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The Copepoda of Indian Seas

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By

R. P. SEYMOUR-SWELL, Vol. I, Part 1, No. 1, 1911
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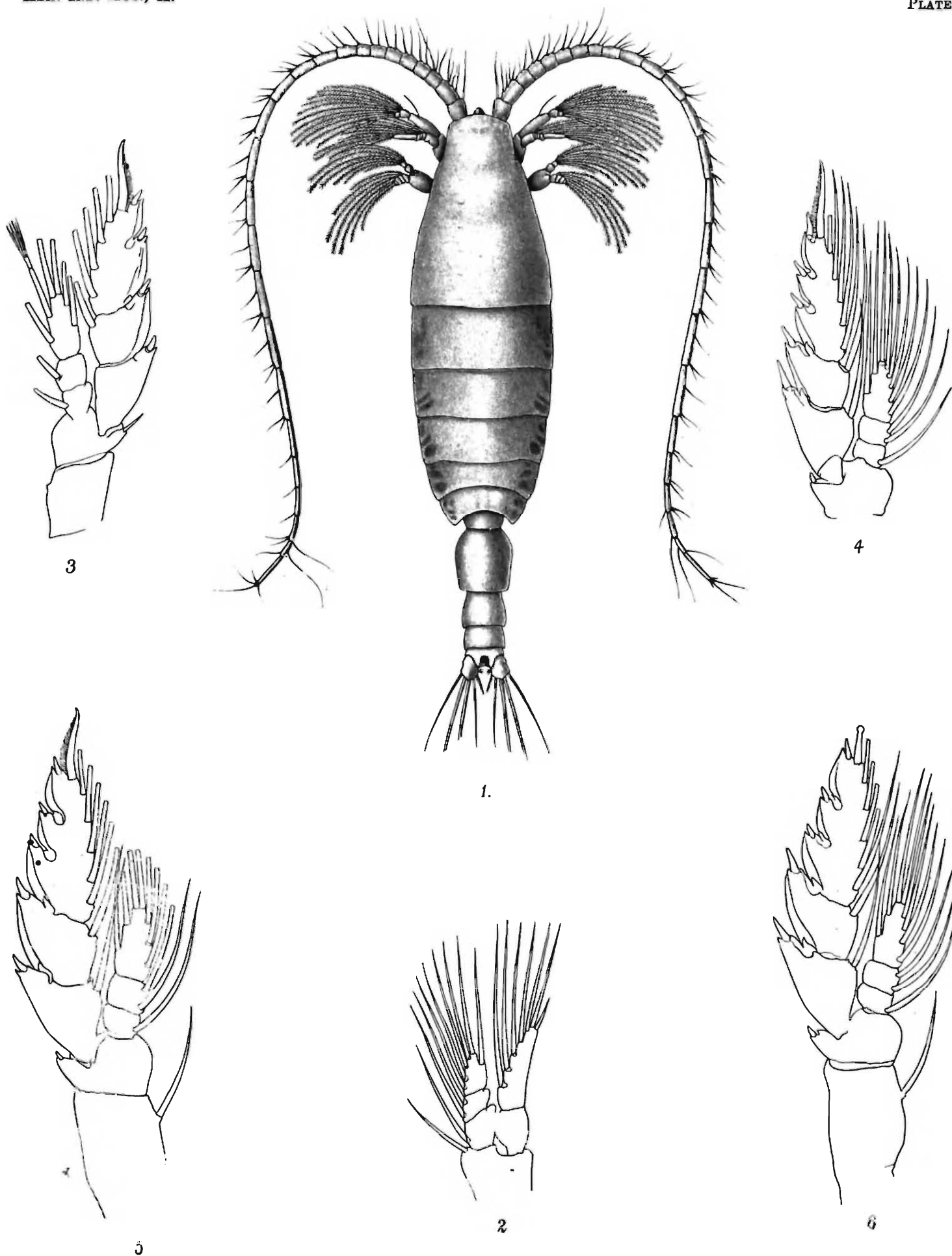
10, GEMBLER STREET

The six plates accompanying this paper were prepared and printed off several years ago. Four of them were to illustrate the "Zoology of the R. I. M. S. Investigator," but owing to the war and financial stringency they were never published. Plates I, II refer to species which were dealt with in the previous part of this report.

EXPLANATION OF PLATE I.

Bathycalanus richardi Sars.

- FIG. 1.—The whole animal from the dorsal side, female.
,, 2.—The 1st swimming leg.
,, 3.—The 2nd swimming leg.
,, 4.—The 3rd swimming leg.
,, 5.—The 4th swimming leg.
,, 6.—The 5th swimming leg.



EXPLANATION OF PLATE II.

Butkycalanus richardi Sara.

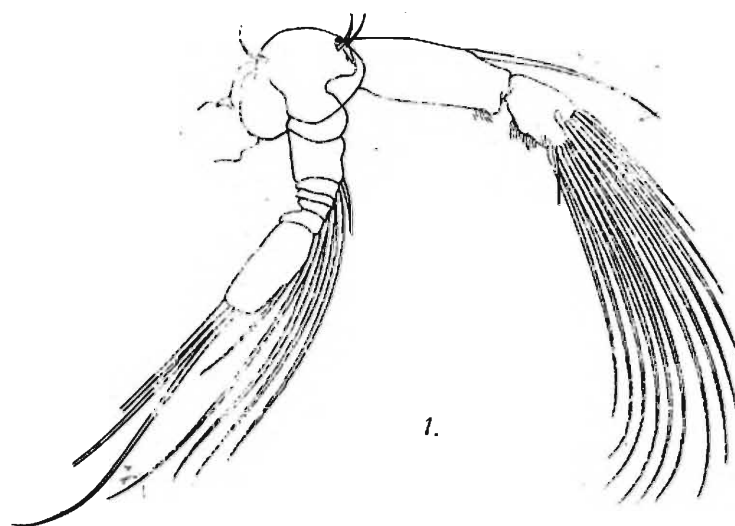
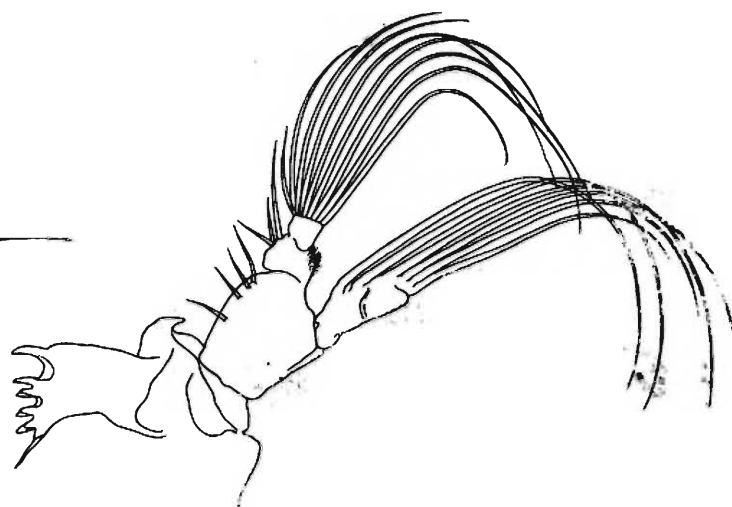
FIG. 1.—The 2nd antenna.

„ 2.—The mandible.

„ 3.—The 1st maxilla.

„ 4.—The 2nd maxilla.

„ 5.—The maxilliped.

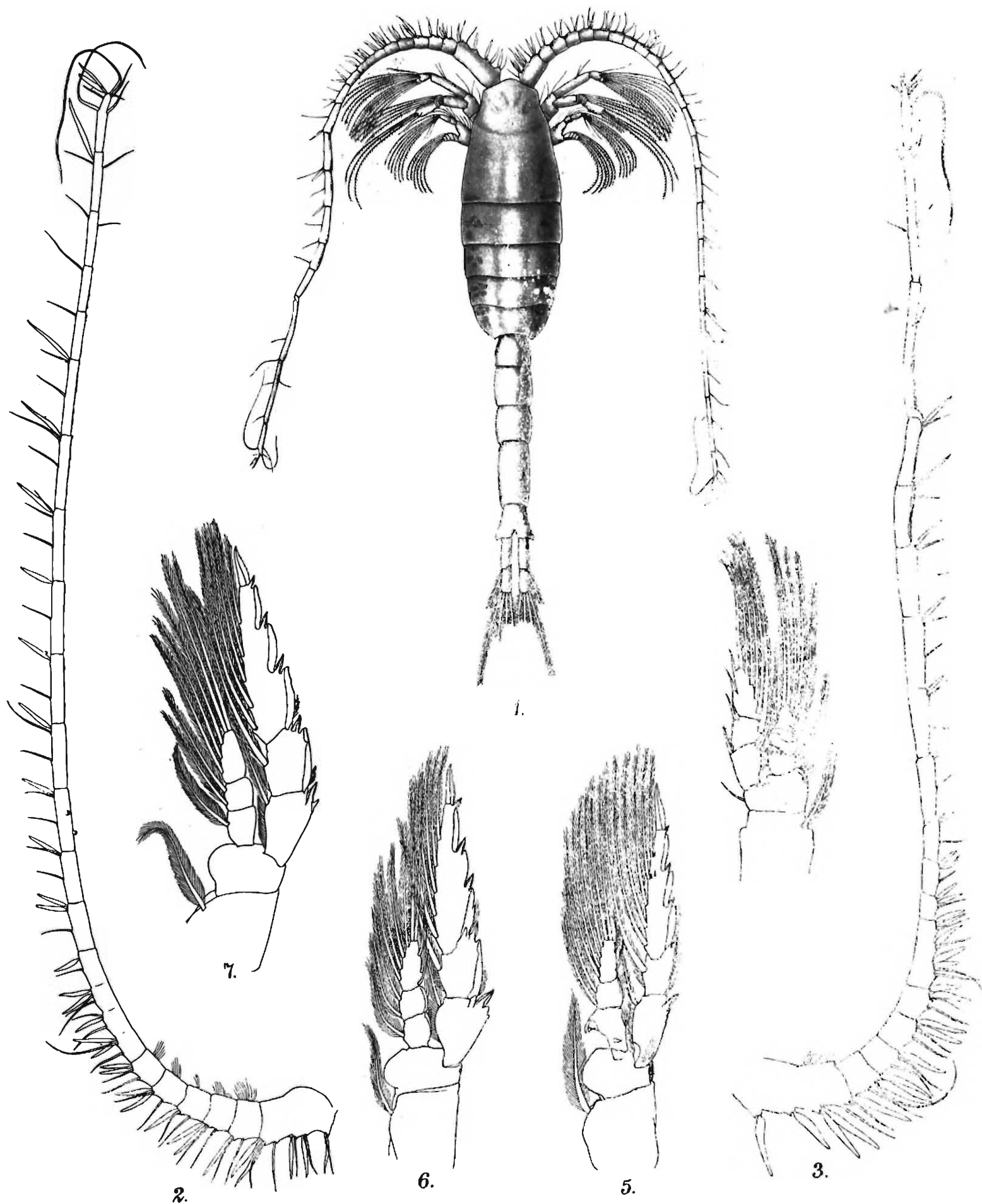


EXPLANATION OF PLATE III.

Metridia princeps Giesbrecht.

FIG. 1.—Adult male from the dorsal side.

