, intermixed with numerous larger keeled tubercles ; belly with small, rounded, keeled scales. Limbs above with subimbricate, keeled scales ; the hinder one reaches to the axilla. Toes long, with well-marked lateral denticulations, the transverse lamellae with several keels. Tail with rows of small, keeled scales. Male with 9 very distinct preanal pores transversely arranged ; female with 9 enlarged pitted scales.

The specimens, which are now somewhat faded, are of a light yellowish-brown colour above with four longitudinal dark brown streaks, the two lateral ones being distinct and unbroken, the two median ones broken up into a series of spots. Dr. Maynard states of their colours in life : "three irregular yellow longitudinal bands, with brownish-black stripes intervening from top of head to tail ; under surface of body and limbs delicate pinkish."

Head and body, ♂45, ♀50, tail, ♂70, ♀76 mm.

The types and only known specimens were collected by Dr. Maynard in Baluchistan near the Afghan frontier.

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DESCRIPTIONS OF TWO NEW GYRINIDAE FROM INDIA.

By GEORGE OCHS, *Frankfurt a. Main.*

Orectochilus horni, sp. nov.

Long. 6-6·5 mm. Oblongo-ovatus, postice ab humeros leviter attenuatus, parum convexus. Supra nigro-piceus vel castaneous, ad latera aureo-tomentosus, flavo-marginatus. Infra piceus, segmento anali epipleuris pedibusque rufis. Labro brevissimo transversali, pronoto utrinque sat late, multo latius antice, punctato-tomentoso. Margine tomentoso in elytris eadem latitudine continuato, postice dilatato, flexuose suturam ante apicem attingente. Spatio laevi cordiformi, postea acuminato, in ♀ paulo latiore. Reticulatione in regionibus glabris parum impressa, areolis leviter transversis, punctatura in pronoto et elytris indistincta. Truncatura paululum obliqua, extus subsinuata, angulo suturali fere recto minime deleto, externo subprominulo. Tibiis anticis in ♂ late triangularibus, fortiter intus dilatatis, angulo apicali externo recto; in ♀ minus latis, angulo apicali externo rotundato. Tarsis anterioribus in ♂ valde dilatatis, ovatis, antice parum attenuatis.

Habitat: Eastern Himalayas, Pedong (A. Desgodens).

Type ♂ in the collection of the Deutsches Entomologisches Institut, Berlin Dahlem, paratype in my collection. Further specimens were seen from Kurseong (R. P. Bretaudeau), Kurseong 5,000 ft., 7-11th March 1924 (Dr. B. N. Chopra), Ghumti 1,500—4,000 ft., June 1914 (Lord Carmichael's Coll.).

Named in honour of Dr. Walter Horn of the Deutsches Entomologisches Institut, in recognition of many favours and helpful assistance.

This species, which has certainly passed through the hands of Régimbart and Zimmermann, was overlooked owing to its strong resemblance to *O. oblongiusculus* and *O. figuratus*. In the shape of the smooth portion of the elytra it is almost intermediate between the two species mentioned above, and it was probably this which led Régimbart to combine these two species into one; in his earlier work he had rightly considered the two as distinct species (*cf.* Zimmermann 1917, *Ent. Mitteil.* VI, pp. 166, 167). *O. horni* is readily distinguished from either of the two species mentioned above by the microsculpture of the smooth portion of the elytra. In the new species there is a superficially impressed reticulation of slightly transverse meshes with traces of a few scattered minute punctures, while in the other two species the microsculpture is more strongly impressed, with round meshes and strong punctures in *O. oblongiusculus*, more transverse meshes and no punctures in *O. figuratus*. As stated above, the shape of the smooth portion of the elytra in *O. horni* is intermediate, its outline is more flexuous posteriorly than in *O. oblongiusculus* and more acuminate than in *O. figuratus*, especially in the females. The aedagus of *O. horni* is subparallel, about as wide and nearly as long as the lateral lobes and acuminate at the apex. In *O. figuratus* the shape of the aedagus is very similar, but it

is a little more slender and in lateral view its apex appears strongly curved, in the form of a hook. In *O. oblongiusculus* the aedagus is shorter than the lateral lobes, slightly constricted at about two-thirds of its length and with a narrowly rounded tip ; the longitudinal furrow, which almost reaches the apex and has a different facies in the other two species is much shorter in *O. oblongiusculus*. Small differences are also noticeable in the aedagi of *O. oblongiusculus* from the Eastern Himalayas (*oblongiusculus*, s. s.), the Western Himalayas (subsp. *parkeri*), Burma (subsp. *feai*) and Tonkin, but the shape is generally of the same type, and there can be little doubt that the minor distinguishing characters of these forms can only be considered as being of racial or subspecific value.

Orectochilus alienus, sp. nov.

Long. 6-7 mm. Ovatus, sat latus, postice ab humeros attenuatus, parum convexus. Supra nigro-piceus vel castaneus, leviter aenescens, ad latera aureo-tomentosus, flavo-marginatus. Infra piceus, segmento anali epipleuris pedibusque rufis. Labro brevissimo, transversali. Margine tomentoso in pronoto lato, antice latiore ; in elytris continuato, postice dilatato et suturam ante apicem attingente. Spatio laevi subcordiformi, lateribus fere rectilinearibus, parum constrictis. Reticulatione in regionibus glabris fortius in capite (areolis rotundatis), levius in pronoto et elytris (areolis transversis) impressa, undique punctatura remota. Truncatura paululum obliqua, angulo suturali fere recto, externo obtuso deleto. Tibiis anticis in ♂ triangulariter intus dilatatis antice recte truncatis, angulo apicali externo recto, vel in individuis magnis acuto extus projecto ; in ♀ minus latis, subparallelis, angulo apicali externo leviter rotundato. Tarsis anterioribus in ♂ dilatatis, ovatis, antice fortiter attenuatis.

Habitat ! Burma, Tavoy, Nwalabo, 3,000 ft., November 1924 (R. N. Parker).

Type a large male ; allotypes a small male and a female in my collection ; paratypes in the collection of the Forest Research Institute, Dehra-Dun.

In the *Catalogue of Indian Insects* (Part 19, 1930, p. 21) I recorded these specimens as *O. cordatus*, but having now compared the material with a type male of the latter species from the Museo Civico, Genova, and a series from Tonkin in my collection (from Lactho and Hao Binh) which does not show any significant differences from the type male, I am of opinion that the Indian specimens represent an undescribed species. *O. alienus* is a relatively smaller insect (*O. cordatus* 6·5-8 mm. *O. alienus* 6-7 mm. in length), and is comparatively broader. The outline of the smooth portion of the elytra is less constricted posteriorly and, therefore, less cordiform, and the oblique sides are nearly rectilinear. The flattened lateral margin of the elytra is less broadened posteriorly and the outer apical angle is not distinctly marked. Further, the male genitalia of the two species differ materially, in *O. cordatus* the aedagus in nearly subparallel and only feebly narrowed in its apical third, while in *O. alienus* there is a strong constriction shortly before the apex, which is broadly expanded for a short distance and notched at the tip.

Small specimens of *O. alienus* might be confounded with *O. oblongiusculus feai*, which was collected from the same locality. The latter, however, is generally smaller in size and more elongated, the reticulation on the smooth portions of the pronotum and the elytra consists of round, strongly impressed meshes, the tomentous border is much broader on the pronotum, especially, behind the eyes and the base of the elytra; the smooth portion of the latter is narrower basally and is on the whole more elongate-cordiform. The aedagus of *O. alienus*, as described above, is also quite different.

FURTHER NOTES ON CRUSTACEA DECAPODA IN THE INDIAN MUSEUM.

III.—On the Decapod Crustacea collected by the Bengal Pilot Service off the Mouth of the River Hughli. Dromiacea and Oxystomata.

By B. Chopra, *D.Sc., Assistant Superintendent, Zoological Survey of India, Calcutta.*

For many years past the members of the Bengal Pilot Service have been enriching the collections of the Indian Museum with large numbers of, sometimes very interesting, zoological specimens, collected by them at the Sandheads, off the mouth of the Hughli River. The association between the Pilot Service and the Museum is a very old one, and there are numerous specimens in the Museum collection registered as having been presented by the Commissioners of Pilot Brigs as long ago as the seventies of the last century, or perhaps even earlier than that. This valuable association was continued even after the replacement of the Pilot Brigs by modern steamships, and has resulted in larger collections since the present Pilot vessels *S.S.* " Fraser " and *S.S.* " Lady Fraser " were equipped a few years ago with beam or otter trawls for such marine investigations as the exigencies of their service permit them. The result of this has been the accumulation of large collections from this interesting region, a considerable part of which consists of Decapod Crustacea. Though several interesting forms of Decapoda, Stomatopoda and other groups of Crustacea from this area have been described by Wood-Mason, Alcock, Kemp and others, and records of other forms from this locality have been included in a number of papers in the accounts of various species, no systematic attempt has up to the present time been made to give a collective account of the fauna of this region. I propose describing the Decapod Crustacea of this area in the present series of papers.

Like most deltaic regions, the Delta of the Ganges is a very interesting area from a zoological point of view. As pointed out by Kemp [1] in his " Notes on the Fauna of the Matlah River in the Gangetic Delta " the conditions governing life in this region are very peculiar, and have resulted in the evolution or preservation of a very specialized type of fauna. As in other deltaic regions, not only is there a rapid and extensive mingling of fresh and salt waters, resulting in a wide range of salinity that varies according to the conditions of the tides, and the amount of fresh water brought down by the river at different times of the year, but the amount of silt that the water of the Ganges brings down with it from the rich alluvial plains through which it flows, plays a very important part in regulating the conditions of life in the Delta. A very large amount of mud held in suspension in the form of minute particles must

[1] Kemp, *Rec. Ind. Mus.*, XIII, pp. 233-241 (1917).

necessarily diminish the amount of light that penetrates to the deeper layers of water, and its slow sedimentation forms a bed of a soft ooze-like mud, which from its very nature is somewhat unsuitable for a certain type of fauna. This result is no doubt also contributed to by the tidal currents and wave action, which must be constantly stirring up the superficial layers of mud at the bottom.

These conditions, though found by Kemp to exist in the Matlah River, are no doubt more or less characteristic of the entire Delta. The physical conditions prevailing at the Sandheads have not yet been adequately studied, but conditions somewhat similar to those in the Matlah River, though perhaps in a lesser degree, must obviously be existing here also. This area, which lies roughly in 21°N. and 88°E., is considerably lower and nearer the open sea than the region investigated by Kemp. The large amount of fresh water brought down either by the Hughli or the neighbouring branches of the Ganges no doubt changes the salinity, especially that of the superficial layers, to a considerable extent. Recently Commander Bacon of the Bengal Pilot Service has very kindly brought us a series of water samples from the Sandheads, covering a period of 24 hours. On titration it is found that the salinity of the surface water at the Sandheads on 18th, 19th October, 1932, varied between 16·175 and 20·990, and that it showed a tendency to rise and fall with the tides. More detailed observations on the salinity etc. of the waters at the Sandheads will be published later. I am very grateful to Col. Sewell for the very valuable help he has given me in studying these water samples.

The silt, that comes down with the river water, makes the water of this area markedly turbid. The bottom, again, for the most part consists of soft mud, though in some places there are patches of mud mixed with sand. The large quantities of mud particles held in suspension must cut off a large proportion of day-light and thus make the lower strata darker than at corresponding depths in the open sea. The depth is nowhere great and most of the collection appears to have been made at or under 20 fathoms.

From his study of the animals living in the Matlah River, Kemp came to some very interesting conclusions regarding the similarity of the Matlah fauna and that of the deep sea. At the present moment I am unable to make any general observations about the fauna of the Sandheads; it may be possible at a later stage to express some definite views on this matter.

The present paper deals with the crabs of the tribes Dromiacea and Oxystomata. Without going into the merits of the different systems of classification of the Oxystomes, so ably discussed by Ihle, I have followed in the present paper the classification adopted by Alcock in his famous "Materials for a Carcinological Fauna of India" For synonymies also the reader is referred to Alcock's work; for later references Ihle's excellent account of the Oxystomes in the Siboga Expedition Reports has been cited.

The Dromiacea are represented in the Sandheads collection by one species only, while there are 20 species and one variety of the Oxystomata. In the Calappidae, *Calappa pustulosa* Alcock, a rather rare species, is

represented by a number of good examples. In the Leucosiinae a new species of *Leucosia* has been described, while Bell's rare *Myra elegans* has also been met with. The Iliinae have six representatives living in this locality ; of these *Arcania erinaceus* (Fabr.), a somewhat uncommon species, has been met with at the Sandheads, and both the known species of *Ixa* are also represented. Of these *I. inermis* Leach appears to be a rare form. The Dorippidae are represented by two species and a variety, and the Raninidae by a single species.

I give below a list of the species met with at the Sandheads ; those recorded from this area for the first time are marked with an asterisk.

Dromiacea.
- Dromiidae.
  - *Conchoecetes artificiosus* (Fabr.).

Oxystomata.
- Calappidae.
  - Calappinae.
    - *Calappa lophos* (Herbst).
    - **Calappa pustulosa* Alcock.
  - Matutinae.
    - *Matuta lunaris* (Forskäl).
    - *Matuta planipes* Fabr.
- Leucosiidae.
  - Leucosiinae.
    - *Leucosia rhomboidalis* de Haan.
    - *Leucosia craniolaris* (Herbst).
    - **Leucosia rotundifrons*, sp. nov.
    - *Philyra globosa*[1] (Fabr.).
    - *Philyra globulosa* M.-Edwards.
    - *Myra fugax* (Fabr.).
    - **Myra elegans* Bell.
  - Iliinae.
    - **Iphiculus spongiosus* Adam and White.
    - **Pariphiculus mariannae* (Herklots).
    - *Arcania septemspinosa* (Fabr.).
    - *Arcania erinaceus* (Fabr.).
    - **Ixa cylindrus* (Fabr.).
    - **Ixa inermis* Leach.
- Dorippidae.
  - Dorippinae.
    - *Dorippe dorsipes* (Linn.).
    - *Dorippe facchino* (Herbst).
    - *Dorippe facchino*, var. *alcocki* Nobili.
- Raninidae.
  - **Raninoides personatus* Henderson.

My best thanks are due to Dr. Baini Prashad for making several valuable suggestions in the course of this work, and to Col. R. B. Seymour Sewell for going through the manuscript with me.

[1] No mention of this species has been made in the following pages on account of the bottle containing examples of it having been mislaid. Only three male specimens were collected at the Sandheads.

Tribe DROMIACEA.

Sub-tribe DROMIIDEA.

Family Dromiidae.

Conchoecetes artificiosus (Fabr.).

1901. *Conchoecetes artificiosus*, Alcock, *Cat. Ind. Decapod Crust.*, Part I, pp. 41, 42.

Seventeen specimens of both sexes and of different sizes, that agree closely with named examples of this species in the collections of the Indian Museum, have been brought back by the Pilot Steamships "Fraser" and "Lady Fraser" at different times between the years 1923 and 1928. The species is very easily recognised, among other characters, by the front having three teeth, by the presence of two teeth on the lateral borders of the carapace, and by the third pair of walking legs being short and ending in strong claws. The fourth pair of legs are very much reduced, and have tiny claw-like dactyli. The chelipeds are massive, especially in the males. The two teeth on the lateral border of the carapace are generally worn away in larger examples.

C. artificiosus has a wide range of distribution in the Indo-Pacific region. There are specimens in the Indian Museum from the Delta of the Indus to as far east as Hongkong. It has also been recorded, among other places, from the east coast of South Africa (Stebbing),[1] Ceylon (Laurie),[2] Gulf of Siam (Rathbun),[3] Japan (Balss)[4] and Queensland in Australia (Haswell).[5] It generally lives in shallow waters, but the examples from the Indus Delta in the Museum collection were dredged at a depth of 62 fathoms.

The species is known to cover itself with the shell of a bivalve mollusc, which it holds over its back by the strong claws of the third legs. One example from the Sandheads, collected by Capt. C. Park on board the "Lady Fraser" in 1927, has the shell of a Gastropod, *Xenophora* (*Onustus*) *solaris* (Linn.)[6] over its carapace.

The largest specimen in the Indian Museum collection has its carapace about 30 mm. long.

Tribe OXYSTOMATA.

Family Calappidae.

Sub-family Calappinae.

Calappa lophos (Herbst).

1896. *Calappa lophos*, Alcock, *Journ. As. Soc. Bengal* LXV, pp. 144, 145.
1918. *Calappa lophos*, Ihle, *Siboga Exped. Rep.* XXXIX b², pp. 182, 183.

I refer to this species 20 examples of both sexes and of varying sizes, collected at the Sandheads between 1923 and 1929. The specimens

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[1] Stebbing, *South African Crust.* II, pp. 19, 20 (1902).
[2] Laurie, *Rep. Pearl Oyster Fish. Ceylon* V, p. 353 (1906).
[3] Rathbun, *Kong. Danske Vidensk. Selsk. Skrifter* (7) V, p. 367 (1910).
[4] Balss, *Arch. Naturgesch.* LXXXVIII, p. 110 (1922).
[5] Haswell, *Cat. Austral. Crust.*, pp. 141, 142 (1882).
[6] I am indebted to my colleague Dr. B. Prashad for the name of this Gastropod.

agree closely with named examples of this species in the Museum collection. There has been some doubt about the shape of the anterior end of the endostomial septum in this species, but in my examples this septum is, as described by Alcock, " deeply excised anteriorly ".

This species occurs very commonly all along the eastern coast of India from the Delta of the Hughli to as far south as Pondicherry. There are also specimens in the Indian Museum collections from the Andamans, Ceylon, the Laccadive Islands, and the Persian Gulf.

C. lophos has a wide range of distribution in the Indo-Pacific region. Balss [1] gives the distribution of the species as : Dar-es-Salaam, Persian Gulf, Indian coasts, Ceylon, Siam, Japan, Celebes, Amboina and ? Port Jackson. Miss Rathbun's[2] record of the species from the Gulf of Siam is rather doubtful, as it is difficult to say whether her examples really belong to this species or not.

The species lives in shallow waters, and, judging from the examples in the Museum collection, does not appear to go below 20 or 22 fathoms.

Calappa pustulosa Alcock.

1896. *Calappa pustulosa*, Alcock, *Journ. As. Soc. Bengal* LXV, pp. 147, 148, pl. vi, fig. 1.

This species has hitherto been known from two immature male specimens only, collected by the R. I. M. S. " Investigator " off the Ganjam and Orissa coasts, at a depth of 25 fathoms. It is very easily recognised by the poor development of the clypeiform extensions of the carapace and by the presence of large rounded tubercles arranged on the carapace in seven longitudinal rows. The clypeiform extension consists of five short, broad teeth, the anteriormost of which has the appearance of a sharp tubercle rather than that of a tooth. The third tooth is the largest, and its tip is somewhat pointed and curved forwards. The last tooth is in advance of the posterior border of the carapace. The antero-lateral margins of the carapace are distinctly crenulated (or coarsely, but evenly, beaded) in their posterior half, while the anterior part is practically smooth in most of the examples that I have examined. In a few specimens this margin is faintly beaded, while in most, though the margin is more or less smooth, the low tubercles on the carapace a little on the inside of the margin, give this part of the margin a superficially beaded appearance, somewhat like that shown in Alcock's figure of the species. Both the type-specimens, on which Alcock based the description of this species, have the anterior part of the antero-lateral margin practically smooth, but the row of low tubercles a little on the inside of the margin is seen in his figure, the true margin being invisible. The front is sharply bilobed and its tip projects beyond the orbits. The posterior border is more or less straight, and has a fairly well-marked prominence on either side at its junction with the postero-lateral margin. The seven rows of bullous tubercles are arranged on the carapace as shown in Alcock's figure. The tubercles near the posterior margin of the carapace are very much lower and less developed than on the rest of the carapace, and some of these belonging to the median row tend to

[1] Balss, *Arch. Naturgesch.* LXXXVIII, p. 123 (1922).
[2] Rathbun, *Kong. Danske Vidensk. Selsk. Skrifter* (7) V, p. 315 (1910).

become short, low crests. This is especially noticeable in larger specimens. At the anterior end of the median row, there are four smaller tubercles arranged almost in the form of a square. The surface of the carapace between the tubercles is finely granular in the anterior part, but is smooth posteriorly.

The endostomial septum in younger examples is as described by Alcock. In its anterior part the septum is a low, and slightly concave ridge, but is somewhat higher posteriorly. This is the case in the type-specimens, and in the smaller examples in my collection. In larger specimens the anterior part of the septum is a high vertical ridge, becoming low posteriorly, in which part it is deeply concave. The ischium of the external maxilliped is, as appears to be usual, strongly toothed on its inner border.

The chelipeds, as is always the case in the genus, are very massive, and the crest at the distal end of the arm is four-lobed, the anteriormost lobe ending in a sharp tooth. The outer surface of the palm (and to a less extent, the upper surface of the wrist) is covered with bullous tubercles like those on the surface of the carapace. The lower borders of the palm are finely milled, and a little above this margin on the outer surface of the palm there is a band of small granules arranged more or less parallel to the margin. The inner surface of the palm is practically smooth, and the crest on its upper margin is as shown by Alcock.

The abdomen in females and small males consists of seven distinct somites, while in large male examples the 3rd, 4th and 5th somites are fused, thus leaving only five pieces. In some comparatively large males there are still traces of lines between the fusing somites.

Calappa pustulosa appears to be a common species at the mouth of the Hughli River, 18 specimens, as listed below, having been collected by members of the Pilot service at the Sandheads. The largest male example has a carapace length of 35 mm., while the largest female, which is ovigerous, is 39·5 mm. long. The type-specimens have a carapace length of about 20 mm. only.

C 1606/1	Sandheads, mouth of the River Hughli.	"Fraser," 4th Nov. 1922.	1 young.
C 1608/1	,, ,, ,,	"Fraser," 22nd Mar. 1923.	1 ♂.
C 1612/1	,, ,, ,,	"Lady Fraser," Capt. A. W. Michie, June 1923.	1 ♂, 2 ♀♀.
C 1607/1	,, ,, ,,	"Lady Fraser," Nov. 1923.	1 young.
C 1605/1	,, ,, ,,	"Fraser," 11th Jan. 1924.	5 ♂♂.
C 1614/1	,, ,, ,,	"Fraser," 29th Feb. 1924.	1 ♂, 1 ♀.
C 1609/1	,, ,, ,,	"Fraser," Jan. 1930	1 young.
C 1610/1	Bay of Bengal, between Pilot Ridge Light Vessel and Eastern Channel Light Vessel. 10 miles N. and S. of Eastern Channel Light Vessel.	"Fraser," Nov. 1923	1 ♀.
C 1611/1	,, ,, ,,	"Fraser," 29th Feb. 1924.	1 ♀.
C 1613/1	,, ,, ,,	"Lady Fraser," Feb., Mar. 1928.	2 ♀♀.

Typical examples of the species are so far known from the eastern coast of India only, though Borradaile[1] has recorded a variety of this species from the Maldive Islands. The variety, which he called *clypeata*, is distinguished from the *forma typica* by having the clypeiform extensions of the carapace much better developed and the antero-lateral margins of the carapace toothed throughout. The endostomial septum is more or less like that described by Alcock, though it is perhaps somewhat better developed. In the Indian examples, including the types, these characters do not exist. The anterior part of the antero-lateral margins is, as mentioned above, faintly beaded in some specimens, but in none can it be called toothed throughout. There are, however, a number of low tubercles quite close to this part of the margin, which give it a superficial appearance of being toothed, but the margin itself is practically smooth. The clypeiform expansion is poorly developed in all examples, and is nothing like that of *C. depressus* Miers,[2] as mentioned by Borradaile for his variety.

C. pustulosa lives in shallow waters, all the specimens in the Museum having been collected at depths of 20-25 fathoms of water.

Sub-family MATUTINAE.

Genus **Matuta** Fabr.

1896. *Matuta*, Alcock, *Journ. As. Soc. Bengal* LXV, pp. 153-157.

There has been a great deal of confusion regarding the correct names applicable to the various species of *Matuta*. Alcock in the paper cited above gave a very careful revision of this genus, but several workers like Stebbing,[3] Miss Rathbun,[4] Ihle, Balss [5] and others did not accept his views with regard to the correct names of *M. lunaris* and *M. victor*. I do not propose going into this matter here, but it seems clear that Alcock was wrong in ascribing the name of *M. lunaris* to Herbst. This species should undoubtedly be called *M. lunaris* (Forskäl) and *M. victor* of Alcock and some other authors should be referred to this species. *M. lunaris* of Alcock would thus appear to be *M. planipes* of Fabricius. In adopting these names I am following the example of most of the present-day workers.

Mutata lunaris (Forskäl).

1896. *Matuta victor*, Alcock, *Journ. As. Soc. Bengal* LXV, pp. 160, 161.
1918. *Matuta lunaris*, Ihle, *Siboga Exped. Rep.* XXXIX b[2], pp. 185, 186.

I refer to this species one ovigerous female specimen, with a carapace length of about 30 mm., collected by " Lady Fraser " at Sandheads in 1927. The species has been very accurately described by Alcock, and my example agrees closely with his description, as also with named specimens of the species in the collections of the Indian Museum.

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[1] Borradaile, *Fauna Geog. Maldive and Laccadive Archipelago* II, p. 436 (1903).
[2] Miers, *Challenger Brachyura* (Zool. XVII), p. 287, pl. xxiii, fig. 2 (1886).
[3] Stebbing, *South African Crustacea* III, pp. 54-57 (1905).
[4] Rathbun, *Kong. Danske Vidensk. Selsk. Skrifter* (7) V, p. 315 (1910).
[5] Balss, *Arch. Naturgesch.* LXXXVIII, p. 125 (1922).

M. lunaris occurs very commonly along the Indian shores. It is very widely distributed in the Indo-Pacific region, having been recorded from the Cape region and the Red Sea on the west to Polynesia on the east. Balss [1] gives the distribution of this species as: Zanzibar, Dar-es-Salaam, Madagaskar, Mauritius, Seychelles, Red Sea, Indian coasts, Ceylon, Amboina, Java, Celebes, Philippines, China Sea, Japan, Samoa, Nicobars, Tabiti, British New Guinea and Australia.

Matuta planipes [2] Fabr.

1896. *Matuta lunaris*, Alcock, *Journ. As. Soc. Bengal* LXV, pp. 161, 162.

This species, though closely resembling *M. lunaris* (=*M. victor* Alcock), can be, as pointed out by Alcock, easily distinguished from it. There is no spine at the angle where the hand comes in contact with the external border of the arm, the spine of the foregoing species being replaced by a tubercle, and the fourth lobe of the median longitudinal ridge on the outer surface of the hand is not raised into a spine in either sex. The colour in freshly preserved specimens is also different. I have examined a large number of specimens, that are preserved in the Indian Museum, of the two species of different ages and of both sexes, and I find that these differences are constant.

M. planipes appears to be a common species at the mouth of the Hughli, 12 specimens having been collected there between 1923 and 1927 In the Indian Museum there are specimens from Mergui, Andaman Islands, Burma and from several localities along both the coasts of Peninsular India. The species is widely distributed in the Indo-Pacific region; Balss [1] gives its distribution as Cape of Good Hope, Coasts of India, Singapore, Siam, China, Bonin Island, Japan, Java, Celebes and N. W Australia.

Family LEUCOSIIDAE.

Sub-family LEUCOSIINAE.

Leucosia rhomboidalis de Haan.

1896. *Leucosia rhomboidalis*, Alcock, *Journ. As. Soc. Bengal* LXV, pp. 234, 235.

1918. *Leucosia rhomboidalis*, Ihle, *Siboga Exped. Rep.* XXXIX b², p. 282.

Leucosia rhomboidalis belongs to the group of species in which *L. craniolaris* (Herbst), *L. vittata* Stimpson and *L. pubescens* Miers are also placed. *L. truncata* Alcock also resembles these species in a number of important characters, but the shape of its front is so distinct that it can be readily distinguished from all other species of the genus. From the two first named species in this group *L. rhomboidalis* can be distinguished by having the two sides of its front more or less sub-parallel, so that a somewhat abrupt junction is formed between the front and the antero-lateral borders of the carapace; and by having the edge of

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[1] Balss, *Arch. Naturgesch.* LXXXVIII, p. 125 (1922).

[2] As mentioned on p. 31, Alcock's name of *M. lunaris* is not applicable to this species, and Fabricius' old name *planipes* should take its place.

the pterygostomian region, which forms the anterior boundary of the thoracic sinus, smooth, there being no milling or granulation. From *L. pubescens* it can be recognised by its smaller size and by the fact that the surface of the carapace below the posterior margin of the dorsum is distinctly granular, while this surface is smooth in *L. pubescens*. Further the inner surface of the hand in the present species has two prominent rows of granules ; in *L. pubescens* this surface is generally smooth, or there is a single row of obsolescent granules. The external orbital angles are also inconspicuous, and the two outer teeth of the front are minute and deflexed, giving the front a superficial appearance of ending in a single sharp point.

I refer to this species two male specimens collected at the Sandheads by the Pilot vessel " Lady Fraser " in November 1923. The larger example is about 14 mm. long. The specimens agree very closely with Alcock's description of the species, as also with named examples in the Museum collection. The colour is somewhat faded, but the crescents of dark red spots, mentioned by Alcock, can be distinctly made out.

There are specimens of this species in the Indian Museum collection from the Andamans, the Delta of the Irrawady River, the Sandheads and the Coromandel coast, besides some examples from Hongkong. According to Ihle the species is distributed from Ceylon to Japan ; Balss [1] mentions its having been found at Vladivostock also.

Leucosia craniolaris (Herbst).

1896. *Leucosia craniolaris*, Alcock, *Journ. As. Soc. Bengal* LXV, pp. 231, 232.
1914. *Leucosia craniolaris*, Parisi, *Atti. Soc. Ital. Sci. Nat. Milano* LIII, pp. 293, 294.

The present species very closely resembles *L. vittata* Stimpson, from which it is somewhat difficult to distinguish it satisfactorily. The character on which Stimpson [2] separates his species from *L. craniolaris*, namely the presence of pubescense on the basal part of the arm, holds good for both species. Alcock mentions a number of characters by which the two species may be distinguished ; the most important of these is afforded by the thoracic sinus. In *L. vittata* the outer limb of the sinus encroaches on the antero-lateral border of the carapace, where it causes a marked emargination, visible in a dorsal view ; in *L. craniolaris* the outer limb of the sinus does not invade the antero-lateral margin of the carapace. This character, though quite constant in *L. vittata*, appears to be somewhat variable in the other species, for in some examples of *L. craniolaris* that I have examined a slight emargination of the antero-lateral border is formed. According to Alcock, the hand in *L. vittata* is " very appreciably longer than broad, and the fingers are every bit as long as the hand " ; and in *L. craniolaris* the hand is nearly as broad as long and the fingers are also nearly as long as the hand. In all the specimens of both the species that I have examined the hand is longer than broad in the same way as the fingers are longer than the hand. In the former species, however, the fingers appear to be proportionately

[1] Balss, *Arch. Naturgesch.* LXXXVIII, pp. 127, 128 (1922).
[2] Stimpson, *Smithsonian Misc. Coll.* XLIX, pp. 149, 150, pl. xviii, figs. 3, 3a (1907).

somewhat longer than those in the other form. The third point mentioned by Alcock is the difference in the colouration of the two species. This difference appears to be constant, and in freshly preserved examples at least is no doubt useful in distinguishing the two forms. It thus appears that, apart from colouration, which in the case of old specimens cannot be relied upon to any great extent, the only point on which the two species can be satisfactorily separated is afforded by the thoracic sinus. Another character which might be of help in recognising these species is the slight difference in the shape of the front. In *L. craniolaris* the antero-lateral borders are practically straight, and meet the converging sides of the front in a more or less continuous sweep, so that there is hardly any angle formed by the two. In *L. vittata* the antero-lateral borders, which have a distinct emargination a little above the bases of the chelipeds, are somewhat arched, and meet the sides of the front in a distinct, though very broad, angle, giving the snout an appearance of being pinched off from the rest of the body. The junction is not as prominent as it is *L. rhomboidalis* or *L. pubescens*, but it is distinctly more so than in *L. craniolaris*. I have found this difference quite constant in all the examples of the two species in the Indian Museum collection.

The carapace in *L. craniolaris* appears to be a little less arched than in *L. vittata*.

There are nineteen specimens in the collection from the Sandheads that I refer to this species. Of these 13 are males, and 6 females, the latter including an ovigerous example. The largest specimen has a carapace length of 23 mm. There are already in the Museum collection specimens from the mouth of the Hughli River. In Indian waters Henderson [1] mentions its having been recorded from Rameswaram, Mutuwartu, Ceylon, Gulf of Martaban and Madras.

L. craniolaris is widely distributed in the Indo-Pacific region. In addition to Henderson's records Parisi has mentioned, in the paper cited above, a number of localities from which the species has been recorded. Ihle [2] gives its distribution as Gulf of Manaar, Indian Archipelago, Torres Strait and East Asia.

Besides the specimens mentioned above there is a young male example in the collection. As mentioned by Alcock [3] in the case of *L. vittata*, the posterior margin of the carapace is practically straight, and the outer angles are dentiform.

Leucosia rotundifrons, sp. nov.

The carapace is bluntly hexagonal, and is slightly longer than broad, the greatest breadth being about nine-tenths of the length. The surface is devoid of hair, and is quite smooth in the posterior and median regions. The hepatic, the gastric and the sides of the branchial regions are, however, minutely, but distinctly punctate, the punctations in fully grown examples being visible even to the naked eye. The antero-lateral

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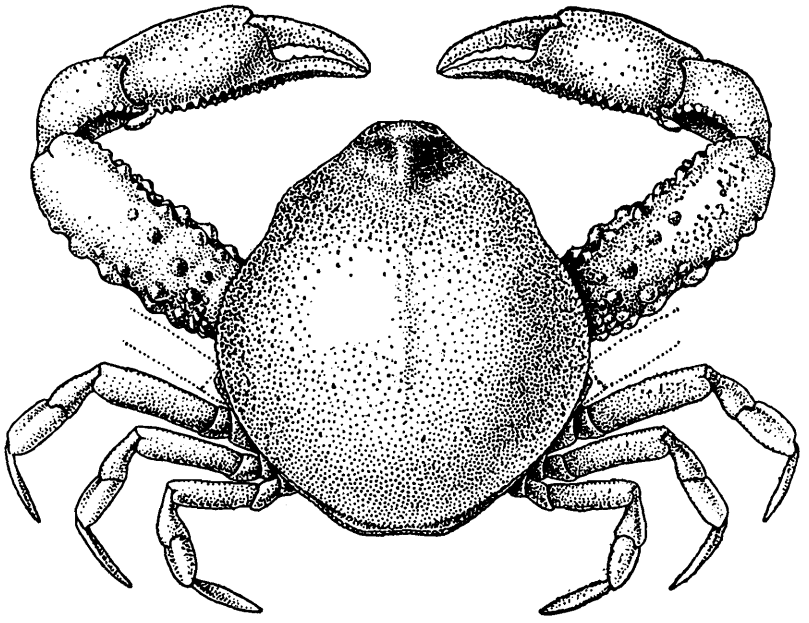
[1] Henderson, *Trans. Linn. Soc. London* (2) Zool. V, p. 397 (1893).
[2] Ihle, *Siboga Exped. Rep.* XXXIX b², p. 315 (1918).
[3] Alcock, *Journ. As. Soc. Bengal* LXV, p. 233 (1896).

borders are markedly sinuous, and are concave, except for a broad notch a little above the base of the chelipeds ; they are beaded through-



TEXT-FIG. 1.—*Leucosia rotundifrons*, sp. nov.
Dorsal view of a male specimen : ×1·5.

out, though the beading in the anterior part is faint. The postero-lateral margins, which are broadly arched, are crenulate, the crenulation becoming sparser posteriorly, and extending up to the base of the last pair of legs. The posterior margin is faintly milled, and is regularly rounded in the female. In the male this margin is very gently curved, or is more or less straight with a concavity in the middle. It is continuous on either side with the thickened and milled epimeral margin, which, for the most part, is not visible in a dorsal view. As is usual the epimeral margin ends in a tooth. The deflexed surface below the posterior margin is quite smooth, though its lower border is beaded.

