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INDIAN EARTHWORMS.

II. *SCOLIOSCOLIDES*, GEN. NOV.

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INTRODUCTION.

On studying the descriptions of the Indian species of *Megascolides*, it was noted that one, *M. bergtheili* Michaelsen 1907, is distinguished from all other Indian species by a combination of characteristics that is also found in the genus *Eutyphoeus*. Examination of the types shows that *bergtheili* actually is marked by a complex of characteristics so distinctive as to necessitate generic separation.

The author's thanks are tendered to Dr. B. Prashad, Director of the Zoological Survey of India, for the opportunity of examining these interesting worms.

Scolioscolides, gen. nov.

Diagnosis.—Setae lumbricine. Bithecal, spermathecal pores on 7/8. Male pores on xviii. One gizzard in a space formed by the disappearance of septa 6/7—7/8. Calciferous glands, intestinal caeca (both paired and unpaired) and supra-intestinal glands as in *Eutyphoeus*. Last hearts in xiii. Excretory organs (closed exonephric?) micronephridia. Holandric. Prostates tubular. Vasa deferentia pass into the entalmost portion of the prostatic duct. Spermathecal diverticula open into ental portion of the duct.

Genotype and only species, *Megascolides bergtheili* Michaelsen 1907.

Distribution.—Known only from the type locality. Especially noteworthy is the nearness of that locality to the central portion of the *Eutyphoeus* area.

Remarks.—The definition above is tentative and liable to modification if and when other species are found but for the present at least, adequately distinguishes the genus from all other Megascolecid genera.

SYSTEMATIC RELATIONSHIPS OF *SCOLIOSCOLIDES*.

Scolioscolides is remarkably like the genus *Eutyphoeus* and especially certain holandric species of that genus. Similarities are as follows: muscularity of septa 4/5—5/6 and 8/9—10/11, absence of 6/7—7/8, close crowding of 8/9—10/11; location of the hearts of vi-viii with relation

to the gizzard, presence of hearts in xiii; presence of a single, large gizzard, of paired and unpaired intestinal caeca and of characteristic calciferous and supra-intestinal glands with associated modifications of the vascular system; closed, exonephric(?), micronephridial excretory organs; size and location of spermathecal pores and number and structure of spermathecae; tubular prostates. In addition, and in part at least of minor importance, may be mentioned: secondary annulation; paired female pores; the genital markings which are similar to those often found in *Eutyphoeus*; the number and location of the seminal vesicles; and the band of nephridial tubules in iii. Furthermore the median and unpaired, ventral intestinal caeca are known only from *Scolioscolides* and *Eutyphoeus*.

In contrast to the list above, a statement of differences between *Scolioscolides* and a considerable portion of the holandric section of *Eutyphoeus* comprises only the following: absence of penial setae, rudimentary condition of the typhlosole, location of the male pores on xviii, ental union of the vasa deferentia and the prostatic duct to open to the exterior by a common aperture. Of these, only the latter two now appear to be of especial importance.

Scolioscolides is Megascolecine (Stephenson 1930) or Megascolecid (Michaelsen 1921). *Eutyphoeus* is equally clearly Octochaetine (Stephenson 1930) or Acanthodrilid (Michaelsen 1921). But *Eutyphoeus* and *Scolioscolides*, if morphological similarity is valid evidence of relationship and if the extent of that similarity is an index of the closeness of relationship, are much more closely related to each other than either is to any other known genus. Transfer of either genus to the other subfamily or family will force the elimination from the definition of the subfamily or family of just those characteristics that alone distinguish it from the other subfamily or family. Union of the two subfamilies (or families) is undesirable as the group so produced cannot be defined morphologically.

Convergence, an explanation that might have been acceptable to Stephenson, permits the retention of the two genera within the Octochaetinae and Megascolecinae (or Acanthodrilidae and Megascolecidae) without modification of present definitions. But such retention is possible only by abandoning, almost entirely, morphological similarity in favour of hypothetical phyletic seriation as a basis for classification.

Recent classifications (Michaelsen 1921 and Stephenson 1930) have been marked by limitation of reference, especially in generic diagnoses, to a few organs, structures or characteristics, and with more attention to, and greater emphasis on, phyletic seriation than morphological similarity. Such procedures have produced families and genera admittedly polyphyletic or under suspicion of polyphyly; groups in which morphologically dissimilar forms are closely related while morphologically similar groups are only distantly related; in one case at least, a generic definition that "is so indefinite as to be meaningless" (Stephenson, 1930, p. 867); and have led Stephenson (1921) to argue for morphologically identical though phylogenetically distinct genera. In these circumstances, as might be expected, some of the family and (or) subfamily definitions are little more than statements of assumed evolutionary development.

Thus the only morphological distinction between the subfamilies *Megascolecinae* and *Octochaetinae* (Stephenson, 1930) is the union of the male and prostatic apertures in the former and the lack of such union in the latter, a characteristic that has been denied even generic value at times by both Stephenson and Michaelsen.

This discussion will be continued and also concluded, for the present, in the section on phylogenetic relationships of the next article in this series, "Indian earthworms. III. The genus *Eutyphoeus*."

***Scolioscolides bergtheili* (Michaelsen).**

1907. *Megascolides bergtheili*, Michaelsen, *Mitt. Mus. Hamburg*, XXIV, p. 150. (Type locality, Sandakphu in Darjiling district, Eastern Himalayas. Types in the Indian and Hamburg Museums).
1909. *Megascolides bergtheili*, Michaelsen, *Mem. Ind. Mus.* I, p. 159.
1910. *Megascolides bergtheili*, Michaelsen, *Abh. Nat. Ver. Hamburg*, XIX, (5), p. 9.
1916. *Megascolides bergtheili*, Michaelsen, *Mjöberg's Austral. Exp.* p. 48. (Prostates).
1923. *Megascolides bergtheili*, Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 196.

Material examined.—From the Indian Museum; 2 clitellate, undissected specimens labelled, "*Megascolides bergtheili* Michaelsen. Sandakphu, B. Sikkim. Messrs. Bergtheil and Burkill. Types. ZEV 2951/7." One of the specimens is ruptured in a postclitellar region.

Not examined.—3 specimens from the type series in the Hamburg Museum.

External characteristics.—There is a well developed secondary annulation similar to that found in species of *Eutyphoeus* and *Tonoscolex*. On iv there is a single, deep, postsetal secondary furrow; on v, a slight presetal and a deep postsetal furrow; on vi, a slight presetal, a deep postsetal and a slight postsetal; on vii, as on vi; on viii, a slight presetal, a deep presetal, a deep postsetal and a slight postsetal; on ix, a slight presetal, a deep presetal and two slight postsetal furrows; on x, a deep presetal, a deep postsetal, a slight postsetal; on xi and xii, a deep presetal and a deep postsetal (listed in anteroposterior order).

The setae begin on ii and are small. On x, $ab < cd < aa < bc$ while on xxii $ab < cd < bc$ but bc is only very slightly greater than cd , while ab and cd are nearly equal; at the middle of the body cd is very slightly smaller than bc which is smaller than aa . Setae a and b of xviii are lacking or invisible.

The first dorsal pore is on 11/12 (2), a pore-like but apparently non-functional marking on 10/11 (one specimen).

The clitellum is reddish brown, conspicuously protuberant (except on xiii), extending from 12/13 to 17/18 and possibly very slightly onto xviii. Intersegmental furrows and dorsal pores (except on 12/13 and 17/18) are lacking but the sites of the pores are indicated by tiny depressions, setae present but deeply retracted, the tips visible only as minute black dots at the bottom of tiny crater-like depressions.

The spermathecal apertures are on 7/8, in ab , slightly median to b .

There is a pair of female pores anteriorly on xiv, each just anterior and median to a , the pores located in paired or unpaired transversely slit-like depressions.

The male pores are small, transversely crescentic, the concave side of the crescent facing anteriorly, the centre about on line *b*, each pore on the ventral face of a slightly protuberant, almost circular, rather soft papilla, the anterior half of which is very slightly more protuberant than the posterior half, the papilla in *ab* but extending slightly median to or nearly to *a* and laterally into *bc*. Each tubercle is surrounded by a thick, conspicuously raised rim that is sharply demarcated peripherally and separated from the male pore tubercle by a narrow but fairly deep groove. As a result of the presence of this groove the male pore tubercle has a rather shortly penis-like appearance. Rim and tubercle together constitute a porophore that is shortly elliptical in outline, transversely placed, extending mesially nearly to the mid-ventral line, laterally nearly to mid *bc*, anteriorly to the presetal secondary furrow and posteriorly to 18/19. The porophores are connected mid-ventrally by a low, wrinkled ridge that is restricted to the middle (setal) annulus of xviii.

The genital markings are unpaired and segmental, on xii, xiii, xx, a half-marking on xxi on the left side. The markings extend anteriorly to the intersegmental furrow, posteriorly to the postsetal secondary annulus or to or nearly to the intersegmental furrow, setae *a* and *b* on the marking and always nearer to or actually on the posterior margin. The markings extend laterally into the median portion of *bc*. Each marking has a sharply demarcated, conspicuously protuberant, narrow rim. The area within the rim appears to be depressed but actually is about at the general epidermal level, the surface smooth and flat. This central portion has a greyish translucent appearance, with a faint indication at the mid-ventral line of being marked off into two distinct portions. The marking of xxi is on the left side but extends mesially slightly onto the right side. On the second specimen the markings are on xi, xii, xiii and xx. The marking of xi has the anterior and posterior portions of the rim united at the mid-ventral line to separate completely two central areas.

Internal anatomy.—Septa 4/5—5/6 are thickly muscular, 6/7—7/8 lacking; 8/9—10/11 muscular and fairly close together behind the gizzard; 11/12 delicate and transparent but apparently complete. The last five segments are filled with a brownish, granular material in which are embedded parasitic cysts.

The gizzard is large, in the space between 5/6 and 8/9. The intestine begins in xv (2). The calciferous glands are in xii and are of the *Eutyphoeus* type. More than 50 vertical partitions were counted in one gland. The intestinal caeca are in xxi, pointed, small but quite definite, arising from the dorsal side of the gut and directed dorsally, except that in the second specimen the left caecum though rising dorsally is bent anteriorly. There are five mid-ventral, unpaired intestinal caeca, in xxiv-xxviii. Each of these caeca is fairly large, about 1 mm. long, with pointed tip, gradually widened passing posteriorly and dorsally to the gut. The apertures into these caeca on the floor of the gut are oval, large and readily visible, a viscid slime in which are flocculent brownish particles passing through the aperture into the caecal lumina. The typhlosole is represented only by a low ridge that terminates posteriorly with the supra-intestinal glands. The supra-intestinal glands are two pairs located either in lix-lx or lx-lxi the anterior pair less than half the

size of the posterior. These glands have an internal structure and attachment to the gut similar to that in *Eutyphoeus*.

The last pair of hearts is in xiii (2). There is a pair of hearts in each of segments ix-xii. Posterior to the gizzard and just in front of 8/9 the dorsal blood vessel gives off two pairs of vessels (hearts of vii and viii) which pass ventrally and (apparently) into the ventral trunk. These commissures are not filled with blood, are covered by a furry sort of tissue and in addition are bound to the ventrolateral trunks near the ventral blood vessel by tough, opaque connective tissue. The dorsal blood vessel is continued anteriorly into iv. Just anterior to the gizzard the dorsal blood vessel gives off a pair of vessels (hearts of vi) which pass ventrally and possibly into the ventral trunk though this connection has not been identified definitely. Heart-like commissures are visible in iv and v. The ventrolateral trunks were noted only in vi-viii. In xii-xiii a supra-oesophageal trunk is present (second specimen). This vessel bifurcates in xii, each of the two branches passing laterally at right angles to the trunk and at the margin of the gut breaking up into three branches which pass into the gut wall. Posteriorly the supra-oesophageal is not visible behind 13/14 and in xiii gives off on each side several branches to the dorsal face of the gut. From segment lxi or lxii posteriorly for several segments there is protuberant into the lumen of the gut from the floor at the midventral line a conspicuous, blood-filled longitudinal vessel. Anteriorly this vessel divides into two branches that are visible on the coelomic wall of the gut as they pass dorsally in lx or lxi into the supra-intestinal gland of the segment. No subneural has been found in the posterior portion of the body.

In iii, on each side, there is a transversely placed band of nephridial tubules on the parietes. The excretory organs are micronephridia. From xii posteriorly there is usually a nephridium on each side just dorsal to *d*, another in, just dorsal or ventral to line *c*, and several closely crowded in the median portion of *bc*. In the posteriormost 60 segments the median nephridium on each side in each segment is quite obviously larger than the other nephridia but just as obviously is a micronephridium.

The testicular coagulum in each of segments x and xi is compacted into a hard mass; that in x U-shaped, that in xi annular and completely surrounding the gut. The mass in xi very much resembles a testis sac such as is found in certain species of *Eutyphoeus* but it was not possible to separate off from the testicular coagulum anything in the way of a bounding membrane although such may have been present. The hearts of xi are imbedded at least in part in the coagulum but slip out on slight manipulation leaving a definite groove. The male funnels are characterized by a brilliant iridescence. The seminal vesicles of xii are medium sized, not reaching up to the dorsal blood vessel but pushing 12/13—13/14 back into contact with 14/15. Each of these vesicles is tough, the margin incised. The vesicles of ix are vertically placed on the anterior face of 9/10.

The prostates are confined to xviii-xix, tubular, the lumen small, slit-like, central or nearly so. The duct is about $1\frac{3}{4}$ mm. long, whitish, with a slight sheen, the ectal 1 mm. slightly thicker and straight, the

ental portion looped. The vasa deferentia pass into the duct shortly after the latter emerges from the prostatic gland.

The spermathecal duct is shorter than the ampulla, not abruptly narrowed within the parietes, rather flattened antero-posteriorly, the relatively large lumen irregular due to a vertical ridging of the wall. The diverticula which pass into the duct on the right and left sides are practically sessile and are characterized by a spermatozoal iridescence. Each diverticulum is shortly ellipsoidal or more or less definitely marked off into two or three lobes.

The longitudinal musculature is uninterrupted above the genital markings.

Remarks.—The diagnosis, admittedly tentative, is similar in form to that developed in course of a revision of the Indian species of *Eutyphoeus*.

Diagnosis.—Male pores small, transversely crescentic, centres about on *b*, each pore on the ventral face of a small, rather penis-like papilla at the centre of a porophore of transversely and shortly elliptical outline that extends from the presetal secondary furrow to 18/19 and from just lateral to the mid-ventral line into mid *bc*. Genital markings unpaired, on (xi) xii-xiii, xx (xxi), primarily presetal(?) but extending posteriorly to or nearly to the intersegmental furrow and laterally into mid *bc*. Female pores paired. Spermathecal pores in *ab*. First dorsal pore on 11/12. Unpigmented(?). Length 100-120 mm. Diameter $4\frac{1}{2}$ -5 mm.

Lateral intestinal caeca in xxi; ventral caeca in xxiv-xxviii. Supra-intestinal glands in lix or lx to lx or lxi. Dorsal blood vessel continued into iii with hearts in iv-vi. Holandric; testis sac annular(?). Spermathecal diverticula paired, median and lateral. Longitudinal musculature uninterrupted above the genital markings.

Distribution.—Known only from the type locality, Sandakphu, Darjiling district, Bengal.

REFERENCES.

- Michaelsen, W.—Zur Stammesgeschichte und Systematik der Oligochäten, insbesondere der Lumbriculiden. *Arch. Naturg.*, LXXXVI, (1921).
- Stephenson, J.—Contributions to the Morphology, Classification, and Zoogeography of Indian Oligochaeta. II. On Polyphyly in the Oligochaeta. *Proc. Zool. Soc. London*, (1921).
- Stephenson, J.—*The Oligochaeta* (Oxford, 1930).

SYSTEMATIC POSITION, GEOGRAPHICAL DISTRIBUTION AND EVOLUTION OF THE CYPRINOID GENERA WITH A PROCUMBENT PREDORSAL SPINE.

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The *Mystacoleucus*-group of Cyprinoid genera, comprising *Mystacoleucus* Günther¹, *Matsya* Day,² *Spinibarbus* Oshima³ and *Spinibarbichthys* Oshima,⁴ is characterised by the presence of a forwardly directed spine in front of the dorsal fin. *Mystacoleucus* is distinguished from the other three genera by its relatively long anal fin, containing 8-10 branched rays as against the usual number 5. *Matsya* (= *Acanthonotus* Day⁵) and *Spinibarbichthys* possess a serrated dorsal spine, whereas in *Spinibarbus* the dorsal spine is smooth. In elucidating the systematic position of these genera most of the workers do not appear to have paid attention to the generic characters of Day's *Matsya*. Smith,⁶ who regarded it as congeneric with *Mystacoleucus*, gave no morphological details for his views. Unfortunately no specimen⁷ of *Matsya argentea* Day is available for study either in the Indian Museum or in the Bureau of Fisheries Bangkok. Three specimens of *Mystacoleucus marginatus* (Cuv. & Val.) were sent to me in 1932 by Dr. H. M. Smith with the remark: "Are these *Matsya argentea* Day?" This observation indicates that Smith had confused either a colour variety of the common species *M. marginatus* with Day's form or he may have obtained specimens of the species—*M. chilopterus* recently described from Siam by Fowler⁸. It may further be noted that Suvatti in his "Index to Fishes of Siam" lists only one species of *Mystacoleucus*, *M. marginatus* (C. V.), which is recorded from Northern, Central and Peninsular Siam. Day's diagnosis of *Matsya* is, however, fairly complete and it leaves no doubt that *Spinibarbichthys* should be regarded as a synonym of *Matsya*. In most of the Cyprinoid genera the nature of the dorsal spine, whether serrated or entire, strong and bony or feeble and articulated, is not considered of sufficient importance for separating genera. I am, therefore, in agreement with Nichols and Pope,⁹ Nichols¹⁰, Myers,¹¹ Mukerji,¹²

¹ Günther, *Cat. Fish. Brit. Mus.*, VII, p. 206 (1868).

² Day, *Faun. Brit. India*, Fish, I, p. 292 (1889).

³ Oshima, *Ann. Carnegie Mus.*, XII, p. 217 (1919).

⁴ Oshima, *Annot Zool. Japan*, XI, p. 10 (1926).

⁵ Day, *Fish. India*, (Suppl.), p. 807 (1888).

⁶ Smith, *Journ. Siam. Soc., Nat. Hist. Suppl.*, VIII, p. 185 (1931); *ibid.*, IX, p. 79 (1933).

⁷ Day's description of *Matsya argentea* was based on Tickell's manuscript description and figure of the species. Presumably Day did not examine any specimen of *M. argentea*.

⁸ Fowler, *Proc. Acad. Nat. Sci. Philadelphia*, LXXXVII, p. 112 (1935).

⁹ Nichols and Pope, *Bull. Amer. Mus. Nat. Hist.*, LIV, pp. 343, 344 (1927).

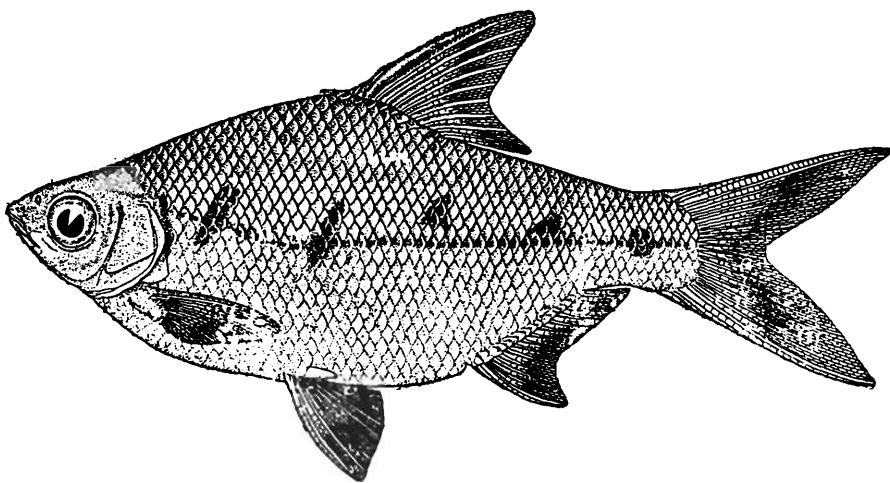
¹⁰ Nichols, *Bull. Amer. Mus. Nat. Hist.*, LVIII, pp. 11, 12 (1928).

¹¹ Myers, *Lingnan Sci. Journ.*, X, pp. 258, 259 (1931).

¹² Mukerji, *Rec. Ind. Mus.*, XXXIV, p. 284-286 (1932).

Mori¹ and Tchang² that *Spinibarbus* and *Spinibarbichthys* should be regarded as congeneric. Both these genera should, therefore, be assigned to the synonymy of *Matsya*. For the sake of convenience and on geographical grounds, it may, however, be desirable to treat *Spinibarbus* as a subgenus of *Matsya*.

In the four species of *Mystacoleucus*³ known so far, *M. marginatus*, *M. padangensis*, *M. chilopteris* and *M. atridorsalis* Fowler,⁴ the number of branched rays in the anal fin varies from 8 to 10 and I agree with Mukerji (*op. cit.*) that on this character alone they should be recognised as belonging to a distinct genus. It may here be noted that in a great majority of Cyprinoid genera there are only 5 branched rays in the anal fin. Any variation from this standard is, therefore, of special significance.



TEXT-FIG. 1.—Lateral view of *Mystacoleucus ogilbii* (Sykes). $\times \frac{2}{3}$.

Recently I collected two specimens of *Rohtee ogilbii* Sykes⁵ (text-fig. 1) at Kurnool which possess a well-marked procumbent, predorsal spine. Other specimens of the same species in the collection of the Indian Museum were examined and a predorsal spine, sometimes hidden below the scales (text-fig. 2 a) was found in all of them. In this species the number of branched anal rays varies from 13 to 14, and the number of scales in the lateral line is about 55. Its pharyngeal bones and teeth are similar to those of *Mystacoleucus* (text-figs. 2 b & d), and its scales also show a close resemblance to those of *M. marginatus* (text-figs. 2 c & e). It seems reasonable, therefore, to include *Rohtee ogilbii* in the genus *Mystacoleucus*, the definition of which should be emended to comprise forms having 8-14 branched rays in the anal fin. In none of the other species of *Rohtee*, such as *R. bakeri* Day, *R. cotio* (Ham.), *R. duvaucelli* (Cuv. & Val.), *R. vigorsii* Sykes, *R. belangeri* (Cuv. & Val.) and *R. feae* (Vinciguerra), I was able to detect any predorsal spine.

¹ Mori, *Studies on the Geographical Distribution of Freshwater Fishes in Eastern Asia* (Chosen: 1936). In the various lists of Chinese fishes *Spinibarbus* is recognised as a valid genus, while *Spinibarbichthys* is considered a synonym of *Spinibarbus*.

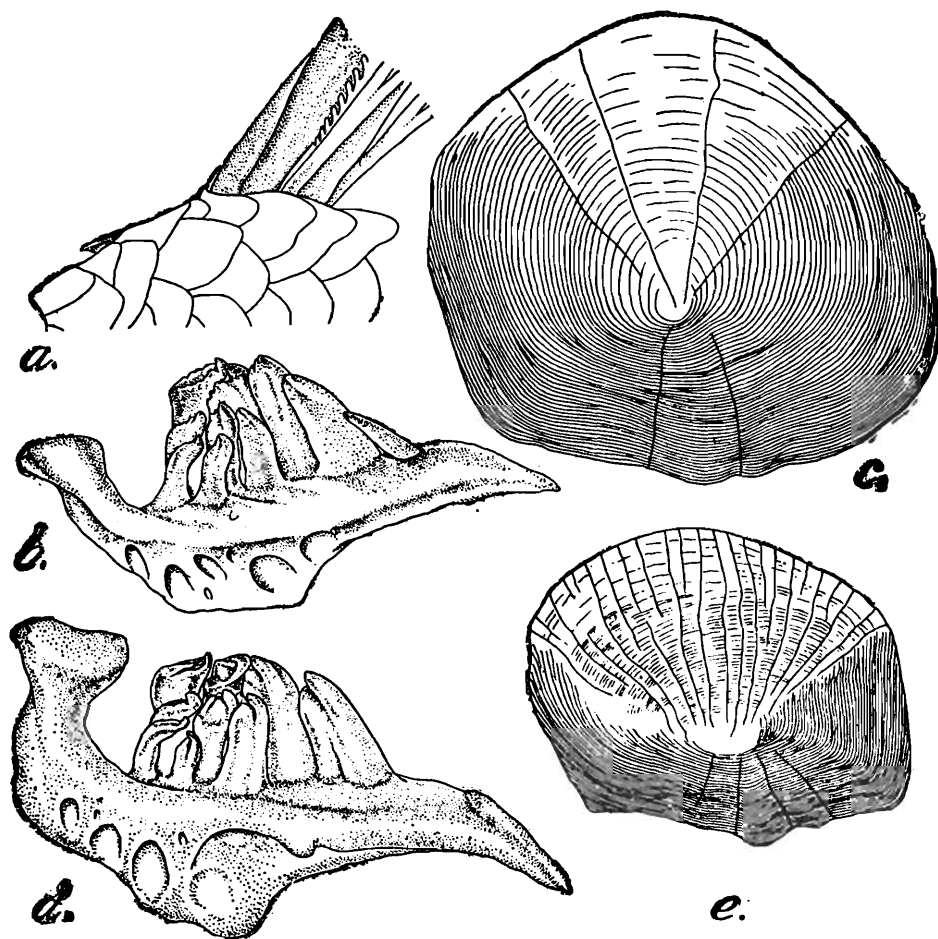
² Tchang, *Zoologia Sinica*, II, p. 43 (1936).

³ For up-to-date descriptions of *Mystacoleucus marginatus* (Cuv. & Val.) and *M. padangensis* (Blkr.) see Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, III, pp. 108-110 (1916).

⁴ Fowler, *Proc. Acad. Nat. Sci. Philadelphia*, LXXXIX, p. 196 (1937).

⁵ Sykes, *Trans. Zool. Soc. London*, p. 36 (1841).

The relationship of these species of *Rohtee* with Sykes' *R. ogilbii* is discussed later (*vide infra* p. 314).



TEXT-FIG. 2.—*Mystacoleucus ogilbii* (Sykes) and *M. marginatus* (Cuv. & Val.).

a. Anterior portion of base of dorsal fin of *M. ogilbii*, showing the position of the procumbent, predorsal spine $\times 2\frac{1}{2}$; b. Pharyngeal bone and teeth of *M. ogilbii*. $\times 7$; c. Scale from below base of dorsal fin of *M. ogilbii*. $\times 25$; d. Pharyngeal bone and teeth of *M. marginatus*. $\times 5$; e. Scale from below base of dorsal fin of *M. marginatus*. $\times 5$.

The question now arises which of the two genera is more primitive—*Matsya* or *Mystacoleucus*? In the case of the Cyprinoid genera it is well recognised that the short anal fin of 5 branched rays is a feature of specialisation, while in the primitive forms, such as *Opsariichthys*, *Chela*, *Barilius*, etc., the anal fin is fairly long. It would, therefore, seem probable on *a priori* grounds that *Mystacoleucus* represents a less specialised form than *Matsya*.

As indicated above the emended genus *Mystacoleucus*, especially the form *M. ogilbii*, shows great affinities with the members of the genus *Rohtee*, and it would be useful, therefore, to examine in the first place the precise limits of *Rohtee* and of its allied genera also.

In the species of *Rohtee* known from India and Burma¹, with the exception of *R. cunma* Day, the dorsal fin possesses a strong serrated spine and the number of branched anal rays varies from 11 in *R. bakeri* Day to 33 in *R. cotio* (Ham.). *R. cunma* was described by Day² from Moulmein and its dorsal fin is characterised by the possession of a "spine

¹ For description of most of the Indian and Burmese species of *Rohtee* see Day's *Fishes of India* and the "Fauna" volumes.

² Day, *Fish. India*, (Suppl.), p. 807 (1888).

weak and longer than the head, not serrated." Unfortunately no specimen¹ of this species is available for study. Vinciguerra², on the nature of the dorsal spine alone, doubted its inclusion in the genus *Rohtee*. Again Tchang's³ separation of his *Parosteobrama* from *Osteobrama* Heckel⁴ (= *Rohtee*) was also based on this feature. Fu and Wang⁵ have, however, shown that Tchang's *Parosteobrama* is in reality *Parabramis* Bleeker and with this view Mori (*op. cit.*) agrees. Mukerji⁶ doubted the advisability of separating *Parosteobrama* from *Rohtee* only on the nature of the dorsal spine. Thus, as in the case of *Matsya* (*vide supra*, p. 312), we have two groups of species in *Rohtee*, those with the dorsal spine serrated (*Rohtee* s. s.) and those with the dorsal spine smooth (*Parabramis*). In most of the species of *Rohtee* the abdominal edge is sharp and trenchant only behind the bases of the ventrals (*Rohtee* s. s.) whereas in *R. belangeri* (C. V.) the whole of the abdominal edge is sharp (*Smiliogaster* (Bleeker⁷)). Similarly among Chinese fishes we have *Chanodichthys* Bleeker,⁸ *Parabramis* Bleeker,⁹ and *Megalobrama* Dybowski¹⁰ which are distinguished from one another by the nature of the abdominal edge. It is thus seen that *Rohtee* and the allied forms constitute a very generalised group showing considerable diversity in form and structure. Ignoring the nature of the abdominal edge and taking into consideration the nature of the dorsal spine, as in the case of *Matsya* and *Spinibarbus*, it may be useful to regard *Parabramis* as a subgenus of *Rohtee* on geographical grounds.

The geographical distribution of the genera *Matsya* and *Mystacoleucus* is very significant. *Matsya* of the *Spinibarbus*-type is known from Formosa [*M. hollandi* (Oshima) and *M. elongatus* (Oshima)], Fukien [*M. caldwelli* (Nichols)] and Hainan [*M. nigrodorsalis* (Oshima)]; while that of the *Spinibarbichthys*-type is found in Hainan [*M. denticulatus* (Oshima)], Szechwan [*M. pingi* (Tchang)] and Tenasserim [*M. argentea* Day]. The members of the two types meet in Hainan, but it may be noted that the forms found towards the west and the south are better armed than those found towards the east. *Mystacoleucus* is found in Siam [*M. marginatus* (Cuv. & Val.), *M. chilopterus* Fowler and *M. atridorsalis* Fowler], South Burma [*M. marginatus* (Cuv. & Val.)], Malay Peninsula [*M. marginatus* (Cuv. & Val.)], Sumatra [*M. marginatus* (Cuv. & Val.) and *M. padangensis* (Blkr.)], Java and Borneo [*M. marginatus* (Cuv. & Val.)] and the Deccan [*M. ogilbii* (Sykes)]. Here again in the more southern forms the dorsal spine is fully armed.

The geographical distribution of the fishes of the *Rohtee* and *Parabramis* groups is also interesting. Species of *Rohtee* are known from

¹ As in the case of *Matsya argentea*, Day's description of this species is based on Tickell's manuscript description and figure. Presumably he had no specimen of *Rohtee cunma*.

² Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova*, (2), IX, p. 188 (1890).

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

⁴ Hora, *Rec. Ind. Mus.*, XXII, pp. 187, 188 (1921), has already explained why *Rohtee* Sykes should have preference over *Osteobrama* Heckel.

⁵ Fu and Wang, *Contrib. Biol. Lab. Sci. Soc. China*, VIII, Zool. Ser. No. 10 (1932).

⁶ Mukerji, *Journ. Bombay Nat. Hist. Soc.*, XXXVII, pp. 69-71 (1934).

⁷ Bleeker, *Nat.-Tijdschr. Neder.-Indie*, XX, p. 428 (1859).

⁸ Bleeker, *ibid.*, p. 432 (1859).

⁹ Bleeker, *Nederl. Tijdschr. Dierk.*, II, p. 21 (1865).

¹⁰ Dybowski, *Verh. Zool.-bot. Gess. Wien.*, XII, p. 212 (1872).

Yunnan [*R. belangeri* (Cuv. & Val.), *R. cotio* (Ham.) and *R. microlepis* (Blyth)] and Burma and India (several species, mostly found in Peninsular India). Fishes of the *Parabramis*-type are found in the Amur System, North China, Kiao-Ho, Yangtse-Kiang, Hainan (several species) and Burma (only one species—*P. cunma*).

If the above distributional records are correlated with the extent of the anal fin, we notice that the forms possessing 5 branched rays in the anal fin (*Matsya*) are restricted to Southern China (Formosa, Fukien, Szechwan and Hainan) while one species (*M. argentea*) is also found in the interior of Tenasserim. The *Mystacoleucus*-type, with 8-14 branched rays, is restricted to Siam, Lower Burma, the Malay Archipelago and the Deccan. The *Rohtee*-type (long anal and serrated dorsal spine) is common in Peninsular India, other parts of India, Burma and Yunnan. The *Parabramis*-type (long anal and smooth dorsal spine) is common throughout China and only one species is found in Burma. As indicated above, in the Cyprinoid fishes a short anal fin of 5 branched rays is to be regarded as a feature of specialisation and it would, therefore, seem probable that *Rohtee* and *Parabramis* represent the ancestral forms of the entire group of fishes discussed above. Considering the present-day density of population of the various forms it seems probable that the centre of origin of these fishes was situated somewhere in South China. The diversity of form and specialisation, therefore, seems to have originated in this region and those species that spread towards north and north-west had probably to face less rigorous conditions of existence and did not, therefore, develop fierce, serrated dorsal spine; whereas those that spread towards south and south-west or remained in Southern China had to contend with more disturbed conditions due to the birth of the Himalayan chain of mountains and developed a strong, denticulated spine. *Rohtee cunma*, like *Matsya argentea*, is, however, an exception; it is found in Burma but corresponds to the forms that spread northwards. Its localised distribution signifies that it is a stray element of the northern-type that probably came to Burma with some later waves of migration.

As the ancestral stock travelled towards the south, the number of anal rays became fewer and fewer so that we get the *Mystacoleucus*-type in the Malay Archipelago on the one hand and in Peninsular India on the other. In the case of *Rohtee*, the species with the largest number of anal rays—*R. cotio*—is widely distributed from Southern China to Burma and India; while that with the smallest number of rays—*R. bakeri*—is found in the southernmost extremity of India. The greatest specialisation of all these forms, however, took place in Southern China, their ancestral home, where the fishes of the group possessing 5 anal branched rays, with the exception of *Matsya argentea*, are found today. It may here be noted that these fishes, with the exception of *Rohtee bakeri* Day, are not found south of the Cauvery watershed and neither have they spread to Ceylon or Africa. This point is discussed later (*vide* p. 318).

Many have regarded the predorsal spine as a character of great taxonomic importance, but Rendahl¹, who investigated its morphology,

¹ Rendahl, *Ark. Zool.*, XXIV A, No. 16, pp. 67-74 (1932).

considers it as a feature of convergence. By convergence we usually mean the presence of the same or a similar character in phylogenetically distantly related forms, and further it implies that the character is of special utility to the individuals concerned, for convergence is the result of adaptation of different organisms to a similar type of environmental conditions. In the case of the predorsal spine it is difficult to understand how it can be used as an organ of defence or offence. If, however, the morphology of the dorsal fin of all the forms referred to above is taken into consideration it may be possible to trace its probable mode of origin and to assign to it some definite function.

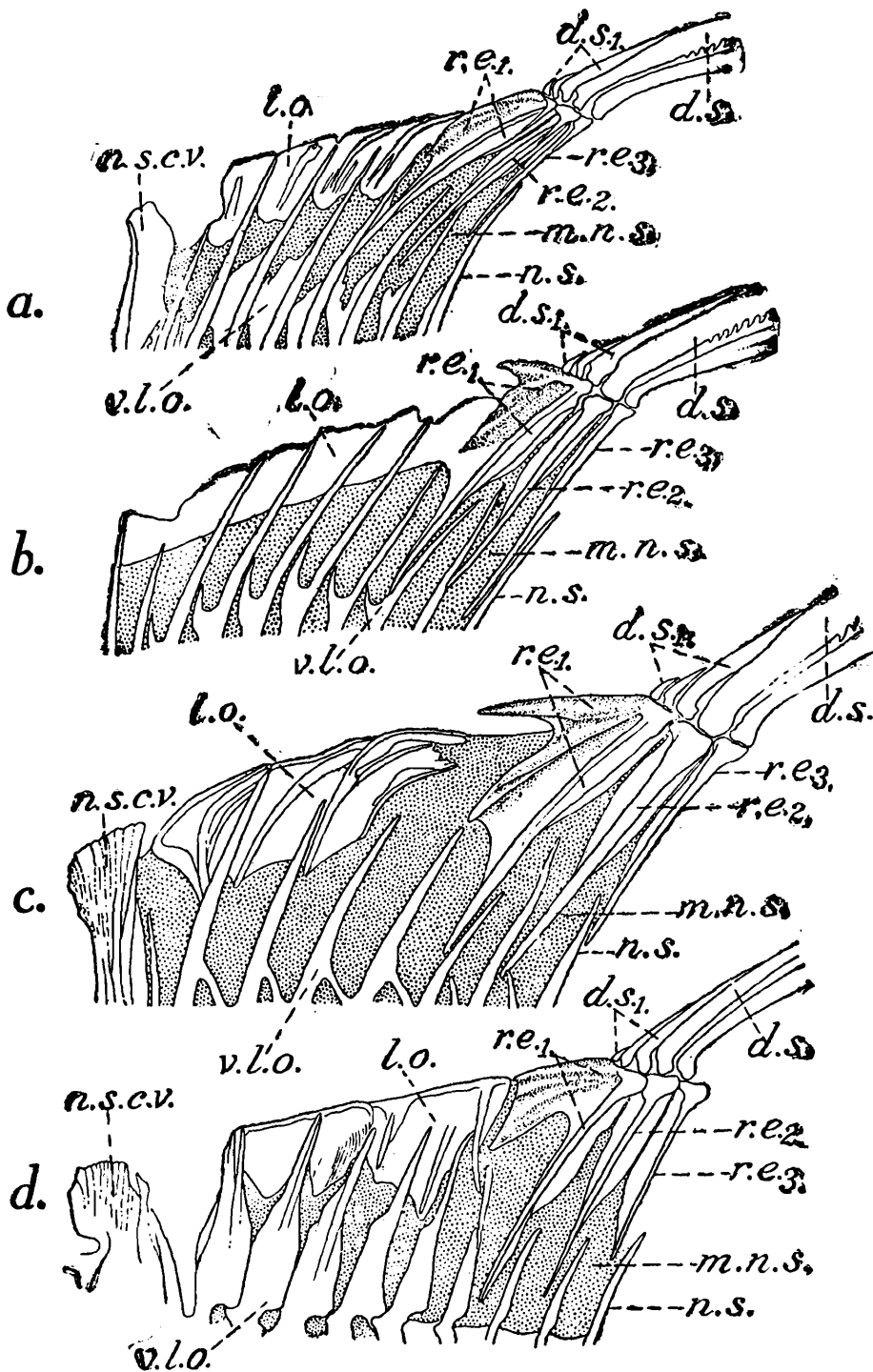
A very characteristic feature of *Rohtee* and *Parabramis* is that both the dorsal and the ventral surfaces are provided with sharp edges—especially the portion of the dorsal surface in front of the dorsal fin and that of the ventral surface behind the ventral fins. To support the sharp edge immediately in front of the dorsal fin the anterior portion of the first radial of the fin (text-fig. 3) is so modified that its distal edge trails close to the surface. In front of the radial elements there is a series of well-developed lamellar ossicles which lie between the neural spines of the adjacent vertebrae; these not only present a suitable surface for the attachment of muscles but also provide the necessary support for the keeled dorsal edge. Anteriorly these ossicles are replaced by the compressed neural spine of the compound vertebra and the supra-occipital crest. Bridge¹ described a similar series of bony elements in *Abramis brama* and *Tinca tinca* and concluded that “These ossicles are proximal segments of the fin supports of the atrophied anterior section of the dorsal fin.” Whatever may be their phylogenetic significance, their presence is undoubtedly meant to provide a support to the sharp dorsal edge.

For the probable mode of origin of the pre-dorsal spine we may consider the structure of the dorsal fin of *Rohtee duvaucelli* (C. V.), *Mystacoleucus ogilbii* (Sykes) and *M. marginatus* (C. V.).

In *Rohtee duvaucelli* (text-fig. 3 a) the character of the radial skeletal elements of the dorsal fin is more or less similar to that of the four Cyprioid types described by Bridge (*op. cit.*) except that its first radial element (*r. e.*) is better developed and its antero-dorsal border lies just below the sharp edge of the dorsal surface. It is preceded by a continuous series of lamellar ossicles (*l. o.*) which lie between the neural spines of the adjacent vertebrae. The median region of each ossicle is thickened to form a ridge-like structure. Near the bases of the neural spines, a further series of lamellar ossicles (*v. l. o.*) is developed from the anterior borders of the neural spines. Anteriorly they become more extensive and form broad supporting laminae between the neural spines. In *R. ogilbii* (text-fig. 3 b) the structures are similar to those of *R. duvaucelli* except that the first radial element (*r. e.*) is produced forward as a short spine, the lamellar ossicles are broad and thin. The ventral lamellar ossicles near the bases of the neural spines have, more or less, coalesced with the spines, so that a forwardly directed outgrowth of the neural spine gives support to the neural spine of the vertebra anterior to it.

¹ Bridge, T. W.—The Mesial Fin of Ganoids and Teleosts. *Journ. Linn. Soc. London (Zool.)*, XXV, p. 549 (1896).

In *R. marginatus* (text-fig. 3 c) the forwardly directed predorsal spine is considerably larger and the dorsal lamellar ossicles are provided with



TEXT-FIG. 3.—The skeletal elements of the dorsal spine and of the region in front of it in Rohtee Sykes, *Mystacoleucus* Günther and *Barbus* Cuvier.

a. *Rohtee duvaucelli* (Cuv. & Val.); b. *Mystacoleucus ogilbii* (Sykes); c. *M. marginatus* (Cuv. & Val.); d. *Barbus kolus* Sykes.

d. s.=Last dorsal spine; d. s.₁=Vestigeal dorsal spines; l. o.=Dorsal lamellar ossicles; m. n. s.=Membrane between neural spines; n. s.=Neural spine; n. s. c. v.=Neural spine of compound vertebra; r. e. 1. to r. e. 3.=Radial elements of the spines and the anterior fin rays; v. l. o.=Ventral lamellar ossicles.

strengthening ridges. The ventral lamellar ossicles are replaced by solid, bony columns between the adjacent vertebrae. Thus in the

three types described above we find that there are bony elements to strengthen the dorsal edge of the fish and that supports are developed to keep the neural spines in position and to prevent them from bending backwards. All these devices are probably meant to combat the stress imposed on the fish as it swims rapidly through water. Under such circumstances the utility of the predorsal spine would seem to present a stream-like wedge to the water before it approaches the dorsal fin. In the earlier stages of the flattening of the keeled dorsal surface it seems probable that more work was thrown on the predorsal spine. This assumption is borne out by the fact that the spine becomes larger and more powerful in the series of forms represented by *Mystacoleucus ogilbii*, *M. marginatus*, and *Matsya pingi*. (The spine of the last species was described and figured by Rendahl). When, however, the entire dorsal surface became stream-lined, the predorsal spine gradually disappeared. Such a course of evolution would indicate the production of "*Barbus*" from *Matsya*-like ancestors. If the presence or absence of a predorsal spine is ignored, *Barbus* and *Matsya* cannot be distinguished from each other by any other well-marked character. There would thus seem to be considerable justification for the views of Nichols and Pope¹ and Nichols² to regard *Spinibarbus* as a subgenus of *Barbus*. In *B. kolus* Sykes (text-fig. 3 d) the neural spine in front of the dorsal fin are laminated in their basal halves and the laminae in some cases overlap one another. The dorsal lamellar ossicles are also well-developed for the attachment of the muscles.

In connection with the above hypothesis, it has also to be considered that *Barbus* is a much more widely distributed genus than the fishes of the *Rohtee* or the *Matsya* groups; it is undoubtedly of great antiquity, as it is found as far afield as Africa. It is possible, therefore, that *Barbus* represents the earliest descendants of the original migrating stock, while *Rohtee*, *Mystacoleucus*, *Matsya*, etc., represent the later waves of migration of a somewhat modified stock which have not been able to reach very distant regions owing to the land connections having disappeared in the meantime.

SUMMARY.

Matsya Day, with 5 branched rays in the anal fin, is recognised as a valid genus and to its synonymy are assigned *Spinibarbus* Oshima and *Spinibarbichthys* Oshima. On geographical grounds, however, species with a serrated dorsal spine are referred to *Matsya* (s. s.) and those with a smooth spine to *Spinibarbus* (subgenus of *Matsya*).

Mystacoleucus Günther, with 8-10 branched rays in the anal fin, is recognised as a valid genus. Owing to the presence of a predorsal spine in *Rohtee ogilbii* Sykes, it is referred to *Mystacoleucus*, the definition of which is emended to include forms with 14 branched rays in the anal fin.

Mystacoleucus, with a longer anal fin, is regarded as more primitive than *Matsya*.

¹ Nichols and Pope, *Bull. Amer. Mus. Nat. Hist.*, LIV, p. 343 (1927).

² Nichols, *ibid*, LVIII, p. 11 (1928).

The inter-relationships of *Rohtee* and *Parabramis* are discussed and the geographical distribution of all the forms referred to above is given. It is observed that the centre of distribution of these fishes has to be placed somewhere in South China whence at different periods different types of forms migrated both towards north and south. The northern forms retained their primitive features while, owing to the orogenic disturbances in South China and further south, the forms migrating towards south and those in the home-country became more highly specialised.

From a comparative study of the skeletal elements of the dorsal fin in 4 forms the probable mode of origin and function of the predorsal spine are given. It is concluded that *Barbus* was probably derived at a very early stage from *Matsya*-like ancestors.

NOTES ON FISHES IN THE INDIAN MUSEUM.

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

XXX.—ON THE SYSTEMATIC POSITION OF *CYPRINUS COSUATIS* HAMILTON.

Cyprinus cosuatis is one of the ten species assigned by Hamilton¹ to the eighth division—*Cabdio*—of the genus *Cyprinus* which comprises a very heterogenous assemblage of forms. The other species of this division are *C. jaya*, *C. mola*, *C. hoalius*, *C. borelio*, *C. solio*, *C. guganio*, *C. cotio*, *C. devario* and *C. dancena*. The generic name *Cabdio* is not in common use, but according to Jordan² its type should be the first species named, i. e., *Cyprinus jaya* Hamilton. In view of this limitation it is likely that *Aspidoparia* Heckel³, with *A. sardina* as orthotype may have to be suppressed in favour of *Cabdio*. Of the other species, *C. mola* is usually assigned to the genus *Amblypharyngodon* Bleeker, *C. cosuatis* and *C. guganio* to *Barbus* Cuvier, *C. cotio* to *Rohtee* Sykes, *C. devario* to *Danio* Hamilton, while the precise generic and specific limits of the remaining species are still in doubt. Of the two small species at present included in the genus *Barbus*, *B. guganio* is known only from Hamilton's original description and figure and so far as I am aware no specimen of the species is at present available in any museum collection, though according to Hamilton (*loc. cit.*, p. 339) "The *Guganio* (*Gugani*) is probably found in most of the rivers and ponds of the Gangetic provinces, as I have seen it in both the Brahmaputra and Yamuna, the extreme rivers of that territory." Day⁴ considered it to be a close ally of his *B. ambassis*, which he found in "Madras, Orissa, Bengal, and Assam at least as high as Suddya." *Barbus cosuatis* was originally described from the Kosi river, but Day extended its range to "Bengal through the N. W. Provinces, the Deccan and Bombay, and down the Western coast as low as Cottayam in Travancore."

Among other characters Hamilton (*loc. cit.*) noted the following distinguishing features of his *Cyprinus cosuatis* :

"The form is deep, compressed, more prominent on the back than below. The colour is silver, with a greenish back, and the scales on the part are dotted towards the root. The ventral fins are red, all the others are yellowish, and those of the back and behind the vent are stained with black. The eyes are silver, stained above with black."

Day (*loc. cit.*) who figured a specimen of the species from Jubbulpore, noted that the fish attains 2 to 3 inches in length and directed attention

¹ Hamilton, F.—*An Account of the Fishes found in the River Ganges and its branches*, pp. 333-343 (Edinburgh : 1822).

² Jordan, D. S.—*The Genera of Fishes*, p. 115 (Stanford University, California : 1917).

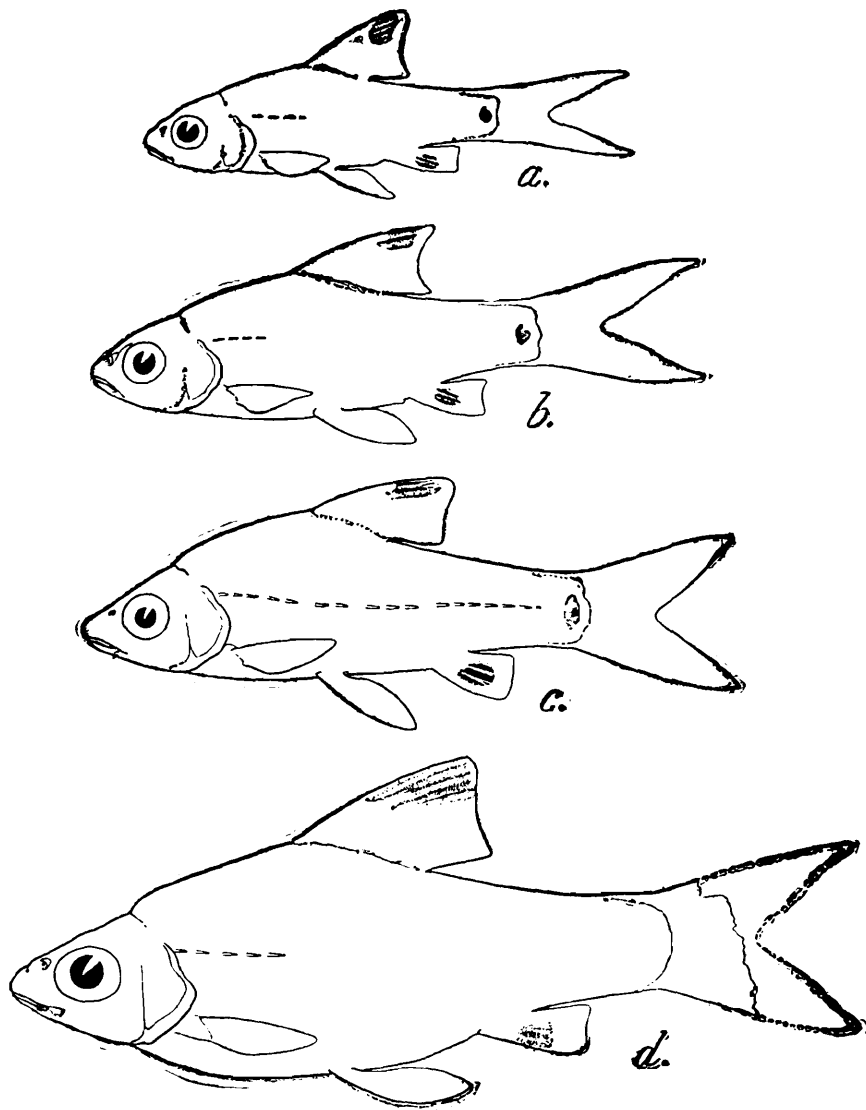
³ Heckel, J. J.—*Ichthyologie (von Syrien)*. In Russeger (Joseph von) : *Reisen in Europe, Asien und Africa, mit besonderer Rücksicht auf naturwissenschaftlichen Verhältnisse der betreffenden Länder, unternommen in den Jahren 1835 bis 1841*. Part 2, p. 288 (1877).

⁴ Day, F.—*Fishes of India*, pp. 576, 579, 581 (1877).

to several of its salient features. Among these mention may be made of the following, (i) dorsal without any osseous ray, (ii) height of dorsal greater than depth of body, (iii) incomplete lateral line, (iv) scales along lateral line larger than others, (v) 8 or 9 rows of scales before base of dorsal and (vi) colouration. Recently in a specimen of the species from Mysore I¹ pointed out the greater extent of the lateral line and the well defined nature of the rounded black spots on the dorsal and the anal fins. Further it was observed that :

“The most remarkable feature of this species appears to be the presence of numerous, fine, parallel sensory folds on the sides of the head. This feature it shares with the fishes of the genus *Cyclocheilichthys* Bleeker, but in other respects it is quite different.”

Later I found that Smith² had already described a new genus *Oreichthys* from Siam for Cyprinid fishes of the type of *Barbus cosuatis* and



TEXT-FIG.1.—Outline drawings of the growth-stages of *Oreichthys cosuatis* (Ham.).

a. 18 mm. in length without caudal ; b. 23 mm. in length without caudal ; c. 26 mm. in length without caudal ; d. 34 mm. in length without caudal.

¹ Hora, S. L.—Notes on Fishes in the Indian Museum, XXVIII. On three collections of Fish from Mysore and Coorg, South India. *Rec. Ind. Mus.*, XXXIX, pp. 17, 18 (1937).

² Smith, H. M.—Contributions to the Ichthyology of Siam, III. A New Genus and New Species of Cyprinoid Fishes. *Journ. Siam Soc., Nat. Hist. Suppl.*, IX, p. 63 (1933).

had assigned to it a new species *O. parvus*, which is said to grow to 31 mm. in total length. In general facies, lepidosis and colouration the Siamese fish seemed so similar to Hamilton's *cosuatis* that I requested Mr. Luang Choola, Officer-in-charge, Bureau of Fisheries, Bangkok, to send me for comparison a few specimens of Smith's species. He very kindly presented 3 examples of *O. parvus* to the Zoological Survey of India, and these have enabled me to come to a definite conclusion that *O. parvus* is a juvenile form of *Cyprinus cosuatis*. Further, it is clear that this species is sufficiently distinct, especially on account of the sensory folds on the head, from the numerous species of the genus *Barbus* known from India, and should, therefore, be retained in a separate genus *Oreichthys* Smith, which as pointed out by its author, is closely allied to *Cyclocheilichthys* Bleeker.

Oreichthys cosuatis (Ham.) is represented by a few specimens in the collection of the Indian Museum, and unfortunately most of them are not in a good state of preservation. The sensory folds on the head are, however, fairly distinct in all of them. A comparison with the young specimens from Siam shows that when the fish is about 18 mm. in length without the caudal fin (text-fig. 1 *a.*), the dorsal spine is longer than the head and the depth of the body, and the spot at the base of the caudal fin is intensely black. The spots on the dorsal and the anal fins are also well marked and seem quite compact. In a specimen about 23 mm. in length without the caudal (text-fig. 1 *b*) the depth of the body is almost equal to the length of the dorsal; the length of the head is considerably shorter than both these dimensions. The three colour spots are somewhat diffuse but more extensive. In a specimen from Mysore, about 26 mm. in length without the caudal (text-fig. 1 *c*), the depth of the body is considerably greater than the length of the dorsal fin, which is almost equal to the length of the head. The dorsal and the anal fin spots are well pronounced, while that at the base of the caudal fin is very diffuse and indistinctly marked. The most remarkable feature about this specimen is that the lateral line, though interrupted in places, extends up to the 20th scale. As a rule, it is present only on the first 4 or 5 scales. In a specimen from the Saran District of Bihar, about 34 mm. in length without the caudal (text-fig. 1 *d*), the length of the dorsal fin, though greater than that of the head, is considerably shorter than the depth of the body. The spot on the dorsal fin is very diffuse and extensive while that on the anal fin is only faintly marked. As far as I can make out from the spirit material, the spot at the base of the caudal fin is almost absent.

Though sufficient material is not available for a detailed study of the variations undergone by this fish with growth, it is clear from the above that the young specimens from Siam are referable to Hamilton's species.

XXXI.—ON A SMALL COLLECTION OF FISH FROM SANDOWAY, LOWER BURMA.

In the course of an investigation of the Anopheline fauna of Sandoway, Lieut. E. S. Feegrade, Malariologist to the Public Health Department of Burma, collected several samples of fish from the stone-lined

shallow wells and the road-side drains of the town of Sandoway, headquarters of the district of the same name in Lower Burma and situated in Lat. 18° 28' N. and Long. 94° 21' E. The fish were collected in several lots between June and August 1936, and sent to the Zoological Survey of India for determination. At my request, Lieut. Feegrade arranged to have further specimens collected through Dr. U. Shwe Baw for the Zoological Survey of India. Though the entire material consists of 24 specimens only, two new species have been discovered. It has also been found that the specimens of the already known species vary considerably from their respective typical series, especially in colouration. These results are not surprising when it is remembered that the fresh-water fish fauna of this region, including that of the neighbouring Arakan Yomas has never been investigated before.

Lieut. Feegrade informed me that most of his material was collected in clear, running water, such as road-side drains, seepage water drains, small hill-streams and small ponds. It may be indicated that Sandoway is situated on the left bank of the Sandoway river, about 15 miles to the S. E. of its mouth and between 4 to 5 miles due east of the sea coast in a direct line. The area in its neighbourhood is full of tidal creeks and there is practically no plain land along the valley of the Sandoway river.

The following species of fish have been found in the collection :—

1. <i>Rasbora daniconius</i> (Ham.)	2 specimens.
2. <i>Brachydanio choprai</i> Hora	4 specimens.
3. <i>Danio feegradei</i> , sp. nov.	1 specimen.
4. <i>Barbus</i> (<i>Puntius</i>) <i>binduchitra</i> , sp. nov.	10 specimens.
5. <i>Barbus</i> (<i>Puntius</i>) <i>stoliczkanus</i> Day	5 specimens.
6. <i>Panchax panchax</i> (Ham.)	2 specimens.

I take this opportunity to offer my sincere thanks to Lieut. E. S. Feegrade for having made a valuable collection of fish for the Zoological Survey of India. The material is in a very good state of preservation.

***Rasbora daniconius* (Ham.).**

1889. *Rasbora daniconius*, Day, *Faun. Brit. Ind. Fish.*, I, p. 336.

Rasbora daniconius is represented in Lieut. Feegrade's collection by two specimens, measuring 42 mm. and 45 mm. in total length. They were collected from a road-side drain. The black lateral band is very well marked and extends from the tip of the snout to the base of the caudal fin, the middle rays of which are stained gray. The scales above the lateral line, as also some below it, are marked with black dots along the margin. The dorsal surface is dusky with a black streak along the mid-dorsal line.

***Brachydanio choprai*¹ Hora.**

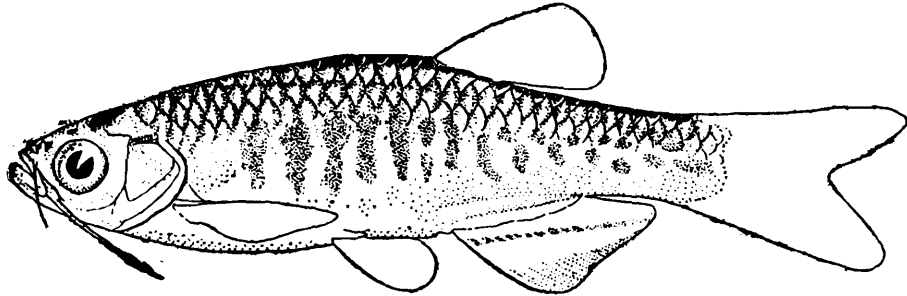
1928. *Danio* (*Brachydanio*) *choprae*, Hora, *Rec. Ind. Mus.*, XXX, p. 39, fig. 2.

1934. *Danio* (*Brachydanio*) *choprae*, Hora & Mukerji, *Rec. Ind. Mus.*, XXXVI, p. 130 (Synoptic Table to species of *Brachydanio*).

There are 4 specimens of *Brachydanio choprai* from Sandoway; 2 were collected from a stone-well, while the remaining two were obtained

¹ By mistake *e* instead of *i* had been previously used in the termination of this specific name. The species was named after my colleague Dr. B. N. Chopra.

from a road-side drain. The two examples, 28 mm. and 30 mm. in total length respectively, from the well are more or less devoid of the typical colour pattern of the species, while those collected from the drain, 33 mm.



TEXT-FIG. 2.—Outline sketch of *Brachydanio choprai* Hora, showing colour markings in a specimen 33 mm. in total length.

and 36 mm. in total length respectively, are very gorgeously coloured. In the larger specimens the anterior vertical bands are replaced by rows of spots at the posterior end. The bands on the dorsal and the caudal fins are either faintly marked or are absent altogether. The band on the anal fin is, however, present in all the specimens.

There are several large sensory pores on the dorsal surface of the head along the supra-orbital edges. Though, as a rule, the lateral line is absent in this species, in certain specimens it may be present on the first few scales; when present, it bends abruptly downward and may extend as far as the base of the pelvic fin.