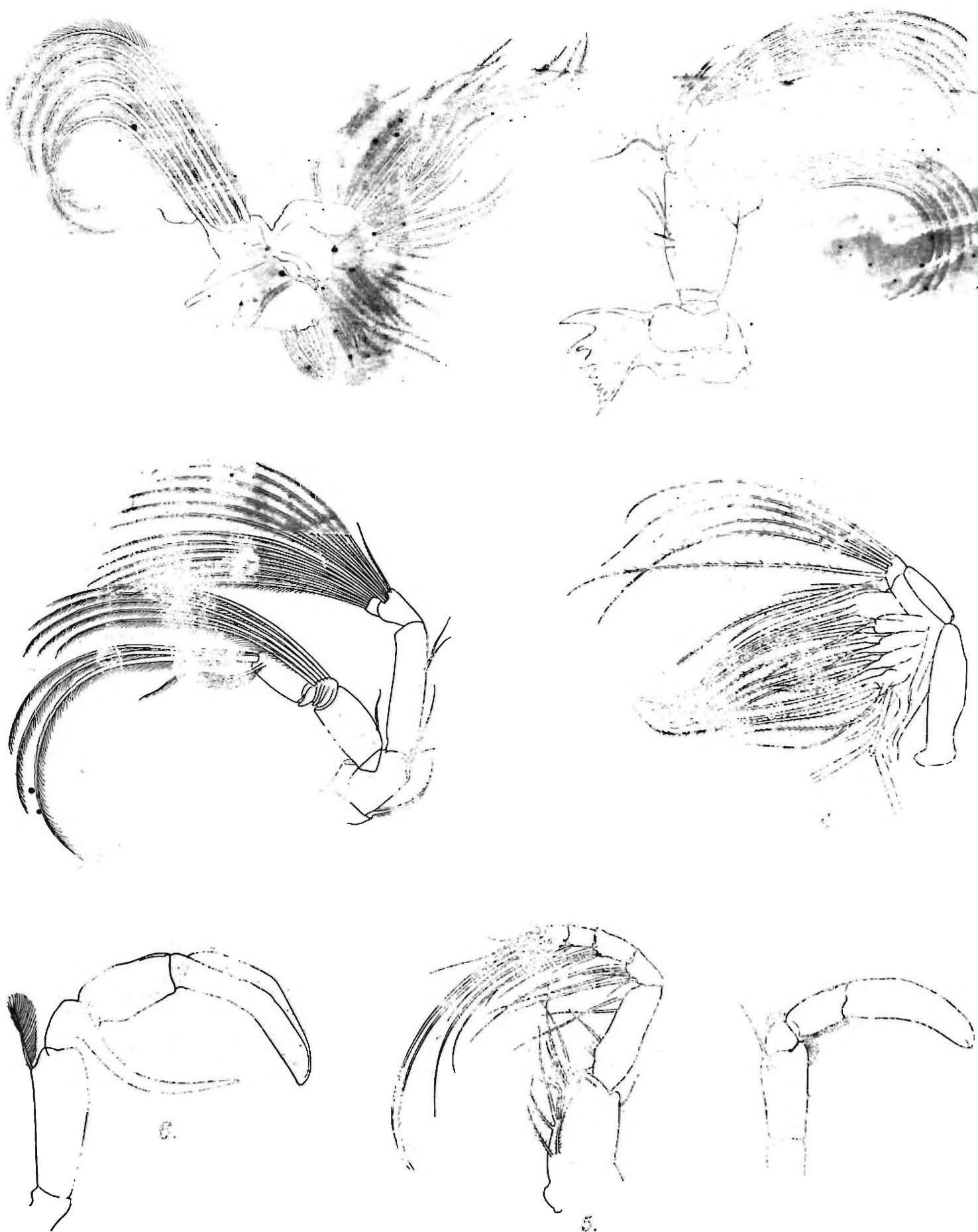
- „ 2.—The left 1st antenna.
- „ 3.—The right 1st antenna.
- „ 4.—The 1st swimming leg.
- „ 5.—The 2nd swimming leg.
- „ 6.—The 3rd swimming leg.
- „ 7.—The 4th swimming leg.



EXPLANATION OF PLATE IV.

Metridia princeps Giesbrecht.

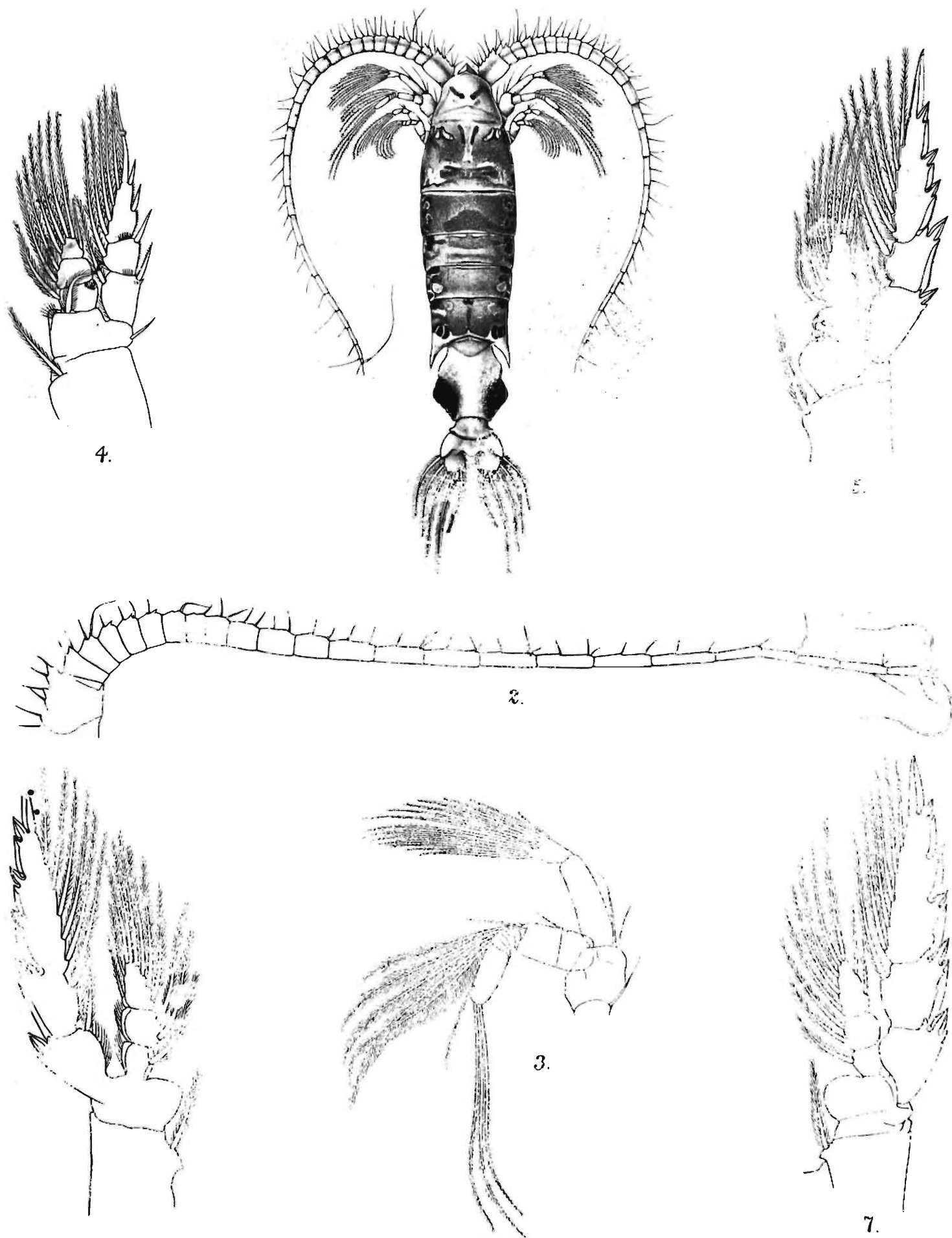
- Fig. 1.—The 2nd antenna.
„ 2.—The mandible.
„ 3.—The 1st maxilla.
„ 4.—The 2nd maxilla.
„ 5.—The maxilliped.
„ 6.—The left 5th leg in the male.
„ 7.—The right 5th leg in the male.



EXPLANATION OF PLATE V.

Gaussia princeps (T. Scott).

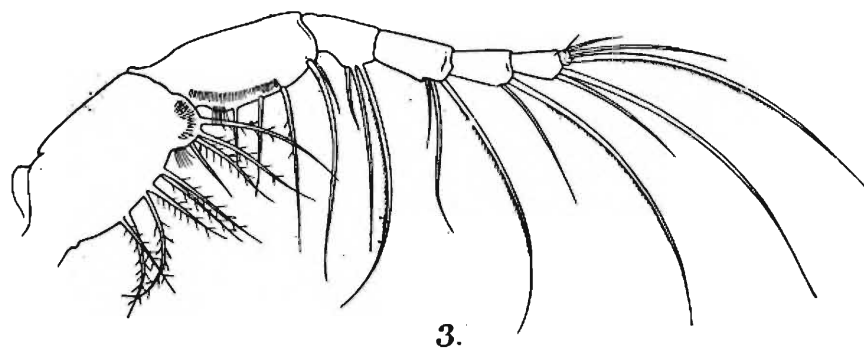
- FIG. 1.—The whole animal from the dorsal side, female.
„ 2.—The 1st antenna.
„ 3.—The 2nd antenna.
„ 4.—The 1st swimming leg.
„ 5.—The 2nd swimming leg.
„ 6.—The 3rd swimming leg.
„ 7.—The 4th swimming leg.



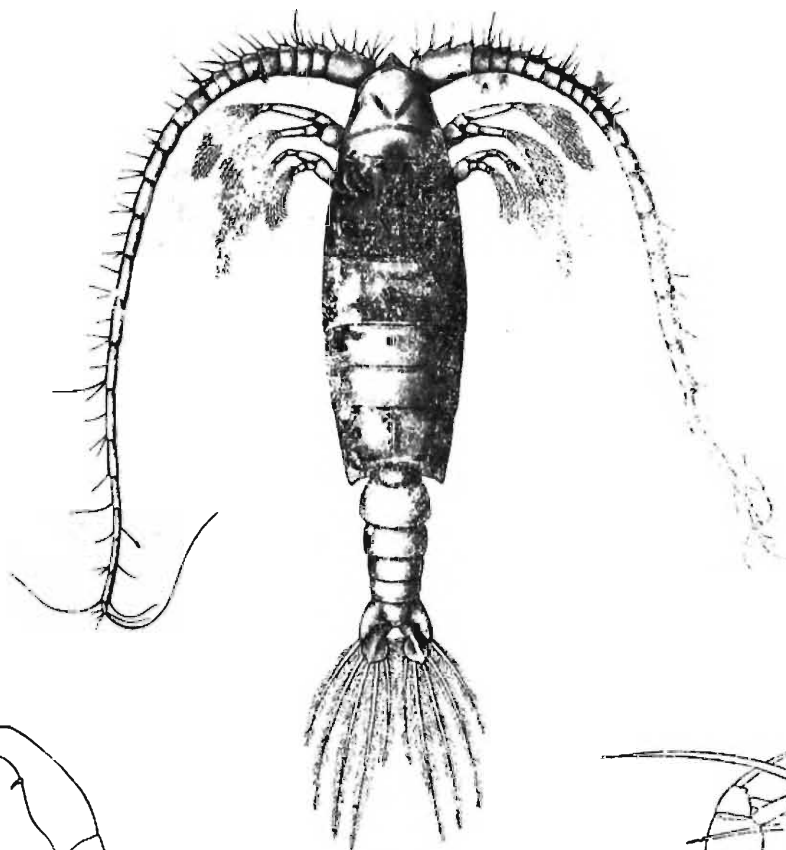
EXPLANATION OF PLATE VI.

Gaussia princeps (T. Scott).

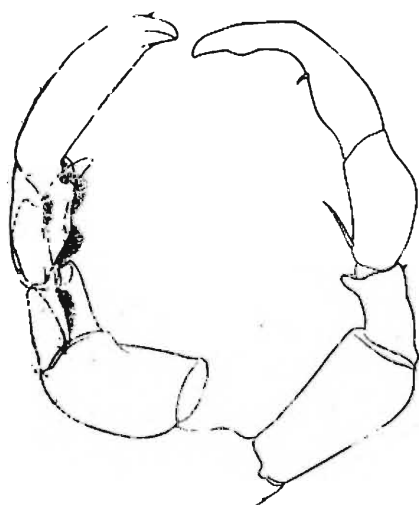
- FIG. 1.—The male ~~from~~ the dorsal side.
,, 2.—The right 1st antenna of the male.
,, 3.—The maxilliped.
,, 4.—The 5th pair of legs, male.
,, 5.—The 5th pair of legs, female.



