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NOTES ON SOME EARTHWORMS FROM THE INDIAN MUSEUM.

By G. E. GATES, *Judson College, Rangoon, and Biological Institute,
Harvard University.*

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INTRODUCTORY NOTE.

As the title indicates this paper is mainly concerned with the results of a study of some of the earthworms belonging to the Indian Museum. A few notes have been included on sundry specimens from other museums.

My heartiest thanks are due to Dr. B. Prashad, Director of the Zoological Survey of India, for the opportunity to examine these collections and for the assistance graciously extended in numerous ways during the course of the investigation.

The figures are from camera lucida sketches by Maung Kyaw Zan to whom the author's thanks are again extended. Except in special cases references to the original specific descriptions are given only for species erected subsequent to the publication of Stephenson's Oligochaeta in the "Fauna of British India" Series.

Family MONILIGASTRIDAE.

Genus *Desmogaster* Rosa.*Desmogaster doriae* Rosa.

Material examined.—Karen Hills, east of Toungoo-Burma, October, 1 fully clitellate specimen in excellent state of preservation.

The blood vessels of the reproductive segments of this worm are distended with blood while the vasa deferentia are unusually firm. It has therefore been possible from this worm to clear up the confusion in previous accounts with regard to the vasa deferentia.

The vas emerges from the testis sac and passes ventrally in a straight line on the posterior face of the septum. Before reaching the ventral parietes the vas turns and passes dorsally (either on the posterior face of the septum and covered over by connective tissue or actually within the septum) nearly to the testis sac. Just before reaching the testis sac the vas turns again and passes ventrally in such a way as to form an elongated hairpin loop, the limbs of the loop either in contact or much closer together than either of the limbs is to the entalmost portion of the duct. Before reaching the parietes the vas is twisted several times into short loops, some of the loops are covered over by strong connective tissue. The vas then passes into the parietes and underneath a fairly thick layer of longitudinal muscles and in a straight line to *c* or nearly to *c*. At this point the vas emerges from the body wall and proceeds dorsally along the prostate to the ental end of the latter. No nephridia were found in xi and xii of this worm. A hairpin loop of the vas deferens attached to the posterior face of the septum was probably mistaken previously for a modified nephridium.

Genus *Drawida* Michaelsen.*Drawida affinis* Stephenson, *sp. inq.*

Material examined.—One specimen, holotype, in tube labelled, "W 131/1. *Drawida affinis* sp. nov. Rangamati, Chittagong Hill Tracts. 11-vii-15 R. Hodgart."

The type is acitellate. Definite reproductive apertures are not recognizable. There is a minute vestige of a pore about in line with

b on each side on the posteriormost margin of *x*; possibly the rudiment of a male pore. There is a pore-like marking about in line with *c* in 7/8 on each side; possibly the rudiment of a spermathecal pore.

The small testis sacs extend from 9/10 only slightly into *x*. The vas deferens is short with very few loops. The prostate is rather long and spirally coiled; a rather short ectal portion is slightly widened. The vas passes into the ectal part of the swollen region.

The spermathecal ampullae are vestigial. The atrium is finger-shaped, erect, on the anterior face of 7/8. The atrium of one side was removed and cleared. The lumen is represented by a narrow slit at the centre, the wall of the atrium being unusually thick.



FIG. 1.—*Drawida affinis*. Spermathecal atrium from holotype. $\times ca. 46$.

There are two or more whitish bodies (enterosegmental organs) on the dorsal surface of the intestine at each side of the dorsal blood vessel, in each of four segments just behind the gizzard region.

In the genus *Drawida* the reproductive apertures and in particular the male pores can be recognized as patent apertures in very small specimens long before the worms have attained their full size. Conversely, the absence of definitely recognizable reproductive apertures on the single specimen of *D. affinis* is evidence that the worm is far from fully grown (or else abnormal). In the absence of any evidence that the specific characteristics of the worm have been developed the species must be regarded as dubious. So far as can be determined the relationships seem to be with *D. hodgarti*. Possibly the holotype of *D. affinis* is a very small and juvenile specimen of *D. hodgarti*.

***Drawida decourcyi* Stephenson.**

Material examined.—One dissected specimen, holotype, labelled "ZEV. 5160/7. *Drawida decourcyi* sp. nov. Upper Rotung, alt. ca. 2,000 ft. Capt. M. de Courcy" and two dissected, paratypes, labelled "ZEV. 5381/7. *Drawida decourcyi*. Abor Exped. Renging. 24-xi-11. F. H. Stewart".

One of the paratypes, an anterior fragment, is more nearly mature than the type and from this specimen the subsequent description is mainly derived.

External characteristics.—The prostomium is prolobous.

In intersegmental furrow 7/8 on each side there is a deep invagination with a transversely slit-like aperture. On the anterior wall of this invagination there is a circular area on which the small, primary, spermathecal pore is located.

The secondary male pores (apertures of copulatory chambers?) are crescentic slits on 10/11, so placed that the concavity of the crescent faces anterolaterally, the median end of the slit about at *b*.

Internal Anatomy.—The gizzards are in xx-xxvii with a rudimentary gizzard in xix.

The testis sacs are (apparently) within posterior outpocketings of septum 9/10 into x, the anterior portion of the pocket is narrowed and contains only the entalmost portion of the vas deferens. The vas is long, twisted into a closely compacted mass of coils that is much larger than the testis sac. Some of the loops of the vas appear to project into ix but are covered over by a delicate transparent membrane that may represent a portion of septum 9/10; coils projecting into x are not (apparently) so covered over. The vas deferens of one side, straightened out but without stretching is 640 mm. long. The prostates are smooth surfaced, firm, rather cone-like bodies. The prostates are not erect but are bent backwards towards the ventral body wall, pushing septa 10/11-12/13 into posteriorly directed pockets within which the prostates are contained. The ental end of the prostate is not pointed but bluntly rounded and at its centre the vas deferens passes into the prostate. To the anterior face of the prostate near the parietes numerous, strong, flattened, muscular bands are firmly attached. The length of the prostate is about 5 mm.; an ental portion about 3 mm. long smooth, an ectal portion about 2 mm. in length roughened by the attachment of the muscular bands. The parietal invagination is continued through the body wall into the ectal portion of the prostate, the lumen within the ectal part of the prostate fairly wide though the wall is by no means thin. On the roof of the copulatory chamber there is a smooth, round, genital papilla, at the centre of which there is a depression. Within this depression and attached at one side is a wrinkled, thin-walled, translucent, penial body. The latter is club-shaped and bears at the centre of the bulbous ventral end a male pore. The stalk portion of the penial body narrows gradually as it passes dorsally into the depression on the genital marking.

The lumen of the prostate is reduced by the projection into it of numerous, long, thick ridges.

The prostates in the holotype are similar to those just described but are smaller.

The ovarian chambers and the ovisacs are not sexual though the ovisacs penetrate into xiv-xvi.

The spermathecal atria are about 8 mm. long and of a rather flattened columnar appearance. An ental, coelomic portion about 5 mm. in length passes into the longitudinal musculature in the anteriormost portion of vii and after a right angled bend passes straight posteriorly within the body wall, opening to the exterior, after passing through the rather thin wall of the parietal invagination, by the pore on the circular area on the anterior wall of the invagination. The lumen of atrium is narrowly slit-like, the wall of the atrium of three distinct layers. The spermathecal duct is about 20 mm. long, glistening throughout and slightly widened ectally. The duct passes through 7/8 and into vii and then into the body wall in vii where it joins the atrium.

Remarks.—The second paratype is quite juvenile. The male pores or apertures of the copulatory chambers are not visible; the *anlage* of the spermathecal pores are possibly represented by the minute, blackish depressions on the posterior margin of vii. The spermathecal ampullae are very rudimentary, the testis sacs are small, the prostates are repre-

sented by a small hemispherical body in the parietes just projecting into the coelom, and the ovarian chamber is shut off only mesially. Even at this stage the coiled mass of the vas deferens is much larger than the testis sacs. The gizzards are in xiv-xx.

Although all of the types are acitellate and the ovarian chambers and ovisacs are juvenile the prostates and spermathecae and associated structures are sufficiently developed to enable adequate characterization of the species, at least to the extent of distinction from all known forms of the genus *Drawida*.

***Drawida hodgarti* Stephenson, sp. inq.**

1917. *Drawida hodgarti* Stephenson, *Rec. Ind. Mus.* XIII, p. 366.

Material examined.—One tube labelled, "W 70/1. *Drawida hodgarti* Stephenson. Rangamati, Chittagong Hill Tracts, Bengal. R. Hodgart (Mus. Collr.) Types," containing 3 acitellate specimens, two of which, paratypes, are unopened.

External characteristics.—On the type-specimen there is on the posteriormost margin of x on each side a whitish, narrow, slightly protuberant, transverse ridge, extending from *a* into *bc*. On the median portion of each ridge is a minute, open, round, male pore, about in line with *b*. The transverse male pore ridge is not quite as well developed on the larger of the two paratypes but is recognizable. The male pores are minute but rather slit-like, diagonally placed but about in line with *b*. The reproductive apertures are not visible on the smaller of the paratypes.

The spermathecal apertures are minute, round pores in 7/8, slightly median to *c* (type). The female pores are minute, transverse slits on the anteriormost margin of xii, about in line with *b* (type).

Immediately anterior to each spermathecal pore, on the type, there is a half-moon-shaped, whitened area, the base or straight margin of the marking on 7/8. There is also a slight, whitish tumescence immediately anterior to the male pore ridge on x on each side.

The definitive genital markings are tiny, transversely oyal, greyish areas, just behind *c* on viii and just behind *b* or *ab* on vii.

There are no genital markings on the smaller paratype. On the larger paratype there are four, transverse, greyish-translucent areas on vii, immediately in front of the spermathecal pores and just posterior and slightly lateral to *d*.

Internal anatomy.—(The larger paratype was opened.)

The testis sacs are kidney-shaped and are not constricted by 9/10. The prostates are elongate and coiled, the entalmost portion slightly thicker than the remainder. The vas is rather short, twisted into a small mass of loops on the posterior face of 9/10 under the testis sac; passing into the prostate quite definitely ventral to the ental end.

The ovarian chamber was opened in opening the worm; 10/11 and 11/12 appear to pass independently to the parietes laterally; segment xi is closed off mesially from the oesophagus as in worms with the horseshoe-type of ovarian chamber.

The spermathecal atria are erect, finger-shaped structures in vii. One of these (text-fig. 2) was removed and treated with lactophenol and glacial acetic acid but was not successfully cleared.



FIG. 2.—*Drawida hodgarti*. Spermathecal atrium. $\times ca.$ 46.

The gizzards are four in xv-xviii (in the type, according to Stephenson) or three in xv-xvii. There are masses of whitish material (entero-segmental organs) on the dorsal surface of the gut, on either side of the dorsal blood vessel for a few segments posterior to the gizzard region.

Remarks.—*D. hodgarti* is very similar to *D. papillifer* and is distinguished from the latter species only by the small, finger-shaped spermathecal atria in vii. This distinction can be regarded as valid evidence for separation of the species only if the spermathecal atria of *D. hodgarti* have attained their definitive form. The condition of the ovarian chambers, the ovisacs and the spermathecal ampullae shows quite clearly that the types of *D. hodgarti* are juvenile. Quite possibly then the spermathecal atria are also incompletely developed and hence not characterized by definitive form. The difficulty of demonstrating a lumen in the atrium may be regarded as an additional evidence for the immaturity of the atrium.

The types of *D. hodgarti* and *D. papillifer* were all secured along with the holotype of *D. affinis* from one locality, by the same collector and apparently at the same time.

Drawida kempii Stephenson.

1914. *Drawida kempii*, Stephenson, *Rec. Ind. Mus.* VIII, p. 376.
 1923. *Drawida kempii*, Stephenson, *Oligochaeta, F. B. I. Series*, p. 144.
 1914. ?*Drawida rotungana*, Stephenson, *Rec. Ind. Mus.* VIII, p. 372.
 1923. ?*Drawida rotungana*, Stephenson, *Oligochaeta, F. B. I. Series*, p. 155.
 1914. ?*Drawida pellucida*, Stephenson, *Rec. Ind. Mus.* VIII, p. 368.
 1923. ?*Drawida pellucida* f. *typica* (part), Stephenson, *Oligochaeta, F. B. I. Series*, p. 150.

Material examined.—One specimen labelled “ZEV. 5382/7. *Drawida kempii* sp. nov. Egar Stream between Renging and Rotung. 9-i-12. Under stones in water”; two specimens labelled “ZEV. 5154/7. *Drawida rotungana* sp. nov. Abor Exped. Rotung. Alt. 1,300 ft. Under stone. 8-iii-12. S. W. Kemp”; and one specimen labelled “*Drawida pellucida* Bourne (?) (not fully mature). Upper Rotung. 5-i-12. ZEV. 5411/7.”

A

The holotype of *D. kempii*.

The male pores are minute apertures, each located on a slight, soft, wrinkled and translucent protuberance which is on 10/11, in *bc*, slightly nearer to *c* than to *b*. The margins of *x* and *xi* immediately in front of and just behind these tumescences are slightly swollen but firm. The spermathecal pores are very small, transverse slits in 7/8, about

in *c*. The female pores are very small transverse apertures in 11/12, just lateral to *b*.

The genital markings (?) are a pair of longitudinal, slightly depressed, translucent areas of epidermal thinness. Each of these areas extends anteroposteriorly from just behind 9/10 to just in front of 11/12 and lateromesially from slightly lateral to *c* (as indicated on segments other than *x* and *xi*) to *b*. The translucence and depression are most noticeable on the posterior, anterior and lateral margins of each of these areas. Setae *c* and *d* (of *x* and *xi*) are displaced laterally, apparently by the development of these markings. In addition to these markings there is a small area, rather faintly indicated, on the right side of *ix* just lateral and slightly posterior to *b*. that may represent a vestige of a genital marking.

The vas deferens is slender, short, with a few loops, passing into the dorsal surface of the prostate towards the anterior margin. The testis sacs are constricted dorsally by 9/10, the portion of the sac in *ix* of about the same size as the part in *x*. "The prostate is a large cuboid milky white mass" (Stephenson, 1914, p. 377) sessile on the parietes. The whitish material is unusually soft, softer than the granular layer so often present on the coelomic face of a prostate in *Drawida*. The whitish material falls apart readily, when probed, into club-shaped bodies. Removal of the whitish material discloses a firm, spheroidal body with the ventral face imbedded in the parietes. This central body is very similar to the prostate of *D. rotungana*.

The spermathecal ampullae are filled with whitish material and are probably fully developed. The ovarian chamber is sexual, distended by ova. The ovisacs appear also to be fully sexual.

Remarks.—The holotype of *D. kempi* is probably fully sexual though acitellate. The clitellum appears to be a rather evanescent structure in *Drawida* and does not appear until after the internal reproductive organs are fully sexual. The type-specimen may be somewhat abnormal; the thinness and translucence of portions of the ventral epidermis and the vestigial condition of the asymmetrical genital marking (?) do not appear to be quite normal.

The club-shaped bodies into which the whitish material on the prostate fragments are larger, softer and less firmly bound together than the granulations of the coelomic layer on the ordinary *Drawida* prostate.

B.

The types of *D. rotungana*.

The posterior margins of *x* and the anterior margins of *xi* are swollen and slightly protuberant in a sort of conical fashion in the region of *bc* on each side. Intersegmental furrow 10/11 is uninterrupted in the region of swelling. The rudiments of the male pores are minute apertures on 10/11, in mid *bc*, each pore about at the centre of the marginal swellings.

The spermathecal pores are minute, in 7/8 just median to *c*, each pore on a slight, transversely ridge-like swelling on the intersegmental furrow. The female pores are transverse slits in 11/12 in *b* or very slightly lateral to *b*.

The genital markings are a single pair of inconspicuous, transversely oval, postsetal areas on ix, the width of the marking about equal to interval *ab*, the depressed centres of the markings in line with *b* or *ab*, the markings about equidistant from the setae of ix and 9/10.

The testis sacs extend into both ix and x, the dorsal margin markedly constricted by 9/10, the portion in ix smaller than the part in x. The vas deferens is short with very few loops. It drops to the ventral body wall in x and after a short loop passes into the anterior face of the prostate close to the parietes. The prostate is a smooth-surfaced, firm, spheroidal body, sessile on the parietes. The coelomic wall of the prostate is a very thin, and transparent but tough membrane. Within this membrane there is very soft, whitish material. At the centre of the whitish material there is a small lumen, crescentic in section. The whitish material is, apparently, continued through the parietes in the form of a small column or plug. If this plug is carefully pulled out from the parietes there is visible at the ventral end of the plug a small bit of epidermis on which the male pore is located.

The spermathecal ampullae of the type are fairly well developed but the ovarian chamber and the ovisacs are not sexual. The spermathecal ampullae are not so well developed in the paratype.

Remarks.—The paratype is smaller, less developed sexually and in a poorer state of preservation than the type. The marginal swellings in the vicinity of the male pores are better developed on the paratype than on the type. On the former the anterior and posterior margins of the swellings (*i.e.*, margins away from the intersegmental furrow) are demarcated by transverse furrows which do not pass, either laterally or mesially, into 10/11.

As the types of *D. rotungana* are not sexual the species cannot be adequately characterized. So far as can be determined the species appears to be close to if not actually conspecific with *D. kempi*. About all that is needed to convert the types of *rotungana* into *kempi* is for the whitish material within the prostate to grow through the tough membranous wall into the coelom as club-shaped bodies. Some such process as this probably takes place in the maturing of *kempi* and a similar development has been previously suggested by Benham in *D. indica*.

Another resemblance possibly of minor importance is that the vestige of a genital marking on the type of *D. kempi* is located approximately in the same position as the genital markings of *D. rotungana*.

C.

The specimen of *D. pellucida*.

The spermathecal apertures are small slits in 7/8, just median to *c*. The male pores are not definitely recognizable. There are no genital markings.

The only indications of the presence of the prostates is the bulging of the floor of x in two places, the longitudinal musculature uninterrupted above the bulges. Presumably rudiments of the prostates within the parietes are responsible for the bulging.

Remarks.—The specimen mentioned above is a very immature juvenile. Organs of taxonomic importance have scarcely begun to develop. Identification, at least at present, is impossible. The worm comes from the same region as *D. kempi* and *D. rotungana* and *D. decourcyi*. The absence of colouration suggests a greater possibility of relationship to *kempi* or *rotungana* than to *decourcyi*.

***Drawida limella*, sp. nov. ?**

Material examined.—“From the edge of a tank at Kinchana,” near Amingaon, Kamrup District, Assam. S. L. Hora, 1 clitellate specimen.

Description : External characteristics.—Length, 58 mm. Maximum diameter, 2 mm. There are traces of bluish pigmentation on the dorsum, the pigmentation especially marked in the region of the intersegmental furrows. In the anterior region on each side there is a longitudinal row of tiny but quite evident, blackish spots, each spot in or close to an intersegmental furrow and in line with *c*. The spots are rather pore-like in appearance and doubtless indicate points of especial thinness in the body wall. Similar but less evident spots also in the intersegmental furrows can be recognized in the same region in line *b* on each side.

Setae *ab* and *cd* are closely paired ; $aa < bc$.

The clitellum is annular and indicated by a definite whitening of segments ix-xiv.

The spermathecal pores are tiny, transverse slits in 7/8 in mid *bc*.

The male pores were not recognised.

The female pores are in 11/12 about in line *b*.

The male porophores are roughly conical, whitened, conspicuous protuberances belonging apparently to both x and xi as 10/11 ends abruptly against the base (dorsal portion) of the porophore mesially and laterally. The base of the porophore extends from just median to *a* to slightly lateral to *b*. At the ventral end of the porophore is a tiny, nipple-like projection on which the male pore is presumably located.

The genital markings are a pair of transversely oval, whitish areas, each marking in *bc* on the posterior margin of vii. At the centre of each marking is a tiny, round pore which is very slightly lateral to the spermathecal pore.

Internal anatomy.—Gizzards, 3. Last hearts, ix.

The testis sacs are ovoidal, in 9/10 projecting into both ix and x. The vas deferens was traced on one side where it passes ventrally on the anterior face of 9/10 nearly to the ventral parietes and then posteriorly into x where it passes into the centre of the mid-dorsal face of the prostate. The vas is short and almost straight, *i.e.*, without loops. The prostates are represented by circular, sessile patches of granular bodies in the parietes. Removal of the granulations reveals a central body that is thin-walled, transparent, longer than thick with a constant diameter except that in the outermost layers of the parietes and within the male porophore (nipple-portion) the thickness gradually decreases.

Segment xi was opened by the mid-dorsal incision. If an ovarian chamber is present its anterior and posterior walls are considerably

distended by the accumulated masses of ova. The ovisacs are rather thick for 2-3 segments but are continued posteriorly through several additional segments as much narrower, cord-like bodies.

The spermathecal ampullae are ovoidal. The spermathecal duct is rather thick considering the size of the worm, whitish not glistening, looped on the posterior face of 7/8 and passes into the parietes without noticeable trace of an atrial enlargement.

Erect in segment vii and passing into the parietes dorsal to each genital marking is a columnar body with a finely granular, coelomic surface. From a central point on the dorsal end of the column a fine thread rises and then drops over onto the ventral parietes from whence it could be traced no further. This thread is, on one side of the worm, of a faint reddish colour. The granulations can be easily scraped off revealing an elongate, tubular, central body.

Remarks.—The account above is not as complete as is desirable. The anteriormost segments are softened; no setae were visible on these segments.

The ectal end of the male deferent apparatus is probably in an everted condition; it is scarcely probable that the conspicuously protuberant porophores represent the normal condition of the ectal end of the male apparatus in the living worm. The central body of the prostate of one side has been traced through the parietes to the nipple at the end of the male porophore, so that the location of the male pores on the nipple can be regarded as established with a fair degree of certainty. The spermathecal duct has not however been traced through the parietes to the spermathecal pore as is usually done. The location of the spermathecal pore and the absence of an atrial widening of the duct require, in these circumstances, confirmation.

The septa just behind the ovarian segment and the ovisacs are very fragile so that the membranes were ruptured in exploring the post-genital segments. The exact location of the gizzards is not known, possibly they are in xiii-xv.

The glands in vii are of interest; their appearance and gross morphology is almost exactly like that of the prostates of certain species of *Drawida*. The thread which hangs over onto the parietes may possibly be a blood vessel.

D. limella is close to *D. periodiosa* but is distinguished from the latter species by the absence of spermathecal atria and the more lateral (but only slightly) location of the spermathecal pores. Just how significant or real these apparent distinctions may be can only be determined when further material from Amingaon becomes available for study.

Drawida nepalensis Michaelsen.

1907. *Drawida nepalensis*, Michaelsen, *Mitt. Mus. Hamburg*, XXIV, p. 146.
 1909. *Drawida nepalensis*, Michaelsen, *Mem. Ind. Mus.* I, p. 147.
 1917. *Drawida nepalensis*, Stephenson, *Rec. Ind. Mus.* XIII, p. 372.
 1922. *Drawida nepalensis*, Stephenson, *Rec. Ind. Mus.* XXIV, p. 430.
 1923. *Drawida nepalensis*, Stephenson, *Oligochaeta, F. B. I. Series*, p. 146.
 1909. *Drawida burchardi*, Michaelsen, *Mem. Ind. Mus.* I, p. 149.
 1923. *Drawida burchardi*, Stephenson, *Oligochaeta, F. B. I. Series*, p. 134.
 1925. *Drawida burchardi*, Stephenson, *Rec. Ind. Mus.* XXVII, p. 50.
 1933. *Drawida burchardi*, Gates, *Rec. Ind. Mus.* XXXV, p. 426.

1925. *Drawida papillifer* (part), Stephenson, *Rec. Ind. Mus.* XXVII, p. 51.
 1925. *Drawida hodgarti*, Stephenson, *Rec. Ind. Mus.* XXVII, p. 50.

Material examined.—Three juvenile specimens without male porophores and 1 acitellate specimen with male porophores labelled “ZEV. 2936/7. *Drawida burchardi* Michl. Mt. Harriet, S. Andaman. B. B. Osmaton;” one acitellate specimen labelled “W 1224/1. *Drawida burchardi* Mich. Mt. Harriet, Andamans. Dr. N. Annandale;” 9 juvenile specimens without male porophores and 6 acitellate specimens with more or less rudimentary male porophores labelled “W 1223/1. *Drawida burchardi* Michl. Amingaon. Dr. S. L. Hora;” fragments of two acitellate specimens labelled “ZEV. 2940/7. *Drawida nepalensis*, Gowchar, Nepal. Hodgart. Type;” one juvenile specimen without male porophores and one acitellate specimen with male porophores labelled “W 72/1. *Drawida nepalensis* Michl. Rangamati, Chittagong Hill Tracts, Bengal. R. Hodgart;” 7 acitellate specimens labelled “W 80/1. *Drawida nepalensis* Michl. Kierpur, Purneah District, Bihar. C. Paiva;” two softened, acitellate specimens with male porophores labelled “W 680/1. *Drawida nepalensis* Michl. Compound of Forest Research Inst., Dehra Dun;” two acitellate specimens with male porophores labelled “W 1226/1. *Drawida papillifer* Steph., Amingaon, Assam;” 4 specimens labelled “W 1225/1. *Drawida hodgarti* Amingaon. Dr. S. L. Hora.” From the Hamburg Museum: 5 acitellate specimens labelled “V 7140. *Drawida nepalensis* Michl. Hodgart. Nepal;” 3 acitellate specimens labelled “V 7170. *Drawida burchardi* Michl. B. B. Osmaton. S. Andaman;” and 1 specimen labelled “V 5781. *Drawida burchardi* Mich. W. Burchard. Sumatra.”

The holotype of *D. burchardi* is represented at present only by a posterior portion, the anterior end containing all the reproductive structures has been removed and lost. The holotype was acitellate but the reproductive apertures and spermathecal atria were developed, presumably the worm was fairly near to sexual maturity though the size was small, only 50×1.4 mm. Michaelsen referred worms from the Andamans to his Sumatran species “notwithstanding certain differences” One of these differences that at first appears to rather unimportant is that of size. The worms from the Andamans and India do not have definite male porophores until they are much larger than the Sumatran specimen. Other differences between the Sumatran and Andaman forms will probably, as in the case of body size, be accentuated by completion of sexual maturity. Further, there is no definite evidence in the original description of *D. burchardi* to indicate that the Sumatran worm is conspecific with the forms from other areas that have been referred to *D. burchardi* or *D. nepalensis*.

All specimens of *D. nepalensis* and *D. burchardi* from India, Burma and the Andaman Islands, so far as can be determined in view of the immaturity and preservation, belong to one and the same species. This species, in the absence of definite evidence of identity with the Sumatran form must bear the name *nepalensis*.

The two specimens of *D. papillifer* are quite obviously referable to *D. nepalensis* as at present defined (*vide* Gates, 1933).

One of the specimens of *D. hodgarti*, an anterior fragment, lacks reproductive apertures and is probably not specifically identifiable. The other three specimens are also juvenile but further developed than the fragment.

Greatest length, 128 mm. Diameter, 5 mm. The setae begin on ii and are closely paired, *aa* and *bc* about equal.

The spermathecal pores are minute but open, transversely slit-like apertures, apparently on the posterior margin of vii slightly median

to *c*. The male apertures are minute, open slits in *bc* but much nearer to *b* than to *c*. On one specimen the male pores are quite definitely in 10/11. On the other two specimens each male pore is on a slight, rather indefinite protuberance that involves the anterior margin of *xi* and the posterior margin of *x*, intersegmental furrow 10/11 only faintly indicated on the protuberance or lacking, in the latter case the male pore in line with 10/11. The female pores are minute, on the anterior-most margin of *xii*, in *b*. The nephridiopores of *vii* and *viii* are slightly more dorsal to *d* than on the neighbouring segments.

Septa 5/6-8/9 are thickly muscular. The last pair of hearts is in *ix*. There are two pairs of commissures in *viii*. There are paired, whitish, enterosegmental organs in each of several segments just behind the gizzard region.

Determination of the segmental locations of the gizzards has been difficult. In a previously opened specimen there are three gizzards in *xv*, *xvi*, and *xvii* and then a break in the gut behind which there is a fourth gizzard much longer than any of the others and apparently in *xx*. In another specimen the gut just behind *xi* is rotten and some of the septa are in bad condition but the septa of the gizzard segments appear to be well preserved with the gizzards apparently in *xx*, *xxi*, *xxii* and *xxiii*. In a third specimen there was, when the worm was first opened, no septum visible at the parietes in the region of intersegmental furrow 18/19. After the specimen had dried slightly it was possible to separate what had appeared at first to be septum 19/20 into two distinct sheets, one of which could be peeled off from the parietes anteriorly to 18/19. In peeling off this septum from the gut the posterior-most gizzard is left in *xix* with no gizzard in *xviii*; other gizzards are in *xv*, *xvi*, and *xvii*.

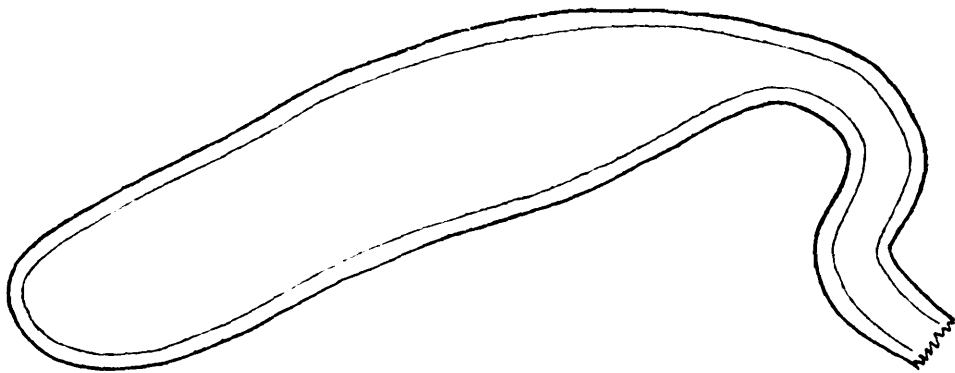


FIG. 3.—*Drawida nepalensis?* Spermathecal atrium of a specimen of *D. hodgarti* Stephenson 1925, non 1917. $\times ca. 26$.

The testis sacs are small. The vas deferens is very long, coiled into a mass of loops that is larger than the testis sac. The prostate is elongate, slender, variously twisted; surface, smooth. The vas passes into the extreme ental end of the prostate.

The ovarian chamber was opened by the mid-dorsal incision in each specimen but is probably closed off from the parietes, at least dorsally; mesially the chamber is closed off from the gut. The ovarian chambers are not distended as in sexual animals and the ovisacs are rudimentary. The spermathecal ampullae are also rudimentary.

The atria are long, in fact so long that an atrium is either folded back on itself or else passes dorsally over the gut and dorsal blood vessel into the other side of the body.

These specimens of *D. hodgarti* are quite obviously specifically distinct from the types of *D. hodgarti*. In view of the juvenile condition of the specimens it is possible at present to indicate nothing more than their resemblances to *D. nepalensis*, as remarked above.

Drawida papillifer Stephenson.

1917. *Drawida papillifer*, Stephenson, *Rec. Ind. Mus.* XIII, p. 370.

1923. *Drawida papillifer*, Stephenson, *Oligochaeta, F. B. I. Series*, p. 148.

1922. *Drawida rosea*, Stephenson, *Rec. Ind. Mus.* XXIV, p. 430.

1923. *Drawida rosea*, Stephenson, *Oligochaeta, F. B. I. Series*, p. 155.

1933. *Drawida ancisa*, Gates, *Rec. Ind. Mus.* XXXV, p. 421.

Material examined.—One specimen labelled, "W 83/1. *Drawida papillifer* sp. nov. Rangamati, Chittagong Hill Tracts, Bengal. 11-vii-15. R. Hodgart" and one specimen labelled, "W 681/1. *Drawida rosea* sp. n. Khasi Hills. Sta. 5. S. L. Hora. Under stones and in muddy pools around Dak Bungalow, Cherrapunji, Assam. 28-x-21" and cotypes of *D. ancisa* from Burma.

A.

The holotype of *D. papillifer*. The male apertures are minute, open, diagonally placed, slit-like pores on the posterior margin of x, each pore just lateral to *b*. (The statement as to the position of the male pores in the original account is inaccurate.) The female apertures are transverse slits, on the anteriormost margin of xii, in *b*. The spermathecal pores are minute, open slits in 7/8 slightly median to *c* and are of about the same size as the male pores. The nephridiopores are about in *d* except on viii where they are displaced slightly dorsal to *d*.

Genital markings. (*a*) Two pairs of greyish, translucent, half-moon shaped areas, one pair on vii, one pair on viii, the markings so placed that the straight base of the half-moon is at intersegmental furrow 7/8 with the spermathecal pore near to the median margin of the marking. (*b*) Transversely oval to almost circular, greyish, translucent, small areas located as follows: one presetal marking on xi in *bc* on the right side, near to 10/11; one pair of presetal markings on x in *bc*, the centre of the right marking slightly lateral to the centre of the marking on xi; one pair of postsetal markings on vii, each marking lateral or dorsal to *d*.

The prostate is club-shaped, gradually narrowing towards the parietes, with the surface granular. The vas deferens is short but is twisted into a small mass of loops and passes into the prostate slightly below the ental end. The spermathecal ampulla is fairly large and filled with whitish material. The atria are fairly large, each atrium with a thin-walled, saccular, ental portion and a much narrower, duct portion. The spermathecal duct is slightly widened as it passes into the atrium. The ovisacs are well developed.

B.

The holotype of *D. rosea*. Each male pore is a minute, open aperture on a short, transversely placed ridge that extends on the posterior

margin of x from a into bc , the male pore very close to b . The ridge is especially protuberant about the male pore as a sort of annular lip. The female pores are minute, on the anteriormost margin of xii , in b . The spermathecal pores are minute (not conspicuous as previously stated) in $7/8$ just median to c .

Genital markings. (a) Four half-moon shaped areas on vii and $viii$ as on the holotype of *D. papillifer*, the presetal areas on $viii$ smaller than the postsetal areas on vii . (b) One pair of presetal, transversely oval, very small areas on xi ; the markings nearer to $10/11$ than to the setae, extending from slightly median to b to slightly lateral to the male pore lines.

The nephridiopores of $iii-vii$ are very slightly dorsal to d , while those of $viii$ and ix are still further dorsal to d .

The epidermis of a midventral region between the male pores and between the markings of xi is thinned and on this thin region $10/11$ is not visible.

There are two pairs of vascular commissures in $viii$. The enterosegmental organs in $xviii-xxi$ are yellowish and translucent.

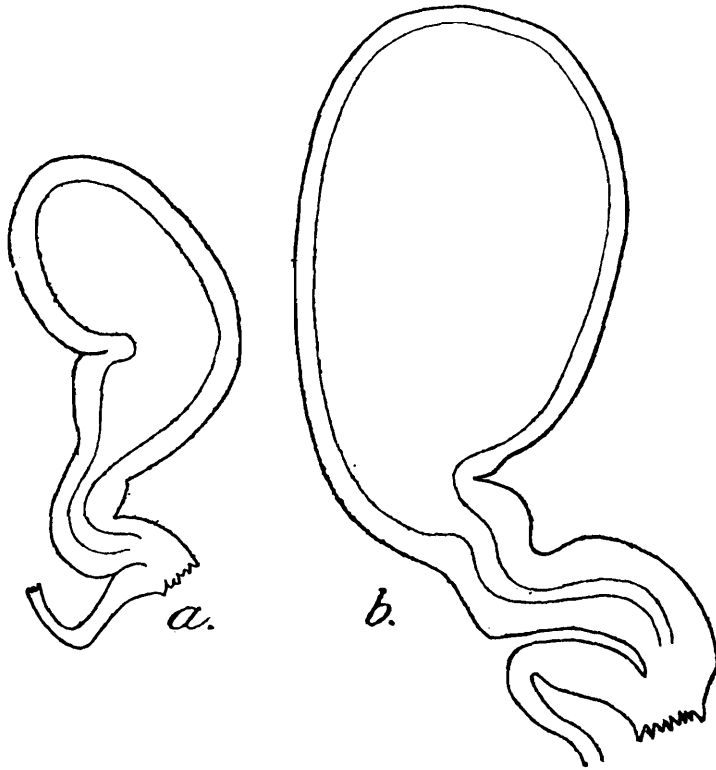


FIG. 4.—*Drawida papillifer*. a. Spermathecal atrium from holotype of *D. papillifer*. $\times ca. 26$. b. Spermathecal atrium from holotype of *D. rosea*. $\times ca. 46$.

The testis sacs are larger than in the holotype of *D. papillifer*. The vas deferens is short and is twisted into a few, loose coils. The prostates are club-shaped, gradually narrowing towards the parietes, the surface granular, but each prostate is slightly flattened and bent into a u-shape. The vas deferens passes into the prostate slightly below the ental end.

The spermathecal ampullae are large and filled with a whitish material. The atria are large, each with a thin-walled, saccular, ental portion and a much narrower, stalk-like, ectal portion. The spermathecal

duct is slightly thickened as it passes into the atrium. An ovarian chamber, which is closed off mesially from the gut, is present. In the ventral portion of the body 10/11 and 11/12 pass to the parietes independently of each other but dorsally there is only one septal attachment to the parietes, 10/11 doubtless in contact with or fused to 11/12 dorsally. The ovisacs are fairly well developed, each being provided with a posterior appendage or tail which is turned dorsally or ventrally.

Remarks.—The holotypes of *D. papillifer* and *D. rosea* are sexually mature. The differences between the two specimens are unimportant taxonomically, similar variations occur in an extensive series of cotypes of *D. ancisa*. The latter are quite obviously conspecific with the types of *D. papillifer* and *D. rosea*. The erection of *D. ancisa* was necessitated by errors in, and the incompleteness of, the accounts of the earlier species. The types of *D. affinis* and *D. hodgarti* are probably juvenile individuals of *D. papillifer*; the types of all three species are from the same locality; but the spermathecal atria of *D. affinis* and *D. hodgarti* are not sufficiently developed to justify a more definite statement.

***Drawida periodiosa*, sp. nov.**

Material examined.—Agarru, West Godavery District, Madras Presidency, April, K. John, 6 a clitellate and 4 clitellate specimens.

Description: External characteristics.—Greatest length, 57 mm. Maximum diameter, 2 mm. Colour dorsally, deep bluish; of clitellum, reddish.

The setae are closely paired, $ab=cd$; behind the clitellar region $aa < bc$. All setae of ii or ii and iii may be lacking or cd only of ii or ii-iii may be lacking.

The clitellum is annular, the clitellar colouration extending across x-xiii and onto the posterior portion of ix and the anterior portion of xiv.

The slit-shaped spermathecal pores are either in line b or very slightly lateral to b , in 7/8 or on vii or viii on one of the genital markings in the region of 7/8.

The male pores are probably about in line b or very slightly lateral to b , the approximate position of the male pore indicated by the lumen of the prostatic duct which is visible in the parietal tissues; the actual male pore and the epidermal tissue immediately around it was not observed.

The female pores are in 11/12, about in line b .

The male porophores are whitish, more or less conical protuberances. On some specimens these protuberances appear to belong to both x and xi while on others they appear to belong solely to segment xi. The porophores are in ab with the median margins slightly median to a and the lateral margins slightly lateral to b .

The genital markings of ix and x are presetal, transversely oval areas about in line with but slightly wider than the male porophores and located as follows: one pair on x, 5 specimens; 1 pair on ix, 3; 1 marking on the left side of x, 1; no markings on ix and x, 1 specimen.

On two specimens there are no further genital markings but on each of the other specimens there is an additional pair of smaller markings located as follows : one postsetal marking on vii on each side, 1 specimen ; one presetal marking on viii on each side, 2 ; one marking on each side, extending across 7/8, 1 ; one marking across 7/8 on the right side, one postsetal marking on vii on the left side, 2 ; one postsetal marking on vii, on the right side and one presetal marking on viii, on the left side, 2. The markings are about in *ab* (the lateral margin may reach slightly beyond *b*) but are not visible until the margins of the deep groove between segments vii and viii are separated. Each marking is demarcated by a slight but definite circumferential furrow and has at its centre, like each of the posterior markings, a circular pore. The shape of the marking varies from spherical to transversely oval or longitudinally oval.

The nephridiopores are about in line with *d* and are not displaced dorsal to *d* on vii, viii or ix.

Internal anatomy.—Septa 5/6-8/9 are thickened and muscular ; succeeding septa thin ; 9/10-10/11 dislocated posteriorly, 10/11 attached to the parietes only ventrally.

The gizzards are two, in xiv-xv (2) or xv-xvi (2) ; or three, in xiii-xv (2) or xiv-xvi (2).

The last pair of hearts is in ix.

The testis sacs are ovoidal or rather flattened bodies, extending apparently into ix and x though not constricted by 9/10. The anterior end of the testis sac is not however in ix but in a space between two lamellae of septum 9/10. These lamellae cannot be separated from each other lateral to the testis sac, but can be traced mesially to the oesophagus and ventrally to the parietes. The ental portion of the vas deferens is between these two lamellae, emerging ventrally into x where it passes posteriorly and into the anterior face of the prostate. The vas deferens is short, looped back and forth in a rather zigzag fashion, especially in x just anterior to the prostate, but not twisted into a mass of coils as in many of the Burmese species. The prostate is a short, cone-like body, erect in x just anterior to the ovarian chamber, with a softish surface of granular appearance. Removal of the granular layer discloses a firm, tubular, relatively quite small, central body just barely protruding through the parietes into the coelom. The vas deferens was broken off while removing the granular layer of the prostate, but as far as can be determined the vas passes into the ental end of the central body.

Segment xi is reduced to a horseshoe-shaped chamber. The ovi-sacs are fairly large, extending posteriorly into xvi, xvii or xviii. The spermathecal ampulla is spheroidal to ovoidal ; the duct which is rather thickish is bent to and fro in a sort of zigzag fashion on the posterior face of 7/8. The spermathecal atrium is a short, stumpy tube, about twice the thickness of the spermathecal duct. Usually the atrium is concealed within the parietes and the tissues of septum 7/8 but in one specimen it protrudes, on each side into vii. The spermathecal duct passes into the posterior face of the atrium.

Dorsal to each genital marking is an erect, thickly tubular gland with a bluntly rounded ental end ; the gland projecting conspicuously into the coelom. Each gland is provided with a finely granular investment. The granulations (glands ?) can easily be scraped off revealing an erect, firm, reddish, central body with a narrow lumen which opens to the exterior by the pore at the centre of the genital marking. In three specimens there is visible at the dorsal terminus of each gland in ix a fine thread which rises slightly in the coelom and then falls over onto the parietes in a series of very short rather zigzagged loops. Attempts to trace this thread further, either on or within the parietes failed completely. The glands in vii and (or) viii are usually of the same size, shape and appearance as those in ix but may be a trifle shorter. In one specimen the anteriormost glands are bent, not erect, but project through the parietes into the coelom.

Remarks.—On the whole the worms are in good condition and appear to have been well preserved. However all the specimens have been eroded, possibly due to friction during transportation. The erosion is especially marked on the anteriormost and posteriormost segments and on the projecting male porophores.

The location of the spermathecal pore has been confirmed by tracing the atrium through the parietes. The pore at the ectal end of the atrium is always slit-shaped. This characteristic shape will serve to distinguish the spermathecal pore from a gland pore even when the two pores are on the same genital marking. On one specimen each spermathecal pore is at the centre of a tiny round genital marking that is clearly demarcated by a slight but definite circumferential furrow. This spermathecal pore marking is in contact with a genital marking. On other worms the spermathecal pore is either on the margin of a genital marking or on the intersegmental furrow a slight distance from the genital marking and with no indication of the delimitation of a special area about the pore.

The structures dorsal to the genital markings that project through the parietes into the coelom of segments vii to ix, which have been referred to in the preceding description merely as glands, are of peculiar interest as they are very similar in appearance and structure to prostates and in particular to those of a generalized *Desmogaster* type, as in *D. doriae*. In another Indian species, *D. scandens*, glands in ix, apparently similar to those of *D. periodiosa*, are “ of the same size, shape and appearance ” (Stephenson, 1921, p. 756) as the prostates in x. In fact, the glands of ix in *D. scandens* have been regarded as prostates and the external apertures as male pores. The interpretation of glands in segment ix as prostates leads to an assumption that the presence of the prostates is evidence for the former presence of an extra pair of testes. Referring to these extra prostates, Stephenson (1921, p. 748) writes, “ Michaelsen has previously found a rudimentary second pair in segment ix in *D. willsi* and has argued that the genus originally possessed two fully-developed pairs, of which the anterior has disappeared. This anterior pair, in turn, is the index of a formerly existing second pair of testes, the ancestors of the genus *Drawida* having been holandric while their present day representatives are metandric.

The genus *Desmogaster* is actually holandric and is to be looked on as the most primitive existing member of the family." *D. scandens* with two pairs of equisized prostates is accordingly regarded "as the most primitive existing member of the genus at any rate in respect of its male reproductive apparatus" (p. 749).

D. periodiosa does not however fit into the phylogenetic scheme quite so nicely as does *D. scandens*. Thus, for instance, is the presence of "prostates" in segments vii, viii and ix to be accepted as evidence for the former existence of four or five pairs of testes in the ancestors of *Drawida*? If not, then why are exactly similar "prostates" in vii and viii not as good an evidence for the former presence of testes as "prostates" in ix? Again, the prostates in the coelom of segment ix may belong morphologically to ix (when associated with the genital markings of ix) or to x (when associated with the genital markings of x). In the latter case the glands are actually within the coelom of ix but only because septum 9/10 has been dislocated posteriorly behind its normal level. In such specimens there are two pairs of "prostates" belonging to x. Is the presence of two pairs of prostates belonging to segment x to be accepted as an index of the former presence of two pairs of testes?

While the supposed vestigial prostates are smaller than the true prostates in *D. willsi* and of about the same size in *D. scandens*, they are actually larger and better developed than the true, functional prostates in *D. periodiosa* and *D. limella*. Yet it is these large "prostates" of *D. periodiosa* which are most like a generalized, supposedly primitive and ancestral type of *Desmogaster* prostate.

In these circumstances it appears preferable to regard the structures in vii-ix merely as glands of a rather peculiar type, variable as to number and segmental location in *D. periodiosa*, but possibly more definitely restricted in certain segmental locations in *D. limella*, *D. scandens* and *D. willsi*.

D. periodiosa is close to *D. limella* and *D. scandens*. From the latter *D. periodiosa* is distinguished by the segmental location of the gland pores and by the presence of genital markings on vii and viii as well as by differences in the male porophores.

Drawida pomella, sp. nov.

1925. *Drawida papillifer* (part), Stephenson, *Rec. Ind. Mus.* XXVII, p. 51.

Material examined.—Twenty-one specimens from a tube labelled "W 1226/1. *Drawida papillifer* Steph. Amingaon, Assam".

The male pores are not in mid *bc* but are minute, open, diagonally placed slits on the anterior margin of xi slightly lateral to *b* toward the median margins of the male porophores. The spermathecal apertures are minute (not conspicuous), open slits in 7/8, slightly median to *c* (not in *b*). The female pores are minute, transverse slits on the anterior-most margin of xii, in *b*.

On segment xi there is visible on each side a protuberant area which may be short and transversely ridge-like or more extensive antero-posteriorly and nearly half-moon shaped. The protuberance extends from *b* nearly to *c* and anteroposteriorly from 10/11 nearly to the setae

of xi or only about half way to the setae of xi and is demarcated anteriorly by 10/11 but is otherwise without definite boundaries. On each of these areas there are usually small genital markings, as a rule lateral and posterior to the male pore but rarely just median to the male pore; the number of the markings is variable. Similar genital markings may be present on the posterior margin of x just in front of the male porophore and on the posterior margin of vii in a limited region anterior to each spermathecal pore. These markings are very small, transversely oval to circular, usually quite sharply delineated. Slightly larger markings, closely paired in *aa* may also be present on the posterior margin of x or the anterior margin of xi. Rarely there may be an odd marking or two on viii.

The vas deferens is short, twisted into a few loose loops. The prostate is elongately club-shaped with a short but thick, rounded ental knob and a fairly long narrow stalk. The prostates are variously bent; the surface smooth or very finely granular. The vas passes into the prostate towards the ectal end of the round terminal portion.

The ovarian chamber is closed off mesially from the gut and probably also from the parietes dorsally, as 10/11 and 11/12 pass independently to the parietes only in the ventral portion of the body. The ovisacs are small and vestigial. The spermathecal ampullae are small but within each ampulla is a little whitish material. The atria are elongate and flattened, narrowing gradually towards the parietes. Attempts to clear the atria were not very successful, at least no lumen was seen. The spermathecal duct passes through 7/8 and into the atrium dorsal to the body wall.

