XXIX NOTES ON THE SURFACE-LIVING COPEPODA OF THE BAY OF BENGAL, I AND II

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(Plates xiv—xxiv).

INTRODUCTION.

Up to the present time, our knowledge of the species and distribution of surface-living Copepoda in the Bay of Bengal is confined to a paper by the late Mr. I. C. Thompson, who worked out a collection made by Captain Wyse of the S. S. "Johannesburg" during a voyage from Delagoa Bay to Calcutta ("Report on two collections of Tropical and more northerly Plankton." I. C. Thompson, F.L.S., *Trans. Liverpool Biol. Soc.*, vol. xiv, 1899-1900). Several extensive collections have, however, been made in neighbouring waters and the results are contained in the following papers:—

(1) The Siboga collection, from the region between Borneo on the west and New Guinea on the east. The Copepoda of the "Siboga" Expedition. A. Scott. Leyden, 1909.

(2) The collection made by Professor Herdman around Ceylon and worked out by I. C. Thompson and A. Scott. The Ceylon Pearl Oyster Fisheries and Marine Biology, pt. i, 1903. London.

(3) The collection made by Professor S. Gardiner in the Maldive and Laccadive Archipelagoes and worked out by Dr. Wolfenden. The Fauna and Geography of the Maldive and Laccadive Archipelagoes, vol. ii, 1903-1906. Cambridge.

In addition to these I must mention other minor collections described in the following papers:—

(4) Giesbrecht: Ueber pelagischen Copepoden des Rothen Meeres: Zoologische Jahrbucher, Syst. Abth., Band ix, 1897. Jena.

(5) Cleve: Planktonic organisms from the Indian Ocean and Malay Archipelago. Kong Sv. Vet. Akad. Handlingar, Bd. 35, No. 5, 1901-02. Stockholm.

(6) A. Scott: Some Red Sea and Indian Ocean Copepoda. Trans. Liverpool Biol. Soc., vol. xvi, 1902 Liverpool.

(7) Cleve: Record of a voyage made by Thorild Wulff to and from Bombay. Arkiv for Zoologi, Band i, 1903-04. Stockholm.

During the early months of 1911 and again in November of the same year the R.I M.S. "Investigator" was carrying out a survey of the coast of Burma, and advantage was taken of the opportunity thus offered to make a collection of the free-living Copepoda that frequent the surface waters of this region.

There was also in the Indian Museum a large collection made some years previously by the "Investigator" in the region of the coast off Chittagong; these collections have been worked out and the results are embodied in the following paper.

For purposes of convenience I have divided the collections into two series, the first comprises those from the Chittagong region and the Rangoon River estuary, while the second deals with the collections made further south in the neighbourhood of the Moscos Islands and the mouth of Tavoy River.

I.—THE GYMNOPLEA OF THE CHITTAGONG AND RANGOON RIVER ESTUARIES; WITH NOTES ON THE APPLICATION OF "BROOKS' LAW" TO THE COPEPODA AND EVIDENCE OF DIMORPHISM IN THIS GROUP OF CRUSTACEA.

As regards the collection from the Chittagong region there is unfortunately no indication of how the collection was made, and whether or not it is composed of the results from several surface trawls or only a single one, nor is there anything to indicate at what time of the year it was taken; it is probable however that the collection was made in 1903 during the months of January to March as that was, I believe, the last occasion on which the R.I.M.S. "Investigator" was surveying in that locality.

The collection from the Rangoon River estuary was made on three consecutive nights by means of a surface tow-net allowed to drift with the tide. The resulting catch was extremely copious, though subsequent examination showed that the actual number of species represented was small; but this lack of variety was amply compensated by the fact that out of a total of seven (or possibly eight) species five were new to science and as regards the *Labidocera euchaeta*, Giesbrecht, not only was the corresponding male, hitherto unknown present in large numbers, but a probably dimorphic form was also obtained. The main bulk of the collection consisted of large numbers of *Acrocalanus inermis*, sp nov. and *Labidocera euchaeta*, Giesbrecht, in various stages of development, and a study of these forms and the various changes that take place during the growth of these two species has led to results of very considerable interest. So many external factors such as temperature, salinity, or food supply, may possibly produce varia-

tion in the developmental changes that it is only in such cases as this, where a large number of stages can be obtained at the same time and place, that one is able with comparative ease to carry out investigations regarding the laws of development. The locality where the collection was made is situated at the mouth of the river close to the fairway buoy ("Investigator" station 394, 16° 16′ 00″ N., 96° 21′ 00″ E., 13-xi-1911), and hydrometer readings showed that the density of the water was very low, the average reading being 1002.

In the following table I have given a list of the Copepoda (Gymnoplea) present in the two collections, and a comparison of the two faunas indicates that the collection from Chittagong was probably made further out to sea, where there was greater admixture of the estuarine and truly marine forms than in the Rangoon River estuary.

RANGOON RIVER ESTUARY.	OFF CHITTAGONG.
Acartia spinicauda, Giesbrecht.	*Acartia spinicauda*, Giesbrecht.
Acartia tortaniformis, sp. nov.	*Acartia tortaniformis*, sp. nov.
Acrocalanus inermis, sp. nov.	*Acrocalanus gibber* (Giesbrecht).
Centropages alcocki, sp. nov.	*Acrocalanus inermis*, sp. nov.
Labidocera euchaeta, Giesbrecht.	*Canthocalanus pauper* (Giesbrecht).
Paracalanus dubia, sp. nov.	*Candacia bradyi*, Scott.
Pseudodiaptomus binghami, sp. nov.	*Centropages notoceras*, Cleve,[1] (? = *dorsispinatus*, Scott and Thompson).
	Centropages furcatus (Dana).
	Centropages orsinii, Giesbrecht.
	Centropages tenuiremis, Thompson and Scott.
	Eucalanus monachus, Giesbrecht.
	Euchaeta concinna, Dana.
	Labidocera acuta (Dana).
	Labidocera euchaeta, Giesbrecht.
	Labidocera kröyeri (G. Brady).
	Labidocera minuta, Giesbrecht.
	Paracalanus aculeatus, Giesbrecht.
	Paracalanus serratipes, sp. nov.
	Pontella andersoni, sp nov.
	Pontellopsis regalis (Dana).
	Undinula vulgaris (Dana).

[1] I am somewhat doubtful about these species. Cleve apparently considered them synonymous, but both accounts differ in certain details and a consideration of the matter will be found below, in the second paper dealing with the Copepoda from the Moscos region.

I have embodied the results obtained in the following paper and for the sake of convenience I have divided it into two parts dealing respectively with the developmental changes in certain species and with a full description of the new forms obtained.

1. DEVELOPMENT.

From time to time results have been published showing that in certain members of the Crustacea the animal during the course of its development, as each succeeding growth-moult takes place, increases in size by a definite proportion.

W K. Brooks (1886, p. 105) was the first to show that such a mathematical relationship existed between the successive larval stages of the Stomatopoda.

Hadley (1906) has shown that a similar condition of affairs is met with in the American lobster, *Homarus americanus*, Milne Edwards. Unfortunately I have not been able to see this paper, but Herrick (1911, p. 362), in his work on the natural history of this animal, has reprinted Hadley's results. In the table given he shows that during the earlier moults the growth-factor is 1·18 and that after the 17th moult this gradually diminishes.

Fowler (1909) has also shown that in all probability the same condition of affairs exists in the case of *Carcinus maenas*, but his chief contribution deals with a group of the Ostracoda, the Halocypridae. He has shown that here also, at each successive moult, there appears to be a definite increase in the size of the animal and he has formulated the following law which he proposes to call "Brooks' Law," that "during early growth each stage increases at each moult by a fixed percentage of its length, which is approximately constant for the species and sex." By applying this law, he has shown that as far as this group of the Ostracoda are concerned, it would appear highly probable that every species possesses two dimorphic forms corresponding to the two final sexually mature stages.

With a view to testing whether the Copepoda followed the same law, I carried out a number of measurements of the various stages in the species *Labidocera euchaeta*, Giesbrecht, *Acrocalanus inermis*, sp. nov., and *Pontella andersoni*, sp. nov. The measurement taken was the total length from the most anterior part of the head to the tip of the furcal rami, and the results were plotted out as shown in the following text-figures, the females being to the left and the males to the right of the middle line.

(*a*) **Labidocera euchaeta,** Giesbrecht.

In this species I have been able to obtain a fairly extensive series of measurements, covering six successive stages of growth in the female and four in the male. Of these stages, stage 2 and all below it undoubtedly were those of *Labidocera euchaeta*, but as regards stage 1, I was for some time of opinion that I was here deal-

ing with a new species; but on measuring these examples and plotting the results obtained with those of the undoubted examples of *L. euchaeta*, I found that they formed a mathematically exact continuation of the series. As, in addition, these examples have only been obtained in association with large numbers of *L. euchaeta*, and a prolonged search has failed to reveal any immature forms other than those of *L. euchaeta* that could correspond with this type, I have come to the conclusion that we have here in the Copepoda an exactly similar state of affairs to that which has been shown by Fowler to exist among the Ostracoda (Halocypridae). The actual measurements of all the examples in each group are shown in text-figure I.

It is at once evident that the different measurements fall into a series of groups, each having a normal curve of variation, and although the extremes of variation of successive groups may to some extent overlap yet each shows a very definite mean.

Taking first the growth stages of the female, the mean length measurement at each successive moult is given below and for purposes of comparison I have also given the lengths calculated from the smallest stage by multiplying each stage by the growth-factor.

	Observed size.	Calculated size.	Growth-factor.
	mm.	mm.	
Stage 6	0·593	0·593	1·4
,, 5	0·844	0·830	1·4
,, 4 ..	1·168	1·162	1·4
,, 3	1·620	1·627	1·27
,, 2 ..	2·054	2·066	1·27
,, 1	2·639	2·624	

From the above it would appear that during the early moults the growth-factor is 1·4, whereas in the last two moults this factor falls to 1·27.

This drop in the factor is of some interest inasmuch as it has not been found to exist in the Ostracoda, though it undoubtedly is a feature in the growth stages of some of the higher Crustacea.

Turning now to the consideration of the males I found that, previous to stage 4, it was quite impossible to differentiate between the two sexes, and hence the growth moults can only be studied from that point.

The mean length-measurements of the various stages of the male are as follows, and here again I have given the calculated measurement for comparison.

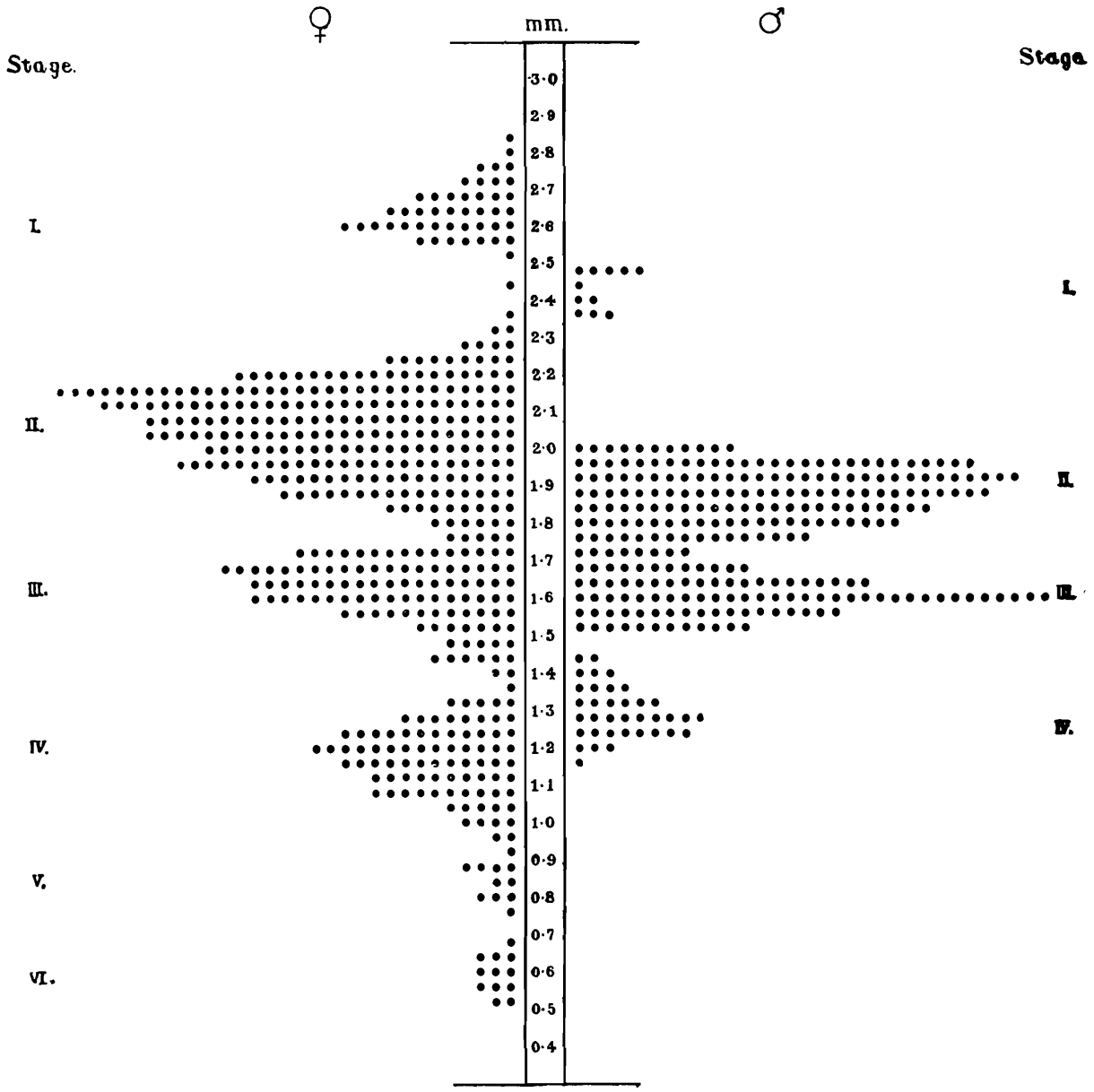


FIG. 1.—Measurements of 808 specimens (500 ♀ : 308 ♂) of *Labidocera euchaeta* from the Rangoon River Estuary.

	Observed size.	Calculated size.	Growth-factor.
	mm.	mm.	
Stage 5	0·844	0·844	1·5
,, 4	1·295	1·266	1·5 or 1·27
,, 3	1·611	1·608	1·5
,, 2	1·880	1·899	.
,, 1	2·429	2·412	..

At first sight the observed length measurements of the various stages did not appear to fit into "Brooks' Law," but a further study revealed the fact that at stage 4 we have a division taking place and an individual may go through one of two processes, either he may at once proceed to stage 2 becoming sexually mature in a single moult or he may have an extra immature moult, reaching stage 3, and then by a final moult attain to stage 1. The growth-factor between stages 5 and 4 is 1·5, and at the next moult some with the same growth-factor reach stage 2, others have an intermediate moult, the growth-factor of which is 1·27, (i.e. the same as that for the final two moults in the females) and then by a final moult having again a growth-factor of 1·5 he reaches stage 1. The number of examples of stage 1 was always considerably less than that of stage 2, and it is possible that these two forms may be seasonal dimorphic forms, the one a summer and the other a winter form.

As regards the structural characters of these various stages I have given a detailed description below; suffice it to say here that in both males and females, the last two stages only (stages 1 and 2), as in the Halocypridae, are sexually mature and in both cases there are, as I have already indicated, considerable differences in structure between the invididuals of the two groups, so much so that if only a few specimens had been met with I should without any hesitation have described them as different species. This difference was most marked in the case of the males, those of stage 2, which become sexually mature direct from stage 4, being totally different as regards their grasping antennae and 5th pair of legs from the individuals of stage 1, in which an intermediate moult is carried out.

In order to check the results, I carried out a further series of measurements on specimens obtained in a tow-netting taken off Chittagong (approximately 620 miles away) in which the same forms were present. I obtained exactly similar results, and the measurements found are shown in text-figure II.

In the table below I have again given the average length-measurements of the various stages, as found, and the calculated size for reference.

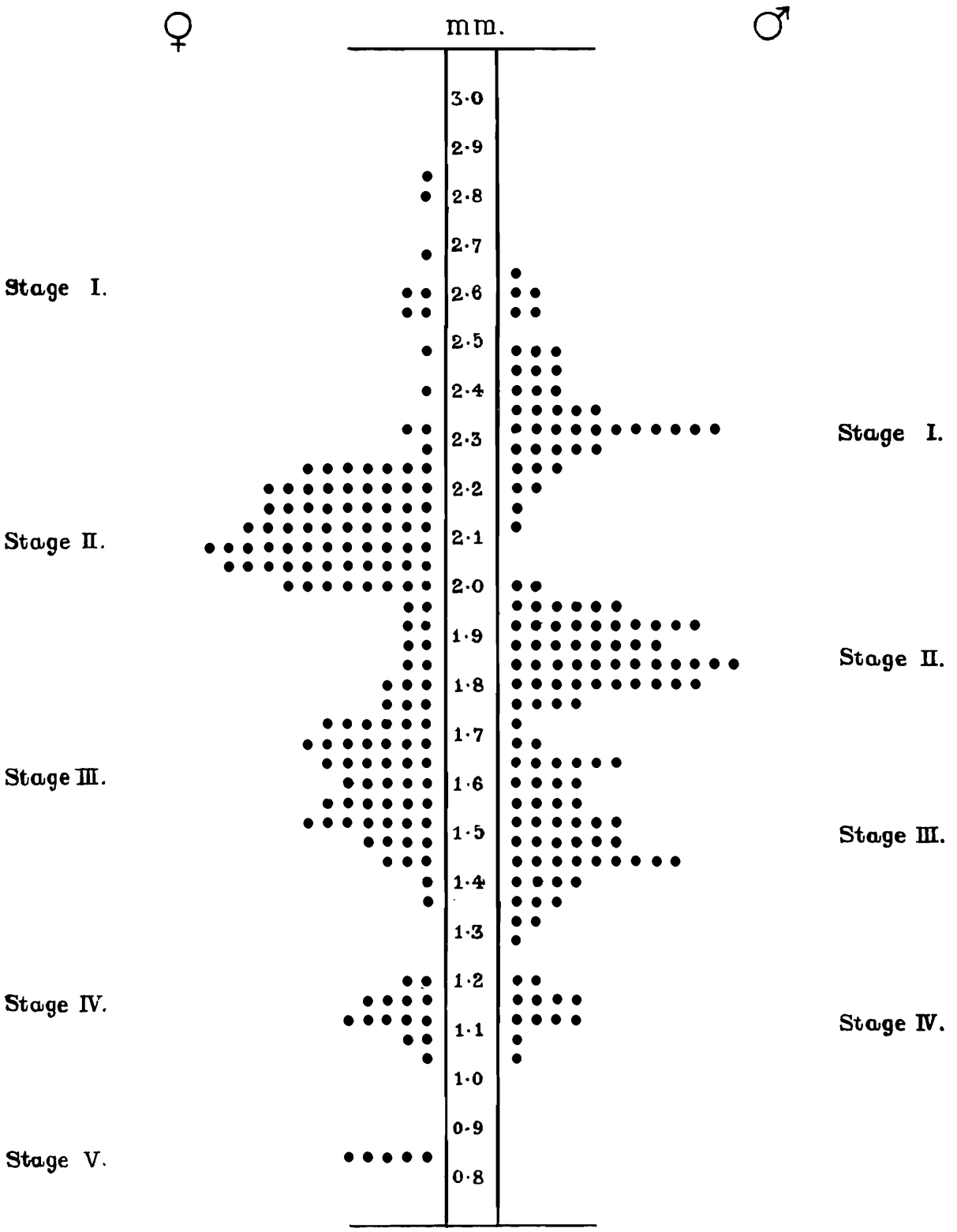


FIG. 2.—Measurements of 303 specimens (153 ♀ : 150 ♂) of *Labidocera euchaeta* from Chittagong.

♀

	Observed size.	Calculated size.	Growth-factor.
	mm.	mm.	
Stage 5	0·840	0·840	1·4
,, 4	1·131	1·176	1·4
,, 3	1·620	1·646	1·27
,, 2	2·114	2·090	1·27
,, 1 ..	2·640	2·654	....

♂

	Observed size.	Calculated size.	Growth-factor.
	mm.	mm.	
Stage 5	0·84	0·84	1·5
,, 4	1·137	1·26	1·5 or 1·27
,, 3	1·502	1·60	1·5
,, 2 ..	1·868	1·89	....
,, 1 ..	2·342	2·40	..

Here again we find exactly the same growth factors and the same dimorphic condition in the males, and from this it would appear by no means improbable that the growth factors remain constant for a given species under altered conditions, variations in the food-supply, etc., merely causing changes in the number of moults carried out in any given period of time.

(*b*) **Acrocalanus inermis**, sp. nov.

A considerable number of examples (367) were measured and the results obtained were plotted out as before (text-figure III).

In this species I was only able to obtain a series of four growth stages in each sex and the final sexual stage, stage 1, was not represented; but so far as these moults go they confirm the results obtained in the previous species.

In the female the observed and calculated sizes for the various moults agree even more closely than in *Labidocera euchaeta*.

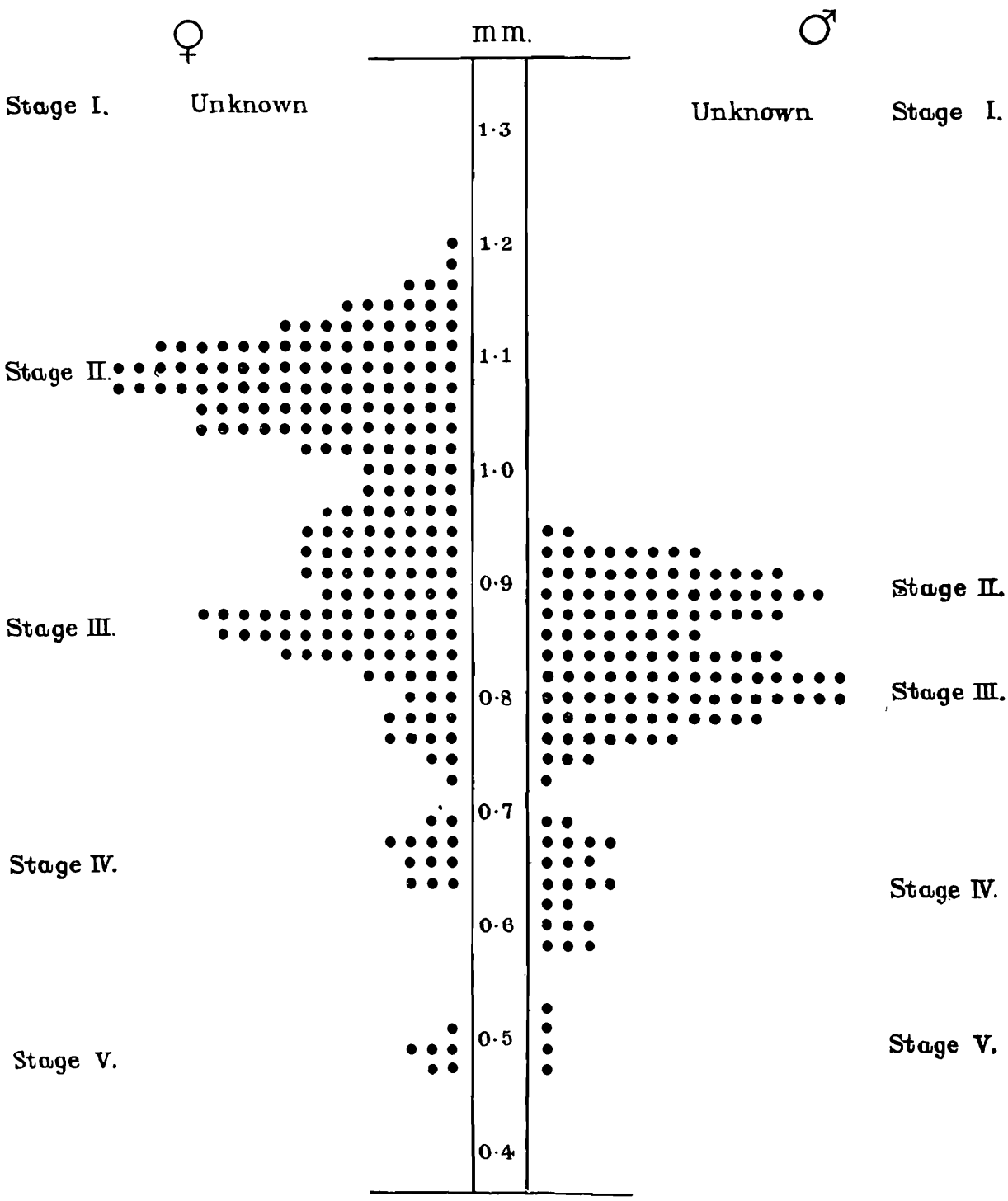


FIG. 3.—Measurements of 367 specimens (222 ♀ : 145 ♂) of *Acrocalanus inermis*, sp. nov.

	Observed size.	Calculated size.	Growth-factor.
	mm.	mm.	
Stage 5	0·49	0·49	1·355
,, 4	0·66	0·664	1·355
,, 3	0·90	0·900	1·208
,, 2	1·08	1·087	1·208
,, 1	Unknown	1·313	..

Here the growth-factors are 1·355 for the first two moults, while the last observed moult had a factor of 1·208 and in consequence the final sexual stage or stage 1, at present unknown, should have a length measurement of 1·313.

In the case of the male also the last sexual stage was missing, but the observed and calculated sizes for the preceding four stages are as follows :—

	Observed size.	Calculated size.	Growth-factor.
	mm.	mm.	
Stage 5	0·51	0·51	1·3
,, 4	0·63	0·66	1·3 or 1·208
,, 3	0·81	0·80	1·3
,, 2	0·86	0·86	....
,, 1	Unknown	1·04	....

The stage growths here follow exactly the same rule as in *Labidocera euchaeta*. At stage 4 we get a division taking place; some individuals becoming at once sexually mature and reaching stage 2, others having an extra moult to stage 3 before presumably doing so at stage 1. The characteristic growth-factor in this case is 1·3 with the single exception of the moult between stages 4 and 3, where it again is the same as in the final female moults, *viz.*, 1·208.

The text-figure does not show any very definite demarcation between stages 2 and 3, owing to the two curves of variation overlapping to a considerable extent; these two stages, however, can be easily recognized by their structural characters (*vide infra*).

(*c*) **Pontella andersoni**, sp. nov.

A fairly large number of individuals of this species were obtained from the tow-netting taken off Chittagong. I have, how-

ever, only been able to obtain three definite growth stages in either sex and although these follow "Brooks' Law" closely yet, as regards the female stages, this species differs in one respect from those of the other species measured.

The actual measurements are plotted out in text-figure IV, but owing to insufficient numbers the last stage of the female and the first of the male do not form very distinct groups.

The average sizes of each group, as found from the actual measurements and those calculated from the smallest stage obtained, are given below:—

♀

	Observed size.	Calculated size.	Growth-factor.
	mm.	mm.	
Stage 4	1·991	1·99	1·29
,, 3	2·575	2·57	1·29
,, 2 ..	3·34	3·31	1·29
,, 1 ..	Unknown	4·27	..

As in the case of the other species only specimens from stage 2 were sexually mature. A peculiarity of the growth of this species is that there is no diminution of the growth-factor for the last two moults.

In the case of all the other species that I have examined the growth-factor drops when stage 3 has been reached, and the last two sexual moults are characterized by a smaller increase in size, but here there is no indication of such a change.

In the case of the male also only the penultimate form was obtained. The table below shows the actual and calculated sizes of the various moult-stages.

♂

	Observed size.	Calculated size.	Growth-factor.
	mm.	mm.	
Stage 4	1·825	1·825	1·29 or 1·57
,, 3	2·343	2·354	1·57
,, 2	2·859	2·865	..
,, 1 ..	Unknown	3·696	....

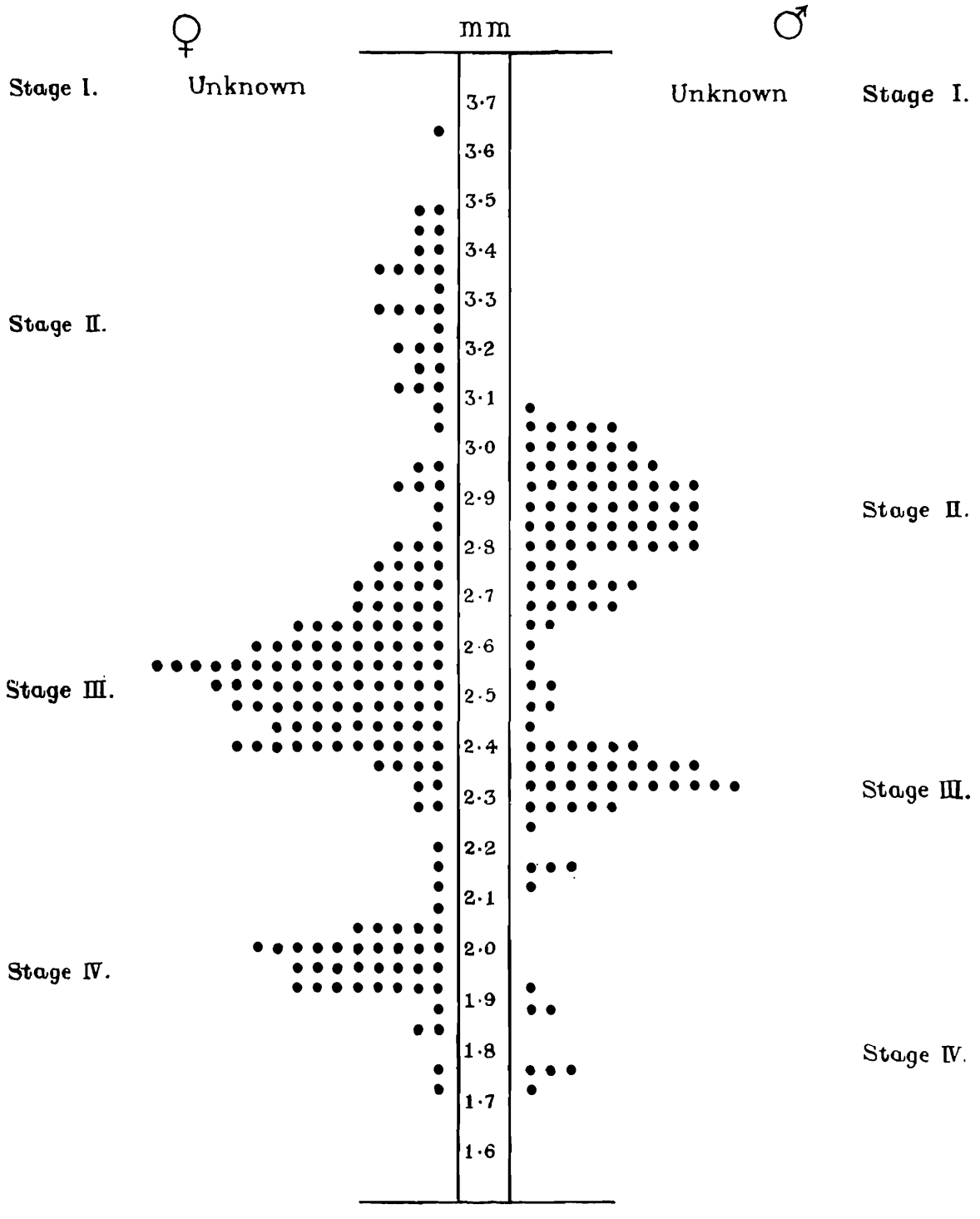


FIG. 4.—Measurements of 296 specimens (175 ♀ : 121 ♂) of *Pontella andersoni*, sp. nov.

As in the other cases we have two growth-factors for stage 4. Some individuals by a factor =1·57 attain sexual maturity direct and reach stage 2, the remainder have a growth factor =1·29 (the same as for the female) and thus reach stage 3, whence by a factor of 1·57 they should attain stage 1. Unfortunately no examples were obtained of this stage, but calculation shows that it should have a length of 3·69 mm., while the final stage of the female should be 4·2 mm. in length.

During the last few weeks a further series of tow-nettings has been received. These were taken in the region at the mouth of Tavoy River (*vide infra* plate xiv), and their chief interest and importance lies in the fact that they contain large numbers of *Paracalanus aculeatus* Giesbrecht, among which are numerous examples of the hitherto unknown male, a detailed description of which will, I hope, be published shortly.

A series of measurements of individuals of both sexes has been carried out and the results are given in text-figure V

In the case of the female only two stages have at present been obtained, and these apparently correspond to the last immature stage (stage 3), and the first sexually mature form (stage 2); the members of this latter group correspond exactly with the description of *P. aculeatus* both as regards size and structure.

As is shown in the accompanying table, the growth-factor between these two stages is 1·284.

Paracalanus aculeatus ♀.	Observed size.	Growth-factor.
	mm.	
Stage 3 (?)	0·874	1·284.
,, 2 (?)	1·120	

The males fall into a series of four stages corresponding to stages 4 to 1. The individuals of stage 3 correspond exactly with the description given by Cleve (1901), so far as their structure is concerned, but are on the whole slightly smaller, measuring only 0·873 mm. as opposed to 1·1 mm. in his specimens.

Stage 2 corresponds exactly with the adult females, while stage 1 is slightly different, having a series of spines on the margin of the second joint of the exopod in the 2nd-4th pairs of legs.

The average measurements of these four stages are given below in the accompanying table.

Paracalanus aculeatus ♂.	Observed size.	Calculated size.	Growth-factor.
	mm.	mm.	
Stage 4 ..	0·667	0·667	1·45 or 1·284
,, 3	0·873	0·856	1·45
,, 2	0·996	0·967	....
,, 1	1·238	1·241	....

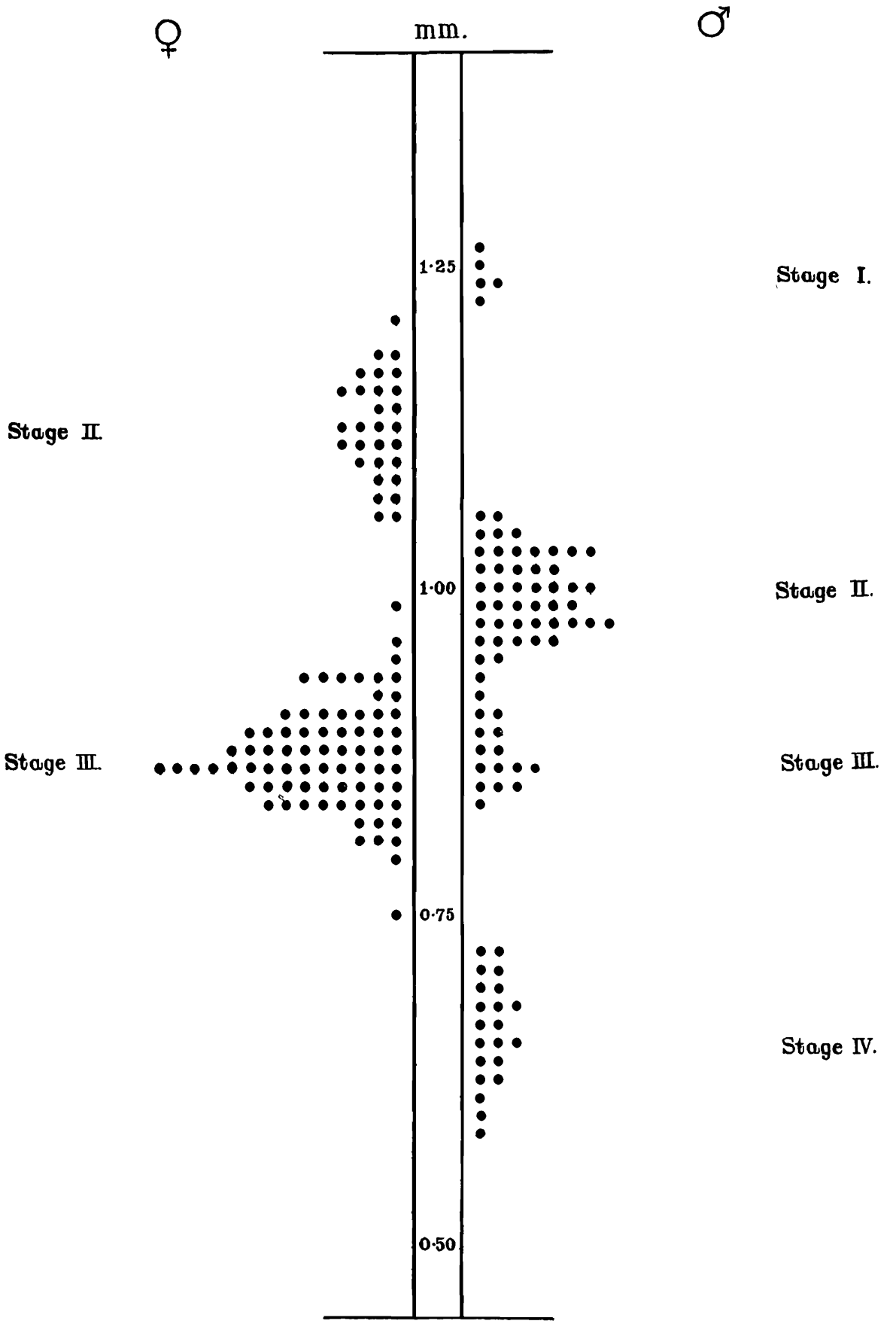


FIG. 5.—Measurements of 192 specimens (1 ♀ : 87 ♂) of *Paracalanus aculeatus* from Tavoy River Estuary.

Here again we see that from stage 4, an individual may either attain sexual maturity (stage 2) in a single moult having a growth-factor of 1·45, or may, by a moult with a growth the same as that of the female, *viz.*, 1·284, reach stage 3 and then become mature (stage 1) by a moult with the typical factor for the male =1·45.

From the above it would appear that under certain conditions we may get two dimorphic forms in any species of Copepod.

Dimorphism in certain groups of the Arthropoda and especially in the Insecta is comparatively common, and several instances have been reported from the Crustacea, among which I may make mention of the dimorphic males in *Pandalus montagui*, Leach (= *P. annulicomis*). This was first noted by Calman (1899) and has since been confirmed and explained by Wollebaek (1908).

In this case the dimorphism affects only the 1st pleopod of the male and is merely a breeding and non-breeding form, that is to say the dimorphism is seasonal and is of the "facultative" type.

Another example of facultative dimorphism in the Decapoda has been described by G. Smith (1906) in two species of *Inachus* (*I. scorpio* and *I. thoracicus*) in which the great chelae are affected.

The type of dimorphism which appears to be present in *Labidocera euchaeta*, *Paracalanus aculeatus*, and possibly in all the species of the Copepoda does not, however, follow either of the above cases, and we have apparently a "high" and a "low" form in both males and females.

As I have already mentioned in the case of *Labidocera euchaeta*, it would appear that in the females growth takes place by a series of moults which follow "Brooks' Law" and the last two stages are sexually mature, thus giving rise to a "high" and a "low" form, which differ from one another not only as regards size but also in respect to certain structural characters, which, however, as I shall subsequently show, are caused by a direct continuation of those changes which are undergone by the individual during the various moults from the later Copepodid stages to the "low" or 1st sexually-mature form. In this respect the dimorphism agrees exactly with that described by Fowler (*loc. cit.*) as occurring in the Ostracoda.

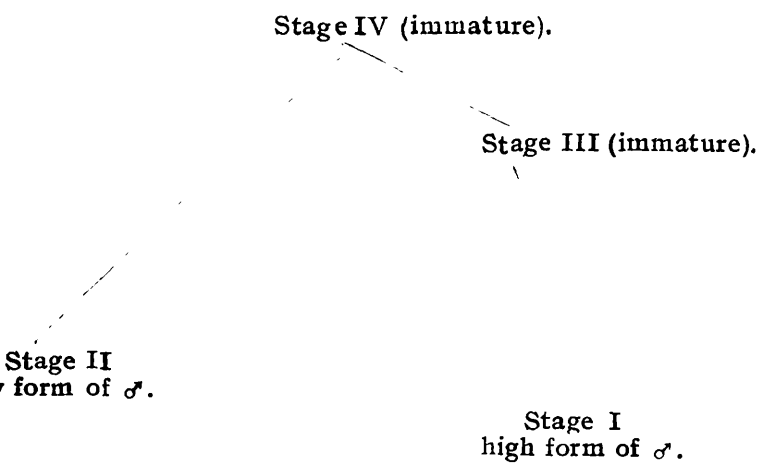
In the case of the males, however, the type of dimorphism is somewhat different and it would appear that the "low" sexually mature form (stage 2) does not directly give rise to the "high" form (stage 1). That is to say, the type of dimorphism is "definitive." Some factor, at present unknown but possibly seasonal, exercises an influence on a Copepodid form (stage 4) and determines which of the two forms shall be finally adopted by the individual.