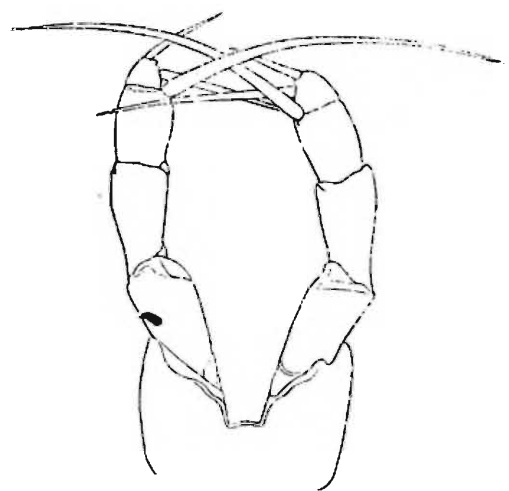
3.



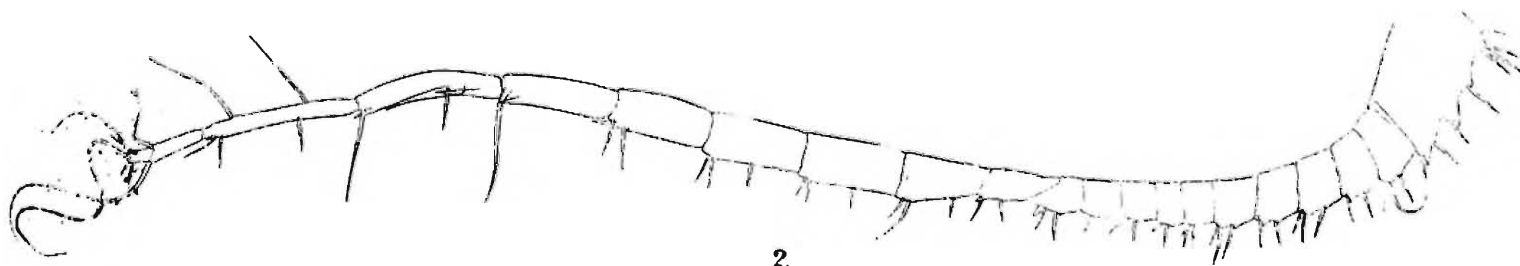
1.



4.



5.



2.

THE COPEPODA OF INDIAN SEAS.

CALANOIDA.

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INTRODUCTION.

In the following paper I have given an account of the Marine Copepoda in the Crustacea collection of the Zoological Survey of India. The bulk of these collections have been made by me personally, while serving as Surgeon-Naturalist to the Marine Survey of India during the years 1910 to 1925 inclusive.

Up to the present time our knowledge of the Copepoda of Indian waters has for the most part been limited to those species that frequent the surface of the ocean and is included in the following papers :—

1. W. Giesbrecht (1896). Collections from the Red Sea.
2. I. C. Thompson (1900). Collections from (a) the East Coast of Africa to Ceylon and the head of the Bay of Bengal and (b) Durban, Africa, up the east coast of Africa and through the Red Sea to the Suez Canal.
3. P. T. Cleve (1901). Along the route from Aden to Java, in the Malay Archipelago and across the Indian Ocean from 45 S. ; 22 E. to 30 S. ; 91 E., and thence to 2 N. ; 94 E.
4. A. Scott (1902). From Suez to Colombo, Ceylon.
5. I. C. Thompson and A. Scott (1903). From Port Said to Colombo and round the Pearl Banks of Ceylon.
6. P. T. Cleve (1904). From the Red Sea, through the Gulf of Aden and across the Arabian Sea.
7. P. T. Cleve (1904a). From the east coast of Africa and the Agullas Current.
8. R. N. Wolfenden (1906). From the Maldivé Archipelago.
9. G. P. Farran (1911 and 1913). Collections from Christmas Island in the Indian Ocean.
10. O. Pesta (1912). From the neighbourhood of Muscat and Bushire in the Persian Gulf.
11. O. Pesta (1913). From the Arabian Sea.
12. R. B. S. Sewell (1912). From the coastal region of the Bay of Bengal.
13. R. B. S. Sewell (1913). From the coastal region of the Bay of Bengal and the mid-water region of the Bay.
14. G. S. Brady (1914-1915). From Durban Bay.
15. R. B. S. Sewell (1914). From the Ceylon Pearl Banks.
16. R. B. S. Sewell (1919-1924). From the Chilka Lake.
17. R. Gurney (1927). From the Suez Canal.

In addition to the above accounts dealing with the Indian Ocean we have the following accounts of the copepodid fauna of the Malayan region, that lies between the Indian and Pacific Oceans :—

1. J. Carl (1907). From the Bay of Amboina.
2. A. Scott (1909). The “ Siboga ” collection from the Malay Archipelago.
3. F. Früchtl (1924). From the Aru Archipelago.

Finally we have the accounts by Wolfenden (1911) and Brady (1910) of the collections made by the “ Gauss ”, which include a number of samples taken in the southern part of the Indian Ocean and the neighbouring Antarctic seas.

The greater part of the collections in the Indian Museum have been made in Indian waters by the R. I. M. S. “ Investigator ” and of these the larger part has been taken in the surface or upper levels or are from weed-washings. As regards the collection of the surface-haunting forms it was the custom during the period 1910 to 1925, in which I was the Surgeon-Naturalist to the Marine Survey of India, for the “ Investigator ” while on the survey ground to be anchored for the night and on most nights a tow-net, of the usual type and having a circular mouth with a diameter of three feet, with the net itself composed of some fine-meshed material, was put over the side at 6 P.M. and the tide drifting through it swept into it a varied collection of organisms. The net was hauled in at 6 A.M. and the catch carefully preserved. The amount of material thus collected varied of course with the strength of the tide, but in most cases a very abundant catch was obtained. In this way I was able to obtain large collections from the coastal region of south Burma, including the Mergui Archipelago, the Andaman and Nicobar Islands, the west coast of India and the Maldivé Archipelago. In 1911 the “ Investigator ” began the investigation of the mid-water region but owing to the outbreak of war in 1914 this line of investigation was interrupted almost at its commencement. Up to the present time the following mid-water trawls have been carried out in the regions and at the depths given :—

Station.	Date.	POSITION.						Total depth. fms.	Depth of net. fms.		
		Lat. N.			Long. E.						
		°	'	"	°	'	"				
393	21st October 1911	.	.	7	21	06	85	07	15	2,000	400
461	19th April 1912	.	.	10	15	00	90	15	00	1,800	375
462	20th April 1912	.	.	9	08	00	87	25	00	..	475
463	21st April 1912	.	.	7	37	00	84	19	00	..	400
670	23rd April 1924	.	.	5	56	00	76	22	00	..	200
682	28th April 1925	.	.	10	26	00	74	32	30	1,249	700

In each case the net used was 6-foot square at the mouth and was composed of ‘ mosquito ’ netting ; the net was lowered to the required depth and was towed at that depth, so far as could be judged, for a period of 1 to 2 hours, at the close of which time it was hauled to the surface. As the net was not a self-closing one it fished all the way to the surface from the depth at which it was towed, but, as Farran (1926, p. 220) points out in the case of similar tow nettings made by H. M. S. “ Research ” in the Bay of Biscay in 1900, the catch made by the net while being hauled in is so small that it will not appreciably affect the total

catch ; occasional specimens will be taken from the higher levels, but the bulk of the catch must have come from the depth at which the net was towed.

It will be clear from the above that although our knowledge of the mid-water forms is still in its infancy, nevertheless a sufficient amount of investigation has now been carried out to enable us to form some conception of the variety and distribution of the copepodid fauna of Indian waters.

In the following account I have under each genus given a list of those species that have been recorded by previous workers in the different parts of the Indian Ocean, including those found in the Malay Archipelago ; although a number of these have not as yet been obtained in Indian waters there is little doubt that with further collections and observations their known distribution will be extended to this area. As Wolfenden (1906, p. 990) has pointed out, Dahl (1894) states that the Copepoda of the deeper levels are completely or nearly completely alike in all the three great Oceans, Atlantic, Indian and Pacific, but that so far as the surface-living forms are concerned, those occurring in the tropical waters of the Pacific and Indian Oceans are alike, whereas the copepodid fauna of the Atlantic Ocean exhibits a number of species that are not known from the other regions and thus has a character of its own. This difference between the Atlantic and the other oceans is attributed to the geographical connections or otherwise between the areas. Between the Pacific and Indian Oceans there is a free interchange of water through the Malay region and the Straits of Malacca and, especially during the period of the north-east monsoon, there is a strong flow of water from the Pacific Ocean through the Straits of Malacca and the Andaman Sea into the Bay of Bengal and through the various openings in the Sumatra-Java-Borneo chain of islands in the Malay Archipelago into the more southerly part of the Indian Ocean, and it was but to be expected that this free interchange of water between the two Oceans would result in an identity of the fauna. The difference between the copepodid fauna of the Indian Ocean and the Atlantic Ocean is attributed to the meeting of the warm westwardly-flowing currents, the Mosambique and Agulhas currents, and the cold Atlantic current of the west-wind drift off the south coast of Africa, the sudden change of temperature caused by this admixture resulting in the death of many of the Indian Ocean forms. While agreeing with Dahl that the copepodid fauna of the deeper waters is alike in all three oceans and that the surface forms in the Indian and Pacific Oceans are the same, I am doubtful regarding the correctness of the view regarding the differences that seem to exist between the surface and the littoral Copepoda of the Indian and Atlantic Oceans. It must be remembered that although there is a certain degree of intermixture between the warm, westwardly-flowing current with colder water in the region of the Cape of Good Hope, yet an appreciable amount of the warm water is able to pass onwards into the southern region of the Atlantic and this will carry with it a certain number of the warm-water inhabiting species from the Indian Ocean ; there is also at the present time a small but none the less important connection between the Indian and Atlantic Oceans through the Red Sea, the Suez Canal and the Mediterranean Sea, and one must admit the possibility of Indian forms gradually making their way through this somewhat tortuous passage from the one area to the other. A. Scott (1909, p. 3) has pointed out that " unless one can deal with Copepoda that have been collected by similar methods in different areas for some considerable period, it would be pure speculation to attempt to explain the differences that are apparent." The fauna of the

North Atlantic Ocean and its offshoots have been thoroughly investigated for many years past, but, even so, further investigations are continually adding new species to the already lengthy list of those that are known to occur in this region ; in the case of the Indian Ocean we are only at the commencement of our studies and every report adds more and more species to the list of those that are known to inhabit both the Indian and Atlantic Oceans. As Scott (*loc. cit.*, p. 4) remarks, "when we find European Harpacticoida like *Phyllothalestris mysis* and *Rhynchothalestris rufocincta* both present in the Malay Archipelago, one is inclined to regard the apparent absence of true littoral forms from any large area that includes very shallow water with some suspicion". I have previously (1924, p. 776) mentioned that in my opinion a great number of species of Copepoda are cosmopolitan, a wide distribution being the rule rather than the exception, and that supposed differences in the fauna of the oceans is in all probability to be attributed to a lack of knowledge rather than to any very marked difference in the indigenous species. I am becoming more and more convinced that much of the apparent difference between the surface and littoral copepodid fauna of the Indian and Atlantic Oceans is due to our present lack of knowledge regarding the fauna of the Indian region ; certainly the vast majority of the Indian species are to be found inhabiting the Atlantic Ocean and such differences as do occur in the copepodid fauna of the two regions are to be attributed to the occurrence in the Atlantic Ocean of an indigenous fauna that has been evolved in that region and, owing to the total absence of any connecting passages between the tropical or temperate regions of this ocean and the Pacific or Indian Ocean, for as a possible route for the dispersal of planctonic marine organisms the Panama Canal can be ignored, these indigenous forms are completely unable to extend their habitat.