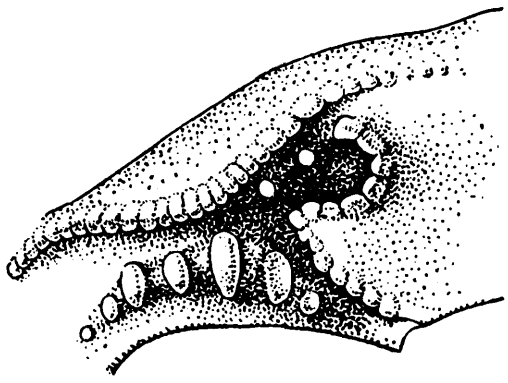
The front is prominent and is conspicuously broader than long. It is dorsally concave, and has a faint long groove on either side a little on the outside of the eye. Its front edge is deflexed and is broadly and regularly rounded. There are distinct concavities on the carapace, one on either side of the middle line at the base of the front.

The ventral surface of the ischium of the external maxilliped in the female is raised into a carina, which, in one specimen, is quite sharp and ends in a blunt tooth. The distal part of the exognath and the merus of the maxilliped, is covered with small pearly granules in both sexes.

The thoracic sinus is like that of *L. obtusifrons* de Haan, as described by Alcock [1] and figured by Parisi.[2] It is a long narrow loop between the base of the cheliped, and the strongly pronounced lateral angle or the eave of the carapace. The granules on the dorsal end of the loop are small in size, and are for the most part hidden under the eave of the

[1] Alcock, *Journ. As. Soc. Bengal* LXV, pp. 216, 217 (1896).
[2] Parisi, *Atti. Soc. Ital. Sci. Nat. Milano* LIII, pp. 291, 292, pl. xiii, fig. 4 (1914).

carapace; those on the lower limb are large and pearl-shaped. The granules of the anterior concavity of the loop are only partly welded



TEXT-FIG. 2.—*Leucosia rotundifrons*, sp. nov.
Thoracic sinus, lateral view: × 4.

together, are cut off from those of the lower limb and form a somewhat isolated incomplete ring. The pterygostomian plate in front of the loop has a small depression, and its lower edge in continuation with the loop is markedly granular.

In the adult male the chelipeds are considerably more than half again as long as the carapace. The inner and outer borders of the arm are covered with large pearly tubercles, and in addition to these the upper surface of the arm has two divergent longitudinal rows of similar tubercles, arising from a number of smaller coalescent tubercles at the base of the arm, and running for about half its length. The inner surface of the arm is completely covered with pearly tubercles, which become smaller in size near the distal end. The under surface has a large number of small tubercles in the basal portion, and similar tubercles along the sides arranged so as to leave a large smooth area of a triangular shape in the middle. The wrist is short and globular, and is smooth, except for two rows of small granules on the inner surface, one along the upper border and the other along the lower. The hand is about one and a half times as long as high, and its outer border is very faintly carinated. The inner surface of the hand has a number of rows of granules on it; the rows on the dorsal and ventral borders consist of larger granules, and are continued on to the fixed finger. The fingers are somewhat shorter than the hand, and leave an appreciable gap at the base when they are closed. They bear short teeth on their entire edges, and their tips are somewhat sharply pointed.

The legs have subcylindrical meropodites, with four longitudinal rows of small indistinct granules; the carpopodities are short and inflated, the propodites have sharp, dorsal carinae and the dactyli are broadly lanceolate.

The abdomen consists of four pieces in both the sexes; the third piece in the male has a strong tooth in the middle line. The second piece in the male is almost as long as the third and has its surface raised in three prominent convexities. In the female the second piece is very small.

The largest specimen, a male, has a carapace length of 28·8 mm. and breadth of 26·5 mm. ; the largest female is 26 mm. long and 24·7 mm. broad.

The colour in spirit specimens is slate-grey, with the pearly tubercles on the arm white. There are generally no characteristic markings on the carapace, but in one female example from the Madras coast a pair of small white spots on either side of the gastric region is faintly visible, as in *L. obtusifrons*. In the specimen from the Sandheads the carapace and the lower surface of the body are mostly black, only the anterior part of the former being whitish. The chelipeds and the tubercles on it are also black, except for parts of the hand and the fingers, which are pale orange. The meropodites of the legs are black, while the remaining parts are light orange. The colouration of this example does not agree with that of any other specimen in the collection. There are tufts of Polyzoan colonies growing on the arms in this example.

The type-specimen is registered under 2855/10 in the registers of the Zoological Survey of India.

Locality.—The species appears to have quite a wide range of distribution in the Indian Ocean, there being specimens in the Museum collection both from the Arabian Sea and the Bay of Bengal. The type-specimen is from the Laccadive Sea (Marine Survey Station 246).

2855/10	Laccadive Sea, 11° 14′ 30″ N., 74° 57′ 15″ E., 68-148 fathoms.	Marine Survey, 15th Oct. 1898.	2 examples including TYPE.
2856/10	,, ,, ,,	,,	1 young.
C1643/1	Madras Coast. ,,	,,	1 ♀.
C1644/1	Near Muscat, Persian Gulf.	T. H. Townsend.	1 young ♂ with a Bopyrid.
C1645/1	Sandheads, mouth of the River Hughli.	" Fraser," 29th Feb. 1924.	1 ♀.

The present species very closely resembles *L. unidentata* de Haan and *L. obtusifrons* de Haan, notably in the shape and proportions of the carapace, the general shape of the front, the granulation of the arm, the form of the legs, and the general shape of the thoracic sinus. It can, however, be easily distinguished from both these species, among other characters, by the punctations of the carapace, the shorter and anteriorly rounded front, and the carina on the ischium of the maxilliped of the female. As is seen from the accompanying table *L. rotundifrons* shows a greater resemblance with *L. obtusifrons* than with de Haan's other species. The resemblance between the three species is so close, that some examples of the new species had been mixed up with specimens of the other two species in the Museum collection. The type-specimen along with another younger example had been included with examples of *L. unidentata*, while the female from Madras coast had been determined as *L. obtusifrons*. Another specimen from Muscat in the Persian Gulf had also been called *L. unidentata*.

L. unidentata.	*L. obtusifrons.*	*L. rotundifrons.*
1. Carapace smooth.	1. Carapace smooth.	1. Carapace distinctly punctate on hepatic, gastric and sides of the branchial regions.
2. Front somewhat broader than long, truncate triangular, its anterior edge faintly trilobed and slightly deflexed.	2. Front more or less as in *L. unidentata.*	2. Front very much broader than long, its anterior edge deflexed and regularly and broadly rounded.
3. Ventral surface of ischium of external maxilliped in the female smooth	3. As in *L. unidentata.*	3. Ventral surface of ischium of external maxilliped in the female carinate.
4. Distal part of merus and exognath of external maxilliped in both sexes smooth.	4. As in *L. unidentata.*	4. Distal part of merus and exognath of external maxilliped having pearly granules in both sexes.
5. Thoracic sinus loop-shaped, with equal sized pearly granules on both limbs. Pterygostomian plate in front of the loop deeply indented transversely.	5. Thoracic sinus loop-shaped, with the anterior end of the loop cut off in an isolated ring of coalesced granules, and with granules of the dorsal limb minute. Pterygostomian plate in front of the loop flat.	5. Thoracic sinus more or less as in *L. obtusifrons.* Pterygostomian plate in front of the loop somewhat depressed, wth its lower edge prominently granular.
6. Divergent rows of granules on the upper surface of arm extending for about three-fourths of the basal part of the arm.	6. Divergent rows of granules extending for about half the length of the arm.	6. Divergent rows of granules extending for about half the length of the arm.
7. Outer border of hand rounded.	7. Outer border of hand rounded.	7. Outer border of hand faintly carinate.
8. Fingers as long as the hand.	8. Fingers shorter than the hand.	8. Fingers shorter than the hand.
9. Chelipeds more than 1½ times the length of the carapace.	9. Chelipeds less than 1½ times the length of the carapace.	9. Chelipeds more than 1½ times the length of the carapace.

The species appears to be uncommon at the Sandheads, only one example, as shown in the list of localities given above, having been collected there by the Pilot Steamship " Fraser " in 1924.

Philyra globulosa M.-Edwards.

1896. *Philyra globulosa*, Alcock, *Journ. As. Soc. Bengal* LXV, pp. 245-247.
1918. *Philyra globulosa*, Ihle, *Siboga Exped. Rep.* XXXIX b², pp. 274, 275.

I refer to this species 21 specimens from the Sandheads, collected between 1922 and 1927 There are 12 males and 9 females, the former varying beween 14 mm. and 20 mm. in length, and the latter between 14 and 16 mm. According to Alcock the adult female is 22-24 mm. long, but in my collection some females, having a carapace length of about 14 mm. only, are ovigerous.

P. globulosa somewhat closely resembles *P. globosa* (Fabr.), but, as shown by Alcock, the two can be distinguished without much difficulty. Ihle in the paper cited above has also given a number of useful characters, which facilitate the recognition of the two species.

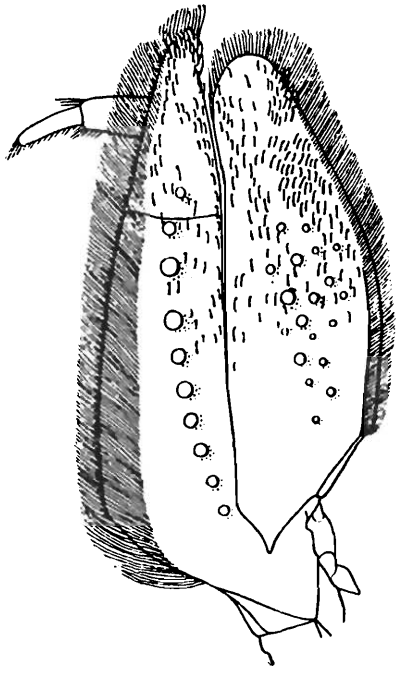
The species appears to be quite common in the Indian Ocean, there being specimens in the Museum collection, as remarked by Alcock, from " all along the East coast, from the mouth of the Hooghly to Point Calimere, and on the coasts of Travancore, the Andamans, and the Persian Gulf " The specimens from the last mentioned locality differ from others in having the upper surface of the arm, and the pterygostomian region less granular than is usually the case.

Ihle gives the distribution of the species as the Indian Ocean from the Persian Gulf to the Gulf of Siam, and the Moluccas.

Myra fugax (Fabr.).

1918. *Myra fugax*, Ihle, *Siboga Exped. Rep.* XXXIX b[2], pp. 256, 257.

Myra fugax occurs very commonly all round the coasts of India. In the Indian Museum collections there are specimens from, among other localities, the Mergui Archipelago, the Andamans, the Irrawady Delta, the Delta of the Ganges, both the coasts of the Indian Peninsula (up to Karachi on the Bombay coast) and from the Persian Gulf. There are also examples from Singapore and Hongkong. In addition to these there are numerous specimens registered under the name of *M. pentacantha* Alcock,[1] which appears to be only a young form of *M. fugax*, from both the coasts of India.



TEXT-FIG. 3.—*Myra fugax* (Fabr.).
External maxilliped of female : × 8.

The species has been very fully described by Alcock [2] and several other writers. In the female the ventral surface of the ischium of the external maxillipeds is distinctly raised in a median longitudinal ridge composed of fairly large pearly granules. This character is very poorly developed in the male, but is present in all females, and even in young specimens of that sex.

As Ihle has pointed out *M. fugax* is rather a variable species. The proportions of the carapace, the size of the terminal spines, the relative length of the chelipeds, and the granulation of the carapace—to mention only a few of the important characters—all vary a great deal with age, and to a certain extent with sex also.

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[1] Alcock, *Journ. As. Soc. Bengal* LXV, pp. 204, 205 (1896).
[2] Alcock, *op. cit.*, pp. 202—204.

I refer to this species 13 examples collected at the Sandheads at different times between the years 1922 and 1928. There are 10 males and 3 females; the largest male has a carapace length (excluding the terminal spine) of 27 mm., while the largest female, which is ovigerous, is about a millimetre longer.

M. fugax has a very wide range of distribution in the Indo-Pacific region. Balss [1] gives the distribution as East Africa, Madagascar, Red Sea, Indian Coasts, Ceylon, Gulf of Siam, Japan, Arafura Sea on the north of Australia and New Caledonia.

Alcock, in the paper cited, pointed out with good reasons that his *M. pentacantha* is probably only a young form of *M. fugax*, and Ihle, agreeing with this view, has included Alcock's species in the synonymy of *M. fugax*. This course he has followed even in spite of the fact that Miss Rathbun[2] considered the two species distinct, chiefly on the ground that in *M. pentacantha* the ischium of the external maxilliped in the female has no fringe of setae along the inner part of apposed edge. Ihle in the young examples of *M. fugax* in his collection—which he considers to be nothing else but *M. pentacantha* of Alcock—found this fringe present. I have examined a number of female examples of *M. pentacantha* on which Alcock based his new species, and in all of these I have found a row of sparsely placed hairs on the inner edge of the ischium of the external maxilliped. This row of hairs is present in *M. fugax* also, but in addition to this there is a thick fringe of closely developed hairs, a little on the outside of the apposed edge. This fringe is altogether absent in all the examples of *pentacantha* that I have examined. Though this fringe is well developed in large females of *M. fugax*, I have failed to find it in younger examples of this sex. It seems probable, therefore, that this fringe grows with age, and as all the examples of *M. pentacantha* are very young, this fringe is naturally absent in these. The row of tubercles on the ventral surface of the ischium, mentioned in the case of *M. fugax*, is present in a similar position in examples of *M. pentacantha* also. These tubercles are poorly developed in very small examples of the latter species, but in comparatively bigger specimens these are very clearly seen. The other characters of *M. pentacantha*, mentioned by Alcock, are for the most part those that one would expect to find in the young of *M. fugax*, and I have, therefore, no hesitation in agreeing with Alcock and Ihle that it is only a young form of the latter.

Myra elegans Bell.

1896. *Myra elegans*, Alcock, *Journ. As. Soc. Bengal* LXV, pp. 208, 209.
1918. *Myra elegans*, Ihle, *Siboga Exped. Rep.* XXXIX b², p. 261.

This species can be very easily recognised by the elongate-oval form of its carapace, having a flat median carina and terminating posteriorly in a long spine with two short spinules, one on each side. The branchial regions have a longish patch of tubercles on the middle of their surface; the carina and the region round the posterior spine are also granular. The prominent marginal notch behind the hepatic region that is generally

[1] Balss, *Arch. Naturgesch.* LXXXVIII, p. 127 (1922).
[2] Rathbun, *Kong. Danske Vidensk. Selsk. Skrifter* (7) V, p. 308 (1920).

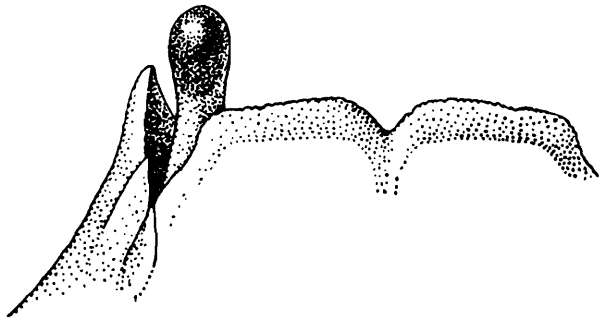
present in other species of the genus is wanting. The chelipeds are slender and rather short, and those of the two sides differ only slightly from one another.

Myra elegans appears to be rather a rare species. The incomplete female specimen on which Bell [1] based the description of the species was collected in the "Mari orientalis" There are five specimens in the Indian Museum collection; of these four are from the Madras Coast and the fifth was collected from East of the Terribles, off the Arakan Coast in Burma. Miss Rathbun [2] has recorded the species from the Gulf of Siam, and the Siboga-Expedition obtained a young example in the Madura Strait, north of Java. The species lives in shallow waters, and is not known to go deeper than about 20 fathoms.

I refer to this species three specimens, one male and two females, collected at the Sandheads.

C1581/1	Sandheads, mouth of the River Hughli.	"Fraser," Capt. R. Smyth, 26th August 1922.	1 ♀.
C1580/1	,, ,, ,,	"Lady Fraser," Capt. A. W. Michie, June 1923.	1 ♀.
C1579/1	,, ,, ,,	"Lady Fraser," Nov. 1923.	1 ♂.

The larger of the two females has a carapace length (excluding the terminal spine) of 17·5 mm., and is about 12·5 mm. broad; the single male is 15 mm. long, and has a breadth of about 10·5 mm.



TEXT-FIG. 4.—*Myra elegans* Bell.
Dorsal view of anterior end of carapace: × 17.

The species has been very well described by Alcock, and besides the illustrations given by Bell, Miss Rathbun has published a photograph of a large male specimen. The deep triangular fissure on the border of the orbit mentioned by Ihle is clearly seen in all the examples that I have examined. It is broad anteriorly, but becomes deeper and narrower posteriorly. The outer orbital angle is also acutely pointed. At the lower anterior angle of the hepatic facet there is a large cylindrical spine projecting considerably beyond the outer orbital angle. This spine, as mentioned by Ihle, is a prolongation of the anterior border of the pterygostomian region. The spine is strongly developed in the

[1] Bell, *Trans. Linn. Soc. London* XXI, pp. 297, 298, pl. xxxii, fig. 4 (1855).
[2] Rathbun, *Kong. Danske Vidensk. Selsk. Skrifter* (7) V, p. 309, pl. i, fig. 12 (1910).

male; in the female, though it is considerably reduced, it can still be made out by the side of the outer orbital angle, beyond which it does not project very much. The upper border of the hepatic facet posterior to the spine is distinctly beaded. The other differences observed by Ihle in his specimen are probably due to its being very young.

M. elegans does not appear to grow to a large size, the largest specimen in the Indian Museum collection is the female from the Sandheads referred to above, in which the length of the carapace, including the terminal spine, is 21·4 mm.

Sub-family ILIINAE.

Iphiculus spongiosus Adam and White.

1896. *Iphiculus spongiosus*, Alcock, *Journ. As. Soc. Bengal* LXV, pp. 256, 257.
1918. *Iphiculus spongiosus*, Ihle, *Siboga Exped. Rep.* XXXIX b², p. 252.

I refer to this species a single female example collected by the Pilot S. S. "Lady Fraser" at the Sandheads in November, 1923. It agrees closely with the published descriptions and figures of the species, as also with Alcock's named examples of it in the collections of the Indian Museum.

I. spongiosus has been recorded from several localities in the Indian waters. In the Museum collection there are several specimens from the Andamans, off the Irrawady Delta, the Ganjam and the Madras coasts, the Mekran coast and the Persian Gulf. The species lives for the most part in shallow waters, but some examples in the Museum collection from the Bay of Bengal are from a depth of 66 fathoms.

The species has quite a wide range of distribution in the Indo-Pacific region. Ihle mentions it as having been recorded from the Red Sea, Mekran coast, Bay of Bengal, Andaman Islands, Singapore, Arafura Sea, Gulf of Siam, Philippine Islands and Hongkong.

Pariphiculus[1] **mariannae** (Herklots).

1896. *Pariphiculus rostratus*, Alcock, *Journ. As. Soc. Bengal* LXV, p. 259, pl. viii, fig. 2.
1918. *Pariphiculus mariannae*, Ihle, *Siboga Exped. Rep.* XXXIX b², pp. 249, 250.

As pointed out by Nobili[2], Alcock's *P. rostratus* is undoubtedly identical with the form described by Herklots[3] in 1852 under the name of *Ilia mariannae*. The description and the figure published by this author leave no doubt on this point.

The one male example that I refer to this species agrees very closely with the description and figure given by Alcock, as also with the named

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[1] In his "Ostasiatische Decapoden. III" Balss [*Arch. Naturgesch.* LXXXVIII, p. 131 (1922)] says that there are four species in the genus *Pariphiculus*. So far as I am aware, the genus consists of only three species, namely, the genotype *P. cornutus* Alcock and Anderson, *P. mariannae* (Herklots) (=*P. rostratus* Alcock), and *P. agariciferus* Ihle. It is possible Balss considers Alcock's *P. rostratus* distinct from *P. mariannae*.

[2] Nobili, *Ann. Sci. Nat. Paris* (9) IV, p. 165, foot-note (1906).

[3] Herklots, *Bijdr. Dierkunde* I, pp. 35-37, pl. fig. 2 (1852).

examples of the species in the Museum collection. The abdomen of the male, as mentioned by Alcock, has segments 3-5 fused, but even in comparatively large specimens the sutures between these segments are still faintly visible. The third segment has two marked convexities, one on either side at the base, and a deep concavity between the two. There are some small granules on the convexities and, though these appear to vary with age, these are present in all male specimens. Besides this, in very young specimens, both male and female, almost the entire surface of the abdomen, and the ventral surface of the thoracic sternites are covered over with granules. These tend to disappear with age, but the 1st and the 2nd sternites, especially the latter, are always granular in both sexes. The ventral surface of the ischium of the external maxilliped has also a median longitudinal ridge of low granules in both sexes.

The species is represented in the Indian Museum collection by examples from the Burma, Coromandel and Malabar coasts, as also by two large females from Hongkong. Herklots described the species from China, while Ihle had a young male in the Siboga collection from the Malay Archipelago. I refer to it one example from the Sandheads.

C1641/1	Sandheads, mouth of the River Hughli.	"Lady Fraser," Nov. 1923.	1 ♂

P. mariannae seems to live on a muddy bottom in comparatively shallow waters. The specimens in the Museum collection are mostly from a depths varying between 25 and 45 fathoms, though one specimen from the Gulf of Martaban was dredged at 61 fathoms.

The largest female in the collection (from Hongkong) is 32 mm. long, while the largest male (from the Sandheads) has a carapace length of about 22 mm.

Arcania septemspinosa (Fabr.).

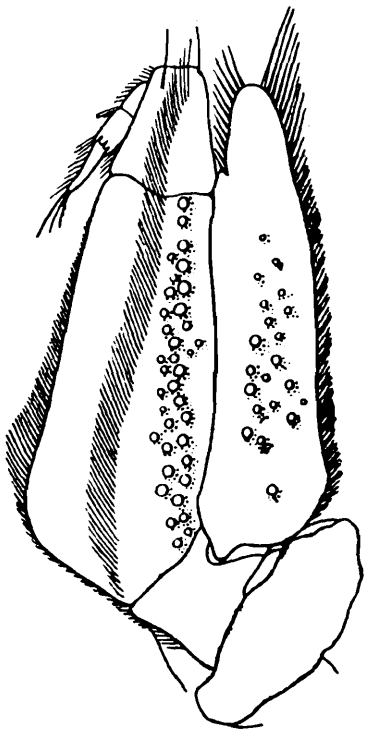
1896. *Arcania septemspinosa*, Alcock, *Journ. As. Soc. Bengal* LXV, p. 265.
1918. *Arcania septemspinosa*, Ihle, *Siboga Exped. Rep.* XXXIX b², pp. 265, 266.

This species appears to be rather common at the Sandheads, 30 specimens having been collected there on six different occasions between 1922 and 1932. Of these 17 are males and 13 females; the largest male has a carapace length of about 23 mm., while in the largest female, which is ovigerous, the carapace has also the same length.

The merus of the external maxilliped in the female has a thick fringe of long hairs running in a longitudinal direction about the middle of the surface, and external to the fringe and running parallel to it there are two or three rows of pearly tubercles placed close to one another. These tubercles are present in the male also, but the fringe of hairs is lacking in examples of this sex. The exognath in both sexes has a number of tubercles scattered on its surface. The palp arises on the underside near the antero-external angle.

In the Indian Museum collections there is a large number of specimens of this species from the Andamans, the Arakan coast, the Delta of the Ganges, all along the eastern coast and from the Persian Gulf.

A. septemspinosa has a wide range of distribution in the Indo-Pacific



TEXT-FIG. 5.—*Arcania septemspinosa* (Fabr.).
External maxilliped of female : × 8.

region. Balss [1] gives the distribution of the species as Cape of Good Hope, Red Sea, Indian Seas, Malay Archipelago and Hongkong.

Arcania erinaceus (Fabr.).

1896. *Arcania erinaceus*, Alcock, *Journ. As. Soc. Bengal* LXV, p. 268.

The present species can be very easily recognised by the fact that the carapace is longer than broad, the fingers are shorter than the hand and that the surface of the carapace is densely covered with spines, of which eleven arranged along the margins are more prominent than the others. Most of the marginal spines are covered with secondary spinules ; the latter, however, appear to vary with age, and in smaller specimens are not as prominent as in well grown examples. The front is deeply bifid, and ends in two short teeth. The ventral surface of the body, including the external maxillipeds, is sharply granular. The meropodites of the chelipeds and the walking legs are spiny even in young specimens. The first walking legs are proportionately long.

I refer to this rather rare species five examples from the Sandheads.

C1570/1	Sandheads, mouth of the River Hughli.	"Lady Fraser," Nov. 1923.	2 ♂♂, 1 ♀.
C1571/1	,, ,, ,,	"Lady Fraser," Aug., Sept. 1927.	1 ♀.
C1572/1	Bay of Bengal, between Pilot Ridge Light Vessel and Eastern Channel Light Vessel. 10 miles N. and S. of Eastern Channel Light Vessel.	"Lady Fraser," Feb., Mar. 1928.	1 ♂.

[1] Balss, *Arch. Naturgesch.* LXXXVIII, p. 132 (1922).

My examples agree very closely with the published descriptions of the species, as also with named examples of it in the Museum collection. There is, however, one small difference in my specimens. According to Alcock, all the joints of the walking legs, except the dactyli, and those of the chelipeds except the distal half of the hand and the fingers are sharply granular, and this character can be clearly seen in all the specimens that Alcock examined. In my examples, however, the granulation on the basal half of the hand, and on some of the distal joints of the legs is very obscure.

The anterior margin of the pterygostomian plate is prolonged into a sharp spine, as is clearly shown in Milne-Edwards' [1] figure of the species. In the female the ischium of the external maxilliped has a thick longitudinal fringe of hairs about the middle of its surface ; this is altogether wanting in the male.

Balss [2] has doubtfully included this species in his account of the Decapoda from Eastern Asia. He had before him only a young female specimen, having a carapace length of 8 mm. His specimen differs from the published account of the species, chiefly in having the front more drawn forwards and not deeply divided into two parts, and in the meropodites of the chelipeds and the walking legs not being armed with spines, but being only granular. The marginal spines also do not bear secondary "Dornen," but only "kleine Stacheln" In the Indian Museum collection also there is an immature female, with a carapace length of about 9 mm. In this example the front is, as in older specimens of the species, deeply bifid, with each part ending in a spine ; the meropodites of the chelipeds and the walking legs are distinctly spiny ; and the marginal spines have secondary spines on them, though the latter are not as prominent as in older specimens. It thus seems probable that the specimen examined by Balss is not referable to this species.

In Indian waters *A. erinaceus* is known to occur along the east coast of India, from the Delta of the Ganges to as far south as Pondicherry. Laurie [3] has recorded it from the Gulf of Manaar. The species is also known from Singapore (Lanchester [4]).

The largest specimen in the Museum collection, a female, has a carapace length (excluding the posterior spine) of 21 mm., while the largest male is about 16·5 mm. long.

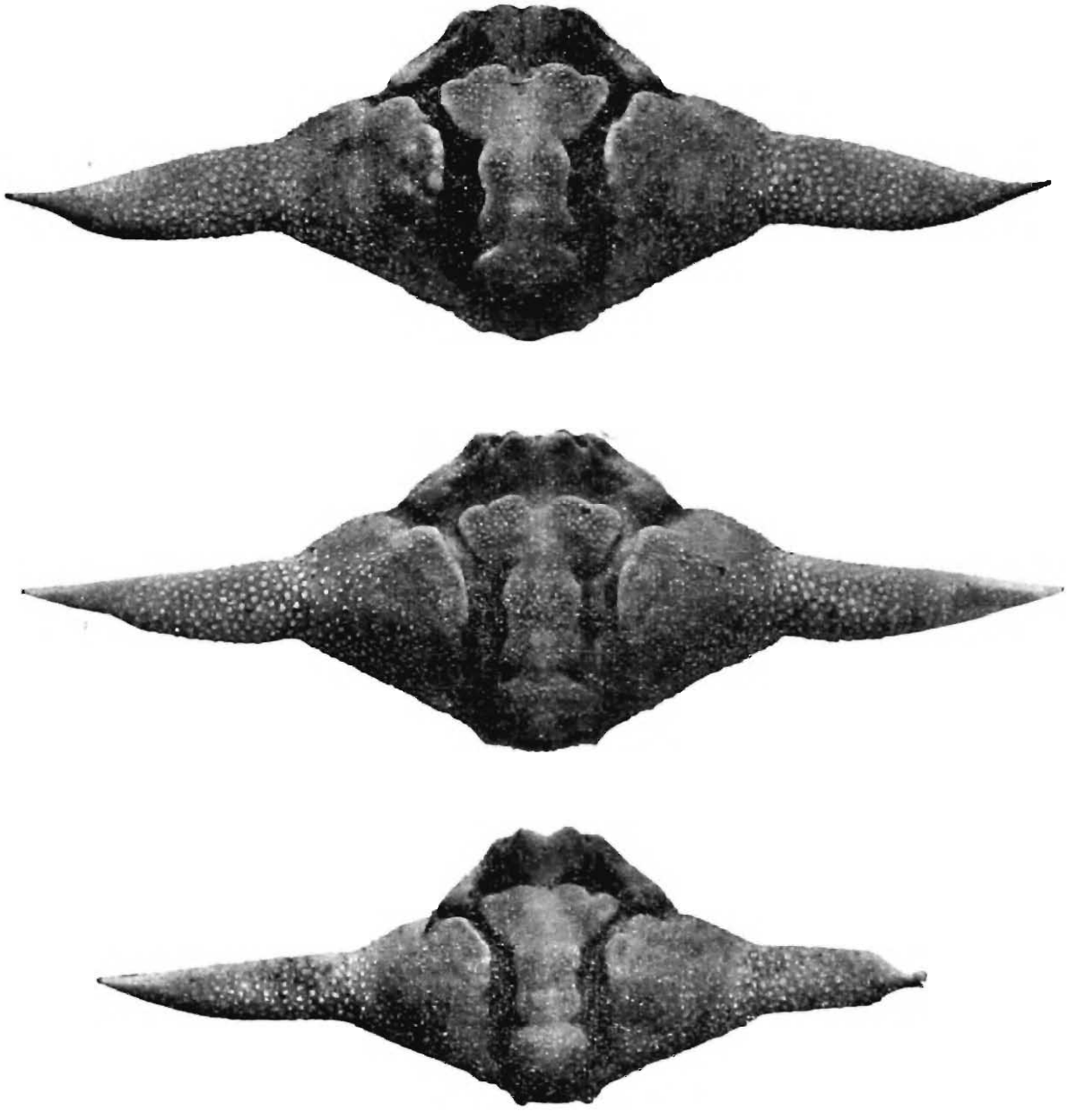
Ixa cylindrus (Fabr.).

1896. *Ixa cylindrus*, Alcock, *Journ. As. Soc. Bengal* LXV, pp. 271, 272.

Ixa cylindrus is characterised by the possession of deep and well-defined channels, with the floor covered with pubescence, on the carapace, the general surface of which is granular, leaving smooth, polished patches in places ; by the presence of huge lateral processes, which have generally the same diameter at their distal ends as near the base, and are abruptly

[1] Milne-Edward, in Cuvier's *Regne Animal*, pl. xxiv, fig. 2 (1838–1849).
[2] Balss, *Arch. Naturgesch.* LXXXVIII, p. 133 (1922).
[3] Laurie, *Rep. Pearl Oyster Fish. Ceylon* V, p. 366 (1906).
[4] Lanchester, *Proc. Zool. Soc. London* for 1900, p. 766 (1900).

surmounted by a spine; and by having the buccal cavern somewhat triangular in shape. The exognath of the external maxilliped has a concave and smooth surface along its inner edge, and the ischium has a narrow band of granules along its outer border. The posterior border of the carapace is not dentiform at the edges. All these characters appear to be very constant in this species, except the shape of the lateral processes. As already pointed out by Bell [1] the form and size of these processes show a great deal of variation in this genus, so much so that on an examination of about a dozen examples referred to the three then-known species of the genus (including Leach's specimens) this eminent carcinologist was led to the conclusion that the genus is mono-



TEXT-FIG. 6.—*Ixa cylindrus* (Fabr.).

Photographs of three specimens showing the variation in the lateral processes.

typic and that the so called different species represent nothing but individual variations. Though I am unable to agree with Bell in consi-

[1] Bell, *Trans. Linn. Soc. London* XXI, pp. 311, 312 (1855).

dering *I. cylindrus* to be the only valid species of this genus, I fully support his statement regarding the variation in the lateral processes. The three specimens from the Sandheads that are in my collection show this variation very clearly. In one female, with a carapace length of about 20 mm., the processes are conical, more or less gradually tapering from a broad base to a finely pointed tip. They are practically straight, with the distal end of one process slightly bent forwards. In the second, slightly larger, female the processes have in a general way the shape described for the first specimen, but they are bent backwards at the base, and the tips very distinctly point forwards. In the third example, a male about 17 mm. long, the condition is still different. The process on the left side of the carapace is like that of the other two examples: conical, gradually tapering from a broad base to a sharply pointed tip, which is directed forwards; the other process is distinctly shorter and is like that of a typical *I. cylindrus* as described by Alcock and other authors. It is cylindrical in shape, almost as broad distally as at the base and the rounded distal end is surmounted by a short, sharp spine. Judging by the somewhat broken tip, it is likely that at least a part of this process has been regenerated. The distal parts of all the processes are smooth, while the rest of the surface is granular. In all other characters, enumerated above, these specimens agree so closely with typical examples of the species that to my mind there cannot be any doubt of their specific identity.

The lateral processes in my example resemble those of *I. edwardsi* Lucas[1], as figured by M.-Edwards,[2] or to a certain extent even those of *I. inermis* Leach (Alcock). But these two forms (which are probably identical) differ from *I. cylindrus* in a number of important and constant characters, notably the channeling on the carapace and the form of the posterior margin.

It is thus clear that the shape and size of the lateral processes do not afford distinguishing characters between the species of the genus *Ixa*. There are, however, other characters, such as the channels on the carapace, the form of the posterior border, the shape of the buccal cavern, etc., on the basis of which the species can easily be separated.

I refer to this species three examples, 1 male and 2 females, collected at the Sandheads between 1924 and 1927. Two of these were obtained by " Lady Fraser," while the single male was collected by " Fraser"

Besides these three, *I. cylindrus* is represented in the Indian Museum collection by specimens from Port Blair in the Andamans, Madras coast and from the Palk Straits between India and Ceylon. Laurie [3] has also recorded the species from near the latter locality and Miss Rathbun [4] obtained examples in the Gulf of Siam. Ihle [5] gives the distribution of the species as Kilwas (coast of British East Africa), India, Singapore and Thursday Island.