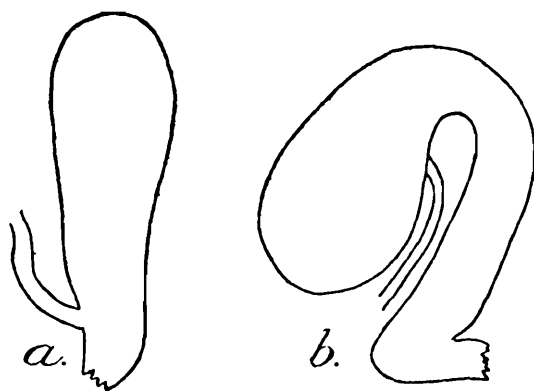


FIG. 5.—*Drawida pomella*. a. Spermathecal atrium. $\times ca.$ 20. b. Prostate. $\times ca.$ 20.

The gizzards are 3-4 in xiii-xviii : xiii-xv (1), xiii-xvi (1), xiv-xvi (2), xv-xvii (1), xvi-xviii (1).

There are paired enterosegmental organs on the dorsal face of the intestine in at least 2-4 segments just behind the gizzard region.

Very small, rounded glands protrude through the parietes into the coelom dorsal to the genital markings in one specimen.

Remarks.—The small size of the spermathecal ampullae, the indistinctness and fineness of the granular layer on the prostates, the empty or nearly empty ovarian chambers and the small ovisacs show that the worms are not fully sexual. Nevertheless *D. pomella* can be distinguished from *D. rangamatiana*—the only other Indian species with

male pores on xi—by the genital markings and the associated parietal glands. In these circumstances the erection of a new species seems to be justified even though the specimens are not sexual.

The two specimens of *D. nepalensis* in the tube with *D. pomella* are very readily distinguished from the latter by the larger setae of the anterior segments and the characteristic male porophores.

Drawida rangamatiana Stephenson.

Material examined.—One specimen labelled “W 82/1. *Drawida rangamatiana* sp. nov. Rangamati, Chittagong Hill Tracts, Bengal. 17th July 1915. R. Hodgart.”

The spermathecal apertures are minute, just median to *c*; each pore on the posteriormost margin and towards the median border of a genital marking on vii. The female pores are minute, transverse slits in 11/12, just lateral to *b*.

The male pores are minute, diagonally placed slits on slight, transverse protuberances of the anterior margin of xi. Each porophore is delimited posteriorly by a slight furrow that passes mesially and laterally into 10/11. The anterior boundary of the male porophore is a deep groove (much deeper than the furrow at the posterior margin of the porophore), which is regarded as intersegmental furrow 10/11 but slightly dislocated anteriorly by the marginal swelling of xi. The median margin of the porophore does not quite reach to *b* nor does the lateral margin reach to *c*, the male pore quite definitely nearer to *b* than to *c*. A portion of xi just behind each male porophore is also slightly swollen.

Genital markings.—On vii: a pair of postsetal, half-moon shaped areas, the straight bases of the markings about at 7/8 or possibly transgressing that furrow very slightly, the centres of the markings about in *c*. On ix: two patches of special glandularity, each patch extending anteroposteriorly the whole length of the segment in the lateral half of *bc*, the margins of the patches are not clearly demarcated. On x: one pair of postsetal markings, each marking just lateral to the male pore. On xii: a single, transversely oval, presetal area on the right side, the median margin about at *b*.

The last hearts are in ix (not viii as previously stated).

The prostates are elongate and spirally coiled as in *D. longatria* the surface finely granular. The vas deferens is fairly short, looped, back and forth into a fairly regular series which forms a dorso-ventral band on the posterior face of 9/10. The ectal portions of the vasa deferentia were broken across, presumably in the previous dissection. Attached to the ental end of one prostate is a filament that may be a portion of the vas.

The ovarian chamber and the ovisacs are not sexual. The spermathecal ampullae are small and do not appear to be fully developed. The atria are large, conspicuous structures, about 3 mm. in length, reaching to the dorsal blood vessel.

Remarks.—The holotype is not sexual. If the interpretation of the furrows and grooves associated with the male porophores that was

given above be correct, the segmental location of the male pores on xi will distinguish *D. rangamatiana* from other Indian species of *Drawida* (except *D. pomella*) even though the prostates, spermathecal atria and genital markings have not attained their definitive, specific characteristics.

***Drawida troglodytes* Stephenson.**

1924. *Drawida troglodytes*, Stephenson, *Rec. Ind. Mus.* XXVI, p. 129.

Material examined.—One specimen labelled "W 1150/1. *Drawida troglodytes*, sp. nov. Siju Cave, 2,000 feet from entrance. Feb. 1922."

The prostomium is probably prolobous and of the usual type but was damaged in the previous dissection.

The spermathecal pores are very small, transverse slits in 7/8, just median to *c*. The female pores are minute, transverse slits in 11/12, in or slightly lateral to *b*.

The male porophores are transversely oval, extending across 10/11, equally onto *x* and *xi* and lateromesially from *b* nearly to *c*. Intersegmental furrow 10/11 ends against the lateral and median margins of the porophores. The anterior and the posterior margins of the porophores are sharply marked off. The male pore is a minute, diagonally placed slit towards the median margin of the porophore and accordingly nearer to *b* than to *c*.

The vas deferens is coiled into a number of loose loops, the mass of loops nearly equal in size to that of the testis sac. One prostate is erect though this may not have been its original condition. The other prostate is bent over posteriorly to pass through the perioesophageal annulus between the ovarian chamber and the oesophagus into *xii*. The prostates are not spirally coiled.

The ovarian chamber and the ovisacs are sexual but the spermathecal ampullae are rather small, translucent and possibly not fully sexual. There is a pair of unusually large atria in *vii*. Each atrium is erect but is so long that it passes over to the opposite side of the body above the dorsal blood vessel. The atria are flattened, thin-walled sacs without definite demarcation of a duct but narrowing gradually towards the parietes. An atrium figured here (text fig. 6) had been severed by the



FIG. 6.—*Drawida troglodytes*. Spermathecal atrium. $\times ca. 11$.

previous dissection so that a small ectal portion is still visible in the coelom. The figure does not accordingly show the whole length of the organ. The ental end of this atrium is bent over on itself as a sort of flap; the ental end of the other atrium is invaginated.

Remarks.—According to the original description "there is no trace of an atrium" Possibly the large size is responsible for the atria being overlooked.

The holotype is probably nearly sexual, but if the small size and translucent appearance of the spermathecal ampullae are characteristic of the species the type may be fully sexual.

According to Stephenson the relationships of *D. troglodytes* are with *D. pellucida* but the large spermathecal atria quite definitely negative this suggestion.

Family MEGASCOLECIDAE.

Subfamily MEGASCOLECINAE.

Genus **Plutellus** E. Perr.

Plutellus sp. ?

Material examined.—Curjung village, Nepaul, K. N. Sharma, 3 acitellate specimens.

Length, to 50 mm. Diameter, to 4 mm. Male pores in *ab* on xviii. Spermathecal pores paired, in or nearly in line with *c*, in 7/8-8/9. Nephridiopores lateral to *b* (probably).

The intestine begins in xv. The male funnels and the female funnels are readily recognizable. The seminal vesicles are paired in ix and xii; the testes and ovaries large, free in x-xi and xiii. The prostates are tubular, the ducts nearly straight. The ectal tips of the penial setae are bent slightly towards one side and ornamented with rows of teeth. The spermathecae are rudimentary, just barely projecting into the coelom of segments viii-ix.

There is a rudimentary gizzard in v.

Remarks.—In the coelom there are numerous nematodes with strong, paired hooks.

Genus **Tonoscolex** Gates.

Tonoscolex oneilli (Stephenson).

1914. *Megascolides oneilli*, Stephenson, *Rec. Ind. Mus.* VIII, p. 377.

1916. *Megascolides oneilli*, Stephenson, *Rec. Ind. Mus.* XII, p. 314.

1923. *Notoscolex oneilli*, Stephenson, *Oligochaeta, F. B. I. Series*, p. 212.

Material examined.—One specimen labelled "ZEV. 5159/7. *Megascolides oneilli*; Steph. Janakmukh (Abor Exped.) Capt. J. S. O'Neill. Type."

None of the olive green colouration is now visible.

All of the grooves on the male genital shield are not of equal importance. Some represent merely creases in the epidermis. The seminal grooves are L-shaped; the longitudinally placed posterior limb of the L parallel to the midventral line; the transverse limb of the L passing midventrally but ending abruptly before reaching the midventral line. Immediately in front of the median end of each anterior limb of the groove there is a deep depression or invagination with a transverse slit-like aperture. The margin of the aperture of the invagination is tumescent and lobulated, one of the lobulations larger than the others and at the median end of the anterior limb of the seminal groove.

The prostate is folded.

Remarks.—The male pores were not identified. The pores were not visible externally and determination of their position would have involved tracing the prostatic duct through the parietes. The holotype is rather badly preserved and the male genital shield should be preserved in as good condition as possible.

T. oneilli is distinguished from the Burmese and other Indian species of the genus by the invaginations near the anterior ends of the seminal grooves.

***Tonoscolex striatus* (Stephenson).**

1914. *Notoscolex striatus*, Stephenson, *Rec. Ind. Mus.* VIII, p. 380.

1923. *Notoscolex striatus*, Stephenson, *Oligochaeta, F. B. I. Series*, p. 218.

1914. *Notoscolex stewarti*, Stephenson, *Rec. Ind. Mus.* VIII, p. 382.

1923. *Notoscolex stewarti*, Stephenson, *Oligochaeta F. B. I. Series*, p. 216.

Material examined.—Two specimens labelled “ZEV. 5394-5/7. *Notoscolex stewarti* Steph. Rotung, alt. 1,300 feet (Abor Expedt.) Capt. F. H. Stewart. Types”; three immature specimens labelled “ZEV. 5385-6/7. *Notoscolex striatus*, sp. nov. Abor Exped. Rotung, alt. 1,300 feet. 21st December 1912. Under stones. S. W. Kemp;” one dissected, acitellate specimen labelled “ZEV. 5384/7. *Notoscolex striatus*, sp. nov. Abor Exped. Upper Rotung, alt. ca. 2,000 feet. 4th January 1912. Found in earth when road making”; and 1 dissected specimen labelled “ZEV. 5410/7 *Notoscolex striatus*, sp. nov. Upper Rotung. 5th January 1912.”

None of the specimens of *N. striatus* are fully clitellate; one of the specimens in the first tube of *striatus* as well as the specimen in the third tube have slight indications of the development of the clitellar glandularity.

The seminal grooves are usually as figured by Stephenson but on one specimen the grooves are straight, without the laterally directed terminations. The absence of these short terminations may be an individual variation, an abnormality or may represent a juvenile condition. The “tags” may be entirely lacking, rudimentary or well developed. The “tags” when present are developments of the anterior-most margins of xvii and xviii just lateral to the seminal grooves (the intersegmental furrows 16/17-17/18 visible ventrally clear to the seminal grooves). The “tags” are slightly more lateral to the seminal grooves on the types of *stewarti* than on *striatus*.

The types of *stewarti* have markedly protuberant clitella on which the intersegmental furrows are lacking.

The prostates are in xvii-xviii, the portion of the gland in xviii folded so that the lobulation is more apparent than real.

Remarks.—The differences between *stewarti* and *striatus* in size, presence or absence of calciferous glands in ix, size of prostates, the presence or absence of seminal vesicles in xii are of little significance especially in view of the immaturity of the specimens of *striatus*. Intra-specific variation in body size may be considerable within the genus *Tonoscolex*. The very striking similarity, almost identity, of structures on the male genital shield, the seminal grooves and tag-like processes, does furnish very definite evidence for the specific identity of the two forms.

Tonoscolex horai (Stephenson), *sp. inq.*1922. *Megascolex horai*, Stephenson, *Rec. Ind. Mus.* XXIV, p. 432.1923. *Megascolex horai*, Stephenson, *Oligochaeta, F. B. I. Series*, p. 247.*Material examined.*—One specimen labelled "W 703/1. *Megascolex horai* Steph. Cherrapunji, Assam. Dr. S. L. Hora."

The male pores are minute, on small papillae on xvii. There are no seminal grooves.

The prostates are small, each with two flattened lobes, the length of the prostatic duct which is bent into a single loop slightly greater than the length of each of the lobes. Prostates and ducts are confined to xvii.

The calciferous glands are three pairs in x-xii. The male funnels are paired in ix and x, but there is only a single pair of seminal vesicles in xi.

The spermathecae are in vi and vii. The duct is slightly coelomic but is shorter and stouter than the diverticulum. The latter is longer than the ampulla, slenderly tubular and passes into the median side of the duct.

Remarks.—The holotype of *T. horai* is acitellate. The species cannot be adequately characterized until mature specimens are available for examination, but even so the type is much more like specimens of *Tonoscolex* than *Megascolex*. Differences from Indian and Burmese species—slightly wider separation midventrally of the spermathecal pores, the absence of the seminal grooves—appear, on the whole to be relatively unimportant, especially in view of the immaturity of the type. Perichaetine setae are present in *T. ferinus* from Burma.

Genus **Pheretima** Kinberg.**Pheretima annandalei** Stephenson.1917. *Pheretima annandalei*, Stephenson, *Rec. Ind. Mus.* XIII, p. 386.*Material examined.*—The holotype in a tube labelled "W 8/1. *Pheretima annandalei* Stephenson, Casuarina woods at Singgora, Talé Sap, Siam. Dr. N. Annandale."

The setal numbers are: vi/28, vii/30, viii/40, xvii/15, xviii/12, xix/17.

The spermathecal pores (secondary) are fairly large, transverse slits in 5/6-8/9.

The apertures of the copulatory chambers are transversely slit-like with tumescent and finely lobulated margins.

The genital markings are very small, rounded tubercles located in the midventral region. On viii, a presetal row of three markings near the anterior margin and a postsetal row of three markings. In addition a single presetal marking between the anterior row and the setae. On xviii, one presetal marking and a postsetal row of 3 markings. On xix, two presetal rows of three markings each and two postsetal tubercles, one near the setae and one just in front of 19/20. Single markings on viii, xviii and xix are in line with one of the markings in the rows.

The intestinal caeca are simple.

The prostatic ducts are bound by connective tissue to the dorsal faces of the very conspicuous copulatory chambers. Within the copulatory chamber is an elongately tubular penis, slightly more than 2 mm. in length. The penis is slightly widened in the dorsalmost portion of the chamber.

The seminal vesicles are very large.

The spermathecae (text fig. 7) are similar to those of *P. gemella*.



FIG. 7.—*Pheretima annandalei*. Spermatheca. $\times ca. 11$.

Remarks.—The holotype is probably incomplete posteriorly.

P. annandalei can be distinguished, for the present, from *P. floweri* by the presence of the genital markings and from *P. gemella* by the absence of the pseudocopulatory chambers in xix or xix and xx.

***Pheretima bipora* (Beddard).**

1900. *Amyntas biporus*, Beddard, *Proc. Zool. Soc. London*, p. 908.

1932. *Pheretima bipora*, Stephenson, *Ann. Mag. Nat. Hist.* (Ser. 10) IX, p. 213.

Material examined.—From the British Museum; three specimens in a tube labelled "*Amyntas biporus*. 1904. 10th May 1915-16. Malay Peninsula. Coll. Beddard."

The genital markings are paired and postsetal on vii. The two markings nearer the midventral line are transversely oval and close to the setae. The smaller markings are circular or nearly circular, close to 7/8, one marking just median to each spermathecal pore in 7/8. The larger markings are probably about 7-8 intersetal intervals median to the spermathecal pores.

Remarks.—Stephenson looked at these specimens, noting that the jar contained "three hard, black and shrunken specimens, in which even the external characters are not distinguishable." The worms were soaked for 24 hours in water and after this treatment the external genital markings could be recognized. None of the specimens had been previously dissected. The soaking in water did not appear to be sufficient to enable much of the internal anatomy to be worked out, but four brief notes were jotted down which are transcribed herewith. The protuberant body in the pseudocopulatory chamber in xix is more like the penis in the copulatory chamber of xviii than in *P. gemella*. The spermathecal diverticulum appears to pass into the duct nearer to the parietes than in *P. gemella*. The last pair of hearts is probably in xiii. The testis sacs of x and xi are probably U-shaped, the seminal vesicles of xi within the sac of that segment (?).

Remarks.—*P. bipora* can be distinguished from *P. gemella*, for the present, by the paired, transversely oval genital markings and the limitation of the genital markings to a postsetal location on vii.

***Pheretima dunckeri* Michaelsen.**

1902. *Pheretima dunckeri*, Michaelsen, *Mitt. Mus. Hamburg*, XIX, p. 9.

Material examined.—From the Hamburg Museum, four clitellate and undissected specimens and some fragments in a tube labelled, "V 5876. *Pheretima Dunckeri* Michl. Duncker. Malayische Halbinsel."

External characteristics.—The first dorsal pore is 11/12 (3).

The spermathecal apertures (secondary) are transversely slit-like openings in 6/7-7/8 into deep invaginations. On the anterior wall of the invagination and sometimes visible from the exterior if the aperture gapes open or is held open there is a genital marking on which there is a minute pore. This pore may possibly be the minute, primary spermathecal pore.

The "grosse männliche Poren" (Michaelsen, 1902, p. 10) are the apertures of the copulatory chambers. The smaller male pores are located on penial bodies in the copulatory chambers. These bodies may be visible from the exterior when the aperture of the chamber is relaxed. The penial bodies are softened and wrinkled and probably somewhat macerated.

On vii there are about 19 spermathecal setae. Presumably the midventral setae on xviii have dropped out.

Internal Anatomy.—The intestinal caeca are simple. The single heart of ix is on the left side. The last pair of hearts is in xiii.

The testis sacs of x and xi are unpaired and U-shaped. The hearts of x are within the limbs of the sac which are in contact dorsally above the gut but apparently not fused mid-dorsally. The seminal vesicles and hearts of xi are included within the limbs of the sac of xi; the limbs of the sac not in contact above the gut and but loosely attached by connective tissue to the gut. The prostatic duct is rather slender, slightly sinuous and passes into the lateral face of the copulatory chamber close to the parietes. The copulatory chambers are large. The prostates extend through xix-xxiv.

The dorsal portion of a spermathecal invagination projects in a rounded fashion quite noticeably into the coelom. The diverticulum which passes into the posterior face of the duct is twisted into a closely compacted mass of loops from which projects slightly the ovoidal ental terminus.

Remarks.—Only one other quadrithecal species of *Pheretima* with spermathecal pores in 6/7-7/8 is known at present from the Asiatic mainland, *P. immerita* from Burma. The latter is distinguished from *P. dunckeri* by the presence of septa 8/9-9/10.

***Pheretima floweri* (Benham).**

1897. *Perichaeta floweri*, Benham, *Journ. Linn. Soc. London*, XXVI, p. 217.

1900. *Pheretima floweri*, Michaelsen, *Das Tierreich*, X, p. 267.

Material examined.—Three softened specimens in a tube labelled "*Perichaeta floweri*. 96. 9. 30. 9-11. Bukit Timah, Singapore. S. S. Flower."

The setal numbers are : vi/11, vii/14, viii/13, xviii/8. Setae are present ventrally on xvi.

The clitellar colouration does not extend either to 13/14 or to 16/17

The female pore is single.

The apertures of the copulatory chambers are transversely slit-like with the margins in apposition.

The spermathecal apertures are tiny, transverse slits ; four pairs, in 5/6-8/9.

There are no genital markings. The "flat, rounded papillae" mentioned by Benham are doubtless the copulatory chambers which are visible through the transparent epidermis as white, circular patches.

According to Benham, "one of the 'penial ducts' is partially protruded" from the aperture of the copulatory chamber. The penes are not actually visible externally but a flattened tag-like process protrudes slightly from one of the copulatory chamber apertures. Doubtless it is this tag-like process which was referred to as a "penial duct."

Septum 8/9 is possibly present (?).

The intestinal caeca are simple, probably extending from xxvii into xxi. The last pair of hearts is in xiii (2).

Each seminal vesicle is provided with a finger-like to conical, primary ampulla (2). There are paired pseudovesicles in xiii and xiv (2). The prostates extend through xvii-xviii or xvi-xviii. The prostatic ducts are short but stoutish and nearly straight. The copulatory chambers are fairly large. Within the copulatory chamber is an elongately tubular penis, the dorsalmost portion slightly thicker than the ventral terminus.

The spermathecal diverticulum comprises a slenderly tubular stalk and an ovoidal, definitely demarcated, seminal chamber.

Remarks.—One of the specimens is very badly softened and was completely disregarded. The account above is based mainly, and so far as the external characteristics are concerned entirely, on an undissected specimen. Some of the internal structures in both specimens are now rather shapeless.

***Pheretima hawayana* (Rosa) 1891.**

"Banks of stream north of Mowkhar," Shillong, Dec. 4, 1930. H. S. Rao, 2 clitellate specimens.

Material examined.—Kali Jhora, Kafibari and Singla Tea Gardens, Kurseong, 4,000 feet, Sta. 20, March 6, 1926, M. Sharif, 6 clitellate specimens.

***Pheretimā houlleti* (E. Perr.) 1872.**

1916. *Pheretima trivandranā*, Stephenson, *Rec. Ind. Mus.* XII, p. 335.

1923. *Pheretima trivandranā*, Stephenson, *Oligogochaeta, F. B. I. Series*, p. 314.

1898. † *Perichaeta travancorensis*, Fedarb, *Journ. Bombay Nat. Hist. Soc.* XI, p. 435.

Material examined.—One specimen labelled "ZEV. 7233/1. *Pheretima trivandranā* Stephenson. Trivandrum Museum, Trivandrum, Travancore. Type." From the British Museum: two dissected specimens labelled "*Pheretima crescentica* ? 1904. 10. S. 18-26. Dehra Dun. Coll. Beddard" and one specimen labelled "*Megascolex (Pheretima) houlleti* E. Perr. 1924. 6. 21. 6. Salem and Bangalore."

The holotype of *P. trivandranā* is acitellate but is quite obviously referable to *P. houlleti*; the spermathecae, copulatory chambers and

penial bodies are quite characteristic. One spermatheca has an extra diverticulum.

The specimens from the British Museum are quite clearly referable to *P. houletti*.

Fedarb's *P. travancorensis* is something of a puzzle. The type is, apparently, no longer in existence. The original account which has never been emended is inadequate. Except for the spermathecae the worm could quite easily be placed in *P. houletti*. Possibly Fedarb mistook the stalked glands associated with the spermathecae for the spermathecal diverticula.

***Pheretima mekongiana* (Cogn.).**

1922. *Megascolex (Promegascolex) mekongianus*, Cognetti di Martiis, *Boll. Mus. Zool. Torino*, XXXVII, No. 744, p. 3.

Material examined.—From the British Museum: the holotype in a tube with the following label "*Megascolex (Promegascolex) mekongianus*. 1921. 7. 30. 4. (Type). R. Mekong (Ban Leum) Annam. Pres. Dr. Malcolm Smith."

The single, female pore is on xiii.

The male pores are short, transverse slits, on xvii; each male pore towards the lateral margin of a fairly large disc that is apparently retractile into the parietes. Just lateral to each male-pore disc there is a rather crescentic but deeply bowed groove, the concave side of the groove facing midventrally.

The spermathecal pores are transverse slits; four pairs, in 4/5-7/8. The intestinal caeca are simple.

In the pharyngeal region there are acinous masses of "blood glands."

Remarks.—The holotype is immature, the clitellar glandularity only slightly indicated. The internal organs of the anterior end are rather messed about as a result of the previous dissection.

The worm is obviously a *Pheretima* as indicated by the testis sacs, the intestinal caeca and the blood glands, but whether the holotype is to be regarded as an abnormal specimen or the species as characterized by an anterior homeosis is not obvious. The male and female pores, the origin of the intestine and the intestinal caeca, and the gizzard are all one segment anterior to the usual locations in the genus. It might almost be expected, in these circumstances that the testis sacs and the seminal vesicles would also be one segment anterior to their usual location. According to Cognetti di Martiis, however, the seminal vesicles are in xi and xii while the testis sacs are in x and xi, *i.e.*, in the segments in which they would normally be found. If these locations are correct the last pair of testes are just one segment anterior to the ovaries while the last pair of seminal vesicles are actually in the ovarian segment. These are characteristics so very unusual that they might almost be regarded as evidences of abnormality.

***Pheretima mirabilis* (Bourne).**

1887. *Perichaeta mirabilis*, Bourne, *Proc. Zool. Soc. London*, 1886, p. 668.

1900. *Pheretima mirabilis*, Michaelsen, *Das Tierreich*, X, p. 284.

1891. *Perichaeta heterochaeta*, Michaelsen, *Abh. Ver. Hamburg*, XI, part 2, p. 6.

1923. *Pheretima heterochaeta* (part), Stephenson, *Oligochaeta in F. B. I. Ser.*, p. 302.

With reference to *P. heterochaeta* Stephenson 1923, "The extra-Indian distribution of *P. heterochaeta* on p. 304 of my F. B. I. volume is all wrong, since it includes the localities of *P. indica* as given in Michaelsen's 'Tierreich' volume—I was under the impression, when I compiled the list, that *P. indica* was a synonym of *P. heterochaeta*" (from a letter of J. Stephenson, dated Aug. 12th 1930).

1926-32. *Pheretima heterochaeta* Gates, *Rec. Ind. Mus.* XXVIII, p. 156 ; XXXII, p. 310 ; XXXIII, p. 387 and p. 487 ; XXXIV, p. 524 ; XXXV p. 529.

1900. *Pheretima indica* (part) Michaelsen, *Das Tierreich*, X, p. 275.

Material examined.—"From among potato plantation fields and cowdung manure on the gorge below Dumpep Dak Bungalow," Cherrapunji, Nov. 19, 1926, S. L. Hora, 109 clitellate and 7 a clitellate specimens.

"Banks of the stream north of Mokhar," Shillong, Dec. 4, 1930, H. S. Rao, 12 clitellate specimens.

Myntaung Valley, Nartiang, Jaintia Hills, Assam, Nov. 28-29, 1930, H. S. Rao, 2 clitellate specimens.

Bababudan Hills, Mysore State, Dec. 1928, Dr. H. S. Rao, 2 clitellate specimens.

"Ravines and tea gardens between Clarendon Hotel and Forest Office," Kurseong, Darjiling District, Sta. 22, March 8, 1926, M. Sharif, 16 clitellate specimens.

Kalimpong, May 23, 1930, 53 clitellate specimens.

Tista Bridge, June 2, 1930, 7 clitellate specimens.

"Round about the forest office near Victoria School," Kurseong, Darjiling District, Sta. 21, March 7, 1926, M. Sharif, 7 a clitellate specimens.

"Under stones along sides of Evelyn Ride and the Golf Course," Shillong, Dec. 7-8, 1930, H. S. Rao, 5 clitellate specimens.

Happy Valley, near Shillong, Nov. 16, 1930, H. S. Rao, 5 clitellate specimens.

Eagles Crag near the Railway Station, Kurseong, Darjiling Dist., Sta. 24, March 10, 1926, M. Sharif, 3 clitellate specimens.

Shillong-Cherrapunji Road, near Shillong, Dec. 6, 1930, H. S. Rao, 3 clitellate specimens.

Kali Jhora, Kafibari and Singla Tea Gardens, Kurseong, 4,000 feet, Sta. 20, March 6, 1926. M. Sharif, 3 clitellate specimens.

Postclitellar genital markings are lacking except for one or two, tiny markings located either on the male pore area or in contact with the male pore area and within the concentric furrows surrounding the male pore area. Preclitellar genital markings are usually present and may be either presetal or postsetal. The presetal markings are 2-3 intersetal intervals median to the spermathecal pores, while the postsetal markings are usually located just in front of the spermathecal pores. The postsetal markings are smaller than the presetal markings. On a series of 44 individuals selected at random the markings are located as shown below.

Genital markings.	Specimens.
Presetal, on vi-ix	1
Presetal, on vii-viii	7
Presetal, on vii-ix	15
Presetal, on viii	3
Presetal, on viii-ix	2
Presetal, on vii-ix ; postsetal, on vi-viii	4
Presetal, on vii-viii ; postsetal, on vi-viii	7
Presetal, on viii ; postsetal, on vii-viii	1
Presetal, on vii-viii ; postsetal, on vii-viii	1
Lacking	3

There are fairly large, paired lymph glands in the postclitellar segments and blood glands in v and vi. There are masses of nephridia in v and vi.

The single heart of ix is on the left side in 13 specimens, on the right side in 3 specimens. Hearts of x are lacking in 15 specimens. In one worm a heart belonging to segment x is present on the side opposite to that of the commissure of ix. This aberrant vessel cannot be confused with a posteriorly dislocated heart of ix as it arises from the supraoesophageal trunk and passes into the testis sac of x ventrally.

The intestine begins with 15/16 (16). The intestinal caeca are simple and in each of the worms are without marginal constrictions of any sort.

One worm has a pair of prostates, 4 worms have each a single, rather small prostate, 11 worms have no prostates. Prostatic ducts are present though the glands are absent, the duct always c or u-shaped.

The testis sac of xi is unpaired and median in each specimen (16). In one worm no funnel is present in the sac of xi on the left side, but on the posterior face of 11/12 projecting freely into xii is a funnel, presumably the missing funnel of xi.

The testicular material of segment x may be in two distinct ovoidal masses on the anterior face of septum 10/11, the masses rather diagonal in position—the dorsal ends more median than the ventral, or the ovoidal masses may not be discrete but connected transversely by testicular material in shape varying from slenderly cord-like to thickly band-like, or the masses themselves may appear to be directly in contact by their dorsal ends, with little if any appearance of a transverse bridge or band in between (fused). The connection or fusion of the testicular masses produces an appearance which has been referred to in phrases such as “testis sacs of x paired but with transverse connection” The variation in the appearance can be interpreted however as the result of varying degrees of contraction of a single, unpaired, testis sac; the greater the contraction the more the resemblance to a paired condition. Weaker contraction on the other hand results in less indication of pairedness. In these circumstances it seems to be preferable to refer to the testis sac as unpaired rather than paired, especially when the latter term must be qualified by some statement as to transverse connection. Furthermore in each of the specimens with two, discrete, ovoidal masses of testicular material it is possible to demonstrate a connection (passage) between the two lateral portions of the sac in which the testicular material has been concentrated, even though there is no testicular material in the passage. In these particular worms it would appear that the semi-fluid contents of the single sac have been thrown into the lateral portions of the sac by strong contraction and there coagulated into ovoidal masses by the process of preservation.

The demonstration in each of these specimens of *P. heterochaeta* that the two discrete masses of testicular material are really in lateral portions of an unpaired testis sac has been possible owing to the fact that in each of the worms the membranes concerned, though thin, are strong enough to permit manipulation with the dissecting instruments. Often one must deal with worms in which the membranes are so fragile or

so poorly preserved that they rupture when manipulated before the condition of the sac can be determined.

Septum 10/11 is held posteriorly in such a way that the testis sac on its anterior face appears, in a mid-dorsal dissection, to be on the ventral parietes with a deeply incised or bilobed anterior margin. But if the tissue which holds 10/11 backwards be cut and the septum held erect, the location of the sac on the anterior face of the septum with the ventral lobes of the sac not quite reaching the ventral parietes becomes immediately obvious.

The length of the spermathecal duct absolutely and relative to the length of the ampulla varies, but is, almost always if not always, fairly slender. The length of the diverticular stalk relative to the length of the spermathecal duct varies but in each of the specimens the stalk is longer than the seminal chamber. The latter is clearly and sharply delimited from the stalk, and is not as in *P. hawayana* merely a rather indefinite and rather slight, short widening of the ental end of the stalk.

The South Indian specimens collected in Mysore not far from the type locality of *P. mirabilis* are characterized by the presence of four pairs of tiny postsetal genital markings on v-viii and two pairs of larger presetal markings on vii-viii. Each postsetal marking is close to the posterior margin of the segment, just in front of or a tiny trifle median to the spermathecal pore. The number, segmental location, and intra-segmental position of these markings is exactly as in Bourne's *P. mirabilis*. There can be very little if any doubt that these Mysore worms actually belong to Bourne's species. *P. mirabilis* as it can now be defined is not distinguished from *P. heterochaeta* Mich. by any characters of specific or subspecific importance. Michaelsen's name accordingly falls into the synonymy of *P. mirabilis*.

An examination of a number of specimens from Northern India which had been identified as *P. heterochaeta* disclosed several with four pairs of postsetal markings. Not all of these markings are however easily recognizable. In most of the worms the markings on v-vi or vii are not visible at all until after the cuticle is peeled off. On other worms no postsetal markings can be found on v-vi or vii even after removal of the cuticle, yet at the approximate site of each marking there is a tiny pit or pore. On opening these worms stalked glands are visible the ducts of which pass through the parietes to the pits or pores just mentioned.

On the other hand, in a number of worms on which postsetal markings are readily visible without removal of the cuticle the stalked glands are smaller and much more difficult to find or lacking (?). The glands (also glands of presetal markings) may be entirely within the longitudinal musculature or on the parietes but covered over by connective tissue or slightly protuberant into the coelom. The glands of the postsetal markings are quite anterior to the markings, the rather long stalk or duct passing posteriorly within the parietes. In worms with four pairs of postsetal genital markings the number of presetal markings varies from 0-3 pairs.

In the table on page 261 only those markings which can be definitely identified without removal of the cuticle are noted ; no reference to pits or pores that may be recognizable is included.

***Pheretima robusta* (E. Perr.).**

1872. *Perichaeta robusta*, E. Perrier, *Nouv. Arch. Mus. Paris*, VIII, p. 112.

1900. *Pheretima robusta*, Michaelsen, *Das Tierreich*, X, p. 299.

1925. ?*Pheretima himalayana*, Stephenson, *Proc. Zool. Soc., London*, p. 893.

Material examined.—From the British Museum: one fairly well preserved, dissected but acitellate specimen in a tube labelled, "*Pheretima mandhorensis*. 1904. 10. 5. 1401. West Indies. Coll. Beddard" and the holotype of *P. himalayana* in a tube labelled, "*Pheretima himalayana* Stephenson. Type. 1924. 10. 21. 27. Darjiling, 7,000 feet. Mount Everest Expedition 1924."

The male pores, on the specimen of *P. mandhorensis*, are minute, each pore on a small, transversely oval tubercle. Just median to each male pore tubercle there is a similar, presetal tubercle. Near the midventral line, close to the setae and also on xviii there is a pair of presetal, genital markings. There are four pairs of presetal, preclitellar genital markings, on viii and ix; one marking immediately posterior to each spermathecal pore and another marking slightly median and slightly posterior to the spermathecal pore marking. Setae: viii/ca. 22, xviii/ca. 23.

The intestinal caeca are simple; the ventral margins lobulated. The last pair of hearts is in xiii. Each seminal vesicles is provided with a distinct primary ampulla. In xiii there is a pair of pseudovesicles.

The setae, on the holotype of *P. himalayana* are: viii/ca. 15, xviii/16. Each minute male pore is on a small, transversely oval tubercle. A single, presetal tubercle is visible on ix, the tubercle just median to the probable location of the spermathecal pore.

The intestinal caeca are simple.

Remarks.—The holotype of *P. himalayana* is probably not fully mature, the clitellar glandularity is only slightly indicated and the setae are visible on all three of the clitellar segments.

The specimen is very similar to some more or less abnormal specimens of *P. robusta* from Szechuan and also to *P. ornata* from the northern portion of the Shan Plateau in Burma.

Pheretima virgo* (Beddard), *sp. inq.

1900. *Amyntas virgo*, Beddard, *Proc. Zool. Soc. London*, p. 895.

1932. *Pheretima virgo*, Stephenson, *Ann. Mag. Nat. Hist.* (Ser. 10) IX, p. 236.

Material examined.—From the British Museum; two specimens in a tube labelled, "*Amyntas virgo* (types) 1924. 3. 1. 211. 13. Malay Peninsula. Cambridge (E.)" and one specimen in a tube labelled, "*Amyntas virgo*. 1904, 10. 5. 197. Malay Peninsula. Coll. Beddard."

The spermathecal setae on vii and viii are about 24 or 25. The spermathecal apertures are transversely slit-like. The apertures of the copulatory chambers are also transversely slit-like.

Each seminal vesicle is provided with a primary ampulla which is sunk into the dorsal margin of the ventral lamina. In xiii there are paired pseudovesicles. In each copulatory chamber that was opened there are three genital markings, one of which is much larger than the others. Owing to the softened condition of the structures the male pores were not definitely identified. The spermathecal diverticulum passes into the lateral side of the duct within the parietes.

In the nerve cord of one of the specimens there are cysts. On the coelomic face of the parietes of another specimen there are numerous, tiny, whitish cysts.

Remarks.—All specimens hitherto referred to this species, *P. virgo*, are doubtless abnormal, at least so far as the spermathecae are concerned. The spermathecal abnormalities are quite possibly the result of a heavy parasitic infestation. The parasites may also have influenced other characteristics of taxonomic importance in these specimens. As the "normal" characteristics of the species to which the worms belong cannot be determined, the status of the species remains dubious, though the relationships appear to be with *P. mamillana* from Burma.

Genus *Perionyx* E. Perr.

Perionyx macintoshii Beddard.

1892. *Perionyx macintoshii*, Beddard, *Proc. Zool. Soc., London*, p. 687.

1895. *Perionyx macintoshii*, Beddard, *Monog.* p. 438.

1900. *Perionyx m'intoshi*, Michaelsen, *Das Tierreich*, X, p. 208.

1917. *Perionyx m'intoshi*, Stephenson, *Rec. Ind. Mus.* XIII, p. 383.

1931. *Perionyx m'intoshi*, Stephenson, *Rec. Ind. Mus.* XXXIII, p. 184.

1883. ?*Perionyx m'intoshii*, Beddard, *Ann. Mag. Nat. Hist.* (Ser. 5) XII, p. 217.

1924. *Perionyx m'intoshi*, Stephenson, *Rec. Ind. Mus.* XXVI, p. 341.

1916. *Lampito dubius*, Stephenson, *Rec. Ind. Mus.* XII, p. 315.

1923. *Megascolex dubius*, Stephenson, *Oligochaeta, F. B. I. Series*, p. 240.

Material examined.—Two specimens of *Perionyx m'intoshii* in tubes with following labels: "W 87/1. Nepal Valley, E. Himalayas. Lt.-Col. J. Manners-Smith. Alt. 4,500-6,500 feet" and "W 1129/1. Cantonment Hill, Cherrapunji, Assam, 4,300 feet. Dr. S. L. Hora" and the holotype of *Megascolex dubius*.

"In red to light brown soil with few rocks," roadside near Leesankhu village, Chowtara District, Nepal, July-August, Prof. K. N. Sharma, 4 clitellate or partially clitellate specimens.

Description: External characteristics (Chowtara specimens).—Length to 420 mm. Greatest diameter, to 13 mm. Dark blueish grey to blueish dorsally; lighter but also pigmented ventrally; clitellum, reddish.

The setae begin on segment ii; v/106, viii/10, ix/124, xii/117, xx/101.

The first dorsal pore is in 5/6.

The clitellum probably extends over xiii-xx but the epidermis of xii and xx or xxi-xxiii may be slightly modified and reddened; intersegmental furrows 12/13 and 18/19 or 20/21-22/23 are much deeper than on the region between.

The spermathecal pores are transverse slits close to the midventral line, two pairs in 7/8-8/9, each pore surrounded by a circumferential lip.

The single female pore is presetal on xiv.

The male pores are minute, transverse slits, 2-2½ mm. apart (9-10 intersetal intervals as measured on xix), within the depressed male shield, posterior to the setae of xviii and about in line with 18/19 which (as well as 17/18) is not visible on the male shield. The pores are quite some distance behind the setae of xviii as the setal line is bent forward in a crescentic fashion with the concavity posteriorly and the anterior-most point about in line with 17/18. The whitened genital shield (male area) extends across xviii and onto xvii and xix and is transversely

oval to longitudinally oval, sharply marked off except in the immediate vicinity of the setal line of xviii where the boundaries are very indistinct or lacking. The surface is cross hatched by numerous furrows producing a warty or minutely lobulated appearance.

Internal anatomy.—(Opened 2 specimens).

The gizzard is in vi, massive and firm. The gut begins to widen gradually in xix, reaching the full width in xx.

The last pair of hearts is in xiii (2).

The male funnels in x and xi are large, several times the size of the female funnels in xiii. Testes are present in both x and xi. The seminal vesicles of xi and xii are horse-shoe-shaped, on the posterior faces of 10/11 and 11/12 to which they are firmly attached; in the anterior portions of segments xi and xii. The prostates are probably confined to xviii but bulge 17/18 and (or) 18/19 anteriorly and posteriorly. The prostatic duct is almost straight, thickish, slightly widened ectally. The posteriormost portion of the vas deferens is nearly one half the thickness of the prostatic duct.

There are no vesicular structures in xiii.

The smooth, glistening spermathecal duct is definitely marked off from the ampulla and is about two thirds to three quarters the length and thickness of the ampulla. Towards the parietes the duct begins to narrow and within the parietes is much slenderer but still muscular so that it can easily be pulled out from the body wall. No trace of a diverticulum was found on any of the eight spermathecae.

No penial setae were found in the coelom as in *P. excavatus* and other species of the genus. However, in separating the muscle fibres a number of branched objects were found, embedded in the parietes just anterior to the male pores; so placed that the long axis is perpendicular to the ventral surface. These branched structures were broken in attempting to dissect them out. Under the microscope these bodies have an appearance very similar to if not exactly like that of setae (*vide* text fig. 8).

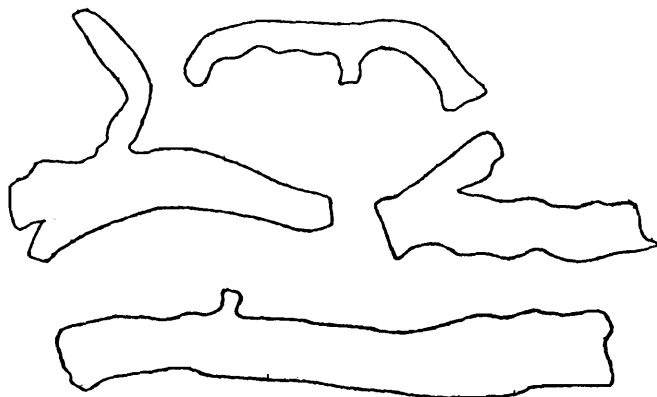


FIG. 8.—*Perionyx macintoshii*. Setal fragments from ventral body wall of xviii. $\times ca.$ 80.

For a discussion of the synonymy and status of *P. macintoshii*, see Stephenson 1931, p. 175 and p. 184.

Stephenson's 1917 specimens are probably abnormal; male pores on xix. The male shield is very similar to that on Prof. Sharma's specimens but is less extensive and appears to be incompletely developed.

With regard to the acitellate, Cherrapunji specimen Stephenson noted (1924, p. 341) that "The male area was much less marked" than on previous specimens. Presumably this is due to immaturity. The male field on the Cherrapunji specimen (of *P. macintoshii*) is almost exactly the same as that on the holotype of *M. dubius*. On both of these specimens the male field is a transverse depression on xviii posterior to the midventral setae which, at least in *M. dubius*, are dislocated anteriorly. The type of *M. dubius* is likewise acitellate. The differences between the male field of *M. dubius* and the male field of fully clitellate specimens of *P. macintoshii* can accordingly be interpreted as due merely to difference in age.

Referring again to the type of *M. dubius*. The setal numbers according to Stephenson's count (v/91, ix/88, xix/ca, 81) are nearer to those of Prof. Sharma's specimens of *P. macintoshii* than are the setal numbers of either of Stephenson's 1917 or 1924 specimens and are also somewhat nearer than are the setal numbers of Beddard's specimen (*vide* Stephenson 1931). Furthermore: the gut is slender, long and bent in xviii, the intestine commencing in xix; the last pair of hearts is in xiii; the seminal vesicles of xi and xii are horseshoe-shaped and attached to the posterior faces of 10/11 and 11/12; the prostates are confined to xviii—the ducts short, straight, muscularly thickened and glistening ectally; penial setae, lacking. So far as all these characteristics are concerned the worm is like *P. macintoshii*. In *M. dubius* according to Stephenson the gizzard is in v and vi. Actually it is the thickened septum 6/7 that passes mesially to the gizzard. Quite possibly this septum can be dissected off from the posterior portion of the gizzard though this was not attempted because of the importance of the specimen. If the septum can be dissected off the location of the gizzard in segment vi will be another point of agreement with *P. macintoshii*. The spermathecae of *M. dubius* are not visible internally according to Stephenson so that comparison with the spermathecae of *P. macintoshii* is not possible. However it is quite evident that there is a very remarkable similarity in many points of systematic importance between *P. macintoshii* and *M. dubius*.

The latter species was placed in the genus *Megascolex* because of the presence of "micronephridia." Bahl (*Q. J. M. S.* LXX, 1926) has shown however that the excretory tubules in the holotype of *M. dubius* are open, exonephric nephridia. In *Perionyx* the excretory organs (with the single rather dubious exception of *P. annulatus*) are open and exonephric but are large and there is only a single pair per segment. The differences in size and number of the nephridia do not appear to be as important as the similarities (*i.e.*, the possession of integumentary nephridiopores and preseptal funnels).

Perionyx sp. ?

Material examined.—Gurjung, Khare and Phoktoy villages, Nepal, August and September, Prof. K. N. Sharma, 15 acitellate specimens with spermathecal pores. (21 specimens without spermathecal pores possibly belong also to the same species.)

External characteristics.—Length, to 60 mm. Greatest diameter, to 5 mm. As a rule dorso-ventrally flattened, widest portion the middle

of the body. Anterior to xii or xi the worms are reddish, dark reddish, or blueish ; posterior to those segments, unpigmented, greyish.

The setae begin on segment ii. The setal numbers are shown below.

v.	vii.	viii.	ix.	xii.	xx.
37	21	20	45	41	44
40	18	18	47	51	45
46	25	26	49	51	47
39	19	20	49	48	46
	17	19			
	22	24			

(vii-viii spermathecal setae.)

The first dorsal pore is in 4/5 (8), 5/6 (3), in 5/6 but with a pore-like marking in 4/5 (3), in 7/8 (1).

Segments xii-xvii are whitened on some of the specimens but the clitellar glandularity is probably not fully developed on any of these.

The spermathecal pores are minute, widely separated, three pairs, in 6/7-8/9 ; the body wall in the immediate vicinity of the pores variously swollen.

The female pores are paired on xiv, presetal, about in line with or very slightly median to *a*.

The male pores were not positively identified but what appear to be vestiges of the male pores are about 5-6 intersetal intervals apart (as measured on xix).

The genital markings are transversely oval, whitened areas, paired on xviii, almost in contact at the midventral line and protuberant in a convex fashion. The setal circle of xviii may be continued in a straight line across these areas or the setae may be zigzagged in such a way as to produce an appearance of two rows.

Internal anatomy.—Septa are present from 5/6 posteriorly.

The rudimentary gizzard is anterior to 5/6. The intestine begins rather gradually in xvi. The gut in xv is narrow, unusually long for the length of the segment and consequently bent.

The last pair of hearts is in xii in each specimen.

The male funnels and testes are naked, in x and xi. The seminal vesicles of xi and xii are horse-shoe-shaped, attached firmly to the posterior faces of 10/11 and 11/12 and in the anterior portions of their segments. The prostates are confined to xviii. The prostatic duct is 2-4 mm. long, the ectal portion stronger than the ental portion and usually glistening.

The spermathecal duct is bulbous, almost spheroidal. The ampulla is rudimentary, shorter and slenderer than the duct.

Remarks.—The rudimentary appearance of the spermathecal ampullae seems to indicate that the worms are not fully developed. There are numerous protozoan cysts and nematodes in the coelom of the segments behind xviii. Possibly in *Perionyx*, as in *Pheretima*, a heavy infestation is able to affect or retard the development of some of the secondary reproductive organs.

Subfamily **Octochaetinae.**Genus **Octochaetoides** Michaelsen.**Octochaetoides birmanicus** Gates.

1926. *Octochaetus (Octochaetoides) birmanicus* Gates, *Ann. Mag. Nat. Hist.* (Ser. 9) XVI, p. 55.

Material examined.—"From the edge of a tank near Kinchana," near Amingaon, Kamrup Dist., Assam, April 5, 1924, S. L. Hora, 139 clitellate and 2 acitellate specimens.

External characteristics.—The length varies up to 110 mm., and the maximum diameter up to $4\frac{1}{2}$ mm. The brown colouration characteristic of the Burmese specimens is lacking but this may be due to solution of the pigment by the preservative.

The setae begin on segment ii; $ab < cd < bc < aa$ represents the setal ratios most frequently observed, cd and bc may however approximate to equality, though both remain smaller than aa .

The clitellum is annular, extending from 12/13 to 16/17 or onto xvii, occasionally reaching to 17/18. On xvii the clitellar glandularity is developed only dorsally and dorsolaterally. Intersegmental furrows and dorsal pores are lacking, except that the pore belonging to 16/17 is often functional even when the clitellar glandularity extends posterior to 16/17. All setae are present on the clitellar segments.

The first dorsal pore is in 12/13 in all cases noted (25).

The female pores are closely paired, in aa on small circular areas of especial whiteness, 125 specimens; a single, median, female pore at the centre of the whitened area, 16 specimens.

The minute spermathecal pores are on viii and ix; each pore in the transverse setal line and about in ab though setae a and b of viii and ix are displaced, a usually median and posterior to its normal location, b often anterior and lateral to its normal location. Each spermathecal pore is at the centre of a tiny, transversely oval to circular area which is removed when the spermathecal duct is pulled out of the parietes.