Gran (1902) and Lebour (1916) have shown that in *Calanus finmarchicus* Gunnerus there are six stages in the post-naupliar life-history, sexual maturity being attained only in the final or sixth stage. With (1915) has also described in some detail the copepodid stages of a number of species ; and all three authors have called attention to the various structural changes that are brought about at each successive moult ; but, so far as I know, no author, except myself, has attempted to trace the mathematical relationships between the various growth-stages. Jespersen and Adler (1920) have directed attention to the occasional occurrence of two groups of sexually-mature examples in the species *Clausocalanus arcuicornis* (Dana) that appear to differ only in size and are otherwise morphologically identical. Farran (1926, p. 236) has obtained exactly similar size-groups in the same species among the collections taken by the "Research" in the Bay of Biscay. That examples of the same species may differ in size in different localities, probably under the influence of differences in the salinity or temperature of the water, is well known and I have myself (1924) called attention to the fact that in a single brackish-water area such as the Chilka Lake the average size of a species may differ at different times of the year in accordance with seasonal changes in the local conditions ; the same phenomenon appears to be present in the species *Undinula vulgaris* (Dana) in the purely marine area of Nankauri Harbour in the central group of the Nicobar Islands (*vide infra*, p. 37). In other instances it has been claimed that a species may exhibit definite local races differing in size and in small details of structure ; Wolfenden (1906 a) has called attention to the existence of various races of *Paracalanus parvus*, namely, var. *borealis* from the Faroe Channel, and var. *indicus* from the Indian Ocean, the typical

form being found in the Mediterranean Sea and N. Atlantic Ocean ; and Früchtl (1924) has similarly divided the species *Paracalanus crassirostris* Dahl into forma *typica* from the Amazon estuary, forma *scotti* from the Gulf of Guinea and forma *sewelli* from the estuarine and brackish-water areas of the Bay of Bengal. The occurrence of two sexually-mature groups within the limits of the same morphological species appears to be of comparatively common occurrence in Indian waters and especially among those forms that inhabit the coastal and littoral regions around the mouths of the great rivers that pour their waters into the Bay of Bengal, and moreover these instances are not limited to any one group or family but have been detected in the Calanoida and the Harpacticoida. When two such perfectly definite size groups, that may or may not differ in small details of structure, are found living together in the same locality and under the same conditions of salinity and temperature, it is clear that they cannot be attributed to differences in their environment and that we have to do with an entirely different phenomenon. Up to the present time such size-groups have been demonstrated in the following species of the Calanoida :—

<i>Clausocalanus arcuicornis</i> (Dana),	<i>Fucalanus subcrassus</i> Giesbrecht,
<i>Calanus minor</i> (Claus),	<i>Rhincalanus nasutus</i> Giesbrecht,
<i>Paracalanus aculeatus</i> Giesbrecht,	<i>Undinopsis armatus</i> (Brady),
<i>Paracalanus crassirostris</i> Dahl,	<i>Calanopia thompsoni</i> A. Scott,
<i>Undinula vulgaris</i> (Dana),	<i>Lophothrix frontalis</i> Giesbrecht,

and in addition a similar condition of affairs appears to be present in certain instances, in which the two forms have been described under different specific names, viz. :—

Pontellopsis herdmani Thompson and A. Scott and *P. macronyx* A. Scott.
Heterorhabdus abyssalis (Giesbrecht) and *H. norvegicus* (Boeck).
Oithona challengerii Brady and *O. plumifera* Baird.
Gaetanus minor Farran and *G. (?) minimus* Wolfenden.

and perhaps also in

Valdiviella insignis Farran and *V. ignota*, sp. nov.

In each of the above cases the two groups differ from one another either in size alone, or else, if there be differences in structure, these are so slight that they cannot in my opinion be regarded as a valid ground for the creation of two separate species. One is thus faced with the problem whether these groups are to be regarded as biological species within the limits of the same morphological species or as two sexually-mature stages within the life-history of the same species. At the present time and in the present state of our knowledge it is extremely difficult, if not impossible, to give a final answer to this question. To the strict systematist the occurrence of such groups, differing in slight details of structure as well as in size, presents no difficulty since, rightly or wrongly, he assumes that they represent different species or races ; but I am extremely doubtful whether such an assumption is justified and am personally inclined to think that we have here evidence of dimorphism in various species.

My own observations have been limited to the examination of examples that have been collected by means of tow-nets, etc., and such conclusions as I have reached are based on the structural and mathematical relationships of these groups and can, therefore, only be tentative. It may be possible in the future to conduct a number of rearing experiments

and thus to determine the correct relationships of such groups but at present I have no such evidence.

I have been able to detect the occurrence of such definite size-groups in quite a number of species belonging to most of the great groups of the Copepoda and in a number of instances I have been able to obtain a series of examples in different stages of development and have thus been able to deduce the probable life-history from these. Owing to the variation in size of individuals, both adult and in the earlier immature stages, of the same species taken in different localities, under the influence of differences in the temperature or salinity of the water, the determination of the average length of each stage of development and the consequent calculation of the mathematical relationships of the different developmental stages to each other, as one moult follows another, can only be made in those instances in which a large number of examples of such growth-stages have been captured *in the same locality and at the same time*; in spite of this difficulty I have been able to trace an appreciable part of the life-history in the following species:—

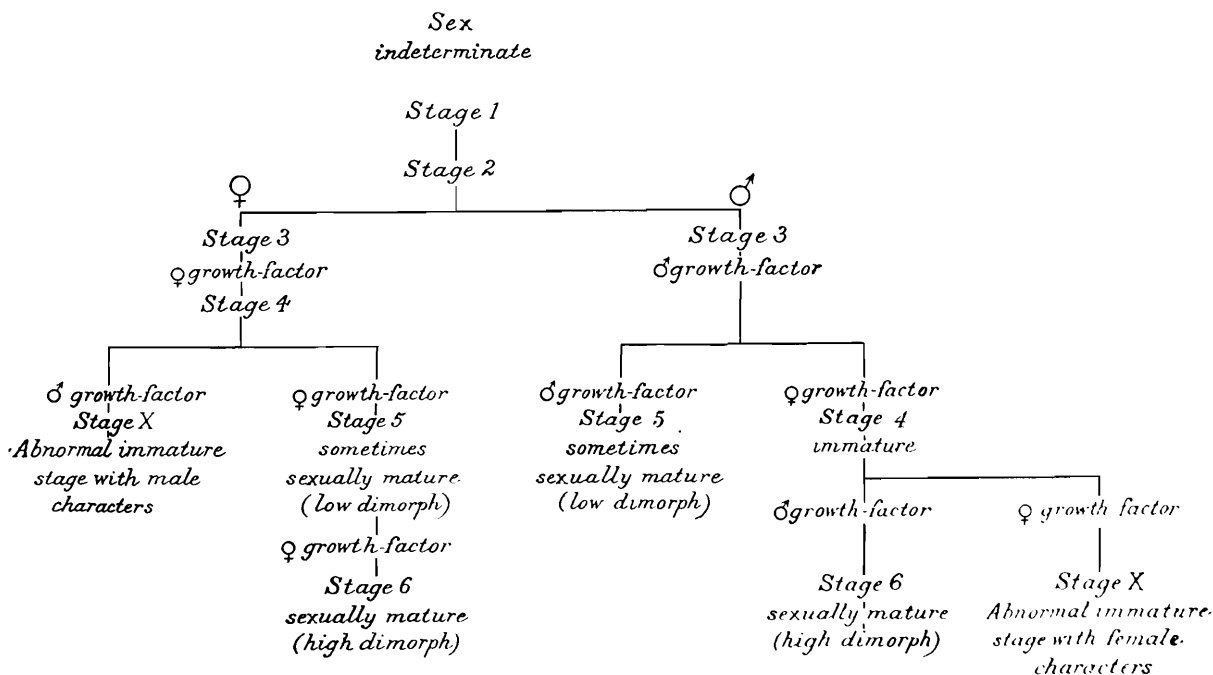
<i>Paracalanus crassirostris</i> Dahl.	<i>Labidocera euchaeta</i> Giesbrecht.
<i>Paracalanus aculeatus</i> Giesbrecht.	<i>Labidocera pavo</i> Giesbrecht.
<i>Acrocalanus inermis</i> Sewell.	<i>Pontella andersoni</i> Sewell.
<i>Eucalanus subcrassus</i> Giesbrecht.	<i>Pontellopsis herdmani</i> Thompson and A. Scott.
<i>Undinula vulgaris</i> (Dana).	<i>Acartia southwelli</i> Sewell.
<i>Euchaeta concinna</i> (Dana).	<i>Acartiella major</i> Sewell.
<i>Lophothrir frontalis</i> Giesbrecht.	<i>Acartiella minor</i> Sewell.
<i>Centropages tenuiremis</i> Thompson and A. Scott.	

I have already (1912 and 1913) called attention to some of the results that I have obtained and have shown that it seems probable that in many instances we may have in a single life-history two distinct and sexually-mature forms in each sex and that in the Copepoda, as in other groups of the animal kingdom, we may find a true dimorphism. In every instance given above the course of development appears in the main to be the same.

It seems probable that in the great majority of species in Indian waters there are the same number of growth-stages, namely six, at any rate so far as the female is concerned. Under certain conditions, however, it appears that the life-history may be shortened, the number of post-naupliar stages being reduced; this appears to be the case in *Paracalanus crassirostris* Dahl and *Acartia southwelli* Sewell, in both of which species only five post-naupliar stages, instead of the usual six, have been discovered. This alteration and shortening of the life-history may, possibly, be associated with changes in the environment, since in both instances the examples were obtained from the Chilka Lake, in which the water is brackish and undergoes very marked changes with the changing seasons (*vide* Sewell, 1924, pp. 773-778).

Several previous authors have called attention, in certain species that frequent the coastal or littoral and estuarine areas, to the occasional occurrence of individuals which exhibit characters that are normally present only in the opposite sex; the commonest examples of such cases are individuals that show all the characters of an immature female with the addition of a rudimentary 5th pair of legs, that differ from the female appendage and exhibit a condition normally restricted to the male sex. Examples of this type of abnor-

malities were of common occurrence among the specimens of *Paracalanus crassirostris* Dahl taken in the Chilka Lake, and an examination of the average size of the different stages of development and of the mathematical relationship of the various growth-stages to each other seems to indicate that these abnormal individuals tend to occur at a definite stage of development and bear a definite relationship to the life-history as a whole. I have previously (*vide* Sewell, 1912 and 1914a) called attention to the fact that the Copepoda appear to follow Brooke's¹ Law and that during the earlier stages of post-naupliar development there is the same proportional increase in the total length of the body at each successive moult, the growth-factor differing, however, in the two sexes, and it is interesting to note that in the only species in which I have been fortunate enough to obtain and measure the naupliar stages, namely *Acartia southwelli* Sewell, the same mathematical relationship appears to hold good also in these early stages of development. With the commencement of the onset of sexual maturity the growth-factor in both sexes tends to diminish, though this does not seem to be invariably the case. In the diagram given below I have attempted to indicate the various lines along which individuals of a given species may develop; it must, however, be borne in mind that these various lines are based merely on the mathematical relationships of the successive growth-stages and have not been proved by actual breeding.



In my previous papers (1912, 1914a) I followed the nomenclature of the successive growth-stages that had been adopted by Fowler for the Ostracoda and termed the final adult stage, Stage I, the 1st post-naupliar or Copepodid stage being in most cases Stage VI. Other authors, in describing the various stages of development, have termed the 1st post-naupliar stage as Stage I and the final adult stage, Stage VI: and I have, therefore, in the following pages adopted this latter method so as to facilitate comparison.

¹ Since this was written, Gurney (1928) has published a paper in which he reaches the general conclusion "that 'Brooke's Law' as stated by Fowler cannot be upheld." At this stage I must leave the evidence that I have brought forward to speak for itself.

At Stage IV in the life-history of the post-naupliar development an individual may, it would appear, follow one of two possible lines.