It may possibly happen that when circumstances such as food supply, etc., are favourable, as in the summer season, the

Copepodid stage can become at once sexually mature and thus give rise to the "low" form (stage 2). Whereas, in unfavourable surroundings an extra Copepodid stage is passed before the individual attains to the "high" form (stage 1). At any rate, if any reliance can be placed on "Brooks' Law," it appears probable that stage 1 never develops direct from stage 2. A similar type of dimorphism has been described by G. Smith (1904) as occurring in a species of Isopod, *Gnathia maxillaris*. In this case, starting from a normal segmented larva, we may get the course of development passing through a small '*praniza*' (1—4 mm. in length) to a small adult (= the "low" form), or on the other hand we may get a larger '*praniza*' (= 5—8 mm. in length) which finally gives rise to a large adult (= "high" form), and in this case also it appears certain that the one form is never derived direct from the other.

In the only two species of Copepoda in which I have been able to investigate all the later stages of the life cycle, *viz.*, *Labidocera euchaeta* and *Paracalanus aculeatus*, the males follow an exactly similar course, and the results obtained in the case of the other species which I have investigated tend to show that this condition of affairs is universal.

We may summarize these changes in the male Copepod as follows:—



In all cases where they have been obtained, examples of stage 1 were much less common than those of stage 2 or 3, and it appears probable that only a few individuals undergo this final moult.

Finally it would appear at least possible that in many instances so-called "species" of Copepoda, which are at present believed to be distinct, are in reality merely high and low forms of one and the same species, and further investigation may necessitate a linking of pairs of species, as is the case at present in the Ostracoda (Halocypridae).

One extraordinary feature in the above dimorphism of the males is the sudden assumption by certain individuals from stage 4 of the female growth-factor.

That the development of the external sexual characters in the Crustacea is largely, if not entirely, dependent on the development of the gonads cannot be denied and, in consequence, any circumstance that retards the full development of either ovary or testes will materially affect the assumption of the respective sexual characters. If from parasitisation or any other cause the sexual development of these organs is retarded we should expect to find that in the Copepoda, as in other groups of the Crustacea, there would be a corresponding modification in the development of the sexual characters; but in such a case we should further expect that if at a future date the animal recovered and developed its sexual functions the external characters of the sex would be less specialized than in the normal individual.

In the present cases the exact reverse is found, for the individuals of stage 1 (the "high" form), in the development of which the female growth-factor makes its appearance, are, besides being altogether larger and finer specimens, also more highly developed as regards their sexual appendages, to wit the grasping antenna and the 5th pair of legs, than is the case with examples of stage 2, the "low" form, in whose development the growth-factor is of the male type throughout. Consequently it would appear highly improbable that we are dealing here with the result of infection by a parasite.

Wollebaek (1909) has recently published observations tending to show that in certain deep-sea Decapoda the individuals are normally hermaphrodite but, in the absence of any observations on the development and structure of the gonads in these various growth-stages, any speculation with regard to the possibility of a similar condition occurring among Copepoda cannot be attempted.

2. SYSTEMATIC.

Family *CALANIDAE*.

Genus **Paracalanus.**

Paracalanus dubia, sp. nov.

Pl. xv, figs. 1—5.

Numerous specimens of a female of a species of *Paracalanus* were present, and at first sight I was inclined to regard them as examples of *P. crassirostris* (Dahl), but a further examination has revealed several differences and I have been forced to conclude that I was dealing with a new form. I have, therefore, given it the name *P. dubia.*

Total length 0·74 mm.

The head and 1st thoracic segment are fused together; the forehead presents a well-developed rounded bulge anteriorly and

terminates in a bifid rostrum, composed of two short, stout, blunt processes.

The thorax presents only three free segments as, in addition to the 1st, the 4th and 5th segments are fused together.

The abdomen consists of four segments of which the 2nd and 3rd are quite short, closely resembling those of *P. crassirostris*. The 1st segment is symmetrical and presents a well-marked genital swelling ventrally. The furcal rami are symmetrical, twice as long as broad, and terminate in four setae of nearly equal length. The proportions of the segments and furca are 15 : 5 : 5 : 10 : 8.

The *1st antennae* reach to the middle of the abdomen; they are composed of 24 free joints having the following relative proportions:—

Segments—

1-2	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.
20.	5.	4.	4.	4.	4.	4	4·5.	5.	5·5.	6.	6.	6.	6.	6.	6.	7.	8·5.	8·5.	8·5.	9.	10.	9.	10.

There is a transverse row of minute spines present on the posterior aspect of segments 2 to 9 inclusive.

The *2nd antennae and mouth parts* are similar to those of other members of the genus.

The *1st pair of legs.* The 1st basal segment bears several scattered delicate spines on its anterior surface. The 2nd basal bears an internal marginal seta. The exopodite consists of three segments, of which the 1st bears a small spine distally on its external margin. The 2nd is devoid of spines and the 3rd has the usual two marginal spines, and an end spine, which is extremely long and delicate and is equal in length to the whole exopodite. The endopodite consists of two segments, both devoid of spines.

The *2nd pair of legs.* The 1st basal carries an inner marginal seta and has delicate spines scattered over its anterior surface. The 2nd basal has no seta or spines. The 1st segment of the exopodite bears a corona of spines on its distal external border. The 2nd segment bears no spines in addition to the usual marginal one. The 3rd segment has a row of fine spinules, six to eight in number, on the proximal part of the margin and a corona of fine spines near the distal end; the terminal spine is nearly half as long again as the end segment. The endopodite is three-jointed and has a group of four long slender spines on the posterior aspect of the 2nd joint.

The *3rd and 4th pairs of legs.* In both there is a row of spinules on the proximal part of the margin of exopod 3, and a few on exopod 2, and the 2nd joint of the endopodite has a group of four spines on its posterior surface. The 3rd leg differs from the 4th, however, in that the 1st basal bears a few scattered spines on its anterior surface which are absent on the 4th leg.

The *5th pair of legs.* These are composed of two joints, the terminal joint bears two end spines, one long and the other quite short. The longer spine bears to the end joint the proportional lengths of 7 : 10, and the margin is serrated so that in reality it is

a saw rather than a spine. In addition there is a corona of spinules on the posterior aspect of the 2nd segment near the distal border.

As will be seen the points in which the present specimens differ from *P. crassirostris* are:—

1. The absence of spines on the margin of exopod 2 of the 2nd leg.
2. The absence of spines on the posterior aspect of exopod 3 of the 3rd and 4th legs.
3. The serrated saw on the 5th pair of legs.
4. The shorter terminal joint of the 1st antennae.

No corresponding males were found in the collection.

Paracalanus serratipes, sp. nov.

Pl. xv, figs. 6–10.

Several specimens were obtained off Chittagong associated with numerous specimens of the preceding species which they fairly closely resemble, especially as regards the proportions of the body and the 5th pair of legs; they differ, however, both as regards size and in the spinulation of the swimming legs.

As I have already pointed out, it would seem probable that for every species proper we have two forms, a first and a second sexual stage such as have been shown to exist among the Ostracoda, and I am inclined to think that this form may be the later sexual stage of *P. dubia*, but this is only a matter of opinion and I have therefore given it the above "specific" name.

♀ Total length 1·1 mm.

The body and abdomen were similar to *P. dubia* and the relative proportions of the latter were 22: 12: 11: 18: 10.

The *1st antennae* reach to the middle of the abdomen and consist of 23 free joints, the 1st and 2nd and the 8th and 9th segments being fused; the relative proportions of these joints are as follows:—

Segments—

1-2.	3.	4.	5.	6.	7.	8-9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.
35.	11.	11.	12.	12.	12.	14.	8.	8.	10.	11.	12.	12.	12.	12.	12.	13.	13.	13.	15.	13.	15.	15.

Segments 2 to 9 inclusive all bear a transverse row of fine spines on their posterior surfaces close to the distal border, and on segments 10 to 24 there are longitudinal rows of spines as in *P. aculeatus*.

Practically the only difference between these two species, as regards the 1st antenna, is in the length of the end segment.

The *2nd antennae and mouth-parts* are as in other members of the genus.

The *1st pair of legs*. The 1st basal segment bears a few spines on its anterior surface. The exopodite is three-jointed and the 1st joint bears a small transverse row of spines on its distal

external margin, and the 2nd joint is devoid of spines. The endopodite is two-jointed and bears no spines; the last segment bears 5 setae.

The *2nd pair of legs.* There are no spines on the basal joints. The segments of the exopodite have the usual marginal and end spines, and in addition the 1st segment of the exopod bears a transverse row of spines on its outer and posterior aspect. The 2nd segment bears a slightly oblique row of 4 spines posteriorly and the 3rd segment bears a corona of spines on its posterior surface.

The *3rd and 4th pairs of legs* are almost exactly similar. There are no spines on the basal joints. The 1st segment of the exopod bears a row of spines on the outer and posterior surface distally in the 3rd leg; this is absent in the 4th. The 2nd joint has a row of 4 spines posteriorly, and the 3rd joint has a corona of fine spines in addition to the marginal row. The 2nd joint of the endopodite has a row of spines on its posterior aspect and a transverse corona of spines on its outer and anterior surface.

In the 2nd—4th legs the endopod bears 2 setae on its 2nd and 7 on its terminal joint.

The *5th pair of legs* is the same as in *P. dubia*, but in a few specimens a third small segment was intercalated between the usual two.

♂ Total length 1·1 mm.

The cephalo-thorax is the same as that of the female. The abdomen consists of five segments and its length is contained 2·5 times in that of the cephalo-thorax. The proportional lengths of abdominal segments and furca are 10 : 20 : 16 : 16 : 12 : 10.

The rostrum consists of two short stout spines.

The *1st antennae* reach a point a short distance behind the posterior border of the 5th thoracic segment. As usual in adult males of this genus the basal segments are fused together, so that there are only twenty joints present. The relative lengths are as follows:—

Segments—

1-2.	3-6.	7-8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.
33.	45.	21.	5.	6.	7.	8.	8.	10.	9.	11.	11.	11.	10.	11.	10.	11.	11.	11.	8.

The *2nd antennae* resemble those of the male of *P. parvus*, and the exopodite terminates in a nipple-like projection.

The *1st pair of legs.* There appear to be no spines on the 1st basal joint; basal 2 as usual bears an internal seta. The 1st joint of the exopodite has no marginal spine, the 2nd carries a transverse row of small spines and the 3rd has a row of delicate spines on the proximal part of the external margin. The terminal spine is long and slender, being longer than the whole exopodite.

The *2nd—4th pairs of legs* are the same as in the female.

The *5th pair of legs.* As usual that of the left side is considerably the larger and possesses four segments in addition to the enlarged basal portion. The proportional lengths of these seg-

ments are 15: 18: 16: 12. The penultimate joint bears a distal spinous process and the last joint terminates in two processes of unequal length. The right leg has only three segments and terminates in two short processes.

These specimens very closely resemble *P. aculeatus*, especially as regards the spinulation of the legs, but they differ markedly in the length of the antennae and the structure of the 5th legs, and I conclude that they are a new species.

NOTE.—Since the above was written, other examples of this species have been obtained at the mouth of the Tavoy River, and it would appear probable that it is a regular inhabitant of estuarine waters in this region.

Genus **Acrocalanus.**

Acrocalanus inermis, sp. nov.

Pl. xvi, figs. 1—9.

As already mentioned a large number of specimens in various stages of development were obtained. As regards their general structure and appearance they agree very closely with other members of this genus; they have all five segments of the thorax separate; the 5th pair of legs is practically absent in the female and only the left one present in the male. They differ, however, in having no spines on the margins of the exopodite of any leg. I do not consider that this is sufficient ground for creating a new genus and propose to include this species under the name of *A. inermis*.

Stage 1. Unknown.

Stage 2.

♀ Total length 1·08 mm.

The head is separate from the 1st thoracic segment and terminates anteriorly, its bifid rostrum consisting of two sharply-pointed processes. The 4th and 5th thoracic segments are also separate and the posterior margin of the thorax is rounded and bears a row of small spines.

The abdomen consists of four segments and is contained 3 times in the length of the cephalo-thorax; the furcal rami are symmetrical and bear four terminal setae. The proportional lengths of the abdominal segments and furca are 24 : 14 : 11 : 18 : 12.

The 1*st antennae* reach to the end of the furcal rami and consist of 23 separate joints; the 1st and 2nd segments are completely and the 8th and 9th partially fused together. The relative proportions are as follows :—

Segments—

1-2.	3.	4.	5.	6.	7.	8-9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25
35.	9.	9.	9.	9.	10.	15.	8.	8.	9.	10.	11.	11.	11.	11.	11	12.	12.	12.	10·5.	12.	11.	12

Each of the 1st six segments bears a transverse row of very small delicate spines.

In *the 2nd antenna* the endopodite and exopodite are of nearly equal length, the former consists of seven segments and the whole closely approximates to the condition found in *Paracalanus parvus.*

The *mandible* is armed with a row of powerful teeth; they are not quite symmetrical, that of the left side having a small extra cusp on the large 1st tooth.

The *maxilliped* resembles that of *A. pediger*, Claus (*vide* Cleve, 1901, pl. i, fig. 9).

The *1st pair of legs* consists of the usual 3-jointed exopod and 2-jointed endopod; the 1st segment of the exopod has no large marginal spine, but its place is taken by a short transverse row of small spinules; the 2nd joint is also devoid of spines but its outer border is fringed with long hairs; the 3rd joint has two marginal and a long terminal spine, this last being twice as long as the segment. The 1st basal joint bears no inner seta and is beset with short stiff hairs. The 2nd basal bears a long inner seta.

The *2nd pair of legs.* Both endopodite and exopodite are 3-jointed. The 1st joint of the exopod has a transverse row of short spines near its distal extremity and a well-marked marginal spine. The 2nd joint has a well-developed marginal spine and an oblique row of 4 long spines on its posterior aspect, but no spinules on its margin. The 3rd joint has 2 outer spines and a terminal spine but no marginal spinules, it also has a transverse row of delicate spinules distally. The 2nd joint of the endopod has a row of small spinules on its anterior surface and an oblique row of long delicate spines posteriorly.

The *3rd and 4th pairs of legs* resemble each other and are devoid of the marginal spinules that are present in other members of the genus.

The *5th pair of legs* is practically absent, being only represented by short rounded unsegmented processes.

♂ Total length 0·86 mm.

The abdomen consists of 5 segments having, together with the furcal rami, the following proportional lengths 5 : 8 : 6 : 6 : 6 : 5, the last three abdominal segments being of equal length.

The *1st antennae* resemble those of *A. gibber* and *A. gardineri* in that the first six segments are fused together to form a solid mass, separated by a constriction from the remainder of the segments. Segments 7 and 8 are also fused and the relative proportions of the joints are as follows:—

Segments—																					
1-6	7-8.	9.	10.	11.	12.	13.	14.	15.	16.	17	18.	19.	20.	21.	22.	23.	24.	25.
52.	14.	4·5.	5·5.	6.	6·5.	7·5.	7·5.	8.	9.	9.	9.	9·5.	10.	10.	9·5.	10·5.	10.	6.

The *2nd antennae* differ from those of the female in that the last segment of the exopodite ends in a stump devoid of bristles.

A *5th leg* is only present on the left side and resembles that of *A. gardineri* in that it is composed of a basal portion and four joints. The last joint bears two terminal processes, one long and the other short, and the penultimate joint also bears a terminal spine.

Immature forms :—

In the younger stages of development we find that the males and females closely resemble one another, practically the only difference being the presence of the 5th leg; neither of the antennae showing, as yet, distinctive male features.

Stage 3. In both sexes the abdomen consists of four segments having, together with the furcal rami, the following proportional lengths :—4 : 6 : 5 : 9 : 5.

The *1st and 2nd antennae* are of the female type and with the exception of the 5th leg in the male all the other mouth parts and appendages are as in the adult.

The *5th leg* of the male is short, reaching only to the 2nd basal joint of the 4th leg and consisting of a basal portion and three joints having the proportional lengths 6 : 5 : 13. The last joint bears 3 spines, two terminally and one midway along the margin, at which point it also shows a slight constriction. From its appearance it is evident that at the next moult it will divide into two, to form the last two segments of the adult leg.

There is a very close relationship between the two genera *Acrocalanus* and *Paracalanus* and, from the study of these immature forms of the present species and examples of so-called adults of other members of these genera, it would appear that in mature males we get certain sexual characters in both 1st and 2nd antennae as well as in the 5th leg.

In *Paracalanus parvus*, *Acrocalanus pediger*, and *A. gardineri*, as well as in the present species, in sexually mature males we find that (1) the 1st antenna has a marked tendency towards the coalescence of the basal segments, (2) the distal part of the end segment of the exopodite of the 2nd antenna is rounded and nipple-like and is devoid of setae, (3) the abdomen consists of five fully-separate segments, and (4) the left leg consists of a basal portion and 4 segments, of which the terminal bears two and the penultimate a single spinous process.

Males have also been described in the case of *A. longicornis*, *monachus* and *gracilis* and *Paracalanus aculeatus*, but in all cases they present only four completely-separate abdominal segments; the antennae are of the female type and the 5th leg has only three separate joints apart from the basal portion and the terminal joint bears three spines. I therefore entirely agree with Wolfenden (1906, p. 1002) that in these instances the males were immature and a comparison of these forms with stage 3 of the above species shows that they are of corresponding ages.

Both Wolfenden (1906) and Cleve (1901) have described forms which they took to be females in which a small 5th leg was present belonging to the following species, *Acrocalanus longicornis*, *A. gracilis*, and *A. gibber* (by Wolfenden) and *Acrocalanus pediger* (by Cleve), but I am inclined to regard most, if not all, of these examples as immature males corresponding to stages 3 and 4 as described above.

NOTE.—Since the above was written Grandori (1912) has published a description of a new genus and new species of Copepod (*Piezocalanus lagunaris*). This is very closely related to *Paracalanus* and *Acrocalanus* and it is interesting to note that in this form also the mature males present the above characters.

Family *CENTROPAGIDAE.*

Genus **Pseudodiaptomus.**

Pseudodiaptomus binghami, sp. nov.

Pl. xvii, figs. 8—11.

A single specimen of a female was found which, while undoubtedly belonging to this genus, yet presents certain characters which indicate that it belongs to a species hitherto undescribed.

♀ Total length 1·3 mm.

The head was fused with the 1st thoracic segment, and thoracic segments 4 and 5 were also fused together. The posterior border of the thorax is rounded and bears a small spine near the dorsal surface. Anteriorly the head terminates in a small bifid rostrum.

The abdomen consists of four segments of which the 1st is considerably the longest; their relative proportions together with the furcal rami being 45: 25: 30: 12: 28. The 1st segment has two transverse rows of minute spines on its dorsal surface and a row of spines round the dorsal half of its posterior border; there is also a small blunt projection on the ventral aspect, behind the genital opening. The 2nd and 3rd segments also have a row of spines on the dorsal part of the posterior margin. The furcal rami are symmetrical and bear 5 short setae, of which the third is considerably wider than the others and is spear-shaped.

The *1st antennae* unfortunately have their terminal segments missing, only 18 being present; the relative lengths of these are as follows:—

Segments—

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.
17.	10.	5.	6.	6.	9.	5.	5.	7.	10.	11.	12.	14.	14.	14.	14.	12.	14.

The *2nd antennae and mouth parts* are of the usual type, but the terminal joint of the endopod of the 2nd antenna bears a row of sharp spines.

The exopodite and endopodite of the *1st—4th pairs of legs* are 3-jointed and only bear two spines on the external margin of the last segment of the exopodite. There is no spine on the 2nd joint of the exopodite of the 1st leg.

The *5th pair of legs* is symmetrical, each consists of three segments; the 2nd bears a spine at its outer distal angle and the third segment terminates in four spines, three of which are short, but the fourth is very long and curved, being longer than

the combined length of the last two segments. All the spines have serrated margins.

At first sight this specimen appeared to be an example of *Pseudodiaptomus lobipes*, Gurney (1907, p. 27, pl. 1, figs. 3—5), but a closer comparison revealed several differences as regards the serration of the spines on the 5th pair of legs and the spinulation of the 1st abdominal segment, and the furcal setae are entirely different.

Unfortunately Gurney's type specimens appear to have been lost by him and have never been deposited in the Indian Museum, but I have examined other specimens from the original locality and have come to the conclusion that the specimen is not identical. I therefore propose to give it the above name after Lt. A. Bingham, R.I.M., who for many years has been 1st Lieutenant on the R.I.M.S. "Investigator" and has personally assisted in the collection of much valuable marine material.

Genus **Centropages.**

Centropages alcocki, sp. nov.

Pl. xvii, figs. 1—7.

Numerous examples of both males and females were present.

♀ Total length 1·2 mm.

The head and 1st thoracic segment are separate as also are the last two thoracic segments. The posterior border of the last segment is rounded and near the ventral border presents a short backwardly directed spinous process. The head is rounded anteriorly and terminates in a small bifid rostrum.

The abdomen possesses three segments and is symmetrical, the proportional lengths of segments and furca being 35 : 22 : 20 : 15. The 1st segment bears on each side a clump of small needle-shaped spines. The furcal setae are 5 in number and of these the 2nd is about twice the length of the others.

The *1st antennae* are short and do not reach to the end of the thorax; the proportional lengths of the segments are as follows:—

Segments—

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
15.	9.	3.	4.	4.	4.	4.	5.	5.	6.	6.	9.	13	14.	15.	16.	16.	17.	15.	11.	11.	7.	7.	12.

There are no spines on any of the proximal segments.

The *2nd antennae and mouth-parts* closely resemble those of *C. typicus*.

The *1st—4th pairs of legs* in their general structure resemble those of other members of the genus, but the terminal spines of the exopods differ from those of other species in that the armature of the saw is composed of a series of coarse teeth separated by comparatively wide intervals, more nearly resembling the condition found in *Temora*. The spine on the 2nd joint of the exo-

pod of the *5th pair of legs* is simple and resembles that present in *C. typicus*.

♂ Total length 1·1 mm.

The head and thorax are as in the female; the abdomen consists of four segments and the furcal rami are symmetrical as in the female.

The *grasping antenna* has the knee-joint, as usual, between the 18th and 19th segments and the proportional lengths of the distal joints are as follows:—

13.	14.	15.	16.	17.	18.	19-21	22.	23.	24.
13.	15.	20.	20.	20.	32.	22.	20.	16.	12.

The 10th, 11th and 12th segments all bear a curved spine-like process on the anterior surface. The 17th segment bears a toothed-plate which is somewhat longer than the segment itself and is prolonged over the proximal part of the 18th segment. The toothed-plate on the 18th segment extends the whole length of the joint, that of the 19th segment bears teeth the whole length of the segment and is then produced as a spinous process beyond the distal extremity.

The *5th pair of legs* is as figured.

The shape of the last thoracic segment and the coarse saw on the exopodites of the legs serve to distinguish it from other members of the genus.

I have much pleasure in dedicating this species to Lt.-Col. A. Alcock, who for many years was Surgeon-Naturalist and subsequently became the Superintendent of the Indian Museum.

Genus **Labidocera.**

Labidocera euchaeta, Giesbrecht.

Stage 1, Dimorph. 1, nov.

Pl. xviii, figs. 1—9.

♀ Total length 2·64 mm.

The head is separate from the 1st thoracic segment and is subdivided into two regions, an anterior and a posterior, by a deep groove that runs transversely across the dorsum, separating the part that carries the two antennae from that which bears the mouth-parts. The 4th and 5th thoracic segments are fused, and the posterior thoracic border is produced backwards in an angular process as in *L. wollastoni*. Anteriorly the head forms a prominent bulge terminating below in a pair of long retrorse rostral spines. There is no rostral lens but a ventral lens is present. Although well marked this forward bulge of the forehead is not so distinct as in the earlier stage (stage 2). Side hooks are absent.

The abdomen is composed of two joints only, the 2nd or posterior of which is very short. The furcal rami are symmetrical and the furcal setae are of practically equal length.

The 1*st antennae* comprise 21 joints, the 7th and 8th segments being completely and the 10th and 11th partially fused. When fully extended they reach nearly to the end of the abdomen. The proportional lengths of the joints are as follows:—

Segments—

1.	2.	3.	4.	5.	6.	7-8.	9.	10-11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23
51.	52.	11.	8.	7.	18.	30.	17.	37.	24.	25.	28.	38.	38.	45.	45.	30.	28.	28.	25.	25.

The distal part of segment 2 and segments 3 to 14 are fringed posteriorly with long hair.

The *2nd antenna, mandible and maxillae* are of the usual type.

The *maxilliped* resembles that of other members of the genus, but is armed with a row of fine teeth down the margin of the 2nd basal joint.

The 1*st pair of legs* is as figured. All the segments of the exopodite are fringed with fine hair and the terminal saw is long and slender, being over 1½ times the length of the last segment.

The 5*th pair of legs* very closely resembles those of the preceding stage as described by Giesbrecht. In both cases there is no endopodite present; it differs, however, in having five spines on the margin of the exopodite instead of four. As we shall see later this increase in the number of spines appears to be connected with the progressive stages of development, the young immature forms only having three spines present.

♂ Total length 2·43 mm.

The general structure of the cephalo-thorax is the same as in the female, but the cephalic groove, described above, appears to be usually somewhat better marked. The rostrum resembles that of the female and has no lenses. A well-developed ventral lens is present.

The abdomen consists of 5 segments, of which the 5th is very small. The furcal rami are symmetrical, as in the female, and the proportional lengths of segments and furca are 5 : 6 : 6 : 4 : 1 : 6.

The *left* 1*st antenna* resembles that of the female, the proportional lengths of the joints being as follows:—

Segments—

1.	2.	3.	4.	5.	6.	7-8.	9.	10-11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
45.	46.	9.	6·5.	7.	16.	27.	15.	35.	23.	23.	26.	38.	38.	45.	44.	30.	27.	27.	24.	24.

The *right* 1*st antenna*, as usual, forms a grasping organ, and the exact determination of the limits of the various segments in the proximal portion is a matter of considerable difficulty; as regards the distal segments the knee-joint is situated between segments 18 and 19 and the 19th to 21st segments are fused together.

The proportional lengths of the last 9 joints are as follows:—

14.	15.	16.	17.	18.	19-21.	22.	23.	24.
31.	30.	45.	38.	78.	78.	32·5.	23.	23.

The 17th segment bears a prominent crest, which terminates distally in a sharp point; the 18th segment is armed with a toothed-plate, which is not produced proximally as in the earlier

stage; the teeth are lancet shaped and are larger in the centre than at the two ends. The 19th—21st segments bear a toothed plate, which extends nearly the whole length of the joint, and the 22nd segment is produced distally in a sharp process which extends nearly the whole length of the succeeding segment.

The *5th pair of legs*. The right forms a grasping organ; the proximal part of the claw is produced in a slender curved process and near the base of this is a single rounded tooth. The distal part of the claw is slender and has no teeth. The left leg has a short terminal joint, which bears a spine on its external margin and has three terminal processes; its inner border is thickly fringed with hair. The penultimate joint also bears a terminal spine at its distal external angle.

L. euchaeta. Stage 2, Dimorph. 2.

Pl. xix, figs. 1—3.

Giesbrecht, 1892, p. 446, pl. 23, fig. 31, and pl. 41, figs. 7-36.
Giesbrecht and Schmeil, 1898, p. 135.

The female of this stage was first described by Giesbrecht (1889). I have not been able to see his original description, but the specimens obtained by me agree almost exactly with the description and figures given by him in his work on the Copepoda of the Gulf of Naples (1892), and by Giesbrecht and Schmeil in the "Das Tierreich" (1898). It is therefore unnecessary for me to give a detailed description.

The head and 1st thoracic segment are separate and a faint groove indicates the division into the two parts of the cranial region, and the 5th thoracic segment is fused with the 4th and terminates posteriorly in an angular process; a point in which my specimens differ from the description is in the sharp forward bulge of the forehead. The rostral spines are long and slender. No rostral lenses are present but there is a small ventral lens.

The abdomen has three segments and the furcal rami are asymmetrical, the left being smaller than the right, and the 2nd furcal seta is much longer than the others, more than three times their length and nearly 2½ times as long as the combined abdomen and furca.

The *1st antenna* is composed of 23 segments; their relative lengths are given below—

Segments—	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
	32.	38.	6.	5.	6.	9.	6.	19.	15.	12.	26.	24.	23.	30.	39.	36.	42.	41.	27.	27.	31.	31.	25.

It reaches back nearly to the posterior end of the furca.

The *5th pair of legs* has no separate endopodite, and the exopodite has a row of spines on its external margin and distal end.

♂ Total length 1·88 mm.

Numerous examples of males were obtained and they correspond very closely with the females as regards their general structure.

The cephalo-thorax is the same as in the female.

The abdomen consists of 5 segments, of which the 3rd is the longest and the 5th very short; the relative proportions of abdominal segments and furca are 22 : 20 : 30 : 15 : 7 : 22. The furcal rami in this sex are symmetrical.

The *grasping antenna* has the knee-joint between the 18th and 19th segments; the proportional lengths of the distal-joints are as follows :—

13-14.	15.	16.	17.	18.	19-21.	22.	23.	24-25.
23.	25.	45.	27.	47.	60.	38.	30.	23.

The 17th segment bears a spine very like that of *L. minuta*, and the toothed-plate of the 18th is longer than the segment itself and is produced proximally over the 17th. The 19th segment bears a row of six angular teeth which increase in size distally.

The *5th pair of legs* is as figured. The spine on the proximal segment of the claw in the right leg is short, and there is a small angular tooth near its base; the distal segment is broad and terminates in two setae. The left leg bears a terminal group of curved spine-like processes and is clothed in hair on its inner margin; the penultimate joint also has a distal spine.

L. euchaeta. Stage 3.

Pl. xix, figs. 4—7.

♀ As regards their general structure, the individuals of this stage do not show any very great differences from stage 2. The abdomen possesses the same three segments, but the furcal rami are symmetrical. The *antennae and mouth parts* are identical with those of the adult.

The *5th pair of legs* is short, only reaching to the end of the 1st basal joint of the 4th pair of legs; they are very similar in structure to those of stage 2.

♂ In the case of the male the cephalo-thorax is the same as in the adult. The abdomen, however, only possesses four segments; of these the 3rd is the longest as in the case of subsequent stages.

The *5th pair of legs* contains only two joints and presents a superficial resemblance to those of the female of the same stage; they are however considerably longer, reaching to the 2nd basal joint of the 4th leg, and are not quite symmetrical, that of the right side being the larger. The main difference in length from that of the female is due to the greater size of the distal joint; four spines are present, one about the middle of the external margin and a group of three distally; on a level with the single marginal spine there is a distinct constriction showing where, at the next moult, the division into two segments will occur.

L. euchaeta. Stage 4.

Pl. xix, figs. 8 and 9.

This is the earliest stage in which any definite difference between the two sexes could be made out, and here the only apparent sexual indication lay in the proportional length of the 5th legs; in the female they were short, reaching only to a point half-way or a trifle more along the 2nd abdominal segment, whereas in the male they reach well beyond the 2nd segment and in some cases half-way along the 3rd.

In both sexes the form of the legs were the same and consisted of two joints, the distal having only three spines, and in both sexes also the abdomen consists of three segments, of which the third is the longest.

From the above descriptions, it is seen that the two final stages (1 and 2) differ very considerably as regards certain characters; especially is this the case in the males, where the grasping antennae and the 5th pair of legs are entirely different.

In the females the differences are less marked, yet a study of the two sexes in these stages must, I think, convince anyone that they actually belong to each other and that we are not dealing with the female of one species and the male of another. For the purpose of reference I have tabulated below some of the main characters following the changes through the four final growth-moults.

	No. of joints in abdomen.		Head lenses.	1st antenna ♀.	5th leg ♀ exopod.
	♀	♂			
Stage 4 ..	3	3	No lenses	23 free segments	3 spines.
,, 3 ..	3	4	No lenses ..	23 free segments	4 spines.
,, 2 ..	3	5	No rostral lenses, small ventral lens.	23 free segments	4 spines.
,, 1 ..	2	5	No rostral lenses, ventral lens.	21 joints, segments 7 and 8, and 10 and 11 fused.	5 spines.

It is at once obvious that these differences are due to a progressive development through the various growth-moults. In all the above-mentioned instances there is a regular gradation such as could not be merely due to coincidence. There is no greater difference between stages 1 and 2 than there is between stage 2 and the sexually immature forms, stages 3 and 4, and I consider that this fact, combined with a study of the developmental moults, justifies me in concluding that these are dimorphic forms

and not distinct species or varieties. Incidentally it is interesting to note that in the female we get a fusion of the abdominal segments taking place, whereas in the male we have the exact reverse, the segments gradually increasing in number owing to division taking place.

Genus **Pontella**, G. Brady.

Pontella andersoni, sp. nov.

Pl. xx, figs. 1—6.

Numerous examples of both males and females were obtained; they differ from all previously described species, and I have given them the above name after Lt.-Col. A. R. S. Anderson, who was for many years Surgeon-Naturalist and is now Civil Surgeon at Chittagong, where the specimens were obtained.

♀ Total length 3·34 mm.

The head and 1st thoracic segment are separate, as are also the 4th and 5th thoracic segments. The posterior thoracic margin terminates in a sharp lateral spine. The forehead is rounded anteriorly and terminates in a strong bifid rostrum. There are no rostral lenses present. The back of the head is crossed by a strongly marked groove. Side hooks are present.

The abdomen consists of two segments, the 2nd of which is small and terminates in symmetrical furca. The 2nd pair of furcal setae are much longer than the others, about twice the length. The relative lengths of the segments and furca are 20 : 6 : 11. The 1st segment is barrrel-shaped and quite symmetrical.

The *1st antennae* do not reach to the end of the thorax. The segments have the following proportional lengths :—

Segments—

1.	2.	3.	4.	5.	6.	7.	8.	9	10.	11-12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
50.	38.	11.	9.	13.	14.	12.	12.	20.	14.	39	24.	28.	32.	41.	37.	43.	45.	34.	31.	32.	23.	28.

The 11th and 12th segments are partially fused and the posterior border of the proximal segments is fringed with hair.

The *2nd antennae*, *mandibles*, *and maxillae* are of the usual type. The *maxillipeds* show the usual seven joints and the 2nd joint is armed with a row of spines down the margin.

The *1st pair of legs* has the usual 3-jointed exopodite and endopodite, and the whole of the external margin of the former is fringed with hair. The spine on exopod 2 is long, reaching well beyond the base of the 1st spine on exopod 3. The terminal saw is longer than the combined lengths of the two end segments of the exopodite.

The *2nd—4th pairs of legs* are as usual.

The *5th pair of legs* consists of a single jointed exopodite and endopodite, the former being about twice the length of the latter. The exopodite bears five spines, a single one near the middle of the outer border and four close together at the distal end. The

endopodite is bifid, the external process being the longer of the two.

♂ Total length 2·86 mm.

The head and thorax resemble those of the female, with the exception that small rostral lenses are present.

The abdomen consists of five segments, of which the 3rd is the longest, the furcal rami are symmetrical and the proportional length of the segments and furca are 7 : 5 : 10 : 5 : 5 : 15.

The *left* 1*st antenna* resembles that of the female. The *right* forms the usual grasping apparatus. The knee-joint is between the 18th and 19th segments. The 17th segment is produced on its anterior surface as a low crest, terminating in a short spine distally. The 18th segment carries a toothed-plate, which is prolonged proximally for a short distance over the 17th segment, and is armed with a double row of fine teeth. The 19th segment bears two tooth-plates each armed with fine teeth, and is prolonged distally as a sharp spine. The proportional lengths of the end segments are as follows :—

13-14.	15.	16.	17.	18.	19-21.	22-25.
8.	8.	12.	5.	23.	20.	26.

The 9th—12th segments each carries a seta-like spine on the anterior border.

The 5*th pair of legs* is as figured. Instead of a single process on the proximal segment of the claw, it bears two spines, and proximal to the spines are a pair of small knot-like projections on the margin. The distal segment is broad and ends in a blunt club-like protuberance. The left leg terminates in a long segment, bearing the usual spine and two processes terminally, and about two-thirds of the distance along its posterior surface arises a serrated spine.

P. andersoni. Stage 3.

Pl. xx, figs. 7—9.

♀ At this period of its existence the animal is as mentioned before, sexually immature, and in consequence we find that the abdomen consists of 3 segments, one more than in the mature female. As regards the appendages, these are for the most part the same as in the adult, and even in the case of the 5th pair of legs there is no very marked difference ; the endopod is, however, a trifle shorter and its two terminal processes have not yet assumed their final delicate shape

♂ In the male, as was pointed out in the case of *Labidocera cuchaeta*, there are very considerable differences between this stage and the next.

The abdomen consists of 4 segments only, of which the third is the longest.

The *left* 1*st antenna* exactly resembles that of the female ; the *right*, though quite unlike that of the adult, yet has begun to

alter in character and has assumed the form described by Brady (1883, p. 95, pl. xlv, fig. 11) in his *Pontella inermis*. The segments 12—16 form a spindle-shaped swelling, but the distal segments have not yet fused completely together, though segments 19—21 show signs of so doing, and there is no distinct knee-joint present. Segment 14 bears a long spinous process, and from the distal end of segment 19 a spinous process arises and extends to the end of segment 21, this is the future toothed-plate.

The *5th pair of legs* is symmetrical and consists of two segments only, the distal of which closely resembles the exopod of the female leg; there is no endopodite present. They reach to the end of the 2nd basal joint of the 4th leg and, as in the immature *Labidocera euchaeta*, are slightly constricted at the level of the first marginal spine, thus indicating where the division into two segments will occur at the next moult.

It is interesting to note that in stage 2, that is, in the first sexually mature stage of the males of both *Labidocera euchaeta* and *Pontella andersoni*, the terminal part of the claw of the 5th right leg is broad and stout and comparatively short, and it may be that this is one of the characteristics of this stage of development, the slender spinous-type of joint being developed only in stage 1.

Genus **Acartia.**

Acartia tortaniformis, sp. nov.

Pl. xxi, figs. 1—10.

Several examples of both sexes were obtained.

♀ Total length 1·4 mm.

The head and 1st thoracic segment are separate. Thoracic segments 4 and 5 are fused together and have a rounded posterior margin. Anteriorly the rostrum is absent, and the line of the forehead is continued round to the ventral surface, where it terminates in a hair-bearing ridge.

The abdomen is long and is contained 1½ times in the length of the cephalo-thorax; it contains 3 segments and a pair of furcal rami which are long, the proportions being 9 : 7 : 5 : 10. The 1st segment bears a row of spines transversely across its dorsal surface and scattered spines on the anterior half of its dorsal aspect. The furcal rami are symmetrical and terminate in four setae, the fifth arising from the external margin; the 2nd is longer than the others and is somewhat stouter at its base: this latter feature is however much more marked in the males. An accessory seta also arises from the dorsal surface.

The *1st antennae* reach to the beginning of the furcal rami; as usual it is difficult to determine the boundaries of the various segments in the proximal part; the proportional lengths of the segments are as follows:—

Segments—

1.	2-6.	7.	8.	9	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.
10.	36.	12.	15.	3.	11.	11.	8.	19.	12.	12.	14.	21.	21.	25.	19.	19.	15.	20.	15.	5.

There are three groups of small triangular spines on the posterior surface of the proximal joints, and with the exception of the distal three segments, all the others bear transverse rows of spines posteriorly.

The *2nd antenna* is of a somewhat unusual type. The basal portion consists of the usual two segments; the 1st basal bears a single and the 2nd basal two setae, and the margins are fringed with hair. The endopodite appears to be fused with the second basal joint and bears a crown of seven setae. The exopodite consists of a single joint and bears 9 setae.

The *mandible* is furnished with four teeth, of which the 1st is separated from the remainder by a wide interval.

The *2nd maxilla* resembles that of other members of the genus.

The *maxilliped* presents a resemblance to that of other members of the genus *Acartia*; the 3rd joint bears four sharp spinous processes and the 2nd joint carries a row of 4 triangular teeth on the margin.

The *1st pair of legs*. The exopodite consists of three segments. There is no marginal spine on exopod 2; both exopod 1 and 2 carry a single seta on their inner margins and exopod 3 has a row of five. The terminal spine is long and slender and is not serrated for some distance along the shaft; the proportional lengths of the spine and the terminal segment are as 46 : 16. The endopodite has two joints, of which the proximal bears a pair and the distal six setae.

The *2nd—4th pairs of legs*. Each consists of a 3-jointed exopod and 2-jointed endopod. Each joint of the exopod bears a single marginal spine, and the end saw is very long and slender resembling that of the 1st leg. The 1st joint of the endopod bears 3 and the 2nd 6 setae.

The *5th pair of legs* is symmetrical and possesses a basal portion carrying a marginal bristle and a single-jointed exopodite and endopodite, of which the former is about twice the length of the latter and each is serrated.

♂ Total length 1·45 mm.