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[1] Lucas, *Ann. Soc. Ent. France* (3) VI, pp. 184-186, pl. iv, fig. 3 (1858).
[2] Milne-Edwards, *Ann. Soc. Ent. France* (4) V, pp. 156-158, pl. vi, fig. 1 (1865).
[3] Laurie, *Rep. Pearl Oyster Fish. Ceylon* V, p. 366 (1906).
[4] Rathbun, *Kong. Danske Vidensk. Selsk. Skrift.* (7) V, p. 314 (1910).
[5] Ihle, *Siboga Exped. Rep.* XXXIX b², p. 314 (1918).

Ixa inermis Leach, Alcock.

1896. *Ixa inermis*, Alcock, *Journ. As. Soc. Bengal* LXV, pp. 272, 273.
1906. *Ixa inermis*, Nobili, *Ann. Sci. Nat. Paris* (9) IV, pp. 171, 172.
1918. *Ixa* sp., Ihle, *Siboga Exped. Rep.* XXXIX b^2, pp. 267, 268.

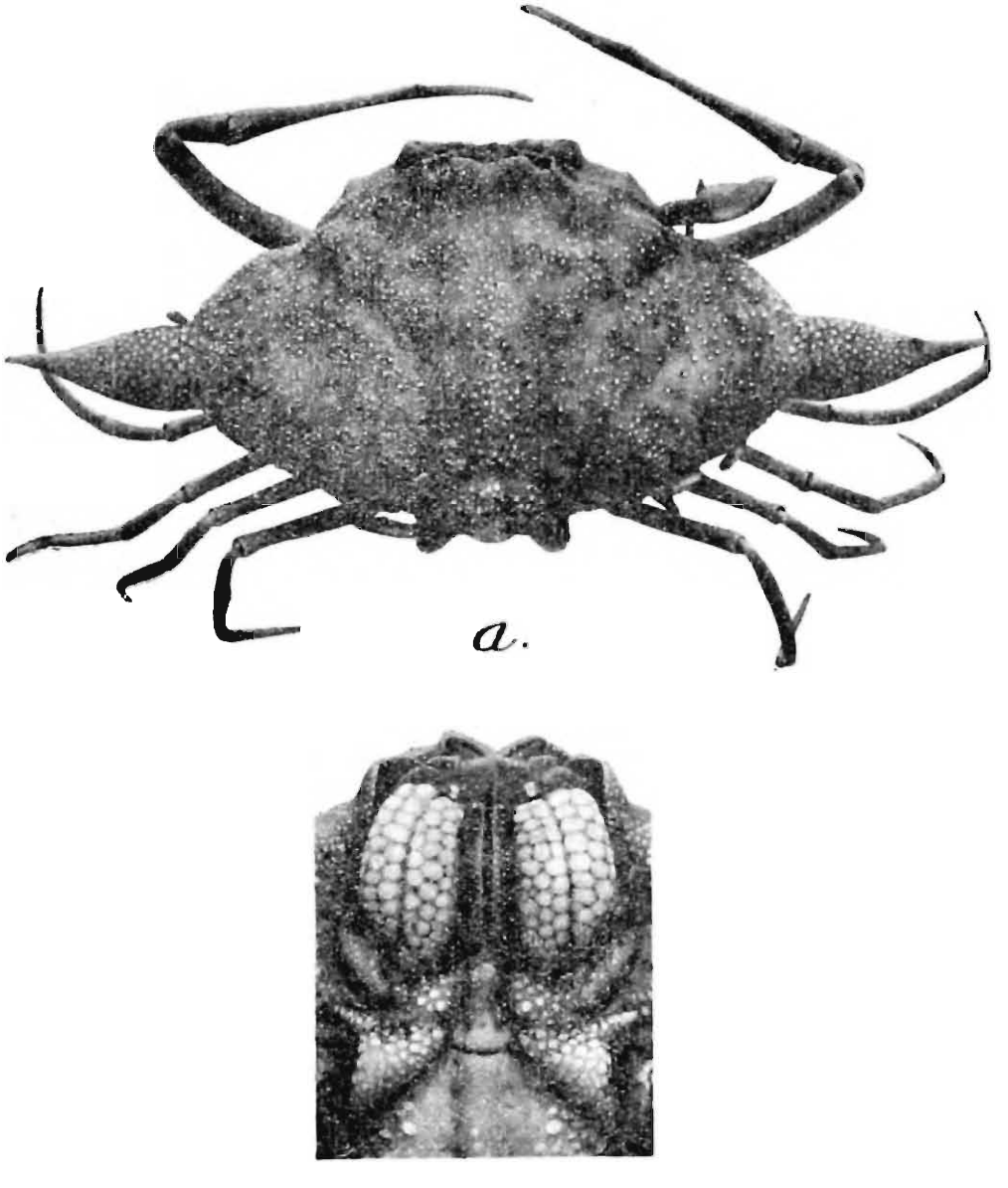
Ixa inermis can be easily distinguished from the foregoing species by the fact that the channels on the carapace of the latter species are represented in the present form by shallow, impressed grooves without any definite margins; the posterior border of the carapace has on each end a petaloid process directed backwards and outwards; the buccal cavern is distinctly quadrate owing to the eversion of the outer lip of the afferent branchial channel; the ischium of the external maxilliped is covered over with pearly tubercles and is strongly convex, except for a small part along the inner border, where it is grooved; and the exognath is also strongly convex, except for a small distal portion, where it is hairy and markedly depressed. The lateral processes are proportionately short, are thick at the base and taper distally to a fine point; the distal part of the process is smooth, while the rest of the surface is densely granular. The surface of the carapace and the ventral surface of the body is granular, more densley so in some parts than in others. The gastric region has three prominent convexities, dotted over with granules, and the tumid intestinal region is surmounted by a blunt, somewhat elongated tubercle. The front is distinctly bilobed, each lobe ending in a blunt tooth-like projection. The sternum of the first thoracic somite (at the base of the cheliped) is raised into a large and prominent area, covered with pearly granules. A similar area is present in the female of *I. cylindrus* also, but is not so much raised or prominent as in the present species.

The large female specimen in the Siboga collection described by Ihle is undoubtedly referrable to *I. inermis* of Leach, as defined by Alcock. All the characters mentioned by Ihle agree with Alcock's description of the species. It is difficult definitely to assign the other smaller example in the Siboga collection to any species, as Ihle has not mentioned any characters by which it can be recognised.

Leach's [1] figure of *I. inermis* does not agree with Alcock's description of the species, chiefly as regards the shape of the lateral processes. In Alcock's *I. inermis* the process is thick at the base, and gradually tapers to a point, where it is surmounted by a sharp smooth spine, somewhat similar to the spine of *I. cylindrus*. In Leach's figure this process is seen to taper distally only slightly, is somewhat rounded at the tip, and has no sharp spine at the end. Miers,[2] who evidently examined Leach's type-specimen, also described the processes as "somewhat narrowed distally" and "without terminal spinules." The other characters of the species that can be judged from the figure and the scanty characterisation of Leach agree with Alcock's description. The shallow grooves on the carapace and the petaloid tubercles on the posterior margin are very characteristic of this species. The lateral processes in this genus, as has already been remarked, appear to be very variable

[1] Leach, *Zool. Misc.* III, p. 26, pl. cxxix, fig. 2 (1817).
[2] Miers, *Challenger Brachyura* (Zool. XVII), p. 301. foot-note (1886).

in shape and size. Until a more detailed description of Leach's type-specimen, especially with reference to its buccal cavern and the external



TEXT-FIG. 7.—*Ixa inermis* Leach.

a. Dorsal view of a female specimen.

b. Ventral view of the anterior part of the body, enlarged.

maxillipeds, is given, the doubts regarding this species cannot be definitely cleared up. I am, however, of the opinion that Alcock's *I. inermis* is identical with the form described by Leach under that name. I give here a figure of *I. inermis*, as understood by Alcock. The specimen on which the figure is based is from the Sandheads, and agrees in every detail with Alcock's examples of the species.

I. edwardsi was originally described by Lucas [1] from a fossil, but the description was amplified by Milne-Edwards [2] from a living example from Zanzibar. From the nature of the grooves and the presence of

[1] Lucas, *Ann. Soc. Ent. France* (3) VI, pp. 184-186, pl. iv, fig. 3 (1858).
[2] Milne-Edwards, *Ann. Soc. Ent. France* (4) V, pp. 156-158, pl. vi, fig. 1 (1865).

petaloid tubercles on the posterior margin of the carapace this species, as remarked by Miers,[1] Nobili and others, appears to be identical with *I. inermis* Leach. The shape of the lateral processes is somewhat different in the two, but as already pointed out, these structures appear to be very variable in the genus *Ixa*.

I refer to this species one large ovigerous female from the Sandheads. The carapace is 25 mm. long, and the breadth, including the lateral processes, is 58 mm., while excluding these the carapace is 35 mm. broad. There are a few barnacles attached to the carapace.

C1642/1	Sandheads, mouth of the River Hughli.	"Lady Fraser," Sept. 1925.	1 ♀ ovigerous.

I. inermis appears to be a rather rare species. Besides the Sandheads example, there is in the Indian Museum collection a large female from off the Ganjam coast, and another young specimen from the Persian Gulf. The species has so far been recorded from the Red Sea (Nobili), Persian Gulf, Ganjam coast (Alcock), Indian Archipelago (Ihle) and North Australia (Haswell).[2] Milne-Edward's example of *I. edwardsi* (=*I. inermis*) was collected at Zanzibar.

Family DORIPPIDAE.

Sub-family DORIPPINAE.

Dorippe dorsipes (Linn.).

1896. *Dorippe dorsipes*, Alcock, *Journ. As. Soc. Bengal* LXV, pp. 277, 278
1916. *Dorippe dorsipes*, Ihle, *Siboga Exped, Rep.* XXXIX b[1], pp. 148, 149.

I refer to this common Indo-Pacific species two examples collected by the Pilot vessel "Lady Fraser" at the Sandheads in May, 1927. Both the specimens are males, and the larger of the two has a carapace length of 30 mm.

My specimens agree closely with Alcock's description of the species, except for the fact that the carapace is slightly broader than long, as was observed by Miss Rathbun in her examples from the Gulf of Siam, and by Ihle in the Siboga material. In the smaller example from the Sandheads (with a carapace length of 24 mm.) the 4th tergum of the abdomen has, in addition to the large median tubercle, a small acute tubercle on each side.

D. dorsipes has a wide range of distribution in the Indo-Pacific region, having been recorded from the east coast of Africa and the Red Sea to Japan and west coast of Australia.

Dorippe facchino (Herbst).

1896. *Dorippe facchino*, Alcock, *Journ. As. Soc. Bengal* LXV, pp. 278, 279.

I refer to this species 13 examples from the Sandheads. Of these, 7 are males, the largest having a carapace length of 28 mm., and 6 are

[1] Miers, *Challenger Brachyura* (Zool. XVII), p. 301, foot-note (1886).
[2] Haswell, *Cat. Australian Crust.*, p. 132 (1882).

females ; some of the latter are ovigerous. Most of the specimens agree with the typical examples of the species, and not with the specimens that Alcock doubtfully referred to as ? *D. granulata* de Haan. The latter, as Nobili[1] pointed out, are different from de Haan's species, and as Alcock himself had suggested, represent a new variety of *D. facchino*. Nobili designated this variety as *alcocki*.

The variety *alcocki* does not differ very markedly from the *forma typica*, but, as pointed out by Alcock and Nobili, can be distinguished from it on account of the carapace and the walking legs of the last two pairs being less hairy and more granular, the first two pairs of walking legs being devoid of hair in both the sexes, and by the chelipeds of the male being more or less symmetrical. Also the sternites of the abdomen of the male in the *forma typica* [2] are entirely unarmed, while in the variety there are low tubercles on some of the sternites.

Besides the scanty pubescence on the carapace and the last two pairs of legs, the most constant distinguishing character in the variety is the absence of hairs on the first two walking legs in the male. In some specimens of the *forma typica* also the legs are more scantily clad than is usually the case, and sometimes the third legs are totally devoid of hair. The pubescence on the carapace also appears to vary in the species ; in some specimens the carapace is more or less densely hairy, while in others the pubescence is scanty. The asymmetry between the two chelipeds of the male is less marked in the variety than in the typical form, but in some examples of the former it can be clearly seen. All the male specimens of the variety that Alcock had examined are rather small, and this may perhaps account for the apparent symmetry between the chelipeds.

Out of the thirteen specimens that I have referred to this species, only two male examples are referrable to the variety *alcocki*. The larger of the two has a carapace length of 11 mm., and both shows all the features that characterise the variety. The two chelae are only slightly asymmetrical.

D. facchino is represented in the Indian Museum collection by a large number of examples collected along the east coast of India, and from the Andaman Islands. The variety (registered in the collections under Alcock's name of *D. granulata*) has also been collected from several localities in the Bay of Bengal. Both the species and the variety appear to be fairly common in the Indo-Pacific region. The species is known from the east coast of India, the Indian Archipelago and Hongkong; while the variety, according to Ihle,[3] is recorded from the Bay of Bengal and Singapore. The two male examples recorded by Laurie[4] from the Gulf of Manaar appear to be referrable to Nobili's variety *alcocki*, in so far as the carapace is less hairy and the first two pairs of walking legs are devoid of hairs.

Most of the Sandheads specimens carry bivalve shells on their backs.

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[1] Nobili, *Boll. Mus. Zool. Torino* XVIII, No. 455, pp. 25, 26 (1903).

[2] In very young males of the *forma typica* also low tubercles are present on some of the abdominal sternites.

[3] Ihle, *Siboga Exped. Rep.* XXXIX b[1], p. 156 (1916).

[4] Laurie, *Rep. Pearl Oyster Fish. Ceylon* V, p. 367 (1906).

Family RANINIDAE.

Raninoides personatus Henderson.

1896. *Raninoides personatus*, Alcock, *Journ. As. Soc. Bengal* LXV, p. 293.

R. personatus is a common species in the Bay of Bengal. I refer to it 5 examples collected at the Sandheads between the years 1923 and 1927 Four of these are females, three being ovigerous and the largest having a carapace length of 27 mm., while one is a male, the carapace of which is a little over 23 mm. The specimens agree closely with Henderson's [1] and Alcock's descriptions of the species, except for the fact that the number of teeth on the inner border of the hand is not constant. According to the authors mentioned above there are three teeth on the inner border of the hand, and Henderson's figure also shows three such teeth. In my specimens, however, only one female has three teeth on the inner border of both the hands; in one there are four on each side; in two examples there are four teeth on the right hand and three on the left; while in the fifth there are three teeth on the right hand and four on the left. I have also examined ten examples of this species from the older collection in the Museum, and find the same difference in these. Only one specimen has three teeth on each hand; four have four teeth on the right hand and three on the left; two have three teeth on the right hand and four on the left; two have four teeth on each hand; while one example differs from all the rest in having four teeth on one hand and five on the other. In some specimens the tooth on the proximal end of the hand is rather small, while in others all the teeth are well developed. It thus appears that in this species there are generally 3-4 teeth, but rarely five, on the inner border of the hand.

R. personatus is represented in the Museum collection by specimens collected mostly off the eastern coast of India, and by two examples off the Burma coast. Henderson's examples were collected off Amboina Island in the Moluccas. The species lives for the most part in shallow waters, but a specimen in the collection from off the Burma coast has been dredged at a depth of 90 fathoms.

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[1] Henderson, *Challenger Anomura* (Zool. XXVII), p. 27, pl. ii, fig. 5 (1888).

DESCRIPTIONS OF REMARKABLE INDIAN PSYCHODIDAE AND THEIR EARLY STAGES, WITH A THEORY OF THE EVOLUTION OF THE VENTRAL SUCKERS OF DIPTEROUS LARVAE.

By A. L. TONNOIR, *Canberra, F. C. T., Australia.*

(Plate II.)

While making ecological observations in February and March in the Teesta valley on the inhabitants of waterfalls, Dr. S. L. Hora " observed that rocks on the sides of waterfalls which are kept moist by the spray harboured a very peculiar fauna. Small stones and pebbles were covered with young stages of Blepharocerid larvae and when collecting them I noticed[1] some very peculiar larvae and pupae of a Psychodid fly. I did not examine the material very carefully so as to differentiate the various types represented in it, but I was, however, aware of the importance of the find as I had seen similar larvae and pupae figured by Müller from Brazil. In no case were the larvae and pupae found submerged under water and the flies were found hopping about on wet rocks near the lips of the falls or in their immediate vicinity "

Dr. Hora intended to make a study of this material and took it with him to Europe, where he showed it to Dr. Edwards at the British Museum. It so happened that Dr. Edwards had a few days before seen some similar larvae in a collection of Simulium larvae made by Thienemann and Feuerborn in Java and knew that the latter was preparing a paper on this interesting animal Hora then relinquished his intention of dealing himself with the subject and sent his tubes to me. In the meanwhile I had found some of these larvae in the tubes containing numerous Blepharocerid larvae from the same localities which had been submitted to me for study by Hora some time before. I sent one of these to Feuerborn asking him to let me know whether it was similar to the form he was then studying. He replied that not only was his Javanese larva similar but also conspecific with Hora's and he, therefore, intended to record in his paper the presence of this species in India and to name it *M. indica* on account of its geographical distribution. However, a careful comparison of both larvae has convinced me that they belong to different species although they are undoubtedly congeneric.

In the meanwhile the material sent to me by Hora from England reached me, and was found to contain—

(1) A number of larvae, two damaged pupae and a few imagines in spirit of the species here described as *Telmatoscopus* (*Neotelmatoscopus*) *horai*, sp. nov.

(2) Three larvae (gone dry after being kept in spirit) and numerous pupae of *Horaiella prodigiosa*, sp. nov.

[1] I quote here a passage from one of Dr. Hora's letters.

(3) A lesser number of pupae of another species of the same genus, *H. consimilis*, sp. nov., some of the pupae were preserved dry *in situ* on a piece of rock.

In order to complete this fragmentary material Dr. Hora in March, 1932, sent Mr. D. D. Mukerji to the Teesta valley and secured an abundant collection consisting of numerous specimens of all the stages of *T horai*, including a large series of pinned flies of this species, with which were associated a few larvae of a second species of *Telmatoscopus* and numerous pupae of *H. consimilis* and *H. prodigiosa*, all from the original locality or its vicinity.

This enumeration shows that some of the missing stages have not yet been found. As, however, no further opportunity was likely to occur of completing this material before the end of the year, Dr. Hora pressed me to publish an account of what was on hand.

I am doing this rather reluctantly because my account is not as complete as one could wish, especially so far as *Horaiella* is concerned; however, by extracting the nearly mature fly from the pupae of the two species of this genus I have been able to gain a fairly good knowledge of the adult stage and to establish, therefore, a sufficient definition of the genus.

I am most grateful to Dr. Hora for giving me the opportunity of making known these most interesting animals and tender him here my most sincere thanks. In order to perpetuate his wonderful discovery I am dedicating the new genus *Horaiella* and one of the new species of *Telmatoscopus* to him.

All the types have been returned to the Indian Museum.

Horaiella, gen. nov.

Body and wings almost bare; antennae elongate, filiform, with cylindrical segments, apparently 17 segmented; eyes round without bridge. Wing with only 8 longitudinal veins, some of which form three contiguous forks on the disc. Larva aquatic, broadly oval and provided with a single large ventral sucker. Pupa oval, very flat with incomplete segmentation of the abdomen.

Genotype :—H. prodigiosa, sp. nov.

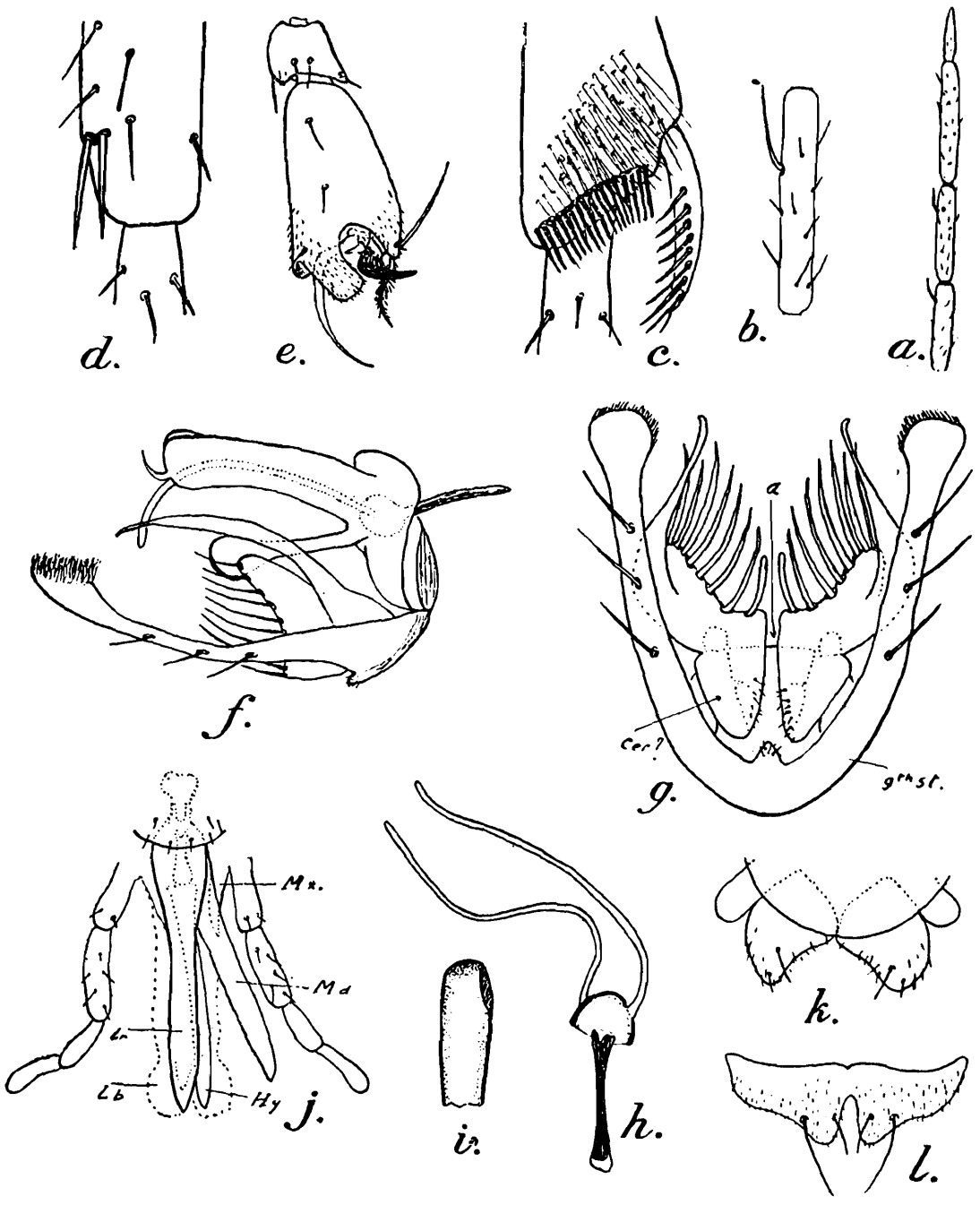
The two species which I include in this new genus can easily be distinguished in the adult stage by the venation, the two anterior forks being at widely different levels in *H. prodigiosa* and at the same level in *H. consimilis*; in addition the conformation of the genitalia is quite characteristic in both sexes of the two species. For the males compare figs. 1*f* and 2*b* and for the females figs. 1*l* and 2*d*. The pupae differ in the shape of the breathing horn, as shown in plate ii, figs. 3 and 5. The larva of only one of the two species is known.

Horaiella prodigiosa, sp. nov.

Male.—Colouration not available. Eyes rounded without a trace of bridge on the vertex. Antennae (fig. 1*d*) in appearance 17 segmented and when fully extended[1] about as long as, if not longer than the

[1] It must be remembered that the description is drawn up from an immature fly extracted from the pupa and, therefore, not fully extended.

wings. First segment small ring-shaped; second globulous; those of the flagellum perfectly cylindrical, the basal ones very long, the others gradually diminishing in length; but the penultimate segment is longer again than the preceding one and the last segment is only half as long and half as thick, and is not distinctly articulated with the preceding one. This last segment is analogous to the apiculus of the last segment of the Bruchomyiinae for instance, but in the species of that subfamily there is not even a distinct suture between the apiculus and the segment, yet Alexander (1929) considers it to be the 17th. The bristles of the flagellum are not numerous and not longer than the diameter of the segment. A single rather long elbowed ascoid (fig. 1*b*) is present on all



TEXT-FIG. 1.—*Horaiella prodigiosa*, sp. nov.

a. Extremity of antenna of male; *b*. A median segment of antenna of male; *c*. Apex of anterior tibia; *d*. Apex of posterior tibia; *e*. Last tarsal segment; *f*. Hypopygium with gonopods removed, lateral view; *g*. Part of hypopygium seen from behind; *h*. Pumpetta of penis; *i*. Apex of filament of penis; *j*. Mouth-parts of female; *k*. Ovipositor; *l*. Subgenital plate.

the flagellar segments except the last two; rather numerous sensory pits, surrounded by setulae, are found on the last few segments.

Palpi four segmented; their actual relative lengths are not ascertainable as the segments are not fully extended; the second is apparently the longest; the small basal segment present in *Nemopalpus* and *Phlebotomus* is here not distinguishable; the first two segments carry very few bristles. The mouth parts are not more developed than in the Psychodinae, there are no mandibles as in the female; the pharynx is large, as in *Phlebotomus*, but without sculpture or bristles on its posterior part.

Thorax bare but for the following chaetotaxy: 4 anterior, 8 lateral plus 1 small behind, 4 scutellar and 2 mesonotal.

Legs moderately elongate; tibiae and basitarsi with regular longitudinal rows of microscopic setulae, the rest of the tarsi practically bare. The anterior tibiae are provided with an apical comb (fig. 1*c*) and a conspicuous strigil, whereas the posterior tibiae have a pair of strong apical spines which may be homologized with tibial spurs (fig. 1*d*). These spurs are absent in the rest of the family. Basitarsi about as long as the tibiae and about twice as long as the four other tarsal segments together, the last one about twice as long and thick as the preceding one; it is provided with an apical dorsal flap; the claws are unequal, one being long, thin and gently curved and the other short, broad and abruptly elbowed near its base; the long claw is provided with a long bristle-like basal projection (fig. 1*e*); empodium well developed, plumose.

Wing elongate and very similar in shape to that of *Phlebotomus*; the base is narrow without a distinct anal lobe and the alula is small; the apex appears to be rounded and is located between the tips of R_5 and M_1. Sc ends in R_1, there is no trace of Sc_1, but h is present. The first branch of Rs is single but the second branch is forked so that the radial sector is composed of only three branches, as in the Trichomyiinae; M_3 and M_4 branch rather far from the base, much further than is usually the case in the family except in the Bruchomyiinae. The venation of this species is similar to that shown in fig. 2*a*, but the three forks are at different levels; that of M_1 M_2 being located midway between the two others.

The vestiture of the wing is exceedingly scanty; there are only a few macrotrichia along the veins (all of them are represented in fig. 2*a*). The fringe is meagre and short but somewhat longer on the posterior border near the base; a conspicuous tuft of 8-10 long bristles is present on the small alula. The wing fringe is characterized especially on the anterior border by the presence of small bristly hairs or spinules disposed at regular intervals, they are larger and coarser than the ordinary small hairs of the fringe and can easily be distinguished among them.

The abdomen is very flattened dorso-ventrally, but it may, of course, assume a more cylindrical shape in the mature fly; the chaetotaxy of the abdomen consists of one row of 6 long bristles on the first segment and two rows of six on the second, the following segments have only a few very small hairs.

The hypopygium of the immature fly enclosed in the pupa is of course in its normal position and it is impossible to say if it will be inverted

later in the mature imago, as is the case in all the Psychodidae except *Sycorax*. The general aspect of the hypopygium resembles that of *H. consimilis* shown in fig. 2*b*, but it differs in the structure of the internal parts, which are shown in fig. 1 *f* and *g*. The large coxites are fused together and with the 9th sternite, and thus form a large capsule; the style is subcylindrical, very elongate, rounded at the apex and gently curved inwards; its inner side is provided with about 8 strong spines between which are some smaller spinules. The aedeagus is as shown in fig. 1*f*, which represents in profile the hypopygium from which the coxites and styles have been removed; it carries on each side an elongate, spathulate projection, which may be the parameres. The penis is of the bifid forked type (fig. 1 *h* and *i*); the filaments are moderately elongate and have their origin in an ampulla to which is attached a posterior rod, both forming thus a pumpetta similar to but not so evolved as that of *Phlebotomus*; the 9th sternite has two lateral lobes, which are homologous with what Feuerborn calls cercopods in the Psychodinae but they are not articulated to the sternite; their apex is spathulate and carries a large number of fine tenacular hairs; on the internal side, interior to the base of these lateral lobes is a pair of complex structures the lower distal part of which seems to be the cerci but the pectinated part is not easy to homologize; the anus appears to be at the point marked " a " in fig. 1*g*.

Length of wing: approx. 2·5 mm.

Female.—Similar to the male in most respects; the antennae are identical, including the ascoids, but the sensory pits of the last segments are less numerous.

The mouth parts (fig. 1*j*) are relatively more elongate, longer than the head; the mandibles are as long as the labrum; the hypopharynx is finely toothed on its inner margins; the maxillae are not more developed than in the Psychodinae; the lack of development of the maxillae casts some doubt on the possibility of this species being a blood sucker,[1] for fully-developed mandibles associated with reduced maxillae are found in females of some Blepharoceridae and Ceratopogonidae which are not haematophagous. Palpi as in male. The anterior tibiae have strigils as shown in fig. 1*c*. The cerci (fig. 1*k*) are not developed into a long ovipositor; the sub-genital plate is as shown in fig. 1*l*.

Holotype.—On slide, from " stream three miles from Teesta," 7th February 1931, S. L. Hora. *Allotype* on slide from Luch-chu Jhora, Teesta Bridge, 25th March, 1932, D. D. Mukerji.

Pupa.—(Plate ii, figs. 1 and 2) testaceous orange on the dorsal face, which is smooth but hard, the underside soft and whitish; its outline is elongate oval as shown in plate ii, and the contour of the body is not broken by the segmentation, even the intersegmental sutures of the first few abdominal segments do not reach the sides of the body whereas those of the last segments reach the sides: the median suture of the thorax through which the emergence of the fly occurs is not distinct except in the cleared pupal exuvium.

The prothoracic breathing horn (plate ii, fig. 5) is quite different from that of the other pupae of the Psychodidae, in which the distal

[1] In a recent letter Dr. Hora says that while collecting in the localities where this species is abundant he has never been bitten by it.

part of the horn carries a number of small round craters closed by a membrane ; *Maruina* may be an exception to this as the figures given by Müller show an apical slit on the pupal horn. In *Horaiella* the stigma opens at the bottom of a deep fold of the horn, the sides and borders of this fold being covered by a fine striation (plate ii, fig. 4). This organ functions differently from the usual prothoracic horn of most aquatic dipterous pupae ; it is more akin to that of the Blepharoceridae in which the fully open prothoracic spiracles are surrounded by lamellae, whose function is to retain a bubble or a layer of air on their corrugated or velvety surface; the gaseous interchange necessary for breathing takes place between this small volume of air and the oxygen in solution in the water. The fine striations of the horns of *Horaiella* pupae must act in the same way. The adhesion of the pupa to the substratum is very strong. Judging from some pupae *in situ* on a small piece of rock which was submitted to me, the animal when ready for pupation selects a little hollow or fold in the rock so that the edge of the flat pupal body is in perfect contact with the rock. The adhesion seems to take place all round the edge of the body but the sticking fluid must also act on other parts of the under side, because sometimes, in detached pupae some tiny pieces of the rock, which is of a friable nature, still adhere to the ventral surface of the pupa, either on the wings or on the leg-sheaths but not at definite places.

Length of pupa : 2mm. width 1·2 mm. The female pupa is usually somewhat larger.

Larva[1].—The specimens here studied were on the verge of pupation ; when cleared in caustic potash, the typical pupal horns, as shown in plate ii, fig. 5, were found inside the body, so that there is no doubt as to their identity.

The figs. 6, 7 and 8 on plate ii give a good idea of the general aspect of this extraordinary larva, which is broadly oval as depicted for *Maruina* by Fritz Müller, but it is not particularly flat. The length of the body is about 2 mm. ; its colouration brownish above, which is due to the numerous dark tiny granulations of the integument ; the head is orange, the anterior dorsal plates of each segment are blackish and the posterior ones orange with an infuscated part in the middle.

The head is almost hexagonal and is inserted well under the first tergite, it leans obliquely downwards ; its chaetotaxy is not much developed, as can be seen from plate ii, fig. 9. The antennae are much longer than is usual in the family except in *Sycorax* ; they are composed of a small annular basal segment and of a long distal one which carries sensory cones at the end. The labrum is provided anteriorly with two comparatively large sensory rods similar to those found in some Chironomid larvae ; the premandibles are present, as in all the larvae of the family except perhaps in *Phlebotomus* ; the mandibles are inserted obliquely and do not meet, they are provided with a longitudinal comb on the outside (plate ii, figs. 10 and 11) which is intended to work in conunction with the posterior portion of the maxilla, which is modified

[1] The description of the larva is drawn up from three specimens, two of which are very defective, owing to the drying up of the tube during transit. The description on account of the paucity of material is, therefore, not absolutely complete.

into a similar comb; this part of the maxilla is articulated to the head capsule along its length, so that mandibles and maxillae can both work together as a carding machine. This is a highly peculiar arrangement which, to my knowledge, has never been recorded in a dipterous larva, and is widely different from what is found in other Psychodid larvae. The mentum is but little developed, it is not toothed but is provided with a flat brush of fine hairs.

The segmentation of the body may at first sight appear to be different from that of other Psychodid larvae on account of the broad and short shape of the body, but actually it is not so. There are seven fully developed abdominal segments, the 8th, 9th and perhaps the 10th being modified to form the breathing armature. All the unmodified segments carry two sclerotized dorsal plates, but in the first thoracic segment the plates are broader and somewhat diffused in the integument; the two sections of this first segment are much more developed than the others, the anterior stigma are placed on the second division of the first segment and well on the dorsum of it; they are more or less olive shaped as shown in plate ii, fig. 12. The sides of this segment are provided with a few coarse lateral bristles. The thoracic segments 2 and 3 have on both sides a peculiar organ which is shown more highly magnified in plate ii, fig. 13. It is not clear whether these are spiracles or the scars of such organs nor whether the dark piece provided with bristles is an operculum which can be brought down to close the circular opening, which does not appear to be closed by a membrane. It has not been possible to detect if this organ is connected with the breathing system; it does not appear to be so but more material is needed to ascertain this point. The only abdominal spiracles are those of the eighth segment, this larva is, therefore, amphipneustic like all the rest of the family except *Neotelmatoscopus,* in which the anterior spiracles are not functional. Each of the thoracic segments 2 and 3 carries two very narrow dorsal plates in every way similar to those of the abdomen. The anterior one is narrower and darker, the posterior is infuscated in the middle only. The plates bear a number of bristles, as in other larvae of the family, but in this case they are exceedingly small. The caudal breathing armature is of a type quite unusual in the Psychodidae; it could be more fittingly compared to that of an aquatic Tipulid larva, in which a spiracular chamber is formed between the bases of several fleshy, more or less elongated lobes, the spiracles being lodged at the bottom of such a cavity. Here the cavity is formed by two latero-dorsal plates, a median extensible membrane, which is usually folded, and, lastly, by a semicircular plate carrying two rather thick processes and two thin ones. The spiracles are not placed at the bottom of this chamber but near the apex of the latero-dorsal plates on their ventral face; they are surrounded by a fan of rather long bristles, which are scarcely visible from above. The median dorsal lobe is formed by a thick membrane, folded like a fan and with its distal half doubled under the basal half; it appears that this membrane can be unfolded and extended distally when the latero-dorsal plates are pulled apart; its function may be to clean the spiracles when it comes to be extended; in fig. 6 on plate ii it is represented with its distal half doubled under, but in fig. 14 on the

same plate it is shown extended though not unfolded towards the sides. The two thick finger-like terminal processes are each provided with a double row of hairs ; I do not think that they are to be homologized with the cerci, as they are not placed on the tenth but on the ninth segment ; they are the homologues of the larger processes of the flabellum of the Psychodinae larvae, which Martini (1928) considers as belonging to the ninth segment whereas Feuerborn considers them as the cerci. The two small styles of the last visible segment are more in the nature of sensillae and have apparently no homologues in other Psychodid larvae. The anus is placed below the dark three-branched sclerite which is seen under the body at the base of the two terminal processes.