In the female the majority of examples pass through Stage V to Stage VI, in each case the ecdysis showing the characteristic female growth-factor, and in Stage VI become the fully mature female. In a certain number of species it appears probable that the individual may, however, become sexually mature at the Vth stage, so that in these species we have sexual dimorphism with a high and a low dimorph. I have already (Sewell, 1912) described this type of dimorphism in certain species, *viz.* :—

Paracalanus aculeatus Giesbrecht,
Acrocalanus inermis Sewell,
Labidocera euchaeta Giesbrecht, etc.,

and it seems probable that this type of development is largely confined, if not entirely restricted, to species that inhabit the littoral region of Indian waters and especially the estuarine and brackish-water areas; in a few instances, as in *Paracalanus crassirostris* Dahl, the development may be completed in five stages, the Vth in this case corresponding to the high dimorph (*vide infra*, p. 75). In addition to the two dimorphic forms mentioned above a certain number of individuals, and to judge from my experience especially in those species that inhabit brackish-water, may, instead of undergoing an ecdysis from Stage IV to Stage V with a female growth-factor, for some reason not yet understood exhibit the growth-factor of the male sex and thus reach a size that is intermediate between the normal Stage V and Stage VI; those individuals that exhibit this abnormal development do not become sexually mature and in a number of cases show a definite advance towards the opposite sex in that certain male characters may make their appearance, such male characters being especially noticeable in species and genera such as *Acrocalanus* in which a 5th leg is normally present only in the male and its appearance in the female is thus entirely abnormal.

The development in the male sex apparently follows a very similar course to that of the female sex. Here we find that at Stage III in the post-naupliar development there are two possible lines of development, one line being associated with the characteristic male growth-factor, while the other exhibits a change towards the opposite sex and shows the female growth-factor. Those examples that at this stage show the male growth-factor reach Stage V that corresponds exactly to the stage that we have called Stage X in the female line of development, but in this case these examples may become sexually mature and form the low dimorph. In the alternative line of development the individual exhibits the female growth-factor and passes from Stage III to Stage IV, but in this case remains still immature and it is only in the final moult from Stage IV to Stage VI, in which ecdysis the growth-factor is again that characteristic of the male, that sexual maturity is reached and we get the high dimorph. It will be noticed that the possible lines of development in the two sexes are exactly identical and that in each sex there is the possibility of the appearance of characters belonging to the opposite sex. In certain rare instances, as in the case of *Labidocera euchaeta* Giesbrecht (*vide* Sewell, 1914a, p. 495) it seems possible that in the male a few individuals, that have reached Stage IV, by the adoption of the female growth-factor, from Stage III, may exhibit a further moult again showing the female

growth-factor and so reach the condition found in Stage X, that corresponds structurally with the Stage X in the development of the female, being sexually immature but exhibiting certain female characters.

In every case in which I have been able to trace any portion of the life-history, the length-measurements of the successive moults fit into the scheme that I have outlined above, the only exception being those species in which the life-history appears to be shortened, as in *Paracalanus crassirostris* and *Acartia southwelli*, in which one of the early stages of development in the female and the final or 6th stage in the male seem to be missing.

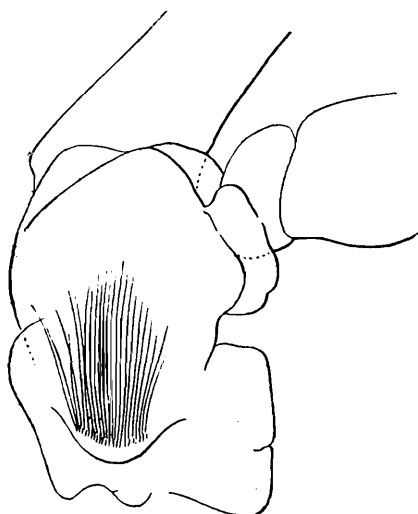
It seems clear that the various species of the Copepoda follow Brooke's Law and, as Fowler (1909) expresses it for the Ostracoda, "increases at each moult by a fixed percentage of its length, which is approximately constant for the species and sex". This, however, is only true to a limited extent, for it appears to be probable that the growth-factor may vary not only with the sex and the species but also with the environment and that in any one species the growth-factor may be larger if the local conditions are favourable and smaller if they are the reverse.

Although the total length of an individual during its development changes in accordance with Brooke's Law, this increase in length is not due to a mere uniform expansion of all the various parts of the body. It has been shown that when a segment of the body divides into two, as, for example, in the course of development of the abdomen, the total proportional length of the two daughter-segments is always greater than the proportional length of the parent segment; as a result of this the increase in the number of segments in the abdomen during the successive copepodid stages results in a proportional increase in the total length of the abdomen, so that at each moult the proportional lengths of the cephalothorax and abdomen alter and the latter region becomes relatively longer.

The change in the proportional lengths of the segments in different stages of development is not confined to the abdominal region but can also be traced in the segments of the 1st antenna. As development progresses the appendage becomes slightly shorter in proportion to the total body-length, but, as in the case with the abdomen, this is not due to a progressive and equal diminution in the proportional lengths of each segment. In those species in which a number of different stages have been taken and examined I have found that, as a rule, in the various growth-stages the proximal segments of this appendage, with the exception of the 1st, tend to become proportionately longer, whereas the distal segments tend in the opposite direction and become relatively shorter; the line of demarcation between these two sets of changes usually occurs at the same point in the antenna, namely between the 18th and 19th segments, and it is interesting to note that it is at exactly this point that the hinge-joint is developed in the grasping antenna of the male in the Heterarthrandria, as well as in the two genera of the Amphaskandria, *Megacalanus* and *Bathycalanus*.

In the following pages I have given the lengths of the various segments of the abdomen as parts per cent and of the 1st antenna as parts per thousand of the whole length, as I have found that this greatly facilitates the comparison of the lengths of the various segments in individuals of different sizes and in different stages of development.

Giesbrecht (1893, p. 103) in his description of the genus *Calanus* (*sensu lato*) calls attention to the presence in that genus of a projecting boss or ridge beset with hairs on the



TEXT-FIG. 1.—The basal segments of the 2nd antenna in *Paraeuchaeta weberi* A. Scott, showing the row of hairs on Basal I.

posterior aspect of the 1st basal segment of the 2nd antenna ; he also mentions the presence of a row of long hairs on the hinder aspect of the same segment of the 2nd antenna in the genera *Chiridius* (*loc. cit.*, p. 226) and *Euchirella* (*loc. cit.*, p. 236), and in this latter genus he states that “ the 1st Basal is short and broad, on the posterior side it possesses a hairy process.” Figures are given by him showing the presence of this row of hairs in *Undinula vulgaris* (*loc. cit.*, Pl. VII, fig. 2) and in *Euchirella messinensis* (*loc. cit.*, Pl. XV, fig. 16). Later observers, so far as I have been able to discover, have for the most part failed to notice this feature ; but Farran (1905, p. 36, Pl. VII, fig. 10) in his description of *Amallothrix emarginata* calls attention to the presence in that species of a row of fine curved setae in the same situation. This row of hairs appears to be of common occur-

rence, if not universally present, in the species of the Amphaskandria and I have been able to detect it in the following :—

Megacalanus longicornis Sars.
Bathycalanus richardi Sars.
Undinula vulgaris (Dana).
Undinula darwini (Lubbock).
Clausocalanus arcuicornis (Dana).
Drepanopsis frigidus Wolfenden.
Gaetanus rectus Wolfenden.
Gaetanus kruppi Giesbrecht.
Gaetanus pileatus Farran.
Chirundina indica, sp. nov.
Pseudochirella crytospina Sars.
Pseudochirella magna Wolfenden.
Pseudochirella obtusa Sars.
Euchirella bella Giesbrecht.
Euchirella messinensis (Claus).
Euchirella curticauda Giesbrecht.
Euchirella galeata Giesbrecht.
Euchirella orientalis, sp. nov.
Euchirella dubia A. Scott.
Euchirella maxima Wolfenden.
Undeuchaeta bispinosa Esterly.
Euchaeta concinna Dana.
Euchaeta marina (Prestandrea).

Euchaeta tenuis Esterly.
Paraeuchaeta bisinuata (Sars).
Paraeuchaeta malayensis nom. nov.
Paraeuchaeta norvegica (Sars).
Paraeuchaeta barbata Brady.
Paraeuchaeta investigatoris, sp. nov.
Paraeuchaeta weberi A. Scott.
Paraeuchaeta californica (Esterly).
Valdiviella insignis Farran.
Valdiviella oligarthra Steuer.
Valdiviella minor Wolfenden.
Phaena spinifera Claus.
Cornucalanus chelifera Wolfenden.
Cornucalanus indicus, sp. nov.
Amallothrix emarginata (Farran).
Amallothrix indica, sp. nov.
Lophothrix frontalis Giesbrecht.
Scolecithrix danae Brady.
Scottocalanus persecans (Giesbrecht).
Scottocalanus thomasi A. Scott.
Scottocalanus daughlishi, sp. nov.
Scottocalanus investigatoris, sp. nov.
Macandrewella scotti, sp. nov.

Up to the present time I have failed to find this row of setae on the 1st basal segment of the 2nd antenna in any member of the group Heterarthrandria and it would seem to be at least probable that its presence is a characteristic of the group Amphaskandria.

I give below (pp. 13-19) a complete bibliography of the various works that I have been able to consult, but as A. Scott (1909) in his monograph of the Copepoda of the "Siboga" collection has given under each species a very complete bibliography of that species, I have not thought it necessary to reproduce these lists here and in most instances have only given the references to those papers that have appeared since the publication of Scott's work.

SYSTEMATIC LIST OF SPECIES.

*The species marked * occur in the Indian Museum Collections.*

Tribe Amphaskandria.

Family Calanidae.

Genus *Calanus* Leach.

1. *Calanus finmarchicus* (Gunnerus).
2. *Calanus propinquus* Brady.
3. **Calanus tenuicornis* (Dana).

Genus *Nannocalanus* Sars.

4. **Nannocalanus minor* (Claus).
- (a) forma *major*.
- (b) forma *minor*.

Genus *Calanoides* Brady.

5. *Calanoides brevicornis* (Lubbock).
6. *Calanoides natalis* Brady.

Genus *Canthocalanus* A. Scott.

7. **Canthocalanus pauper* (Giesbrecht).

Genus *Neocalanus* Sars.

8. **Neocalanus gracilis* (Dana).
9. *Neocalanus robustior* (Giesbrecht).

Genus *Megacalanus* Wolfenden.

10. **Megacalanus longicornis* (Sars).

Genus *Bathycalanus* Sars.

11. **Bathycalanus richardi* Sars.

Genus *Undinula* A. Scott.

12. **Undinula vulgaris* (Dana).
- (a) forma *major*.
- (b) forma *minor*.
13. **Undinula darwini* (Lubbock).

Family Eucalanidae.

Genus *Eucalanus* Dana.

14. **Eucalanus attenuatus* (Dana).
15. **Eucalanus elongatus* (Dana).
16. **Eucalanus crassus* Giesbrecht.
17. **Eucalanus longiceps* Matthews.
18. **Eucalanus monachus* Giesbrecht.
19. **Eucalanus mucronatus* Giesbrecht.
20. **Eucalanus pileatus* Giesbrecht.
21. **Eucalanus subcrassus* Giesbrecht.
22. *Eucalanus dentatus* A. Scott.

Genus *Rhincalanus* Dana.

23. **Rhincalanus cornutus* Dana.
24. **Rhincalanus nasutus* Giesbrecht.

Genus *Mecynocera* Thompson.

25. **Mecynocera clausi* Thompson.

Family Paracalanidae.

Genus *Paracalanus* Boeck.

26. **Paracalanus aculeatus* Giesbrecht.
- (a) forma *major*.
- (b) forma *minor*.

27. **Paracalanus serratipes* Sewell.

28. **Paracalanus denudatus*, sp. nov.

29. **Paracalanus parvus* Giesbrecht.

30. **Paracalanus nanus* Sars.

31. **Paracalanus crassirostris* Dahl.

32. **Paracalanus dubia* Sewell.

33. **Paracalanus nudus*, sp. nov.

Genus *Acrocalanus* Giesbrecht.

34. **Acrocalanus gracilis* Giesbrecht.

35. **Acrocalanus gibber* Giesbrecht.

36. **Acrocalanus inermis* Sewell.

37. **Acrocalanus longicornis* Giesbrecht.

38. **Acrocalanus monachus* Giesbrecht.

39. **Acrocalanus gardineri* Wolfenden.

Family Pseudocalanidae.

Genus *Calocalanus* Giesbrecht.

40. **Calocalanus pavo* (Dana).
41. **Calocalanus plumulosus* (Claus).
42. **Calocalanus styliremis* Giesbrecht.
43. **Calocalanus contractus* Farran.