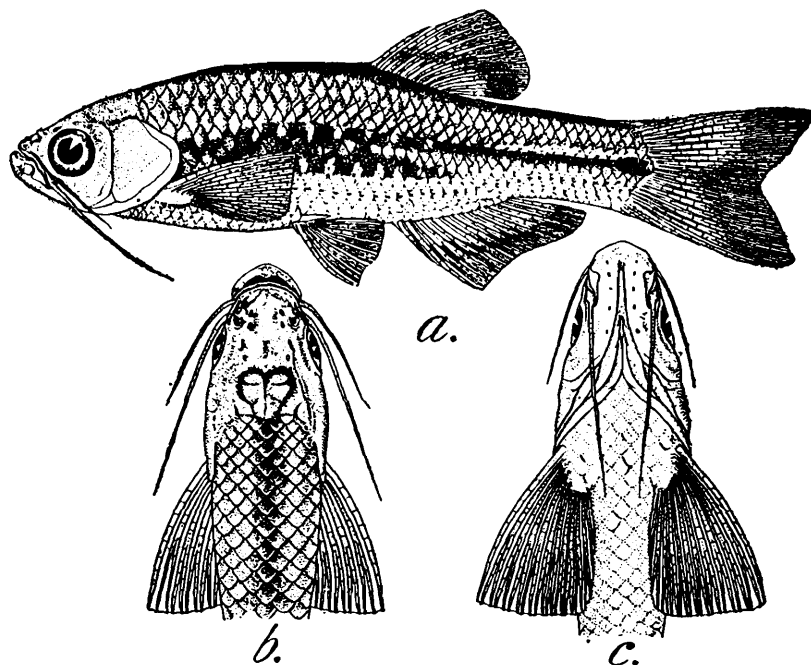
The species was hitherto known only from the Myitkyina District of Upper Burma.

Danio feegradei, sp. nov.

D. 2/9; A.3/12; P.12; V.8; C.19; L.1.39; L.tr.7½/2½.

The new species possesses a graceful form with both the dorsal and the ventral profiles slightly arched. The head and body are greatly compressed. The head is bluntly pointed and its length is contained 4.9 times in the total length and 3.9 times in the length without the caudal. The height of the head at the occiput is contained 1.3 times, and its width 1.8 times in its length. The diameter of the eye is contained about 3.3 times in the length of the head, 0.9 times in the length of the snout and 1.2 times in the interorbital distance. The nostrils are situated close to the anterior margin of the eye; the anterior nostril is somewhat tubular. Inner to the upper margin of the eye is a series of 4 large sensory pits similar to those described above in the case of *Brachydanio choprai*. Similar pores are also present on the ventral surface of the head. The mouth is small and oblique; it extends to below the anterior margin of the eye. The lips are thin, but are somewhat better developed near the angles of the mouth. Inner to the lower lip, on either side, there is a small pad of skin covered with spinous outgrowths. Presumably these structures represent the secondary sexual character of the male. There are two pairs of barbels; the rostrals are considerably shorter than the head, while the maxillary barbels are almost as long as the head or slightly longer. The basal portion of the rostral barbel is enclosed in a groove.

The depth of the body at the commencement of the dorsal fin is equal to the length of the head. The least height of the caudal peduncle



TEXT-FIG. 3.—*Danio feegradei*, sp. nov.

a. Lateral view. $\times 1\frac{1}{2}$; b. Dorsal surface of head and anterior part of body. $\times 2$.

is contained 1.5 times in its length. The lateral line is complete and runs along the lower half of the caudal peduncle. There are about 39 rows of scales along the lateral line and $7\frac{1}{2}$ rows between it and the base of the dorsal fin. There are $2\frac{1}{2}$ rows of scales between the lateral line and the base of the pelvic fin which is provided with a scaly appendage. There are about 20 predorsal scales and 14 round the caudal peduncle. There are a few rows of small scales at the base of the anal fin.

The dorsal fin is short; its commencement is equidistant between the posterior margin of the eye and the base of the caudal fin; its height is considerably less than the depth of the body below it. The pectoral fin is smaller than the head and just reaches the base of the pelvic fin. The pelvic fin extends to the anal opening, but not to the anal fin. The anal fin is fairly extensive; the length of its base is equal to the head without the snout. The caudal fin is somewhat longer than the head, it is emarginate, with the upper lobe slightly longer than the lower.

The general ground colour, after preservation in spirit, is pale-olivaceous. The dorsal surface is dusky with a black streak along the mid-dorsal line. In the middle of the fish there is a black band which is considerably broader anteriorly and terminates posteriorly in a somewhat darker spot at the base of the caudal fin. Anteriorly the black band is marked, both above and below, with short pearl-white bands and in the posterior region there is a white longitudinal band above it. The rays of the dorsal and anal fins are marked with longitudinal bands across them.

Type-specimen.—F. 12477/1, Zoological Survey of India, Indian Museum, Calcutta.

Habitat.—Road-side drains, Sandoway, Lower Burma.

Remarks.—In referring this species to the genus *Danio* Hamilton a certain amount of difficulty has been experienced. Weber and de Beaufort¹ restricted this generic denomination to fishes with “Dorsal fin elongate, with 12-16 branched rays. Lateral line complete.” The remaining species, “With dorsal fin short, with 7 branched rays only. Lateral line incomplete or absent.”, were referred to *Brachydanio*. In 1934, Mukerji and the writer² observed that

“During recent years several new forms of the *Brachydanio*-type have been discovered in Burma and though in all of them the dorsal fin is short, the lateral line has been found to be very variable. In the majority of forms it is either absent or extends over a few scales in the anterior region; but there are some species in which it is fairly extensive or even complete.”

Danio feegradi has only 9 branched rays, as against 7 in *Brachydanio* and 12-16 characteristic of the other species of *Danio*. In this respect it is intermediate between the two genera; while in the possession of long barbels and a complete lateral line it shows greater affinities with the typical members of the *Danio* group. The colouration of this fish is quite different from other species of the genus known so far.

The name of this gorgeously coloured little fish is associated with that of Lieut. E. S. Feegrade.

Measurements in millimetres.

Total length excluding caudal	43.0
Length of head .	11.0
Height of head at occiput	8.0
Width of head	6.0
Length of snout	3.0
Diameter of eye .	3.3
Interorbital width	4.1
Height of body	11.0
Width of body	5.0
Longest ray of dorsal	8.3
Longest ray of anal	7.5
Length of pectoral	9.0
Length of caudal peduncle	9.0
Least height of caudal peduncle	6.0

***Burbus (Puntius) binduchitra*,³ sp. nov.**

D.3/8; A.3/5; P.16; V 10; C.19; L.1.28-30; L.tr.5½/4½.

Puntius binduchitra is a small species in which both the dorsal and the ventral profiles are considerably arched. The body is greatly compressed; the dorsal surface in front of the dorsal fin is more or less keeled. The head is bluntly pointed; its length is contained from 4.5 to 4.7 times in the total length, and from 3.4 to 3.7 times in the length without the caudal. The height of the head at the occiput is contained from 1.1 to 1.2 times and its width from 1.3 to 1.6 times in its length. The head is proportionately smaller in the young specimens. The eye is lateral and situated close to the dorsal surface of the head; its diameter is almost equal to the length of the snout and is contained from 2.6 (in the young) to 3.5 times in the length of the head; usually it is contained from 3 to 3.5 times in the length of the head. The interorbital space

¹ Weber & de Beaufort, *Fish. Indo-Austral. Archipel.*, III, p. 85 (1916).

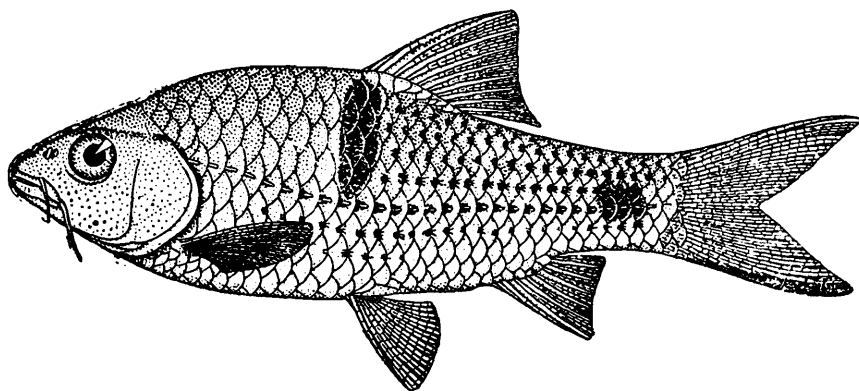
² Hora & Mukerji, *Rec. Ind. Mus.*, XXXVI, p. 130 (1934).

³ *Binduchitra* is a combined Sanskrit word which means “spotted”. In the specific name reference is made to the characteristic colouration of the species.

is flat and in the young specimens it is equal to the diameter of the eye ; in older specimens it is somewhat greater than the diameter of the eye. The nostrils are situated close to the front border of the eye and are separated by a flap of skin. The mouth is semicircular, almost inferior and sub-terminal. The lips are thin but continuous ; the labial groove is interrupted in the middle. There are two pairs of well developed barbels ; the rostral barbels are equal to the diameter of the eye, but the maxillary barbels are somewhat longer.

The depth of the body increases with growth ; it is contained from 3.6 to 4.4 times in the total length and from 2.8 to 3.4 times in the length without the caudal. The least height of the caudal peduncle is contained from 1.1 to 1.4 times in its length. The scales are large and firmly adherent ; there are from 28 to 30 series of scales along the lateral line, $5\frac{1}{2}$ rows above it and $3\frac{1}{2}$ rows below it to the base of the pelvic fin. The number of predorsal scales varies from 9 to 10. There are 14 scales round the caudal peduncle. The pelvic fin is provided with a scaly appendage at its base. The rows of scales at the bases of the dorsal and anal fin contain somewhat smaller scales and their shape is also different from those covering the other parts of the body.

The dorsal fin commences slightly in advance of the pelvics and somewhat nearer to the base of the caudal fin than to the tip of the snout ; its longest ray is usually shorter than the head. The last simple ray is articulated, but is serrated along the inner border. The anal fin is provided with 3 spines and 5 branched rays, the last of which is divided to the base. The pectoral fin is considerably shorter than the head and does not extend to the pelvic fin. The vent is situated just in front of the anal fin. The caudal fin is deeply forked ; both the lobes are pointed ; it is invariably longer than the head.



TEXT-FIG. 4.—Lateral view of the type-specimen of *Barbus (Puntius) binduchitra*, sp. nov. $\times 1\frac{1}{4}$.

The most characteristic feature of the species is its colouration. In all specimens there is a broad vertical band below the commencement of the dorsal fin which extends to the lateral line and a black blotch on the sides of the tail slightly in front of the base of the dorsal fin. In specimens over 56 mm. in total length, the scales above the lateral line and posterior to the large mark develop small rounded black spots in the centre so that the body in this region becomes spotted in a series of rows. Similar black spots appear on the scales of the lateral line and of those of the two rows below it, but they extend anteriorly beyond

the limit of the vertical mark. The upper edge of the dorsal and both the upper and lower margins of the caudal, especially the lower, become dusky in half-grown specimens and intensely black in somewhat older specimens.

Type-specimen.—F. 12478/1, Zoological Survey of India, Indian Museum, Calcutta.

Habitat.—Road-side drains and small streams at Sandoway, Lower Burma.

Remarks.—In its spotted colouration as well as in the possession of 4 well developed barbels and a serrated dorsal spine, *B. binduchitra* shows considerable affinity to *B. pinnauratus* (Day¹) from South India and *B. sewelli* Prashad and Mukerji² from the Myitkyina District. In *B. sewelli* the body is considerably deeper (2.3 to 2.5 times in the length with the caudal in specimens over 90 mm. in length without the caudal), and there is always a large black blotch behind the gill-opening. Moreover, the vertical band and the caudal spot characteristic of the new species are lacking in *B. sewelli*. Both the species agree in having the dorsal surface in front of the dorsal fin keeled. *B. binduchitra* has greater affinity with *B. pinnauratus*, but its head is proportionately longer and not so high, the eye is relatively smaller, the interorbital width is less, the body is not so high but is relatively more compressed. Most of these differences seem to be correlated with the keeled nature of the dorsal surface in the new species; in *B. pinnauratus* the dorsal surface is flatly rounded. In *B. pinnauratus* there is a black band behind the gill-opening and in some specimens a short oval spot below the commencement of the dorsal fin³; it has hitherto been known "From fresh waters at Coconada down the east coast of India to Ceylon, and inland as far as the Neilgherries, also along the Western Ghats and rivers at their bases,"⁴ but recently Mr. Duncan sent me very similar specimens from the Chindwin drainage near the border of Assam and Burma. Comments on his specimens are made below on p. 336.

Measurements in millimetres.

Total length including caudal	78.0	72.0	69.0	56.0	56.0	50.0	49.0	46.0	43.0	39.0	38.0
Length of caudal	18.5	15.3	16.0	12.5	12.3	12.0	11.5	11.0	10.3	9.0	9.0
Depth of body	20.2	20.0	18.8	15.0	15.0	13.0	12.3	10.5	10.0	9.0	8.5
Length of head	16.5	16.0	14.0	12.0	12.0	11.0	11.0	10.0	9.5	8.0	8.0
Height of head at occiput	13.3	13.0	12.5	11.0	11.0	9.0	9.0	8.0	7.5	7.0	7.0
Width of head	11.5	10.0	9.9	7.5	7.5	7.5	8.0	7.0	6.5	5.5	5.0
Length of snout	5.3	4.8	4.0	3.6	3.9	3.5	3.5	3.0	3.0	3.0	3.0
Diameter of eye	5.1	4.8	4.0	3.6	3.9	3.5	3.5	3.0	3.0	3.0	3.0
Interorbital width	5.7	5.0	4.8	4.3	4.5	4.0	4.0	3.5	3.3	3.0	3.0
Longest ray of dorsal	14.5	14.0	14.0	10.3	10.3	10.0	10.0	9.0	9.0	8.0	8.0
Longest ray of anal	10.0	10.0	10.0	7.5	8.0	7.0	7.0	6.5	6.3	5.0	5.0
Length of pectoral	12.0	12.0	11.3	8.5	9.0	7.3	7.3	6.8	6.5	6.0	6.0
Length of caudal peduncle	11.0	9.0	8.5	7.0	8.0	7.0	7.0	6.0	5.5	5.0	5.0
Least height of caudal peduncle	8.2	8.0	8.0	6.5	6.5	6.0	5.0	5.0	4.5	4.0	4.0

¹ Day, *Proc. Zool. Soc. London*, p. 300 (1865).

² Prashad & Mukerji, *Rec. Ind. Mus.*, XXXI, p. 197, pl. ix, fig. 1 (1929).

³ Hora, *Rec. Ind. Mus.*, XXXIX, p. 9, fig. 1 (1937).

⁴ Day, *Fish. India*, p. 562 (1877).

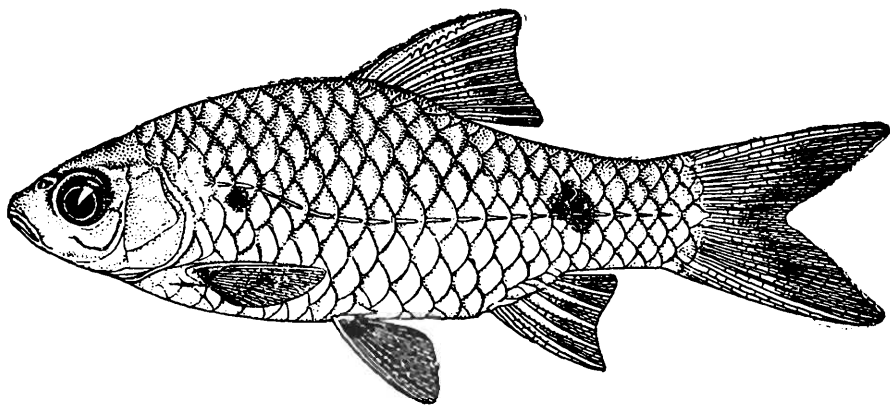
Barbus (Puntius) stoliczkanus Day.

1869. *Barbus M'clellandi*, Day (nec Cuvier & Valenciennes), *Proc. Zool. Soc. London*, p. 619.
 1871. *Barbus (Puntius) Stoliczkanus*, Day, *Journ As. Soc. Bengal*, XL, pt. 2, p. 328.
 1877. *Barbus stoliczkanus*, Day, *Fish. India*, p. 577, pl. cxliv, fig. 8.
 1889. *Barbus stoliczkanus*, Day, *Faun. Brit. Ind., Fish.*, I, p. 326.
 1893. *Barbus stoliczkanus*, Boulenger, *Ann. Mag. Nat. Hist.*, (6), XII, p. 202.
 1918. *Barbus stoliczkanus*, Annandale, *Rec. Ind. Mus.*, XIV, p. 35.
 1919. *Barbus stoliczkanus*, Chaudhuri, *Rec. Ind. Mus.*, XVI, p. 283.

Barbus stoliczkanus was originally described from a series of 21 specimens, 6 from Pegu and 15 from Moulmein, up to 4 inches in length. It was observed by Day that:—

“This species bears a strong resemblance to the *B. ticto*, H. B., which it appears to supersede in Eastern Burma. But it is distinguished by a complete instead of incomplete lateral line, and its body is not so compressed; its dorsal spine and colouring also differ.”

The dorsal spine of this species is less strongly serrated than in *B. ticto*, while the position of the lateral spots is also different. The most important difference between the two species, however, lies in the number of the predorsal scales—8 to 9 in *B. stoliczkanus* and 11 in *B. ticto*. The



TEXT-FIG. 5.—Lateral view of a specimen of *Barbus (Puntius) stoliczkanus* Day. $\times 2\frac{1}{2}$.

extent of the lateral line in the 5 specimens from Sandoway is variable; in two specimens it is almost complete, in two other specimens it extends over 17 to 19 scales while in one specimen it is limited to the first 7 scales. Sometimes the extent of the lateral line varies on the two sides of the same fish.

Day (1877) noted that “Some Darjeeling examples agree with the Burmese fish.” Since Day’s time, however, the species has been recorded only from Northern Burma (Boulenger: S. S. States; Chaudhuri: Putao). The Sandoway specimens are young, none exceeding 47 mm. in total length; they were collected from a road-side drain. In their proportions, lepidosis and number of fin rays, they agree with Day’s description of the species, except in having a somewhat different colouration.

Measurements in millimetres.

Total length including caudal	47.0	42.0	41.0	40.0	37.0
Length of caudal	11.0	9.0	10.0	9.0	9.0
Length of head	8.0	7.0	7.0	7.0	7.0
Height of body	14.5	13.5	12.2	11.0	10.5
Diameter of eye	3.0	2.5	2.5	2.5	2.5
Length of snout	2.5	2.0	2.0	2.0	2.0
Interorbital distance	4.0	3.8	3.8	3.5	3.5
Commencement of dorsal from tip of snout	18.5	17.0	16.0	15.0	15.0
Longest ray of dorsal	9.5	8.0	8.0	8.0	8.0

Panchax panchax (Ham.).

1889. *Haplochilus panchax*, Day, *Faun. Brit. Ind. Fish.*, I, p. 417.

There are two specimens, about 44 mm. in total length, of *Panchax panchax* in the collection from Sandoway; they were collected from a road-side drain. *P. panchax* is a widely distributed species of the Oriental Region; its range extends from Orissa, through Lower Bengal, to Burma, Andaman Islands, Siam, Malay Peninsula and the Archipelago.

XXXII.—ON A SMALL COLLECTION OF FISH FROM THE UPPER CHINDWIN DRAINAGE.

At my request Mr. S. J. Duncan, Sub-Divisional Officer at Ukhrul, Manipur State, Assam, in the course of his tours made a small collection of fish for the Zoological Survey of India from the Upper Chindwin Drainage. As the area traversed by him is very close to the boundary between Assam and Burma, the material is of special interest for zoogeographical studies, and throws considerable light on the distribution of some of the species represented in the collection.

The material consists of 46 specimens which are referable to 12 species belonging to the families Cyprinidae, Cobitidae, Sisoridae and Ophicephalidae. These are listed below according to the localities from where the material was obtained.

1. Small stream below the village Singcha Tangkhul flowing into the Khunukong or Nambalok (called Nampanga in Burma). 21.1.1937.

i. *Oreinus molesworthi* Chaudhuri. 2 specimens.

2. Small stream below the village Chahong Khulen flowing into the Khunukong or Nambalok. 25.1.1937

i. *Barbus hexagonolepis* McClelland 1 specimen.

ii. *Barbus clavatus* McClelland 1 specimen.

3. Upper reaches of the Namya river at Kongan Thana, a Kabo or Shan village. 28.1.1937.

i. *Barilius barila* Ham. 1 specimen.

ii. *Labeo devdevi* Hora 4 specimens.

iii. *Garra gotyla* (Gray). 4 specimens.

iv. *Barbus myitkyinae* Prashad & Mukerji 2 specimens.

v. *Nemachilus vinciguerrai* Hora 7 specimens.

vi. *Glyptothorax trilineatus* Blyth 3 specimens.

vii. *Ophicephalus gachua* Ham. 2 specimens.

4. Chakpi river at Chakpi Karong. 1.iii.1937.
- | | |
|---------------------------------------------------------|--------------|
| i. <i>Barilius barila</i> Ham. | 3 specimens. |
| ii. <i>Barbus pinnauratus</i> (Day) | 3 specimens. |
| iii. <i>Barbus clavatus</i> var. <i>burtoni</i> Mukerji | 2 specimens. |
5. Lokchao river at Tamu. 15.iii.1937.
- | | |
|--------------------------------------------------|--------------|
| i. <i>Barbus pinnauratus</i> (Day) | 5 specimens. |
| ii. <i>Lepidocephalichthys berdmorei</i> (Blyth) | 6 specimens. |

The range of distribution of the following species is extended in this article : *Barbus myitkyinae*, *B. pinnauratus* and *Glyptothorax trilineatus*. The most interesting record is that of *B. pinnauratus* which was hitherto known from South India only. It is also clear from the collection that the typical Burmese fauna is well represented in the Upper Chindwin Drainage.

I take this opportunity to record my sincere thanks to Mr. S. J. Duncan for the opportunity he has afforded me of examining fishes from a zoologically interesting region. The material is in an excellent state of preservation and forms a valuable addition to the collection of the Zoological Survey of India. Mr. Duncan's notes on the colouration of the species, reproduced below, are most helpful.

Family CYPRINIDAE.

***Barilius barila* Hamilton.**

1921. *Barilius barila*, Hora, *Rec. Ind. Mus.*, XXII, p. 190.

Vernacular Names.—*Thêlbôl* Kuki; *Ngapâilâ* Tangkhul; *Pakham* Kabo.

1 specimen. Namya river at Kongan Thana. 28.i.1937.

3 specimens. Chakpi river at Chakpi Karong. 1.iii.1937.

There are altogether 4 specimens of *Barilius barila* in the collection, ranging in length from 105 mm. to 120 mm. in total length. In none of the specimens the outer rays of the pectoral fins are specially strengthened for the purpose of adhesion to rocks. In all the specimens, particularly those from the Chakpi river, the body is covered with a number of black spots which represent encysted Trematode larvae; these should not to be confused with the colour markings. According to Mr. Duncan's observations the colouration is as follows :—

“Dorsal surface dark. Ventral white (or silvery). The sides are transversed by dark bluish broad stripes running parallel to each other. Fins pinkish.”

B. barila is known both from India and Burma.

***Oreinus molesworthi* Chaudhuri.**

1913. *Oreinus molesworthi*, Chaudhuri, *Rec. Ind. Mus.*, VIII, p. 247, pl. vii, figs. 2, 2a, 2b.

1935. *Oreinus molesworthi*, Hora & Mukerji, *Rec. Ind. Mus.*, XXXVII, p. 391.

Vernacular Names.—*Sana-nga* Manipuri; *Nganam* Kuki; *Khaingui* Tangkhul. The Manipuri name means “Goldfish”.

2 specimens. Stream below Singcha Tangkhul. 21.i.1937.

Oreinus molesworthi is represented by 2 young specimens in the collection which are about 130 mm. and 142 mm. in total length

respectively. Though the specimens were collected only from one small stream below Singcha Tangkhul, Mr. Duncan states that "This fish is also found in other streams of the same drainage, but it is *not* found in all streams. It inhabits mostly the higher and colder reaches of the streams where they are found." It may be noted here that the type-specimen, 202 mm. in total length, was collected from Yembung at an altitude of 1,100 feet only.

Mukerji and I had recently extended the range of the species to the Chindwin drainage system in the Naga Hills.

According to Mr. Duncan the colouration of the species is as follows :—

"The dorsal surface is dark brown. This colour decreases in intensity as it approaches the dark thin line that runs right through the middle of the side from the angle of the operculum to the root of the caudal fin. When looked at laterally the colour appears steel grey. Below the dark line the colour is silvery white. The ventral surface is also white. The scales are very very small. Fins are slightly pinkish except perhaps the dorsal."

Labeo devdevi Hora.

1934. *Labeo (Labeo) dyocheilus* (in part), Mukerji (*nec* McClelland), *Journ. Bombay Nat. Hist. Soc.*, XXXVII, pp. 55-59 (Burmese and Siamese form, p. 58).

1936. *Labeo devdevi*, Hora, *Rec. Ind. Mus.*, XXXVIII, pp. 323-324.

Vernacular Names.—*Ngatin Macha* Manipuri; *Ngachuntam* Kuki; *Ngalu* Kabo.
4 specimens. Namyra river at Kongan Thana. 28.i.1937.

In Mr. Duncan's collection *Labeo devdevi* is represented by 4 young specimens, varying in length from 83 mm. to 92 mm. in total length. Its superficial resemblance to *L. dero* (Ham.) is very great indeed; but the two species can be readily distinguished by their lepidosis. Both *L. dero* and *L. devdevi* are liable to be confused with *L. dyocheilus* McClelland, but I have shown in the paper referred to above that McClelland's species has a very characteristic type of adhesive surface of the lower lip.

According to Mr. Duncan the colouration of the species is as follows :—

"Dark green dorsal surface and white ventral. The scales are small and have a coppery tint. Opercular region with a golden tint. Fins pinkish."

Garra gotyla (Gray).

1921. *Garra gotyla*, Hora, *Rec. Ind. Mus.*, XXII, p. 653.

1936. *Garra gotyla*, Hora & Mukerji, *Rec. Ind. Mus.*, XXXVIII, p. 144.

Vernacular Names.—*Ngamu Sangkhom* Manipuri; *Ngapum* Kuki; *Masangla* Tangkhul; *Pachup-hen* Kabo.

4 specimens. Namyra river at Kongan Thana. 28.i.1937.

Garra gotyla is perhaps the most widely distributed species of the genus, as it is found all along the Himalayas. The four specimens in Mr. Duncan's collection are from 97 mm. to 104 mm. in total length. The colour is almost black along the dorsal surface and the sides. Mr. Duncan found that "The whole body of the fish is dark green in colour except the ventral surface which is flattish and white." All the specimens are provided with a well developed proboscis on the snout.

In 1921, I¹ recorded *G. gotyla*, for the first time, from the north-eastern border of Burma and the Naga Hills.

***Barbus hexagonolepis* McClelland.**

1936. *Barbus hexagonolepis*, Hora, *Rec. Ind. Mus.*, XXXVIII, p. 330.

Vernacular Names.—*Ngara* Manipuri; *Ngaha* Kuki.

1 specimen. Stream below Chahong Khulen. 25.i.1937.

In the paper referred to above I discussed the specific limits of the various species of the large-scaled Barbels found in Assam. It was also indicated that *B. hexagonolepis* is the commonest Barbel of the torrential streams of the Naga Hills. In Mr. Duncan's collection there is only one specimen, about 107 mm. in length without the caudal. Mr. Duncan states that it is the mighty *Mahseer* of this region and observes that it "is found in almost all the rivers in these hills" His description of the colour is as follows:—

"Dark green dorsal surface. A white (sometimes yellowish) broad line runs laterally and below it another dark broad line runs in the same direction from the operculum to the root of the caudal fin. White ventral surface."

***Barbus myitkyinae* Prashad and Mukerji.**

1929. *Barbus myitkyinae*, Prashad & Mukerji, *Rec. Ind. Mus.*, XXXI, p. 198, pl. ix, figs. 2, 2a, 2b.

Vernacular Names.—*Ngasang* Kuki; *Khaisang* Tangkhul; *Pachak* Kabo.

2 specimens. Namya river at Kongan Thana. 28.i.1937.

In Mr. Duncan's collection there are two specimens of *Barbus myitkyinae*, 97 mm. and 104 mm. in total length respectively. The species was described from the Myitkina District, Upper Burma, where it is stated to be quite common in the Indawgyi Lake and the streams in the adjacent area. The present record of *B. myitkyinae* from the Upper Chindwin Drainage shows that the species is probably widely distributed in the headwaters of the Chindwin and the Irrawadi rivers.

***Barbus clavatus* McClelland.**

1921. *Barbus clavatus*, Hora, *Rec. Ind. Mus.*, XXII, p. 185, pl. ix, fig. 1.

1935. *Barbus clavatus*, Hora & Mukerji, *Rec. Ind. Mus.*, XXXVII, p. 388.

Vernacular Names.—*Ngasang* Kuki; *Khaisang* Tangkhul.

1 specimen. Stream below Chahong Khulen. 25.i.1937.

From the vernacular names and the notes supplied by Mr. Duncan it seems that the local people make no distinction between *Barbus clavatus* and *B. myitkyinae*. The two species are, however, abundantly distinct and can be readily distinguished by the relative length of the dorsal spine, which in the former is considerably longer than the head. The dorsal surface of *B. clavatus* in front of the dorsal fin is distinctly keeled.

Mr. Duncan notes that this fish is called, rightly or wrongly, the "White Mahseer" 'Mahseer' can only be used for this species in a

¹ Hora, *Rec. Ind. Mus.*, XXII, p. 743 (1921).

very loose sense, as it neither possesses large scales nor is its dorsal spine smooth. Moreover, the body of *B. clavatus* is considerably more compressed than that of the 'Mahseers'

According to Mr. Duncan, the colouration of the species is as follows :—

“Dorsal surface dark green. Ventral surface white. The head or rather the opercular region golden tint. The whole body shows a slight golden tint when held up against the sun.”

The only specimen of the species in Mr. Duncan's collection is about 112 mm. in total length.

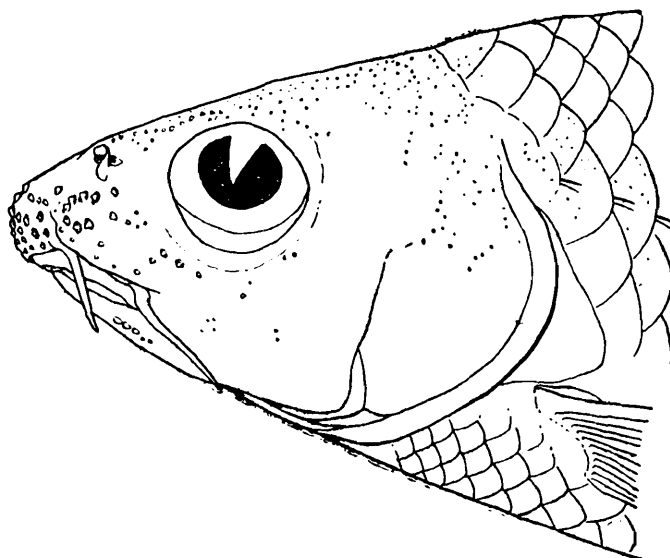
***Barbus clavatus burtoni* Mukerji.**

1934. *Barbus clavatus burtoni*, Mukerji, *Journ. Bombay Nat. Hist. Soc.*, XXXVII, p. 64, pl. iii, fig. 1 and text-figures 10 & 11.

Vernacular Name.—*Ngasang Kuki.*

2 specimens. Chakpi river at Chakpi Karong. 1.iii.1937.

In describing *burtoni* as a subspecies of *Barbus clavatus*, Mukerji distinguished it from the typical form by its longer snout (greater than the diameter of the eye), shorter dorsal spine (less than the length of the head), lepidosis (small number of scales) and colouration (much darker, especially along the dorsal surface). In all these characters the two specimens in Mr. Duncan's collection, 132 mm. and 142 mm. in total length respectively, agree with the subspecies *burtoni*. The dorsal half



TEXT-FIG. 6.—Lateral view of head and anterior part of body of *Barbus clavatus* var. *burtoni* Mukerji, showing tubercular areas on the snout. $\times 2$.

of the fish is intensely dark ; the whole of the caudal fin is dusky and especially the lower lobe. The membranes in between the dorsal rays are black, except at the bases. The distal portion of the anal fin is grayish as also the dorsal surface of the pectoral fins. As in the typical form, the dorsal surface in front of the dorsal fin is distinctly keeled. In both the specimens the snout is provided with rows of well defined tubercles.

Although Kuki Nagas make no distinction between the typical form and the subspecies *burtoni*, Mr. Duncan distinguished them in the field by their different colouration.

Barbus pinnauratus (Day).

1877. *Barbus pinnauratus*, Day, *Fish. India*, p. 561, pl. cxxxix, fig. 3.

1937. *Barbus pinnauratus*, Hora, *Rec. Ind. Mus.*, XXXIX, p. 9, fig. 1.

Local Name.—Ngahao Manipuri.

3 specimens. Chakpi river at Chakpi Karong. 1.iii.1937.

5 specimens. Lokchao river at Tamu. 15.iii.1937.

According to Day, *Barbus pinnauratus* is found in "fresh waters at Coconada down the East coast of India to Ceylon, and inland as far as the Neilgherries, also along the Western Ghats and rivers at their bases" So far as I am aware¹ this species has not been found so far in any other part of India, and its present record from the Upper Chindwin is, therefore, of exceptional interest. Attention may here be directed to the similar distribution of *Danio strigillifer* Myers² which was originally described from Upper Burma but was recently recorded from South India.³ To explain these and several other similar cases of a discontinuous range of distribution I⁴ recently advanced a hypothesis. According to this view, when through a differential orogenic movement in the region of the present high peaks of the Himalayas (the region between the Assam and the Nepal Himalayas), the Himalayas were uplifted the migration of the aquatic fauna towards the Western Himalayas was checked and diverted along the Satpura trend of mountains to the Western Ghats whence it spread southward to the hills of the Peninsula. There is abundant evidence in favour of such a view both from the distribution of fishes and from the palaeogeographical features of the country during the Tertiaries.

The specimens in Mr. Duncan's collection agree very closely with those from South India, except that the spots on the scales are not so well defined and the head is relatively smaller. The younger specimens possess a black mark below the dorsal spine similar to the one recently described by me in the Tunga river specimens.

Sundara Raj⁵ referred to the close similarity between *B. chrysopoma*, *B. pinnauratus* and *B. sarana*, all occurring in the Madras Presidency. To this complex of allied species may be added *B. caudimarginatus*, *B. oatesii*, *B. sewelli*, *B. mitkyinae*, *B. binduchitra* (a new species described above *vide* p. 327), etc., from Burma. In discussing the relationships of the new species I have already referred to the distinguishing features of *B. sewelli* and *B. pinnauratus*.

To bring out the close similarity in proportions, etc., between the South Indian and the Upper Chindwin specimens of *B. pinnauratus*

¹ Karoli (*Term. füzetek*, V, p. 179, 1882) recorded *Barbus pinnauratus* by name only from Siam and Java. Weber and de Beaufort did not include this species in their work on the "Fishes of the Indo-Australian Archipelago". Suvatti has, however, listed *B. pinnauratus* in his "Index to Fishes of Siam" on the authority of Karoli. Without further details it is not possible to be sure of Karoli's record.

² Myers, *Amer. Mus. Novitates*, No. 150, p. 1 (1924).

³ Hora, *Rec. Ind. Mus.*, XXXIX, p. 10, fig. 3 (1937).

⁴ Hora, *Rec. Ind. Mus.*, XXXIX, p. 255 (1937).

⁵ Sundara Raj, *Rec. Ind. Mus.*, XII, p. 254 (1916); also see Annandale, *Rec. Ind. Mus.*, XIV, p. 46 (1918).

I give below a table of measurements of the specimens from the two regions.

Measurements in millimetres.

	Upper Chindwin.				Shimoga.	
	83.0	90.0	103.0	116.0	83.0	92.0
Total length	83.0	90.0	103.0	116.0	83.0	92.0
Length of caudal	18.0	20.0	23.0	25.0	18.0	20.0
Length of head	15.0	16.0	17.2	21.5	16.0	19.0
Height of head	14.0	15.0	16.0	20.0	14.5	17.0
Width of head	11.0	12.2	13.0	16.1	12.0	13.0
Length of snout	4.0	5.0	5.0	6.0	5.0	5.0
Diameter of eye	6.0	6.5	6.5	7.0	6.1	6.8
Interorbital width	7.0	7.5	8.2	10.0	6.9	7.0
Height of body	23.0	26.0	27.0	32.0	24.0	25.0
Width of body	12.0	13.5	14.0	16.5	13.0	12.0
Longest ray of dorsal fin	14.0	17.0	21.0	23.0	15.0	18.0
Longest ray of anal fin	11.0	12.0	13.0	14.0	11.0	12.0
Length of pectoral fin	12.3	14.5	16.0	19.0	13.0	14.0
Length of caudal peduncle	12.0	13.0	13.5	16.0	12.0	13.0
Least height of caudal peduncle	9.0	10.0	11.0	13.0	9.0	10.0

Mr. Duncan made the following observations about the colouration of the species :—

“Dark dorsal and white ventral surface. In young specimens a biggish black spot, though not very prominent, on the body near the beginning of the caudal fin.”

Family COBITIDAE.

***Nemachilus vinciguerrai* Hora.**

1935. *Nemachilus vinciguerrae*, Hora, *Rec. Ind. Mus.*, XXXVII, p. 62, pl. iii, fig. 12.

Vernacular Names.—*Ngajou* Kuki ; *Hangkorkhai* Tangkhul ; *Pasulai* Kabo.

7 specimens. *Namyá* river at *Kongan* Thana. 28.i.1937.

In Mr. Duncan's collection there are seven specimens of *Nemachilus vinciguerrai* ranging from 57 mm. to 76 mm. in total length. They agree fairly closely with the species recently described by me from Burma and Siam. Mr. Duncan's description of the colouration is as follows :—

“The general effect of the colouration scheme is a dirty biscuit colour, but the whole body is marked with transverse zebra stripes of light and dark alternately. The stripes are narrow in front of the dorsal and broader behind it as they approach towards the caudal fin. Fins have red edges.”

In larger specimens the broader stripes behind the dorsal fin are stated to be alternately pink and dark.

***Lepidocephalichthys berdmorei* (Blyth).**

1921. *Lepidocephalichthys berdmorei*, Hora, *Rec. Ind. Mus.*, XXII, p. 196.

Local Names.—*Nga Krichou* or *Nga Kachirou* Manipuri.

6 specimens. *Lokchao* river at *Tamu*. 15.iii.1937.

The specimens of *Lepidocephalichthys berdmorei* in Mr. Duncan's collection range from 46 mm. to 75 mm. in total length. In the smaller individuals the caudal fin is more markedly emarginate. Usually there

is a dark spot in the upper portion of the caudal fin near the base, but in the largest individual there is a well marked black ocellus in the same situation. This species is widely distributed in the Burmese waters.

Family SISORIDAE.

Glyptothorax trilineatus Blyth.

1923. *Glyptothorax trilineatus*, Hora, *Rec. Ind. Mus.*, XXV, p. 29.

Vernacular Names.—Monglheng Kuki; Ngaprangla Tangkhul; Payahat Kabo.

3 specimens. Namya river at Kongan Thana. 28.i.1937.

Glyptothorax trilineatus is represented by 3 specimens varying from 78 mm. to 87 mm. in total length. They possess the characteristic three white streaks and agree in every respect with Blyth's description of the species. Mr. Duncan observes that it is not a very common fish. The largest specimen he had ever caught was about 5 to 6 inches in length. The colouration of the living specimens is noted by him as follows:—

“Dark brown colour with a reddish tint. A light line runs laterally on both sides as well as along the dorsal profile. Fins very light red.”

G. trilineatus is known from Tenasserim, Rangoon and Upper Burma. It is here recorded from the Chindwin Drainage for the first time.

Family OPHICEPHALIDAE.

Ophicephalus gachua Ham.

1935. *Ophicephalus gachua*, Hora & Mukerji, *Rec. Ind. Mus.*, p. 404.

Vernacular Names.—Ngamu Manipuri; Ngavoh Kuki; Khaiwā Tangkhul.

2 specimens. Namya river at Kongan Thana. 28.i.1937.

In Mr. Duncan's collection there are two young specimens of *Ophicephalus gachua*; they are about 85 mm. in total length. The colouration of the species, according to Mr. Duncan's notes, is as follows:—

“Dark colour. White and greenish ventral. The body shows angular bands. The fins have half circles of light and dark.”

XXXIII.—ON A COLLECTION OF FISH FROM THE KUMAON HIMALAYAS.

In May-June 1936, Mr. E. O. Shebbeare, Chief Conservator of Forests, and Mr. M. P. Bhola, Divisional Forest Officer, Haldwani Division, made a small collection of fish for me in the outer Himalayan hills below Naini Tal. The fish were obtained from the Nandhaur and Kalaunia rivers; the former has its source in the Naini Tal District and flows over a bed of boulders. Within the hills its valley is narrow but broadens out in the plains. The fish were collected in the rocky portion of the stream. The Kalaunia river is similar to that of the Nandhaur river in its general physical features, but its source lies in the outer Himalayan hills of the Almora District. The fauna of the two streams is almost identical.

The entire collection comprises 207 specimens which belong to the following species.

MASTACEMBELIDAE.

Mastacembelus armatus (Lacép.) . . . 1 specimen.

CYPRINIDAE.

Barilius bendelisis Ham. 24 specimens.
Barilius vagra Ham. 9 specimens.
Brachydanio rerio (Ham.) 7 specimens.
Labeo dero (Ham.) 9 specimens.
Garra gotyla (Gray) 8 specimens.
Garra prashadi Hora. 77 specimens.
Crossochilus latius (Ham.) 4 specimens.
Barbus putitora (Ham.) 17 specimens.
Barbus chilinoides McClelland 2 specimens.
Barbus conchoniis (Ham.) 2 specimens.

COBITIDAE.

Nemachilus botia (Ham.) 13 specimens.
Nemachilus beavani Günther 22 specimens.
Lepidocephalichthys guntea (Ham.) 3 specimens.

SISORIDAE.

Glyptothorax pectinopterus (McClelland) 2 specimens.

ABLYCEPIDAE.

Amblyceps mangois (Ham.) 1 specimen.

OPHICEPHALIDAE.

Ophicephalus gachua Ham. 6 specimens.

The majority of the species listed above represent well known forms. Attention may, however, be directed to *Garra prashadi*, which was hitherto known from 3 specimens obtained in Malwa Tal; and to *Nemachilus beavani*, the precise specific limits of which were only recently defined by me from examples collected in the Eastern Himalayas. Notes on these two species are given below.

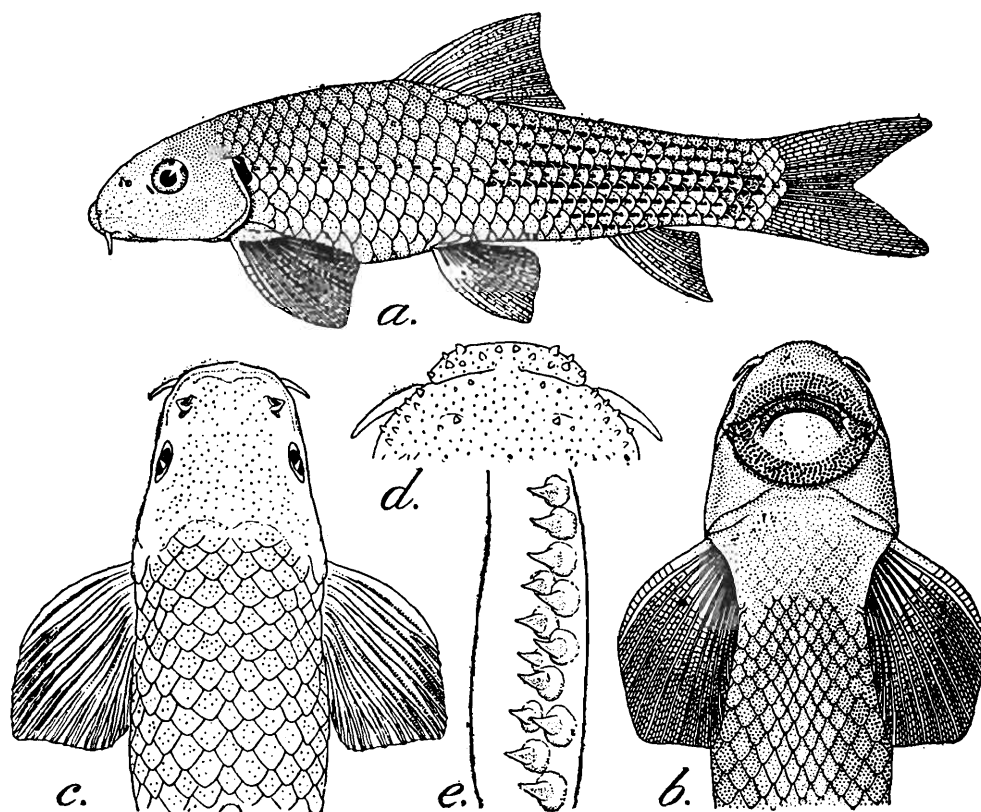
I take this opportunity to offer my sincere thanks to Messrs. E. O. Shebbeare and M. P. Bhola for their kindness in making a valuable collection of fish for the Zoological Survey of India.

Garra prashadi Hora.

1921. *Garra prashadi*, Hora, *Rec. Ind. Mus.*, XXII, p. 669, pl. xxiv, fig. 3.

As indicated above *Garra prashadi* was described from 3 specimens, of which 2 were males and 1 damaged female. Now a large series of 77 specimens has become available and it is possible to make some observations on the sexual dimorphism exhibited by the fish. In species of *Garra*, in which a well-developed proboscis is present on the snout, usually both the sexes are provided with 'pearl organs', etc.

In this respect I noted some sexual differences in the case of *G. lamta* and *G. graveleyi*. As regards the former species further material has shown (*vide infra*, p. 344) that I had grouped two distinct forms under *lamta*. The material of the latter species is not sufficient to elucidate this point.



TEXT-FIG. 7.—*Garra prashadi* Hora.

a. Lateral view of a female specimen. Nat. size; *b.* Ventral surface of head and anterior part of body of above. $\times 1\frac{1}{2}$; *c.* Dorsal surface of head and anterior part of body of a male specimen. $\times 1\frac{1}{2}$; *d.* Dorsal surface of snout of a female specimen. $\times 3\frac{1}{2}$; *e.* Dorsal surface of a portion of one of the outer pectoral fin-rays of a male specimen showing the nature of horny tubercles. $\times 35$.

In the female specimens of *G. prashadi* the tip of the snout is marked off by a shallow transverse groove and is covered with a few horny tubercles. A few horny tubercles are also present on the sides of the head in front of the eyes. In the males, however, the snout is smooth and there are only faint indications of two short lateral grooves which mark off the tip of the snout. The dorsal surface of the head in front of the eyes is slightly raised into two triangular patches; these areas are better marked in the female specimens. In the males the outer rays of the pectoral fins are provided with series of spines on the dorsal surface similar to those described by me¹ in the males of certain species of *Nemachilus*. As is usually the case, the body is relatively deeper in the females as compared with the males.

From the table of measurements given below, it will be seen that the head is relatively longer and the eye larger in young specimens. Other proportions also vary with growth to a limited extent.

¹ Hora, *Rec. Ind. Mus.*, XXIV, p. 81 (1922).

Measurements in millimetres.

	♀			♂		
Total length including caudal	75.0	82.0	96.0	61.0	75.0	82.0
Length of caudal	16.0	17.1	21.0	14.0	16.0	17.1
Length of head	14.5	15.1	17.0	12.0	14.3	15.0
Width of head	12.0	12.5	14.1	10.0	11.3	12.0
Height of head at occiput	10.0	10.5	12.1	8.0	10.0	10.5
Height of body	16.0	16.5	21.0	11.0	15.0	15.5
Width of body	11.3	13.0	16.0	9.0	11.0	12.0
Length of snout	7.0	7.1	8.0	6.0	7.0	7.1
Diameter of eye	4.0	4.0	4.7	3.8	4.0	4.0
Interorbital width	7.0	7.0	8.0	6.0	7.0	7.1
Length of caudal peduncle	10.1	11.0	14.0	8.0	10.0	11.0
Least height of caudal peduncle	8.0	8.8	11.0	6.2	8.0	8.8
Longest ray of dorsal	15.0	15.0	18.5	12.0	15.2	15.3
Length of pectoral	14.0	15.0	18.0	12.1	15.0	16.0
Longest ray of anal	12.8	12.5	15.0	9.5	12.0	13.0

In *G. prashadi* the skin covering the anterior fin rays of the dorsal, the pectoral, the ventral, and the anal fins is produced into lappets which form a sort of a sheath for the following ray or rays. Such structures are characteristic of practically all torrential fishes and attention has already been directed to this feature by Smith and Deraniyagala. Their exact significance appears to be to provide a gliding surface for the current and thus minimise resistance. Their production seems to have been facilitated by the tearing away action of the current which would naturally pull an object in the direction of its flow.

Nemachilus beavani Günther.

1924. *Nemachilus* sp., Hora, *Rec. Ind. Mus.*, XXVI, p. 28, fig. 1.

1935. *Nemachilus beavani*, Hora, *Rec. Ind. Mus.*, XXXVII, p. 63.

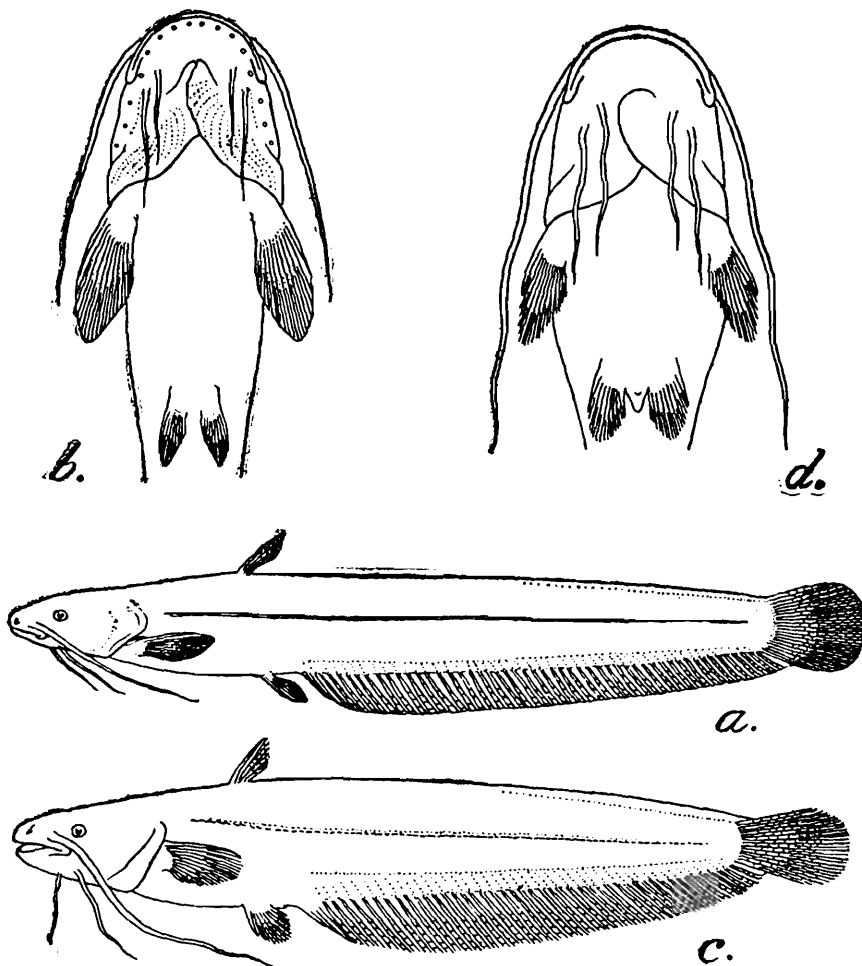
There are 22 examples in the collection under report which agree fairly closely with the Assamese and Eastern Himalayan specimens recently assigned by me to *Nemachilus beavani*. There are, however, variations in the number of bands and in the proportions of certain parts. It may here be noted that the species was originally described from the Kosi river and it is probable that the present lot represents the typical form of the species. I hope to deal with this point in my account of the species from the Western Himalayas.

XXXIV.—ON A NEW CATFISH FROM KWANGSI, CHINA.

In his 'Study on some Chinese Catfishes', Tchang¹ referred a specimen of *Silurus* Linn. from Luchow in the Kwangsi Province, China, to Day's *S. wynaadensis*, which is known only from the Wynaad and Canara Hills in South India. At the same time he published a full description of the specimen along with two illustrations—a lateral view

¹ Tchang, *Bull. Fan Mem. Inst. Biol.*, VII, p. 35 (1936).

of the whole fish and a view of the ventral surface of the body in front of the anal fin. As I¹ had been working recently on the Indian species of *Silurus*, this interesting record attracted my attention and I requested Mr. T. L. Tchang to lend me the specimen of his *S. wynaadensis* for comparison with the typical examples of the species in the collection of the Zoological Survey of India, but he regretted his inability to comply with my request. Fortunately his description and figures are sufficiently detailed to enable me to institute a comparison between his form and the typical examples.



TEXT-FIG. 8.—*Silurus wynaadensis* Day and *S. sinensis*, sp. nov.

a. Lateral view of *Silurus wynaadensis* Day. $\times ca \frac{4}{5}$; *b.* Ventral surface of head and anterior part of body of *S. wynaadensis* Day. $\times 1\frac{1}{2}$; *c.* Lateral view of *S. sinensis*, sp. nov. $ca \frac{4}{5}$; *d.* Ventral surface of head and anterior part of body of *S. sinensis*, sp. nov. $ca 1\frac{1}{2}$.

Figs. *c.* and *d.* are copied from Dr. T. L. Tchang's drawings.

In the Indian specimens the dorsal fin is entirely in advance of the ventrals, the pectorals are separated from the ventrals by a considerable distance and the maxillary barbels do not extend beyond the pectoral fin. In the specimen from Kwangsi a portion of the dorsal fin is situated above the bases of the ventrals, the pectorals almost extend to the bases of the ventrals and the maxillary barbels extend beyond the

¹ Hora, *Rec. Ind. Mus.*, XXXVIII, pp. 351-356 (1936).

commencement of the anal fin. A comparative table of proportions of the various parts is given below :—

	Kwangsi.	Wynaad.		Canara.
	90 mm.	100 mm.	122 mm.	123 mm.
Length to base of caudal				
Depth in length without caudal	. 6.0	9.1	8.1	7.3
Head in length without caudal	. 4.7	5.4	5.5	5.6
Eye in head	. 8.0	9.2	7.3	7.3
Interorbital distance in head	. 1.9	2.5	2.2	2.2
Snout in head	2.4	3.1	3.0	3.0
Outer Mandibular barbel in head	1.2	1.8	1.8	1.8
Inner Mandibular barbel in head	1.3	1.9	2.0	2.0
Longest dorsal ray in head	2.1	2.5	2.4	2.6
Pectoral in head	. 1.5	1.5	1.7	1.7
Ventral in head	2.5	3.0	3.1	3.1

It is clear from the above table that in the Chinese example the body is considerably deeper, the head is longer, the interorbital space wider, the snout longer and all the barbels much better developed than those in the Indian examples. On account of the differences noted above and also on geographical grounds it is necessary to regard Tchang's specimen of *S. wynaadensis* as representing a new species which I propose to name ***Silurus sinensis***. For a description of the species reference may be made to Tchang's account. His illustrations are reproduced here along with fresh drawings of a typical specimen of *S. wynaadensis* for comparison.

The occurrence of a true *Silurus*, with 4 mandibular barbels, in South China is of special significance. Hitherto only two species of the genus, in its restricted sense, were known, *S. glanis* Linn. from Europe (east of the Rhine) and *S. wynaadensis* Day from South India. Among the species, which are usually included in the genus *Parasilurus* on account of having only two mandibular barbels, we have two very widely distributed species, one in the north, *Parasilurus asotus* (Linn.) known from Japan, China and Eastern Russia, and the other in the south, *P. cochinchinensis* (Cuv. & Val.), found in Formosa, South China, Cochin-China, Mergui Archipelago, Burma, and Eastern Himalayas. The remaining species of the group, *P. cinereus* (Dabry), *P. grahami* (Regan) and *P. mento* (Regan), are found only in Yunnan. It has been found that very young specimens of *Parasilurus asotus* are provided with 2 pairs of mandibular barbels¹ which shows that *Silurus* (s.s.) certainly represents a more primitive type of fish.

From the distributional records given above it is clear that the largest number of species of the genus *Silurus* are found in South China. In fact, all the species, with the exception of *S. glanis* and *S. wynaadensis*, have been found in this region. *S. glanis* and *S. wynaadensis* are characterised by 4 mandibular barbels and, therefore, represent the earliest stock of the genus which is now pushed out into very great distances from the original centre of the distribution of the genus. *Silurus sinensis* should, according to this view, represent a part of the original stock in the home country of the genus.

¹ Atoda, *Dolutsugaku rasshi*, XLVII, p 228 (1935); Kimura, *Journ. Shanghai Sci., Inst. Sec. 3, III*, p. 105 (1935).

XXXV.—A FURTHER NOTE ON HAMILTON'S *CYPRINUS* (*GARRA*) *LAMTA*.

In my¹ revision of the fishes of the genus *Garra* it was indicated that the type-locality of Hamilton's² *Cyprinus lamta* had to be located in "small streams among rocks south of Monghir" whence he obtained his specimens of *Godyari*, also called *Sahari*. It was further pointed out that in the 'rocks south of Monghir' reference was probably made to the well-known Kharagpur Hills in the present-day district of Monghir. To elucidate the precise specific limits of the species, topotypes were obtained, but unfortunately I was only able to secure very young specimens, less than 50 mm. in total length. Among the material thus obtained two distinct types were recognised, one with a short central proboscis on the snout and the other without a proboscis. It was then presumed that the former represented the male and the latter the female of the same species. The characters of *G. lamta*, based on juvenile specimens, were, however, not found sufficiently distinctive by Prashad and Mukerji³ and Mukerji⁴, who referred certain examples from Burma to *Garra lamta*. It thus seemed clear that only mature specimens of *G. lamta* could enable a proper appreciation of the species.

In February 1937, I came to know that Mr. A. Das, a botanist and a keen naturalist, was touring in the Kharagpur Hills. A request was made to him to collect specimens of the local fish *Godyari* and sufficient details were sent for the recognition of the species. In March, I received 10 specimens of the desired type with a small miscellaneous lot. Mr. Das, like myself, found that *Garra* is known as *Patharchata*, stone-licking fish, in the Bhimband locality, Kharagpur Hills. The specimens, from 36 mm. to 67 mm. in length without the caudal, were collected from the Man river. The material contains the adult examples of both the sexes, so it is now possible to give a detailed description of the species and to remove a certain amount of confusion from the taxonomy of the genus.

Hamilton's description of *G. lamta* is of a very generalised type, but attention may be directed to the following salient features as noted by him :—

1. Pectoral fins sharp in the middle.
2. Grows to about three inches in length.
3. A faint spot on each side towards the end of the tail.
4. Dorsal fin before the middle.
5. Pectoral fins nearly as long as the head.

In the manuscript drawing of the species there is an indication of a lateral band about the level of the lateral line which terminates behind in the precaudal spot and extends forwards to the gill-opening. The

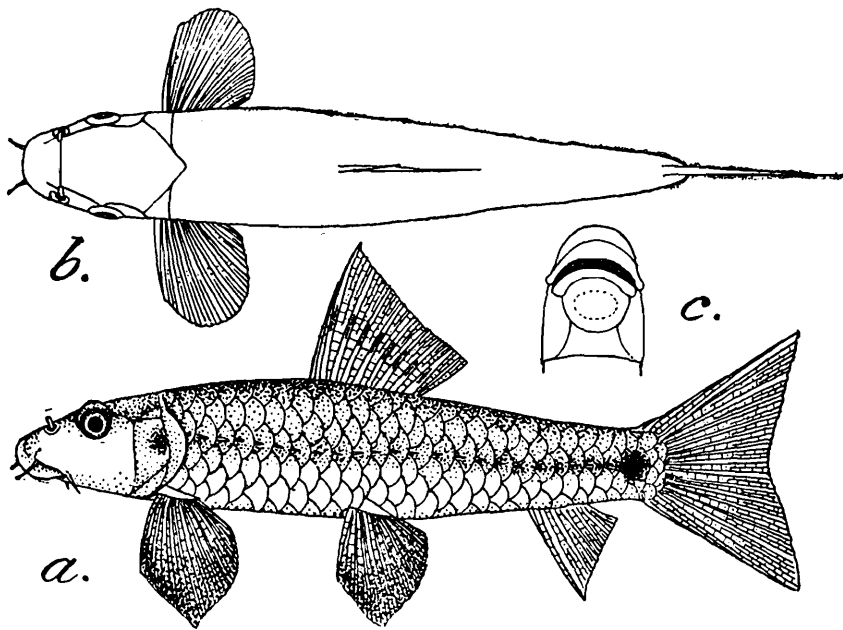
¹ Hora, *Rec. Ind. Mus.*, XXII, pp. 633-687, pls. xxiv-xxvi (1921).

² Hamilton, *Fish. Ganges*, pp. 343, 393 (Edinburg: 1822).

³ Prashad & Mukerji, *Rec. Ind. Mus.*, XXXI, p. 192 (1929).

⁴ Mukerji, *Journ. Bombay Nat. Hist. Soc.*, XXXVII, p. 48 (1934).

fins are grayish with the middle portions of the inter-radial membranes of the dorsal fin marked with black spots.