The ventral side of the body exhibits a most peculiar structure in the shape of a very large sucker, the edge of which is formed by a rather thin membrane composed of very fine and numerous agglutinated hairs. On account of the paucity of material for sectioning and dissecting, it has not been possible to ascertain on to which segments this sucker extends, especially anteriorly, but it seems that only the first thoracic sternite is not included in it ; at the posterior end, as it extends right to the anus, it is clear that the ninth abdominal segment is included within the sucker. The ventral surface within the fringe is concave, its colouration is pale as the skin is there rather thin and soft ; there is a slight indication of segmentation in the shape of darker transverse lines, along which there are in certain parts, especially in the middle, very weak and small fringes of hairs similar to those of the edge of the disc ; similar hairs are also present on the middle of the sternites. These hairs have not been represented in plate ii, fig. 7, so as not to complicate the drawing and destroy the effect of concavity of the ventral surface which I have not too well succeeded in bringing out in the drawing.

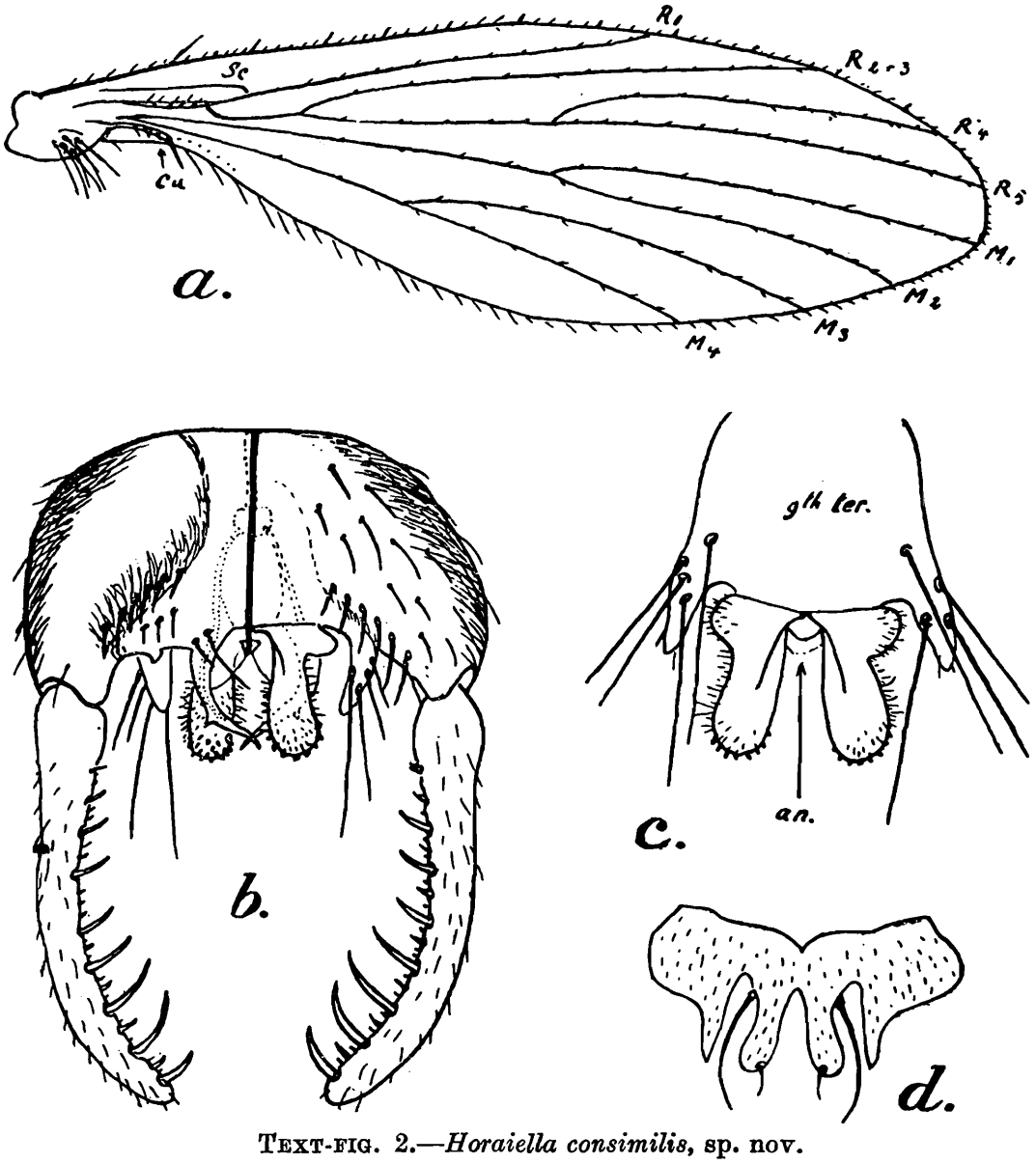
As this larva is provided with only one sucker it is clear that it is unable to move on the substratum by reptation movements which would tend to destroy the vacuum within the sucker. It has, therefore, evolved other means of locomotion in the shape of a modification of the edge of the eighth or ninth segment which is produced in a ridge or curtain provided with a double row of conspicuous hooks ; the movement of this curtain backwards and forwards allows the animal to glide on the stones. This proleg is composed of two symetrical parts, as indicated by the small but quite distinct median indentation ; this double organ appears, therefore, to be the homologue of the posterior proleg of the Chironomid larvae, in which case it would be part of the ninth sternite.

On each pleura of the abdominal segments 1–7 there is, just against the fringe of the sucker, a small brush of hairs inserted on a little stalk and also some sensory setae on the fringe itself (not figured) ; these apparently have only a tactile function.

Horaiella consimilis, sp. nov.

Male.—Very similar to that of the preceding species, from which it differs only in the wing venation and the structure of the hypopygium. The anterior and the middle fork on the disc of the wing are approximately at the same level. The general aspect of the hypopygium is the same as in the genotype, the gonocoxites and styles being identical and

equally developed. Fig. 2*b* shows this organ from above on the right and from below on the left; the dorsal part has a simpler structure than



TEXT-FIG. 2.—*Horaiella consimilis*, sp. nov.

a. Wing with all hairs represented in position; *b*. Hypopygium, right-half ventral view and left-half dorsal view; *c*. Hypopygium, 9th tergite and cerci; *d*. Subgenital plate.

in *H. prodigiosa*, the side lobes of the ninth tergite are small (fig. 2*c*) and carry only a few rather long bristles; the cerci are short, more or less club-shaped and provided distally with a large number of short blunt spines.

The female differs only in the shape of the subgenital plate, as shown in fig. 2*d*, the two pairs of lobes are not found in any other Psychodid.

Pupa (plate ii, figs. 1 and 2).—It is somewhat smaller than that of *H. prodigiosa* and the breathing horns are provided with a very thin, elongate stalk which enables one to identify the species at first sight.

Larva.—Unknown.

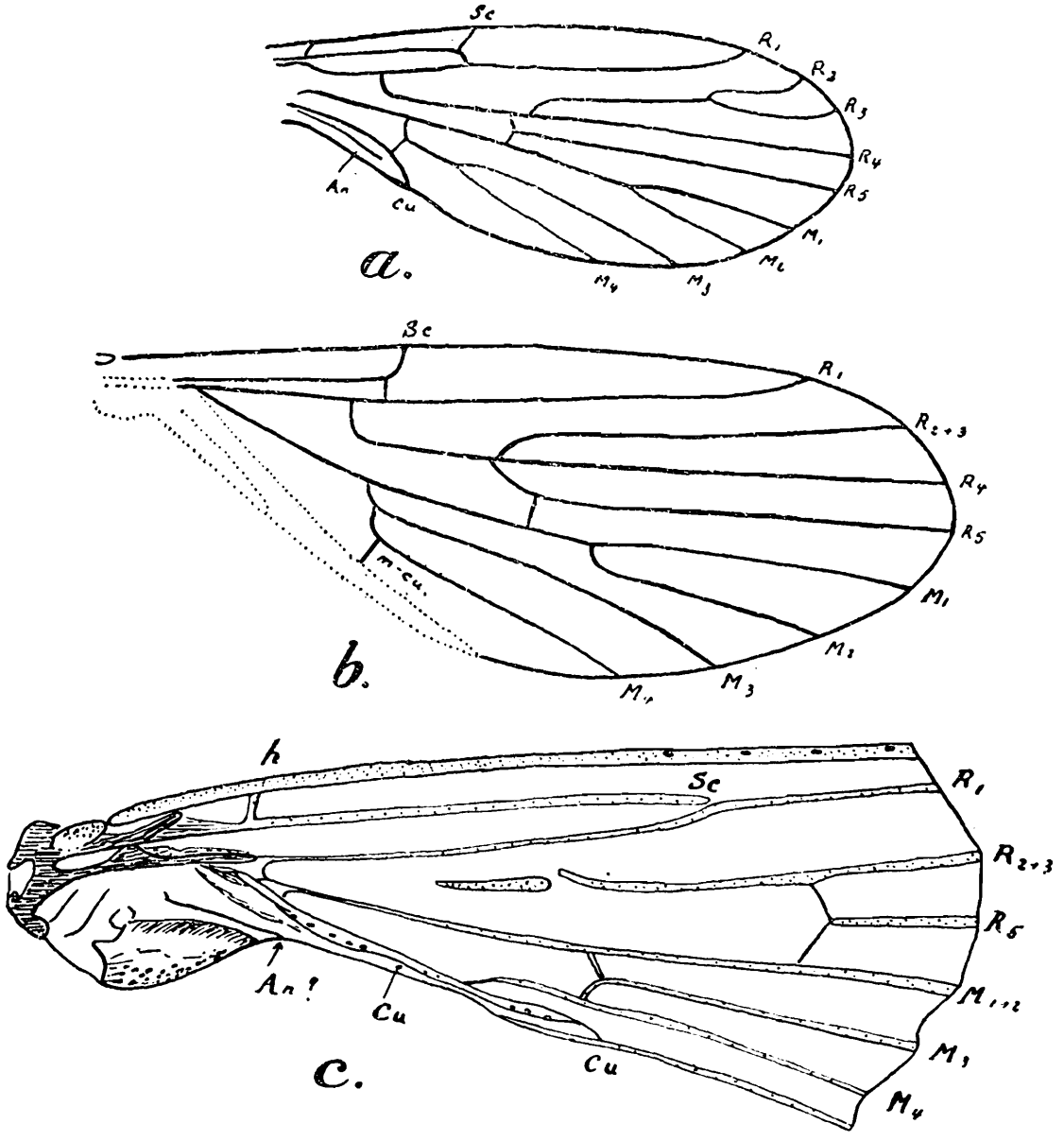
Holotype.—Teesta Bridge (stream three miles from) 7th February 1931. S. L. Hora.

Allotype with Holotype.

Paratypes with types and at Luch-Chu Jhora. D. D. Mukerji, March 1932.

It now remains to discuss the affinities of this strange insect.

The antennae of the fly are of a primitive type, similar to those of *Phlebotomus* and with the same kind of ascoids but there is one more segment. The terminal segment may, of course, be a specialisation due to the modification of the extremity of the 16th segment, because, as mentioned above, this apical section is not truly articulated on the 16th segment. The round eyes are found in all genera of the family except those of the Psychodinae; the palpi are four segmented, as in all genera except *Phlebotomus*, *Nemopalpus* and *Bruchomyia*. The well developed toothed mandibles have their equal only in *Phlebotomus*. The lack of long hairs or scales on the body, legs and wing is unparalleled in the family although *Sycorax* is comparatively less hairy than the other genera. The conformation of the tarsi is more akin to that of the Psychodinae; the strong development of the last segment is an adaptation allowing the insect to cling to rocks in strongly ventilated places; the dorsal flap of this segment is also present, but much less developed than in the Psychodinae.



TEXT-FIG. 3.—Wings of *Eophlebotomus*, *Eatonisca* and *Phlebotomus*.

a. Eophlebotomus after Edwards; *b. Eatonisca* from Eaton's manuscript; *c.* Wing base of *Phlebotomus* sp.

The wing shape and the venation find their strongest affinities with those of *Phlebotomus*. The wedge-shaped narrow base without any trace of anal lobe and the reduced alula is almost exactly as in the latter. As the venation of *Phlebotomus* has seldom, if ever, been correctly interpreted or even figured, I am giving here (fig. 3*c*) an exact drawing of the base of the wing of an Australian species of the *minutus* group, in which it will be seen that Cu is a very short strong vein and An is very doubtfully to be traced at the base. In both genera Sc runs straight into R_1, and M_4 is four branched ; but the main difference lies in the conformation of the radial sector, which is four branched and of the pectinated type in *Phlebotomus* and only three branched in *Horaiella ;* however, in this latter genus, although it seems that the first branch of Rs is simple and represents R_{2+3} and the second branch is forked and represents R_4 and R_5, it is not certain that this is really the case, the anterior vein of the latter fork may be R_3 whose base has switched over to R_4 ; instances of such a switching over of the base of R_3 can be found in other species of the family (*Psychoda aberrans* Tonn. and an, as yet, unnamed species of *Telmatoscopus*). What seems to give some weight to this interpretation is the lack of any macrotrichia on the base of that vein which is marked R_4 in fig. 2*a* but on the other hand, if the venation of *Horaiella* is compared with that of two fossil genera of the family, *Eatonisca* and *Eophlebotomus*, it seems as if the first branch of Rs might be a simple vein on account of the loss of R_2. *Eatonisca tertiaria* has been described by Meunier (1905) from the baltic amber, the complete insect being figured ; the venation as given by Meunier is somewhat puzzling on account of the presence of an unusual cross vein and the bifurcation of the veins at the base of the wing. Fortunately the type of this species had been loaned by Meunier to Eaton who made a new drawing of the venation of the only good wing. This drawing and a few comments on it were included in the uncompleted manuscript which Eaton was preparing on his extensive collection. Thanks to Dr. F. W Edwards' kindness his collection and manuscript have been loaned to me for revision by the authorities of the British Museum. This revision will appear shortly in some other publication. I am giving here (fig. 3*b*) a reproduction of Eaton's drawing of the wing of *Eatonisca tertiaria* ; from this it will be seen that, firstly, there is no basal cross vein and that, therefore, the anterior basal cell is large and shaped as in *Sycorax* or *Trichomyia* and secondly, that the base and a part of the posterior margin was so broken that the shape and the length of Cu and An are purely hypothetical in Meunier's as well as in Eaton's drawing. What is specially to be noted, however, is the three-branched condition of Rs. If one now refers to the wing venation of *Eophlebotomus connectens* Cog. as given in the amended drawing of Edwards (1929) made from the type (fig. 3*a*), one sees how closely *Eatonisca* and *Eophlebotomus* agree in spite of the four branched condition of the radial sector in the latter genus ; a study of this part of the wing allows one to conclude, without much doubt, that it is one vein of the anterior branch of the sector which has disappeared in *Eatonisca*. It should be remarked that in *Eophlebotomus* Cu is a decidedly shorter vein and, therefore, approaches the condition found in *Horaiella*.

If we now compare the venation of *Horaiella* with that of these two genera, and with that of *Phlebotomus*, we note that the unbranched Sc running straight into R_1, the short basal cell, the extremely short Cu and the apparent absence of An, as well as the presence of some regularly spaced spinules on the costa are characters which are also shared with *Phlebotomus*. The three-branched condition of the radial sector, brought about by the loss of one vein of the anterior branch, is found in *Eatonisca* in which the conformation of Rs would be the same as in *Horaiella* if the base of the vein marked R_{2+3} in fig. 2*a* were shifted towards the base of the wing along the stem of Rs. On the other hand it is not improbable to conceive that the venation of *Horaiella* may have been evolved from a type similar to that of *Sycorax*, in which the posterior vein of the anterior fork has switched over to the simple second branch of Rs.

The male genitalia of *Horaiella* are on the whole more like those of *Phlebotomus* on account of the presence of the cerci, as well as the lateral lobe of the ninth tergite, the gonostyles with long spines, and the bifid penis with its pumpetta. A species of *Sycorax* is also known which has a bifid penis (*S. chilensis* Tonn.) but it is apparently an exception in the genus, of which I know all the described species and a few more still undescribed.

If we now examine the larva of *Horaiella* we see at once that it has nothing in common with that of *Phlebotomus*. This latter is not aquatic, its head is not flattened but rounded, the antennae are short and bulbous, the mouth parts are of a generalised type without premandibles and with simple mandibles and maxillae ; the body segments are subdivided into two but they do not carry sclerotized dorsal plates and the last segments are not modified into a breathing organ; the spiracles are simple, small buttons on the sides of the eight segment.

The larva of *Horaiella* with its dorsal plates and its modified last few segments would seem at first sight to be more closely related to those of the Psychodinae ; its general shape is not unlike that figured for *Maruina ursula* by Fritz Müller but a comparison with the larva of *Sycorax* deserves closer attention although *prima facie* it would seem that the simple undivided tergite of the latter genus would preclude any sort of affinity.

I know the larva of *Sycorax* only from the figures of C. W Müller (1927) and those of Baugerter (1928) and Feuerborn (1932) ; I have, therefore, been unable to ascertain if there is no trace of the anterior dorsal plates left. As far as the head is concerned the only point of resemblance is found in the elongate antennae ; but the continuous fringe which surrounds the body is evidently the homologue of the fringe of the sucker of *Horaiella* in which it has been shifted more ventrally. Feuerborn remarks (*l. c.* p. 96) that this fringe in *Sycorax* aids in the adhesion of the larva to the substratum, so that this animal can be considered as a " wandelnde saugscheibe " ; the same applies also to *Horaiella*. One of the strongest points of resemblance between the two larvae is the division of the 8th tergite into two lateral lobes which carry the hind spiracles near their extremity, in *Horaiella* the spiracles have shifted to the ventral side of the lobes, so as to be included in the chamber or

cavity formed by these lobes and the ninth tergite, but the latter does not carry any appendages in *Sycorax.*

The pupa of *Horaiella* shows no affinity either with that of *Phlebotomus* or with that of *Sycorax*; it is more closely related to that of *Maruina.*

From this analysis it results that *Horaiella* should find its place between *Phlebotomus* and *Sycorax,* the affinity being greater with the former genus in the adult stage; I cannot, however, see my way to placing it in the same subfamily : on the other hand I am not yet prepared to erect a new subfamily for it and prefer to reserve my decision on this point until the study of more abundant material, especially of mature flies, allows me to throw more light on the subject. We are already threatened with too many monogeneric subfamilies in the Psychodidae, besides the Phlebotominae, there are the Trichomyiinae which would also remain with a single genus if Edwards' suggestion, to remove *Sycorax* from it and place it in a subfamily of its own, be accepted. Theodor has even proposed that *Phlebotomus* should be separated from the rest of the Psychodidae and be placed in a new family. The discovery of *Horaiella,* which is a link between *Phlebotomus* and the rest of the Psychodidae, completely invalidates this suggestion.

In his recent paper, already referred to, Feuerborn has described from Java a species of Psychodid whose larva is provided with ventral suckers and for that reason he has placed it in the genus *Maruina.* Before discussing the generic status of this species and of the closely related one discovered in India by Hora, I think it more expedient to give first a detailed description of all the stages of the latter species, which I place in a new subgenus of *Telmatoscopus* characterised by the larvae provided with six ventral suckers, the subgenotype being the following species.

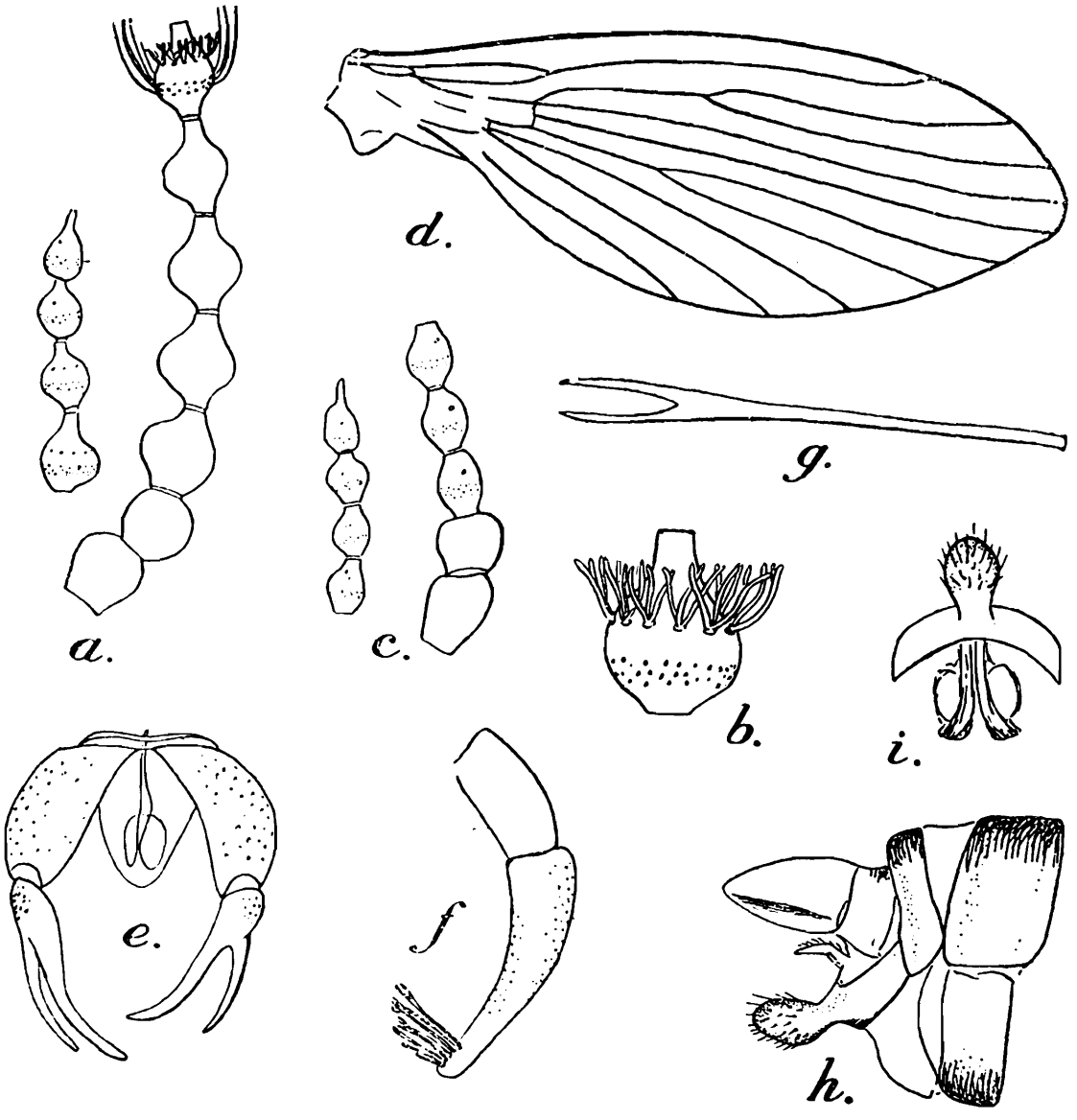
Telmatoscopus (Neotelmatoscopus) horai, sp. nov.

A small species with uniformly blackish vestiture on the body, wings and legs, and with the habitus of a *Psychoda.*

Male.—Eye bridges contiguous on their whole width, no noticeable tuft of hairs on face or vertex; antennae 16 segmented, distinctly longer than the width of wing when fully extended [1], first segment rounded, not longer than broad, second spherical, the following one bulbous with a short distal neck (fig. 4*a*); the basal segments of the flagellum are somewhat asymetrical, as is often the case in species of *Telmatoscopus,* they gradually diminish in size but the last ones are not diminutive as in *Psychoda*; the neck of the basal segments is short but it gradually

[1] In most, if not all, the pinned specimens submitted to me, the segments of the flagellum are telescoped; this gives to the antennae of the male a very thick appearance, the verticils thus fitting into one another. This is often the case in recently emerged *Psychoda* because when still enclosed in the antennal sheath of the pupa the segments of the flagellum are telescoped in this manner and when specimens are kept in a dark and moist place after emergence the antennae do not extend for some time, if at all; but when a telescooped antenna is treated in caustic potash it soon extends to its normal size and shape. As the examples of the above species were collected on the rocks of a waterfall it is possible that they had recently emerged and had not had time to dry and harden properly; they all have a rather immature appearance.

increases up to the 12th segment where it is about half as long as the bulb ; the last segment is pear-shaped and ends in a thin cylindrical apiculus placed on one side. The numerous ascoids are arranged in a circle on the distal half of the bulb (fig. 4*b*) ; on the basal segments there



TEXT-FIG. 4.—*Telmatoscopus* (*Neotelmatoscopus*) *horai*, sp. nov.

a. Antenna of male ; *b*. A median segment of antenna of male ; *c*. Antenna of female ; *d*. Wing ; *e*. Gonopods ; *f*. Inferior appendages ; *g*. A retinaculum ; *h*. Side view of female genitalia ; *i*. Subgenital plate.

are about 12 pores in which are inserted two-or three-branched ascoids which do not reach over the level of the end of the neck ; on the 10th segment the number of pores is only ten and on the last three there are only two pores each with a multibranched fan-shaped ascoid. The verticils of ordinary bristles are not specially developed or distinctly campanuliform, as in many species of the genus they are inserted only on a part of the basal half of the bulb.

Palpi formula : 12 ; 16 ; 17 ; 27 The last segment thinner but not conspicuously so ; vestiture moderately dense.

Thorax without organs for erotic display. Legs uniformly dark, the last segment of the tarsi somewhat more developed than in other species of the genus, its dorsal flap extends well in between the claws which are strong and sharply elbowed.

Wing ovate lanceolate (fig. 4*d*), not sharply pointed at apex which is placed a little below the tip of R_4 ; Sc ending straight in R_1, the posterior fork somewhat before the anterior one, which is placed a very little before the level of the tip of Cu ; origin of the stem of the anterior fork on the apex of the anterior basal cell, the second basal cell much shorter than the first.

Wing vestiture uniformly dark brown without any tuft or any marking, the rows of erect hairs moderately dense and, therefore, only slightly conspicuous, they are absent on the usual veins : R_1, R_5 and M_4 ; on the branches of Rs they do not extend as far as the level of the tip of R_1 and on the branches of M a little beyond the tip of M_4 on Cu they reach the tip of that vein.

Hypopygium.—Gonocoxites (fig. 4*e*) several times as long as broad and arched on the outside, gonostyles with a scarcely swollen base, its distal two thirds divided into two equally long and almost equally strong beaks which are only moderately curved ; aedeagus of a simple symetrical pattern almost similar to that of *Pericoma exquisita* and allied species. Inferior appendages (fig. 4*f*) about twice as long as the ninth tergite, their distal third becoming suddenly thinner than the basal part but not very much more so, apex with 7-8 retinacula which are forked at the tip (fig. 4*g*).

Length of wing 2 mm.

Female.—Similar to male. Antennae relatively shorter (fig. 4*c*). the necks of the flagellar segments being much shorter so that the last segments appear to be almost spherical, but not diminutive. The ascoids on all the segments are similar to that of the last three segments in the male, they are multibranched and inserted on a pair of pores only. The verticils are much less developed than in the male. The genitalia (fig. 4, *h* and *i*) are very peculiar on account of the relatively large oval knob-like hairy process on the middle of the subgenital plate ; ovipositor short, subtriangular.

Holotype.—Teesta bridge, 7th February 1931. S. L. Hora.

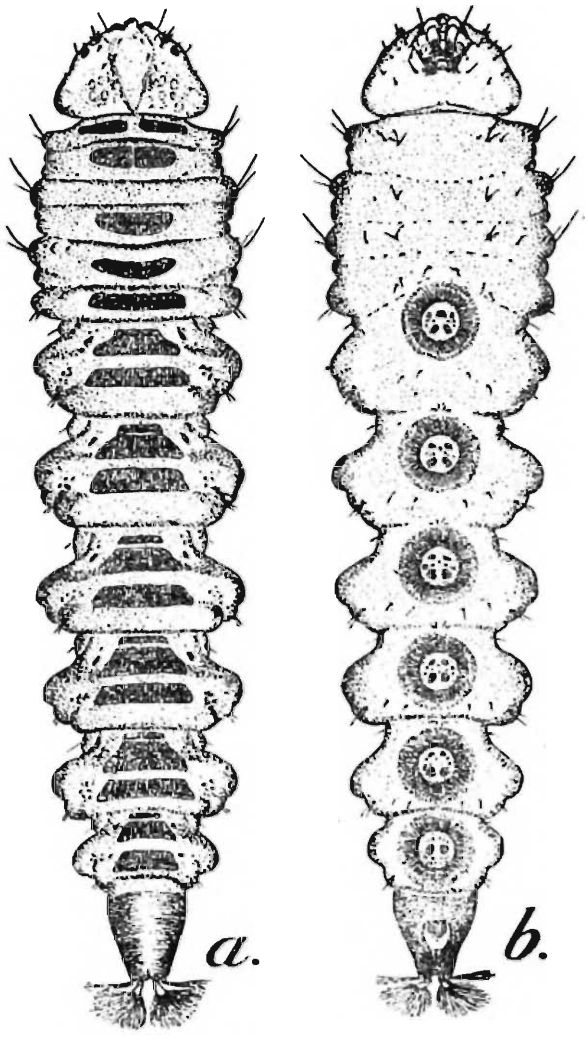
Allotype with the holotype.

Paratype same locality and Luch-chu Jhora, Peshoke Jhora, etc., all in the vicinity of Teesta Bridge in March 1931. D. D. Mukerji.

Larva (fig. 5, *a* and *b*).—As a similar larva has been described in detail by Feuerborn (1932) I shall only give here a description of its main features. The most remarkable of these, besides the presence of the ventral suckers, is the reduction of the basal segments of the abdomen. This occurs to a much lesser extent in many, if not all, the larvae of the Psychodinae, the first abdominal segment having only two subdivisions instead of three (and, therefore, two instead of three dorsal plates, when these plates are present at all). In the larva of *T horai* the first abdominal segment has only one plate, the second two and the third three so that at first sight the larva may be taken to have an abdomen with only six unmodified segments, the more so as the third thoracic tergite is apparently undivided and carries only one dorsal plate.

The ventral suckers evidently belong to segments 2 to 7 ; as the most anterior sucker is placed almost below the first abdominal segment, which, as mentioned above, is very reduced, there may be some doubt

as to the segment to which it belongs, the first or the second. A study of the musculature of the suckers shows, however, that the first sucker does



TEXT-FIG. 5.—Larva of *Telmatoscopus* (*Neotelmatoscopus*) *horai*, sp. nov.
a. Dorsal view; *b*. Ventral view.

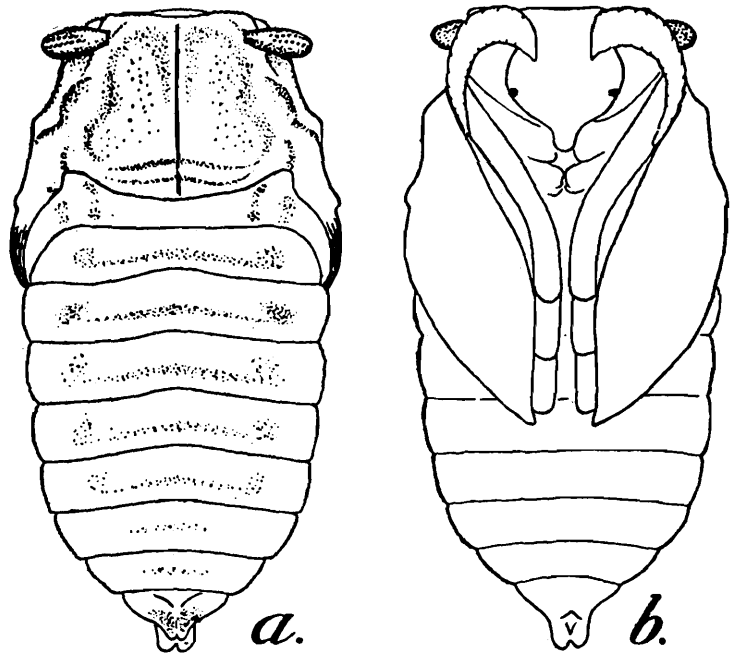
not belong to the first segment. Even without dissection or cross section this conclusion can be reached by studying the position of the dorso-lateral sclerosities of the integument, which indicate the point of attachment of the dorso-ventral muscles; these callosities are missing on the first abdominal segment, therefore the first sucker does not belong to it.

The head is wider than long; its posterior part is widened into moderately developed lobes which do not extend backwards as in *T. indica*. The mouth parts are as in most Psychodinae larvae, except that the maxillae are provided with a large brush of hairs in the form of a fan directed backwards. The terminal segments are strongly sclerotized and fused in a conico-oval flabellum with the usual four apical processes provided with small hair fans. There are four pairs of anal gills which are retracted in most specimens. The anterior spiracles are not functional; they are represented by very weak tiny scars.

The round suckers are of a simple type, the edge of the disc is formed by a simple layer of agglutinated rods which are analogous to those found in the Blepharoceridae, they are prolonged by a thinner felty tissue giving more fexibility to the edge of the sucker; the disc is not invaginable like the piston of the Blepharoceridae, the suction power is, therefore,

very much weaker, as can logically be inferred from the difference of habitat.

Pupa (figs. 6 *a* and *b*).—It is not unlike that of any other Psychodinae ; it is not greatly modified in shape to suit its habitat, though it is much more so than that of the Javanese species. The underside of the body is fairly flat, soft and whitish and the contour of the abdomen is fairly continuous, although the segmentation remains clearly indicated by shallow indentations between the segments. Adhesion to the substratum seems to take place by the whole of the ventral face ; there is no special



TEXT-FIG. 6.—Pupa of *Telmatoscopus* (*Neotelmatoscopus*) *horai*, sp. nov.
a. Dorsal view ; *b*. Ventral view.

sealing mass at the end of the wing sheath, as mentioned by Feuerborn in his Janvanese species. The breathing horns do not present any special features ; they are provided with a double row of about ten little craters. The integument of the horn has a fine sculpture which gives it the appearnce of being covered with minute imbricated scales.