Genus *Clausocalanus* Giesbrecht.

44. **Clausocalanus arcuicornis* (Dana).
- (a) forma *major*.
- (b) forma *minor*.

45. **Clausocalanus furcatus* (Brady).

46. **Clausocalanus farrani*, sp. nov.

Genus *Spinocalanus* Giesbrecht.

47. **Spinocalanus magnus* Wolfenden.

Genus *Monacilla* Sars.

48. *Monacilla typica* Sars.

49. **Monacilla tenera* Sars.

Genus *Drepanopsis* Wolfenden.

50. **Drepanopsis frigidus* Wolfenden.

Family Aetideidae.

Genus *Aetideus* Brady.

51. **Aetideus armatus* (Boeck).

52. *Aetideus giesbrechti* Cleve.

53. *Aetidius bradyi* A. Scott.

Genus *Aetideopsis* Sars.

54. *Aetideopsis rostrata* Sars.

Genus *Undinopsis* Sars.

55. *Undinopsis armatus* (Brady).

Genus *Chiridius* Giesbrecht.

56. *Chiridius poppei* Giesbrecht.

57. **Chiridius gracilis* Farran.

Genus *Gaidius* Giesbrecht.

58. **Gaidius minutus* Sars.

59. **Gaidius tenuispinus* (Sars).

Genus *Gaidiopsis* A. Scott.

60. *Gaidiopsis crassirostris* A. Scott.

Genus *Chiridiella* Sars.

61. *Chiridiella macrodactyla* Sars.

Genus *Gaetanus* Giesbrecht.

62. **Gaetanus armiger* Giesbrecht.

63. *Gaetanus caudoni* Canu.

64. *Gaetanus hamatus* A. Scott.

65. **Gaetanus kruppi* Giesbrecht.

66. **Gaetanus latifrons* Sars.

67. **Gaetanus miles* Giesbrecht.

68. **Gaetanus minor* Farran.

69. **Gaetanus pileatus* Farran.

70. **Gaetanus rectus* Wolfenden.

Genus *Euchirella* Giesbrecht.

71. *Euchirella amona* Giesbrecht.

72. **Euchirella bella* Giesbrecht.

73. **Euchirella brevis* Sars.

74. **Euchirella curticauda* Giesbrecht.

75. **Euchirella galeata* Giesbrecht.

76. **Euchirella maxima* Wolfenden.

77. **Euchirella messinensis* (Claus).

78. *Euchirella pulchra* (Lubbock).

79. *Euchirella venusta* Giesbrecht.

80. **Euchirella orientalis*, sp. nov.

Genus *Chirundina* Giesbrecht.

81. *Chirundina streetsi* Giesbrecht.

82. **Chirundina indica*, sp. nov.

Genus *Undeuchaeta* Giesbrecht.

83. *Undeuchaeta major* Giesbrecht.

84. *Undeuchaeta plumosa* (Lubbock).

85. *Undeuchaeta intermedia* A. Scott.

86. **Undeuchaeta bispinosa* Esterly.

Genus *Pseudochirella* Sars.

87. **Pseudochirella notacantha* Sars.

88. **Pseudochirella cryptospina* Sars.

89. **Pseudochirella magna* (Wolfenden).

90. **Pseudochirella obtusa* Sars.

Family Euchaetidae.

Genus *Valdiviella* Steuer.

91. **Valdiviella bevicornis* Sars.

92. **Valdiviella insignis* Farran.

93. **Valdiviella ignota*, sp. nov.

94. **Valdiviella minor* Wolfenden.

95. **Valdiviella oligarthra* Steuer.

96. *"*Valdiviella gigas*" Brady.

Genus *Euchaeta* Philippi.

97. *Euchaeta acuta* Giesbrecht.

98. *Euchaeta affinis* Cleve.

99. **Euchaeta concinna* Dana.

100. *Euchaeta longicornis* Giesbrecht.

101. **Euchaeta marina* Prestand.

102. **Euchaeta media* Giesbrecht.

103. **Euchaeta spinosa* Giesbrecht.

104. **Euchaeta tenuis* Esterly.

105. *Euchaeta tonsa* Giesbrecht.

106. **Euchaeta wolfendeni* A. Scott.

Genus *Paraeuchaeta* A. Scott.

107. *?*Paraeuchaeta barbata* (Brady).

108. **Paraeuchaeta bisinuata* (Sars).

109. **Paraeuchaeta californica* (Esterly).

110. **Paraeuchaeta investigatoris*, sp. nov.

111. *Paraeuchaeta dentata* A. Scott.

112. **Paraeuchaeta gracilicauda* A. Scott.

113. *Paraeuchaeta propinqua* (Esterly).

114. *Paraeuchaeta sarsi* (Farran).

115. *Paraeuchaeta sibogae* A. Scott.

116. *Paraeuchaeta tonsa* (Giesbrecht).

117. *Paraeuchaeta spinifera* (Esterly).

118. **Paraeuchaeta malayensis* nom. nov..

(=*P. barbata* A. Scott).

119. **Paraeuchaeta tuberculata* A. Scott.

120. **Paraeuchaeta weberi* A. Scott.

Family Phaennidae.

Genus *Phaenna* Claus.

121. *
- Phaenna spinifera*
- Claus.

Genus *Amallophora* T. Scott.

- 122.
- Amallophora typica*
- T. Scott.

Genus *Heteramalla* Sars.

- 123.
- Heteramalla dubia*
- (T. Scott).

Genus *Onchocalanus* Sars.

- 124.
- Onchocalanus cristatus*
- (Wolfenden).

- 125.
- Onchocalanus hirtipes*
- Sars.

126. *
- Onchocalanus trigoniceps*
- Sars.

Genus *Xanthocalanus* Giesbrecht.

- 127.
- Xanthocalanus agilis*
- Giesbrecht.

- 128.
- Xanthocalanus fragilis*
- (Aurivillius).

Genus *Brachycalanus* Farran.

- 129.
- Brachycalanus gigas*
- A. Scott.

Genus *Cornucalanus* Wolfenden.

130. *
- Cornucalanus chelifer*
- (Thompson).

131. *
- Cornucalanus simplex*
- Wolfenden.

132. *
- Cornucalanus indicus*
- , sp. nov.

Family Scolecithricidae.

Genus *Scottocalanus* Sars.

133. *
- Scottocalanus farrani*
- A. Scott.

134. *
- Scottocalanus helenae*
- (Lubbock).

- 135.
- Scottocalanus persecans*
- (Giesbrecht).

- 136.
- Scottocalanus setosus*
- A. Scott.

- 137.
- Scottocalanus longispinus*
- A. Scott.

138. *
- Scottocalanus thomasi*
- A. Scott.

139. *
- Scottocalanus investigatoris*
- , sp. nov.

140. *
- Scottocalanus daughlihi*
- , sp. nov.

Genus *Lophothrix* Giesbrecht.

141. *
- Lophothrix frontalis*
- Giesbrecht.

(a) forma major.

(b) forma minor.

142. *
- Lophothrix quadrispinosa*
- Wolfenden.

Genus *Macandrewella* A. Scott.

143. *
- Macandrewella chelipes*
- (Giesbrecht).

- 144.
- Macandrewella joanae*
- A. Scott.

145. *
- Macandrewella scotti*
- , sp. nov.

Genus *Scaphocalanus* Sars.

146. *
- Scaphocalanus affinis*
- Sars.

147. *
- Scaphocalanus elongatus*
- A. Scott.

148. *
- Scaphocalanus magnus*
- (T. Scott).

- 149.
- Scaphocalanus major*
- (T. Scott).

150. *
- Scaphocalanus medius*
- Sars.

Genus *Scolecithrix* Brady.

- 151.
- Scolecithrix bradyi*
- Giesbrecht.

152. *
- Scolecithrix danae*
- (Lubbock).

153. *
- Scolecithrix nicobarica*
- , sp. nov.

Genus *Scolecithricella* Sars.

- 154.
- Scolecithricella auropecten*
- (Giesbrecht).

- 155.
- Scolecithricella abyssalis*
- (Giesbrecht).

156. *
- Scolecithricella ctenopus*
- (Giesbrecht).

- 157.
- Scolecithricella longicornis*
- (T. Scott).

- 158.
- Scolecithricella longifurca*
- (Giesbrecht).

- 159.
- Scolecithricella marginata*
- (Giesbrecht).

- 160.
- Scolecithricella minor*
- (Brady).

- 161.
- Scolecithricella profunda*
- (Giesbrecht).

- 162.
- Scolecithricella tenuipes*
- A. Scott.

163. *
- Scolecithricella pearsoni*
- Sewell.

Genus *Amallothrix* Sars.

- 164.
- Amallothrix curticauda*
- (A. Scott).

- 165.
- Amallothrix gracilis*
- (A. Scott).

166. ?
- Amallothrix obtusifrons*
- Sars.

- 167.
- Amallothrix tydemani*
- (A. Scott).

168. *
- Amallothrix emarginata*
- (Farran).

169. *
- Amallothrix arcuata*
- Sars.

170. *
- Amallothrix valida*
- (Farran).

171. *
- Amallothrix indica*
- , sp. nov.

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Tribe AMPHASKANDRIA.

Family CALANIDAE.

Genus **CALANUS** Leach.

From time to time the genus *Calanus* has been reduced in size by the separation of a number of groups that have been raised to the dignity of generic rank. It is, in my opinion, doubtful whether these various groups should be considered as true genera or

regarded merely as sub-genera, but at the present time it seems best, for purposes of convenience, to treat them as genera. In 1847 Dana created the genus *Undina* but this name was preoccupied and in 1909 A. Scott renamed the genus *Undinula*. In 1852 Dana separated off the two genera *Eucalanus* and *Rhincalanus*; in 1864 Boeck created the genus *Paracalanus*; and in 1883 Brady founded the genus *Calanoides*. Recently, in 1925, G. O. Sars has still further reduced the limits of the genus *Calanus* by the separation of a number of other forms and the creation of the genera *Nanocalanus*, to accommodate *Calanus minor* Claus, and *Neocalanus*, in which he includes three forms, viz., *Calanus gracilis* Dana, *C. robustior* Giesbrecht, and *C. tenuicornis* Dana; of these three latter forms the first two were in 1909 included by A. Scott in his new genus *Megacalanus*. It is unfortunate that in several instances Sars gives no reasons for the creation of these new genera nor does he give any definition of the genus; for instance (1925, p. 7) regarding his proposed new genus *Neocalanus* he merely remarks "Ce nouveau genre est proposé pour y comprendre les 3 espèces suivantes, généralement référées au genre *Calanus*, mais qui s'endistinguent par quelques caractères bien prononcés, spécialement manifestés chez le mâle."

Of the various species that are still included in this now much restricted genus, *Calanus propinquus* Brady has been recorded from the Indian Ocean by Brady himself (1915, p. 135), who found it in a collection made in Durban Bay; *Calanus finmarchicus* Gunnerus has been recorded from the south and east of Cape Colony by Cleve (1904, p. 185), and *Calanus tenuicornis* (Dana) was taken by the "Siboga" in the Malay Archipelago and is recorded by A. Scott (1909, p. 8). Only this last form has so far been discovered in the "Investigator" collections.

Calanus tenuicornis (Dana).

Calanus tenuicornis, A. Scott, 1909, p. 8.

Calanus tenuicornis, T. Scott, 1912, p. 527.

Calanus tenuicornis, Sewell, 1914, p. 193.

Calanus tenuicornis, Farran, 1920, pp. 16, 19 and 24.

Calanus tenuicornis, Früchtl, 1920, p. 468 (6).

Neocalanus tenuicornis, G. O. Sars, 1925, p. 9.

Calanus tenuicornis, Farran, 1926, p. 227.

Calanus tenuicornis, Farran, 1929, p. 217.

This species, though very rare, is occasionally found in Indian waters; it has now been recorded from the Malay Archipelago (A. Scott), the Ceylon Pearl banks (Sewell) and the South African Seas (Cleve).