The cephalo-thorax resembles that of the female. The abdomen is composed of four segments.

The *right antenna* is modified to form a grasping organ. The knee-joint is situated between segments 18 and 19. The 17th segment bears a toothed-plate which is prolonged distally over the 18th segment, which bears a toothed-plate carrying numerous needle-like teeth, and distally has a pair of sharp fang-like teeth. The 19th segment bears two long spine-like tooth-plates armed with fine teeth on their anterior margins.

The *left antenna* resembles that of the female.

The *-th pair of legs*. The left leg consists of three segments and the right of four, as in other members of the genus; arising from the basal joint of the right leg is a well-developed process, the endopodite.

This species is of considerable interest as it shows marked affinities on the one hand to the genus *Acartia* and on the other to the genus *Tortanus*; it forms, as it were, a distinct connection between these two genera, though on the whole, its structure is nearer that of *Acartia*. I propose therefore to give it the name *Acartia tortaniformis*.

BIBLIOGRAPHY

Brady, 1883. Report H. M. S. "Challenger." Zoology, vol. viii. London.

Brooks, 1886. "The Stomatopoda." Report H. M. S. "Challenger." Zoology, vol. xvi. London.

Calman, 1899. "On the British Pandalidae." Ann. Mag. Nat. Hist., series 7, vol. iii. London.

Cleve, 1901. "Plankton from the Indian Ocean and the Malay Archipelago." Kongl. Svens. Vet. Akad. Handlingar, vol. 36, No. 6. Stockholm.

Fowler, 1909. "Biscayan Plankton collected during a cruise of H. M. S. 'Research,' 1900." Pt. xii. The Ostracoda. Trans. Lin. Soc., Zoology, 2nd ser., vol. x, pt. 9. London.

Giesbrecht, 1892. F. und Fl. des Golfes von Neapel, vol. xix. Berlin.

Giesbrecht and Schmeil, 1898. Copepoda: Gymnoplea. Das Tierreich, Part 6. Berlin.

Grandori, 1912. "Due nuove specie di Copepodi." Zoologischer Anzeiger, vol. xxxix, No. 3, p. 97. Leipzig.

Gurney, 1907. "Further notes on Indian freshwater Entomostraca." Records Indian Museum, vol. i, p. 21. Calcutta.

Hadley, 1906. "Regarding the rate of growth of the America lobster." 36th Annual Report of the Commissioners of Inland Fisheries of Rhode Island, pp 183-226. Providence.

Herrick, 1911. "Natural History of the American lobster": Bulletin of the Bureau of Fisheries, vol. xxix, 1909. Washington.

G. Smith, 1904. 'Metamorphosis and life history of *Gnathia maxillaris*." Mitth. Stat. Zool. Neapel, vol. xvi, p. 469 Berlin.

,, 1906. "High and low dimorphism." Mitth. Zool. Stat. Neapel, vol. xvii, p. 313. Berlin.

Wolfenden, 1906. "Notes on the collection of Copepoda." The Fauna and Geography of the Maldive and Laccadive Archipelagoes, vol. ii, p. 989. Cambridge.

Wollebaek, 1908. "Remarks on Decapod Crustaceans." Bergens Museums Aarbog, No. 12, p 65. Bergen.

,, 1909. "Hermaphroditism in *Calocaris macandreae*." Nyt. Mag. Naturvidensk., vol. 47, pp. 251-68. Kristiania.

II.—THE GYMNOPLEA OF THE S. BURMA COAST AND MOSCOS ISLAND.

The regions of the coast of Burma in which the collections were made comprise (1) Hinzé Basin (lat. 14° 41′ 95″ N., long. 97° 53′ 00″ E.) and its neighbouring waters, and (2) the region extending from the Middle Moscos South Island (lat. 14° 15′ 95″ N.) on the north to the entrance of Tavoy River (lat. 13° 31′ 45″ N.) on the south, and from the coast line on the east to about latitude 97° 40′ 00″ on the west. Over the whole area the plankton was found to be abundant, especially during the later part of the season, *i.e.* March and early April, and the following diatoms were identified:—

Amphilonche belonoides.
Asterionella glacialis.
Asterionella challengerensis.
Asteromphalus hookeri.
Bacteriastrum delicatulum.
Bacteriastrum spirillum.
Bacteriastrum varians.
Chaetoceras criophilum.
Chaetoceras coarctatum.
Chaetoceras compressum.
Chaetoceras densum.
Chaetoceras dichaeta.
Chaetoceras didymum.
Chaetoceras diversum.
Chaetoceras furca.
Chaetoceras lorenzianum.
Climacodium biconcavum.
Climacodium frauenfeldianum.
Coscinodiscus centralis.
Coscinodiscus excentricus.
Coscinodiscus lineatus.
Eucampia zoodiacus.
Guinardia flaccida.
Hemiaulus hauckii.
Melosira borreri.
Nitzschia closterium.
Nitzschia lineola.
Nitzschia migrans.
Planktoniella sol.
Pyrocystis lunula.
Rhizosolenia alata.
Rhizosolenia arafurensis.
Rhizosolenia calcar avis.
Rhizosolenia robusta.
Rhizosolenia setigera.
Rhizosolenia shrubsolei.
Rhizosolenia stolterfothii.
Rhizosolenia styliformis.
Skeletonema costatum.
Thalassiosira antarctica.
Thalassiosira aurivillii.
Thalassiosira longissima.

It was soon seen, however, that although in the main the same diatoms were present in all the different parts of this region, in certain very definite areas the proportional distribution was extremely different, and this appeared to be constant during the whole of the two months in which the investigations were carried out So striking were the differences that one could tell at a glance from which particular area the collection of plankton had been made. I was thus able to divide the region, from the Middle Moscos Islands to Tavoy River, into four areas, each differing from the other in their surface plankton, and in the accompanying map (pl. xiv) I have indicated, as nearly as possible, the limits of these areas.

Area I extends from the mainland to some distance west of the Middle Moscos Islands, and from there is continued southward along the coast in a narrow band. The diatom flora of

this area was composed, in the main, of large quantities of *Coscinodiscus* and *Thallasiosira*. In this respect it resembled the flora of the waters off Hinzé Basin, some 25 miles further to the north; but I am unable to state whether these areas were confluent as no observations were made in intermediate waters. The flora of Hinzé Basin itself agreed with that of area III and the estuary of Tavoy River.

Area II extends from the south point of the Middle Moscos South Island to the north of the South Moscos group and then splits into two; one band passes down on the west side of the Islands, but the main area is continued to the south, in a gradually decreasing band, as far as the coast. In this area the tow-nettings were extremely large and of a dark green colour and consisted very largely of a thread-like alga of the genus *Trichodesmium*; there were also present, in fairly large numbers, several species of the genus *Ceratium*, principally *C. tripos*, which occurred not only as single individuals but also in the chain form.

Area III extends in a band from the east of the South Moscos Islands down to the entrance to Tavoy River, where it becomes continuous with the estuarine plankton. Here again the tow-nettings were very copious and of a dark green colour. Diatoms were exceedingly abundant, the commonest forms being *Rhizosolenia* and *Chaetoceras*.

Area IV extends over the whole of the region lying to the west of the 20-fathom line. The tow-nettings were of a pale pink colour, thereby being in marked contrast to those obtained from the two preceding areas. In some respects the plankton here was very similar to that of area II in that it contained quantities of the alga *Trichodesmium*, but it differed very materially in the large number of *Radiolaria* that were present. As I have already mentioned, its eastern boundary corresponds fairly closely with the 20-fathom line, and it is possible that we are in reality dealing here with a continuation of area II, the differences being due solely to the increased depth of the water; but as, in addition to the differences above mentioned, it was found that there were certain differences in the Copepod fauna present in these two areas I have preferred to keep them separate.

One cannot help being struck by the manner in which these areas are arranged, in roughly parallel bands running approximately from north north-west to south south-east Along this part of the coast, the main trend of the ebb and flood tides is in this same direction, but it does not appear to me to be probable that tide alone could cause such a definite banded arrangement, and a much more likely explanation would be that we are here dealing with a slow though definite current of water moving down the coast from the north and carrying the plankton with it, and this view receives further support from a study of the physical conditions of the coast-line, where we see that the sand-banks at the mouth of Hinzé Basin and in Maungmagan Bay have a well-marked southerly trend, and at the south end of the

South Moscos South Island there is a very definite scouring out of the sea bed, the depth here suddenly increasing to over 20 fathoms. Such a current coming down from the more northerly region of the Bay of Bengal would also account for the presence in area II of the serial form of *Ceratium tripos*, a form which, it is generally stated, is only found well out to sea and remote from any land.

On the other hand, however, area III would appear to run in a direction exactly opposed to such a current, for this area is directly continuous with the region at the mouth of Tavoy River. There is no doubt that this area is largely influenced by tides, for on two occasions the ship while carrying out a line of soundings passed right across this region, and although the net was down the whole time, the type of plankton obtained was typically that of area II; on both occasions, however, the tide was on the ebb, and this would appear to indicate that during the flood tide this area is carried up from the south from the region of Tavoy River to the east of the South Moscos Islands, and on the ebb tide it again recedes, its place being taken by water from area II.

The variations in the tow-nettings of these four areas were, however, not confined merely to the diatom flora; marked differences were found to exist regarding the occurrence of various species of Copepoda. This was particularly well marked in the case of area I as compared with the remaining three areas, and in the following table I have endeavoured to indicate these differences as fully as possible, the frequency or the reverse of several species being shown in percentages of the total Copepod catch.

	Area I (5 localities).	Areas II and III (8 localities).	Area IV (2 localities).
CALANIDAE.			
Canthocalanus pauper	12·33% in one locality; less than 4% in all others.	From 6 to 29·5% in 5 of the 8 localities.	From 6 to 8%.
Undinula caroli ..	Less than 1% in all localities.	From 3 to 16% in five localities.	Less than 1%.
Eucalanus subcrassus	6·6% and 13·2% in two localities: less than 2·5% in all others.	From 8 to 22% in seven localities.	11% in both localities.
Acrocalanus longicornis.	Less than 1% ..	From 5 to 29·5% in six localities.	2% in both localities.
PONTELLIDAE.			
Labidocera acuta ..	From 19·8 to 59% in all localities.	From 5·4 to 8% in three localities: less than 3% in all others.	Less than 4%.

	Area I (5 localities).	Areas II and III (8 localities).	Area IV (2 localities).
Labidocera minuta ..	From 4·1 to 10·1% in two localities: less than 4% in others.	Less than 1% or absent.	1% or less.
Pontella spinipes	From 5·5 to 21·5% in three localities.	Absent ..	Less than 1% or absent.
Tortanus gracilis	Less than 1% or absent.	Less than 4% or absent.	From 6 to 9%.

In addition to the above, area IV differed from all the other areas in the presence—though only in very small numbers—of *Eucalanus attenuatus*, *Rhincalanus cornutus* and *Candacia truncata*, *C. aethiopica* and *C. pachydactyla*.

The Copepod fauna of this region of the Burma coast, considered as a whole, seems in many respects to be intermediate between that of the Arabian Sea and Ceylon on the one hand and the Malay Archipelago and its neighouring waters on the other; thus we find present such species as *Centropages dorsispinatus*, *Centropages tenuiremis* and *Labidocera pectinata*, and such variations as *Pontella danae* var. *ceylonica*, *Labidocera kroyeri* var. *stylifera* and the "*plumulosus*" variety of *Undinula vulgaris* and allied species, all of which have so far only been recorded from the west, and *Candacia discaudata*, *Calanopia thompsoni*, *Tortanus barbatus*, *Pontella princeps* and *Labidocera euchaeta*, which link the fauna of this region with that of the Malay Archipelago and Pacific Ocean on the east. In several instances the specimens obtained furnish interesting examples of "continuous" variation, being intermediate between specimens already known from regions on both sides or a further development of previously-described variations from Ceylon and the Arabian Sea; a more detailed account of these will be given under the different species.

In the following systematic notes I have dealt solely with the Gymnoplea. Of these 73 different species and varieties were obtained, two of the former being new to science, *Pseudodiaptomus hickmani* and *Pontella investigatoris*. In the table below I have given a list of these species and varieties and have indicated in the succeeding columns their presence or absence, so far as is at present known, from the neighbouring areas that have already been investigated.

		Red Sea (Giesbrecht, Cleve, A. Scott).	Arabian Sea (Cleve, A. Scott).	Maldive and Laccadive Archipelagoes (Wolfenden).	Around Ceylon (Thompson & Scott).	Malay Archipelago (Cleve).	Between Borneo and New Guinea (A. Scott).
1	*Calanus minor*		×	×	×	×	×
2	*Canthocalanus pauper*	×	×	×	×	×	×
3	,, ,, var. *plumulosus*, nov.						
4	*Undinula vulgaris*	×	×	×	×	×	×
5	,, ,, var. *plumulosus* ..			×			
6	,, *darwini*		×	×	×	×	
7	,, *caroli*			×			×
8	,, ,, var. *plumulosus*, nov. ..						×
9	*Eucalanus attenuatus*.		×	×	×	×	
10	,, *crassus*	×	×	×	×	×	
11	,, *monachus* ..		×	×	×	×	×
12	,, *pileatus*			×	×		×
13	,, *subcrassus*	×	×	×	×	×	×
14	,, *subtenuis*	×	×	×	×	×	×
15	*Rhincalanus cornutus*..	×	×	×	×	×	×
16	*Paracalanus aculeatus*	×	×	×		×	×
17	,, ,, var. *plumulosus* ..			×			
18	,, *parvus*	×	×	×	×	×	×
19	*Acrocalanus gardineri*..			×			
20	,, *gibber*	×	×	×	×	×	×
21	,, *gracilis*	×	×	×	×	×	×
22	,, *inermis*						
23	,, *monachus*			×			×
24	,, *longicornis*		×	×	×	×	×
25	,, ,, var. *plumulosus*, nov.						
26	*Calocalanus pavo*	×	×	×	×	×	×
27	,, *plumulosus*	×	×	×	×	×	×
28	*Clausocalanus arcuicornis*		×	×	×	×	×
29	*Euchaeta concinna*			×	×	×	×
30	,, *marina*	×	×	×	×	×	×
31	*Scolecithrix danae*		×	×	×	×	×
32	*Centropages notoceras*		×		×		
33	,, *furcatus*	×	×	×	×	×	×
34	,, *orsinii*	×	×	×	×	×	×
35	,, *tenuiremis* ..		×		×		
36	*Pseudodiaptomus aurivillii*		×		×	×	×
37	,, *hickmani*, sp. nov. .						
38	*Temora discaudata*	×	×	×	×	×	×
39	,, *stylifera*	×	×	×	×	×	
40	,, *turbinata*				×		×
41	*Lucicutia flavicornis*	×	×	×	×	×	×
42	*Candacia æthiopica*		×		×		×
43	,, *bradyi*	×	×	×			×
44	,, *catula*	×	×	×	×	×	×
45	,, *discaudata*						×
46	,, *pachydactyla*		×	×	×	×	×
47	,, *truncata*	×	×	×	×		×
48	*Calanopia elliptica*	×	×	×	×	×	×
49	,, *minor*	×	×	×	×		×
50	,, *thompsoni*						×
51	*Labidocera acuta*	×	×	×	×	×	×
52	,, *euchaeta*						
53	,, *kroyeri*		×		×	×	×
54	,, ,, var. *bidens*, nov. ..						
55	,, ,, var. *burmanica*, nov. ..						

		Red Sea (Giesbrecht, Cleve, A. Scott).	Arabian Sea (Cleve, A. Scott).	Maldive and Laccadive Archipelagoes (Wolfenden).	Around Ceylon (Thompson & Scott).	Malay Archipelago (Cleve).	Between Borneo and New Guinea (A. Scott).
56	*Labidocera kroyeri* var. *stylifera*				×		
57	,, *minuta*	×	×	×	×	×	×
58	,, *pectinata*		×		×		
59	*Pontella andersoni*						
60	,, *danae* var. *ceylonica*				×		
61	,, *investigatoris*, sp. nov. ..						
62	,, *princeps*				×		×
63	,, *securifer* ..			×	×		×
64	,, *spinipes* ..			×			
65	*Pontellopsis herdmani* ..				×		×(?)
66	,, *krämeri*	×		×			×
67	,, *regalis* ..		×			×	×
68	*Pontellina plumata* ..	×	×	×	×	×	×
69	*Acartia danae*			×			×
70	,, *erythraea*	×	×	×	×	×	×
71	,, *spinicauda*		×				×
72	*Tortanus barbatus* ..						×?
73	,, *gracilis*	×	×	×	×(?)	×	×

Family *CALANIDAE*.

Genus **Calanus**, Leach.

1. **Calanus minor** (Claus).

Occurrence: Localities B, E, F, K, N, P.[1]

On the whole, this species was comparatively rare; in only a single locality (F) was it present in comparative abundance. The specimens obtained are, with one exception, typical, and in size correspond to the measurement, as given by Scott, 1·7 mm. in length.

As regards colouration, the females usually showed a uniform faint red pigmentation, whereas the males were as a rule colourless.

In one specimen, a female, the 3rd and 4th legs of the left side were abnormal; instead of the usual three-jointed exopodite and endopodite, it consisted of a single paddle-shaped segment, bearing on its free margin a number of setae, 10 in the 3rd and 11

[1] These letters afford reference to the list of localities given at the end of the paper. All of them, with the exception of Q (Hinzé Basin), are also shown on the map.

in the 4th leg, in the latter the basipodite also presented at its distal external angle a short process carrying four teeth. Probably this abnormality was the result of some previous injury.

Genus **Canthocalanus**, Scott.

1. **Canthocalanus pauper** (Giesbrecht).

Calanus pauper, Giesbrecht and Schmeil, Das Tierreich, Lief. 6; p. 16, 1898.

Occurrence: Localities A, B, C, D, E, G, H, J, K, L, N, O, P, Q.

This species was almost invariably present all over the area of investigation, its maximum frequency of occurrence being obtained to the E. and S. E. of South Moscos South Island.

In point of size it agrees very closely with the figures given by Giesbrecht and Schmeil (*loc. cit*).

In this species also a single specimen, again a female, possessed an abnormal 4th leg right side. The endopodite was normal but the exopodite was composed of only two segments: the distal segment was paddle-shaped and carried one external marginal spine and six setae, the proximal segment carried a single seta but no spine.

2. **Canthocalanus pauper** (Giesbrecht) var. **plumulosus**, nov.

Occurrence: Localities H, K, M.

Seven specimens were obtained which presented, in varying degree, the plumose variation of the furcal setae. So far as I am aware the only previous record of this type of variation was given by Dr. Wolfenden, who found it in several closely allied species; in *Undinula* (*Calanus*) *vulgaris*, *Paracalanus aculeatus* and *Calocalanus pavo* bilaterally, and in *Euchirella bella* var. *indica* and *Euchaeta norvegica* [1] unilaterally, all his examples being obtained from the Maldive and Laccadive Archipelagoes.

As he points out, the variation is extremely irregular, only two, of the seven specimens obtained, being identical; the absence of feathering on the side branches of the plumose setae also agrees with his description of the variation as he found it in *Undinula vulgaris*.

It would appear that this type of variation is extremely local in its occurrence, for as will be seen later, almost all specimens showing it were obtained in the region round the South Moscos South Island.

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[1] Dr. Wolfenden gives a figure of the variation in this species (the Fauna and Geography of the Maldive and Laccadive Archipelagoes, vol. ii, plate C, fig. 21), but I can find no mention of it in the text.

Genus **Undinula**, Scott.

Undina, Brady, *nom. præocc.*

1. **Undinula vulgaris** (Dana).

Occurrence: Localities B, D, E, F, G, H, K, L, M. O, P.

Although widely distributed over the whole of the Middle and South Moscos regions, it was much more abundant over the region to the S. and E. of the South Moscos South Island.

In size it was as a rule rather below the average as given by Giesbrecht and Schmeil (*l.c.*, p. 17), varying from 1·9 to 2·3 mm. in length. A few specimens were obtained having the double spine on the left side of the last thoracic segment as figured by Giesbrecht (*Calanus vulgaris*: F. u. Fl. Gulf. Neap., xix, pl. 7, fig. 28).

2. **Undinula vulgaris** (Dana) var. **plumulosus** (Wolfenden).

Calanus vulgaris, Wolfenden, Notes on the Collection of Copepoda. *The Fauna and Geography of the Maldive and Laccadive Archipelagoes*, vol. ii, p. 994, pl. xcvi, figs. 21 and 22.

Occurrence: Localities K, L, Q.

This variety appears to be of comparatively infrequent occurrence, only four specimens being obtained. These, with a single exception from Hinzé Basin, were obtained in the same locality as *Canthocalanus pauper* var. *plumulosus*. They show the same irregularity in the number and arrangement of the plumose setae.

3. **Undinula darwini** (Lubbock).

Occurrence: Localities O and P.

This species appears to be very rare in the different areas investigated and very few specimens were obtained; all those examined were, with one exception, females.

4. **Undinula caroli** (Giesbrecht).

Calanus caroli, Giesbrecht, Atti. Acc. Lincei Rend., ser. 4, vol. 4, Sem. 2, p. 331 (1892).—F. u. Fl. Neapel, vol. 19, p. 91, t. viii, f. 36.

Calanus caroli, Wolfenden, Notes on the Collection of Copepoda. *The Fauna and Geography of the Maldive and Laccadive Archipelagoes*, vol. ii, p. 994.

Occurrence: Localities B, C, E, F, G, H, K, L, M, P, Q.

A large number of females were obtained, which agree in every particular with the description of the specimens obtained

by Wolfenden in the Maldive and Laccadive Archipelagoes; that is to say, they have no teeth on the external margin of the last segments of the 2nd or 3rd legs, and in addition, the fine denticulation on the proximal segment of the basipodite of the 5th legs and the spines on the margin of the 1st and 2nd abdominal segments, which are met with in *U. darwini*, are absent in these specimens.

I agree with Wolfenden in thinking that these are probably the female *Undinula caroli*. No males were obtained.

5. **Undinula caroli** (Giesbrecht) var. **plumulosus**, nov.

Two specimens showing the plumose variation of the furcal setae were found in locality K.

Genus **Eucalanus**, Dana.

1. **Eucalanus attenuatus** (Dana).

A few specimens only were taken in localities O, P. They all differed slightly from the description given by Giesbrecht, in possessing a more pointed forehead. In this respect they much more nearly resembled *Eucalanus elongatus*.

2. **Eucalanus crassus**, Giesbrecht.

Occurrence: Localities D, E, L, M, O, P, Q.

A considerable variation in colouration was found to be present; in a few specimens the pigmentation was well marked and closely resembled the figure in Giesbrecht, the setae on the exopodite of the mandible being bright crimson; in the majority however, all trace of pigmentation was absent.

The females were covered all over the posterior part of the cephalo-thorax and the 1st abdominal segment with short close-set hairs. In the males, however, this was not the case.

In one male specimen the 5th leg was found to terminate in two apical hairs, the distal end of the last segment being slightly bifid, and a specimen of a female was found in which a rudimentary 5th left leg was present; in structure this extra leg closely resembled that normally present in the male, though slightly smaller in size.

3. **Eucalanus monachus**, Giesbrecht.

Occurrence: Localities E, G, H, O, P.

This species was comparatively rare especially in locality H in which only three specimens were obtained.

4. **Eucalanus pileatus**, Giesbrecht.

Occurrence: Localities J, L, M, P, Q.

This species also was not common, except in locality J where it formed 6% of the whole catch.

5. **Eucalanus subcrassus**, Giesbrecht.

Occurrence : Localities A, B, C, D, E, F, H, J, L, M, N, O, P, Q.

This species was one of the commonest ; it was widely distributed over the whole area of investigation and was usually present in large numbers ; in one locality (Q) it formed very nearly half the total catch.

6. **Eucalanus subtenuis**, Giesbrecht.

Occurrence : Locality Q.

The species was apparently absent over the whole of the Moscos Archipelago ; a few specimens were obtained further north in Hinzé Basin (locality Q).

Genus **Rhincalanus**, Dana.

1. **Rhincalanus cornutus** (Dana).

This species appears to be extremely rare in this region, only two specimens were obtained from locality O and one from P.

Genus **Paracalanus**, Boeck.

1. **Paracalanus aculeatus**, Giesbrecht.

Occurrence : Localities A, D, E, G, J, K, L, N, O.

Although by no means common, this species of *Paracalanus* was fairly widely distributed.

2. **Paracalanus aculeatus**, Giesbrecht, var. **plumulosus**, Wolfenden.

Two specimens were obtained showing the plumose arrangement of the furcal setae, one each in localities G and P ; in other respects they were identical with *P. aculeatus*.

3. **Paracalanus parvus** (Claus).

A few specimens were obtained in localities A, J and Q, but in all other localities this species appears to be absent.

Genus **Acrocalanus**, Giesbrecht.

1. **Acrocalanus longicornis**, Giesbrecht.

Occurrence : Localities A, F, G, H, K, L, M, N, O, P.

This species was fairly widely distributed and in certain regions (G, K, L, M) was exceedingly common.

In one specimen an unusual condition was present in the 4th right leg ; the proximal "aussenranddorne" was missing on the

3rd joint of the exopodite and the coarse teeth on the proximal part gradually diminished in size and finally blended with the finer denticulations on the distal part of the margin, forming a continuous series.

2. **Acrocalanus longicornis**, Giesbrecht, var. **plumulosus**, nov.

A single specimen was obtained from locality G, which showed a slight form of variation of this type, the 2nd seta of the left furcal appendage showing a single dichotomous branching.

3. **Acrocalanus gardineri**, Wolfenden.

A. gardineri, Wolfenden, Notes on the Collection of Copepoda. *The Fauna and Geography of the Maldive and Laccadive Archipelagoes*, vol. ii, p. 1004, pl. xcvii, figs. 5, 10, 14-21.

Occurrence: Localities M, N, Q.

Examples of this species were rare. Those that were obtained were all males and tallied with Wolfenden's description, with the exception that the 2nd basal segment of the 5th leg was in all cases much shorter than the 1st, not longer, as he describes it.

4. **Acrocalanus gibber**, Giesbrecht.

Occurrence: Localities D, E, H, J, K, L, N, O, P.

This species was fairly widely distributed, and in certain localities, notably D, H, K, was quite common.

5. **Acrocalanus gracilis**, Giesbrecht.

Occurrence: Localities C, G, H, J, M, N.

With the exception of localities H, N in which it formed 10—11% of the total catch, it occurred only in comparatively small numbers. It was also less widely distributed than the preceding species.

6. **Acrocalanus monachus**, Giesbrecht.

Only a single specimen was obtained from locality G.

Genus **Calocalanus**, Giesbrecht.

1. **Calocalanus pavo** (Dana).

Occurrence: Localities D, E, O.

With the exception of a single specimen found in D, all those obtained came from E and O, where the species was comparatively common.

2. **Calocalanus plumulosus** (Claus).

A single female was obtained in locality O.

Genus **Clausocalanus**, Giesbrecht.

1. **Clausocalanus arcuicornis** (Dana).

Occurrence: Localities J, O, P.

Only a few specimens were obtained in each of the above localities and the species was apparently absent in all others.

Genus **Euchaeta**, Philippi.

1. **Euchaeta concinna**, Dana.

Occurrence: Localities B, J, O, P, Q.

This species seems to be extraordinarily local in its distribution, and, if present at all, is so in comparatively large numbers.

2. **Euchaeta marina** (Prestand).

This species appeared to be comparatively rare; a few specimens were found in Hinzé Basin (Q).

Genus **Scolecithrix**, Brady.

1. **Scolecithrix danae** (Lubbock).

A single male specimen was obtained from locality O.

Family *CENTROPAGIDAE.*

Genus **Centropages**, Kröyer.

1. **Centropages furcatus** (Dana).

Occurrence: Localities A, B, C, D, E, G, J, L, N, O, P.

This species was of almost universal distribution and in certain localities, especially C and N, was exceedingly common, large numbers of both sexes being obtained.

2. **Centropages notoceras**, Cleve.

C. notoceras, Cleve, Report on Plankton collected by Mr. Thorild Wulff during a voyage to and from Bombay. *Archiv för Zoologi*, vol. i, p. 373, pl. 17, figs. 2-10; pl. 18, fig. 1, 1903-4.

? *C. dorsispinatus*, Thompson and Scott, Report on the Copepoda. *Ceylon Pearl Oyster Fisheries and Marine Biology*, (Suppl. Rept. vii), vol. 1, p. 247, pl. i, figs. 19—25.

Occurrence: Localities B and Q.

Numerous examples of this species were obtained, both males and females, and they agree very closely with the description given by Cleve (*loc. cit.*) of his specimens from the Arabian Sea. As, however, they differ in a few details I append a full description below.

♀ Length from 1·2 to 1·4 mm.

The forehead, when viewed in profile, has a rounded outline, terminating anteriorly in a bifid, backwardly directed rostrum; behind the forehead is a well-marked dorsal hump. A little anterior to the posterior border of the head region, in the middle line, is a large backwardly-curved spine, which terminates in a pair of small antrorse hooks.

The head and 1st thoracic segments are separate. The last thoracic segment is armed on each side with a sharp backwardly-directed spine.

The abdomen is composed of three segments, of which the 1st is markedly swollen and bears on each side ventrally a row of sharp spines. The 2nd segment is longer than the anal and bears on its right side two short rows of spines, of which the proximal is the more ventrally situated. The furcal joints are three times as long as broad and the 5th seta is much shorter and stouter than the others, and arises at the junction of the middle and distal thirds.

The *1st antennae* are composed of 21 free joints, the first or basal joint being formed by the fusion of 1st to 4th segments, though in a few specimens traces of separation could be made out between the 3rd and 4th. The proportional lengths are as follows:—

1-4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
42.	7.	10.	10.	10.	14.	14.	14.	17.	23.	25.	28.	30.	30.	31.	29.	21.	19.	14.	14.	14.

The fused basal joint carries three spines, on its anterior border a small proximal and a large distal, and on its posterior border a small spine opposite the small proximal one on the anterior surface.

The *1st leg* closely resembles that of *C. typicus* (Krōyer), in having serrated spines on the 1st and 2nd segments of the exopodite, but differs in the possession of a small spine on the inner border of the 2nd basal segment near the joint for the endopodite.

The *5th pair of legs* corresponds exactly with Cleve's description and figures.

♂ Length 1·2 mm.

Abdomen 5-jointed, the last segment being very short.

The *anterior antennae* are, as usual, asymmetrical; that of the left side is identical with the female type; the right grasping antenna has the first four segments separate, not fused as in the female and left male antenna, and the 19th to 21st and 22nd

and 23rd segments are respectively fused together. The proportional lengths are as follows:—

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19-21.	22-23.	24.
11.	15.	7.	6.	7.	5.	8.	8.	7.	10,	10.	8.	15.	17.	25.	30.	27.	35.	50.	27.	15.

The knee-joint occurs between the 18th and 19th segments, and the 17th, 18th and proximal half of the 19—21st segments are all armed with rows of delicate teeth. The 2nd, 5th and 19—21st segments all bear spines, that on the 5th being large and well-marked.

The *5th leg* is exactly similar to that of *C. dorsispinatus.*

There can, I think, be no doubt that these examples, obtained by me in Hinzé Basin, are identical with those described by Cleve under the name of *C. notoceras* from the Arabian Sea. But there seems to be certain discrepancies between them and *C. dorsispinatus.*

Cleve himself, after seeing Thompson and Scott's paper, came to the conclusion that his examples were identical, but on comparing the two descriptions certain differences are apparent and I have tabulated these as far as possible:—

	C. notoceras, Cleve, and present specimens.	*C. dorsispinatus*, Thompson and Scott.
1	Abdomen ♀ 3-jointed.	Abdomen ♀ 4 (?) jointed (three only are shown in the fig., but in the text it is stated that four are present).
2	Spines on genital (1st) segment of abdomen ♀ on both sides.	Spines only on left side.
3	Rostrum, bifid.	Rostrum broad and triangular.
4	Antennal joints 1-4 fused (in female and left male).	Antennal joints all separate.
5	Well-marked spine on 5th joint right antenna ♂.	No spine present. (They make no mention of it in the text but figure it as absent).

Were it not that Cleve himself was convinced of the identity of his specimens with those from Ceylon, I should have had no hesitation in describing my examples as representatives of *C. notoceras* and distinct from, though closely allied to, *C. dorsispinatus.* Under these circumstances, however, I have left the matter open.

3. Centropages orsinii, Giesbrecht.

Occurrence: Localities B, C, D, F, G, H, K, M, N, O, P.

This species was quite common, especially in localities G and H.

4. **Centropages tenuiremis**, Thompson and Scott.

Pl. xxiv, figs. 6—7.

C. tenuiremis, Thompson and Scott, Report on the Copepoda. *Ceylon Pearl Oyster Fisheries and Marine Biology*, (Suppl. Rept. vii), vol. 1, p. 247, pl. i, figs. 14—18, 1903.

C. arabicus, Cleve, Report on Plankton collected by Mr. Thorild Wulff during a voyage to and from Bombay, *Arkiv for Zoologi*, vol. i, p. 371, pl. 16, figs. 1—9; pl. 17, fig. 1, 1903-4.

Occurrence: Localities C and E.

Numerous specimens were obtained in the above localities and agree very well with the descriptions of Cleve, and Thompson and Scott. The latter, however, state that in their examples the abdomen of the female possesses four segments (they only figure it with three). As Cleve (*loc. cit.*) points out, the 1st and 2nd segments of the exopod of the right 5th leg of the female are fused together, a point apparently overlooked by Thompson and Scott. Both authors figure the spine as arising from the 1st segment. I have examined a large number of specimens, but can find no evidence whatever in favour of this view; on the contrary, where any trace of separation can be made out, it invariably runs on the proximal side of the spine, which therefore arises, as one would have expected, from the distal portion of the fused segment (vide pl. xxiv, fig. 6). A second point in which my examples appear to differ is in the length of the endopodite which reaches to the end of the spine, whereas both the previous authors show it as falling considerably short of this. Possibly this latter is a local variation, as Cleve figures it much shorter in his examples than in those from Ceylon.

Another point in which my specimens differ is in the 4th pair of legs of the male. Thompson and Scott state that in their specimens this appendage resembled that of *C. typicus*, that is to say the marginal spine of the 2nd joint of the exopodite of the 3rd and 4th legs of the right side is increased in length in comparison with its fellow of the opposite side. In all the specimens that I have examined, however, the 3rd pair of legs is symmetrical and the 4th leg of the right side bears enlarged spines on both exopod 1 and 2.

Genus **Pseudodiaptomus**, Herrick.

1. **Pseudodiaptomus aurivillii**, Cleve.

A few specimens were obtained in locality Q; they were, without exception, females and agreed with Cleve's description.

2. **Pseudodiaptomus hickmani**, sp. nov.

Pl. xxii, figs. 1—7.

Occurrence : Locality Q.

Several specimens were obtained, both males and females; they appear to differ from any previously described species, and I have much pleasure in naming it after Commander C. S. Hickman, R.I.M., Officer in charge, Marine Survey of India.

♀ Total length 1·37 mm.

The abdomen and furca are contained twice in the length of the cephalo-thorax. The head is separate from the 1st thoracic segment and terminates anteriorly in a bifid rostrum with long and delicate spines. The 5th thoracic segment is armed laterally with a sharp spine, directed backwards and slightly outwards. The abdomen is composed of four segments, the first three of which are armed posteriorly with a row of triangular teeth extending across the dorsal surface. The relative lengths of these segments and the furcal rami are 10 : 4 : 6 : 4 : 7. The latter are three times as long as wide.

The genital segment has a well-marked ventral swelling, and the genital operculum is produced posteriorly in a single spine on the right side. On the right side of the segment is a blunt spinous process and anterior to the genital orifice is a curved row of needle-shaped spines, which terminates laterally in the above mentioned process. Dorsally the segment is armed on each side with an elongated group of very fine spines.

The *1st antennae* are composed of 21 joints having the following relative proportions:—

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
15.	8.	4.	8.	7.	9·5.	6.	7.	12.	13.	14.	15.	14.	14.	15.	13.	10.	11.	11.	11.	13.

The *2nd antennae* have the usual characters as in the other members of the genus, but differ from the others in possessing a row of fine spine-like processes on the margin of the last segment of the endopodite.

In the *1st pair of legs* the endopodite and exopodite are of nearly the same length. The 1st joint of the exopodite bears a long slender serrated external margin spine and the 3rd joint has two short non-serrated external spines and a terminal spine, whose length is almost equal to the combined length of the last two segments; the 2nd joint is without a spine. The 1st joint of the basiopodite bears two rows of delicate spines on its antero-external surface, one at its distal margin and the second, in which the spines are somewhat longer, about the middle of its length.

The *2nd-4th pairs of legs* are of the usual type, but the 2nd pair differs in having three series of very delicate spines on the 1st joint of the basiopodite; two of these are similar to those of the 1st leg, the third is a delicate row of spines proximal to the origin of the seta on the inner border.

The *5th pair of legs* very closely resembles those of *P. serricaudatus* (Th. and Scott). The outer claw bears an inner toothed lamella and is slightly longer than the inner claw.

♂ Total length 1·3 mm.

Cephalo-thorax as in the female.

The abdomen consists of 5 segments, of which the 2nd, 3rd and 4th are armed posteriorly with a complete ring of triangular teeth; the relative lengths of the segments and furca are 2 : 5 : 5 : 5 : 3 : 5.

The *grasping antenna* consists of 21 free joints, of which the 13th-17th are swollen; the knee joint occurs between the 18th and 19th segments. The "endabschnitt" comprises three segments. Sickle-shaped spines are articulated with the anterior border of segments 10-13.

The *1st to 4th legs* are the same as in the female.

The *5th pair of legs*. On the right side, the 2nd basal segment carries on its inner aspect a Y-shaped spinous process, the endopodite. The exopodite is three-jointed; the 1st segment is produced externally in a Y-shaped spinous process, and the posterior border of the articulation with the 2nd segment is armed with a row of teeth. The 2nd segment bears on its outer surface distally a short thick spine with serrated margins, and the 3rd segment is sickle-shaped and its inner margin is finely denticulate. On the left side the endopodite is represented by a fringed unjointed process. The exopodite is two-jointed and the 2nd segment consists of a thin plate bearing a spine at each corner of the distal extremity, the margin between being finely denticulate; the outer border bears a blunt process which projects at a right angle.

It is not improbable that many of the records of the occurrence of *P. serricaudatus* in Indian waters really refer to this species.

Family *TEMORIDAE*.

Genus **Temora**, W Baird.

1. **Temora discaudata**, Giesbrecht.

Pl. xxii, figs. 8 and 9.

Occurrence: Localities A, B, D, E, F, G, J, L, M, N, O, P.

This species was of almost universal distribution; its maximum frequency was obtained in A and B. A considerable degree of variation was found to exist in the structure of the 5th pair of legs of the female. In the majority of cases the condition was that usually described, the inner spine arising close to the end of the terminal segment, but in others it arose from the inner border some distance from the extremity, at about the junction of the middle and distal thirds; in all cases it appeared to retain the same relative position to the external margin spine, thus indicating that it was the terminal post-spinal portion of the segment that had increased in length.

2. **Temora turbinata** (Dana).

Occurrence: Localities A, B, C, D, E, F, G, H, J, K, L, M, N, O, P.

This species was usually present in large numbers and was much the commonest representative of the genus.

3. **Temora stylifera** (Dana).

Occurrence: Localities E, J, L.

This species appeared to be comparatively rare; only a few specimens being obtained.

Family *LUCICUTIIDAE.*

Genus **Lucicutia**, Giesbrecht, 1898.

1. **Lucicutia flavicornis** (Claus).

Occurrence: Localities F, J, N, O, P.

This species was comparatively rare, only a few specimens being obtained in each of the above localities.

Family *CANDACIIDAE.*

Genus **Candacia**, Dana.

1. **Candacia aethiopica**, Dana.

Only a single specimen, a female, was found in locality O. While agreeing with the description as regards structure, it differed in that it was only slightly pigmented, the spots most pigmented being not the back but the bases of the maxillae and the ends of the swimming feet.

2. **Candacia bradyi**, Scott.

Pl. xxiii, figs. 6 and 7.

C. bradyi, Scott, Some Red Sea and Indian Ocean Copepoda. *Trans. L. B. S.*, vol. xvi, p. 406, pl. 1, figs. 9—12.

C. tuberculata, Wolfenden, Notes on the collection of Copepoda. *The Fauna and Geography of the Maldive and Laccadive Archipelagoes*, vol. ii, p. 1015, pl. xcvi, figs. 40—44.

C. bradyi, Scott, The Copepoda of the Siboga Expedition, pt. 1, p. 156, pl. xlvii, figs. 1—9.

A large number of specimens were obtained in localities J, N, O. Associated with these were several females, which I take to be the hitherto undescribed female of this species.

♀ Length 1·8 mm.

The last thoracic segment terminates in a short spine.