In the same locality occurs also another larva, differing from that of *T horai* by the shape of the head, which has latero-posterior lobes as much developed as those of *T indica* ; in shape the abdominal segments are wider at the posterior end and thus are also quite different. I have not seen the pupa or the fly of this species, I shall, therefore, refrain from describing it ; it is intermediate in character between *T horai* and *T indica*.

The generic status of this remarkable insect has now to be discussed. Feuerborn has placed the species that he discovered in Java in the genus *Maruina* established by Fritz Müller (1895) to receive three Brazilian species, because the larva of this Malayan moth-fly is also provided with ventral suckers. This is the only ground on which it can be done because very few reliable characters are given by Müller for the adult stage of *Maruina*. These points have already been discussed by Eaton (1895) and Feuerborn takes them up again in his recent paper but he reaches a conclusion which is totally unsound from a taxonomic point of view

He says (*l. c.*, p. 106) that as the two species of *Maruina*, more or less described in the adult stage by Müller, *viz.*, *M. spinosa* and *M. pilosella*, belong very likely to *Pericoma*, and as the third species has not been described in the imaginal stage, the generic name given by Müller, therefore, becomes untenable (hinfällig) for the American species but can be transferred to the Javanese species, the more so because the idea of larval suckers is already linked up with the name of *Maruina*; and this in spite of the fact that he recognizes that the imago of his species "ist durchaus Arten der Gattung *Telmatoscopus* ähnlich".

Through the kindness of Mr. F. D. Klyver I am now in possession of all the stages of *Maruina californiensis* (Kellog); a study of these shows that, contrary to Eaton's and Feuerborn's opinion, *Maruina* is a perfectly valid genus, quite distinct in all stages from any other known genus of the family. It is, therefore, impossible to place Feuerborn's Javanese and Hora's Indian species in it, even if only larval characters are considered. The larva of *Maruina* has eight incomplete more or less oval suckers (exactly as depicted by Müller), whereas those of the Indo-malayan species number only six and are in the form of a complete round dics.

Feuerborn has rightly remarked that the imago of his *Maruina indica* is in every respect similar to members of the genus *Telmatoscopus*. This genus was erected by Eaton (1904) to receive a number of species that he had previously classified in the genus *Pericoma;* no genotype was mentioned by him and, so far as I am aware, none has been designated since. At the end of his generic diagnosis Eaton gives the following indication: "This genus is nearly coextensive with section 3*c*, 3*d* and 4*a* of *Pericoma* in the supplement to my Synopsis" (*l. c.*, 1900, p. 206, etc.). If we now turn to section 3*c* we see that the first species mentioned there is *Pericoma morula* Eaton. I therefore propose here definitely to consider this species as the genotype of *Telmatoscopus*.

Eaton's diagnosis of this genus is based on the structure of the antennae, the male genitalia and the venation; as the last two characters are too general and may be applied to almost any species of the Psychodinae, only the structure of the antennae need be considered.

The 16 segmented antennae of *Telmatoscopus* have a flagellum composed of segments formed by a bulbous basal part and a distal more or less elongate neck, the last few segments being similar to the others and not diminutive or indistinctly articulated on each other, so that the flagellum is "furnished with 14 sets of verticillate hairs inserted upon the nodes, the verticils mostly cupuliform or bowl-shaped and imbricate; several nodes towards the base of the series oblate or napiform and gibbous or extended laterally into a rounded lobe so as to render the thread or beak of the joint excentric instead of cimate"

Among the many species possessing these antennal characters, the venation varies to a very large extent; the radial sector may or may not be pectinate, Sc may run straight into R_1 or not and the apex of the wing may or may not be placed at the extremity of one of the longitudinal veins. Furthermore, the structure of the male genitalia is also varies greatly from one species to another.

T indica Feuer. and *T. horai*, sp. nov. answer in every point of their antennal structure to the definition just given above, and there is nothing in the wing venation and the male genitalia which would preclude their admission in the genus *Telmatoscopus*.

Up-to-date, about 36 species of this genus have been described ; they are mostly found in the Palaearctic region ; there is no doubt that a certain number of species will turn up also in the Indo-Malayan region although so far only one of the species of Psychodidae described by Brunetti can be referred with certainty to the genus *Telmatoscopus*, whereas a few more of his species could but doubtfully be placed in it. In Australia about a dozen as yet undescribed species are known to me ; it is amongst these that *T indica* and *T horai* find their closest allies rather than among the Palaearctic species. About six of these Australian species have the same venation with Sc running straight into R_1, the origin of the stem of the anterior fork at or very near the apex of the first basal cell and the two main forks more or less at the same level ; the structure and the disposition of the ascoide are also very similar and the necks of the flagellar segments more or less elongate ; however they all differ from the Indo-Malayan species in the presence of organs for erotic display on the thorax of the males. None of the early stages of these Australian species is known so far and the habitat of the flies, except for two species, is not in the vicinity of waterfalls but along the edges of sluggish streams ; this habitat would preclude the presence of a strong fixation organ, in the larva, such as the series of suckers of *T horai*.

The larva of the genotype has not yet been found, so far as I am aware, and only those of two other species have been recorded up to the present. It is therefore, very difficult, if not impossible, to establish the general characters of the early stages of the genus on such scanty knowledge.

The larva and pupa of *T albipunctatus* Willist. (=*meridionalis* Eat.) have been well described by Efflatoun (1920) and later in much more detail by Zavattari (1924). The larva of *T deminuens* Feuer. has been well figured by Feuerborn (1923, p. 198, fig. 7) but not described.[1]

These two larvae are widely dissimilar, although the imagines are fairly closely related. Their difference of structure is evidently due to adaption to different habitats. The larva of *T albipunctatus* lives in bilge water or similar foul liquids ; it is elongate and possesses a long flabellum and has well developed dorsal plates, whereas the larva of *T deminuens*, which according to Feuerborn is oligomydobiontic (living among grass, plants and leaves at the edge of the water) is stumpy with a short flabellum and is almost devoid of dorsal plates.

From this it can be seen that the larvae of this group are eminently plastic in their faculty of adaptation, just like those of the rest of the family : for instance the larva of *Trichomyis* living in wood has the appearance of a wood borer (Keilin 1914), whereas that of the closest

[1] The imago of *T. deminuens* has not been described by Feuerborn ; it has been made known only by a drawing of a few segments of the male antennae (1922, fig. 7) which are so characteristic that I am convinced that this species is the same as the one described by me previously as *Pericoma longicornis* (1919).

related genus, *Sycorax*, is an aselliform larva living in damp moss. One should, therefore, not be too surprised to find in *Telmatoscopus* some species whose larvae are provided with special means of adhesion as an adaptation to their special habitat.

From an examination of all the stages of *Maruina californiensis* (Kell.)[1] I can definitely state that *Maruina* and *Telmatoscopus* are in no way closely related. In fact we have here a curious state of affairs because in *Maruina* the imago, which has a lesser number of antennal segments and a more reduced venation, is more specialized than that of *Neotelmatoscopus*, whereas the larva with a larger number of suckers is more primitive.

It seems most probable to me that the larval suckers have been evolved independently here and there, in various groups of the family with such plastic larvae, in response to the same special habitat.

From the above analysis I can only conclude that *T indica* and *T horai* cannot be placed elsewhere but in the genus *Telmatoscopus* on imaginal characters ; however as the larvae of the two known species are so peculiar I think that it is convenient to erect a new subgenus, *Neotelmatoscopus*, based on larval characters alone and defined by the presence of six ventral suckers.

After Fritz Müller and Hora, Feuerborn has treated of the relationship of the Blepharoceridae and the Psychodidae at full length in his recent paper (1932) ; however, in spite of his efforts his arguments do not seem to me to be convincing enough and I cannot see that the relationship between the two families is as close as he would make us believe. I stand by Hora when he says (1930, p. 231) " I do not believe that any genetic affinity exists between the two families ; the resemblances are the result of convergence " The resemblances Hora had in mind are those between the larvae and not between the imagines. The latter are much further apart than Feuerborn makes out as a result of his incomplete knowledge of the Blepharoceridae, which he himself acknowledges. This family has quite a number of archaic characters such as the presence of the tibial spurs, the presence of the ocelli, the long anal vein, and the non-twisted hypopygium, which are not to be found in the Psychodidae. Crampton as a result of his study of the structure of the thorax of the Psychodoid diptera (1926) also fails to find any strong affinities between the two families.

However, if the discovery of the early stages of *Horaiella* and *Neotelmatoscopus* does not shed a new light on the affinities of the Psychodidae with other families of the Nemocera besides those included by Crampton in his Psychodoid complex, it gives at least a very good indication as to how the complicated sucker of the Blepharocerid larvae may have been evolved.

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[1] Malloch has pointed out (1917, p. 266) that M. *californica* Kinc. is a synonym of *M. californiensis* Kellog because the description of the very characteristic early stages of this species appeared under the latter name before that of the imago by Kincaid. In reality the question is more complicated than Malloch thought because the fly described by Kincaid has certainly not been bred from the larva and pupa described by Kellog. The nearly mature fly which I extracted from similar pupae from a locality near that of the type does not at all correspond to Kincaid's description either in antennal structure or in the shape and venation of the wing. Some confusion must have occurred when the specimens were sent for description to Kincaid by Kellog.

To my knowledge there are two attempts at an explanation of the origin and evolution of these suckers, neither of which seems satisfactory to me.

The first one is by Komaıek (1914) who assumes that at the beginning, at the places where we now find the suckers, there were some glands producing a sticky secretion by means of which the animal adhered to the bottom of the stream ; in order to release the hold on the substratum the dorso-ventral muscles came to converge at that spot and produced an invagination of the soft skin and thus formed beginning of a sucker. The chief objection to this explanation is that it is purely theoretical since no aquatic insect larvae are known which can fix themselves on the substratum by means of a glandular secretion on the ventral surface.

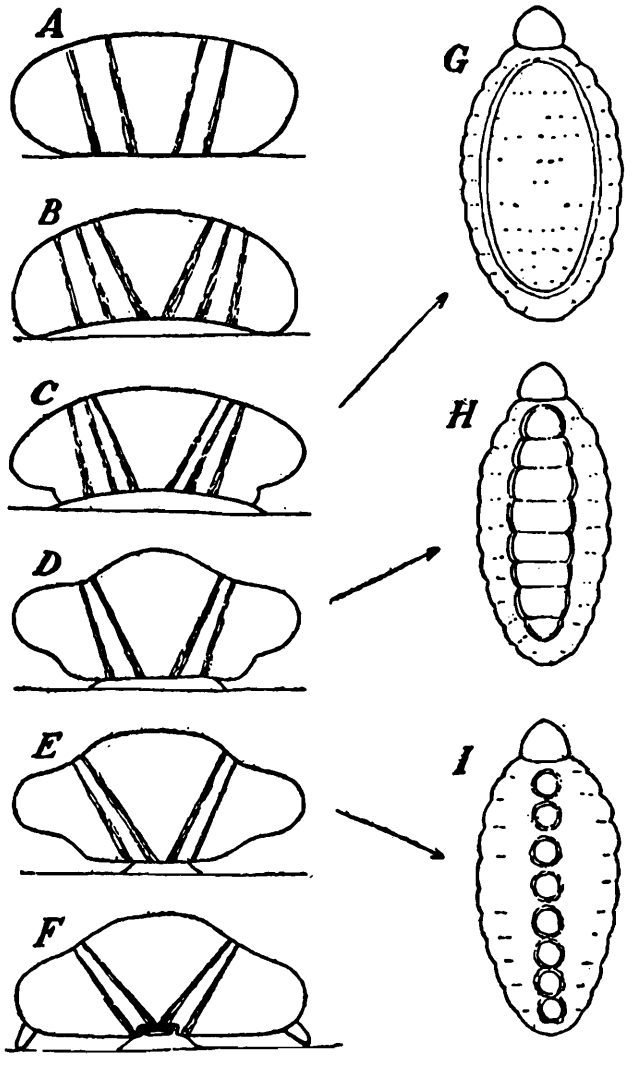
The second tentative explanation is that of Hora (1930, p. 224) who tried to find the origin of the suckers by studying the ontological development of this organ in the Blepharocerid larva. He found that : " in the young larva the sucker is comparable to the abdominal proleg of a caterpillar with a circle of crochets of equal length, all the hooks being turned towards the centre of the planta which can be engaged or disengaged by the contraction and relaxation of the muscles acting on the centre of the disc. As the larva grows it seeks more rapid waters and as life in rapid waters demands a close application of the ventral surface of the animal to the substratum, in this process the crochets have gradually flattened down and have formed the disc as we know it in the larger larvae "

Unfortunately this explanation does not rest on facts because the structure of the sucker in all the genera, including the most primitive *Edwardsina,* is the same in the first instar, just hatched, as in the fully grown fourth instar larva, except that the number of rods is not as large and that the valvular gate is not yet present. It is to be wondered if Hora would have found something of real value if he had started his ontological study with the embryo.

I am now proposing a third tentative explanation which has come to my mind while studying the Psychodid larvae which are the main subject of this paper.

The two series of diagrams here given (fig. 7) are almost self-explanatory : A is a section of an insect larva living in rapid water which, as a beginning of adaptation to this habitat (stage I of Steinmann), is flattened dorso-ventrally and has a large surface of adhesion ; in B there is a sucker action of the whole ventral surface brought about by the action of the dorso-ventral muscles ; to facilitate the retention of the suction or vacuum a pleural fringe of hairs or a pleural membrane has been evolved in C such as we find respectively in *Sycorax* and *Horaiella* ; D shows a section of a larva in which the fringe has migrated towards the axis of the body in order to allow more mobility, at that stage, this fringe may be either continuous as in *Horaiella* or interrupted and form a series of oval more or less complete discs as in *Maruina californiensis* ; the number of discs is probably not higher than eight. E is a stage similar to *Neotelmatoscopus* and as the animal takes to swifter waters a

more powerful type of sucker is evolved as shown in F such as we find in the Blepharoceridae.



Text-fig. 7.—Diagram illustrating the probable evolution of the suckers of dipterous larvae.

G, H, and I are the stages corresponding respectively to the sections C, D and E seen from below; they do not require any explanations.

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EXPLANATION OF PLATE II.

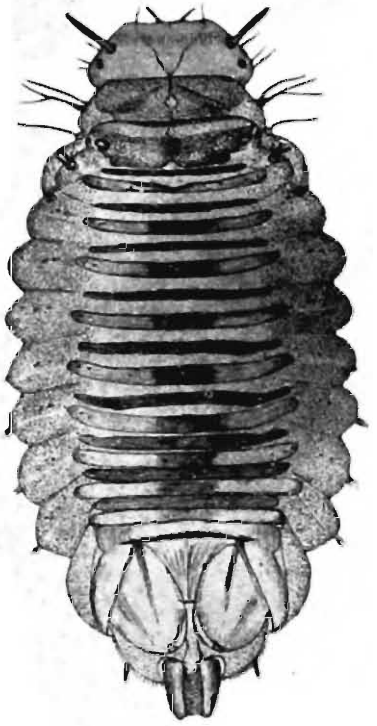
Earlier Stages of *Horaiella*, gen. nov.

Horaiella consimilis, sp. nov.

FIG. 1.—Dorsal view of pupa.
FIG. 2.—Ventral view of pupa.
FIG. 3.—Lateral view of breathing-horn of pupa.
FIG. 4.—Front view of same.

Horaiella prodigiosa, sp. nov.

FIG. 5.—Lateral view of breathing-horn of pupa.
FIG. 6.—Dorsal view of larva.
FIG. 7.—Ventral view of larva.
FIG. 8.—Lateral view of larva.
FIG. 9.—Head of larva.
FIG. 10.—Outside view of mandible of larva.
FIG. 11.—Inside view of same.
FIG. 12.—Anterior spiracles of larva.
FIG. 13.—Enigmatic organ of larva.
FIG. 14.—Dorsal view of posterior end of larva.



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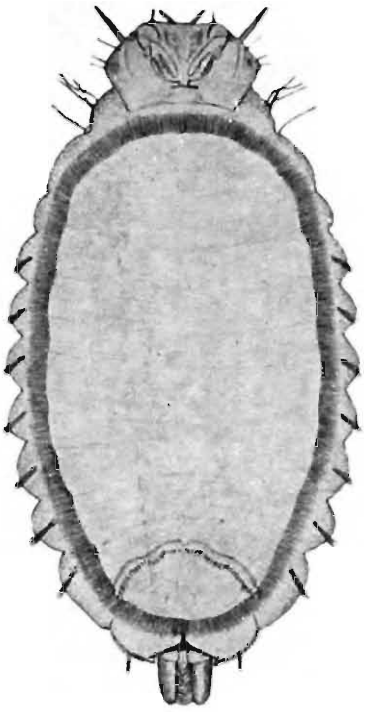

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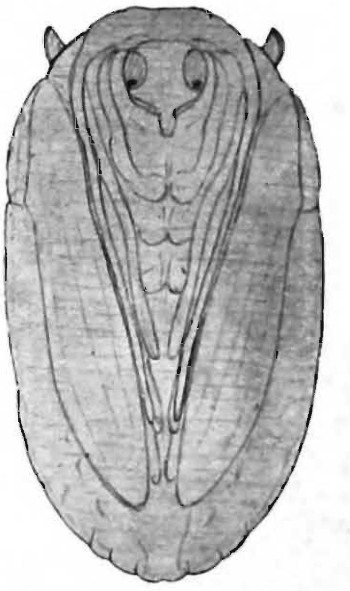

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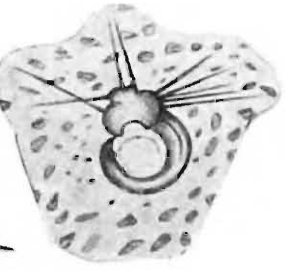

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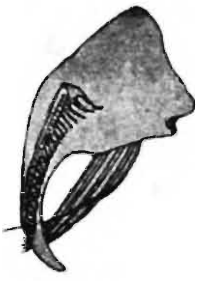

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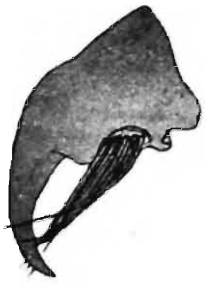

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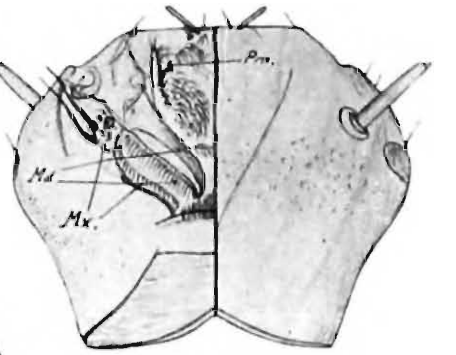

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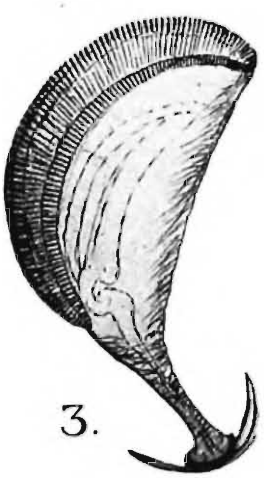

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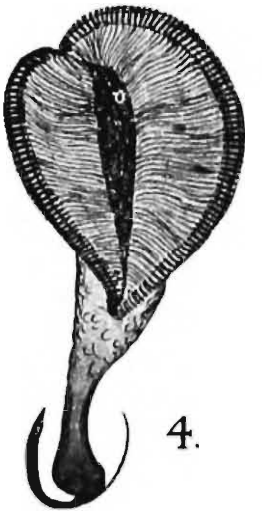

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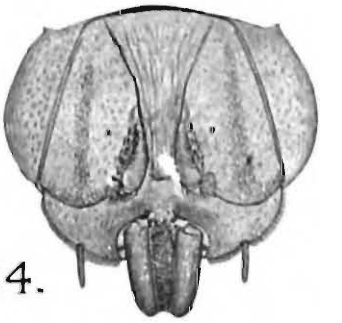

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A. L. Tonnoir, del.

Early Stages of HORAIELLA.

FURTHER NOTES ON CRUSTACEA DECAPODA IN THE INDIAN MUSEUM.

IV. On two new species of Oxystomous Crabs from the Bay of Bengal.

By B. Chopra, *D.Sc., Zoological Survey of India, Calcutta.*

(Plate III.)

While sorting out a miscellaneous unnamed collection of the Oxystomes in the course of my work on these crabs from the mouth of the Hughli River,[1] I came across a specimen of the interesting genus *Ixa*, that even on a superficial examination appeared to differ in several material respects from both the hitherto-known species of this genus. On a closer examination it has proved to represent an unknown species, and is described as new in the present paper. Even though I have had to base my description on a single example, the specimen shows so many important distinguishing characters that there cannot be any doubt that it represents a species hitherto unknown to science. The specimen is an ovigerous female. The second new species belongs to the genus *Raninoides* Milne-Edwards, of the family Raninidae. This species is also based on a single specimen. This particular example had been examined by Alcock, and named by him as a variety of *Raninoides personatus* White, Henderson. On a careful examination it has shown so many material differences from Henderson's species, as also from the other species of *Raninoides*, that I have no hesitation in describing it as new.

In his masterly account of the Raninidae, Bourne[2] has recently set up a new genus under the name of *Notosceles*, that according to him comes very close to *Raninoides* Milne-Edwards. Besides describing a new species (*N. chimmonis*), Bourne has included in this genus the form that Henderson[3] had described as *Raninoides serratifrons*. The new species described here shows a number of characters that suggest that it is intermediate between the typical species of *Raninoides* on the one hand, and forms like *Raninoides serratifrons* and *Notosceles chimmonis* on the other. Similarly in connection with the new species of *Ixa*, the question of the validity of *Ixoides* MacGilchrist[4] is discussed and it is shown that except for some differences in the external maxillipeds, the genus *Ixoides* so closely resembles *Ixa* Leach, that it can hardly be distinguished from it.

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[1] Chopra, *Rec. Ind. Mus.* XXXV, pp. 25—52 (1933).

[2] Bourne, *Journ. Linn. Soc. London* (Zool.), XXXV, pp. 25-79, pls. iv-vii (1922).

Henderson, *Trans. Linn. Soc., London* (Zool.), V, pp. 408, 409, pl. xxxviii, figs. 10-12 (1893).

[4] MacGilchrist, *Ann. Mag. Nat. Hist.* (7) XV, pp. 255-257 (1905)

Ixa investigatoris, sp. nov.

(Plate III, figs. 4, 4*a*.)

The carapace is broadly hexagonal in shape, the breadth, excluding the lateral processes, somewhat exceeding the length. The surface of the carapace is thickly covered over with prominent raised tubercles, which are distinctly stalked on the lateral processes and the posterior half of the carapace. Between the tubercles the surface appears to be smooth. The margins of the carapace and the pterygostomian regions are also covered over with similar tubercles. On the surface of the carapace in addition to the ordinary raised and stalked tubercles there are several prominently raised areas, with secondary tubercles on them. There are three such prominences on the median part of the carapace—a small one on the gastric region, a somewhat larger one on the cardiac, and a very prominent double one on the intestinal region. There are three of these on each branchial region, and one on each hepatic region near the margin. Besides these there is a pair of small prominences, one on each side of the median gastric prominence. The grooves on the carapace, as compared with those of *I. cylindrus* are very indistinct and shallow but even in this species they separate off the median parts of the carapace from the branchial and the hepatic regions. There is a broad, transverse depression behind the frontal region, which has the effect of separating off the front from the rest of the carapace, more or less as in other species of *Ixa*.

The front is somewhat broad, and prominently bilobed, and projects almost as far as the salient edges of the afferent branchial channels. The orbits are small and rather deep and the granulation of the carapace on their edges conceals all traces of sutures. There is, however, a wide gap at the inner canthus, where the antennae are lodged. The antennules fold obliquely. The gap at the inner canthus of the orbits, and the antennae and the antennules are seen in figure 4*a* on plate III.

The antero-lateral border is not distinct, on account of the tubercles present all along the margin, but it is somewhat sinuous in outline. There is a marked prominence, covered over with raised tubercles, on this margin, a little in front of the lateral process. At the junction of the antero- and postero-lateral borders are the lateral processes—huge, spine-like structures, projecting transversely from the sides of the body. They are rather short, as compared with those of *I. cylindrus*, broad at the base and taper gradually towards the tip, which is bluntly pointed. They are thickly covered all round with raised and stalked tubercles. The postero-lateral borders are practically straight, and like the rest of the carapace are covered over with tubercles. A little above the base of the last walking leg there is on each margin a large petaloid process, covered with stalked tubercles. A similar and somewhat larger process is present at the junction of the posterior and postero-lateral borders. This process is also covered with stalked tubercles. The posterior border is very short and is partly hidden in a dorsal view by the large overhanging prominence on the intestinal region of the carapace. This border is straight, and carries a few small stalked tubercles on it.

The buccal cavern (Plate III, fig. 4*a*), though truncated anteriorly, is distinctly triangular in outline, and the external maxillipeds are not appreciably sunk below the level of its edges, which are not everted. The ischium is somewhat grooved along its inner half, but the outer half is strongly convex and is tuberculated. The merus, measured along the inner border, is about half as long as the ischium. It has the usual shape, has a more or less flat surface, with a few small tubercles on it and is somewhat rounded at the tip. The exognaths are also tuberculated, are convex towards their outer edges and only slightly fall short of the tip of the merus.

The chelipeds are considerably stouter than the walking legs, and are rather more than twice as long as the carapace. The long arm is cylindrical in shape, and is strongly granulated all round. The wrist is short, is somewhat dilated distally and is covered over with small granules. The palm is long, broad at the base and tapers markedly towards the tip. It is sharply granular on the outer margin. The fingers are thin and almost filiform, are about two-thirds as long as the palm, and open in a more or less vertical plane. They are somewhat hooked at the tip, and their inner margins are beset with a row of minute teeth, interspersed at irregular intervals with some larger ones.

The walking legs have the margins of their basal segments serrated. The surface of the segments, especially that of carpus and propodus, is finely granular, and the dactyli, which are almost straight, are fringed with hairs.

The thoracic sternites are strongly tuberculated, those at the base of the chelipeds being prominently raised.

The abdomen of the female consists of four pieces, the 3rd–6th somites being coalesced into a large piece. The first two segments are strongly tuberculated and the large third piece bears tubercles on the basal part and some near the apex also.

The colour in spirit is white, and there are no characteristic markings either on the carapace or on the legs. The prominently-stalked tubercles on the carapace have a superficial appearance of some Madreporarian corals.

The single ovigerous female, that I have seen, has the following measurements :—

Length of carapace	8·0 mm.
Breadth of carapace, including lateral processes	14·8 mm.
Length of lateral process	2·8 mm.
Length of palm	4·6 mm.
Length of free finger	3·3 mm.

Type-specimen.—C 1560/1, Zoological Survey of India (*Ind. Mus.*).

Locality.—The single specimen on which the present species is based was collected by Lt.-Col. R. B. Seymour Sewell on board the R. I. M. S. " Investigator " in the Mergui Archipelago, 12° 14′ 30″ N., 98° 15′ 30″ E., on 23rd October, 1913. The depth at this place, according to the " Investigator " Station Book, was 24 fathoms, and the bottom consisted of mud, sand and broken shells.

Ixa investigatoris differs from both the hitherto known species of the genus chiefly in its small size, in having its surface closely covered with

raised and stalked tubercles, in the great reduction of the grooves on the surface of the carapace, in having rather short lateral processes and in having a pair of petaloid processes on the postero-lateral borders of the carapace, in addition to those on the posterior border. The three species of the genus *Ixa* may be distinguished from one another with the help of the following table :—

I. Cylindrus (FABR.).	*I. Inermis* LEACH, A. COC.	*I. Investigatoris*, SP. OV.
1. Lateral processes very large, more or less uniformly thick throughout, or sometimes tapering from the base, but the tip always sharply pointed.	1. Lateral processes comparatively short, gradually tapering from a broad base to a pointed tip.	1. Lateral processes short, gradually tapering from a broad base to a bluntly pointed tip.
2. Grooves on the carapace as deep and broad channels.	2. Channels replaced by ordinarily shallow grooves without any definite margins.	2. Grooves only faintly indicated.
3. Carapace with minute vesiculous granules; surface between granules smooth.	3. Carapace with vesiculous granules; surface between granules rough.	3. Carapace thickly covered over with raised and stalked tubercles, looking like corals; surface between tubercles somewhat smooth.
4. No prominent convexities on the carapace, the gastric region raised and the intestinal region somewhat tumid.	4. Some prominent convexities on the gastric region and one blunt elongated tubercle on the tumid intestinal region.	4. A number of regularly arranged convexities on the carapace : three on the gastric region, one on the cardiac, a double one on the intestinal, three on each branchial and one on each hepatic region.
5. No processes on the margins of the carapace in addition to the large lateral processes.	5. One petaloid process on each end of the posterior border of the carapace.	5. One petaloid process on each end of the posterior border, a similar one on each postero-lateral border, and a small one on each antero-lateral border a little in advance of the lateral process.
6. Buccal frame, though truncated anteriorly, distinctly triangular in outline.	6. Buccal frame quadrangular.	6. Buccal frame, though truncated anteriorly, distinctly triangular in outline.
7. Exognath of external maxilliped concave along its inner border, and falling short of the anterior edge of the afferent branchial channel. The raised outer border of the ischium with a narrow band of vesiculous granules, wanting at the basal end.	7. Exognath of external maxilliped strongly convex, except for a small distal portion, closely covered over with pearly granules and extending upto almost the anterior edge of the afferent branchial channel. Ischium grooved along the inner border, rest of the surface strongly convex and covered over with pearly tubercles.	7. Exognath of external maxilliped convex, especially towards the outer border, tuberculated and hardly falling short of the front edge of the afferent branchial channel. Ischium grooved along its inner half, outer half strongly convex and tuberculated.

Besides comparing *I. investigatoris* with the other species of the genus *Ixa*, it may be useful to consider here the position of MacGilchrist's genus *Ixoides*.[1] According to MacGilchrist the genus *Ixoides* differs from *Ixa* Leach in the following characters:—"The fingers are two-thirds the length of the palm, or about half the combined lengths of wrist and palm; the sides of the carapace are produced into two stout, conical, horn-like processes, tapering from the base; carapace is globular and its median regions are not pronouncedly demarcated by channels or grooves; the merus of the external maxilliped has its outer edge cut away and bevelled, and this bevelled edge forms the inner wall of the afferent branchial canal; the front is moderately prominent, projecting about as far as the salient edges of the afferent branchial canal." The characters pertaining to the relative length of the fingers appear to be applicable to the male specimens only that MacGilchrist had examined; in a large female example in the Indian Museum collection the fingers are barely half the length of the palm. In *Ixa* on the other hand, the fingers are not always "hardly half the length of the hand" as mentioned by Alcock.[2] In *I. inermis*[3] Leach, as redescribed by Alcock, the fingers are more than half the length of the hand, and the same is the case in the new species described in this paper. Conical, horn-like lateral processes are not characteristic of *Ixoides* only, but are commonly met with in the species of *Ixa* also.[4] In the absence of deep channels or grooves on the carapace *Ixoides cornutus*, the only species of MacGilchrist's genus, resembles *Ixa inermis* and *Ixa investigatoris*. The front is moderately bilobed in all the species of *Ixa* also, and projects about as far as the salient edges of the afferent branchial canal in at least one species—*I. investigatoris*. In the characters of the external maxillipeds, however, *Ixoides cornutus* differs markedly from all the species of *Ixa*, the merus, as mentioned by MacGilchrist, is of a perculiar shape, and the exognath also differs materially from that of all the species of *Ixa*. It is thus seen that the only important character by which MacGilchrist's genus can be distinguished from *Ixa* is afforded by the external maxillipeds, and that in practically every other respect the two genera are almost indistinguishable. In view of this the advisability of regarding *Ixoides* as a distinct genus is open to doubt; in my opinion it should be merged in the synonymy of *Ixa*, or at best should be given a subgeneric rank.

Raninoides hendersoni, sp. nov.

(Plate III, figs. 1, 1*a*.)

The carapace is more or less barrel-shaped in outline, having its greatest breadth about the middle of the body; its greatest length is considerably less than twice of its maximum breadth. Its surface is

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[1] MacGilchrist, *Ann. Mag. Nat. Hist.* (7) XV, pp. 255-257 (1905); *Illust. Zool.* '*Investigator*', pl. lxxiii, figs. 2, 2*a*, 2*b* (1905).

[2] Alcock, *Journ. As. Soc. Bengal* LXV, p. 271 (1896).

[3] I have discussed the question of the identity of this species in an earlier paper—*vide Rec. Ind. Mus.* XXXV, pp. 48-50 (1933).

[4] It has been shown that in *I. cylindrus* also the lateral processes are sometimes conical, horn-like and tapering—*vide* Chopra, *Rec. Ind. Mus.* XXXV, p. 46, 47 (1933).

smooth and polished, except for the anterior region behind the front, which is minutely punctate. The surface of the carapace adjoining the antero-lateral margins is also punctate. There is a distinct transverse line behind the front and the region between this line and the fronto-orbital margin of the carapace is covered with hairs and small squamiform granules; the area immediately behind this line is also granular. The carapace is markedly convex from side to side, and the regions are not indicated. The fronto-orbital margin is long, and is a little more than two-thirds the greatest breadth of the carapace. The rostrum is more or less like that of *R. personatus*[1]; it is prominent and entire, its apex is rounded, with a minute blunt process at the tip. There is a shallow groove running in a longitudinal direction from the tip of the rostrum to the transverse line behind the frontal region. On each side of the rostrum and continuous with it, is a large triangular lobe, more or less acutely pointed at the tip. A broad and deep fissure separates this lobe from a large and prominent tooth-like process, with a somewhat rounded apex, surmounted by a minute spine-like process at the tip. Another fissure, somewhat broader than the one described above, separates this large median process from the external orbital spine. This is broad at the base, and appears to be hollowed out anteriorly, where it terminates in two small spines: one, somewhat blunt, on the dorsal surface, and the other larger and more sharply pointed in a lateral position. The fissures on either side of the median process do not run to the transverse line behind the frontal region, mentioned above, but are continued backwards into shallow grooves partly covered over by long hairs. The fronto-orbital margin is strongly hairy, as also the lateral margins immediately behind the external-orbital lobes. The eye-stalks are long, broad and dilated at the base and taper towards the tip, where the cornea occupies practically the entire thickness of the stalk.

The lateral borders of the carapace are broadly arched. A little distance behind the external orbital process is a small and sharply-pointed spine. In the single specimen that I have examined the tip of this spine is broken on one side and thus appears to be blunt, but on the other side it is seen to be sharply pointed. A prominent line runs across the surface of the carapace joining these spines on the two sides. Near the lateral margins this line runs obliquely, inwards and forwards, but becomes transverse on the median region. The lateral margin, a little behind the spine, is defined by a raised and very finely milled line. The border anterior to the spine is markedly hairy, while that immediately behind it is finely crenulate and sparsely hairy.

The pterygostomian regions are puffed out and are densely hairy. In between the hairs the surface is seen to be somewhat granular.

The external maxillipeds are like those of *R. personatus*. They are long and narrow, and their terminal parts encroach on the epistomial region. The ischium is about one-third longer than the merus and both have a raised inner margin. The surface of the merus is granular and somewhat hairy, and there is a strong fringe of hairs along its outer

[1] Henderson, *Challenger Anomura* (Zool. XXVII), pp. 27, 28, pl. ii, fig. 5 (1888).

margin, which is broadly rounded. The flagellum is short and is inserted opposite a slight depression along the inner edge of the merus near its tip. The exognath is short, and extends up to the end of the ischium only.