As mentioned above, Sars includes this species with *Calanus gracilis* Dana and *Calanus robustior* Giesbrecht in his proposed new genus *Neocalanus*, but the absence of any hook on the basal segment of the 1st leg and the fact that in this species the head and 1st thoracic segment are separate, whereas in *C. gracilis* and *C. robustior* they are fused, are, I think, sufficient grounds for disagreeing with Sars's suggestion and keeping this species separate from the other two.

Genus NANNOCALANUS Sars.

Nannocalanus minor (Claus).

Calanus minor, A. Scott, 1909, p. 7.

Calanus minor, Steuer, 1910, p. 1025.

Calanus minor, Sharpe, 1911, p. 406.

Calanus minor, Wolfenden, 1911, p. 193.

Calanus minor, T. Scott, 1912, p. 527.

Calanus minor, Sewell, 1912, p. 354.

Undinula caroli, Sewell, 1912, p. 356.

Calanus minor, Sewell, 1913, p. 367.

Calanus minor, Pesta, 1913, p. 30.

Calanus minor, Sewell, 1914, p. 192.

Calanus minor, Früchtl, 1920, p. 467 (5).

Nannocalanus minor, G. O. Sars, 1925, p. 9.

Calanus minor, Farran, 1929, p. 214.

This species appears to be widely distributed throughout Indian waters; it has now been obtained from the Malay Archipelago, the coastal region of Burma and the Mergui Archipelago, the Nicobar Islands, the Ceylon Pearl Banks and from the Maldivé Archipelago. Though of wide distribution it is, as a rule, not particularly common; but in certain catches it has been taken in fairly large numbers. The females are in the live state usually tinged with pink, whereas the males are colourless.

The "Investigator" collections made at Station 614 (Nankauri Harbour, Nicobar Islands) contain a number of examples of what I take to be this species, but a close examination of these examples has revealed that there are two very closely related and extremely similar forms, differing from each other for the most part only in size, though there are also a few minor structural differences; but these latter are so slight that I am convinced that there are two forms of the same species. I have, therefore, referred to them as forma *major* and forma *minor*.

Forma **major**.

(Text-fig. 2, *a-d*).

♀ The total length varies from 1.55 to 1.64 mm.

The proportional lengths of the cephalothorax and abdomen are as 60 to 19; the abdomen is thus contained 3.2 times in the length of the anterior region of the body.

The head and 1st thoracic segment are fused, but thoracic segments 4 and 5 are separate. The forehead is rounded and the posterior thoracic margin forms a uniform rounded curve.

The abdominal segments have the following proportional lengths:

Abdominal segment 1 and 2	3	4	5	Furca.	
36	20	15	7	22	= 100.

The furcal ramus is 1.75 times as long as wide. The distal margin bears five setae, of which the 2nd is thickened and is at least twice as long as the others. The 5th seta is small and is only one-half to one-third as long as setae 3 and 4. The dorsal seta is small and projects inwards in an S-shaped curve.

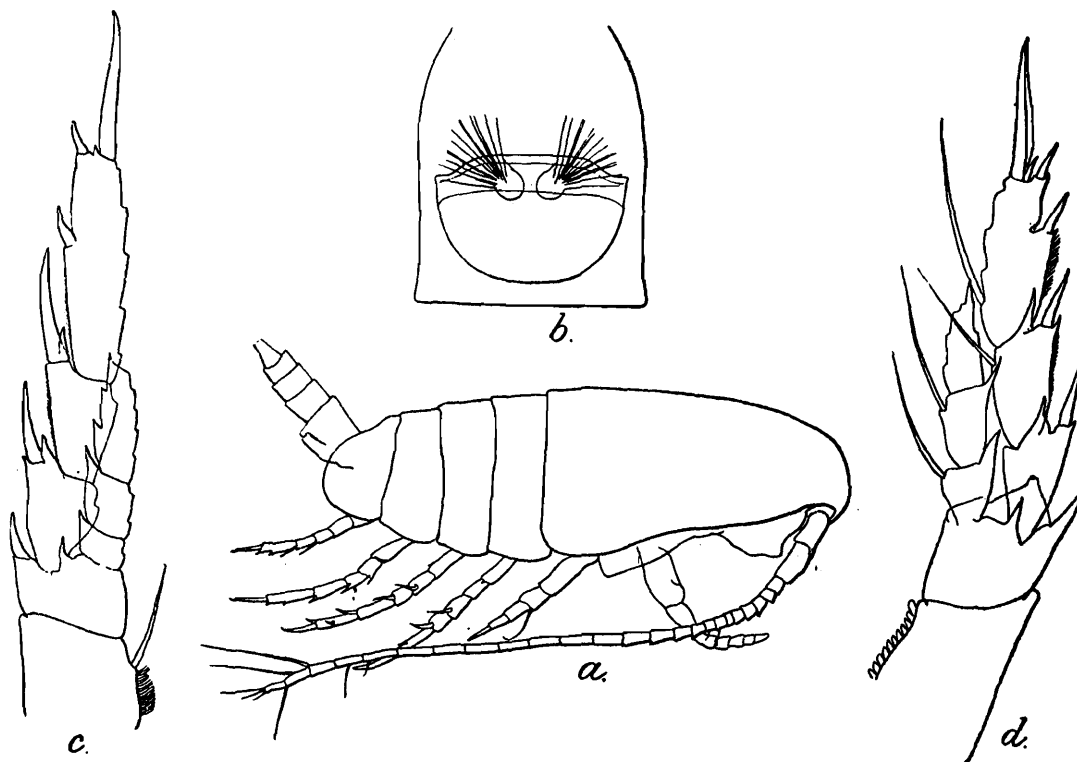
The genital aperture on the ventral face of the 1st abdominal segment (text-fig. 2, *b*) is guarded by a semi-circular flap, that reaches across slightly more than four-fifths of the ventral aspect and is one and a half times as wide from side to side as it is from before backwards.

The 1st antenna reaches back to the hinder margin of the genital segment. Segments 1 and 2 are separate but segments 8 and 9 are fused. The segments have the following proportional lengths :

Segment	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
	53	58	27	24	26	27	27	57	37	39	43	45	45	48	50	50	50	47	40	40	45	47	42	32	=1,000.

The 2nd antenna and the mouth-parts are of the usual Calanoid type.

The 1st swimming leg has the usual structure, both exopod and endopod consisting of three segments. The endopod reaches to the level of the 2nd inner seta on the margin of exopod 3.



TEXT-FIG 2.—*Nannocalanus minor* (Claus) forma major, ♀.

a. The whole animal from the right side,

b. The genital segment of the abdomen, from below.

c. The 2nd swimming leg.

d. The 5th swimming leg.

The 2nd swimming leg (text-fig. 2, c) is, at any rate in certain individuals, characterised by the strong development of the marginal spines on exopod 1 and 2; the spine on exopod 1 reaches to the level of the junction of the third and fourth quarters of the external margin of exopod 2 and the spine on this latter segment may reach the level of the articulation of the proximal spine on exopod 3.

The 5th swimming leg (text-fig. 2, d) agrees closely with the figure given by Giesbrecht (1892, Pl. VIII, fig. 19). The end-spine is nearly as long as the distal segment of the exopod; its length being contained 1.17 times in that of the segment.

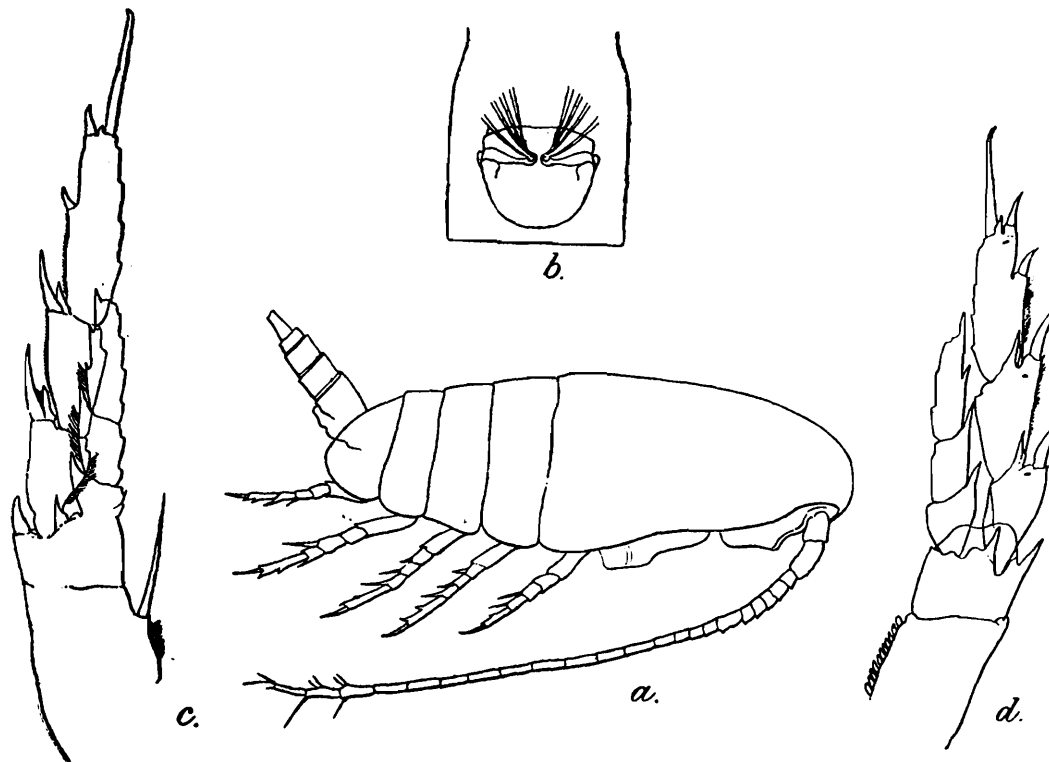
Forma **minor**.

(Text-fig. 3, a-d).

♀ Total length from 1.32 to 1.49 mm.

The proportional lengths of the cephalothorax and abdomen are as 54 to 17, the abdomen being contained 3.2 times in the length of the anterior region of the body, as in the larger form.

The general conformation of the body agrees with that of the larger form with this very slight difference that the posterior margin of the last thoracic segment does not form a uniform curve, but exhibits a faint tendency to be produced at the apex of the curve.



TEXT FIG. 3.—*Nannocalanus minor* (Claus) forma *minor*, ♀.

- a. The whole animal from the right side. c. The 2nd swimming leg.
b. The genital segment of the abdomen, from below. d. The 5th swimming leg.

The abdominal segments have the following proportional lengths :

Abdominal segments	1 and 2	3	4	5	Furca :
	37	19	16	7	21 = 100.

The genital aperture (text-fig. 3, b) is guarded by a valve flap that is very distinctly narrower than in forma *major* and only reaches across a little more than one-half of the ventral surface, while the transverse diameter of the valve is only one and a quarter times that of the antero-posterior diameter, instead of one and a half-times as in the larger form.

The 1st antenna reaches back to the hinder margin of the genital segment and, as in forma *major*, segments 1 and 2 are separate and 8 and 9 are fused. The proportional lengths of the various segments are as follows :

Segment	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
	57	62	26	22	25	25	23	45	34	34	41	44	48	48	49	49	49	51	44	42	47	54	47	35	= 1,000.

The 2nd antenna, mouth-parts and the 1st swimming leg appear to be identical with those of forma *major*.

The 2nd swimming leg in this form (text-fig. 3, c) exhibits a considerable difference from that of forma *major* in the degree of development of the marginal spines on exopod 1 and 2; these are considerably smaller than in the larger form and the marginal spine on exopod 1 reaches to a level of the junction of the middle and distal thirds of the outer margin of exopod 2, while that on exopod 2 reaches only a little more than half the distance to the point of origin of the proximal spine on exopod 3.

The 5th swimming leg (text-fig. 3, *d*) closely resembles that of the larger form; the serration of the inner margin of the 1st basal segment is identical and the degree of development of the marginal spines is also similar, but the end-spine is distinctly shorter; its length being contained 1.41 times in that of the 3rd segment of the exopod.

Copepodid Stage V (Text-fig. 4, *a*, *b*.)

Associated with the adult specimens in the same tow-netting from "Investigator" Station No. 614 were a number of examples of the last Copepodid stage.