The genital shield (male area) is protuberant and convex, or protuberant but flat or with two definite, transverse depressions on the shield as previously figured (Gates, 1930, p. 326). The latter more nearly approximates the appearance in the living Burmese worms, the protuberant conditions doubtless the result of varying reactions at time of killing and preserving. The seminal grooves are as in the Burmese specimens. One worm has an unusually long seminal groove on the right side, the groove extending onto segment xx. (In this worm there are three prostates and three bundles of penial setae on the right side, the extra prostate is in segment xx.)

Genital markings are often lacking as in the Burmese forms but when present are posterior to the genital shield and usually unpaired. Each marking represents a slight thickening of the epidermis only (no glandular material extends through the parietes into coelom).

A marking is transversely oval or with more bluntly rounded or more finely pointed ends, with a greyish, translucent centre and an opaque, slightly more protuberant, cream-coloured rim. The markings are regarded as postsetal but intersegmental furrows are lacking or not clearly indicated on the midventral region so that in some cases the markings appear to extend posteriorly onto the next segment and

almost to the setae of that segment. Anteriorly seta *a* or both *a* and *b* may be incorporated in the margin of the marking. Laterally the markings extend to *a*, *b* or slightly lateral to *b*. The number varies. On 44 specimens the markings are as follows: Unpaired: on xx, xxi and xxii—18 specimens; on xx and xxi—13 specimens; on xx—7 specimens; on xxi—2 specimens. Paired: on xx—4 specimens.

Internal anatomy.—(Opened 25 specimens.)

Septum 4/5 is present, muscular, funnel-shaped, the mesial point of the funnel directed posteriorly. The next septum definitely present is 8/9, septa 5/6-7/8 lacking or represented only by very fragmentary rudiments.

The intestine begins in xvii (25). The typhlosole, for 10-12 segments extending from xxiv or xxv to xxxiv or xxxvi, projects conspicuously into the gut lumen, the ventral portion separated more or less deeply into two lamellae. Behind this region the typhlosole continues posteriorly as a much less prominent ridge with only a faint line on the ventral face to mark the two lamellae.

Each specimen has a pair of calciferous glands in 15/16 extending into both xv and xvi. The gland is so placed that a larger and more dorsal portion is in xv with a smaller more ventral portion in xvi or *vice versa*. The condition on one side of the gut is the reverse of that on the opposite side.

The last pair of hearts is in xiii (25). There are paired hearts in each of segments ix-xii (25). Anterior to 8/9 the commissures and the longitudinal trunks except the ventrolaterals are usually empty and difficult to trace. In specimens in which the anterior vessels are filled with blood the following conditions have been noted. Anterior to the gizzard the dorsal trunk gives off a pair of vessels which have been traced to the ventral parietes but not to the ventral trunk. Posterior to the gizzard the dorsal trunk gives off two pairs of commissures. The anterior commissures have been traced to the ventral parietes but not to the ventral trunk. The posterior commissures can, as a rule, be traced readily to the ventral trunk. Just median to each of these posterior commissures (hearts of viii) is a commissural vessel which passes from the supra-oesophageal trunk nearly to the ventral parietes and then anteriorly as the ventrolateral trunk of its side. The supra-oesophageal trunk ends abruptly just anterior to these commissures. In two worms a definite pair of vessels passing from the dorsal trunk to the posterior margin of gizzard anterior to the commissures of vii has been observed.

The testis sacs are cylindrical formed by a thin, shortly cylindrical sheet of tissue passing from 9/10-10/11 or 10/11-11/12, testis sacs not opened by a careful mid-dorsal dissection. The hearts of x and xi are imbedded in the testicular material. The seminal vesicles are paired, in ix and xii (25). The vasa deferentia are conspicuously looped on the ventral parietes. In xvii the vasa pass lateral to the prostatic ducts, in xviii turning mesially and passing into the parietes about in line with the prostatic ducts. Deep within the parietes the vasa of a side unite.

In several specimens two setae, doubtless representing *a* and *b* of xviii have been found within the parietes on the median face of the

vasa. These setae are 0.31-0.36 mm. in length, ornamented with short, transverse rows or ridges of fine teeth, the bluntly rounded, ectal tip bent very slightly towards one side. These setae could not be found in the majority of the specimens but whether this is due to poor dissection or absence of the setae is not quite clear.

The penial setae are contained within connective tissue bands which are on the median faces of the prostatic ducts, the ental ends of the bands passing to the parietes dorsolaterally. Each seta has a bluntly rounded tip and is usually ornamented by longitudinal rows of 4, 5, 8 or more triangular teeth. Rarely a seta may be quite smooth (*i.e.*, without dental ornamentation). Occasionally only 1, 2 or 3 teeth can be recognized.

Just behind each spermathecal duct is a Y-shaped mass of connective tissue inverted so that the paired arms pass to the ventral parietes, one just lateral to and one just median to the spermathecal duct while the tail of the Y passes to the parietes dorsolaterally. In the paired arms of the Y are the copulatory setae. The ectal tip of a copulatory seta is sharply pointed and rather diamond or spear-head-shaped. The shape of the setae is such that when they are placed on a slide they rest thereon with the ornamented portions laterally. The ornamented portions are very refractive. After treatment with strong corrosives two longitudinal, closely placed rows of thorny or spinous projections can be readily seen, at either side of the shaft. Occasionally slight traces of transverse membranes between pairs of spines can be seen. If these membranes are actually parts of the setae the ornamentation at the sides can probably be described as a longitudinal row of pouch or stirrup-like pockets, the apertures of which face towards the ectal tip of the shaft.

Both pairs of spermathecae are anterior to 8/9 (25). The spermathecal duct is elongate and barrel-shaped, narrowed just below the ampulla and just before passing into the parietes. The roughly spheroidal diverticulum passes by a short and slender stalk into the duct just ventral to the ampullary constriction.

Remarks.—In the coelom of one of the acelitellate specimens are large numbers of protozoan cysts. The reproductive organs of this worm are apparently fully developed and of normal appearance though there is no trace of clitellar glandularity.

O. birmanicus is most closely related, apparently, to *O. surensis* (Michaelsen) 1910, from which it is distinguished mainly by the absence of septum 7/8.

Genus **Eutyphoeus** Michaelsen.

Eutyphoeus assamensis Stephenson.

1926. *Eutyphoeus assamensis*, Stephenson, *Rec. Ind. Mus.* XXVIII, p. 262.

Material examined.—Seventeen specimens labelled "W 1951/1. *Eutyphoeus assamensis* Steph. Katlicherra, S. Cachar, Assam. S. I. Hora. March 1925."

A.

The spermathecal pores are small, transverse slits in 7/8, about in *b* or very slightly lateral to *b*. On xvii there is a pair of smooth, glisten-

ing, circular areas that extend from *a* into *bc*. At the centre of each of these areas and about in *b* there is a very small, transversely slit-shaped aperture through which, on some of the specimens, penial setae project.

The transversely oval, postsetal genital markings are on xvi, each marking just behind *ab*, reaching slightly median to *a* and slightly lateral to *b*, the median margin slightly nearer to the midventral line than the median margin of a marking on xvii. The genital markings are present on 12 of the 13 specimens under consideration.

The dorsal blood vessel is continued anteriorly into the pharyngeal region with fairly large commissures in v and paired hearts belonging to vi at the anterior end of the gizzard.

Lateral intestinal caeca are lacking (2). The unpaired ventromedian intestinal caeca are in xxxvi-xlvi (1).

Segment xi is apparently not closed off from the parietes laterally and ventrally though 10/11 and 11/12 are in contact dorsally. The testicular material surrounds the gut and the dorsal blood vessel.

The spermathecal duct is glistening and barrel-shaped. On the lateral and median side of each duct near the ental end is a small diverticulum.

The bulbous ejaculatorius is definitely coelomic.

Remarks.—The clitella are not well developed on any of the specimens, as was noted by Stephenson.

B.

On three specimens including the single dissected specimen the circular areas on xvii are lacking but in their place is a narrow, transversely elongated depression that extends laterally nearly to *c*. Towards each lateral margin of this depression there is a very small slit through which the penial setae project. At each end of the depression there is a u-shaped, rather conspicuously protuberant ridge, the limbs of the u short and reaching midventrally only to *a*.

The dorsal blood vessel is continued anteriorly at least to 5/6 with hearts belonging to vi at the anterior end of the gizzard.

The unpaired, ventromedian, intestinal caeca are in xxxvi-xlv (1).

The spermathecal ducts are not so well developed in these specimens and the bulbous ejaculatorius projects less conspicuously into the coelom.

Remarks.—Stephenson's description of the species is based on specimens with u-shaped ridges. So far as can be determined from an examination of segment xi these specimens are not as mature as those without the ridges. The reason for the statement that the dorsal blood vessel "ends behind the gizzard" is not obvious.

It is possible that two distinct but closely related species are represented in these two groups.

Eutyphoeus gigas Stephenson.

Material examined.—One specimen labelled, "W 73/1. *Eutyphoeus gigas*. Rangamati, Chittagong Hill Tracts, Bengal. R. Hodgart. Type."

On 19/20 there are slight indications of special glandularity that may represent genital markings, extending from *a* or slightly lateral to *a* into mid *bc* on each side.

The ventral intestinal caeca are in xxxiii, xxxiv (?), xxxv-xlvii. The lateral caeca are well developed ; the caecum of one side directed dorsally, of the other side anteriorly into xxv.

The hearts of xi are bound down to the gut but the testicular material is ventral to the oesophagus.

There is a definite but short and stoutish spermathecal duct, probably narrowed in the parietes.

Remarks.—The type is hard and strongly contracted and in this condition the determination of certain important characteristics involves risk of damaging or breaking the specimen.

E. gigas is probably close to *E. longiseta* and *E. rarus* and may actually be conspecific with one of the Burmese forms but the relationships cannot be determined until further material from Rangamati is available for study.

***Eutyphoeus lippus*, sp. nov.**

Material examined.—“ In dark brown soil intermixed with rocks and stones ”
Gurjung, Khare and Phoktey villages, Ramechap District—East 2, Nepal, August and September, Prof. K. N. Sharma, 2 clitellate, 6 partially clitellate and 133 acitellate specimens.

Description: External characteristics.—Length, to 120 mm. Diameter, 4-6 mm. Unpigmented, clitellum reddish.

The setae begin on ii ; on segment xx the setal distances can usually be represented by the formula $ab < cd < bc < aa$, but cd and bc may occasionally be equal or nearly equal ; bc may be one half, two thirds, or three fourths of aa .

The first dorsal pore is located as follows : in 7/8 (1), in 8/9 (3), in 8/9 but with a distinctly pore-like marking in 7/8 (3), in 9/10 (4), in 9/10 but with a definitely pore-like marking in 8/9 (3) or with pore-like markings in 7/8-8/9 (4), in 10/11 (4), in 10/11 but with a pore-like marking in 9/10 (8) or with pore-like markings in 8/9-9/10 (3) or with a pore-like marking in 7/8 only (2) or with markings in 7/8-8/9 (4).

The clitellum extends from mid xiii to 16/17 or dorsally and laterally only to mid xvii ; intersegmental furrows and dorsal pores lacking.

The spermathecal pores are transverse slits, in ab or extending from a or from mid ab into bc or mid bc .

The female pores are paired on xiv, each pore just anterior and median to a .

On xvii, on each side there is a shallow, rather slit-like depression, about in ab . The whitish margin of this depression may be slightly protuberant as a smooth or lobulated circumferential lip. In the depression but really a part of the anterior lip is a shortly transverse tubercle or papilla. The median margin of the tubercle reaches practically to the median margin of the depression but the lateral margin may not quite reach to the lateral margin of the depression. On this tubercle there are either two penial setae or two setal pits. The penial setae are almost but not quite as widely spaced as setae a and b on xvi or xviii. The peni-setal tubercle is always definitely marked off by a slight furrow. At the bottom of the transverse depression and usually towards the lateral side there can be seen on favourable specimens two pores,

one of which is slightly lateral to the other. These pores are presumably the male and prostatic pores. Just anterior to each peni-setal tubercle is a small, transversely oval genital marking (probably on the anterior portion of xvii). Immediately posterior to each depression is a similar marking, probably on the posterior portion of xvii. Every specimen has these two pairs of markings though the markings may be only faintly indicated on the smallest of the acelitellate specimens.

The preclitellar genital markings are a pair of nearly circular areas on x, each area in *ab* and delimited by a slight furrow or (acelitellate specimens) by a fine greyish line (140 specimens). On one specimen the marking of the right side is lacking. A posterior portion of x including the ventral setae on its anterior margin and also including the genital markings may be protuberant as a transversely placed, dumb-bell-shaped area.

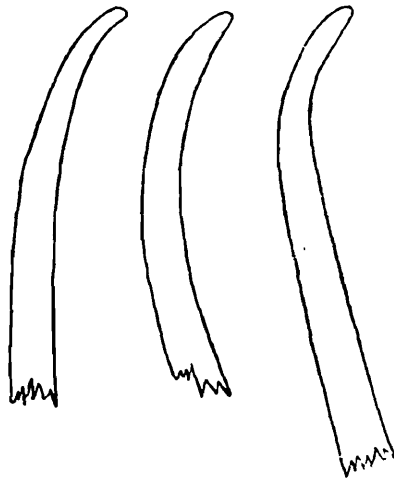


FIG. 9.—*Eutyphoeus lippus*. Tips of penial setae. $\times ca. 80$.

Internal anatomy.—(Opened 95 specimens.)

The intestine begins in xv (95). The lateral intestinal caeca are paired, in xxiv, each caecum a dorsally directed flap with a bluntly rounded tip, flattened against the oesophagus (67). The median caeca are located in segments xxx-xxxvii as shown below.

Segments.	Specimens.
xxx-xxxiv	7
xxx-xxxv	7
xxx-xxxvi	1
xxxi-xxxiv	5
xxxi-xxxv	15
xxxi-xxxvi	5
xxxi-xxxvii	1
xxxii-xxxv	2

The dorsal blood vessel is continued into the pharyngeal region (95). Paired commissures belonging to v-xiii are present (94). In one worm the right commissure of v is lacking. All commissures of v-xiii pass into the ventral blood vessel (5).

There are no male funnels in x or seminal vesicles in ix (95). The seminal vesicles of xii push 12/13 and 13/14 back into contact with

14/15. The testis sac (xi) is in the form of a horse-shoe on the oesophagus, the dorsal blood vessel and the hearts imbedded in the testicular coagulum (95). In several specimens dissected from the ventral side no transverse communications between the ventral ends of the limbs of the horseshoe were visible but this may not always be the case. The prostates are in xvii-xviii. The prostatic duct is 3-5 mm. in length. The bulbus ejaculatorius is small, short and softish but coelomic. The penial setae pass into the parietes median to the prostatic duct while the bulbus passes into the parietes immediately posterior to the prostatic duct.

The spermathecal duct is short but stout, easily pulled out from the parietes within which it is not narrowed. Each spermatheca (189) has a median and a lateral diverticulum. In one specimen the median diverticulum of the left spermatheca is lacking. The diverticula are usually elongate, and may be said to be finger shaped but in a number of specimens the ental end of the diverticulum is bilobed. The diverticula are usually bent posteriorly, but in very small specimens may project straight out from the lateral and median faces of the duct.

There is a whitish (glandular?) material projecting slightly into the coelom through the parietes over each genital marking on x and also but less conspicuously, xvii.

Remarks.—The worms are rather brittle and break easily. In a number of specimens the gut is macerated in the region immediately behind the prostates. The handling of specimens in such condition is not easy; the determination of the position of the first dorsal pore is especially difficult. Very slight pressure is sufficient to force fluid out through the dorsal pores in the region just anterior to the clitellum. In front of the first dorsal pore, as indicated by the exertion of very slight pressure, there are usually several pore-like markings. Further pressure often breaks the worms without indicating whether or not these additional markings are also pores.

The position of the lateral intestinal caeca could not be determined in a number of specimens because of the decay of the intestine.

A number of aclitellate specimens appear to be otherwise fully sexual. The seminal vesicles are well developed; the testis sacs are filled with testicular coagulum; within the spermathecal ducts are masses of iridescent material (spermatozoa?) which extend externally through the spermathecal pore and internally into the lumen of the spermathecal ampullae. In the smallest aclitellate specimens the seminal vesicles are well developed but the prostates and spermathecae are small.

In some of the smallest aclitellate specimens there are numbers of parasites scattered throughout the coelom of the segments behind the prostatic region. Each parasite is surrounded by a thickish layer of a pearly iridescence and contains a single ovoidal nucleus within which is an eccentric endosome.

Aclitellate specimens of *Eutyphoeus* from Jata Pokhrie and Panch Pokhrie in Ramechap District may perhaps be also referable to *E. lippus*. These particular specimens were collected at an altitude of 13,000-15,500 feet and were found in a thin layer of mud on rocks covered

over by lichens. In this thin layer of "mud" there were also found some clitellate Lumbricids. The latter were very badly preserved and were not identified.

E. lippus is probably close to *E. nepalensis* but is distinguished from the latter by the absence of postclitellar markings, by the presence of preclitellar markings and by the simpler, undivided condition of the paired spermathecal diverticula.

Eutyphoeus manipurensis Stephenson.

Material examined.—One undissected and two dissected specimens labelled "W 555/1. *Eutyphoeus manipurensis* Steph. Swamps round Thanga Island in Loktak Lake, Manipur. Manipur Survey."

The circular to longitudinally oval male pore markings on xvii are more deeply retracted into the parietes than on the Burmese specimens (*vide* Gates, 1933, p. 583). The annular lip-like margins of the depressions produced by the retraction are in contact at the midventral line. Within each depression are two softish protuberances, the posterior rounded and much larger than the other which is anteroposteriorly flattened. On the anteroventral margin of the posterior protuberance there is a very small, transversely slit-like pore. At the bottom of the slit between the two protuberances is a transversely oval, smooth, glistening papilla on which two setal pits are visible.

The dorsally or ventrally directed, lateral, intestinal caeca are in xxvii on the anterior face of 27/28 except on one side of one specimen where the caecum is in xxvi.

The spermathecal diverticulum is on the lateral side of the duct which is fairly thick. The ampullae are filled by a greyish-brown, granular material.

Eutyphoeus nepalensis Michaelsen.

Material examined.—One specimen labelled, "*Eutyphoeus nepalensis* Michlsn. ZEV 2880/7. Chitlong, Nepal. Mus. Coll. (R. Hodgart) Type" and from the Hamburg Museum, two dissected and 1 undissected clitellate specimens labelled, "V 7131. *Eutyphoeus nepalensis* Michlsn. Hodgart. Nepal."

Vestibula and penes are lacking. The male porophores are transversely oval, thickened areas on xvii which are fairly widely separated midventrally. On each of these areas there is a transversely slit-like aperture. Within the slit are the penial setae which pass into the anterior wall of the invagination where they are separated from each other by a septum. At the bottom of the invagination there is a single, minute, but readily recognizable pore, in line with the lateral penial seta, the pore a trifle larger than the aperture of the setal pit.

The genital markings are transversely oval and protuberant in a convex fashion, paired, separated midventrally; on 19/20-20/21.

The lateral, intestinal caeca are small, dorsally directed; in xxiv. The ventral caeca are in xxxi-xxxv. The dorsal blood vessel is continued anteriorly into the pharyngeal region with paired hearts belonging to v, vi, vii and viii.

The testis sac is annular, the hearts of xi and the dorsal blood vessel surrounded by testicular material. The seminal vesicles of xii push 12/13 and 13/14 into contact with 14/15. The bulbus ejaculatorius is coelomic and passes into the parietes just posterior to the prostatic duct. Penial setae are present; the ectal ends ornamented but the tips softened and probably deformed.

The spermathecal diverticula are in two groups, one group on the lateral face of the spermathecal duct, the other on the median face.

Glandular material projects through the musculature into the coelom over the genital markings.

Remarks.—The penial setae were overlooked by Michaelsen.

E. nepalensis is probably close to *E. lippus* but can be distinguished at present by the characteristics of the genital markings and the spermathecal diverticula.

Eutyphoeus sp. ?

Material examined.—Happy Valley, near Shillong, Nov. 11, 1930, H. S. Rao, 1 acelitellate specimen.

Length, 190 mm. Maximum diameter, 8 mm. Unpigmented, no trace of clitellar glandularity.

The setae are very small and retracted, $aa > bc$. The first dorsal pore is in 13/14 but there is a tiny, dark spot, somewhat pore-like, in 12/13.

Tiny grey spots in 7/8 in *b* probably represent the rudiments of the spermathecal pores.

On the middle annulus of xvii there is a narrow, transverse depression with a rather tumid circumferential lip, extending laterally on each side to slightly beyond *b*. On the roof of this depression on each side and about in line with *b* is a tiny, transversely oval, slightly protuberant, whitish papilla at the centre of which is a pit or pore. There is a transversely depressed groove in the region of 19/20 much like the groove on xvii but without the tumid lip.

Lateral intestinal caeca are lacking; three tiny, whitish, ventral caeca were found in the region of segments xxxvi-xxxviii. The dorsal trunk ends with the hearts of vii.

The seminal vesicles are fairly large, the right vesicle confined to xii but folded in a pleated fashion, the left vesicle extending into xiii. The bulbus ejaculatorius is well developed, ovoidal.

The spermathecal ampulla is elongately saccular; the duct short but thickish; the diverticula are paired.

THE FISH OF CHITRAL.

By SUNDER LAL HORA, *D. Sc., F.R.S.E., F.A.S.B., Assistant Superintendent, Zoological Survey of India, Calcutta.*

(Plates III and IV.)

In the summer of 1929, a small party of the Zoological Survey of India was sent to Chitral to investigate the zoology and anthropology of the country. At the same time, Dr. G. Morgenstierne of Oslo, after obtaining permission and necessary facilities from the Government of India, went to Chitral to study the languages, folklore, custom and dramatic performances of the Kafirs of Kafiristan. The zoological section of the party, which worked under the leadership of Dr. B. N. Chopra, visited several places in the valley and made extensive collection of fish, besides that of other animals.

According to the Imperial Gazetteer of India,¹ Chitral is a state in the Dir, Swat and Chitral Agency of the North-West Frontier Province and lies between 35° 17' and 37° 8' N. and 71° 22' and 74° 6' E.; it has an approximate area of 4,500 square miles. The state is bounded on the north by the Hindu Kush range, on the west by Badakhshan and Kafiristan, on the south by Dir and on the east by the Gilgit Agency, Mastuj and Yasin. Generally, Chitral, like Kafiristan "consists of an irregular series of main valleys, for the most part deep, narrow, and tortuous, into which a varying number of still deeper, narrower, and more difficult valleys, ravines and glens pour their torrent waters. The mountain ranges which separate the main drainage valleys from one another are all of them of considerable altitude, rugged and toilsome."² (Pl. iv, figs. 1, 2.) The Chitral River, which is the principal river of the valley, is formed by the union of two large streams, the Lutkuh from the north-west and the Mastuj from the north-east (pl. iv, fig. 2). These streams arise along the southern slopes of the Hindu Kush and join each other about four miles above the town of Chitral. The Chitral River (Plate iii) flows almost due north and south and is joined by a number of streams along its course; these are the Rambhur and the Bomboret joining near Ayun, the Shishi joining near Drosh and the Lahozai joining near Mirkhani. At this place the river takes a south-west course and at Arnawai (or Arandu, as it is known locally) it passes out of the Chitral territory. In its lower reaches it is called the Kunar River and joins the Kabul River near Jallalabad. The banks are for the most part steep and high, but in places the river flows through a broad and fertile valley and its water is extensively used for irrigation. During summer months the river carries a very large amount of silt in suspension giving the water a distinctly reddish tint, on account of the colour of the soil over which it flows.

¹ *Imp. Gazetteer of India*, X, p. 301 (1908).

² Robertson, *The Kafirs of the Hindu-Kush*, p. 66 (London: 1896).

The tributaries of the Chitral River, such as Lutkuh and Mastuj flow through deeper valleys and amid more precipitous hills. In consequence, the nature of their beds and the swiftness of their currents correspond more closely with the torrential streams on the southern slopes of the Himalayas. A brief description of the various streams, in which collection of fish was made, is included under the list of localities (*vide infra*, pp. 283-285).

The ichthyology of Chitral proper has never been studied before, though Griffith in his travels through Afghanistan made a collection of fish in the Kunar River near Jallalabad and remarked that "The fish of the Koonur River, the largest tributary of the Kabul River, so far as I know, are all characteristic of Afghanistan, consisting of a *Barbus* with an elongated body, enormously developed fleshy lips, the lower being three-lobed, another *Barbus*, and one or two *Oreini*".¹ The two species of 'Barbus' referred to in Griffith's notes are evidently *Schizothorax labiatus* (McClelland) and *Sch. esocinus* Heckel, and the *Oreinus* is probably *O. sinuatus* var. *griffithii* McClelland, a very variable form as is clear from Dr. Chopra's collection from the Chitral Valley. Besides these three species, Dr. Chopra collected a large series of specimens of *Glyptosternum reticulatum* and of a new species of *Nemachilus*. It is probable that the two latter species are characteristic of swift currents and are not found in the Kunar River at Jallalabad, where several Indian species were also collected by Griffith in the Kabul River.

Robertson² observed that the rivers of Kafiristan "teem with fish which no Káfir could be persuaded to eat. The people declare that fish live on dirt, and shudder at the idea of using them for food, as we would shudder at the idea of eating rats" Griffith³ also noticed that "The fish of Afghanistan, except perhaps those of the valley of Peshawar, cannot be considered as administering to any extent to the food of the inhabitants. It is only about Jallalabad, and more especially along the Koonur valley, that I have seen Afghans employed in fishing. The only nets in use are common casting nets, but this method did not appear to me so successful as that of the hook and line"

Dr. Chopra also observed that "the Káfirs do not eat fish, though the Red Káfirs are now taking to it. They catch fish with their hands by feeling under stones and rocks. They also put a basket under a fall in the course of a stream (pl. iv, fig. 3) and drive fish down into it with their hands and feet working under stones and thus driving the fish out" The common cast net is also employed for catching fish, but these are all very primitive methods and show that the fish are not in much demand in the valley.

As is characteristic of the fish-fauna of any particular valley in Central Asia, the fauna of Chitral is poor in the number of species, only five having been found as enumerated above; while the number of individuals of each species, with the exception of *Schizothorax esocinus*, is very large indeed. *Sch. esocinus* is represented in Dr. Chopra's collection

¹ McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 565 (1842).

² Robertson, *The Káfirs of the Hindu-Kush* p. 68 (1896).

³ McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 565 (1842).

by a single specimen and is probably a casual visitor to the valley from the lower reaches of the Chitral River. The paucity of species of fish in the valleys of Central Asia is probably due to several causes, the most important of these, however, seems to be that the waters of the valleys have been colonised¹ gradually by the migration of fishes from neighbouring territories. I have already pointed out that "there is no indication in this fauna which shows that it is indigenous and that it has not been derived from the fauna of the low-lying lands of the neighbouring countries" The valleys themselves contain, as is indicated below in the short descriptions of the stations in the Chitral Valley, a fair diversity of habitats to permit a certain amount of 'ecological segregation' to take place so as to influence the production of new species; but the factors that inhibit the multiplicity of species are very powerful indeed. In the first place, access to the valleys of Central Asia to the south of the Hindu Kush is through the tempestuous torrents that flow all along the slopes of the Himalayas, and it will be admitted that the conditions of life are very exacting in these swift and turbulent waters. In consequence, *Nemachilus*, *Glyptosternum* and the Schizothoracinae are the only fish that have been able to invade the higher altitudes and establish themselves in the valleys of Central Asia. It was pointed out by Griffith (*op. cit.*) that some species of Indian fish extend in the Kabul River up to Jallalabad, to the north of which the fauna, so far as the fish are concerned, is typically Central Asiatic. It seems probable, therefore, that the small torrential streams along the southern slopes of the Himalayas form effective barriers for the penetration of sluggish-water species from India and other countries. In the Chitral Valley, there are places where *Barbus*, *Cirrhhina*, *Labeo*, etc., if introduced, would probably flourish, but in the normal course these genera have no chance to reach the valley. The species, that were able to cross the barrier, found rich feeding grounds and vast tracts of unoccupied territory. In accordance with biological laws, they multiplied and occupied every suitable niche in the environment and even though they still exhibit marked habitat preference, they developed a certain amount of tolerance for variation in the intensity of environmental factors. This can be clearly seen from the lists of species given below under each station.

The best adapted torrential fish in Chitral is *Glyptosternum reticulatum*; it feeds on insect larvae, such as the Ephemeropterous nymphs of *Iron* and Blepharocerid larvae, which live on or under rocks in very swift currents. *Oreinus*, which is confined usually to the rapids, is a bottom feeder and takes up food indiscriminately, though it seems to feed mainly on the algal matter encrusting rocks and stones in swift currents. *Schizothorax esocinus* is carnivorous, feeding on young fish and decaying flesh; while *Sch. labiatus* feeds on algae, caddis-worms and other insect larvae. Both species of *Schizothorax* live in deeper waters of large rivers and can withstand fairly swift currents. *Nemachilus choprai* lives among rocks and pebbles at the bottom and feeds on algae and insect larvae. From an ecological study of the fish fauna of three Central

¹ Hora, *Phil. Trans. Roy. Soc. London* (B), CCXVIII, p. 268 (1930).

Asiatic rivers, Nikolski¹ has shown that "there are well-marked communities of species associated with different rates of flow of rivers". It has been shown by me² that the rate of flow of water is the principal ecological factor that determines the types of association of animals in mountain streams. According to the rapidity of the current, the five Chitral species can thus be arranged in a series: *Glyptosternum reticulatum*, *Oreinus sinuatus* var. *griffithii*, *Nemachilus choprai*, *Schizothorax labiatus* and *Schizothorax esocinus*. From certain stations two or more species were collected, but it should be remembered that habitats vary sometimes within a very short distance of one another in the same environment. The five species from Chitral, though superficially they seem to live together, do not appear to compete with one another either for food or for space. The slow waters in Chitral, especially those containing a rich growth of vegetation, seem to be the haunts of young specimens and are, no doubt, the nurseries of the Chitral species.

As has been remarked by Griffith (*op. cit.*), the fish of the Kunar River are all characteristic of Afghanistan. *Sch. labiatus* is widely distributed in Afghanistan both in the Kabul and the Helmand river systems; *Sch. esocinus* is found in the Kashmir Valley and in the Kabul and the Helmand river systems of Afghanistan; *Oreinus sinuatus* var. *griffithii* is also found in the Kabul and the Helmand river systems of Afghanistan and *Glyptosternum reticulatum* has a much wider range of distribution, being found in the head-waters of the Indus, the Kabul, the Syr-Darya and the Amu-Darya rivers. The only endemic species in Chitral is *Nemachilus choprai*, which, in general facies, is very much like its congeners of Central Asia. On account of its close resemblance to *N. kashmirensis* Hora,³ a full description, with figures, of the latter species is included here to facilitate reference.

Dr. Chopra observed that the fish were most abundant at the junctions of the side streams with the main river. During my recent visit to the Tista Valley in May-June 1934, I noticed that the fish were to be found in large numbers at the junction of the Kalijhora stream with the Teesta river. During my brief stay at Kalijhora, it rained heavily and the water of the river was very muddy. The water of the Kalijhora stream was black. I was informed that the black colour was due to certain friable rocks that lie in the bed of the stream. The black stream did not mingle with the muddy water for about a hundred yards. According to the popular belief the fish like the taste of this water and in consequence gather in large numbers at the junction of the two streams. It is difficult to say, whether there is any truth in this belief or not but there seems no doubt that the small streams flowing through deep, forest-covered valleys bring down large quantities of vegetable débris and detritus with them, especially after heavy rainfall. This leads to a great increase in the available food supply and at the same time large quantities of nutrient salts, derived from the soil, are brought down with the current. Another possible factor is that the waters of the small streams, on account of the tempestuous nature of their currents, are

¹ Nikolski, *Journ. Animal Ecology* II, pp. 266-281 (1933).

² Hora, *Phil. Trans. Roy. Soc. London* (B) CCXVIII, pp. 171-282 (1930).

³ Hora, *Rec. Ind. Mus.* XXIV, p. 76 (1923).

much more highly oxygenated than those of the main stream. These are some of the possible factors that may account for the abundance of fish at the junctions of small streams with the principal river of a valley.

Reference may here be made to another observation which Dr. Chopra made in the Chitral Valley. On the 24th and 25th of July 1929, Dr. Chopra was camping between Daimali and Karakal in the Bumboret Valley. The Bumboret is a large river formed of a number of snow-fed streams; it has a rocky bed and the water is usually clear. During Dr. Chopra's stay, there was a heavy rainfall in the valley and in consequence the river was flooded. The intensity of the flood was so great that bridges were washed away down the valley and considerable damage was done. The water rose very high in the river and became turbid and muddy. These abnormal conditions must have incommoded the fish, as with the subsidence of water they were found washed along the banks in a dead or dying condition. The majority of these consisted of *Glyptosternum reticulatum* and the only other fish found on the banks was *Oreinus sinuatus* var. *griffithii*. Both the species are specially adapted to adhere to rocks in swift currents and have undergone structural modifications for this purpose; they are not capable of sustained swimming, though they can dart from rock to rock with great rapidity. It seems reasonable to presume that fishes with such habits, once dislodged from their moorings, either by the swiftness of the current, by the disturbance caused by the suspended pebbles and stones in the current or by the choking effect of muddy water in respiration, are probably carried helplessly in deep water by the flood till they are washed on the banks. A number of fishes picked up by Dr. Chopra were merely stupified and were revived by keeping in water. There are previous records of similar happenings in Central Asia and other mountainous countries. Lt.-Col. F. M. Bailey once sent me specimens of *Nemachilus* picked up by him after heavy floods from the bank of a stream in Eastern Tibet.

The following is a list of stations whence Dr. Chopra collected fish in the Chitral Valley. Short descriptions of the stations from Dr. Chopra's field notes and lists of species of fish collected at each station are given.

Sta. 1. 20th-28th June, 31st July and 1st-3rd August, 1929. Chitral or Kunar River near Chitral town.

“A large and broad river of muddy water flowing over a bed of sand and mud with some stones and boulders. The current is moderately swift and the banks are in most places steep and rocky. There is no vegetation in the water.”

- i. *Glyptosternum reticulatum* McClelland.
- ii. *Schizothorax esocinus* Heckel.
- iii. *Schizothorax labiatus* (McClelland).
- iv. *Oreinus sinuatus* var. *griffithii* McClelland.
- v. *Nemachilus choprai*, sp. nov.

Sta. 2. 1st-3rd July and 19th July, 1929. Pallarga stream about 2 miles below Kunisht (Red Kaffir village) in the Rambhur Valley.

“A small stream of clear, rapidly flowing water over stones and rocks in a somewhat north to south direction and joining the Rambhur River

almost midway between Kunisht and Rambhur. Practically no plant life in water, though some trees and shrubs on the banks, which are quite steep in places. The water is considerably warmer than that in the Rambhur River or other streams in the locality." At 12 noon on the 19th of July 1929, the temperature of water in the Pallarga stream was 71.0 F. while that of Rambhur River was only 57.0 F.

- i. *Glyptosternum reticulatum* McClelland.
- ii. *Schizothorax labiatus* (McClelland).
- iii. *Oreinus sinuatus* var. *griffithii* McClelland.

Sta. 7. 24th and 25th July, 1929. Bumboret River between Daimali and Karakal in the Bumboret valley.

"A large river formed of a number of snow-fed streams, running for the most part from south-west to north-east and joining the Rambhur River a few miles above Ayun before falling in the Chitral River. It has a very swift current of clear water flowing over stones and boulders and irrigates by means of side channels an extensive area of land." Heavy floods killed the fish and washed them up the banks.

- i. *Glyptosternum reticulatum* McClelland.
- ii. *Oreinus sinuatus* var. *griffithii* McClelland.

Sta. 8. 4th August, 1929. Lutkuh River at Sheghor.

"A very large stream of moderately swift current with water almost dark with suspended mud and clay, flowing over a more or less sandy bed, with comparatively few stones and boulders. No vegetation in the stream."

- i. *Schizothorax labiatus* (McClelland).

Sta. 9. 5th and 6th August, 1929. Lutkuh River near Hot-Springs.

"A large stream of rapid current with clear water flowing over a bed of stones and sand. No vegetation."

- i. *Glyptosternum reticulatum* McClelland.
- ii. *Schizothorax labiatus* (McClelland).
- iii. *Oreinus sinuatus* var. *griffithii* McClelland.
- iv. *Nemachilus choprai*, sp. nov.

Sta. 12. 20th-27th August, 1929. Mastuj River between Koghazi and Mastuj.

"A large river of muddy water and swift current flowing for the most part over stones and boulders, with occasional patches of sand and mud, between steep banks. No vegetation of any kind in the water."

- i. *Glyptosternum reticulatum* McClelland.
- ii. *Schizothorax labiatus* (McClelland).
- iii. *Oreinus sinuatus* var. *griffithii* McClelland.
- iv. *Nemachilus choprai*, sp. nov.

Sta. 13. 29th August, 1929. A small stream near Surguz in the Mastuj Valley.

"A stream of clear water, originating from some springs and fed by other springs along its course, with a moderately swift current flowing

over a bed of sand and stones, and with plenty of vegetation consisting of grasses and algae.”

i. *Oreinus sinuatus* var. *griffithii* McClelland.

Sta. 14. 30th August, 1929. A small stream above Charun in the Mastuj Valley.

“ The stream is fed by a number of springs along its course, has clear water with plenty of vegetation and a bottom of mud and sand with a few stones.”

i. *Nemachilus choprai*, sp. nov.

Sta. 15. 6th and 10th September, 1929. Small spring-fed streamlets between Tar and Drosh.

“ Small streams of clear water, and slow current used in some places for irrigation, with plenty of vegetation and a somewhat muddy bottom.”

i. *Glyptosternum reticulatum* McClelland.

ii. *Schizothorax labiatus* (McClelland).

iii. *Oreinus simatus* var. *griffithii* McClelland.

Sta. 16. 15th and 16th September, 1929. Ramram gol near its junction with the Chitral River below Arandu.

“ A large hill stream of clear water, with swift current flowing over stones and boulders and without any vegetation.”

i. *Glyptosternum reticulatum* McClelland.

ii. *Schizothorax labiatus* (McClelland).

iii. *Oreinus sinuatus* var. *griffithii* McClelland.

Before giving the systematic account of the collection, I wish to express here my sincerest thanks to Dr. B. N. Chopra for the valuable information he has supplied to me during the preparation of this report and for his helpful suggestions and to Dr. B. Prashad for going through the manuscript. Mr. R. Bagchi has made all the drawings, except those of *Nemachilus kashmirensis* Hora, under my supervision with great care and skill and for this I am much obliged to him.

Glyptosternum McClelland.

1842. *Glyptosternon*, McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 584.
 1860. *Glyptosternon*, Blyth, *Journ. As. Soc. Bengal*, XXIX, p. 152.
 1876. *Exostoma*, Day (in part), *Fish. India*, p. 501.
 1889. *Exostoma*, Day (in part), *Faun. Brit. Ind. Fish.*, I, p. 108.
 1889. *Glyptosternum*, Vinciguerra, *Ann. Mus. civ.-stoz. Nat. Genova*, XXIX, p. 245.
 1905. *Parexostoma*, Regan, *Ann. Mag. Nat. Hist.* (7), XV, p. 182.
 1911. *Parexostoma*, Regan, *Ann. Mag. Nat. Hist.* (8), VIII, p. 564.
 1922. *Glyptosternum*, Hora (in part), *Rec. Ind. Mus.*, XXIV, p. 33 (foot-note).
 1923. *Glyptosternum*, Hora (in part), *Rec. Ind. Mus.*, XXV, p. 30.
 1923. *Glyptosternum*, Annandale (in part) *Ann. Mag. Nat. Hist.* (9), XII, pp. 573-577.
 1925. *Parexostoma*, Norman, *Ann. Mag. Nat. Hist.* (9), XV, p. 572.
 1931. *Glyptosternum*, Myers, *Lingnan Sci. Journ.*, X, p. 260.
 1932. *Glyptosternum*, Hora, *Ann. Mag. Nat. Hist.* (10), X, pp. 176-179.
 1933. *Glyptosternum*, Smith, *Journ. Siam Soc., Nat. Hist. Suppl.*, IX, pp. 70-74.
 1933. *Glyptosternum*, Berg, *Poiss. Eaux Douces, U. R. S. S.*, 3rd ed. pt. ii, p. 596.

In 1922 and more particularly in 1923, I assigned to the genus *Glyptosternum* a group of Sisorid fishes in which the structure of the paired fins agrees with McClelland's description of the fins of *G. reticulatum*. This structure is so remarkable that Blyth seems to have been greatly influenced by it in restricting the name *Glyptosternum* to *G. reticulatum*, which thus constitutes the type of the genus. Though, at the time, I was fully aware of the heterogenous nature of the assemblage I referred to *Glyptosternum*, it was not possible then to divide it into genera as the name *Glyptosternum* could not be applied to any of the forms with certainty. Regan¹ and Myers (*op. cit.*) have also indicated that until *G. reticulatum* is rediscovered and redescribed it is not possible to arrive at a satisfactory solution concerning the application of this generic name. Recently, however, I gave reasons to believe that "*Parexostoma stoliczkae*," a widely distributed species in the western parts of Central Asia, is identical with *Glyptosternum reticulatum*, and pointed out that of the several genera, into which Glyptosternoid fishes have been divided, *Parexostoma* Regan becomes synonymous with *Glyptosternum* McClelland. This supposition has received further support from the fact that McClelland's species have been rediscovered² from the Kabul River near Kabul in Afghanistan. The Surgeon to the British Legation at Kabul made a small collection of fish in the Paghman River, a tributary of the Kabul River, and this included a specimen of *Glyptosternum reticulatum* (or the hitherto well known species *Parexostoma stoliczkae*). This discovery leaves no doubt about the identity of McClelland's *G. reticulatum* described from Sir-i-Chashma, the source of the Kabul River. From within the limits of Afghanistan the species has also been obtained in the Bannu Anderab River³ of the Oxus System, about 79 miles north of Kabul. Both Smith and Berg in their recent works have upheld my views regarding the generic identity and limits of *Glyptosternum* McClelland. In view of this evidence it is now possible to split up the composite assemblage and to define the generic limits of each group. The genus *Glyptosternum* may be characterized as follows:—

The genus *Glyptosternum* comprises large-sized and greatly flattened Sisorid fishes in which the head and the anterior part of the body are depressed and the tail is compressed from side to side. The skin is soft except on the ventral surface in front of the anal-opening where it is thickly or sparsely covered with soft papillae. The eyes are minute, almost indistinguishable; they are subcutaneous and are situated on the dorsal surface of the head. The mouth is transverse and is situated considerably behind the tip of the snout. The teeth are pointed, those of the upper jaw form a band which is produced backwards at the sides. The teeth on the lower jaws form two bands which are pointed towards the sides. The fold of the lower lip is broadly interrupted. There are 8 barbels, 2 nasal, 2 maxillary and 4 mandibular; the mandibular barbels are provided with very broad bases and on the ventral surface in their

¹ Regan, *Ann. Mag. Nat. Hist.* (9), XI, p. 609 (1923). Berg (*Bull. Acad. Sci. U. R. S. S.*, p. 1267, 1931) used the name *Glyptosternum* for species of the genus *Glyptoithorax* Blyth.

² Hora, *Journ. Bombay Nat. Hist. Soc.*, XXXVI, p. 697 (1933).

³ Hora, *ibid.*, XXXVII (*in press*).

outer halves bear striated pads of adhesive skin. The gill-openings are wide, extending to the ventral surface for a short distance. The gill-membrane is broad and free throughout its length. The fins are "without spines, the first ray of the pectoral and ventral fins soft and pinnate, giving off soft, pointed cartilaginous rays along the anterior margin, which are enveloped in the membrane of the fin" The dorsal is situated above or slightly behind the pectorals, but entirely in advance of the ventrals. The adipose fin is long and low. The paired fins are broad, rounded and horizontally placed; they are vertical in their inner and horizontal in their outer halves. The skin on the ventral surface of the first ray of the paired fin is corrugated in pinnate folds for the purposes of adhesion. The caudal fin is truncate, obliquely truncate or somewhat rounded. The air-bladder is greatly reduced and enclosed in two bony capsules.

Type-species.—*Glyptosternum reticulatum* McClelland.

In view of the uncertainty prevailing about *G. reticulatum* I¹ suggested in 1923 that *G. labiatum* McClelland should be considered as the type of *Glyptosternum* instead of *G. reticulatum*. Myers² has pointed out that this suggestion is in violation of the International Rules of Zoological Nomenclature, but in view of the rediscovery of *G. reticulatum* no new genotype need be considered.

Geographical Distribution.—So far only two species are known in this genus. *Glyptosternum maculatum* (Regan) is known from Eastern Tibet (Lhasa and Gyang-tse) and Sikkim; whereas the other species *G. reticulatum* McClelland is widely distributed in the head waters of the Indus (Basgo, Sneema, Leh, Ladak and the Kashmir Valley), of the Kabul River (Sri-i-Chushmah, Julraiz³, Paghman and the Chitral Valley), of the Syr-Darya and the Amu-Darya in Eastern Turkestan (Oxus System).

***Glyptosternum reticulatum* McClelland.**

1842. *Glyptosternon reticulatus*, McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 584.
 1860. *Glyptosternon reticulatus*, Blyth, *Journ. As. Soc. Bengal*, XXIX, p. 153.
 1876. *Exostoma Stoliczkae*, Day, *Proc. Zool. Soc. London*, p. 782.
 1877. *Exostoma Stoliczkae*, Day, *Fish India*, p. 502, pl. cxvii, fig. 3.
 1878. *Exostoma Stoliczkae*, Day, *Sci. Res. 2nd Yarkand Miss.* Ichthyology, p. 1, pl. i, fig. 1.
 1889. *Exostoma Stoliczkae*, Day, *Faun. Brit. Ind., Fish.*, I, p. 110, fig. 45.
 1889. *Exostoma Oschanini*, Herzenstein, *Mel. biol.*, XIII, p. 69.
 1890. *Exostoma Oschanini*, Herzenstein, *Bull. Ac. St. Petersburg*, XXXIII, p. 120.

¹ Hora, *Rec. Ind. Mus.*, XXV, p. 35 (1923).

² Myers, *Lingnan Sci. Journ.*, X, p. 260 (1931).

³ According to Day (*Ichthyology Sci. Res. 2nd Yarkand Miss.*, p. 19, 1878, foot-note), Griffith's remark (*Calcutta Journ. Nat. Hist.*, II, p. 564, 1842) regarding the most remarkable "dark coloured Loach-like *Silurus*, which is not uncommon about Julraiz" probably refers to a species of *Amblyceps*. In my revision of the genus *Amblyceps*, I have indicated (*Rec. Ind. Mus.* XXXV, p. 610, 1933) that *Amblyceps* has never been recorded from any place west of the Kangra valley. I am of opinion that in his remark about "Loach-like *Silurus*" Griffith made a reference to *Glyptosternum reticulatum* which is found in abundance at Sir-i-Chashma.

1905. *Exostoma Stoliczkae*, Berg, *Ryby Turkestana*, p. 211, fig. 31.
 1905. *Parexostoma Stoliczkae*, Regan, *Ann. Mag. Nat. Hist.* (7), XV, p. 183.
 1907. *Exostoma gracile*, Grazianov, *Trudy Otdela Ichtyologii*, IV, p. 58.
 1907. *Exostoma labrax*, Grazianov, *ibid*, p. 59.
 1908. *Exostoma stoliczkae*, Berg, *Ezhegodnik Zoologicheskago Muxeya Akademii Nauk*, XIII, p. 450 (1908).
 1916. *Parexostoma stoliczkae*, Berg, *Poiss. Eaux Douces Russie*, p. 371, figs. 289, 290.
 1923. *Glyptosternum stoliczkae*, Hora, *Rec. Ind. Mus.*, XXV, p. 37.
 1925. *Parexostoma stoliczkae*, Norman, *Ann. Mag. Nat. Hist.* (9), XV, p. 572.
 1932. *Glyptosternum reticulatum*, Hora, *Ann. Mag. Nat. Hist.* (10), X, p. 179, fig.
 1932. *Glyptosternum reticulatum*, Hora, *Cur. Sci.*, I, p. 130.
 1933. *Glyptosternum reticulatum*, Hora, *Journ. Bombay Nat. Hist. Soc.*, XXXVI, p. 697.
 1933. *Glyptosternum reticulatum*, Berg, *Poiss. Eaux Douces U. R. S. S.*, 3 ed. pt. ii, p. 597, figs. 549-551.
 1934. *Glyptosternum reticulatum*, Hora, *Journ. Bombay Nat. Hist. Soc.*, XXXVII (*in press.*)

From the above synonymy it is clear that *Glyptosternum reticulatum*, instead of being an obscure species as hitherto believed to be, is a well-known representative of the Sisorid group of fishes. Several authors have described it and published its illustrations under the title "*Exostoma stoliczkae*" I, therefore, do not propose to redescribe the species here, but in view of the abundant material before me from the Chitral Valley the following notes should prove useful.