The abdomen is contained $2\frac{1}{2}$ times in the length of the cephalothorax. The 1st segment viewed from above is symmetrical and somewhat globular in shape, ventrally there is a well-marked genital swelling. The 2nd segment is produced ventrally in the middle line in a short spine, its length is about half that of the genital segment.

The furcal joints are about twice as long as broad; they are slightly asymmetrical, that on the right side being broader than the left.

The 1*st antennae* consist of 23 joints. The proportional lengths of the joints are as follows:—

1.	2.	3.	4.	5.	6.	7.	8	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
16.	21.	7.	12.	16.	13.	7.	8.	8.	8.	14.	19.	19.	25.	26.	30.	29.	34.	23.	18.	12.	21.	24.

In the male the proportional lengths of the joints of the left antenna are:—

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
16.	21.	7.	15.	17.	10.	8.	8.	9.	9.	13.	20.	20.	27.	27.	33.	32.	37.	24.	16.	13.	19.	21.

The 2nd segment of the 2*nd maxilla* bears three spines and the proximal spine of the 3rd segment is longer and much stouter than the distal.

The 1*st leg* resembles that of the male in having a single jointed endopodite and in the absence of any hair on the basiopodite.

The terminal spine on the exopodite of the 3*rd leg* is, as in the male, two-thirds the length of the last segment.

In the 5*th legs* the terminal segments are almost symmetrical, are slightly curved inwards and bear on their inner margin two setae. The outer border carries three spines, the first about the middle of its length and the other two close together near the tip, which ends in a single stout spine. These external spines on the left side are blunt and pigmented, and on the right are sharp and devoid of pigment.

3. **Candacia catula** (Giesbrecht).

This species appears to be very rare in this region, only a single male specimen was obtained in locality O and one female in locality P.

4. **Candacia discaudata**, A. Scott.

Occurrence: Localities B, D, E, F, J, K, L, M, N, O, P.

A considerable number of specimens, both males and females, were obtained, especially in localities F, L, M. They were all quite typical, agreeing exactly with the description given by Scott (Siboga Expedition. Copepoda, pt. 1, p. 157, pl. xlvii, figs. 10—20, 1909).

5. **Candacia pachydactyla**, Dana.

Occurrence: Localities O and P.

A few specimens were obtained in the above localities, but on the whole this species was conspicuous by its absence. The examples obtained were quite typical.

6. **Candacia truncata**, Dana.

Occurrence: Localities O and P.

Several specimens, both males and females, were obtained.

Family *PONTELLIDAE*.

Genus **Calanopia**, Dana.

1. **Calanopia elliptica** (Dana).

Occurrence: Localities E, F, J, M, N, O, P.

This species was most abundant in localities F and J

2. **Calanopia minor**, A. Scott.

Occurrence: Localities F, J, O, P.

As in the preceding species, this was most abundant in F and J; in other localities, however, it was rare or entirely absent.

3. **Calanopia thompsoni**, A. Scott.

C. thompsoni, A. Scott, The Copepoda of the Siboga Expedition, pt. i, p. 178, pl. xlix, figs. 1—8, 1909.

A single specimen, a female, was obtained in locality E. The specimen was somewhat immature, measuring only 1·6 mm., but from the barbed rostrum, the small 3rd segment of the antenna and the lateral spines on the head, I have no doubt that it belongs to this species.

Genus **Labidocera**, Lubbock.

1. **Labidocera acuta** (Dana).

Occurrence: Localities A, B, C, D, E, F, G, H, K, L, M, O, P, Q.

In localities A, B, C, D and E this species was extremely common, forming from 20% to 60% of the total catch, whereas in the remaining localities it was comparatively rare.

The males differ slightly from the Mediterranean form in that the "reibleistes" of the grasping antennae were somewhat longer on both joints of the knee-joint than as shown in Giesbrecht's figure (F. u. Fl. des Golfes von Neapel, vol. xix, plate 23, fig. 15), especially on the distal segment.

In several cases, in young specimens, it was found that the 3 central furcal setae were deeply pigmented at their bases with a purple-blue pigment; this appears to grow fainter and is finally lost during the later development.

2. **Labidocera euchaeta,** Giesbrecht.

Occurrence: Locality Q.

Several specimens of both sexes were obtained.

3. **Labidocera kroyeri** (G. Brady).

Occurrence: Localities B, E, O, P, Q.

On the whole this species was comparatively rare, occurring only in small numbers in the localities given above. The females were all typical in their structure, but all the corresponding males showed some form of variation.

4. **Labidocera kroyeri** (Brady) var. **stylifera,** Th. and Scott.

Several specimens were obtained showing this variation.

5. **Labidocera kroyeri** (Brady) var. **burmanica,** nov.

Pl. xxiii, figs. 4 and 5.

In this form the right side of the 5th thoracic segment terminates in a branched arrangement of 5 spines. Three of these spines are large and conspicuous and two smaller ones project respectively from the inner and outer surface of the lower border of the projection. In general structure the 5th natatory legs closely resemble those of the variety "*gallensis*" (Thompson and Scott)[1] from Ceylon; it differs, however, in possessing an extra process on the terminal segment of the left leg; this process arises from the inner border and is bluntly rounded.

This variety, like "*gallensis*," has the spine on the right basal corner of the first abdominal segment.

6. **Labidocera kroyeri** (Brady) var. **bidens,** nov.

Plate xxiv, fig. 8.

A single female, obtained in locality O, presented a variation from the normal in the structure of the 5th pair of legs.

As usually figured and described, the normal exopods of the 5th pair of legs have no spines on their outer margins, but in this case a single spine was present near the termination, and on the left side gave a bifid appearance to the exopodite. The endopodites were normal in structure. In all other respects the structure was perfectly normal.

[1] "Ceylon Pearl Oyster Fisheries and Marine Biology," pt. 1, p. 251, pl. ii, figs. 6 and 7, 1903.

7. **Labidocera minuta**, Giesbrecht.

Occurrence : Localities A, B, C, D, E, G, I, N, O, P.

This species, like *L. acuta*, was common in localities A to E ; in the remaining ones, however, it was comparatively rare.

8. **Labidocera pectinata**, Thompson and Scott.

Pl. xxiii, figs. 8, 9.

L. pectinata, Thompson and Scott, *Ceylon Pearl Oyster Fisheries.* (Suppl. Report vii), vol. i, p. 252, pl. ii, figs. 10—14, 1903.

L. similis, Cleve, Report on Plankton collected by Mr. Th. Wulff. *Arkiv för Zoologi*, vol. i, p. 378, pl. 19, figs. 4—6, 1903-04.

♀ A single specimen was obtained in locality Q. This species was first described by Thompson and Scott from the Pamban Pass, Ceylon : almost simultaneously another account was published by P. T. Cleve, who had found it in the plankton off Karachi. These two descriptions, while agreeing in all main essentials, differ slightly in certain details. Cleve's specimens presented a symmetrical furca, and on the genital segment a large dorsal apophysis and a single lateral spine, whereas in the specimens from Ceylon the furca is slightly asymmetrical and the genital segment has two lateral spines and is without the apophysis. Another point of difference, judging from the figures given, is in the number of spines on the endopodites of the 5th pair of legs. These are more numerous in the specimens from Ceylon. In the single specimen that I obtained in Hinzé Basin this feature was still more marked, though in all other respects it exactly corresponded with the Ceylon specimens. It would appear that we have here an example of continuous variation, the further to the east the locality in which the species is obtained, the more numerous become the spines of the endopodites of the 5th pair of legs.

Genus **Pontella**, G. Brady.

1. **Pontella andersoni**, Sewell.

Vide *Ante.*

A single male and a single damaged female were obtained in locality D.

2. **Pontella danae**, Giesbrecht, var. **ceylonica**, Thompson and Scott.

P. danae var. *ceylonica*, Thompson and Scott, Report on the Copepoda. *Ceylon Pearl Oyster Fisheries and Marine Biology* (Suppl. Report vii), vol. i, p. 252, pl. ii, figs. 1—5.

P. danae, A. Scott, The Copepoda of the Siboga Expedition, pt. i, p. 159.

A few specimens were obtained in locality Q.

These all agreed exactly with the description given by Thompson and Scott of the variety found by them round Ceylon.

A. Scott also describes a form of *P danae* found by him in the "Siboga" collection, in which the 5th pair of legs are the same as in var. *ceylonica*, but the furca agrees with Giesbrecht's original specimens. This form is of interest in supplying the intermediate stage of variation.

3. **Pontella investigatoris**, sp. nov.

Pl. xxiii, figs. 1—3.

Three males were obtained in localities A and E.

These specimens appear to differ from any previously described species. No corresponding females were found.

♂ Total length 2·9 mm.

The cephalo-thorax is robust; the head is furnished with side hooks and terminates anteriorly in a well-developed rostrum, provided with well-marked rostral lenses; there is also a well-developed ventral lens. The 4th and 5th thoracic segments are separate and the latter terminates laterally in a triangular plate, which is slightly asymmetrical, being more sharply pointed on the right side.

The abdomen is contained $3\frac{1}{2}$ times in the length of the cephalo-thorax, it consists of 5 segments, of which the relative lengths are 7 : 4 : 6 : 2 : 4. The furcal rami are slightly asymmetrical, the right being a little stouter than the left; they are $2\frac{1}{2}$ times as long as broad and are equal in length to the preceding three segments. The 2nd furcal seta is about twice the length of the others.

The 1*st antennae* are as usual asymmetrical and the relative proportions of the joints of the left antenna are as follows:—

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
50.	33.	8.	8.	10.	12.	10.	9.	15.	12.	10.	20.	18.	19.	24.	32.	33.	37.	40.	30.	29.	29.	29.	25.

The 10th and 11th joints are partially fused together.

In the right *grasping antenna* the middle joints are much swollen. The proximal segment of the knee-joint bears on its upper margin a toothed-plate somewhat longer than the joint itself, and produced proximally over the preceding segment, and bears a series of sharply-pointed teeth that diminish in size distally. The distal segment bears two toothed-plates, each armed with a series of fine needle-shaped teeth, and has a sharp spine at its distal extremity. The proportional lengths of the three terminal joints are 21 : 18 : 23.

In the 5*th pair of legs* that of the right side somewhat resembles *P. atlantica* (M.E.); the proximal segment of the claw

has a well-marked proximal process and bears on its margin a single trilobed tooth, from the base of which a single seta arises. The distal segment is somewhat sharply curved about the middle of its length, and bears on its proximal half two setae but no tooth-like process. In the left leg the terminal segment is short and bears on its external border a short spine; terminally it is provided with a long curved spine and two shorter and more delicate processes, one of which is ribbed; the inner surface is clothed with hair. The penultimate segment carries a short spine at its distal external angle.

The remaining appendages resembled those of the other members of the genus.

4. **Pontella princeps**, Dana.

A single specimen, a male, was obtained in locality A.

5. **Pontella securifer**, G. Brady.

Pontella securifer, Brady, Rep. Voy. Challenger, Copepoda, vol. viii, p. 96, pl. 45, 1883.

Pontella securifer, Claus, Ueber die entwicklung und das system der Pontelliden. *Arb. Zool. Inst. Wien*, vol. x, p. 233, pl. v, fig. 6, 1892-93.

Pontella securifer, Giesbrecht, F. u. Fl. Neap., vol. xix.

Pontella spinipes ♂, Wolfenden, The Fauna and Geography of the Maldive and Laccadive Archipelagoes, vol. ii, p. 1020, 1903-4.

Occurrence: Localities A, B, E.

This species was comparatively rare in this region. Several typical examples of the female were obtained and associated with them were a few males.

From previous descriptions it would appear that the male of this species is somewhat variable as regards the grasping antenna. Brady's original description is of the briefest character and his figure of this antenna is very poor. Claus figures it as having on the proximal end of the 19th segment a rounded elevation bearing three pointed teeth. Giesbrecht, however, represents this portion as consisting of a plate bearing a number of lamellar teeth.

In the males obtained by me the right antenna agrees exactly with Claus's figure, and differs from that given by Giesbrecht.

The *5th legs* of my specimens agree with Giesbrecht. Wolfenden has described a male *Pontella*, which he takes to be the male of *P. spinipes*; in this, the right grasping antenna has on the 19th segment a "rounded projection with three arrow-shaped teeth." Other points of difference are that in his specimens the teeth on the 19th segment are smaller and the toothed plate on

the 18th segment is also smaller than in *P. securifer.* With regard to these last two points, it would appear not improbable that they may be merely a variety, and as I shall show in the next species, a considerable degree of variation is met with in specimens of undoubtedly the same species.

In the few specimens that I obtained the relative lengths of the two limbs of the knee-joint were 47 : 43, thus agreeing with Wolfenden's measurements of his supposed *P. spinipes* ♂

The only difference that would appear to be constant between Wolfenden's *P. spinipes* ♂ and *P. securifer* ♂ is the absence of the large triangular tooth on the proximal limb of the claw of the 5th leg. I have, therefore, come to the conclusion that he was in reality dealing with a variation, either local or seasonal, of *Pontella securifer.*

6. **Pontella spinipes,** Giesbrecht.

Pl. xxiv, figs. 1—4.

Occurrence: Localities A, C, D, E, O.

A considerable number of typical females were obtained in the above localities and associated with them were several males that I believe to be the true male of this species.

♂ In these specimens the total length is 3·15—3·5 mm. The head is furnished with side hooks and the rostral lens is large and well-developed.

The last thoracic segment and abdomen are like *P. securifer.* The length of the abdomen and furca is contained nearly $3\frac{1}{2}$ times in that of the cephalo-thorax.

1st antennae. The left antenna very closely resembles that of the female, the proportionate lengths of the segments in the two sexes are given below :—

♀

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
50.	35.	10	7.	10.	11.	11.	12.	16.	15.	14.	27.	25.	30.	31.	41.	37.	44.	46.	34.	30.	30.	23.	25.

♂

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23	24.
50.	37.	9.	7.	10.	11.	11.	11.	13.	14.	15.	17.	24.	22.	25.	33.	33.	40.	45.	31·5.	31.	33.	23.	25.

In both sexes the 11th and 12th segments are partially fused together.

In general appearance the grasping antenna very closely resembles that of *P. securifer;* there are slight differences in the toothed plate of the 18th segment, which is shorter apparently than in *P. securifer* and has fewer teeth; the teeth are long and sharp and set fairly widely apart, diminishing gradually in size towards the distal end. The number present varies from 25 to 30.

The toothed-plate is invariably shorter than the segment itself; an average of 8 measurements gave the relative proportions of segment and "reibleiste" as 27·5 : 24·5, whereas in *P. securifer*, Giesbrecht figures the reibleiste as much longer than the segment, and in my specimens the average was 20 : 24. The distal segment of the knee-joint bears two toothed-plates, the proximal being the smaller and having from 8 to 11 arrow-shaped teeth. These two segments appear to vary very considerably in their relative proportions; in some the proximal is the longer, while in others it is very distinctly shorter than the distal joint. Below I give the measurements in ten different individuals:—

(1) 22 : 21	(6) 21 : 19
(2) 23 : 21	(7) 20 : 21
(3) 21 : 21·5	(8) 20 : 21·5
(4) 22 : 21·5	(9) 24 : 22
(5) 22 : 22	(10) 22 : 22.

From the above it will be noted that it is in the smaller specimens, with a measurement of 20 or 21 for the proximal joint, that the distal exceeds the proximal in length, the condition becoming reversed in the larger specimens.

It appears possible that we are here dealing with a depauperized condition, the small size of the animal and the alteration in the proportions of the segments forming the knee-joint being correlated with one another. In any case, the relative proportions of these joints, in the absence of any other measurements, would seem to be of doubtful specific value.

It is in the *5th pair of legs* that these males present their greatest difference from *P. securifer*. The proximal segment of the claw has a well-marked simple process proximally and bears on its margin three teeth; the first is stout and triangular in shape, the other two are thin and more delicate and are respectively rounded and sharply pointed; between these two latter a single seta arises. The distal segment also bears on its margin three rounded teeth. The left leg has a short terminal joint, bearing a stout curved spine and two more delicate processes at its distal extremity and a short spine on its external border, and the inner surface is covered with hair. The penultimate joint has a short spine at its distal external border.

As I have shown (*vide P. securifer*, above), the male described by Wolfenden as the male of *P. spinipes* is in all probability merely a variation of the male of *P. securifer*, and not the hitherto-unknown male of *P. spinipes*. The above males are unlike anything previously described, though fairly closely resembling *P. securifer* in certain respects; they were associated in all the catches with undoubted females of *P. spinipes* and are, in my opinion, the hitherto-unknown male.

Genus **Pontellopsis**, G. Brady.

1. **Pontellopsis herdmani**, Thompson and Scott.

Pl. xxiv, fig. 5.

Pontellopsis herdmani, Thompson and Scott, Ceylon Pearl Oyster Fisheries (Suppl. Report vii), vol. i, p. 253, pl. ii, figs. 15—17 (1903).

Pontellopsis macronyx, A. Scott, The Copepoda of the Siboga Expedition, pt. i, p. 137, pl. liv, figs. 1—10 (1909).

Occurrence: Localities A, B, C, D, E, F, L, O, P.

A large number of specimens, both males and females, were obtained. The males correspond exactly with the description of *Pontellopsis macronyx*, A. Scott, from the "Siboga" collection. The females however present certain differences and are exactly intermediate between *Pontellopsis macronyx* and *Pontellopsis herdmani*, which was described by Thompson and Scott from Ceylon and to which no corresponding male was obtained.

Considering the differences between the two forms obtained from Ceylon and the waters to the east of Borneo, Scott was quite justified in making them different species, but the discovery of a third and intermediate form from the Burma coast indicates that in reality we are dealing with a single very variable species, and I propose to combine the three under the name of *P. herdmani*.

In the following table I have given the main characters of the three forms:—

	P. herdmani.	*P. macronyx.*	Intermediate form.
Total length	1·9 mm.	1·97 mm.	1·64 mm.
Length of abdomen and furca.	Contained twice in cephalothorax.	Contained 2½ times.	As *P. macronyx.*
Abdomen ..	Composed of 2 joints, 1st segment twice as large as 2nd, two thorn-like projections on right side	2 joints. Genital segment long, two spines on each side.	2 joints. Genital segment long. Spines variable from 2 to 4.
Furca	Rami twice as long as broad, fine hairs on inner surface, 5 short non-plumose setae.	Furcal joints short. 5 short setae.	As *P. herdmani.*
Rostrum ..	Long, narrow and bifid.	Rami long and slender.	Ditto ditto.
Antenna ..	16 jointed (judging from the fig segments 3 and 4 are each composed of 3 segments fused together), extend to end of thorax. Relative lengths as follows: 1. 2. 3. 4 5. 6. / 6. 7. 5. 8. 3. 5.	20 jointed, extend to end of thorax.	As *P. herdmani.* Segments 3 and 4 each composed of 3 partially fused segments. Relative lengths as in *P. herdmani.*

	P. herdmani.	*P. macronyx.*	Intermediate form.
5th pair of legs	Symmetrical. Each 2 branched. Each branch bifid.	Asymmetrical. Inner margin of right exopodite produced into a strong spine. The spine on the inner margin of the left leg has become suppressed.	As *P. macronyx.*

In a few cases the abdomen, instead of being almost symmetrical, is produced on the left side into a long spine-like process, this being apparently an exaggerated phase of the condition normally found in which a rod-like spine is present at this point (plate xxiv, fig. 5).

From the above it would appear that we are here dealing with another example of continuous variation, apparently affecting only the females of the species, for as the habitat extends to the westward we meet with a tendency for a reduction of the number of spines on the genital segment of the abdomen, a fusion of certain joints at the base of the antennae, and the formation of a second spine on the left 5th leg.

2. **Pontellopsis krämeri**, Giesbrecht.

♀ A single specimen was obtained in each locality A and J and two in locality P.

The asymmetry of the furcal joints was well-marked and corresponded with Giesbrecht's original figures. The spines on the 5th pair of legs also resembled those in Giesbrecht's specimens. In both these points the specimens differed from Wolfenden's description of the specimens obtained by him in the Maldive and Laccadive Archipelagoes.

3. **Pontellopsis regalis** (Dana).

Occurrence: Localities A, C, D, E, K.

A few specimens were obtained in each of the above localities, but on the whole the species was comparatively rare.

Genus **Acartia**, Dana.

1. **Acartia danae**, Giesbrecht.

A single specimen, a female, was obtained in locality F.

2. **Acartia erythraea,** Giesbrecht.

Occurrence: Localities C, E, G, J, L.

Only a few specimens were obtained in the above localities, with the exception of locality E, where it was quite common.

3. **Acartia spinicauda,** Giesbrecht.

Occurrence: Localities A, C, K, N, O, P.

Genus **Tortanus,** Giesbrecht.

1. **Tortanus barbatus** (Brady).

Corynura barbata, Brady, Rep. Voy. Challenger, vol. 8, p. 71, plate 31, figs. 11-12, 1883.

Corynura barbata, Giesbrecht, F. u. Fl. Neapel, vol. 19, p. 525, 1892.

Tortanus barbatus, Giesbrecht and Schmeil, Das Tierreich, pt. 6. Copepoda, p. 158.

Tortanus barbatus, Scott, The Copepoda of the Siboga Expedition, pt. 1, p. 189, pl. lv, figs. 16—18.

Several specimens were obtained in localities E and Q.

A. Scott considers that *T denticulatus* and *T barbatus* are in reality the same species, but the present specimens differ in several particulars from the specimens that he describes as *T barbatus* in the "Siboga" material. In my specimens the teeth on the left 5th leg all have whip-like ends, the outer hair of the furca is long and reaches to the end of the furcal joint, and in the mid-dorsal line there arises from the anal segment of the abdomen a spine-like projection. Brady in his original illustration figures a rounded projection.

The length of the specimens were 1·43 mm.

I consider that it is advisable to retain the distinction between these two species and the above would appear to be typical specimens of *Tortanus barbatus*, while Scott's specimens were in all probability *Tortanus denticulatus*.

2. **Tortanus gracilis** (Brady).

Tortanus gracilis, Cleve, Plankton from the Indian Ocean and Malay Archipelago. *Kongl. Svens. Vet. Akad. Handl.*, Bd. 35, No. 5, p. 51, pl. vii, figs. 11—15, 1901-02.

Occurrence: Localities B, E, F, G, J, N, O, P.

Considerable variation was met with in the degree of asymmetry of the 5th legs of the females. I am inclined to agree with Cleve that *T forcipatus* and *T gracilis* are in reality the same species, the difference in the 5th leg being due to age.

List of Localities showing species of Copepoda (Gymnoplea) taken.

LOCALITY A { 14·8 to 14·10 N. / 97·42¾ to 97·46½ E. } 17 species.

Acartia spinicauda.
Acrocalanus longicornis.
Canthocalanus pauper.
Centropages furcatus.
Eucalanus subcrassus.
Labidocera acuta.
Labidocera minuta.
Paracalanus parvus.
Pontella investigatoris, sp. nov.
Pontella princeps.
Pontella securifer.
Pontella spinipes.
Pontellopsis krämeri.
Pontellopsis herdmani.
Pontellopsis regalis.
Temora discaudata.
Temora longicornis.

LOCALITY B { 14·6 to 14·15½ N. / 97·49 to 97·58½ E. } 19 species.

Calanus minor.
Candacia discaudata.
Canthocalanus pauper.
Centropages notoceras.
Centropages furcatus.
Centropages orsinii.
Eucalanus subcrassus.
Euchaeta concinna.
Labidocera acuta.
Labidocera kroyeri.
Labidocera kroyeri var. *stylifera.*
Labidocera minuta.
Pontella securifer.
Pontellina plumata.
Pontellopsis herdmani.
Temora discaudata.
Temora turbinata.
Tortanus gracilis.
Undinula caroli.
Undinula vulgaris.

LOCALITY C { 14·5 to 14·6½ N. / 98·1¾ to 98·5 E. } 16 species.

Acartia erythraea.
Acartia spinicauda.
Acrocalanus gracilis.
Canthocalanus pauper.
Centropages furcatus.
Centropages orsinii.
Centropages tenuiremis.
Eucalanus subcrassus.
Labidocera acuta.
Labidocera minuta.
Pontella danae.
Pontella spinipes.
Pontellopsis herdmani.
Pontellopsis regalis.
Temora turbinata.
Undinula caroli.

LOCALITY D { 14·2¼ to 14·5 N. / 98·2½ to 98·5 E. } 19 species.

Acrocalanus gibber.
Calocalanus pavo.
Candacia discaudata.
Canthocalanus pauper.
Centropages furcatus.
Centropages orsinii.
Eucalanus crassus.
Eucalanus subcrassus.
Labidocera acuta.
Labidocera minuta.
Paracalanus aculeatus.
Pontella andersoni.
Pontella spinipes.
Pontellina plumata.

Pontellopsis herdmani.
Pontellopsis regalis.
Temora discaudata.
Temora turbinata.
Undinula vulgaris.

LOCALITY E { 13°47¼ to 13°52½ N. / 98°3½ to 98°4¾ E. } 31 species and varieties.

Acartia erythraea.
Acrocalanus gibber.
Calanus minor.
Calanopia elliptica.
Calanopia thompsoni.
Calocalanus pavo.
Candacia discaudata.
Canthocalanus pauper.
Centropages furcatus.
Centropages tenuiremis.
Eucalanus crassus.
Eucalanus monachus.
Eucalanus subcrassus.
Labidocera acuta.
Labidocera minuta.
Labidocera kroyeri.
Labidocera kroyeri var. *stylifera.*
Paracalanus aculeatus.
Pontella investigatoris, sp. nov.
Pontella danae var. *ceylonica.*
Pontella securifer.
Pontella spinipes.
Pontellopsis herdmani.
Pontellopsis regalis.
Temora discaudata.
Temora stylifera.
Temora turbinata.
Tortanus barbatus.
Tortanus gracilis
Undinula caroli.
Undinula vulgaris.

LOCALITY F { 13°59½ to 14°4½ N. / 97°51½ to 98°0 E. } 20 species.

Acartia danae.
Acrocalanus longicornis.
Calanopia aurivillii.
Calanopia elliptica.
Calanopia minor.
Calanus minor.
Candacia discaudata.
Canthocalanus pauper.
Centropages orsinii.
Eucalanus subcrassus.
Labidocera acuta.
Lucicutia flavicornis.
Pontellina plumata.
Pontellopsis herdmani.
Temora discaudata.
Temora turbinata.
Tortanus gracilis.
Undinula caroli.
Undinula vulgaris.
Undinula darwini.

LOCALITY G (13. 49¼ N. : 97.58½ E.) 16 species and varieties.

Acartia erythraea.
Acrocalanus gracilis.
Acrocalanus longicornis.
Acrocalanus longicornis var. *plumulosus.*
Acrocalanus monachus.
Canthocalanus pauper.
Centropages furcatus.
Centropages orsinii.
Labidocera acuta.
Labidocera minuta.
Paracalanus aculeatus.
Paracalanus aculeatus var. *plumulosus.*
Temora discaudata.
Temora turbinata.
Undinula caroli.
Undinula vulgaris.

LOCALITY H { 13°51½ to 13°55½ N. / 97°57½ to 98°2 E. } 11 species.

Acrocalanus gibber.
Acrocalanus gracilis.
Acrocalanus longicornis.
Canthocalanus pauper.
Centropages orsinii.
Eucalanus monachus.
Eucalanus subcrassus.
Labidocera acuta.
Temora turbinata.
Undinula caroli.
Undinula vulgaris.

LOCALITY J { 13°41 to 13°95 N. / 97°55 to 98°0 E. } 22 species.

Acartia erythraea.
Acrocalanus gibber.
Acrocalanus gracilis.
Acrocalanus longicornis.
Calanopia elliptica.
Calanopia minor.
Candacia bradyi.
Candacia discaudata.
Canthocalanus pauper.
Centropages furcatus.
Clausocalanus arcuicornis.
Eucalanus subcrassus.
Eucalanus pileatus.
Euchaeta concinna.
Lucicutia flavicornis.
Paracalanus aculeatus.
Paracalanus parvus.
Pontellopsis krämeri.
Temora discaudata.
Temora stylifera.
Temora turbinata.
Tortanus gracilis.

LOCALITY K { 13°50 to 13°45 N. / 97°59½ to 97°55 E. } 14 species and varieties.

Acartia spinicauda.
Acrocalanus gibber.
Calanus minor.
Candacia discaudata.
Canthocalanus pauper.
Centropages orsinii.
Eucalanus subcrassus.
Labidocera acuta.
Paracalanus aculeatus.
Temora turbinata.
Undinula caroli.
Undinula caroli var. *plumulosus.*
Undinula vulgaris.
Undinula vulgaris var. *plumulosus.*

LOCALITY L (13°50 N. : 97°56 E.) 20 species and varieties.

Acartia erythraea.
Acrocalanus gibber.
Acrocalanus longicornis.
Candacia discaudata.
Canthocalanus pauper.
Centropages furcatus.
Eucalanus crassus.
Eucalanus pileatus.
Eucalanus subcrassus.
Labidocera acuta.
Labidocera minuta.
Paracalanus aculeatus.
Pontellopsis herdmani.
Temora discaudata.
Temora stylifera.
Temora turbinata.
Tortanus gracilis.
Undinula caroli.
Undinula vulgaris.
Undinula vulgaris var. *plumulosus.*

LOCALITY M (13·44½ N. : 98·0½ E.) 14 species.

Acrocalanus gardineri.
Acrocalanus gracilis.
Acrocalanus longicornis.
Calanopia elliptica.
Candacia discaudata.
Centropages orsinii.
Eucalanus crassus.
Eucalanus pileatus.
Eucalanus subcrassus.
Labidocera acuta.
Temora discaudata.
Temora turbinata.
Undinula caroli.
Undinula vulgaris.

LOCALITY N { Byikhwaaw Bay. 13·33 N. : 98·8½ E. } 21 species.

Acartia spinicauda.
Acrocalanus gardineri.
Acrocalanus gibber.
Acrocalanus gracilis.
Acrocalanus longicornis.
Calanopia elliptica.
Calanus minor.
Candacia bradyi.
Candacia catula.
Candacia discaudata.
Canthocalanus pauper.
Centropages furcatus.
Centropages orsinii.
Eucalanus subcrassus.
Labidocera minuta.
Lucicutia flavicornis.
Paracalanus aculeatus.
Pontellopsis regalis.
Temora discaudata.
Temora turbinata.
Tortanus gracilis.

LOCALITY O { 13·32 to 13·40 : N. 97·40 to 97·55 : E. } 35 species and varieties.

Acartia spinicauda.
Acrocalanus gibber.
Acrocalanus longicornis.
Calanopia elliptica.
Calanopia minor.
Calocalanus pavo.
Calocalanus plumulosus.
Candacia aethiopica.
Candacia bradyi.
Candacia discaudata.
Candacia truncata.
Canthocalanus pauper.
Centropages furcatus.
Centropages orsinii.
Clausocalanus arcuicornis.
Eucalanus attenuatus.
Eucalanus crassus.
Eucalanus monachus.
Eucalanus subcrassus.
Euchaeta concinna.
Labidocera acuta.
Labidocera minuta.
Labidocera kroyeri.
Labidocera kroyeri var. *stylifera.*
Labidocera kroyeri var. *bidens.*
Lucicutia flavicornis.
Paracalanus aculeatus.
Pontella spinipes.
Pontellopsis herdmani.
Rhincalanus cornutus.
Scolecithrix danae.
Temora discaudata.
Temora turbinata.
Tortanus gracilis.
Undinula vulgaris.

LOCALITY P { 13·40 to 14·5½ N. 97·40 to 97·50 E. } 32 species and varieties.

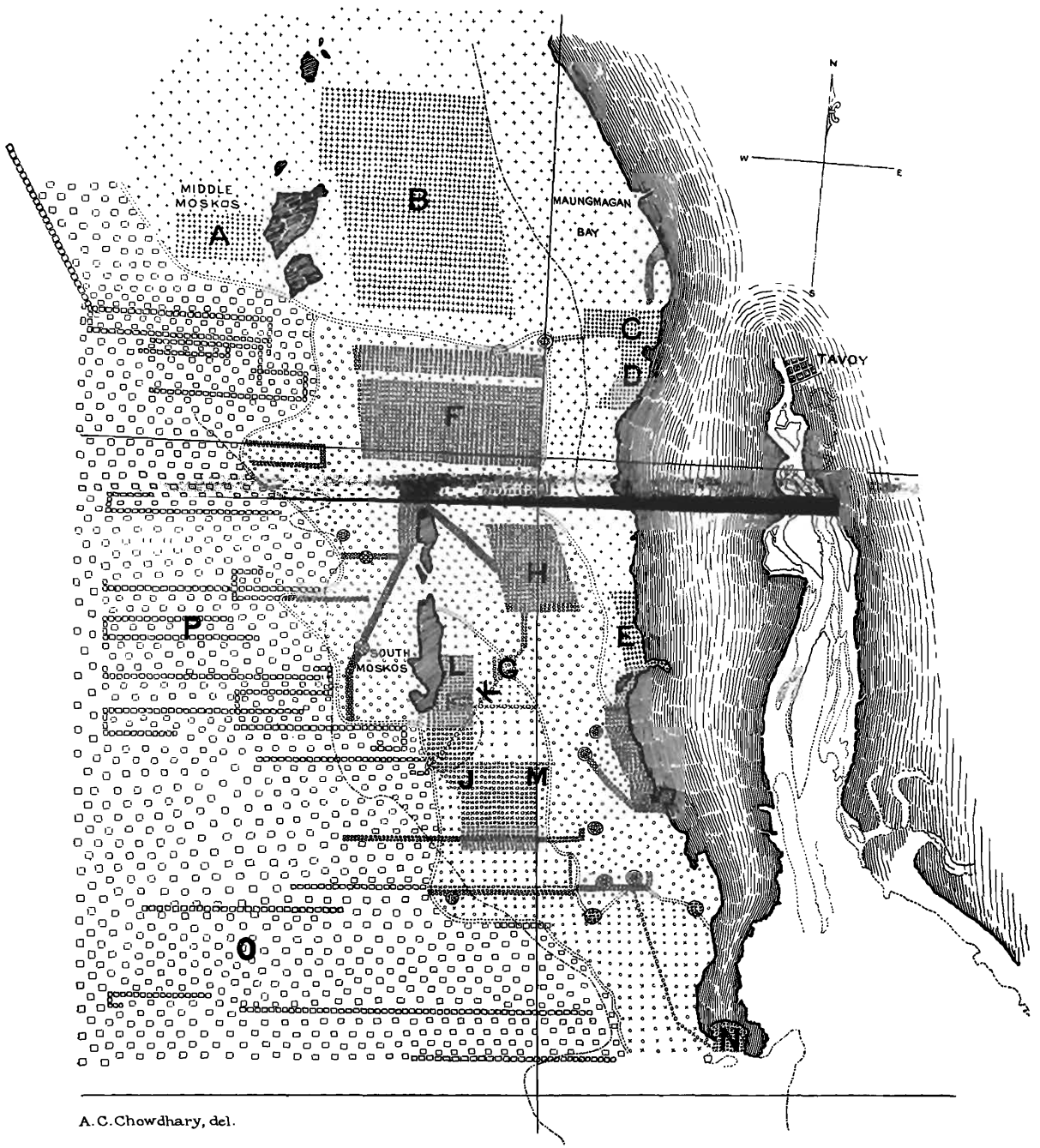
Acartia spinicauda.
Acrocalanus gibber.
Acrocalanus longicornis.
Calanopia elliptica.

Calanopia minor.
Calanus minor.
Candacia catula.
Candacia discaudata.
Candacia truncata.
Canthocalanus pauper.
Centropages furcatus.
Centropages orsinii
Clausocalanus arcuicornis.
Eucalanus attenuatus.
Eucalanus crassus.
Eucalanus monachus.
Eucalanus pileatus.
Eucalanus subcrassus.
Euchaeta concinna.
Labidocera acuta.
Labidocera kroyeri.
Labidocera minuta.
Lucicutia flavicornis.
Paracalanus aculeatus var. *plumulosus.*
Pontellopsis herdmani.
Rhincalanus cornutus.
Temora discaudata.
Temora turbinata.
Tortanus gracilis.
Undinula caroli.
Undinula vulgaris.
Undinula vulgaris var. *plumulosus.*

LOCALITY Q { Hinzé Basin. 14°41½ N. : 97°53 E. } 21 species and varieties.

Acrocalanus gardineri.
Canthocalanus pauper.
Centropages notoceras.
Eucalanus crassus.
Eucalanus pileatus.
Eucalanus subcrassus.
Eucalanus subtenuis.
Euchaeta concinna.
Euchaeta marina.
Labidocera acuta.
Labidocera euchaeta.
Labidocera kroyeri.
Labidocera kroyeri var. *burmanica*, nov.
Labidocera pectinata.
Paracalanus parvus.
Pontella danae var. *ceylonica.*
Pseudodiaptomus aurivillii.
Pseudodiaptomus hickmani, sp. nov.
Tortanus barbatus.
Undinula darwini.
Undinula vulgaris var. *plumulosus.*

Plate XIV

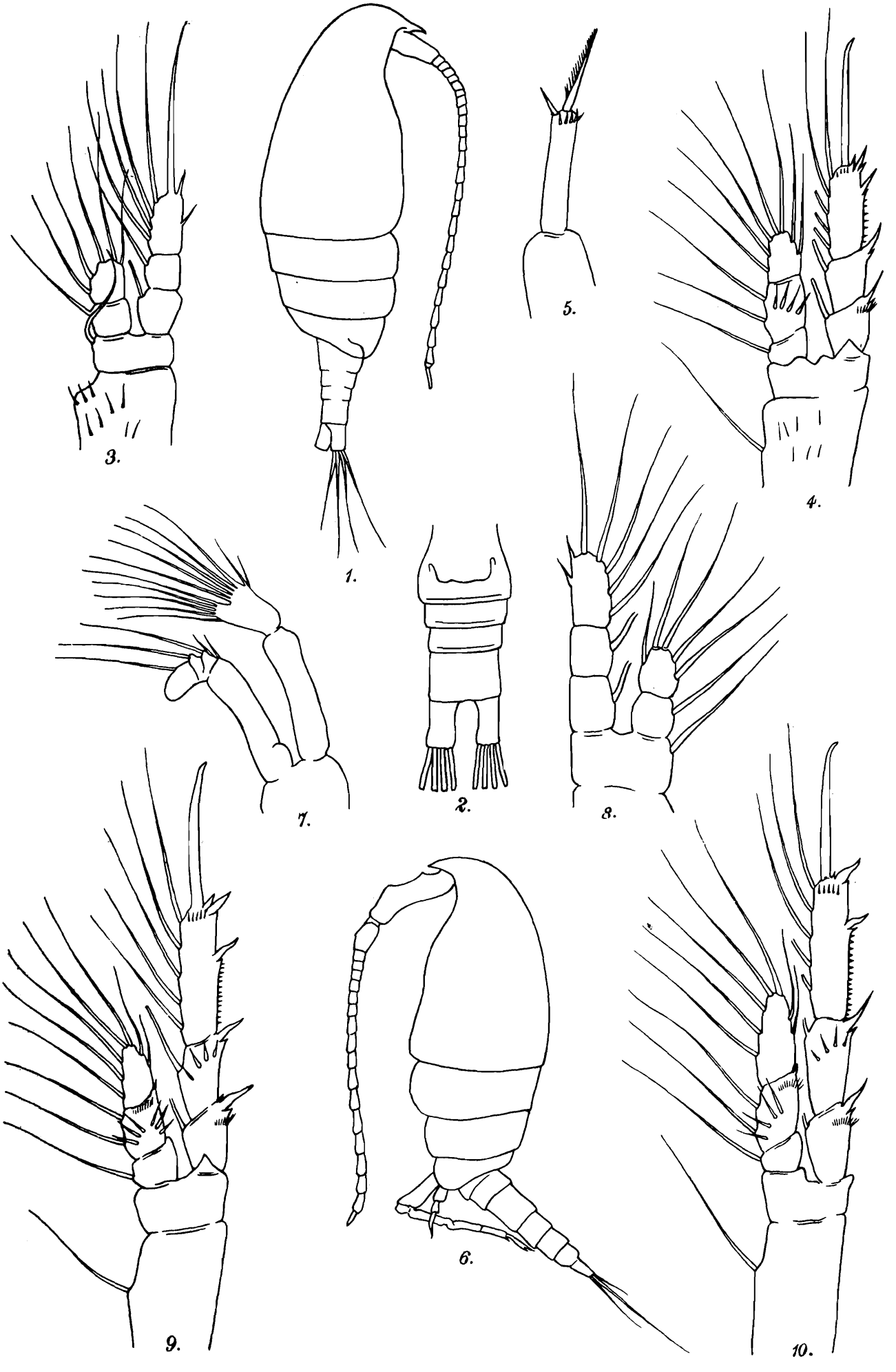


A.C.Chowdhary, del.

Photo.-Engraved & printed at the Offices of the Survey of India, Calcutta, 1912.