TEXT-FIG. 9.—Copies of Francis Hamilton's manuscript drawings of *Cyprinus (Garra) lamta*.

a. Lateral view finished in colour in the original ; b. Outline sketch of dorsal view ; c. Ventral surface of head, finished in pencil in the original.

Judging from the characters noted above, there seems no doubt that the material sent by Mr. Das is definitely referable to *G. lamta* which may now be defined as follows :—

***Garra lamta* Hamilton.**

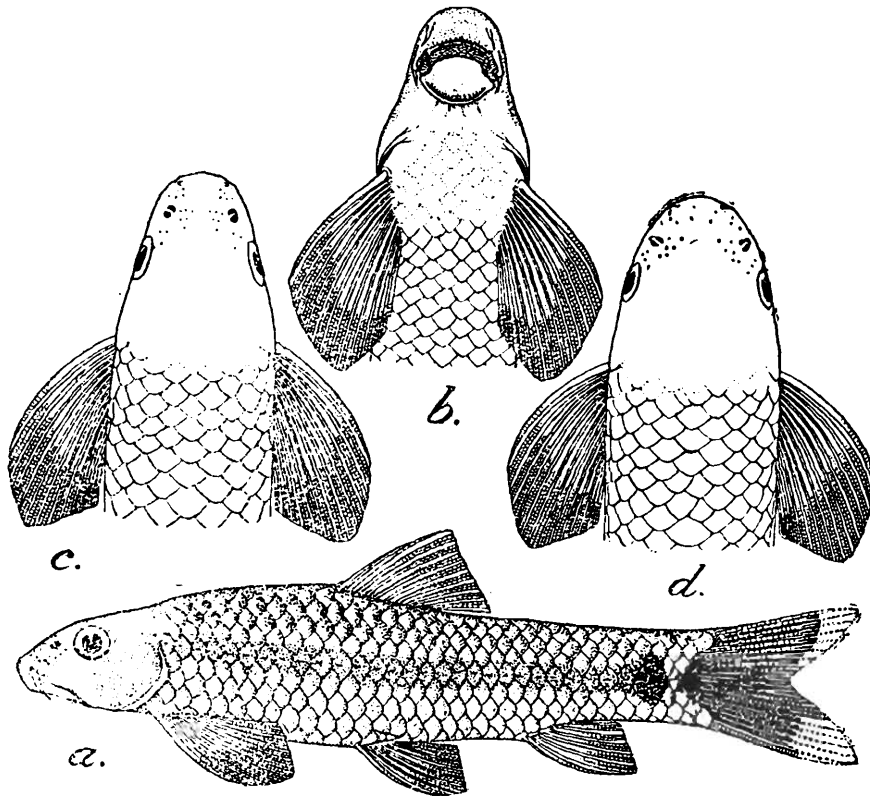
1822. *Cyprinus (Garra) lamta*, Hamilton, *Fish. Ganges*, pp. 343, 393.

1838. *Gonorhynchus lamta*, McClelland, *As. Res.*, XIX, p. 282, pl. cliii, fig. 2.

1921. *Garra lamta*, Hora, *Rec. Ind. Mus.*, XXII, p. 660.

Garra lamta is a small species in which both the dorsal and the ventral profiles are somewhat arched. The head and the anterior part of the body are flattened. The head is small, broad and broadly rounded in front ; its length is contained from 4.3 to 4.6 times in the total length and from 4.1 to 4.5 times in the length without the caudal. The head is proportionately longer in younger specimens. The head is relatively narrower in the smaller individuals ; its width is contained from 1.2 to 1.4 times and its height at occiput about 1.3 times in its length. The eye is situated near the dorsal profile of the head and in adult males it is almost in the middle of the head while in females it is nearer to the posterior margin of the operculum than to the tip of the snout. The snout is considerably broader in the females than in the males. The diameter of the eye is contained from 2.5 (in the young) to 3.5 times in the length of the head. In young specimens the diameter of the eye is greater than the length of the snout, but in adults it is about two-thirds of the same dimension. The interorbital distance is only slightly greater than the diameter of the eye in young specimens but with growth it almost becomes double the eye diameter. In the adult

females the interorbital space is somewhat greater than that in the males. The tip of the snout is marked off by two short lateral grooves. There is no proboscis but a few horny tubercles are usually present. The mental disc is relatively small.



TEXT-FIG. 10.—*Garra lamta* Hamilton (Specimen from the Kharagpur Hills, Bihar).

a. Lateral view of a male specimen. Nat. size; b. Ventral surface of head and anterior part of body of a male specimen. $\times 1\frac{1}{2}$; c. Dorsal surface of head and anterior part of body of a male specimen. $\times 1\frac{1}{2}$; d. Dorsal surface of head and anterior part of body of a female specimen. $\times 1\frac{1}{2}$.

The depth of the body varies from 4 to 5.2 times in the total length and from 3.7 to 4.1 times in the length without the caudal. The caudal peduncle is only slightly longer than its height. The body is covered with firmly-set scales which are only faintly marked in the chest region. There are about 32-34 scales along the lateral line and $3\frac{1}{2}$ rows below it to the base of the ventral fins. The rows of scales between the lateral line and base of the dorsal fin varies from $4\frac{1}{2}$ to $5\frac{1}{2}$. The number of predorsal scales is 12. The ventral fin is provided with a scaly appendage at its base.

The dorsal fin commences slightly in advance of the ventrals; its commencement is nearer the tip of the snout than the base of the caudal fin. The longest ray of the dorsal fin is somewhat longer than the head in young specimens and shorter in adults. The pectoral fin is slightly longer than the head and is separated from the ventrals by a considerable distance. The ventrals are considerably nearer the base of the caudal than the tip of the snout; they just extend to the anal opening. The distance between the vent and the base of the anal fin is less than one-third the distance between the commencements of the anal and ventral fins.

The most characteristic feature of the species is its colouration. There is a broad lateral band from behind the gill-openings to the base of the caudal fin where it ends in a rounded spot. It is bordered, both above and below, by light pale stripes. The dorsal surface is grayish and each scale is marked with a dense black dot in the centre of the posterior margin. These black spots form longitudinal stripes. A black spot near the upper angle of the gill-opening is present and the membranes between the dorsal spines, especially near the base, are marked with dark spots. The lateral surface below the lateral line is dusky and so are the dorsal and the caudal fins.

The lateral band and the precaudal spot should enable this species to be readily distinguished.

Measurements in millimetres.

Total length without caudal	36.0	39.0	45.0	46.0	49.0	51.0	♂ 58	♂ 65	♀ 67
Length of head	8.8	9.0	11.0	11.2	11.7	12.0	13.0	14.3	15.0
Width of head	6.3	7.0	8.0	9.0	9.2	9.3	10.1	12.0	12.1
Height of head at occiput	7.0	7.3	8.0	8.2	8.5	9.0	10.0	10.5	11.0
Height of body	9.0	10.5	11.0	12.2	13.0	13.0	15.0	17.0	17.0
Length of snout	3.1	3.0	4.3	4.7	4.9	4.8	5.0	6.0	6.0
Diameter of eye	3.5	3.5	4.0	3.9	4.0	4.0	4.25	4.25	4.3
Interorbital width	3.9	4.0	5.0	5.0	5.5	6.0	6.0	7.0	7.5
Longest ray of dorsal	9.0	9.0	11.5	11.2	12.0	13.0	13.7	14.0	13.0
Longest ray of anal	7.3	7.5	7.5	8.0	9.0	10.0	11.5	11.0	11.0
Length of pectoral	10.0	10.0	11.0	11.2	12.5	14.5	14.5	16.0	15.4
Length of caudal peduncle	5.7	5.8	7.5	8.0	8.0	9.0	9.0	11.0	11.0
Least height of caudal peduncle	5.0	5.0	6.2	6.9	7.0	8.0	8.0	9.0	9.5

Remarks.—From the above it is clear that the small specimens with a median proboscis on the snout, which I¹ had regarded to be the males of this species, do not belong to *G. lamta*. They seem to be similar to the young specimens of *G. gotyla*, which Mukerji and I² collected in the Eastern Doons. It was observed by us that “The proboscis is present in both the sexes and even in young specimens, about 53 mm. in total length, it is fairly prominent.”

The young specimen recorded by Prashad and Mukerji³ from the Sankha hill-stream in the Myitkyina District, Upper Burma, as *G. lamta* belongs to *G. gotyla*, as also the specimen reported upon by Mukerji⁴ from the Mali Hka river. The last specimen is undoubtedly similar to the form recorded by Vinciguerra⁵ as *G. lamta*, but a detailed study of the specimens has shown that they belong to *G. gotyla*. The proboscis is broad and massive in these specimens and is anteriorly lobed

¹ Among the specimens I had referred to *G. lamta* in 1921, I find that there are only four, 1 from the Man river and 3 from the Katin nallah, which belong to this species while all the others are young of *G. gotyla*.

² Hora & Mukerji, *Rec. Ind. Mus.*, XXXVIII, p. 144 (1936).

³ Prashad & Mukerji, *Rec. Ind. Mus.*, XXXI, p. 192 (1929).

⁴ Mukerji, *Journ. Bombay Nat. Hist. Soc.*, XXXVII, p. 48 (1934).

⁵ Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova* (2), IX, p. 275 (1890).

by the presence of the hard, horny tubercles. In the Indian specimens of *G. gotyla* the proboscis is narrower and projects forward as a short cylinder. It is probable that when further material becomes available from Burma it may have to be regarded as a separate species, but in the present state of our knowledge such a course is not justified. *G. gotyla* is known from the Chindwin and Irrawadi drainage systems (*vide supra*, p. 333); its range extends all along the Himalayas. Deraniyagala¹ found a closely allied form in Ceylon and in commenting on its relationships I observed (*vide Deraniyagala, op. cit.*): "The Ceylonese *G. gotyla*, if I may use this phrase, seems to have evolved the characters of the species independently, so that these two forms are the results of a parallel evolution." In view of certain palaeogeographical considerations² I now find that at a certain period the fauna of the Himalayas probably spread along the Satpura trend to the Western Ghats and thence to the hills of the Peninsula and Ceylon. The record of the young specimens of *G. gotyla* from the eastern section of the Vindhyan Range is, therefore, of special significance in this connection. The antiquity of *G. gotyla* is also evident from the fact that, according to Deraniyagala, the young of *G. ceylonensis ceylonensis*, the commonest form of *Garra* in the island, often show the characters of *G. gotyla*.

From the above observations it may be concluded that *G. lamta* is known so far only from the Kharagpur Hills for it is likely that the Rapti river form (Gorakhpore Dist.) may prove to be quite different.

XXXVI.—ON A NEW GENUS OF CHINESE CATFISHES ALLIED TO
PSEUDECHENEIS BLYTH³.

In his "Study on some Chinese Catfishes", Tchang⁴ recorded *Pseudecheneis sulcatus* (McClelland)⁵ from China and very fortunately gave a description and two figures of the single specimen obtained in Yunnan and now preserved in the Zoological Museum of Fan Memorial Institute of Biology, Peiping (No. 12016). The description and figures are so different from those of the form known to me from India and Burma that I wrote to Dr. Tchang for a loan of the interesting specimen for comparison with the numerous topotypes of the species in the collection of the Zoological Survey of India, but in reply he expressed his inability to accede to my request. The Yunnanese example, however, seems to be so different from the Indian species that I have no hesitation in suggesting for it a separate genus **Propseudecheneis** and to christen the species, after the name of its discoverer Dr. T. L. Tchang, **Propseudecheneis tchangi**, sp. nov.

¹ Deraniyagala, *Ceylon Journ. Sci.* (B), XVII, p. 227 (1933).

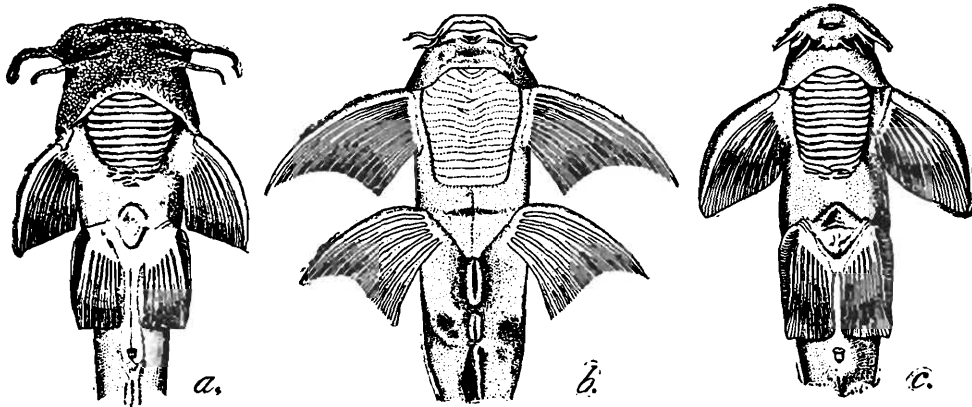
² Hora, *Rec. Ind. Mus.*, XXXIX, p. 255 (1937).

³ The article along with a specimen of *Pseudecheneis sulcatus* (McClelland) was sent in April 1937 to Dr. T. L. Tchang for his comments and its subsequent publication in the Bulletin of the Fan Memorial Institute of Biology. No reply has yet been received and owing to the Sino-Japanese war its publication in China now seems doubtful.

⁴ Tchang, *Bull. Fan Memorial Inst. Biol.* (Zool.), VII, p. 47 (1936).

⁵ McClelland, *Calcutta Journ. Nat. Hist.*, II, p. 584 (1842).

Propseudecheneis can be readily distinguished from *Pseudecheneis* Blyth¹ and *Parapseudecheneis*² by the nature of its mouth, lips and



TEXT-FIG. 11.—Ventral surface of head and anterior part of body of *Parapseudecheneis* Hora, *Propseudecheneis*, gen. nov., and *Pseudecheneis* Blyth.

a. *Parapseudecheneis paviei* (Vaillant); *Propseudecheneis tchangi*, gen. et sp. nov.; *Pseudecheneis sulcatus* (McClelland).

Figure b. is copied from Dr. T. L. Tchang's drawing.

jaws and also by the form and position of its paired fins. The general build of the body is also different in the three genera. Some of their distinguishing features are tabulated below:—

<i>Propseudecheneis</i> , gen. nov.	<i>Pseudecheneis</i> Blyth.	<i>Parapseudecheneis</i> Hora.
Head and body greatly depressed; head considerably narrower anteriorly with the apex truncate.	Head and body sub-cylindrical; head broadly rounded anteriorly.	Head and body greatly depressed; head broad and almost truncate anteriorly.
Mouth small, inferior, transverse; lips thick, with small papillae.	Mouth very small considerably behind tip of snout; lips thick, reflected round the mouth and studded with papillae.	Mouth somewhat extensive, sub-inferior; transverse; lips thick and corrugated.
Adhesive disc composed of 21 folds which are probably faintly marked.	Adhesive disc composed of 14-15 prominent folds.	Adhesive disc composed of 10-11 prominent folds.
Outer ventral ray the longest; probably not provided with adhesive folds on ventral surface.	Outer ventral ray short, broad and provided with adhesive folds on ventral surface.	Outer ventral ray short, broad and provided with adhesive folds on ventral surface.

Tchang's description of the unique specimen of *Propseudecheneis* is not sufficiently detailed to institute any further comparison with the other two allied genera, but the figures of the ventral surface of the head and the anterior part of the body of the type-species of *Pseudecheneis*, *Parapseudecheneis* and *Propseudecheneis* reproduced here clearly show their principal distinguishing features.

In 1930, I (*op. cit.*, p. 217) regarded *Pseudecheneis* and *Parapseudecheneis* as having been evolved independently under the influence of

¹ Blyth, *Journ. As. Soc. Bengal*, XXIX, p. 154 (1860).

² Hora, *Rec. Ind. Mus.*, XXXIII, p. 215 (1930).

some similar factor or factors in their environment, but recently, when I¹ became aware of the probable changes in the drainage system of South-eastern Asia, I considered them to be genetically related. The discovery of the Chinese form lends considerable support to the latter view. Judging from the structure of the three genera, it seems probable that *Propseudecheneis* represents the generalised form and that the other two genera are derived from it under somewhat different sets of environmental conditions. *Parapseudecheneis* appears to have been evolved in somewhat deeper rocky streams with fast currents, such as are now found in the plateau of Central Asia where somewhat similar forms of *Glyptosternum* McClelland, but without the thoracic adhesive apparatus, such as *G. maculatum* (Regan) in Eastern Tibet and *G. reticulatum* McClelland in Eastern Turkestan, Chitral, Afghanistan, Kashmir, etc., are found today. *Pseudecheneis* seems to be specially adapted to live in turbulent waters of small rocky streams of the south-eastern slopes of the Himalayas and the connected chain of hills. I have indicated in several of my earlier works that the "transfer of the adhesive organ from the centre of the animal to the extremities is a remarkable feature of all the hill-stream animals."² Such a transfer is well illustrated in the case of the species of *Glyptothorax* Blyth, where in the less specialised forms the adhesive folds are very extensive in the thoracic region but are totally absent from the paired fins. In the highly specialised forms, such as *G. striatus* (McClelland) and *G. pectinopterus* (McClelland), on the other hand, the thoracic apparatus is greatly reduced while the outer rays of the paired fins are provided with adhesive pads. Judging by this criterion alone, *Propseudecheneis* would seem to be the most generalised form, which gave rise to *Pseudecheneis* in India and to *Parapseudecheneis* in Indo-China. *Parapseudecheneis* probably gave rise to *Glyptosternum*-like fishes while the other two genera seem to be the progenitors of a variety of Glyptosernoid fishes found in China, Siam, Burma and India.

It seems to be the case with practically all the present-day freshwater genera of Indian fishes that their ancestral home was in South China or in the case of the mud-loving forms Indo-Chinese region. From these regions the aquatic fauna spread towards the south and west, and the subsequent changes in their environment induced the evolution of a great variety of genera, especially in the regions of the Himalayan upheavals.

Propseudecheneis is found in Yunnan, *Parapseudecheneis* in Tongking and *Pseudecheneis* in Northern Burma, Assam and the Eastern Himalayas (Brahmaputra Drainage System). The first two genera are thus found in the Red River System, which according to Gregory³ was once a mighty stream as it comprised the headwaters of the Yangtse-Kiang. The ancestral form of *Pseudecheneis* was probably transferred to Burma and India at a later date through the beheading of the eastern rivers by the younger western rivers which were being produced on the rising slopes of the Himalayas.

¹ Hora, *Cur. Sci.*, V, p. 354 (1937).

² Hora, *Phil. Trans. Roy. Soc. London*, CCXVIII, p. 234 (1930).

³ Gregory, *Scottish Geog. Mag.*, XLI, pp. 121-141 (1925).

THE INDIAN EPHEMEROPTERA (MAYFLIES) OF THE SUB-ORDER EPHEMEROIDEA.

By H. A. HAFIZ, *Ph.D. (London), D.I.C. (London), Assistant Superintendent, Zoological Survey of India, Calcutta.*

(Plates IV & V.)

INTRODUCTION.

The study of this interesting group of insects was suggested to me by Dr. Bains Prasad, Director, Zoological Survey of India, with a view to continue the work of my friend and colleague Dr. B. Chopra, whose paper on the Palingeniidae and Polymitarcidae of the sub-order Ephemeroidea was published in 1927.¹ The Mayfly material of the Indian Museum has in the meantime been increased by collections made by the Officers of the Zoological Survey of India and I am therefore obliged to include in this paper references to Palingeniid and Polymitarcid species already dealt with by Chopra, together with the description of a new species of the genus *Anagenesia*. This paper deals with all the Indian representatives of the sub-order Ephemeroidea so far as was possible with the material available. I have, however, not so far seen any material of the family Potamanthidae.

I have, as was done by Chopra, preferred to follow Comstock and Needham's notation of wing venation throughout my work. I have also adopted Ridgway's nomenclature in describing colouration. As is usual in this group, slide mounts of certain appendages of the specimens that I have seen have been made. These are deposited in the collections of the Zoological Survey of India.

I am much obliged to Dr. Bains Prasad, Director, Zoological Survey of India, for his kind guidance and generous help in preparing this paper for the press. I wish to express my grateful thanks to Dr. B. Chopra for his notes and figures on the two new species of *Ephemerella*, viz., *E. diffusa* and *E. annandalei*, as also on some other Ephemerid species dealt with in this paper. I have, however, re-examined the specimens that are in the collections of the Zoological Survey of India on which Chopra based his descriptions of the two new species and have made a few alterations and additions to his descriptions and figures. Some of the specimens are, however, in a rather damaged condition. My best thanks are also due to Dr. F. H. Gravely for his kindness in loaning me the Madras Museum material for study and to my assistant, Mr. G. Mathai, for general help rendered in the course of my work. Babu Subodh Mondul, one of the talented artists of the Zoological Survey of India, executed under my supervision some of the illustrations of this paper.

¹ Chopra, B.—*Rec. Ind. Mus.* XXIX, pp. 91-138 (1927).

SYSTEMATIC ACCOUNT.

Suborder EPHEMEROIDEA.

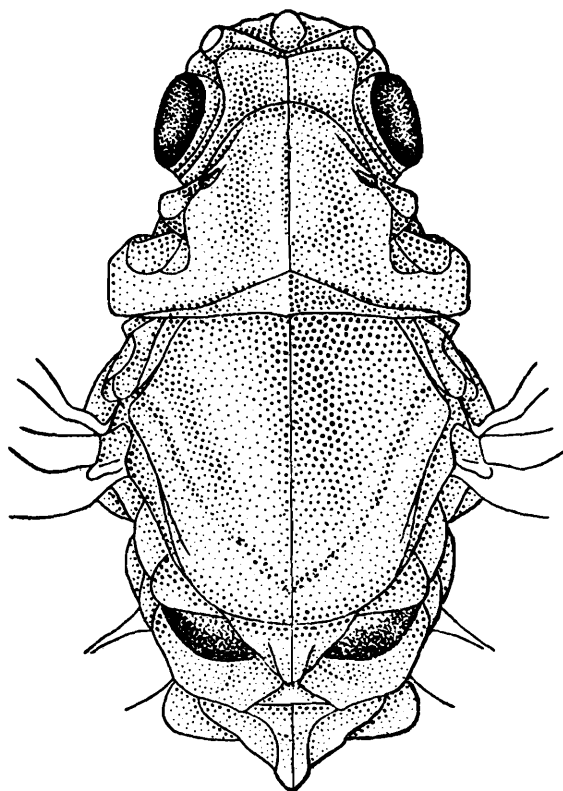
Family PALINGENIIDAE.

Anagenesia lontona, sp. nov.

(Plate IV, figs. 1-3.)

This species is represented in the Indian Museum collection by a single pinned female specimen from Lonton, Upper Burma, collected by Dr. B. Chopra; the specimen is in a fairly good state of preservation.

Imago ♀ (*dried*).—The general colouration of the body varies from walnut brown to vandyke brown. The head is pitch black; the eyes are also black, encircled basally with dark brown; the ocelli are light brown encircled with black; the lateral ocelli are connected by fine shallow grooves meeting in the middle. The pronotum is well developed, and of a vandyke brown colour except at the sides and at the posterior margins which are somewhat lighter. The anterior corners of pronotum are deeply notched. The mesonotum is slate black, robust, bearing two obliquely running shallow grooves forming a V. The metanotum is more or less of the same colour as the pronotum (Text-fig. 1). The dorsum of abdomen is walnut brown except the last three

TEXT-FIG. 1.—*Anagenesia lontona*, sp. nov.Head and thorax of female, dorsal view: $\times 8$.

segments, which are vandyke brown and more convex than the anterior segments. Segments 3 to 7 bear blackish gray semicircular markings; the free ends of the arches are directed forwards close to the

posterior margins of the preceding segments. The posterior margin of the last abdominal segment is deeply notched in the middle and the rudimentary median caudal seta is visible from above. The venter of thorax is more or less concolourous with the dorsum but that of the abdomen is considerably lighter and the posterior margins of segments, except the last, with pale thick lines.

The wings are dirty-whitish and translucent. The fore-wings are large; the wing venation is typical of the genus; M_1 , however, appears to fork slightly beyond Rs ; there is a single longitudinal vein in the first anal fork; costa, sub-costa, radius and the great cross vein are prominent and dark brown; the rest are cream yellow. The neuration of hind-wings is typical of the genus; the costal projection near the humeral angle is prominent and is of a dark brown colour; C , Sc , R , M , Cu and the anal veins are well developed; the forking of Rs is not well marked.

The legs are considerably reduced, particularly the first pair. The coxae of the first and second pairs of legs are concolourous with the sternum; the femora, tibiae and tarsi are very much lighter. It is difficult to make out the joints of the fore-tarsus owing to its being greatly shrivelled in the only specimen available. The claws of fore-legs are uniuugiculate. The second and third pairs of legs are more strongly developed, but the tarsi are considerably reduced. The hind-tarsus bears one claw.

The lateral caudal setae are ribbon-like, about half as long as the length of the body and uniformly pubescent; the tips are pointed and brownish; the median seta, as stated before, is rudimentary and is situated in the middle of the notch of the last abdominal segment.

♂ not known.

Length of body 29 mm.; fore-wing 26 mm.; lateral seta 13 mm.

Type specimen.—No. $\frac{963}{H 8}$, Zoological Survey of India (*Ind. Mus.*).

Locality.—Lonton, a small village on the western shore of the Indawgyi Lake, Myitkyina district, Upper Burma, B. Chopra, 18th to 31st October 1926.

The present species is about the darkest in colour of all the Indian species of the genus *Anagenesia* Etn. that I have seen. It is by far the largest species of the genus, being slightly larger than even the males of *A. robusta* (Etn.). It differs from *A. lata* (Walk.) in its very much larger size and dirty-whitish wings. It is easily distinguished from the Bornean species, *A. picta* (Grav.), by the larger size of its body and wings, darker colouration of notum and abdomen and by the characteristic blackish gray semicircular markings on the 3rd to 7th abdominal tergites.

Anagenesia minor (Eaton).

1927. *Anagenesia minor*, Chopra, *Rec. Ind. Mus.* XXIX, p. 113.

I refer to this species a very large number of male specimens, both pinned and in alcohol, from Belgaum district in the Bombay Presidency. *A. minor*, as remarked by Chopra, certainly appears to be a widely distributed species having been previously recorded from Upper Burma, Bengal and Bihar.

Some of the specimens from Belgaum are much smaller than those recorded by Chopra from other localities, the smallest measuring about 14 mm. They, however, very closely resemble the specimens from Saraghat, Bengal. The characteristic feature of the species, *viz.*, the clouding of the dorsum of the posterior segments of the abdomen is quite clear but the general colouration of the specimens is somewhat lighter. The gray clouding of segments 7-9 is continued to other segments but less and less so anteriorly and very much so in the first segment. Specimens, in which the segments of abdomens are telescoped, have the gray clouding as a continuous mid-dorsal gray band. The terminal joints of the genital forceps are distinctly longer than the preceding ones. In all other characters the specimens agree with previous descriptions.

Locality.—Dhupdal and Gokak, Belgaum district, Bombay Presidency, Bani Prashad and H. S. Rao, November 1928 (at light).

Family POLYMITARCIDAE.

Polymitarcys indicus (Pictet).

1927. *Polymitarcys indicus*, Chopra, *Rec. Ind. Mus.* XXIX, p. 124.

I refer to this rather common species a large number of examples from Gokak, Belgaum district, Bombay Presidency, Sarai, Rewa State, and Kamaing, Upper Burma. The large number of specimens from the Bombay Presidency are all females. Specimens of both sexes from Rewa State include a number of male sub-imagos and the specimens from Upper Burma comprise both males and females.

The specimens agree in all respects with previous descriptions. The number of subsidiary veins in the first anal fork of the fore-wing, ranging from 4 to 6, however, is variable. This character, therefore, does not appear to be of any great importance. The genital forceps in specimens from Sarai, Rewa State, are arranged as described by Chopra, the left forcep being more dorsally placed than the left penis lobe. But in one of the male sub-imagos from the same locality it is the right forcep which is more dorsally placed than the left.

There are altogether six male sub-imagos. In all essentials they show great resemblance to the imagos but the colouration of the mesonotum is very much darker than that of the imago. The first pair of legs are very short. Femur with blackish brown streaks on the outside; tibia very robust and a little longer than the femur and has on its inner and outer surfaces a series of closely placed transverse blackish brown lines giving it a characteristic appearance. Tarsus three-fourths as long as tibia, also robust, the five joints decrease in size proximo-distally ending in unequal biunguiculate claws. The second and third pairs of legs are as in the imago but the tarsi are not so much reduced and the segments are quite clear. The second tarsus has three distinct joints and the third four joints ending with biunguiculate claws. Venation as in the adult; six subsidiary veins in the fork of the first anal vein. Genital apparatus as in the imagos but in one example the right forcep appears to be more dorsally placed than the left. One of the specimens has the cast of the skin attached to the posterior end of the body and the first pair of legs in this specimen are as in the adults.

Locality.—Gokak, Belgaum district, Bombay Presidency (at light), B. Prashad and H. S. Rao, November 1928, Sarai (land) 2,700 ft., Rewa State, H. S. Pruthi, February 1927, Kamaing, Myitkyina district, Upper Burma, B. Chopra, November-December 1926, and Mysore, S. India, Gangadaran, November 1925.

Family EPHEMERIDAE.

Ephemera Linn. and *Hexagenia* Walsh. are the only two of the five known genera of the family so far recorded from India. The former comprises ten species including two species described in this paper as new and also *E. fulvata* described by Navas (1935). The genus *Hexagenia* is, so far as I know, represented by a single species *H. indica* described by Chopra (1924).

Genus *Ephemera* Linn.

Ephemera diffusa Chopra, sp. nov.

(Plate IV, figs. 4-9.)

♂ *Imago (in spirit)*.—The general colouration of the body is warm sepia to vandyke brown or in some cases burnt umber, with the venter somewhat paler and the dorsum considerably tinged with black.

The head is almost entirely black or rather blackish brown with only a small area in the middle near its posterior end somewhat paler. Another pale circular depression encircles a dark spot above the middle. Eyes are oval in outline with their inner orbits curved, and are separated from one another dorsally by a fairly extensive interspace. The eyes are black and the ocelli slightly lighter. The anterior ocellus is considerably smaller than the paired posterior ones. The antennae are brownish.

The pronotum is long but at its posterior end the breadth exceeds the length. In about its anterior third the pronotum is pale brownish, but the rest of it excluding the margins only is covered by a large quadrilateral patch of vandyke brown. The sides of this quadrilateral patch are almost blackish. The mesonotum is large and is uniformly coloured, vandyke brown to warm sepia; near its posterior extremity it is somewhat blackish. The metanotum is short and is of the same colour as the pronotum.

The dorsum of the abdomen is vandyke brown, with the margins considerably darker than the remaining surface. The apical borders of all the segments are also appreciably darker than the general surface. The characteristic abdominal markings, which are very prominent, are in the form of slightly curved to straight lines of dark vandyke brown on the segments 2-9, on either side of the median line. In the anterior segments the markings are more or less ovalish while in the last three or four segments they are in the form of slightly bent bands. These bands in the posterior segments extend almost completely from the apical to the basal margins but in the anterior somites they are nearer to the basal than the apical margins. The marginal dark bands run from end to end of the abdomen close to the pleura on each side. There is another sub-median band or streak on each side running close and

parallel to the dorsal line. In the anterior segments this is very faint, but becomes more discernible in the posterior segments, where it becomes considerably broader than anteriorly. The sub-median streaks, except in the ninth segment, are lighter in colour than the large lateral patches. It will thus be seen that the colour markings of the abdomen in *Ephemera diffusa* are more or less exactly like those of *Ephemera supposita* as described by Eaton in the *Journal of the Asiatic Society of Bengal*.

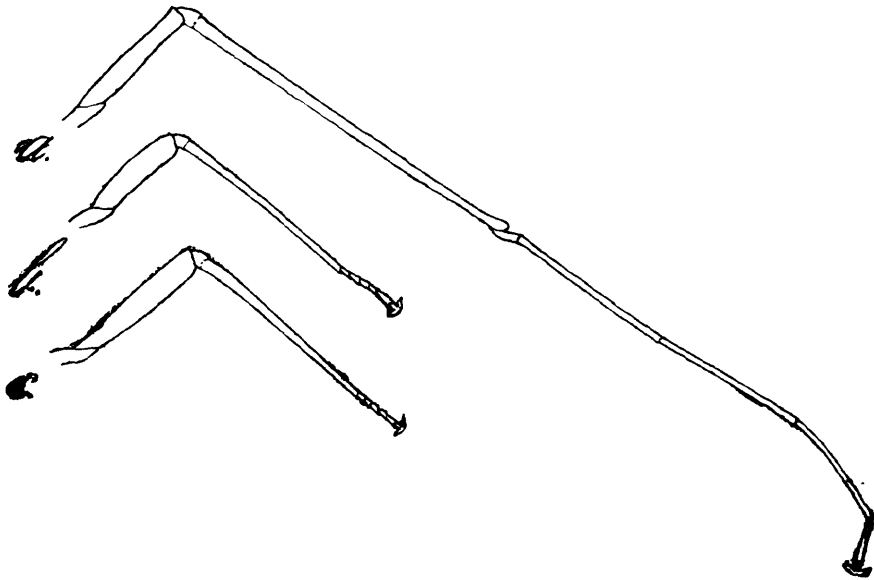
The venter is much lighter than the dorsal surface and there are fairly large and prominent whitish spots on the 9th and the 10th sternites. The prosternum behind the head and the head around the base of the antennae are also whitish.

The fore-wings are perfectly transparent in transmitted light, slightly iridescent, and are of a shade between antique brown and raw umber (nearer the latter than the former); the terminal and the inner margins are slightly darker than the rest of the membrane. The submarginal area is considerably darker. The longitudinal and transverse veins are opaque and of a raw umber colour. The sub-costa and first radial veins are considerably darker than the other longitudinal veins. The usual spotting of the wing is not at all clear perhaps owing to the specimen being in spirit. The spot in the fork of the media may have been present, but there is no trace of any marking on the *Cu*. R_5 a little beyond the forking of *M* has a small circular completely transparent spot which originally may have had pigment around it. There is a similar transparent area on R_2 and *Sc* but they are more proximally situated. The venation is typical of the genus. The costa is well developed; the sub-costa and the first radial are strongly developed. The radial-sector forks well in advance of media, the latter dividing beyond the middle. The cubitus branches quite close to the wing-root, the hinder branch being conspicuously curved near its origin. The first anal is obscurely connected with the cubitus at its base and forms a curve almost similar to that of the posterior branch of *Cu*. A_1 does not give many branches from its inner margin; A_2 is connected at its base to A_1 ; A_3 near the inner margin runs parallel to A_2 .

The hind-wing is concolourous with the fore-wing. The membrane is transparent and is more or less raw umber in colour; near the margins the membrane is much darker. There are no colour spots and the veins are not edged with colour. The costal projection is fairly conspicuous; *Rs* arises from R_1 and is forked quite near the wing base. *M* also divides near the fork of *Rs* and as usual M_3 joins *Cu*. The veins of the inner margin are not very prominent.

The legs, except for some parts of the fore-legs, are somewhat lighter in colour than the body (Text-fig. 2). The tibia of the fore-leg is vandyke brown, but the outer surface of the femur has a number of pale longitudinal streaks. The tarsus is considerably paler than the tibia. The second and third legs are somewhat light umber-brown with darker streaks on the femora. In their structure the legs are more or less typical of the genus. The fore-legs are very long and are about as long as or even longer than the body. The tibia is a little less than 3 times as long as the femur, while the tarsus is 4 times as long. The tarsus

is formed of 4 long, distinct segments and a rudimentary basal joint. The 4 large tarsal segments decrease in size progressively from the first



TEXT-FIG. 2.—*Ephemera diffusa* Chopra, sp. nov.

a. 1st leg of male : $\times 7$; b. 2nd leg of male : $\times 7$; c. 3rd leg of male : $\times 7$.

to the last ; the first is only slightly longer than the second and is almost equal to the third and the fourth joint together ; the 3rd is about twice as long as the 4th. Both the claws are similar. The second leg, the shortest of the three, is only a little shorter than the third. The femora of the 2nd and 3rd legs are of about the same length as that of the 1st ; the tibiae and tarsi of the 2nd and 3rd legs are less than even a third as long as those of the 1st. The tarsi of the last two pairs of legs are small, being about a third of the length of the tibiae. The tarsus is formed of 5 joints, the basal rudimentary segment is also more or less fully differentiated. The tarsal joints are sub-equal, except the ultimate one which is the longest.

The genital apparatus is lodged in a deep concavity of the very short 10th tergite. The forceps are concolourous with the venter. Each forcep is formed of 4 distinct segments. The two terminal segments of each are small, about as long as the basal and less than half as long as the 2nd. The basal segment is stout and the 10th tergite near its origin has a short spine. The second segment has a large prominence on its inner side near the base, is grooved ventrally and has hairs all along the groove. The penultimate and the terminal segments are hairy. The penis lobes are of the same colour as the venter and are proportionately very small in size ; they are lodged in a deep concavity of the 10th sternite, but a thin membrane-like structure covers their basal portions. The lobes are short, stumpy, finger-shaped, distally rounded, each having a sharp spine about as long as the lobe itself lying by its side along the inner margin. The presence of any such spine in connection with the genital apparatus has not been observed in any other mayfly and it is difficult to make any suggestion regarding its function, etc. The spine on the tergite near the base of the forcep is also unusual.

The setae are thin and long and are more or less circular in cross section. The setae in most of the specimens are broken, but the median seta appears to have been almost quite as long as the lateral ones. The setae are vandyke brown in colour, but in some specimens are antique brown especially towards their posterior ends. They are clearly segmented and are uniformly setose.

♂ *Sub-imago (in spirit)*.—This differs from the imago in being much lighter in colour. The wings are pale, dirty whitish with yellowish costal shoulder and brownish (darker near the wing base than distally) sub-costal and first radial veins. The principal veins are light brownish near the root but are milky whitish distally. Except in the sub-costal region most of the transverse veins are whitish and opaque. The dorsum of the abdomen is much lighter in colour than that of the adult but the colour markings in the two are identical. The prothorax is proportionately much shorter than that of the adult.

The legs in the proportion of their component parts resemble those of the female sub-imago more closely than those of the ♂ imago. In the fore-leg the femur is proportionately large and the tarsus is correspondingly reduced. The genital forceps are like those of the adult but the penis lobes are small. The caudal setae are long and have very prominent dark brown joints.

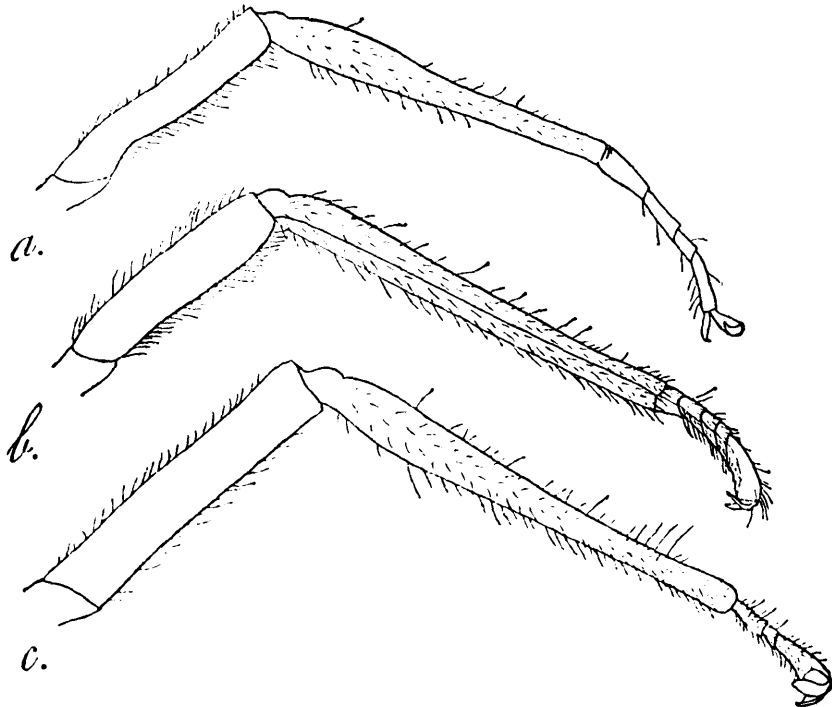
♀ *Sub-imago (in spirit)*.—The body is much paler in colour than that of the male imago. It is raw sienna above in places becoming antique brown to raw umber and is maize yellowish below. The head is dark brown and the eyes are blackish. The pronotum is short and is distinctly transverse. The notum has small irregular short setae of antique brown. The dorsum of the abdomen appears to have the same scheme of colour markings as that of the male but the marginal row of markings is hardly visible. The sub-median and the lateral rows are very well defined. The venter and the sides, as already mentioned, are light maize yellow.

The wings are dull whitish, with a pale tint in certain aspects and the veins are whitish. The sub-marginal area in the fore-wing is grayish. This wing, as compared with that of the male, is slightly longer and narrower, but the venation in the two appears to be more or less identical. The meta-thoracic wing is concolourous with the fore-wing and the venation is exactly like that of the hind-wing of the male.

The legs are more or less of the same colour as the venter (Text-fig. 3). The fore-leg has, however, a dull brownish streak on the femur and another on the tibia. The fore-leg is much shorter than the body; the femur is slightly over $\frac{3}{4}$ as long as the tibia and is somewhat longer than the tarsus. The latter consists of 4 distinct and one indistinct (basal) segments. Of the 4 segments the ultimate is the longest, while the 3rd is the shortest; the first is longer than the 2nd and is considerably shorter than the last. The claw is well developed and the two halves are dissimilar. In the 2nd leg the tibia is twice as long as femur and the tarsus is reduced. Of the 4 distinct segments, the last is by far the longest and the other three are sub-equal. In the last leg the tarsus is further reduced and the segments are not clearly seen.

The setae are dirty whitish with brown joints, which become considerably faded distally.

Along with the specimens described above a large number of cast sub-imaginal skins were also collected. Both sexes are represented



TEXT-FIG. 3.—*Ephemera diffusa* Chopra, sp. nov.

a. 1st leg of female sub-imago : $\times 20$; b. 2nd leg of female sub-imago : $\times 20$; c. 3rd leg of female sub-imago : $\times 20$.

but the females far outnumber the males. The characters briefly mentioned above for male and female sub-imagos are clearly brought out by the specimens. They are transparent, whitish with only certain thoracic parts raw sienna.

Length of body, ♂ imago 10 mm., sub-imago 10.5 mm., skins up to 13 mm., ♀ sub-imago 10.5 mm., skins 11-15 mm., wings ♂ imago 10.5 mm., sub-imago 11 mm., ♀ sub-imago 11 mm.; setae ♂ imago up to 22 mm., sub-imago 16 mm., skins 18 mm., ♀ sub-imago 15 mm., skins up to 13.5 mm.

Nymph not known.

Type specimens.—♂ imago No. $\frac{964}{H8}$, ♂ sub-imago No. $\frac{965}{H8}$, and ♀ sub-imago No. $\frac{966}{H8}$. *Paratypes.*—♂ imagos No. $\frac{969}{H8}$. A fairly large number of cast sub-imaginal skins No. $\frac{970}{H8}$, Zoological Survey of India (*Ind. Mus.*).

Locality.—All the specimens described above were collected by Dr. H. S. Rao in October 1924, sitting on a wall on the bank of the Bhavani river at Bhavani in the Coimbatore district. It is stated by Dr. Rao that the wall was covered with thousands of cast skins of which a few were collected. Also taken at Mettupalliyam, Gravely, 10-vi-1928.

E. diffusa is easily distinguished from *E. immaculata* Eaton¹ by its smaller size and warmer colour and by the penis lobes being shorter. It differs from *E. expectans* (Walk.)² by its more prominent abdominal markings.

¹ Eaton, A. E.—*Trans. Ent. Soc. London*, p. 74 (1871).

² Walker, F.—*ibid.*, 198 (1860).

Ephemera annandalei Chopra, sp. nov.

(Plate V, figs. 1-4.)

A single male specimen in certain respects resembling very closely *E. expectans* (Walk.) is in the collection of the Indian Museum.

♂ probably *Sub-imago* (*in spirit*).—The general colour, as in *E. expectans*, is white but there is considerably more of brown on the dorsal surface. The head is very pale orange yellow, with a few short irregular streaks scattered on it. The eyes are slate gray and the ocelli are white with grayish broad rings at their bases. The pronotum is also pale orange yellow with broad areas along each side suffused with vandyke brown and a distinct fairly broad streak of the same colour on each side. The median area between the streaks is whitish. The mesonotum is mostly whitish but in parts maize yellowish and has two broad curved streaks one on each side. These streaks are continued into broad patches of raw sienna to antique brown. The metanotum is suffused with small brownish spots.

The colour markings of the abdomen are principally very much like those of *E. expectans*, but the streaks are not chocolate but clove brown to blackish brown. The whitish ground surface of the dorsum is much less visible in between the streaks in the present species than in *E. expectans*. In segments 3-9 there are three clearly visible streaks on each side. The sub-median streak is slanting so that it meets its companion of the opposite side at the anterior end of the tergite. The laterals and marginals are more or less straight and run parallel to one another, the latter being quite close to the margin. In the 9th segment these two streaks more or less meet one another so that there appears to be one broad band on each side. In the first two segments the streaks are not differentiated, so that there is a general suffusion of colour. On the 10th tergite there is a blackish square spot on each side in continuation with the side streak and a crescent-shaped arch at the bases of the setae.

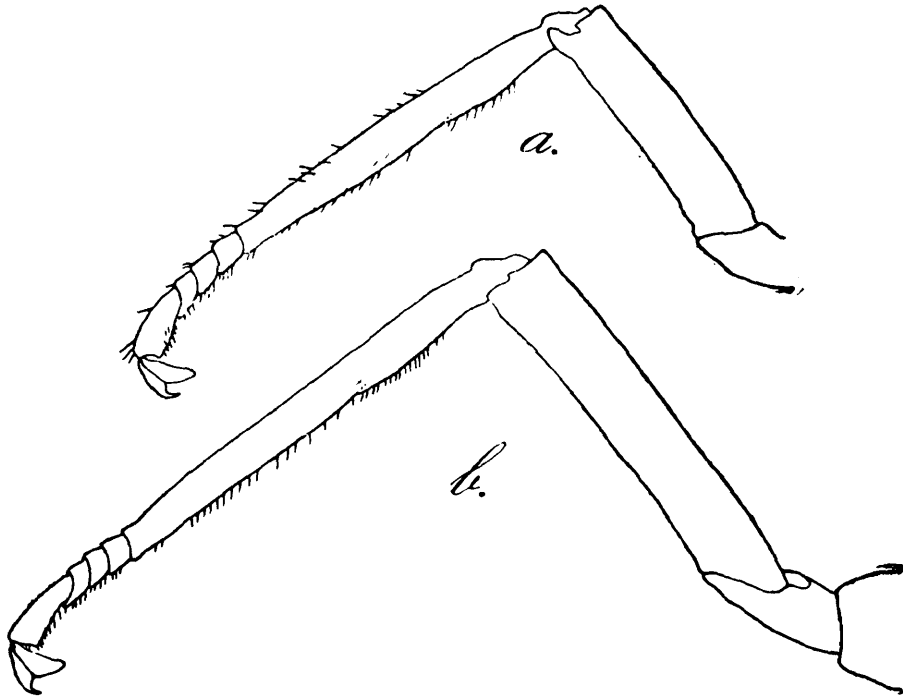
The venter is like that of *E. expectans* there being 2 rows of streaks on the abdomen; those on the 9th being much broader than the others. Between the bases of first legs there is a faint triangular spot. The sides are concolourous with the venter, but in the thorax there is a short streak near the mesothoracic wing-root. On the sides of the abdomen there is a short streak on each segment and some of the spiracles are also encircled with brown.

The wings are dirty-whitish, with the sub-costal area of the fore-wing very pale yellow orange. The membrane is dull but transparent and the longitudinal veins except the *Sc* and *R* are opaque and white. The sub-costa and the first radius are pale yellowish orange. The transverse veins are vandyke brown to warm sepia. There are no transverse veins near the inner margin. At the bifurcation of *M* there is a large and very prominent spot and the other 3 spots are also present in the usual position though considerably smaller than that of *M*. The venation is like that of *E. expectans*, but there are fewer subsidiaries given from *A*₁ to the margin.

The hind-wing is concolourous with the fore-wing and the longitudinal and the transverse veins are also of the same colour. The venation

is typical of the genus and the posterior branch of *M* distinctly arises from *Cu*₁.

The legs are concolourous with the venter and are for the most part devoid of prominent colour markings (Text-fig. 4). In the fore-leg¹



TEXT-FIG. 4.—*Ephemera annandalei* Chopra, sp. nov.

a. 2nd leg of male sub-imago: $\times 22$; b. 3rd leg of male sub-imago: $\times 22$.

the tibia has a longitudinal streak of vandyke brown and one or two of the same colour, but fainter, are present on the femur. The coxa of the 3rd leg has a dark brownish spot on its anterior surface. The fore-tarsi of both the sides are broken but the fore-tibia (as is the case in all sub-imagos) is comparatively shorter, being only slightly longer than the femur. In the 2nd and 3rd legs the tibia is much longer than the femur and the 3 basal joints of the tarsus are sub-equal while the terminal is the longest; a 5th rudimentary joint is hardly differentiated.

The genital forcep is of the same colour as the venter and has a very fine brownish streak along the outer margin. Of the 4 segments, of which it is formed, the basal is short and stout and has a prominent rounded projection on the inner side of its posterior extremity. The second joint is the longest, is curved and slightly grooved ventrally, there being hairs all along the sides of this groove. The last two segments are small, but the penultimate is about twice as long as the last. There is a small and faint brownish streak at the junction of the 2nd and 3rd joints. The concavity formed by the 9th sternite to receive the genital apparatus is fairly deep. The penis lobes are short and triangular with the apices very slightly rounded. The spine-like structure near the bases of the forceps is prominent and is a little larger than the penis lobes. It is finger-like and rounded at the base.

¹ The fore-legs are missing from the specimen and I have not been able to trace them from slides either.

The setae are dirty-whitish on the underside with white joinings near the base. On the upper surface and the outer sides the joints are brown and the general surface is also suffused with brown. Somewhat away from the base there is a brownish patch on each segment besides the ring of the same colour. Near the posterior end the setae are rounded and the joints are brown all round. The median seta is almost as long as the lateral.

Length of body 15 mm., fore-wing 13.5 mm., setae 14.5 mm.

♀ *Imago (in spirit)*.—The colouration of the head, thorax and abdomen is like that of the male, though it is slightly less white, being palish. The abdominal markings are also similar, though somewhat brighter. The wings are transparent and iridescent. The dirty-whitish colour of the wing of ♂ is no doubt due to the specimen being a sub-imago. The yellowish orange tint of the longitudinal veins in the costal region is more well marked than in the ♂.

The colouration and structure of the legs are more or less as in ♂. The wing venation is also apparently like that of the ♂.

Setae are as in male, but broken.

Length of the body 15 mm., fore-wing 15 mm., setae broken but appear to be about 14 mm.

Nymphs not known.

Type specimens.—♂ sub-imago No. $\frac{967}{H8}$ and ♀ imago No. $\frac{968}{H8}$, Zoological Survey of India (*Ind. Mus.*).

Locality.—The single male specimen was collected at Shillong (Assam) at an altitude of 4,500 ft. by Dr. N. Annandale in April 1918. The female specimen was collected by Mr. T. B. Fletcher at Shillong in November 1924.

The species superficially resembles *E. expectans*, but may easily be distinguished from it in having a considerably warmer colour and in the dorsum being more profusely and darkly coloured. The wing membrane is not quite as dull and whitish as in *E. expectans*. The markings on the dorsum of the abdomen are also different in the two species. There are fewer subsidiary veins going to the inner margin from A_1 than in *E. expectans* and the spine-like structure on the side of the penis lobe more pointed and finger-like.

Since Dr. B. Chopra wrote the foregoing description of the present species a large number of female imagos both pinned and in alcohol have been collected by him at light from Lonton, Upper Burma. The tibia of the fore-leg in these specimens has dark chocolate brown rings at the proximal and distal ends. The transverse veins of wings are also dark chocolate brown.

There are two more female specimens in spirit from Namkhai river, Kutkai, North Shan States, Burma (4,500 ft.) collected by Dr. H. S. Rao in November, 1926. The specimens are somewhat damaged and the fore-legs in both the specimens are missing. Setae are broken but the wings are in a fairly good condition. I have placed these specimens under this species with some doubt, as the characteristic abdominal markings are not so very prominent and the general appearance is like that of *E. expectans*. They, however, differ from *E. expectans* by their longer bodies and shorter wing expanse.

There are 5 more pinned females from Nyaungbin, Upper Burma, collected by Dr. B. Chopra in November 1926, which closely resemble *E. annandalei* in their general appearance and wing venation but differ like the specimens from Lonton in having the ends of the tibiae of the fore-legs coloured dark chocolate brown. The broader ungues of the second and third claws are also dark brown as in the specimens from Lonton.

I also refer to this species a female specimen (in spirit) from Sagar, Shimoga district, Mysore, collected at light by Dr. H. S. Rao (l. xii. 1928), a specimen from Danster Wah, Bubak, Sind, collected by Dr. B. Prashad and Dr. B. Chopra (21-23. xi. 1927), and three more females (in spirit) from near Harai, altitude 2,700 ft., Rewa State, collected by Dr. H. S. Pruthi (February 1927). From more or less the same locality (Opposite the Camp at Harai, 2,625 ft., Rewa State, March 1927) Dr. H. S. Pruthi also collected a single male. The male specimen is in a fairly good condition and as Chopra described only the ♂ sub-imago, I give below the description of what I consider to be an adult.

♂ *Imago (in spirit)*.—There is only a superficial difference between the adult and the sub-imago in that the general colouration of the former is much darker than that of the latter.

The front portion of the head is damaged but the general structure appears to be the same as in the sub-imago. The thorax is more darkly coloured, approaching umber brown, especially at the sides of the mesonotum.

The abdominal markings are better defined than in the sub-imago but the abdomen appears to be shorter than that of the sub-imago.

The fore-legs are missing in this specimen. The coxae and femora of the second and third pairs of legs are concolourous with the sides of the thorax. The coxae of third pair of legs on their outer surface have a dark brown spot. The tarsi of both the pairs of legs end in biunguiculate claws. Structurally the second and third pairs of legs are very similar to those of the sub-imago.

The wings are clear and transparent, with the sub-costal area light brown. The longitudinal veins, especially the first three, are conspicuously brown. The transverse veins are also brown. The wing venation is similar to that of the sub-imago.

The genital apparatus is lodged in the concavity of the last abdominal segment, and the general structure is similar to that in the sub-imago. Only one lateral seta of a dirty-whitish colour with brownish joints is present in the specimen.

Length of body 13 mm., fore-wing 12 mm., lateral seta 23 mm.

Distribution.—*E. annandalei* has a fairly wide range of distribution, extending from Upper Burma in the east to Sind in the west and as far down south as Mysore in the Peninsula.

***Ephemera immaculata* Eaton.**

(Plate V, figs. 8-11.)

1871. *Ephemera immaculata*, Eaton, *Trans. Ent. Soc. London*, p. 74, pl. iv, fig. 10.

1883. *Ephemera immaculata*, Eaton, *Trans. Linn. Soc. London*, (2), III, p. 72.

1920. *Ephemera immaculata*, Ulmer, *Entomol. Zeitung. Stettin*. LXXXI, p. 109.

1927. *Ephemera immaculata*, Lestage, *Ann. Soc. Ent. France*, XCVI, p. 95,

Eaton's description of *E. immaculata* is too inadequate to enable one to recognise it satisfactorily, but as a number of specimens in the Indian Museum agree fairly closely with Eaton's description I have considered it best to identify them with Eaton's species. The specimens are from Bangalore in South India; Eaton's example came from "Cuna".¹ I have also examined a single male from the same locality captured by Dr. Gravely in May 1921 and preserved in the collection of the Madras Museum.

The general colouration of the specimens is somewhat lighter than that described by Eaton, but this may be due to preservation in spirit for a number of years.

The head and the thorax are pale brownish, the latter being darker than the former. The eyes are grayish and the ocelli are white encircled with chestnut brown. Behind the ocelli there are two short, parallel, longitudinal streaks of a chestnut colour not extending to the anterior margin of the pronotum. The thorax is pale brownish with a few darker streaks. The abdomen is dark, and the tips of the segments and the spiracular lines are considerably darker. The penultimate segment of the abdomen is considerably darker than the rest of the abdomen. The venter and the sides are lighter than the dorsal surface. The lateral margins of the penultimate abdominal sternites are streaked with brown.

The legs are more or less concolourous with the venter. The femur of the fore-leg is considerably lighter than the rest of that limb. The tarsi of all the legs are very light, almost pale whitish. The setae are light brownish, somewhat warmer in the proximal portions.

The wings are spotless; the usual spots on *Sc*, *Rs* and near the fork of *M*, so characteristic of the other species are absent. The membrane of the fore-wing is clear and more or less devoid of colour. The coloured veins, however, make it appear somewhat brownish. The veins are raw sienna to antique brown. The cross veins in the sub-marginal area especially towards the base are considerably darker than in the rest of the wing. The venation is more or less typical of the genus. *Rs* forks well in advance of *M*, the latter dividing somewhat about the middle. The disposition of *Cu*, *A* and their branches is very similar to that of *E. diffusa*.

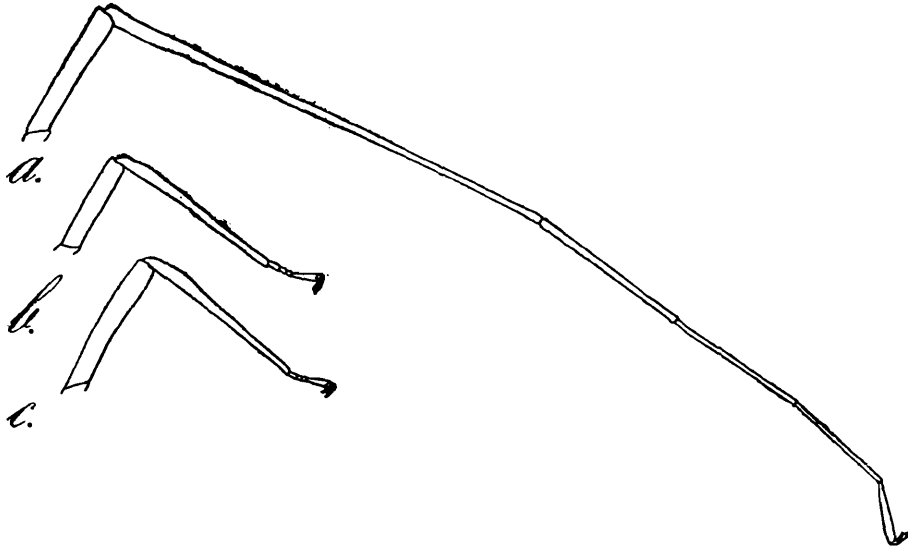
The terminal margin of the hind-wing is coloured raw sienna like the sub-marginal area of the fore-wing. The marginal and sub-marginal areas near the wing root are also lightly tinted. The venation is more or less typical of the genus. The costal projection is very prominent; *Rs* forks near the wing base and the second branch of *M* is joined on to *Cu*. The venation in the hinder portion of the wing, somewhat contrary to rule, is rather well developed, the anals being quite prominent.

The legs are very well developed, those of the first pair being very long (Text-fig. 5). The first legs are broken in all the specimens. The tibiae and the tarsi of the second and the third pairs of legs are reduced.

¹ I have not been able to trace "Cuna", it may probably be a *lapsus calami* for Guna in Gwalior.

The mid-tarsus consists of 5 segments; the first joint is rudimentary and the terminal is by far the longest. The third leg is similar to the second.

The genital apparatus is very like that of *E. diffusa*. The forceps are concolourous with the venter and have the usual structure. The



TEXT-FIG. 5.—*Ephemera immaculata* Eaton.

a. 1st leg of male: $\times 10$; b. 2nd leg of male: $\times 10$; c. 3rd leg of male: $\times 10$.

terminal segment appears slightly shorter than the sub-terminal. A shallow protuberance is visible along the outer side of the base of the second segment. The spine of the 10th sternite near the base of the forceps is fairly well developed. The cup-like concavity of the last sternite formed for the genital apparatus is rather shallow. The penis lobes are finger-shaped structures arising from a quadratic basal area and are proportionately longer than those in *E. diffusa*; the spines on their inner sides are considerably longer than the lobes themselves.

The three setae have the usual structure and are sub-equal in length. They are light brown near their bases, but become lighter distally.

There are no females or nymphs in the collection before me.

Length of body $\text{\textcircled{m}}$ imago up to 12 mm., fore-wing up to 11.5 mm.; setae missing in most of the specimens.

Distribution.—Eaton's type which is stated to be in the Hope Museum, Oxford, came from Cuna, but this is possibly a misprint for Guna in Gwalior. The specimens that I assign to *E. immaculata* are from Bangalore (alt. ca. 3,000 ft.) and most of them were collected by the late Dr. Annandale in October 1910. All these specimens are males. Also taken at Bangalore (alt. ca. 3,000 ft.) by Dr. Gravely in May 1921.