Day (1876) has already indicated the remarkable variation in the comparative length of the head to that of the total length in this species. I have noticed that such a range of variation exists in the relative proportions of all the principal organs. For instance, the length of the caudal fin is contained 6.4—9.8 times in the total length including the caudal. In smaller individuals this fin is relatively longer. The head is also proportionately longer in young individuals; the length of the head is contained 4.9—6.2 times in the total length with the caudal and 4.2—5.6 times without it. The depth of the body is also variable but it is not in any way correlated with the size of the specimen; it is contained 7.3—10.5 times in the total length with the caudal. The caudal peduncle becomes proportionately longer with the growth of the fish; its least height is contained 2.6—3.4 times in its length. The increase in the length of the fins does not keep pace with the growth of the fish. In young specimens the pectorals are separated from the ventrals by a short distance, and the latter are separated from the anal by a still shorter distance. While in fully grown examples these fins are considerably removed from one another. The longest ray of the dorsal is greater than the depth of the body in specimens up to 110 mm. in length while in larger specimens it is considerably shorter than the same dimension. For further details reference may be made to the table of measurements on page 291. It seems probable that the variability of the species has led to its being described under so many different names in various parts of its extensive range of distribution.

Distribution.—It has been pointed out above (p. 287) that *Glyptosternum reticulatum* is widely distributed in the upper reaches of the Indus, the Kabul, the Amu-Darya and the Syr-Darya Rivers. Thus the species is found in Eastern Turkestan and in the mountain regions that border

it on the south and west. In the Chitral Valley, Dr. Chopra obtained 215¹ specimens from the following localities :—

- (i) 37 specimens from the Chitral River near the Chitral town (Sta. 1).
- (ii) 18 specimens from the Pallarga Stream 2 miles below Kunisht in the Rambhur Valley (Sta. 2).
- (iii) 154 specimens from the Bumboret River between Daimali and Karakal (Sta. 7).
- (iv) 2 specimens from the Lutkuh River near Hot-springs (Sta. 9).
- (v) 1 specimen from the Mastuj River between Koghazi and Mastuj (Sta. 12).
- (vi) 1 specimen from a small spring-fed stream between Tar and Drosh (Sta. 15).
- (vii) 2 specimens from the Ramram gol stream near its junction with the Chitral River below Arandu (Sta. 16).

It is clear from the above that *G. reticulatum* is found all over the Chitral Valley and that it is abundant in large rivers and streams. Dr. Chopra has observed that the species is commonly found near the junction of the side streams with the principal river of the valley. Owing to the heavy floods in the valley, a large number of fish were washed on the banks of the Bumboret River and were picked up next day in an almost dead condition.

Berg remarks that *G. reticulatum* (= *Parexostoma stoliczkae*) 'lives under stones'. Dr. Chopra has also observed that in the Chitral Valley the fish lives in fair numbers under stones and rocks. The species lives in large and clear streams with rapid-flowing current and with the bed strewn with rocks and boulders. Except for the algae and slime that cover the rocks in such situations, Dr. Chopra did not observe any vegetation in most of these streams. The nature of the food of these fishes (*vide infra*, p. 290) shows that they browse over the exposed surface of rocks where they must live under the direct influence of the swift current. So it seems probable that a bed of smooth rocks is essential for these fishes, that their feeding grounds are the exposed surfaces of rocks and that they seek shelter under rocks when frightened or when not feeding. These habits correspond very closely to those of the fishes of the genus *Garra* and other hill-stream fishes.

Sexual Dimorphism and the Proportion of Sexes in the population.—In *Glyptosternum reticulatum* the males do not possess any well-marked secondary sexual characters; but by dissecting a number of specimens, I have been able to find some difference in the region of the anus by which the sexes can be distinguished readily by a superficial examination of the specimens. Behind the anal opening, there is a deep groove. In the male a sharp, conical, well-developed papilla projects behind the anus in this groove; whereas in the females, there is no anal papilla but the anal opening is bordered laterally by two prominent lips which cover the groove behind the anus. Judging by these characters, I have been able

¹ In my note on *G. reticulatum* in the *Annals* I mentioned only 176 specimens. Unfortunately, I overlooked to count the specimens in one bottle. Four specimens have been presented to the British Museum (Nat. Hist.), two were sent to Dr. G. S. Myers and a dozen specimens to the Zoological Museum at Moscow.

to divide the 209 specimens into 122 males and 87 females. So far as can be judged by these figures, it seems that males predominate in the population; they form 58.4 per cent as against 41.6 per cent females. Of the 148 specimens from the Bumboret River (6 specimens from this locality have been presented to outside institutions) there are 78 males and 70 females giving a percentage of 52.7 males and 47.3 females. As has been indicated above, these specimens were picked up from the banks of the river after a heavy flood. In these circumstances the males and females must have been equally affected and judging from the above figures there is only a negligible higher percentage of males over the females. The figures indicate that the males and females occur in almost equal proportions. The females are probably less active and of more secretive habits than the males and this would account for the preponderance of males over females from other localities. The samples are, however, not sufficiently large to permit of any generalisation.

Bionomics.—The alimentary canal is not very much convoluted; its length is 0.94 of the total length of the fish. On an examination of the stomach-contents of about a dozen and a half specimens, it was found that the fish feeds on the flattened larvae of Ephemeroptera, such as *Iron* and other Heptageniid larvae, and the *Ephemerellid* nymphs, on the larvae and pupae of Trichoptera and the larvae and pupae of Blepharoceridae. Among the stomach-contents were a few other larvae of the *Baetis*-type (Ephemeroptera) as well as Chironomid and other highly specialised Dipterous larvae. The major part of the food consists of the Heptageniid nymphs of the *Iron*-type. All these insect larvae are specially adapted to live on or under the exposed surfaces of rocks in very swift currents,¹ in fact the Blepharocerid larvae cannot live and have not yet been found in slow currents. It is reasonable, therefore, to conclude that *Glyptosternum reticulatum* frequents exposed, smooth surfaces of rocks in swift currents for the purpose of feeding and that it also searches for the Heptageniid nymphs under stones. The relatively large size which this species attains (Day's largest example was 175 mm. in length, Berg had examples 215 mm. in length and in the present material the largest example is about 230 mm. in total length) shows that it lives in somewhat deeper waters, for large size is a distinct disadvantage in shallow waters. The fish is perfectly adapted for the type of habitat depicted above. Its flattish ventral surface can be closely applied to the hard substratum and by means of the broad, corrugated, outer ray of the paired fins it adheres to rocks. The structure of its paired fins further shows that the fish vigorously pumps out any water that flows on its under surface thus creating a negative pressure for the purposes of adhesion. The broad and reflected lips and the broad maxillary barbels with corrugations on their ventral surface help in adhesion. There is also no doubt that the papillae on the ventral surface are used for the same purpose. The large and unspecialised gill-openings show that the fish breathes continuously; but its large gill-membrane would indicate

¹ Hora, "Ecology, Bionomics and Evolution of the Torrential Fauna," *Phil. Trans. Roy. Soc. London (B)*, CCXVIII, pp. 171-282 (1930).

Measurements in millimetres.

	Sta. 2. ♂					Sta. 16. ♂		Sta. 7. ♀		Sta. 7. ♂	
	-----					-----		-----		-----	
Total length including length of caudal	81.8	84.5	89.0	¹ 34.2	147.5	101.8	105.5	160.0	164.5	207.0	225.5
Length of caudal	10.7	10.9	11.8	21.0	20.0	14.0	14.0	19.5	20.3	24.0	23.0
Length of head	16.6	16.5	17.0	26.4	29.0	20.0	21.0	28.8	30.0	38.2	36.0
Width of head in front of pectorals	14.7	15.2	16.0	25.0	28.0	19.2	19.0	27.6	29.2	34.8	36.4
Height of head at occiput	8.8	8.1	8.8	12.7	13.0	10.4	10.1	15.0	15.0	16.8	20.0
Depth of body	9.0	8.9	10.0	17.6	17.6	11.8	12.8	15.2	22.4	26.0	23.2
Length of snout	8.8	8.4	8.8	13.2	16.0	10.8	10.0	14.5	14.6	20.0	18.5
Interorbital width	5.0	4.6	6.0	8.0	9.0	5.8	5.2	9.0	8.7	10.5	11.0
Length of caudal peduncle	16.0	18.2	19.0	28.0	30.0	21.0	20.5	33.0	36.5	48.6	51.0
Least height of caudal peduncle	6.0	6.7	7.1	9.1	10.3	7.0	6.2	10.0	10.5	15.0	16.0
Longest ray of dorsal	13.2	12.0	13.5	16.8	17.2	13.5	13.2	15.0	16.0	22.2	23.0
Longest ray of anal	11.2	10.8	11.6	16.5	18.0	11.7	12.2	16.0	16.0	19.4	22.0
Length of pectoral	19.0	19.3	21.0	30.0	33.3	21.6	22.7	35.0	35.3	39.2	43.0
Length of ventral	15.2	15.0	17.0	23.6	24.5	17.7	17.2	27.0	25.6	29.2	33.3

that the respiration is initiated and carried on by its flapping movements. On rocks the fish seems to crawl with the help of its paired fins by using them alternately and it is likely that the lips and the associated structures also help during progression. Its powerful and muscular tail is no doubt used for darting movements from rock to rock. *G. reticulatum* is a bottom-dwelling fish, and is not capable of sustained swimming in swift currents. It is probable that the broad, lunate band of teeth on the upper jaw is used for rasping off from the rocks encrusting organisms of the type of Blepharocerid larvae and nymphs of *Iron*, etc. The teeth on both the jaws are sharp and pointed and are directed backwards. Between these two sets of teeth the scraped food has little chance to escape. The gill-rakers are long, broad and pointed, and are closely set; they decrease in size on the posterior gill-arches.

In 1923, I (*op. cit.*, p. 34) expressed the opinion that "*Glyptosternum stoliczkae*" and *G. maculatum* represented the less specialized members of the assemblage denominated as '*Glyptosternum*,' and from the simple nature of the lips and mouth, tooth-bands, gill-openings, paired fins and general facies I was misled to regard them as ancestral forms of Glyptosternoid fishes. Later work¹ has shown that on account of life in deeper and less turbulent waters of the Highlands of Central Asia as compared with those of the small Himalayan streams, *G. reticulatum* has assumed a mask of apparent simplicity and that its simple organisation is the result of retrogression and in no way represents a truly primitive or ancestral condition. These conclusions are borne out by the type of streams in which specimens of *Glyptosternum* were collected by Dr. Chopra in the Chitral Valley.

Local Name.—According to Dr. Chopra *Glyptosternum reticulatum* is known as *Karmatchhi* among the Kafirs.

Schizothorax labiatus (McClelland).

1842. *Racoma labiatus*, McClelland, *Calcutta Journ. Nat. Hist.* II, p. 578, pl. xv, fig. i.
 1842. *Schizothorax Ritchieana*, McClelland, *ibid.*, p. 580.
 1868. *Racoma labiatus*, Günther, *Cat. Fish. Brit. Mus.* VII, p. 162 (foot-note).
 1868. *Schizothorax ritchianus*, Günther, *ibid.*, p. 168.
 1877. *Schizothorax Ritchianus*, Day, *Fish. India*, p. 531 (foot-note).
 1877. *Schizothorax labiatus*, Day, *ibid.*, p. 532 (foot-note).

McClelland's description and figure of *Schizothorax labiatus*, though meagre and inadequate, are sufficiently clear as regards the most distinctive feature of the species—the nature of the lips. Since McClelland's original account, no observations seem to have been made on *Sch. labiatus*, owing to the fact that no specimen was hitherto available for study. The species was described from Griffith's drawing and the specimens, which were "accidentally left behind with the Ornithological portion of the collection" by Griffith, seem to have been lost in transit. McClelland's characterisation is as follows:

"Length of head greater than depth of body, and equal to a fourth of the entire length. Inter-maxillary very protractile and covered with a thick adipose integument, a thick trilobed integument to the lower jaw, cirri terminating in trident points.

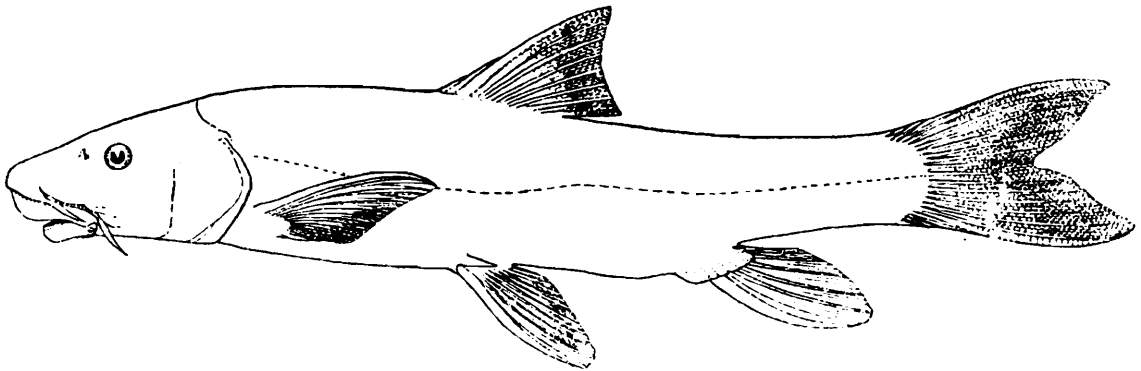
¹ Hora, *Phil. Trans. Roy. Soc. London* (B), CCXVIII, p. 237 (1930).

D. $\frac{3}{8}$: P. 19 : V. 10 : A. 7

Intestine short, disposed in $3\frac{1}{2}$ or four double folds.

Habitat.—Pashut, Koonar River near Jallalabad.—Griffith's Mss.

Mr. Griffith remarks that this singular form is nearly allied to the Lalpore species, but that the intestines of the latter are infinitely longer, nor is there any enlargement of the lips in the latter; but this last character Mr. Griffith remarks is not so remarkable in young specimens." (Italics are mine).



TEXT-FIG. 1.—Lateral view of a large specimen of *Schizothorax labiatus* (McClelland) from the Pallarga stream (Sta. 2) $\times \frac{1}{4}$.

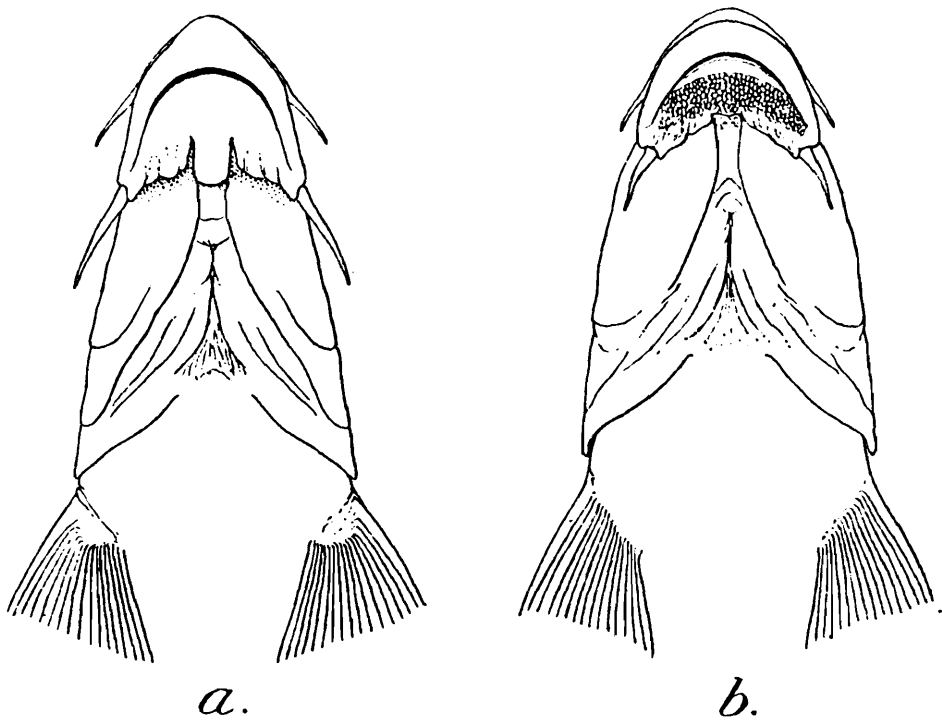
As a rule, in *Schizothorax* the lips are moderately fleshy and it is only in a few characteristic species that they are greatly enlarged. So far as I am aware the lips are hypertrophied in *Sch. regelli* Herz.,¹ of which a single specimen is known from the Amu-Darya, and in *Sch. baileyi* (Lloyd)² known from two specimens collected at Gyantse, Tibet. Whereas in these two species the posterior lip is bilobed, in *Sch. labiatus* it is trilobed and forms a very characteristic feature of the species. In another species—*Sch. ritchieana*—described by McClelland from Afghanistan, the lower lip is trilobed. It is characterized as: “*Reflected posterior margin of the lower lip trilobate; lips broad, round and soft; width of the mouth equal to about $\frac{1}{2}$ the length of the lower jaw; which is narrow at the apex; snout narrow and compressed; dorsal spine large, scales very small, lateral line raised, body spotted.*” (Italics are mine). In a large series of specimens collected by Dr. Chopra from the Chitral Valley, there are quite a number of specimens in which the lower lip is greatly enlarged, whereas in the majority of specimens the lips are of the *ritchieana*-type. Moreover, all possible gradations are found in the collection before me between the two types of lips. Fortunately McClelland sent a specimen of *ritchieana* to the Museum at the India House whence it was transferred to the British Museum and later served for Günther's description of the species in the *Catalogue*. The Chitral specimens agree with Günther's description and there seems to me no doubt that *Sch. labiatus* and *Sch. ritchieana* are synonymous. Both

¹ Herzenstein, *Fische*, in *Wiss. Res. Przewalski Central-As. Reis. Zool.*, III, pl. ix, fig. 1. According to Berg (*Poiss. Eaux Douces U. R. S. S.* 3rd Ed., pt. 1, p. 458, 1932), *Sch. regelli* is a synonym of *Sch. fedtschenkoi* Kessler and that the enlarged lips are of the nature of secondary sexual characters of the male. In *Sch. labiatus* both sexes possess enlarged lips.

² Lloyd, *Rec. Ind. Mus.*, II, pl. xxv, fig. 2 (1908).

McClelland and Günther observed that in the Helmand River examples the dorsal spine is relatively small. The Chitral collection shows that the dorsal spine is very variable in this species. In certain examples it is strong and well developed, whereas in others it is rather feeble and flexible. But in every case, it is conspicuously serrated posteriorly.

Day included *Sch. labiatus* in the group of species characterized by the "Lower labial fold interrupted", but this is obviously wrong.



TEXT-FIG. 2.—Ventral surface of head and anterior part of body in two specimens of about equal size of *Schizothorax labiatus* (McClelland) showing variation in size and form of lower lip; etc., $\times \frac{2}{3}$.

a. True *labiatus* type; b. *ritchiana* type.

In a number of young specimens it is observed that the condition of lips and jaws is intermediate between *Schizothorax* and *Oreinus*. Such a condition appears to have resulted from hybridisation (*vide infra* p. 307).

McClelland, on the observations of Griffith, stated that *Sch. chrysochlora* has much in common with *Sch. labiatus*. The resemblance is probably closer with the specimens of *Sch. labiatus* in which the lower lip is not well developed. The two species can, however, be readily distinguished by the following features:—

In *Sch. labiatus* the body is more slender and the head is considerably pointed; the labial fold is well developed and prominently trilobed; the commencement of the dorsal fin is almost midway between the tip of the snout and the base of the caudal fin, and the anal scales are very small, considerably less than half the diameter of the eye.

Schizothorax labiatus may be redescribed as follows:—

D. $3\frac{1}{8}$; A. $3\frac{1}{5}$; P. 18-20; V 11-12; C. 20.

Schizothorax labiatus is a narrow, elongated species in which the body is subcylindrical and both the profiles are slightly arched. The ventral

surface of the head and the anterior part of the body are flattish. The head is large and pointed anteriorly ; its length is contained 3.7—4.4 times in the total length without the caudal. The width of head is almost equal to its height at the occiput and is contained 1.6—1.7 times in the length of the head. The snout is smooth, but in some specimens it is studded with sharp, wart-like protuberances. These structures are usually characteristic of the males but certain ripe male specimens were without them. The eyes are placed laterally slightly below the dorsal profile of the head and are not visible from the ventral surface ; they are situated in the middle of the head or slightly nearer to the tip of the snout than to the posterior margin of the operculum. The diameter of the eye is contained 5.3—7.6 times in the length of the head, 2.1—3.3 times in the length of the snout and 1.7—2.5 times in the inter-orbital width. The interorbital space is flattish and is marked with a short, longitudinal bony ridge in the middle with two other low ridges on the sides. The mouth is inferior, horizontal and greatly arched ; it is bordered by thick and fleshy lips which are continuous at the angles of the mouth. The lower lip is trilobed, the side lobes are free while the middle lobe is only free at the tip. The structure of this lip is subject to great variation as indicated above (*vide supra*, p. 293). The lower jaw is sharp, shovel-like and covered with a thick, horny sheath. There are two pairs of well developed barbels which are longer than the diameter of the eye. The gill-openings are moderately extensive.

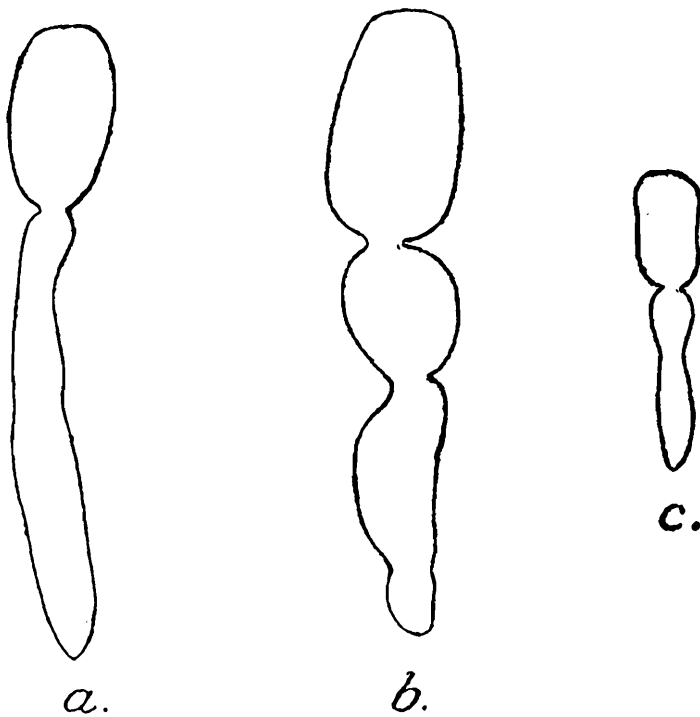
The depth of the body is contained 4.4—5.6 times in the total length without the caudal ; it is covered with small scales which are inconspicuous on the ventral surface in front of the ventral fins. The lateral line is slightly raised and there are about 107 scales along it and 28 rows between it and the base of the dorsal spine. The tiled row of anal scales is rather indistinct ; the largest scale being less than half or about half the diameter of the eye.

The commencement of the dorsal fin is opposite to that of the ventral and is almost equidistant between the tip of the snout and the base of the caudal fin. The dorsal spine is strong and horny or feeble ; its length in middle-sized specimens is contained 1.0—1.2 times in the length of the head. In older specimens the spine is proportionately shorter, its length being contained 1.6 times in the length of the head. The spine is strongly serrated posteriorly. The posterior margin of the dorsal fin is slightly emarginate. The pectoral fin is shorter than the head and its outermost ray is the longest ; it is separated from the ventral by a considerable distance. The anal opening is situated at the base of the anal fin and is considerably removed from the ventral fin. The anal fin, when laid flat, does not reach the caudal fin. The caudal fin is deeply emarginate. The caudal peduncle is strong and muscular ; its least height is contained 1.5—1.9 times in its length.

In very young specimens the body is marked with short, black streaks. In half-grown and adult specimens the body is uniformly silvery with a slightly darker tint on the dorso-lateral surface of the body.

Air-bladder.—The air-bladder of *Schizothorax labiatus* shows considerable variation as regards the form of the posterior chamber. In adult examples the walls of the bladder are thickened, fibrous and

inelastic. The anterior chamber is of the normal Cyprinoid form, whereas the posterior chamber is long and narrow. In one specimen the posterior chamber was found to be constricted in two places asymmetrically so that the bladder appeared four chambered. In a young specimen the posterior chamber was slightly narrowed in the middle. Similar variations also occur in the bladder of *Oreinus sinuatus* var. *griffithii*. The significance and the probable mode of origin of these abnormal types of bladders are discussed below (*vide infra*, p. 304).



TEXT-FIG. 3.—Air-bladders of 3 specimens of *Schizothorax labiatus* (McClelland) showing variation in form and structure. $\times \frac{2}{3}$. The thickness of the lines roughly indicates the thickness of the walls of the different chambers.

a. Normal type; from a specimen 350 mm. in length.

b. An abnormal four-chambered air-bladder from a specimen 325 mm. in length.

c. Air-bladder of a young specimen 160 mm. in length.

Distribution and Habitat.—*Schizothorax labiatus* was described from the Kunar River near Jallalabad, but the form *ritchiana* was stated to be fairly common in Afghanistan. Dr. Chopra's collection shows that the species is very common in the Chitral River and its tributaries. Specimens were obtained from the following localities:—

- (i) 1 large specimen from the Pallarga stream, 2 miles below Kunisht in the Rambhur Valley (Sta. 2).
- (ii) 6 specimens collected at Chitral in August 1929.
- (iii) 47 specimens from the Lutkuh River at Sheghor (Sta. 8).
- (iv) 1 specimen from the Lutkuh River near Hot Springs (Sta. 9).
- (v) 21 specimens from the Mastuj River between Koghzai and Mastuj (Sta. 12).
- (vi) 28 very young specimens from a small stream between Tar and Drosh.
- (vii) 11 specimens from Ramram gol near its junction with the Chitral River below Arandu (Sta. 16).

The larger individuals were obtained from rivers with swift current and rocky bed whereas the young specimens were collected in small streams. In young specimens the character of the lower lip is not so well developed as has already been remarked by Griffith. Both *Oreinus* and *Schizothorax* prefer large rivers with or without backwaters; the former is confined to these habitats whereas the latter occurs in lakes also. *Schizothorax* lives in rapids under stones and rocks.

Bionomics.—In young specimens the alimentary canal is about 1.5 times the total length of the fish and in a specimen about 300 mm. in length it was 2.3 times the length. The stomach was empty in most of the specimens dissected which suggests not only that feeding is intermittent but that the digestive action is fairly rapid. The alimentary canal was full of grayish pulp and pieces of gravel. It seems likely that *Schizothorax* feeds on caddis-worms, algae and insect larvae. The shorter length of its intestine shows that it is more carnivorous in its feeding habits than *Oreinus*. It seems likely that the broad lips of *Sch. labiatus* are spread out and applied to rocks for adhesive purposes. The horizontal paired fins and the flattish ventral surface are no doubt used for this purpose. The pointed and subcylindrical body of the fish is well adapted to offer less resistance to the rushing currents.

Measurements in millimetres.

Total length excluding caudal	184.5	215.0	243.0	262.0	350.0
Length of caudal	41.0	53.0	57.0	55.5	78.0
Length of head	42.5	51.0	58.3	59.0	93.0
Width of head	25.0	29.2	37.0	35.0	57.0
Height of head at occiput	26.5	30.3	37.8	37.0	54.0
Length of snout	17.0	21.0	23.0	26.0	41.3
Diameter of eye	8.0	8.0	10.0	8.4	12.2
Interorbital width	13.5	16.0	21.0	20.3	30.5
Depth of body	37.6	37.8	55.0	53.0	68.5
Length of dorsal spine	38.3	41.0	47.0	50.0	56.0
Length of pectoral	31.4	40.0	43.2	46.0	67.3
Length of ventral	30.6	37.6	41.5	42.0	63.0
Length of caudal peduncle	19.0	21.6	30.0	28.0	36.8
Least height of caudal peduncle	40.5	40.0	46.0	52.0	66.7

Schizothorax esocinus Heckel.

1838. *Schizothorax esocinus*, Heckel, *Fische aus Caschmir*, p. 48, pl. ix.
 1842. *Schizothorax esocinus*, McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 579.
 1844. *Schizothorax esocinus*, Heckel, *Fische Kaschmir*, p. 372, 3 figs.
 1868. *Schizothorax esocinus*, Günther, *Cat. Fish. Brit. Mus.*, VII, p. 166.
 1876. *Schizothorax esocinus*, Day, *Proc. Zool. Soc. London*, p. 785.
 1876. *Schizothorax punctatus*, Day, *ibid.*, p. 785.
 1877. *Schizothorax esocinus*, Day, *Fish. India*, p. 533, pl. cxxiii, fig. 4.
 1877. *Schizothorax punctatus*, Day, *ibid.*, p. 532, pl. cxxiii, fig. 3 (foot-note).
 1878. *Schizothorax esocinus*, Day, *Sci. Res. 2nd Yarkand Miss.*, Ichthyology, p. 4, pl. i, fig. 4.
 1878. *Schizothorax punctatus*, Day, *ibid.*, p. 4, pl. 1, fig. 3.
 1889. *Schizothorax esocinus*, Day, *Faun. Brit. India, Fish.*, I, p. 254.
 1889. *Schizothorax punctatus*, Day, *ibid.*, p. 252 (foot-note).
 1910. *Schizothorax esocinus*, Zugmayer, *Zool. Jahrb.*, XXIX, p. 277.
 1916. *Schizothorax esocinus*, Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova* (3), VII, p. 20.

Both Zugmayer and Vinciguerra have referred at some length to the discrepancies in Day's descriptions, and to the inaccuracies in his drawings of *Schizothorax punctatus* and *Sch. esocinus*. From an examination of specimens in their possession they came to the conclusion that the two species are identical. The Zoological Survey of India possesses the originals of Day's figures of these two species, and a comparison of the specimens shows that Day, who probably did not possess a large series of specimens of *Sch. esocinus* to study its range of variation, had some justification to regard them as belonging to two species. Besides the differences in the general facies of the two specimens clearly shown in Day's delineations, they differ in the form and proportion of the head, the nature of the jaws, the extent and form of the mouth opening and the way in which the bones of the hyoid arch lie on the ventral surface of the head. The following table of measurements shows some of the salient differences between the two specimens:—

Measurements in millimetres.

	<i>Sch. esocinus.</i> (No. 678).	<i>Sch. punctatus.</i> (No. 511).
Total length excluding caudal	170.5	192.0
Length of head	46.0	59.5
Width of head	23.0	26.3
Height of head at occiput	23.7	30.0
Greatest diameter of eye	8.0	10.2
Interorbital width	13.2	19.3
Length of snout	15.5	20.8
Depth of body	32.2	34.2
Length of rostral barbel	10.0	9.0
Length of maxillary barbel	12.0	8.0
Length of caudal peduncle	30.0	35.0
Least height of caudal peduncle	16.0	17.2

Day's illustrations are inaccurate in several respects and it seems probable that he drew up his descriptions from the figures without reference to the specimens, otherwise it is not possible to believe how his descriptions could be so faulty and misleading. *Schizothorax esocinus* seems to vary considerably and when a number of specimens are examined the differences noted above between the two forms are bridged over. Sufficient material is not available to decide whether these differences are in any way related to the sexes of the individuals. Berg¹ has indicated that in the case of *Sch. fedtschenkoi* Kessler there may be great structural differences between the two sexes.

Griffith obtained specimens of *Sch. esocinus* in the tributaries of the Helmand and the Kabul Rivers in Afghanistan. In the Chitral Valley the fish is said to be very rare; it is represented by a single specimen which was collected by Dr. Chopra from the Chitral River near the Chitral town. Dr. Chopra informs me that he made special efforts to obtain more specimens of this species but without any success. This example represents the typical *esocinus* of Day and in it the length of the head is

¹ Berg, *Abhandlungen der Pamir Expedition 1928*, VIII, p. 23, pl. ii, figs. 1 and 2.

contained 3.6 times in the total length without the caudal. The height of the head at the occiput is almost equal to the width of the head which is nearly half the length of the head. The diameter of the eye is contained 6.5 times in the length of the head, 2.2 times in the length of the snout and 1.9 times in the interorbital width. This specimen is about 275 mm. in length, but Dr. Chopra was informed that the species grows to a much larger size and is a very good eating fish. In comparison, it is considered to be a better fish for eating than other species of *Schizothorax* and *Oreinus* commonly met with in Chitral. In spite of its qualities of flesh, the local people consider it a foul feeder. The stomach contents of the Chitral example consist of a semi-digested young specimen of *Schizothorax* and plenty of dark-coloured gravel and sand. It is likely that this species lives in pools and puddles where it feeds on dead animal matter deposited at the bottom. Its jaws are somewhat protrusible so that it can probe about in the mud and suck in food mixed with gravel like some of the typical Cyprinid fishes. Enough material is not available, however, to make any detailed observations on the bionomics of this species.

Besides the specimens referred to above there are five other examples of *Schizothorax esocinus* from Kashmir in the collection of the Zoological Survey of India. These specimens were obtained in June-July 1921 by the Kashmir Survey Party. Of these, 3 comparatively young specimens up to 135 mm. in total length were obtained in the Jhelum River at Srinagar, one from Wular Lake and a large one from Gandarbal. These specimens show that the head is relatively longer in younger individuals ; its length being contained 3.3—3.6 times in the total length without the caudal. The depth of the body is very variable, being contained 4—5.6 times in the length without the caudal. The eyes are relatively much larger in the young specimens ; the diameter of the eye is contained 4.5—7.6 times in the length of the head, 1.5—2.5 times in the length of the snout and 1.2—2.1 times in the interorbital width. The caudal peduncle is narrower and longer in larger specimens, the least height of the caudal peduncle is contained 1.7—2.1 times in its length. The fins are nearer to one another in young specimens whereas in grown-up individuals they are situated more widely apart. The osseous and serrated ray of the dorsal fin is always longer than the postorbital part of the head ; it is proportionately longer in the young specimens. The longest ray of the dorsal fin is contained 1.2—1.7 times in the length of the head. The young specimens are generally marked with largish black spots, while the larger specimens are covered with numerous black marks. The example from Chitral as well as the smallest specimen from Kashmir are without any marking. They are grayish above and silvery on the sides and below.

Remarks.—In describing *Schizothorax punctatus* Day referred to "*Racoma nobilis* McClelland" (*op. cit.*, p. 577), and remarked that it "has more fleshy lips, while the mouth appears more transverse, as in *Oreinus*, and the under jaw much the shorter" McClelland had no specimen of the species, but described it from Griffith's drawing. Day's remarks are also based on this illustration. *Schizothorax nobilis* is said to grow to a large size (18 inches) and its habits of preying on small fish

and feeding on offal show that it may prove to be identical with *Sch. csocinus*. Its body and fins are covered with spots as is usually the case in *Sch. esocinus*.

In the following table I give the measurements of the Chitral example as well as of the five specimens from Kashmir :—

Measurements in millimetres.

	Chitral.	Jhelum River.			Wular Lake.	Gandarbal.
Total length without caudal	224.2	95.0	107.3	110.3	191.0	273.0
Length of head	62.2	28.5	32.0	33.0	54.0	76.5
Width of head	31.5	13.3	18.3	16.3	26.0	39.5
Height of head	31.3	15.2	19.0	18.0	31.0	41.6
Diameter of eye	9.5	6.0	7.0	6.0	8.0	10.0
Length of snout	21.6	9.0	10.8	10.4	18.6	25.0
Interorbital width	18.5	8.0	8.8	8.2	14.0	21.0
Depth of body	43.5	20.3	26.8	23.3	37.5	48.0
Longest ray of dorsal	38.0	20.2	23.0	27.2	32.0	42.5
Longest ray of anal	34.0	15.1	18.3	20.3	27.2	40.0
Length of pectoral	38.2	16.6	18.8	19.2	29.0	39.2
Distance between pectoral and base of ventral.	25.5	11.6	13.3	14.0	23.0	34.3
Length of ventral	35.5	15.7	17.2	20.0	26.2	37.0
Distance between ventral and base of anal.	17.0	7.3	10.5	8.0	21.2	26.5
Length of caudal peduncle	41.0	15.7	19.0	18.7	31.0	52.0
Least height of caudal peduncle	23.5	9.0	11.0	11.0	17.0	24.0

***Oreinus sinuatus* var. *griffithii* McClelland.**

1842. *Oreinus Griffithii*, McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 581.

1842. *Oreinus maculatus*, McClelland, *ibid.*, p. 580.

1868. *Oreinus griffithii*, Günther, *Cat. Fish. Brit. Mus.*, VII, p. 160 (foot-note).

1868. *Oreinus sinuatus*, Günther (in part), *ibid.*, p. 161.

1933. *Oreinus sinuatus* var. *griffithii*, Hora, *Journ. Bombay Nat. Hist. Soc.*, XXXVI, p. 700.

1934. *Oreinus sinuatus* var. *griffithii*, Hora, *ibid.*, XXXVII (in press).

In his account of the fish of Afghanistan in Griffith's collection, McClelland recorded specimens of the genus *Oreinus* from the head of the Ali Musjid stream (Khyber Pass), Kabul River, Gandamak, Pashat and Girdun Dewar. The examples from the Helmand River (Girdun Dewar) were referred by him to *O. plagiostomus* Heck., while those collected at Pashat (Kunar River) were described as *O. griffithii*. The young specimens obtained in the Kabul River, Ali Musjid stream and at Gandamak were designated *O. maculatus*, a species described by McClelland from the Simla Hills. From Günther's *Catalogue* it appears that no specimen of *O. griffithii* passed into the collection of the British Museum and consequently Günther could not define its exact specific limits as the description is meagre and defective. The species was, therefore, referred to in a foot-note as a doubtful form. *O. plagiostomus* was characterized by Günther on Afghanistan specimens (1 stuffed adult from Jallalabad and skins of one adult and one half-grown from Helmand River), while McClelland's young specimens of *O. maculatus*

from Gandamak were referred by Günther to *O. sinuatus*. Day in the *Fishes of India* (pp. 529-531) followed Günther's views, but in referring to *O. griffithii* under the description of *O. plagiostomus* made the following remark: *O. griffithii* "is said to differ but little from the above, its intestine are six times the length of the body, its *habitat* is Afghanistan, Koonur river, Pushut" It would thus appear that since the publication of the description of *O. griffithii* McClelland, it has not been possible for later workers to elucidate its exact systematic position. This was due to the fact that so far no specimens of the species were available for examination.

Dr. Chopra obtained a large series of specimens of a species of *Oreinus* in the Chitral Valley and though it differs but little from *O. sinuatus*, there are features which, in the present state of our knowledge of the genus, warrant separation of the two forms. Fortunately specimens have also become available from the Paghman River and Sir-i-Chashma (Kabul River) for comparison and these have made it clear that the Chitral *Oreinus* is also found extensively in the Kabul River and its tributaries in Afghanistan. It may be mentioned that Kunar River (or Chitral River), the type-locality of *O. griffithii*, is the principal river of the Chitral Valley whence Dr. Chopra obtained abundant material of the species.

Oreinus griffithii was briefly characterized by McClelland as follows: "The breadth of the mouth is equal to half the length of head, and of the interval from the extremity of the snout to the commencement of the pectorals. Dorsal spine large, vertical scales at the anal obsolete, posterior margin of the operculum round, snout smooth.

D. $\frac{4}{8}$: P. 20 : V 11 : A. $\frac{1}{8}$: C. 19.

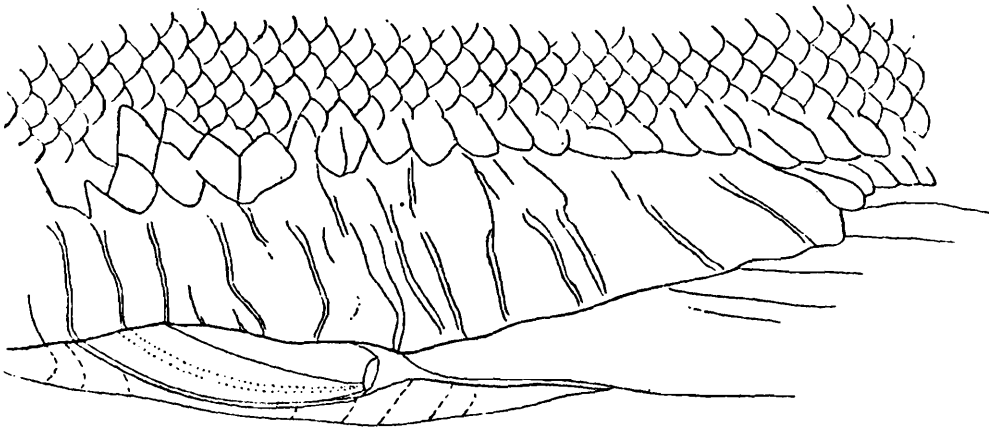
The intestines are six length of the body, and contain a brownish pulp. (Griffith.)

This species although perfectly distinct, differs but little in appearance from *Oreinus plagiostomus*.

Habitat.—Afghanistan, Koonur river, Pushut. (Griffith.)"

The reference to *O. plagiostomus* in the above description seems to have been partly responsible for our ignorance of *O. griffithii*. According to McClelland, the breadth of the mouth of *O. plagiostomus* "is equal to a third of the length of the head, and of the interval from the extremity of the snout to the pectoral fins"; the dorsal spine is "slender and soft" and the "vertical scales at the base of the anal are rather large" Günther's and Day's descriptions of *O. sinuatus*, to which *O. griffithii* is closely allied, and of *O. plagiostomus* show that the main differences between the two species lie in the character of the dorsal spine and the size of the anal scales. In the Schizothoracinae these characters are of great diagnostic value and are usually employed in distinguishing genera. Judging by these features, most of the specimens in Dr. Chopra's collection agree with *O. sinuatus* but there are two specimens, one 260 mm. long without the caudal from Pallarga stream in the Rambhur Valley and

the other 325 mm. long without the caudal from the Mastuj River between Koghazi and Mastuj, in which the anal scales are well developed and are as large as or larger than the diameter of the eye. The dorsal spine is of the nature so characteristic of *O. sinuatus*, and in other respects also they correspond with the remaining specimens. It is not possible to account for this variation as there are no gradations in the large series before me, and in the present state of our knowledge it would be better to consider them as abnormalities.



TEXT-FIG. 4.—Enlarged anal scales of a specimen of *Oreinus sinuatus* var. *griffithii* McClelland from the Pallarga stream. $\times 2$. The scales are very thin and their outlines are not well defined.

It has been indicated above that *O. griffithii* very closely resembles *O. sinuatus* in its general facies, but differs in having somewhat finer serrations on the dorsal spine, in the shorter length of the spine and in the fact that all the fins, especially the anal, are shorter. The vertical anal scales are obsolete in *O. griffithii*, with the exception of the two specimens noted above, whereas in *O. sinuatus* the scales, though small, are fairly well marked and distinct. In view of these differences it seems desirable to treat *O. griffithii* as a distinct form, for the time being at least, and at the same time to express its close affinity to *O. sinuatus*. For these reasons, I have regarded *griffithii* as a variety of *sinuatus*.

There can be hardly any doubt that *Oreinus* is a specialized form of *Schizothorax* and that the evolutionary steps by which this modification has been brought about are not very difficult to comprehend. In fact, it is very difficult to distinguish the young of *Oreinus*, at least in the earlier stages, from those of *Schizothorax*. This difficulty is further augmented by a hybridization between *Schizothorax* and *Oreinus* which, as Dr. Chopra's collection shows, is a very common occurrence in nature and results in the production of forms intermediate between *Schizothorax* and *Oreinus*. I refer to this phenomenon later (*vide infra* p. 307). In the light of the above observations, McClelland's remarks regarding *O. maculatus* that "it is an intermediate form between *Schizothorax* and *Oreinus*" is readily understood. According to McClelland, *O. maculatus* "seldom exceeds six inches in length" and is, therefore, a young form. There are several young specimens of *O. griffithii* in Dr. Chopra's collection which agree with *O. maculatus*, both in general

features and colouration. I have no doubt, therefore, that *O. maculatus* is a synonym of *O. sinuatus* and that both Günther and Day were justified in this conclusion.

The Kabul River form, *O. sinuatus* var. *griffithii*, may be redescribed as follows :—

D. 3/8 ; A. 3/5 ; P. 21 ; V 10 ; C. 20.

Oreinus sinuatus var. *griffithii* is a strong and muscular fish in which the body is subcylindrical and both the profiles are somewhat arched. The ventral surface of the head and the anterior part of the body are flattish. The head is short and bluntly pointed ; its length is contained 4.1—5.0 times in the total length without the caudal. In the young specimens, the head is proportionately larger, but during growth the other parts of the body develop more vigorously so that in larger examples it is about one-fifth of the length without the caudal. The head is almost as broad as deep at the occiput ; the width of the head is equal to its length behind the anterior nostrils. The snout is usually smooth but in a number of half-grown and adult specimens it is covered with warts. These structures seem to characterize male specimens. The eyes are, for the most part, in the anterior half of the head ; they are lateral in position but their upper margin is slightly below the dorsal profile of the head and they are not visible from the ventral surface. The eyes are proportionately larger in young specimens ; their diameter is contained 4.1—6.7 times in the length of the head ; 1.3—2.5 times in the length of the snout and 1.3—2 times in the interorbital width. The interorbital space is broad and flat. The mouth is inferior, transverse and slightly arched ; the width of the mouth is somewhat greater than half the width of the head. The lips are fleshy and continuous ; the upper lip covers the jaw and is simple, the lower lip is reflected from the jaw and is papillated. The exposed portion of the lower jaw is sharp and enclosed in a thick horny sheath. There are two pairs of small barbels. The gill-openings are moderate and extend to the ventral surface for a considerable distance.

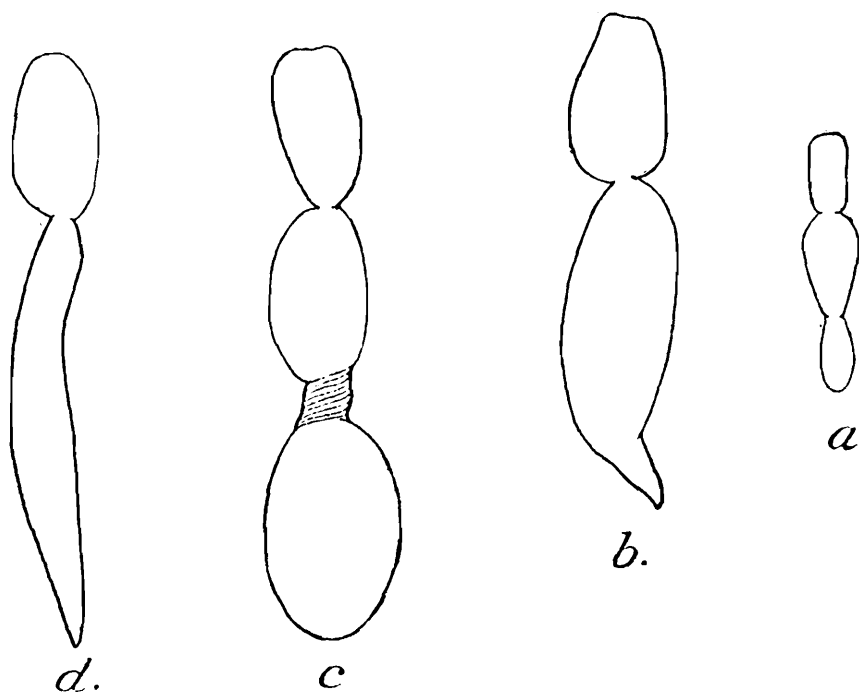
The depth of the body is contained 4.7—5.3 times in the length without the caudal ; it is covered with small scales, about 110 along the lateral line and 28 between it and the base of the dorsal spine. The lepidosis is irregular. The tiled row of anal scales is indistinct, the largest scale being much less than half the diameter of the eye. The lateral line is slightly curved but it runs to the middle of the base of the caudal fin.

The dorsal fin commences in advance of the ventral and is nearer to the tip of the snout than to the base of the caudal fin ; the dorsal spine is long and strong and is serrated with moderate spines posteriorly ; it is not as long as the head and possesses a thin, flexible portion which is equal to the diameter of the eye. The posterior margin of the dorsal fin is slightly emarginate. The paired fins are horizontally placed and their outer rays are the longest. The pectoral fin is shorter than the head and is separated from the ventral by a considerable distance.

The ventral fin is considerably removed from the anal. The anal opening is situated just in front of the anal fin, which, when laid flat, is separated from the caudal fin by a considerable distance. The caudal fin is deeply emarginate; the lower lobe is better developed than the upper. The caudal peduncle is strong and muscular; its least height is contained 1.6—1.9 times in its length.

In young specimens the upper part of the body is marked with short, black streaks characteristic of *Oreinus maculatus*. The ground colour is grayish above and pale white below. In half-grown and adult specimens, the black markings disappear and the fish takes on a silvery hue. On this account it is usually known as "snow-trout"

Air-bladder.—When dissecting specimens to examine the stomach contents, I found a great range of variation in the structure and form of the air-bladder in *O. sinuatus* var. *griffithii*. As the air-bladder is a character of great diagnostic value in the taxonomy of Cyprinoid fishes, it is necessary to make a few observations on the condition of the organ in the specimens before me.