EXPLANATION OF PLATE XV.

1.—*Paracalanus dubia*, sp. nov.		♀	Lateral view.
2.—	,, ,, ,, ,,	♀	Abdomen, ventral view
3.—	,, ,, ,, ,,	♀	1st Leg.
4.—	,, ,, ,, ,,	♀	2nd Leg.
5.—	,, ,, ,, ,,	♀	5th Leg.
6.—*Paracalanus serratipes*, sp. nov.		♂	Lateral view.
7.—	,, ,, ,, ,,	♂	2nd Antenna.
8.—	,, ,, ,, ,,	♂	1st Leg.
9.—	,, ,, ,, ,,	♀	2nd Leg.
10.—	,, ,, ,, ,,	♀	3rd Leg.

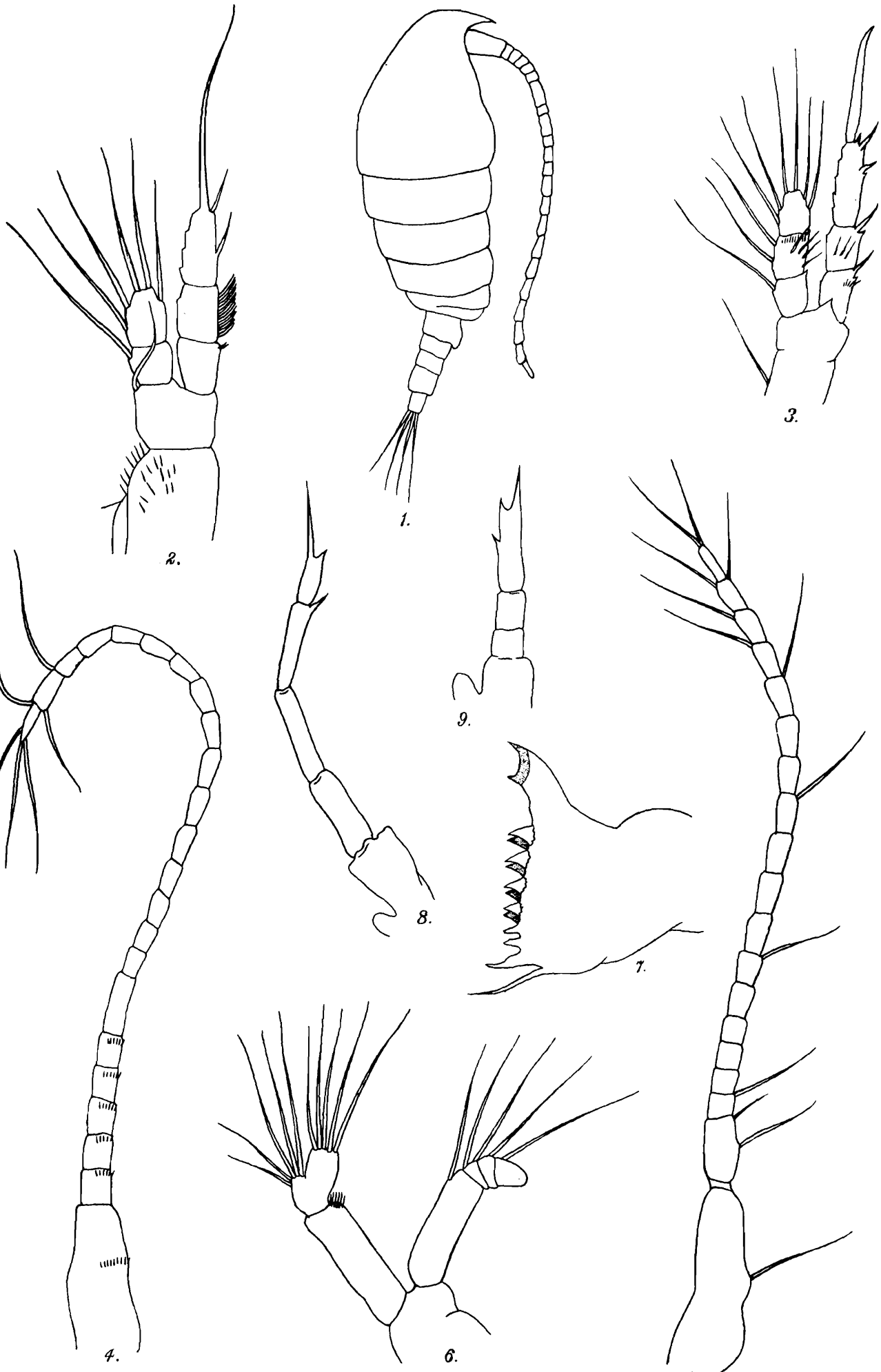


R.B.S. Sewell del.

S.C. Mondul lith.

EXPLANATION OF PLATE XVI.

1.—	*Acrocalanus inermis*,	sp.	nov.		♀	Lateral view.
2.—	,,	,,	,,	,,	♀	1st Leg.
3.—	,,	,,	,,	,,	♀	2nd Leg.
4.—	,,	,,	,,	,,	♀	1st Antenna.
5.—	,,	,,	,,	,,	♂	1st Antenna.
6.—	,,	,,	,,	,,	♂	2nd Antenna.
7.—	,,	,,	,,	,,	♂	Mandible.
8.—	,,	,,	,,	,,	♂	5th Leg, adult.
9.—	,,	,,	,,	,,	♂	5th Leg, immature.

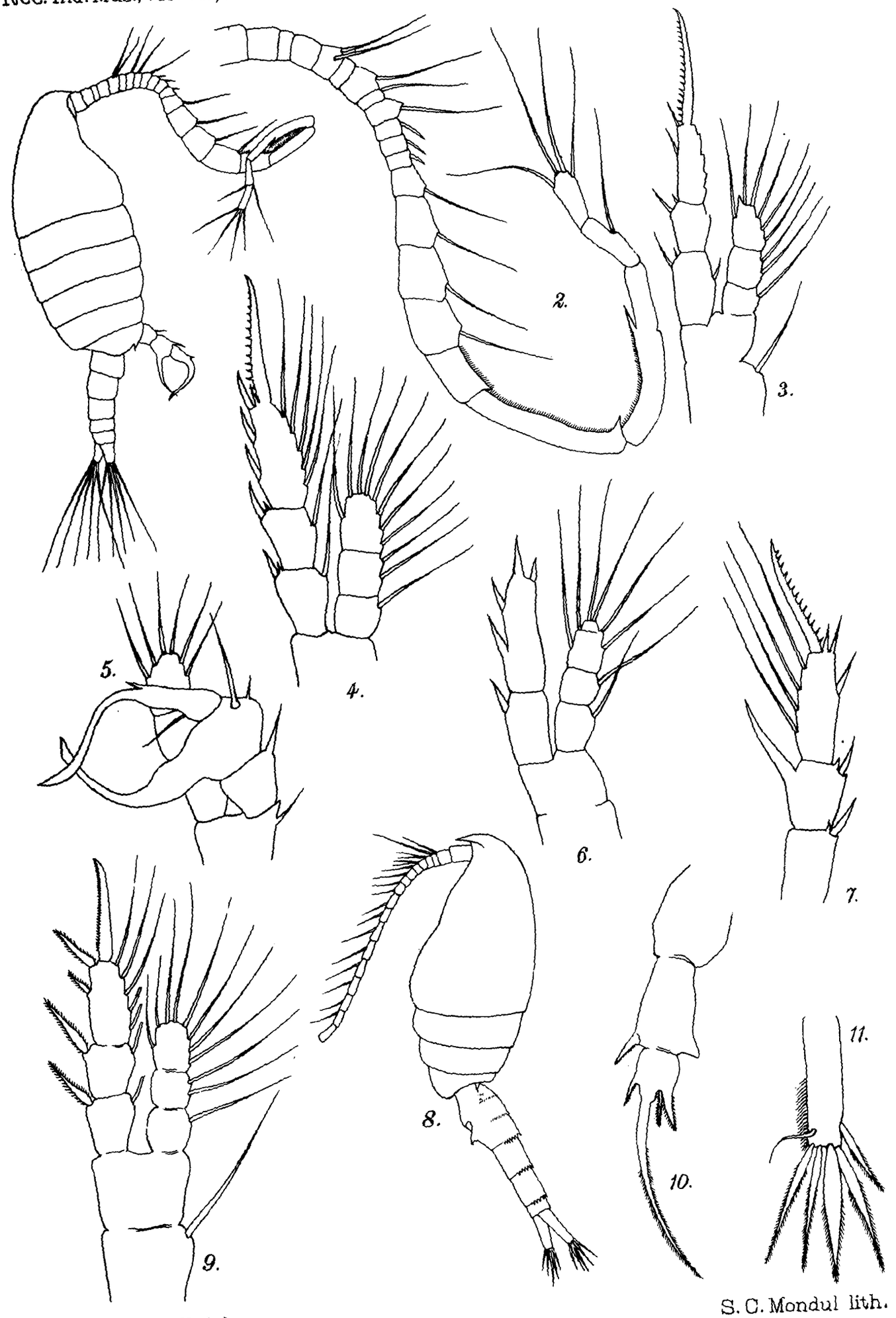


R.B. S. Sewell del.

S.C. Mondul lith.

EXPLANATION OF PLATE XVII.

1.—*Centropages alcocki*, sp. nov.		♂	Lateral view.
2.—	,, ,, ,, ,,	♂	1st Antenna.
3.—	,, ,, ,, ,,	♂	1st Leg.
4.—	,, ,, ,, ,,	♂	2nd Leg.
5.—	,, ,, ,, ,,	♂	5th Leg, right side.
6.—	,, ,, ,, ,,	♂	5th Leg, left side.
7.—	,, ,, ,, ,,	♀	5th Leg.
8.—*Pseudodiaptomus binghami*, sp. nov.		♀	Lateral view.
9.—	,, ,, ,, ,,	♀	2nd Leg.
10.—	,, ,, ,, ,,	♀	5th Leg.
11.—	,, ,, ,, ,,	♀	Furcal ramus and setae.

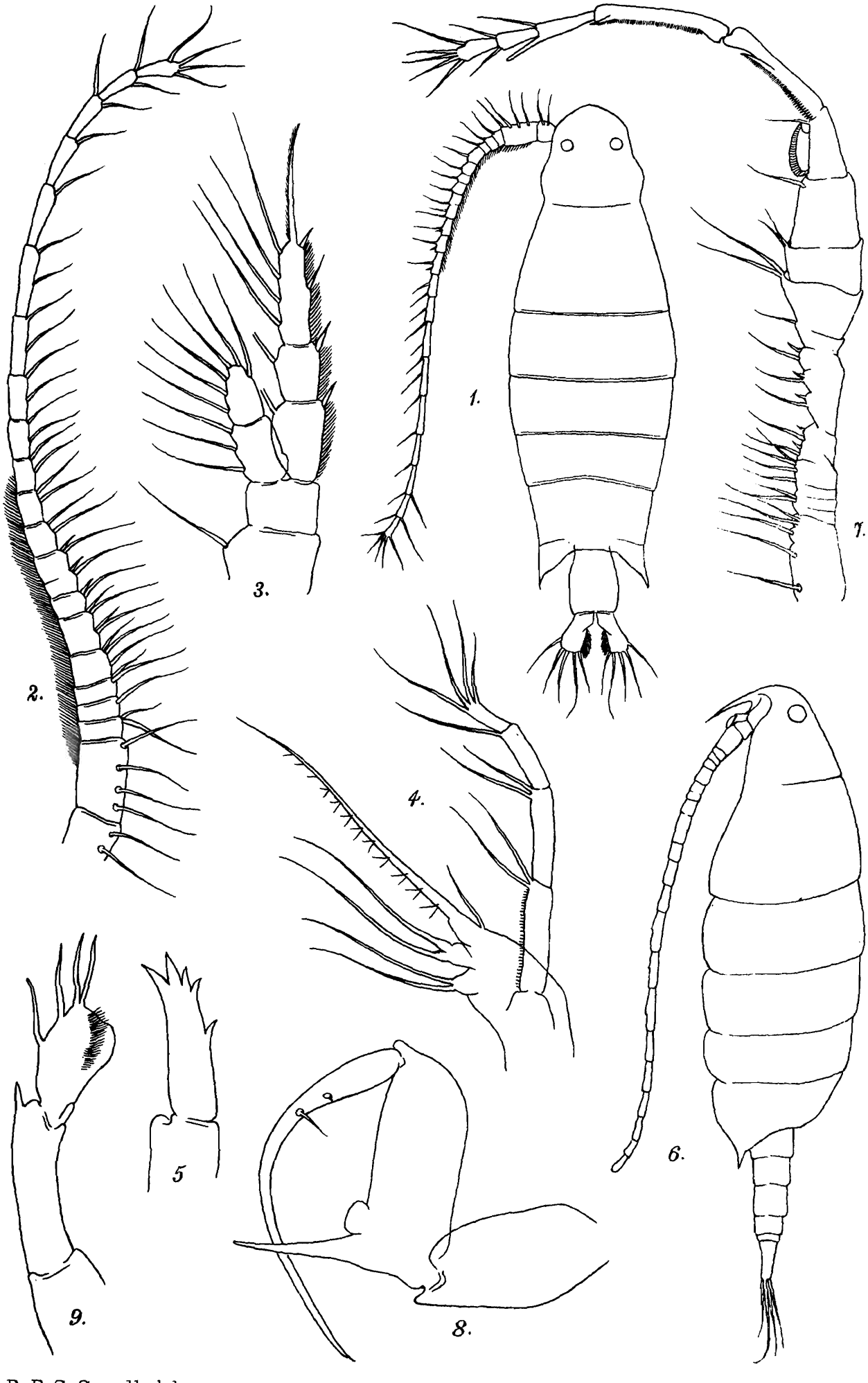


R.B.S. Sewell del.

S. C. Mondul lith.

EXPLANATION OF PLATE XVIII.

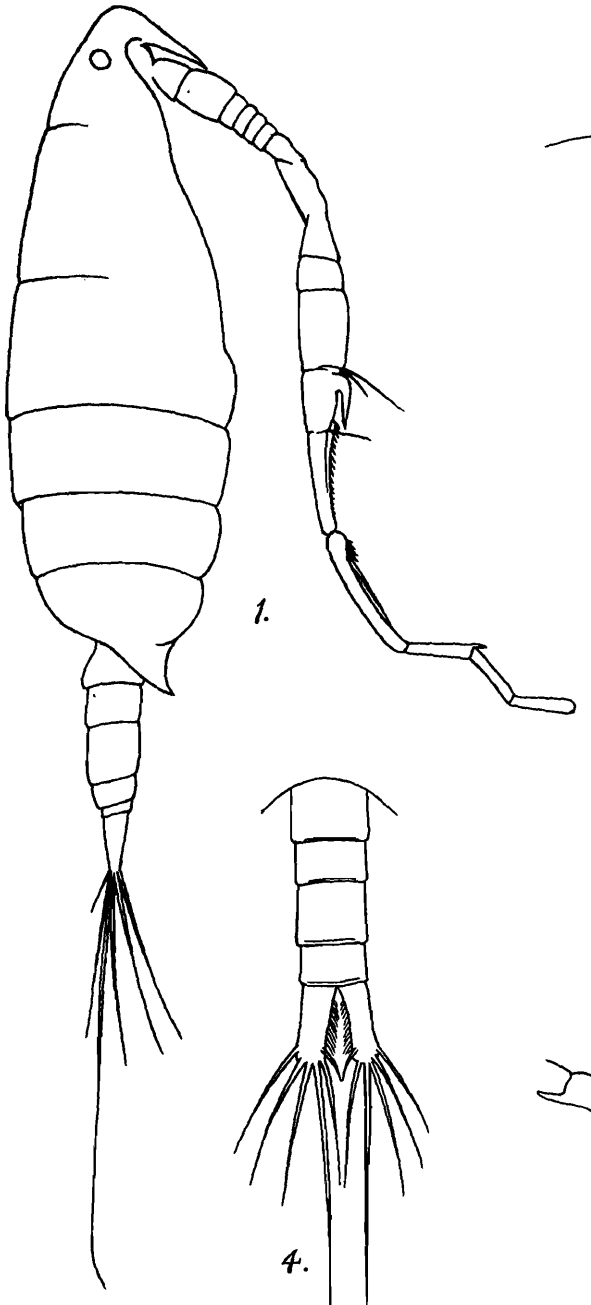
1.—	*Labidocera euchaeta*,	stage	1,	nov.	♀	Dorsal view.
2.—	,,	,,	,,	,,	,,	♀	1st Antenna.
3.—	,,	,,	,,	,,	,,	♀	1st Leg.
4.—	,,	,,	,,	,,	,,	♀	Maxilliped.
5.—	,,	,,	,,	,,	,,	♀	5th Leg.
6.—	,,	,,	,,	,,	,,	♂	Lateral view.
7.—	,,	,,	,,	,,	,,	♂	1st Antenna.
8.—	,,	,,	,,	,,	,,	♂	5th Leg, right side.
9.—	,,	,,	,,	,,	,,	♂	5th Leg, left side.



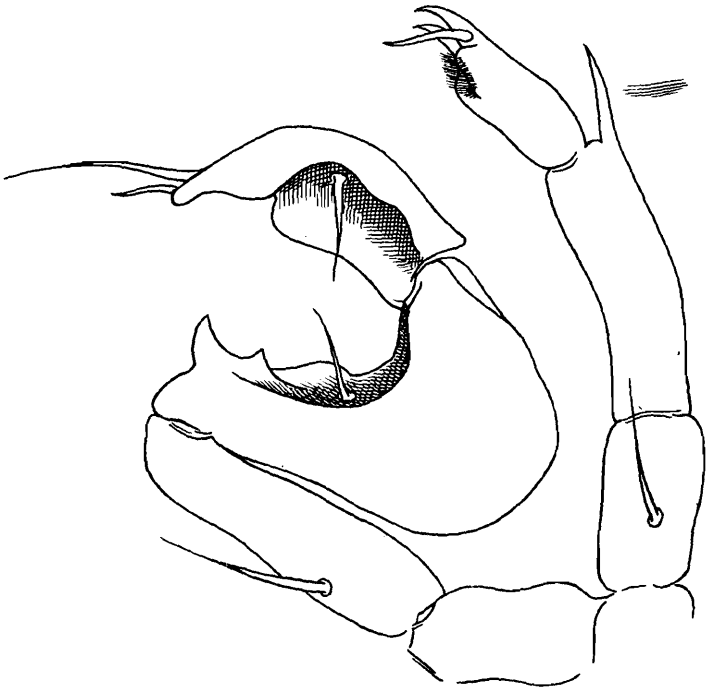
R. B. S. Sewell del. S. C. Mondul lith.

EXPLANATION OF PLATE XIX.

1.—*Labidocera euchaeta*, Giesbrecht, stage II. ♂ Lateral view.
2.— ,, ,, ,, ,, ,, ♂ 1st Antenna.
3.— ,, ,, ,, ,, ,, ♂ 5th pair of legs.
4.— ,, ,, ,, stage III. ♂ Abdomen, dorsal view.
5.— ,, ,, ,, ,, ,, ♀ Abdomen, dorsal view.
6.— ,, ,, ,, ,, ,, ♀ 5th Leg.
7.— ,, ,, ,, ,, ,, ♂ 5th pair of legs.
8.— ,, ,, ,, stage IV. Abdomen.
9.— ,, ,, ,, ,, ,, 5th pair of legs.



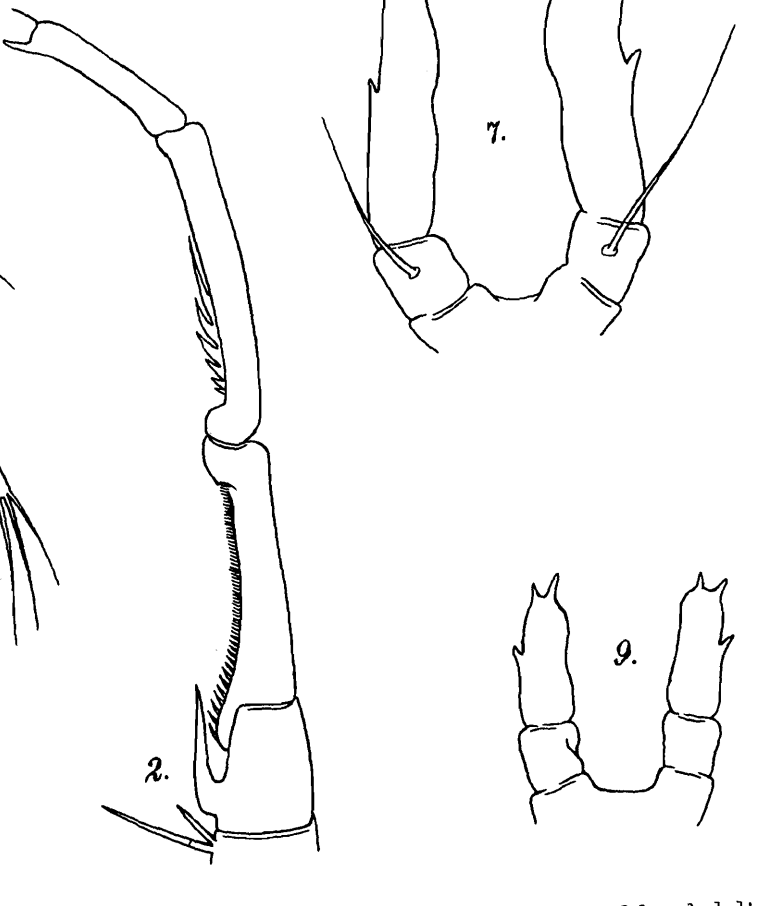
1.



3.

6.

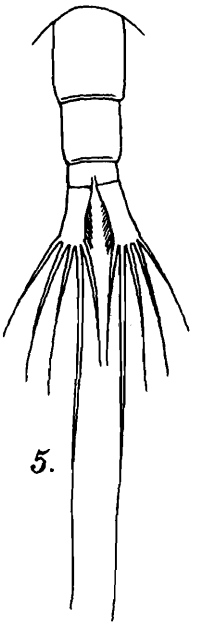
4.



2.

7.

8.



5.

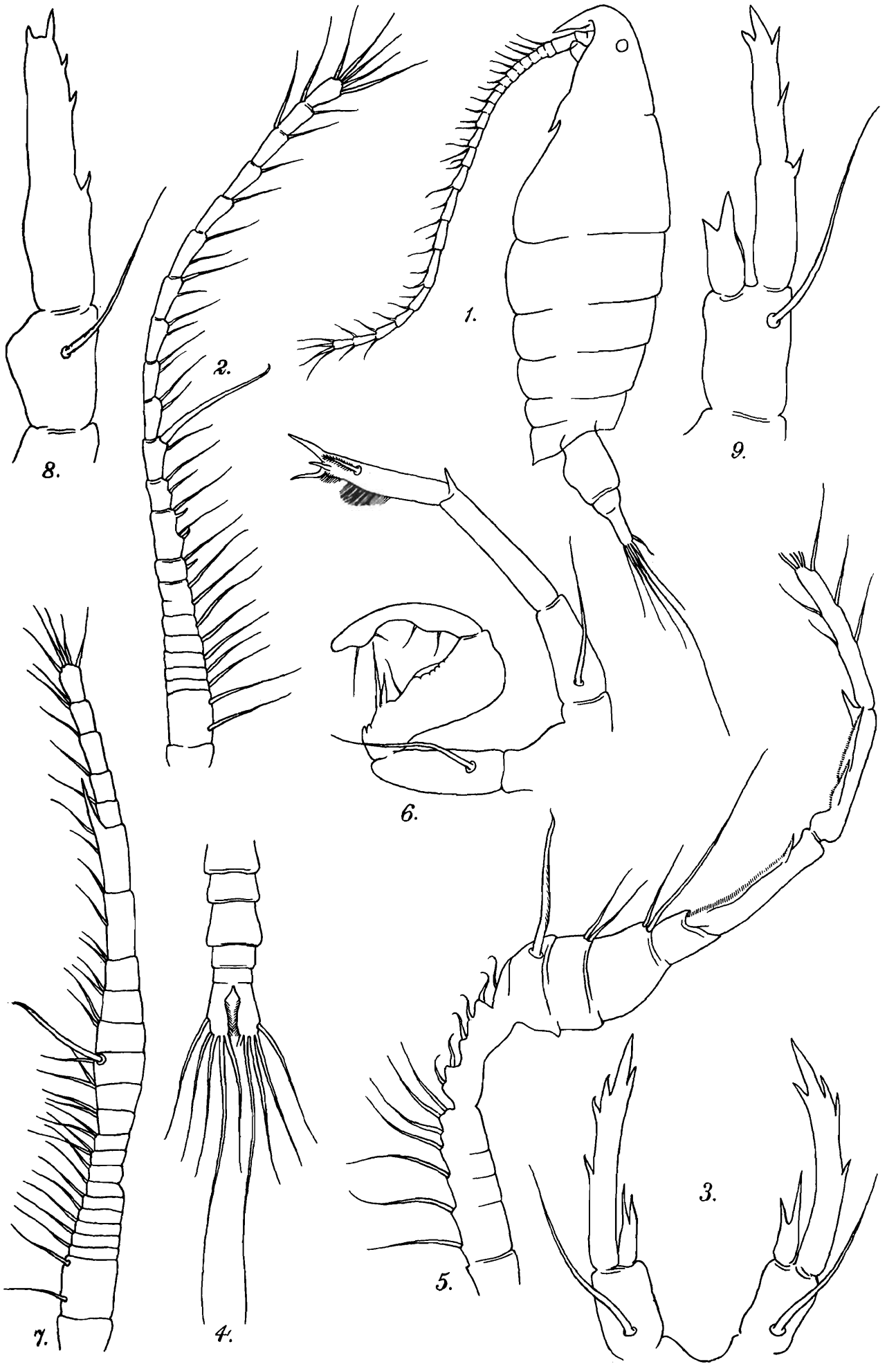
9.

R. B. S. Sewell del.

S. C. Mondul lith.

EXPLANATION OF PLATE XX.

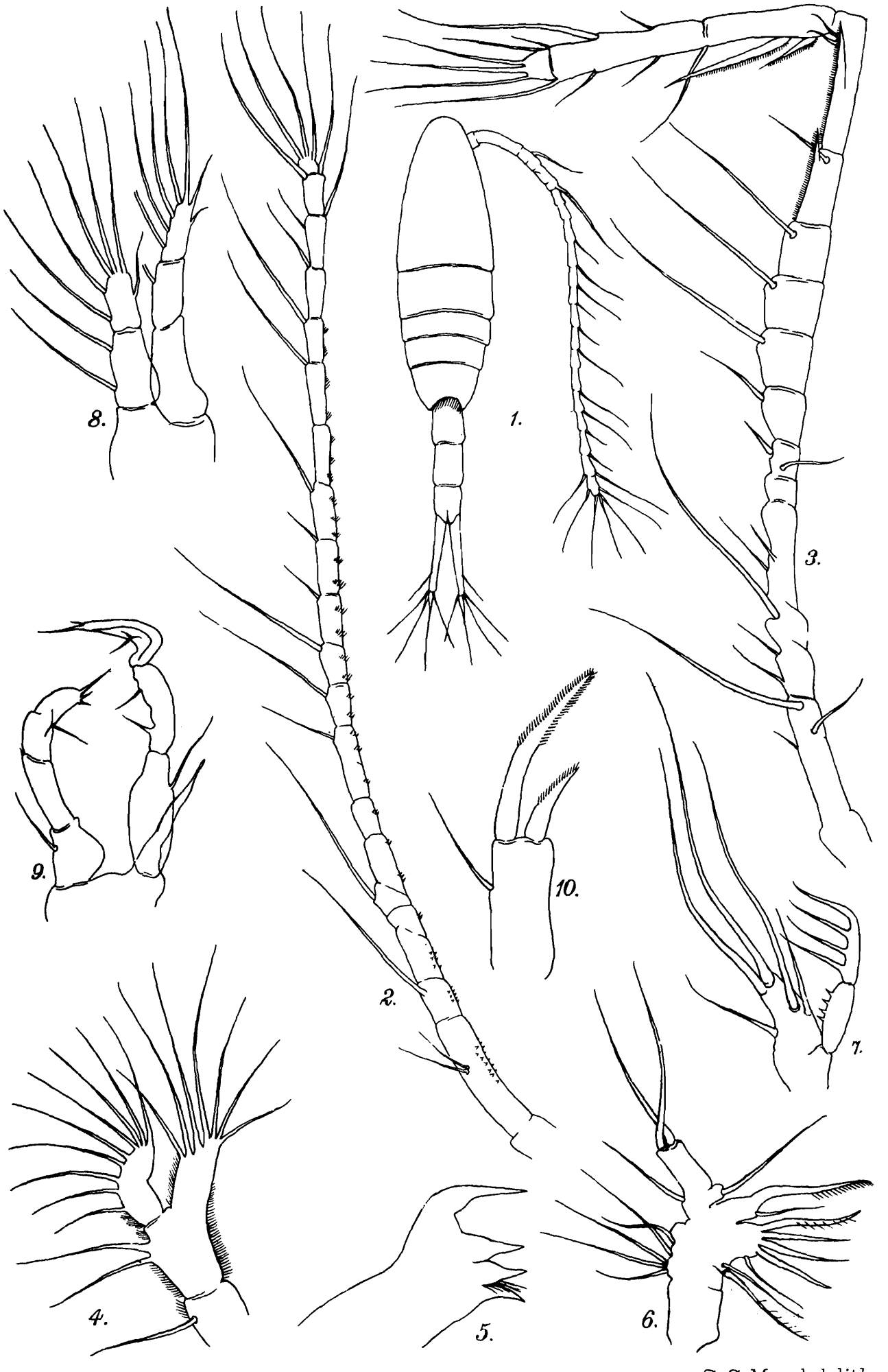
1.—	*Pontella andersoni*,	sp.	nov.	♀	Lateral view.
2.—	,,	,,	,, ,,	♀	1st Antenna.
3.—	,,	,,	,, ,,	♀	5th pair of legs.
4.—	,,	,,	,, ,,	♂	Abdomen.
5.—	,,	,,	,, ,,	♂	1st Antenna.
6.—	,,	,,	,, ,,	♂	5th pair of legs.
7.—	,,	,,	,, ,,	♂	1st Antenna, immature.
8.—	,,	,,	,, ,,	♂	5th Leg ,,
9.—	,,	,,	,, ,,	♀	5th Leg ,,



R. B. S. Sewell del. S. C. Mondul lith.

EXPLANATION OF PLATE XXI.

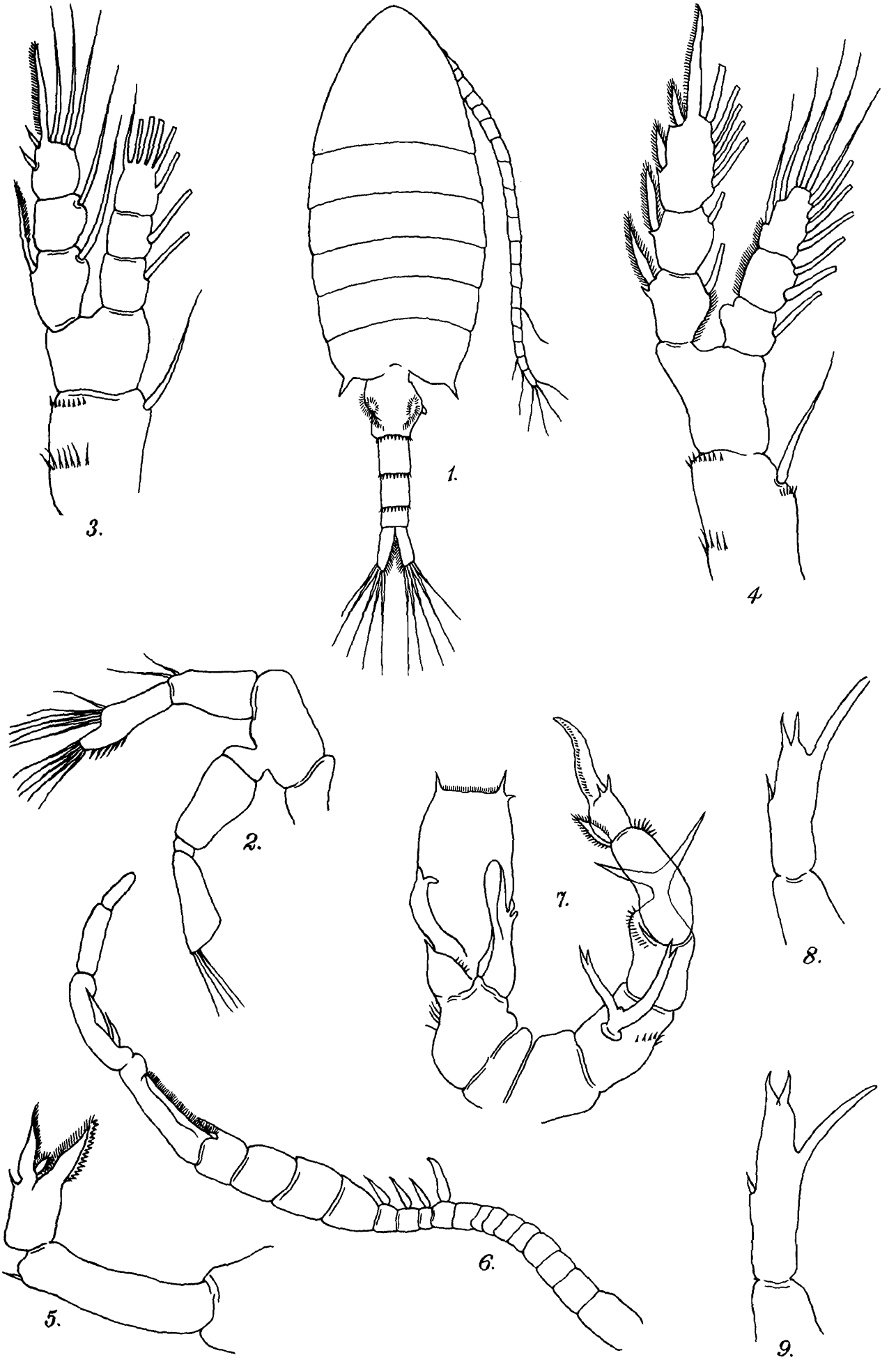
1.—	*Acartia tortaniformis*, sp. nov.	♀	Dorsal view.
2.—	,, ,, ,, ,,	♀	1st Antenna.
3.—	,, ,, ,, ,,	♂	1st Antenna.
4.—	,, ,, ,, ,,	♀	2nd Antenna.
5.—	,, ,, ,, ,,	♀	Mandible.
6.—	,, ,, ,, ,	♀	1st Maxilla.
7.—	,, ,, ,, ,,	♀	Maxilliped.
8.—	,, ,, ,, ,,	♂	1st Leg.
9.—	,, ,, ,, ,,	♂	5th pair of legs.
10.—	,, ,, ,, ,,	♀	5th pair of legs.



R. B. S. Sewell del. S. C. Mondul lith.

EXPLANATION OF PLATE XXII.

1.—*Pseudodiaptomus hickmani*, sp. nov.	♀	Dorsal view.
2.— ,, ,, ,, ,,	♀	2nd Antenna.
3.— ,, ,, ,, ,,	♀	1st Leg.
4.— ,, ,, ,, ,,	♀	2nd Leg.
5.— ,, ,, ,, ,,	♀	5th Leg.
6.— ,, ,, ,, ,,	♂	1st Antenna.
7.— ,, ,, ,, ,,	♂	5th pair of legs.
8.—*Temora discaudata*, Giesbrecht.	♀	5th Leg, normal.
9.— ,, ,, ,,	♀	5th Leg, variety.



R. B. S. Sewell del. S. C. Mondul lith.

EXPLANATION OF PLATE XXIII.

1.—*Pontella investigatoris*, sp. nov. ♂ Lateral view.

2.— ,, ,, ,, ,, ♂ 1st Antenna, right side.

3.— ,, ,, ,, ,, ♂ 5th pair of legs.

4.—*Labidocera kröyeri* (Brady) var. *burmanica*, nov., lateral thoracic angle.

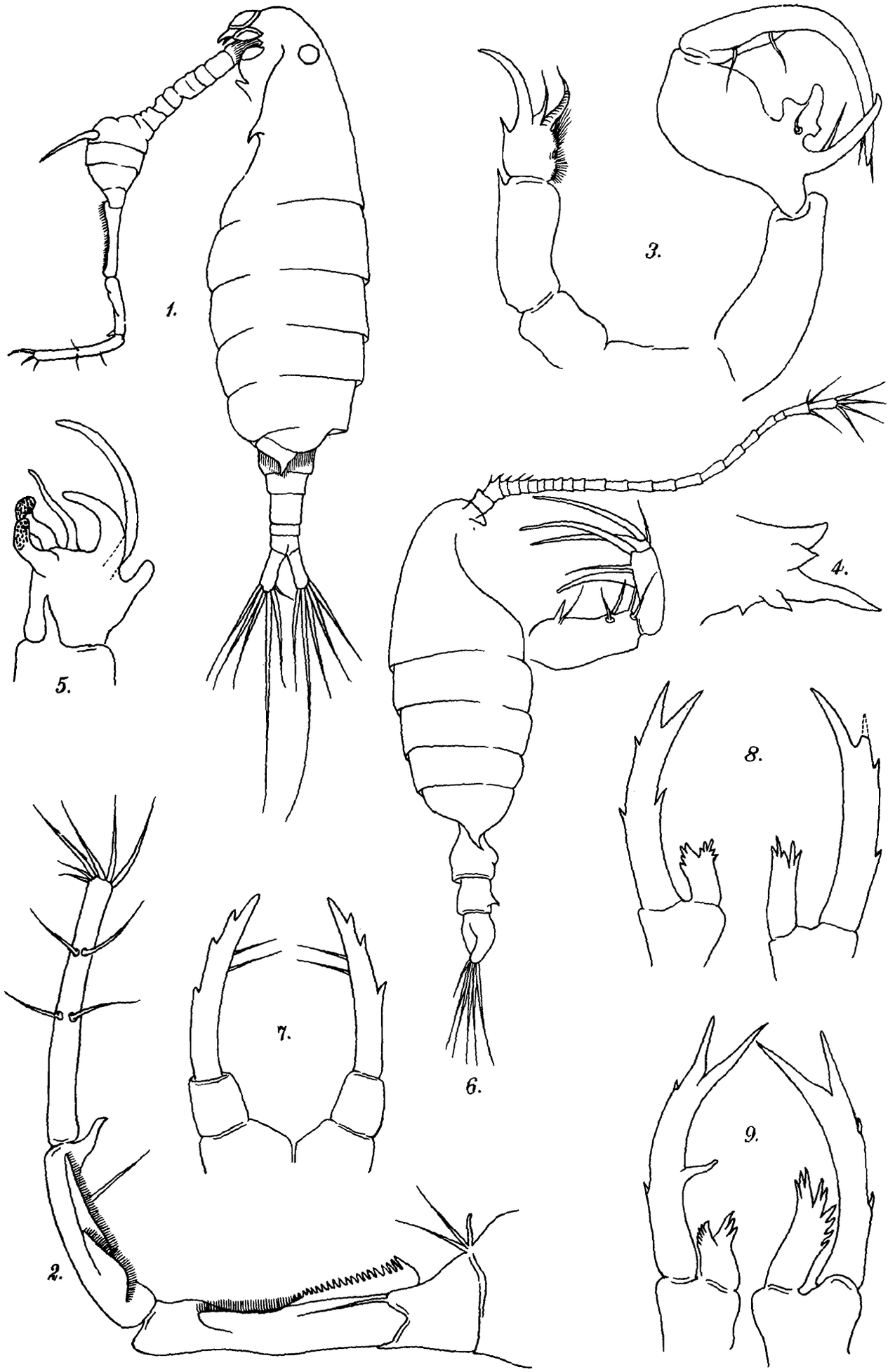
5.— ,, ,, ,, ,, ,, ,, ♂ 5th left leg, terminal segment.

6.—*Candacia bradyi*, A Scott. ♀ Lateral view.

7.— ,, ,, ,, ,, ♀ 5th pair of legs.

8.—*Labidocera pectinata*, Thomp. and Scott. ♀ 5th pair of legs (after Cleve).