Remarks.—*E. immaculata* as described above seems to resemble the South Indian *E. diffusa* in several respects. It is, however, slightly larger in size and is of a much lighter colour. The wing membrane is very differently coloured, and the male genitalia are very different.

Ephemera expectans (Walker.)

1860. *Potamanthus expectans*, Walker, *Trans. Ent. Soc. London*, (n. s.) V, p. 198.
 1871. *Ephemera expectans*, Eaton, *Trans. Ent. Soc. London*, p. 74.
 1883. *Ephemera expectans*, Eaton, *Trans. Linn. Soc. London*, (2) III, p. 72.
 1913. *Ephemera vedana*, Banks, *Proc. Ent. Soc. Wash.* XV, pp. 137-138.
 1920. *Ephemera expectans*, Ulmer, *Entomol. Zeitung. Stettin.* LXXXI, p. 109.
 1927. *Ephemera expectans*. Lestage, *Ann. Soc. Ent. France* XCVI, p. 95.

♂ *Imago (in spirit)*.—There is a single male specimen from Naukuchia Tal (alt. 4,200 ft.), Kumaon Hills, collected by Dr. S. W. Kemp (5. v. 1911). It agrees with previous descriptions of the species, except for the colouration. This difference, however, may be due to the specimen having been in spirit since 1911. The measurements of this specimen are:—Length of body 13.5 mm., wing 12 mm.

I also refer to this species a large number of rather damaged adult females collected by Dr. B. Chopra (12-15. xi. 1926) from Chaungwa, Upper Burma. These specimens closely agree with Eaton's description in his well known monograph. Their measurements are almost identical with those of the female sub-imagos described by Eaton. I have also seen five male specimens preserved in the Madras Museum and collected by Gangadaran from Mysore in November 1925.

Ephemera supposita Eaton.

(Plate V, figs. 5-7.)

1858. *Potamanthus fasciatus*, Hagen, *Verh. Zool. Bot. Gessells. Wien.* VIII, p. 476.
 1871. *Ephemera fasciata*, Eaton, *Trans. Ent. Soc. London*, pp. 74-75, pl. iv, figs. 11, 11a.
 1883. *Ephemera supposita*, Eaton, *Trans. Linn. Soc. London*, (2), III, pp. 72-73, pl. viii, fig. 12c.
 1891. *Ephemera supposita*, Eaton, *Journ. As. Soc. Bengal*, LX, pp. 409-410.
 1920. *Ephemera supposita*, Ulmer, *Entomol. Zeitung. Stettin.* LXXXI, p. 109.
 1921. *Ephemera supposita*, Ulmer, *Arch. f. Naturg.* LXXXVII, p. 261.
 1924. *Ephemera supposita*, Lestage, *Ann. Soc. Ent. Belgique*, LXIV, p. 39.
 1927. *Ephemera supposita*, Lestage, *Ann. Soc. Ent. France*, XCVI, p. 97.

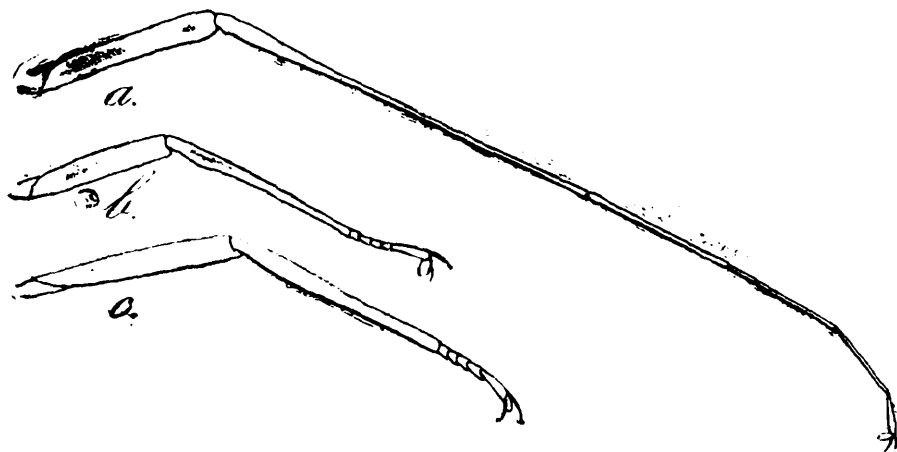
None of the specimens identified by Eaton as *E. supposita* are preserved in the collection of the Indian Museum.

Three pinned males collected in the Malabar district in South India and preserved in the collections of the Madras Government Entomologist at Coimbatore are referred to this species. The 3 specimens, which were examined by Dr. Chopra, the present Government Entomologist at Coimbatore informs me, are not present in his collections. I, however, give below a few notes Dr. Chopra made while examining the specimens together with the figures which were prepared under his supervision.

“ In general colouration the specimens agree closely with the published accounts. The general tint of the dorsum is more of vandyke brown than bistre, but this may be due to the fact that Eaton's examples were, as stated by him, faded. The head is considerably darker than the rest of the body, and there are two dark squarish patches near the posterior margin of the pronotum. The mesonotum is lighter in colour (approaching testaceous) than the abdomen and the metanotum

is in places still lighter. The colour pattern of the abdomen seems to agree closely with Eaton's account. The venter is somewhat lighter than the dorsum.

The fore-legs in two specimens are missing, while only one is present in the third (Text-fig. 6). The femur is brownish, while the tibia,



TEXT-FIG. 6.—*Ephemera supposita* Eaton.

a. 1st leg of male : $\times 9$; b. 2nd leg of male : $\times 9$; c. 3rd leg of male : $\times 9$.

especially towards its distal end, is considerably darker. The tarsus is also dark brown. Hind-legs are much lighter in colour, yellow-umber, as described by Eaton and have the ungues considerably darker.

The setae are umber brown proximally, and the distal parts are yellow. The joints are reddish brown to blackish.

The colouration of the wings is exactly as described by Eaton and the four colour spots described by him are well seen. The venation is quite typical of the genus.

The hind-wing is coloured like the fore-wing. The sub-costal vein is brown. The other longitudinal and cross veins are as in the fore-wing. The terminal margin, as also a part of the inner margin is clouded with grayish colour, very lightly tinted with brown.

The genital forceps are as described by Eaton ; they are dull yellowish in colour (with a slight shade of brown) and the two terminal joints are black.

Length of body, ♂ 17 mm., fore-wing 16.5 mm., setae 39 mm."

I refer to this species 3 specimens (in spirit). They were all collected from Peradeniya, Ceylon, 1,500 ft. by Drs. N. Annandale & F. H. Gravely. Two are males and the third is a female. The female appears to be a sub-imago and is in a damaged condition. One of the males also appears to be a sub-imago. It is 15 mm. long, and in general characters is very similar to previous descriptions.

The female sub-imago is only 13 mm. long. Its general colouration is lighter than that of the ♂ sub-imago.

Locality.—The three pinned specimens that were referred to this species by Dr. B. Chopra were lent to him for examination by the Madras Government Entomologist at Coimbatore. Two of these were collected at Santhanatbod in the Malabar district at an altitude of 2,500 ft. in the month of October 1917. The third specimen came from near a stream at Taliparamba and was captured in October 1908. All the specimens

were dry males and were said to be in quite a good state of preservation. A single male specimen was also collected by Dr. Gravely from Kodaikanal, Palni Hills (alt. *ca.* 6,500—7,500 ft.) in May-June 1926 and is preserved in the Madras Museum. Eaton's specimens were from Rambodde, Ceylon.

Ephemera remensa Eaton.

1891. *Ephemera remensa*, Eaton, *Journ. As. Soc. Bengal*, LX, pp. 410-412.

1920. *Ephemera remensa*, Ulmer, *Ent. Zeitung. Stettin*. LXXXI, p. 109.

1927. *Ephemera remensa*, Lestage, *Ann. Soc. Ent. France*, XCVI, p. 96.

Of the five male imagos from Kulu on which Eaton based his description of this species only three pinned specimens are preserved in the collections of the Indian Museum. All the specimens are in a pretty bad condition, the abdomen and the head of one being completely lost and in the other two badly damaged. The wings in the specimen without the abdomen and the head are, however, in a good state of preservation. In the spirit collection there are a few fragments of another specimen, including a portion of the male genital apparatus and a leg.

Typespecimens.—Nos. $\frac{6942-43}{1}$, $\frac{6946}{1}$ and $\frac{6948}{1}$, Zoological Survey of India (*Ind. Mus.*).

Locality.—Kulu, Western Himalayas.

Ephemera consors Eaton.

1891. *Ephemera consors*, Eaton, *Journ. As. Soc. Bengal*, LX, pp. 412-413.

1920. *Ephemera consors*, Ulmer, *Ent. Zeitung. Stettin*. LXXXI, p. 109.

1927. *Ephemera consors*, Lestage, *Ann. Soc. Ent. France*, XCVI, p. 99.

Of the two ♂ imagos and two ♀ sub-imagos from the Indian Museum on which Eaton based his description of the species only one male imago and one female sub-imago (both pinned) are available in the Indian Museum collections. The specimens are in a very poor condition, the sub-imago having lost its abdomen completely. The imago too possesses only a portion of the abdomen. The wings in both the specimens are, however, in good condition and so are some of the legs.

Typespecimens.—Nos. $\frac{5852}{5}$ and $\frac{5855}{2}$, Zoological Survey of India (*Ind. Mus.*).

Locality.—Kulu, Western Himalayas.

Ephemera pulcherrima Eaton.

1892. *Ephemera pulcherrima*, Eaton, *Trans. Ent. Soc. London*, pp. 185-186.

1927. *Ephemera pulcherrima*, Lestage, *Ann. Soc. Ent. France*, XCVI, p. 99.

I have not so far seen any specimen belonging to this species. From Eaton's description, which is fairly detailed, the species appears to resemble *E. annandalei* described in this paper as new. Eaton's species is, however, much smaller, measuring 12 mm. in length while *E. annandalei* is 15 mm. long. The single female on which Eaton based his description is probably in the British Museum, and came from Tenasserim Valley.

Genus **Hexagenia** Walsh.**Hexagenia indica** Chopra.

1924. *Hexagenia indica*, Chopra, *Rec. Ind. Mus.* XXVI, pp. 416-418.

H. indica is the only species of the genus *Hexagenia* Walsh. so far described from India. There are altogether eleven specimens belonging to this species in the Indian Museum collections. All the specimens are females, the male being unknown, and two of them are pinned. The specimens were collected by the late Dr. Annandale on the surface of the Chilka Lake off Barkuda Id. in August 1919.

Family POTAMANTHIDAE.

Of the seven known genera of the family only four, *viz.*, *Potamanthus* Pict., *Rhoenanthus* Etn., *Rhoenanthodes* Lest. and *Potamanthodes* Ulm. have so far been recorded from India. A useful key is provided by Lestage in his "Contribution a L'Etude des Larves des Ephemeropteres" for recognising the genera and species. As stated in the introduction, I have not so far seen any mayflies belonging to this family.

Genus **Potamanthus** Pictet.**Potamanthus subcostalis** Navas.

1932. *Potamanthus subcostalis*, Navas, *Rev. Acad. Cienc. Zaragoza*, XV, pp. 17-18.

This species appears to have been described from females only and the locality is given as Khandala (Bombay).

Genus **Rhoenanthus** Eaton.**Rhoenanthus posticus** Bks.

1914. *Rhoenanthus posticus*, Banks, *Proc. Acad. Nat. Sc. Philadelph.* LXVI, p. 613.

1930. *Rhoenanthus posticus*, Lestage, *Mem. Soc. Ent. Belgique*, XXIII, p. 131.

This species described by Banks was recorded from Kandy, Ceylon.

Genus **Rhoenanthodes** Lestage.**Rhoenanthodes amabilis** (Eaton).

1892. *Rhoenanthus amabilis*, Eaton, *Trans. Ent. Soc. London*, pp. 188-189.

1925. *Rhoenanthus amabilis*, Ulmer, *Arch. f. Naturg.* XCI, heft V, p. 100.

1930. *Rhoenanthodes amabilis*, Lestage, *Mem. Soc. Ent. Belgique*, XXIII, p. 136.

This species was originally described by Eaton under the genus *Rhoenanthus* from a single ♂ imago (dried) collected from the Tenasserim Valley. Lestage has, however, created a new genus *Rhoenanthodes* to accommodate this species and has redescribed it. The species, as Lestage redescribed it, is also known to occur in China and Tonkin.

Genus **Potamanthodes** Ulmer.**Potamanthodes formosus** (Eaton).

1892. *Potamanthus formosus*, Eaton, *Trans. Ent. Soc. London*, pp. 186-188.

1919. *Potamanthodes formosus*, Ulmer, *Arch. f. Naturg.* LXXXV, heft XI, p. 11.

1925. *Potamanthodes formosus*, Ulmer, *Arch. f. Naturg.* XCI, heft V, p. 98.

1930. *Potamanthodes formosus*, Lestage, *Mem. Soc. Ent. Belgique*, XXIII, p. 139.

Eaton based his description of the species on dried male and female imagos. Ulmer in 1920 redescribed the species and referred it to his new genus *Potamanthodes*. Eaton's specimens came from the Tenasserim Valley and the species has since been recorded from Japan, China, Tonkin and Formosa.

The following is a list of Indian Ephemeroptera of the sub-order Ephemeroidea which have been described in journals I have not been able to consult and specimens of which I have not so far seen :

Family Palingeniidae.—*Anagenesia birmanica* Navas, *Mem. Accad. Nuovi Lincei* (2), XVI, p. 954, 1932 (Burma).

Family Polymitarciidae.—*Polymitarcys birmanus* Navas, *Mem. Pont. Accad. Sci.* (2), XVII, p. 87, 1933 (Burma).

Family Ephemeridae.—*Ephemera fulvata* Navas, *Broteria Ci. Nat.*, XXXI, pp. 100-101, 1935. (Lonawla near Khandala, Bombay).

REFERENCE TO LITERATURE.

[The following list is supplementary to the bibliography published by Chopra in 1927.]

- Chopra, B., 1924.—The Ephemeroptera of Barkuda Island. *Rec. Ind. Mus.* XXVI, pp. 416-418.
- Chopra, B., 1927.—The Indian Ephemeroptera. *Rec. Ind. Mus.* XXIX, pp. 91-138, pls. viii-x.
- Hora, S. L., 1929.—Swarming of Ephemeroptera and lunar periodicity. *Journ. As. Soc. Bengal*, XXIII, pp. 339-341.
- Lestage, J. A., 1927.—Une *Ephemera* nouvelle du Tonkin et tableau des espèces de la faune orientale. *Ann. Soc. Ent. France*, XCVI, pp. 93-100.
- Lestage, J. A., 1930.—Contribution à l'Etude des Larves des Ephemeropteres—Le groupe Potamanthidien. *Mem. Soc. Ent. Belgique*, XXIII, pp. 73-146.
- Navas, R. P. L., 1932.—Comunicaciones Entomologicas. *Rev. Acad. Cienc. Zaragoza*, XV, p. 17.
- Navas, R. P. L., 1932.—“Description of *Anagenesia birmanica* sp. nov. from Burma” *Mem. Accad. Nuovi Lincei* (2), XVI, p. 945.
- Navas, R. P. L., 1933.—“Description of *Polymitarcys birmanus* sp. nov. from Burma” *Mem. Pont. Accad. Sci.* (2), XVII, p. 87.
- Navas, R. P. L., 1935.—“Description of *Ephemera fulvata* sp. nov. from Bombay” *Broteria Ci. Nat.* XXXI, pp. 100-101.
- Needham, J. G., Traver, J. R. and Hsu, Y. C., 1935.—“The Biology of May-flies” (New York).
- Ulmer, G. 1930—Key to the genera of Ephemerida. *Peking Nat. Hist. Bull.* IV, pp. 1-18.
- Ulmer, G., 1932.—Bemerkungen über die seit 1920 neu aufgestellten Gattungen der Ephemeropteren. *Stettin. Entomol. Zeitung*, XCIII, pp. 204-219.
- Ulmer, G., 1933.—Revised key to the genera of Ephemeroptera. *Peking Nat. Hist. Bull.* VII, pp. 195-218, pls. i-ii.

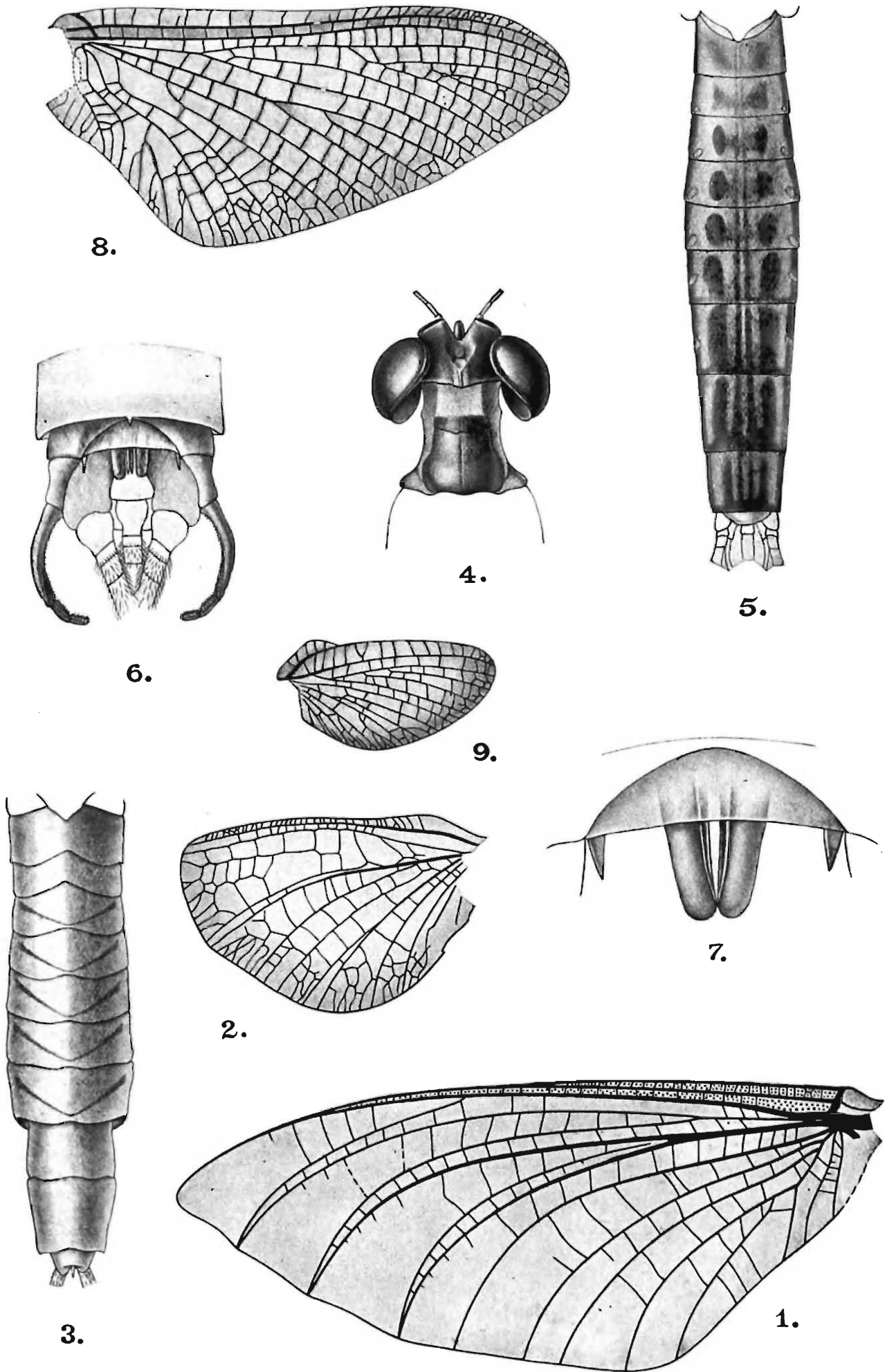
EXPLANATION OF PLATE IV.

Anagenesia lontona, sp. nov.

- FIG. 1.—Forewing of female : $\times 4$.
FIG. 2.—Hindwing of female : $\times 4$.
FIG. 3.—Abdomen of female, dorsal view : $\times 4$.

Ephemera diffusa Chopra, sp. nov.

- FIG. 4.—Head and prothorax of male, dorsal view : $\times 16$.
FIG. 5.—Abdomen of male, dorsal view : $\times 10$.
FIG. 6.—Genitalia of male, ventral view : $\times 28$.
FIG. 7.—Penis lobes : $\times 70$.
FIG. 8.—Forewing of male : $\times 8$.
FIG. 9.—Hindwing of male : $\times 8$.



D. Bagchi and Subodh Mondul del.

INDIAN EPHEMEROPTERA.

Photo.-Litho. Office, Survey of India.

EXPLANATION OF PLATE V.

Ephemera annandalei Chopra, sp. nov.

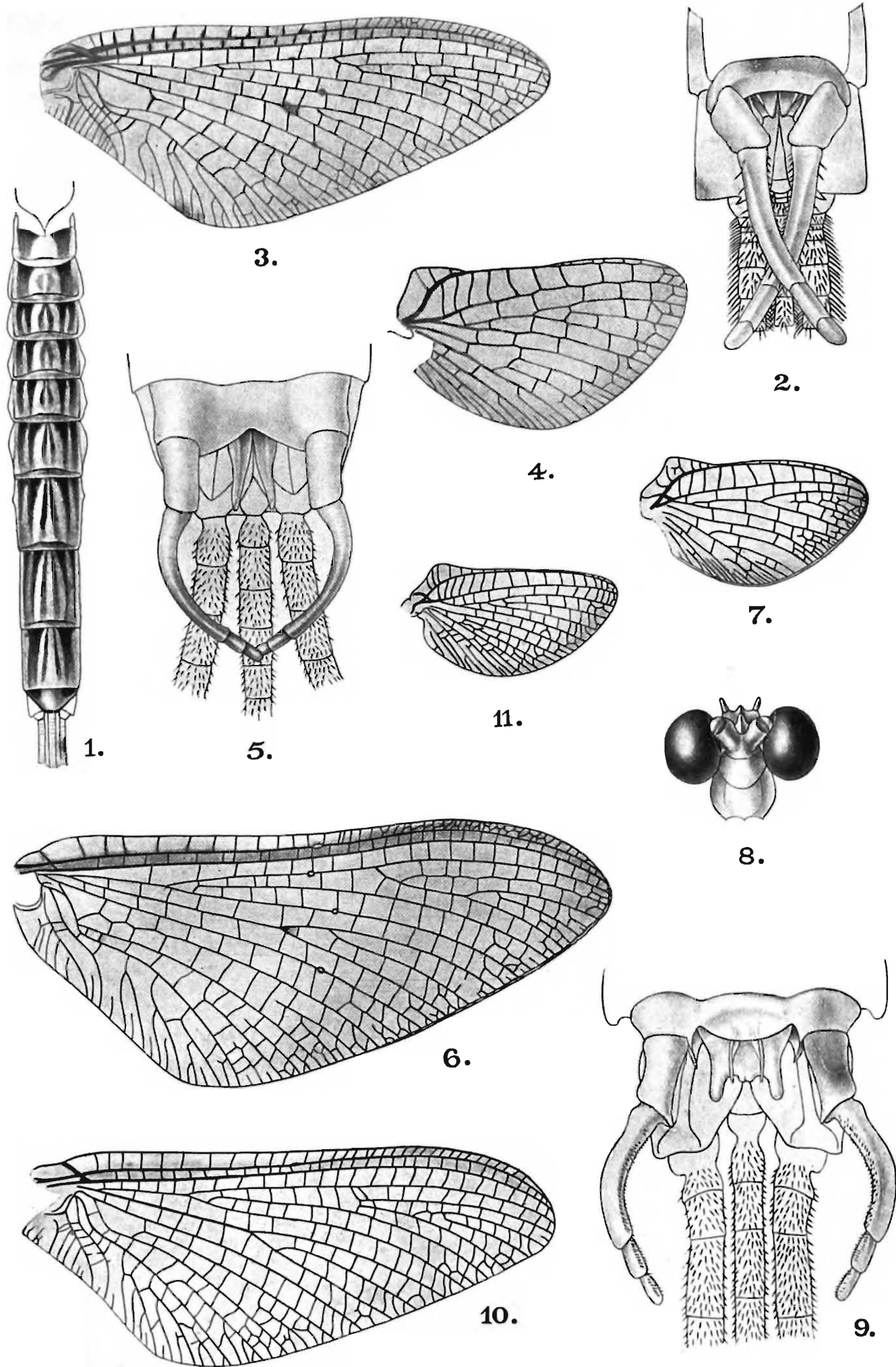
- FIG. 1.—Abdomen of male, dorsal view : $\times 9$.
FIG. 2.—Genitalia of male, ventral view : $\times 30$.
FIG. 3.—Forewing of male : $\times 6$.
FIG. 4.—Hindwing of male : $\times 10$.

Ephemera supposita Eaton.

- FIG. 5.—Genitalia of male : $\times 28$.
FIG. 6.—Forewing of male : $\times 6$.
FIG. 7.—Hindwing of male : $\times 5$.

Ephemera immaculata Eaton.

- FIG. 8.—Head and prothorax of male, dorsal view : $\times 10$.
FIG. 9.—Genitalia of male, ventral view : $\times 45$.
FIG. 10.—Forewing of male : $\times 8$.
FIG. 11.—Hindwing of male : $\times 8$.



D. Bagchi del.

INDIAN EPHEMEROPTERA.

Photo.-Litho. Office, Survey of India.

NOTES ON *NEVADNE GLAUCA* (ANNANDALE).

By N. KESAVA PANIKKAR, M. A., D. Sc.

(From the University Zoological Laboratory, Madras.)

INTRODUCTION.

In 1915, Annandale (1) described a rare anemone from the Chilka Lake as a new species of the genus *Gyrostoma* belonging to the family Actiniidae. The numerous differences between this species, *Gyrostoma glaucum*, and the other members of the Actiniidae were pointed out by Stephenson (6) who in his papers on Actinian classification assigned Annandale's species to a new genus *Nevadne*, and placed it in the Endomyarian family Myonanthidae, constituted of the genera *Myonanthus*, *Macroactyla*, *Boloceroïdes* and *Nevadne*. Later investigations by Carlgren (2) showed that this family could be dispensed with since *Myonanthus* and probably *Macroactyla* were really Actiniid genera, while *Boloceroïdes* was in many respects a primitive form requiring a separate place in classification. A new sub-tribe, Boloceroïdaria, was constituted by him for *Boloceroïdes* and *Bunodeopsis* since these genera included forms without basilar muscles but at the same time having a well developed longitudinal ectodermal musculature on the wall of the column and feebly developed retractor muscles on the mesenteries. On re-examination of Annandale's type specimen of *Gyrostoma glaucum*, Carlgren (3) discovered some of the Boloceroïdarian features in the anemone, like, for example, the ectodermal longitudinal musculature of the body wall. On the basis of this, he provisionally referred the genus to the Boloceroïdaria, under an independent family, the Nevadneidae. A very peculiar arrangement of tentacles that involves an atypical mode of development of the later sets of micromesenteries and tentacles was also reported by Carlgren as a result of his detailed examination of a sextant of the oral disc. In view of the peculiarities in the tentacular arrangement and of the many gaps in our knowledge of *Nevadne glauca*, a thorough re-investigation of the species is highly desirable; but this would be possible only if the anemone is rediscovered. The following observations are based on a single specimen (one of the type series) from the Indian Museum, kindly lent me from the collections of the late Dr. Annandale. I wish to thank Dr. Bains Prashad for the loan of this interesting and rare material and Prof. Gopala Aiyar for valuable help and suggestions.

I have examined one of the specimens labelled ZEV 6825/7. After carefully noting the external characters, the anemone was cleared in Turpineol, and the arrangement of mesenteries and their relationship with the different cycles of tentacles were followed as far as possible under the binocular. The anatomy was studied from serial transverse sections of the same anemone, stained in Heidenhain's Haematoxylin and Orange G. The preservation of the material being indifferent, the histological details could not be followed in detail.

EXTERNAL CHARACTERS.

The specimen is vase-shaped and evidently in a state of contraction. The measurements are as follows :—

Total length of the column	9 mm.
Diameter of the basal disc	3 mm.
Maximum width of the column	5 mm.
Diameter of the oral disc	4 mm.
Average length of tentacles—	
(a) Outer	14 mm.
(b) Inner	6 mm.

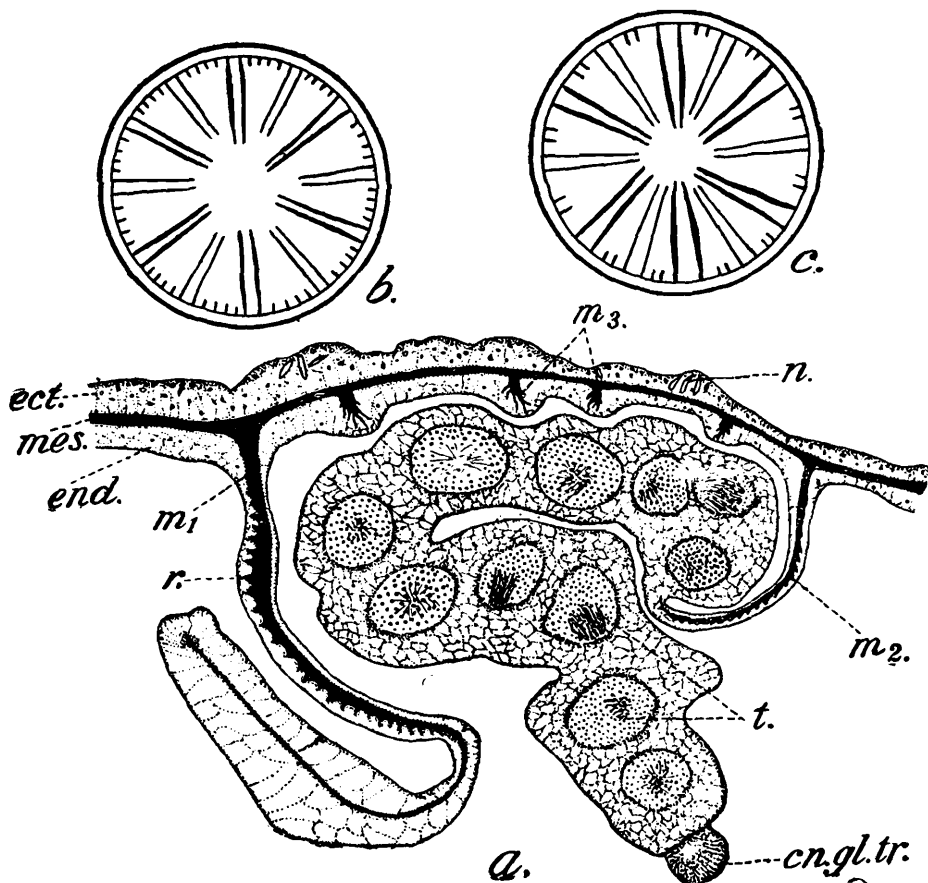
The basal disc is distinct and is provided with a distinct minute aperture in the centre. Annandale has described this as a distinct aboral pore characteristic of the species, but I doubt if this is a constant feature. As is frequently the case with young Actinaria and certain Ceriantharia, these openings are not permanent structures, but are only punctures caused by sudden contractions. Basilar muscles are definitely absent. Insertions of the first and second cycles of mesenteries are clearly visible on the basal disc.

The column is broader at the distal part than at the proximal, and is narrowest just below the oral disc. The microscopic prominences described by Annandale are indistinguishable in the specimen, but the nematocysts on the column are arranged in groups as also noticed by Carlgren (3). The wall of the column is thin, and insertions of the mesenteries and their relationship with the tentacles are easily made out through the column of the cleared specimen. Columnar sphincter appears to be absent, but I have not been able to verify this from longitudinal sections of the anemone. Carlgren has already noted the presence of ectodermal longitudinal musculature on the column. In the specimen investigated by me, this muscle layer is absent from the column except in the upper region near the oral disc where it is quite distinct; but even here the musculature is rather feeble in comparison with that of other Boloceroidaria. However, these muscle fibres are quite clear at the portion of the column adjacent to the outermost row of tentacles; and it must have been this feature that led Carlgren to remark that they are rather well developed at the distal part of the column.

The Oral Disc is narrow and crowded with tentacles, there being no distinct margin. The throat is not open and has three or four faint throat ridges discernible on either side of the mouth.

The tentacles of the specimen examined number 78, which is considerably lower than the full quota of 144, described by Annandale and Carlgren. Among the 78, six are rather very small and obviously belong to cycles that have just begun to appear. Among the remaining 72, a set of 24 outermost tentacles can easily be distinguished as they are the largest in the anemone. The next in size is a set of six tentacles situated just adjacent to the mouth and evidently belonging to the primary cycle. Another set of six smaller tentacles is observed outside them, these being the tentacles of the second cycle. The remaining cycles are arranged between the latter and the last cycle of outermost tentacles. Based upon Annandale's remarks and his own examination

of the type specimen, Carlgren has found that the tentacular formula for the species is $6+6+12+48+48+24$. This fact goes to prove that the specimen examined by me is one that has not attained the final stage in tentacular arrangement.



Anatomy of *Nevadne glauca* (Annandale).

a. Part of a transverse section passing through the column of *Nevadne glauca*, showing one primary mesentery, one secondary mesentery bearing gonad, and four tertiary mesenteries ($\times 300$); *b.* Scheme of arrangement of the mesenteries at the distal-most part of the column, showing the 24 pairs of tertiary mesenteries; *c.* Scheme of arrangement of mesenteries on the column, somewhat below the oral disc, where only twelve pairs of tertiary mesenteries are visible. The primary mesenteries are shaded a little darker than the secondaries, while the tertiary mesenteries are represented as very small septa.

cn. gl. tr. cnidoglandular tract; *ect.* ectoderm of the column; *end.* endoderm of the column; *mes.* mesoglea; *m1.* primary mesentery; *m2.* fertile secondary mesentery; *m3.* tertiary mesenteries, four of them occurring between adjacent pairs of primary and secondary mesenteries; *n.* nematocysts; *r.* retractor; and *t.* testes.

The tentacles are without basal sphincters of the type noted for the Boloceroididae. The longitudinal musculature of the tentacles and the radial musculature of the oral disc are ectodermal, and are well developed.

ANATOMY.

The actinopharynx extends to about half the length of the column. There are two siphonoglyphs with aboral prolongations which are associated with two pairs of directive mesenteries. The musculature of the stomodaeum is weak.

The arrangement of the mesenteries is indicated in text figures *a*, *b* and *c*. There is no sharp distinction into macrocnemes and microcnemes. In all there are three cycles of mesenteries, consisting of a primary and a secondary cycle each with six pairs of septa, and a tertiary group of twenty-four mesenteries. Only the first and second cycles extend to the aboral extremity of the column, the last cycle of mesenteries being seen only near the oral disc. In each exocoel between one primary and secondary pair of septa, four mesenteries belonging to the last set are seen in sections of the upper-most part of the column. As pointed out by Carlgren, there is thus a doubling of the youngest cycle of mesenteries in this specimen also; but there is this important difference that the doubling of mesenteries occurs in the fourth cycle in his specimen, while in the present individual, the doubling is in the third cycle. This fact is of considerable importance as it would mean that the deviation in the development of micro-mesenteries and tentacles commences even with the appearance of the third cycle of mesenteries. The relationships of the different cycles of mesenteries with the tentacles are as follows: The endocoels of the primary mesenteries are in communication with the innermost cycle of tentacles. The second cycle of tentacles belongs to the endocoels of the secondary mesenteries. The two pairs of mesenteries that lie in each exocoel between the pairs of primary and secondary septa are in communication with two endocoelic tentacles which are situated between the outermost group of large tentacles and those belonging to the inner group of endocoelic tentacles composed of the first and second cycles. Between each pair of endocoelic tentacles belonging to the third cycle, a single small exocoelic tentacle is seen in most sextants; in others they are not observed, probably not being developed. The largest outermost set of twenty-four tentacles is also exocoelic.

Of the two pairs of mesenteries found in each exocoel between the first and second cycles of mesenteries, one pair is always found to be younger than the other as could be judged from the degree of development of the mesenteries and the extent to which they traverse the length of the column. Hence, in sections taken a little below the disc where the mesenteries of the first, second, and third cycles are found, only two mesenteries are seen between any two pairs of primary and secondary mesenteries (text figure *c*). As we proceed higher up, the two other mesenteries make their appearance, thus making the full complement of four (cf. text figures *b* and *c*). Hence, the mesentrial arrangement throughout the anemone, except where the last-mentioned younger mesenteries are found, is such as to suggest a normal condition, involving the six primary, six secondary, and twelve tertiaries. A parallel condition is also found in *Phytocoeteopsis ramunni* described by me in a previous paper (4), where the doubling of later sets of micromesenteries and the attendant irregularities in arrangement could be noticed only near the oral disc of the anemone, the other regions of the column presenting the normal condition.

The primary mesenteries are provided with feeble retractors which have only a few muscle folds. Parietal muscles are absent. The secondary mesenteries attain almost the same amount of development as

the primaries, but the tertiaries are very weak. Mesenterial filaments are found on the mesenteries of the first and second cycles, and are absent from those of the third. The ciliated tracts of the filaments appear to be very short as only the cnidoglandular tract traverses the major portion of the mesenteries.

Annandale has observed the reproductive organs borne by the mesenteries of the second order as shown clearly by his figure of a section passing through an anemone (Figure 1, p. 71). The specimen studied by me is a male having well developed testes on some of the mesenteries, and containing spermatozoa in numerous chambers (text figure *a.*). The mesenteries belonging to the second cycle are provided with gonads, while the last cycle is completely sterile. The same is true of all the mesenteries of the first cycle except one which shows traces of gonads.

So far as could be ascertained from sections, spirocysts appear to be absent from the column, while a large number of nematocysts are arranged in groups. The capsules are of the usual type and are slightly curved. The spirocysts and nematocysts occur in great abundance on the tentacles. I am unable to make out the different types of capsules, but their measurements taken from sections are given below.

	L. B. (In Microns).
Nematocysts of the column (Majority Capsules).	12-18 × 2.5-3.0
Nematocysts of the tentacles—	
(1)	22-26 × 3.0
(2)	14-18 × 2.0
Spirocysts of the tentacles	25-28 × 3.0
Nematocysts of the throat	16-18 × 2.0
Nematocysts of the filament	20-22 × 3.0

REMARKS.

This re-investigation is in some respects incomplete in as much as certain points of structure are left unsettled owing to lack of sufficient material. Definite data have, however, been brought forward relating to the absence of basilar muscles on the pedal disc, and the structure of the column, actinopharynx, and the mesenteries. Of these the first feature definitely settles the unmistakable Athenarian character of the anemone, which along with the presence of longitudinal ectodermal muscles on the body-wall confirms its position in the Boloceroidaria. The distribution of the gonads and the presence of siphonoglyphs are in conformity with the views expressed in my paper on *Boloceractis* (5), where I have endeavoured to link up *Nevadne* to the Boloceroididæ, through an intervening *Boloceractis*-stage. The cardinal feature of the genus *Nevadne* is the doubling of the last set of micromesenteries and tentacles, involving an atypical mode of development of later orders which, as Carlgren has pointed out, is a marked deviation from what is found in all other Actiniaria. A similar peculiarity has also been noticed in *Phytocoeteopsis* (4); in both cases, there is reason to believe that there is a regular zone of growth where new tentacles appear and remain as interpolated structures, disturbing the original arrangement which otherwise would be quite normal. A detailed comparison of

the conditions in *Nevadne* and *Phytocoeteopsis* is being made in another study dealing with the development of the later sets of micromesenteries and tentacles in *Phytocoeteopsis ramunni*.

The structural differences between the specimen described by Annandale and by Carlgren, and that which I have examined, are worthy of note since they seem to point to a reasonable doubt as to whether the present individual is conspecific with *Nevadne glauca*, in spite of its being labelled by Annandale as *Gyrostoma glaucum*. There is agreement between the two in all the main features excepting the absence of the 4th cycle of mesenteries and the presence of gonad in one of the primary mesenteries in my example. The cycle of mesenteries that has undergone doubling in this instance is the 3rd, while in the type specimen this occurs in the 4th cycle consisting of 48 septa. Do these characters necessitate the formation of a separate species for this anemone? The last mentioned character is of much significance and would easily have marked off the anemone as belonging to a different species but for the fact the specimen does not seem to have reached its final stage of growth as judged by the nature of the mesenteries and tentacles. Further, the sizes of cnidae from different regions of this specimen are found to be in close agreement with those given by Carlgren. In view of these facts, I have described it as *Nevadne glauca*. The anemone is certainly a member of the genus *Nevadne*, but whether it is merely a developmental stage of *Nevadne glauca* or an almost adult stage of another closely related species cannot finally be settled until other specimens are investigated and the problem of the order of succession of later septa in the genus is subjected to a closer scrutiny.

REFERENCES.

1. Annandale, N.—Coelenterata: Fauna of the Chilka Lake. *Mem. Ind. Mus.*, V, pp. 65-114 (1915).
2. Carlgren, Oskar.—On *Bolocerooides*, *Bunodeopsis* and their supposed allied genera. *Ark. Zool. Stockholm*, XVII A, No. 1, pp. 1-20 (1924).
3. Carlgren, Oskar.—A Revision of the Actiniaria of the Chilka Lake. *Ark. Zool. Stockholm*, XVII A, No. 21, pp. 1-21 (1925).
4. Panikkar, N. Kesava.—The Structure, Bionomics, and Systematic Position of Two New Brackish Water Actiniaria from Madras. *Proc. Zool. Soc. London*, pt. 1, pp. 229-249 (1936).
5. Panikkar, N. Kesava.—The Morphology and Systematic Relationships of a New Bolocerooidarian from Brackish-Water together with an Account of its Asexual Reproduction. *Proc. Ind. Acad. Sci. Bangalore*, V, No. 2, pp. 76-90, pl. v, (1937).
6. Stephenson, T. A.—On the Classification of Actiniaria: Pts. II and III. *Quart. Journ. Micros. Sci.* LXV, pp. 493-576 (1921), LXVI, pp. 247-319 (1922).

FURTHER NOTES ON CRUSTACEA DECAPODA IN THE INDIAN MUSEUM.

IX. ON THREE COLLECTIONS OF CRABS FROM TAVOY AND MERGUI ARCHIPELAGO.

By B. CHOPRA, *D.Sc., F.N.I., Assistant Superintendent*, and K. N. DAS, *M.Sc., Assistant, Zoological Survey of India, Calcutta.*

(Plate VI.)

The present report deals with three collections of crabs, two made by Prof. F. J. Meggitt of the University College, Rangoon, mostly at Maungmagan on the Tavoy Coast of Burma and the third by Drs. B. Prashad and B. N. Chopra of the Zoological Survey of India in the Mergui Archipelago. In the first collection of Prof. Meggitt, made in October 1933, there are also some specimens labelled "Mergui"; these were presumably collected in the neighbourhood of the town of Mergui. The second collection of Prof. Meggitt was made entirely at Maungmagan in October 1935, while the Mergui collection of Drs. Prashad and Chopra was made in January this year.

Maungmagan is a small village on the Tavoy Coast in Lower Burma, north-west of the town of Tavoy ($14^{\circ} 15' N.$, $97^{\circ} 50' E.$), and is, on account of its fine sandy beach, a popular sea-bathing resort. A sketch-map of the sea coast at Maungmagan, supplied by Prof. Meggitt, showing the exact location of the rock pools, sandy pools, etc., has already been published by Hora and Mukerji¹ with their account of the fishes of Prof. Meggitt's collection.

The collection from the Mergui Archipelago is chiefly from the group of small islands on the south-west and west of King Island, mostly between it and the large, more or less unsurveyed, Doung Island (or Ross Island, as it is also called). For the most part the collection was made from submerged coral reefs, but several specimens were collected on the beach at low tide also.

A list of the species found in all the three collections is given below and the species found in each collection are separately indicated. The species collected either only at Mergui or both at Mergui and Maungmagan and included in Prof. Meggitt's first collection are marked "M". An asterisk before the name of a species indicates that this was not represented in Dr. J. Anderson's collection from the Mergui Archipelago (*vide infra* p. 380).

¹ Hora and Mukerji, *Rec. Ind. Mus.* XXXVIII, p. 16 (1936).

			Prof. Meggitt's first collection from Mergui and Maungmagan.	Prof. Meggitt's second collection from Maungmagan.	Drs. Prashad and Chopra's collection from Mergui Archipelago.
Oxystomata.					
Calappidae.					
Calappinae.					
	* <i>Calappa hepatica</i> (Linn.)	...	+M	—	—
Matutinae.					
	* <i>Matuta lunaris</i> (Forskäl)	...	+M	+	—
	* <i>Matuta planipes</i> Fabricius	...	—	+	—
Leucoiidae.					
Leucoisiinae.					
	* <i>Heteronucia mesanensis</i> Rathbun	...	—	—	+
	<i>Philyra scabriuscula</i> (Fabricius)	...	+	—	—
Brachygnatha.					
Oxyrhyncha.					
Maiidae.					
Pisinae.					
	<i>Hyastenus hilgendorfi</i> de Man	...	—	—	+
	<i>Hyastenus</i> sp.	...	—	—	+
Maiinae.					
	<i>Schizophrys asper</i> (M.-Edw.)	...	+M	—	+
Parthenopidae.					
Parthenopinae.					
	* <i>Oethra scruposa</i> (Linn.)	...	+M	—	—
Brachyrhyncha.					
Portunidae.					
Carcininae.					
	* <i>Carcinus maenas</i> (Linn.)	...	+	—	—
Lupinae.					
	* <i>Scylla serrata</i> (Forskäl)	...	+M	+	—
	* <i>Neptunus (Neptunus) sanguinolentus</i> (Herbst)	...	—	+	—
	<i>Charybdis (Goniosoma) cruciata</i> (Herbst)	...	—	+	—
	* <i>Charybdis (Goniosoma) lucifera</i> (Fabricius)	...	+M	—	—
	* <i>Charybdis (Goniosoma) annulata</i> (Fabricius)	...	—	+	—
	<i>Charybdis (Goniosoma) merguiensis</i> (de Man)	...	+	+	—
	* <i>Charybdis (Goniosoma) ? callianassa</i> (Herbst)	...	+	—	—
	<i>Thalamita prymna</i> (Herbst)	...	—	+	—
Xanthidae.					
Xanthinae.					
	* <i>Carpilodes margaritatus</i> A. M.-Edw.	...	—	—	+
	<i>Atergatis integerrimus</i> (Lamarck)	...	+M	—	—
	* <i>Xantho neglectus</i> Balss	...	+M	+	—
	<i>Leptodius exaratus</i> (M.-Edw.)	...	+	+	+
	<i>Leptodius cavipes</i> (Dana)	...	+	—	—
Actaeinae.					
	<i>Actaea areolata</i> Dana	...	—	—	+
	* <i>Actaea calculosa</i> (M.-Edw.)	...	—	—	+
Chlorodinae.					
	<i>Chlorodiella niger</i> (Forskäl)	...	—	—	+
	* <i>Cymo melanodactylus</i> de Haan	...	—	—	+
Menippinae.					
	<i>Menippe rumphii</i> (Fabricius)	...	+	+	—
	<i>Myomenippe hardwickii</i> (Gray)	...	—	—	+

			Prof. Meggitt's first collection from Mergui and Maungmagan.	Prof. Meggitt's second collection from Maungmagan.	Drs. Prashad and Chopra's collection from Mergui Archipelago.
Ozinae.					
<i>Epixanthus frontalis</i> (M.-Edw.)	—	—	+
Pilumninae.					
<i>Pilumnus longicornis</i> Hilgendorf	—	—	+
* <i>Pilumnus hirsutus</i> Stimpson	—	—	+
<i>Actumnus elegans</i> de Man.	—	—	+
Eriphinae.					
<i>Trapezia cymodoce</i> (Herbst)	—	—	+
* <i>Trapezia ferruginea</i> , var. <i>areolata</i> Dana	—	—	+
* <i>Tetralia glaberrima</i> (Herbst)	—	—	+
Gonoplacidae.					
Pseudorhombilinae.					
* <i>Litocheira angustifrons</i> Alcock	—	—	+
Potamonidae.					
Potamoninae.					
* <i>Potamon (Acanthotelphusa) dayanum</i> (W.-M.)	+	—	—
<i>Potamon</i> sp.	+	—	—
Gecarcinucinae.					
<i>Paratelphusa (Phricotelphusa) callianaria</i> (de Man)	—	—	+
Ocypodidae.					
Ocypodinae.					
<i>Ocypoda ceratophthalma</i> (Pallas)	—	+	—
* <i>Ocypoda macrocera</i> M.-Edw.	+	+	—
<i>Ocypoda cordimana</i> Desmarest	—	+	—
<i>Gelasimus triangularis</i> A. M.-Edw.	—	—	+
* <i>Gelasimus marionis</i> (Desmarest)	—	—	+
<i>Gelasimus manii</i> (Rathbun)	+	—	+
Scopimerinae.					
<i>Dotilla intermedia</i> de Man	+	—	—
Macrophthalminae.					
* <i>Macrophthalmus telescopicus</i> (Owen)	—	—	+
* <i>Macrophthalmus convexus</i> Stimpson	+	—	—
<i>Macrophthalmus erato</i> de Man	—	—	+
Grapsidae.					
Grapsinae.					
<i>Grapsus strigosus</i> (Herbst)	+	+	+
Varuninae.					
* <i>Varuna litterata</i> (Fabricius)	+	—	—
Sesarminae.					
<i>Sesarma (Sesarma) taeniolata</i> White...	+	—	—
* <i>Sesarma (Parasesarma) prashadi</i> , sp. nov.	—	—	+
<i>Sesarma (Chiromantes) bidens</i> (de Haan)	+	—	+
<i>Clistocoeloma merguiense</i> de Man	—	—	+
<i>Metaplax dentipes</i> (Heller)	+	—	+

It will be seen from this list that of the total number of 57 species in all the three collections there are 26 in the first collection (of which 8 are from Mergui), 15 in the second and 30 in the third. These 57 species

belong to 10 families and are distributed in the three collections as shown below :—

Family.	Number of species in each collection.			TOTAL.
	I	II	III	
Calappidae ...	2	2	..	3
Leucosiidae ...	1	..	1	2
Maiidae ...	1	..	3	3
Parthenopidae ...	1	..	..	1
Portunidae ...	5	6	..	9
Xanthidae ...	5	3	14	18
Gonoplacidae ...	..	..	1	1
Potamonidae ...	2	..	1	3
Ocypodidae ...	4	3	5	10
Grapsidae ...	5	1	5	7
	—	—	—	—
TOTAL	26	15	30	57
	—	—	—	—

Of the 57 species dealt with by us there are only eight that occur both on the Tavoy Coast and in the Mergui Archipelago ; these are listed below. The apparent difference in the composition of the crab-fauna of these two, more or less adjacent areas can perhaps be easily explained by the fact that the collections in the two localities were made in different types of habitats. At Maungmagan Prof. Meggitt obtained most of his material from pools near shore, from under rocks near shore, or from the sandy beach ; this would no doubt account for large numbers, at least of individuals, if not of species, of Portunids, Oxystomes, Grapsids, etc., being collected. The collections from the Mergui Archipelago, on the other hand, were made, to a large extent, in coral reefs where certain types of Xanthids are abundant.

List of species found both at Maungmagan and Mergui.

Calappidae.

Matuta lunaris (Forskäl).

Portunidae.

Scylla serrata (Forskäl).

Xanthidae.

Xantho neglectus Balss.

Leptodius exaratus (M.-Edw.)

Ocypodidae.

Gelasimus manii (Rathbun).

Grapsidae.

Grapsus strigosus (Herbst).

Sesarma bidens (de Haan).

Metaplox dentipes (Heller).

The Decapod fauna of the Mergui Archipelago is already very well known, for, besides the work of earlier naturalists, de Man's monograph on¹ the Decapods of this area, based on the very extensive collections of Dr. J. Anderson, the first Superintendent of the Indian Museum, is a very comprehensive and masterly treatise on the subject.

¹ de Man, *Journ. Linn. Soc. London (Zool.)* XXII, pp. 1-312, pls. i-xix (1887, 1888).

Dr. Anderson's collections were so extensive that in crabs alone de Man found as many as 115 species, compared with the 57 that we have before us. Another proof of the extensiveness of Dr. Anderson's collection is the fact that out of our 57 species only one is described as new. The species that were not represented in the collection that de Man examined, but are present in our collection are indicated in the list on pp.378,379 by an asterisk. Most of these species have been collected in the Mergui Archipelago or from closely adjoining areas since de Man's time, but so far as we have been able to ascertain the following five species are being recorded from this area for the first time :—

Leucosiidae.

Heteronucia mesanensis Rathbun.

Portunidae.

Carcinus maenas (Linn.).

Xanthidae.

Carpilodes margaritatus A. M.-Edw.

Gonoplacidae.

Litochaira angustifrons Alcock.

Grapsidae.

Sesarma (*Parasesarma*) *prashadi*, sp. nov.

The occurrence of these species in the Mergui Archipelago does not call for any special comments, for most of them have also been collected from other parts of the Indo-Pacific region. The case of *Carcinus maenas*, however, deserves special consideration. Alcock¹ described the distribution of this crab as : " The species has been found at various places on the Atlantic Coast of the Northern United States and off the coast of Pernambuco (Brazil) : it is the common shore-crab of the British Islands, and occurs in the North Sea almost up to the Arctic limits, in the Baltic, and on the Atlantic coasts of the European continent : it is common in all parts of the Mediterranean, and has been found in the Black Sea and the Red Sea : it is an Indian species, though evidently a very rare one, and has been reported from the Hawaiian Islands, from the Bay of Panama, and—though there is doubt about this locality—from Australia." In the Indian waters the species has been recorded from Ceylon only. Some of the records of this cosmopolitan species from the Indo-Pacific region have been doubted by some carcinologists ; its occurrence on the Tavoy coast definitely establishes the species as an inhabitant of at least the eastern part of this area. Hora and Mukerji² have recently recorded from Tavoy some species of fishes that were so far supposed to live in the European Atlantic only ; the distribution of *Carcinus maenas*, as indeed of a large number of other species of marine animals enumerated by Alcock,³ suggests that the occurrence of some Atlantic fishes in the Indian waters is not so very singular as has been supposed by some Zoologists.

In working out the present collections several interesting points concerning either the taxonomy of certain species or their distribution,

¹ Alcock, *Journ. As. Soc. Bengal* LXVIII, p. 14, (1899).

² Hora and Mukerji, *Rec. Ind. Mus.* XXXVIII, pp. 15-39 (1936).

³ Alcock, *Investigator Deep-Sea Madreporaria, Calcutta* (1898) ; *Investigator Deep-Sea Brachyura, Calcutta* (1899).

etc., have arisen; these are dealt with in their appropriate places in the following pages, and need not be referred to here. In the classification and arrangement of species we have closely followed Alcock's system as given in his masterly treatment of the Indian crabs in the series of papers entitled "Materials for a Carcinological Fauna of India" and published in the *Journal of the Asiatic Society of Bengal* between 1895 and 1900. In the Xanthidae Dr. Heinrich Balss and some other carcinologists have considerably altered Alcock's classification, but for the present at least we have preferred to follow Alcock's arrangement of subfamilies, etc. We have not given anything like complete synonymies of species, but have given a reference to Alcock's work and in some cases a few later important references only.

We have paid special attention to a study of the abdominal appendages of the male as these structures sometimes afford good characters for distinguishing males of closely allied species, and for this reason we have given figures of these appendages in a large number of species dealt with by us.

The illustrations accompanying this paper have been prepared, under our supervision, by Babu D. N. Bagchi and Babu Subodh Mondul, two of the talented artists attached to the Zoological Survey of India; both of them are jointly responsible for the text-figures, while the photographs are the work of Babu Subodh Mondul alone. We are very thankful to them for the skill and accuracy with which they have done the work. We would also like to express our special indebtedness to Dr. Bains Prashad, Director, Zoological Survey of India, for constant help and valuable suggestions received throughout the course of our work and for going through the manuscript with us. And lastly we have to express our thanks to Prof. F. J. Meggitt for giving us the opportunity to study his valuable collections.

Tribe OXYSTOMATA.

Family CALAPPIDAE.

Subfamily CALAPPINAE.

Calappa hepatica (Linn.).

1896. *Calappa hepatica*, Alcock, *Journ. As. Soc. Bengal* LXV, pp. 142-144.
 1918. *Calappa hepatica*, Ihle, *Siboga Exped. Rep.* XXXIXb², pp. 183, 184.
 1922. *Calappa hepatica*, Balss, *Arch. Naturgesch.* LXXXVIII, p. 123.
 1936. *Calappa hepatica*, Sakai, *Sci. Rep. Tokyo Bunrika Daigaku* (B) II, No. 37, p. 157.

One young specimen referable to the present species is in Prof. Meggitt's first collection from Mergui. The specimen is typical in every respect.

Calappa hepatica has a very wide range of distribution. Ihle gives its range as the Red Sea and the East African Coast to Japan, Australia and Sandwich Islands. In the Indian Museum there are numerous specimens both from the Bay of Bengal and the Arabian Sea.

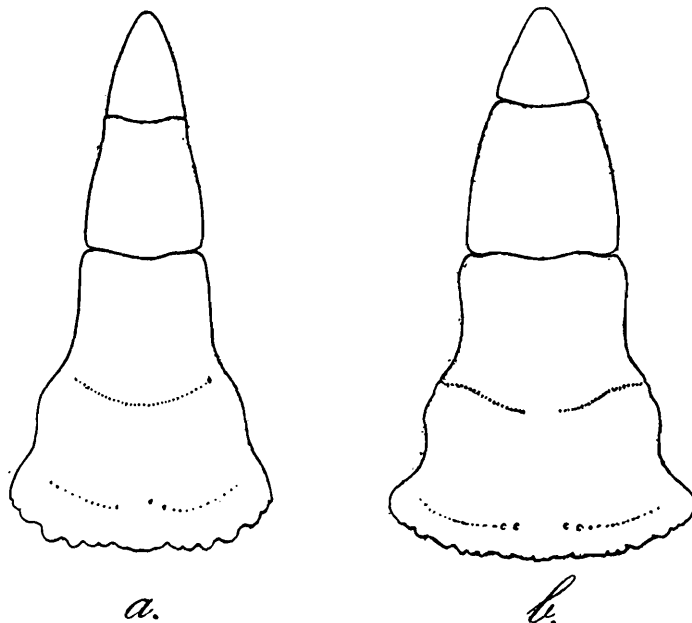
Subfamily MATUTINAE.

Matuta lunaris (Forskäl).1896. *Matuta victor*, Alcock, *Journ. As. Soc. Bengal* LXV, pp. 160, 161.1933. *Matuta lunaris*, Chopra, *Rec. Ind. Mus.* XXXV, pp. 31, 32.

There is a large number of specimens of the present species in the two collections of Prof. Meggitt. Only one of these specimens is from Mergui, while all the rest are from Maungmagan; of the latter some were collected from rock pools near shore, some from fisher-boat nets, and the others at Cat's Eye Rocks. The specimens are for the most part typical.

Two of the most important characters mentioned by Alcock for the separation of this species from the closely allied *M. planipes* (= *M. lunaris* of Alcock) are the presence in large males, of a spine at the angle where the hand comes in contact with the distal lobule of the arm and the presence, in females and young males, of two enlarged spines (counting from the proximal end, the second and the fourth) on the median longitudinal ridge on the outer surface of the hand. In *M. planipes* the spine at the angle of the hand is replaced by a tubercle, and the fourth lobe of the median longitudinal ridge of the hand is never enlarged into a spine. In all the specimens that we have examined in the present collection the spine near the junction of the arm is well developed; the fourth spine on the median longitudinal ridge is present in all the females and in most of the very young males; while in all medium-sized and large males this spine is invariably missing.

In addition to the characters mentioned by Alcock, the males of the two species can be generally recognised by the shape of the abdomen.



TEXT FIG. 1.—Terminal part of male abdomen of *a. M. lunaris*: \times ca. 3
b. M. planipes: \times 3½.

The abdomen in the males of *Matuta* consists of five pieces only, segments 3-5 being completely fused. In *M. lunaris* the length of the composite segment 3-5 is always greater than its breadth at the base,

and the terminal segment is always considerably longer than its posterior breadth. In *M. planipes*, on the other hand, the length of the composite segment is at most equal to, but generally less than, its breadth at the base and the last segment is almost as long as, or only slightly longer than, its posterior breadth. The sixth segment is also proportionately longer in *M. lunaris* than in *M. planipes*. These points are brought out clearly in text-figure 1 and the table of measurements.

			<i>M. lunaris.</i>	<i>M. planipes.</i>
Posterior breadth of composite segment 3-5	...	...	9.5	9.0
Median length of composite segment 3-5	...	...	10.8	9.0
Posterior breadth of segment 6	...	...	4.2	4.2
Median length of segment 6	...	...	5.0	4.4
Posterior breadth of segment 7	...	...	2.7	2.7
Median length of segment 7	...	...	4.0	2.9

The colour pattern of the species, mentioned by Alcock, is clearly seen only in some specimens.

Matuta lunaris has a very wide range of distribution having been recorded from several localities from Polynesia in the east to as far as the Red Sea and the Cape region on the west. In India it has been collected both in the Bay of Bengal and the Arabian Sea.

Matuta planipes Fabricius.