TEXT-FIG. 5.—Air-bladders of 4 specimens of *Oreinus sinuatus* var. *griffithii* McClelland showing variation in form and structure. $\times \frac{2}{3}$. The thickness of the lines roughly indicates the thickness of the walls of the different chambers.

- a. Three-chambered bladder of a young specimen 110 mm. long.
- b. Air-bladder of a specimen 225 mm. long showing modification of the posterior chamber at the hinder end.
- c. Three-chambered bladder of a specimen 265 mm. long. Notice the broad collar separating second and third chambers.
- d. Normal type of air-bladder in an adult specimen. Notice the posterior chamber is narrow, elongated and thick walled and has not the form and structure of the normal bladder of the Cyprinoid fishes.

In a young specimen about 110 mm. long, the air-bladder is almost tripartite; the anteriormost chamber possesses somewhat thick walls,

the middle chamber is moderately thick-walled while the small, third chamber is thin-walled. The pneumatic duct opens between chambers one and two. At the constriction between the middle and the last chamber, the skin is specially thick. This tripartite condition is better marked in the bladder of another specimen (fig. 5 c.) about 265 mm. in length. Here instead of a constriction between chambers two and three, there is a definite collar of very thick skin while the last chamber is very thin walled. Normally in these fishes the air-bladder is bipartite, as is characteristic of the Cyprinidae. Owing to life in rapid waters and in consequence of a ground habit, the air-bladder is not much used as a hydrostatic organ and its walls become thick and inelastic (fig. 5a). The lumen decreases and the bladder becomes greatly reduced in size. It has been shown in the case of other genera¹ that the reduction and solidification of the bladder starts with the posterior chamber. In *griffithii* also probably the same process takes place. In a specimen 225 mm. in length, the end portion of the posterior chamber of the bladder was found to be thin and pointed and had very thick walls (fig. 5 b). Evidently the solidification of posterior chamber had started in this specimen at the right place and in course of time the bladder would have assumed the normal form as shown in figure 5d. The tripartite condition of the bladder in this species is certainly abnormal and, in my opinion, is produced by the thickening of the skin of the middle part of the posterior chamber instead of its hindermost part. In any case such a condition is not of any great importance for taxonomic purposes. I have shown elsewhere² that the bladder of hill-stream fishes is greatly reduced as they invade swifter and swifter currents and that if they happen to revert to deeper waters, a structure similar to the original bladder makes its appearance for hydrostatic purposes. Thus there is a close correlation between the structure of the bladder and the habitat of the fish. In fishes that live in rapid, but relatively deeper waters, the structure of the bladder must be very variable as has been shown above in the case of *Oreinus*.

Tchang,³ in establishing his genus *Parosteobrama* has observed that "vessie natatoire en 3 parties, la' premiere, ovale et arrondie aux deux bouts, la deuxieme plus longue que la premiere, la troisieme tres petite" Unfortunately no figure is published but the description indicates a structure similar to the one figured here as 5b. It is probable that the so-called third chamber of *Parosteobrama* represents the area where the bladder has started to acquire thick walls. It should also be borne in mind that *Rohtee* (= *Parosteobrama*) is a genus of clear-water streams and though it is not found in very swift currents, it is always subject to sudden rush of waters. Such a habitat also denotes a varying environment. Mukerji⁴ has shown that normally there are only two chambers in *Rohtee*. In *R. pelligrini* the third chamber may be only a modified portion of the second as stated above.

¹ Hora, *Journ. As. Soc. Bengal* (N. S.) XVIII, pp. 5-7 (1922).

² Hora, *Journ. Bombay Nat. Hist. Soc.* XXXIV, pp. 374-385 (1930).

³ Tchang, *Bull. Soc. Zool. France* LV, pp. 46-52 (1930).

⁴ Mukerji, *Journ. Bombay Nat. Hist. Soc.* XXXVII, p. 69 (1934).

Distribution and Habitat.—*Oreinus sinuatus* var. *griffithii* has so far been recorded from the Kabul River and its tributary streams. It was originally described from the Kunar or Chitral River. The species is well represented in the Chitral Valley whence Dr. Chopra collected specimens from the following localities :—

- (i) 38 specimens from the Pallarga stream, 2 miles below Kunisht in the Rambhur Valley (Sta. 2).
- (ii) 21 specimens from the Bumboret River between Daimali and Karakal in the Bumboret Valley (Sta. 7).
- (iii) 86 specimens from the Lutkuh River near Uts or Hot Springs (Sta. 9).
- (iv) 14 specimens from the Mastuj River between Koghazi and Mastuj (Sta. 12).
- (v) 22 young specimens from a small stream near Surguz (Sta. 13).
- (vi) 11 specimens from a small stream between Tar and Drosh (Sta. 15).
- (vii) 12 specimens from Ramram gol near its junction with the Chitral River below Arandu (Sta. 16).
- (viii) 28 specimens collected at Chitral in August 1929.

The larger specimens were obtained from rivers with rocky beds and fast currents, while the young ones were collected from small streams generally containing vegetation or with a sandy bed. It seems probable that the small streams form the nurseries where larger fish resort to for breeding purposes. Most of the young specimens appear to be intermediate between *Schizothorax* and *Oreinus*, and it seems likely that some of them are hybrids. I have discussed the affinities of such specimens below. According to Dr. Chopra's observations the species lives under stones and rocks.

Bionomics.—The alimentary canal of *O. griffithii* is greatly convoluted and is about 2.6 times the total length of the fish. As has already been observed by Griffith, it contains a brownish pulp, but in one case both the stomach and the intestine were full of sand and gravel. The structure of the lips and jaws shows that the fish adheres to smooth rocks and scrapes off algal matter which, no doubt, forms its principal food. Its horizontal paired fins, flattish ventral surface and the papillated lower lip are modified for the purpose of adhesion; whereas its sub-cylindrical body is adapted to offer the least resistance to rushing currents. During floods in the Bumboret River, a few specimens of *griffithii* were washed ashore; but the mortality among this species was not so high as in *Glyptosternum reticulatum*. *Oreinus* is a powerful swimmer and can dart from rock to rock with great rapidity. It prefers to live among rocks on the sloping side of a rapid over which water rushes with great speed.

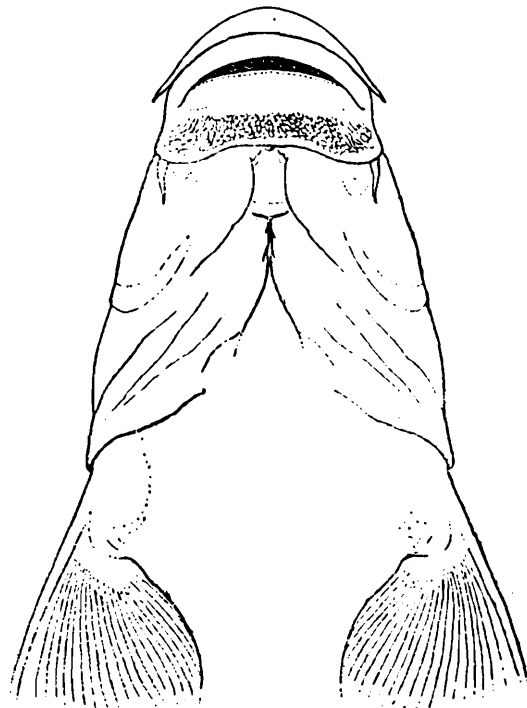
Local Name.—According to Dr. Chopra, *O. sinuatus* var. *griffithii* is known as *Omatchhi* among the Kafirs.

Measurements in millimetres.

	Specimens with en- larged anal scales.		Sta. 2.		Sta. 12.		Sta. 9.	
	Sta. 2.	Sta. 12						
Total length excluding caudal	325.0	260.0	168.0	102.0	122.0	103.0	265.0	255.0
Length of head	64.0	52.0	38.0	22.0	27.0	25.0	52.0	52.0
Width of head .	43.0	33.0	24.0	14.5	17.0	14.0	36.0	35.0
Height of head	43.0	33.0	24.0	14.5	19.0	16.5	34.0	34.0
Diameter of eye.	10.0	8.0	7.0	4.5	6.0	6.0	9.0	9.0
Length of snout	25.0	18.0	14.0	9.0	9.0	8.0	20.0	17.0
Interorbital width	20.0	16.0	10.0	6.0	9.0	8.0	16.0	15.0
Depth of body	66.0	49.0	33.0	20.0	25.0	22.0	55.0	53.0
Length of dorsal spine	45.0	41.0	29.0	18.0	22.0	22.0	42.0	38.0
Longest ray of anal	60.0	39.0	27.0	15.0	21.0	19.0	43.0	38.0
Length of pectoral	64.0	43.0	32.0	19.0	21.0	20.0	45.0	43.0
Distance between pectoral and base of ventral.	35.0	30.0	12.0	9.5	10.0	8.0	25.0	26.0
Length of ventral	58.0	40.0	28.0	17.0	20.0	19.0	41.0	39.0
Distance between ventral and anal	30.0	24.0	9.0	6.0	6.0	6.0	16.0	18.0
Length of caudal peduncle	60.0	42.0	22.0	13.0	16.0	14.0	46.0	42.0
Least height of caudal peduncle	35.0	30.0	17.0	10.0	13.0	10.0	32.0	30.0

? *Schizothorax labiatus* × *Oreinus sinuatus* var. *griffithii*.

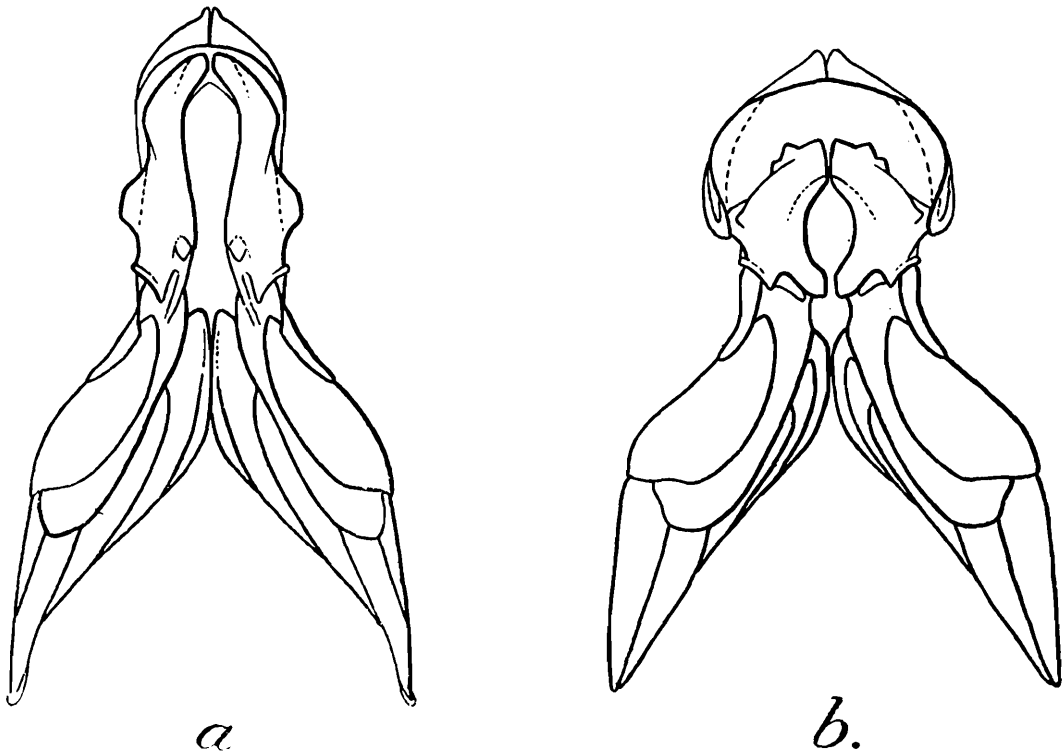
References have already been made (*vide supra*, pp. 294, 302) to the fact that in Dr. Chopra's collection there are several young and half-grown specimens in which the structure of the lips and jaws is interme-



TEXT-FIG. 6.—Ventral surface of head and anterior part of body of *Oreinus sinuatus* var. *griffithii* McClelland showing the nature of lips and jaws.

diate between *Schizothorax* and *Oreinus*. In fact, all possible gradations exist between the *Schizothorax* and the *Oreinus* types of mouth,

I have also no doubt that *Oreinus* is a more specialised form of *Schizothorax* and that it is better adapted to live in swifter currents. The modifications of the lips and jaws are clearly indicative of such a specialisation. The two genera are very closely related, the main difference being that in *Oreinus* the broad, short and flat mandibles are loosely joined together. The anterior margin of the lower jaw is exposed and is covered with a thick horny sheath. The lower lip forms a papillated, broad band behind the naked portion of the jaw and is probably used for adhesion. In conformity with the bony structures mentioned above the head is short, flat and depressed in *Oreinus*, while it is elongated and narrow in *Schizothorax*.



TEXT-FIG. 7.—Skeleton of the lower jaw and associated structures of *Schizothorax* and *Oreinus* in ventral view. $\times 1\frac{1}{2}$.

a. *Schizothorax labiatus* (McClelland).

b. *Oreinus sinuatus* var. *griffithii* McClelland.

A few selected stages between the *Schizothorax* and the *Oreinus* types of mouth-parts may be described here.

(a) Total length 148 mm. Length of head 34 mm.

The central lobe of the lower lip is much narrower otherwise it is similar to that of *Schizothorax labiatus*.

(b) Total length 131 mm. Length of head 31 mm.

The structure of the lips and the associated parts is not very different from that of the typical examples of *Schizothorax labiatus*.

(c) Total length 141 mm. Length of head 31 mm.

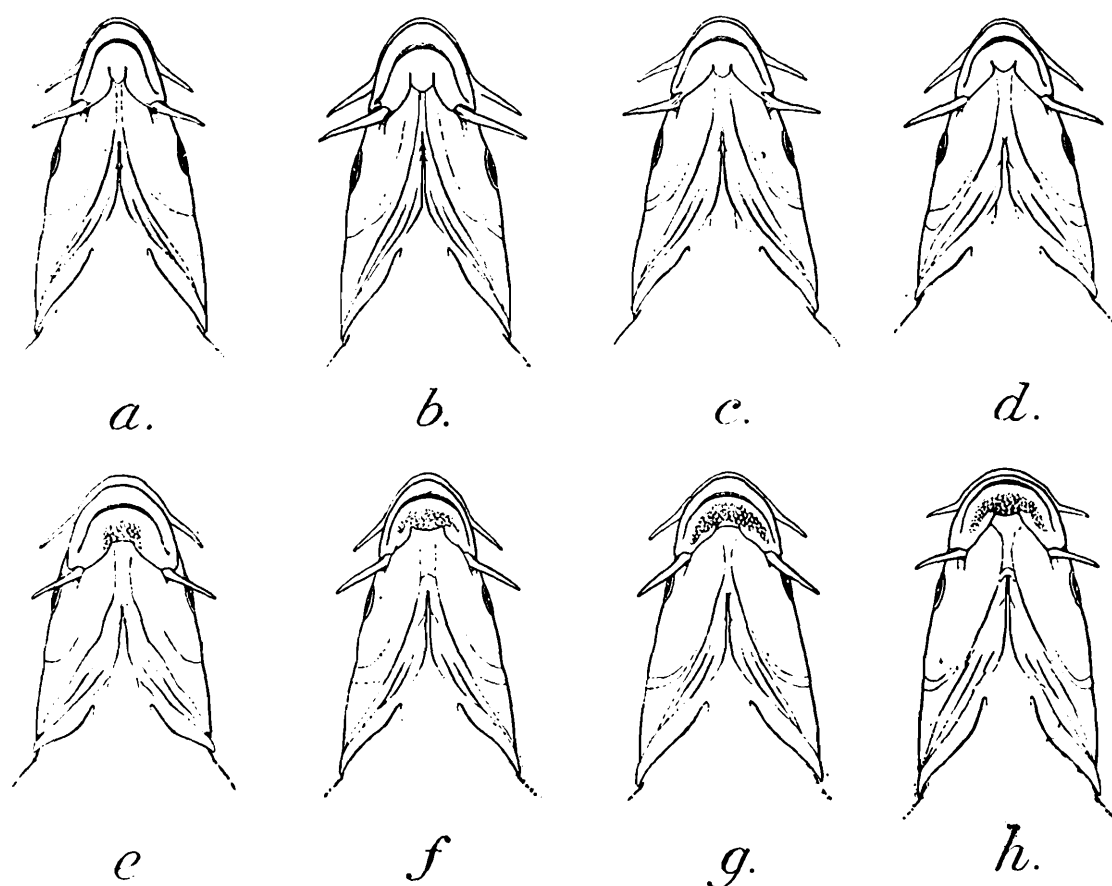
The mandible has become somewhat shorter and broader and the central lobe of the posterior lip is slightly reduced.

(d) Total length 153 mm. Length of head 34 mm,

The posterior lip is still further modified and the snout is considerably broad.

(e) Total length 137 mm. Length of head 30 mm.

The head has assumed the *Oreinus* form though the structure of the lips and jaws is not of the *Oreinus* type yet. The central lobe of the posterior lip has disappeared and its middle part has become papillated. The barbels are somewhat shorter.



TEXT-FIG. 8.—Ventral surface of head in eight specimens intermediate between *Schizothorax* and *Oreinus* in regard to the nature of the lips and jaws and the form of the head. All figures are more or less of natural size.

a-d represent retrogressive modifications in the *Schizothorax labiatus* type of mouth-parts, while *e-h* represent progressive modifications towards the formation of an *Oreinus* type of mouth-parts.

(*f*) Total length 128 mm. Length of head 30 mm.

The head is more or less of the *Schizothorax* type but the lips are considerably modified. The posterior lip is papillated.

(*g*) Total length 145 mm. Length of head 34 mm.

The head is not so broad as in *Oreinus* but the extent of papillae on the lower lip is considerably greater.

(*h*) Total length 141 mm. Length of head 32 mm.

The head is of the *Oreinus* type and the posterior lip is papillated. The most remarkable feature of this specimen is that the mouth is situated only slightly behind the tip of the snout.

It is clear from the measurements given above that the various modifications are not correlated with size.

When determining the collection from Chitral these intermediate forms proved very troublesome, for it was noticed that in the normal young of *Oreinus* the characters of the genus were present in earlier stages of development and they could readily be referred to *O. sinuatus* var. *griffithii*. Similarly the lip character of *Schizothorax labiatus* is also marked at an early stage. After a great deal of consideration I can suggest two possibilities for the occurrence of these intermediate forms. They are either the young of *Oreinus* which have not shaken off the ancestral characters of *Schizothorax* or they represent hybrids between the two common 'Barkels' of the Chitral Valley. The latter supposition seems to be more justified, for intermediate forms occur in great abundance. Even Griffith and McClelland noticed their presence in Afghanistan. Hybridisation among fishes in nature is not a rare occurrence, and several instances have been figured and described by Berg from Central Asia. Both *Oreinus* and *Schizothorax* live in large, rapid-water rivers and prefer a more or less similar habitat—the rocks of the rapids in the course of streams. If the breeding period of the two Chitral species were to coincide at any place, there is a likelihood of the production of a large number of hybrids. The examination of the gonads of the two species shows that they both breed in the summer months and it is not unlikely, therefore, that the intermediate forms in Dr. Chopra's collection represent hybrids between *Schizothorax labiatus* and *Oreinus sinuatus* var. *griffithii*.

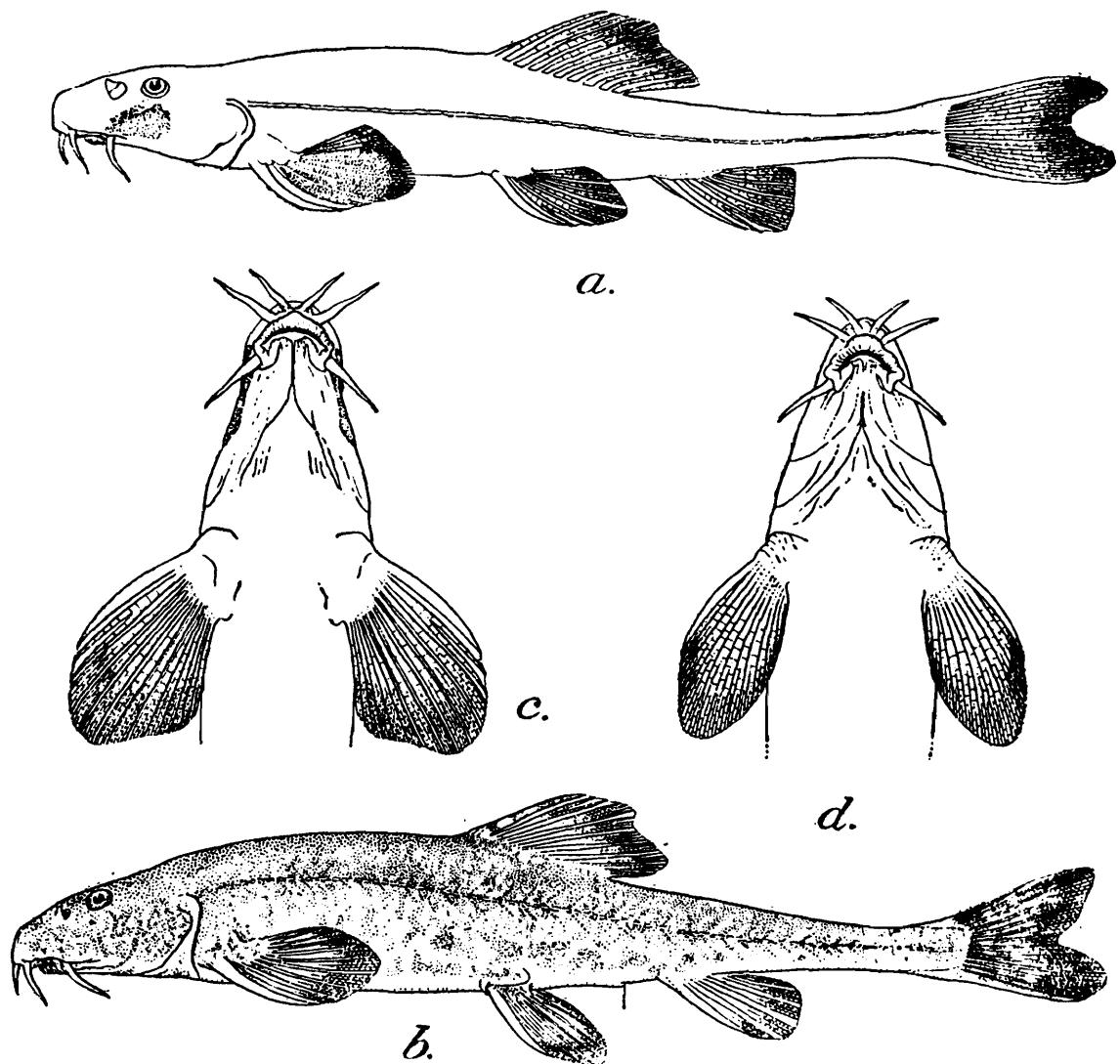
***Nemachilus choprai*, sp. nov.**

D. 3/8 ; A. 2/5 ; P. 11-12 ; V. 8.

Nemachilus choprai is a large and stoutly built species in which the body tapers towards both ends, but very markedly towards the tail. The dorsal profile is gently arched, but the ventral surface is flat and horizontal and the ventral profile is almost straight up to the anal-opening. The caudal peduncle is long and narrow and whip-like. The body is naked, smooth and glossy. The paired fins are horizontally placed.

The head is depressed and flattened on the ventral surface ; it is evenly pointed in the female specimens whereas in the males the snout is broader and the extremity is much more rounded. The length of the head is contained 4.7—5.1 times in the total length without the caudal and 5.6—5.9 times in the length with the caudal. The width of the head is contained 1.4—1.6 times and its height at the occiput 1.6—1.9 times in its length. The depth of the body varies considerably with the sex of the individuals ; in some ripe females it is contained 5 times in the length without the caudal. Usually the depth is contained 5.9—9 times in the length with the caudal and 5—7.6 times in the length without the caudal. The eye is situated either entirely or for a greater part of its length in the posterior half of the head ; it is placed dorso-laterally and is not visible from the ventral surface. The diameter of the eye is contained 6.1—7.4 times in the length of the head, 2.9—3.5 times in the length of the snout and 1.5 to 2 times in the interorbital distance. The nostrils are situated nearer to the eyes than to the tip of the snout ; there is a well marked flap between the

two nostrils on each side. There are six well-developed barbels, 4 rostral and two maxillary; all are much longer than the diameter of the eye. The small, lunate mouth is situated on the ventral surface considerably behind the tip of the snout; it is bordered by prominent fleshy lips which are continuous at the angles of the mouth. The lower lip is interrupted in the middle where the lower jaw is left uncovered. When the mouth is closed, the upper jaw, which is sharp and vertical, lies in front of the lower jaw. The lateral line is complete and well marked throughout its length. The caudal peduncle is long and narrow; its least height is contained 4.5—5.2 times in its length in the females and 5—5.9 times in the males.



TEXT-FIG. 9.—*Nemachilus choprai*, sp. nov.

- a. Outline drawing of the lateral view of a male specimen showing secondary sexual characters. $\times \frac{2}{5}$.
 b. Lateral view of a female specimen. $\times \frac{2}{5}$.
 c. Ventral surface of head and anterior part of body of a male specimen. $\times 1$.
 d. Ventral surface of head and anterior part of body of a female specimen. $\times 1$.

The difference in the general facies and in the form of the head in the two sexes is very marked.

The dorsal fin begins in advance of the ventrals and its commencement is almost midway between the tip of the snout and the base of the caudal; in some individuals it is somewhat nearer to the former than to

the latter. The longest ray of the dorsal is shorter than the depth of the body in ripe females ; whereas it is invariably longer in the males. The upper margin of the fin is notched and its anterior upper corner is rounded. The pectoral fin is shorter than the head and is provided with a muscular base ; it is rounded, horizontally placed and provided with a number of broad, bony rays anteriorly. The pectoral fin extends for about three-fifths of the distance between the bases of the pectoral and ventral fins. The ventral fin is situated on the ventral surface and is similar to the pectoral fin though considerably shorter ; it just reaches or extends beyond the anal opening, which is followed by a deep groove. The males are provided with a well-marked papilla in this groove and in them the ventrals almost reach the base of the anal fin. There is a fleshy appendage at the base of the ventral which is adnate to the body throughout its length. The anal fin is short and its posterior margin is rounded ; it is separated from the caudal fin by a considerable distance. The caudal fin is shorter than the head and is deeply emarginate with the lobes rounded. In some examples the upper lobe is slightly longer than the lower.

The colouration of this species seems to be fairly constant. The ground colour is pale-olivaceous with the ventral surface possessing a uniform lighter colour. The dorsal surface and the sides are clouded with a number of black patches which are more numerous and of a deeper colour above the lateral line. The ground colour appears in minute spots here and there. On the dorsal surface in the tail region there is a series of four to five broad, but short, bands of the ground colour. There are sometimes horizontal, narrow streaks of lighter colour in front of the dorsal fin. The pectoral, ventral and anal fins are without any markings. The caudal fin is irregularly marked with a number of bands, while there are indications of similar bands on the dorsal fin. The anterior margin of the undivided rays of the dorsal fin is conspicuously marked with about 5 dark spots. This last feature is characteristic of the species.

In young specimens, up to about 100 mm. in total length, the general colouration is relatively lighter and there is usually a series of rounded spots all along the lateral line.

Type-specimen :—F 11301/1, *Zoological Survey of India (Ind. Mus)*.

Distribution and Habitat :—*Nemachilus choprai* is the only loach known from the Chitral Valley whence Dr. B. N. Chopra obtained as many as 131 specimens. They were collected in the following localities :—

- (i) Forty-seven specimens from the Lutkuh River near Hot Springs (Sta. 9). (*Type-locality*).
- (ii) Thirty-two specimens from the Mastuj River between Koghazi and Mastuj (Sta. 12).
- (iii) Three specimens from a small stream above Charun in the Mastuj Valley (Sta. 14).
- (iv) Forty-nine specimens from the Chitral River near the Chitral town.

Nemachilus choprai lives in large rivers with a swift current. The bed of such streams consists of stones and boulders with patches of sand and mud here and there. The water is usually clear but becomes muddy after freshets. Dr. Chopra did not observe any vegetation growing

in the large streams, but in the small stream above Charun there was plenty of vegetation and the bottom consisted of mud and sand with a few stones. The three relatively young specimens in the collection were obtained from this small stream, and it seems probable that the mature specimens migrate to smaller streams with plenty of vegetation for spawning purposes. In such situations the young not only get protection in vegetation, but they find a number of small organisms to feed on.

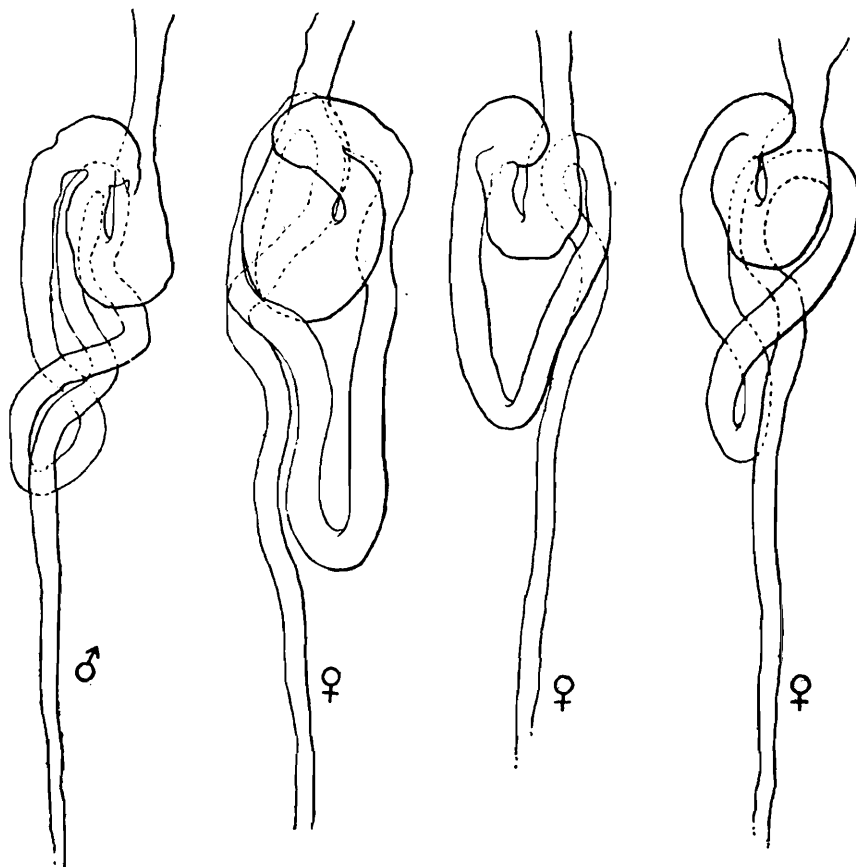
Sexual Dimorphism and the Proportion of Sexes :—*Nemachilus choprai* exhibits well-marked secondary sexual characters and the two sexes can be separated even in specimens about 100 mm. in total length though the species grows to about twice this size. The males are provided with the usual secondary sexual characters which consist of a raised tuberculate area below the nares, separated ventrally by a groove from the adjacent parts of the skin, of a second tuberculate area behind and below the first one and of broad pectoral rays which are provided with thickened tuberculate pads on their dorsal surface. Besides these obvious differences the males possess a broader and more rounded snout, a longer and narrower caudal peduncle and a papilla in the groove behind the anal opening. The males are usually of a larger size and in them the ventrals almost reach the anal fin.

Of the 131 specimens of *Nemachilus choprai*, there are 30 females and 101 males, or a proportion of 22·9 per cent. females and 77·1 per cent. males. If these calculations indicate an actual proportion of sexes in the population, the fact is remarkable. The preponderance of the males in the collection may be due to the fact that they are of much stronger build and are possibly of very active habits; whereas the females may be of secretive habits and thus liable to escape the notice of collectors. This alone, however, does not seem sufficient to account for the great difference in the percentage of the two sexes.

Bionomics.—*Nemachilus choprai* is a bottom dwelling fish. Its flattened ventral surface and broad, rounded and horizontal paired fins are no doubt used for grappling on to the smooth surfaces of rocks. The greatly reduced air-bladder also indicates that the fish lives mostly at the bottom, where it either crawls with the help of its paired fins, or darts from rock to rock with the help of its muscular tail and the whip-like caudal peduncle. Its long and narrow streamline form is adapted both for rapid movements as also for offering less resistance to swift-flowing currents. At the bottom the fish feeds on algae and slime that grow on rocks. Several kinds of Dipterous, Trichopterous and Ephemeropterous larvae that live on bare stones or among algae also form a substantial part of the food of this species. Large Coleopterous larvae that usually live among pebbles at the bottom were also found in the stomach of *N. choprai*. The nature of food indicates a ground habit of life. The entire intestine is usually full of sand and gravel, most of which is probably derived from the cases of Trichopterous larvae and pupae.

The food is scraped from the rocks with the sharp and shovel-like posterior jaw while the anterior jaw, which lies in front of it and forms a vertical plate, helps to prevent the escape of the heterogeneous scraped matter. The position, in which the coils of the alimentary canal lie,

varies considerably as shown in the accompanying figure. It appears that females feed most voraciously when the gonads begin to develop, but in specimens with fully developed ovaries the stomach is either empty or contains very little food. In such cases the liver is also greatly reduced. It seems probable, therefore, that about the spawning time the females give up feeding altogether. The ovaries fill up the body cavity to such an extent that feeding seems almost a physical impossibility. Most of the individuals opened had only insect larvae in their stomachs.



TEXT-FIG. 10.—Alimentary canal of *Nemachilus choprai*, sp. nov. $\times 1\frac{1}{2}$.

The four drawings illustrate the variable nature of the coils of the alimentary canal.

Remarks.—*Nemachilus choprai* belongs to the Central Asiatic group of species in which the caudal peduncle is long and narrow. It is closely allied to *N. tenuis* Day and *N. kashmirensis* Hora. The former possesses a narrower head and longer barbels; while in the latter the caudal peduncle is 3—3.9 times its least height and the eyes are situated almost in the middle of the length of the head. The colouration of *N. choprai* is different from either.

Until quite recently very little was known regarding the Nemachili that inhabit the waters of Afghanistan. Griffith¹ had observed that a loach was very common in the small channels by which the springs at Sir-i-Chashma run off and through the kindness of Major A. E. Farwell

¹ McClelland, *Calcutta Journ. Nat. Hist.* II p. 564 (1842).

Measurements in millimetres.

	♀	♀	♀	♀	♀	♀	♀ (fig.)	♂	♂	♂ (fig.)	♂	♂
Total length including caudal	133.5	134.5	141.5	144.0	150.5	162.0	162.0	150.0	156.0	161.6	163.0	172.0
Length of caudal	20.0	21.0	21.0	21.0	22.0	22.0	25.5	25.0	22.0	23.8	25.0	27.7
Length of head	23.0	24.0	23.7	25.2	25.4	28.3	28.0	26.2	27.5	29.0	29.0	30.0
Width of head	15.7	16.3	16.5	16.7	16.3	20.0	19.2	17.2	17.4	19.0	20.0	18.0
Height of head	13.2	13.2	13.2	14.3	14.0	15.3	16.0	16.0	15.8	14.8	16.0	15.7
Depth of body	17.8	19.0	24.0	16.0	21.2	25.3	25.0	17.5	21.0	19.0	20.2	21.0
Length of snout	11.0	11.2	12.2	11.6	12.2	13.5	14.0	12.5	14.0	14.2	15.0	14.7
Diameter of eye	3.5	3.7	3.4	3.7	3.6	4.1	4.4	4.3	4.5	3.9	4.2	4.6
Interorbital width.	5.6	5.8	6.0	6.5	7.0	7.5	8.0	7.0	7.2	7.8	6.3	8.0
Length of caudal peduncle	29.2	31.0	29.3	30.0	31.0	36.0	34.5	32.0	35.8	37.0	35.0	38.0
Least height of caudal peduncle	5.6	6.0	6.5	6.5	6.5	7.0	7.0	6.0	6.6	6.2	7.0	7.5
Longest ray of dorsal	18.7	17.5	18.2	18.6	20.1	21.8	21.0	18.5	21.0	20.6	22.0	26.0
Longest ray of anal	15.5	15.0	16.0	18.5	17.0	20.6	18.0	19.0	18.8	20.2	20.0	23.0
Length of pectoral	20.6	20.5	22.0	24.0	21.2	26.6	24.5	25.0	24.2	27.0	26.0	29.0
Length of ventral	18.0	17.0	19.6	20.0	19.5	21.0	21.5	20.5	20.7	22.0	21.0	24.2

four young specimens were obtained last year from this locality.¹ Similar specimens have also been collected from the Paghman River² and the Chahiltran stream, both tributaries of the Kabul River. This Kabul River form has been described by me as *Nemachilus griffithii* var. *afghana*. In this variety the caudal peduncle is not so long and whip-like as in *N. choprai*; the least height of the caudal peduncle being contained 2—2.2 times in its length. Besides these two forms, no other loach has so far been described from the upper reaches of the Kabul River and its tributary streams.

I (*op. cit.*, 1934) have recently remarked on the other species known from Afghanistan and it may be noted that *N. choprai* is abundantly distinct from all these forms. *Adiposia boutanensis* possesses an adipose dorsal and has a very characteristic facies, while *Nemachilus griffithii*, though very close to *N. choprai*, differs slightly in the length of the barbels, the position of the eye, the length of the pectoral, the colouration, etc., and has a different type of caudal peduncle. In the types of *N. griffithii* the least depth is contained 2.6—3 times in the length, whereas in *N. choprai* the figures are 4.5—5.9. When comparing the two forms, this character strikes one directly.

The measurements of a dozen specimens (7 ♀♀ and 5 ♂♂) collected in the Lutkuh River near Hot Springs are given on the opposite page.

***Nemachilus kashmirensis* Hora.**

1876. *Nemacheilus rupicola*, Day (*nec* McClelland), *Proc. Zool. Soc. London*, p. 799.
 1878. *Nemacheilus rupicola*, Day (*nec* McClelland), *Sci. Res. 2nd Yarkand Mission Ichthyology*, p. 17.
 1922. *Nemachilus kashmirensis*, Hora, *Rec. Ind. Mus.* XXIV, p. 76.

In 1922, it was shown that Day had confused his Kashmir specimens of *Nemachilus* and had wrongly referred them to *N. rupicola* (McClelland), a species widely distributed in the Simla Hills. The name *kashmirensis* was proposed for this form and several specimens collected in the Verinag and Kukarnag Springs and in a small stream at Harwan were assigned to it. At the time I did not give a full description of the species and subsequently, owing to pressure of other work, it has not been possible to prepare a monograph on the Indian species of the genus in which I hoped to publish the description of the new species. *N. kashmirensis* is closely allied to the species described above and as Kashmir and Chitral are adjacent countries I have thought it advisable to publish the account of the Kashmir form here.

D. 3/8; A. 2/5; P. 12; V 8.

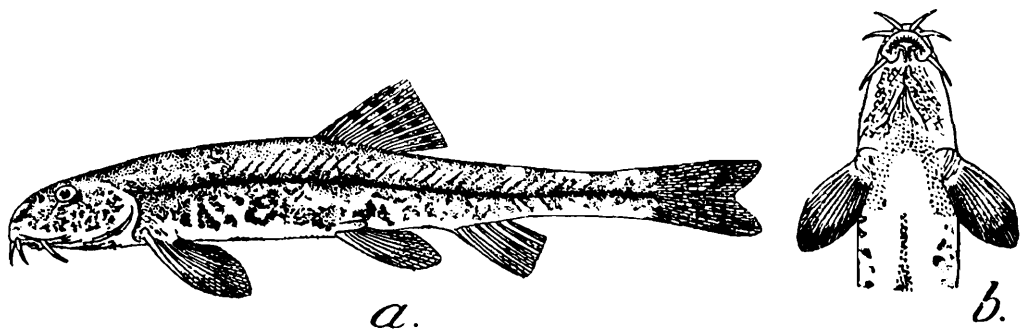
In *Nemachilus kashmirensis* the body tapers towards both ends and the dorsal profile is gracefully arched. The ventral surface is broad and flattened, and the ventral profile is straight and horizontal except in the region of the caudal peduncle. The fish is strongly built and

¹ Hora, *Journ. Bombay Nat. Hist. Soc.* XXXVII, (in press).

² Hora, *Journ. Bombay Nat. Soc.* XXXVI, pp. 697-699, pl. figs. 1 and 2 (1933).

possesses a whip-like, long and narrow caudal peduncle. The body is smooth and glossy and devoid of scales. The head is evenly pointed, but somewhat rounded towards the extremity.

The head is proportionately much longer in the young specimens ; its length is contained 4—4.7 times in the total length without the caudal and 4.7—5.8 times in the length with the caudal. The width of the head is contained 1.3—1.5 times and its height at the occiput 1.6—1.8 times in its length. The depth of the body varies with age as well as with sex ; it is contained 5.7—7.2 times in the total length without the caudal and 7—8.8 times in the length with the caudal. The eye is situated dorso-laterally in the middle of the head and is not visible from the ventral surface ; its diameter is contained 5—6.5 times in the length of the head, 2—2.6 times in the length of the snout and 1.3—1.8 times in the interorbital width. The nostrils are situated nearer to the eye than to the tip of the snout. There are six barbels, two maxillary and four rostral ; they are well marked and are longer than the diameter of the eye. The mouth is on the ventral surface behind the tip of the snout ; it is bordered by well-developed lips, which are continuous at the angles of the mouth and are fimbriated. The lower lip is interrupted in the middle and each portion is reflected backwards. The ventral surface of the head is rugose and papillated. The lateral line is complete and well marked throughout its length. The caudal peduncle is long and narrow ; its least height is contained 3—3.9 times in its length.



TEXT-FIG. 11.—*Nemachilus kashmirensis* Hora.

a. Lateral view. $\times \frac{3}{4}$.

b. Ventral surface of head and anterior part of body. $\times \frac{3}{4}$.

The dorsal fin is situated in advance of the ventrals and its commencement is equidistant between the tip of the snout and the base of the caudal fin ; its longest ray is greater than the depth of the body below it and its upper margin is oblique and truncate. The pectoral fin is somewhat shorter than the head and is rounded posteriorly ; it is horizontally placed and possesses a strong muscular base ; it extends almost two-thirds of the distance to the base of the ventral fins. The ventral fin is situated on the ventral surface and is similar to the pectoral fin ; it extends considerably beyond the anal opening and is provided with a fleshy appendage at its base. The appendage is adnate to the body throughout its length. The anal fin is short and is similar to the dorsal ; it is separated from the base of the caudal fin by a considerable distance. The caudal fin is somewhat shorter than the head ; it is emarginate

with the lobes rounded, the lower lobe being slightly longer than the upper.

N. kashmirensis exhibits sexual dimorphism, but the secondary sexual characters of the male are not so well marked as is the case in several species of the Highlands of Central Asia. The rays of the pectoral fins are broad and bony in the males of *N. kashmirensis*, but tuberculated thickenings are absent on their upper surface. There is a slit-like groove in front of the eye, but there is no tuberculated pad on the head.

The colouration seems to vary considerably with growth. In adult specimens there are broad, black bands on the dorsal surface of the body. They are more marked in the tail region where they extend to the sides also; but anteriorly they become lost in the general mottled colouration of the body. The body is of a dark colour just above and below the lateral line; the upper surface of head is grayish while the entire ventral surface is pale-olivaceous. The dorsal fin is marked with three rows of spots across it, while the caudal fin is provided with about three wavy bands. The ventral and the anal fins are also spotted sometime, while the dorsal surface of the pectoral fins is infuscated with black markings. In the young individuals, besides the saddle-shaped bands on the dorsal surface, there are series of blotches along the lateral line or just below it on both sides. The general surface of the body is irrorated with black dots. In some specimens the body is covered with a number of anastomosing markings which superficially impart a uniform dark colouration to the upper surface and sides of the fish.

Type-specimen :—F10122/1, Zoological Survey of India (Ind. Mus.).

Distribution :—*N. kashmirensis* has been collected in Kashmir from the following localities :—

- (i) Eight specimens from a stream flowing from the waterwork reservoir to the trout-farm at Harwan (*Type-locality*).
- (ii) Seven specimens from a stream flowing out of the Kukarnag Spring.
- (iii) Several young and half-grown specimens from the Verinag Spring.

Remarks.—It has already been indicated that *N. kashmirensis* shows great similarity to species with long and narrow caudal peduncle, such as *N. tenuis*, *N. lhasae*, *N. yasinensis*, etc. The following combination of characters distinguishes it from the allied species :—

- (i) The ventral fin extends considerably beyond the anal opening.
- (ii) The commencement of dorsal is equidistant between tip of snout and base of caudal.
- (iii) The lateral line is complete and well marked.
- (iv) The eye is in the middle of the head.
- (v) The pectoral fin is somewhat shorter than the head.
- (vi) The least height of the caudal peduncle is considerably greater than the diameter of the eye.

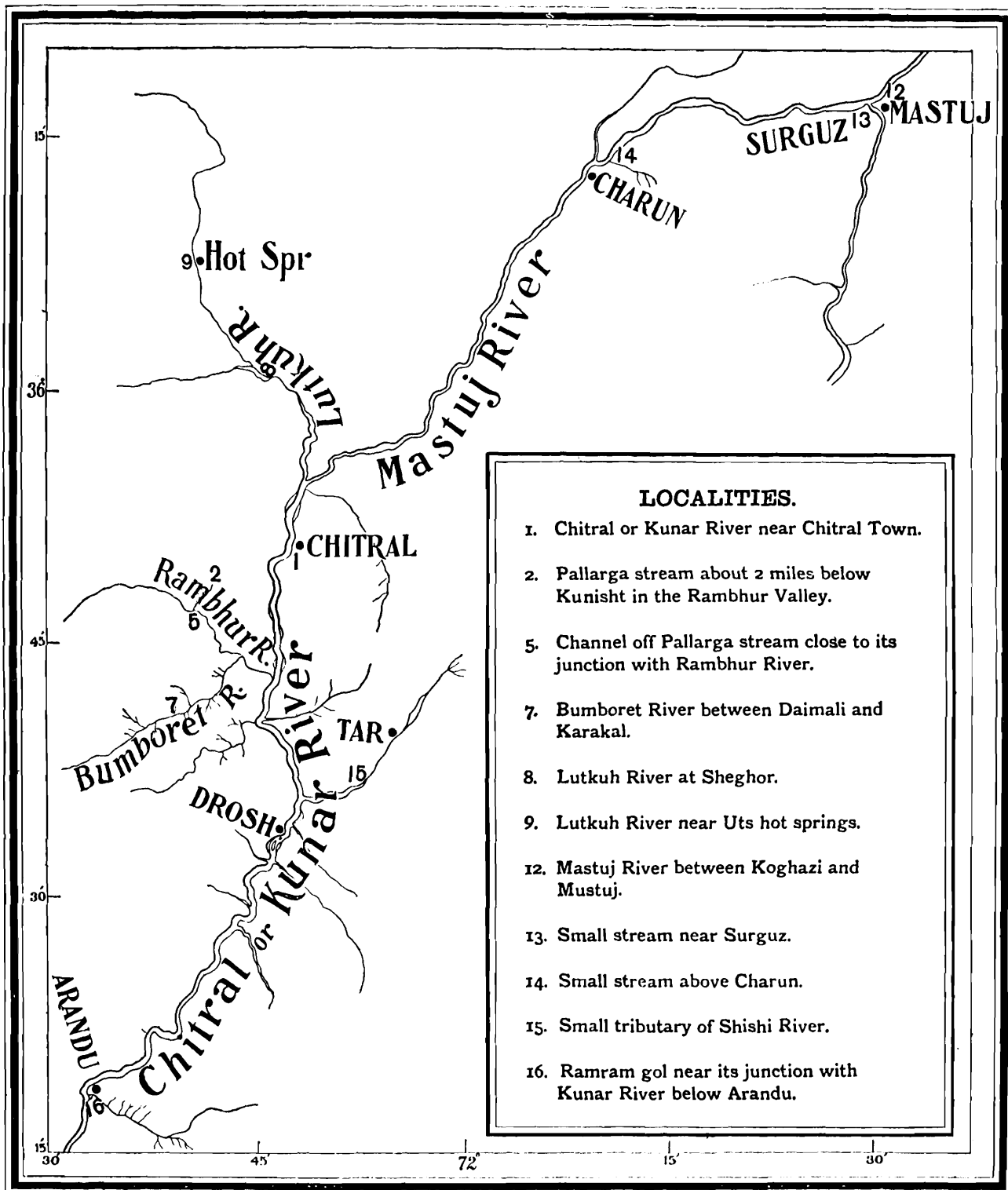
N. kashmirensis is further distinguished from all the related species by its general facies and the characteristic colouration.