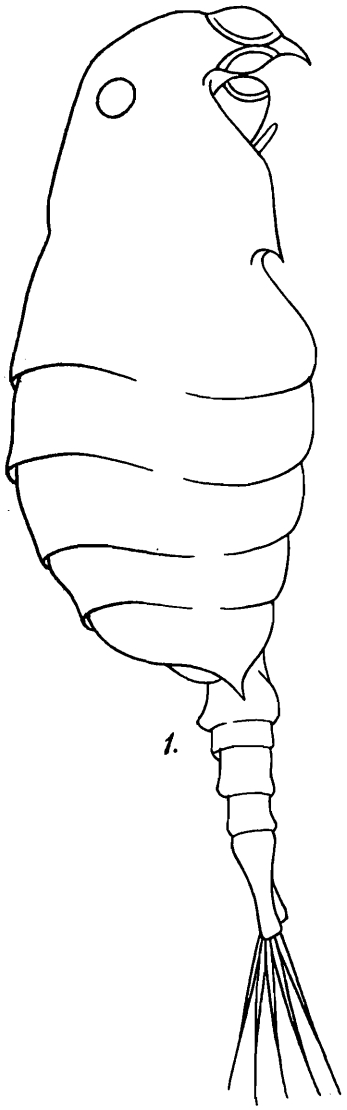
9.— ,, ,, ,, ,, ,, ♀ 5th pair of legs (from Burma).



R.B. S. Sewell del. S. C. Mondul lith.

EXPLANATION OF PLATE XXIV

1.—*Pontella spinipes*, Giesbrecht. ♂ Lateral view.
2.— ,, ,, ,, ♂ 1st Antenna, right side.
3.— ,, ,, ,, ♂ 5th left leg.
4.— ,, ,, ,, ♂ 5th right leg.
5.—*Pontellopsis herdmani*, Thomp. and Scott. ♀ Abdomen with abnormal spine.
6.—*Centropages tenuiremis*, Thomp. and Scott. ♀ 5th right leg.
7.— ,, ,, ,, ,, ,, ♂ Exopodites, 4th pair of legs.
8.—*Labidocera kröyeri* (Brady) var. *bidens*, nov. ♀ 5th pair of legs.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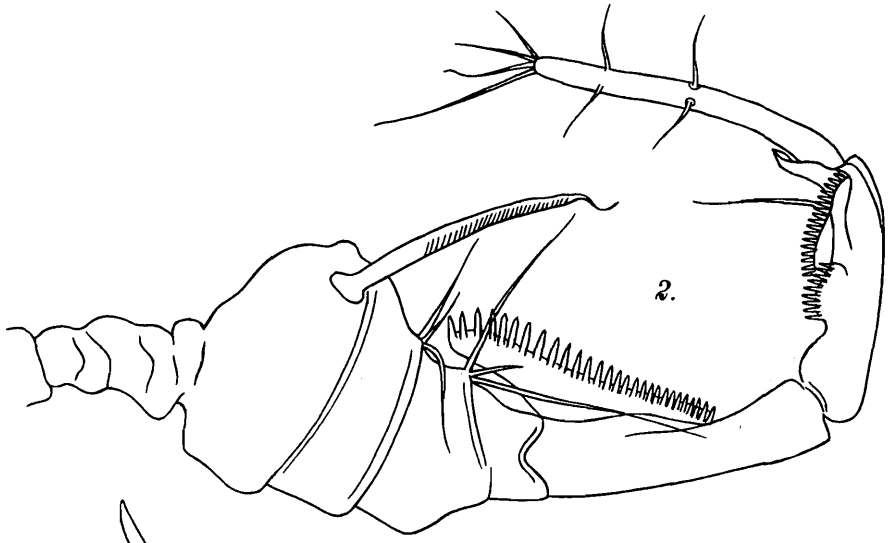
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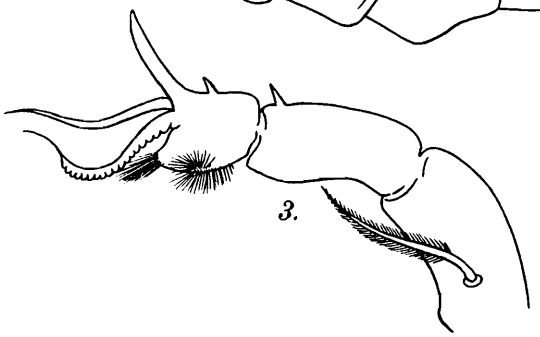
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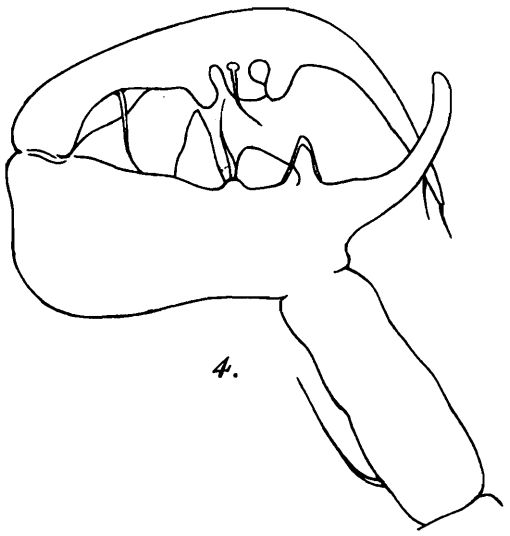
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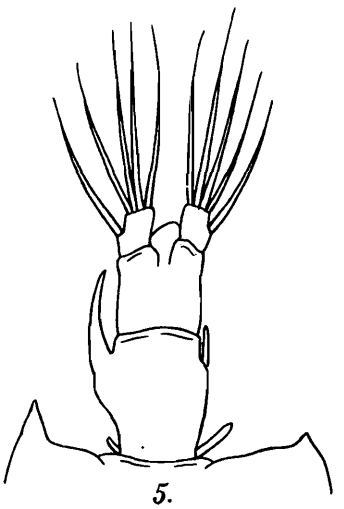
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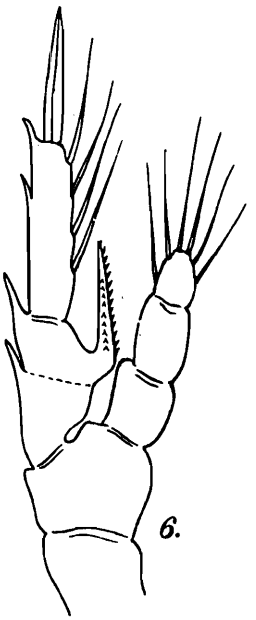
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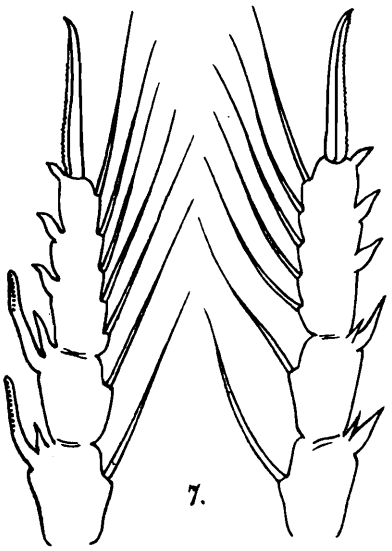
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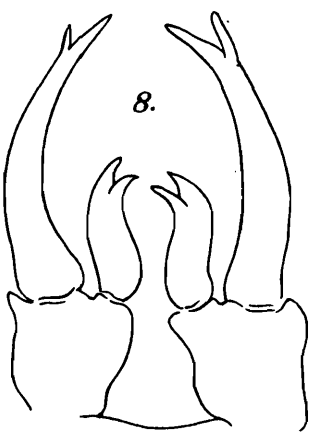
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XXX THE FRESHWATER SPONGES OF THE MALABAR ZONE.

By **N.** ANNANDALE, *D.Sc., F.A.S.B., Superintendent of the Indian Museum.*

The Malabar Zone is defined as consisting of the narrow strip of land on the west coast of Peninsular India between the Western Ghats and the Arabian Sea and of the Western Ghats themselves from the Tapti River in the northern part of Bombay proper to the extreme south of the Peninsula at Cape Comorin. The Western Ghats are a mountain-range (or rather a somewhat interrupted series of ranges) about 800 miles long and occupying in Peninsular India somewhat the same position as the Andes do in South America. They have not, however, anything like the same relative importance from a geographical point of view, for as a whole they cannot be reckoned among the higher ranges of the Indian Empire and they become insignificant in every way if compared with the Himalayas. It is true that in the so-called High Range in the north of Travancore an altitude of over 9,000 feet above sea-level is attained and that there are numerous peaks of over 3,000 feet at other points; but on the eastern side the mountains fall away gradually in the northern part of the Ghats into the plateau of the Deccan trap, while in the south they are inextricably confused with the ranges of the central part of the Madras Presidency, so that, although their height is often striking when they are viewed from the plains that lie below them to the west, it is difficult to distinguish them as a separate range at all from the east.

The freshwater sponges of the Malabar Zone were first studied by the late Dr. H. J Carter over sixty years ago, but his investigations were confined to the Island of Bombay, the fauna of which is not nearly so characteristic as that of the Ghats. Recently large collections have been obtained by Mr. S. P. Agharkar of the Elphinstone College, Bombay, Mr. F. H. Gravely of the Indian Museum, Mr. R. Shunkara Narayana Pillay of the Trivandrum Museum, and myself in the Nasik, Poona, Satara and Ratnagiri districts of Bombay and in the Native State of Travancore. With this material in my hands I have thought it worth while to discuss the Spongillid fauna of the Malabar Zone as a whole.

LIST OF THE FRESHWATER SPONGES OF THE MALABAR ZONE.

Genus SPONGILLA, Lamarck.

Subgenus EUSPONGILLA, Vejdovsky.

1. *S. lacustris* subsp. *reticulata*, Annandale.
2. *S. proliferens*, Annandale.
3. *S. alba*, Carter.
4. *S. cinerea*, Carter.
5. *S. travancorica*,* Annandale.
6. *S. crateriformis* (Potts).

Subgenus EUNAPIUS, Gray.

7. *S. carteri*, Carter.
7*a*. ,, ,, subsp. *lobosa*, Annandale.

Subgenus STRATOSPONGILLA, Annandale.

8. *S. gravelyi*,* nov.
9. *S. indica*,* Annandale.
10. *S. bombayensis*, Carter.

Genus PECTISPONGILLA,* Annandale.

11. *P. aurea*,* Annandale.
11*a*. ,, ,, var. *subspinosa*,* Annandale.

Genus EPHYDATIA, Lamouroux.

12. *E. meyeni* (Carter).

Genus DOSILIA, Gray.

13. *D. plumosa* (Carter).

Genus TROCHOSPONGILLA, Vejdovsky.

14. *T pennsylvanica* (Potts).

Genus CORVOSPONGILLA, Annandale.

15. *C. caunteri*, Annandale.
16. *C. ultima*, Annandale.
16*a*. ,, ,, var. *spinosa*,* nov.
17. *C. burmanica* subsp. *bombayensis*, Annandale.
18. *C. lapidosa*,* Annandale.

In the above list the names of those genera, species, etc. that are only known from the Malabar Zone are distinguished by an asterisk (*).

I.—SYSTEMATIC.

The great majority of the Malabar sponges have recently been discussed very fully in my volume on the Freshwater Sponges, etc. in the *Fauna of British India* and in subsequent papers, and it is not necessary to say anything more about them from a systematic point of view. So much new material has, however, been obtained in the genus *Corvospongilla* that I propose to revise this genus, so far as the Indian forms are concerned. It is also necessary to describe a new species of the subgenus *Stratospongilla* (genus *Spongilla*) discovered by Mr. Gravely.

Genus SPONGILLA.

Subgenus STRATOSPONGILLA.

The essential characters of this subgenus are, (1) that the gemmule-spicules lie parallel to the surface of the gemmule and (2) that the pneumatic coat, which is often poorly developed or altogether absent, lies entirely outside the gemmule-spicules. The skeleton is hard owing to the large number of megascleres present but friable owing to the poor development of spongin. Spicule-fibres are never very distinct, at any rate in the Indian species.

Key to the Indian species of Stratospongilla.

1. Skeleton-spicules sharply pointed.
   - A. Gemmules attached to base of sponge; gemmule-spicules cylindrical — *S. bombayensis.*
   - B. Gemmules free in parenchyma; gemmule-spicules knobbed at the ends — *S. gravelyi*, nov.
2. Skeleton spicules abruptly rounded at the ends.
   Gemmules attached to base of sponge; their spicules sausage-shaped — *S. indica.*

SPONGILLA (STRATOSPONGILLA) GRAVELYI, sp. nov.

Sponge forming small, shallow cushions, very hard but easily broken; external surface smooth and rounded to the eye, with very long and shallow channels radiating beneath the dermal membrane from the oscula, which are minute and not raised above the surface. Colour bright green.

Skeleton forming a regular network of single spicules and slender, ill-defined spicule-fibres of which the radiating or vertical ones are a little more distinct than the transverse. At the external surface the spicules project vertically upwards without being grouped together in any very definite manner.

Spicules.—The megascleres are slender, sharply pointed and almost straight amphioxi. Their surface is neither smooth nor spiny but covered with minute, irregular projections; sometimes a ring of short spines encircles the spicule near one or both ends. The length is about 12 to 14 times the greatest breadth. There are very few flesh-spicules, which appear to be confined to the dermal membrane and the neighbourhood of the gemmules. The few that I have seen are short, slender, almost straight, sharply pointed amphioxi covered with relatively long and very irregular spines that project at right angles to their main axis. The gemmule-spicules are of peculiar form. Each is curved in a

wide arc and bears at either end a more or less distinct knob; the concave surface is slightly flattened and almost smooth, whereas the convex is rounded and densely covered with minute spines of somewhat unequal size; the length is usually from 3 to 4 times the thickness in the middle, but the proportions are variable.

Gemmules.—The gemmules are spherical and lie each in a little loculus in the skeleton near the base of the sponge. They do not, however, appear to be fixed to its support and the specimens

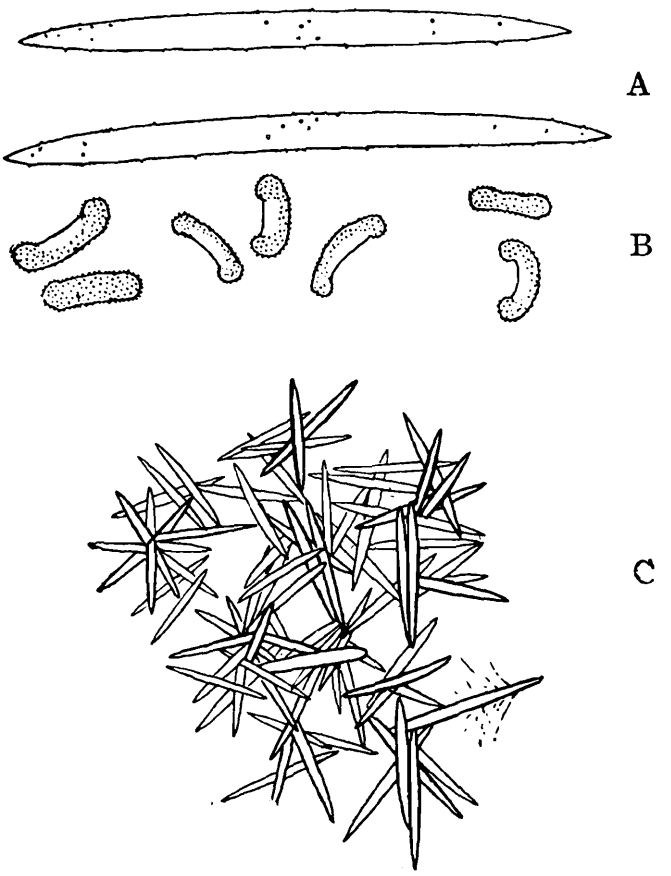

FIG. 1.—Spicules and skeleton of *Spongilla gravelyi.*
A. Megascleres, × 250.
B. Gemmule-spicules, × 250.
C. Vertical section through part of skeleton from external surface downwards, × 70.

do not possess a basal membrane. Each gemmule has a single aperture provided with a short cylindrical foraminal tubule.

Type.—No. Z.E.V $\frac{5107}{7}$, Ind. Mus. (a dried specimen collected by Mr. Gravely in May, 1912).

Locality.—Pool in the Koyna River at Taloshi, Satara district, on the eastern slope of the Ghats.

This sponge is closely related to *Spongilla sumatrana*, Weber, which (*fide* Weltner) occurs in tropical Africa (in varietal forms) as well as in Sumatra. It is distinguished from that species by its peculiar gemmule-spicules, much more strongly spined flesh-spicules and smoother megascleres. From *S. indica*, its closest

Indian ally, it is distinguished by the sharp points of its megascleres as well as by the form of the gemmule-spicules and its free gemmules. In external appearance and in the form of its megascleres *S. gravelyi* closely resembles the mountain form of *Spongilla* (*Euspongilla*) *cinerea*, Carter, which Mr. Gravely took at Medha on the eastern side of the Ghats, but the structure both of the skeleton and of the gemmule are completely different.

Genus CORVOSPONGILLA.

Annandale, *Faun. Brit. Ind.*, Freshwater Sponges, etc., pp. 122, 243 (1911); *Rec. Ind. Mus.*, vii, p. 99 (1912).

When this genus was originally described only two Indian species (*C. burmanica* and *C. lapidosa*) were assigned to it, but it shortly became necessary, owing to the acquisition of fresh material, first to describe another Indian species and then to transfer to *Corvospongilla* a fourth species originally referred to *Stratospongilla*. A new race of one of the already-known species was also added, and I propose to describe here a new variety of another known species. The list of Indian forms now comprises, therefore, four species, a subspecies and a variety.

Owing to these additions to our knowledge of the genus its position and characters have become much less obscure, and, thanks to specimens recently obtained, a new fact has come to light, *viz.*, that certain forms of the genus produce two kinds of gemmules, which differ from one another not only in that one kind is fixed to the solid support of the sponge while the other lies free in the parenchyma, but also in form, in the structure of the external layers and in spiculation. The genus may be redescribed as follows:—

Sponge.—The sponge encrusts rocks or brick-structures in the form of a film or a more or less solid layer. It never possesses branches or bulky upward projections. There is always a stout chitinous membrane at the base

Skeleton.—The skeleton is always remarkably hard and sometimes has an almost stony consistency. Except in the basal membrane, however, and in the covering of the gemmules, chitinous substance is often present only in small quantities, although in some species it is unusually abundant In some species it is difficult to detect a definite skeletal network, while in others the skeleton-fibres, and especially the radiating or vertical fibres are very stoutly formed.

Spicules.—The megascleres are never very slender and are often stout and amphistrongylous. They are always very numerous. Flesh-spicules are always present in the form of birotulates in which each rotule consists of a ring of very long and slender recurved spines.

The free spicules of the parenchyma have a very characteristic form, closely resembling that of the longer gemmule-spicules of *Heteromeyenia* and *Asteromeyenia*. Each has a slender cylindrical

shaft, which is always more or less curved and invariably smooth. It bears at both ends a circle of relatively long and strongly recurved, slender spines, which are proportionately long enough, as well as sufficiently close together, to give the appearance of a regular rotule with back-turned margin.

The skeleton spicules are normally short, stout, cylindrical, blunt and spiny. They are, however, subject to great individual variation and in some species (*e.g.*, *C. ultima*) exhibit many abnormal forms.

Gemmules.—The gemmules are sometimes of two kinds, fixed and free. The latter are either spherical or subcylindrical. In either case they have a close layer of spicules arranged like a mosaic on the external surface and are further enclosed in a dense case formed of chitinous substance in which true gemmule-spicules, more or less deformed, or modified megascleres and sometimes even birotulate flesh-spicules are firmly bound together. Sometimes the wall of this outer case can be separated into definite layers. Its inner surface is separated from the gemmule by an empty space. Pneumatic substance is altogether absent or very poorly developed. The wall of the case is in continuity with the basal membrane of the sponge.

The free gemmules are situated in the parenchyma, lying in interstices of the skeleton. They are invariably spherical. Each has a horizontal layer of spicules on its external surface and is surrounded, outside these spicules, by a pneumatic coat. Outside the pneumatic coat there is, in some species, a cage of more or less deformed megascleres. The microscleres of the free gemmules are as a rule longer and more slender than those of the fixed ones. Thus the former differ from those of certain species of the subgenus *Eunapius* (*e.g.*, *Spongilla fragilis*) in which a "pavement-layer" of gemmules is sometimes formed, in that they have a different structure from the fixed gemmules.

Both fixed and free gemmules sometimes occur in the same sponge, but probably only free ones are produced in some species.

Remarks.—Even the more delicate forms of the genus can be distinguished, so far as my experience goes, from any other oriental Spongillidae (except certain *Spongillae* of the subgenera *Eunapius* and *Stratospongilla*) by their very hard consistency. In skeletal structure the species vary considerably; but the skeleton, owing to the large number of megascleres, is always extremely massive.

Although free microscleres of the type described are always present, their number is very variable even in sponges of the same species taken at different times and they are sometimes scattered so scantily in the parenchyma that it is difficult to find them.[1] The dermal membrane is apparently aspiculous.

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[1] Great care is also necessary to prevent them floating away if spicule-preparations are made by allowing the spicules to settle in a liquid.

The fixed and free gemmules are apparently analogous in function to the fixed and free statoblasts of *Plumatella*. The fixed reproductive bodies of both sponge and polyzoon serve to ensure renewed growth of the organism in a situation that has already, in certain conditions, proved favourable for its proper development. Their production is either correlated with a change in conditions or perhaps in some few cases precedes any such change and is due rather to a form of senescence. Conditions suitable for renewed activity on the part of the organism are similarly either correlated with or antecedent to renewed vegetative growth on the part of the resting bodies. The free gemmules, on the other hand, are carried away by floods and thus aid in the dispersal of the species. So far as the facts as yet ascertained justify a statement as to conditions that bring about or precede the production of the two kinds of gemmules in *Corvospongilla*, it would seem that the fixed gemmules are formed as soon as the sponge is in full vigour or just past its prime, and that the free gemmules are formed at a later season. Sponges of the genus frequently occur on the beds of rocky streams that rise with great violence in the "rains" but sink to a series of more or less disconnective pools in the cool season. They are often left high and dry at the latter time of year. Their compact skeletons remain firmly adherent to the rock until the floods come again. Then, in all probability, the free gemmules are washed away to places down stream, while the fixed gemmules cling fast and in due course produce a new sponge on the old basis.

Key to the Indian Forms of Corvospongilla.

I. Majority of the megascleres sharply pointed.
  1. Delicate species with only free gemmules .. *C. caunteri*.
  2. Much stouter species with fixed (and sometimes also free) megascleres.
    (*a*) External surface rough but not spiny *C. ultima* (typical).
    (*b*) External surface distinctly spiny *C. ultima* var. *spinosa*.

II. Majority of the megascleres distinctly amphistrongylous.
  1. Sponge hard but brittle, radial spicule-fibres produced vertically upwards to form spines on external surface.
    (*a*) Oscula elevated on cylindrical, turret-like eminences. *C. burmanica*.

(*b*) Oscula either not elevated or on eminences of irregular form — *C. burmanica bombayensis.*

2. Sponge of almost stony consistency, external surface without spines; radiating fibres indistinct — *C. lapidosa.*

CORVOSPONGILLA CAUNTERI, Annandale.

Faun. Brit. Ind., Freshwater Sponges, etc., p. 243, fig. 48 (1911).

The first specimens of this species were taken in April, 1911, on the pier of a brick-work bridge near Lucknow. Mr. Gravely obtained others in April, 1912, on rocks in the pool of a stream at Medha on the eastern side of the Western Ghats. Both sets of specimens were taken in running water. Both contained only free gemmules with well-developed pneumatic coats and formed only very thin films on their supports. It is improbable that fixed gemmules are ever formed in this species, unless it sometimes attains a very much greater thickness than the specimens examined have attained, for the outer cases of such gemmules would be almost as deep as the sponge itself. Although the sponge only forms a thin film of two or three millimetres' thickness, its hardness can be readily felt if it is squeezed between the finger and thumb. Mr. Gravely's specimens are a trifle thicker than the types and darker in colour.

CORVOSPONGILLA ULTIMA (Annandale).

Spongilla (*Stratospongilla*) *ultima*, Annandale, *tom. cit.*, p. 104, fig. 19.

Corvospongilla ultima, *id.*, *Rec. Ind. Mus.*, vii, p. 99 (1912).

Specimens obtained by Mr. Gravely on rocks in a pool of a stream at Taloshi on the eastern watershed of the Western Ghats in April are sufficiently different from those taken at Cape Comorin and at Tanjore to be made the types of a new variety, for which I propose the name,

var. SPINOSA, nov.

The chief taxonomic peculiarity of this variety lies in the fact that its external surface is distinctly spiny. This is due to the protrusion of the radiating fibres, which, instead of becoming dissipated as they approach the surface, are prolonged upwards beyond it, often for a distance of several millimetres. The oscula also are larger than in the typical form and have no radiating furrows.

A more striking peculiarity is the occurrence of free as well as fixed gemmules; but of course this may be due to the season at which the sponge was taken or to its physiological condition rather than to any inherent character. The free gemmules are smaller

than the fixed ones; their diameter is about 0·42 mm., whereas that of the fixed gemmules is about 0·9 mm. without the external case. The free gemmules are spherical and have as a rule two apertures, each of which is provided with a short conical or cylindrical tubule. The pneumatic coat is poorly developed and there is no outer cage of megascleres. The spicules of the free gemmules are long and narrow and as a rule somewhat inflated at the ends; their measurements on an average are:—length from 0·054 to 0·063 mm., breadth about 0·0048 mm. The spicules of the fixed gemmules are, like those of the fixed gemmules of the typical form of the species, exceedingly variable and liable to all sorts of abnormalities, but those of the inner layer are, unless deformed, from 0·029 to 0·05 mm. in length and from 0·007 to 0·012 mm. in greatest breadth.

Type.—No. Z.E.V $\frac{5106}{7}$, Ind. Mus.

Locality.—Taloshi, Koyna valley, Satara district, Bombay Presidency (2,000 ft).

CORVOSPONGILLA BURMANICA (Kirkpatrick).

Spongilla loricata var. *burmanica*, Kirkpatrick, *Rec. Ind. Mus.*, ii, p. 97, pl. ix (1908).

Corvospongilla burmanica, Annandale, *Faun. Brit. Ind.*, *tom. cit.*, p. 123.

The typical form of the species has only been found as yet in the Pegu-Sittang Canal in Lower Burma, but the Bombay race has now been taken at three different localities in that Presidency.

Subsp. BOMBAYENSIS, Annandale.

Annandale, *Rec. Ind. Mus.*, vi, p. 225 (1911).

The first specimens of this race were taken by Mr. Agharkar at Khed in the Poona district and others were found by Mr. Gravely and him at Pimpli in the Ratnagiri district. The former place is on the eastern, the latter on the western face of the Ghats. Remarkably fine examples were also obtained by Mr. C. S. Middlemiss of the Geological Survey of India in the native state of Idar, which lies between 23°6′ and 24°29′ N. and 72°45′ and 73°39′ E., considerably north of the Tapti River. About these specimens, which he mistook at first sight for a calcareous tufa, Mr. Middlemiss writes: "The locality of the specimens is Hàthmati River opposite Thuravas, Idar State (Máhi Kántha); occurring as incrustations on pebbles of recent conglomerate left dry by subsidence of the water." They were taken in December, 1911, and covered considerable areas; some of them are 2·5 cm. thick.

Both the specimens from Idar and those from the Ratnagiri district contain free as well as fixed gemmules, although there are only fixed gemmules in those from the Poona district. In the Idar specimens the free gemmules are only in a few instances fully developed and many stages can be found, but in the Ratnagiri ones they are complete.

Although the free gemmules do not differ so much from the fixed ones as is the case in *C. ultima* var. *spinosa*, the differences are of the same nature. In both kinds of gemmules the shape (apart from the external case) is almost spherical and there is a single aperture with a straight foraminal tubule, but the free gemmule is slightly more flask-shaped than the other and has a longer and more tapering tubule. The diameter of both varies somewhat, but in the case of the free gemmule it is on an average about 0·5 mm. and in that of the fixed gemmule about 0·6 mm. The free gemmule has a well-developed pneumatic coat outside its proper spicules and, outside this coat, is enclosed in a hollow sphere of unusually small and often ill-formed megascleres mixed with spicules like its own and held together by a chitinous membrane. The microscleres are very little longer or more slender than is the case in the fixed gemmules.

II.—GEOGRAPHICAL.

In the introduction to my volume on the Freshwater Sponges, etc., in the *Fauna of British India* I laid great stress on the African affinities of the lower invertebrates that inhabit the streams, lakes and pools of the Western Ghats. So far as the sponges are concerned the chief foundation for this view lies in the strong representation of the genus *Corvospongilla* and the subgenus *Stratospongilla* of the genus *Spongilla*. Recent investigations have on the whole given support to my belief but have shown that the African element is more widely distributed than was at first realized. The discovery of a freshwater medusa of the genus *Limnocnida* in the Western Ghats is evidence in favour of African affinities, and so also is the fact that three additional forms of *Corvospongilla* have now been added to the known fauna of the range, as well as a new species of *Stratospongilla*; but on the other hand two species of *Corvospongilla* have been found in India east of the Ghats and the range of *Spongilla* (*Stratospongilla*) *bombayensis*, formerly believed to be peculiar to Bombay and Natal, is now known to extend into the W. Himalayas in the north and to the Mysore plateau in the south, while there is strong evidence that *Limnocnida indica* only occurs in those streams which run eastwards from the Ghats.

Of the genus *Corvospongilla* three species, *C. loricata* (Weltner), *C. böhmi* (Hilgendorf) and *C. zambesiana* (Kirkpatrick), and possibly a fourth only recognized from isolated spicules are known to occur in Africa. The first, which is the type of the genus, is from an unknown locality in that continent, while the other three occur in Central Africa. Of the four Indian and Burmese species, one (*C. burmanica*) is very closely allied to *C. loricata*, while another (*C. lapidosa*) is perhaps no more than a local race of the African *C. zambesiana*, the gemmules of which are not known. The two sponges apparently differ only in the structure of their skeleton. All the Indian forms, with the exception of the typical

race of *C. burmanica* (the only species as yet found east of the Bay of Bengal), occur in the Western Ghats. One of them ranges eastwards and northwards in practically identical form to Lucknow, another has been found north of the Tapti River and the third occurs in one form at Cape Comorin, in Travancore and at Tanjore near the east coast of Madras, and in another on the western side of the Ghats in Bombay.

It is difficult to say what are the exact limits of distribution of *Stratospongilla*. Although I believe that this subgenus is founded on characters of sufficient weight, it is difficult to say whether it is really distinct from *Potamolepis*,[1] Marshall, the gemmules of which are unknown. Certain African species, however, namely *Spongilla sumatrana*, Weber, *S. rousseletii*, Kirkpatrick, and possibly *S. cunningtoni*, Kirkpatrick, are closely related to the three Indian species, *S. indica*, *S. gravelyi* and *S. bombayensis*, the type of the subgenus. *S. sumatrensis* was originally described from the Malay Archipelago, as its name would suggest, and it is possible that the two African forms which Weltner has ascribed to the species as varieties are specifically distinct from it, if not one from the other. In any case the three forms at present associated under the name are closely related to *S. indica*, *S. gravelyi* and less closely to *S. bombayensis*, which occurs in Natal as well as India. These sponges differ considerably from the Congo species originally ascribed to *Potamolepis* by Marshall (15) and even from *P. barroisi*, Topsent (17) from the Lake of Tiberias. They are, however, less different from the latter than they are from the former, while the species from Western China and the Philippines (*S. coggini* and *S. clementis*) that I have assigned provisionally to *Stratospongilla* (4,5) come very near to *P. barroisi*, from which it is difficult to believe that they are subgenerically distinct. It is noteworthy, moreover, that the gemmules of *S. coggini* are of a very simple nature, totally lacking microscleres, as is also the case with two of the Tanganyika species, while the gemmule-spicules of *S. clementis* are small and poorly developed. The fact that the gemmules of all known species of *Potamolepis* are wanting is, however, one of little importance. I recently examined a large collection of Spongillidae from France and Switzerland comprising all the common European species of *Spongilla* and *Ephydatia*. Only a very small proportion of the specimens, most of which had been collected in summer, contained gemmules. On the other hand I have recently found these bodies in *Veluspa bacillifera* from Lake Baikal and they are known to occur in many sponges not even remotely related to the Spongillidae.

On the whole, therefore, we can only say as regards *Stratospongilla* that the species which occur in the Malabar Zone are closely allied to African species but have, with one exception, not

[1] I cannot accept the view that *Potamolepis* is identical with the S. American genus *Uraguaya*, the gemmule-spicules of which resemble those of *Trochospongilla*. *Veluspa*, Micl. Macl. (*Lubomirskia*, auct.) is not, in my opinion, a Spongillid at all.

been found outside that zone. The exception (*S. bombayensis*), which occurs in Natal, has been found both in the W. Himalayas and on the Mysore plateau in the very centre of southern Peninsular India.

The only genus of Spongillidae that appears to be endemic in India is *Pectispongilla*, which has not been found except on the western side of the Western Ghats. It has no very close allies, so far as we know, in any other district.

The majority of the remaining sponges of the Western Ghats and the plains between them and the Arabian Sea are widely distributed forms. *Spongilla cinerea*, however, has only been found at Bombay, in the Ghats and in the W Himalayas, its range somewhat resembling the Indian range of *Spongilla bombayensis*, but being more restricted in that it does not, apparently, extend into the main area of the Peninsula. The race *lobosa* of *Spongilla carteri* appears to be endemic in Travancore on the western side of the Ghats, while *Trochospongilla pennsylvanica* has probably, according to Miss Stephens (16), only been found in N. America and in Travancore.

It is thus clear that the sponge fauna of the Malabar Zone is abundantly distinct from that of any other part of India, although it includes many widely distributed species that occur in other districts. It appears to have distinct affinities with that of tropical Africa, and especially with that of Lake Tanganyika, but exhibits no more trace of a recent marine origin than is shown by the Spongillidae of any other country. In considering its peculiarities, however, allowance must be made for the bionomical factor. Some of the most characteristic sponges of the zone are only found in the beds of rocky streams which for part of year are raging torrents and for part a series of almost isolated pools. Few sponges have been found in similar conditions in other parts of India, the mountainous districts of which are for the most part almost unexplored so far as the aquatic fauna is concerned. It may be that many of the peculiarities or apparent peculiarities of the Spongillidae of the Western Ghats are merely characteristic of sponges that flourish in the peculiar circumstances that prevail there, and that these peculiarities will be found to be much less distinctive when other mountain ranges are as well known as the Western Ghats.

LITERATURE.

1. Alcock, A. W *Catalogue of the Indian Decapod Crustacea in the Collection of the Indian Museum*, pt. I, fasc. II (Potamonidae), 1910.
2. Annandale, N. "Notes on Freshwater Sponges. VIII.—Preliminary Notice of a collection from Western India, with descriptions of two new species." *Rec. Ind. Mus.*, II, p. 25 (1908).
3. ,, "Report on a small collection of Sponges from Travancore." *Rec. Ind. Mus.*, III, p. 101 (1909).

4. Annandale, N. "Freshwater Sponges in the collection of the U. S. National Museum. I.—Specimens from the Philippines and Australia." *Proc. U.S. Nat. Mus*, XXXVI, p. 627 (1909).
5. ,, "Contributions to the Fauna of Yunnan. I.—Sponges and Polyzoa." *Rec. Ind. Mus.*, V, p. 197 (1910).
6. ,, "Freshwater Sponges, Hydroids and Polyzoa." *Fauna of British India* (1911).
7. ,, "Specimens collected in the Poona district, Bombay Presidency, by S. P. Agharkar." *Rec. Ind. Mus.*, VI, p. 225 (1911).
8. ,, "The generic position of "*Spongilla ultima*." *Rec. Ind. Mus.*, VII, p. 99 (1912).
9. Carter, H. J "Notes on the species, structure, and animality of the Freshwater Sponges in the tanks of Bombay." *Ann. Mag. Nat. Hist.*, (2) I, p. 303 (1848).
10. ,, "A descriptive account of the Freshwater Sponges in the Island of Bombay." *Ann. Mag. Nat. Hist.*, (2) IV, p. 81 (1849).
11. ,, "On *Spongilla cinerea*." *Ann. Mag. Nat. Hist.*, (5) VII, p. 263 (1881).
12. Kemp, S. W., and Annandale, N. "Observations on the Invertebrate Fauna of the Kumaon Lakes." *Rec. Ind. Mus.*, VII, p. 129 (1912).
13. Kirkpatrick, R. "Zoological Results of the third Tanganyika Expedition.—Report on the Porifera." *P.Z.S.*, 1906 (1), p. 218.
14. ,, "Description of a new variety of *Spongilla loricata*, Weltner." *Rec. Ind. Mus.*, II, p. 97 (1908).
15. Marshall, W "On some new Siliceous Sponges collected by M. Pechuël-Lösche in the Congo." *Ann. Mag. Nat. Hist.*, (5) XII, p. 391 (1883).
16. Stephens, Miss J "Clare Island Survey.—Freshwater Porifera." *Proc. Roy. Irish Acad.*, XXXI, pt. 60 (1912).
17. Topsent E. "Sur une Eponge du Lac de Tibériade." *Rev. Biol. Nord France*, V, p. 1 (1892).
18. Weber, Max. *Zoologische Ergebnisse einer Reise in Niederlandish Ost-Indien*, I, p. 30 (1890).
19. Weltner, W "Katalog und Verbreitung der bekannten Süsswasserschwämme. *Arch. f. Naturgesch.*, 1895 (1), p. 114.
20. ,, "Die Coelenteraten und Schwamme des süssen Wassers Ost-Afrikas," in Mobius' *Deutsch-Ost-Afrika*, V (1898).

Geographical List of Freshwater Sponges of the Malabar Zone.

Name.	Malabar Zone. East.	Malabar Zone. West.	W. Himalayan Territory.	North-East Frontier Territory.	Burma Territory.	Main Peninsular Area.	Indo-Gangetic Plain.	Distribution outside India.	Remarks.
Genus SPONGILLA ..	×	×	×	×	×	×	×	Cosmopolitan.	
Subgenus EUSPONGILLA.	×	×	×	×	×	×	×	Ditto.	
S. lacustris subsp. *reticulata.*	×	×	×	×	×	×	×	....	The typical form of the species is cosmopolitan.
S. proliferens.. ..	×	—	—	×	×	×	×	Yunnan; Java; Celebes, etc.	A purely Oriental species.
S. alba	—	×	—	—	—	×	×	Egypt (var. *cerebellata*) ..	The "varieties" *cerebellata* and *bengalensis* are perhaps no more than phases.
S. cinerea	×	×	×	—	×	×	—	....	Not known outside India.
*S. travancorica** ..	—	×	—	—	—	—	—	..	Only known from Travancore.
S. crateriformis ..	—	×	—	—	—	—	×	Common in N. America; probably occurs in Ireland.	Distribution apparently discontinuous.
Subgenus EUNAPIUS ..	×	×	×	×	×	×	×	Cosmopolitan.	
S. carteri	×	×	×	—	×	×	×	S.-E. Europe; Mauritius; Malay Archipelago.	Possibly occurs in Central Africa (*fide* Kirkpatrick). The form *lobosa* seems to be confined to Travancore, while the "varieties" *cava* and *mollis* may be mere phases.
S. carteri lobosa ..	—	×	—	—	—	—	—		
Subgenus STRATOSPONGILLA.	×	×	×	—	—	—	—	Central and South Africa; Sumatra; S.-W. China; the Philippines.	The Chinese and Philippine species are by no means typical.

*S. gravelyi** ..	×	—	—	—	—	—	—	....	Only known from Taloshi; Koyna valley in the Satara district.
*S. indica**	×	×	—	—	—	—	—	....	Only known from Igatpuri and Nasik in the W. Ghats.
S. bombayensis ..	—	×	×	—	—	—	—	Natal.	
Genus PECTISPONGILLA.*	—	×	—	—	—	—	—	....	Only known from Travancore and Cochin.
*P. aurea**	—	×	—	—	—	—	—	....	Only known from the western base of the W. Ghats in Travancore.
P. aurea var. *subspinosa**	—	×	—	—	—	—	—	..	Only known from the coastal districts of Cochin.
Genus EPHYDATIA ..	—	×	×	—	—	—	×	Almost cosmopolitan ..	Apparently a scarce genus in the Oriental Region but abundant in Japan.
E. meyeni	×	×	—	—	—	—	×	Sumatra ..	Only known from a few widely separated localities.
Genus TROCHOSPONGILLA.	—	×	—	—	×	×	×	N. America; Europe ..	The headquarters are in N. America.
T. pennsylvanica ..	—	×	—	—	—	—	—	Tropical Africa.	
Genus CORVOSPONGILLA.	×	×	—	—	×	×	—		
C. annunteri	×	—	—	—	—	×	—	....	Described from Lucknow; taken by Mr. Gravely at Medha on the eastern slope of the W. Ghats.
C. ultima	—	×	—	—	—	×	—		
C. ultima var. *spinosa** ..	—	×	—	—	—	—	—	....	Described from Cape Comorin; also taken at Tanjore.
C. burmanica bombayensis.	×	×	—	—	—	×	—	....	Also taken in Idar State some distance north of the W. Ghats. The typical race is from Lower Burma.
*C. lapidosa**	×	×	—	—	—	—	—	....	Only known from Igatpuri and Nasik; possibly a variety of the African *C. zambesiana*, Kirkpatrick.