1896. *Matuta lunaris*, Alcock, *Journ. As. Soc. Bengal* LXV, pp. 161, 162.
 1933. *Matuta planipes*, Chopra, *Rec. Ind. Mus.* XXXV, p. 32.
 1936. *Matuta flagra*, Shen, *Chinese Journ. Zool.* II, pp. 64-66.

The species is represented in the present collection by five examples, two females and three young males, obtained by Prof. Meggitt from fisher-boat nets at Maungmagan.

Alcock has described a distinctive colour pattern in this species, which can sometimes be seen in very old specimens also. In the present collection this colour pattern is distinctly seen in one female example only; in the second female and the three males there is practically no colour pattern at all.

The male specimens are for the most part without claws, but in the claws that are present the typical *planipes* characters can be seen—at the angle near the arm there is only a somewhat low tubercle, and not a spine, as in the preceding species, and there is only one enlarged spine, the second from the proximal end, on the median longitudinal ridge on the outer surface of the hand. One of the females, with the distinct *planipes* colouration, also shows these characters clearly, but the second female has the typical *planipes* claw only on one side; in the other claw there is a sharp tubercle on the hand near its junction with the arm, and the fourth tubercle on the median ridge is also spiniform. This seems to be a rare abnormality, for a condition like this is not present in any of the large number of specimens of this species in the Indian Museum collection.

The species recently described by Shen under the name of *M. flagra* seems to be based on young specimens of the present species. The characters of the hand mentioned by him agree almost exactly with those of young examples of *M. planipes* that we have examined. Shen

has also mentioned that the epibranchial spines in his species are directed straight outwards, instead of curving forwards as in *M. lunaris* (= *M. victor* of Alcock). We have examined a large number of specimens of both the allied species, *M. lunaris* and *M. planipes* and find that this character is far from constant. The spines are sometimes curved forwards, sometimes they point straight outwards, while in some cases they are directed distinctly backwards even. The smoothness of the outer surface of the movable finger of the hand is, as pointed out by Alcock for his *M. victor*, a character of the young; this is equally applicable to the young of the present species also. The colour pattern of the species, as already pointed out, is variable. From all these considerations we are of the opinion that Shen's *M. flagra* cannot be maintained as a distinct species, but must be sunk in the synonymy of *M. planipes* Fabricius.

Like the preceding species, *M. planipes* has a very wide range of distribution, having been met with from North-West of Australia in the east to the Cape of Good Hope in the west.

Family LEUCOSIIDAE.

Subfamily LEUCOSIINAE.

Heteronucia mesanensis Rathbun.

(Plate VI, fig. 1).

1910. *Heteronucia mesanensis*, Rathbun, *Skrift. K. Dansk. Vidensk. Selsk. Copenhagen* (7) V, pp. 306, 307.

1918. *Heteronucia mesanensis*, Ihle, *Siboga Exped. Rep.* XXXIXb², p. 309 (reference only).

One small female specimen from Mergui is referred to Miss Rathbun's species with some hesitation. In a general way our specimen agrees closely with the brief description published by Miss Rathbun, but in view of some important differences between the two, as pointed out below, we have thought it worth while giving a full description of our specimen.

The carapace (Plate VI, fig. 1) is subcircular in outline, it is strongly convex and its surface is markedly uneven on account of the prominent convexities of the different regions. The entire surface of the carapace, chelipeds and legs is covered with vesiculous granules closely studded together. The regions of the carapace are clearly demarcated by convexities, separated from one another by broad shallow grooves. The narrow triangular area embracing the mesogastric and the anterior part of the cardiac regions, mentioned by Miss Rathbun, is clearly seen, but is bordered by only shallow grooves. The convexities of the gastric, cardiac and branchial regions are very distinct, there being two on the last-named region, the anterior of which is the larger of the two. There is only an inconspicuous, low tubercle on each hepatic region.

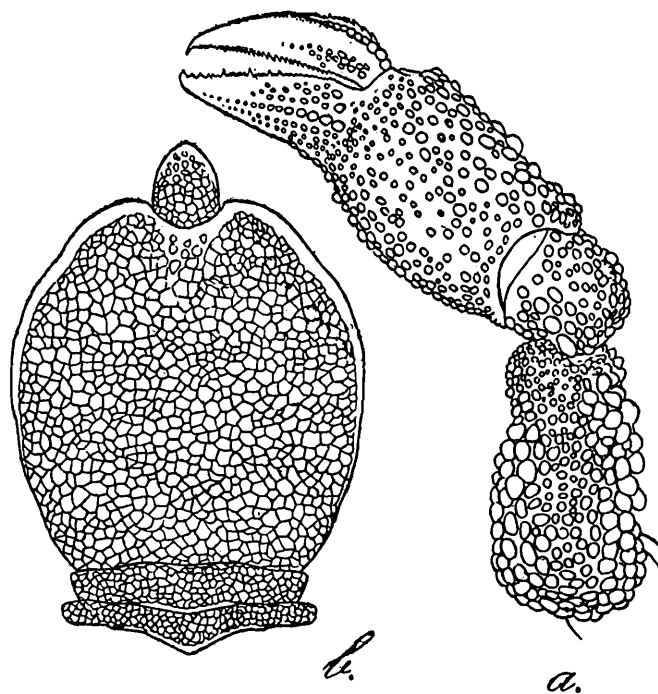
The carapace is distinctly broader than long and its lateral margins are slightly expanded. The front is broad and a narrow fissure in the middle makes it bilobed; the margin of each lobe is truncate or even slightly rounded. The pterygostomian regions are puffed out, but their anterior margin, which is almost transverse, is on a level with the eye, and when viewed from above does not extend beyond or even up to the

front. The tips of the external maxillipeds are just visible beyond the front in a dorsal view. The antero-lateral margins are divided into two subequal lobes by a rather broad and shallow notch. The postero-lateral margins are spinate, the granules near the lateral margins on the convexities of the branchial regions being sharply pointed and taking the form of short spines. The spines decrease in size distally, but extend almost up to the posterior margin of the carapace in the shape of sharply-pointed tubercles. The posterior margin of the carapace is on a lower level than the rest of the surface, and is somewhat convex posteriorly.

The orbits are shallow and do not conceal the rather large eye, even when fully retracted. Except for a narrow fissure the lower border of the orbit is practically complete, on account of the fusion of the basal antennal joint with it. The antennal flagellum has not been seen; it is either altogether missing or is very extremely reduced.

There is a remarkably broad space between the lower orbital border and the free edge of the buccal cavern. The maxillipeds completely close the buccal cavity, which is triangular in shape. Each maxilliped is strongly bent about its middle, so that the merus is nearly at right angle to ischium. Measured along the inner border the merus is only slightly more than half the length of the ischium. The exognath is quite stout, being only a little narrower than the endognath, and is straight along the outer edge.

The chelipeds are considerably stouter and longer than the walking legs and are densely covered with vesiculous granules. The arm is sub-cylindrical and is only slightly broader distally than at the proximal



TEXT FIG. 2.—*Heteronucia mesanensis* Rathbun.

a. Cheliped of female, outer view : \times ca. 8. b. Abdomen of female : \times ca. 8.

end. The wrist is globular. The palm is massive and swollen, the greatest diameter being about the middle, and the granules near its margins are sharp and pointed. The fingers are arched and taper

towards their tips, the immobile finger being distinctly more massive than the dactylus. The latter opens in a vertical plane. The fingers are shorter than the palm, their cutting edges are finely and evenly denticulated and they are hollowed and concave on the inner side. There is no gap left when the fingers meet. The tips are pointed and are apposed when the fingers meet. The fingers are also minutely granular and elegantly grooved. The lower border of the distal part of the palm and the proximal part of the fixed finger is concave.

The basal part of the walking legs is only slightly concealed beneath the lateral expansions of the carapace. The legs are also thickly covered with granules and even the dactyli are minutely granular. The merus is cylindrical, the carpus is nodular and the lanceolate dactylus is almost as long as the propodus. The granules on the margins of the different segments are sharp. The dactyli end in corneous tips.

The abdomen of the female (text-fig. 2 *b*) is large and oval and occupies practically the entire space between the legs. The exposed surface is covered with flattened granules. The two basal segments are short, the next four are completely fused and form a large broad plate. The seventh segment is a small, more or less, pear-shaped structure, somewhat deeply sunk in the distal margin of the preceding segment; its tip is rounded and reaches almost to the posterior end of the buccal cavern.

The specimen in spirit is of a pale-whitish colour, with an indistinct diffusion of light brownish tint on the carapace and a few small pale-orange spots on the ventral surface. There is a small triangular patch of a light brownish colour on the mesogastric region of the carapace.

The measurements of the specimen in millimetres (taken under a microscope) are given below.

Length of carapace	...	...	...	...	3.75
Breadth of carapace	...	...	...	...	4.50
Proto-orbital border	...	...	...	...	1.91
Length of upper border of palm	...	...	...	...	1.33
Length of dactylus	...	...	...	...	1.17

The specimen is registered in the collection of the Zoological Survey of India under the number C2283/1. It was collected by Drs. B. Prashad and B. N. Chopra from amongst corals in a submerged reef near shore, off Palaïow on the east coast of Doung Island in the Mergui Archipelago on 20th January, 1937. Miss Rathbun based the species on two female specimens collected between two islands in the Gulf of Siam at depths of 15 and 30 fathoms. As at present known the species seems to have a very restricted distribution.

Though the present specimen agrees very closely with Miss Rathbun's description of *Heteronucia mesanensis* in a large number of characters, there are some important differences between the two. The fronto-orbital border of the carapace is stated to be about half the carapace width in the Siam specimen, whereas in our example it is only about two-fifths of the breadth of the carapace. The frontal margin is faintly bidentate in Miss Rathbun's species; in the Mergui example this margin is obscurely bilobed by a narrow median fissure, the borders of each lobe being somewhat rounded. The hand in our example also differs materially from Miss Rathbun's description. The palm is thickest

about the middle and not at the proximal end, the fingers are shorter than the upper border of the palm and the dactylus is distinctly less massive than the immobile finger. The points of similarity between our specimen and Miss Rathbun's species are, however, so striking that it must, at least for the present, be referred to this species.

Heteronucia as defined by Alcock¹ is characterised, among other features, by having fingers longer than the palm, and this character is clearly seen in his figure, as also in the type-specimen of *H. vesiculosa* preserved in the Indian Museum. In *H. venusta* Nobili² the fingers are slightly longer than the palm.³ Besides, both these species have a peculiar type of front. In *H. mesanensis*, on the other hand, the fingers, according to Miss Rathbun, are not longer than the palm, though in her figure the palm actually appears to be somewhat longer than the fingers. In our specimen also the fingers are shorter than the palm. The front also in Miss Rathbun's species, or at least in the specimen that we are referring to it, has not the characteristic *Heteronucia* shape. It seems quite possible, therefore, that *H. masanensis* Rathbun, or at least the Mergui specimen that we have provisionally referred to this species, may have to be accommodated in a new genus.

Philyra scabriuscula (Fabricius).

1896. *Philyra scabriuscula*, Alcock, *Journ. As. Soc. Bengal* LXV, pp. 239, 240.

There are two male specimens from Maungmagan that we have referred to the present species. They bear the label "crabs on beach, sluggish: Maungmagan, 1933". The specimens agree with typical examples in the Museum collection. The dull brown and greenish mottling of the carapace, mentioned by Alcock, is not, however, visible.

The species has a very wide range of distribution. According to Ihle⁴ it is met with from Amboina to the Red Sea and East Coast of Africa. In the Indian Museum there are numerous specimens from Tavoy to the Persian Gulf.

Tribe BRACHYGNATHA.

Subtribe OXYRHYNCHA.

Family MAIIDAE.

Subfamily PISINAE.

Hyastenus hilgendorfi de Man.

1895. *Hyastenus hilgendorfi*, Alcock, *Journ. As. Soc. Bengal* LXIV, pp. 209, 210.

The species is represented in the present collection by seven specimens collected in the Mergui Archipelago. Three of these are males, three

¹ Alcock, *Journ. As. Soc. Bengal* LXV, p. 177 (1896).

² Nobili, *Bull. Mus. Hist. Nat. Paris* XII, p. 261 (1906); *Mem. Acad. Sci. Torino* (2) LVII, pp. 379, 380, pl. i, fig. 14 (1907).

³ Ihle in *Siboga Exped. Rep.* XXXIXb², p. 320 (1918) states that the upper border of the palm in *H. venusta* is almost as long as the upper border of the dactylus, but in his figure (text-fig. 123, p. 219) the fingers are seen to be slightly longer than the upper border of the palm.

⁴ Ihle, *Siboga Exped. Rep.* XXXIXb², p. 275 (1918).

ovigerous females and one young female. The largest male has a total length (carapace and rostrum) of over 26 mm., while the smallest ovigerous female is only 15 mm. in total length.

All the specimens agree very closely with de Man's¹ and Alcock's detailed and accurate descriptions of the species, as also with named specimens, including de Man's types from Mergui, in the Indian Museum collection. In the large male example, however, the spines are a little shorter than in the type-specimens and the fingers also gape, perhaps, a little more near the base. The proportions of the different parts of the hand are also very slightly different. As pointed out by Laurie² the rostral spines are longer and diverge distally more in the males than in the females. The measurements, in millimetres, of the largest male example in our collection are given below.

Total length of carapace and rostrum	...	...	26.2
Length of carapace	...	...	15.8
Distance between external orbital angles	...	...	6.5
Distance between internal orbital angles	...	...	4.5
Breadth of carapace	...	...	13.2
Length of cheliped	...	...	33.5
Length of hand and fingers	...	...	14.5
Median length of palm	...	...	10.0
Length of fingers	...	...	5.0
Height of palm	...	...	4.2
Length of first walking leg	...	...	38.0

The present specimens are registered as under :—

C2284/1. From corals in a submerged reef near shore off Palauiow, on the east coast of Doung Island, Mergui Archipelago.	Drs. B. Prashad and B. N. Chopra, 20th Jan., 1937.	3♂♂, 4♀♀ (3 ovig.).
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The species is represented in the Indian Museum collection by examples from the Straits of Malacca, Mergui, Nicobar Islands, the Ganjam coast and from Ceylon.

For reasons given by one of us in an earlier paper³ we have retained the name of *Hyastenus* White in preference to *Halimus* Latrielle.

Hyastenus sp.

There is one young male specimen in Drs. Prashad and Chopra's collection from the Mergui Archipelago that we are unable to put in any of the known species of *Hyastenus* with any degree of certainty. The carapace is practically smooth. The gastric and the intestinal tubercles are hardly developed, while the epibranchial and the sub-hepatic tubercles are fully formed. The rostral spines are a little more than half the length of the carapace and are distinctly divergent. The dactyli of the walking legs are strongly toothed.

The specimen was collected from a submerged reef off Cantor Island in the Mergui Archipelago on 19th January, 1937.

¹ de Man, *Journ. Linn. Soc. London (Zool.)* XXII, pp. 14-19, pl. i, figs. 3, 4 (1887).

² Laurie, *Ceylon Pearl Oyster Fish. Rep.* V, p. 376, (1906).

³ Chopra, *Rec. Ind. Mus.* XXXVII, p. 467, (1935).

Subfamily *MAIINAE*.**Schizophrys asper** (M.-Edwards).

1895. *Schizophrys asper*, Alcock, *Journ. As. Soc. Bengal* LXIV, pp. 243, 244; *Ill. Zool. Investigator, Crust.*, pl. xxxv, fig. 1 (1899).
 1924. *Schizophrys asper*, Balss, *Arch. Naturgesch.* XC, Heft 5, p. 35.

There are three specimens of *S. asper* from Mergui in the collection. Two of these, a large male and a young female, are from Prof. Meggitt's first collection and are labelled only "Mergui," while the third, a small male, was collected by Drs. Prashad and Chopra from amongst corals in a submerged reef at Palaiow on the east coast of Doung Island in the Mergui Archipelago on January 20th, 1937. The large male from Prof. Meggitt's collection has a carapace length of 42.5 mm., while the smaller male from Doung Island is only 10 mm. long. The measurements of the larger male are given below in millimetres.

Length of carapace	...	...	...	...	42.5
Length of carapace and rostrum	...	...	...	...	50.0
Maximum breadth of carapace (excluding spines)	...	...	...	...	36.0
Length of chelepeda	...	...	...	...	74.0
Length of palm (including fixed finger) along lower border	...	...	...	...	35.0
Median length of palm	...	...	...	...	23.0
Height of palm	...	...	...	...	12.0
Length of dactylus	...	...	...	...	16.5
Length of 1st walking leg	...	...	...	...	57.0

In large male examples the fingers are considerably more than half the length of the palm, and meet only at the tips, which, along with a distal part of the fingers, are channelled. In the female the chelipeds are distinctly thinner and shorter than the legs, the fingers are hardly channelled and meet throughout.

The female specimen has entangled between the legs strings of eggs of some sort arranged like bunches of grapes. The eggs are too young to be identified, only yolk granules being visible through the semi-transparent shell.

Schizophrys asper is quite a common species in the Indian coastal waters, there being specimens of it from several localities both from the Bay of Bengal and the Arabian Sea. Balss gives the distribution of the species as: "Im warmen Indopacific von der Ostküste Afrikas u. dem roten Meere bis Neu-Caledonien, Samoa u. Funafuti."

Family PARTHENOPIDAE.

Subfamily PARTHENOPINAE.

Oethra scruposa (Linn.).

1895. *Oethra scruposa*, Alcock, *Journ. As. Soc. Bengal* LXIV, pp. 285, 286.
 1930. *Oethra scruposa*, Flipse, *Siboga Exped. Rep.* XXXIXc², p. 89.

One male specimen of this apparently somewhat uncommon species is in the present collection. It agrees closely with named examples in the Museum collection, as also with Alcock's description of it. The specimen is labelled "Mergui" and is from Prof. Meggitt's first collection.

There are only two examples of this species in the collection of the Indian Museum, a male from the Andamans and a female from Ceylon. The species has a fairly wide range over the Indo-Pacific area, being known from the Indian Archipelago to the east coast of Africa,

Subtribe *BRACHYRHYNCHA*.

Family PORTUNIDAE.

Subfamily CARCININAE.

***Carcinus maenas* (Linn.).**1899. *Carcinus maenas*, Alcock, *Journ. As. Soc. Bengal* LXVIII, pp. 13, 14.

Four large examples of this rare Indian species were collected by Prof. Meggitt at Maungmagan in October, 1933. All the specimens agree closely with the numerous published descriptions of the species, as also with our named material from Galle in Ceylon and from a number of other localities in the Mediterranean Sea and the North Atlantic; the specimens are typical in every respect. All the four of them are infested with *Rhizocephala*.

The geographical distribution of *Carcinus maenas* has already been referred to on p. 381. As stated by Alcock, it is evidently a very rare Indian species, there being only one Indian example of it (from Galle) in the Museum collection so far. The species is, however, very common in the Atlantic Ocean and the Mediterranean Sea. Alcock has discussed the distribution of this species in the work cited above, and of several other species of Crustacea and other groups in his account of the "Investigator" *Madreporaria*¹ and *Brachyura*²). The distribution of *Carcinus maenas* is, however, especially remarkable on account of its being a shore crab.

Subfamily LUPINAE.

***Scylla serrata* (Forskäl).**1899. *Scylla serrata*, Alcock, *Journ. As. Soc. Bengal* LXVIII, pp. 27, 28.1922. *Scylla serrata*, Balss, *Arch. Naturgesch.* LXVIII, Heft 11, p. 110.

There are seven specimens of this common Indo-Pacific species in the present collection; three of these are in Prof. Meggitt's first collection from Mergui and four from Maungmagan in the second. All the specimens are typical.

Scylla serrata is the common edible crab of India and many other countries. In India it is met with extensively in backwaters and estuaries all along the coast. Hora³ has described an ingenious method of its capture for market purposes in the creeks in the Gangetic Delta. The species has a very wide range of distribution all over the Indo-Pacific region; Balss gives its distribution as: "Rein indopazifisch vom Rotten Meere, der Ostküste Afrikas und dem Kap bis Japan, Australien, Tahiti und Aucklandinseln"

***Neptunus (Neptunus) sanguinolentus* (Herbst).**1934. *Neptunus sanguinolentus*, Sakai, *Sci. Rep. Tokyo Bunrika Daigaku* (B) I, No. 25, p. 303.1935. *Neptunus (Neptunus) sanguinolentus*, Chopra, *Rec. Ind. Mus.* XXXVII, pp. 474-476.

One young female example of this species is in Prof. Meggitt's second collection; it was obtained from fisher-boat nets at Maungmagan. The

¹ Alcock, *Investigator Deep-Sea Madreporaria*, Calcutta (1898).² Alcock, *Investigator Deep-Sea Brachyura*, Calcutta (1899).³ Hora, *Current Sci.* III, pp. 543-546 (1935).

specimen is very badly mutilated and its identification is, therefore, somewhat doubtful.

As mentioned by Chopra, *N. sanguinolentus* has a very wide range of distribution. Sakai gives Simoda as the northernmost limit of the range of the species in Japan.

***Charybdis (Goniosoma) cruciata* (Herbst).**

1935. *Charybdis (Goniosoma) cruciatus*, Chopra, *Rec. Ind. Mus.* XXXVII, pp. 482, 483.

There are two very young specimens referable to the present species in Prof. Meggitt's second collection; these were collected from fisher-boat nets at Maungmagan. No colour markings are present on the specimens.

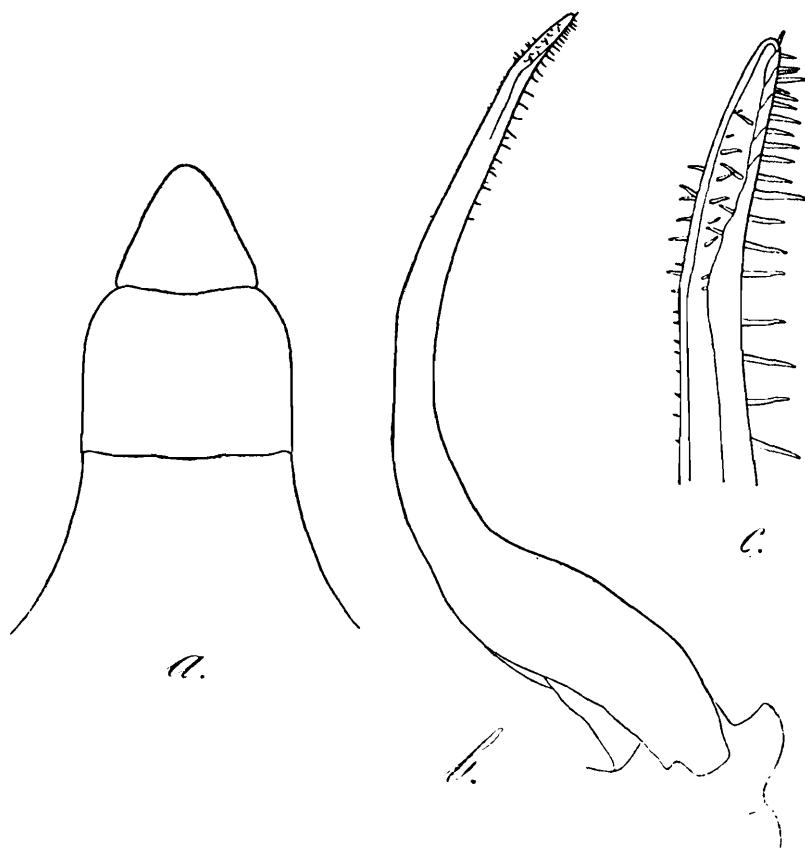
This species also, as described by Chopra, has a very wide range of distribution.

***Charybdis (Goniosoma) lucifera* (Fabricius).**

1899. *Charybdis (Goniosoma) quadrimaculata*, Alcock, *Journ. As. Soc. Bengal* LXVIII, p. 54.

1922. *Charybdis lucifer*, Balss, *Arch. Naturgesch.* LXXXVIII, Heft 11, p. 106.

A single ovigerous female, collected at Mergui, is in Prof. Meggitt's first collection. It agrees closely with named specimens in the Indian Museum collection. In some specimens from the Coromandel coast in



TEXT-FIG. 3.—*Charybdis (Goniosoma) lucifera* (Fabr.).

a. Terminal part of male abdomen: $\times 5$. b. Left anterior male appendage: $\times 11$.
c. Tip of the same enlarged: $\times 34$.

the Museum collection the carapace is somewhat thickly furred; the present example does not show any trace of the fur.

The sixth segment of the male abdomen has a characteristic shape.

The anterior abdominal appendages of the male are as shown in the accompanying text-figure. They are of the type usual in the genus *Charybdis*. There is no bend near the tip, and except for the fact that the small lobe on the inner border a little behind the tip is absent, the appendages are very much like those of *C. merguensis* as figured by Chopra.¹

C. lucifera is met with on both the coasts of the Indian Peninsula. Balss gives its distribution as: "Ceylon, Küsten von Vorderindien, Java, Malabarenküste, Siam"

***Charybdis (Goniosoma) annulata* (Fabricius).**

1899. *Charybdis (Goniosoma) annulata*, Alcock, *Journ. As. Soc. Bengal* LXVIII, pp. 54, 55.

1922. *Charybdis annulata*, Balss, *Arch. Naturgesch.* LXXXVIII, Heft 11, p. 106.

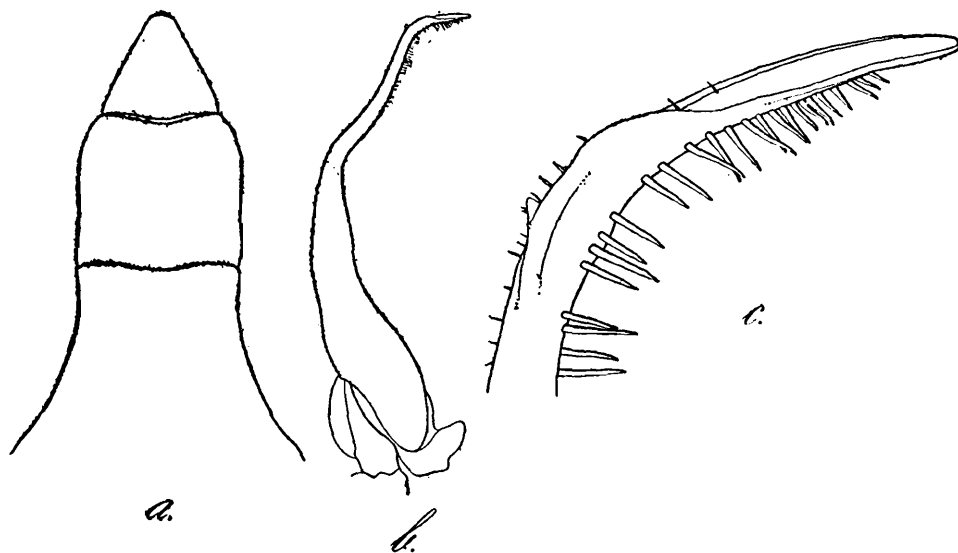
1937. *Charybdis (Goniosoma) annulata*, Leene, *Zool. Meded. Leiden* XIX, pp. 167-168.

The following specimens referable to the present species are in Prof. Meggitt's second collection:—

C 2285/1	Maungmagan, Cat's Eye Rocks	Prof. F. J. Meggitt	1 large ♂
C 2286/1	Maungmagan Rocks: low tide	Prof. F. J. Meggitt	1 ♀, 1 small ♂

The large male has a carapace length of about 47 mm. and a breadth of 68 mm. The female is about 38 mm. long and 55 mm. broad.

C. annulata closely resembles the preceding species, but the carapace is narrower and more convex, the orbits are shorter, being about one-third of the distance between the inner supra-orbital angles, and the



TEXT-FIG. 4.—*Charybdis (Goniosoma) annulata* (Fabr.).

a. Terminal part of male abdomen: $\times 2\frac{1}{2}$. b. Left anterior male appendage: $\times ca. 3$.
c. Tip of the same enlarged: $\times 24$.

lobule at the outer end of the lower orbital border is not dentiform. The sixth tergum of the male abdomen, as seen in text-fig. 4, is also longer

¹ Chopra, *Rec. Ind. Mus.* XXXVII, p. 485, text-fig. 8 (1935).

and has parallel sides. The acute spine on the posterior border of the carpus of the last leg, so characteristic of *C. merguiensis*, is absent in this species.

The anterior male appendages are of the usual type and are as shown in the accompanying text-figure. They are somewhat sharply bent near the tip. The inner margin has a small lobe-like process a little behind the tip, as in *C. merguiensis*.¹

Most of the specimens examined have no characteristic colour-markings, but the female specimen from Maungmagan has three rather prominent purplish patches on the carapace, one on each hepatic region and a larger one on the gastric.

A few measurements in millimetres of the large male from Maungmagan are given below :—

Length of carapace	...	...	...	...	...	...	46.9
Greatest breadth of carapace	...	...	...	...	...	...	68.2
Distance between outer and inner supra-orbital angles of one side	...	...	...	...	...	...	7.3
Distance between inner supra-orbital angles	...	...	...	...	...	...	24.0

Miss Leene has shown that *Cancer fasciatus* of Herbst is not a synonym of the present species as Alcock had suggested.

C. annulata is represented in the Indian Museum collection by specimens from Penang, Bimlipatam and Karachi. The species has a fairly wide range of distribution, being known from Tahiti, Siam, Mergui Archipelago, Ceylon and the Indian coasts.

***Charybdis (Goniosoma) merguiensis* (de Man).**

1934. *Charybdis merguiensis*, Sakai, *Sci. Rep. Tokyo Bunrika Daigaku* (B) I, No. 25, p. 303.
 1935. *Charybdis (Goniosoma) merguiensis*, Chopra, *Rec. Ind. Mus.* XXXVII, pp. 484-486.
 1937. *Charybdis (Goniosoma) merguiensis*, Leene, *Zool. Meded. Leiden* XIX, pp. 165-167.

This species appears to be very common at Maungmagan and is represented by 10 specimens, eight males and two females in the two collections of Prof. Meggitt. Some of the specimens are very young.

The strongly arched "Querlinie" of Monod and Steinitz is faintly indicated in all the specimens, but the fringe of pile is practically absent in all the examples. The three dark red spots also are not seen on the carapace of any of the specimens.

The tips of the lateral spines of the carapace and the chelipeds and the distal parts of the fingers are brownish in colour.

Chopra mentioned the range of distribution of *C. merguiensis* from Hongkong in the east to the coast of Palestine in the Mediterranean Sea on the west. Sakai has given a record of occurrence of the species from Japan also and has thus extended the range considerably.

¹ Chopra, *Rec. Ind. Mus.*, XXXVII, p. 485, text-fig: 8 (1935).

***Charybdis (Goniosoma) ? callianassa* (Herbst).**

1935. *Charybdis (Goniosoma) callianassa*, Chopra, *Rec. Ind. Mus.* XXXVII, pp. 489-491, pl. ix, fig. 1.

A single small female specimen in Prof. Meggitt's first collection from Maungmagan is referred to the present species with some doubt. The specimen is very immature and is badly damaged.

C. callianassa, as mentioned by Chopra, is known to occur from the Gulf of Siam to Karachi.

***Thalamita prymna* (Herbst).**

1899. *Thalamita prymna*, Alcock, *Journ. As. Soc. Bengal* LXVIII, pp. 78, 79.

1922. *Thalamita prymna*, Balss, *Arch. Naturgesch.* LXXXVIII, Heft 11, p. 112.

There is one ovigerous female belonging to the present species in Prof. Meggitt's first collection ; this was collected at Cat's Eye Rocks, Maungmagan.

The specimen agrees closely with Alcock's description, as also with named specimens in the Museum collection.

The species is represented in the collection of the Indian Museum by several specimens collected in the Bay of Bengal from Mergui to Madras. Balss gives its distribution as : " Natal, Rotes Meer, Indische Küsten und Inseln, Malayischer Archipel, Liu-Kiu-Inseln, Japan (Tokio-bai), Australien, Neu-Caledonien, Tongatabu, Samoainseln "

Family XANTHIDAE.

Subfamily XANTHINAE.

***Carpilodes margaritatus* A. M.-Edw.**

1898. *Carpilodes margaritatus*, Alcock, *Journ. As. Soc. Bengal* LXVII, pp. 85, 86.

1925. *Carpilodes margaritatus*, Odhner, *Handl. Kungl. Vetensk. Vitterh. Göteborg* XXIX, No. 1, pp. 24, 25, pl. ii, fig. 4.

A single specimen from Drs. Prashad and Chopra's collection from Mergui is referred to the present species.

C2287/1	A submerged coral reef, off Jounjounja, a small rocky Island, Mergui Archipelago.	Drs. B. Prashad and B. N. Chopra, 20th Jan. 1937.	1 ♂
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The specimen has the following measurements (in millimetres) :—

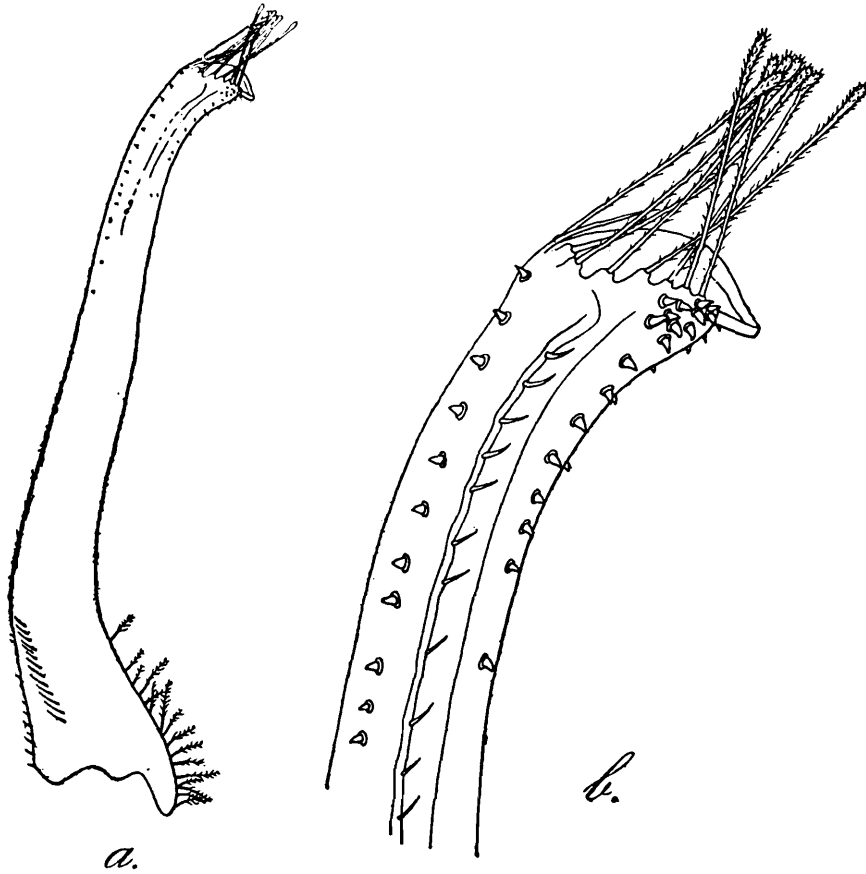
Length of carapace	5.8
Greatest breadth of carapace	...	...	...	...	...	...	9.4
Breadth of front	...	...	...	...	...	...	3.3

The specimen agrees exactly with the figure given by Odhner, as also with the figure and brief description of A. Milne-Edwards.¹ The breadth of the front does not appear to be a constant character of the species. In our example it is slightly more than one-third of the carapace breadth, as is the case in Odhner's figure also. In a specimen of

¹ A. Milne-Edwards, *Nouv. Arch. Mus. Paris* IX, p. 182, pl. v, fig. 2 (1873).

C. dioderus, which according to Odhner is only a synonym of the present species, the front is stated to be sometimes very much narrower.

The anterior male appendages of *C. margaritatus* are illustrated in the accompanying text-figure. Each appendage is practically straight



TEXT-FIG. 5.—*Carpilodes margaritatus*, A. M.-Edw.

a. Anterior left pleopod of male : $\times 40$. b. Tip of the same enlarged : $\times 113$.

and has a short claw-like tip. There are some long club-shaped, feathery hairs just below the tip on the exposed surface of the appendage, and some more or less similar, but shorter hairs near the base on the outside. Along both the margins behind the tip there are some very minute spinules, and a number of these bunched together just close to the tip on the outer side. The characteristic "scroll-like projection" shown in the figure given by Miss Gordon¹ for *C. lippus* (Nobili) is not present in this species.

C. margaritatus seems to be rare in Indian waters. There is no example of this species in the collection of the Indian Museum and Alcock included it in the Indian fauna on the authority of Henderson.² The species according to Odhner, however, has a wide range of distribution, having been recorded from a number of places from Samoa on the east to Madagascar and the Red Sea on the west.

¹ Gordon, *Mem. Mus. Roy. Hist. Nat. Belgique* III, Fasc. 15, pp. 24, 25, text fig. 13 (1934).

² Henderson, *Trans. Linn. Soc. London* (2) V, p. 353 (1893).

Atergatis integerrimus (Lamarck).

1898. *Atergatis integerrimus*, Alcock, *Journ. As. Soc. Bengal* LXVII, pp. 95, 96.
 1922. *Atergatis integerrimus typicus*, Balss, *Arch. Naturgesch.* LXXXVIII, Heft 11, p. 124.

There is one young female of this somewhat common species in Prof. Meggitt's first collection from Mergui. The carapace breadth of the specimens is about 35 mm.

The present specimen agrees closely with named examples in the Museum collection. The surface of the external maxillipeds has, however, a scanty growth of short hairs, and the walking legs, in addition to the usual little tuft of hairs near the far end of lower border of the propodus, have a few stiff hairs in a similar position on the ischium and merus also. In the allied species *A. dilatatus* de Haan (see Alcock, *op. cit.*, p. 97) the external maxillipeds are closely covered with long thick bristles and the lower border of ischium and merus of the walking legs has remarkable comb-like tufts of long stiff bristles.

A. integerrimus has a wide range of distribution, having been recorded from several localities from Japan to Zanzibar on the east African coast. In the Indian Museum there are examples from the Bay of Bengal only.

Xantho neglectus Balss.

1898. *Xantho distinguendus*, Alcock, *Journ. As. Soc. Bengal* LXVII, pp. 113, 114 (*nec* 1835. *Xantho distinguendus*, de Haan, *Faun. Japon. Crust.*, p. 48, pl. xiii, fig. 7; 1922. *Xanthodius distinguendus*, Balss, *Arch. Naturgesch.* LXXXVIII, Heft 11, pp. 127, 128).
 1922. *Xantho neglectus*, Balss, *Zool. Anz.* LIV, p. 6 (name only).

On account of the fact that de Haan (*op. cit.*, p. 66) described the tips of the fingers in his *Xantho distinguendus* as "obtusus", Balss is of the opinion that de Haan's species cannot be retained in the genus *Xantho*, and further as in Alcock's (and several other authors') *Xantho distinguendus*, among other characters, the fingers are sharp-pointed, this crab, though rightly placed in the genus *Xantho*, cannot be considered the same form as de Haan had described under the name of *distinguendus*. Balss has, therefore, given the new name *neglectus* to the form that Alcock and several other writers had identified and described as *Xantho distinguendus* of de Haan. We have not gone deeply into this matter, but as the specimens¹ in the Indian Museum collection identified by Alcock as *Xantho distinguendus* differ considerably from the detailed description of *Xanthodius distinguendus* given by Balss in *Archiv für Naturgeschichte* (*loc. cit.*), we have preferred to adopt Balss' name for the Indian form.

There are six specimens of this species, one from Mergui and five from Maungmagan Rocks, low tide, in the two collections of Prof. Meggitt. They are all small and both the sexes are represented. The specimens agree closely with named examples in our collection, as also with Alcock's excellent description of the species.

¹ The specimens from Hongkong differ from all the other specimens in the collection in having the tips of their figures blunt and hollowed out, in having the carapace and chelipeds more profusely granulated and in a number of other characters. They agree fairly closely with the description of *Xanthodius distinguendus* given by Balss, and are probably referable to this species.

X. neglectus is represented in the Indian Museum collection by several specimens both from the Bay of Bengal and the Arabian Sea. The species seems to have a wide range over the Indo-Pacific area.

Leptodius exaratus (M.-Edwards).

1898. *Xantho* (*Leptodius*) *exaratus*, Alcock, *Journ. As. Soc. Bengal* LXVII, pp. 118, 119.
 1922. *Leptodius exaratus*, Balss, *Arch. Naturgesch.* LXXXVIII, Heft 11, p. 127.
 1934. *Xantho* (= *Leptodius*) *exaratus*, Gordon, *Mem. Mus. Roy. Hist. Nat. Belgique* III, Fasc. 15, pp. 29, 30.

A large number of specimens referable to this common Indo-Pacific species are represented in both the collections of Prof. Meggitt as also in that of Drs. Prashad and Chopra from Mergui. Both the sexes are represented and some of the females are ovigerous. The largest male specimen has a carapace length of 14.5 mm. and carapace breadth of 22.5 mm. Some of the very small specimens have the claws and most of the walking legs missing. Three or four specimens are infested with *Rhizocephala*.

There seems to be a great deal of variation in the shape and acuteness of the lateral lobes and teeth of the carapace; in younger individuals generally, though not always, the lobes are less distinct and the teeth are blunter. The carapace is non-granular in practically all the specimens.

In the Indian Museum there are numerous examples of this species from both the Bay of Bengal and the Arabian Sea, including the Persian Gulf. The species has a very wide range of distribution over the Indo-Pacific area having been recorded from a larger number of localities from Polynesia to the east coast of Africa.

Leptodius cavipes (Dana).

1898. *Xantho* (*Leptodius*) *cavipes*, Alcock, *Journ. As. Soc. Bengal* LXVII, pp. 122, 123.
 1906. *Leptodius cavipes*, Nobili, *Ann. Sci. Nat. Paris* (9) IV, p. 243.

Two male examples of this somewhat rare species were collected by Prof. Meggitt from under stones in rock pools, between tide-marks at Maungmagan in October, 1933, along with a large number of specimens of the preceding species.

The species is easily recognised, among other characters, by the presence of a trough-like concavity on the upper surface of the carpopodites of the walking legs. Both our specimens agree in every respect with named specimens in the Museum collection.

L. cavipes is represented in the collection of the Indian Museum by specimens from Mergui, Andaman Islands and the Palk Strait between India and Ceylon. The species has a wide range of distribution, having been recorded from Bonin Island in the North Pacific in the east to the Red Sea and the east African coast on the west. Sakai¹ has recorded it from the Japanese coast.

¹ Sakai, *Sci. Rep. Tokyo Bunrika Daigaku* (B) I, No. 25, p. 310 (1934).

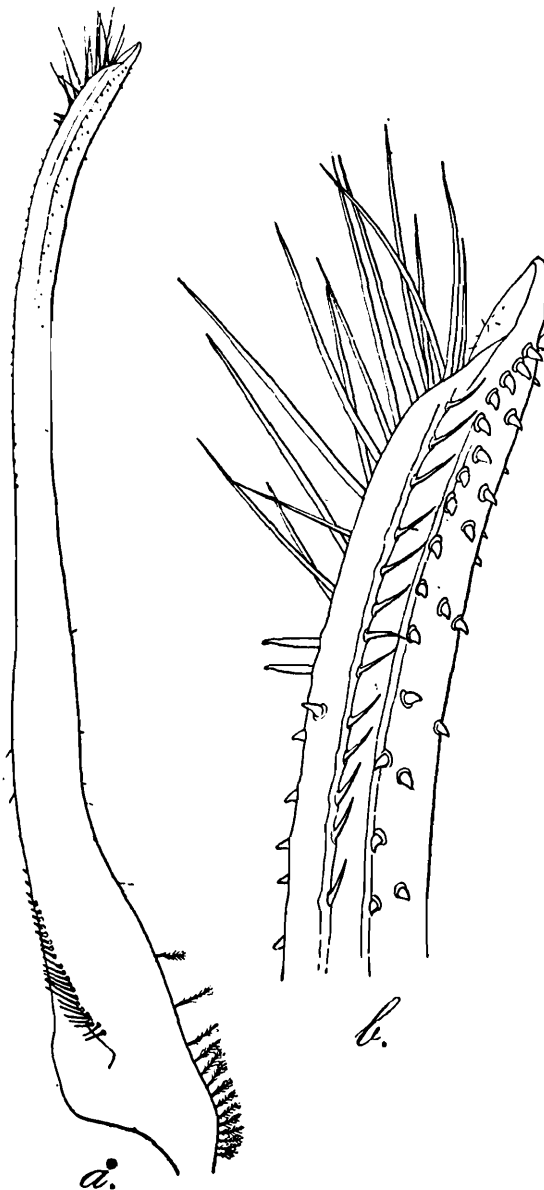
Subfamily *ACTAEINAE.*

Actaea areolata Dana.

1898. *Actaea areolata*, Alcock, *Journ. As. Soc. Bengal* LXVII, p. 141.

1925. *Actaea areolata*, Odhner, *Handl. Kungl. Vetensk. Vitterh. Göteborg* XXIX, No. 1, pp. 65, 66, pl. iv, fig. 12.

On account of the fact that Alcock described a dense covering of fur on the carapace of the single specimen from Mergui that he had examined, Odhner has expressed the opinion that Alcock's (and de Man's¹) *A. areolata* is not the same form as that described by Dana² under this name. Unfortunately this specimen from Mergui cannot be



TEXT-FIG. 6.—*Actaea areolata* Dana.

a. Left anterior pleopod of male : $\times 28$. b. Tip of the same enlarged : $\times 113$.

traced in the Museum collection and we are, therefore, unable to compare it with Odhner's description of the species. There are, however,

¹ de Man, *Journ. Linn. Soc. London (Zool.)* XXII, pp. 25, 26 (1887).

² Dana, *U. S. Explor. Exped. Crust.* I, pp. 162, 163, pl. viii, figs. 1a, b (1852).

three examples from Mergui in the present collection that are clearly referable to Dana's *A. areolata*. Two of these are males (the larger one having a carapace length of 9.5 mm. and carapace breadth of 12.5 mm.) and the third, a young female. These specimens agree almost exactly with the descriptions and figures of Dana and Odhner. The hairs on the carapace are short and do not conceal the granulation and much less the areolae. The arrangement of the granules and the hairs is exactly as described and figured by Dana. The basal antennal joint reaches little beyond the front and the orbital border, therefore, does not form a complete ring as is shown by Odhner (*op. cit.*, pl. iv, fig. 11a) in his figure of *A. semoni* (Ortmann). The areolae of the carapace are almost exactly as in Odhner's figure of *A. areolata*, the only difference from Dana's figure being in the fact that the innermost areola on the proto-gastric lobe (2 M) is hardly broader than the areola on the mesogastric lobe (3 M). This difference was noticed by de Man in the case of his specimen from Mergui also. The mesogastric areola is in the form of an inverted T. The claws are densely hairy as described by Alcock.

We give here a figure of the anterior abdominal appendage of one of our male specimens. These are long and slender and are more or less of the type usual in the genus *Actaea*. The tips are as shown in the figure.

In the absence of the specimen on which de Man and Alcock based their descriptions of *A. areolata* it is difficult to express any opinion on Odhner's observations, referred to above, regarding the correct identification of this specimen. Our specimens are from more or less the same locality as de Man's and agree with it in practically every character, including the comparatively narrow innermost branch of the areola 2 M. de Man made no mention of the dense growth of hair on the carapace concealing the granulation, though Alcock seems to have considered this point of special importance. Except for a denser growth of hair on the carapace there does not seem to be any other difference between de Man's Mergui specimen and typical examples of *A. areolata* and it seems to us likely, therefore, that this specimen is referable to Dana's species.

The three specimens in the present collection are registered as under :—

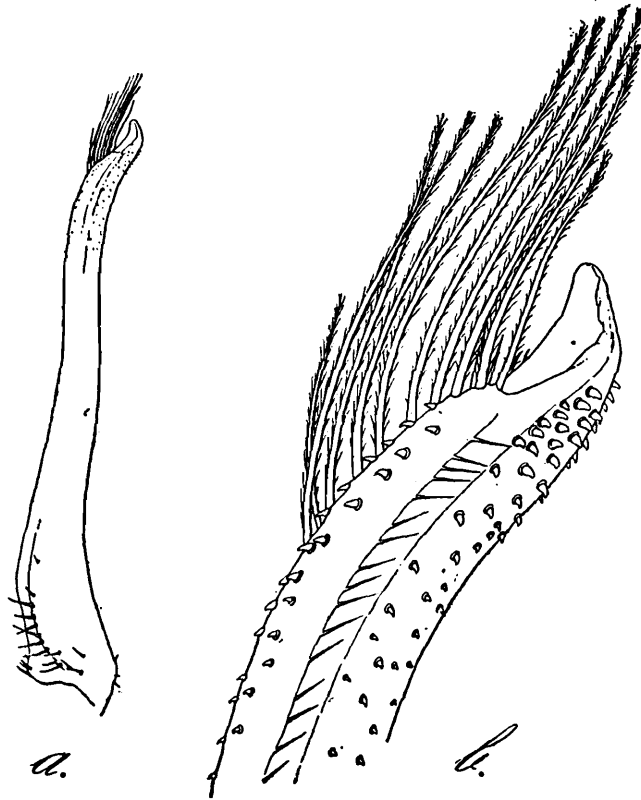
C2288/1	A submerged coral reef, off Joun-jounja, a small rocky island, Mergui Archipelago.	Drs. B. Prashad and B. N. Chopra, 20th Jan., 1937.	1 ♂
C2289/1	A submerged coral reef near shore, off Palaïow on the east coast of Doung Island, Mergui Archipelago.	Drs. B. Prashad and B. N. Chopra, 20th Jan., 1937.	1 ♂, 1 ♀

The only record of *A. areolata* from Indian waters is from the Mergui Archipelago. Odhner has given several records of the species from the east coast of Queensland, Japan, N. W. Australia, Gulf of Siam and Singapore. The species seem to be restricted to the eastern part of the Indo-Pacific area only.

***Actaea calculosa* (M.-Edwards).**

1898. *Actaea calculosa*, Alcock, *Journ. As. Soc. Bengal* LXVII, pp. 152, 153.
 1922. *Actaea calculosa*, Balss., *Arch. Naturgesch.* LXXXVIII, Heft 11, p. 122.
 1925. *Actaea calculosa*, Odhner, *Handl. Kungl. Vetensk. Vitterh. Göteborg* XXIX, pp. 52, 53.

The present species resembles very closely *Actaea granulata* (Audoin), which according to Odhner and some other writers should be known



TEXT-FIG. 7.—*Actaea calculosa* (Milne-Edwards).

a. Left anterior pleopod of male : $\times 20$. b. Tip of the same enlarged : $\times 83$.

under H. Milne-Edwards' name of *savignyi*. The differences between *A. calculosa* and *A. savignyi* have been fully described by Alcock and Odhner. The male appendages also show some differences.

A. calculosa is represented in our collection by one male specimen (carapace length 7.7 mm., carapace breadth 10.5 mm.), collected by Drs. Prashad and Chopra from amongst corals in a submerged reef near shore, off Palaiow on the east shore of Doung Island in the Mergui Archipelago on 20th Jan., 1937. It agrees very closely with named examples of this species in the Museum collection.

The anterior male appendages are as shown in the accompanying text-figure. They are shorter and stouter than those of the preceding species, and the tip is blunter and somewhat more upturned. The hairs on the inner margin just behind the tip are also longer and have minute secondary hairs on them.

A. calculosa is represented in the Indian Museum collection by specimens from Mergui, Karachi and the Persian Gulf. Balss gives the distribution of the species from Torres Strait and Japan to the Red Sea. Odhner has extended the known range considerably by giving records of occurrence of the species from Adelaide, South Australia, and Tahiti in the Pacific.

Subfamily CHLORODINAE.

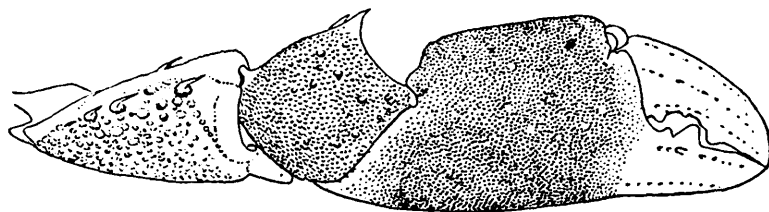
Chlorodiella niger (Forskäl).

(Plate VI, fig. 2.)

1898. *Chlorodius niger*, Alcock, *Journ. As. Soc. Bengal* LXVII, pp. 160, 161.1936. *Chlorodiella niger*, Sakai, *Sci. Rep. Tokyo Bunrika Daigaku* (B) II, p. 166.

This common Indo-Pacific species was collected from a number of localities in the Mergui Archipelago by Drs. Prashad and Chopra and is represented in our collection by several specimens. Most of the specimens are small, the largest male having a carapace length of 7.8 mm. and carapace breadth of 11.5 mm. The species does not grow to a large size, as some of the females with a carapace length of between seven and eight millimetres are ovigerous.

An examination of some of the very young examples in our collection has shown that in a number of characters young individuals show considerable difference from adults. In one female specimen (plate VI, fig. 2) with a carapace length of about 4 mm. the external orbital tooth is sharper than is usually the case, the first spine on the anterolateral border is very small, blunt and almost like a tubercle, the next two spines are sharp and prominent and the fourth is smaller and blunter than the two preceding ones. There are a few stiff hairs scattered on the carapace, especially in the anterior part and along the edge of the front. The cheliped also shows some differences. There is a sharp spine on the anterior border of the arm, and the posterior border also has a spine and some crenulations. The inner angle of the wrist has

TEXT-FIG. 8.—*Chlorodiella niger* (Forskäl).

Right cheliped of a small female specimen, with a carapace length of about 4 mm., outer and upper view: $\times 13$.

two sharp and unequal spines. Further in the walking legs the anterior border of the merus is crenulate, or even sometimes spiny.

Some very young examples from the named collection of the Indian Museum that we have examined show all these characters clearly. In specimens even a little over 5 mm. in carapace length these characters can be seen. In slightly larger examples the fourth spine of the lateral margin of the carapace becomes increasingly acute; the second spine on the wrist becomes smaller and the other becomes a little blunter. In examples with a carapace length of 6 mm. all the characters of the adult can generally be seen.

Chlorodiella niger is represented in the Museum collection by a large number of specimens mostly from the Bay of Bengal. The species has a wide range of distribution, being known to occur from Hawaii on the east to the Red Sea and the African coast on the west. Sakai has given the records of its occurrence from Japan.

***Cymo melanodactylus* de Haan.**

1898. *Cymo melanodactylus*, Alcock, *Journ. As. Soc. Bengal* LXVII, p. 174.

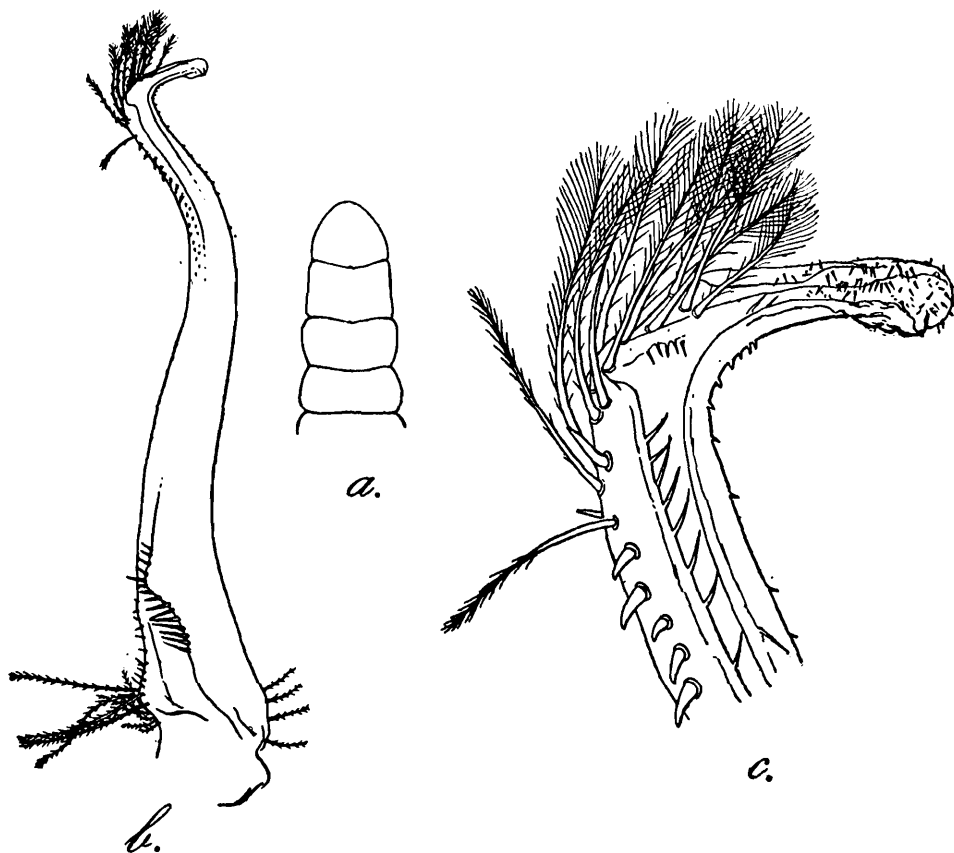
There are two male examples of the present species from Drs. Prashad and Chopra's collection from Mergui.

C2290/1	Submerged coral reef, off Cantor Island, Mergui Archipelago.	Drs. B. Prashad and B. N. Chopra, 19th Jan., 1937.	1 ♂
C2291/1	Submerged coral reef near shore, off Palaiow on the east coast of Doung Island, Mergui Archipelago.	Drs. B. Prashad and B. N. Chopra, 20th Jan., 1937.	1 ♂

The specimens have the following measurements, in millimetres :—

Length of carapace	..	..	..	10.0	7.2
Greatest breadth of carapace	..	..	..	11.0	8.0
Breadth of front	..	..	..	4.7	3.5

C. melanodactylus seems to be variable in the amount of granulation and lumps on the carapace, some specimens in the Museum collection having the carapace even more or less smooth. Similarly the tubercles on the chelipeds show considerable variation. In our examples the rows



TEXT-FIG. 9.—*Cymo melanodactylus* de Haan.

a. Terminal part of male abdomen of one of our specimens : $\times 4\frac{3}{4}$. b. Left anterior male pleopod : $\times 23$. c. Tip of the same enlarged : $\times 93$.

of tubercles on the upper surface and also on the outer surface near the upper border of the hand are in the form of broad-based, curved spines.

Some of the tubercles on the outer surface of the hand, unlike what is mentioned by Stimpson¹, are also reddish in colour. The basal parts of the fingers are strongly granulated, and are black. The dactyli of the walking legs are also tipped black.

The penultimate segment of the male abdomen in both our specimens has practically straight sides, whereas in some of the named examples in the Museum collection the sides are distinctly concave. The last segment also appears to be somewhat longer.

The anterior abdominal appendages of the male are sharply bent upwards (as seen in a specimen lying on its back) near the tip. Their form is shown in the accompanying text-figure. The tips are bluntly pointed and are beset with numerous minute spines. On the inner side just behind the tip there is a bunch of long plumose hairs, and the outer border behind the tip is a little serrate. In specimens in the Museum collection with sixth segment of the male abdomen having concave sides the anterior abdominal appendage does not show any material differences from what has been described above.

In the Indian Museum there are specimens of *C. melanodactylus* from Mergui, Andamans and Ceylon. According to Balss² the species is known from Tahiti to east coast of Africa.

Subfamily *MENIPPINAE*.

Menippe rumphii (Fabricius).

1898. *Menippe rumphii*, Alcock, *Journ. As. Soc. Bengal* LXVII, pp. 178, 179.
1936. *Menippe rumphii*, Shen, *Chinese Journ. Zool.* II, p. 67.

There are several specimens of this species from Maungmagan in both the collections of Prof. Meggitt. Some of the specimens are light orange in colour on the upper side of the carapace, chelipeds and legs, with the lower side dirty whitish yellow.

The species is very common in Indian waters both in the Bay of Bengal and the Arabian Sea. Its range of distribution in the Indo-Pacific area is very wide.

Myomenippe hardwickii (Gray).

1898. *Menippe*, (*Myomennippe*) *granulosa*, Alcock, *Journ. As. Soc. Bengal* LXVII, pp. 179, 180.
1899. *Myomenippe hardwickii*, de Man, *Notes Leyden Mus.* XXI, p. 56.
1934. *Myomenippe hardwickii*, Balss, *Faune des Colonies Francaises* V, Faso. 8, pp. 516, 517.

The correct synonymy of this species has been given by de Man and Balss.

Two specimens of *M. hardwickii* are in our collection.

C2292/1 Submerged coral reef, off Cantor Island, Drs. B. Prashad and 2 ♂♂
Mergui Archipelago. B. N. Chopra, 19th
Jan., 1937.