Measurements in millimetres.

	Stream near trout-farm at Harwan.			Stream flowing out of Kukarnag Spring.		Verinag Spring.	
Total length including caudal	98.5	92.4	77.4	93.8	62.4	55.0	41.2
Length of caudal	16.5	16.2	12.4	15.0	11.4	10.0	7.2
Length of head	17.6	16.0	13.7	17.0	12.2	11.0	8.6
Width of head	12.0	11.8	9.5	12.0	8.2	7.2	5.7
Height of head at occiput	10.0	9.8	7.3	10.6	7.1	6.2	4.8
Depth of body	12.2	13.3	9.0	12.3	8.3	6.2	4.8
Length of snout	7.9	7.7	5.3	7.8	5.6	4.9	3.4
Diameter of eye .	3.2	3.0	2.1	3.1	2.4	2.0	1.7
Interorbital distance	4.9	5.0	3.9	4.8	3.2	2.8	2.6
Length of caudal peduncle	18.3	16.5	16.6	16.5	11.0	10.2	7.8
Least height of caudal peduncle .	5.6	5.5	4.4	5.0	3.3	2.8	2.0
Longest ray of dorsal	12.8	13.0	11.0	13.0	9.5	9.5	6.2
Longest ray of anal .	12.0	10.8	8.5	11.5	7.5	7.0	4.3
Length of pectoral . .	16.5	14.0	13.5	15.6	12.0	10.7	6.4
Length of ventral . .	13.2	12.4	10.8	13.5	9.0	8.5	4.6

EXPLANATION OF PLATE III.

A sketch map of the river system of the Chitral Valley, showing the principal localities in which fish were collected.



Sketch Map of the River System of Chitral Valley

EXPLANATION OF PLATE IV.

PHYSICAL FEATURES OF THE CHITRAL VALLEY.

- FIG. 1.—The narrow and deep valley of the Lutkuh River.
- FIG. 2.—Junction of the Lutkuh and the Mastuj Rivers to form the Chitral River. Notice the steep and bare hills.
- FIG. 3.—A Red Kaffir basket used as a trap below a small waterfall to catch fish.
- FIG. 4.—A small stream couple of miles above Rambhur, showing growth of vegetation on its sides.



Physical Features of the Chitral Valley.

FURTHER OBSERVATIONS ON THE BIONOMICS OF THE TADPOLES OF *RANA AFGHANA* GÜNTHER.

By SUNDER LAL HORA, D.Sc., F.R.S.E., F.A.S.B., Assistant Superintendent, Zoological Survey of India, Calcutta.

In recent years considerable advance has been made (*vide* list of references) in our knowledge of the adaptive modifications undergone by the remarkable tadpoles of the section *Ranae Formosae* of the subgenus *Hylarana* of the genus *Rana*. These tadpoles possess an extensive suctional disc by which they adhere very firmly to smooth rocks and boulders in the fiercest currents of the small torrential streams of south-eastern Asia. From time to time, I have made observations on the tadpoles of *Rana afghana* which are found in great abundance in suitable places in the Eastern Himalayas and in the hills of Assam. In the living condition, the animal has been studied hitherto from the dorsal surface, but during a recent visit—May-June 1934—to the Tista Valley below Darjeeling advantage was taken to study the mechanism of attachment by watching in a mirror the rôle of the different structures on the ventral surface of the animal. I have described elsewhere¹ the nature of the simple apparatus used for such a purpose. With the help of a mirror, it was possible to elucidate precisely the mode of progression and fixation of the tadpoles and to follow the course of the respiratory current with the help of carmine powder. Besides observations on these points, attention is directed to the nature of the food and to the probable feeding habits of the tadpoles.

PROGRESSION.

Crawling.—As has been indicated above, tadpoles of *Rana afghana* live on rocks in swift currents, and under these conditions they crawl about with the head always pointing upstream. A tadpole, quietly lying on the substratum, holds on to a rock both by means of its disc, including the posterior lip which forms the anterior border of the disc, and the broad anterior lip. As the tadpole begins to crawl, the animal appears to move forward with a series of short jerks, and corresponding with these movements the anterior lip seems to be relaxed and is thrust forwards in a continuous series of rapid waves. It has been assumed (5, p. 242) that during progression the anterior lip and the sucker perform the function of adhesion alternately, but recent observations have shown conclusively that the forward movement is initiated and carried on entirely by the broad anterior lip, while the sucker, which is firmly attached to the substratum throughout progression, follows in its wake with the forward movements. The sucker is pulled forward while still attached to the substratum, and in this process the vacuum inside it is not disturbed. In a normally active tadpole, under water, these

¹ Hora, S. L., Biological Notes on a Fish from Brazil in the Society's Aquarium. *Proc. Zool. Soc. London*, p. 205 (1932).

movements are too rapid to be analysed but the following device proved very helpful. A tadpole was placed in a wet dish and, by poking with a sharp point, it was made to crawl for some time. When the animal was sufficiently exhausted, the crawling movements became very slow, so that every action of the tadpole could be clearly observed and analysed.

During the forward movement, the mouth opened and closed in rapid succession in conformity with the jerking movements of the anterior lip. On account of the prominent black jaws, it was easy to observe these movements.

With the help of a pair of sharp scissors, the anterior lip was cut off, and it was observed that tadpoles treated in this way lost the power of crawling. They progressed slowly by slight jerks of the body which was detached from the substratum.

The above observations indicate that the anterior lip is the chief organ of progression, and that its power of fixation is so great that not only can it withstand the rush of water at the anterior end but can pull forward the entire body which is attached to the substratum by means of the sucker.

Occasionally tadpoles were observed to crawl backwards; but the mechanism by which this reverse movement was effected could not be elucidated. The anterior lip does seem to play some part in this process, but the reverse movement was so rare and of such a short duration that the actual mechanism could not be studied. It was noticed, however, that in the reverse movement the "steps" were somewhat longer than those in the forward movement, and that the distal part of the anterior lip trailed along at each "step."

The backward crawling movement of the tadpoles of *Rana afghana* is remarkable, especially when it is remembered that the teeth on both the lips and the spines on the tuberculated area along the posterior and lateral parts of the disc are directed backwards. All these sharp points are meant to prevent the slipping of the tadpole backward. It follows, therefore, that without the actual lifting of the organs of attachment from the substratum, any movement in the reverse direction would seem hardly possible. At all events only one of the two main organs of attachment could be disengaged with safety at a time. It seems probable that in the reverse movement the suctorial disc is disengaged first, moved backwards and fixed in a new position. The anterior lip is then disengaged and pulled backwards. By the repetitions of these movements, the tadpole is probably enabled to crawl in the backward direction.

Swimming.—Reference has already been made (5, p. 242) to the darting movement of these tadpoles. This movement is too rapid and its mechanism could not be studied with the naked eye. The body did not appear to be thrown into noticeable series of waves and the tail seemed to flap just a little. Probably the succession of muscular waves along the body was so quick that to the naked eye the body appeared to be held straight during progression.

In a dish containing water, the tadpoles were observed to swim occasionally, but the movements were very clumsy. Progression was effected by the undulating movements of the body and the head moved alternately from side to side. With an increase in the rate of progression,

the awkward slow movements of the animal became more and more graceful till in the darting movement the body appeared to be straight as mentioned above.

RESPIRATION.

In the tadpoles of *Rana afghana* the respiratory current enters through the nostrils though these structures are not in any way specially modified for this function. Reference may here be made to the nostrils of *Ascaplus truei* which according to Noble (8, p. 65, fig. 8), are specially modified for respiration in swift currents. In the tadpoles of *R. afghana*, the floor of the buccal cavity was noticed to rise and fall, and the passage of the respiratory current, which flows in from the nostrils, could also be inferred from the movements of the surface of the head in this region. When a cloud of carmine powder was floated over the head of the tadpole, it was sucked in through the nostrils but immediately "coughed" out through the mouth. The animal moved to another place at the same time. In tadpoles that had become languid through exertion the colouring matter was allowed to pass over the gills and was ultimately ejected through the spiracle. When clouds of carmine were floated along the lower margins of the head, no particle was taken in showing thereby that no current flowed below the head. When the anterior lip was damaged, the carmine powder was noticed to enter below the head but no definite current could be traced.

The tadpoles are capable of suspending respiration for short periods as is usual in the case of hill-stream fishes (3, p. 591).

The tadpoles frequently push their heads out of water by crawling along the sides of the dish in which they are kept, but they can stay in this position only for a short period. A tadpole kept in a wet dish desiccated and died within about an hour or so, showing thereby that the animal is not fully adapted for aerial respiration. When the head was out of water, the floor of the mouth showed no movement but a regular rise and fall of the area round the nostrils was observed.

It may be noted that the lungs of these tadpoles are small and thick-walled (3, p. 584; 6, p. 382) and are apparently non-functional. In these circumstances aerial respiration can take place to a limited extent only through the skin of the animal.

FIXATION.

Sucker is the chief organ of fixation, but if its margin is in any way injured or damaged its efficiency is greatly impaired. The rows of backwardly directed teeth on the posterior lip and of spines on the tuberculated area prevent the sucker from slipping backwards in strong currents. It has been indicated above that in the natural habitat, the sucker is kept in action for almost the whole of the time, even during progression. The broad anterior lip, with its several rows of backwardly directed teeth, is also a powerful organ of adhesion. It may be pointed out here that the lips in conjunction with the mouth do not form a vacuum sucker. Normally the respiratory current does not flow in through the mouth and the

lips lie closely adpressed to the substratum, but there is no mechanism in this area that can produce a vacuum. The efficacy of adhesion in this region depends upon the strength of the anchoring devices, and on "seizing" which takes place when two surfaces are brought together in close contact. It has further to be noted that in the absence of a respiratory current flowing in through the mouth there is no area of low pressure in the region of the mouth, as is usually the case in a number of hill-stream fishes.

In the absence of any direct observations, it was presumed by me (5, p. 243) that the folds of the lips at the corners of the mouth form respiratory channels. In the case of *Rana afghana* tadpoles the respiratory current does not enter through the mouth (*vide supra*, p. 323), but it was observed that these folds serve a very important function during progression. When the anterior lip is thrust forward, the anterior jaw and the associated structures are also carried forwards along with it. At this time the folds open out so that the posterior lip which forms the anterior border of the sucker is not disturbed from its position. By this simple device, the action of the sucker is not impaired in any way. In the case of the tadpoles of *Ascaphus truei*, Noble has observed that "folds in sucker arranged to permit opening of the mouth (for locomotion) without seriously detracting from the suctorial nature of the apparatus" (8, p. 68). The lips of this animal do not form a sucker, but it seems probable that during progression the anterior lip moves in the same way as described above in the case of the tadpole of *R. afghana*, while the posterior lip is pulled forwards when still attached to the substratum. The folds of the lips permit the thrusting forward of the anterior lip without detracting from the adhesive properties of the posterior lip. It seems probable that wherever folds exist at the corners of the mouth in hill-stream tadpoles, they subserve the function as detailed above.

NATURE OF FOOD AND MODE OF FEEDING.

The alimentary canal of the tadpoles of *Rana afghana* consists of a long tube of almost uniform diameter throughout and possesses 3 or 4 coils. It is about five to six times as long as the distance between the tip of the snout and the anal opening. In its entire length, it is full of brownish, pulpy substance which, when examined under a binocular microscope, seems to consist of fine particles of sand and slime. No green filamentous algae were found inside the gut. It is probable, therefore, that the tadpoles feed on the slimy matter that is found encrusting apparently smooth rocks and stones even in very swift currents. The particles of sand no doubt get entangled in the slime as they drift down with the current. As is usual with the tadpoles of frogs, the slimy matter is probably rasped off the rocks with the help of the powerful jaws. No direct observations could, however, be made on the actual mode of feeding, but it seems probable that the anterior V-shaped jaw scrapes the food material and the broad posterior jaw prevents it from being washed away by the current. In any case it seems certain that in the tadpoles of *Rana afghana* the respiratory current does not serve as the food current of the animal.

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THREE NEW INDIAN SPECIES OF EUCNEMIDIDAE
(COLEOPTERA)

By E. FLEUTIAUX, *Paris*.

Adelothyreus (Chevrolat) Bonvouloir, 1871-75.

Génotype : *A. flavosignatus* Bonvouloir.

Adelothyreus bengalensis, sp. nov.

♂ $4\frac{1}{2}$ à 5 mm. Allongé ; noir opaque ; pubescence jaune plus apparente sur la moitié antérieure des élytres. Tête convexe, légèrement rugueuse ; épistome à peu près aussi large que l'espace susantennaire, sinué sur son bord antérieur ; carène interoculaire interrompue sur la base de l'épistome. Antennes dépassant les angles postérieurs du pronotum, noires fortement pectinées à partir de 3e article. Pronotum aussi long que large, parallèle, arrondi en avant, peu convexe sur le dos, déprimé de chaque côté à la base, brièvement sillonné au milieu sur l'éperon en face de l'écusson, avec deux bosses sur le dos, parfois vers la base, précédées chacune d'une fossette plus ou moins marquée ; surface rugueuse ; carène antérieure brusquement recourbée et prolongée en arrière jusque vers la moitié ; limite latérale entière ou presque, aboutissant au niveau du bord inférieur de l'oeil. Elytres légèrement plus étroits que le pronotum, déprimés transversalement à la base, parallèles, arrondis au sommet, convexes, rugueux, substriés. Dessous noir opaque ; pubescence jaune légère. Propectus fortement ponctué, métasternum un peu moins, abdomen plus légèrement. Propleures sans impression antennaire suturale, seulement un peu lisses le long de la suture prosternale. Episternes métathoraciques élargis en arrière. Hanches postérieures parallèles. Dernier arceau ventral en bec. Fémurs noirs ; tibias et tarses bruns. ♀ $4\frac{3}{4}$ à $5\frac{1}{2}$ mm. Plus robuste. Antennes serriformes à partir du 3e article.

Bengale : Samsingh, Kalimpong, 1800 pieds, dans les troncs pourris d'*Anthocephalus cadamba* et de *Macaranga denticulata*, janvier à avril (Balwant Singh). Ma collection et Musée de Dehra-Dun.

Plus long que *A. africanus* Fleutiaux ; carène antérieure du pronotum plus prolongée en arrière, impressions antednaïres des propleures tout à fait nulles.

Pendant longtemps l'on n'a connu que des espèces américaines ; ce n'est que tout récemment que deux formes africaines ont été décrites.

Arhipis BONVOULOIR, 1871-75.

Génotype : *Hylocharis subacata* Guérin-Méneville.

Arhipis balwanti, sp. nov.

$3\frac{1}{4}$ à $4\frac{1}{4}$ mm. Oblong ; noir opaque ; pubescence courte, obscure, rare. Tête fortement ponctué, sillonné au milieu ; épistome à peu

près aussi large que l'espace susantennaire. Antennes noires, brunes vers le bout, moniliformes, ne dépassant pas la base du prothorax. Pronotum aussi long que large, parallèle, arrondi près des angles antérieurs, aplati sur le dos, très fortement et densément ponctué ; carène antérieure rejoignant la carène latérale. Elytres parallèles, arrondis à l'extrémité, convexes, très rugueusement ponctués, distinctement striés. Dessous de même couleur. Pattes brunes, fémurs plus foncés.

Bengale : Samsingh, Kalimpong, dans du bois d'essence inconnue, avril (Balwant Singh). Ma collection et Musée de Dehra-Dun.

Distinct de *A. orientalis* Fleutiaux par sa forme plus courte, les élytres parallèles jusque près du bout, arrondis seulement à l'extrémité ; sa couleur noire ; la forte ponctuation rugueuse des élytres plus dense, les stries distinctes.

Melasis Olivier, 1790.

Génotype : *Elater buprestoides* Linné.

Melasis balwanti, sp. nov.

♂ 7 mm. $\frac{1}{2}$. Allongé, cylindrique ; noir à peine brillant ; pubescence courte, obscure, peu apparente. Tête convexe, légèrement sillonnée au milieu en arrière, assez fortement et densément ponctuée ; épistome plat, court, large, peu rétréci en arrière ; bord antérieur bidenté ; base plus large que l'espace susantennaire. Antennes noires, ne dépassant pas la base du prothorax ; 2e article petit et étroit ; 3e deux fois plus long, triangulaire ; 4e fortement denté ; suivants pectinés ; dernier simple et allongé. Pronotum aussi long que large, droit sur les côtés, élargi en avant ; convexe, sillonné au milieu en arrière, très brusquement déclive à la base ; très grossièrement ponctué, surtout sur les côtés, presque rugueux ; bord antérieur largement échancré en cercle ; angles postérieurs arrondis ; postérieurs courts aigus. Elytres longs, cylindriques, conjointement arrondis au sommet, légèrement mais distinctement ponctués-striés ; interstries rugueux. Dessous de même couleur ; pubescence grise. Pattes comprimées ; fémurs et tibia bruns ; tarses noirâtres, derniers articles pâles.

Bengale : Samsingh, Kalimpong, avril, sur *Gynocardia odorata* (Balwant Singh). Ma collection et Musée de Dehra-Dun.

Plus étroit et plus parallèle que *M. buprestoides* Linné ; aspect plus brillant ; antennes plus longuement pectinées ; pronotum moins élargi en avant, sillonné au milieu seulement en arrière, notablement moins rugueux ; élytres plus parallèles, également moins rugueux ; pattes beaucoup moins épaisses et moins largement comprimées.

ON A COLLECTION OF INDIAN CEPHALOCHORDATES, WITH
NOTES ON THE SPECIES FROM THE INDIAN WATERS IN THE
INDIAN MUSEUM, CALCUTTA.

By B. PRASHAD, D.Sc., F.R.S.E., F.A.S.B., Director, Zoological Survey
of India.

Dr. F. H. Gravely, Superintendent, Government Museum, Madras, sometime back sent me a small collection of Cephalochordates for identification. The collection is not very large, but is of special interest in that some of the species represented in it have not been adequately described so far. The specimens are mainly from the collections made by "Lady Goschen"—the trawler of the Madras Fisheries Department, but there are also two tubes containing well-preserved material of the interesting species, *Branchiostoma indicum* (Willey) from Madras. In the following account I have also included short notes on the species from Indian waters in the Indian Museum collection.

The literature on the Indian Cephalochordates is not very extensive. The earliest account of a species of the genus *Branchiostoma* from the area is that of Gray¹, who described a species from Borneo under the name *Amphioxus belcheri*. Thurston recorded that the species had been dredged some 30 miles south of Madras in 1887-88². Forster-Cooper³ also recorded it from Madras, from off "Seven Pagoda, Mahabali" and according to Tattersall⁴, who considered it to be a variety of *B. lanceolatum*, the species was collected from Singapore by Bedford and from Ceylon by Herdman.

Andrews⁵ doubtfully recorded *B. lanceolatum* from Ceylon and Tattersall⁶ after a careful review of the literature recorded the same species from various localities round the same Island. Franz⁷, however, considered the specimens from round Ceylon to be distinct and described this form under the name *B. haeckelli*.

Willey⁸ described an interesting species from the Black Pagoda, Orissa Coast, under the name *Dolichorhynchus indicus*. Tattersall considered the subgenus *Dolichorhynchus* superfluous and referred the species *indicum* to the genus *Branchiostoma*; he redescribed the species and recorded specimens of it from round Ceylon.

¹ Gray, J. E., *Proc. Zool. Soc. London*, p. 35 (1847).

² Thurston, E., *Bull. Madras Govt. Mus.*, I, p. 26 (1980).

³ Forster-Cooper, C., *The Fauna and Geography of the Maldive and Laccadive Archipelagoes*, I, p. 359 (1903).

⁴ Tattersall, W. M., *Ceylon Pearl Oyster Rept.*, I, p. 212 (1903).

⁵ Andrews, E. A., *Studies Biol. Lab. Johns Hopkins Univ.*, V, p. 238 (1893).

⁶ Tattersall, W. M., *Op. cit.*, p. 210.

⁷ Franz, V., *Jenais. Zeitschr. Naturwissen.*, LVIII, p. 403, text-fig. 18 (1922).

⁸ Willey, A., *Quart. Journ. Microsc. Sci.*, XLIV, pp. 269-71, figs. 1, 2 (1901). The author in this paper unfortunately uses the new name *Dolichorhynchus* both in a generic and subgeneric sense.

In addition to the neotenic form *Branchiostoma pelagicum* Günther, which was later separated by Goldschmidt¹ under the generic name *Amphioxides*, Tattersall² doubtfully referred a specimen from round Ceylon to Cooper's species, *B. californiense*. Franz³, however, was of opinion that this record is probably to be referred to *B. elongatum* (Sundevall), of which the Ceylon form and the Cape species, *B. capense* (Gilchrist), are probably geographical varieties. In the Madras Museum collection, there are a number of specimens which agree with Tattersall's description, and as they differ from the true *B. elongatum*, I propose separating these under the name *B. gravelyi*.

Of the genus *Asymmetron* E. A. Andrews, *A. cultellus* (Peters), *A. cingalense* (Kirkaldy), *A. maldivense* (Forster Cooper), *A. agassizi* (Parker), *A. parvum* (Parker), *A. lucayum* Andrews and *A. orientale* (Parker) have been recorded from the Indian waters by various authors. For full literature regarding these species reference may be made to the works of Tattersall⁴, Forster Cooper and Franz.

In reference to the nomenclature of the genera I have followed the masterly memoirs of Franz, and it is not necessary, therefore, to discuss the controversial questions of the genera and their nomenclature.

In the collections before me the following species are represented :—

1. *Branchiostoma belcheri* (Gray).
2. *Branchiostoma indicum* (Willey).
3. *Branchiostoma gravelyi*, sp. nov.
4. *Asymmetron cingalense* (Kirkaldy).

Genus **Branchiostoma** Costa.

Branchiostoma belcheri (Gray).

1847. *Amphioxus belcheri*, Gray, *Proc. Zool. Soc. London*, p. 35.
 1889. *Branchiostoma belcheri*, Günther, "Challenger" Reports, XXXI, *Pelagic Fishes*, p. 43.
 1890. *Branchiostoma belcheri*, Thurston, *Bull. Madras Govt. Mus.*, I, p. 26.
 1895. *Branchiostoma (Amphioxus) belcheri*, Kirkaldy, *Quart. Journ. Microsc. Sci.*, XXXVII, p. 313, pl. xxxv, fig. 8.
 1901. *Branchiostoma nakagawae*, Jordan & Snyder, *Proc., U. S. Nat. Mus.*, XXIII, p. 726.
 1903. *Branchiostoma lanceolatum* var. *belcheri*, Tattersall, *Trans. Liverpool Biol. Soc.*, XVII, p. 299.
 1903. *Branchiostoma lanceolatum* var. *belcheri*, Tattersall, *Ceylon Pearl Oyster Rept.*, I, p. 212, pl. i, fig. 3.
 1913. *Branchiostoma belcheri*, Jordan, Tanaka & Snyder, *Journ. Coll. Sci. Tokyo.*, XXXIII, p. 4.
 1922. *Branchiostoma belcheri*, Franz, *Jenais. Zeitschr. Naturwissen.*, LVIII, p. 391, text-figs. 8-13.
 1927. *Branchiostoma belcheri*, Franz, *Ergebn. Anat. Entwicklung.*, XXVII, p. 482.

B. belcheri originally described from Borneo is widely distributed in the Indo-Pacific. It has been recorded from the east coast of Africa,

¹ Goldschmidt, R., *Biol. Centralbl.*, XXV, pp. 235-40 (1905).

² Tattersall, W. M., *op. cit.*, p. 216.

³ Franz, V., *op. cit.*, p. 406; see also Franz, V., *Ergebn. Anat. Entwicklung*, XXVII, p. 483 (1927).

⁴ Tattersall, W. M., *Trans. Liverpool Biol. Soc.*, XVII, pp. 269-302 (1903).

Ceylon, Borneo, Philippines, the Prince of Wales Islands, Torres Straits, China and Japan.

Thurston remarked that the species had also been dredged earlier some 30 miles south of Madras, while Tattersall recorded it from Ceylon as a variety of *B. lanceolatum* (Pallas).

In the Madras Museum collection before me the species is represented by two series of specimens from :—

1. Tholayiram par, 10-16 fathoms, 28. iii. 28. 4 specimens.
2. Off Coilpatam, S. W. and W. of Tuticorin, 7-10 fathoms, 30. iii. 28—1. iv. 28.

The specimens are mostly immature and rather poorly preserved, but agree with the descriptions of Kirkaldy, Tattersall and Franz.

The largest specimen from off Coilpatam is 45 mm. and the youngest about 20 mm. long. In the larger specimens traces of gonads are to be seen, and in one specimen 27 and 25 on the right and left sides respectively were counted. The myotome formula is 37, 17, 10.

The Tholayiram par specimens vary from 30-35 mm. in length, and in one specimen 27 gonads on the right and 25 on the left side could be seen. The myotome formula is 37, 17, 9-10.

In the Indian Museum collection the species is represented by 11 specimens collected by the Surgeon Naturalist on the R. I. M. S. "Investigator" in the Mergui Archipelago, 16-20 fathoms. The largest specimen is 52 mm. long, and the myotome formula varies as 37-38, 17-18, 9-10. The gonads are developed in some specimens, but their exact numbers cannot be counted.

***Branchiostoma indicum* (Willey).**

1901. *Dolichorhynchus indicus*, Willey, *Quart. Journ. Microsc. Sci.*, XLIV, p. 269, figs. 1, 2.
1903. *Branchiostoma indicum*, Tattersall, *Trans. Liverpool Biol. Soc.*, XVII, p. 300.
1903. *Branchiostoma indicum*, Tattersall, *Ceylon Pearl Oyster Rept.*, I, p. 215, pl. i, figs. 11-13.
1922. *Branchiostoma indicum*, Franz, *Jenais. Zeitschr. Naturwissen.*, LVIII, p. 410.
1927. *Branchiostoma indicum*, Franz, *Ergebn. Anat. Entwicklung*, XXVII, p. 483.

Of *B. indicum* I have examined the 4 badly preserved types and a mounted slide in the collection of the Indian Museum and a large series of fresh specimens from off Madras kindly sent to me by Dr. R. Gopala Iyer of the Madras University. In addition I have also examined a few old specimens from Madras in the Indian Museum collection and two series of specimens marked " ? Madras " in the collection from the Madras Museum. In view of this extensive material I give below a few notes on the species and a good figure showing its main characters.

The specimens vary from white to pink or even brown in colour and the largest is 27 mm. long and about 3 mm. in maximum width. The

myotome formula (text-fig. 1) generally is 41, 14, 14, but in 3 specimens 42-43 preatrial and in 2 specimens 15 postanal myotomes were found.

The myotomes in the anterior third of the animal are comparatively narrow as the main part of the body is occupied by the very broad pharynx.

All the specimens show distinct preoral lobes, but their proportionate length agrees in general with Tattersall's figure rather than Willey's.

The rostrum is comparatively long, about as long as the first five myotomes, and appears as a somewhat narrow, tubular structure.

The dorsal fin is low and of an even height; it ends slightly in front of the first myotome anteriorly and slightly behind to the anus posteriorly.

The ventral fin has the usual fin chambers which also extend postanally. The caudal fin is relatively broad and almost pointed posteriorly; the infra-caudal lobe is slightly less deep than the supra-caudal, but is longer, extending very slightly beyond the anus.

The metapleural folds terminate symmetrically on either side of the ventral fin behind the V-shaped atripore (text-fig. 2).

The oral cirri are moderately long, about 40 in number, and are provided with distinct sense papillae.

The notochord extends into the long rostrum as a thin tube, but does not extend to the tip.

The neural tube projects slightly in front of the dorsal fin chambers, but stops short of the anterior termination of the dorsal fin.

There is no eye-spot.

FIG. 1.—*Branchiostoma indicum* (Willey). Lateral view. $\times 6$.

The number of gonads varies from 25-27 on the right side to 22-24 on the left in both male and female specimens.

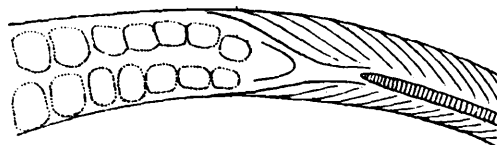


FIG. 2.—*Branchiostoma indicum* (Willey). Ventral view showing the symmetrical termination of the metapleural folds. $\times 6$.

From the above description it is clear that all the specimens from off Madras are to be referred to Willey's species, *B. indicum*.

Branchiostoma gravelyi, sp. nov.

1903. ? *Branchiostoma californiense*, Tattersall, (nec J. G. Cooper), *Ceylon Pearl Oyster Rept.*, I, p. 216, pl. i, figs. 14, 15.
 1922. *Branchiostoma elongatum*, Franz (in part), *Jenais. Zeitschr. Naturwissen.*, LVIII, p. 405.
 1927. *Branchiostoma elongatum*, Franz (in part), *Ergebn. Anat. Entwicklung.*, XXVII, p. 483.

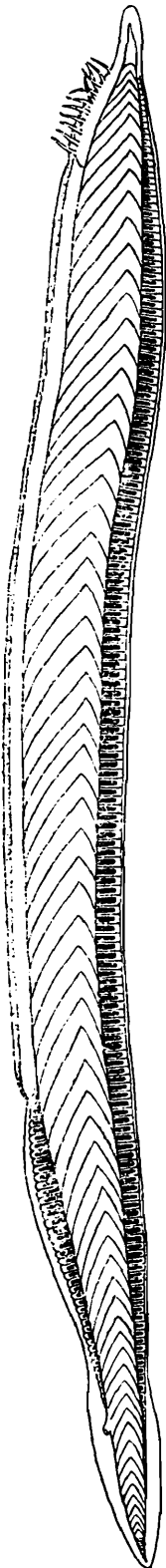


FIG. 3.—*Branchiostoma gravelyi*, sp. nov.
Lateral view. \times ca. 5.

Tattersall referred with some doubt a specimen from the Cheval District, Ceylon, to Cooper's species *Branchiostoma californiense*, and remarked that the Ceylon specimen "differs but very slightly from either *B. californiense* or *B. capense*" Franz considered *B. capense* to be probably a "geographische Varietät" of *B. elongatum* (Sundevall), but considered *B. californiense* as distinct. He also doubtfully referred Tattersall's *B. californiense* from Ceylon to *B. elongatum* (Sundevall), even though he gave the distribution of this species as "Westküste Südamerikas"

The rostral fin (text-fig. 3) is almost continuous with or separated by a shallow notch from the dorsal and is only slightly produced into a snout-like structure. The dorsal fin is low and has a continuous series of fine rays. The caudal fin is a little higher than the dorsal and ventral fins; the infra-caudal lobe is slightly longer and deeper. The ventral fin is very long, and has a series of double fin rays throughout its entire length, but the fin chambers do not extend postanally. The metapleural folds terminate symmetrically.

The oral cirri are moderately long, about 30 in number, and bear well-marked, almost triangular, sense-papillae. The "Räderorgan" agrees with Tattersall's description.

The notochord extends far in front of the anteriormost myotome and slightly beyond the last myotome. The nervous system projects anteriorly to almost the beginning of the rostral fin. There is no eye-spot.

All the specimens are apparently immature as no gonads can be seen.

The measurements and myotome formula of 4 specimens are as follows:—

- Length 44 mm. Myotomes 41—18—10=69.
 Length 41 mm. Myotomes 40—18—10=68.
 Length 36 mm. Myotomes 40—18—10=68.
 Length 23 mm. Myotomes 40—18—10=68.

This form, as the above description shows, agrees very closely with Tattersall's single specimen from Ceylon which he recorded doubtfully as *B. californiense*, but differs in myotome formula and the absence of the eye-spot. I am inclined to consider the differences as of little value and believe that the specimens before me are conspecific with Tattersall's form. They, however, differ materially from *B. californiense* and *B. elongatum*, and I propose to separate them under the name *B. gravelyi*, sp. nov. with the following diagnosis :—

Myotomes 68-69, with the general formula 40—18—10. Rostral fin rather low, only slightly or not marked off from the dorsal. Caudal fin beginning about 2 myotomes in front of the anus dorsally and extending ventrally about 5 myotomes beyond it. Posterior end distinctly pointed. Ventral fin chambers not extending postanally. Preoral tentacles moderately large with distinct, triangular sense papillae. Length up to 44 mm.

Distribution.—About a dozen specimens of this species were dredged from off Coilapatam, S. W. × W. of Tuticorin on 30. iii. 28 by the Madras Fisheries Trawler "Lady Goschen"

Holotype.—F 11675, *Zoological Survey of India, Indian Museum, Calcutta.*

Remarks.—*B. gravelyi* is allied to *B. elongatum*, but differs in its myotome formula, form and extension of the fins, and the entire absence of the eyes.

Genus *Asymmetron* Andrews.

Asymmetron cingalense (Kirkaldy).

1895. *Amphioxus (Heteropleuron) cingalense*, Kirkaldy, *Quart. Journ. Microsc. Sci.*, XXXVII, p. 315, pl. xxxv, fig. 7.
 1903. *Asymmetron cingalense*, Tattersall, *Trans. Liverpool Biol. Soc.*, XVII, p. 301.
 1903. *Asymmetron cingalense*, Tattersall, *Ceylon Pearl Oyster Rept.*, I, p. 217.
 1922. *Asymmetron cingalense*, Franz, *Jenais. Zeitschr. Naturwissen.*, LVII, p. 425.
 1927. *Asymmetron cingalense*, Franz, *Ergebn. Anat. Entwicklung.*, XXVII, p. 484.

A. cingalense is represented in the collection before me by 7 specimens dredged from Tholayiram par, 10-16 fathoms, on 28. iii. 1928.

The specimens vary from 21-27 mm. in length and the myotome formula is 8-9, 15-16, 26-37. In one specimen, a male, 15 gonads were present on the right side. In other respects the specimens agree very closely with the descriptions of Kirkaldy and Tattersall.

TWO NEW COPEPODS OF THE GENUS *ACARTIA* FROM BURMA.

By ADOLPH STEUER, *Rovigno d' Istria, Italy.*

(PLATE V.)

Recently Mr. F. Kieffer of Dieselberg near Heidelberg handed over to me for identification the two Copepods described in this note. The specimens had been collected near Myitkyo about 100 miles north-east of Rangoon, Burma, on 6th February, 1933, and were found in the Sittang River and the Sittang-Pegu Canal. According to a communication of Mr. Kieffer the collection also contained the Copepods *Mesocyclops leuckarti* and *M. hyalinus*.

A few specimens of the two new forms have been deposited in the Zoological Museum, Berlin.

***Acartia (Acartiella) sewelli*, sp. nov.**

(Pl. V, figs. 1-7.)

♀: Total length, 1.38-1.57 mm.

The 1st abdominal segment (*Ab* 1-3) is without the row of transverse spines and the scattered spines on its dorsal surface such as were described by Sewell for *A. tortaniformis* (2, p. 346). During copulation the neck-piece of the spermatophore is introduced beneath the valve (pl. v, fig. 1) which lies dorsally on the left side close to the posterior end. The right furcal ramus is somewhat longer than the left; the 2nd furcal seta is scarcely thickened.

The fusion of the proximal segments of the first antenna (pl. v, fig. 2) is more advanced than in *A. tortaniformis*, and ventrally on the posterior surface there are traces of "triangular spines" in the form of minute chitinous knobs. Spines are entirely absent on the distal segments.

On the 2nd antenna (pl. v, fig. 3), B1 protrudes globularly from the inner edge as in *A. clausi* Giesbr. (see Giesbrecht 1, p. 514, pl. xxx, fig. 13). The two ramii of the 2nd antennae have been differently interpreted in *A. clausi* by Giesbrecht (*op. cit.*) and in *A. tortaniformis* by Sewell (2, p. 347, pl. xxi, fig. 4). Following Giesbrecht's terminology, the exopodite of *A. sewelli* is fused with the second basal joint (B2 Re), and the free endopodite (Ri1-2) is directed forwards. In addition to the more proximal two setae, B2 bears on its inner margin a third seta; this is wanting in *A. tortaniformis*. The outer margin of the endopodite is straight in *A. sewelli*, but is sharply bent in *A. tortaniformis*.

The exopodite of the 5th leg (pl. v, fig. 4) bears on its inner margin a row of strong teeth, while along the outer margin there is only a small bristle.

♂: Total length, 1.27-1.51 mm.

On the 1st abdominal segment (pl. v, fig. 5) the genital opening lies on the left; the right furcal ramus is conspicuously longer than the left.

The grasping antenna lies on the right; the proximal segments of the left antenna are less fused than those of the female and the chitinous knobs are even further reduced.

Concerning the succession of joints in the 5th leg (pl. v, fig. 6) I have already expressed my views (5, pp. 13, 101); these differ from those of Sewell (2) for the nearly allied species *A. tortaniformis*. In the present species the "endopodite" which arises from the ventral surface, is much smaller than in Sewell's species. On the right leg on Re1 a curved bristle is present in addition to the two straight ones on the dorsal inner margin. Re2-3 is much less bent than in *A. tortaniformis* and has a few short hairs externally near the base of the distal spine; the latter bears hairs along its inner margin. On the left leg Re2-3 bears on its outer margin a projection with a short spine and a well developed tuft of hairs.

The new species, which I have dedicated to Col. R. B. Seymour Sewell, the well known student of Indian Copepods, is very closely allied to *A. tortaniformis* Sewell. The latter species, however, may be regarded as a little more primitive, as in the female the fusion of the joints of the 1st antenna is not so far advanced. In the 2nd antenna the notch on the outer margin of the endopodite still indicates its formation by the fusion of two segments.

In one female a large nematode ($1500\mu \times 56\mu$) was found. This probably belongs to the genus *Philometra*, as the intestinal caeca characteristic of the genus *Contracoecum*, were not visible (see Wülker, 6, p. 2). The anterior end bears a small boring spine; the posterior is "spitz geschwanzt" (pl. v, fig. 7).

Epistylis lacustris Imhoff kindly determined for me by Dr. A. Kahl of Hamburg, was found attached to a number of specimens.

***Acartia (Acanthacartia) chilkaensis* Sewell var. *sittangi*, nov.**

(Pl. V, figs. 8-14).

♀: Total length, 1.06-1.15 mm.

The head bears a rostrum and is separated from Th1 (pl. v, fig. 8). Th4-5 is rounded; laterally it is minutely spinose both on the ventral and dorsal surfaces and the ventral spines (about 5) are larger than the more numerous dorsal (pl. v, fig. 9).

On the 1st antenna (pl. v, fig. 10) segments 15-24 bear a delicate row of minute spines ventrally on its posterior margin.

The basal region of the terminal claw of the 5th leg (pl. v, fig. 11) is ventrally thickened and somewhat bent in the middle; often a distinct tooth is found in this situation on the outer margin. The terminal piece is feathered along both sides.

♂: Total length 1.00-1.06 mm.

The abdomen (pl. v, fig. 12) bears dorsally on its distal margin from Ab1-Ab4 a row of minute spines which is continued to the ventral side on Ab2 and Ab3.

On the grasping antenna (pl. v, fig. 13), which is on the right side, the 17th segment bears a small spine on its upper surface; this may be identical with the "spine-like tooth-plate" which Sewell (3, p. 10)

mentions but which he does not figure. The same spine is also to be found on the left antenna in the same location. On Aa 19-21, a chitinous knob is present proximally; this sometimes terminates in a sharp point.

On the 5th right leg (pl. v, fig. 14) Re1 bears a bristle about the middle of the ventral side. Re2 has on its inner side a somewhat quadrangular plate, but lacks the distal process figured by Sewell for *A. (A.) chilkaensis* (3, pl. ix, fig. 5). On the other hand it bears on its distal margin the little bristle which occurs there very frequently. A similar one is present on Re2 in the middle of the concave inner margin; this is mentioned by Sewell in his description, but not shown in fig. 5. The terminal spine is small and blunt.

On the left leg, B1 is indicated in Sewell's figure and B2 appears divided, as a result of which the distal piece would be the 1st joint of the exopodite. The position of the bristle of the outer margin indicates undoubtedly that it is the 2nd basal joint. In my specimens the "rounded projection" on the inner margin of this segment is only very feebly indicated, and the bristle of the outer margin arises at a distance from it. The terminal joint Re2-3 (=Exopodite 3 of Sewell) is somewhat more complicated in the specimens from the Sittang River. It terminates in a large bent cone which bears a terminal spine. From the base of the second proximal spine starts a delicate veil-like membrane, which seems to be absent in the typical form.

The new variety is distinguished from the typical form by the following characters:—

- (1) In the female the 1st antenna in the typical form bears, according to Sewell, transverse rows of minute spines only on the 16th, 17th and 19th segments, while in the variety *sittangi* the rows extend from the 15th to the 24th segments. The row of the 18th is very feebly developed. In the 5th leg, Sewell figures the terminal claw as smooth; I have found minute hairs along its lateral borders.
- (2) In the male, the armature of the abdomen is different. In the typical form the abdomen is naked, in the new variety Ab1-4 bear rows of minute spines. On the right 5th leg the distal outgrowth of the quadrangular plate of Re2 is absent, and on the left Re2-3 the base of the proximal spine bears a delicate membrane.

The specimens from the Sittang River are larger than those from the Chilka Lake; the averages for the two forms are:

♀: 1.10 mm. (as compared to 0.75 mm. in the *forma typica*).

♀: 1.03 mm. (as compared to 0.70 mm. in the *forma typica*).

Sewell (3, p. 10) noted that he had also examined some males from Cochin¹ which resembled his species, but which were somewhat larger (0.82 mm.) than the Chilka Lake specimens. These had a row of minute spines on the posterior margin of the abdominal segments 2, 3 and 4. He was inclined to regard these specimens from Cochin "as a local variation," as they agreed in all characters with the Chilka Lake

¹ This sample is not mentioned in Sewell's later work (4, p. 395).

specimen. The specimens from the Sittang River seem to be more closely related to those from Cochin, than to the *forma typica* from the Chilka Lake.

Of all species of the subgenus *Acanthacartia* so far known from India, *A. chilkaensis* is most closely allied to *A. plumosa* Th. Scott.

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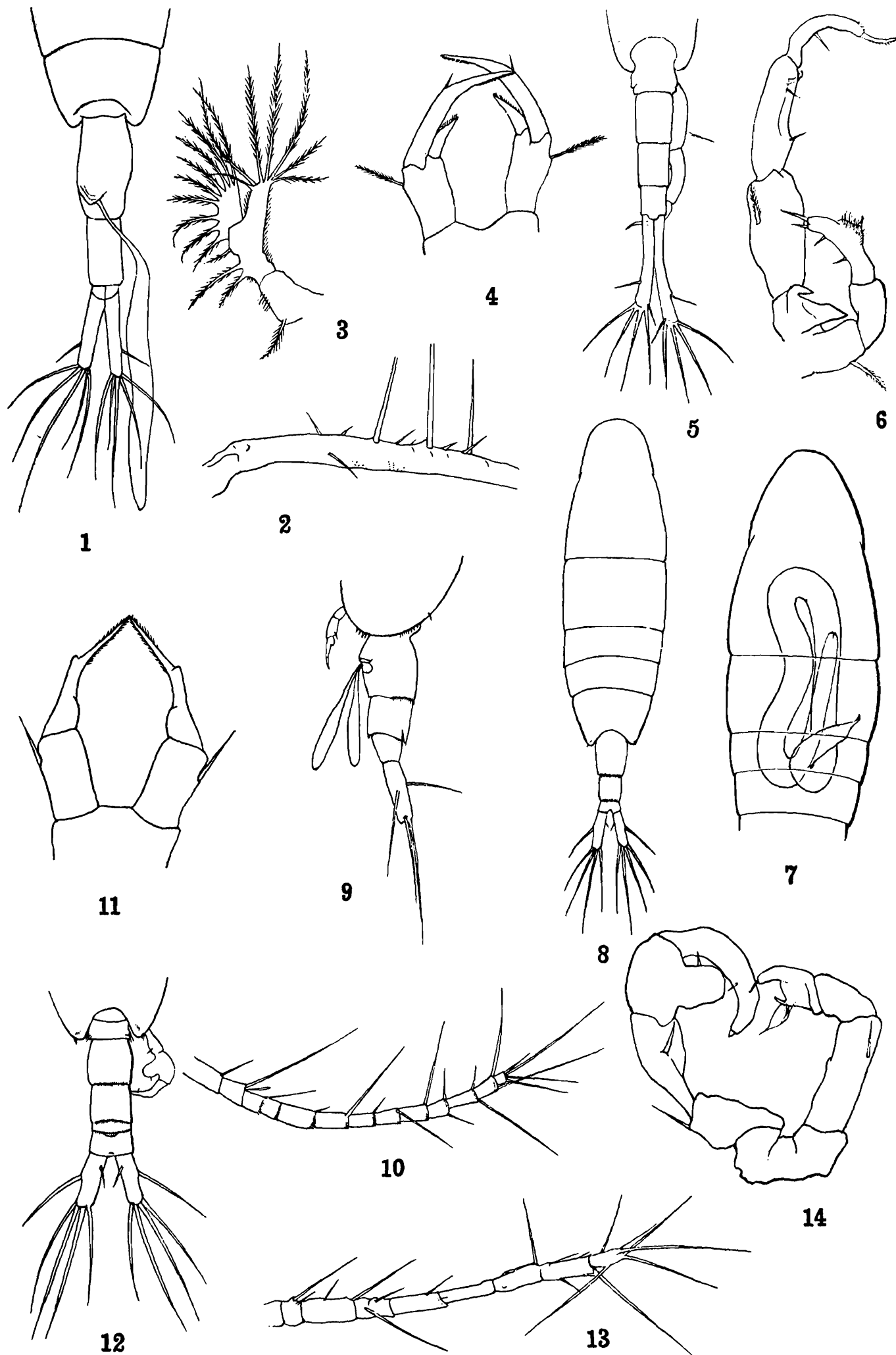
EXPLANATION OF PLATE V.

Acartia (Acartiella) sewelli, sp. nov.

- FIG. 1.—Last thoracical segment (Th 4-5) and abdomen (with spermatophore). ♀, dorsal view.
- FIG. 2.—Left 1st antenna, proximal joints, ♀ from below.
- FIG. 3.—2nd antenna, ♀.
- FIG. 4.—5th leg, ♀.
- FIG. 5.—Last thoracic segment and abdomen, ♂, dorsal view.
- FIG. 6.—5th leg, ♂, ventral view.
- FIG. 7.—Anterior part of the body of a ♀ with parasitic Nematode.

Acartia (Acanthacartia) chilkaensis Sewell var. *sittangi*, nov.

- FIG. 8.—♀, dorsal view.
- FIG. 9.—Last thoracic segment and abdomen (with spermatophores). ♀, lateral view.
- FIG. 10.—Left 1st antenna, terminal joints, ♀, from below.
- FIG. 11.—5th leg, ♀.
- FIG. 12.—Last thoracic segment and abdomen, ♂, dorsal view.
- FIG. 13.—Right grasping 1st antenna, terminal joints, ♂, from above.
- FIG. 14.—5th leg, ♂, ventral view.



New Copepods of the Genus *Acartia*.

FURTHER OBSERVATIONS ON THE BIONOMICS OF THE EARLY STAGES OF TORRENTIAL LEPIDOPTERA FROM INDIA.

By SUNDAR LAL HORA, D.Sc., F.R.S.E., F.A.S.B., Assistant Superintendent, Zoological Survey of India, Calcutta.

(PLATE VI.)

Though the existence of aquatic Lepidoptera has been known for a long time, our knowledge of the torrential forms is comparatively recent. In 1909, Poulton¹ published an account of the life-history of a torrential species—*Aulacodes simplicialis* Snell—based on observations made in China by Kershaw and Muir. Five years later, Llyod² discovered in America a species of *Elophila* with similar habitat and, in 1927, I³ directed attention to the occurrence of Lepidopterous larvae and pupae in the hill-streams of India. It was pointed out that similar larvae had previously been collected from India by Drs. F. H. Gravely and B. N. Chopra, and were present in the collection of the Zoological Survey of India. In 1928, Pruthi⁴ published certain observations on the biology and morphology of the immature stages of *Aulacodes peribocalis* Wlkr. Some of the views expressed by Pruthi are at variance with those of mine, but as the proper elucidation of the subject required further observations in the field, no reference was made to Pruthi's article in my monograph⁵ on the "Ecology, Bionomics and Evolution of the Torrential Fauna." Since 1930, the bionomics of these insects has been studied by me on three different occasions in the Tista Valley where torrential Lepidoptera are found in great abundance in suitable places in all the streams of the Valley. It has thus been possible to check and verify observations made at different places on different occasions and the results given below are based on a thorough and extensive investigation of the problem. Some of these results have been briefly referred to in my account of the "Silken Shelters of Torrential Insect-Larvae"⁶.

HABITAT.

In February 1927, torrential Lepidopterous larvae were found by me in great abundance in the Nerbuda river near Pharisemar in the Rewa State, Central Provinces. In places the bed of the shallow stream was stony without any large boulders and the current was fairly rapid. The stones had a profuse growth of filamentous algae and such places were the chief haunts of the larvae of *Aulacodes*; their silken shelters were covered with a rich growth of algae. In other parts of the river, where the rocks were without any visible vegetation but had a cover of slimy

¹ Poulton, *Trans. Ent. Soc. London*, pp. xl-xliv (1909).