The chelipeds (Plate III, fig. 1*a*) are large and are considerably longer than half the length of the carapace. The ischium is small and has a minute spine on the anterior border near its distal end. The merus is large and dilated, and its outer surface is somewhat squamiform and the edges are faintly crenulate. The carpus is considerably shorter than the merus and has two small, more or less subequal, spines at its distal end, one on the dorsal and the other on the outer border. The upper and the outer surface of the carpus is covered with scale-like tubercles, interspersed with stiff hairs and the borders are markedly granular. The propodus is flattened and has is a stout acutely-pointed spine about the middle of its outer border. There are three such spines on the inner border also. The outer and upper surfaces of the hand, like those of the wrist, are covered over with scaly tubercles and stiff hairs, and the outer border is also granular. The fixed finger forms an obtuse angle with the hand, and its base is only moderately flattened. Its cutting edge is sharply dentate almost up to the finely pointed tip. The dactylus is broadly arched ; its cutting edge is totally unarmed, and ends in a blunt tip. The outer edge of the dactylus is somewhat crenulate near the base. The fingers leave a small gap when they meet, and the dactylus somewhat falls short of the tip of the fixed finger.

The first three walking legs progressively increase in size from before backwards, while the last legs, which are placed in advance of the penultimate pair in a dorsal position, are very much reduced. The legs are modified in the usual way, the distal segments being foliaceous. The dactyli of the first two pairs are acutely pointed, and the carpus is strongly carinate dorsally in the first three pairs. In the last pair the carpus and propodus are subequal, and the dactylus is distally broadened and rounded. All the legs have long hairs along their edges.

In the single female example that I have examined the abdominal segments are smooth and polished above and are ciliated laterally. The first segment is considerably shorter in breadth than the posterior breadth of the carapace, and the remaining segments diminish in size progressively from before backwards. The appendages are strongly ciliated.

The thoracic sternal shields are somewhat like those of *R. personatus*. The first element is broad, and thus separates widely the bases of the chelipeds ; the second piece is more narrowed posteriorly than that of *R. personatus*, with the result that the bases of the first pair of walking legs are more approximated to the middle line than in the other species ; the third piece is still more narrowed posteriorly, and the bases of the second pair of legs almost touch one another in the middle line. In this respect the sternal shields somewhat resemble those of *R. serratifrons* Henderson,[1] in which species there is a still further narrowing of the posterior ends of the second and third pieces. There is a groove running along the median line, almost from end to end, of the shield.

[1] Henderson, *Trans. Linn. Soc. London* (Zool.), V, pp. 408, 409, pl. xxxviii, figs. 10-12 (1893).

The process on each side between the basal joints of the chelipeds and the first pair of legs is distinctly seen in this species also, though it is not acutely pointed as in *R. personatus.*

In the single specimen that I have in the collection, the carapace, including the rostrum is 17 mm. long, while the greatest breadth is 10·1 mm.

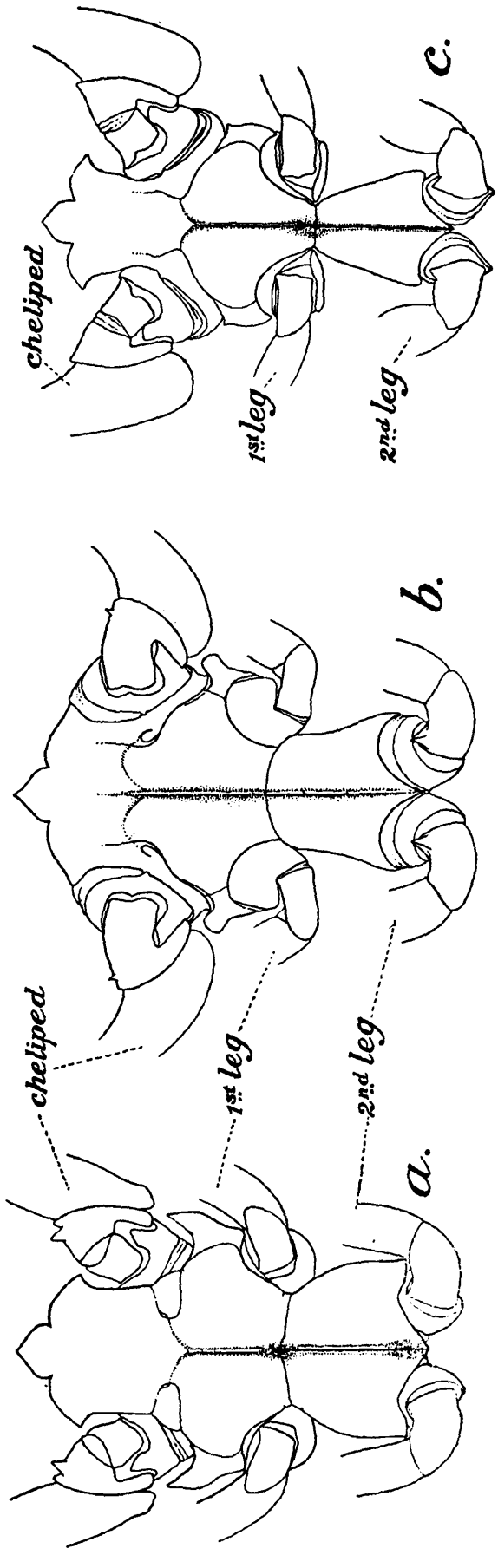
Type-specimen.—2640/10, Zoological Survey of India (*Ind. Mus.*).

Locality.—The single example on which the present species is based, was dredged in the Andaman Sea at 11° 49′ 50″ N., 92° 52′ E. at a depth of 55 fathoms in April 1898, by the R. I. M. S. "Investigator". According to the "Investigator" station book the bottom at this place consists of sand and stones. This specimen had been entered up in the registers of the Indian Museum, probably in Alcock's hand, as "*Raninoides personatus* White, variety" It is in a fair state of preservation, but one cheliped and parts of some of the legs are missing. It is a female example, and does not carry eggs.

Raninoides hendersoni can be readily distinguished from the other species of the genus by a number of well-marked characters. The carapace is remarkably broad in the anterior half, with a distinct line behind the frontal region, the area between this line and the front being covered over with scaly tubercles and long hairs; there are two deep and broad fissures on each side of the frontal region, between the rostrum and the external orbital lobe, separating a large and prominent tooth-like process on the inner side of the orbit; there is a single spine on the lateral margin; the external orbital lobe is bidentate; the cheliped has the arm and wrist covered with squamiform granules on the outer aspect; and the hand has a single spine about the middle of its surface. The present species somewhat resembles *R. laevis*[1] (Lat.), and its variety *lamarcki* Bouvier,[2] in the shape of the fronto-orbital border, but the fissures in the present case are considerably broader. Further in *R. laevis* the spine on the lateral border of the carapace is very large; there is no line on the carapace connecting the lateral spines of the two sides; and the form of the hand is altogether different. In *R. nitidus* M.-Edwards,[2] there are two spines on each antero-lateral border; there is only one fissure on each side on the fronto-orbital border; the external orbital spine is very large; there are clear indications of the regions on the carapace; and the hand is very different in shape. In Milne-Edwards' *R. fossor*[2] the rostrum is somewhat serrated, and the fissures on the fronto-orbital border of the carapace appear as insignificant sutures only. The nearest ally of *R. hendersoni* seems to be *R. personatus* Henderson, but the two may be destinguished by the fact that in Henderson's species the carapace is proportionately longer than broad (Plate III, fig. 2), the frontal fissures are narrower, and the median lobe is squarish; there is no line behind the frontal region; the first abdominal somite is much narrower; the spine on the outer border of the hand is more terminal in position; and the fixed finger is more broadened out at the base (Plate III, fig. 2*a*).

[1] Milne-Edwards, *Hist. Nat. Crust.* II, pp. 197, 198 (1837); Desmarest, *Consider Gén. Crust.*, pl. 19, fig. 2 (1825).

[2] Milne-Edwards and Bouvier, *Mem. Mus. Comp. Zool. Harvard* XLVII, pp. 298-300, pl. i, figs. 8-10, pl. ii, figs. 1-5, pl. iii, fig. 1 (1923).



TEXT-FIG. 1.

Sternal shield of *a. Raninoides personatus* Henderson, *b. Raninoides hendersoni*, sp. nov., and *c. Raninoides serratifrons* Henderson.

All the figures are from female specimens, and are drawn to different magnifications but show the same length of the shield. In the narrowing of the posterior ends of the second and third pieces of the shield *R. hendersoni* (fig. *b*) shows an intermediate condition between *R. personatus* (fig. *a*) and *R. serratifrons* (fig. *c*)

The second species that Henderson described under the name of *Raninoides serratifrons*[1] (Plate III, figs. 3, 3*a*) has still to be considered. This species, according to Gilbert Bourne,[2] is not a member of *Raninoides* at all, but should be included in his new genus *Notosceles*. Bourne's new genus differs from *Raninoides* " in the proportions of the carapace, the shape of the rostrum, the lesser width of the fronto-orbital region, the larger corneae of the eyes, the proportions of the antennal peduncles, and in other characters, but especially in the relatively much greater width of the base of the abdomen, and the proportion and shape of the sternal shield." Another important character mentioned by Bourne is that in *Notosceles* the merus of the third maxilliped is little more than half as long as the ischium, while in *Raninoides* it is only a little shorter than the ischium. The difference in the sternal shield mentioned by Bourne lies in the fact that in *Notosceles* the second and the third pieces are narrowed posteriorly, so that the bases of the first and the second pereiopods are approximated to the middle line; in *Raninoides* these pieces are broad posteriorly and, therefore, the bases of the two first legs, are placed far apart from the middle line. All these characters mentioned by Bourne are no doubt present in his species *Notosceles chimmonis*, but some of them do not appear to be applicable to Henderson's *R. serratifrons*. Further the new species described in this paper shows a number of characters that are clearly intermediate between those of *R. serratifrons* and of a typical *Raninoides*, like *R. personatus*. The proportion between the length of the carapace and its breadth is practically the same in *R. serratifrons* and R. *personatus*, and there is no material difference between the proportion of the merus and ischium of the third maxilliped either. The fronto-orbital border is no doubt shorter as compared with the breadth of the carapace in *R. serratifrons* than in the species of *Raninoides*, but the sutures and lobes, etc., on this margin are similar to those of *R. hendersoni*, and to some extent to those of *R. laevis*. Regarding the width of the base of the abdomen there is a very marked difference between *R. serratifrons* and *R. personatus*, but in this respect, as the accompanying illustrations (Plate III, figs. 1, 2 and 3) show, *R. hendersoni* appears to be clearly an intermediate form, and bridges very considerably the difference between the two. The one great difference between *R. serratifrons* and the other species of *Raninoides*, apart from the shorter fronto-orbital border, is in the sternal shield, but even in this character the new species shows signs of approximating towards the condition found in *R. serratifrons*. From the accompanying illustration (text-figure 1) it is clearly seen that in the narrowing of the second and the third pieces of the sternal shield *R. hendersoni* is an intermediate species between *R. serratifrons* (and possibly *Notosceles chimmonis* Bourne also) on the one hand, and the other typical species of *Raninoides*, like *R. personatus*, on the other. All these considerations have led me to the opinion that Henderson's *R. serratifrons* does not show sufficiently important differences from the other species of *Raninoides* to justify its separation into another genus, and that in all probabilities Bourne's *Notosceles* will have to be sunk in the synonymy of *Raninoides* Milne-Edwards.

[1] Henderson, *Journ. Linn. Soc. London* (Zool.), V, pp. 408, 409, pl. xxxviii, figs. 10-12, (1893)

[2] Bourne, *Journ. Linn. Soc. London* (Zool.), XXXV, pp. 73-75 (1922).

EXPLANATION OF PLATE III.

Raninoides hendersoni, sp. nov.

FIG. 1.—Dorsal view of carapace and first abdominal somite : × 4.

FIG. 1*a*.—Right cheliped, further enlarged.

Raninoides personatus Henderson.

FIG. 2.—Dorsal view of carapace and first abdominal somite : × 4.

FIG. 2*a*.—Right cheliped of another specimen, further enlarged.

Raninoides serratifrons Henderson.

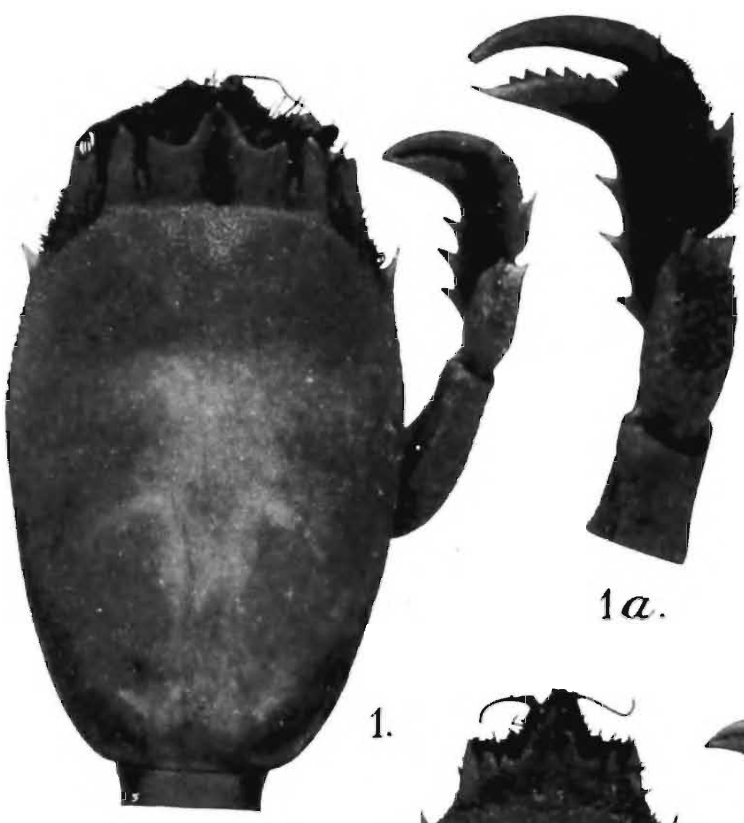
FIG. 3.—Dorsal view of carapace and first abdominal somite : × 4.

FIG. 3*a*.—Right cheliped, further enlarged.

Ixa investigatoris, sp. nov.

FIG. 4.—Dorsal view : × 4.

FIG. 4*a*.—Buccal cavern, further enlarged.



1.

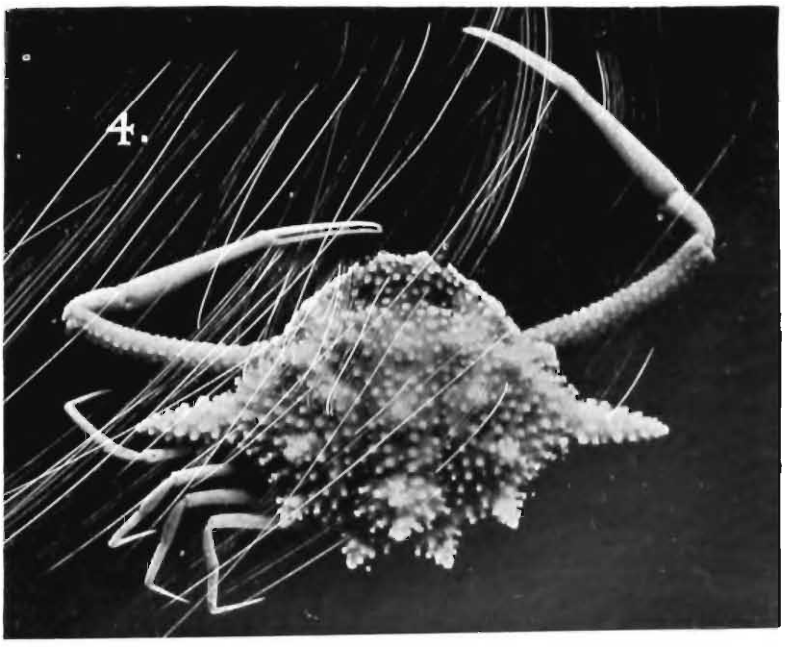
1a.

2.

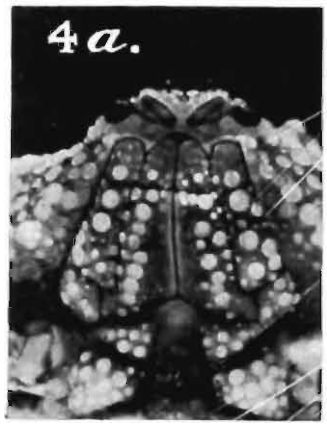
3.

3a.

2a.



4.



4a.

Subodh Photo.

AN ECOLOGICAL STUDY OF THE FAUNA OF THE KHEWRA GORGE AND SOME OTHER SALT WATERS IN THE SALT RANGE, PUNJAB.

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INTRODUCTORY.

The Khewra Gorge is a small stream which runs between low hills[1] near Khewra village (Jhelum district) in the Punjab. It is actually a stream only during and just after the rainy season; for the most part of the year it is a chain of pools, some of which are connected with one another by underground water channels. The water of this stream is absolutely fresh at a distance of about three miles from Khewra, and from there it is brought down by pipes for the use of the inhabitants of this and the neighbouring villages. As the stream approaches Khewra, it becomes gradually saline, its salinity near this village being more than twice that of the sea. Below this village it loses the form of a stream; its water spreads and falls into the Jhelum river, which runs at a distance of about three miles from Khewra.

Extensive literature exists on the fauna of the sea coasts of various parts of Europe[2]. Blanchard and Richard (1892) and Roy and Gauthier (1927) described the Crustacean fauna (chiefly Copepods) of some salt water lakes of Algeria and Tunis (N. Africa). Sars (1903) gave an extensive account of the Crustacea of a large number of salt lakes in Central Asia, but unfortunately did not give any exact salinity data of the waters investigated. In India, Annandale (1907) and Kemp (1917) made several investigations on the brackish-water fauna of the Gangetic Delta and studied very exhaustively the fauna of the Chilka Lake in Orissa and the Talé Sap lake in Peninsular Siam[3]. Dr. S. L. Hora in 1922 made a collection of both terrestrial and aquatic fauna at several localities, including the Khewra Gorge, in the Salt Range, Punjab. The reports on this fauna were published in the *Records of the Indian Museum*, Vol. XXV, 1923. Dr. Hora examined the Khewra Gorge at one or two places only and did not study the chemical and physical condition of the water at the time of making collections. As the available literature shows, very few inland streams like the Khewra Gorge, in which the salinity varies greatly at different places at the same time of the year and in which it is not due to the addition of sea water, have been thoroughly investigated. It is fairly well known that, even though the salinity may be the same, the conditions of life in an inland water are quite different from those in the sea. Buxton (1926)

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[1] The geological structure of the Salt Range is described by Sir H. Hayden in the Jhelum district Gazetteer as follows:—"The greater part of the district lies on the sandstones and conglomerates of the Sewalik Series (upper tertiary), etc. The lowest bed is the salt mark and rock salt which affords the material for extensive mining industry."

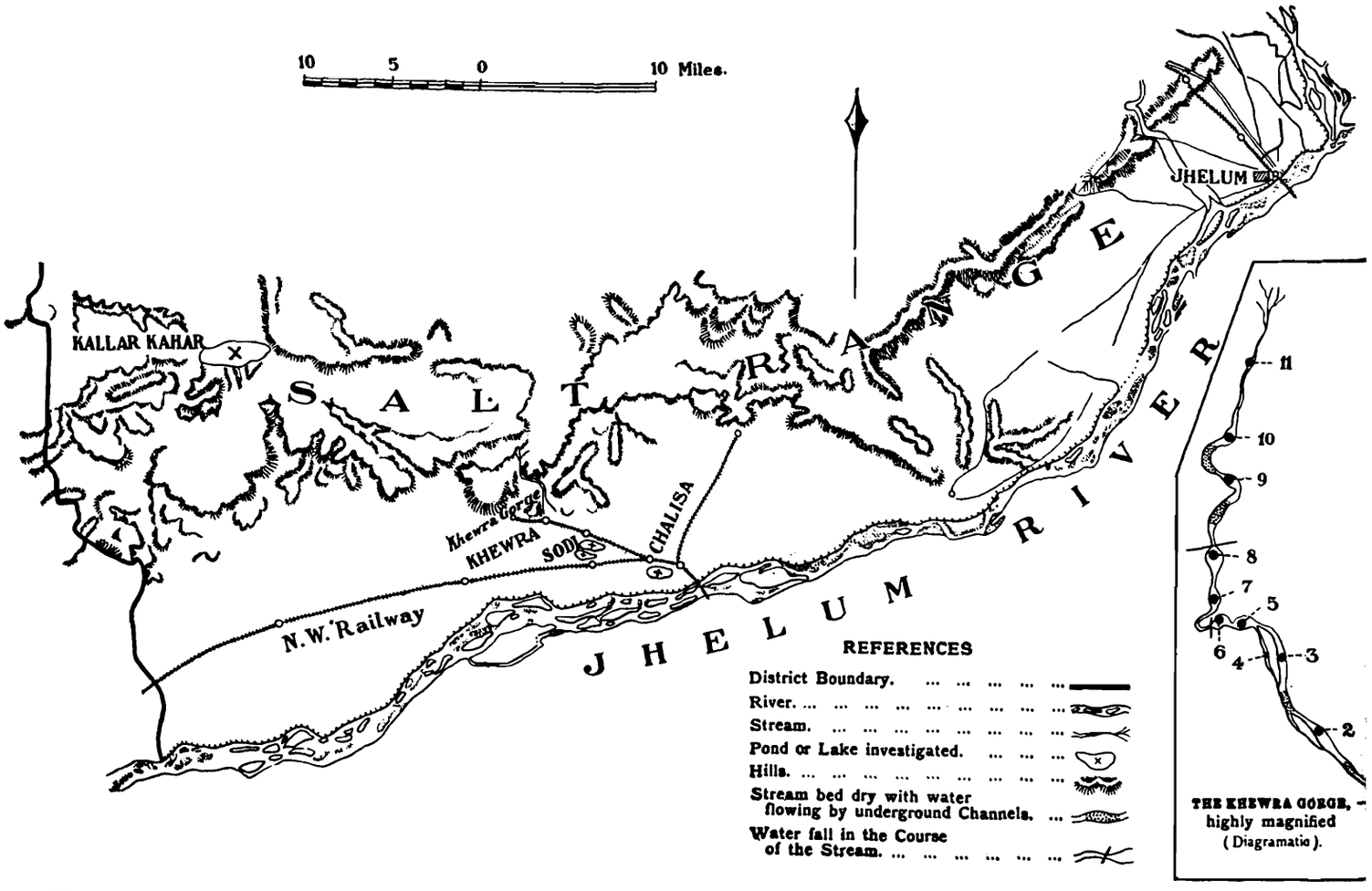
[2] H. v. Lengerken (*Die Tier Welt d. Nord U. Ostsee*, Teil XIe, Lief. 16, 1929) gives a complete list of these works.

[3] Systematic reports on the fauna of these two areas were made by numerous workers and were published in the *Memoirs of the Indian Museum*, Vol. V, 1915-1924 and *Mem. Asiat. Soc. Beng.*, VI, 1916-1925, respectively.

gave instances of several animals which can tolerate inland waters of very high salinities but cannot apparently live in the sea. It was, therefore, considered desirable to make an intensive study of the fauna of the Khewra Gorge in special reference to the nature of its water.

The fauna of this stream was collected in the autumn of 1930 and the spring of 1931. On both occasions the stream was in the form of a series of pools. The salinity was found to be higher on the latter occasion. Between the two periods of making collections there had been no intervention of a rainy season, which lasts from July to September. During and just after this season the stream is continuous and flows very rapidly and there is consequently a thorough mixing of the fauna of its different parts. To study the changes in the fauna after the intervention of a rainy season and thus complete the investigation, I intended to pay another visit to the locality in September, 1931, but in view of the financial stringency the project had to be abandoned. As the financial conditions are not likely to improve in the near future, it has been thought advisable to publish the results of the investigations made on the two occasions mentioned above.

In addition to the Khewra Gorge, the fauna of the salt water lake near Kallar Kahar and of a series of pools at Chalisa and Sodi were also investigated. On the occasion of my second visit I examined also the San Sakesar Lake near the village Uchhali at the base of the Sakesar hills in the Salt Range. In the map of the Salt Range given below the various waters investigated, except the San Sakesar Lake, are indicated. This lake lies about 60 miles west of Kallar Kahar.



TEXT-FIG. 1.—Map of the Salt Range (part), Punjab, showing all the waters investigated except the San Sakesar Lak

I determined the PH value (Colorimetric method), the temperature and the oxygen content (Winkler's method) of the water at the side of the stream at the time of making collections. The salinity was roughly measured in the Dak Bungalow at Khewra on the same day on which the water samples were collected. But since, as was shown by Bert (1883), Varigny (1883), Plateau (1883), Pantin (1931), etc., salinity changes alone hardly give an accurate index to the suitability of a water as a habitat for different animals, and ions like sodium, potassium, calcium, etc., play an important role in this connection, it was proposed to have all the water samples completely analysed. Dr. A. N. Puri, D.Sc. (Lond.), of the Irrigation Research Laboratory, Lahore, carried out the chemical analyses including salinity determinations soon after the collection of the samples. Col. R. B. Seymour Sewell made accurate salinity determinations (by titration method as recommended by the Conseil Permanent pour l'Exploration de la Mer) in Calcutta after the expiry of one year, when the water samples were received back from Dr. Puri. The samples had been stored in spring-stoppered glass bottles provided with good rubber washers. The salinities mentioned in the following pages were calculated from Col. Sewell's figures of halogen contents.

The credit for starting this research is mainly due to my colleague and friend Dr. S. L. Hora, who as above mentioned had toured in the Salt Range in 1922 and who not only drew my attention to the stream but accompanied me to Khewra on the occasion of my first visit, *viz.*, October 1930. My best thanks are also due to Col. R. B. Seymour Sewell, Director, Zoological Survey of India, who took keen interest in the investigations and afforded facilities for carrying out the same, and to Dr. Baini Prashad for going through the manuscript and making some useful suggestions.

Naturally I had to seek the help of many specialists both in India and abroad for naming the various groups of animals collected and I take this opportunity of expressing my indebtedness to them. I give below the list of such workers. The orders and families of insects, which are not mentioned below but are dealt with in the report, have been named by myself with the help of my Assistant, Mr. S. Ribeiro.

Pisces . . .	Mr. D. D. Mukerji, Indian Museum, Calcutta.
Amphibia and Mollusca	Mr. J. L. Bhaduri, Indian Museum, Calcutta.
Crustacea . .	Mr. K. N. Das, Indian Museum, Calcutta.
Insects.	
Coleoptera	Prof. Dr. Heinrich Kuntzen (Berlin).
	Dr. A. d'Orchymont (Brussels).
	Dr. M. Cameron (London).
	Mr. H. E. Andrewes (London).
	Mr. S. Maulik (London).
	M. E. Fleutiaux (Paris).
Rhynchota (part)	Dr. G. E. Hutchinson (Yale).
	Dr. O. Lundblad (Stockholm).
Odonota .	Lt.-Col. F. C. Fraser.
Ephemeroptera .	Dr. B. N. Chopra, Indian Museum, Calcutta.
Diptera . .	Mr. F. W. Edwards (London).
Algae	Dr. S. L. Ghosh, Government College, Lahore.

The fauna of the Khewra Gorge and the condition of its water at the time of making collections.

At the beginning of the investigation, the salinity of the stream was roughly measured at several places, and eleven stations were selected for intensive work. In this chapter these stations are described in detail, the physical and chemical analyses of the water at each station are appended and the animals collected at the stations are enumerated. In the analyses the values are expressed as grams per litre except when otherwise stated. The salinity was calculated from the halogen content by the following formula of Knudsen :—Sal.$=0{\cdot}03+1{\cdot}805\times$cl, where cl is equal to the halogen content.

Sta. 1.

Near the first dam across the stream, about one furlong from Khewra. Water shallow, clear, with long tufts of filamentous algae. Bottom rocky, covered with fine, dark mud with a coating of reddish coarse sediment.

Date and time of collection.—11th October, 1930. 3-15—10-30 a.m.

Physical and Chemical condition of the water.—Temp. 27°C ; PH 8·0 ; Alkali reserve 0·0038N ; Oxygen 4·14 cc. per litre. Total solids 75·96 gm. per litre ; Ca 1·748 ; Mg 0·252 ; K 0·142 ; Na 27·691 ; SO_4 1·799 ; HCO_3 0·0114 ; NO_3 0·0124 ; Conductivity 13·98. Halogen content 43·49 ; Salinity 78·529.

Na & Cl constituted the major portion (36·46 per cent. and 58·33 per cent. respectively) of the total solids ; Ca 2·3 per cent. (Tables I and II).

Fauna.—No animal life except insects.

Coleoptera.			
Hydrophilidae	1. *Octhebius* sp.	(Adult).	Very common.
	2. *Berosus punctulatus* f. col. *immaculicollis* Fairm. *sensu* Knisch	,,	Common.
Ephemeroptera.			
Baetidae	*Cloëon* sp.	(Larvae).	Extremely common.
Diptera.			
Chironomidae	*Culicoides* sp.	(Larvae).	Some.
,,	Gen. and sp. ?	,,	,,
Tabanidae	*Tabanus* sp.	,,	A few.

Under stones on the sides of the water channel an earwig, *Labidura* sp. and a spider, *Lycosa* sp. were fairly common.

Date and time of collection.—27th March, 1931. 8—10 a.m.

Physical and Chemical condition of the water.—Temp. 21·0°C ; PH 7·85 ; Oxygen 3·02 cc. per litre ; Halogen content 92·42 ; Salinity 166·830.

Fauna.—The *Berosus* beetle, may-fly and chironomid larvae obtained in October, 1930 were absent. In addition to the other species obtained in October, 1930, the following were collected :—

Coleoptera.			
Hydrophilidae	Probably *Berosus* sp. .	(Larvae).	Some.
Chrysomelidae	*Psylliodes tenebrosus* * Jac. .	(Adult).	,,
Elateridae	*Drasterius collaris* Cand.	,,	A few.
Rhynchota.			
Hydrometridae	*Hydrometra* sp. .	(Adult).	A few.
Diptera.			
Sciomyzidae	Gen. and sp. ? .	(Larvae).	Some.

Sta. 2.

About $\frac{1}{4}$ mile beyond Sta. 1. High red rocks on both sides of the stream. Water shallow, laden with red sediment. Some algae present, chiefly *Chaetomorpha* sp., near *herbipolensis* Lag.

Date and time of collection.—12th October, 1930. 7-30—10-30 a.m.

Physical and Chemical condition of the water.—Temp. 26·4°C ; Oxygen 3·35 cc. per litre ; PH 7·95 ; Alkali reserve 0·0044 N. Total solids 87·536 gm. per litre ; Ca 1·888 ; Mg 0·231 ; K 0·089 ; Na 33·047 ; SO_4 1·530 ; HCO_3 0·0126 ; NO_3 0·0093 ; Conductivity 15·65 ; Halogen content 50·55 ; Salinity 91·273.

Na and Cl constituted the major portion (37·76 per cent. and 57·97 per cent.) of the total solids. Ca 2·16 per cent. only (Tables I and II).

Fauna.—No animal life except insects.

Coleoptera.			
Hydrophilidae	*Octhebius* sp. . .	(Adult).	Extremely common.
,,	*Berosus punctulatus* f. col. *immaculicollis* Fairm. *sensu* Knisch.	,,	Common.
,,	. *Enochrus* sp.	,,	A few.
,,	*Enoplurus* sp.	,,	,,
,,	Gen. and sp. ? .	(Larvae).	About 1 doz.
Ephemeroptera.			
Baetidae	*Cloëon* sp.	(Larvae).	Common.
Diptera.			
Chironomidae	*Culicoides* sp. . .	(Larvae).	A few.
,,	Gen. and sp. ? . .	,,	,,

Under stones on the sides of the water channel the earwig *Labidura riparia* and a spider, *Lycosa*, sp. were present.

* In the opinion of Mr. S. Maulik, the presence of *Psylliodes tenebrosus* in salt water is probably accidental.

Date and time of collection.—9th April, 1931. 8—9 a.m.

Physical and Chemical condition of the water.—Temp. 20·7°C ; PH 7·95 ; Oxygen 3·4 cc. per litre ; Halogen content 68·66 ; Salinity 123·961.

Fauna.—The *Berosus* beetle, may-fly and chironomid larvae obtained in October, 1930 were not found. In addition to the other animals obtained in October, 1930, the following were collected :—

Coleoptera.			
Hydrophilidae	. Probably *Berosus* sp.	. (Larvae).	Common.
Staphylinidae	*Platystethus cornutus* Gr.	(Adult).	Few.

Sta. 3.

About ¼ mile beyond station 2. Water clear, thickly covered with algae of several species, *e.g.*, *Enteromorpha* sp., near *salina* Kutz. ; *Chaetomorpha herbipolensis* Lag. and *Cocconeis pediculus* Ehr. Bottom rocky or covered with pebbles. Depth 1-2 ft.

Date and time of collection.—13th October, 1930. 8—11 a.m.

Physical and Chemical condition of water.—Temp. 24·4°C ; Oxygen 4·65 cc. per litre ; PH 8·05 ; Alkali reserve 0·0052 N ; Total solids 40·916 ; Ca 1·2 ; Mg 0·17 ; K 0·086 ; Na 15·059 ; SO_4 1·473 ; HCO_3 0·0174 ; NO_3 0·0124 ; Conductivity 8·264 ; Halogen content 23·45 ; Salinity 42·357.

Na 36·81 per cent.; Cl 55·97 per cent. ; Ca 2·93 per cent. (Tables I and II).

Fauna.—No animal life except insects.

Coleoptera.			
Hydrophilidae	*Berosus punctulatus* f. col. *immaculicollis* Fairm. *sensu* Knisch	(Adult).	A few.
,,	. *Octhebius* sp.	,,	,,
,,	*Enochrus* sp.	,,	,,
Dytiscidae	. *Potamodytes* sp.†	,,	Few.
Dryopidae	*Dryops* sp.	,,	,,
Ephemeroptera.			
Baetidae .	*Cloëon* spp.	(Larvae and dead adults).	Numerous.

Under stones near the sides of the water channel, the earwig *Labidura riparia* present.

Date and time of collection.—9th April, 1931. 9—10 a.m.

Physical and Chemical condition of water.—Temp. 21·7°C ; PH 8·1 ; Oxygen 4·1 cc. per litre ; Halogen content 28·27 ; Salinity 51·057.

Algae in great abundance.

Fauna.—*Berosus*, *Potamodytes* and *Dryops* beetles obtained in October, 1930 were absent. In addition to the other species obtained in October, 1930, the larvae of a species of *Tabanus* were found in large number.

† Dr. H. Kuntzen considers this to be a new species.

Sta. 4.

A small and shallow streamlet flowing out of the main stream near station 3. Bed covered with small stones, water clear, slightly yellowish. Sides covered with deposits of salts. Hardly any vegetation.

Date and time of collection.—13th October, 1930. 7—9-30 a.m.

Physical and Chemical condition of water.—Temp. 24·0°C ; Oxygen 2·85 cc. per litre ; PH 8·1 ; Alkali reserve 0·0038 N. Total solids 137·84 ; Ca 2·752 ; Mg 0·372 ; K 0·152 ; Na 54·064 ; SO_4 0·783 ; HCO_3 0·0126 ; NO_3 0·0124 ; Conductivity 22·42 ; Halogen content 79·70 ; Salinity 143·889.