The specimens agree very closely with de Man's³ detailed description of the species given under the name of *Myomennippe granulosa*, as also

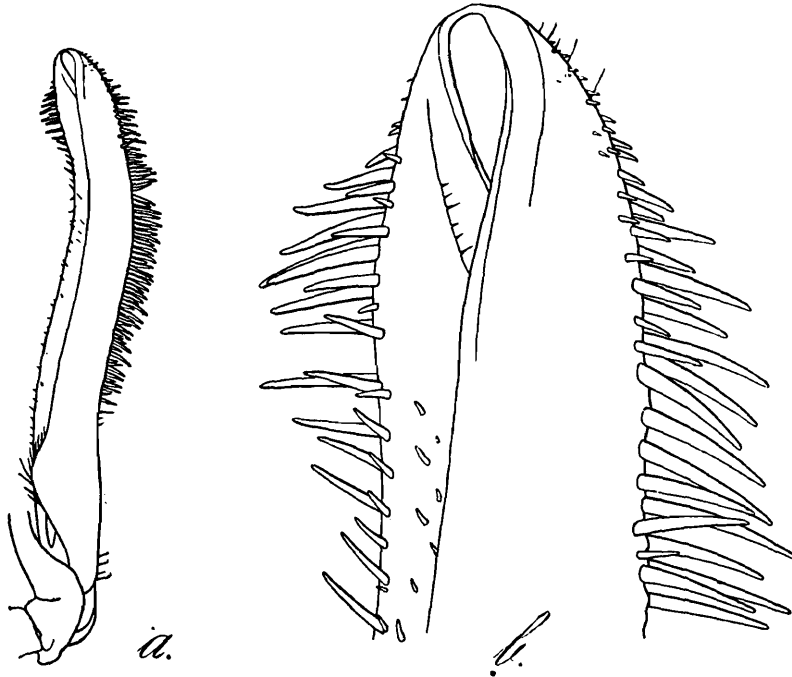
¹ Stimpson (Rathbun), *Smithsonian Misc. Coll.* XLIX, p. 59 (1907).

² Balss, *Arch. Naturgesch.* LXXXVIII, Heft 11, p. 128 (1922).

³ de Man, *Journ. Linn. Soc. London (Zool.)* XXII, pp. 40-43, pl. ii, fig. 1 (1887).

with examples named by him and by Alcock preserved in the Museum collection.

The anterior male appendages are as shown in the text-figure ; they are short and stout and are rounded at the tip. The usual ciliated



TEXT-FIG. 10.—*Myomenippe hardwickii* (Gray).

a. First left pleopod of male : $\times 4$. b. Tip of the same enlarged : $\times 20$.

channel is entirely closed leaving only an ovalish aperture near the distal end. The sides are beset with long stout hairs. The second pleopods are whip-like, as is usual in the subfamily.

The measurements, in millimetres, of the two examples from Mergui are given below :—

Length of carapace	..	..	..	40.0	23.0
Breadth of carapace	..	..	..	55.0	33.0
Distance between external orbital angles			..	27.5	18.0
Length of larger hand and fixed finger along lower border	..	..	..	40.0	23.0

In the Museum collection there are specimens of the present species from several localities in the Bay of Bengal. The only record outside the Bay is that of Balss from Dar-es-Salaam on the east coast of Africa.

Subfamily OZIINAE.

Epixanthus frontalis (Milne-Edwards).

1898. *Epixanthus frontalis*, Alcock, *Journ. As. Soc. Bengal* LXVII, p. 185.

1922. *Epixanthus frontalis*, Balss, *Arch. Naturgesch.* LXXXVIII, Heft 11, pp. 132, 133.

Two male examples referable to the present species are in the collection of Drs. Prashad and Chopra from Mergui. They are typical in every respect. The suture below the outer orbital angle is somewhat indistinct.

In the Museum collection there are specimens both from the Bay of Bengal and the Arabian Sea. The species is known from Tasmania to the east coast of Africa and the Red Sea.

Subfamily *PILUMNINAE*.

Pilumnus longicornis Hilgendorf.

(Plate VI, fig. 3.)

1898. *Pilumnus longicornis*, Alcock, *Journ. As. Soc. Bengal* LXVII, pp. 193, 194.

1898. *Pilumnus andersoni*, Alcock, *op. cit.*, p. 194.

1933. *Pilumnus longicornis*, Balss, *Capita Zool.* IV, Af. 3, pp. 15, 16.

One specimen of this species, collected by Drs. Prashad and Chopra at Mergui, is in the present collection. We give below its measurements in millimetres.

Length of carapace	..	..	..	..	10·5
Breadth of carapace	..	..	..	..	14·0
Breadth of front (distance between internal orbital angles)					4·6
Length of larger hand along lower border			..	..	9·2
Height of larger hand	..	..		..	5·0
Length of smaller hand along lower border			..	..	8·0
Height of smaller hand	..	..	..	..	3·5

The specimen has some features which might be mentioned here :—

1. The inner orbital angles are acute.
2. The external margin of the second tooth on the lateral margin of the carapace is distinctly spiniform, that of the third is obscurely so.
3. The subhepatic granule is sharp.
4. The postero-lateral margins of the carapace are slightly more arched than is usually the case.
5. There are two spines on the inner angle of the wrist.
6. Meropodites of the walking legs are spiny on the upper margin.

Most of these characters are seen in our named examples also, though Alcock and some other authors have not mentioned these. The only noteworthy difference between our example and the older specimens that we have examined is in the sharpness of the subhepatic granule and in the postero-lateral margin of the carapace being somewhat more arched. So far as the latter character is concerned it seems, however, that in the males the postero-lateral borders of the carapace are generally arched a little more than in females of the same size.

P. longicornis is represented in the collection of the Indian Museum by specimens from both the coasts, as also from more eastern parts of the Bay. Balss gives the range of the species as : “ von Ostafrika bis Hawaii und Ponape.”

Pilumnus hirsutus Stimpson.

1898. *Pilumnus hirsutus*, Alcock, *Journ. As. Soc. Bengal* LXVII, p. 197.

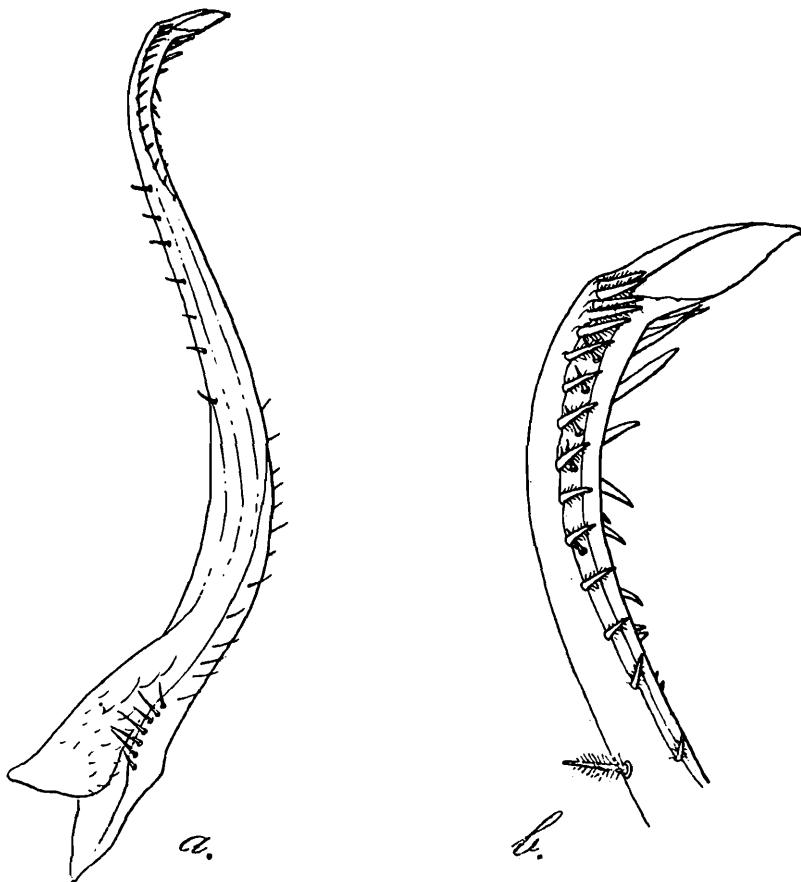
1922. *Pilumnus hirsutus*, Balss, *Arch. Naturgesch.* LXXXVIII, Heft 11, pp. 117, 118.

1933. *Pilumnus hirsutus*, Balss, *Capita Zool.* IV, Af. 3, p. 20.

There are three examples of *P. hirsutus* in the present collection. They were collected by Drs. Prashad and Chopra in different localities in the Mergui Archipelago; two of these are young males and the third, a young female. The specimens are typical.

The amount of granulation on the large claw varies considerably in our named examples.

The anterior abdominal appendages of the male from Mergui are as shown in the accompanying text-figure. In their general appearance



TEXT-FIG. 11.—*Pilumnus hirsutus* Stimpson.

a. Left anterior pleopod of male : $\times 34$. b. Tip of the same enlarged : $\times 113$.

they more or less conform to the type figured by Balss (1933, *op. cit.*, p. 10, fig. 2) as characteristic of the subfamily Pilumninae, but they seem to show a closer resemblance to the appendages figured by Miss Gordon¹ as of *P. seminudus* Miers, which species Balss (1933, *op. cit.*, pp. 13 and 39) has transferred to his new genus *Glabropilumnus*.

In the Museum collection there are specimens of the present species from the eastern part of the Bay of Bengal only. Balss (1922, *loc. cit.*) gives the range of distribution of the species as New Caledonia to the Red Sea, extending as far north as Korea on the coast of China.

¹ Gordon, *Journ. Linn. Soc. London (Zool.)* XXXVII, p. 541, text-fig. 17a, b (1931).

Actumnus elegans de Man.1898. *Actumnus elegans*, Alcock, *Journ. As. Soc. Bengal* LXVII, p. 206.1933. *Globopilumnus globosus*, Balss, *Capita Zool.* IV, Af. 3, p. 7, pl. i, figs. 1 and 2 (*partim*).

Balss is of the opinion that the form described by de Man and Alcock as *Actumnus elegans* is only a young stage of Dana's¹ *Pilumnus globosus*, which species he has transferred to his new genus *Globopilumnus* in the subfamily Menippinae. He was led to this opinion on a comparison of de Man's paratype of *A. elegans* with young specimens of, what he identified as, *Pilumnus globosus* of Dana. We are unable to subscribe to this view. We have before us one of the original specimens of de Man from Mergui (labelled co-type), two specimens from Kyuk Phyu Harbour and four examples from Mergui recently collected by Drs. Prashad and Chopra. All these seven specimens agree very closely with the descriptions of de Man and Alcock, and are no doubt conspecific. One of these specimens, from Kyuk Phyu, is an ovigerous female and, shows unmistakably all the characters on which de Man based his species. This specimen, which is the largest in our collection, has the following measurements (in millimetres):—

Length of carapace	..	..	..	..	7.2
Greatest breadth of carapace	..	..	..	..	9.2
Breadth of front	..	..	..	..	3.0
Breadth of fronto-orbital border	..	..	..	..	6.2

It would thus appear that *Actumnus elegans* is normally a small species, and what Balss believed to be the characters of the young only persist up to the adult stage also. The co-type from Mergui is a young male with a carapace length 3.9 mm. and there are hardly any characters to distinguish this specimen from the ovigerous female referred to above.

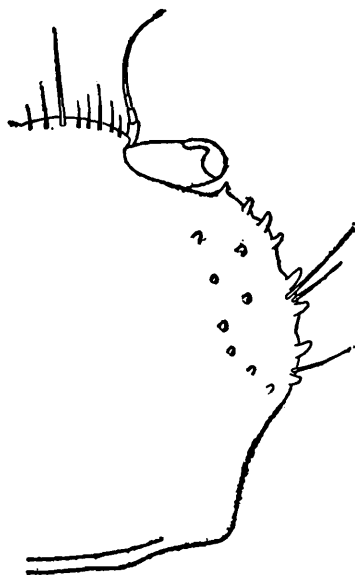
Actumnus elegans is easily recognised, among other characters, by the paired arrangement of the spinuliform granules on the antero-lateral margins of the carapace. Typically there are eight of these granules on each margin; six of these are arranged in three pairs, the seventh is between the granules of the first pair and the outer orbital angle and the eighth is at the outer orbital angle itself. We give here an outline-figure of the carapace of the ovigerous female from Kyuk Phyu and the disposition of the granules will be clearly seen from it. In one of the recently collected specimens from Mergui, however, there are two or three additional minute granules in between the larger paired granules. In all the other examples the number and arrangement of the granules is quite typical. In Dana's *Pilumnus globosus*, as described both by Dana and de Man,² there are only three or four isolated granules on the antero-lateral border of the carapace. The upper orbital border in *Actumnus elegans*, as described by de Man³ has a characteristic shape. In de Man's words "the frontal or inner part of the upper margin of the orbits makes nearly right angles both with the frontal and the external, somewhat granular portion of the upper orbital margin"; this is

¹ Dana, *U. S. Explor. Exped. Crust* I, pp. 236-237, pl. xiii, fig. 10 (1852).

² de Man, *Notes Leyden Mus.* XII, pp. 59-61, pl. xiii, fig. 10 (1890).

³ de Man, *Journ. Linn. Soc. London (Zool.)* XXII, 1 p. 47-49 (1887).

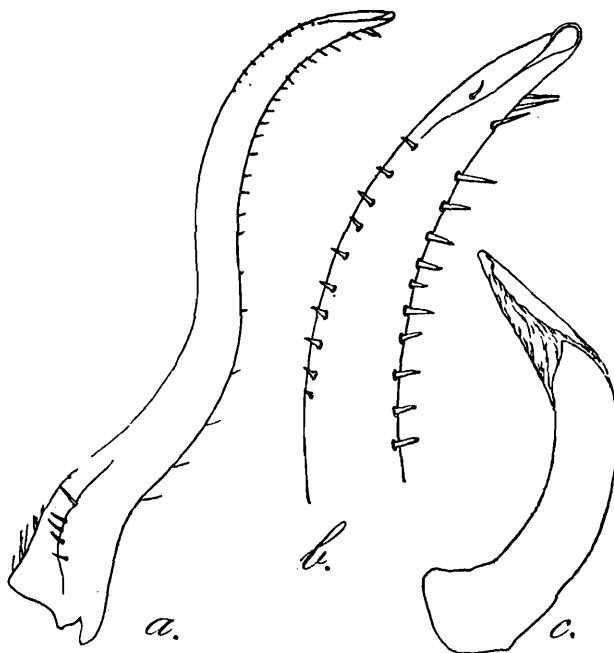
clearly seen in the text-figure. In *P. globosus*, as seen in Dana's figure, the upper margin of the orbit. is regularly rounded.



TEXT-FIG. 12.—*Actumnus elegans* de Man.

Upper view of carapace of ovigerous female specimen from Kyuk Phyu : \times ca. 9.

The abdominal appendages of the male, that we have been able to examine in the single male specimen (co-type from Mergui) in our collection are unmistakably of the *Pilumnus* type.¹ They are as illustrated



TEXT-FIG. 13.—*Actumnus elegans* de Man.

a. First left pleopod of male : \times 41. b. Tip of the same enlarged : \times 107. c. Second left pleopod of male : \times 107.

in the accompanying text-figure. The second pleopod is very much shorter than the first and is not whip-like. The species, therefore, cannot be included in the subfamily Menippinae as proposed by Balss.

¹ We have also examined these appendages in a specimen of *A. setifer* (de Haan) that has been seen by Dr. Balss ; they are more or less like those of *A. elegans* in their general form and structure.

The species is represented in the present collection by four examples collected by Drs. Prashad and Chopra in the Mergui Archipelago.

- | | | | |
|---------|-----------------------------------------------------------------------------------------|-------------------------------------------------------|--------------------|
| C2293/1 | Submerged coral reef off Cantor Island, Mergui Archipelago. | Drs. B. Prashad and B. N. Chopra, 19th January, 1937. | 1♀ from an oyster. |
| C2294/1 | Submerged coral reef off Palaïow on the east coast of Doung Island, Mergui Archipelago. | Drs. B. Prashad and B. N. Chopra, 20th January, 1937. | 3 ♀♀ from corals. |

One of the specimens from Palaïow is infested with a Rhizocephalon. *A. elegans* is so far known from Mergui only.

Subfamily *ERIPHINAE*.

Trapezia cymodoce (Herbst).

1898. *Trapezia cymodoce*, Alcock, *Journ. As. Soc. Bengal* LXVII, pp. 219, 220.
 1922. *Trapezia cymodoce*, Balss, *Arch. Naturgesch.* LXXXVIII, Heft 11, p. 134.
 1936. *Trapezia, cymodoce*, Sakai. *Sci. Rep. Tokyo Bunrika Daigaku* (B) II, pp. 169, 170.

This common coral crab is represented in the collection of Drs. Prashad and Chopra by 19 specimens from a number of localities in the Mergui Archipelago. There are examples of both the sexes and some of the females are ovigerous. The largest specimen, a female, has a carapace length of 15 mm., carapace breadth 19 mm. and the fronto-orbital border 16 mm. One female has two Bopyrids under the carapace, forming lumps one on each side near the junction of the antero- and postero-lateral borders; this specimen has a little pubescence on the carapace, especially in the anterior half. All the specimens are typical.

The species is represented in the collection of the Indian Museum by specimens both from the Bay of Bengal and the Arabian Sea. According to Balss it is distributed from Polynesia to the east coast of Africa.

Trapezia ferruginea, var. *areolata* Dana.

1898. *Trapezia ferruginea*, var. *areolata*, Alcock, *Journ. As. Soc. Bengal* LXVII, p. 221.
 1907. *Trapezia cymodoce areolata*, Rathbun, *Mem. Mus. Comp. Zool. Harvard* XXXV, p. 59.

Miss Rathbun is of the opinion that a large number of forms that have been described as *T. cymodoce*, *T. ferruginea* and its varieties or as *T. maculata* are all referable to the first-named species.

We have before us six female examples (three ovigerous) that are referable to Dana's *Trapezia areolata*. These were collected by Drs. Prashad and Chopra in the Mergui Archipelago.

The "elegant honeycomb network of fine brown" described by Alcock is very distinct and in most cases extends to the claws, sides and ventral surface of the carapace and even to the abdomen. The upper part of the outer surface of the hand is finely pubescent in most of the examples.

The largest female has a carapace length of 9 mm., carapace breadth 11.5 mm. and fronto-orbital border 10 mm. The range of distribution of the present form is more or less the same as that of *Trapezia cymodoce*,

Tetralia glaberrima (Herbst).

1898. *Tetralia glaberrima*, Alcock, *Journ. As. Soc. Bengal* LXVII, pp. 223—225.
 1922. *Tetralia glaberrima*, Balss, *Arch. Naturgesch.* LXXXVIII, Heft. 11, p. 134.

Like the two preceding species *Tetralia glaberrima* is also very commonly met with living in corals; twelve examples of this species were collected by Drs. Prashad and Chopra from amongst corals in the Mergui Archipelago. Both the sexes are represented in the collection and some of the females are ovigerous. We give below some measurements, in millimetres, of two males and two ovigerous female specimens.

		Ovig. ♀	Ovig. ♀	♂	♂
Length of carapace ...	...	10.2	7.5	8.0	8.8
Breadth of carapace ...	...	12.2	9.0	9.2	10.0
Breadth of fronto-orbital border...		10.5	8.2	8.2	9.0

In the Indian Museum there are numerous examples of this species both from the Bay of Bengal and the Arabian Sea. The species has a very wide range of distribution over the Indo-Pacific area, being met with from Polynesia to the east coast of Africa.

Family GONOPLACIDAE.

Subfamily PSEUDORHOMBILINAE.

Litocheira angustifrons Alcock.

(Plate VI, fig. 4.)

1900. *Litocheira angustifrons*, Alcock, *Journ. As. Soc. Bengal* LXIX, p. 315.
 1918. *Litocheira angustifrons*, Tesch, *Siboga Exped. Rep.* XXXIX c¹, p. 163, foot-note.
 1933. *Heteropilumnus angustifrons*, Balss, *Capita Zool.* IV, Af. 3, pp. 41-44.

A single specimen of this apparently rare species is in the present collection :—

C2295/1 Palaiow, on the east coast of Doung Island, Mergui Archipelago, on beach at low tide. Drs. B. Prashad and B. N. Chopra, 20th January, 1937. 1♀

The specimen agrees very closely with Alcock's named examples in the collections of the Indian Museum, as also with his description. Alcock's description of the species is very brief and does not mention several important characters and as Tesch has expressed some doubts about the validity of the species we have thought it desirable to redescribe it in some detail.

The entire surface of the carapace (Plate VI, fig. 4), chelipeds (excepting the fingers) and the legs is covered with a short, dense fur and long silky hairs, the latter being most abundant on the lateral margins of the carapace and on the chelipeds and legs. There is a row of similar hairs

just behind the fronto-orbital margin surmounting a low and somewhat indistinct ridge. The length of the carapace is almost three-fourths of its breadth. It is more or less flat, especially in the posterior part, the anterior region being somewhat curved and markedly deflexed anteriorly. When denuded the surface of the carapace is smooth, with only a few small granules on and near the antero-lateral margins. The regions are very faintly distinguishable and the crecentic groove between the gastric and cardiac regions is deeply impressed.

The fronto-orbital border is distinctly shorter than the length of the carapace, and, as mentioned by Alcock, is about five-ninths of its greatest breadth. The front is strongly deflexed anteriorly and is distinctly bilobed, each lobe being somewhat convex anteriorly. It is a little less than one-third of the carapace breadth. The two lobes of the front are separated from one another by a small deep notch, followed by a shallow groove running longitudinally for some distance on the carapace. The front is not demarcated from the supra-orbital angles.

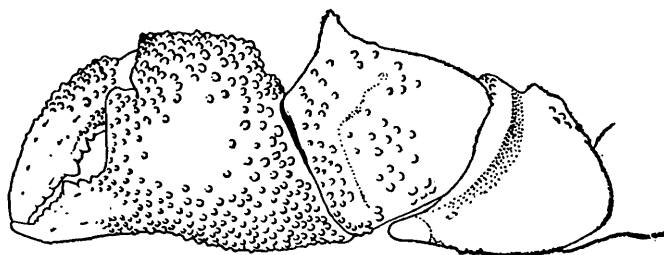
The antero-lateral borders of the carapace are shorter than the postero-lateral and are arched. On each side the antero-lateral margin is cut up by three deep notches into four lobes. The first lobe is confluent with the external orbital angle; its margin is truncate, with the anterior angle acute, and the posterior somewhat blunt. The second lobe is as large as, or even a little larger than the first; its margin is rounded, the anterior angle sharp and the posterior regularly rounded. The third lobe is considerably smaller than the first two and is sharply truncate, while the fourth is the smallest, is triangular and somewhat acutely pointed. The margins of all the lobes are crenulate as is also a small part of the postero-lateral margin of the carapace behind the fourth tooth. The postero-lateral margins are more or less straight and converge posteriorly. The posterior margin is slightly sinuous.

The upper border of the orbit is crenulate. There is a small triangular groove near the outer orbital angle and one in a similar position on the lower border. There is another small and indistinct notch on the middle of the upper border. The outer orbital angle is acute. The eye-stalks are cylindrical, fill up the orbits completely and the greatly reduced and pigmented corneas are somewhat ventrally placed at their tips.

The antennules fold transversely in their fossae and the antennal flagella, as usual, stand in the orbital hiatus. The epistome is quite distinct, and the buccal cavern is somewhat widened anteriorly. The external maxillipeds completely close the buccal cavern and the broad merus has its antero-external angle slightly produced.

The chelipeds are slightly unequal, especially in the male, in which they are about twice the length of the carapace and are almost as long as the penultimate pair of walking legs. In the female the chelipeds are less than twice the carapace length and are shorter than the legs. They are thickly covered with fur and long hairs, except on the fingers which are quite bare. In the Mergui specimen the larger claw has a part of the outer surface of the palm near the distal end also bare, but

in the smaller claw the whole of the outer surface of the palm is thickly covered with hairs. The inner surface of the palm is almost completely devoid of hairs. The upper border of the arm has a thin longitudinal crest on it, with a spine-like lobule near its distal end. There is also an indistinct transverse ridge on the outer face of the arm, a little from the distal end. The wrist has its inner angle acute, almost spiniform, and its upper surface granular, especially near its junction with the hand. The upper surface of the palm is densely covered with granules, and the



TEXT-FIG. 14.—*Litocheira angustifrons* Alcock. Outer view of the left cheliped of male from Karachi: $\times 3$.

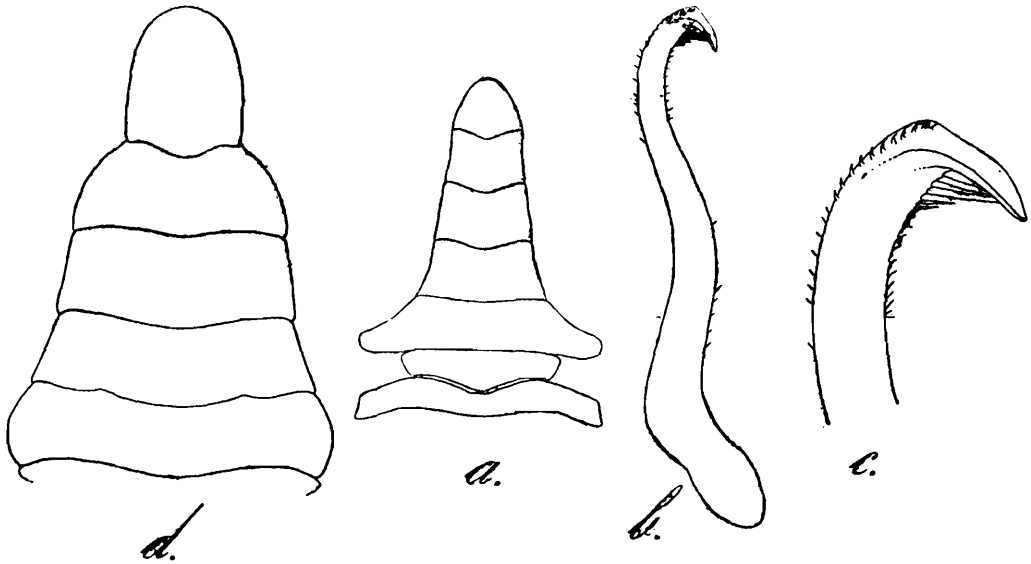
outer surface also is granular, except for a smooth patch in the middle. In the larger chela of the Mergui specimen the outer surface of the palm is quite smooth, as described by Stimpson¹ for *Pilumnoplax ciliata*. The inner surface of the palm is altogether devoid of granules. The upper margin of the palm is straight and is considerably shorter than its height. The fingers are long and stout and the dactylus is slightly arched. The proximal half of the upper surface of the dactylus and less than half of the lower surface of the fixed finger is granular. The cutting edges of the fingers are finely dentate, with one large tooth on each finger about the middle of the cutting edge. There is a small gap near the base when the fingers meet and the pointed tips cross one another slightly.

The third walking legs are the longest, while those of the last pair are the shortest. The merus in all the legs is without any crest, anterior or posterior. The dactyli of the first three pairs are long and straight with short, pointed horny tips, while those of the last pair are short and stout. In the large male specimen from Karachi the third leg of one side is shorter than the second, but it has possibly been regenerated, for it is shorter than the corresponding leg of the other side.

All the seven abdominal segments are distinct in both the sexes. The first segment of the male abdomen (text-figure 15 a) occupies all the space between the bases of the last pair of walking legs. The second is narrower, and the third at the base is almost as broad as the first. The sides of this segment converge strongly distally so that it is very much broader at the base than at its distal end. From the third segment the abdomen tapers gradually to the tip. The fourth, fifth and sixth segments are subequal in length and the basal breadth of the sixth is about one and a half times of its median length. The anterior abdominal appendages

¹ Stimpson (Bathbun), *Smithsonian Misc. Coll.* XLIX, pp. 92, 93 (1907).

of the male are somewhat like those of *L. subintegra* Lanchester, as figured by Miss Gordon.¹ The appendages of the two sides are not in any close contact distally and the apex of each is bent outwards and considerably upwards, perhaps not quite as sharply as shown in Miss Gordon's figure. Just behind the tip on the outside there is a tuft of long hairs decreasing in size distally and on the inner side there are a few minute spinules just at the place where the tip bends.



TEXT-FIG. 15.—*Litocheira angustifrons* Alcock. a. Abdomen of male specimen from Karachi: $\times 2\frac{2}{3}$. b. Anterior left abdominal appendage of same: $\times 7$. c. Tip of the abdominal appendage magnified: $\times 20$. d. Abdomen of male of *Clistocoeloma balanse*² A. M.-Edw.: $\times 4\frac{1}{2}$.

The older specimens are a dirty light brownish in colour, with the fingers white and the pearly granules on the palm also showing white through the long hairs. In the Mergui specimen the colour is dirty greyish, but on removal of the fur and hairs it is seen to be ivory white. The fingers in this specimen are light brownish in their entire length.

Alcock based the species on two specimens, a female from Bombay and a larger male from Karachi. In the Indian Museum collection the female specimen from Bombay is labelled as the type, and is numbered 6182/3. The species has since been recorded, without any comments, by Borradaile³ from Male Atoll in the Maldives and has now been obtained from the Mergui Archipelago.

We give below measurements in millimetres and the proportions of certain measurements of the carapace in the three specimens of *L. angustifrons* in the Museum collection. For purposes of comparison we have also included similar measurements and proportions of *L. cristata* Rathbun,⁴ so far as published by the author.

¹ Gordon, *Journ. Linn. Soc. London (Zool.)* XXXVII, p. 549, text-fig. 25b (1931).

² The figure of the male abdomen of *Clistocoeloma balansae* has been included in this block through a mistake; it should have formed a part of text-figure 21 on p. 432.

³ Borradaile, *Fauna Geog. Maldive Laccadive Arch.* I, p. 430 (1903).

⁴ Rathbun, *Skrift. K. Dansk. Vidensk. Selsk. Copenhagen* (7) V, pp. 340, 341 (1910).

	<i>L. angustifrons.</i>			<i>L. cristata.</i>
	Female Type- specimen from Bombay.	Male from Karachi.	Male from Mergui.	Female Type- specimen.
Length of carapace	11.0	13.2	9.4	5.5
Greatest breadth of carapace	14.8	18.4	12.2	7.7
Fronto-orbital breadth	8.2	10.0	7.0	5.0
Breadth of front	4.6	5.5	4.0	2.8
Length of hand along lower border (large claw)	8.9	13.2	9.0	..
Height of palm (large claw)	5.1	7.8	5.1	..
Length of hand along lower border (small claw)	8.7	12.8	8.4	..
Height of palm (small claw)	4.7	7.4	4.8	..
Penultimate walking leg—				
Length of merus	8.8	9.5	7.5	..
Length of carpus	4.5	} 11.5	4.2	..
Length of propodus	5.5		4.5	..
Length of dactylus	5.5	6.3	4.7	..
<u>Carapace length</u> ... ..	.74	.72	.77	.71
<u>Carapace breadth</u>				
<u>Fronto-orbital breadth</u> <u>Carapace breadth</u> ... ..	.55	.54	.57	.65
<u>Front</u> <u>Carapace breadth</u> ... ..	.31	.30	.33	.36

Litocheria angustifrons resembles *L. ciliata* (Stimpson) and *L. cristata* Rathbun so closely that Tesch has suggested that the three may have to be combined under Stimpson's name. Alcock's species, however, differs from Stimpson's in having a narrower carapace and from both the allied species in having the walking legs without any crest on the merus. In *L. cristata* the upper surface of the wrist is strongly eroded and has a blunt ridge along the inner edge; there is hardly any trace of the erosion or the ridge in Alcock's species, nor has their presence been mentioned by Stimpson. The front and the fronto-orbital border are also broader in Miss Rathbun's species than in *L. angustifrons*. The walking legs of the second pair are stated to be longer than those of the third in *L. cristata*, while, as is usually the case, the third legs are the longest in both Alcock's and Stimpson's species. The shape of the teeth on the antero-lateral margins of the carapace is also slightly different in Alcock's and Miss Rathbun's species. Stimpson's species is very inadequately known and it is therefore, impossible to enumerate any other differences that may possibly exist between his species on the one hand and Alcock's and Miss Rathbun's species on the other. The general resemblance between the three species is, however, very close and striking.

The position of a number of species grouped in the genus *Litocheira* appears to us to be far from satisfactory. According to Kinhan's¹ definition of the genus and the genotype, in addition to other characters, members of the genus *Litocheira* are characterised by having a front which is about half as broad as the carapace, and by the possession of an orbit the upper border of which is entire. A large number of species that are now included in the genus agree with the type-species, *L. bispinosa*, in these, as also in most other characters, but there are certain others in which the frontal breadth is markedly less than half the carapace breadth, or in which the upper border of the orbit has one or two distinct gaps. In *L. angustifrons*, *L. setosa* (A. M.-Edw.)² and *L. integra* (Miers),³ to mention only the species that we have ourselves examined, the front is either exactly or only a little more than one-third of the carapace breadth, while in *L. angustifrons*, *L. quadrispinosa* Zehntner² and perhaps in several others the upper border of the orbit has two more or less distinct gaps. In the matter of the anterior abdominal appendages of the male also there appears to be a great deal of difference between the genotype and several other species. We give here a figure of the anterior male appendage in *L. bispinosa* from a specimen



TEXT-FIG. 16.—*Litocheira bispinosa* Kinhan. a. Left anterior pleopod of male : $\times 12$.
b. Tip of the same magnified : $\times 35$.

from St. Vincent Gulf, South Australia, presented to the Indian Museum, and a comparison of this with the similar appendage of *L. angustifrons* as figured here, or of *L. subintegra* Lanchester, *L. subintegra*, var. *hirsutior* Lanchester and *L. amoyensis* Gordon, as figured by Miss Gordon⁴ will

¹ Kinhan, *Journ. Roy. Dublin Soc.* I, pp. 121-123, pl. iii, fig. 1 (1856).

² See Tesch, *Siboga Exped. Rep.* XXXIX c¹, pp. 165-167, pl. vii, fig. 1 and pp. 168-171, pl. vii, fig. 3 (1918).

³ Miers, *Zool. "Alert"*, p. 543, pl. xlvi, fig. c (1884).

⁴ Gordon, *Journ. Linn. Soc. London (Zool.)* XXXVII, p. 549, text-fig. 25 (1931).

show the great difference between the appendage of the type-species on one hand, and that of the species named here on the other. We have also examined this appendage in *L. setosa* (A. M.-Edw.) and *L. beaumontii* Alcock¹ and find that in these species also the anterior abdominal appendages of the male are more or less of the same type as in *L. angustifrons* and the other species named here. Miss Gordon² believes that in the genus *Litocheira* the anterior abdominal appendages of the male are of two kinds, both the kinds having a beak-like apex, but, differing from one another chiefly in the presence or absence of a very large spine just under the apex; all the species that we have examined, except *L. bispinosa*, or the figures of the male appendages of which have been published conform to one of these types. In the genotype, however, the appendage, besides being short and proportionately very stout, has no beak-like apex. The terminal portion is straight, blunt and truncate and is beset with a profuse growth of long hairs on both the margins. From all the differences enumerated above it seems to us likely, therefore, that the inclusion of some of the species now grouped in the genus *Litocheira* is only a matter of convenience, and does not represent their true natural relationship with the other members of the genus. An examination of the anterior abdominal appendages of the male in all the known species of the genus seems to us very desirable.³

Balss has recently suggested that *L. angustifrons* along with some other species that are now included in the genus *Litocheira* should be accommodated in de Man's genus *Heteropilumnus* in the family Xanthidae. From what has been stated above we are also of the opinion that certain species at present assigned to the genus *Litocheira* do not agree with the type-species of this genus in a number of important characters, and it may perhaps be advisable to put such species in another genus. We are not, however, convinced that these species could find a place in the genus *Heteropilumnus* or be included in the family Xanthidae. A considerable amount of further work on all the species included in *Litocheira* and *Heteropilumnus*, and specially on their male appendages, could only settle this point. We have included *L. angustifrons* in the genus *Litocheira* in the family Gonoplacidae chiefly as a matter of convenience.

Family POTAMONIDÆ.

Subfamily POTAMONINÆ.

Potamon (Acanthotelphusa) dayanum (Wood-Mason).

1910. *Potamon (Acanthotelphusa) dayanum*, Alcock, *Cat. Ind. Decapod Crust.* I, *Brachyura* Fasc. II, pp. 61-63, pl. xi, fig. 49.

One large female specimen of the present species is in Prof. Meggitt's first collection from Maungmagan. The exact locality from which it was obtained is not mentioned. The specimen is quite typical. A

¹ Alcock, *Journ. As. Soc. Bengal* LXIX, pp. 315, 316 (1900).

² Gordon, *Journ. Linn. Soc. London (Zool.)* XXXVII, p. 526 (1931).

³ Of the seven species of the genus *Litocheira* in the Indian Museum collection, viz., *L. bispinosa* Kinhan, *L. setosa* (A. M.-Edw.), *L. beaumontii* Alcock, *L. angustifrons* Alcock, *L. integra* (Miers), *L. quadrispinosa* Zehntner, and *L. kingsleyi* Miers the last three are represented by female examples only.

large number of more or less fully-formed young ones are under the abdomen of the specimen and some are lying loose in the bottle in which it had been put.

There is a large number of specimens of this species in the Museum collection from various localities in Burma. So far as we are aware the species is not known outside the "Burma-Malay Territory" as defined by Alcock (*op. cit.*, p. 10).

Potamon sp.

Two female examples with the chelipeds missing and otherwise badly damaged are in Prof. Meggitt's first collection from Maungmagan. We have found it impossible to give them a specific name.

Subfamily GECARCINUCINAE.

Paratelphusa (Phricotelphusa) callianaria (de Man).

1910. *Paratelphusa (Phricotelphusa) callianaria*, Alcock, *Cat. Ind. Decapod Crust. I, Brachyura* Fasc. II, pp. 102, 103, pl. xiii, fig. 62.

One female specimen with a carapace length of 10.7 mm. and greatest carapace breadth of 12.5 mm. was collected by Drs. Prashad and Chopra in a small freshwater stream near shore at Kamachaung on the east coast of Doung Island in the Mergui Archipelago. The specimen agrees very closely with the original examples of de Man from Mergui.

The species is represented in the collection of the Indian Museum by specimens from Mergui only. So far as we know it has not been recorded from any other locality.

Family OCYPODIDAE.

Subfamily OCYPODINAE.

Ocypoda ceratophthalma (Pallas).

1900. *Ocypoda ceratophthalma*, Alcock, *Journ. As. Soc. Bengal* LXIX, pp. 345-347.

1918. *Ocypoda ceratophthalma*, Tesch, *Siboga Exped. Rep.* XXXIX c, p. 36.

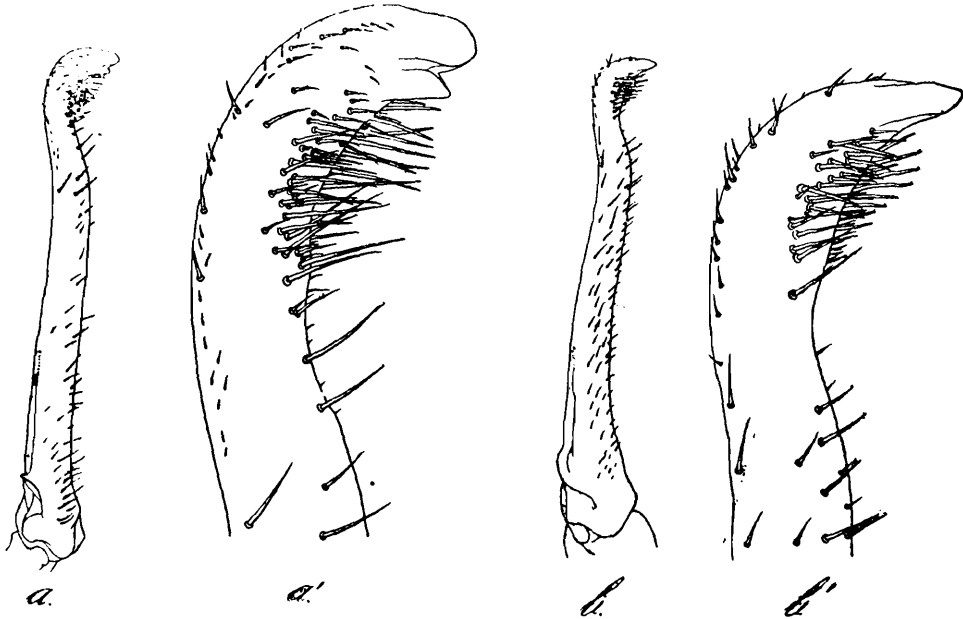
1922. *Ocypoda ceratophthalma*, Balss, *Arch. Naturgesch.* LXXXVIII, Heft 11, pp. 141, 142.

1937. *Ocypoda ceratophthalma*, Tweedie, *Bull. Raffles Mus. Singapore* XIII, p. 141.

A large number of examples of this common Ocypod are in the two collections of Prof. Meggitt from Maungmagan. They were collected on beach and in Rock Pools near shore.

Ocypoda ceratophthalma resembles *O. macrocera* M.-Edwards (*vide infra*) so closely that it is sometimes difficult to distinguish young examples, and especially young females of the two species. The fingers of the smaller chela, however, afford a useful character for separating the species; in *ceratophthalma* these are pointed at the tips, while in *macrocera* the fingers are lamellar right up to the tips, which are broad and blunt and not pointed. The stridulating organ on the inside of the palm is always much shorter and more hairy in the present species than in *O. macrocera*, and, as pointed out by Alcock, consists, in its upper

half, of tubercles gradually passing to striae, which in the lower half are short and generally very closely arranged; in *macrocera* the stridulating ridge consists entirely of striae. The abdomen of the male in the two species is also different; in the present species it is narrower than in *macrocera*. The sixth segment is narrower and longer, its median length being more than its greatest breadth while in *macrocera* the length of this segment more or less equals its greatest breadth. The fifth abdominal segment is also proportionately longer and narrower in the present species than in the allied form. The first pleopods of the male are somewhat



TEXT-FIG. 17.—*a.* First left pleopod of male in *Ocypoda ceratophthalma* (Pallas): $\times 5^3$, *a'*. Tip of the same enlarged: $\times 21$. *b.* First left pleopod of male in *Ocypoda macrocera* Milne-Edwards: $\times 5^3$. *b'*. Tip of the same enlarged: $\times 22$.

different in the two species, as is seen in the accompanying text-figure. In the present species the appendage is a little more sharply bent near the tip, which is more rounded and consists of two somewhat flattened and distally rounded lobes, separated by a narrow incision between them. In *O. macrocera* there is just a suggestion of the incision, but the two lobes are not differentiated.

In young examples the horn at the end of the eye is generally very poorly developed.

O. ceratophthalma occurs very commonly in the Bay of Bengal. Balss gives the distribution of the species as Tahiti to the east coast of Africa.

***Ocypoda macrocera* Milne-Edwards.**

1900. *Ocypoda macrocera*, Alcock, *Journ. As. Soc. Bengal* LXIX, p. 347.

1915. *Ocypoda macrocera*, Kemp, *Mem. Ind. Mus.* V, pp. 219, 220.

A number of examples of this species were collected by Prof. Meggitt in Rock Pools near shore at Maungmagan in October 1933.

The species can be distinguished from the closely similar *O. ceratophthalma* by the characters enumerated above. The characters of the male abdomen appears to be constant even in young examples. The present species is of a smaller size than the preceding one.

Kemp has described the colour of the species and has given very interesting notes on the habits, etc., of the species, in its early stages.

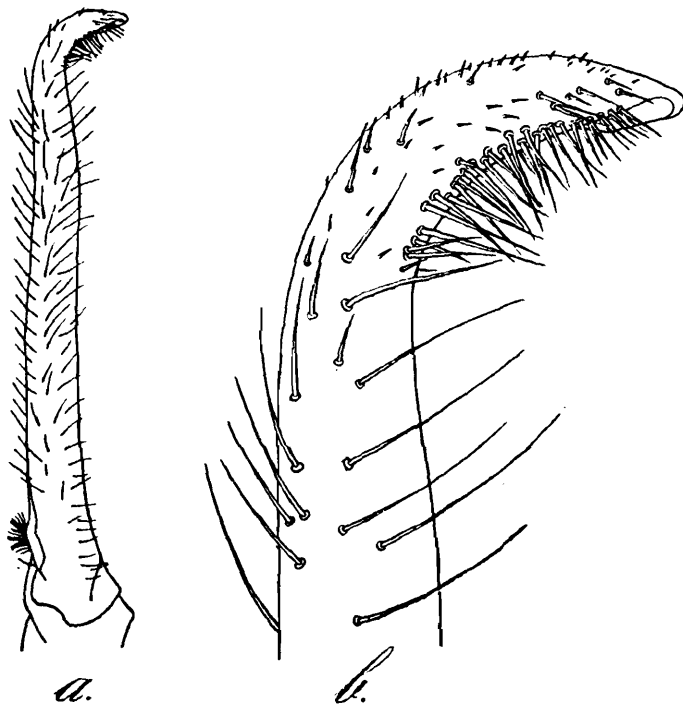
The species is mostly confined to the Bay of Bengal only, though it has been recorded from the Gulf of Siam also.

Ocypoda cordimana Desmarest.

1900. *Ocypoda cordimana*, Alcock, *Journ. As. Soc. Bengal* LXIX, pp. 349, 350.
 1918. *Ocypoda cordimana*, Tesch, *Siboga Exped. Rep.* XXXIX c, pp. 35, 36.
 1922. *Ocypoda cordimana*, Balss, *Arch. Naturgesch.* LXXXVIII, Heft. 11, p. 142.

Several large males and females of this species are in Prof. Meggitt's second collection from Maungmagan. The specimens are typical and agree very closely with named examples in our collection, as also with Alcock's description of the species.

The anterior abdominal appendages of the male are more or less like those of *O. macrocera* (*vide* p. 419 and text-figure 17 *b*, *b'*). There is no deep incision separating the two lobes at the tip, though the lobes



TEXT-FIG. 18.—*Ocypoda cordimana*. Desmarest. *a.* First left pleopod of male : $\times 5$.
b. Tip of the same enlarged : $\times 20$.

are better differentiated than in the other species. The condition is more or less intermediate between *O. ceratophthalma* and *O. macrocera*.

O. cordimana occurs very commonly in the eastern part of the Indo-Pacific area. There is a large number of specimens of the species in the collection of the Indian Museum from various localities in the Bay of Bengal, but none from the Arabian Sea. Balss gives the range of distribution as Tahiti to the Red Sea. The species is frequently met with in Japan also.

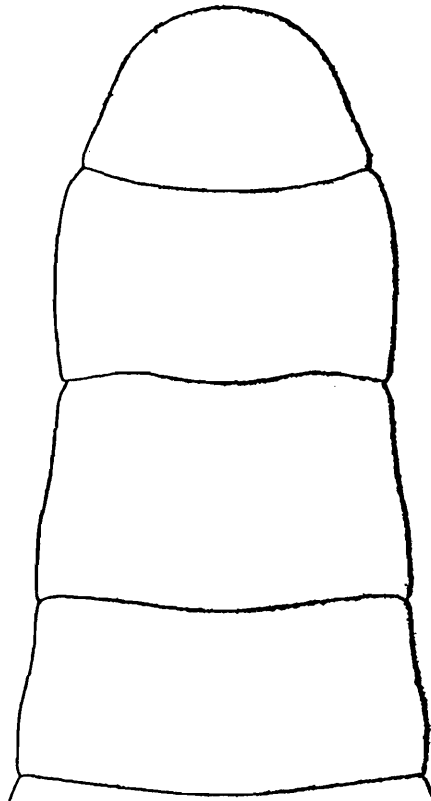
Gelasimus¹ triangularis A. Milne-Edwards.

1900. *Gelasimus triangularis*, Alcock, *Journ. As. Soc. Bengal* LXIX, pp. 356, 357.

1937. *Gelasimus triangularis*, Tweedie, *Bull. Raffles Mus. Singapore* XIII, p. 144, fig. 1c.

A single male specimen of this species was collected by Drs. Prashad and Chopra in Bockachaung, a small freshwaters tream near Mergui. The specimen, which is quite typical, has a carapace length of 6·5 mm., carapace breadth of 11·5 mm. and the large hand is 13·2 mm. long.

The male abdomen in this species is as shown in text-figure 19. The fifth segment is somewhat broader than long, and is appreciably



TEXT-FIG. 19.—*Gelasimus triangularis* A. M.-Edw.

Terminal part of male abdomen : $\times 17$.

longer than the fourth and the sixth segments. The seventh segment is semicircular. The anterior pleopod of the male has been figured by Tweedie.

G. triangularis is a very common species in the Bay of Bengal and is known to extend up to New Caledonia in the east.

¹ We agree with Miss Gordon that the name *Galasimus* should be retained for the Fiddler-crab in preference to *Uca* Leach : see Gordon, *Mem. Mus. Roy. Hist. Nat., Belgique* III, Fasc. 15, p. 10, foot-note (1934).

Gelasimus marionis (Desmarest).

1900. *Gelasimus Marionis* and var. *nitidus*, Alcock, *Journ. As. Soc. Bengal* LXIX, pp. 359, 360.
 1918. *Uca marionis*, Tesch, *Siboga Exped. Rep.* XXXIXc, pp. 38, 39.
 1922. *Uca marionis nitidus*, Balss, *Arch. Naturgesch.* LXXXVIII, p. 143.
 1937. *Gelasimus marionis* and var. *nitidus*, Tweedie, *Bull. Raffles Mus.* XIII, pp. 143, 144, fig. 1 d, e.

Tesch has shown that *Gelasimus nitidus* of Dana, or the variety *excisa* Nobili of the species *marionis*, as it should be called, is only a claw-variation of Desmarest's species and as such should not be recognised as distinct from the *forma typica*. This view is further confirmed by Tweedie who failed to find any significant differences between the abdominal appendages of the male in the two forms. According to Tweedie it is probably a case of "geographically local dimorphism confined to the males"; the females in the two forms are inseparable.

Five large males and a female of this species were collected by Drs. Prashad and Chopra on beach at low tide at Palaiow on the east coast of Doung Island in the Mergui Archipelago. The species is represented in the Museum collection by a large number of examples from the Bay of Bengal and some from the Arabian Sea. Balss gives the range of distribution of the species from Samoa and Fiji Island to the east coast of Africa and the Red Sea.

Gelasimus manii (Rathbun).

1900. *Gelasimus acutus*, Alcock, *Journ. As. Soc. Bengal* LXIX, pp. 360, 361.
 1918. *Uca manii*, Tesch, *Siboga Exped. Rep.* XXXIXc, p. 38.
 1937. *Gelasimus manii*, Tweedie, *Bull. Raffles Mus. Singapore* XIII, p. 143, fig. 1 b.

Miss Rathbun has shown (see Tesch, *loc. cit.*) that *Gelasimus acutus* of de Man and Alcock is not the same form as *Gelasimus acutus* of Stimpson, which is synonymous with *G. dussumieri* Milne-Edwards. For de Man's form she has given the name of *Uca manii*.

G. manii is represented in our collection by a large number of specimens from Maungmagan and some from Bockachaung, a freshwater stream near Mergui. All the specimens are typical, agreeing very closely with the descriptions of de Man and Alcock, as also with examples named by them.

The front measured between the bases of the eye-stalks is about one-twelfth of the greatest breadth of the carapace, but rarely it is a little narrower than this even. Tweedie has figured an anterior pleopod of the male.

The species is known from both the coasts of India, but is most common in the Bay of Bengal.

Subfamily *SCOPIMERINAE*.**Dotilla intermedia** de Man.

1919. *Dotilla intermedia*, Kemp, *Rec. Ind. Mus.* XVI, pp. 331-333.

Three male examples referable to the present species were found mixed with specimens of *Ocypoda macrocera* collected by Prof. Meggitt at Maungmagan. Two of these are mutilated, but the third has most of the legs intact.

The specimens agree closely with the description of *D. clepsydrodactylus* Alcock¹ or with that of "high" males of *intermedia*, as described by Kemp. As Kemp has shown these species are synonymous. We have compared our examples with the named material, including types of the two species, in our collection.

D. intermedia is represented in the collection of the Indian Museum by a large number of specimens from the Mergui and Tavoy coasts of Burma and the Orissa coast of India. To our knowledge the species has not been recorded from any locality outside the Bay of Bengal.

Subfamily *MACROPHTHALMINAE*.

Macrophthalmus telescopicus (Owen).

1900. *Macrophthalmus Verrauxi*, Alcock, *Journ. As. Soc. Bengal* LXIX, p. 377.
 1915. *Macrophthalmus telescopicus*, Tesch, *Zool. Meded. Leiden Mus.* I, pp. 161-164, pl. v, fig. 2.
 1919. *Macrophthalmus telescopicus*, Kemp, *Rec. Ind. Mus.* XVI, pp. 387, 388, pl. xxiv, figs. 10, 11.
 1934. *Macrophthalmus telescopicus*, Sakai, *Sci. Rep. Tokyo Bunrika Daigaku* (B) I, p. 320, pl. xviii, fig. 2.
 1934. *Macrophthalmus telescopicus*, Balss, *Faune des Colonies Francaises V*, p. 522.

Two female specimens, one of which is ovigerous, collected by Drs. Prashad and Chopra on beach at low tide at Palaiow on the east coast of Doung Island, Mergui Archipelago are referable to the present species.

Kemp and Tweedie² have suggested that Tesch's *M. telescopicus* may possibly consist of more than one species. Both these authors have shown that in the characters of the male chela and in some other respects the species, as understood by Tesch, is not quite homogeneous.

M. telescopicus is represented in the Museum collection by examples from Mergui, Tavoy, Andamans, Gulf of Manaar and the Red Sea. The species has a very wide range of distribution extending from Hawaiian Islands in the Pacific to the east coast of Africa and the Red Sea. It has been met with in a number of localities in Japan also.

Macrophthalmus convexus Stimpson.

1900. *Macrophthalmus convexus*, Alcock, *Journ. As. Soc. Bengal* LXIX, pp. 378, 379.
 1915. *Macrophthalmus convexus*, Tesch, *Zool. Meded. Leiden Mus.* I, pp. 175-178, pl. vii, fig. 8.
 1919. *Macrophthalmus convexus*, Kemp, *Rec. Ind. Mus.* XVI, pp. 389, 390, pl. xiv, fig. 2.

Two somewhat mutilated examples of the present species are in Prof. Meggitt's first collection from Maungmagan. They appear to be typical in every respect.

As stated by Tesch the carapace length in young individuals is distinctly more than half of the carapace breadth. Similarly the front appears to be somewhat broader in young specimens than in the adult forms.

¹ Alcock, *Journ. As. Soc. Bengal* LXIX, p. 367 (1900); *Ill. Zool. Investigator, Crust.*, pl. lxiii, figs. 2, 2a (1905).

² Tweedie, *Bull. Raffles Mus. Singapore* XIII, pp. 164, 165 (1937).

There are specimens of *M. convexus* in the Museum collection from Mergui, Andaman Islands and the Gulf of Manaar. The species is restricted to the eastern part of the Indo-Pacific area only, being known from the Hawaiian Islands and Tahiti on the east to the Gulf of Manaar between India and Ceylon on the west. It has been recorded from Japan also.

Macrophthalmus erato de Man.

1900. *Macrophthalmus erato*, Alcock, *Journ. As. Soc. Bengal* LXIX, pp. 381, 382.
 1915. *Macrophthalmus erato*, Tesch, *Zool. Meded. Leiden Mus.* I, pp. 179-181, pl. viii, fig. 9.
 1919. *Macrophthalmus erato*, Kemp, *Rec. Ind. Mus.* XVI, p. 390.
 1936. *Macrophthalmus eratus*, Shen, *Contrib. Inst. Zool. Nat. Acad. Peiping* III, pp. 70, 71.

There are seven specimens of the present species in Drs. Prashad and Chopra's collection from Mergui. Six of these are females (two ovigerous) and one young male.

The lower margin of the orbit has a very characteristic shape in this species. The claw in the male, as described by de Man¹ in detail, differs considerably from that of the female, but in some young males that we have examined from the Museum collection the claw is more or less of the female type. In a young male example from Chandipur on the Orissa coast (carapace length 4.75 mm., carapace breadth 6.5 mm.) the fingers are almost as long as the palm and have no lobe-like teeth on the cutting edges, all the teeth being minute and more or less uniform and the spine on the inside of the palm is hardly noticeable. As in all the females, there is a strongly-marked ridge on the outer surface of the palm more or less parallel to the lower border and running almost up to the tip of the fixed finger; this ridge is faintly discernable on the fixed finger in large males even. In another male of about the same size from the same locality the claws are typically like those of the male. In a third male (carapace breadth 6.5 mm.) from Jack and Una Island in the Mergui Archipelago the claws are still more interesting, for they are intermediate between the male and the female types. The fingers are longer than is usually the case in the male, the lobes on the cutting edges are less well developed and the ridge on the palm, though fainter than it is usually in the female, is fairly well marked throughout. The inner surface of the palm is less hairy and the spine is altogether absent.

In two very small males from Chandipur (carapace breadth less than 5 mm.) the claws are definitely of the female type.

In the single male example in the present collection (carapace breadth 5.3 mm.) the fingers are as long as the palm and are not arched; the teeth are minute and uniform; the muscular crest, the spine on the inner surface of the palm and the usual pad of hairs are suppressed; and the ridge near the lower border of the palm is strongly marked up to the tip of the fixed finger. All these characters are typical of the female chela.

¹ de Man, *Journ. Linn. Soc. London (Zool.)* XXII, pp. 125-129, pl. viii, figs. 12-14 (1887-1888).

It is thus seen that in the young examples of *M. erato* the claws are of one type only and that whereas this type is retained by the females throughout life, in males after attaining a carapace breadth of 6 mm. or a little more, a differentiation into what ultimately becomes the "male type" starts appearing.

Tweedie¹ has recorded the occurrence of the species in "burrows consisting of the bark of a buried mangrove twig from which the wood had rotted away"

There is a large number of specimens of *M. erato* in the collection of the Indian Museum; all of these are from the Bay of Bengal. The species extends from Java and the Chinese coast on the east to the Orissa coast in India on the west.

Family GRAPSIDÆ.

Subfamily GRAPSINÆ.

Grapsus strigosus (Herbst).

1900. *Grapsus strigosus*, Alcock, *Journ. As. Soc. Bengal* LXIX, pp. 393, 394.
 1918. *Grapsus strigosus*, Tesch, *Siboga Exped. Rep.* XXXIXc, pp. 71-74, pl. iv, figs. 1 and 4.
 1922. *Grapsus strigosus*, Balss, *Arch. Naturgesch.* LXXXVIII, Heft 11, p. 147.

A large number of specimens of this species are in all the three collections under report.

Alcock and Tesch have enumerated the differences between this species and the closely allied *Grapsus grapsus* (Linn.). Our specimens are all typical examples of the present species.

In young individuals the length of carpus and propodus of the walking legs is more than the length of the merus; in older individuals, however, the two are generally equal.

Grapsus strigosus is a very common species in the Indian coastal waters, both in the Bay of Bengal and the Arabian Sea. It has a very wide range over the entire Indo-Pacific region, being met with from Polynesia to the east coast of Africa. The species possibly extends to the west coast of America² also.

Subfamily VARUNINÆ.

Varuna litterata (Fabricius).

1900. *Varuna litterata*, Alcock, *Journ. As. Soc. Bengal* LXIX, pp. 401, 402.
 1922. *Varuna litterata*, Balss, *Arch. Naturgesch.* LXXXVIII, Heft 11, pp. 149, 150.

Only one female specimen of this widely-distributed species is in the first collection of Prof. Meggitt from Maungmagan. The species is met with in large numbers in estuaries and backwaters along the Indian coasts, and is frequently collected in places where the water is even quite fresh. Kemp³ has described the "modes of invasion" of this

¹ Tweedie, *Bull. Raffles Mus. Singapore* XIII, p. 164 (1937).

² Rathbun, *Bull. U. S. Nat. Mus.*, XCVII, p. 231 (1918).

³ Kemp, *Mem. Ind. Mus.* V, pp. 232, 233 (1915).

species in order to establish itself in fresh water in the neighbourhood of Calcutta. The species has been frequently collected in the open sea also.

V. litterata has a very wide range of distribution; Balss gives it as: "In See-und Süßwasser, von der Ostküste Africa (nicht im roten Meere) bis zur Südsee; im eigentlichen Pazifik seltener."

Subfamily *SESARMINAE*.

Sesarma (Sesarma) taeniolata White.

1900. *Sesarma taeniolatum*, Alcock, *Journ. As. Soc. Bengal* LXIX, pp. 419, 420.
 1917. *Sesarma (Sesarma s. s.) taeniolata*, Tesch, *Zool. Meded. Mus. Leiden* III, pp. 201-203, pl. xvi, fig. 3.
 1936. *Sesarma (Sesarma) taeniolata*, Tweedie, *Bull. Raffles Mus. Singapore* XII, p. 53.

A single male specimen, perhaps not fully grown, of this species is in Prof. Meggitt's first collection from Maungmagan.

The specimen shows all the characters enumerated by Tesch. The upper border of the arm ends in a somewhat blunt tooth. The distance between the external orbital angles of the carapace equals the distance between the epibranchial teeth. The breadth of the meropodites of the walking legs is a half or a little more than half of their length. The "tympana" mentioned by Tesch can only be faintly made out in the usual position.

Sesarma taeniolata is represented in the Indian Museum collection by specimens from the Bay of Bengal only. The species seems to be restricted to the eastern part of the Indo-Pacific region only.

Sesarma (Parasesarma) prashadi, sp. nov.

(Plate VI, figs. 5-7.)