² Lloyd, *Journ. N. Y. Ent. Soc.*, XXII, pp. 145-152 (1914).

³ Hora, *Journ. Bombay Nat. Hist. Soc.*, XXXII, pp. 124-126 (1927).

⁴ Pruthi, *Rec. Ind. Mus.*, XXX, pp. 353-356 (1928).

⁵ Hora, *Trans. Roy. Soc. London*, (B) CCXVIII, pp. 201, 202 (1930).

⁶ Hora, *Current Science*, I, p. 341 (1933).

matter, only a few larvae in suitable situations were found. In places the bed of the stream consisted of a single, flat rock over which the water flowed with considerable speed. Such places were also found to be the favourite resorts of the *Aulacodes* larvae. These observations on the habitat of the larvae have been confirmed by visits to the Tista Valley. It was found that the larvae prefer rapids, but are not usually found in very fast currents, such as on the lips of falls or rocks at the bases of waterfalls.

Smooth rocks are usually devoid of silken shelters, but only rough rocks, especially those with small fissures and crevices, are preferred by the Lepidopterous larvae. The young larvae take shelter in these unevennesses of the rocks and cover themselves with silken sheets which they go on extending according to their requirements. As a rule, the silken shelters are more extensive on bare rocks than on algae-covered rocks. The significance of this is explained later (p. 343).

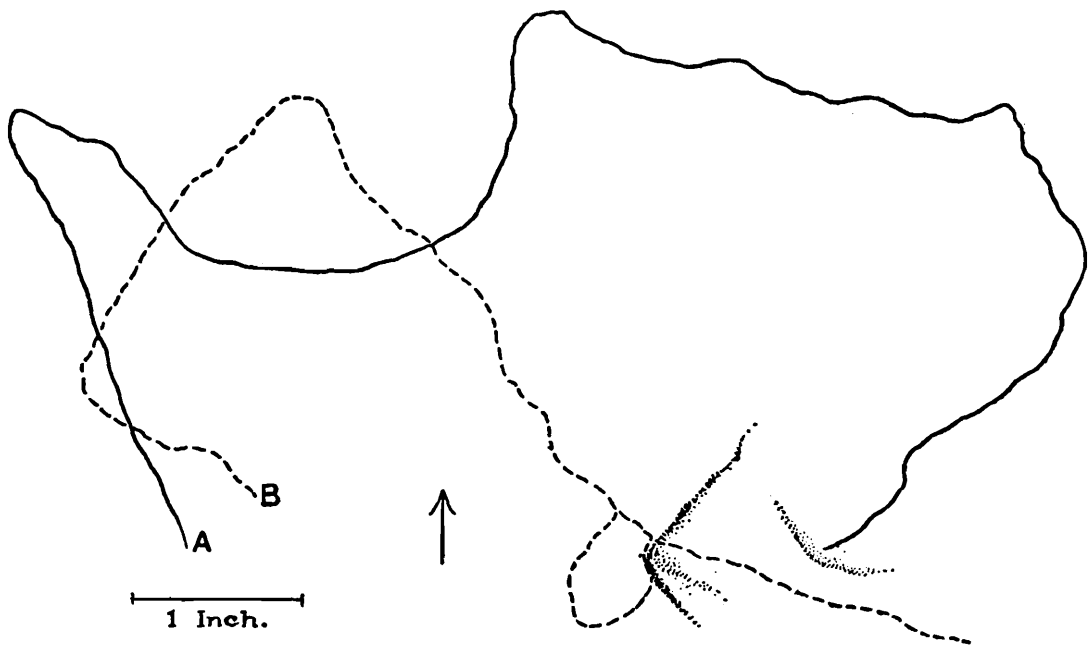
Apparently, therefore, there are two factors which determine the presence or absence of Lepidopterous larvae in a suitable stream, (i) the rapidity of the current and (ii) the nature of the surface of the rocks forming the beds. Thus the torrential Lepidopterous larvae and pupae show a marked habitat preference. In suitable places, I have found small pieces of stones with six or seven larvae (plate vi, fig. 2) and in the Lupchu-Jhora under the bridge on the Rangit-Darjeeling Road I found about 60 pupal cases on a rock with a surface of about 2 square feet exposed to the current. The rock was lying on the edge of the stream and only a portion of it was being washed by a moderate current. The biological factors, such as food, enemies, etc., have not been considered in the above account.

SILKEN SHELTERS.

The silken shelters are turgid and fully distended under water in swift currents, but they collapse partially when taken out. I have explained elsewhere (*op. cit.*, 1933) the physical principles that bring this about, but it is necessary to reiterate that the water flows with greater speed over the shelter than underneath the silken sheet. This differential rate of flow produces low pressure above the shelter and pulls it upwards.

Efforts were made to study the process of manufacture of the silken sheet by the larva, but it was difficult to observe the animal under natural conditions for a long period. A suitable piece of stone was selected, and all the larval shelters were removed from it. It was then placed in its old position in a rapid. After obstructing the current from flowing over this piece, a larva was placed on it and as soon as it had secured a firm hold on the stone, the current was allowed to run over it with full force. The animal at first crawled towards the leeward edge of the stone and then turned back from the edge. On finding a groove in the stone, it lay there quietly. A second larva was then placed on the same stone and it behaved in the same way, except that on finding a groove, it did not abandon its search for a more suitable place. It made periodic excursions, but finding no other place more suitable, it returned to the

same groove. It became dark and the observations could not be continued, but a few larvae were brought to the camp and left in water in petrie dishes. By morning all the larvae, whether young or old, had formed silken shelters (plate vi, figs. 1 & 3) of a somewhat flimsy nature between the bottoms of the dishes and their walls. In manufacturing the sheets the larvae must have touched the bottoms and the sides of the dishes alternately in a criss-cross fashion so that a meshed pattern was formed by the salivary threads. The older larvae spun a more



Tracts of two Lepidopterous larvae (A and B) marked on a piece of stone as it lay in a rapid, Kalijhora stream, Tista Valley.

close-meshed sheet than the younger ones. The silken sheets (plate vi, fig. 6) of the natural shelters manufactured in the course of the swift currents are fairly thick and consist of several of layers of threads closely placed together in the manner indicated above. These sheets become covered with algae, Diatoms, slime and fine particles of sand, etc., that drift in the current and become fairly compact structures for the larvae to live in safety. The grooves on pieces of stones, no doubt, provide starting places for the manufacture of silken sheets.

At the time of pupation, a larva strengthens a part of the larval shelter which then becomes somewhat brownish in colour. The entire complicated structure of the cocoon¹, including the pillars, strands, etc., is manufactured with the help of the salivary secretion and is not due to any mineral deposition on the web. The cocoon was kept in strong nitric acid for several minutes and no effervescence was noticed. The cocoon did not suffer in any way by this treatment. The outer brownish wall of the cocoon (plate vi, fig. 5) is very thick and tough, almost leathery, and appears to be composed of several layers of silken sheets.

The above observations do not bear out Pruthi's statement that the "power of secreting silk for making a fresh shelter is very much limited"

¹ For the details of the structure of the cocoon, see Pruthi, *Rec. Ind. Mus.*, XXX, p. 355 (1928).

in mature larvae. In captivity, without food, the mature larvae manufactured shelters again and again though, through mere exhaustion, the mesh became flimsier with every fresh effort. The capacity for the production of silk is probably greatest in the larvae just before pupation.

PROGRESSION.

The caterpillar usually lies quietly under its silken shelter and I have never observed it moving about. If, however, it is disturbed, it moves from one part of the shelter to another and is very reluctant to leave it. When forced out or when the silken sheet is removed, the larva moves towards the under side of the rock, especially if the day light is strong. Progression is effected in the usual way with the help of the thoracic legs and the abdominal prolegs. The larva moves fairly quickly in a series of forward waves. In the case of larvae kept in a petrie dish, it was observed that they poured out salivary secretion along the paths (plate vi, figs. 1 & 4) of their progression, so that the claws of the thoracic legs and hooks of the abdominal prolegs could take a firm hold of the substratum. When a larva was lifted from a dish, a salivary thread was pulled out with it. It seems probable that in nature the caterpillar behaves like a *Simulium* larva which uses its hooks and salivary secretion for progression¹; the latter helps in providing a secure substratum in which sharp points can be fixed. It also seems probable that, in nature, if a caterpillar is detached from its moorings, it hangs on to the rock by means of its salivary thread, by which it can probably crawl back to its shelter.

It is known that "tent-caterpillars" (*Malacosoma*, Family Easio-campidae) lay out extensive paths of silky secretion over which they travel during their foraging expeditions. The silky secretion of the larvae of torrential Lepidoptera provides a suitable substratum on which the animal can progress securely and rapidly. I believe the larvae come out from underneath the silken sheets at night and wander about on it for feeding purposes (*vide infra*).

In a dish of water, when not crawling at the bottom, the larvae were observed to move fairly fast by means of the jerking movements of the body. There are no special organs for swimming and in nature the larvae probably never swim at all.

FOOD AND MODE OF FEEDING.

Recently I² advanced the view that the silken shelters of torrential insect larvae serve to snare or entangle food particles. The extensive sheets of the Lepidopterous larvae, when examined under a microscope, show a large amount of extraneous matter entangled in them and some are even thickly covered with a growth of filamentous algae. It has further been observed that whether the algal growth on the silken sheets is visible or not, its presence is readily detected by keeping a silken sheet in spirit which dissolves the chlorophyll and turns green instantly. Mr.

¹ Hora, *Phil. Trans. Roy. Soc. London*, CCXVIII, p. 213 (1930).

² Hora, *Cur. Sci. I.*, p. 341 (1933).

K. P. Biswas, Curator of the Herbarium, Royal Botanical Garden, Sibpore (Calcutta), has very kindly studied the algae growing on the rocks harbouring Lepidopterous larvae and compared them with the algae growing on or entangled in the sheets and also with those found in the gut of the larvae. The material was, in all cases, collected from the Kalijhora stream below the bridges in the Tista Valley. Mr. Biswas has informed me that the species of algae, Desmids and Diatoms obtained from the three sources are the same. When mature larvae were put in spirit, some ejected from the mouth bundles of long filamentous algae, and this leaves no doubt that the larvae feed on the food they find in their neighbourhood. From an examination of the gut-contents of several individuals, Pruthi¹ found that "they mostly consist of, besides water, extremely minute particles of vegetable matter which are quite different in appearance and size from those usually found in the gut of a typical terrestrial caterpillar. It is highly probable, therefore, that the larvae depend for their nourishment on *minute bits of algae suspended in the surrounding water*" (Italics are mine). Pruthi and I are in agreement in regard to the nature of the food of these larvae, but we differ regarding the mode of collection of the same by the larvae.

Among the brook inhabitants, which I have studied for a number of years, I have found that those which have taken to feeding on microplanktonic organisms, have evolved complicated and ingenious devices to strain minute particles of food out of the rushing current. Among insects² reference may be made to the snares of the water-spiders (*Hydropsyche*, Trichoptera), to the fans of *Simulium* (Diptera) and to the bristle-fringed legs of *Chironetes* (Ephemeroptera) and *Brachycentrus* (Trichoptera). Reference may also be made to the feeding mechanism of the funnel-mouthed tadpoles of *Megalophrys*³. The mouth-parts of the torrential Lepidopterous larvae "are exactly like those of typical terrestrial caterpillar suitable for masticating tough leaves, etc." (Pruthi, p. 355). Thus there would seem to be no mechanism in the mouth-parts of these larvae to collect planktonic food, but there is no doubt that their larval shelters act as snares or gardens. The animals feed by making periodic excursions to the upper surfaces of the sheets; the under surface is usually devoid of vegetable growth. It is also possible that the larvae wander about at night on the parts of the rock in the vicinity of the shelters and pick up algae and other food material. In any case, the larva has to bite off its food from a solid substratum and not to pick up the floating particles.

In the parts of the streams where there is a rich growth of algae, etc., the silken shelters of the Lepidopterous larvae are small and covered with filamentous algae; whereas the shelters on the bare rocks are vast and extensive. This shows that with the presence of abundant food-material in the form of algae, etc., small sheets are enough to entangle sufficient quantities of food for the requirements of the larvae inhabiting them.

¹ Pruthi, *Rec. Ind. Mus.*, XXX, p. 354 (1928).

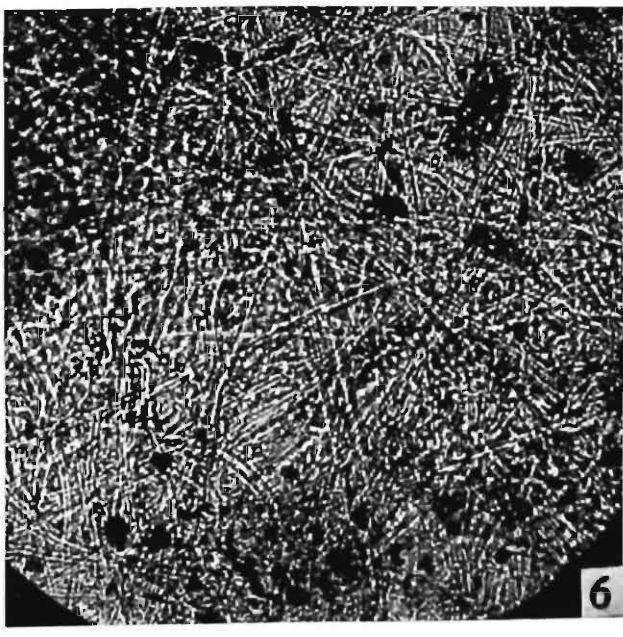
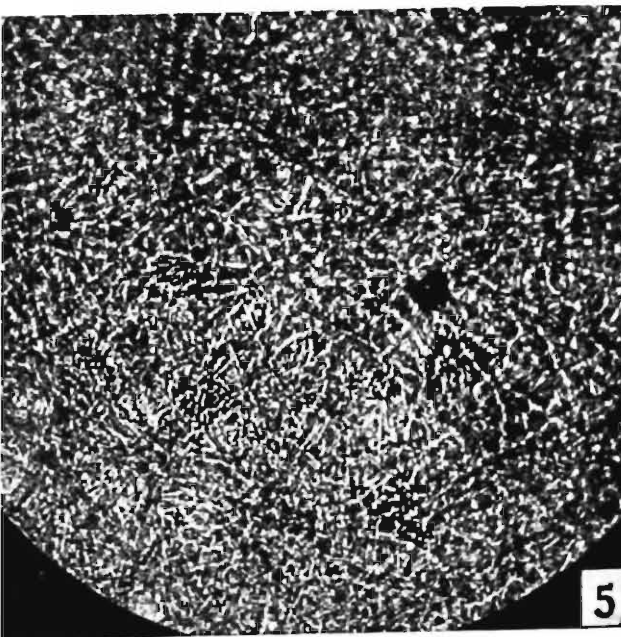
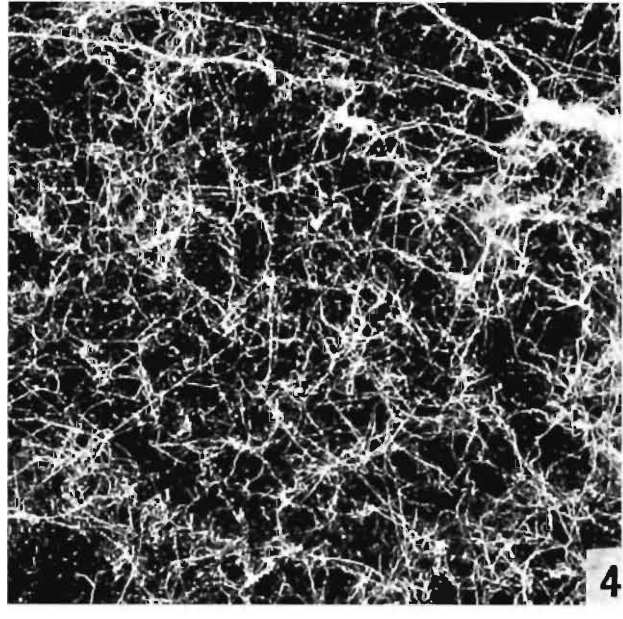
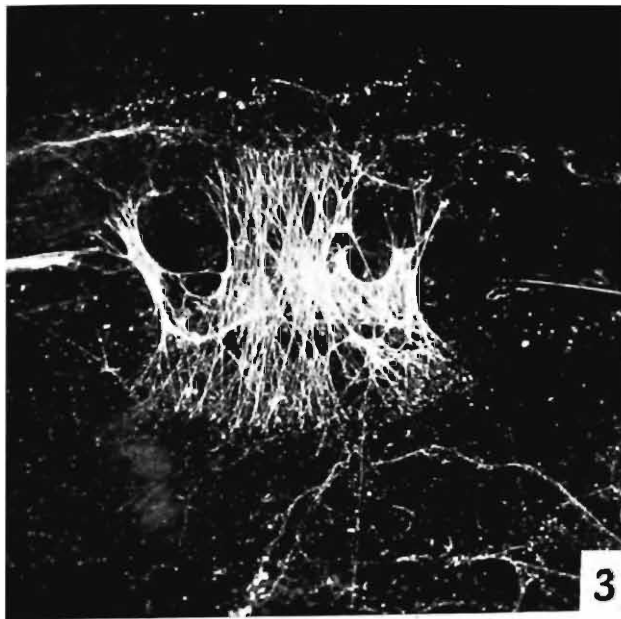
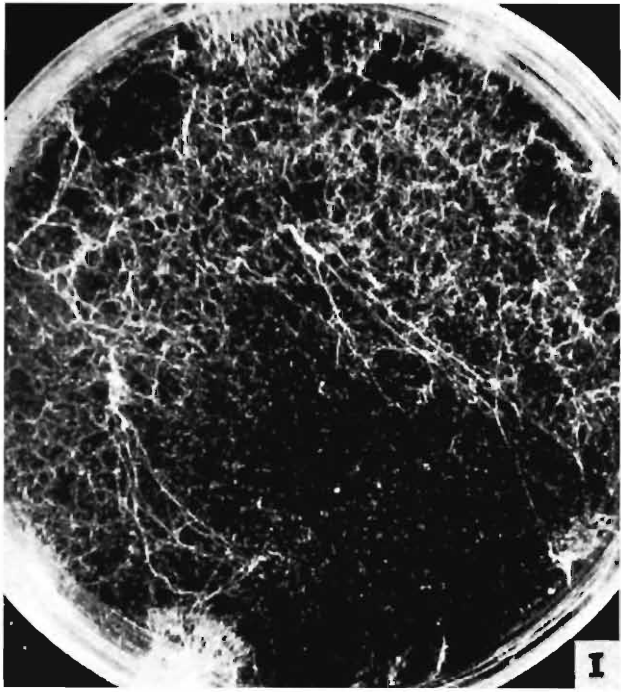
² Needham & Lloyd, *Life in Inland Waters*, p. 365 (1916).

³ Hora, *Rec. Ind. Mus.*, XXX, pp. 139-144 (1928).

EXPLANATION OF PLATE VI.

Silken Shelters of Torrential Lepidoptera.

- FIG. 1.—Photograph of the bottom of a petrie dish showing the paths of silky secretion laid out by torrential Lepidopterous larvae, and 5 silken shelters manufactured by them in the course of a night. *Nat. Size.*
- FIG. 2.—A portion of a stone picked up from a rapid in the Kalijhora stream, Tista Valley, showing a number of larval shelters of Torrential Lepidopterous larvae.
- FIG. 3.—A silken shelter manufactured by a Torrential Lepidopterous larva in a petrie dish. $\times 3$.
- FIG. 4.—Paths of silky secretion laid out by Torrential Lepidopterous larvae at the bottom of a petrie dish. $\times 3$.
- FIG. 5.—Microphotograph of a portion of the uppermost, brownish, thick sheet of the cocoon of a Torrential Lepidopterous pupa. $\times 300$.
- FIG. 6.—Microphotograph of a portion of the natural silken shelter of a Torrential Lepidopterous larva, showing the structure of the thick sheet and of the extraneous matter entangled in it. $\times 300$.



Silken Shelters of Torrential Lepidoptera.

ON A NEW INDIAN LEECH, *HEMICLEPSIS VIRIDIS*, SP. NOV.

By JOHN E. CHELLADURAI, M.A., *Department of Zoology, The Science College, Trivandrum.*

Material.—Two specimens of the new species were first obtained on December 8, 1927; both were young and were seen in a basin of water containing *Hydrilla* collected from a freshwater tank at Trivandrum, Travancore. Since then water with *Hydrilla* was regularly examined and on January 30, 1928, a full grown specimen with young ones clinging to its ventral side was obtained. Though a periodical search was thereafter maintained no further specimens were obtained till August 15, 1929, when a medium-sized specimen was collected. The stomachs of all the four specimens were empty and colourless and therefore indistinct. Later in November, 1929, specimens were seen on the common tank frogs, *Rana hexadactyla* and *R. tigrina*. Since then several specimens of different sizes were obtained from time to time from these frogs. All of these had their stomachs fully gorged with blood.

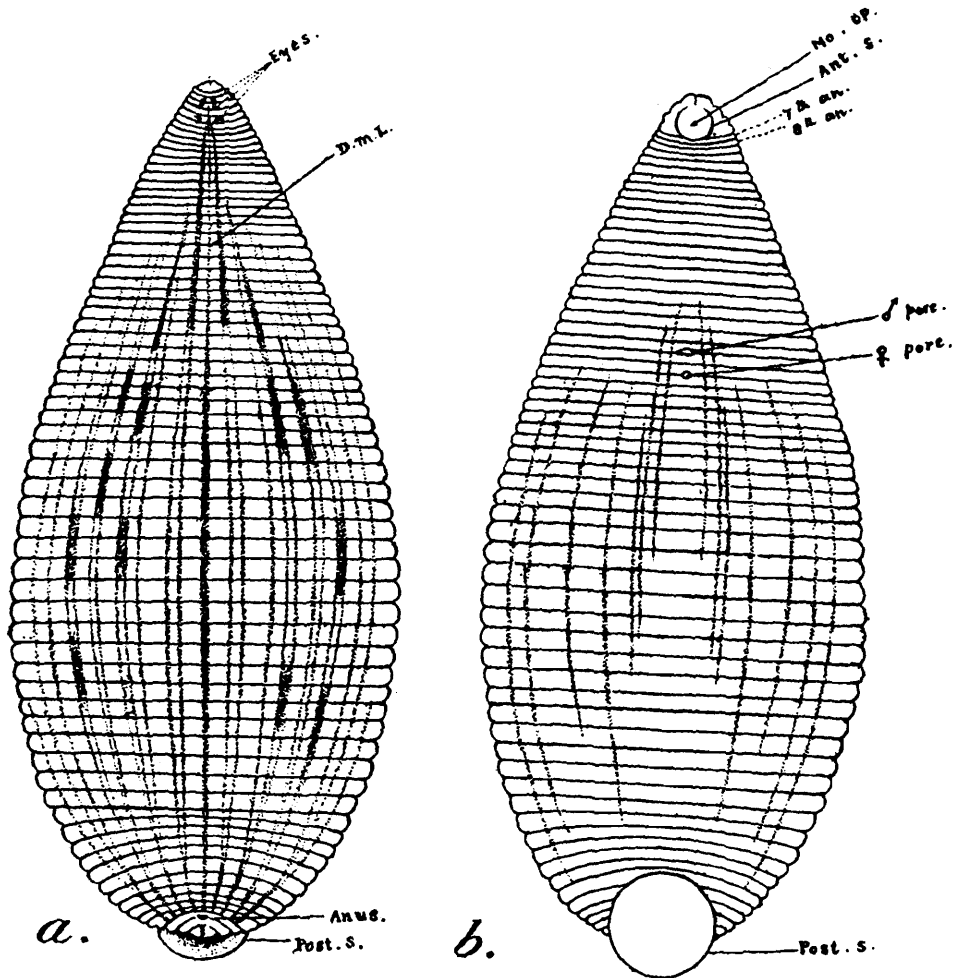
Chief features.—(1) Eyes three pairs. (2) Stomach with more than seven pairs of caeca. (3) Mouth opening in the middle of the oral sucker. (4) Fifteen to twenty-five pea-green sub-parallel longitudinal lines on the dorsal surface.

Dimensions.—(1) Of a full grown preserved specimen:—Length, 8 mm., greatest breadth, 3.7 mm., width of posterior sucker, 1.2 mm.

(2) Of a living specimen resting in a dish of water:—Length, 24 mm., greatest breadth, 3 mm.

Description.—When at rest the body is ovate-lanceolate. The head is faintly dilated. The dorsal surface bears minute uniform papillae in a transverse line across the middle of each annulus. The colouration is characteristic of the species. The dorsal surface of a full grown specimen bears fifteen to twenty-five bright pea-green longitudinal sub-parallel lines, which have the following arrangement: mid-dorsally there is a bright dark green line, this begins between the second and third pairs of eyes and runs to the peduncle of the posterior sucker. On either side there are seven to twelve lines which are most distinct about the middle region of the body. Of these, the two paramedian lines converge and unite posteriorly. Anteriorly they unite with each other and merge into the dorso-median line behind the last pair of eyes. The other lines tend to converge and unite in groups posteriorly but in front they remain distinct. All are composed of numerous close-set pigment spots. When these are well developed the lines are distinct and continuous; otherwise they appear as dotted lines. In very young specimens all the lines appear as serial rows of dots. The ventral surface also bears a few lighter lines. There is no ventro-median line. In a full grown specimen seven to nine lines of unequal length are seen on either side. They are mostly confined to the post-gonoporal region. In some specimens the ventral surface is diffusely pigmented throughout.

Eyes.—There are three pairs of eyes arranged in two sub-parallel rows in annuli three, four, and six. The eyes of the first pair are the smallest and their pigment cups are directed forward with a slight oblique tilt. The eyes of the second pair are large and are but a shade smaller than those of the third. Their pigment cups are directed obliquely forward. The eyes of the third pair are the largest and are directed obliquely backward. The ratios between the diameters of the first, the second and the third pair of eyes are as 3.5 : 6 : 7.



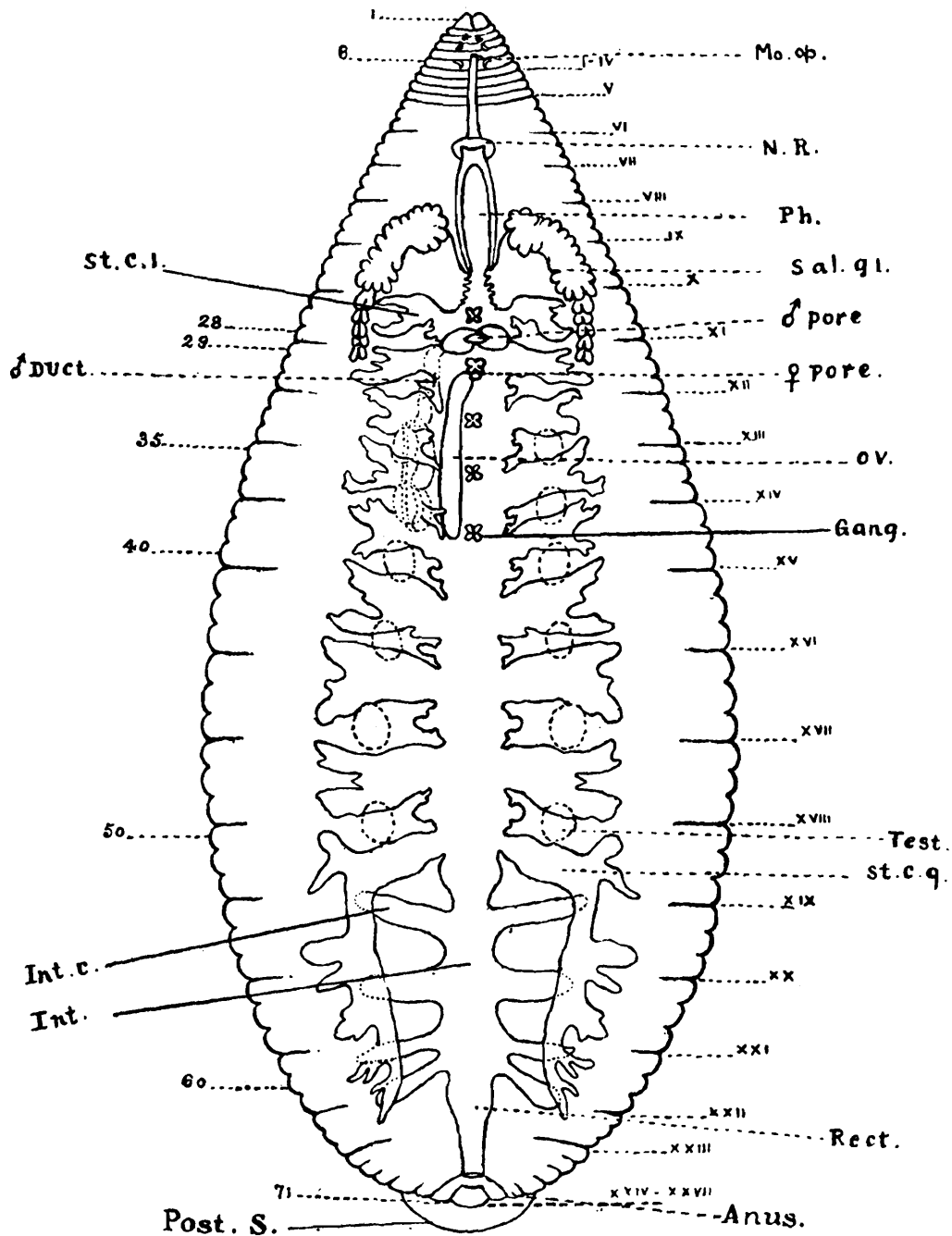
TEXT-FIG. 1.—*Hemiclepsis viridis*, sp. nov. $\times 11\frac{1}{2}$.

a. Colour pattern of dorsal side; b. Colour pattern of ventral side.

Ant. S. = anterior sucker; *D. M. L.* = dorso-median line; *Mo. op.* = mouth opening; *Post. S.* = posterior sucker; *7th an.* = seventh annulus; *8th an.* = 8th annulus.

Annulation.—The annuli are 71 in number. Two annuli, the first and the second, are pre-ocular. Somites I to IV are formed by the first seven annuli. Somites V to XXIII are complete and each is triannulate. Somites XXIV to XXVII are formed by the last seven annuli. Between annuli 69 and 70 is placed the anus, and there are two post-anal annuli. On the ventral side the seventh annulus forms the posterior margin of the oral sucker. The male pore is conspicuous and is placed between annuli 28 and 29, *i.e.*, between somites XI and XII. The female pore is minute and is placed two annuli behind the male in the interannular furrow between the second and the third annuli of somite XII.

Suckers.—The anterior sucker bears the minute mouth aperture in its centre. In a freshly killed specimen, the position of the mouth is clearly visible. The posterior sucker is, as usual, circular in outline.



TEXT-FIG. 2.—Annulation and internal structure of *Hemiclepsis viridis*, sp. nov. $\times 17$.

1 to 71=annuli; I to XXVII=somites; *Gang.*=ganglion; *int.*=intestine; *Int. C.*=intestinal caecum; *Mo. op.*=mouth opening; *N. R.*=nerve ring; *Ov.*=ovary; *Ph.*=pharynx; *Post. S.*=posterior sucker; *Rect.*=rectum; *St. C. 1*=first stomach caecum; *St. C. 9*=ninth stomach caecum; *Sal. gl.*=salivary gland; *Test.*=Testes.

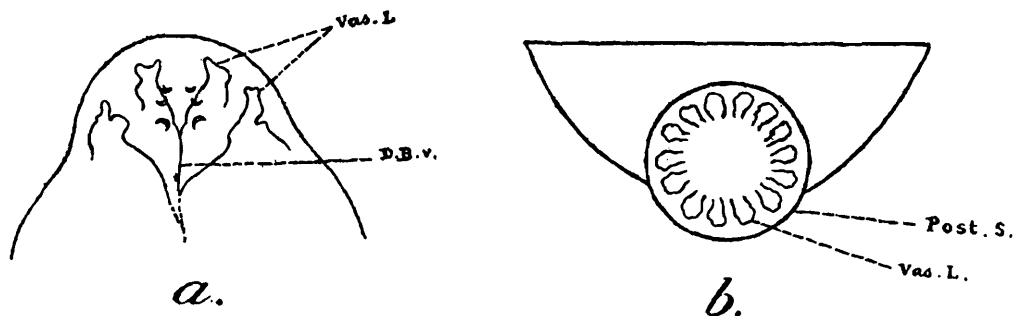
Alimentary System.—The mouth is placed in the centre of the oral sucker. Since the position of the mouth is an important feature, its location in the middle of the oral sucker was carefully noted. Living specimens were observed under a microscope and as the anterior end was waved about on the slide before fixation, the mouth was distinctly visible in the middle of the oral sucker. In freshly fixed specimens also

the mouth appeared as a triradiate pore in the middle of the oral sucker. Finally from longitudinal serial sections of the anterior half of the body the position of the mouth within the anterior sucker was confirmed.

When the anterior sucker contracts, its margin becomes slightly wrinkled and presents an undulating line. Due to the wrinkling there is a constant and comparatively more distinct furrow in the antero-medial edge of the sucker.

The pharynx is slender. The salivary glands are well developed and form on either side a compact mass. They extend from the middle of the retracted pharynx to the posterior limits of the second pair of the caeca of the stomach. A distinct salivary duct opens behind the caudal termination of the pharynx. The stomach has nine pairs of lobed caeca. When the stomach is fully distended with blood, the inter-caecal regions also become expanded into the lateral lobed pockets. The first pair of caeca is small. The remaining caeca show a gradual increase in size from front to back. The last pair is the largest and extends far back towards the posterior sucker. The intestine has the usual complement of four pairs of caeca. They are directed laterally, the first pair with a slightly forward and the last pair with a slightly backward inclination. The rectum opens through the anus which is placed two annuli in front of the posterior sucker.

Vascular System.—The following few points were noted regarding the vascular system. The dorsal blood vessel at its anterior end bifurcates just behind the level of the third pair of eyes. Each of its two branches runs forward below the second pair of eyes. Near the margin of the sucker it bends back, the backward arm of the loop being



TEXT-FIG. 3.—*Hemiclepsis viridis*, sp. nov.

a. Vascular loops of anterior sucker $\times 34$; b. Vascular loops of posterior sucker $\times 16\frac{2}{3}$.

D. B. V.=dorsal blood vessel; Post. S.=posterior sucker; Vas. L.=vascular loops.

external to the forward one. A second pair of vascular loops from the dorsal blood vessel, which starts a little behind the first pair, also enters the anterior sucker, the two arms of each loop being disposed as before. The posterior sucker is provided with the full complement of seven vascular loops.

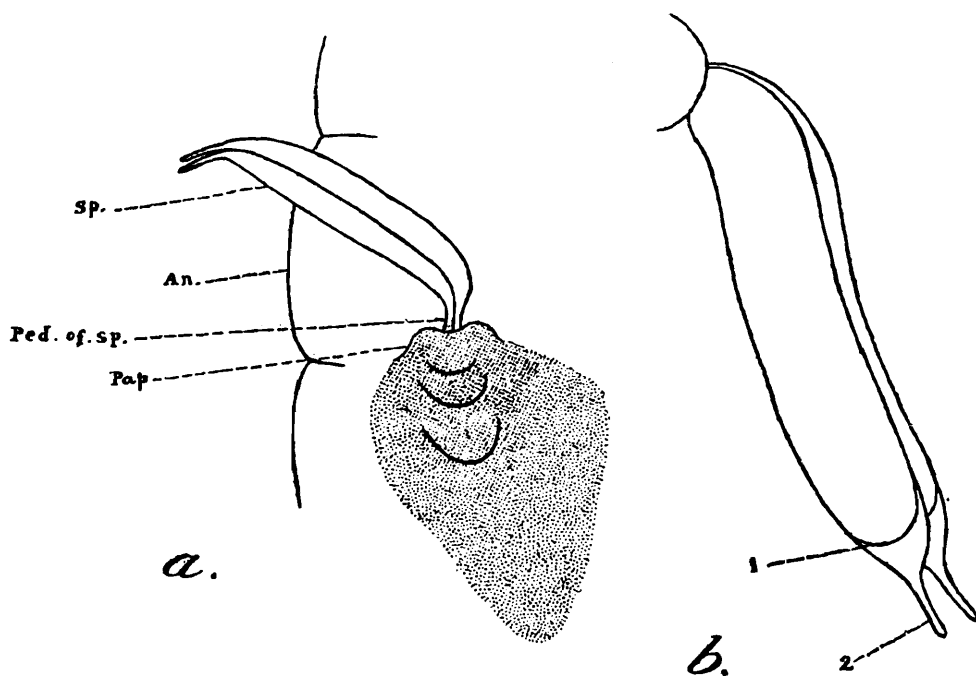
Nervous System.—The nerve ring is placed in somite VII.

Reproductive System.—The testes are six pairs. The two ovarian tubes are distinct. Their length depends upon the state of development

of the ova. When the ova are immature the ovarian tubes extend back only a short distance behind the female pore. When, however, the ova are ripe and ready for laying, they are very long and extend far backwards, their hind ends reaching the level of the origin of the last pair of caeca of the stomach.

The number of eggs laid at a time is variable and probably depends upon the condition of nutrition of the specimen before egg laying. In two specimens the count was 82 (specimen obtained on September 4, 1932) and 52 (specimen obtained on September 12, 1932).

A periodical search for specimens with spermatophores proved eventually successful. Three specimens with spermatophores were obtained, two on September 12, 1932, and one on September 13, 1932. One of these bore a single spermatophore on its left lateral border; and each of the others bore three spermatophores. Of the latter, one had all the spermatophores attached to the ventral side and the other had two on the ventral and one on the dorsal side. The spermatophores appear to be scattered without any apparent order and more than one spermatophore may be deposited on a single leech. The freshly attached



TEXT-FIG. 4.—*Hemiclepsis viridis*, sp. nov.

a. Spermatophore $\times 60$; b. Empty spermatophore. Diagrammatic.

An. = annulus; *Pap.* = papilla on body wall to which spermatophore is attached; *Ped. of sp.* = pedicle of spermatophore; *Sp.* = spermatophore; 1 = convex surface of sperm mass; 2 = finger-like termination of spermatophore.

spermatophore has the outline of a minute double cucumber. Its proximal end, which forms a common pedicle, is attached to a papilliform projection of the skin. The distal end of each half terminates in a slender finger with a very narrow lumen. The tips of the two finger-like ends are covered over by a quantity of mucus. Since the spermatophore is fixed only by the pedicle, it freely waves about whenever the leech moves. The wall of the spermatophore is thin and transparent.

Dimensions of the spermatophore in a fixed specimen :—

Length excluding the distal finger	440 μ
Width	100 μ
Length of distal finger	77 μ
Width of finger near its base	11 μ

One of the spermatophores appeared to be newly fixed. It was nearly full and whitish in colour. Near its distal end at the base of each of the finger-like processes there was a clear, crescentic space which indicated that the spermatophore had just begun to empty its contents.

This spermatophore was kept under observation and the process of the discharge of the sperm mass was continuously watched. The sperm mass at the distal end of the spermatophore presented a distinct convex surface which gradually moved towards the pedicle, as the sperm mass passed into the body wall of the leech. In twenty-five minutes the spermatophore was completely empty and allowing a few minutes for what was expelled before the observation began, one is led to conclude that it takes about half an hour for a spermatophore to empty itself.

The sperm mass that passed into the body wall of the leech could be seen for a time as a spreading white drop.

Observations on habits, etc.—The leech often rests on the stem or on a leaf of *Hydrilla*. In the latter case it places itself lengthwise on the leaf fitting itself snugly in the upper angle of the slightly folded leaf. In either position, its dark green colour blends with that of the plant and the leech cannot be easily distinguished.

If disturbed while resting on *Hydrilla* or on the side of a dish, the leech détaches itself, curls up into a ball with the ventral side inside and drops down. This is a habit common to most Glossiphonids.

While resting on the side of a dish or when attached to a frog, the little leech often keeps up a gentle oscillation of its body which helps to renew the water surrounding it. This movement is probably useful in respiration.

For sucking blood, the leech attaches itself to any part of the frog's skin. I have picked off specimens from near the eye, the middle of the back, the sides of the legs and the web between the toes. A few were found on the lower side also, where alone they were conspicuous against the whitish background of the frog's skin. Fixing itself by both its suckers, the leech continues to suck blood till its stomach is filled to its utmost capacity. Then the stomach region shows itself through the body wall as a very distinct dark red region. The caeca of the stomach are so much expanded that they press against each other, and their limits are not clear. The dilated caeca also extend very close to the lateral margin of the body wall. Even the intercaecal lobes of the stomach become distended into lateral lobed pockets. When such a specimen is mounted alive on a slide, the gentle pressure of the cover slip is sufficient to force a little of the blood into the pharynx. A specimen with an empty stomach was observed from time to time while feeding and it was seen that the last pair of caeca of the stomach became filled first and then the others in order from back to front. But when a specimen with a full stomach was kept in a basin of water and examined

from day to day, it was found that the first pair of caeca which were the last to fill were the first to become empty and the other caeca became empty in order from front to back.

The leech moves off from the frog when the ova are ripening and attaches itself to the leaf or the stem of some water plant. Here it slowly digests its full meal of blood and the caeca of the stomach become gradually empty. Then the maturing ovary can be seen through the body wall, the outline of each developing ovum being distinctly visible. By the time the ova are ripe for laying, the stomach has become completely empty. It is while resting on the water plant that the eggs are laid and these adhere to the ventral side of the leech. During this period, though the stomach is quite empty, the leech does not feed. Specimens carrying eggs, when gently dropped on a frog resting in a basin of water, promptly moved off and fixed themselves to the sides of the basin. As long as the ova cling to the parent's body, the ventral surface of the leech forms a shallow concave surface in which the ova are accommodated. Should the leech now gorge itself with blood, the ventral surface would flatten out and the ova would be in danger of being rubbed off whenever the leech moved about. It is possible that the starvation habit during this period is to safeguard the eggs.

After hatching, the young ones cling by both their suckers to the body of the parent. A freshly hatched young is colourless with the exception of the pigment cups of the eyes. Its stomach with its caeca is distinct but it is completely filled with yolk granules. It cannot feed for a time till all the yolk is absorbed. Specimens with young ones, when dropped on a frog, fix themselves to it, but after a partial meal of blood move off from the frog. That the meal was partial was decided by the condition of the stomach which was bright red in colour with distinct caeca, the full stomach being dark red in colour with indistinct caecal limits.

Occurrence.—Trivandrum and Ootacamund. The specimens that I collected were all obtained from Trivandrum, either from the local fresh-water tanks from among *Hydrilla*, or from the local frogs. Prof. Percy Moore, when he was in India three years ago on his collecting tour, was shown one of my slide specimens and my sketches. He then told me that he had collected similar leeches from Ootacamund which he picked off from the under side of the leaves of the water lily. He also presented me two of his specimens for comparison with mine.

Position of the present Species.—The genera *Hemiclepsis* and *Paraclepsis* agree in having more than seven pairs of stomach caeca, but differ in the following respects :—

Hemiclepsis.

Paraclepsis.

- | | |
|---|---|
| (1) Eyes typically two pairs. | Eyes typically three pairs. |
| (2) Mouth opening within the oral sucker. | Mouth opening subterminal, leaving the oral sucker imperforate. |

The present species agrees with *Hemiclepsis* in having the mouth opening within the oral sucker, and with *Paraclepsis* in having three pairs of eyes ; but as the position of the mouth within the oral sucker is a more important feature than the number of eyes, I have placed my new

species for which I propose the name *viridis* in the genus *Hemiclepsis*. *H. viridis*, however, tends to lessen the differences between the genera *Hemiclepsis* and *Paraclepsis*.

I am indebted to Prof. J. Percy Moore who read through the manuscript and made various corrections.

The type of *H. viridis* is deposited in the Indian Museum, Calcutta.

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NOTES ON FISHES IN THE INDIAN MUSEUM.

XXIII. ON A COLLECTION OF FISH FROM THE S. SHAN STATES, BURMA.

By SUNDER LAL HORA, *D.Sc., F.R.S.E., F.A.S.B.*, and DEV DEV MUKERJI, *M.Sc., Zoological Survey of India, Calcutta.*

During the field-season of 1933-34, Mr. V. P. Sondhi of the Geological Survey of India made a traverse through the country between the Lawksaw and Kēngtūng States of the Southern Shan States in Burma. In the course of the journey, Mr. Sondhi worked in the drainage basins of three principal rivers, namely, the Irrawaddy, the Salween and the Mekong. The exigencies of his service did not permit him to devote much time to the collection and preservation of fish, but, all the same, he availed himself of this opportunity to collect some material in all the three basins. The collection is of considerable interest as in addition to the three new species from the Lawksaw canal and the Salween River at Takaw it contains specimens of several species not hitherto represented in the collections of the Indian Museum.

The country traversed by Mr. Sondhi is hilly in the main and consists of high hills and valleys. The collection was made from pools or slow-running streams and, therefore, lacks in typical torrential forms, with the exception of two species of *Garra*. We give below a list of localities with the names of the species of fish collected therefrom and a short description of each locality as supplied to us by Mr. Sondhi.

IRRAWADDY DRAINAGE SYSTEM.

1. Paddy fields at Gaunphpo, Lawksaw State. November, 1933.

"The paddy fields at Gaunphpo are irrigated by water diverted from small rapid streams issuing from the hills to the west of the Gaunphpo plain. The fish were caught from fields irrigated by the Chaung Gyi stream."

- i. *Lepidocephalichthys berdmorei* (Blyth) 1 specimen.

2. Chaung Gyi stream, north-west of Gaunphpo, Lawksaw State. November, 1933.

"A moderately torrential stream with a bed of large, rounded boulders. The water is clear and devoid of vegetation. The fish were caught from a small pool with a sandy bottom after stunning them by shooting into the water."

- i. *Barbus sarana caudimarginatus* Blyth 2 specimens.
ii. *Danio (Danio) aequipinnatus* (McClelland) 13 specimens.
iii. *Nemachilus rivulicola* Hora 1 specimen.
iv. *Lepidocephalichthys berdmorei* (Blyth) 1 specimen.

3. Lawksaw Canal at Lawksaw, Lawksaw State. April, 1934.

"Just south of the town of Lawksaw is a large perennial spring that gives rise to a small lake, about half a furlong across. The lake is almost chokeful of vegetation which can be clearly seen through the crystal clear water, the actual bottom of the lake is rarely seen. The discharge or overflow from the lake is diverted into a canal which runs along the eastern end of the town. As the canal is aligned and dug by local people

it is not uniformly graded throughout and has therefore pools and rapids at different points in its course. The sluggish portions are usually full of vegetation and in rapids a pebbly or coarsely sandy bottom is seen. As the spring issues from limestones, the water is highly charged with lime."

- | | |
|--|--------------|
| i. <i>Barbus tor</i> (Ham. Buch.) | 2 specimens. |
| ii. <i>Barbus savana caudimarginatus</i> Blyth | 2 specimens. |
| iii. <i>Barbus shanensis</i> , sp. nov. | 2 specimens. |
| iv. <i>Garra gravelysi</i> (Annandale) | 2 specimens. |

SALWEEN DRAINAGE SYSTEM.

4. A tributary of the Salween on the east bank at Takaw, Kēngtūng State. January, 1934.

"A torrential stream with rocky bed. The water is clear and devoid of vegetation. Only one specimen of fish was obtained by shooting into the water near the edge."

- | | |
|--|-------------|
| i. <i>Ophicephalus gachua</i> Ham. Buch. | 1 specimen. |
|--|-------------|

5. The Salween River at Takaw, Kēngtūng State. 21st January, 1934.

"The Salween river at Takaw has a strong current and a deep channel. It is difficult to catch fish in the dry months, but during the monsoon, when the water rises to cover the sloping banks, fish are extensively caught in shallow embayments formed in places. The fish were netted from a pool in the course of the river."

- | | |
|---|--------------|
| i. <i>Osteochilus sondhii</i> , sp. nov. [<i>Pa-sat</i>] ¹ | 2 specimens. |
| ii. <i>Garra salweenica</i> , sp. nov. [<i>Pa-ing</i>] | 2 specimens. |

6. Stream at Hsenmawng, Kēngtūng State. 28th January, 1934.

"The stream at Hsenmawng is very torrential, and the bed consists of huge boulders of granite and coarse sand. The water is clear and devoid of vegetation. The fish were obtained by shooting into stationary water behind large boulders."

- | | |
|---|-------------|
| i. <i>Lepidocephalichthys berdmorei</i> (Blyth) | 1 specimen. |
| ii. <i>Ophicephalus gachua</i> Ham. Buch. | 1 specimen. |

MEKONG DRAINAGE SYSTEM.

7. Kēngtūng, Kēngtūng State. Market specimens. 1st February, 1934.

- | | |
|---|--------------|
| i. <i>Cyprinus carpio intha</i> Annandale | 1 specimen. |
| ii. <i>Mystacoleucus marginatus</i> (C. V.) | 2 specimens. |

8. Nawng Kyawk tank at Kēngtūng, Kēngtūng State. 2nd February, 1934.

"Nawng Kyawk is a small artificial lake. Its water is slightly turbid so that the bottom is not seen below a few feet."