Na 39·23 per cent. (more than in any other water examined), Cl 57·84 per cent. ; NO_3 0·009 per cent. (least) ; Ca 2·00 per cent. (Tables I and II).

Fauna.—No animal life except insects.

Coleoptera.

Hydrophilidae	*Octhebius* sp. . .	(Adult).	Extremely common.
	Berosus punctulatus f. col. *immaculicollis* Fairm. *sensus* Knisch	,,	Some.
	Enochrus sp. . .	,,	,,
	Enoplurus sp. . .	,,	,,

Date and time of collection.—9th April, 1931. 8—9 a.m.

Physical and Chemical condition of water.—Temp. 23·8°C ; PH 7·8 ; Oxygen 2·8 cc. per litre ; Halogen content 72·46 ; Salinity 130·82.

Fauna.—No animal life except insects. *Berosus, Enochrus* and *Enoplurus* beetles not found. In addition to *Octhebius* sp. which was very common, a specimen of a Thysanuran and a large number of Sciomyzid larvae (Diptera) were found.

Sta. 5.

A large, deep pool in the course of the stream near its first sharp turning. Bottom rocky, in some places muddy or covered with coarse shingle. Water clear. Several species of algae present, *e.g., Spirogyra* sp., *Oedogonium* sp., *Navicula* (*Pinnularia*) *parva* Ehrenb., *Cymbella helvetica* Kutz., *C. cymbiformis* Kutz., *Synedra acus* Kutz., *Nitzschia angustata* W. Sm. var. *genuina* Meist. and *Tryblionella punctata* (W. Sm.) Grun.

Date and time of collection.—14th October, 1930. 9-30—11-30 a.m.

Physical and Chemical condition of water.—Temp. 25·2°C ; Oxygen 5 cc. per litre ; PH 8·0 ; Alkali reserve 0·0054 N. Total solids 38·224 ; Ca 1·140 ; Mg 0·178 ; K 0·129 ; Na 13·856 ; SO_4 1·463 ; HCO_3 0·0183 ; NO_3 0·0124 ; Conductivity 7·874 ; Halogen content 21·51 ; Salinity 38·856.

Na 36·25 per cent.; Cl 56·06 per cent.; Ca 2·98 per cent.; K 0·337 per cent.; SO_4 3·83 per cent. (Tables I and II).

Fauna.—No animal life except insects.

Coleoptera.			
Hydrophilidae	*Berosus punctulatus* f. col. *immaculicollis* Fairm. *sensu* Knisch	(Adult).	Common.
	Enochrus sp. . .	,,	A few.
Dytiscidae .	. *Potamodytes* sp. . .	,,	Common.
Dryopidae	. *Dryops* sp. .	,,	Some.
Ephemeroptera.			
Baetidae .	. *Cloëon* spp. .	(Larvae).	Common.
Diptera.			
Tabanidae	*Tabanus* sp. .	,,	,,

Date and time of collection.—9th April, 1931. 9—10 a.m.

Physical and Chemical condition of water.—Temp. 21·7°C; PH 7·7; Oxygen 4·8 cc. per litre.

Fauna.—In addition to the species found in October, 1930, a few specimens of the Carabid *Tachys quadrillum* Schaum and the Hemipteron *Heleocoris* were obtained. The beetle *Enochrus* sp. was much more common. Some dead specimens of adult may-flies (*Cloëon* spp.) were also obtained.

Sta. 6.

The stream at the first sharp turning, about 50 yds. from Sta. 5; Water clear, depth 2—2·5 ft. Bottom covered with pebbles, stones and large pieces of rock. Several species of algae present, *e.g.*, *Enteromorpha* sp. prox. *salina* Kutz., *Chaetomorpha herbipolensis* Lag., *Cocconeis pediculus* Ehr., *Amphora* sp., *Nitzschia* sp.

Date and time of collection.—14th October, 1930. 7-15—10-30 a.m.

Physical and Chemical condition of water.—Temp. 23·20°C; Oxygen 5·7 cc. per litre; PH 8·15; Alkali reserve 0·0052 N. Total solids 9·928; Ca 0·436; Mg 0·090; K 0·096; Na 3·345; SO_4 0·482; HCO_3 0·0177; NO_3 0·0124; Conductivity 2·278; Halogen content 6·01; Salinity 10·878.

With the exception of Na and Cl the percentage of all the ions more than at the previous five stations. Na 33·7 per cent.; Cl 54·91 per cent.; Ca 4·39 per cent.; Mg 0·906 per cent. (Tables I and II).

Fauna.—In addition to insects, an amphibian and some fish were also obtained.

Insecta.			
Coleoptera.			
Dryopidae	*Dryops* sp.	(Adult).	Very common.
Dytiscidae	*Hydaticus fabricii*, Mac-Leay	,,	Some.
,,	. *Potamodytes* sp.	,,	Common.
Ephemeroptera.			
Baetidae .	. *Cloëon* sp.	(Larvae).	Numerous.

Odonata.			
Libellulidae	*Trithemis* sp., probably *festiva* (Ramb.)	(Nymphs).	Some.
Diptera.			
Tabanidae	*Tabanus* sp.	(Larvae).	Some.
Amphibia.			
Ranidae	*Rana cyanophlyctis* Schneid.	(Adult).	Some.
Pisces.			
Cyprinidae	*Barilius vagra* (Ham. Buch.)		Some.

The lip of a small fall at the head of station 6 was covered with a thick growth of algae in which Chironomid larvae (forming tubes on stones) and a Veliid bug (Hydrometridae) were fairly abundant.

Date and time of collection.—29th March, 1931. 10—11-30 a.m.

Physical and Chemical condition of water.—Temp. 21·6°C ; PH 7·9 ; Oxygen 6·4 cc. per litre ; Halogen content 5·26 ; Salinity 9·524.

Fauna.—May-fly larvae were absent. In addition to the other species found in October, 1930, the following were obtained :—

Coleoptera.			
Hydrophilidae	? *Berosus* sp.	(Adult).	Common.
,,	*Enochrus* sp.	,,	Some.
,,	Gen. and sp. ?	(Larvae).	Common.

Sta. 7

A large pool in the course of the stream, about 100 yds. from Sta. 6. Water clear, greatest depth 6 ft., bottom sandy. Algae few, *e.g.*, stray filaments of *Oedogonium* sp., *Phromidium molle* (Kutz.), and *Cocconeis pediculus* Ehrenb.

Date and time of collection.—14th October, 1930. 9-45—11-30 a.m.

Physical and Chemical condition of water.—Temp. 23·3°C ; Oxygen 5·0 cc. per litre ; PH 8·0 ; Alkali reserve 0·0051 N. Total solids 4·42 ; Ca 0·284 ; Mg 0·122 ; K 0·034 ; Na 1·376 ; SO_4 0·304 ; HCO_3 0·0171 ; NO_3 0·0124 ; Conductivity 1·064 ; Halogen content 2·85 ; Salinity 5·174.

Percentage of Na and Cl less, and that of all other ions higher than at the previous stations. Great increase in the percentage of Ca (6·43 per cent.) and Mg (2·76 per cent.). (Tables I and II.)

Fauna.—Representatives of Insecta, Mollusca, Amphibia and Pisces obtained.

Insecta.			
Coleoptera.			
Hydrophilidae	Gen. and sp. ? . .	(Adult).	Common.
,,	*Enochrus* sp.	,,	Some.
Ephemeroptera.			
Baetidae	*Cloëon* sp. . .	(Larvae).	Some.

Trichoptera.			
Polycentropidae	Gen. and sp. ? . .	(Larvae)	Some.
Odonata.			
Libellulidae .	*Trithemis* sp. probably *festiva* (Ramb.) .	(Nymphs).	Common.
Rhynchota.			
Nepidae .	*Ranatra elongata* Fabr.	(Adult).	Some.
Mollusca.			
Melanidae	*Melanoides flavidus* (Nevill) .		Common.
Amphibia.			
Ranidae . .	*Rana cyanophlyctis* Schneid. . .	(Adult).	Common.
Pisces.			
Cyprinidae	*Scaphiodon readingi* Hora		Common.

Date and time of collection.—31st March, 1931. 9-30—10-30 a.m.

Physical and Chemical condition of water.—Temp. 21·2°C; PH 7·7; Oxygen 6 cc. per litre; Halogen content 3·51; Salinity 6·366.

Fauna.—In addition to the animals obtained in the autumn of 1930, the following species were collected :—

Insecta.			
Rhynchota.			
Notonectidae	*Enithares lineatipes* Horv. . . .	(Adult).	A few.
Coleoptera.			
Carabidae	*Dyschirius* sp. .	(Adult).	A few
Hydrophilidae	? *Berosus* sp.	,,	Common.
Dytiscidae .	*Potamodytes* sp. .	,,	A few.
Dryopidae .	*Dryops* sp.	,,	Common.
Diptera.			
Tabanidae .	*Tabanus* sp. .	(Larvae).	Some.
Pisces.			
Cyprinidae .	*Crossochilus latius* (Ham. Buch.) . . .		Some.

Sta. 8.

A deep pool below a water fall near the second dam across the stream. Water clear. Bottom sandy or covered with gravel and small stones. Several species of algae present, *e.g.*, *Oedogonium* sp. (stray filaments, sterile); *Phromidium molle* (Kutz.) Gom., *Denticula crassula* Naeg., *Gomphonema subclavatum* Grun., *Calothrix minima* Fremy.

Date and time of collection.—15th October, 1930. 8—10 a. m.

Physical and Chemical condition of water.—Temp. 23·0°C ; Oxygen 5·0 cc. per litre ; PH 8·20 ; Alkali reserve 0·0053 N. Total solids 1·744 ; Ca 0·224 ; Mg 0·107 ; K 0·020 ; Na 0·385 ; SO_4 0·276 ; Cl 0·710 ; HCO_3 0·0093 ; NO_3 0·0124 ; Conductivity 0·422 ; Halogen content 0·74 ; Salinity 1·366.

Sudden fall in the percentage of Na (22·08 per cent.) and Cl (40·71 per cent.) and sudden rise in that of Ca (12·84 per cent.), Mg (6·13 per cent.), K (1·147 per cent.) and SO_4 (15·83 per cent.), etc. (Tables I and II).

Fauna.—Representatives of Platyhelminthes, Annulata, Crustacea, Insecta, Mollusca, Amphibia and Pisces obtained.

Platyhelminthes.		
Turbellaridae	Gen. and sp. ?	Common on stones.
Annulata.		
Hirudinea	*Glossiphonia reticulata* Kaburaki	2 specimens.
Crustacea.		
Potamonidae	*Potamon (Potamon) fluviatile* (Latr.) var. *monticola* W.-M.	Common under stones.
Insecta.		
Coleoptera.		
Dryopidae	*Dryops* sp.	(Adult). Few.
Ephemeroptera.		
Baetidae	*Caenis* sp.	(Larvae). Few.
,,	*Choroterpes* sp.	,, ,,
Trichoptera.		
Polycentropidae	Gen. and sp. ?	(Larvae). Very common.
Odonata.		
Aeschnidae	*Anax guttatus* Burm.	(Nymphs). A few.
Mollusca.		
Melanidae	*Melanoides flavidus* (Nevill)	Common on stones near the edges.
Amphibia.		
Ranidae	*Rana cyanophlyctis* Schneid.	Common.
Pisces.		
Cyprinidae	*Garra montis-salsi* Hora	,,
	Crossochilus latius (Ham. Buch.)	Some.
	Scaphiodon readingi Hora	Common.

Date and time of collection.—10th April, 1931.

Physical and Chemical condition of water.—Temp. 21·4°C ; PH 7·8 ; Oxygen 5·72 cc. per litre ; Halogen content 1·08 ; Salinity 1·979.

Fauna.—Planarians and *Choroterpes* larvae (Ephemeroptera) were not found. In addition to the other animals obtained in the autumn of 1930, the following were collected :—

Insecta.			
Coleoptera.			
Carabidae	*Tachys blandus* Andr.	(Adult).	Some.
Dytiscidae	*Potamodytes* sp. . .	,,	Fairly common.
,,	*Hydaticus* sp. . .	,,	A few.
,,	Gen. and sp. ? . .	,,	,,
Elateridae	*Drasterius collaris* Cand.	,,	,,
Rhynchota.			
Nepidae	*Ranatra elongata* Fabr.	(Adult).	Some.
Notonectidae	*Enithares lineatipes* Horv.	,,	,,
Odonata.			
Libellulidae	*Trithemis* sp., probably *festiva* (Ramb.)	(Nymphs).	Some.

At the lip of the fall at the head of station 8, aquatic caterpillars belonging to the genus *Aulocodes* (Pyralidae), a small Veliid bug (Hydrometridae), a tiny Corixid bug (considered to be a new species by Dr. Lundblad) and Chironomid larvae were obtained.

Sta. 9.

A series of small pools and rapids in the course of the stream, 50 yds. beyond station 8. Bottom and sides rocky (limestone). Five species of algae present, *viz.*, *Chaetomorpha herbipolensis* Lag., *Fragillaria capucina* Desm., *Nitzschia palea* Kutz., *Cymbella heloetica* Kutz., *Amphora* sp.

Date and time of collection.—15th October, 1930. 10—12 a.m.

Physical and Chemical condition of water.—Temp. 23·4°C ; Oxygen 6·3 cc. per litre ; PH 8·25 ; Alkali reserve 0·0056 N. Total solids 1·344 ; Ca 0·168 ; Mg 0·052 ; K 0·032 ; Na 0·431 ; SO_4 0·107 ; HCO_3 0·0162 ; NO_3 0·0124 ; Conductivity 0·317 ; Halogen content 0·51 ; Salinity 0·951.

Great increase in the percentage of K (2·381 per cent.) ; Ca and Cl about same as at Sta. 8 ; Na 32·07 per cent. (Tables I and II).

Fauna.—Representatives of Insecta, Mollusca, Amphibia and Pisces obtained.

Insecta.			
Coleoptera	Gen. and sp. ?	(Larvae).	Common.
Ephemeroptera.			
Baetidae .	*Baetis* sp. .	,,	,,
Trichoptera.			
Polycentropidae	Gen. and sp. ? . .	(Larvae).	Common.
Rhynchota.			
Gerridae .	*Metrocoris ståli* (Dohrn)	(Adult).	Some.
	Metrocoris sp. . .	,,	,,

Mollusca.		
Melanidae	*Melanoides flavidus* (Nevill) .	Some.
Amphibia.		
Ranidae .	*Rana cyanophlyctis* Schneid.	Quite common.
Pisces.		
Cyprinidae	*Garra montis-salsi* Hora	Some.
,,	*Crossochilus latius* (Ham. Buch.)	,,
,,	*Scaphiodon readingi* Hora	,,

Date and time of collection.—10th April, 1931.

Physical and Chemical condition of water.—Temp. 21·6°C ; PH 7·85 ; Oxygen 6·88 cc. per litre ; Halogen content 1·08 ; Salinity 1·979.

Fauna.—In addition to the animals obtained in the autumn of 1930, the following were collected :—

Coleoptera.			
Hydrophilidae	? *Berosus* sp.	(Adult).	Common.
Dytiscidae	*Potamodytes* sp. .	,,	,,
,,	*Hydaticus fabricii* Mac-Leay	,,	A few.
Odonata.			
Libellulidae	*Trithemis* sp., probably *festiva* (Ramb.)	(Nymphs).	Common.
Rhynchota.			
Notonectidae	*Enithares lineatipes* Horv.	(Adult).	A few.
Gerridae	*Metrocoris stâli* Dohrn.	,,	Some.
Naucoridae	*Heleocoris* sp.	(Nymphs).	,,
Diptera.			
Simuliidae	*Simulium* sp.	(Larvae).	Some.
Chironomidae	Gen. and sp. ?	,,	,,
Trichoptera.			
Polycentropidae	Gen. and sp. ?	(Larvae).	Some.

Sta. 10.

About ¼ mile from station 9, where the water pipes cross the stream. Water shallow, flowing very slowly. Bottom rocky. Four species of algae present, *viz.*, *Spirogyra* sp. (sterile), *Fragillaria capucina* Desm., *Denticula crassula* Naeg., *Cymbella ehrenbergi* Kutz.

Date and time of collection.—18th October, 1930.

Physical and Chemical condition of water.—Temp. 23·0°C ; PH 8·1 ; Alkali reserve 0·0084 N ; Oxygen 5·75 cc. per litre. Total solids 0·480 ; Ca 0·152 ; Mg 0·039 ; K 0·004 ; Na 0·066 ; SO_4 0·136 ; HCO_3 0·0144 ; NO_3 0·0186 ; Conductivity 0·112 ; Halogen content 0·08 ; Salinity 0·174.

Na 13·75 per cent. (least); Cl 10·42 per cent. (very low); percentage of Ca (31·67 per cent.), Mg (8·12 per cent.), SO_4 (28·33 per cent.), NO_3 (3·85 per cent.) and HCO_3 (3·0005 per cent.) higher than at any other place in the Khewra Gorge.

Fauna.—Representatives of Insecta, Crustacea, Mollusca and Pisces obtained.

Insecta.			
Rhynchota.			
Nepidae .	*Ranatra elongata* Fabr.	(Adult).	A few.
Gerridae .	*Metrocoris* sp. .	,,	,,
Ephemeroptera.			
Baetidae	*Choroterpes* sp.	(Larvae).	Common.
Odonata.			
Aeschnidae .	*Anax guttatus* Burm.	(Nymphs).	Common.
,, .	*Brachydiplax* sp. . .	,,	A few.
,,	*Gomphus* sp. . .	,,	,,
Crustacea.			
Potamonidae	*Potamon (Potamon) fluviatile* (Latr.) var. *monticola* W.-M.		Some.
Mollusca.			
Melanidae	*Melanoides flavidus* (Nevill) .		Common.
Pisces.			
Cyprinidae	*Scaphiodon readingi* Hora .	(Young).	Common.

Date and time of collection.—2nd April, 1931.

Physical and Chemical condition of water.—Halogen content 0·32; Salinity 0·608.

Fauna.—In addition to the animals obtained in the autumn of 1930, the following were collected :—

Insecta.			
Coleoptera.			
Carabidae	*Tachys blandus* Andr. .	(Adult).	Some.
Dytiscidae	*Potamodytes* sp. .	,,	,,
,,	Gen. and sp. ?	(Larvae).	A few.
,,	Gen. and sp. ? .	,,	,,
Hydrophilidae	? *Berosus* sp. .	(Adult).	,,
Elateridae	*Drasterius collaris* Cand.	,,	,,
Ephemeroptera.			
Baetidae	*Choroterpes* sp.	(Larvae).	Very common.
,,	*Ephemera* sp.	(Larva).	1 specimen.
Rhynchota.			
Naucoridae	*Heleocoris* sp.	(Adult).	A few.
Diptera.			
Chironomidae .	Gen. and sp. ?	(Larvae).	Some.

Sta. 11.

A series of shallow pools, rapids and falls above the water reservoir. Water clear; bed rocky. Several species of algae present, *e.g.*, *Spirogyra* sp. (sterile); *Oedogonium* sp. (sterlie); *Cosmarium* sp. (rare); *Cymbella helvetica* Kutz.; *Denticula crassula* Naeg.; *Gomphonema subclavatum* Grun.; *Navicula* (*Pinnularia*) *parva* Ehrenb.; *Rhopalodia gibba* (Ehrenb.) Muller; *Cymbella ventricosa* Kutz.; *Chroococcus turgidus* (Kutz.) Naeg.; *Homoeothrix* sp., prox. *juliana* (Menegh.) Kirchn.

Date and time of collection.—18th October, 1930. 8-30—11-30 a.m.

Physical and Chemical condition of water.—Temp. 21·0°C; Oxygen 6·5 cc. per litre; PH 8·1; Alkali reserve 0·0048 N. Total solids 0·720; Ca 0·204; Mg 0·044; K 0·040; Na 0·233; SO_4 0·113; HCO_3 0·0171; NO_3 0·0186; Conductivity 0·1171; Halogen content 0·05; Salinity 0·120.

Percentage of K (5·556 per cent.) much higher and that of Cl (6·94 per cent.) lower than in any other water investigated. Ca (28·34 per cent.), NO_3 (2·5835 per cent.) and HCO_3 (2·3750 per cent.) very high; Na 32·36 per cent. (Tables I and II).

Fauna.—Representatives of Platyhelminthes, Insecta, Crustacea, Mollusca, Amphibia and Pisces obtained.

Platyhelminthes.			
Turbellaridae	Gen. and sp. ?	.	Common.
Insecta.			
Ephemeroptera			
Baetidae	*Baetis* sp. . .	(Larvae).	Common.
Trichoptera.			
Polycentropidae	Gen. and sp. ? .	(Larvae).	Common.
Rhynchota.			
Gerridae .	*Metrocoris stâli* (Dohrn)	(Adult).	Some.
	Metrocoris sp. .	,,	,,
Veliidae . .	Gen. and sp. ? .	,,	Common in rapid water.
Diptera.			
Chironomidae	Gen. and sp. ? .	(Larvae).	Common in rapid water.
Crustacea.			
Potamonidae .	*Potamon* (*Potamon*) *fluviatile* (Lat.) var. *ibericum* (Mar. deBieb.)	..	Some.
Mollusca.			
Melanidae .	*Melanoides flavidus* (Nevill) .	..	Common.
Amphibia.			
Ranidae	*Rana cyanophlyctis* Schneid.		Fairly common.
Pisces.			
Cyprinidae .	*Scaphiodon readingi* Hora .		Very common.
,,	*Garra montis-salsi* Hora	.	Common.
,,	*Crossochilus latius* (Ham. Buch.) . .	..	,,

Date and time of collection.—3rd April, 1931.

Physical and Chemical condition of water.—Halogen content 0·09; Salinity 0·192.

Fauna.—Planarians were not found. In addition to the other animals collected in October, 1930, the following were obtained :—

Insecta.			
Coleoptera.			
Hydrophilidae	? *Berosus* sp.	(Adult).	Some.
Dytiscidae	*Potamodytes* sp.	,,	A few.
,,	*Laccophilus flexuosus* Aube	,,	,,
Rhynchota.			
Naucoridae	*Heleocoris* sp.		A few.
Notonectidae	*Enithares lineatipes* Horv.		,,

A LARGE TANK NEAR THE CHALISA RAILWAY STATION.

Close to the Railway line. Water slightly turbid. Bottom muddy. Plenty of vegetation both on the shore and in the water. The alga *Cyclotella kutzingiana* Thwait very common.

Date and time of collection.—22nd October, 1931. 6-30—9-30 a.m.

Physical and Chemical condition of water.—Temp. 24·2°C; Oxygen 5·00 cc. per litre; PH 8·7; Alkali reserve 0·0012 N. Total solids 6·920; Ca 0·660; Mg 0·143; K 0·132; Na 1·755; SO_4 0·854; HCO_3 0·0036; NO_3 0·0139; Conductivity 1·548; Halogen content 3·27; Salinity 5·932.

Ca 9·54 per cent.; Mg 2·07 per cent.; K 1·907 per cent.; Na 25·36 per cent.; SO_4 12·34 per cent.; Cl 48·52 per cent.

Fauna.—Representatives of Insecta and Pisces obtained.

Insecta.			
Coleoptera.			
Hydrophilidae	*Enoplurus indica* Motsch.	(Adult).	Some.
Dytiscidae	*Laccophilus flexuosus* Aube	,,	Very common.
,,	*Canthydrus laetabilis* Walk.	,,	A few.
Rhynchota.			
Nepidae	*Ranatra sordidula* Dist.	(Adult).	Common.
,,	*Laccotrephes* sp.	(Nymphs).	Some.
Gerridae	*Gerris tristan* Kirk.	(Adult).	,,
,,	*Gerris spinolae* Leth. and Serv.	,,	,,
,,	*Gerris fossarum* Fabr.	,,	,,
Belostomidae	*Sphaerodema molestum* Duf.	,,	A few.
Notonectidae	*Anisops* sp.	,,	,,
,,	*Plea* sp.	..	..

Odonata.			
Agrionidae	*Ischnura aurora* (Brauer)	(Nymphs).	Very common.
Coenagrionidae	Gen. and sp. ?	,,	A few.
Aeschnidae	*Anax guttatus* (Burm.)	,,	,,
Ephemeroptera.			
Baetidae	*Cloëon* sp.	(Larvae).	Numerous.
,,	*Baetis* sp.	,,	Some.
Diptera.			
Chironomidae	*Culicoides* or *Dasyhelea* sp.	(Larvae).	Common.
,,	Gen. and sp. ?	,,	,,
Trichoptera.			
Sericostomatidae	Gen. and sp. ?	(Larvae).	Common.
Pisces.			
Cyprinidae	*Chela punjabensis* Day		Common.
,,	*Barbus punjabensis* Day		,,

TWO PONDS NEAR THE SODI RAILWAY STATION.

Water shallow, bottom muddy. Plenty of vegetation both on the shore and in the water. Three species of algae present, *viz.*, *Cyrosigma acuminatum* Kutz., stray filaments of *Spirogyra* sp. (sterile) and *Oedogonium franklianum* Witter.

Date and time of collection.—17th October, 1930. 4-30—6-30 p.m.

Physical and Chemical condition of water.—Temp. 27·0°C ; Oxygen 8·88 cc. per litre ; PH about 10 ; Alkali reserve 0·0015 N. Total solids 23·474 ; Ca 1·188 ; Mg 0·772 ; K 0·056 ; Na 6·247 ; SO_4 7·744 ; CO_3 0·003 ; HCO_3 0·0001 ; NO_3 0·0124 ; Conductivity 3·02 ; Halogen content 7·01 ; Salinity 12·683.

Percentage of SO_4 (33·00 per cent.) higher than in any other water investigated ; Ca 5·06 per cent. ; Mg 3·29 per cent. ; K 0·239 per cent. ; Na 26·61 per cent. ; Cl 31·76 per cent. (Tables I and II).

Fauna.—Representatives of Insecta and Pisces obtained.

Insecta.			
Coleoptera.			
Dytiscidae	*Eretes sticticus* L. sub-sp. *griseus* Fabr.	(Adult).	Very common.
Rhynchota.			
Notonectidae	*Anisops* sp..	(Adult).	Very common.
Odonata.			
Coenagrionidae	Gen. & sp.?	(Nymphs).	A few.
Agrionidae	*Agriocnemis* sp.	,,	Some.
Libellulidae	Gen. and sp. ?	,,	A few.
,,	*Trithemis* sp., probably *festiva* (Ramb.)	,,	,,
Pisces.			
Cyprinidae	*Barbus punjabensis* Day	..	Common.

THE KALLAR KAHAR LAKE.

A large body of water, about a mile long and half a mile broad. Greatest depth 3 or 4 ft. Margins formed of black fetid mud. Plenty of vegetation in the water, making rowing of even a small boat difficult. Hardly any tree on the sides. No macroscopic free swimming algae, but the following found in bits :—*Cladophora, Anabaena, Chroococcus, Aphanocapsa,* etc.

Date and time of collection.—20th October, 1931. 3-30—6 p.m., and 21st October, 1931. 7—10 a.m.

Physical and Chemical condition of water.—PH 9·5 ; Alkali reserve 0·0010 N. Total solids 4·508 ; Ca 0·080 ; Mg 0·116 ; K 0·312 ; Na 1·2716 ; SO_4 0·8443 ; CO_3 0·0156 ; HCO_3 0·0132 ; NO_3 0·0093 ; Conductivity 0·954 ; Halogen content 1·83 ; Salinity 3·333.

Percentage of K (6·92 per cent.) higher than in any other water investigated ; SO_4 18·72 per cent. (very high) ; Ca 1·771 per cent. ; Mg 2·57 per cent. ; Na 28·20 per cent. ; Cl 40·95 per cent. (Tables I and II).

Fauna. No animal life except insects.

Rhynchota.			
Notonectidae	*Anisops* sp..	(Adult).	Very common.
Trichoptera.			
Sericostomatidae	Gen. and sp. .	(Larvae).	Very common.
Odonata.			
Libellulidae	Gen. and sp. ?	(Nymphs).	A few.
Coenagrionidae	Gen. and sp. ? . .	,,	Common.
Diptera.			
Chironomidae	*Tanytarsus* sp. . .	(Larvae).	Common.
,,	*Chironomus* sp.	,,	,,

A great variety of Diptera (Ephydridae, Dolichopodidae, Anthomyiidae) were seen hovering near the edges of the lake. This indicates that the larval life of these forms is most probably passed in this water.

Remarks.—The animal life in the Kallar Kahar Lake was undoubtedly poor, but it was not so poor as in 1922 when Dr. Hora visited it and reported that " no animals were found to live in it ".

THE SAN SAKESAR LAKE.

A large and shallow body of water, with hardly any vegetation. Shores absolutely bare, of very soft, dark mud. At some distance from the lake the soil suitable for ordinary crops.

Date and time of collection.—17th April, 1931. 4—6 p.m.

Physical and Chemical condition of water.—Total solids 53·34 ; Ca 0·058 ; Mg 1·545 ; K 0·323 ; Na 18·1 ; SO_4 13·1 ; CO_3 0·18 ; HCO_3 0·41 ; N 0·01593 ; Halogen content 17·86 ; Salinity 32·267.

Percentage of Ca (0·11 per cent.) lower than in any other water investigated ; Mg 2·95 per cent. ; K 0·615 per cent. ; Na 34·46 per cent. ; Cl 35·67 per cent. ; SO_4 24·98 per cent. (Tables I and II).

Fauna.—The collection was mostly made near the edges of the lake, it being impossible to get to the centre. The only animal obtained was a red coloured Cyclop, *Diaptomus salinus* v. Daday, which was in such large numbers that it gave to the water a reddish hue. This and several other species of *Diaptomus* are known from salt waters of Central Asia (Sars, 1903), Algeria and Tunis (Roy and Gauthier, 1927).

Remarks.—This lake has recently been visited by Mr. G. E. Hutchinson, a member of the Yale University North-India Expedition, who informs me that he has found nothing in the lake except *Microcystis roseopersicina* which is probably the food of *Diaptomus salinus.*

REMARKS ON THE POWER OF VARIOUS GROUPS OF ANIMALS COLLECTED TO WITHSTAND HIGH SALINITIES.

Platyhelminthes.—A Planarian was collected in the Khewra Gorge at Stations 9 (Sal. 0·95) and 11 (Sal. 0·12) in October, 1930. It was not met with in April, 1931, when the salinity of these two stations was 1·97 and 0·19 respectively. Obviously its absence at station 10 (Sal. 0·32—0·80) was not due to a higher salinity, but probably due to the peculiar chemical condition of the water (*see* p. 99).

Annulata.—HIRUDINEA. Several species of this group have been obtained from brackish waters. Annandale and Kemp obtained *Limnatis nilotica* from salt water springs in Seistan. Two specimens of the Leech *Glossiphonia reticulata* Kaburaki were collected in the Khewra Gorge at station 8 (Sal. 1·36) in October, 1930. None was obtained in April, 1931. Kaburaki described this species from a single specimen found attached to the mantle of a species of *Anodonta** at Jullundur (Punjab). According to Harding and Moore (1926), the family Glossiphonidae, under which *G. reticulata* is included, is known to occur in fresh water only. But it appears that the genus *Glossiphonia* has some attraction for salt water, as two species of this genus were collected from the Chilka Lake (Harding, 1920 and Kaburaki, 1921), while *G. reticulata* as mentioned above, has been obtained from the Khewra Gorge.

Crustacea.—The crab *Potamon* (*Potamon*) *fluviatile* (Latr.) var. *monticola* W.-M. was collected in the Khewra Gorge at stations 8 (Sal. 1·97) and 10 (Sal. 0·08). At station 11 (Sal. 0·12) the variety *ibericum* (Mar. de Bieb.) was obtained. These crabs were met with both in October, 1930 and April, 1931. The variety *ibericum* which was described from Assam has so far not been reported from the Punjab, though the variety *monticola* occurs abundantly in this area. The San Sakesar Lake (Sal. 32·26) had no animal life except the Crustacean, *Diaptomus salinus*, which was found in extremely large numbers. Blanchard and Richard (*loc. cit.*), Roy and Gauthier (*loc. cit.*), Sars (*loc. cit.*) and Annandale and Kemp gave an account of the Ostracoda, Cladocera and Copepoda of several salt waters of North Africa, Central Asia and Seistan. Kemp (1915 and 1918) and Sewell (1924) recorded several freshwater Crustacea from the Chilka Lake, with water of 1·008—1·011

* Dr. Baini Prashad informs me that *Anodonta* is not known to occur in the plains of the Punjab and that most probably it was a species of the genus *Lamellidens* on which the above leech was found.

specific gravity, the sea water being 1·027 Becking (1920) obtained *Artemia salina* from concentrated brine (35 per cent. salt). Tattersall (1921) described several species of Mysidacea, Tanaidacea and Isopoda from brackish waters (the Tâle Sap) in Siam.

Insecta.—This is the only group of animals which was found to be represented in all the waters investigated. It is, therefore, evident that some insects can tolerate salinity higher than 160, which is about 5 times as much as that of the Indian Ocean. The different orders of Insecta were restricted to definite salinities. The distribution of this group is described in detail hereafter in a separate chapter.

Mollusca.—Many brackish water mollusca are known (*see* Nevill, 1880, Annandale and Kemp, 1916, Eliot, 1917 and Annandale, 1921), but only one species of this phylum, namely, *Melanoides flavidus* (Nevill) was found in the Khewra Gorge at stations 7—11, where the salinity ranged from 0·12 to 6·36. This species mostly occurs in fresh water. In addition to the Salt Range, this species is known only from the desert regions of Southern Baluchistan, from Seistan and Iraq.

Amphibia.—The frog *Rana cyanophlyctis* Schneider was fairly common in the Khewra Gorge at stations 6—11, having salinity varying from 0·12 to 9·5. This frog is distributed from Arabia to India, Ceylon and Northern parts of the Malay peninsula. It mostly occurs in fresh water, but has been obtained in several salt waters as well, *e.g.*, some salt lakes near Calcutta, the Tâle Sap in Siam, the Chilka Lake, some brackish water pools near Port Canning (NaCl 13·8 gms. per litre), etc. As pointed out by Annandale, this is a very adaptable species. In the Tâle Sap, Annandale and Kemp obtained seven other species of Batrachia in addition to *R. cyanophlyctis*.

Pisces.—Many freshwater fishes are known from salt waters. Chaudhuri (1916) and Hora (1923 and 1924) recorded several such species from the Chilka Lake and from the Tâle Sap (Siam). Freshwater fishes generally do not occur in highly saline waters.

Scaphiodon readingi Hora was fairly common both in October, 1930 and April, 1931 in the Khewra Gorge at station 7 to 11 (Salinity 0·12—12·63). This species is widely distributed in the freshwater streams of the Salt Range, where according to Hora it is endemic.

Crossochilus latius (H. B.) Day was met with at the same stations as the above species but was more common in April, 1931 than in October, 1930. This species is quite common in fresh water in all parts of India and Burma. Chaudhuri (*loc. cit.*) recorded it from the Chilka Lake, when its salinity was as much as that of the sea water.

Garra montis-salsi Hora was found along with the above two species except at stations 7 and 10. Its absence at station 7 may be due to the higher salinity, but at station 10 it was obviously due to some other factor, most probably the nature of the bed of the stream, or the peculiar chemical composition of the water (p. 99). This species also is widely distributed in the Salt Range.

Barilius vagra (Ham. Buch.) Day was found in the Khewra Gorge at station 6 only (Sal. 9·5). Hora obtained it from a small stream near Dheri Jaba. This fish is common in almost all parts of India.