The carapace is for the most part flat, though it is slightly convex in a longitudinal direction in the anterior part. The branchial regions, as usual, slope strongly downwards towards the margins. The regions are fairly well demarcated; the mesogastric lobe forms an independent convexity, with the anterior narrow longitudinal projection running forward for a short distance. The intestinal region also forms a convexity. There are seven or eight prominent oblique ridges, rather than striations, on the epibranchial regions, each ridge being microscopically beaded. The surface of the carapace is smooth, there being only a few low and blunt tubercles, with short, stiff hairs on them, scattered on the surface. The four post-frontal lobes run in almost a straight line; the inner lobes are about twice as broad as the outer lobes. The two inner lobes are separated from one another by a deep longitudinal groove, which runs for a considerable distance backwards. The groove between the outer and the inner lobes on each side is broad and V-shaped and is much shorter than the groove between the median lobes. All the four lobes are anteriorly rounded and those of the median pair are minutely rugose on the anterior aspect.

The carapace is distinctly broader than long, the median length being about three-fourths of the distance between the outer orbital angles, where the carapace is the broadest. The sides are somewhat convergent posteriorly, the breadth of the carapace at the postero-lateral angles being less than that at the outer orbital angles. The sides are straight in the anterior part, somewhat concave about the middle and bulge outwards posteriorly. The margins are entire and there is no tooth behind the acute external orbital angle; the latter is directed outwards and somewhat forwards.

The front (Plate VI, fig. 6), as usual, is very much deflexed. Its sides are more or less parallel and the anterior angles are broadly rounded. In dorsal view the anterior margin of the front forms a broad and shallow depression in the middle, with an anteriorly convex lobe on either side. Just close to the margin of each lobe there is a transversely oval tubercle with a single short stiff hair on it. In frontal view the anterior margin of the front is straight or slightly convex.

The orbits are markedly slanting. From the inner supra-orbital angle the upper orbital border comes more or less directly backwards, but from about the level of the posterior limit of the thick eye-stalk it runs backwards and outwards, in its last part, near the lateral margin of the carapace the orbital border runs directly outwards. For the most part this border forms a broad regular curve, but a portion about the middle is somewhat convex. The lower orbital border is prominent, and a part of it is visible in dorsal view. The lower border is finely beaded.

The chelipeds are unequal, that on the right side being distinctly longer and stouter than that on the left. The arm is trigonous, with all the three border cristiform and beaded. The outer surface of the arm is covered with squamiform granules, while the inner and lower surfaces are smooth. The inner border is distally expanded and terminates in a large, broad-based and pointed spine. There is no subterminal spine on the upper border. The outer surface of the wrist is only faintly granular, though it has squamiform markings; the inner angle is broad and obtuse. The palm is swollen and is markedly high, the length of the propodus (palm and fixed finger) along the lower margin being only one and a half times of its height. The upper border is very short and finely beaded. The outer surface of the palm is quite smooth, though there are a few indistinct squamiform markings arranged in irregular lines near the carpal joint, and a few stiff hairs scattered about. The inner surface is more or less smooth with a few isolated granules scattered in the distal portion. The lower border of the palm is denticulate, the denticulation extending up to about the middle of the fixed finger. The usual chitinous pectinated ridges are arranged transversely near the upper border of the palm, and more or less parallel to its posterior border. The anterior or the distal-most ridge is quite straight, the second is somewhat sinuous, while the third, which is more or less obsolete, consists of only a few pectinations and some granules. The teeth in the first ridge are so closely arranged, more or less like the teeth of a very fine comb, that it is difficult to count them, but there appear to be at least 40 of these. In the second ridge the teeth are

less high and their number is also smaller. The fingers are stout and gape only slightly at the base. The lower border of the fixed finger is somewhat concave near the base. The dactylus is as long as the height of the palm and tapers gradually towards the tip. The cutting edge has seven or eight blunt teeth, the proximal-most of which is the largest. The fixed finger has only five teeth arranged on about the distal half of the cutting edge and, as in the dactylus, the most proximal tooth is the largest. The tips are broadly pointed, hollowed and almost spoon-shaped. The outer surface of the dactylus is profusely granular near the base. On the upper border of the dactylus (Plate VI, fig. 7), slightly on the outer aspect, there is the usual row of transverse tubercles extending from the base to almost the tip. Each tubercle, except in the distal part, is in the form of a narrow oval dome, with a median, somewhat smooth longitudinal ridge. The tubercles are quite symmetrical with respect to their long axes. Near the base of the finger they are small and crowded together, but the distance between them increases distally and near the tip they again become small, almost squarish and are widely separated from one another. The most distal ones, quite close to the tip, are indistinct, but 27 of them can be counted on the large claw. On the inside of this row of tubercles the basal half of the upper border of the dactylus is densely studded with largish granules. The smaller chela differs from the larger one only in size.

The merus of the walking legs is broad, that of the third pair being two and a half times as long as broad. The posterior margin of the merus is entire, but the anterior has a subterminal sharp spine. In the first three pairs the merus has prominent squamiform markings on the upper surface. The carpus has two, more or less, longitudinal ridges on its upper surface, one about the middle and the other close to the anterior margin. The propodus also has one ridge running obliquely from about the middle at the proximal end to the posterior margin at the distal end. The dactylus is large and sharply pointed; in the first three legs it is almost as long as the propodus, but in the last leg it is longer than the preceding segments. The last three segments are sparsely clothed with short stiff hairs on the margins.

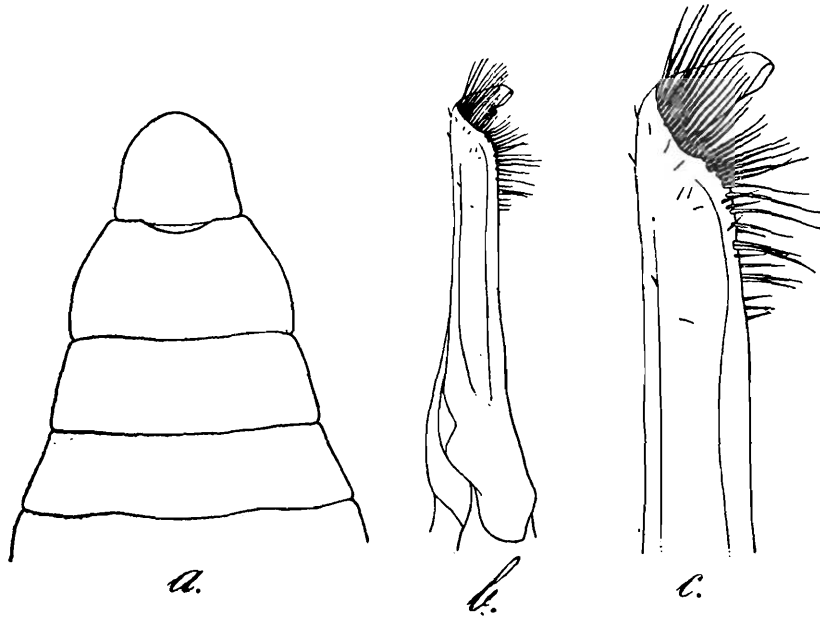
As usual in the genus the abdomen of the male (text-figure 20a) is somewhat broad and occupies the whole breadth of the sternum between the bases of the last legs. The terminal segment is short and broadly rounded; its basal breadth is a little more than its median length. The sixth segment is very slightly shorter than the seventh and is almost half as long as its breadth at the posterior margin. The fifth segment is shorter than the sixth and its posterior breadth is a little less than three times of its median length. The sides of the abdomen are somewhat concave.

The anterior abdominal appendages of the male are rather short and stout and the tip is sharply bent outwards. There is a dense growth of long hairs on the outer margin behind the tip.

The carapace and legs in the single specimen preserved in spirit that we have examined are of a dull mottled purplish colour; the chelipeds are pale and the fingers light orange. The sternum and the ventral surface of the legs are lighter than the dorsal surface.

Type-specimen.—C 2296/1, Zoological Survey of India (*Ind. Mus.*).

Locality.—The single specimen on which the present species is based was collected in a small freshwater stream, quite near the sea-shore, at Kamachaung, a small village on the east coast of Doung Island in the



TEXT-FIG. 20.—*Sesarma (Parasesarma) prashadi*, sp. nov.

a. Terminal part of male abdomen : $\times 7$. b. First left pleopod of male : $\times 13$, c. Tip of the same enlarged : $\times 30$.

Mergui Archipelago, by Drs. B. Prashad and B. N. Chopra on 19th January, 1937. The water at the place where the specimen was obtained tasted quite sweet, but may possibly have been subject to the influence of the tides.

The measurements, in millimetres, of the male specimen of *S. prashadi* are given below, and, for purposes of comparison, the corresponding measurements of a male specimen of *S. plicata* (Latreille) from Burma are included.

	<i>S. prashadi</i>	<i>S. plicata</i>
	♂	♂
Length of carapace	9.2	10.5
Distance between external orbital angles	12.2	13.2
Distance between postero-lateral angles of carapace	10.3	12.0
Breadth of front	6.3	7.5
Breadth of carapace at posterior margin	5.1	6.3
Length of palm and fixed finger (larger claw) along lower border	9.3	7.8
Height of palm (larger claw)	6.1	4.4
Length of dactylus (larger claw) along upper border	6.1	4.8
Length of upper border of palm (larger claw)	3.9	2.8
Length of merus of 3rd walking leg	7.8	8.5
Breadth of merus of 3rd walking leg	3.2	3.8
Median length of 5th abdominal somite of male	1.4	1.7
Posterior breadth of 5th abdominal somite of male	4.0	4.6
Median length of 6th abdominal somite of male	1.6	1.7
Posterior breadth of 6th abdominal somite of male	3.3	3.9
Median length of 7th abdominal somite of male	1.7	2.3
Posterior breadth of 7th abdominal somite of male	1.9	2.3

That *Sesarma prashadi* belongs to the subgenus *Parasesarma* of de Man is clearly seen by the fact that the lateral margins of the carapace are not dentate behind the external orbital angles, that the upper surface of the palm has two or three transversely arranged pectinated ridges, and that the upper border of the dactylus has a row of transverse tubercles. In the key given by Tesch¹ for the identification of the Indo-Pacific species of *Parasesarma* the present species—in so far as there are no spines on the posterior border of the meropodites of the walking legs, the sides of the carapace converge distally and the tubercles on the upper border of the dactylus are symmetrical with respect to their long axes—seems to come close to *Sesarma plicata* (Latreille), which name Tesch,² presumably on the authority of Miss Rathbun, has given to the species so far known to most carcinologists as *Sesarma quadratum* (Fabricius). There are, however, some noteworthy differences between these two species. In the new species the carapace is a little more convex, the regions are a little more distinct, the outer post-frontal lobes are considerably smaller than the inner and the front, as compared with the carapace breadth, is a little narrower. Further the upper margin of the arm does not end in a spine, the inner angle of the wrist is broader than in *plicata*, the palm is considerably higher, its outer surface is less granular and the inner less tuberculate. The number of teeth in the pectinated ridges on the palm is also very much larger in the new species. The number of tubercles on the upper border of the dactylus is about 27 in our species, whereas in *S. plicata* there are usually 12-14 tubercles, though the number may vary between 11 and 18 or even rarely 19. The proportions of the last three abdominal segments of the male are also different in the two species and the anterior male abdominal appendages are not quite similar. A comparison of the measurements of *S. prashadi* with those of *S. plicata* given on p. 429, and of the figures of the male abdomens and the male appendages of the two species will bring out most of these points.

In having 20 or more tubercles on the upper border of the movable finger the present species shows some resemblance to *S. erythroductyla* (Hesse)³ and *S. bataviana* de Man.⁴ In both these species, however, the tubercles are not symmetrical with respect to their long axes and are prominently striated longitudinally. There are several other differences also. *S. melissa* de Man⁵ has also a superficial resemblance with *S. prashadi*, but besides other differences, the number of tubercles on the dactylus in de Man's species, is smaller and the tubercles are asymmetrical. In *Sesarma (Parasesarma) obliquifrons* Rathbun⁶, described from Samoa, the general shape of the front and the hands is more or less like that in our new species, but the differences between the two species are far more numerous than these points of superficial similarity.

¹ Tesch, *Zool. Meded. Mus. Leiden* III, pp. 251-255 (1917).

² Tesch, *op. cit.*, pp. 187-190; see foot-note 3 on p. 187.

³ See Tesch, *op. cit.* p. 149 (1917).

⁴ See Tesch, *op. cit.*, p. 132.

⁵ See Tesch, *op. cit.*, p. 174.

⁶ Rathbun, *Proc. Biol. Soc. Washington* XXXVII, pp. 127, 128 (1924).

S. prashadi seems to show the closest resemblance to the species recently described by Tweedie¹ under the name *Sesarma* (*Parasesarma*) *rutilimana* from a small island near Singapore. The points of similarity are clearly seen by comparing our description of the new species with that given by Tweedie for his. There are, however, some noteworthy differences between the two. *S. prashadi* appears to be a somewhat broader form than the Singapore species and, unlike the latter, has unequal chelipeds. There are three (two distinct and one obsolete) pectinated ridges on the outer surface of the palm and the first of these has over 40 teeth; in Tweedie's species there is only one ridge having rather more than 20 teeth. Further the tubercles on the dorsal surface of the distal half of the movable finger, in *S. rutilimana*, become elongated, asymmetrical, with the longer proximal slopes striated; in our species they become squarish distally, but, are all symmetrical and are not striated. The colouration of the two species is also markedly different. The two species in our opinion, in spite of their very close similarity, must, therefore, be considered distinct.

***Sesarma* (*Chiromantes*) *bidens* (de Haan).**

1900. *Sesarma bidens*, Alcock, *Journ. As. Soc. Bengal* LXIX, p. 415.
 1917. *Sesarma* (*Chiromantes*) *bidens*, Tesch, *Zool. Meded. Mus. Leiden* III, pp. 132-135.
 1922. *Sesarma* (*Chiromantes*) *bidens*, Balss, *Arch. Naturgesch.* LXXXVIII, Heft 11, p. 156.

In our collection there are examples of the present species from Maungmagan (Prof. Meggitt's first collection) and from a fresh-water stream near Mergui (Drs. Prashad and Chopra). The specimens are quite typical.

In the Museum collection there are specimen of *S. bidens* from a number of localities in the Bay of Bengal. The species has a very wide range of distribution being known from Australia and New Guinea to the east coast of Africa. It is one of the commonest species of *Sesarma* in Japan.

***Clistocoeloma merguiense* de Man.**

1900. *Clistocoeloma merguiense*, Alcock, *Journ. As. Soc. Bengal* LXIX, p. 429.
 1917. *Clistocoeloma merguiense*, Tesch, *Zool. Meded. Mus. Leiden* III, p. 222.
 1936. *Clistocoeloma merguiense*, Tweedie, *Bull. Raffles Mus. Singapore* XII, p. 68.

A single specimen referable to de Man's species is in the present collection. It was collected in a small fresh-water stream on a small Island in the Mergui Archipelago. The place from which the specimen was obtained is probably subject to a certain extent to tidal influence.

C2297/1 A small fresh-water stream at Kama- Drs. B. Prashad and 1 ♂
 chaung on the east coast of Doung B. N. Chopra, 19th
 Island, Mergui Archipelago Jan., 1937

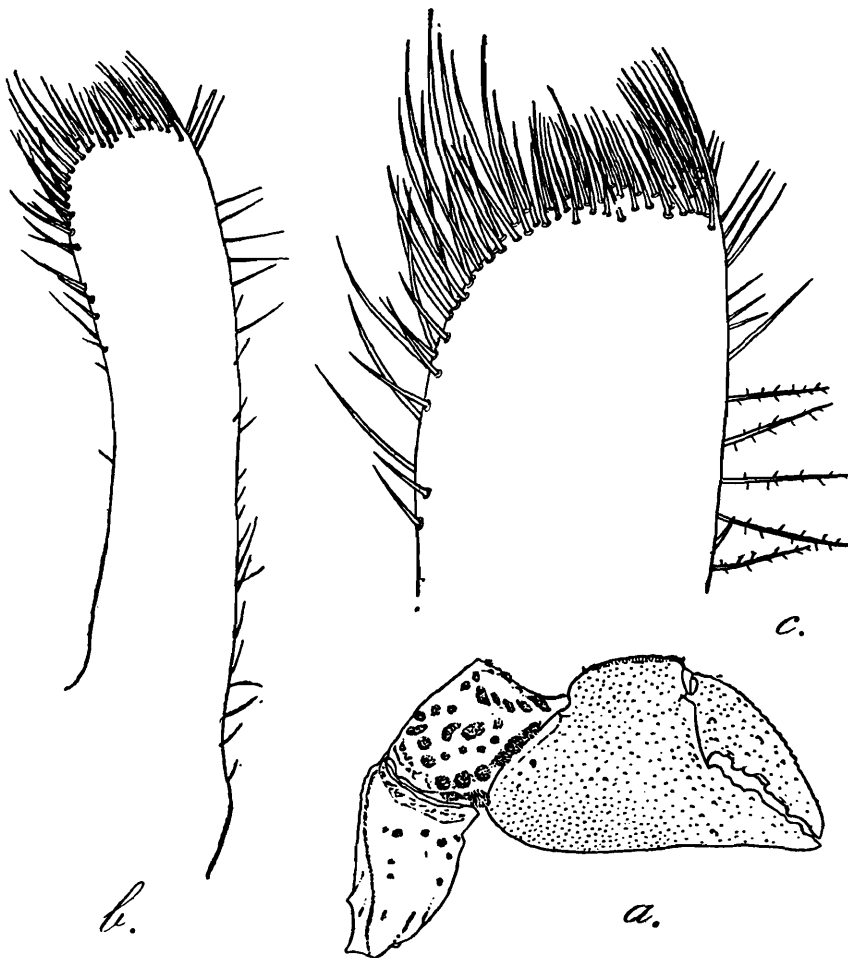
The specimen agrees very closely with the detailed description given by de Man,² as also with the named examples in the Museum collection

¹ Tweedie, *Bull. Raffles Mus. Singapore* XII, pp. 63-65, pl. xv, fig. 2 (1936).

² de Man, *Journ. Linn. Soc. London (Zool.)* XXII pp. 195, 196, pl. xiii, fig. 10 (1888).

identified by Alcock. The key given by Tesch (*op. cit.*, p. 259) for the recognition of this species is very helpful. The abdomen of the male, as mentioned by de Man, is very much like that of *C. balansae* A. M.-Edwards.¹ the genotype, and differs considerably from that *C. tectum* Rathbun, as described and figured by Tesch (*op. cit.*, pp. 224, 225, pl. xvii, fig. 3c). The chelipeds in our specimen are also as described by de Man.

The anterior male appendages are as shown in the accompanying text-figure. They are short and stumpy and are broadly truncate at the tip, which is densely hairy.



TEXT-FIG. 21.—*Clistocoeloma merguiense* de Man.

a. Cheliped of male : $\times 3\frac{3}{4}$. b. Anterior left pleopod of male : $\times 22$. c. Tip of the same enlarged : $\times 47$.

The measurements, in millimetres, of the Mergui specimen are as given below :—

Length of carapace	...	...	...	11.3
Distance between external orbital angles	...	...	...	12.8
Breadth of front	...	...	...	8.2
Length of claw (palm and fixed finger) along lower border	...	...	...	9.2
Height of palm	...	...	...	6.0
Length of dactylus along upper border	...	...	...	6.1
Median length of 4th abdominal somite of male	...	...	...	1.3
Median length of 5th abdominal somite of male	...	...	...	1.6
Median length of 6th abdominal somite of male	...	...	...	1.4
Posterior breadth of 6th abdominal somite of male	...	...	...	4.1
Median length of 7th abdominal somite of male	...	...	...	2.8
Posterior breadth of 7th abdominal somite of male	...	...	...	2.2

¹ A. Milne-Edwards, *Nouv. Arch. Mus. Paris IX*, p. 311, pl. xvii, fig. 1 (1873).

C. merguiense is known mostly from the Bay of Bengal only, having been recorded from Penang, Mergui Archipelago and Nicobar Islands; the only record outside the Bay is that of de Man from Amboina Island.

Owing to the carapace being "symmetrically and boldly lobulated" Tesch (*loc. cit.*, foot-note) is of the opinion that the specimens which Alcock referred to *C. balansae* really belong to Miss Rathbun's *C. tectum*. We have carefully re-examined these specimens and though we have no examples of *C. tectum* to compare them with, we have checked them with the published descriptions of the species and especially with the detailed account given by de Man.¹ We are of the opinion that Alcock's specimens cannot be referred to *C. tectum* and that they have been rightly identified as *C. balansae*. In the form of the upper orbital border and the proportion of the abdominal segments of the male, to mention only the two characters especially stressed by Tesch for the identification of the species of *Clistocoeloma*, the Indian Museum specimens show their close similarity with Milne-Edward's species. We give here a figure (text fig. 15*d*, p. 414) and measurements, in millimetres, of the male abdomen of one of Alcock's specimens of *C. balansae*, and a comparison of these with the similar figure and measurements of *C. tectum* given by Tesch will show that they are not referable to Miss Rathbun's species. The curvature in the upper orbital border is perhaps not so well pronounced as mentioned by de Man, but it can still be clearly seen.

Median length of 4th abdominal segment of male ...	...	1.6
Median length of 5th abdominal segment of male ...	...	1.9
Median length of 6th abdominal segment of male ...	...	1.7
Posterior breadth of 6th abdominal segment of male	...	4.5
Median length of 7th abdominal segment of male ...	...	3.2
Posterior breadth of 7th abdominal segment of male	...	2.4

In the character of the lobulation of the carapace, it must be admitted that Alcock's specimen of *C. balansae* comes very close to *C. tectum*. The number and arrangement of the tubercles on the dorsal surface of the carapace in the Indian Museum specimens is more or less identical with that described and figured by Tesch for *C. tectum*. The length of the carapace also equals the distance between the outer orbital angles and the outer post-frontal lobe is subdivided into two by a longitudinal fissure, but these characters, as mentioned by Tesch, are common to both the species.

Metaplax dentipes (Heller).

1900. *Metaplax dentipes*, Alcock, *Journ. As. Soc. Bengal* LXIX, pp. 433, 434.
 1918. *Metaplax dentipes*, Tesch, *Siboga Exped. Rep.* XXXIXc, p. 117, foot-note.

Two males of this species are in Prof. Meggitt's first collection from Maungmagan and four males were collected by Drs. Prashad and Chopra in Bockachaung, a freshwater stream near Mergui.

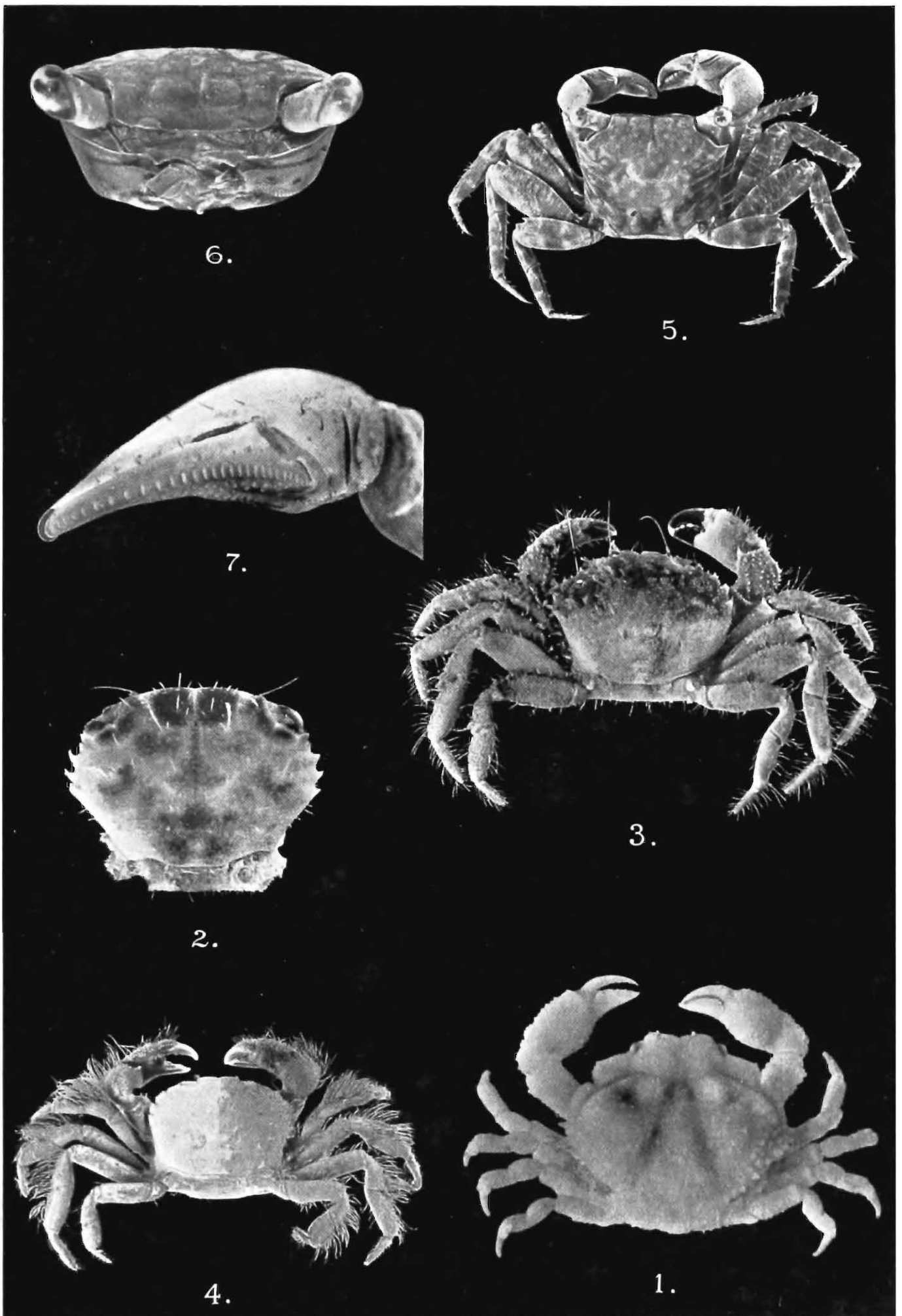
¹ de Man, *Zool. Jahrb. Syst.* IX, pp. 340-343 (1896).

The specimens agree very closely with our named examples. The dactylus of the chelipeds may sometimes be a little longer than the upper border of the palm. In one example from Maungmagan the chelae are unequal.

Metaplex dentipes is a common coastal form in the Bay of Bengal. Tesch gives its distribution as the Gulf of Siam, Mergui Archipelago, Ceylon and the Indian (eastern) coast.

EXPLANATION OF PLATE VI.

- FIG. 1.—*Heteronucia mesanensis* Rathbun, dorsal view of the female specimen from Mergui : $\times 8$.
- FIG. 2.—*Chlorodiella niger* (Forskäl), dorsal view of the carapace of a young female : $\times 7$.
- FIG. 3.—*Pilumnus longicornis* Hilgendorf, dorsal view of a specimen from Mergui : $\times 2$.
- FIG. 4.—*Litocheira angustifrons* Alcock, dorsal view of a male specimen from Karachi : $\times 1\frac{1}{2}$. One side of the carapace has been denuded.
- FIG. 5.—*Sesarma* (*Parasesarma*) *prashadi*, sp. nov., dorsal view of the type specimen : $\times 2$.
- FIG. 6.—Frontal view of the carapace of the same : $\times 4$.
- FIG. 7.—Large cheliped of the same : $\times 7$. The arrangement of the tubercles on the dactylus is seen.



Subodh Mondul Photo

CRABS FROM TAVOY AND MERGUI.

Photo.-Litho. Office. Survey of India

STRUCTURE, HABITS AND EARLY DEVELOPMENT OF A NEW SPECIES OF *STILIGER* EHRENBERG.

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(From the University Zoological Research Laboratory, Madras.)

(PLATES VII—IX.)

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INTRODUCTION.

While engaged in faunistic studies of the brackish waters of Madras, Professor R. Gopala Aiyar drew my attention to the occurrence of a small Eolid-like Mollusc. An examination of the brackish water pools near the mouths of the rivers Cooum and Adyar in Madras during August and September 1935, revealed this tiny Mollusc creeping on algae floating in the waters. A careful study of its external characters and anatomy convinced me that it was a new species of the genus *Stiliger* Ehrenberg, and a preliminary note on this form was read by me before the Zoology Section of the Indian Science Congress held at Indore in the month of January 1936.

Though the genus was discovered as early as 1831, our knowledge of its anatomy is incomplete in most respects while nothing is known about its life-history. I have therefore given in this paper a full description of the external morphology and internal anatomy of this new form, which I have named *Stiliger gopalai*, sp. nov., and a brief account of the bionomics and development. *Stiliger gopalai* is a hardy form and affords good scope for study under laboratory conditions. Captivity affects neither its normal activities nor its breeding habits.

The species is named after Professor R. Gopala Aiyar, Director of the University, Zoological Research Laboratory, Madras, to whom I express my warmest gratitude for his unfailing help and kind encouragement throughout this work. I wish to express my thanks to Dr. Baini Prashad, Director of the Zoological Survey of India, and Dr. H. S. Rao for having kindly gone through the manuscript and made useful suggestions; and my indebtedness to the Syndicate of the Madras University for the award of a Research Studentship.

MATERIAL AND METHODS.

When salinity and temperature conditions were favourable and when the growth of a common alga, *Chaetomorpha*, was abundant, large numbers of the mollusc were collected by a careful search among the algal meshes from the brackish water pools near the mouth of the river Cooum and in the backwaters of Adyar. They continued to be active for a couple of months when kept in large glass vessels containing brackish water and algae (particularly *Chaetomorpha*) brought from their natural habitat. Under these conditions a study of most of its habits, especially the method of feeding, copulation and spawning was made. That these Opisthobranchs shrivel and lose their shape on sudden fixation has been repeatedly stated by previous writers, and it is not necessary therefore to refer to the importance of careful narcotisation prior to fixation for dissection as well as for section cutting. Menthol was used with success as a narcotising agent. As the animals are very small, their anatomical structure was studied by dissections with the aid of a Zeiss binocular microscope and by means of serial sections. Of the several fixatives used, Brasil's modification of Bouin's fluid and corrosive formol gave the best results. For staining, iron haemotoxylin and eosin or Meyer's acid haemalum and eosin were employed. For a study of the early development, water in the dishes was renewed at least twice a day. Some stages of development, in which the various parts were opaque, were fixed in glacial acetic acid and rendered transparent in increasing grades of glycerine for microscopic study. To prevent escape of the minute larvae while the water was changed, the siphon was plugged with a small quantity of cotton wool. Though unfortunately I was not able to observe the actual metamorphosis of the larvae, metamorphosed young ones of varying growth were obtained from the brackish water pools near the mouth of the river Cooum. The growth of these young forms was studied by keeping them in glass vessels containing brackish water and algae. The vessels were wrapped in thin cloth which was kept constantly moist.

HISTORY OF THE GENUS *Stiliger*.

For a tiny Opisthobranch mollusc found in the Red Sea, Ehrenberg¹ erected the genus *Stiliger* in 1831 and named the species '*ornatus*' with the following description: "Habitus Eolidae. Corpus oblongum,

¹ Symbolae Physicae—Decas I—1831, as referred by Allman (8), Chenu (17), Bergh (9) and Eliot (26).

Mag. de Zool., 1837, also referred by the above-mentioned authors.

pallio discreto nullo. Latera Corporis branchiarum stiliformium seriebus longitudinalibus instructa. Tentacula duo tantum in medio dorso." Later in 1837 d'Orbigny gave the name *Calliopaea bellula* to an animal whose generic characters were identical with those of *Stiliger*. The description of *Calliopaea bellula* like that of *Stiliger ornatus* is incomplete ; and d'Orbigny not only mistook the rhinophores to be the buccal tentacles, but also made a serious mistake regarding the position of the anus. Milne-Edwards (19) described the digestive apparatus of *Calliopaea bellula* giving the correct position of the anus, but he assumed that the digestive system communicated with the vascular system in the region of the cerata and introduced the term 'gastrovascular system' which later on led to a great controversy. Verany's *Calliopea souleyeti* (60) was described in fair detail by Souleyet (57). Alder and Hancock (6) established that *Calliopaea* of d'Orbigny was identical with *Stiliger* of Ehrenberg. They retained the name *Stiliger* which had six years' precedence over *Calliopaea*, and placed the genus in the family Hermaeidae (synonymous with *Stiligeridae* of O'Donoghue, 1928). Meyer and Moebius in 1865 in their *Fauna der Kieler Bucht* (p. 13) described a similar animal as *Embletonia mariae*. The figures of *Calliopaea bellula* of d'Orbigny and *Embletonia* of Meyer and Moebius agree so closely that the identity of these two forms was first pointed out by Fischer (32) and later by Bergh (9). Bergh referred both these forms to the genus *Stiliger* of Ehrenberg, but he preferred to retain the specific name 'mariae' of Meyer and Moebius. Eliot (22 and 26) opined that, since d'Orbigny's description of the species *C. bellula* has undoubted priority over *E. mariae*, these forms should be named *Stiliger bellulus*, thus retaining the oldest generic and specific names. Eliot also believed that *Stiliger ornatus* might agree with *S. bellulus* but this could not be decided as the specific characters and the nature of the radula still remain unknown in that species. *Calliopaea dendritica* Alder and Hancock has no place in the genus *Stiliger* as it is identical with *Hermaea dendritica*. Loven's *Stiliger modestus* as shown by Allman (8) ceases to be a *Stiliger* and becomes *Alderia modesta*. Kelaart's description of *Pterochilus viridis* (38, p. 492) is too incomplete for recognition of the species, but Eliot (23) referred it to '*Stiliger viridis*.' Hutton's *Calliopaea felina* was redescribed by Eliot (25) as *Stiliger felinus*. Eliot (21) recorded two species, i.e., *Stiliger varians* and *Stiliger irregularis* from the Zanzibar harbour, South Africa, and later (29) described *S. tentaculatus*—the only *Stiliger* with oral tentacles so far known collected by Annandale in Siam. *S. pica* of Annandale and Prashad (56) was yet another species of Hermaeid from the Chilka Lake. Labbe (39) described a variety of *S. bellulus*. Of the various authors who have described species of *Stiliger*, only Bergh and Souleyet have given a description of the anatomy ; and presumably for want of living material no one has described the bionomics and development of any of the species. Of the several species referred to above, *S. tentaculatus*, *S. pica* and the present species, *S. gopalai*, are inhabitants of brackish waters while the rest are marine.

It is worth mentioning here that the validity of Trinchese's *Ercolania* as a separate genus from *Stiliger* was questioned by Eliot (20) and

O'Donoghue (43). Vayssiere (59) treated *Ercolania* as a separate genus ; and Bergh¹ and Eliot (20) have described new species of *Ercolania*. In my view the genus *Ercolania* is distinct from *Stiliger* in that the former has canaliculated grooves in the rhinophores. This character, though minute, is quite distinct, and a similar difference in the nature of the rhinophores also distinguishes *Hermaea* from *Stiliger*.

EXTERNAL FEATURES OF *Stiliger gopalai*, sp. nov.

The animal (Pl. VII, figs. 1, 2 and 5) has the general appearance of an Eolid and measures when fully expanded 11 to 12 mm. in length and 4 to 4.5 mm. in breadth. The ground colour is deep brownish gray speckled with yellow here and there. The yellow colour completely disappears on preservation and the depth of the gray varies with the physiological condition of the animal. When kept in captivity without food for a couple of days, the gray fades into a pale colour. The dark gray colour of the dorsal part of the snout is striking with a pale yellow streak running on either side of this area beginning from the base of the dorsal tentacle and extending up to the anteriormost cerata. The rest of the dorsal surface and the sides are finely spotted yellow with the region surrounding the anus slightly pale. The yellow spots are very minute in the anterior half of the back and comparatively large in the posterior half.

The snout, 1.75 mm. in length, is more or less convex dorsally, and slightly notched in the anterior middle region over the mouth giving the appearance of two minute lumps, one on either side, which represent the thickenings of the outer lips (Pl. VII, fig. 3, *la.*). The snout bears antero-dorsally a pair of smooth, long, slender and pointed tentacles or rhinophores measuring about 3 to 3.25 mm. in length. A pair of dark, minute eyes is seen through the transparent integument covering the neck region behind the dorsal tentacles.

The part that follows the neck is conspicuously broad and bears the dorsal papillae or the cerata, which are arranged in two longitudinal bands, one on either side of the back leaving the middle region bare throughout its length. Each band appears at first sight to consist of two or more rows of cerata, but as in *Stiliger bellulus* the arrangement is irregular. The cerata are 3 mm. long, neither very slender nor very much inflated. They are dark gray with distinct white tips, and reveal all over their surface microscopical white dots representing the gland cells (Pl. VII, fig. 4, *o. gl.*). Such gland cells are also seen at the bases of the rhinophores. Each band consists of thirty to forty cerata, of which, as a rule, the anterior ones are the smallest and the posterior the longest ; but the autotomy of these organs and their subsequent regeneration are so common that small and minute cerata may appear occasionally at any region in the band. The hepatic ramifications (*d. gl. r.*) extending into the cerata show only one main stem which gives off but a few minute branches. When the animal is disturbed the gland cells secrete a copious, whitish, slimy, pungent-smelling fluid, and the

¹ Beitr. Z. Kennt. der Aeolidiaden—Ver. k.k. Zool. Bot. Gessel. Wien., V, (1878) referred by Eliot (20).

cerata break off spontaneously as in *Tergipes* and *Galvina*. The cerata thus cast off swim freely in water in all directions by means of their cilia and may continue to be active for nearly a week.

The foot, which is 1 mm. wide, is considerably narrower than the back and extends from one end of the body to the other, tapering posteriorly into a fine filamentous tail nearly as long as the rhinophore. It is pale yellow in colour and bears a few minute, yet distinct, white spots.

The middle of the anterior region of the foot is slightly grooved with its antero-lateral edges rounded into two small lobes. The narrow foot seems to be adapted to the habit of creeping on filamentous algae (*Chaetomorpha*) which form its chief food. Movements of the animal from place to place are effected by waves of muscular contractions characteristic of all Gastropods. When the animal creeps from one filament of the alga to another lifting up the anterior part of the body, the muscular contractions of the foot are clearly seen in the region which is raised above the substratum. The cilia of the foot are in constant action but they only play a secondary part in the locomotion of the animal.

The mouth, a vertical slit, is anterior and median and lies immediately above the median cleft of the foot; and the anus (Pl. VII, fig. 1, *an.*), which opens out to the exterior on a minute papilla, is dorsal and median, lying in front of the pericardium. The genital openings are three in number and are situated on the right side of the body in the neck region. Of these the male genital or the penial opening (Pl. VII, fig. 5, *op. pen.*) lies foremost immediately beneath the right eye. The second in order is the oviducal opening (*op. ov.*) for the purpose of spawning, which lies close behind the male genital opening. The third, the vaginal (*op. va.*), is situated some distance from the other two beneath the first or the second cerata of the right side. The ampulla of the vagina, which lies closely pressed to the integument, shows an external demarcation as a pale white scar behind the vaginal opening.

Histology of the Body-Wall and the Foot.—The body-wall is thin, soft and smooth and consists of an outer ectodermal epithelium of varying thickness formed of pigment cells. The pigment is, however, absent in the cells lining the labial folds and the region immediately surrounding the anus. The lining epithelium of the rhinophores, the labial folds and the cerata is provided with vibratile cilia, but that of the back and the sides is without any cilia. Associated with the dermal epithelium are seen two types of glands, *i. e.*, the mucous and the odoriferous glands. The mucous glands are either unicellular or multicellular and stain darkly with haematoxylin. The comparatively large-sized, flask-shaped odoriferous glands are multicellular and are particularly numerous in the head region at the bases of the rhinophores and all over the cerata. They lie beneath the epithelium and open to the exterior by short necks. Beneath the dermal epithelium there is a loose connective tissue traversed by muscle fibres and blood sinuses.

The foot (Pl. VIII, fig. 1) has an outer ciliated epithelium of columnar ciliated cells (*ci.c.*) with a thin cuticle separating the cells from the cilia. Beneath this epithelium lies the dermal connective tissue penetrated

by muscle strands (*m.f.*) and blood sinuses. The mucous glands are either unicellular (*m.g.*) and interspersed between the epithelial cells, or multicellular (*m.m.g.*) and sub-epithelial. They open to the exterior through minute crypts (*cr.*) and secrete a copious quantity of mucus which aids the animal to creep easily on any substratum or to cling to the surface of water with the ventral side upwards.

DIGESTIVE SYSTEM.

The digestive system of *Stiliger* was first studied in *S. bellulus* by Milne-Edwards (19). He observed a number of ramifications of the gut in the dorsal papillae and other external organs, and believed that there was a definite communication of the digestive organs with the vascular system in those regions. He accordingly termed this apparatus, the gastro-vascular system, which, as remarked by Alder and Hancock (6), "he compares to the system of vessels radiating from the stomach of the *Medusidae* on the one hand, and to the caeca connected with the digestive organs of the *Nymphons* among the *Crustacea* on the other." The work of Quatrefages (48) on *Eolidina paradoxum* confirmed the results obtained by M.-Edwards. His (49, 50) further investigations on the subject led him to establish the Order Phlebenterata, to include certain forms allied to *Stiliger* such as *Acteonia*, *Chalidis* etc., which were supposed to exhibit what he called 'phlebenterism'. He believed that the members of this order suffered a very great deterioration of the vascular system, the heart and the blood vessels being completely absent, and that the digestive system was likewise modified. He believed that the anus was absent in all these forms, and that the alimentary system discharged the double function of digestion and circulation. The researches of Alder and Hancock, and of Souleyet and others did not confirm Quatrefages' observations. After much controversy over the subject, the Biological Society of Paris proved definitely that the conclusions arrived at by Quatrefages were erroneous and that in all the Phlebenterata there is a definite circulatory system independent of the organs of digestion.

In *Stiliger gopalai* the mouth is a narrow slit placed on the inferior side of the head and bounded by a pair of fleshy lips (Pl. VII, fig. 3, *la.*), which are continuous with each other except for the presence of a deep furrow running in the median line above the mouth. The ectodermal epithelium of the lips is ciliated and is invaginated evenly into a short and narrow passage, the channel of the mouth. The epithelium (Pl. VIII, fig. 2, *epi.*) of the channel of the mouth has a number of small crypts (*cr.*) along which the numerous club-shaped glands (*b.gl.*) of varying sizes open by their slender ducts. These glands correspond to the buccal or oral glands of Opisthobranchiata described by several authors. Posteriorly the channel of the mouth leads into a pale white, muscular organ, the pharyngeal bulb or the bucco-pharynx (Pl. VII, fig. 7 and Pl. VIII, fig. 3, *ph.*), 0.7 mm. long, 0.6 mm. high. This organ, which is suctorial in function, is provided with a radula and an ascus (*as.*) and receives the discharge of a pair of salivary glands (*s.gl.*). The lumen of the pharyngeal bulb is lined by an epithelium of columnar

non-ciliated cells, the secretion of which forms a thin cuticle lining the entire interior of the pharyngeal bulb.

At the base of the lips and guarding the entrance to the mouth there is a ring of circular muscles acting as a sphincter. From this region several strands of muscles forming the anterior retractors pass backwards to be attached to the anterior region of the pharyngeal bulb. The paired posterior retractors of the pharyngeal bulb proceed backwards from its sides to the foot. By the action of these two sets of muscles the pharyngeal bulb moves backwards and forwards.

The radula (Pl. VIII, fig. 4) measuring 0.6 mm. in length lies ventrally in the pharyngeal bulb. It is of the uniseriate type characteristic of all Ascoglossa. It shows (i) a straight ascending axis bearing five well formed teeth and one growing tooth surrounded by odontoblasts in a short horizontally placed radular sac, (ii) a descending axis of seven teeth proceeding towards the ascus and (iii) the ascus itself, a minute pouch antero-ventral to the pharyngeal bulb and containing a small heap of about twenty worn out teeth. Throughout the life of the animal the odontoblasts in the radular sac continuously secrete material for the formation of fresh teeth, while the worn out teeth are being stored in the ascus. The teeth (Pl. VIII, fig. 5) are all of the same shape and size. Each tooth is 0.125 mm. long, and has a wavy margin. One half of the tooth bears a spoon-shaped depression into which the tooth behind closely fits. The teeth closely resemble those of *Stiliger varians* and *Ercolania siottii*. On comparing the radula of this form with that of *S. bellulus* (syn. *S. mariae*, Bergh 1872, Taf. 26, fig. 6) we find that in the latter the descending axis is spirally coiled and shows a larger number of teeth, broad at their bases and narrow and pointed at their apices.

The animal possesses a pair of slender salivary glands (Pl. VII, fig. 7, and Pl. VIII, fig. 3, *s.gl.*) measuring about 1.1 mm. in length and 0.1 mm. in thickness. The great development of the anterior genital complex on the right side has pushed the glands to the left of the oesophagus. A pair of narrow salivary ducts nearly as long as the glands, and 0.017 mm. thick, pass through the nerve collar and open into the pharyngeal bulb, one on either side of the oesophagus. The gland (fig. 6) is composed of large cells (*gl.c.*) with small ciliated interstitial cells (*ci.c.*) wedged in between. The glandular cells are cubical, highly vacuolated and contain a large number of granules. The secretion of the gland is poured into the central lumen and is driven forwards by the ciliary action of the interstitial cells. The duct of the gland is formed of an inner layer of low ciliated cells and an outer layer of thin fibrous tissue.

The oesophagus (Pl. VII, fig. 7, and Pl. VIII, fig. 3, *oe.*), a thin semi-transparent slender tube 1.2 mm. long, starts from the postero-dorsal region of the pharyngeal bulb (immediately behind which it is encircled by the central nervous system) and running backwards beneath the spermatheca communicates with the stomach (*st.*). It has an inner layer of tall columnar ciliated cells and a thin outer muscular layer. There is no oesophageal caecum as in *Elysia viridis*. Souleyet (57) figured a caecum in *S. souleyeti* describing it as the first stomach. Neither Bergh nor Eliot has described an oesophageal caecum in any of the species of *Stiliger*.

The thin-walled and roughly triangular stomach (*st.*) which is shorter and wider than the oesophagus, lies medially above the ampulla of the hermaphrodite duct and in front of the pericardium. The inner wall of the stomach is longitudinally plicated and lined by a layer of low columnar ciliated cells. The stomach receives its nerve supply from the gastro-oesophageal plexus formed by the anastomosis of gastro-hepatic and gastro-oesophageal nerves from the visceral and the stomatogastric centres respectively. A pair of diverticula (Pl. VII, fig. 7, *di.*) opens posteriorly into the stomach, one on either side; and each of these gives two caecal prolongations (*ca.*), anterior and posterior, running along the sides of the body. These caecal prolongations in their turn communicate with the glandular ramifications (*d.gl.r.*) of the digestive gland present in the cerata. The lining of the diverticula and of the caecal prolongations is ciliated like that of the stomach, but has no folds, and its cells are very short.

The ramifications of the digestive gland of *Stiliger* penetrate into the cerata as in the allied genera *Hermaea* and *Ercolania*. In *S. gopalai* there is only a single main stem in each of the cerata (Pl. VII, fig. 4, *d.gl.r.*), with but a few minute short branches. In *S. bellulus* and *S. tentaculatus* a number of fairly long branches fill up the large space in the cerata. The digestive gland is grayish green in life, and though very much diffuse it has the same histological structure as in *Kalinga ornata* (Rao, 52). The glandular epithelium (Pl. VIII, fig. 7) lining the ramifications, projects in the form of folds into the central lumen (1) and is formed of tall columnar and short cubical cells. The latter are few in number. Their cytoplasm is vacuolated and contains granular inclusions (*gr.*) of several kinds. The digestive gland in Mollusca is a hepato-pancreas, but it is supposed to discharge the function of excretion also.

The short intestine (Pl. VII, fig. 7, *int.*), 0.5 mm. long, arising antero-dorsally from the stomach, proceeds upwards and is continued as an extremely short rectum to the anus situated medially on the dorsal body wall in front of the pericardium. The intestinal walls are composed of an outer fibrous layer of sparse musculature and an inner glandular layer of tall columnar ciliated cells. The rectum does not differ to any extent from the intestine in histological structure.

S. gopalai, like the rest of the members of the Sub-Order Ascoglossa, is a vegetable feeder. Even in captivity the animal feeds voraciously on *Chaetomorpha* only, preferring starvation to feeding on other algae. In the act of feeding it rests on a thread of alga and applying its mouth to one of the cells, punctures it with the outermost tooth of the radula. This is brought about by the contraction of the anterior retractor muscles, which shortens the channel of the mouth. Immediately after the puncture is made the suctorial pharynx begins to work emptying the contents of the cell. When the feeding animal is watched under a binocular microscope, the pharyngeal bulb is seen through the translucent skin to contract and expand very rapidly sucking in the juice and driving it through the oesophagus into the stomach and the caecal prolongations of the digestive system. After emptying one cell of the algal thread it moves on to the next and repeats the same process. When young specimens without much pigment or the pale semi-starved

adults are watched under the binocular microscope after feeding on the algae for about a quarter of an hour the course of the gut is clearly seen through the integument because of the bright green colour of the algal juice. It is also observed that the cerata expand and contract independently of one another driving the contents of the caecal prolongations into the ramifications of the digestive gland and back again into the former. The sphincter at the base of each of the cerata controls this action.

CIRCULATORY AND RESPIRATORY SYSTEMS.

The organs of circulation are very simple and consist of the heart, the blood vessels and the blood sinuses. The heart (Pl. VIII, fig. 8) is a two-chambered muscular organ consisting of an auricle (*au.*) and a ventricle (*v.*) enclosed in a thin transparent membranous sac, the pericardium (*pe.*). The oval pericardial chamber, about 2.25 mm. long lies behind the anus, immediately beneath the dorsal body wall. As is common in all Mollusca, it is coelomic in origin. It communicates with the renal organ by the reno-pericardial opening (*r.p.o.*) situated posteriorly on the right side. Through the semi-transparent wall of the dorsal surface the heart is seen to pulsate about forty times per minute. The walls of the auricle and the ventricle in the live animal are thin, muscular and transparent. There is no endothelial lining to the auricle or the ventricle. The auricle receives several minute veins (*vei.*) posteriorly and pumps the blood into the ventricle. The auriculo-ventricular opening is provided with a pair of valves, which prevent the flow of blood back into the auricle when the ventricle contracts. The aorta arises from the anterior part of the ventricle and runs forward supplying blood to all the visceral organs and the foot, from which it is brought into the general body cavity. From the general body cavity, which is a haemocoel in all Gastropods, the blood enters into a number of sinuses in the integument and the cerata. The blood brought to these organs is aerated and is collected by various small veins which join together to form a few main trunks that open into the auricle.

The function of respiration is performed by the entire integument and the cerata. The sinuses, filled with blood present in these organs, are bounded by loose connective tissue and are separated from the exterior only by a thin dermal epithelium. Aeration takes place effectively in these organs. The cerata do not, however, discharge exclusively the function of respiration as when all the cerata are lost the animal remains normally active. For this reason, some authors prefer the term dorsal papillae to cerata, which is a near approach to the ctenidium or the true gill.

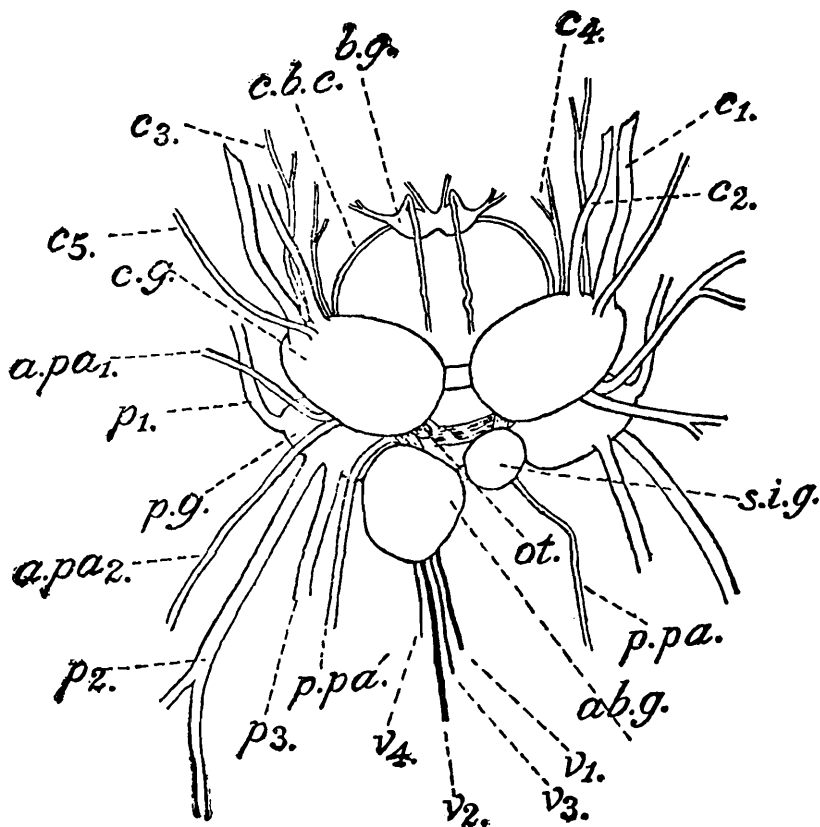
RENAL SYSTEM.

The renal system (Pl. VIII, fig. 8.) consists of a thin-walled renal chamber or the kidney (*r.c.*) which is coelomic in origin like the pericardium (*pe.*). It is situated immediately behind the pericardium and extends almost to the posterior end of the body. From the anterior right corner it gives off a diverticulum (*di.r.*) which, after communicating with the pericardial chamber by means of the reno-pericardial

opening (*r.p.o.*), runs forward on the right side of the pericardium close to the body wall, and turning to the left in front of the pericardium opens out medially on the dorsal body wall by the renal pore (*r.o.*) situated immediately behind the anus. The renal chamber and its diverticulum are lined with small cubical cells with vacuolated cytoplasm and basally placed nuclei. The reno-pericardial opening is without a funnel, and provided with short ciliated cells. The extremely minute renal pore can only be made out in serial sections of the kidney and is lined by a ciliated epithelium which is a continuation of the general epithelium of the body wall.

NERVOUS SYSTEM AND SENSE ORGANS.

Souleyet (57) remarked on the nervous system of *Stiliger souleyeti* (syn. *Calliopaea souleyeti*) as follows: "Le system nerveux ressemble a celui des *Tergipes*; les ganglions qui composent dans des connexions un peu differentes, (fig. 27 et 28) Les yeux ne sont plu aussi en rapport immediant avec les ganglions cerebraux." His diagrams represent the dorsal and the ventral aspects of the brain alone, and indicate the origin of three nerves from the cerebro-pleural ganglion, one from the pedal, two from the abdominal and three from the supra-intestinal.



TEXT FIGURE. 1.—Central nervous system dissected out and highly magnified to show the various ganglia and the origin of nerves.

From his drawings it is, however, clear that the sub-intestinal ganglion is absent, but neither the ganglia nor the nerves are named. Later, Bergh (9) and Eliot (25 and 26) did not give any account of the nervous system in their descriptions of *Stiliger*; and thus the nervous system in the genus remains practically unknown.

The animals being extremely small, the investigation of the various ganglia and the numerous delicate nerves in particular was very difficult. Dissections were made under a binocular microscope focussing a strong beam of light from an illuminator on the object. The methods adopted by Russel (54) for the investigation of the nervous system of *Elyisia viridis* have been followed here with success.

The central nervous system of *Stiliger gopalai* consists of four pairs of oval, pale white ganglia placed immediately behind the pharyngeal bulb forming a ring round the oesophagus. There are a pair of cerebro-pleural ganglia (text fig. 1 and Pl. VIII, fig. 9, *c.g.*), a pair of pedals (*p.g.*), a pair of viscerals (*ab.g.* and *s.i.g.*) and a pair of buccals (*b.g.*). The cerebral and the pleural centres are fused together to form the cerebro-pleural ganglia, which are united above the oesophagus by a short cerebral commissure. The cerebral centres are also joined below the oesophagus by a very delicate connective, the cerebro-buccal commissure (*c.b.c.*), which bears a pair of minute and elliptical buccal ganglia (*b.g.*) lying posteriorly on the pharyngeal bulb. The pleural centres are likewise joined beneath the oesophagus by the visceral loop bearing a pair of visceral ganglia of unequal size. Of these two ganglia, the one to the left, the abdominal (*ab.g.*), is bigger and the other to the right, the supra-intestinal (*s.i.g.*), is comparatively small. The two are joined by a short connective between them. The supra-intestinal is joined to the right pleural centre by a short commissure, and similarly the abdominal to the left pleural centre. The pedal ganglia (*p.g.*), which are of the same size as the cerebro-pleurals, lie posteriorly beneath the cerebro-pleural ganglia and are joined by the pedal commissure lying beneath the oesophagus. The pedals are also connected to the cerebral and the pleural centres by means of the cerebro-pedal and the pleuro-pedal connectives respectively.

Eight pairs of nerves arise from the cerebro-pleural ganglia, of which the first six are cerebral nerves from the cerebral centres and the remaining two are the anterior pallial nerves¹ from the pleural centres. The first pair of cerebral nerves (text. fig. 1 and Pl. VIII, fig. 9, *cl.*), which is comparatively stout, arises from the antero-dorsal region of the cerebro-pleural ganglia and proceeding forward divides at the bases of the rhinophores into several branches to innervate these organs. This pair of nerves does not bear any discrete ganglia either at the proximal or the distal end. The second pair (*c2.*) arising in front of the first pair, reaches the labial folds and supplies them with several minute branches. The third pair (*c3.*) innervates the channel of the mouth and the retractors of the pharyngeal bulb. The fourth pair (*c4.*) is extremely delicate and supplies the pharyngeal bulb itself. The fifth (*c5.*) and the sixth pair of cerebral nerves supply the eyes and otocysts respectively. The optic nerve (*c5.*) bears a small optic ganglion (*op.g.*) as shown in Pl. VIII, fig. 9. The otocyst (text. fig. 1, *ot.*) being sessile, its nerve is extremely short. The anterior pallial nerves (*a.pa.1* and *a.pa.2.*) arise from the junction of the pleural and the pedal centres. The first of these two pairs proceeds anteriorly and supplies the sides of the neck

¹ The terminology followed here with reference to the various nerves is essentially that adopted by Russel (54).

region, while the second pair turns behind to supply the sides of the animal immediately behind the neck. The first pallial nerve of the right side gives off a short branch (*n.p.*) to supply the penis-pouch and the vas deferens. Owing to the fact that this nerve arises from the junction of the pleural centres and that a few fibres pass from the pedal ganglia into this nerve, the innervation of the penis was believed by some authors to be pedal.

Three pairs of nerves arise from the pedal ganglia (*p1*, *p2* and *p3*.) to supply the entire length of the foot. The pedal nerves, compared to other nerves, are fairly stout.

Three pairs of very delicate nerves take their origin from the buccal ganglia, of which the first pair (Pl. VIII, fig. 10, *b.n1.*) arises anteriorly from the buccal ganglia and innervates the radular sac. The second pair (*b.n2.*) arising laterally close to the cerebro-buccal connective (*c.b.c.*) supplies the pharyngeal bulb. The nerves forming the third pair (*b.n3.*), known as the gastro-oesophageal nerves, arise directly from the anterior middle region of the buccal ganglia (*b.g.*). There are no gastro-oesophageal ganglia. The gastro-oesophageal nerves (*b.n3.*) proceed backward remaining in close contact with the oesophagus. Along with the oesophagus and the ducts of the salivary glands they pass through the nerve collar and proceed ventrally on the wall of the stomach ending in a pair of minute ganglia (*g.*). The gastro-oesophageal nerves in the region of the oesophagus and the stomach bear a number of small ganglion cells (*g'*). From all these ganglion cells nerve fibres start and ramify on the surface of these organs. Posteriorly this network joins a similar ramification derived from the gastro-hepatic nerve supply of the abdominal ganglion.

There are only two visceral ganglia, *viz.*, the abdominal and the supra-intestinal ganglia (Pl. VIII, fig. 9, *ab.g.* and *s.i.g.*). As in *Limapontia* the sub-intestinal ganglion is absent since it is fused with the pleural centre of the left side. A single nerve, the posterior pallial (*p.pa.*), arises from the supra-intestinal ganglion and passing beneath the spermatheca reaches the dorso-lateral region of the integument and innervates it. The corresponding nerve of the left side (*p.pá.*) takes its origin from the junction of the pleural and the abdominal centres since the sub-intestinal is absent as already stated. A branch from the main nerve of the supra-intestinal ganglion innervating the pericardium, the aorta and the kidney has been described by Russel (54). Owing to the minuteness of this branch I was unfortunately not able to trace it.

Four extremely delicate and ganglionated nerves, the visceral nerves, take their origin from the posterior face of the abdominal ganglion. The first of these nerves (*v1.*) proceeds beneath the oesophagus and reaching the mucous gland ends in a small ganglion (*ge.g.*) from which a ramification of nerve fibres spreads all over the surface of the mucous gland and the vagina forming thus the genital plexus. This nerve, before it ends in the genital plexus, gives a short branch, the right hepatogastric nerve (*r.h.g.*), which supplies the right side of the stomach and its diverticulum of the same side. The second visceral nerve (*v2.*) from the abdominal ganglion is seen as a thin wavy line passing by the side

of the oesophagus on its left side. It proceeds nearly to the posterior region of the left side of the stomach and forms the gastro-hepatic plexus. The third nerve (*v3.*) passes by the side of the intestine and after giving a short branch (*n.in.*) to that organ proceeds hindward to innervate the aorta, the heart, the pericardium and the renal chamber (*p.c.r.*). The fourth of the visceral nerves (*v4.*), which takes its origin from the lower surface of the abdominal ganglion, innervates the ampulla of the hermaphrodite duct.