XXXI NOTES ON THE HABITS AND DISTRIBUTION OF *LIMNOCNIDA INDICA*, ANNANDALE

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(Plate xxxvi).

The medusa which forms the subject of the present paper was discovered in May, 1911, by Mr. Agharkar who sent the few specimens he was then in a position to collect to Dr. Annandale for examination. Dr. Annandale communicated the discovery to the Asiatic Society (see A.S.B. Proceedings for August, 1911) and to "Nature" (vol. lxxxvii, 1911, p. 144). As the specimens had reached him in a fragmentary condition Dr. Annandale was unable to describe them fully and further collecting was undertaken by the authors of this note in April, 1912, since when he has described the species under the name *Limnocnida indica* (Rec. Ind. Mus. vii, pp. 253–256).

Our knowledge of the distribution of the genus *Limnocnida* in India is probably still very incomplete. So far it has only been collected in Western India from the Yenna and Koyna, two tributaries of the Krishna, and we have been unable to add to these records by personal observation; but the Mamlatdar of Medha, after seeing the specimens we had collected near his village, told us that he had seen similar organisms at Dhôm in the Krishna itself in March, 1912, and we think his evidence may be accepted as trustworthy. These three rivers, together with two others which flow down on the western side of the Ghats, rise in a small temple near Mahabaleshwar at an altitude of 4385 ft. above sea level. All of them sooner or later fall precipitously over a band of hard rock from the plateau into wide valleys which at their commencement are probably not more than 3000 ft. above sea level. No medusae have been seen or heard of above these falls, although we searched the only place in which they were likely to occur—an artificial lake in the upper course of the Yenna Valley close to Mahabaleshwar. Nor did we hear of any place where they were known west of the Ghats, or find them ourselves in the Vashishti, the only river we were able to examine on that side.

In the Yenna *Limnocnida* was found in May, 1911, and again in April, 1912, in a pool at Medha, about 2200 ft. above sea level and about 15 miles below the falls; and local information points to its occurrence in a pool at Kelghar at the head of the deep valley and in some pools considerably below Medha. In the Koyna

the medusae were equally abundant in the same months in a pool at Tambi, about 2100 ft. above sea level, and a single specimen was obtained by Mr. Agharkar in 1911 at approximately the same altitude at Vela, about 10 miles further down the valley; again local information points to the occurrence of the organism in places we were unable to visit, particularly at Bamnoli, 5 miles above Tambi, and at Patan, 27 miles lower down.

We have no evidence of the occurrence of *Limnocnida* in the Krishna below its junction with the Yenna and Koyna, where it flows throughout the year without becoming broken into a series of pools in the dry season; and at present we are unable to confirm Col. Alcock's record from the lake at Purulia ("Nature," vol. lxxxvii, p. 214). With regard to this record, however, it is noteworthy that the rivers near Purulia are of a very similar character to those in which *Limnocnida* lives in the Western Ghats; and there is no reason to suppose that at the right time of year a more careful enquiry than we have yet been able to institute in Chota Nagpur will not result in its discovery there in large numbers in widely separated pools just as in Western India.

The Yenna, so far as our observations went, resembles the rivers near Purulia and Chakardharpur—the only ones in Chota Nagpur known to either of us personally--more closely than does the Koyna. Near Medha it consists of a number of rather shallow mud-lined pools varying greatly in length and connected to one another by channels among rocks where the fall of the river is usually more rapid than elsewhere. In the midst of one of these rocky portions of its bed, just below the foot-bridge, there is a pool of exceptional depth with rocks rising vertically out of it on both sides, and it was in this pool only that we found *Limnocnida*, a pool in which it had been found in the previous year also. There seemed to be nothing unusual about this pool except its depth and vertical rocks; but there was no means at hand of making any attempt at a survey either of this or any other part of the river. The total depth cannot have been more than fifteen or twenty feet; and the bottom as far as we could discover consisted entirely of mud. Though of small size its character makes it a favourite bathing pool for the village, and every morning, while the water is free from the sediment brought down by the first rains, it is filled with bathers.

The medusa is most easily obtained at this time, as it frequents the deepest part of the pool, a few rising to the surface at frequent intervals, particularly after any great disturbance of the water. Though colourless and more or less translucent it is a conspicuous and beautiful object when at the surface and the natives of all places where it occurs seem to know it well. They have applied to it two most appropriate names—*chakra* meaning a wheel, and *phul*, a flower. The few who speak English talk simply of "flowers." When actively swimming to the surface the tentacles naturally trail out behind; but when at rest either on

the bottom of an aquarium or when sinking through the water they are carried somewhat as in Günther's figure of *L. tanganicae* (P.Z.S. Lond., II, 1907, pl. xxxvii, fig. 1) except that the small tentacles, which are less adherent to the exumbrella than are the large ones, hang downwards when not carried upwards by the motion of sinking. Both the position of these tentacles in Gunther's figure and the unnatural thinness and flatness of the bell there indicated are no doubt due to the imperfect preservation of the specimen from which it was drawn. For the preservation of our specimens we used a mixture of corrosive-sublimate solution and 5% formalin; when the specimens were carefully fixed and the corrosive solution used was saturated excellent results were obtained, the medusae shrinking but little when transferred gradually to strong spirit; but when, on one occasion, the preservation of the specimens was hurried and the corrosive weak, by the time the specimens were in spirit they were found to have shrunk enormously and some of the best of them are very like the one shown in Günther's figure.

The mouth varies greatly in size from time to time in the same individual. It generally falls open when specimens are fixed, but it is usually we think, if not always, a sign of decrepitude for the wall of the stomach to be vertical and the mouth as widely open as in Günther's figure. In all our best preserved specimens it is more or less oblique, and in many it is very markedly so, the thin lip within the gonad ring being much deeper and the aperture much smaller than when the mouth is more widely open. In life, we saw the aperture abruptly contracted on many occasions; but we never remember to have seen it reduced to the "minute star-shaped aperture" found in the specimen figured by Dr. Annandale in his recent paper (*loc. cit.* fig. 1). This specimen is a very minute one and was not examined microscopically when alive. Small specimens in general seemed to close their mouths more than big ones; but we never saw the mouth other than circular in thoroughly healthy specimens. We failed to observe any of the specimens feeding; but the stomachs of some small specimens mounted in Canada balsam have been found to contain the skins of entomostraca from which all trace of the soft parts has disappeared, having presumably been absorbed by the medusa.

The medusae in the pool at Medha, when we were there, included specimens of all sizes and both sexes; but no asexual generation was observed. In both sexes the gonad ring is white, but in the female it is marked by numerous equidistant vertical grooves, whereas in the male it is quite smooth. The number of very small medusae in the pool made it evident that reproduction of some kind was actively going on; but whether this was direct from the sexual generation or from an asexual hydroid stock we were unable to determine. We attempted to obtain large numbers of all the earliest stages with the help of a townet; but the swimmer to whom the net was entrusted dropped it, and it was not recovered till too late to use it again that day. Next day all the medusae

had disappeared before the thick brown sediment brought down by the first heavy rain of the season. That they had completely disappeared we established as far as was possible both by stirring the pool with our nets and by attaching a townet to a large fishing net on the end of a very long bamboo, which the village fishermen were passing backwards and forwards over the muddy bottom of the deep rocky channel with which the pool commences. The townet must have been fishing quite close to the bottom, for it several times came up filled with thick black mud. The fact of the complete disappearance of the medusae has since been further established by the Forest Ranger at Medha, who reported a month later that nothing more had been seen of them although the river became clear about a fortnight after the sediment first appeared.

From Medha we crossed over the hills into the valley of the Koyna. The pools of which this river is composed in April are much broader and often much longer than are those of the Yenna. As many of them are connected only by the percolation of water through gravel barriers, rain near the source of the river does not carry sediment very far down; and all the pools near Tambi, where we first halted, were still quite clear. Only one of them contained medusae, again a pool in which they had been found in the previous year, but we were told that they were sometimes found in others. The pool in which we found them was long and wide without rocky banks, differing completely from that in which they had been found at Medha so far as could be judged from the surface. One evening, when a strong wind had swept the pool from end to end for a few hours, the medusae were found in enormous numbers in the shallow water at the leeward end, many of them in very poor condition. This shoal had entirely disappeared next morning. Medusae were often found in quite shallow water at the other end (the one we could most easily get to), having come there without the assistance of any wind so far as we could see, but these too were often in bad condition. The best specimens were obtained by watching for them to come up out of deeper water,[1] but even these seemed to us scarcely as healthy as those we saw at Medha. Moreover not a single specimen of unusually small size could be found even with the help of townets dragged both along the bottom and nearer the surface. From this we think it follows either that all the medusae were being produced in some unknown rocky cavity out in the middle of the pool and that only the feebler adults ever wandered far enough to drift ashore, or else that the season of the medusae was drawing to a close and would not require any catastrophe to end it completely. In either case the existence of a hydroid generation seems to us to be clearly indicated, since even the dying medusae showed no signs

[1] While at Tambi we tried to ascertain whether they were more abundant at certain times of day than at others. Local testimony on this point was conflicting. We found medusae plentiful between daybreak and sunrise, as well as throughout the heat of the day. We seemed to see them best during brief times of sunshine, but this may have been due to the illumination of the water to a greater depth than when the sun was obscured by clouds.

of the production of special resting eggs. The completeness of the disappearance of all medusae from the pool at Medha when this became muddy, and the absence of medusae from all pools between May of one year and February of the next[1] also seem to point to the same conclusion. Moreover the occurrence of the medusa year after year in certain pools and its absence from others seems probable from what we saw, though by no means certain; and the organism must by now have had ample time to establish itself in every pool suited to its requirements. As far as one can see from above there is no difference between the various pools of the Koyna which can account for the occurrence of the medusa in one and not in all of them, so we are driven to suppose this difference to exist in the bottom—a point, unfortunately, which could only be settled by a survey such as our equipment did not permit us to carry out. The character of the pool at Medha seems to indicate that the hydroid must live on solid rock; and as the medusae always came up from deep water and no hydroid could be found near the edge it is probable that the hydroid lives only at a distance from the surface.

We therefore conclude that in the life-cycle of *Limnocnida indica* there is probably an asexual hydroid stage which lives attached to rocks[2] at the bottom of deep pools, and that this hydroid produces medusae by budding from February till April or May, when it ceases to do so whether the pool in which it lives is flooded or not, and very possibly dies. It is perhaps noteworthy that the long duration of this supposed fixed asexual generation corresponds to that of the free asexual medusae found in Tanganyika, while the duration of the free medusoid generation of which only sexual individuals are yet known corresponds to that of the sexual generation of Tanganyika and occurs only a little earlier in the year, this difference of season being necessitated by the summer rains of India. It is still possible, however, that asexual medusae may be found in India earlier in the medusa season; and our knowledge of the times at which the Tanganyika form reproduces in different ways rests on very few observations[3] and may prove to be misleading.

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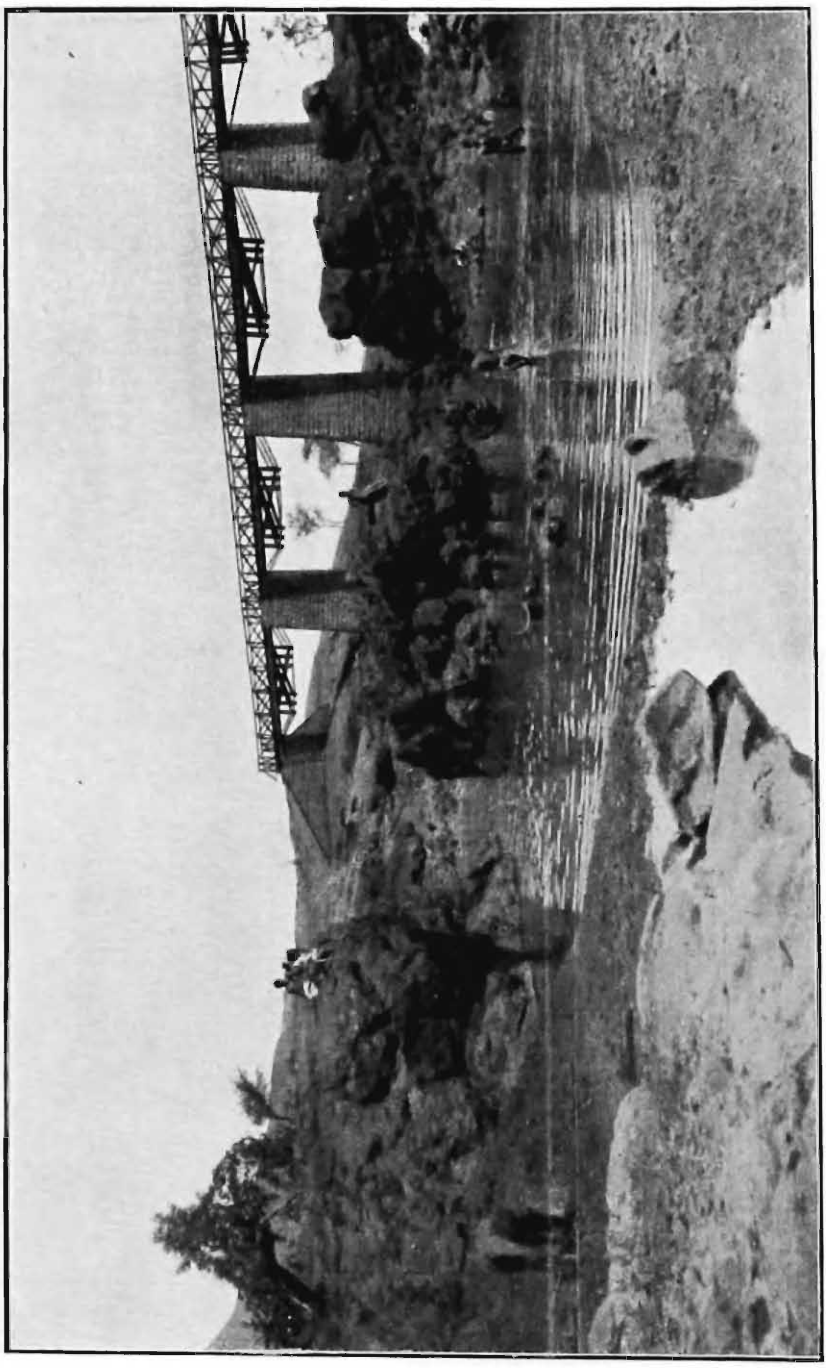
[1] All the inhabitants of the district seem to be agreed on this point.
[2] These pools contain no water-weeds.
[3] For a summary of these see Günther, *P.Z.S.* II, 1907, p. 644.

EXPLANATION OF PLATE XXXVI.

The pool inhabited by *Limnocnida indica* near Medha. The medusa is only found in the deep water between the rocks at the back of the picture.



Habitat of *Limnocnida indica*.

XXXII. THE ANATOMY OF *MELO INDICUS*, Gmelin.

By H. J FLEURE, *Professor of Zoology, University College of Wales, Aberystwyth.*

(Plates xxviii–xxxii).

I.—INTRODUCTORY.

Through the kindness of the authorities of the Indian Museum of Natural History, and of Dr. J Travis Jenkins, two specimens of *Melo indicus*, Gmelin, were forwarded to me for examination.

The identification was made by Mr. Preston and confirmed by Mr. E. A. Smith. *Melo* is a genus, or subgenus, in the family *Volutidae*, belonging to the Stenoglossa Rhachiglossa in Bouvier's classification of the Monotocard Gastropods.

Bouvier makes the following the chief characteristics of the RHACHIGLOSSA:—

1. The central tooth of the radula is nearly always well developed and the radular formula is not above 1. 1. 1.
2. The special unpaired gland of the oesophagus is well developed, but its duct only rarely traverses the nerve collar (pl. xxx, fig. 6, Unp. Gl.).
3. The supra-intestinal ganglion approaches the right pleural ganglion (pl. xxxii, fig. 21, R. Pl. G. and Sp. Int. G.).
4. The visceral ganglion is subdivided (pl. xxxii, fig. 21, V and V^1).

These characters seem to mark them out among the STENOGLOSSA, which are characterized by Bouvier as follows:—

1. Radular formula 1. 1. 1., often reduced in various ways.
2. A retractile proboscis (pls. xxviii and xxix, figs. 1—4, Pr.), a well-developed pallial siphon (S), a siphonostomatous shell, a large and bipectinate osphradium (Osph.), a penis. Accessory tubular buccal glands (pl. xxx, fig. 6, T. B. G.) may occur, there is one pair in *Halia*, one pair with ducts uniting in Volutidae, etc., none are found in Buccinidae.
3. A pair of racemose buccal glands with ducts which do not traverse the nerve collar (pl. xxx, fig. 6, R. B. G.).
4. A special unpaired gland of the oesophagus in many forms (pl. xxx, fig. 6, Unp. Gl.).
5. A highly concentrated nervous system without labial commissure or pedal cords. The ganglia of the reduced buccal mass near the cerebrals. Zygoneury

very highly developed on the right side (pl. xxxii, fig. 22, Zy.). Position of supra-intestinal ganglion variable. One otolith in each otocyst.

The Volutidae are a family of the Stenoglossa Rhachiglossa with the following characters, according to Bouvier:—

Externals (pls. xxviii–xxx, figs. 1—5). A fore-roof (Fore-R.) above and in front of the mouth, covering a part of the front end of the foot. On this are the reduced tentacles (t.), and, behind them, at the sides, the oculiferous projections (e.). Innervation shows that this fore-roof is due to concrescence and enlargement of the tentacle-bases. A strong, rather short siphon (S.) with a large thin projection on each side of the siphonal gutter (R.S.T. and L.S.T.). A fairly short proboscis and sheath.

Alimentary canal (pl. xxx, figs. 5—7). A pair of normal, racemose, buccal glands (R.B.G.) forming a mass from which the ducts go far forwards, becoming engaged in the gut-wall on the way. Accessory glands of tubular form (T.B.G.), typically uniting before they reach the gut, the common duct lying in the ventral wall of the radular sac and opening very far forwards, almost into the mouth.

Nervous system (pl. xxxii, figs. 21—22). Cerebral ganglia fused to form a trapezium. Pleurals barely separated from cerebrals. Supra-intestinal ganglion relatively very far from the right pleural (but in thus generalising Bouvier is probably wrong). Subintestinal ganglion almost continuous with left-pleural, zygoneurous (Zy.) connection with the right pleural short and broad.

Pilsbry-Tryon describes the Volutidae as characterized by the radula:—

Tooth formula 0-1-0, the tooth being tricuspid with large lateral points in *Cymbium*, *Melo*, *Voluta*, *Hyria*, etc. In *Voluta musica* the tooth is multicuspid and very transverse. In *Amoria* the tooth is unicuspid with a concave base.

The genus *Melo* is defined by shell characters and Pilsbry thinks the absence of an operculum is not proven for many of them. Adams states that the animal is ovoviviparous, the young ones being arranged in the oviduct of the female in a long string without egg-shells. In *Voluta*, the mantle is not so greatly expanded as in *Cymbium* and *Melo* and the foot is proportionately not so large. Volutid shells are rarely collected with the animal except when accidentally thrown ashore after a storm. The reason is that, like the Naticae, they bury themselves under the surface as soon as the water falls and the sand is left dry by the tide (Gray).

Haller's papers on the Rhachiglossa relate to Buccinids and Purpurids for the most part. Bouvier examined *Voluta neptuni* which is said to belong to the genus *Melo*. Woodward worked at *Voluta* (*Cymbiola*) *ancilla*, Sol., *Neptuneopsis gilchristi*, Sby., and *Volutilithes abyssicola*, Ad. and Reeve. My results are in very general agreement with his.

Pace has worked at *Voluta musica*, about the relationships of which there is some doubt. It is a West Indian form, whereas 80% of the species of Volutes live within a triangle having its extreme points at Ceylon, Japan and New Zealand. It has a fusoid, narrowly elongated operculum mounted on a distinct pad. This is also found in *Neptuneopsis*, *Volutolyria* and *Lyria*, but no trace of it appears to subsist in *Melo*.

II.—EXTERNAL CHARACTERS AND BRANCHIAL CAVITY.

(Pls. xxviii–xxx, figs. 1–5).

The lack of adequate illustrations of the Rhachiglossa has led me to sketch this type from several points of view, both the specimens used being females.

The foot is large and massive with a long definite anterior edge, grooved (pl. xxviii, fig. 2, Gr.) and glandular as usual. This type of foot can be compared with that of *Natica*, *Bulla*, *Scaphander*, etc., being apparently in every case an adaptation to the burrowing habit. In this connection, too, the compact rolling of the spire above the foot is noteworthy. The disposition of the spire and the columellar muscle makes possible the wide opening of the branchial cavity on the animal's right side (pls. xxviii and xxix, figs. 1 and 4) with the result that the rectum opens well back on that side (pl. xxix, fig. 4, A.), and the other openings are also a good way off from the ctenidium and osphradium. The roof of the cavity between the ctenidium and rectum has the usual mucus gland with oblique ridges in its surface. In one specimen, as also in a part of another sent, but not in the other complete one, there was a well-marked swelling (pl. xxviii, fig. 1) not far in from the edge of the cavity's roof.

The siphon (S.) is short and strong and possesses two tentacles at its base, one above and to the right (R.S.T.) and the other below and to the left (L.S.T.) of the gutter.

The osphradium (Osph.) is situated in the branchial roof and is bipectinate, with its leaflets approximately parallel to those of the ctenidium and somewhat oblique to the incoming stream of water along the siphon. The leaflets are rather thinner and finer than those of the ctenidium.

The monopectinate ctenidium (ct.) and the osphradium both curve round to the left as they go back. The leaflets of the ctenidium are long-based low triangles.

The proboscis (Pr.) is fairly short and pleurembolic. Pl. xxviii, fig. 1 shows it expanded to some extent while pl. xxx, fig. 5 gives it in the completely retracted condition. The great mass formed by the retracted proboscis and the sheathing body wall displaces the oesophagus (pl. xxx, fig. 5). When the proboscis is extended its wall continues back practically without a kink into that of the proboscis sheath.

The lamina or fore-roof (Fore-R.) above the proboscis, mentioned as a characteristic of the Volutes, is very well developed

and the small tentacles (t.) occur at the sides of its front edge with an eye (e.) on the outer side of the base of each of the two anterior ones; the additional tentacle is situated at the base of the fore-roof on the right side. The fore-roof may be compared with the analogous developments in *Bulla*, *Scaphander*, etc., and pl. xxviii, fig. 2 shows how it lies over the proboscis If the siphon is contracted and the anterior edge of the mantle pressed against the fore-roof, the proboscis, etc. being contracted underneath and pressed up by the expansion of the foot in burrowing, the branchial cavity must be fairly effectually closed in front.

III.—ALIMENTARY CANAL. (Pl. xxx, figs. 5—7).

The actual entrance to the food canal found on dissection will vary a little according to the state of protraction or retraction but there is always a short conjoint section of the canal which then divides giving fore-gut above and radular sac below. The cavity of the latter is practically nil except just in front.

There is a cushion for the radula, a membrane with thickening on either side, *i.e.*, one may speak of a pair of cartilages which are long and narrow, lath-like in fact. They are bound together by the membrane in which they develop and by muscle-fibres joining them. There are also muscle-fibres around them and at the sides, joining them to the proboscis wall. Some of the fibres run forwards and protract the cushion and others run backwards and serve for retraction. The fact that the radula is in an organ (the proboscis) which moves back and fore, however, makes the separate movement of the radula less important and the odontophore and its musculature are therefore less complex than in Gastropods without a long retractile proboscis.

The radula has been described elsewhere. It is reduced to one tooth, the median or Rhachis tooth, in each row; the tooth is powerful and tridenticulate. The whole radula rests on a strong membrane, the front end of which, bent down over the cushion, is held by a strong pair of ventral-stretching muscles going back in the middle line.

Muscle-fibres arise also from the sides of the subradular membrane and go to join the sheath; they keep the main part of the radula tense, pulling it backwards and outwards on either side.

The glands of importance to the mouth region of the gut have their ducts much elongated as they are necessarily massed behind the proboscis region. They are:—

(*a*) One pair of ordinary acinous buccal glands (R.B.G.). The ducts run alongside the fore-gut and get involved in its wall, ultimately opening near the junction of gut and radular sac.

(*b*) One pair of glands (T.B.G.) formed of long, much bent, folded tubes. These tubes ultimately unite and the united duct curls along in the ventral wall of the radular sac to open near the junction of the sac with the fore-

gut. The distal ends of the tubes are much longer than the ends which unite.

Behind the proboscis, the gut lies in the general anterior cavity suspended by many fibrous strands. Just behind the proboscis is a short section of somewhat increased diameter (Ph. L., pl. xxx, fig. 6) corresponding with the "Pharynx de Leiblein" noted by French observers in some other Rhachiglossa. Behind this, the nerve-collar gathers round the gut, and, some distance behind this, the great median or unpaired gland of the fore-gut stands out above it. The duct of the latter goes forward in the gut wall and opens near the level of the nerve-collar. Bouvier thought the gland was usually small in Volutids but large in *Melo neptuni* which he studied. Woodward thought the gland longer in Volutids than in the Rhachiglossa in general. Pace found a very large gland in *V. musica*. It is certainly large in *M. indicus* and the other observations make it probable that Woodward is right.

The oesophagus is continued back as a cylindrical tube which widens suddenly at a certain level. The lining of the wider section is strongly ribbed by longitudinal folds (pl. xxx, fig. 7*a*) and this section goes back into the visceral mass where it opens into a stomach which is of a **U**, or, rather, a **V**-shape with a caecal outgrowth on one side. The digestive gland occupies the upper part of the spiral and communicates, so far as I have been able to trace it, with the caecal outgrowth of the stomach by two openings (see pl. xxx, figs. 6—7). Following upon the stomach is the short intestine overlying the oviduct and wrapped around to a considerable extent by the right (or posterior) portion of the excretory organ. The anus (pl. xxix, fig. 4, A.) is deeper in the branchial cavity than the oviducal opening. Both lie, as already stated, well back on the right side and thus out of the way of the ctenidium and osphradium and the arrangements which, it has been suggested, secure the closing of the front margin of the branchial cavity.

IV.—NERVOUS SYSTEM. (Pl. xxxii, figs. 21 and 22).

The nervous system has been described more thoroughly than any other, and Bouvier's observations are established and confirmed, as usual, by subsequent workers. A detailed account of the system is therefore superfluous though reference may be made to the interesting question of the supra-intestinal ganglion.

Cerebral, pleural and pedal ganglia are intimately united in pairs and the cerebrals are closely fused with the pleurals to form a trapezoidal mass. From this mass are given off, as Bouvier found,—

(*a*) Two large nerves to the proboscis on each side.
(*b*) Nerves to the fore-roof above the head.
(*c*) Nerves to the anterior part of the body wall.

The above are from the cerebral ganglia.

(*d*) Parietal nerves from the pleural ganglia.

(*e*) The short connective, so short as to be almost non-existent, to the supra-intestinal ganglion (pl. xxxii, fig. 21, Sp. Int. Gl.).

This ganglion is similarly near the cerebropleural mass in the Volutids examined by Woodward, in *Voluta* (*Cymbiola*) *ancilla* (Sol.), *Neptuneopsis gilchristi* (Sby.), and *Volutolithes abyssicola* (Ad and Rve). Pace examined *Voluta musica* and found that this form has the supra-intestinal ganglion separated from the cerebropleural mass by a considerable length of visceral connective. Bouvier's type was *Voluta neptuni*, Gmelin, which is referred by Pace and Woodward to the section "*Melo*," but is grouped by Pilsbry-Tryon with *Cymbium*; he found the connective between the pleural and the supra-intestinal ganglion long. This seems to indicate that the type now under discussion, *Melo indicus*, Gmelin, can hardly be in the same section of "*Voluta*" as Bouvier's species.

The supra-intestinal ganglion gives rise to three chief trunks, not so many as in Bouvier's type which had eight to ten nerves arising here. The two anterior trunks branch and supply the body-wall and the ctenidium and osphradium. There seems to be an anastomosis between one branch nerve to the body-wall and siphon from this ganglion and a nerve from the left pleural ganglion.

The third of the trunks is the visceral loop (V.L. sp.).

The sub-intestinal ganglion is, as usual, close to the pleural, but is more closely bound up with the right pleural than in Bouvier's type, the zygoneurous connection (Zy.) being very short and thick. The zygoneurous connection, it will be remembered, is formed by a great parietal nerve of the right-side passing through the subintestinal ganglion. The subintestinal ganglion therefore appears to give off this parietal nerve (R. par.) and also the visceral loop.

The visceral loop is quite normal, with two ganglia (v and v^1) at the back, the supplementary ganglion being to the left of the principal one. From the supra-intestinal part (V.L. sp.) of the commissure, near the point when it passes over the oesophagus, a nerve seems to branch off to the branchial region. The supplementary ganglion is situated on the loop just after it has crossed the intestine, and from it a nerve runs up towards the heart and visceral mass. The principal ganglion is a short distance to the right and it gives off various nerves including one to the heart, etc. and one to the rectum and neighbouring parts.

The buccal ganglia are close below the cerebrals and are connected by a commissure. The pedal ganglia are connected closely with the cerebropleural mass and with one another and give off numerous nerves which I have not further studied.

V.—CIRCULATORY SYSTEM.

The heart is slung in the pericardial cavity (pls. xxix & xxxi, figs. 3 and 8) by the connection of the efferent ctenidial vein with

the auricle above (technically forwards and to the left) and by the base of the aortæ below. The pericardial cavity is fairly spacious and its connection with the renal organ is on the posterior or right side of its floor. The pericardial lining does not seem to possess glandular specialisation though my specimens were not in a condition for histological examination. The ventricle is strongly muscular, with the muscle internally in longitudinal bands, the bands being radially arranged. The auricle was strongly contracted in the specimens examined, but a valve seems to exist between it and the ventricle.

The base of the aortae is guarded by a pocket valve on the side towards the anterior aorta and the wall projects inwards from the side towards the posterior aorta; these arrangements must be effective against back-flow.

There are as usual two aortae.

The anterior aorta is strongly walled and follows the oesophagus for some time (pl. xxxi, fig. 9), giving off several branches to bodywall, columellar muscle and foot across it. A large branch goes to the siphonal region, and the anterior region generally.

The visceral aorta is also strong and it divides as shown in fig. 9.

The spaces throughout the body are blood spaces. They may be grouped, more or less, into sets :—

(*a*) The spaces in the foot, often running along with the nerves.

(*b*) The general anterior cavity continued into the cavity of the proboscis. This cavity communicates with the spaces in the foot more especially, though not exclusively, in the neighbourhood of the pedal ganglia.

(*c*) The spaces between and amongst the parts of the renal organ, reproductive organs, and intestine, *i.e.*, the lower part of the visceral mass. The connection of these spaces with those of the anterior cavity appears to be regularized into what is practically a vessel (pl. xxxii, fig. 16, Ant. V.) and certainly these spaces are, otherwise, practically completely cut off from those under (*a*) and (*b*).

(*d*) The spaces amongst the parts of stomach and liver, *i.e.*, in the upper part of the visceral mass, somewhat distinctly marked off from those under (*c*) with what may be called an anterior visceral sinus.

(*e*) The spaces in mantle roof, cteniduim, and siphon. The afferent channel to the ctenidium continues the anterior visceral sinus. These spaces, especially towards the siphon, are also in connection with those of the general anterior cavity (*b* above). The afferent ctenidial channel is well marked.

The blood channels in connection with the renal organ are regularized to some extent and are discussed in connection with that system.

If one may infer from the arrangement of blood channels, the general course of the circulation would be from the heart *via* the aortae to either the head, foot, siphon, etc., or to the visceral mass. From the former to the general anterior cavity, thence *via* the renal organs to the anterior visceral sinus which presumably also gets the blood from the channels amongst the viscera (*d* above). Thence to the mantle and ctenidium roof and so back to the heart.

The separation of the sets of spaces is perhaps somewhat marked and one gets the idea of a fairly regular system allowing of course for movements of blood due to such other causes as the expansion and contraction of the foot, the protrusion and retraction of proboscis and siphon, and so on.

VI.—Excretory System.

The renal organ is treated by Perrier who studied *Voluta neptuni*. It is situated on the right side of (that is, actually, behind) the pericardium (pl. xxix, fig. 3), and is a large massive organ occupying the lower part of the visceral mass and covered by the ovarian tubules. It consists of (1) the massive posterior or right lobe (see R. L., pls. xxix & xxxi, figs. 3, 10—13), which has a spongy structure (pl. xxxi, fig. 15) and opens into the general renal cavity by fissures between some of its projecting lobes (pl. xxxi, figs. 12 and 13). This lobe is wrapped around the rectum on the dorsal side of the latter.

(2) The smaller anterior or left lobe (L.L., pls. xxix & xxxi, figs. 3, 10—13), a band of tissue of a lighter colour than the other lobe. It runs vertically, parallel to the posterior (morphologically right) wall of the pericardium. This band is, as it were, suspended from the roof of the cavity (pl. xxxi, figs. 11 and 12) and is attached to the floor just within the lips of the external openings (see fig. 12). Through this attachment it receives a branch channel (pl. xxxii, fig. 16, L.L.V.) from the great blood channel leaving the general anterior cavity (A.V.). The surfaces of the left lobe are somewhat swollen out, making numerous flat lobes with furrows between them (pl. xxxi, fig. 14).

(3) The so-called nephridial gland (N. G., pls. xxix & xxxi, figs. 3 and 10—13) against the pericardial wall, but not extending over its (morphologically) anterior end. The internal surface is somewhat ridged and grooved and there are pits at intervals (pl. xxxi, fig. 13).

The general renal cavity is partly subdivided by the vertically hanging left lobe as described. Just below the nephridial gland, and towards the right side (morphologically, forwards) the reno-pericardial canal (Rn. P.P., pl. xxxi, fig. 12) enters. The pericardial canal is short and direct. The circulatory arrangements of the renal

organ were worked out as far as possible. A very definitely walled channel (Ant. V., pl. xxxii, fig. 16) coming from the anterior cavity of the animal (see above) runs just beneath the side of the external opening of the renal organ and, once arrived under the floor of the organ, it gives off branches as follows:—

(*a*) A branch to the nephridial gland (N. G. V., pl. xxxii, fig. 16).
(*b*) A branch to the left lobe (L.L.V., pl. xxxii, fig. 16).
(*c*) A branch to the large part of the posterior or right lobe which lies morphologically in front of and topographically to the right of the external aperture (R.L.V., pl. xxxii, fig. 16).
(*d*) A branch which goes along beneath the floor of the renal cavity and gives off branches to the several projecting lobes of the right lobe (R.L.V., pl. xxxii, fig. 16).

The last-named blood channel appears to connect with the anterior visceral or abdominal sinus (A. Abd. S). The latter apparently also gathers blood from sinuses in the body wall and elsewhere around the renal organ, liver, etc.; it is situated between the pericardium and the stomach and communicates with the afferent blood channel of the ctenidium.

VII.—REPRODUCTIVE SYSTEM. (Pl. xxxii, figs. 17—20).

Both my specimens were females so I can only describe this sex and, in connection with it, I have mainly to confirm Haller's results from *Concholepas peruviana* with some additional observations. In other words, the genitalia are very similar in this sex for the two types.

The ovary is composed of a number of long tubules spreading over the surface of that portion of the visceral mass which is occupied by the large posterior or right lobe of the kidney. The tubules form a branched system and lie side by side. As they unite they approach the posterior edge of the upper surface of this portion of the visceral mass and then bend round to its under (posterior) side in the lower part of which they open (after further uniting in pairs) into the common collecting duct which goes forward to open into the large oviduct.

This collecting duct receives a duct from a large bladder-like structure which I shall call, tentatively at least, the albumen sac (Alb., pl. xxx, fig. 7). It is in the position of the receptaculum seminis, so called at any rate, of *Concholepas*, but in the latter the collecting duct from the ovary seems to go into this organ and the channel to the uterus out from it again. The relations are therefore not exactly the same, even if, as seems probable, the name receptaculum seminis is an error.

The oviduct is a large sac-like duct abutting on the posterior side of the branchial cavity narrowing down to a terminal duct-

like portion which projects freely into the branchial cavity (pl. xxix, fig. 4).

Internally the duct portion of what has been tentatively named albumen sac is marked by numerous fine longitudinal ridges, all of which become much weaker as soon as they enter the sac. Most of the sac seems to have a simple membranous wall. The collecting duct of the ovarian tubules is also ridged longitudinally.

The wall of the oviduct internally is evidently glandular almost throughout. Slight ridges and hollows run in transverse lines on the side towards the branchial cavity, being weakest (see pl. xxxii, figs. 18—20) along the line where they are nearest to that cavity (through the wall).

Along the back-line, almost dorsally, a swollen ridge with grooves in its surface projects as an almost horizontal shelf into the cavity along practically its whole length. Sheltering beneath its under side is the main channel which is bounded on its forward and lower side by a thick ridge. This ridge rises up towards the end and finally goes into the roof of the terminal narrow part of the duct. On the anterior side of this ridge the transverse ridges and hollows mentioned above are much higher than elsewhere (pl. xxxii, figs. 18 and 19).

The whole effect is to partially mark off a canal portion of the oviduct, ventral and posterior, from a large chamber, more or less dorsal and anterior. The shelf and the thick ridge already mentioned have not grown sufficiently to meet and fuse so the canal portion and the chamber are connected all along (see pl. xxxii, figs. 18 and 20).

The following are some of the papers referring to Volutidæ :—

Bouvier, E. L.—Le système nerveux des Gasteropodes Prosobranches.—*Ann. Sci. Nat. Zool.*, ser. vii, tome 3, 1887.

Bouvier, E. L.—L'organisation des Volutes.—*Bull. Soc. Philomathique*, ser. vii, tome xii, p. 102, 1886-7.

Gray, J E.—Observations on Volutids.—*Ann. Mag. Nat. Hist.*, ser. 4, vol. i, p. 310, 1868.

Pace, S.—Voluta musica.—*Proc. Malacol. Soc.*, vol. v.

Perrier, R.—Le rein des Gasteropodes Prosobranches.—*Ann. Sci. Nat Zool.*, 1890.

Pilsbry-Tryon.—Manual of Conchology.

Woodward, M. F.—Anatomy of Voluta, etc.—*Proc. Malacol. Soc.*, iv, 1900.

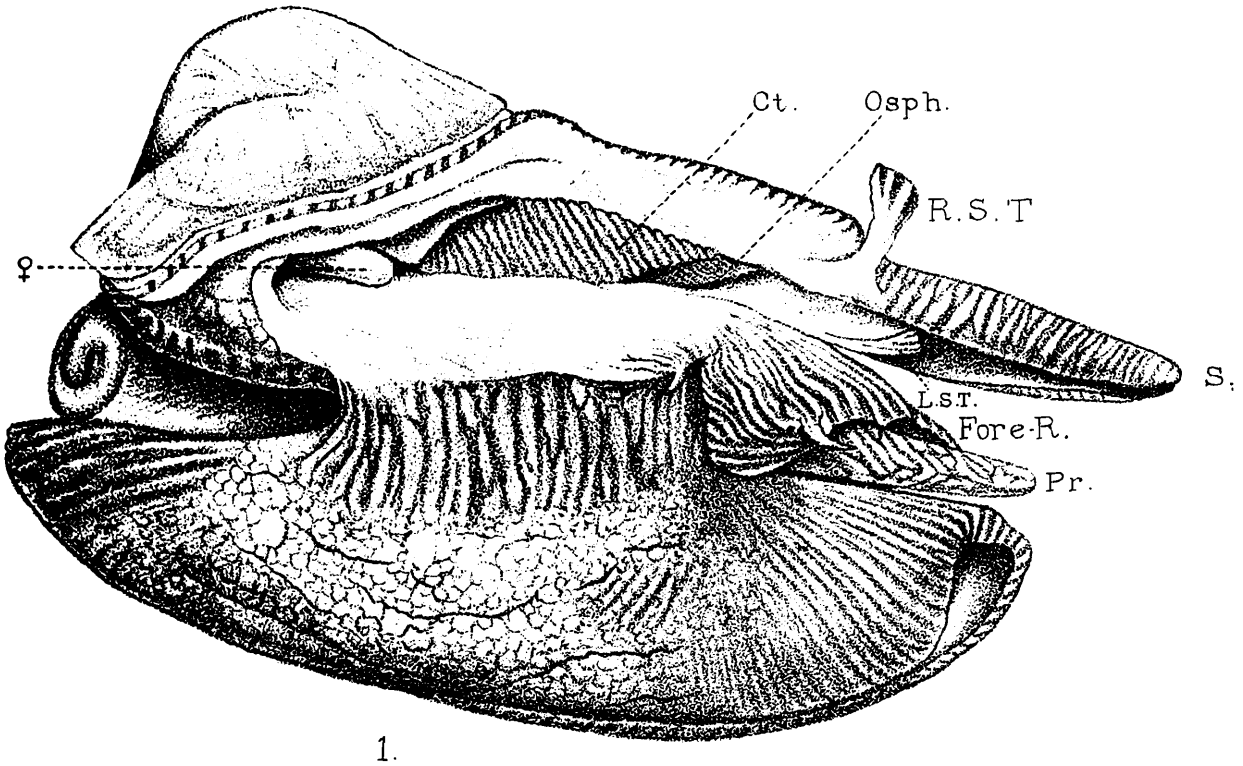
EXPLANATION OF PLATE XXVIII.