Barilius sophore (Ham. Buch.) Day was obtained in fairly large numbers from the pond near Sodi (Sal. 12·683). This species was described from Assam and the Khasi hills.

Barbus punjabensis Day and *Chela punjabensis* Day were obtained in small numbers from the pond at Chalisa (Sal. 5·93). The former was also present in the ponds at Sodi (Sal. 12·683). *Chela punjabensis* was described from the river Ravi, near Lahore. *Barbus punjabensis* is, however, more widely distributed. It has been obtained from Sind, Lahore and Jubbulpore. Chaudhuri (*loc. cit.*) recorded several species of *Barbus* from the Chilka Lake.

INSECTA.

As mentioned above, the group Insecta was represented in all the waters investigated. But the distribution of its different orders was limited to a definite range of salinity. Below is given the distribution of various groups of insects collected.

COLEOPTERA.

Of all the different orders of Insecta, Coleoptera seems to be the most common group met with in salt waters. Thienemann (1913), Wesenburg Lund (1915), Keys (1918), Walsch (1925), Lengerken (1929), etc. have given a long list of "Halophile" and "Halobionte" beetles met with on the coasts of several parts of Europe. Annandale and Kemp collected numerous species of this order from the Chilka Lake and from some salt water springs in Seistan.

HYDROPHILIDAE.—Members of this family were collected from very highly saline waters. *Octhebius* sp. was obtained both in October, 1930 and April, 1931, from the Khewra Gorge at stations 1 to 4, where the salinity ranged from 78·5 to 166·8. It was not met with at other stations where the water was less saline or almost fresh and thus it appears that this species has become entirely adapted to highly saline waters. The genus *Octhebius* is represented in fresh, brackish and sea water. According to Hase (1926), *O. quadricollis* can live in all these three habitats and can stand a salinity up to 27 per cent. Becking (1920) obtained this species from highly concentrated brine (35 per cent. salt). Lengerken included four species of *Octhebius* under his "Halophile" and one, *O. auriculatus* Key, under "Halobionte" categories. Walsch and Keys mentioned two species of *Octhebius* frequenting British coasts as truly brackish water forms.

Berosus punctulatus f. col. *immaculicollis* Fairm. *sensu* Knisch. was collected in the Khewra Gorge from stations 1 to 5, where the salinity varied from 38·8 to 143·8. Except at station 5 this species was obtained only in October, 1930. Its absence at other stations in the Khewra Gorge indicates that like *Octhebius* sp., enumerated above, this species also seems to have become adapted to highly saline waters. Prof. Kuntzen of Berlin informs me that this species is widely distributed in salt waters of the Indo-Australian and Ethopion regions.

In April, 1931 I obtained another species of (?) *Berosus* in fairly large numbers from stations 7 to 11, where the salinity varied from 0·19 to 6·3.

Berosus is a typical salt water genus. *Berosus spinosus* Stev. is fairly common in brackish water on the northern coasts of Europe and the south coast of England (Lengerken and Watsch). This genus is represented in polluted waters also (Alexander, 1925).

Enochrus sp. was collected in the Khewra Gorge at stations 2 to 7, where the salinity varied from 6·36 to 143·8. This species was nowhere obtained in large numbers. Walsch found *E. bicolor* in fresh and brackish waters of England.

Enoplurus indicus Motsch. was obtained in small numbers from the pond at Chalisa only (Sal. 5·9).

Another species of *Enoplurus* was obtained in small numbers from stations 2 and 4 in the Khewra Gorge (Sal. 91·2 and 143·8).

DYTISCIDAE.—As compared with Hydrophilidae, this family is represented in waters of comparatively lower salinity. Lengerken (op. cit.) included only one species of this family under the " Halophile " category.

An undescribed species of the genus *Potamodytes* was obtained in the Khewra Gorge at stations 3, 5, 6, 7, 9, 10, 11, with salinity varying from 0·192 to 42·3. It was most common at station 6 (Sal. 10·8). This species was found to be more common in April, 1931 than in October, 1930, except at station 3 where it was not found in April, 1931 at all, when the salinity there was 51·05.

Hydaticus fabricii MacLeay was obtained from stations 6 (Sal. 10·87) and 9 (Sal. 1·97) only, being fairly common at the former locality.

Laccophilus flexuosus Aubè. was very common in the pond at Chalisa (Sal. 5·93). It was also obtained in small numbers from station 11 (Sal. 0·19) in the Khewra Gorge.

The genus *Laccophilus* is represented in both fresh and salt waters. *L. variegatum* Germ. occurs commonly in fresh and brackish waters of England and of the continent of Europe.

Canthydrus laetabilis Walk. was found in small numbers in the pond at Chalisa, having salinity 5·93.

Eretes sticticus L. subsp. *griseus* Fabr. was very common in ponds at Sodi (Salinity 12·68).

E. sticticus L. is very widely distributed. It is found in Africa, tropical and sub-tropical regions of Asia, Australia and on the Pacific side of America. The subsp. *griseus* has been recorded from North India and the Andamans.

It may be mentioned that with the exception of *Potamodytes* sp., which as already mentioned is considered to be a new species, all the above named Dytiscid beetles are known from salt waters.

DRYOPIDAE (PARNIDAE).—*Dryops* sp. was found in the Khewra Gorge at stations 3, 5, 7 and 8, with salinity varying from 1·97 to 51·05. It was obtained in large numbers in April, 1931 than in October, 1930 and was most common at stations 5 and 7

STAPHYLINIDAE.—Many Staphylinid beetles have not been found to occur near or in salt waters. Cameron (1930) enumerated the following from the sea shore under sea weed :—certain *Trogophlaeus*, *Thinobius*,

Cafius, *Phucobius* and numerous Aleocharinae. I have found the following species in the Khewra Gorge :—

Platystethus cornutus Gr.—Some specimens of this species were collected from station 2, with salinity 123·9. Cameron recorded this species from Dehra Dun, Chakrata and Mussoorie districts, Pusa (Bihar) and Poona. This species occurs also in Europe and the Canary Islands.

A few specimens of another species of *Platystethus*, which Mr. Cameron thinks to be new, were obtained from station 9 (Sal. 1·97).

Two specimens of *Aleochara bipustulata* were also obtained from station 9.

Four specimens of a new species of *Chilopora*, which Mr. Cameron will be describing in a separate paper, were collected from under stones on the sides of the water at station 5.

DIPTERA.

The Diptera are next in importance to Coleoptera in their power to live in highly saline waters. In fact, Buxton (1926) put this order at the top of all others from this point of view. Several Diptera (mostly Chironomidae) are permanent inhabitants of the sea (Carpenter 1884, Thienemann 1915-1916, Kieffer 1913, Edwards, 1926, etc.). Chironomid larvae have been obtained from waters of a salinity as high as 28·53 per cent. (Suworow, 1908). Dalziel (1920) and Balfour (1921-1922) mentioned a large number of mosquito larvae which can live in waters having salinities up to 2·88 per cent. Sewell (1913) obtained larvae of a *Culex* from a rock pool on the Burma coast, which was nearly three times as concentrated as ordinary sea water. Annandale and Kemp (1915) obtained the larvae of a Syrphid fly, of *Anopheles rossi* and *Palpomyia* sp. (Chironomidae) from the Chilka Lake, when the specific gravity of its water was 1·000—1·015 and that of the sea water was 1·027 The occurrence of Ephydrid diptera has been reported from waters of salinity up to 10 times as much as that of sea water (Becking, 1920 ; Günther, 1899 ; Thienemann, 1913 ; etc.).

The following species of this order have been collected from the salt waters under report :—

CHIRONOMIDAE.—Larvae of a species of *Culicoides* were collected in October, 1930 in the Khewra Gorge at stations 1 (Sal. 78·52) and 2 (Sal. 91·27) and in the pond near Chalisa (Sal. 5·93). Kieffer described several species of *Culicoides* and *Tanytarsus* from Puri on the Orissa Coast.

Another species of Chironomid larvae was found occurring together with *Culicoides* sp. mentioned above. Annandale collected larvae of two Chironomids from brackish water pools at Port Canning.

Larvae of a species of *Chironomus* were obtained from the Khewra Gorge at stations 6, 8, 10, and 11, wherever the water was flowing rapidly. The salinity at these localities did not exceed 10·87

In the lake at Kallar Kahar (Sal. 3·35) larvae of a species of *Tanytarsus* and *Chironomus* were obtained. The presence of Ephydrid, Dolichopidid and Anthomyiid flies near this water indicated that the larval stage of these flies was most probably passed in this water.

SIMULIIDAE.—The larvae of a species of *Simulium* were obtained in large numbers in the Khewra Gorge from stations 9 (Sal. 0·95) and 11 (Sal. 0·12), where the water was flowing rapidly.

TABANIDAE.—The larvae of a big Tabanid fly were found in extremely large numbers in the Khewra Gorge at stations 3 and 5 (Sal. 38·85 and 51·05). Some were found at stations 1, 6 and 7 also. The salinity at these localities varied from 5·17 to 78·52.

SCIOMYZIDAE.—The larvae of a big Sciomyzid fly were found in fairly large numbers in the Khewra Gorge at stations 1 and 4 in April, 1931. The salinity at these stations was very high, being about 166·83.

EPHEMEROPTERA.

This order was very well represented in the Khewra Gorge. Larvae of a species of *Cloëon* were found in great abundance in October, 1930 at stations 1 and 2, where the salinity was 78·5 and 91·27 respectively. This species was also found at stations 3 and 5 (Sal. 38·85—51·05). I think that it is the first record of the occurrence of may-fly larvae in such highly saline waters, *i.e.*, more than twice as much as sea water. Thorpe (1927) recorded the occurrence of may-fly larvae (Baetinae, probably *Cloëon* sp.) in the Suez Canal (Lake Tamsah) in waters of specific gravity 1000—1030.

Another species of *Cloëon* was found in large numbers at stations 3, 5, 6 and 7 and in the ponds at Chalisa (Sal. 6·36—51·05).

The larvae of a species of *Choroterpes* were found at stations 8 (Sal. 1·36) and 10 (Sal. 0·17), being very common at the latter locality.

Some larvae of a species of *Caenis* and *Ephemera* were also found at stations 8 and 10 respectively.

The larvae of a species of *Baetis* were very common at stations 9 (Sal. 0·95) and 11 (Sal. 0·12).

RHYNCHOTA.

Several members of this order can stand fairly saline waters, but not as highly saline as can be tolerated by Coleoptera and Diptera. Annandale obtained several heteropterous genera from brackish water pools at Port Canning, while he and Kemp (1915) obtained about fifteen species of this order from the Chilka Lake and about 10 species from the Tále Sap lake in Siam (Paiva, 1917). Thorpe (*loc. cit.*) described three species of this order from the Suez Canal, while Hutchinson (1927-1929, and 1931) and Poisson (1924) have recorded the occurrence of aquatic bugs in waters having chlorine content up to 14 grms. per litre. Mr. Hutchinson informs me that one species, *Trichocorixa wallengreni* (Stál) was obtained from water probably much more saline than the sea water. *Aepophilus bonnairei* and *Salda phallipes* are known to be truly "Halophile" and occur on the sea coasts of several parts of Europe. *Halobates*, a typical marine genus also belongs to this order.

VELIIDAE.—A small Vellid bug was obtained in the Khewra Gorge at station 11, and near the lips of the falls at the heads of stations 6 and 8, where the water was flowing very rapidly. The salinity at these localities did not exceed 10·87

GERRIDAE.—*Metrocoris stâli* Dohrn was fairly common in the Khewra Gorge at stations 9, 10 and 11 (Sal. 0·192—1·97) both in October, 1930 and April, 1931.

Gerris tristan Kirk., *G. spinolae* Leth. and Serv. and *G. fossarum* Fabr. were present in the pond near Chalisa (Sal. 5·93). All these three species of *Gerris* and several others were obtained by Annandale and Kemp from the Chilka Lake and several other salt waters.

NEPIDAE.—*Ranatra elongata* Fabr. was common at stations 7, 8 and 10 (Sal. 0·174—5·17) in the Khewra Gorge.

Ranatra sordidula Dohrn was very common in the pond near Chalisa (Sal. 5·93). This species was also found occurring in the Chilka Lake.

A species of *Laccotrephes* was also common in the Chalisa pond.

NAUCORIDAE.—A few specimens of a species of *Heleocoris* were obtained at stations 5, 9, 10 and 11 (Sal. 0·192—38·85) in the Khewra Gorge in April, 1931.

BELOSTOMIDAE.—A few specimens of *Sphaerodema molestum* Duf. were collected from the pond near Chalisa (Sal. 5·93).

NOTONECTIDAE.—*Enithares* lineatipes Horv. was present in small numbers at stations 7 to 11 (Sal. 0·19—6·36) in the Khewra Gorge in April, 1931. No specimen of the species had been obtained in the previous autumn.

Several species of *Anisops* were very common in the pond at Sodi (Sal. 12·68) and in the Kallar Kahar Lake (Sal. 3·33). Another species of this genus was present in the pond at Chalisa (Sal. 5·93) and at station 10 (Sal. 0·60) in the Khewra Gorge.

A species of *Plea* was present in small numbers in the pond at Chalisa.

CORIXIDAE. A species of *Micronecta* was very common at the lip of a fall at the head of station 8 (Sal. 1·97) in the Khewra Gorge in April, 1931.

ODONATA.

Like Rhynchota, this order is represented in waters of comparatively lower salinities. Dragon-flies are known to breed in coastal lagoons, where the water is brackish. Osburn (1906) showed by a series of experiments that Dragon-fly larvae could withstand a salinity up to a density of 1·01 (sea water being 1·026). At the density of 1·015 the larvae soon died. Osburn appended a list of the species known to breed in brackish water, most of which belong to Libellulinae, Agrioninae and Aeschninae (*Anax*, etc.). Laidlaw (1915) recorded about half a dozen species from the Chilka Lake, when the specific gravity of its water was 1·001—1·008 (sea water being 1·027). Thorpe (*loc. cit.*) recorded three species of Aeschnidae and Agrionidae from the Suez Canal with sp. gr. 1000—1030.

AESCHNIDAE. A few specimens of the nymphs of *Anax guttatus* Burm. were collected from stations 8 and 10 (Sal. 0·174—1·97) in the Khewra Gorge and from the pond near Chalisa (Sal. 5·93).

Gomphus sp. and *Brachydiplax* sp. Nymphs of these forms were collected in large numbers in the Khewra Gorge both in October, 1930 and April, 1931 at station 10, where the salinity varied from 0·174 to 0·608. A species of *Brachydiplax* was also found occurring in the Chilka Lake.

LIBELLULIDAE.—The nymphs of a species of *Trithemis*, probably *festiva* (Ramb.) were met with at stations 6, 7, 8, 9 (Sal. 0·951 to 10·87) in the Khewra Gorge. It was very common at stations 7 and 9, where the salinity was 0·951—5·17.

A few nymphs of a species of *Orthetrum* were collected from the ponds at Sodi (Sal. 12·68).

Nymphs of another species of Libellulinae were found in the lake at Kallar Kahar.

AGRIONIDAE AND COENAGRIONIDAE—Nymphs of *Ischnura aurora* (Br.) were extremely common in the pond near Chalisa (Sal. 5·93). Annandale obtained in large numbers the nymphs of *Ischnura senegalensis* in the Chilka Lake and in the brackish water ponds at Port Canning. Several species of this genus, *e.g.*, *I. ramburri*, *I. verticalis*, etc., breed in brackish waters in certain parts of the United States of America.

Nymphs of a species of Coenagrionidae were abundant in the ponds at Sodi (Sal. 12·68) and were found in small number at Kallar Kahar and Chalisa also (Sal. 3·33 and 5·93 respectively).

In the pond at Sodi there were some nymphs of *Agriocnemis* also. This genus was also found in the Chilka Lake.

TRICHOPTERA.

Very few members of this order live in salt waters. Eaton found some in salt and brackish water streams on the borders of the Sahara, while McLachlan (1883) gave an account of a marine Trichopteron, *Philanisus* from New Zealand, the larvae of which live habitually in rock pools, between high and low water marks. Gresens (1928) described some from Central Europe.

Larvae of a *Polycentropid* Trichopteron were fairly common in the Khewra Gorge at station 11 (Sal. 0·192) and at stations 7 to 9 (Sal. 1·97 to 6·3). Its absence at station 10 (Sal. 0·60) was obviously not due to salinity, but might be due to the peculiar chemical composition of the water. These larvae live in loosely built houses, made of bits of stones held together by means of silk threads. These larvae are also met with in fresh waters in several parts of India.

In the pond near Chalisa (Sal. 5·93), larvae of a Sericostomatid Trichopteron were very abundant. These larvae live in well built houses, made out of straw.

LEPIDOPTERA.

Aquatic caterpillars, most probably belonging to the genus *Aulocodes* (Pyralidae) were fairly common in the rapid water at the head of station 8 (Sal. 1·36) in the Khewra Gorge in April, 1931. Annandale and Kemp (1915) obtained the caterpillars of *Nymphula diminutales* from the Chilka Lake.

THYSANURA.

A Thysanuran was collected in small numbers at station 4 (Sal. 130·8) in the Khewra Gorge in April, 1931.

CONCLUSIONS.

The foregoing account of the occurrence of different animals in salt waters indicates that most of the species met with therein are also known

from fresh water and that various groups of the animal kingdom are restricted to a definite range of salinity (Table IV). It is only the insects that were found in all the waters investigated, the salinity of which ranged from 0·12 per cent. to as much as 17·0 per cent., *i.e.*, about five times that of the sea water. The few representatives of Platyhelminthes, Hirudinea and Crustacea collected do not seem to tolerate a salinity higher than 2; Mollusca (one species) could stand about 8, whereas Amphibia (one species) and Pisces (numerous species) were found living in waters with salinity up to 11. Thus with the exception of insects, no other group of animals was found in water of a salinity equal to or more than that of sea water.

Though the group Insecta was represented in waters with salinity ranging from 0·12 to 170, its different orders, however, showed a restricted distribution. In Table V the distribution of the various Insect orders is diagrammatically expressed. The Lepidoptera were found occurring in waters of salinity up to 2, while Trichoptera and Odonata could tolerate a salinity of 8, and Rhynchota and Ephemeroptera 47 and 51 respectively. The Coleoptera and Diptera were found flourishing in all the waters investigated (salinity up to 170), though their different families were restricted to definite salinities.

It thus appears that Buxton's conclusion (1926) that the only Insects which live in water containing 3 per cent. or more salts (*i.e.*, water at least as salty as the sea) are some families of Diptera (Ephydridae, Culicidae and Chironomidae) and a Trichopteron requires modification. In addition to the Dipterous families named above, Tabanid larvae, several families of Coleoptera, May-fly larvae and Rhynchota can live in waters of a salinity much higher than that of the sea.

The occurrence of May-fly larvae in highly saline waters is really very remarkable. The impervious nature of the integument of Coleoptera and Rhynchota may afford protection to the members of these orders against the dehydrating influence of salt waters, but the same cannot be said of the integument of May-fly larvae, which is well known for its delicacy. This suggests that the adaptation to salt water does not necessarily consist in the acquisition of an impervious integument, as is postulated by some authors (Walsh, etc.), but is due to changes in the body fluids so that the osmotic pressure of the latter may be in equilibrium with that of the external medium.

Regarding the interesting question of the colonization of the sea by Insects it is evident from the above that the salinity of sea water is not a barrier, nor is the force of the ocean currents and tides, as many insects can live in mountain torrents having tremendous force and velocity. Furthermore, many insects can live on the sea shore (Flattely and Walton), where the physical effect of the tides is the greatest. The most important difference which one notices on carefully comparing the analyses of the waters of the Salt Range (Tables I and II) with those of the samples of sea water taken by the "Challenger" from different oceans of the world (Table III) is that the percentage of calcium (1·16 to 1·20) in the sea is much less than that in any water investigated by me except the San Sakesar Lake. In this lake calcium was 0·11 per cent., and as mentioned on page 105 there was no insect life at all. Thus it appears that it is most probably the low calcium

content of the sea that does not permit insects to inhabit the sea, while it is the large amount of calcium in the waters of the Salt Range which helps the insects in keeping their body fluids in equilibrium with the highly saline water in which they live. Pantin (1931 (*a*)), Weil and Pantin (1931) and Pantin (1931 (*b*)) by means of carefully conducted experiments have recently shown in the case of estuarine animals that calcium has a profound influence on their permeability to water and salts. McCutcheon and Lucke (1928) had earlier shown the influence of this ion on the permeability of *Arbacia*, and Pearsall (1924) while describing the distribution of purely freshwater organisms, demonstrated the significance of calcium, especially in reference to its effect on the sodium and potassium contents of the medium. Thorpe (1931), however, obtained some insects from the saline waters of the Californian desert regions, in which the amount of calcium was less than that in sea water.

I have started experiments with a view to ascertaining the influence of calcium on Insects living in salt waters and will publish the results in due course.

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TABLE I.—*Physical and Chemical Analyses of water samples. (All values expressed in grms. per litre).*

Localities	Total solids	Ca	Mg	K	Na	SO_4	Cl	CO_3	HCO_3	Conductivity $\frac{1}{R} \times 10^{-3}$	NO_3
Khewra Gorge, Station No. 1	75·960	1·748	0·252	0·142	27·691	1·799	44·304	..	0·0114	13·98	0·0124
Ditto 2	87·536	1·888	0·231	0·089	33·047	1·530	50·729	..	0·0126	15·65	0·0093
Ditto 3	40·916	1·200	0·170	0·086	15·059	1·473	22·898	..	0·0174	8·264	0·0124
Ditto 4	137·840	2·752	0·372	0·152	54·064	0·783	79·712	..	0·0126	22·42	0·0124
Ditto 5	38·224	1·140	0·178	0·129	13·856	1·463	21·427	..	0·0183	7·874	0·0124
Ditto 6	9·928	0·436	0·090	0·096	3·345	0·482	5·449	..	0·0177	2·278	0·0124
Ditto 7	4·42	0·284	0·122	0·034	1·376	0·304	2·270	..	0·0171	1·064	0·0124
Ditto 8	1·744	0·224	0·107	0·020	0·385	0·276	0·710	..	0·0093	0·422	0·0124
Ditto 9	1·344	0·168	0·052	0·032	0·431	0·107	0·525	..	0·0162	0·317	0·0124
Ditto 10	0·480	0·152	0·039	0·004	0·066	0·136	0·050	..	0·0144	0·112	0·0186
Ditto 11	0·720	0·204	0·044	0·040	0·233	0·113	0·050	..	0·0171	0·1171	0·0186
Pond near Chalisa	6·920	0·660	0·143	0·132	1·755	0·854	3·358	..	0·0036	1·548	0·0139
The Lake at Kallar Kahar	4·508	0·080	0·116	0·312	1·2716	0·8443	1·846	0·0156	0·0132	0·954	0·0093
Ponds near Sodi	23·474	1·188	0·772	0·056	6·247	7·744	7·454	0·003	0·0001	3·02	0·0124
San Sakesar Lake	53·34	0·058	1·545	0·323	18·1	13·1	18·7	0·18	0·41	..	..

Table II.—*Physical and Chemical Analyses of water samples. (All values expressed as percentages of total solids).*

Sample No.	Total solids (grms. per litre)	Ca %	Mg %	K %	Na %	SO_4 %	Cl %	NO_3 %	HCO_3 %	CO_3 %	Conductivity $\frac{1}{R} \times 10^{-3}$
Khewra Gorge, No. 1	75·960	2·30	0·332	0·187	36·46	2·37	58·33	0·0163	0·0150	..	13·98
Ditto 2	87·536	2·16	0·264	0·102	37·76	1·75	57·97	0·0106	0·0144	..	15·65
Ditto 3	40·916	2·93	0·415	0·210	36·81	3·60	55·97	0·0303	0·0425	..	8·264
Ditto 4	137·840	2·00	0·270	0·110	39·23	0·568	57·84	0·0090	0·0091	..	22·42
Ditto 5	38·224	2·98	0·466	0·337	36·25	3·83	56·06	0·0324	0·0479	..	7·874
Ditto 6	9·928	4·39	0·906	0·967	33·70	4·86	54·90	0·1249	0·1783	..	2·278
Ditto 7	4·42	6·43	2·76	0·769	31·14	6·88	51·36	0·2806	0·3869	..	1·064
Ditto 8	1·744	12·84	6·13	1·147	22·08	15·83	40·71	0·7110	0·5333	..	0·422
Ditto 9	1·344	12·50	3·87	2·381	32·07	7·96	39·07	0·9226	1·2053	..	0·317
Ditto 10	0·480	31·67	8·12	0·833	13·75	28·33	10·42	3·8750	3·0005	..	0·112
Ditto 11	0·720	28·34	6·11	5·556	32·36	15·69	6·94	2·5835	2·3750	..	0·1171
Pond near Chalisa	6·920	9·54	2·07	1·907	25·36	12·34	48·52	0·2008	0·0520	..	0·954
The Lake at Kallar Kahar	4·508	1·77	2·57	6·92	28·20	18·72	40·95	0·2060	0·2930	0·346	1·548
Ponds near Sodi	23·474	5·06	3·29	0·239	26·61	33·00	31·76	0·0528	0·0004	0·0128	3·02
San Sakesar Lake	53·34	0·11	2·950	0·615	34·46	24·98	35·67	0·0300	0·782	0·343	..

TABLE III.—*Chemical Analysis of the Indian Ocean and of the 77 samples of sea water taken by the "Challenger" from different Oceans of the World.**

Name of the Ocean.	Salinity.	Ca.	Mg.	K.	Na.	SO_4.	Cl.	Co_3.
Indian Ocean	33·53—36·68	1·16	3·67	0·85	30·89	7·79	55·54	0·05
All the Oceans	33·01—37·37	1·20	3·73	1·11	30·59	7·69	55·48	0·21

* From Johnstone's "*Introduction to Oceanography.*"

TABLE IV.—*Distribution of various Phyla of the Animal Kingdom in reference to different salinities.*

Fauna.	Salinity.				
	0·12—2 Stas. 11, 10, 9 & 8.	5—15 Stas. 7, 6 & waters at Chalisa, Sodi & Kallar Kahar.	30—55 Stas. 5, 3 & San Sakesar Lake.	75—95 Stas. 2 & 1.	120—170 Stas. 2 & 1 (April, 1931) & Sta. 4.
Platyhelminthes	▬				
Hirudinea (Annulata)	▬				
Crustacea	▬	▬			
Insecta	▬	▬	▬	▬	▬
Mollusca	▬	▬			
Amphibia	▬	▬	▬		
Pisces	▬	▬	▬		

TABLE V.—*Distribution of various Orders of Insects in reference to different salinities.*

Fauna.	Salinity.				
	0·12—2 Stas. 11, 10, 9 & 8.	5—15 Stas. 7, 6 & waters at Chalisa, Sodi & Kallar Kahar.	30—55 Stas. 5, 3 & San Sakesar Lake.	75—95 Stas. 2 & 1.	120—170 Stas. 2, 1 (April, 1931) & Sta. 4.
Thysanura .					▬
Ephemeroptera	▬	▬	▬		
Odonata . .	▬	▬			
Dermaptera .			▬	▬	▬
Coleoptera . .	▬	▬	▬	▬	▬
Rhynchota	▬	▬	▬		
Trichoptera .	▬	▬			
Lepidoptera . .	▬				
Diptera . . .	▬	▬	▬	▬	▬

ON THE VALIDITY OF *ANDAMIA CYCLOCHEILUS* WEBER, WITH SOME OBSERVATIONS ON *ANDAMIA HETEROPTERA* (BLEEKER).

By D. D. MUKERJI, *M.Sc., Zoological Survey of India, Calcutta.*

There has been a certain amount of confusion both as regards the systematic position of Blyth's genus *Andamia* and the specific limits of the three allied species referred to the genus, *viz.*, *Salarias heteroptera* Bleeker, *Andamia expansa* Blyth, and *Salarias aequipinnis* Günther. In 1925, Annandale and Hora [1] considered *Andamia* to be a highly specialised genus referable to the family Blenniidae rather than to Runulidae of Jordan. They also definitely relegated *A. expansa* and *S. aequipinnis* to the synonymy of *A. heteroptera* (=*S. heteroptera*) on the authority of Mr. J. R. Norman of the British Museum (Nat. Hist.), who came to a similar conclusion on comparing the paratype of *A. expansa* with the type of *S. aequipinnis*.

Among the fishes of the Siboga Expedition Prof. Max Weber described first in 1909 [2] and later in his *Die Fische der Siboga-Expedition* (1913), a new species of *Andamia*, *A. cyclocheilus*, taken in western New Guinea. On reading his description of the species and comparing his beautiful illustration (Weber, 1913, pl. iii, fig. 3) with a fine series of fresh material of *A. heteroptera* recently brought back from the Andamans by several parties of the Zoological Survey of India, I came to the conclusion that *A. cyclocheilus* from New Guinea is identical with *A. heteroptera*.

Weber characterised his new species chiefly by the transversely oval mental sucker and the simple dorsal fin. Bleeker [3] in his original description of *S. heteroptera* did not make any mention of the sucker, and both the type specimens of his species preserved in the S'Rijks Museum in Leiden which were examined by Weber are in such a state of maceration that no conclusive decision could be arrived at regarding the structure of this organ, and this led to some confusion in respect of the exact relationship of the Siboga fish with *A. heteroptera*. *A. heteroptera* is provided with a longitudinally oval sucker (*vide* Annandale and Hora, 1925, pl. ii, fig. 6) even at a very early stage of growth. Though Day both in his *Fishes of India* (1878, pl. lxxi, fig. 2) and in the *Fauna* volume (1889, II, p. 323, fig. 104) published ventral views of the head region of *A. heteroptera* (=*A. expansa*), the structure of the sucker is not shown in either of the illustrations. It seems probable, therefore, that Weber was misled by Day's inaccurate illustrations and mistook for the sucker

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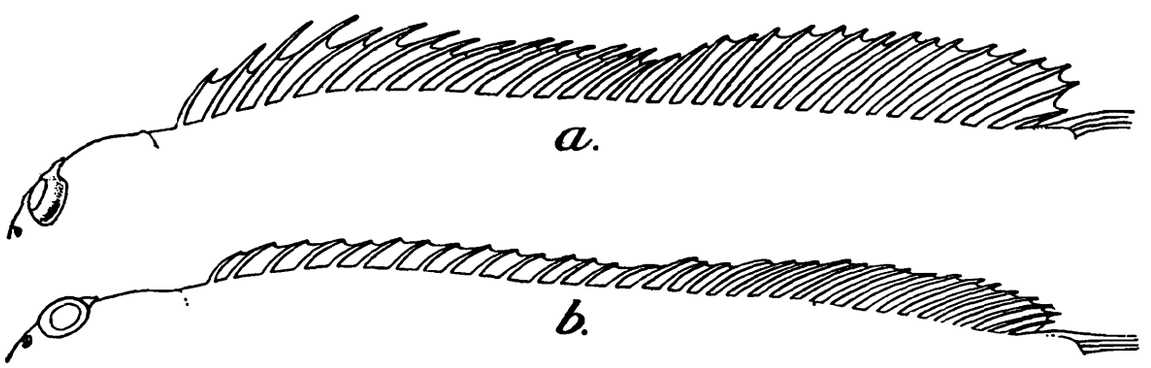
[1] Annandale, N. & Hora, S. L.—"The fresh-water fish from the Andaman Islands." *Rec. Ind. Mus.*, XXVII, pp. 33-41, pl. ii, 1925.

[2] Weber, Max.—"Diognosen neuer Fische der Siboga—Expedition." *Notes Leyden Museum*, XXXI, pp. 143-169, 1909.

[3] Bleeker, P.—"Visfauna van Amboina." *Act. Soc. Sci. Indo-Neerl*, II, pp. 1-102, (1857).

the posterior outlines of the opercular edges, which, when seen from the ventral surface, appear like two diverging triangular structures.

Further, the character of the dorsal fin being without a notch in *A. cyclocheilus* does not separate it from *A. heteroptera*, for, Day already found that the dorsal fin was " not notched " in the latter species. He also pointed out that " in some specimens the two dorsal fins are continuous and in others the second dorsal is higher than the first." Another feature to which Weber gave importance is that the dorsal spines in *A. cyclocheilus* are not prolonged beyond the fin membrane ; but this can hardly be taken as a differentiating character for the two species. On examining extensive material of *A. heteroptera* both in their natural habitat and in the laboratory, I have found that the species exhibits sexual dimorphism, the chief characters of the males being their larger size and more gorgeous colouration with a golden sheen. The prolongation of the dorsal spines is found invariably in grown up males alone, (Text-fig. 1) as in some species of *Periophthalmus* and *Boleophthalmus*, although exceptions and variations are by no means infrequent. Hence no characters are present in *A. cyclocheilus*, which are not possessed by *A. heteroptera*.



TEXT-FIG. 1.—Dorsal fin of *Andamia heteroptera* (Bikr.) × *ca* 2.
(*a*) Male, showing prolongations of spines ;
(*b*) Female, without such prolongations.

In order to have my views confirmed, I wrote to Dr. S. L. Hora who was then working in the British Museum, London, and requested him to examine the type specimens of *A. cyclocheilus* which are preserved in the Amsterdam Museum in Holland. Dr. Hora kindly arranged with Prof. L. F. de Beaufort who very courteously brought the material with him to London when he came there for the British Association meeting of 1930. Subsequently, Dr. Hora favoured me with the following remarks :

" Dr. de Beaufort brought the specimens (2 large and 3 young) of *Andamia cyclocheilus* with him. *A. cyclocheilus* is based on female specimens (in none of the five specimens the dorsal rays are produced beyond the membrane) and your remarks concerning the validity of this species are fully justified. The species *A. heteroptera* (=*A. cyclocheilus*) exhibits sexual dimorphism and, I believe, that must have confused Max Weber "

In a meeting of the Asiatic Society of Bengal held on August 1, 1932, Dr. S. L. Hora [1] briefly communicated his preliminary observations on the habits of *A. heteroptera*. To these may be added the following which were observed by me at Port Blair in the Andaman Islands.

A. heteroptera lives not only on the scattered rocks of the fore-shore kept moist by the spray from the surf line but also inside the various narrow and deep fissures of the vertical rock cliffs which back the beach, and inside the crevices of the stone embankments of the Port Blair Settlement. At high tide, the rocks on which this fish lives in large numbers, become submerged and the exposed areas are often, if not constantly, washed by the high waves that dash violently against and break upon the shore. It is specially at this time that the fish takes shelter inside the fissures and crevices mentioned above. These fissures are well above the water level, but are kept moist by the spray, and form a very suitable retreat for the fish, inasmuch as it is protected from the direct influence of the crashing waves. At low tide, however, when the water recedes, the fishes come out of their hiding places and frequent the exposed areas of the rocks, occasionally moving from rock to rock by swiftly skipping over the water.

Whatever may have impelled the fish to take to a non-aquatic life and to aerial respiration, its bionomics clearly indicate that moisture is an essential physiological need. But it seems probable that *Andamia heteroptera* can withstand long exposures to the sun, and in such cases its skin becomes somewhat dried up. On three occasions I observed the fish (four specimens in all) lying practically on their sides on the dry rocks in the brightest sunshine, apparently in a torpid condition; but when approached they jumped off into the water, skimmed along the surface and perched themselves on another rock where there were large numbers of individuals of the same species. This basking habit, if confirmed and corroborated by further studies, may throw some light on an altogether new aspect of bionomics of this highly interesting marine air-breathing fish.

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[1] *Vide* communication by A. S. B. in *Current Science*, I, No. 2, p. 5 (1932).

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