- | | |
|---|--------------|
| i. <i>Clarias batrachus</i> (Linn.). [<i>Pa-lupp-pawn & Pa-lupp-tumm</i>] | 2 specimens. |
| ii. <i>Lepidocephalichthys berdmorei</i> (Blyth). [<i>Pa-soo</i>] | 2 specimens. |
| iii. <i>Monopterus albus</i> (Ziew). [<i>Pa-yin</i>] | 2 specimens. |
| iv. <i>Ophicephalus striatus</i> Bloch. [<i>Pa-ko</i>]. | 1 specimen. |
| v. <i>Trichopodus trichopterus</i> (Pallas). [<i>Pa-shep</i>] | 2 specimens. |
| vi. <i>Betta splendens</i> Regan. [<i>Pa-kut</i>] | 2 specimens. |

¹ Names in square brackets are the local names of the species.

9. Nam MeHsai stream, Kēngtūng State. 14th and 16th February, 1934.

“Nam MeHsai is the boundary stream between the British territory and Siam. At the point at which the fish were caught the stream enters the plain and loses its torrential character. The channel is wide and shallow and in the dry months the water is confined to a narrow course in the wide bed of the stream. The water is turbid and carries lot of drift wood. The bed is covered with coarse sand and shingle.”

i. <i>Mystus</i> ² <i>bleekeri</i> (Day)	1 specimen.
ii. <i>Barbus puntio</i> (Ham. Buch.) Day	1 specimen.
iii. <i>Crossochilus latius</i> (Ham. Buch.)	1 specimen.
iv. <i>Mystacoleucus marginatus</i> (C. V.)	2 specimens.
v. <i>Rasbora taytayensis</i> Herre	2 specimens.
vi. <i>Lepidocephalichthys bermorei</i> (Blyth)	1 specimen.
vii. <i>Acanthopsis choirorhynchus</i> (Blkr.)	1 specimen.
viii. <i>Ophicephalus gachua</i> Ham. Buch.	1 specimen.
ix. <i>Trichopodus trichopterus</i> (Pallas)	6 specimens.
x. <i>Betta splendens</i> Regan	2 specimens.
xi. <i>Anabas testudineus</i> (Bloch).	2 specimens.

10. Nam Hōk stream east of Hawnglūk. 15th February, 1934.

“Nam Hōk is a large stream with a sluggish current and steep banks. The bed consists of mud and sand and is devoid of any vegetation. The water is turbid.”

i. <i>Clarias batrachus</i> (Linn.)	1 specimen.
ii. <i>Barbus sophore</i> (Ham. Buch.)	2 specimens.
iii. <i>Ophicephalus striatus</i> Bloch.	1 specimen.
iv. <i>Trichopodus trichopterus</i> (Pallas)	2 specimens.
v. <i>Anabas testudineus</i> (Bloch)	1 specimen.

11. Nam Long stream a mile west of Mong Hpayak, Kēngtūng State.

“The stream is large and torrential with crystal clear water and a bed covered with large boulders and sand. There is no vegetation in the stream bed. The fish were caught by shooting into the water of a clear shallow pool which was about a foot deep. The fish were present in a thick shoal over a hot sulphur spring. The sandy bed of the pool was unbearably hot and there was a strong smell of sulphuretted hydrogen. The fish were living in warm water about eight inches above the hot sand.”

i. <i>Barbus</i> spp. Juvenile	5 specimens.
4 specimens with a smooth dorsal spine and 1 with a serrated spine.	

² In 1919, Jordan (*Genera of Fishes*, p. 269) pointed out that the generic name *Macrones* (Dumeril 1856, orthotype *Bagrus lamarii* Cuv. & Val.) was preoccupied in Coleoptera (Newman 1841) and proposed *Aoria* to replace it. In spite of this, *Macrones* is still being used by a number of ichthyologists, both Indian and foreign, and *Aoria* has been only partially adopted. Fowler (*Journ. Bombay Nat. Hist. Soc.*, XXXII, p. 105, 1928), however, pointed out that *Aoria* Jordan was not a suitable name, as three Bleekorian generic names—*Hemibagrus*, *Hypselobagrus* and *Aspidobagrus* (*Atlas Ichthyol.*, II, pp. 54, 57, 59, 1862)—were available to replace *Macrones*. At the same time, it was indicated that *Mystus* Gronow, a much earlier name, was originally used for Bagrid fishes of the type of *Macrones* and had thus precedence over all other names. After careful consideration, we agree with Fowler and have adopted the name *Mystus* for species of the genus *Macrones*.

Mystus Gronow (*Zoophylaceum*, p. 124, 1763, type *Silurus pelusius* Solander) was introduced by Scopoli (*Introd. Hist. Nat.*, p. 451, 1777) but the name was originally used by Russell in the 1st edition of his *History of Aleppo* in a popular sense for a Bagrid fish, but in the 2nd edition of the work Solander designated it *Silurus pelusius* (Günther, *Cat. Fish. Brit. Mus.*, V., p. 431, 1864). One of the typical specimens from Russell's collection is described by Günther in his *Catalogue* (p. 75) and the description leaves no doubt that *Macrones* is synonymous with *Mystus*.

It may be pointed out that *Aoria* is also preoccupied among Coleoptera (Baly, *Journ. Ent.*, II, p. 49, 1863) and is, therefore, not available for fishes.

Of the 79 specimens listed above, it has not been possible to determine specifically 5 very young specimens of *Barbus* obtained from the Nam Long stream. The remaining 72 specimens are referable to 24 species, the majority of which belong to the order Cyprinoidea as is clear from the list given below :—

CLARIIDAE.

Clarias batrachus (Linn.)

BAGRIDAE.

Mystus bleekeri (Day).

COBITIDAE.

Acanthopsis choirorhynchus (Bleek.).

Lepidocephalichthys berdmorei Blyth.

Nemachilus rivulicola Hora.

CYPRINIDAE.

Rasbora taytayensis Herre.

Danio (*Danio*) *aequipinnatus* (McClell.).

Cyprinus carpio intha Annandale.

Mystacoleucus marginatus (Cuv. & Val.).

Osteochilus sondhii, sp. nov.

Barbus shanensis, sp. nov.

Barbus sarana caudimarginatus Blyth.

Barbus tor (Ham. Buch.).

Barbus puntio (Ham. Buch.) Day.

Barbus sophore (Ham. Buch.).

Crossochilus latius (Ham. Buch.).

Garra salweenica, sp. nov.

Garra gravelyi (Annandale).

SYMBRANCHIDAE.

Monopterus albus (Ziew).

OPHICEPHALIDAE.

Ophicephalus striatus Bloch.

Ophicephalus gachua Ham. Buch.

ANABANTIDAE.

Anabas testudineus (Bloch).

Betta splendens Regan.

Trichopodus trichopterus (Pallas).

With the exception of the three new forms—*Osteochilus sondhii*, *Barbus shanensis* and *Gara salweenica*—and three other species, viz., *Rasbora taytayensis*, *Garra gravelyi* and *Barbus puntio*, the remaining species are quite well known and do not call for any comments. We have, however, added a short note on the colouration of *Danio aequipinnatus* to amend our recent key to the species of the subgenus *Danio*.

Very little is known about the ichthyology of Burma as a whole, and the fish of the upper reaches of the Salween River have received practically no attention so far. It is not surprising, therefore, that both the species collected by Mr. Sondhi at Takaw in the Salween River have proved to be new. The occurrence of *Rasbora taytayensis* in the Nam MeHsai stream, a tributary of the Mekong River, is remarkable as the species was so far known from the Philippines. Mr. Sondhi's small collection has added materially to our knowledge of the fishes of Burma and we are grateful to him for affording us an opportunity to investigate such an interesting material. We have to thank Dr. B. Prashad for his kindness in going through the manuscript and Mr. R. Bagchi for the drawings which he has executed with his usual skill and care under our supervision.

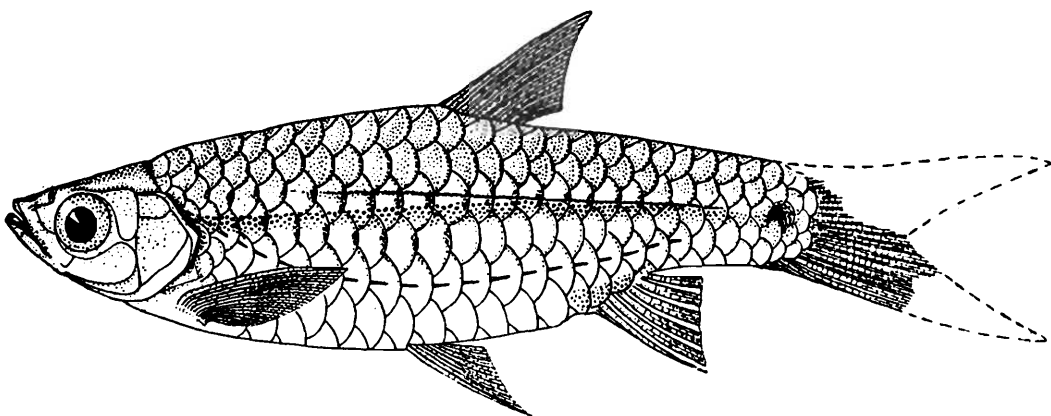
***Rasbora taytayensis* Herre**

1924. *Rasbora taytayensis*, Herre, *Philippine Journ. Sci. Manila*, XXIV, pp. 264, 265.

In Mr. Sondhi's collection there are two specimens of *Rasbora* from the Nam MeHsai stream which agree in all essential respects with *R. taytayensis* Herre from the Philippines. The only differences that we can notice are (i) the presence of two lateral bands in *R. taytayensis* and only one in the Nam MeHsai specimens, and (ii) 15-17 perforated scales in *R. taytayensis* and 18-20 in the specimens under report. These differences are not of much diagnostic value and will probably be bridged over when large series of specimens are examined from Burma and Siam. Unfortunately Herre did not publish a figure of his species, and as it is here recorded from a place widely separated from the type-locality, we describe our specimens in detail and figure one of them.

D. 3/7 ; A. 2/5 ; P. 14 ; V 8-9 ; C. 18.

In the Nam MeHsai species of *Rasbora* the dorsal profile is slightly arched while the ventral profile is deeply concave. The head is small and pointed ; its length is contained from 4.7 to 5 times in the total length



TEXT-FIG. 1.—Lateral view of the larger specimen of *Rasbora taytayensis* Herre. $\times 1\frac{1}{2}$.

and 3.8 times in the length without the caudal. The height of the head at the occiput is contained 1.4 times and the width from 1.9 to 2.2 times

in its length. The eyes are lateral, large and prominent ; their diameter is contained 3 times in the length of the head, from 0.7 to 0.8 times in the length of the snout and 1.2 times in the interorbital width. The interorbital space is flat and wide. The mouth, lips and jaws are as in the genus. The cleft of the mouth ascends strongly, its anterior end is almost in level with the upper border of the eye while the posterior just misses the level of the anterior border of the eye.

The commencement of the dorsal is slightly behind that of the ventral, and is nearer the base of the caudal than the tip of the snout. The longest ray of the dorsal is considerably shorter than the depth of the body below it. The pectoral fin is long and pointed but does not extend to the base of the ventral. The ventral fin is similar to the pectoral but its outer rays are prolonged and it is separated from the anal by a short distance. The anal fin is short and does not reach the base of the caudal. The caudal fin is deeply forked ; the lobes are long and pointed, the lower lobe is slightly longer than the upper.

The depth of the body is contained from 3.8 to 4.6 times in the total length and from 3.1 to 3.5 times in the length without the caudal. The larger specimen is proportionately much deeper. The caudal fin is contained 4.4 times in the total length. The body is covered with large and well-marked scales. There are about 25 to 26 scales in a longitudinal series between the upper angle of the operculum and the base of the caudal fin. There are 10 to 12 predorsal scales and 12 round the caudal peduncle. The lateral line is concave and incomplete ; the number of perforated scales varies from 18 to 20 and the lateral line does not seem to extend to the caudal peduncle. There are $4\frac{1}{2}$ or 5 rows of scales between the lateral line and the base of the dorsal and 1 or $1\frac{1}{2}$ rows between it and the base of the ventral. Anteriorly the lateral line organs are continued above the eyes. The bases of the ventrals and anal fins are provided with scaly sheaths. In one of the specimens there are scaly appendages in the axils of the ventral fins. The least height of the caudal peduncle is contained from 1.4 to 2 times in its length. The caudal peduncle of the smaller specimen is long and slender.

The fish has a silvery sheen, the upper half is somewhat darker than the lower. There is a broad, faint band along the middle of the body which ends in front of the caudal in an oblong, black mark. The head and body are marked with small black dots which are aggregated along the margins of the scales. An aggregation of black spots at the base of the anal forms a narrow band. There is a black streak along the dorsal surface.

Locality.—Nam MeHsai stream forming the boundary between the British Territory and Siam.

Remarks.—*Rasbora taytayensis* belongs to the group of species in which the lateral line is incomplete, and the origin of dorsal is behind that of ventral. According to Rendahl¹, its close ally is *R. vegae* from the Island of Labuan.

¹ Rendahl, *Arkiv. f. Zoologi*, XVIII B, No. 13, p. 113 (1926).

Measurements in millimetres.

Total length including caudal	48.6	58.2
Length of caudal	11.0	12.1
Depth of body	10.5	15.0
Length of head	9.7	12.3
Height of head at occiput	7.0	9.0
Width of head	4.3	6.5
Length of snout	2.3	3.4
Diameter of eye	3.3	4.1
Interorbital width	4.0	5.0
Length of pectoral	8.4	10.6
Length of ventral	8.4	9.0
Longest ray of dorsal	9.0	11.7
Longest ray of anal	8.5	8.8
Length of caudal peduncle	9.0	10.0
Least height of caudal peduncle	4.3	7.2

Danio (Danio) aequipinnatus (McClelland)

1934. *Danio (Danio) aequipinnatus*, Hora & Mukerji, *Rec. Ind. Mus.*, XXXVI, p. 131.

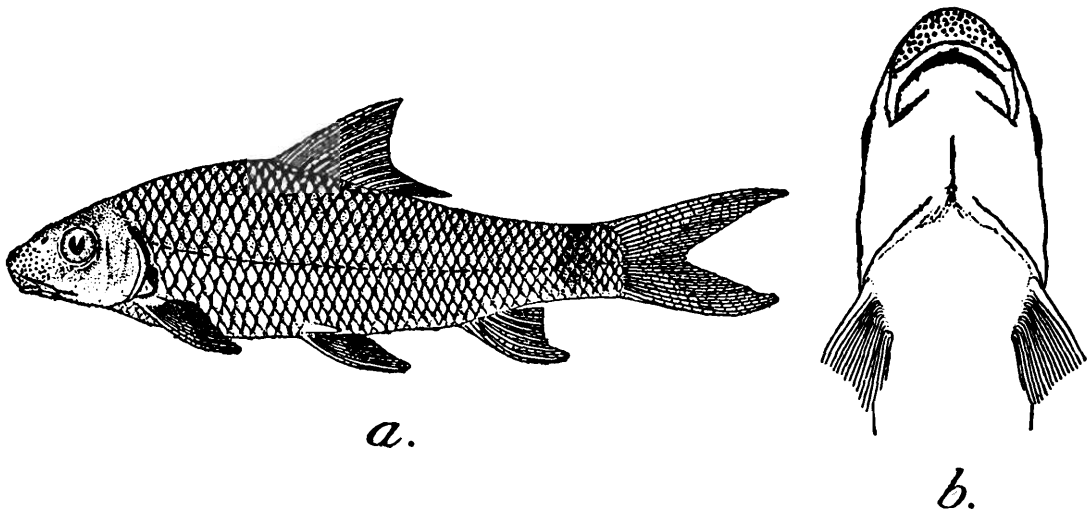
In our recent key to the species of the subgenus *Danio*, *D. aequipinnatus* was included among a group of species with "A well-defined black mark near upper angle of gill-opening." Some of the specimens collected by Mr. Sondhi in the Chaung Gyi stream near Gaunphpo do not bear this mark, but the species can be readily recognised by the characteristic colouration of the body.

Osteochilus sondhii, sp. nov.

D. 4/12 ; A. 3/5 ; P. 17 ; V 9 ; C. 19.

In *Osteochilus sondhii* both the profiles are considerably arched ; the dorsal profile rises from the tip of the snout to the commencement of the dorsal fin with a gradual, but steep, gradient, behind which it slopes gradually to the base of the caudal fin. The ventral profile is more evenly arched and in the region of the caudal peduncle is straight and horizontal. The body is considerably compressed, though somewhat flat on the ventral surface in front of the ventral fins. The head is short, thick and broadly pointed ; its length is contained from 4.4 to 4.6 times in the total length without the caudal. The height of the head at the occiput is contained from 1.2 to 1.3 times and its width from 1.4 to 1.7 times in its length. The eye is placed in the upper half of the head and is just visible from the ventral surface ; its greater part is situated in the posterior half of the head. The diameter of the eye is contained from 3.5 to 3.9 times in the length of the head ; from 1.3 to 1.6 times in the length of the snout and from 1.4 to 1.8 times in the interorbital width. The nostrils are situated in front of the eyes at a distance of half its diameter. The snout is covered with sharp tubercles which extend backward to the front margin of the eyes. The mouth is distinctly inferior, horizontal and crescent-shaped ; it is as wide as the length of the snout and is bordered by fleshy lips. The anterior lip is slightly fimbriated, but the

posterior one is distinctly papillated. Both the jaws are covered with a horny substance, that of the posterior jaw forms a sharp edge anteriorly.



TEXT-FIG. 2.—*Osteochilus sondhii*, sp. nov.

a Lateral view of the type-specimen. $\times \frac{1}{2}$.

b. Ventral surface of head and anterior part of body of the type-specimen. Nat. size.

The maxilla extends to just below the anterior margin of the eye. The maxillary groove is deep and contains a small maxillary barbel which is not visible from outside. There are no rostral barbels. The labial groove is broadly interrupted in the middle. The gill-opening is mostly restricted to the side and extends to the ventral surface only for a short distance. The operculum is provided with a broad membranous flap.

The commencement of the dorsal fin is opposite the 12th perforated scale and is much nearer to the tip of the snout than to the base of the caudal; it is in advance of the ventrals. The last spine of the dorsal fin is as long as the head and considerably longer than the base of the fin. The pectoral fin is shorter than the head; its outer rays are the longest and the fin is separated from the ventral by a distance greater than the diameter of the eye. The ventral fin is similar to the pectoral and does not extend to the anal-opening. The anal fin, when laid flat, does not reach the base of the caudal. The caudal fin is slightly longer than the head and is deeply forked with both the lobes pointed. The upper lobe is longer than the lower.

The depth of the body is contained from 3.4 to 3.7 times in the total length without the caudal. The scales are closely set and adhere firmly; there are 39 to 40 perforated scales along the lateral line, seven rows above it to the base of the dorsal fin and 5 rows below it to the base of the ventral fin. There are about 22 scales round the caudal peduncle and 16 scales in front of the dorsal fin. The least height of the caudal peduncle is contained from 1.4 to 1.7 times in its length.

In preserved specimens the dorsal surface and the sides are grayish while the ventral surface is much lighter. Every scale on the sides and the dorsal surface is provided with a black mark at its base, thus longitudinal rows of spots are formed. In the posterior region the entire border of each scale is darker, imparting a very characteristic colouration

to the species. A dull round spot near the root of the caudal fin is visible in both the specimens, while the smaller specimen is marked with a vertical patch of dull colour extending above and below the lateral line in the region of the 5th and 6th perforated scales. There is a broad, black mark behind the gill-opening. The caudal and the dorsal fins are tipped with black.

Mr. Sondhi noted that the colouration in the living specimens was "Light yellowish pink, sides pearly with a splash of orange dots. A shade of pink in the tail and keel fins."

Local name.—*Pa-sat.*

Locality.—Two specimens of the species were netted by Mr. Sondhi from the Salween River at Takaw in the Kēngtūng State on the 21st January, 1934.

Type specimen.—F. 11600/1, *Zoological Survey of India, Indian Museum, Calcutta.*

Remarks.—*Osteochilus sondhii* differs from all the seventeen species included by Weber and Beaufort in their account of the fishes of the Indo-Australian Archipelago (Vol. III, p. 124, 1916) by the following combination of characters:—

- (i) There are 39 to 40 scales along the lateral line; 7 rows above it to the base of the dorsal fin and 5 rows below it to the base of the ventral fin.
- (ii) The snout is covered with a large number of tubercles.
- (iii) There are only two short, maxillary barbels.
- (iv) There are only 12 branched rays in the dorsal fin.
- (v) The caudal peduncle is surrounded by 22 scales.
- (vi) Colouration.

The above characters also separate the new species from the three Burmese species of *Osteochilus* described by Day in his *Fishes of India* (pp. 545, 546). *O. chalybeatus* from the Irrawaddi and Salween Rivers possesses 54 scales along the lateral line and 8 rows above it to the base of the dorsal fin. The number of branched rays in the dorsal fin is 18, and there are four barbels. *O. neilli* from "Sittoung and Billing" possesses 15-16 branched rays in the dorsal fin, four barbels and only 34 scales along the lateral line. The systematic position of *O. cephalus* from Pegu is somewhat doubtful, but presuming that Day had examined the type-specimen before he wrote his description, it is clear that the new species agrees with *O. cephalus* in having fewer rays in the dorsal fin, 40 scales along the lateral line, many pores on the snout and one short pair of maxillary barbels. The two species, however, differ in the relative position of the fins and proportions. In *O. cephalus* "the dorsal commences midway between the snout and the base of the caudal", whereas in *O. sondhii* the commencement of the dorsal is distinctly nearer to the tip of the snout than to the base of the caudal. In the former "The anal laid flat reaches the caudal," while in the latter the two fins are separated by a considerable distance. In *O. cephalus*, the eye is "1/5 of length of head, 2 diameters from end of snout," while in *O. sondhii*, the eye is contained from 3.5 to 3.9 times in the length of the head and from 1.3 to 1.6 times in the length of the snout. Judging from Cuvier and Valen-

cienne's figure of *O. cephalus* (pl. 487), the two species appear to be abundantly distinct in their general facies.

The species of *Osteochilus* recently described, *O. prosemion* Fowler¹ from Cheing Mai, Upper Siam, *O. salsburyi* Nichols and Pope² from Hainan and *O. kükenhali* Ahl³ from Borneo, possess 4 barbels and differ from the new species either in proportions, colouration, number of rays in the dorsal fin or in the number of scales along the lateral line.

Osteochilus sondhii is the 5th species to be recorded from the Burmese waters. Besides the three species mentioned by Day, Mukerji⁴ recorded *O. vittatus* from the Mergui District, Lower Burma. It seems probable that with an extension of our knowledge of the ichthyology of Burma, more species of this interesting genus will be discovered. The range of the genus does not extend to India proper.

Measurements in millimetres.

Total length without caudal	106.6	121.2
Length of caudal	damaged	27.0
Depth of body	29.0	35.7
Length of head	23.8	26.3
Height of head at occiput	18.2	22.0
Width of head	14.0	18.0
Length of snout	8.0	12.0
Diameter of eye	6.0	7.5
Interorbital width	8.8	13.8
Length of pectoral	20.5	24.7
Length of ventral	18.0	23.0
Longest ray of dorsal	23.6	26.8
Length of anal spine	18.0	20.0
Length of caudal peduncle	16.4	23.0
Least height of caudal peduncle	12.5	15.7

***Barbus shanensis*, sp. nov.**

D. 4/8 ; A. 3/5 ; P. 15-16 ; V. 8-9 ; C. 19.

In *Barbus shanensis* the dorsal profile rises gradually from the tip of the snout to the commencement of the dorsal fin ; in the region of the base of the dorsal it falls down abruptly but beyond the dorsal it slopes down gradually to the base of the caudal fin. The ventral profile is deeply, but evenly, arched throughout. The body is greatly compressed and the back between the dorsal fin and the head is ridge-like. The head is short and almost pointed at the tip ; its length is contained from 4.2 to 4.6 times in the total length without the caudal. The height of the head at the occiput is contained from 1.1 to 1.3 times and the width from 1.6 to 1.8 times in its length. The eyes are moderately

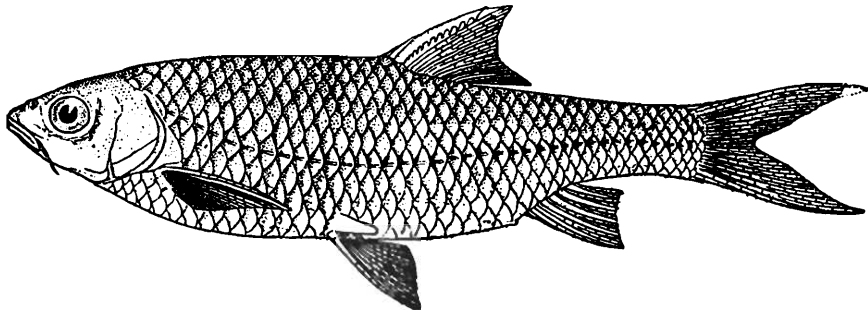
¹ Fowler, *Proc. Acad. Nat. Sci. Philadelphia*, LXXXVI, p. 116 (1934).

² Nichols & Pope, *Bull. Amer. Mus. Nat. Hist.*, LIV, p. 348 (1927).

³ Ahl, *Sitzungsber. Gesell. Nat. Freunde Berlin*, p. 33 (1924).

⁴ Mukerji, *Rec. Ind. Mus.*, XXXIV, p. 286 (1932).

large and lateral in position; their diameter is contained from 3 to 3.5 times in the length of the head, from 1 to 1.1 times in the length of the snout and from 1.2 to 1.3 times in the interorbital width. The interorbital space is broad and almost flat. The snout is smooth. The mouth is deeply arched and the maxillary bone just extends to below the anterior border of the eye. The upper jaw projects in front of the lower so that the mouth is subinferior in position. There are four barbels; the maxillary barbels are as long as the diameter of the eye while the rostrals are somewhat shorter.



TEXT-FIG. 3.—Lateral view of the type-specimen of *Barbus shanensis*, sp. nov. $\times \frac{1}{2}$.

The depth of the body is contained from 3 to 3.3 times in the length without the caudal. The height of the caudal peduncle is contained from 1.5 to 1.6 times in its length. The scales are thin and adhere to the body firmly; there are 36 to 38 perforated scales along the lateral line and 6 or $6\frac{1}{2}$ series between it and the commencement of the dorsal fin. There are 3 or $3\frac{1}{2}$ series of scales between the lateral line and the base of the ventral fin. The number of predorsal scales varies from 15 to 16 and there are about 16 scales round the caudal peduncle. The scales on the ventral surface are somewhat smaller.

The commencement of the dorsal fin is considerably nearer to the base of the caudal than to the tip of the snout; it is almost equidistant between the middle of the eye and the base of the caudal fin. The last dorsal spine is strong and denticulated; the length of its bony portion is contained from 1.2 to 1.4 times in the length of the head. There are 16 pairs of teeth along the posterior border of the spine, and, with the exception of the last two, they are graded. The upper teeth are more widely spaced than the lower ones. The longest ray of the dorsal fin is considerably shorter than the depth of the body below it. The pectoral fin is long, narrow and sickle-shaped; it is separated from the ventral by a considerable distance. The ventral fin is more extensive than the pectoral. The anal opening is situated just in front of the base of the anal fin, which is short and does not reach the base of the caudal fin. The caudal fin is longer than the head and is deeply bifurcate. The lobes are sharp and pointed.

The colouration of the spirit specimens is silvery gray above and silvery below. In the smaller specimen, the edges of the scales along the lateral line and of those above it are shot with small black dots which produce longitudinal series of black markings. These markings are most prominent along the lateral line. The distal half of the caudal fin, especially

of the lower lobe, and of the anal fin is dark. The dorsal fin is tipped with black. The distal half of the ventral fin is also grayish. The snout, behind the tip, is marked with a black patch.

Type-specimen.—F. 11625/1, Zoological Survey of India, Indian Museum, Calcutta.

Locality.—Lawksawk Canal at Lawksawk, S. Shan States, Burma.

Remarks.—As a result of recent researches on the ichthyology of Yunnan¹ and Upper Burma² a number of interesting species of the genus *Barbus* with 4 barbeles and strong, serrated dorsal spine have been discovered. Unfortunately some of these have not been figured and their descriptions also are inadequate.

Barbus shanensis, differs from all the species hitherto described by the following combination of characters:—

- (i) Length of head 4.2-4.6 times in length without caudal.
- (ii) Eye 3-3.5 times in length of head and almost equal to length of snout.
- (iii) Interorbital width 2.4-2.6 times in length of head.
- (iv) 36-38 perforated scales along lateral line; 6 or 6½ above it to base of dorsal and 3 or 3½ below it to base of ventral.
- (v) 15-16 predorsal scales.
- (vi) Commencement of dorsal considerably nearer base of caudal than tip of snout.
- (vii) Strong dorsal spine with coarse and widely spaced teeth.

Judged by these characters, the new species comes very close to *Barbus gregorii* Norman. We have examined a co-type of the latter species almost as long as the type of *B. shanensis*, and from the general facies the two species appear to be quite distinct. Morphologically the differences lie in the size of the head and the eyes. In *B. gregorii* the length of the head is contained 3½-4 times in the length and the diameter of the eye 3½-4¼ in the length of the head. Of the species known from the Southern Shan States and the adjacent parts of Upper Burma, *B. catesii* Boulenger is closely allied to *B. shanensis*, but differs from it in having the commencement of the dorsal fin equidistant between the tip of the snout and the base of the caudal fin, 12-13 predorsal scales and 29-33 scales along the lateral line.

¹ Anderson, *Zoological Results of the Two Expeditions to Western Yunnan in 1868 and 1875*, p. 868, pl. lxxix, fig. 1, 1878 (*Barbus margaritanus*): Regan, *Ann. Mag. Nat. Hist.* (7) XIII, pp. 190 & 191, 1904 (*B. grahmi* and *B. yunnanensis*): Chaudhuri, *Rec. Ind. Mus.*, VI, p. 16, 1911 (*B. cogginii*): Norman, *Ann. Mag. Nat. Hist.* (9) XI, p. 562, 1923 (*B. gregorii*).

² Boulenger, *Ann. Mag. Nat. Hist.* (6) XII, p. 201, 1893 (*Barbus catesii* and *B. schanicus*): Annandale, *Rec. Ind. Mus.*, XIV, pl. iii, figs. 3 & 4, 1918 (*Barbus sarana caudimarginatus* Blyth and *B. schanicus* Boulenger); Prashad & Mukerji, *Rec. Ind. Mus.*, XXXI, pp. 195-200, pl. ix, 1929 [*B. chagunio* (H. B.); *B. sewelli*: *B. myithyinae* and *B. sarana caudimarginatus* Blyth]; Hota & Mukerji, *Rec. Ind. Mus.*, XXXVI, p. 126, 1934 (*B. sarana* and its subspecies *caudimarginatus* and *sewelli*): Mukerji, *Journ. Bombay Nat. Hist. Soc.*, XXXVII, pp. 64-68, 1934 [*B. caratus lurtzoni*, *B. chagunio* (H. B.) *B. chola* (H. B.) and *B. sarana caudimarginatus* Blyth].

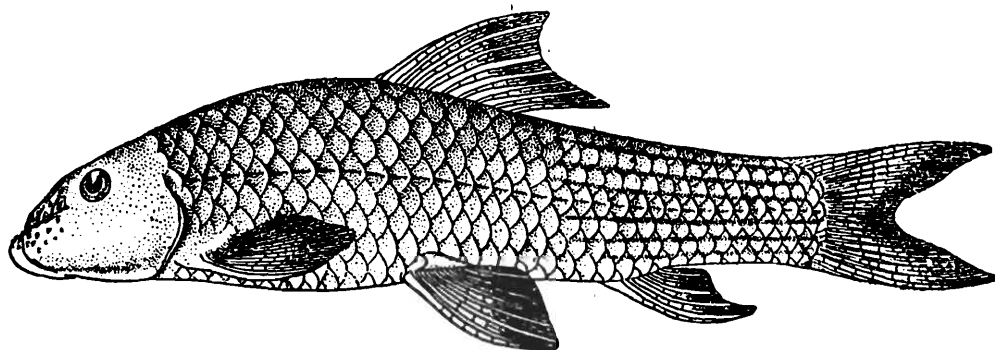
Measurements in millimetres.

Total length without caudal	104.6	128.5
Depth of body	34.8	38.3
Length of head	22.5	30.3
Length of snout	7.5	9.5
Diameter of eye	7.5	8.5
Interorbital width	9.4	11.3
Width of head	14.0	16.7
Height of head at occiput	20.0	23.4
Length of pectoral	22.3	27.0
Length of ventral	20.2	24.0
Length of bony portion of dorsal spine	18.7	21.3
Length of 1st branched ray of dorsal	20.0	23.3
Longest ray of anal	18.5	20.2
Length of caudal peduncle	19.3	20.3
Least height of caudal peduncle	12.0	13.3

***Garra salweenica*, sp. nov.**

D. 3/8; A. 1/5; P. 16; V 8; C. 19.

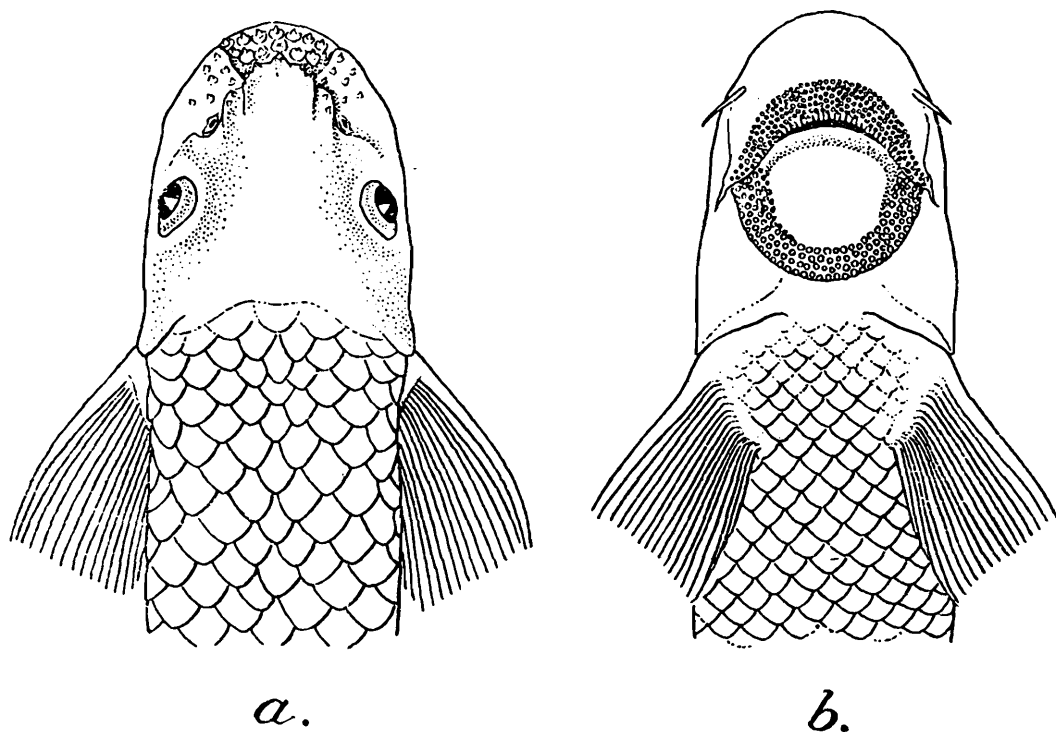
Garra salweenica is a stoutish species in which the dorsal profile rises abruptly from the tip of the snout to the dorsal fin. The ventral profile is almost horizontal and straight throughout. The body is depressed anteriorly but is moderately compressed in the posterior region. The head is flattish and tapers anteriorly; its length is contained 3.9 times in the total length without the caudal. The width of the head is contained 1.3 times and the height at occiput 1.4 times in its length. The eyes are small and situated in the posterior half of the head; their diameter is contained 6.2 times in the length of the head, 3.4 times in the length of the snout and 2.6 times in the interorbital width. The interorbital space is slightly convex and the eyes, though dorso-lateral in position, are considerably below the dorsal profile of the head. The snout

TEXT-FIG. 4.—Lateral view of the type-specimen of *Garra salweenica*, sp. nov. $\times \frac{3}{4}$.

has a prominent proboscis which is trilobed and free anteriorly; the lateral lobes are small but well defined. The area in front of the proboscis and two smaller areas at the sides of it are covered with 3 to 4 rows of large, spiny tubercles while there are a few similar tubercles on all the three lobes of the proboscis. The nostrils are situated at the base of the proboscis and are separated from each other by a membranous flap.

The rostral barbel is smaller than the diameter of the eye while the mandibular barbel is hidden in the labial groove and is hardly visible on the surface. The mental disk is well developed; its central, callous portion is large and prominent. The gill-openings extend to the ventral surface for a short distance and the distance between them is slightly greater than 2.5 times the diameter of the eye.

The dorsal fin commences in advance of the ventral and is distinctly nearer to the tip of the snout than to the base of the caudal; its last undivided ray is longer than the head but is shorter than the depth of the body. The paired fins are horizontally placed and their outer rays are provided with adhesive pads on the ventral surface; the pectoral fin is slightly shorter than the head and is pointed in the middle. The commencement of the ventral is almost equidistant between the tip of the snout and the base of the caudal; the ventrals extend beyond the anal opening and are separated from the anal by a distance equal to the diameter of the eye. The anal fin, when laid flat, does not reach the base of the caudal. The caudal fin is deeply forked; the lobes are pointed, the lower lobe being somewhat better developed and slightly longer than the upper lobe.



TEXT-FIG. 5.—*Garra salweenica*, sp. nov. $\times 1\frac{1}{2}$.
 a. Dorsal surface of head and anterior part of body.
 b. Ventral surface of head and anterior part of body.

The depth of the body is contained 3.8 times in the total length without the caudal. The scales are large and adhere firmly to the surface; there are about 33-34 perforated scales along the lateral line, $3\frac{1}{2}$ rows above it to the base of the dorsal, 3 rows below it to the base of the ventral fin. There are about 9 predorsal scales and 16 scales round the caudal peduncle. The scales on the ventral surface are reduced and those between the bases of the pectoral fins are very small. The scaly appendage in the axil of the ventral fin is well developed. The length of the caudal peduncle is 1.2 times its least height.

The species of *Garra* possess, more or less, a similar type of colour pattern, but in this species the dorsal surface is much more gray than is usually the case. The dorsal surface of the outer rays of the paired fins, especially of the pectorals, is deep black, and the lower lobe of the caudal fin with the exception of a small distal portion and a small part of the upper lobe are infuscated with gray. The branched rays of the dorsal fin and the inner rays of the anal fin are also black. The black mark, usually present in species of *Garra*, near the upper angle of the gill-opening is absent; but a series of spots at the base of the dorsal fin and longitudinal streaks of gray colour along the sides of the body, especially in the tail region, are present.

Type-specimen.—F. 11602/1, *Zoological Survey of India, Indian Museum, Calcutta*.

Locality.—The Salween River at Takaw Kēngtūng State, Southern Shan States, Burma.

Local Name.—*Pa-ing*.

Remarks.—The above description is based on the type-specimen, but there is another specimen, 71.7 mm. in total length without the caudal, from the type-locality which we also refer to *G. salweenica*. In the young example, the proboscis is not well developed and there is just a faint indication of its three-lobed condition. The colouration is similar to that of the type-specimen but its proportions are different. The depth of the body is contained 4.2 times and the length of the head 4.8 times in the total length without the caudal. The width of head is contained 1.1 times and the height at occiput 1.2 times in its length. The diameter of the eye is contained 4.9 times in the length of the head, 2.6 times in the length of the snout and 2.4 times in the interorbital distance. The least height of the caudal peduncle is contained 1.3 times in its length. Both the pectorals and the last undivided ray of the dorsal are considerably longer than the head. These differences from the type-specimen are due, in our opinion, to the immaturity of the second specimen, otherwise the two are conspecific.

Relationships.—Of the large number of species of *Garra* known to us from India and other neighbouring countries, there is no form in which the proboscis is trilobed in the way described above for *G. salweenica*. The trilobed condition in *G. bicornuta* Rao¹ is due to the development of two horn-like structures in front of the eyes and above the nostrils. The only species in which the structure of the proboscis is similar to that of *G. salweenica* is *G. arabica* Hora.² Unfortunately the colouration of the latter species is not known, but the two forms seem to differ in general facies and proportions. In several respects, *G. salweenica* approaches *G. fuliginosa*, a species recently described by Fowler³ from N. Siam (Metang River, 35 miles north of Chieng Mai) and *G. schismatorhyncha* Nichols and Pope⁴ from Hainan; but differs from them in the character of the proboscis and proportions. Judging from Fowler's figure of his species, the two forms seem to differ greatly in physiognomy.

¹ Rao, *Ann. Mag. Nat. Hist.* (9) VI, p. 57, pl. i (1920).

² Hora, *Rec. Ind. Mus.*, XXII, p. 677, text-fig. 5 (1921).

³ Fowler, *Proc. Acad. Nat. Sci. Philadelphia*, LXXXVI, p. 139, figs. 108-111 (1934).

⁴ Nichols and Pope, *Bull. Amer. Mus. Nat. Hist.*, LIV, p. 358, fig. 25 (1927).

Attention may here be directed to *Garra lamta* (*sensu lato*) recorded by one of us¹ from N. Burma. In this form the proboscis is broad and extensive, but not trilobed. The lateral tubercular areas were mistaken for the lateral lobes of the proboscis. The body is greatly depressed and the dorsal profile is only slightly arched.

So far as we are aware, *G. salweenica* is the first species of the genus to be described from the Salween River system.

Measurements in millimetres.

Total length excluding caudal	71.7	99.3
Depth of body	17.0	26.0
Length of head	14.8	25.5
Width of head	13.3	19.7
Height of head at occiput	11.6	18.0
Diameter of eye	3.0	4.0
Length of snout	8.0	13.8
Interorbital width	7.3	10.7
Length of pectoral	16.2	24.7
Length of ventral	14.9	23.0
Longest ray of dorsal	15.2	23.6
Longest ray of anal	12.7	21.5
Length of caudal peduncle	12.7	18.4
Least height of caudal peduncle	9.8	15.6

Garra gravelyi (Annandale)

1918. *Discognathus lamta*, Annandale (*nec* Hamilton), *Rec. Ind. Mus.*, XIV, p. 45.
 1919. *Discognathus gravelyi*, Annandale, *Rec. Ind. Mus.*, XVI, p. 133, pl. ii, figs. 3, 3a.
 1921. *Garra gravelyi*, Hora, *Rec. Ind. Mus.*, XXII, p. 654.

Five specimens, ranging in length from 63 mm. to 96 mm. without the caudal, were collected by the late Dr. N. Annandale in the Inlé Basin and referred by him to the composite species *G. lamta* Ham. Buch. He remarked at the time that one individual from the He-Ho stream "represents a distinct and apparently undescribed species." In the following year, Annandale described this specimen as a new species and remarked: "It is distinguished from *D. lamta* by the different shape and the larger size of its mental disk, by the different shape of the head, by its larger scales and apparently also by difference in the formulae of the fin-rays." In 1921, one of us pointed out that the differences noted by Annandale could be correlated with difference in the sexes of the specimens and referred all the specimens from the Inlé Basin to *G. gravelyi*. In Mr. Sondhi's collection, there are two large, male specimens which we refer to *G. gravelyi* and give below a table of measurements to show differences in proportions from the typical specimens which are of a much smaller size. Mr. Sondhi obtained his examples from a paddy field at Gaunphpo, Lawksawk State (Southern Shan States), which received its supply of water from a small, torrential stream Chaung Gyi.

¹ Mukerji, *Journ. Bombay Nat. Hist. Soc.*, XXXVII, p. 48, text-figs. 4, 5 (1934).

The males of *Garra gravelyi* are characterized by the possession of 4 barbels, by the eyes being situated wholly in the posterior half of the head, by the presence of an ill-defined proboscis without lateral lobes and by the fact that the last spine of the dorsal fin is longer than the head. The mental disk is of a large size in this species.

Measurements in millimetres.

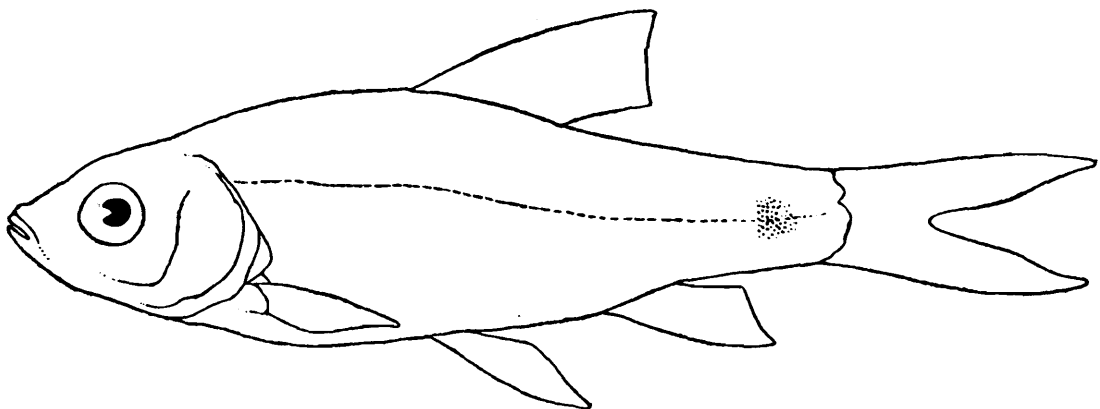
Total length including caudal	142.0	146.0
Length of caudal	31.6	29.0
Depth of body	26.0	27.0
Length of head	24.0	24.5
Width of head	17.2	17.5
Height of head at occiput	18.2	18.0
Diameter of eye	5.2	6.0
Length of snout	12.0	12.0
Interorbital distance	10.8	10.2
Length of pectoral	25.5	25.0
Length of ventral	24.0	24.2
Longest ray of dorsal	25.0	26.0
Longest ray of anal	21.0	20.5
Length of caudal peduncle	20.0	22.5
Least height of caudal peduncle	13.5	14.5

***Barbus puntio* (Ham. Buch.) Day**

1870. *Barbus (Puntius) puntio*, Day, *Proc. Zool. Soc. London*, p. 100.

1878. *Barbus puntio*, Day, *Fish. India*, p. 582, pl. cxlv, fig. 6.

In Mr. Sondhi's collection, there is a small specimen, 34 mm. in length excluding the caudal, which agrees in all essential respects with Day's descriptions of *Barbus puntio*; it was obtained from the Nam MeHsai stream in the Kēngtūng State.



TEXT-FIG. 6.—Lateral view of the Nam MeHsai specimen of *Barbus puntio* (Ham. Buch.) Day. $\times 2\frac{1}{2}$.

In the example under report, the commencement of the dorsal fin is almost midway between the tip of the snout and the base of the caudal fin. The last dorsal spine is smooth, osseous and entire though weak. The caudal fin is bifurcate and longer than the head. The length of the head is contained 3.5 times and the depth of the body 3.25 times in the total length without the caudal. The head is slightly longer than high.

The eyes are large and prominent; the diameter of the eye is contained 2.5 times in the length of the head, 0.5 times in the length of the snout and 0.75 times in the interorbital width. There are about 22 scales along the lateral line and 3 rows of scales below it to the base of the ventral fin. The lateral line is prominent on the first 9 to 10 scales and then it becomes indistinct or is absent. The colour is silvery, darker above and lighter below. There is a distinct black blotch at the base of the caudal; the dorsal and the anal fins are tipped with black. The body is covered with small, black spots which are packed more closely along the edges of the scales.

Under the name *Cyprinus puntio*, Hamilton¹ described a small species from the "ponds and ditches of the southern parts of Bengal," and a reference to his 'Original Notes' shows that the species was obtained by him at 'Luckipur' and Calcutta. Unfortunately it has never been taken from Bengal since Hamilton's time, and the original description is very meagre and inadequate. No illustration of the species exists in Hamilton's published or manuscript drawings. In the circumstances it is very difficult to be certain of the identity of Hamilton's *puntio* and the species must be regarded as a *species inquirendum*.

In 1870, Day redescribed Hamilton's *puntio* from 5 specimens obtained at "Sittoung" in Burma and remarked "I have redescribed the species, as its existence has been doubted, apparently not having been taken since Hamilton Buchanan's time." Day appears to have been influenced by the markings in front of the caudal fin and large scales in associating his Burmese examples with *puntio*. There is no other indication that the two forms are conspecific. For this reason we have indicated the authorship of the species as given above. In Day's figure of the species, the dorsal profile is shown as greatly arched, but this is not so in the specimen before us. Day's original of the figure preserved in the collection of the Indian Museum, is greatly damaged and it is not possible, therefore, to elucidate exactly the specific characters of his species.

Barbus terio is closely allied to Day's *puntio*, but the two species differ in certain body proportions, colouration and the extent of the lateral line.

¹ Hamilton, *Fish. Ganges*, pp. 318, 319 (1822).