MELO INDICUS.

FIG. 1.—The animal after removal of shell, from the right side.

,, 2.—The same, from the front.

Ct., Ctenidium; Osph., Osphradium; R. S. T., Right siphonal tentacle; L. S. T., Left siphonal tentacle; S., Siphon; Fore-R., Fore-roof; Pr., Proboscis; Gr., Groove in anterior edge of foot; t., Cephalic tentacle (on fore-roof); e., Eye.



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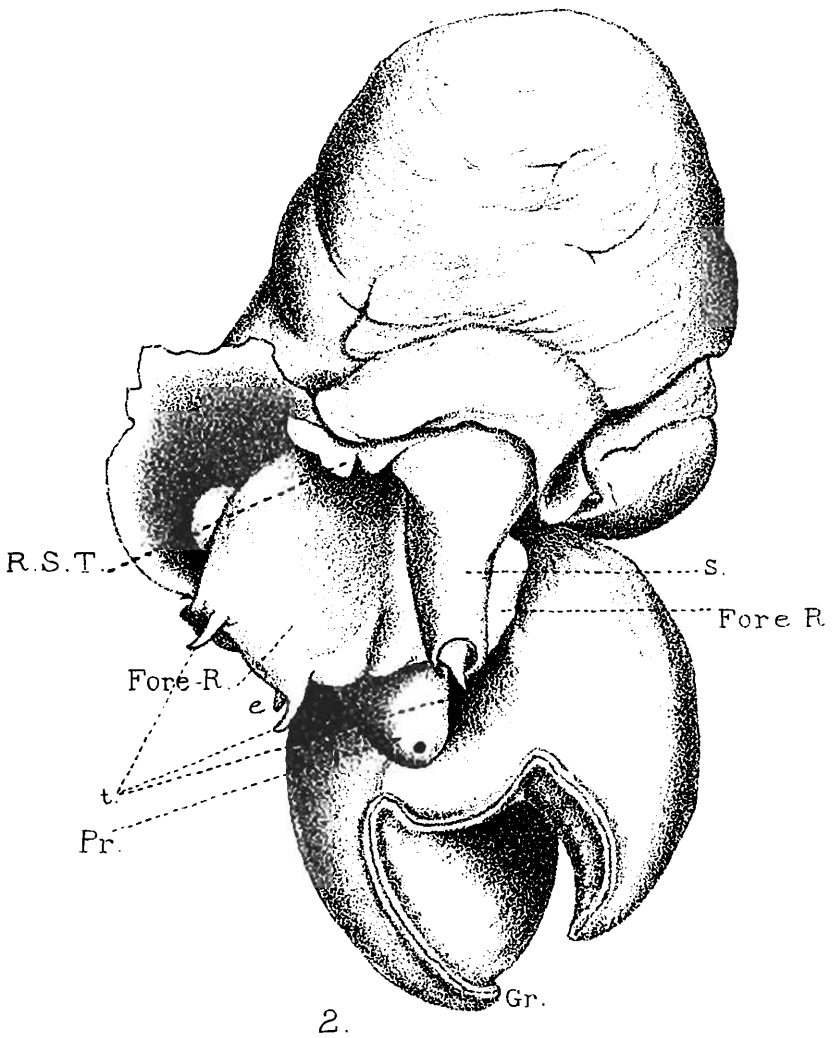

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H.J. Fleure, del. A.C. Chowdhary, Lith.

ANATOMY OF MELO INDICUS.

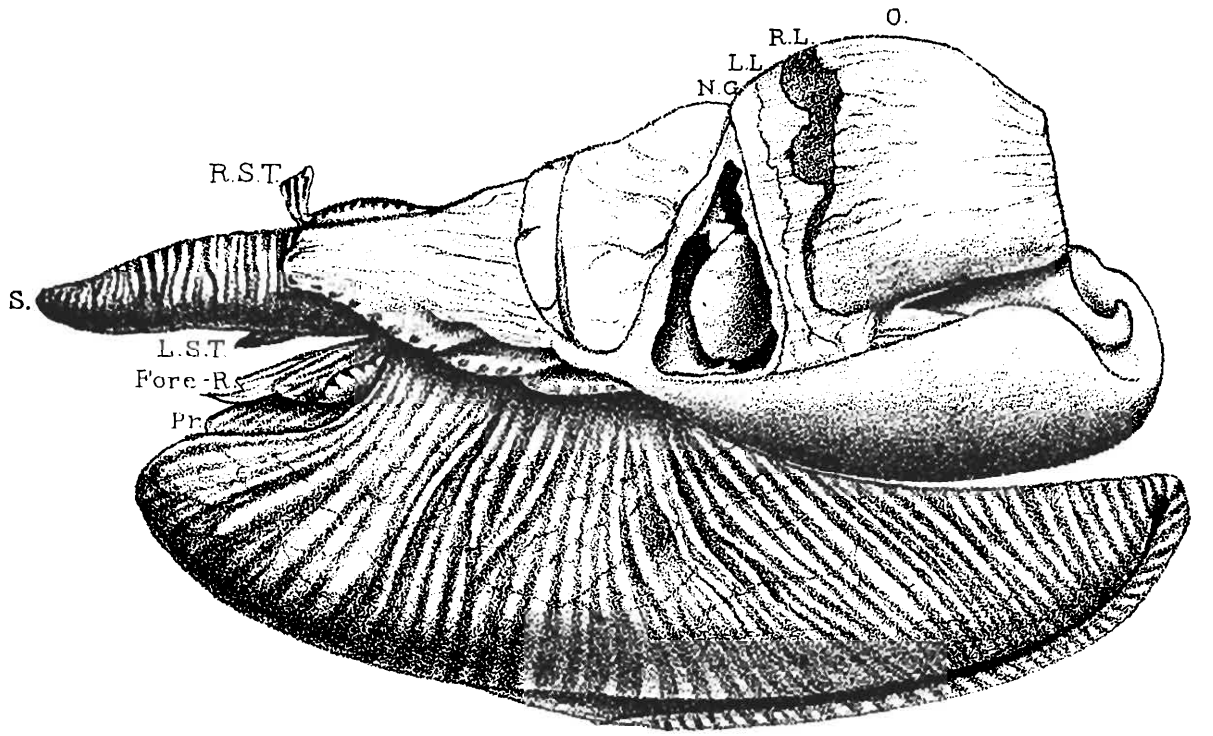
EXPLANATION OF PLATE XXIX.

MELO INDICUS.

FIG. 3.—The animal after removal of shell, from the left side. The pericardial roof has been removed.

,, 4.—The same, from the right side. The branchial roof has been cut and turned back.

Ct., Ctenidium; Osph., Osphradium; R. S. T., Right siphonal tentacle; L. S. T., Left siphonal tentacle; S., Siphon; Fore-R., Fore-roof; Pr., Proboscis; t., Cephalic tentacle (on fore-roof); e., Eye; O., Ovarian tubules; R. L., Right lobe (or posterior lobe) of renal organ; L. L., Left lobe (or anterior lobe) of renal organ; M. Gl., Mucus gland in branchial roof; U., Excretory aperture; A., Anus; ♀., Oviduct, in branchial cavity.



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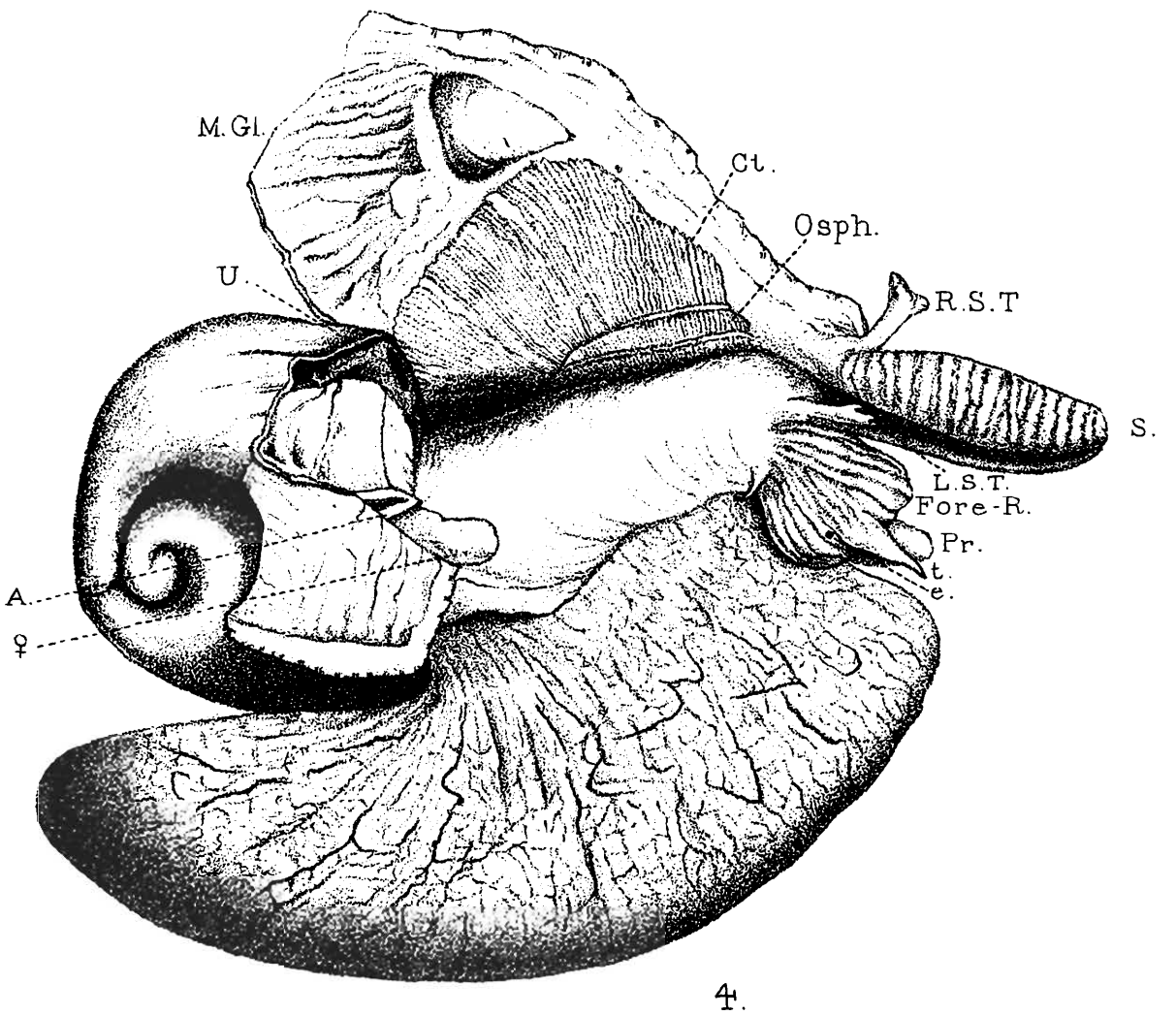

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H.J. Fleure, del A.C. Chowdhary, Lith.

ANATOMY OF MELO INDICUS

EXPLANATION OF PLATE XXX.

MELO INDICUS.

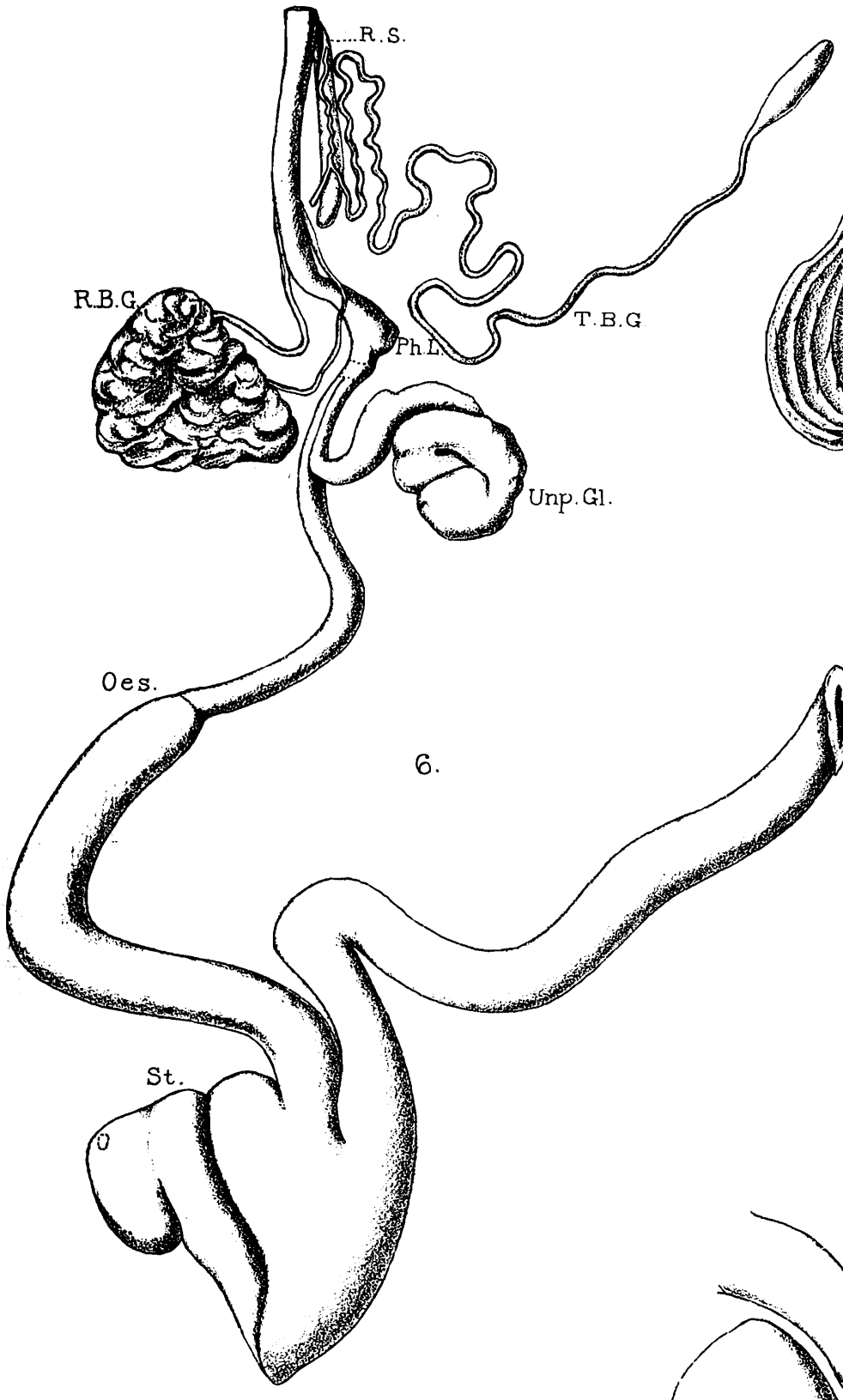
FIG. 5.—A longitudinal section through the proboscis, etc. in a state of complete retraction.

,, 6.—The alimentary canal.

,, 7.—The stomach region showing the openings from the digestive gland.

,, *7a*.—The oesophagus and stomach opened, to show the longitudinal ribbing of the wall.

Ph. L., Expansion of oesophagus called by French authors "Pharynx de Leiblein"; R. S., Radular sac (turned to show ventral surface); R. B. G., Ordinary or racemose buccal glands; T. B. G., Tubular buccal glands; Unp. Gl., Unpaired gland of oesophagus; Oes., Oesophagus; St., Stomach; Int., Intestine.



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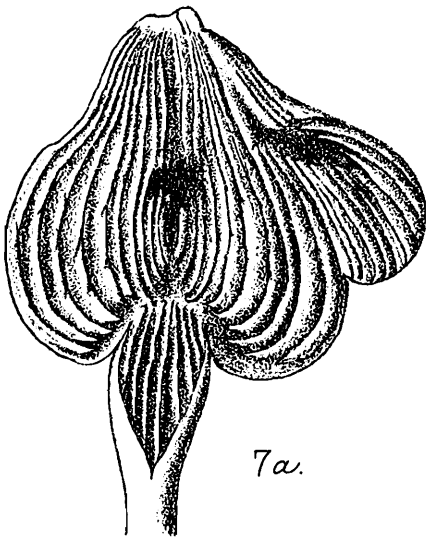

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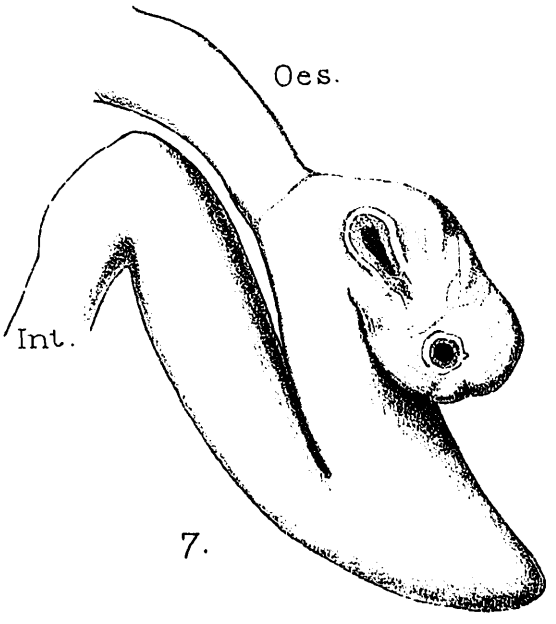

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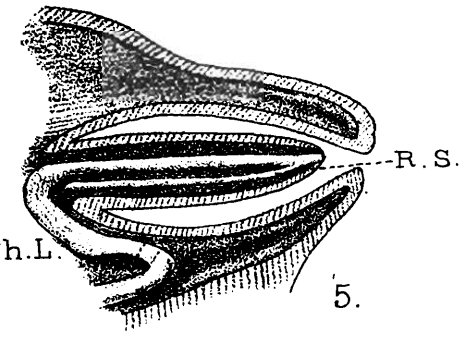

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H.J. Fleure, del. A.C. Chowdhary, lith.

ANATOMY OF MELO INDICUS.

EXPLANATION OF PLATE XXXI.

MELO INDICUS.

FIG. 8.—The pericardium.

,, 9.—The aortae and their chief branches.

,, 10.—The renal organ as seen at the side of the pericardium before opening.

,, 11.—An imaginary section through the renal cavity about the level of R. L. (Fig. 12).

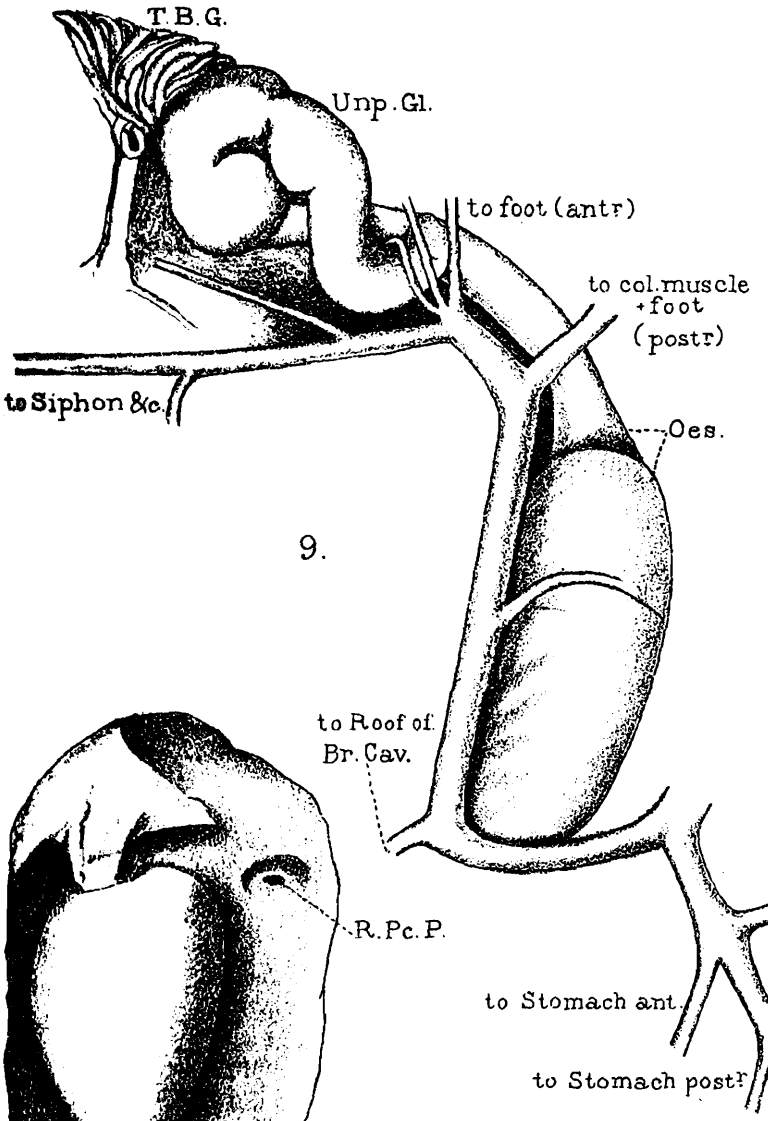
,, 12.—The renal cavity after removal of the roof.

,, 13.—The renal cavity looking up towards the roof

,, 14.—The left lobe of the renal organ seen from the side.

,, 15.—The spongy structure of the greater part of the right lobe of the renal organ

R. Pc. P., Pericardial opening of renopericardial canal; T. B. G., Tubular buccal glands; Unp. Gl., Unpaired gland of oesophagus; Oes., Oesophagus; R. L., Right lobe (or posterior lobe) of renal organ; L. L., Left lobe (or anterior lobe) of renal organ; N. G., Nephridial gland; U. L., Lip of excretory aperture; Rn. P. P., Renal opening of renopericardial canal.



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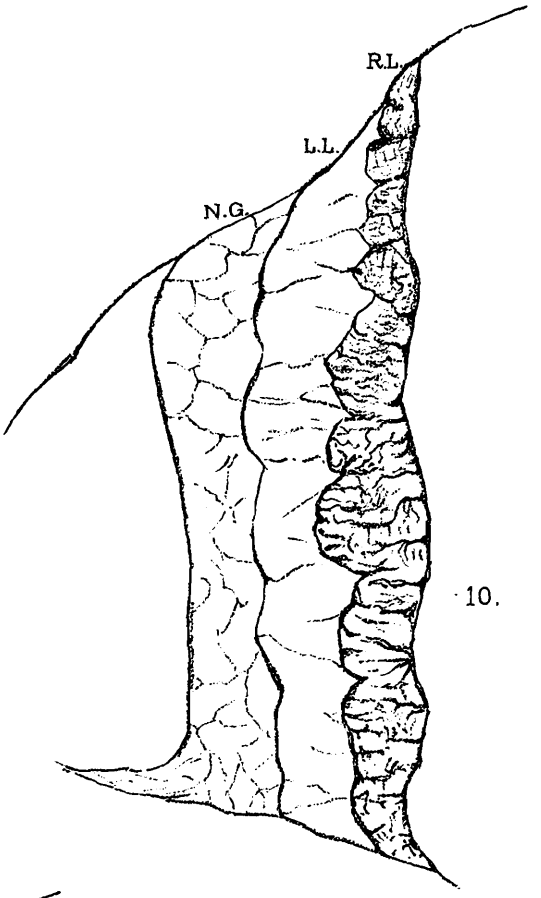

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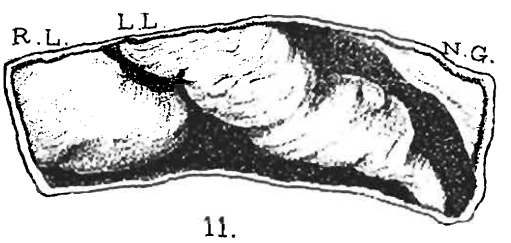

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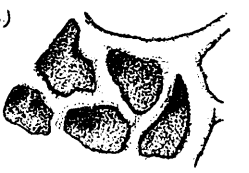

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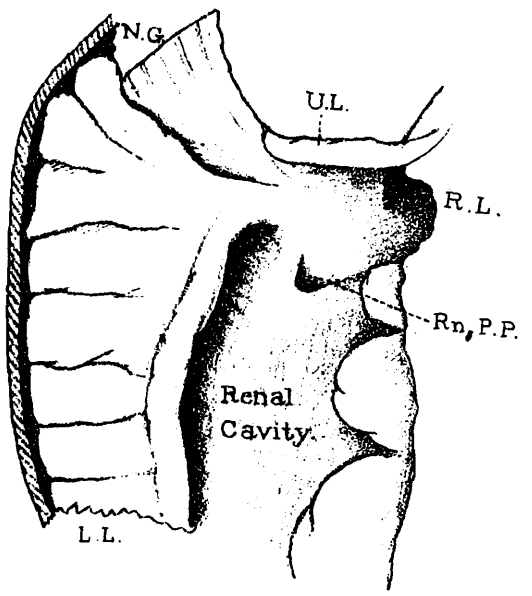

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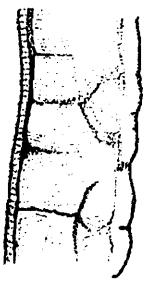

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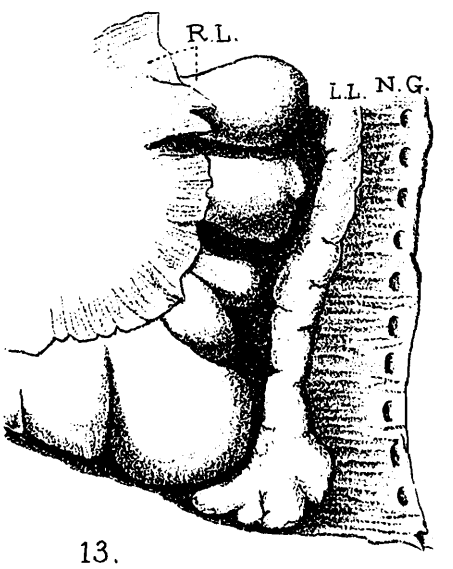


13.

H.J. Fleure, del. A.C. Chowdhary, lith.

ANATOMY OF MELO INDICUS.

EXPLANATION OF PLATE XXXII.

MELO INDICUS.

FIG. 16.—The principal blood channels in the neighbourhood of the renal organ.

,, 17.—The female reproductive system.

,, 18.—A section through the expanded portion of the oviduct showing the canal and chamber.

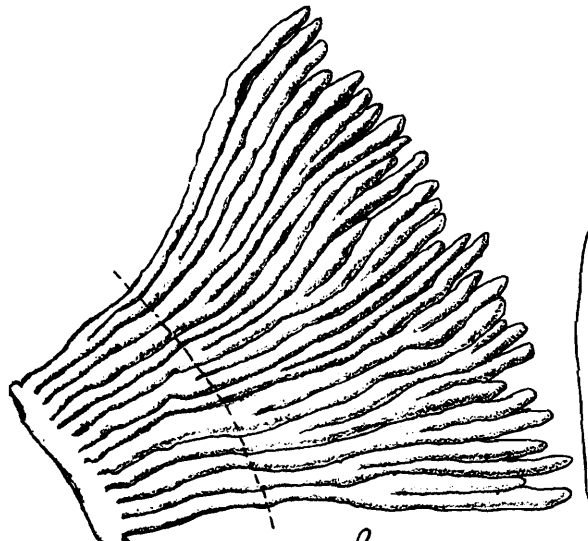
,, 19.—View of the same to show the folds, the projection on the left side of the diagram in fig. 18 being turned back.

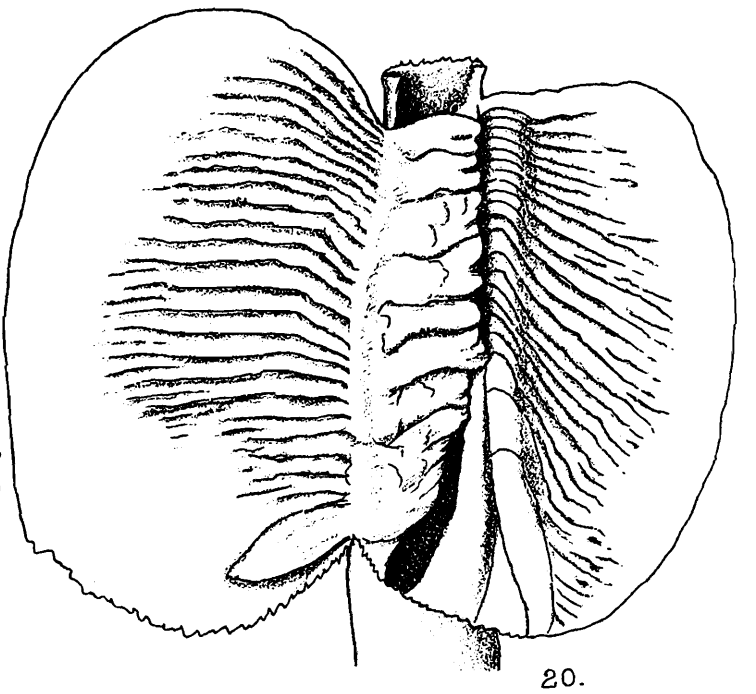
,, 20.—The chamber of the oviduct opened along its anterior edge, the roof is turned back and the canal is shown.

,, 21.—General diagram of the nervous system.

,, 22.—The relations of the subintestinal ganglion, etc.

R. L. V., Blood channel to right lobe of renal organ; Ant. V., Blood channel from general anterior cavity to the renal organ; N. G. V., Blood channel to nephridial gland; L. L. V., Blood channel to the left lobe of renal organ; A. Abd. S., Anterior abdominal or visceral sinus; Alb., Albumen gland; O., Ovarian tubules; Buc., Buccal connectives; R. Pl. G., Right pleural ganglion; Sp. Int. G., Supra-intestinal ganglion; R. par., Right parietal nerve (from right pleural ganglion *via* subintestinal ganglion; V. L. Sp., V. L. Sb., Supra and subintestinal portions of visceral loop; V., Principal visceral ganglion; Vl, Accessory visceral ganglion; Ped., Pedal ganglion; Zy., Zygoneurous connection.





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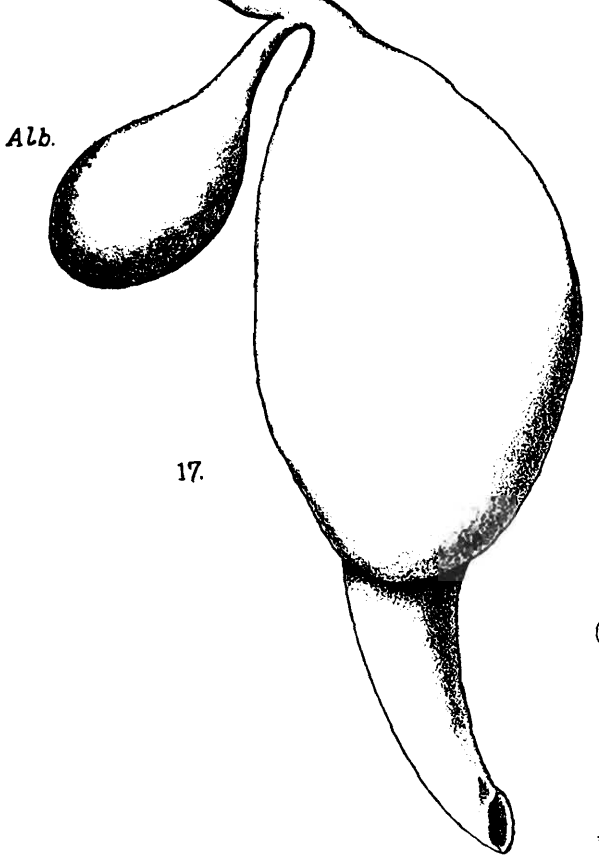

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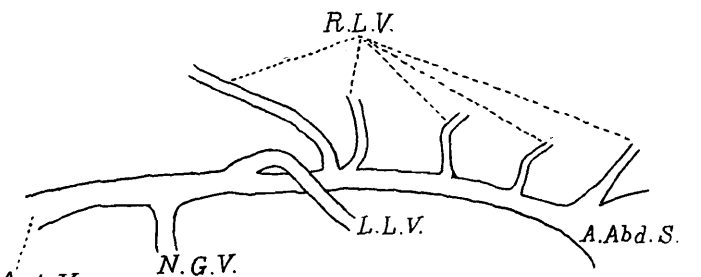

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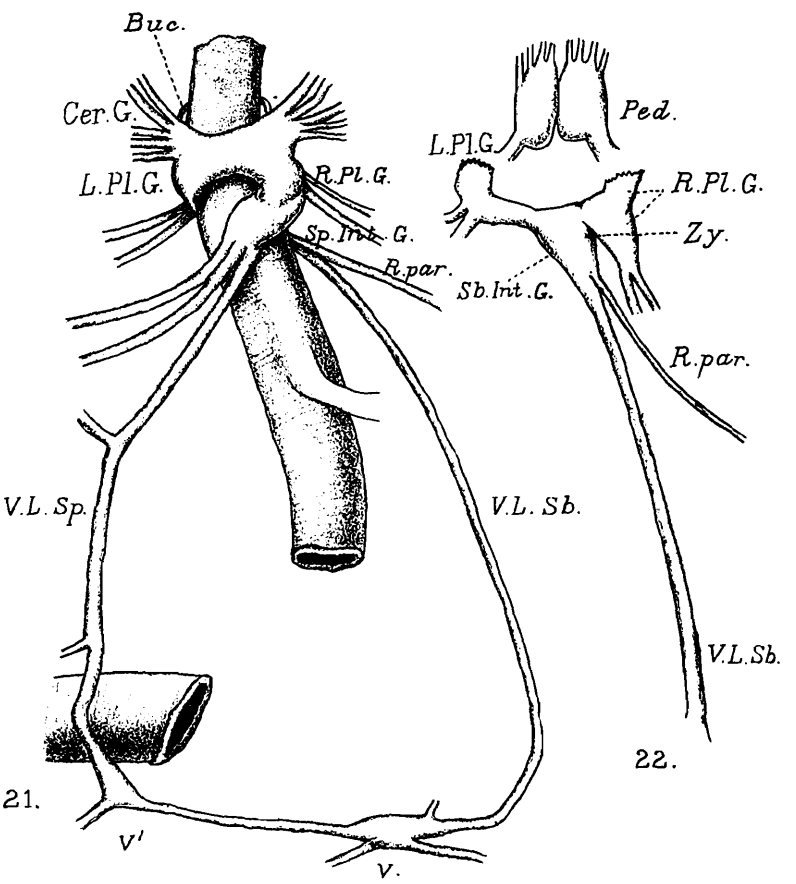

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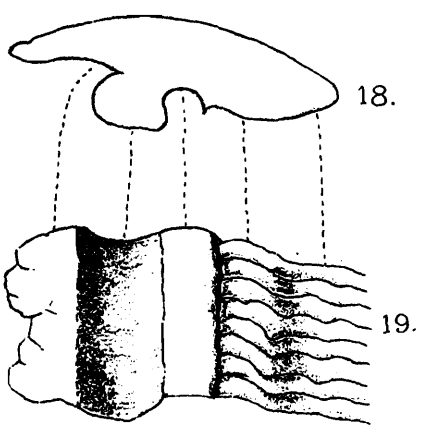

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19.

ANATOMY OF MELO INDICUS.

XXXIII. TWO NEW SPECIES OF SCOLOPENDRIDAE.

By F. H. GRAVELY, *M.Sc.*, *Assistant Superintendent, Indian Museum.*

The Indian Museum collection of Scolopendridae has increased very rapidly since it was catalogued after being examined by Dr. Kraepelin two years ago (Rec. Ind. Mus., v, 1910, pp. 161-166). In spite of this, very few additional species have been added to it, and the new locality records for the most part only seem to show that our knowledge of the distribution of such species as are easily obtained is already complete. Such records as extend the known range of any species all happen to refer to species obtained by Mr. Kemp during the Abor Expedition, and have been incorporated in the special report on the zoological results of that expedition (Rec. Ind. Mus., vol. viii). Two out of the four undescribed species added to our collection since it was returned to us by Dr. Kraepelin were also obtained in the Abor Country, and have been described in the same report. In the present paper the two remaining species and one subspecies are dealt with.

Subfamily *OTOSTIGMINAE.*

Genus **Rhysida.**

R. ceylonicus, n. sp.

A single specimen was found under a stone in damp mud in the jungle on the hill above the experiment station at Peradeniya, Ceylon, at an altitude of about 2000 feet. Before it was finally caught it escaped into a small stream down which it swam with lateral undulating movements of the body, diving under the water to hide beneath stones that were partially immersed. This is the only centipede I have seen under such conditions, but whether or not it is normally amphibious I am unable to say.

Description.—Length (excluding appendages) 57 mm. Antennae 20-jointed, all the joints longer than broad, the distal ones from two to four times longer, the first two smooth and hairless throughout, the third with a ventral pilose patch distally, the rest pilose throughout. Dorsal surface somewhat slate-coloured, segments 4-19 with a pair of very short longitudinal grooves close to the posterior margin; no segments grooved more extensively than this except marginally; more or less complete marginal grooves present from about the sixth or eighth segment, those on

the posterior segments being better developed than those further forwards; strong marginal ridges present on the twenty-first segment only. Ventral surface paler than dorsal. Sternocoxal plate armed on each side with five teeth of which the three innermost are very close together, the fourth distinctly separated from the third, and the fifth somewhat more distant from the fourth, behind these teeth the defining lines meet in an angle of about 120°; sterna of body segments not grooved except the last of them which is vaguely grooved behind in the middle line; this last sternum is nearly as broad in front as it is long, narrower behind, with its posterior margin very broadly V-shaped, forming a distinct right angle with the oblique lateral margins on each side. Pseudopleural processes bluntly conical, with a pair of terminal teeth, without dorsal teeth, and with a minute side tooth on one side only in my one specimen. First pair of legs armed with 1 (ventral) claw spur and 1 (anterior) tarsal spur; second, third and fourth pair with 1 (anterior) tibial spur, 2 tarsal and 2 claw spurs, fifth to eighteen pairs with 2 tarsal and 2 claw spurs, nineteenth with 1 tarsal and 2 claw spurs, twentieth with 2 claw spurs only; anal legs also with 2 claw spurs only, femora armed only with a single minute tooth on the (outer ?) side.

This species is very near *R. brasiliensis*, Kraepelin, but differs in that the grooves behind the teeth of the sternocoxal plate meet not in a straight line but in an angle of about 120°.

Subfamily *SCOLOPENDRINAE.*

Genus **Pseudocryptops,** Poc.

Members of this genus, which has hitherto been recorded only from Perim Island, can be recognized at sight by their short stumpy antennae and enormously thick anal legs.

P. agharkari, n. sp.

This sluggish little centipede is not uncommon under stones in jungle at Taloshi and Helvak in the Koyna Valley of the W Ghats, Satara Dist., Bombay Presidency, at an altitude about 2000 feet.

Description.—Length up to 29 mm. Antennae 17-18-jointed. Colour dark reddish purple in life, various paler shades of greyish or brownish tints in spirit. Head rounded in front, more or less broadly grooved in the middle line in front, not produced. First segment vaguely grooved in the middle line, segments 2-4 usually with more or less incomplete, 5-20 with complete and very strongly marked pair of longitudinal grooves, but without marginal grooves or ridges; anal segment very short, grooved in the middle line, marginal ridges present, posterior margin convex. Sternocoxal plate armed with three teeth on each side of the middle line which is strongly grooved. Sterna of segments 2-20 marked

throughout with a pair of longitudinal grooves; sternum of anal segment almost semi-circular in outline, vaguely grooved in the middle. Femur of poison-jaws armed with a distinct tooth. All legs armed with a pair of claw-spurs except the anal legs which are entirely unarmed. This species differs from *P. walkeri*, the only species previously described, in the shape of the head. The antennae too are usually as long as the head and first segment together, but this depends purely on the extent to which they are expanded or contracted at the time of death. Specimens with contracted antennae usually have the back of the head drawn under the margin of the tergum of the first segment, whereas the others do not.

P. agharkari subsp. **singhbhumensis,** nov.

This subspecies occurs under stones in jungle on the hills near Chakardharpur in the Singhbhum district of Chota Nagpur, but is far from common there. It differs from the Koyna Valley form in colour only, being grey with a dark line down the middle of the back between the longitudinal grooves in life, and blue (ultimately brown ?) still with a dark middle line, in spirit.