The organs of special senses consist of the eyes, the otocysts, the rhinophores and the labial folds. Besides these the dorsal papillae and the whole of the external surface of the animal serve as organs of touch.

A pair of dark minute eyes (*ey.*) lies behind the rhinophores immediately beneath the integument covering the neck region. The optic nerves are long and bear the optic ganglia (*op.g.*). Each eye is enclosed in a thin membranous capsule and shows a black pigmented cup-shaped retina, a round globular lens and a thin transparent cornea. The optic nerve enters the eye from its lower surface and innervates the retinal cup. The otocysts (text. fig. 1, *ot.*) are a pair of minute bodies placed close to the pedal ganglia, but they receive their nerve supply from the cerebro-pleural ganglia. Each otocyst contains a single otolith. These are the earliest sense organs to make their appearance in the course of development and serve as the balancing organs.

The rhinophores are smooth, pointed at their tips, and without the grooves found in *Ercolania*. They are provided with a ciliated epithelium and receive their nerve supply from the first pair of cerebral ganglia. Their function has been believed to be olfactory by some authors [Alder and Hancock (6), Hancock and Embleton (35), and Eliot (26)], but Agersborg (2) is of opinion that they respond only to a general chemical stimulus.

The labial folds lie on either side of the mouth as fleshy thickenings. They are provided with vibratile cilia and receive their innervation from the second pair of cerebral nerves. They are supposed to be the seat of the sense of taste.

REPRODUCTIVE SYSTEM.

The organs of reproduction of *Stiliger* were first studied by Souleyet (57) and later on by Bergh (9). As the complicated ducts and their glandular annexes are imperfectly understood, I propose to describe them in this species in somewhat greater detail. The general arrangement of the ducts and the position of the glands are very much as in *Limapontia nigra* described and figured by Alder and Hancock (5).

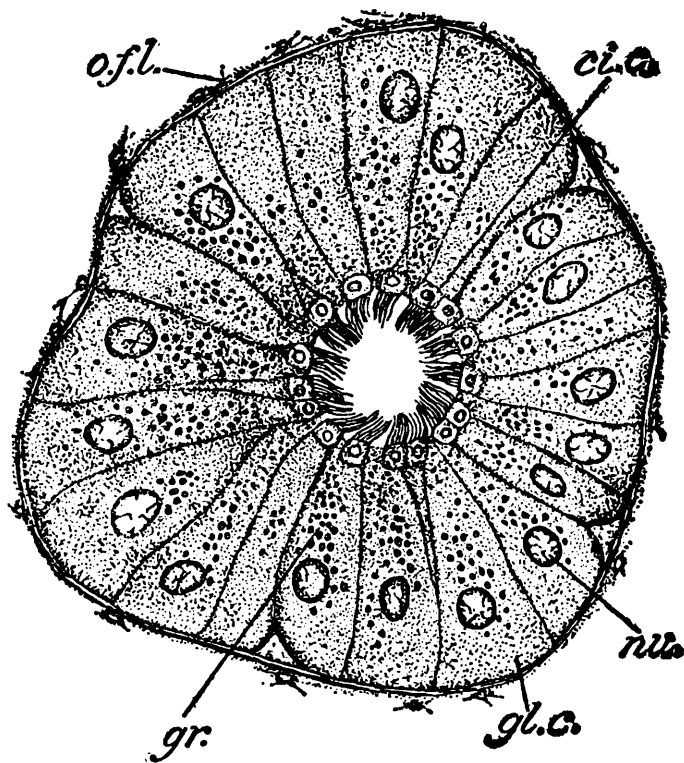
In *S. gopalai* the reproductive organs (Pl. VIII, fig. 11 and Pl. IX, fig. 1) occupy by far the largest space in the peri-visceral cavity and consist of numerous follicles of the hermaphrodite gland, the hermaphrodite duct and the anterior genital complex. The follicles of the hermaphrodite gland (Pl. VIII, fig. 11, *hr.gl.*) are reniform and small in size, each measuring about 0.6 mm. along its long axis. Most of them lie close to the integument, and in life the yolk-laden eggs give

a pale yellow colour to them. As in all Ascoglossa described by Pelse-
 neer (46) and Eliot (26), each follicle produces spermatazoa as well as
 ova. Sections of the animal fixed in Brasil's modification of Bouin's
 fluid and stained with iron haematoxylin and eosin show the follicles
 clearly. Each of the follicles has a thin germinal epithelium close to
 which lie a number of spermatocytes and oocytes of all stages of growth.
 Besides these, there are always well developed sperms and eggs. Each
 ovum is filled with granules of yolk, and has a fairly large nucleus and
 a nucleolus. The sperms are found in clusters and each possesses a
 sinuous head (which is deeply stained by haematoxylin) and a long
 tail (stained red by eosin). The follicles have the same histological
 structure, but for convenience of description may be divided into (i)
 an anterior group placed in front of the left hepatic diverticulum and
 to the left of the oesophagus; and (ii) a comparatively large posterior
 group occupying almost the entire posterior half of the body behind
 the hepatic diverticula. The thin, minute, transparent ductules (Pl.
 VIII, fig. 11, *du.*) arising from the follicles (*hr.gl.*) of each group form
 a small duct. The duct from the anterior group (*hr.d1.*) passes beneath
 the hepatic diverticulum and meets its fellow (*hr.d2.*) from the posterior
 group about the middle region of the body to form a common herma-
 phrodite duct (*hr.d.*). The hermaphrodite duct is very narrow and thin
 at its origin but has an abrupt, opaque, whitish dilatation in its course
 called the ampulla (*hr.am.*) about 2.5 mm. long and 0.5 mm. thick.
 After passing forwards beneath the stomach and the oesophagus it turns
 to the right becoming narrow again on reaching the anterior genital
 complex.

The anterior genital complex (Pl. VIII, fig. 11 and Pl. IX, fig. 1)
 is placed to the right side of the oesophagus and the stomach, and is
 disproportionately large in relation to the size of the animal. It con-
 sists of the male genital organs (*pen.*, *pen.s.*, *pr.d.*), the oviducal organs
 (*al.gl.* and *mu.gl.*) and the apparatus consisting of the vagina (*va.a.*),
 the vaginal canal (*va.c.*) and the spermatheca (*spt.*) for receiving and
 storing sperms during coitus. In order to show the narrow part of the
 hermaphrodite duct and its communication with the male genital and
 oviducal organs, it is essential to remove the entire spermatheca (with
 its outline shown in dotted lines in Pl. IX, fig. 1). The downward
 loop of the mucous gland is slightly twisted to the right so that the
 bulged part of the vaginal canal (*va.d.*) and the duct of the prostate
 (*pr.d.*), which lie normally ventral to the anterior region of the mucous
 gland (*mu.gl.*), come in direct view, with the short communication be-
 tween them clearly seen.

The narrow terminal region of the hermaphrodite duct communi-
 cates anteriorly with the vas deferens (Pl. IX, fig. 1, *v.d.*) and ventro-
 laterally with the oviducal organs (*al.gl.* and *mu.gl.*). The vas deferens
 is an extremely narrow and short duct which swerves round the penis
 pouch (*pen.s.*). The latter lodges the penis, which, in a retracted condi-
 tion lies inverted and in expanded condition becomes everted and push-
 ed out through the male genital opening situated on the right side of
 the neck immediately behind the eye. It then assumes a conical form
 bearing at its tip a minute recurved crystalline stylet (Pl. IX, fig. 2).

The vas deferens is continued through the penis and opens out to the exterior by a small perforation present at the tip of the stylet. A duct (Pl. IX, fig. 1, *pr.d.*) from the prostate gland joins the vas deferens at the point where the latter communicates with the hermaphrodite duct. It runs backwards communicating with the vaginal canal, and at a point where the stomach receives the hepatic diverticula, it divides into two branches. Following the course of the hepatic diverticula the branches reach the body wall on either side, each dividing into two slender ducts (Pl. VIII, fig. 11, *pr.d1.* and *pr.d2.*). One proceeds anteriorly and the other posteriorly parallel to the caecal prolongations of the digestive system, communicating with the glandular ramifications of the prostate gland (*pr.r.*) in the cerata. The branch running anteriorly along the right side of the animal is much shorter than its fellow on the left and is supplemented by another branch that joins the main duct directly. In life the ramifications of the prostate are slender and pale white in contrast to the stout and grayish-green ramifications of the digestive gland found in the cerata. In transverse sections of the cerata the slender branches of the prostate are seen close to the outer wall with the granular contents of their cells stained deeply with eosin; whereas the digestive gland occupies the central space with the granules of its cells stained densely with haematoxylin.



TEXT FIGURE 2.--Transverse section of the albumen gland. $\times 600$.

A small translucent albumen gland (Pl. IX, fig. 1, *al.gl.*) and a large transparent mucous gland (*mu.gl.*) belong to the oviducal organs. The albumen gland lies ventral to all other parts of the anterior genital complex and is paired being divisible into two rami, each about 1.75 mm. long. The length of the gland varies with the numbers of eggs passing into it. In preserved specimens its surface is much lobed. There is a single short duct arising from the gland, which, along with the mucous gland communicates with the terminal region of the hermaphrodite

duct as already stated. The albumen gland of *Stiliger* corresponds to the opaque and greatly coiled albuminous part of the muco-albumen gland of the Nudibranchs in general, but here it is much more simple. The gland is tubular in section (text fig. 2.) and has a thin outer layer (*o.f.l.*) of fibrous tissue with a few strands of muscles and a comparatively thick inner layer formed of groups of large glandular cells (*gl.c.*) alternating with small ciliated interstitial cells (*ci.c.*). The cytoplasm of the glandular cells reveals large granules (*gr.*) staining deeply with haematoxylin. There are indications that this gland provides the albumen that surrounds the egg and also the outer capsule. The mucous gland (Pl. IX, fig. 1, *mu.gl.*) is about 3.5 mm. long and 2.5 mm. wide and lies along the right side of the body. In dissecting specimens preserved in formalin the gland swells up on contact with water, frays out and loses its shape. Specimens preserved in alcohol are for this season preferred. The mucous gland is a simple wide roughly U-shaped tube lined with tall columnar glandular ciliated cells (Pl. IX, fig. 3) and opens out to the exterior by the oviducal opening (fig. 1, *op.ov.*) situated immediately behind the male genital opening. The nuclei (*nu.*) of the gland cells are basal, and the cells which stain deeply with eosin contain very little cytoplasm (*cy.*). The slimy transparent secretion of this gland exudes with the eggs at the time of oviposition through the oviducal opening.

The vagina (*va.a.*), its passage and the spermatheca (*spt.*) constitute the apparatus for receiving the sperms during copulation. These are collectively termed 'the androgynous organs' by some authors [Alder and Hancock (5)]. In tracing back these organs from the vaginal opening (*op.va.*), we find that the latter leads into a small tubular passage, which at once dilates into what is called the ampulla of the vagina (*va.a.*) which is about 0.2 mm. long. The narrowed vaginal passage (*va.c.*) runs at a right angle to the ampulla on the surface of the mucous gland, and proceeds parallel to the main duct of the prostate (*pr.d.*) which is continued as a small dilatation (*va.d.*) at the anterior region of the mucous gland. In figure 1, this dilatation communicates on the right with the duct of the prostate (*pr.d.*), on the left with a short duct leading to the spermatheca (*spt.*) and ventrally with the oviducal organs (*al.gl.* and *mu.gl.*). The ampulla of the vagina and its long narrow passage are lined internally by a layer of low ciliated cells. The dilatation of the vaginal passage close to the mucous gland is likewise ciliated, but the cells lining it are peculiar in that they resemble the cells of the mucous gland, though they are much shorter in length. The spermatheca is large and spherical having a diameter of about 2.25 mm. It is situated behind the pharyngeal bulb and rests partly on the oesophagus and partly on the mucous gland. When full, its contents impart a brown colouration to it. It has an outer fibrous layer, and an inner glandular layer, the cells of which do not bear any cilia. The duct of the spermatheca is extremely short and arises ventrally on its right. Sections of the animal show spermatozoa in the vaginal ampulla, in the dilatation of the vaginal passage and in the spermatheca.

Souleyet and Alder and Hancock mistook the hermaphrodite gland in many of the Elysoid forms for the ovarium and the prostate for the

testis. Souleyet (57) was apparently not fully aware of the significance of the albumin gland and associated it with the male genitalia. This gland has been represented by Bergh (9) in *S. bellulus* as an unpaired structure ; but in *S. gopalai* it is paired as in *S. souleyeti*. In *S. bellulus* the penial stylet is slender and as long as the penis itself ; in *S. pica* [Annandale and Prashad (56)] it is extremely short, slender and minute ; in *S. gopalai* it is short, recurved and has the same shape as that of *Limapontia capitata* (Bergh 9, Taf. 26, fig. 21.).

BREEDING AND SPAWNING HABITS.

Animals kept in captivity in brackish water amidst algae in glass dishes were often observed to copulate. The details may be observed with a hand lens. When two individuals approaching in opposite directions come in contact with each other their short, conical penis is usually exerted. Their right neck regions are brought close together, and as soon as the penis of one individual is thrust into the vaginal passage of the other, the animals come closer and curve in the manner shown in (Pl. VII, fig. 6). Muscular spasms pass over them as they lie curled up. The copulation does not last more than three minutes, after which the individuals separate. As a rule they do not feed until the spawn is deposited. But some animals have been observed to copulate more than once before spawning. A few hours after spawning their normal movements are resumed until the next stimulus of contact prepares them for copulation.

During copulation the sperms from the terminal region of the hermaphrodite duct find their way into the vas deferens. The duct of the prostate brings directly into the vas deferens a slimy secretion, together with which the sperms of each individual are conducted through the penis into the vaginal passage of the other. The sperms thus received in the vaginal passage find their way into the spermatheca where they remain for some time. As the eggs pass from the hermaphrodite duct into the oviducal organs, the sperms from the spermatheca enter into the dilatation of the vaginal canal and from there into the oviduct. The eggs are then fertilized and are immediately directed into the albumen gland, where they receive a coating of albumen and are enclosed in small capsules. They next pass through the mucous gland to the exterior along with its secretion.

Copulation does not seem to be absolutely necessary for the production of fertile ova. Animals kept separately for about a fortnight in confinement produced perfectly healthy and fertile ova, but they were observed to deposit fewer strings of spawn at longer intervals. This was apparently a case of self-fertilisation. As the animals under laboratory conditions spawn an hour or two after receiving the sperms of other individuals, it is presumed that in separated individuals the sperms have not already been received and stored in some part of the reproductive system. If it is remembered that the dilated part of the vaginal passage communicates with the duct of the prostate (*vide* Pl. IX, fig. 2.), the passage of the sperms from the vas deferens into the region of the prostate duct and thence through the vaginal passage

and the short connecting canal into the oviducal organs to fertilize the eggs is readily explained.

The spawn is usually attached to a clean thread of alga, but in captivity it is also deposited on the surface of the glass dish or of water. In spawning as observed under the binocular microscope, the oviducal opening becomes widened and the animal bends slightly to the right bringing the pressure of the blood to bear upon the anterior genitalia by a slight contraction of the posterior region of the body. The albumen gland is extended to twice its normal length and gets filled with eggs, which, provided with small enclosing capsules, pass to the mucous gland and thence to the exterior through the oviducal opening. As the eggs pass out they are arranged in a regular closed anti-clockwise spiral. The transparent and sticky secretion of the mucous gland covers the spiral egg-mass completely, giving it the appearance of a string and keeping the eggs in position. The secretion becoming slightly hardened in contact with water, also serves to fix the strings of spawn to the algae or to any other surface upon which they are deposited. While the spawn is being deposited on an algal thread the animal moves forward twisting it round. On a plane surface, however, it assumes the form of a crescent. When the spawn is deposited on the surface of water, the animal floats in the usual manner with its ventral side upwards, so that the eggs come to lie beneath the surface of water suspended by the secretion of the mucous gland. Each string of spawn (Pl. IX, fig. 4.) when stretched is 10 to 25 mm. long, 1.25 mm. thick and contains 700 to 1,500 minute eggs. Two individuals left together in water for a couple of days produce nearly a dozen such strings of spawn. As a result of repeated spawning the individuals are much reduced in size. The length of the string and the number of eggs in it vary with the external environmental conditions. It has been observed that while healthy individuals under favourable conditions deposit long strings of spawn with large number of eggs, those that are starved or exhausted deposit only short strings with fewer eggs.

NOTES ON DEVELOPMENT.

Of the various workers who studied the development of Opisthobranchs, Casteel (16) gave a detailed account of the cell-lineage and early development of the egg into a veliger in the Nudibranch, *Fiona marina*. In this paper I have attempted to describe the more important stages in the early development of *S. gopalai*. The egg (Pl. IX, fig. 5) is a pale yellow spherical body with a diameter of 70μ surrounded by an albuminous, viscous substance, and is enclosed in a thin, roomy, transparent capsule consisting of two laminae. The capsule is slightly oval, about 175μ long, but becomes rounded as the egg divides. Occasionally a capsule of unusually large size with two or three eggs is met with. Only one egg, however, grows into a larva at the expense of the others. The egg has an extremely delicate vitelline membrane and finely divided yolk globules distributed almost uniformly throughout the egg. Immediately after spawning, one or two minute polar bodies are seen loosely attached to the egg near the apical region.

Two hours after spawning, the first cleavage appears, dividing the egg into two almost equal cells, which are rounded at first, but later flattened at the point of cleavage as they press each other (fig. 6). The second cleavage appears two hours after the first at right angles to the latter resulting in four cells of equal size (fig. 7). At about the end of five hours after spawning, the four blastomeres divide giving rise to an upper group of four micromeres and a lower group of four megameres (fig. 8). Further cleavages are rapid with the result that about twenty hours after spawning the egg has divided into a mass of minute cells.

At the end of about twenty four hours after spawning, invagination followed by the formation of the blastopore begins in the central region of the mass of cells at the vegetative pole, (Pl. IX, figs. 9 and 10) resulting in a gastrula. When the invagination is complete, the gastrula has the appearance of an inverted cup with its longitudinal axis shorter than its transverse axis, and its apical region slightly flattened. Soon the gastrula becomes elongated with its apical region prominently pointed (fig. 11). Increased division of the cells near the blastopore causes the region surrounding it to become broader while the blastopore itself is narrowed gradually until it is reduced to a minute crescentic slit (fig. 12), which is probably finally closed¹.

At a later stage which it reaches in about forty five hours (Pl. IX, fig. 13), the gastrula is so far advanced as to pass on to an early veliger larva. In the region of the crescent of the blastopore the stomodaeum (*sto.*) is formed as a deep invagination of the ectoderm. Immediately above this region the velar lobes (*ve.*) make their appearance as two rounded lobes, one on either side, with minutely ciliated margins with the help of which the early veliger rotates inside the capsule. Ventral to the stomodaeum the foot (*ft.*) is formed as a broad median protuberance. The posterior region of this early veliger reveals a broad layer of glandular cells which secrete a thin, transparent shell (*sh.*). The preceding stages, however, show that the shell gland begins as an ectodermal invagination, which opens and extends over the posterior region followed by the thickening of its cells. In the early veliger stage the enteron appears below the shell gland. The anterior end of the enteron touches the stomodaeal invagination (*sto.*) but does not communicate with it. The region immediately behind this is slightly saccular and forms the stomach (*st.*). The liver appears in the form of two lobes of unequal size (fig. 13, *l.l.* and *r.l.*), the left being considerably larger than the right. The intestine (*int.*) is a narrow posterior prolongation of the stomach and joins the ectoderm near the base of the foot. Above the level of the intestine lies a group of vacuolated cells forming the larval kidney (*k.*). The otocysts (*ot.*) which are the earliest sense organs to appear in the larva are seen, one on either side, at the base of the foot below the ectoderm.

¹ As the cells are opaque in this region and as no sections of the gastrula have been taken, I cannot say with certainty that the blastopore closes completely after it is reduced to a minute slit. In *Fiona marina* and other Opisthobranchs the blastopore has been observed by several authors to close completely and in *S. gopalai*, which is an allied form, the same phenomenon may occur.

A typical veliger is formed before the completion of sixty five hours after spawning. During this period the velar lobes increase enormously in size followed by a thickening of their free edge with bigger cilia. The constriction between the two lobes of the velum grows deeper. The stomodaeum finally opens into the stomach where it communicates with the larger left liver lobe. The intestine gets elongated and slender and opens to the exterior. The shell gland thins out as it grows in extent, as a consequence of which the shell grows in size. The foot, which is merely a median protuberance beneath the stomodaeal region, now gradually becomes broadened and flattened. Its upper surface comes to possess minute cilia, while the cells lining its under surface secrete the operculum. The strongly pigmented larval kidney lies immediately above the terminal region of the intestine. At the end of sixty five hours the veliger is fully formed in its egg-capsule with its various organs still slightly opaque, and is seen to rotate inside with the help of its powerful velar cilia which strike against the wall of the enclosing capsule. By about the end of ninety hours or early on the fifth day after oviposition, the thinned-out enveloping membrane is ruptured liberating the larva. The sticky substance, which surrounds the eggs and keeps them in position, becomes soft enough to allow the larvae to escape into the surrounding water. All the larvae in a string of spawn do not escape simultaneously, some taking a longer time than the others.

The larva is a typical free swimming veliger, 120 μ long and 85 μ broad, (Pl. IX, figs. 14 and 15) with a transparent nautiloid shell (*sh.*) and an operculum (*op.*). The antero-dorsally situated velum (*ve.*), is much constricted in the middle region, dividing it into two large lobes with their upper surface hollow. The margins of the velar lobes bear big locomotive cilia and are continuous with those of the narrow constricted middle region. Lower down the velum lies the broad, flattened ciliated foot (*ft.*), which bears on its ventral side an operculum (*op.*). The dorsal retractor muscles (*d.r.*) runs forwards from the left posterior side of the larva behind the large liver lobe to about the middle region of the stomach, where it divides into two strands, which terminate in the antero-dorsal region of the larva. By the contraction of this muscle the velum is withdrawn into the shell. The retraction of the foot is caused by the right and the left retractor muscles of the foot (*r.f.*), which start from the dorsal middle region of the posterior half of the larva and turning along the sides pass anteriorly to terminate in the foot. The mouth lies between the velum and the foot and leads into a fairly long ciliated passage, the stomodaeum (*sto.*), the posterior end of which communicates with a large saccular stomach (*st.*). The latter bears a large liver lobe on the left side and a similar but a smaller one on the right. The intestine (*int.*), starting from the middle region of the stomach, passes forwards to open at the anus situated on the right side slightly below the level of the margin of the shell. The stomach and the intestine are internally ciliated like the stomodaeum. Green unicellular algal matter, which the animal has taken in, is seen in the stomach revolving with great rapidity by the action of cilia. The larva has a pair of large otocysts (*ot.*) placed at the base of the foot, one on either side. The

eyes are absent in the just hatched larva, but four or five days later they make their appearance as two dark spots at the base of the velar lobes.

Our knowledge of the metamorphosis of the larvae of Opisthobranchs is inadequate. Nordman (41) and Schultze¹ have described briefly some aspects of the post-larval development of *Tergipes edwardsii* and *Tergipes lacinulatus* respectively. In spite of all precautions, Infusorians, which grew under laboratory conditions in dishes and attacked the larvae, could not be kept under check. The larvae that escaped the attack of Infusorians for a fortnight grew only in size.

Two or three days after a heavy shower in the first week of October and in the last week of December 1935, metamorphosed young ones in various stages of growth, exceeding 1.25 mm. in length, were obtained from the brackish water pools near the mouth of the river Cooum. In structure they did not differ much from the adults, but the gray and yellow colour of the integument characteristic of the adults was not developed. The young ones were all bright green owing to the presence of algal matter in the gut and the hepatic caeca, and without shell or operculum. The velum had completely disappeared, but the large cilia in the anterior region of the animal (Pl. IX, fig. 16) were still present. The rhinophores of the young ones had blunt tips in contrast to the pointed ones of the adult. The eye posterior to the base of each rhinophore was disproportionately large in relation to the size of the animal. The otocysts near the cerebral ganglia, were seen conspicuously through the transparent integument. The anterior cleft of the foot was not prominent, but the foot was extended into a tail like filament. The only two pairs of cerata were in the form of small protuberances, with the hepatic caeca extending into them. Under the binocular microscope the cerata were of a purple shade in colour, which, however, faded as more were formed. At the stage when five or six cerata were formed on either side, the gray pigment gradually appeared. In the laboratory, the young ones fed voraciously on *Chaetomorpha* and grew rapidly in size. Young forms, only 1.25 mm. in length, attained the full size of the adult within a period of twelve days, and began depositing spawn from the fifteenth or the sixteenth day.

Some points of interest in the breeding habits, early development and growth of *S. gopalai* need special mention here.

That there is no definite period of breeding is clear from the fact that sexually mature individuals were obtained throughout the year either from the Adyar or from the Cooum brackish water pools. Semper (55) and Orton (45) believed that in the tropics, where the temperature is high and remains constant or almost constant, most of the animals breed throughout the year. Aiyar² and Subramaniam³ have observed continuous breeding in Madras in *Salmacis bicolor* and *Clibanarius olivaceus*.

¹ Weigm. Arch. 1849, i. p. 277, as referred by Eliot (26).

² Proc. Ind. Acad. Sci., I, p. 726 (1935).

³ Journ. Royal Micr. Soc., LV, p. 14, (1935).

It has been observed by various writers that when the temperature is high the development of early larvae is accelerated. In *S. gopalai* the veligers escaped out of the spawn within a period of not more than five days after oviposition, whereas in allied Opisthobranchs of the British coasts the minimum time taken was not less than a fortnight (*vide* Reid, 53 and Eliot, 26). Such a rapid development in this form is due probably to high temperature conditions which prevail in Madras.

In *S. gopalai* the young ones grow rapidly to adult size and attain maturity within a fortnight. Orton (44) recorded a similar phenomenon in the life-history of *Galvina picta*. A raft moored about six weeks after it was in the sea showed a number of Nudibranchs, particularly *Galvina picta* of varying sizes and their egg masses among a thick growth of *Obelia geniculata*, on which those animals were observed to feed. He observed that "the Nudibranchs had undoubtedly peopled the raft as veligers, rushed through their development at the expense of the Hydroids and were giving off veligers again to populate Hydroids elsewhere within a period of not longer than six weeks and two days" In *S. gopalai* the growth of the young ones is more rapid than in the case of *Galvina picta*. In the brackish waters of Madras where the environmental conditions are continually changing, an extremely rapid growth to attain maturity seems to be a necessity, as favourable conditions do not last long.

BEHAVIOUR OF THE ANIMAL IN RESPECT OF VARIATIONS IN SALINITY.

Apart from other factors such as temperature and food supply, the salinity of the brackish water, which has been observed to be always changing, seems to exercise a great control over the animals. When the animals were first observed in the brackish water pools near the mouth of the Cooum about the end of August 1935 and in the backwaters of Adyar in the month of September, the waters in both the places had a low salinity as the localities were not in open communication with the sea and were flooded by freshets brought by the rivers. The bar near the mouth of the river Cooum opened during the last week of September 1935, much earlier than the one at the Adyar river mouth. As more and more sea water was brought into the brackish water pools, the salinity increased and the algae disappeared, the animals were no longer found. In the Adyar backwaters, however, the salinity remained low, and individuals of *S. gopalai* were still found. By about the middle of October 1935, the salinity in the pools at the mouth of the Cooum had been brought down by rainfall. Three days after the rain numerous young ones ranging from 1.25 mm. to 2.5 mm. in length appeared suddenly. But the low salinity condition was not maintained long with the opening of the bar. With the gradual rise in the salinity the animals began to diminish in numbers until they grew scarce. Up to the month of November 1935, adult animals were collected in Adyar, but none after the bar had been opened. The bar near the mouth of the river Cooum silted up very early; and during the last week of December 1935, a few days after rains, metamorphosed young ones appeared again with the sudden fall in the salinity. The appearance of the young forms coincided with the growth of *Chaetomorpha* (on which they feed)

on the sides of rocks and other hard surfaces. From the last week of December 1935, and as long as the bar remained closed near the mouth of the Cooum, the animals continued to occur.

The observations made seem to show that the animals live in water of salinity distinctly lower than that of the sea. Since they are rare when the bar remains open for considerable periods, I am led to believe that, due to the incoming sea water and the increase in salinity a large number perishes. When more fresh water accumulates in the brackish water pools reducing the salinity, the animals occur in large numbers and breed. As the metamorphosed young ones were obtained nearly always after a heavy shower, it seems probable that a lowered salinity is an essential condition for metamorphosis.

SYSTEMATIC POSITION OF *S. GOPALAI*.

The Sub-Order Ascoglossa, of the Order Opisthobranchiata, is characterised by the presence of a suctorial pharynx, of a uniseriate radula the teeth of which when worn out are retained in a sac or ascus, of a single otolith in each otocyst, of a penial spine, and of a visceral loop with two or three visceral ganglia. There are no jaws.

The family Hermaeidae of Ascoglossa includes *Stiliger*, *Ercolania*, *Hermaea* and *Alderia*. O'Donoghue (43) is of opinion that the family should be named Stiligeridae and not Hermaeidae, for the reason that *Stiliger* and not *Hermaea* is the oldest member of the family. According to strict rules of biological nomenclature he is correct, though the family is better known by the name Hermaeidae.

The general Eolidiform appearance of the body, the position of the anus in front of the pericardium and the presence of a single pair of long and smooth tentacles place the present form in the genus *Stiliger* of Ehrenberg.

The specific characters of *Stiliger gopalai*, sp. nov. may be summarized as follows: colouration of the body is deep brownish gray stippled with yellow; cerata, about forty on each side coloured dark gray with white tips, are neither very slender nor bulged out; the ramifications of the digestive gland in the cerata have a single main stem with a few minute branches; foot is narrow, pale yellow, with the anterior lobes rounded and the tail filamentous; the radula has five teeth in the ascending axis and seven in the descending axis; axes are straight but not spiral; margin of the teeth is wavy; penial armature is short and recurved; there is no pericardial prominence.

Stiliger gopalai differs from all other species described hitherto but combines in itself several characteristics of different species of the genus. The present form differs from *Stiliger bellulus* (syn. *S. mariae* 22; 26; and 9, 1872) in the nature of the radula, cerata and penial armature. In *S. bellulus* the descending axis of the radula is a spiral showing a large number of teeth which have broad bases and narrow apices; the cerata are conspicuously bulged showing a large number of hepatic ramifications; and the penial armature is long and slender. In *S. souleyeti* (57) the presence of a uniform green colouration, of large and club-shaped cerata and of a radula resembling that of *S. bellulus*, clearly separate it out

from the present species. The teeth of *S. gopalai* resemble very closely those of *S. varians* (21); but the marine habitat, the extremely small size of the body, the inflated cerata and the bladder-like pericardial prominence in the latter make it distinct from the former. *S. irregularis* (21) is marine, the general colouration is reddish gray, the oral veil is not notched and the margins of the teeth are less wavy than those of *S. varians*. These important features of *S. irregularis* distinguish it from the present form. The presence of a spirally coiled descending axis of the radula, a very prominent posterior prolongation of the pericardium and the probable absence of the penial armature in *S. felinus* (25) distinguish it from *S. gopalai*. *S. tentaculatus* (29) differs from all others of the genus in having well developed oral tentacles and tentacular prolongations of the foot. The absence of filamentous tail and of white spots in the foot, and the presence of a radula resembling that of *S. bellulus* and of the very slender cerata in *S. pica* (56) differentiate it from *S. gopalai*. *S. gopalai* and *S. pica*, however, agree in their brackish water habitat and short penial armature.

In Eliot's opinion *Stiliger ornatus* Ehrenberg, the specific characters of which are not given, agrees with *S. bellulus*. *Pterochilus viridis* of Kelaart (38) was, however, doubtfully referred as '*Stiliger? viridis*' by Eliot in 1906 (23); but the green colouration of the body and the capsular spawn distinguish it from the present species. The nature of the radula in *S. ornatus* and '*Stiliger? viridis*' is not known. *Custiphorus vesiculosus* of Deshayes was ascribed by Fischer (32) to the genus *Calliopaea* while in 1928 O'Donoghue (43) referred it to *Stiliger*. Apart from other characters, the colouration of *S. vesiculosus* and the presence of vesicles or globules in the cerata distinguish it from *S. gopalai*. Doubting the correctness of treating *Ercolania* as a genus separate from *Stiliger*, O'Donoghue (43) provisionally included under the genus *Stiliger* all the species of *Ercolania*, viz., *E. siottii*, *E. panceri*, *E. uzilli*, etc. As discussed in the history of this genus at the beginning of this paper (*antea* pp. 436-438) *Ercolania* can be distinguished as a separate genus from *Stiliger* on account of the absence of canaliculated grooves in the rhinophores of the latter.

SUMMARY.

1. The external and internal morphology of *Stiliger gopalai*, sp. nov. from the brackish waters of Madras is fully described with a brief account of the bionomics and early development.
2. The digestive system of *S. gopalai* while agreeing with that of several species of the genus, differs from that of *S. souleyeti* in having no oesophageal caecum. The radula closely resembles that of *S. varians* and *Ercolania siottii*. The hepatic ramifications are simple and give off very minute branches.
3. The central nervous system shows a primitive condition as in all Ascoglossa. The visceral loop bears only two ganglia, the abdominal and the supra-intestinal. The sub-intestinal ganglion is absent as in *Limapontia*. Gastro-oesophageal ganglia are absent.

4. The reproductive system is fully described including the histology of the accessory glands. The penial armature is extremely short unlike that of *S. bellulus* and closely resembles that of *Limapontia*.
5. The process of copulation and spawning has been observed. The course of the eggs from the hermaphrodite follicles to the exterior is described. The spawn is a cylindrical string and the eggs are closely arranged in anti-clockwise spiral within. Animals were observed to deposit spawn even without copulation. The animals breed throughout the year.
6. The eggs develop into veligers very rapidly. The metamorphosed young ones, collected from the natural habitat, attain the adult size and maturity within a period of fifteen days.
7. The animals become scarce with the increase in salinity in the brackish waters due to communication with the sea. Large numbers of animals were collected when the salinity was low. A sudden fall in the salinity seems to favour matamorphosis.

BIBLIOGRAPHY.

1. Agersborg, H. P. K.—“Notes on the Locomotion of the Nudibranchiate Mollusk *Dendronotus gigantius* O'Donoghue.” *Biol. Bull.*, XLII, pp. 257-266, (1922.)
2. Agersborg, H. P. K.—“The Morphology of the Nudibranchiate Mollusc, *Melibe* (syn. *Chioraera*) *leonina* (Gould).” *Quart. Journ. Micr. Sci.*, LXVII, pp. 507-592, (1923).
3. Alder, J. and Hancock, A.—“Notice of a British species of *Calliopa*, D'Orbigny, and of four new species of *Eolis*, with observations on the Development and Structure of the Nudibranchiate Mollusca.” *Ann. Mag. Nat. Hist.*, London, XII, pp. 233-238, (1843).
4. Alder, J. and Hancock, A.—“Remarks on the Genus *Eolidina* of M. de Quatrefages.” *Ann. Mag. Nat. Hist.*, London, XIV, pp. 125-129, (1844).
5. Alder, J. and Hancock, A.—“On a proposed New Order of Gasteropodous Mollusca.” *Ann. Mag. Nat. Hist.*, London, (2) I, pp. 401-415, (1848).
6. Alder, J. and Hancock, A.—“A Monograph of the British Nudibranchiate Mollusca.” *Ray Soc. London*, Pt. 7, (1855).
7. Alder, J. and Hancock, A.—“Notice of a Collection of Nudibranchiate Mollusca made in India by Walter Elliot Esq., with Descriptions of several New Genera and Species.” *Trans. Zool. Soc. London*, V, Pt. 3, pp. 113-147, (1866).
8. Allman, Geo. J.—“Note on a new Genus of Nudibranchiate Mollusca.” *Ann. Mag. Nat. Hist.*, London, XVII, pp. 1-5, (1846).
9. Bergh, R.—“Malacologische Untersuchungen.” *Semper's Reisen im Archipel der Philippinen*. I Bd. II, (1870-75).
10. Bergh, R.—“Report on the Nudibranchiata dredged by H. M. S. Challenger during the years 1873-76.” *Rep. Sci. Res. Expl. Voy. H. M. S. Challenger, Zool.* X, pp. 1-154, (1873-76).

11. Bergh, R.—“ Die cladohepatischen Nudibranchien.” *Zool. Jahrb. Systematik*, Bd. V, pp. 1-75, (1891).
12. Bergh, R.—“ Die Opisthobranchiata der Siboga Expedition.” *Siboga Exped. Monogr. L*, Leiden, (1905).
13. Bergh, R.—“ Uber clado- und holohepatische Nudibranchiate Gastropoden.” *Zool. Jahrb. Systematik*. XXIII, pp. 739-741, (1906).
14. Brown, Herbert, H.—“ A study of a Tectibranch Gasteropod Mollusc, *Philine aperta* (L.).” *Trans. Royal Soc. Edin.*, LVIII, pp. 179-210, (1934).
15. Bucking, G.—“ *Hedyle amboinensis* (Strubell).” *Zool. Jahrb. Systematik*, LXIV, pp. 549-582, (1933).
16. Casteel, D. B.—“ The Cell-Lineage and Early Larval Development of *Fiona marina*, a Nudibranch Mollusk.” *Proc. Acad. Nat. Sci.*, Philadelphia LVI, pp. 325-405, (1904).
17. Chenu, J. C.—“ Manuel de Conchyliologie et de Paleontologie Conchyliologique ” (*Calliopaëa bellula* in natural colours on page 131, Fig. 559—*S. ornatus* on page 414, Fig. 3081), Paris, (1859).
18. Eales, N. B.—“ *Aplysia* ” *Liv. Mar. Biol. Comm. Memoir*, 24, (1921).
19. Edwards, H. Milne, “ Sur l'Existence d'un Appareil Gastro-vasculaire chez la *Calliopee* de Risso, Mollusque de la famille des Eolidiens.” *Annales des Sci. Naturelles*, 2 ser. XVIII, pp. 330-350, (1842).
20. Eliot, C. “ On some Nudibranchs from East Africa and Zanzibar. Pt. II.” *Proc. Zool. Soc. London*, pp. 250-257, (1903).
21. Eliot, C.—“ On some Nudibranchs from East Africa and Zanzibar. Pt. VI.” *Proc. Zool. Soc. London*, pp. 268-298, (1904).
22. Eliot, C.—“ Notes on some British Nudibranchs.” *Journ. Mar. Biol. Assoc.*, VII, pp. 333-382, (1906).
23. Eliot, C.—“ On the Nudibranchs of Southern India and Ceylon, with special reference to the Drawings made by Kelaart and the Collections belonging to Alder and Hancock preserved in the Hancock Museum at Newcastle-on-Tyne.” *Proc. Zool. Soc. London*, pp. 636-691, (1906).
24. Eliot, C.—“ The Nudibranchiata, with some remarks on the families and genera and description of a new genus *Doridomorpha*.” Stanley Gardiner's *Fauna and Geography of the Maldive and Laccadive Archipelagoes*, II, pp. 540-573, (1906).
25. Eliot, C.—“ Nudibranchs from New Zealand and the Falkland Islands.” *Proc. Malac. Soc. London*, VII, pp. 327-361, (1907).
26. Eliot, C.—“ A Monograph of the British Nudibranchiate Mollusca.” *Ray Soc. London*, Pt. 8 supplementary, (1910).
27. Eliot, C.—“ Notes on Nudibranchs from the Indian Museum.” *Rec. Ind. Museum*, V, pp. 247-252, (1910).
28. Eliot, C.—“ Fauna of the Chilka Lake : Mollusca Nudibranchiata.” *Mem. Ind. Museum*, V, pp. 377-379, (1916).
29. Eliot, C.—“ Zoological Results of a Tour in the Far East : Mollusca Nudibranchiata (Ascoglossa).” *Mem. Asiatic Soc., Bengal*, VI, pp. 179-182, (1916).

30. Eliot, C. and Evans, T. J.—“*Doridoeides gardineri* : a Doridiform Cladohepatic Nudibranch.” *Quart. Journ. Micr. Sci.*, LII, pp. 279-299, (1908).
31. Evans, T. J.—“*Calma glaucoides* : A Study in Adaptation.” *Quart. Journ. Micr. Sci.*, LXVI, pp. 439-455, (1922).
32. Fischer, P.—“Note sur le genre *Calliopaea*, D’Orbigny.” *Journ. de Conchyl.*, Tome. XIX, pp. 89-91, (1871).
33. Fischer, P.—“Manuel de Conchyliologie et Palaeontologie Conchyliologie.” Paris, I, (1887).
34. Hancock, A.—“On the Anatomy of *Doridopsis*, a genus of the Nudibranchiata Mollusca.” *Trans. Linn. Soc. London*, XXV, pp. 189-207, (1865).
35. Hancock, A. and Embleton, D.—“On the Anatomy of *Eolis*, a genus of Mollusks of the Order Nudibranchiata.” *Ann. Mag. Nat. Hist.*, London, XV, pp. 1-10 and pp. 77-88, (1845); 2 ser. I, pp. 88-105, (1848); III, pp. 183-202, (1849).
36. Herdman, W. A.—“On the structure and functions of the cerata or dorsal papillae in some Nudibranchiate Mollusca.” *Quart. Journ. Micr. Sci.*, XXXI, pp. 41-63, (1890).
37. Jeffreys, J. G.—“*British Conchology*.” V, London, (1869).
38. Kelaart, E. F.—“Descriptions of new and little-known species of Ceylonese Nudibranchiate Mollusks.” *Ann. Mag. Nat. Hist.*, London, (3) III, pp. 488-496, (1859).
39. Labbe, A.—“Liste des Nudibranches Recueillis a la station du Croisie de 1913 A 1931 : *Stiliger bellulus* d’Orbigny, Var.” *Bull. de la soc. Zool. de France*, Tome, LVI, pp. 452-453, (1931).
40. MacFarland, F. M.—“The Nudibranch family Dironidae.” *Zool. Jahrb.* (Suppl. 15 : Festschrift für J. W. Spengel), Bd. I, pp. 515-533, (1912).
41. Nordmann, A. De.—“Essai d’une Monographie du *Tergipes Edwardsii*.” *Ann. des. Sci. Naturelles, Zool.*, (3) V, pp. 109-159, (1846).
42. O’Donoghue, C. H.—“Report on Opisthobranchiata from the Abrolhos Islands, Western Australia, with Description of a new parasitic Copepod.” *Trans. Linn. Soc. London*, XXXV, pp. 521-579, (1923).
43. O’Donoghue, C. H.—“Zoological Results of the Cambridge Expedition to the Suez Canal 1924. Report on the Opisthobranchiata.” *Trans. Zool. Soc. London*, XXII, Pt. 6, pp. 713-841, (1928).
44. Orton, J. H.—“Preliminary Account of a Contribution to an Evaluation of the Sea : The Life-History of *Galvina picta*.” *Journ. Mar. Biol. Assoc.*, X, pp. 323-324, (1914).
45. Orton, J. H.—“Sea Temperature, Breeding and Distribution in Marine Animals.” *Journ. Mar. Biol. Assoc.*, XII, pp. 339-366, (1922).
46. Pelseneer, P.—“Hermaphroditism in Mollusca.” *Quart. Journ. Micr. Sci.*, XXXVII, pp. 19-46, (1895).
47. Pelseneer, P.—Lankester’s Treatise on Zoology. Pt. 5, (1906).
48. Quatrefages, M. De.—“Memoire sur l’Eolidine paradoxale (*Eolidina paradoxum*).” *Ann. des Sci. Naturelles*, (2 Se.) XIX, pp. 274-312, (1843).

49. Quatrefages, M. De.—“Memoire sur les Gastropodes Phlebenteres.” *Ann. des Sci. Naturelles*, (3 Se.) I, pp. 129-179, (1844).
50. Quatrefages, M. De.—“Note sur le Phlebenterisme.” *Ann. des Sci. Naturelles*. (3 Se.) IV, pp. 83-94, (1845).
51. Quatrefages, M. De.—“Resume des Observations faites en 1844, sur les Gasteropodes Phlebenteres.” *Ann. des Sci. Naturelles*. (3 Se.) X, pp. 121-143, (1848).
52. Rao, K. V.—“The Morphology of *Kalinga ornata* (Ald. & Han.)” *Rec. Ind. Museum*, XXXVIII, pp. 41-79, (1936).
53. Reid, J.—“On the Development of the Ova of the Nudibranchiate Mollusca.” *Ann. Mag. Nat. Hist.*, London, XVII, pp. 377-389, (1846).
54. Russel, L.—“The Comparative Morphology of the Elysioid and Aeolidioid Types of the Molluscan Nervous System, and its Bearing on the Relationships of the Ascoglossan Nudibranchs.” *Proc. Zool. Soc. London*, pp. 197-233, (1929).
55. Semper, K.—“Animal Life,” *Int. Sci. Ser.* London, (1883).
56. Sewell, R. B. S. and Annandale, N.—“Fauna of Chilka Lake: The Hydrography and Invertebrate Fauna of Rambha Bay in an abnormal year—*Stiliger pica* Ann. & Prashad.” *Mem. Ind. Museum*, V, pp. 700-702, (1922).
57. Souleyet, F. L. A.—“Genere *Calliopee*—*Calliopaea*, d’Orbigny.” *Voyage De la Bonite. Zoologie*, II, pp. 447-450, (1852).
58. Tryon, Jr., G. W.—“Structural and Systematic Conchology: An Introduction of the Study of Mollusca.” Philadelphia, II, (1883).
59. Vayssiere, A.—“Recherches Zoologiques et Anatomiques sur les Mollusques Opisthobranchs du Golfe de Marseille.” Pt. II, Nudibranchs (Cirrobranchs) et Ascoglossess. *Ann. du Musee d’Hist. Nat. de Marseille, Zoologie*, Tome, III, pp. 160, (1888).
60. Verany, D. G. B.—“Catalogue des Mollusques: Cephalopodes, Pteropodes et Gastropodes Nudibranches. *Journ. de Conchyl.* Tome. IV, pp. 375-392, (1853).

KEY TO LETTERING

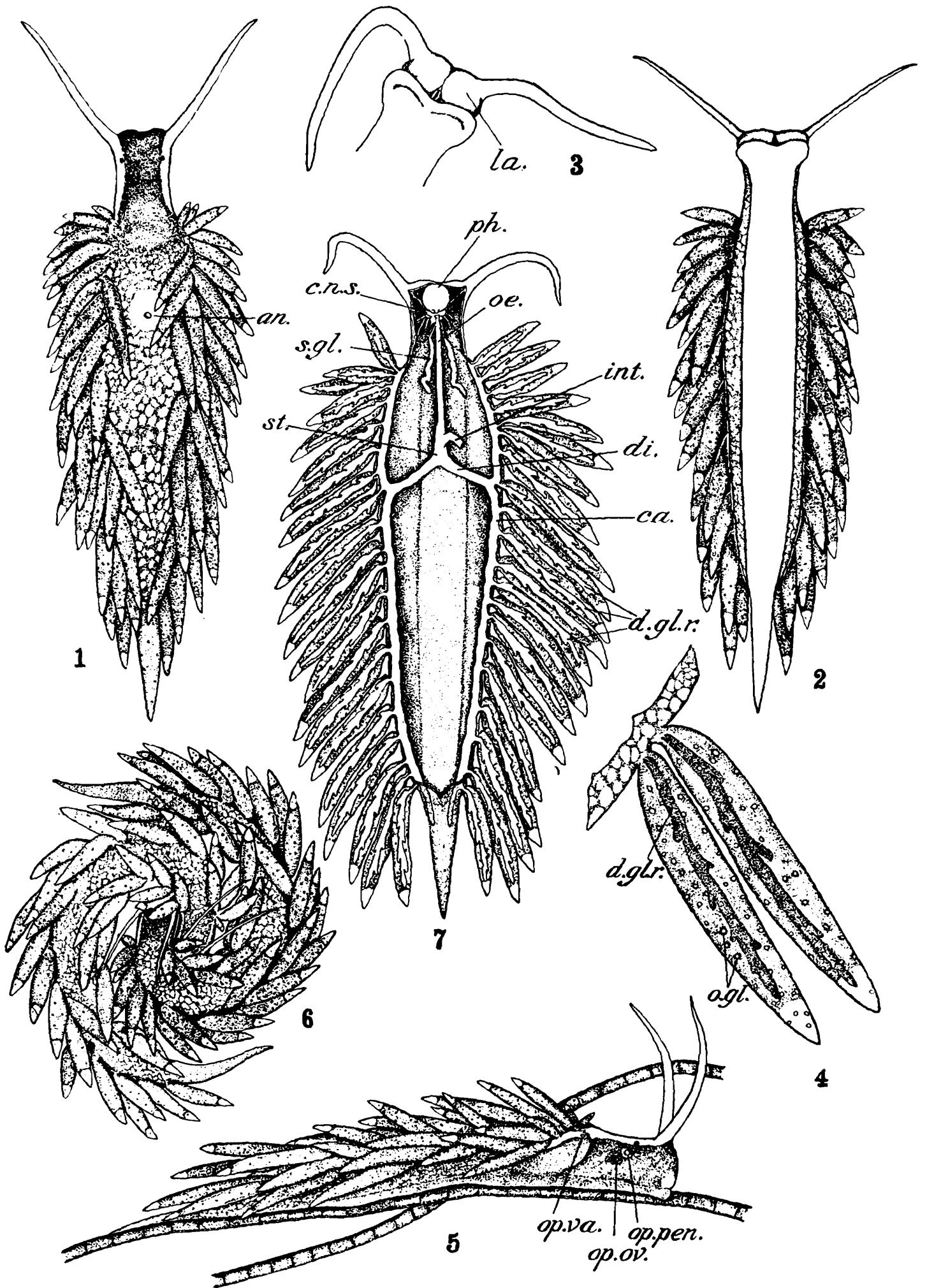
<i>ab. g.</i>	abdominal ganglion.
<i>al. gl.</i>	albumen gland of the anterior genitalia.
<i>an.</i>	anus.
<i>a. pa 1.</i>	1st anterior pallial nerve.
<i>a. pa 2.</i>	2nd anterior pallial nerve.
<i>as.</i>	ascus.
<i>au.</i>	auricle.
<i>b. g.</i>	buccal ganglia.
<i>b. gl.</i>	large buccal glands.
<i>b. gl'</i>	small buccal glands.
<i>b. n 1.</i>	1st pair of nerves from buccal ganglia.
<i>b. n 2.</i>	2nd pair of nerves from buccal ganglia.
<i>b. n 3.</i>	gastro-oesophageal nerves.
<i>c 1.</i>	1st pair of cerebral nerves.
<i>c 2.</i>	2nd pair of cerebral nerves.

<i>c 3.</i>	3rd pair of cerebral nerves.
<i>c 4.</i>	4th pair of cerebral nerves.
<i>c 5.</i>	5th pair of cerebral nerves.
<i>ca.</i>	caecal prolongations of the digestive system.
<i>c. b. c.</i>	cerebro-buccal commessure.
<i>c. g.</i>	cerebro-buccal ganglia.
<i>ci.</i>	cilia.
<i>ci. c.</i>	ciliated cells.
<i>c. n. s.</i>	central nervous system.
<i>cr.</i>	crypts through which the glands open.
<i>ct. c.</i>	connective tissue.
<i>cy.</i>	cytoplasm of gland cells.
<i>d. gl. r.</i>	glandular ramifications of digestive gland.
<i>di.</i>	diverticulum communicating with the stomach.
<i>di. r.</i>	diverticulum of the renal chamber.
<i>d. r.</i>	dorsal retractor muscle of the veliger.
<i>du.</i>	ductules from the follicles of hermaphrodite gland.
<i>epi.</i>	epithelium.
<i>ey.</i>	eye.
<i>ft.</i>	foot.
<i>g. and g'</i>	small ganglia of the gastro-oesophageal nerves.
<i>ge. g.</i>	a small ganglion of the first visceral nerve situated in the anterior genitalia.
<i>gl. c.</i>	gland cells.
<i>gr.</i>	granules.
<i>hr. am.</i>	ampulla of the hermaphrodite duct.
<i>hr. d.</i>	common hermaphrodite duct.
<i>hr. d 1.</i>	hermaphrodite duct from the anterior group of follicles.
<i>hr. d 2.</i>	hermaphrodite duct from the posterior group of follicles.
<i>hr. gl..</i>	follicles of hermaphrodite gland.
<i>int.</i>	intestine.
<i>k.</i>	kidney of the veliger.
<i>l.</i>	central lumen.
<i>la.</i>	labial folds.
<i>l. l.</i>	left lobe of the liver in the larva.
<i>l. ph.</i>	lumen of anteriormost region of pharyngeal bulb cut in section.
<i>m.</i>	mouth.
<i>m. f.</i>	muscle fibres.
<i>m. g.</i>	unicellular mucous glands of foot.
<i>m. m. g.</i>	multicellular mucous glands of foot.
<i>mu. gl.</i>	mucous gland of the anterior genitalia.
<i>n. in.</i>	a branch of the third visceral nerve to intestine.
<i>n. p.</i>	a short branch from the first pallial nerve to penis pouch.
<i>nu.</i>	nuclei of the gland cells.
<i>oe.</i>	oesophagus.
<i>o. f. l.</i>	outer fibrous layer.

<i>o. gl.</i>	odoriferous glands.
<i>op.</i>	operculum of veliger.
<i>op. g.</i>	optic ganglion.
<i>op. ov.</i>	oviducal opening.
<i>op. pen.</i>	opening of the male genital organ.
<i>op. va.</i>	vaginal opening.
<i>ot.</i>	otocyst.
<i>p 1.</i>	1st pedal nerve.
<i>p 2.</i>	2nd pedal nerve.
<i>p 3.</i>	3rd pedal nerve.
<i>p. c. r.</i>	branch of 3rd visceral nerve to the pericardium, heart and renal chamber.
<i>pe.</i>	pericardium.
<i>pen.</i>	penis.
<i>pen. s.</i>	penis pouch.
<i>p. g.</i>	pedal ganglion.
<i>ph.</i>	pharyngeal bulb.
<i>p. pa..</i>	posterior pallial nerve of the right side.
<i>p. pa'</i>	posterior pallial nerve of the left side.
<i>pr. d.</i>	main duct of the prostate.
<i>pr. d 1.</i>	anterior lateral branch of the prostate.
<i>pr. d 2.</i>	posterior lateral branch of the prostate.
<i>pr. r.</i>	glandular ramifications of the prostate.
<i>r. c.</i>	renal chamber.
<i>r. f.</i>	retractor muscles of the foot of the Veliger.
<i>r. h. g.</i>	right hepato-gastric nerve.
<i>r. l.</i>	right lobe of liver in larva.
<i>r. o.</i>	renal pore.
<i>r. p. o.</i>	reno-pericardial opening.
<i>s. gl.</i>	salivary glands.
<i>sh.</i>	shell of the larva.
<i>s. i. g.</i>	supra-intestinal ganglion.
<i>spt.</i>	spermatheca.
<i>st.</i>	stomach.
<i>sto.</i>	stomodaeum of the larva.
<i>v.</i>	ventricle.
<i>v 1.</i>	1st visceral nerve.
<i>v 2.</i>	2nd visceral nerve.
<i>v 3.</i>	3rd visceral nerve.
<i>v 4.</i>	4th visceral nerve.
<i>va.</i>	vacuoles in the cytoplasm.
<i>va. a.</i>	ampulla of the vagina.
<i>va. c.</i>	vaginal passage.
<i>va. d.</i>	dilated bulb of the vaginal passage.
<i>v. d.</i>	vas deferens.
<i>ve.</i>	velum of the veliger larva.
<i>vei.</i>	veins.

EXPLANATION OF PLATE VII.

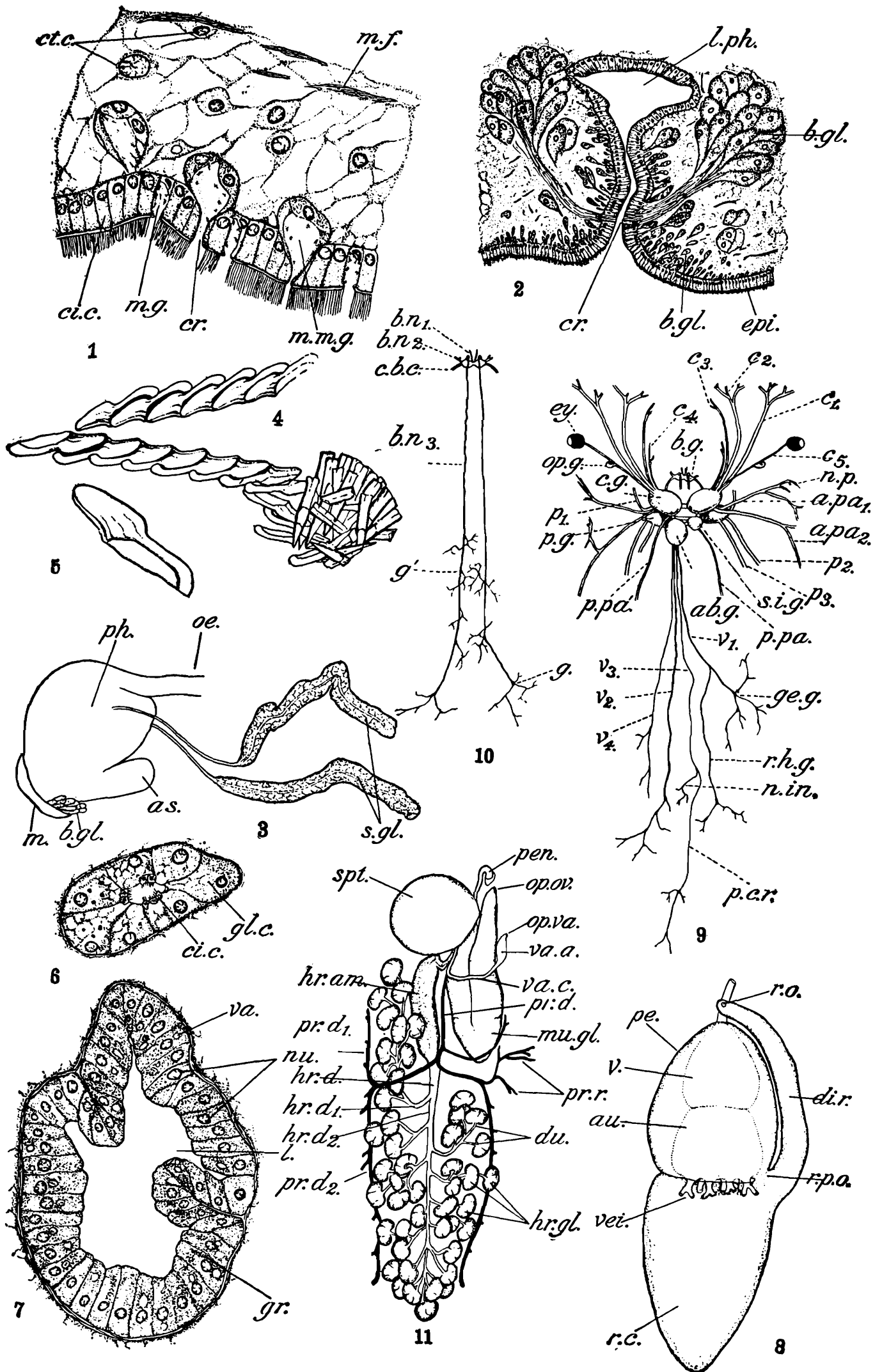
- FIG. 1.—Dorsal view of *Stiliger gopalai*, sp. nov. ×8.
FIG. 2.—Ventral view of *Stiliger gopalai*. ×8.
FIG. 3.—Ventral view of the snout. ×16.
FIG. 4.—Cerata magnified to show the ramifications of the digestive gland and the odoriferous glands.
FIG. 5.—Side view of *Stiliger gopalai* creeping on *Chaetomorpha*. ×8.
FIG. 6.—A pair of individuals seen in copulation.
FIG. 7.—Digestive system of *Stiliger gopalai* as seen in a dissection made with the aid of the binocular microscope.



Stiliger gopalai, sp. nov.

EXPLANATION OF PLATE VIII.

- FIG. 1.—Transverse section of the foot. $\times 600$.
- FIG. 2.—A transverse section passing through the mouth region showing the buccal glands. $\times 100$.
- FIG. 3.—Side view of pharyngeal bulb with the salivary glands and the buccal glands. $\times 30$.
- FIG. 4.—The radula. $\times 100$.
- FIG. 5.—A single tooth magnified twice as in Fig. 4.
- FIG. 6.—Transverse section of salivary gland. $\times 300$.
- FIG. 7.—Transverse section of the digestive gland in the cerata. $\times 300$.
- FIG. 8.—Diagrammatic representation of the pericardium containing the heart and its relation to the renal system, reconstructed from serial sections.
- FIG. 9.—General view of the nervous system. Highly magnified.
- FIG. 10.—The buccal ganglia and their nerves. Highly magnified.
- FIG. 11.—General view of the reproductive system as revealed in dissection under the binocular microscope.



Stiliger gopalai, sp. nov.