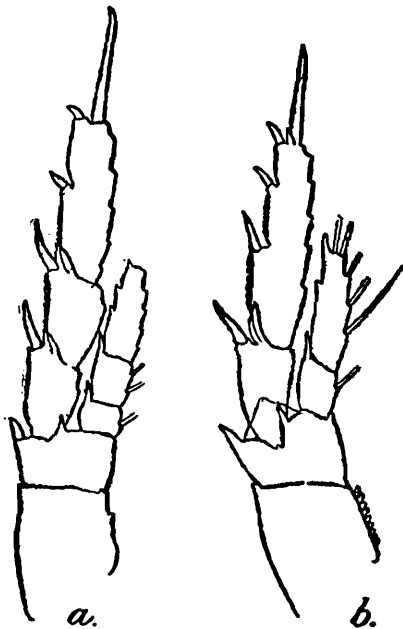
♀ Total length, 1.302 mm.

The proportional lengths of the cephalothorax and abdomen are as 69 to 17, so that the abdomen is contained 4.06 times in the length of the anterior region of the body.

In their general conformation these examples closely resemble the adult except that the segments of the abdomen have not yet assumed their adult character, and the cephalon and the 1st thoracic segment are still separate. The posterior margin of the thorax is very slightly produced at the apex of the curve as in the small form of the adult.

The abdomen consists of four segments but in this case the 1st and 2nd are separate and it is the 4th and 5th that are still fused. The proportional lengths of the segments are as follows:

Segment	1	2	3	4	5	Furca,
	21	21	18	24	16	= 100



TEXT-FIG. 4.—*Nannocalanus minor* (Claus): Copepodid Stage V. ♀.

- a*. The 2nd swimming leg.
b. The 5th swimming leg.

The 1st antenna is segmented as in the adult; segments 1 and 2 being separate and 8 and 9 fused; the proportional lengths of the segments are as follows:

Segment	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
	62	67	27	24	26	25	23	43	26	29	39	42	45	56	46	48	49	51	49	43	48	57	49	40	= 1,000

The 2nd antenna and the mouth-parts resemble those of the adult.

In the swimming legs the first four pairs possess three segments in both the exopod and the endopod. In the 2nd leg (text-fig. 4, *a*) the marginal spines on exopod 2 and 3 reach about half way to the base of the next marginal spine.

In the 5th leg (text-fig. 4, *b*) the rami consist of only two segments. In the immature male the legs of the two sides in the 5th pair are very nearly symmetrical, almost the only trace of the differentiation that will be reached in the adult between the right and left legs being seen in the terminal spines of exopod 3, which is much shorter on the left side than on the right.

A comparison of the different stages or size-groups in this species indicates that during the course of development the individual passes through a series of definite gradations in structure. The first change to which I would call attention is the change in the relative lengths of the various segments of the 1st antenna. In the following table I have given the proportional lengths of these segments in the three growth-stages, namely the last Copepodid stage, the small adult (forma *minor*) and the large adult (forma *major*).

Segment	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
Final Copepodid stage.	62	67	27	24	26	25	23	43	26	29	39	42	45	46	48	49	51	49	43	48	57	49	40		
Small adult	57	62	26	22	25	25	23	45	34	34	41	44	48	48	49	49	49	51	44	42	47	54	47	35	
Large adult	53	58	27	24	26	27	27	57	37	39	43	45	45	43	50	50	50	47	40	40	45	47	42	32	

A comparison of the different lengths of the segments shows that in the first two proximal segments of this appendage there is a distinct tendency for the length of the segment to decrease with each stage in the increase of size in the individual. In this instance I hesitate to call these stages actual growth-stages, since I have no reason, beyond the difference in size, for concluding definitely that these stages are portions of the same life-history, and it is possible that the two forms, forma *major* and forma *minor*, may each be the final stage in the development of distinct races of the same species. Between segments 3 and 6 there is but little appreciable change but in segments 7 to 18 there is a clear tendency for the length of the segments to increase relatively with each increase in size of the individual. At this point in the appendage there is, however, a complete change and from the 19th to the 25th segment inclusive the length of the various segments gets definitely less with an increase in the size of the individual.

As I shall show later, in other species we can trace the same change in the proportionate length of the antennal segments in successive growth-stages and it is interesting to note that the point at which the change in the proportional length switches over from an increase to a decrease occurs, in almost every instance in which I have been able to obtain data, at the same point, namely between the 18th and 19th segments, which is also the point at which the hinge joint in the grasping antenna of the male develops in the Podoplea.

Another point that appears to be brought out by a comparison of the above three forms is that the length of the marginal spines on the exopod of the swimming legs may alter considerably during the course of growth.

Genus **CALANOIDES** Brady.

Calanoides brevicornis (Lubbock) has been recorded from the region of the Malay Archipelago by A. Scott (1909, p. 10) and by Früchtl (1924, p. 33), while Cleve (1904, p. 185) has recorded its occurrence in the region of the Indian Ocean lying to the east of Natal. Brady (1914, p. 4) has described a second species belonging to this genus, under the name *C. natalis*, from Durban Bay on the East Coast of Africa. Up to the present time I have failed to detect the presence of either species in the "Investigator" collections from Indian waters.

Genus **CANTHOCALANUS** A. Scott.

Canthocalanus pauper (Giesbrecht).

Calanus pauper, A. Scott, 1909, p. 9.

Calanus pauper, Wolfenden, 1911, p. 193.

Calanus pauper, Pesta, 1912, p. 43.

Canthocalanus pauper, Sewell, 1912, pp. 315, 355.

Calanus pauper, Pesta, 1913, p. 30.

Canthocalanus pauper, Sewell, 1913, p. 367.

Canthocalanus pauper, Sewell, 1914, p. 193.

Canthocalanus pauper, Früchtl, 1924, pp. 12, 32.

Canthocalanus pauper, Gurney, 1927, p. 142.

Calanus pauper, Farran, 1929, p. 215.

Canthocalanus pauper, var. *plumulosus*, Sewell, 1912, p. 355.

Canthocalanus pauper var. *plumulosus*, Sewell, 1914, p. 193.

This species is widely distributed throughout Indian waters ; it has now been recorded from the Malay Archipelago (Scott, Früchtl), the Burma coast (Sewell), the region of the Nicobar Islands (Sewell), the Pearl Banks of Ceylon (Thompson and Scott ; Sewell), the Maldive Archipelago (Wolfenden), the Arabian sea (Thompson and Scott), the Red Sea (A. Scott), and the Gulf of Suez (Gurney). In the "Investigator" collections it occurs in the following Stations : 540, 541, 542, 543, 544, 545, 547, 552, 555, 556, 558, 559, 561, 562, 577, 578, 582, 583, 584, 587, 588, 590, 591, 614, and in Expedition Harbour in the central group of the Nicobars.

As I have previously pointed out (Sewell, 1914, p. 193) the variety *plumulosus*, based on the dichotomous branching of some or all of the furcal setae, is merely an abnormality due in all probability to injury to and subsequent regeneration of the setae. Früchtl (1924, p. 12), who appears not to have seen my paper, has independently arrived at the same conclusion and considers that the increased size of the regenerated setae and their dichotomous branching is an attempt at compensation for loss of balance and diminished powers of swimming caused by the loss of the original setae ; while most often seen in the setae that arise from the furcal rami, a similar dichotomous branching may also occur in the setae arising from the segments of the 1st antenna.

Genus **NEOCALANUS** G. O. Sars.

Sars (1925, pp. 7-8) created the genus *Neocalanus* in order to include the three forms, *Calanus gracilis* Dana, *C. robustior* Giesbrecht, and *C. tenuicornis* Dana, basing his action "on certain well pronounced characters, especially manifested in the male" A. Scott (1909, p. 12) had included *Calanus gracilis* and *C. robustior* in the genus *Megacalanus* along with *M. princeps* on the grounds that in all three species we find a hook on the 2nd basal joint of the 1st swimming leg. Sars, however, does not consider this sufficient grounds for classing these three forms together, and in view of the fact that in *Calanus gracilis* and *C. robustior* the head and 1st thoracic segment are fused, whereas in *Megacalanus princeps* they are separate, it certainly seems advisable to keep these forms apart. The same objection, however, holds good in the case of *Calanus tenuicornis*, in which also the head and 1st thoracic segment are separate. I have, therefore, included *Calanus gracilis* and *C. robustior* in the genus *Neocalanus*, leaving, for the time being, the position of *Calanus tenuicornis* undecided.

Both *Calanus gracilis* and *C. robustior* have been recorded from Indian waters. The former species has now been taken in the Malay Archipelago and on the Pearl Banks of Ceylon, and occurs very rarely in the "Investigator" collections. *Calanus robustior* has been recorded by Wolfenden (1906, p. 996) from the Maldive Archipelago.

Neocalanus gracilis (Dana).

Megacalanus gracilis, A. Scott, 1909, p. 12.

Megacalanus gracilis, T. Scott, 1912, p. 528.

Neocalanus gracilis, G. O. Sars, 1925, p. 7.

Calanus gracilis, Farran, 1926, p. 229.

Calanus gracilis, Farran, 1929, p. 217.

Two specimens (♀) were taken in the tow-netting at "Investigator" Station 614 (Nankauri Harbour, Nicobars) on January 18th-19th, 1922.

Genus **MEGACALANUS** Wolfenden.(= *Macrocalanus* G. O. Sars.)

The genus *Megacalanus* was created by Wolfenden in 1904 to accommodate a large Copepod that he had obtained in the deep water of the Atlantic Ocean and which he called *Megacalanus princeps*. A month or two later G. O. Sars independently described the same species under the name *Macrocalanus longicornis*. Wolfenden subsequently (1905, pp. 1-3) included in the same genus a second form which he took to be identical with that described by Brady in the "Challenger" report under the name *Calanus princeps*. This necessitated a change of name for the original species, which he, therefore, renamed *M. bradyi*. Still later it was pointed out by both Wolfenden (1906, p. 25) and A. Scott (1909, p. 11) that Brady's *Calanus princeps* does not belong to the genus *Megacalanus* at all, so that Wolfenden's original name *M. princeps* still held good and to add to the confusion the form which Wolfenden had taken to be identical with *Calanus princeps* Brady was shown not to be so and was transferred by A. Scott (1909, p. 14) to a new genus *Bradycalanus* that he created to accommodate *Calanus princeps* Brady and a new form that he discovered in the "Siboga" collection. This appeared to clear up the confusion that had arisen in the nomenclature; Sars, however, in his monograph of the Copepoda taken by the late Prince of Monaco has combined the genera *Megacalanus* and *Bradycalanus*, this latter name becoming a third synonym of the genus *Megacalanus* and therefore once again the name *Megacalanus princeps* for Wolfenden's original species becomes untenable and must be replaced by the name given to it by Sars, namely *M. longicornis*.

Megacalanus longicornis* (Sars).Megacalanus princeps*, Wolfenden, 1904, p. 112, pl. ix, fig. 1 (*non Calanus princeps* Brady).*Megacalanus bradyi*, Wolfenden, 1905, p. 1, figs. 1-6.*Macrocalanus longicornis*, Sars, 1905, p. 7.*Megacalanus longicornis*, Pearson, 1906, p. 6.*Megacalanus longicornis*, Farran, 1908, p. 21.*Megacalanus longicornis*, V. Breemen, 1908, p. 13, fig. 9.*Megacalanus princeps*, A. Scott, 1909, p. 13, pl. i, figs. 12-18.*Megacalanus princeps*, Wolfenden, 1911, p. 196, pl. xxii, figs. 1-11.*Megacalanus princeps*, Sewell, 1913, p. 354.*Megacalanus princeps*, With, 1915, p. 41, pl. i, figs. 3a-i, text-fig. 8, a-d.*Megacalanus princeps*, Lysholm and Nordgaard, 1921, p. 8.*Megacalanus longicornis*, Sars, 1925, p. 14, pl. iii.*Megacalanus princeps*, Farran, 1926, p. 230.

This species appears to have a wide distribution; it has now been recorded from the Atlantic Ocean, the west coast of Ireland, the south Atlantic Ocean, the Indian Ocean as far south as Lat. 65° S., and from the Malay Archipelago. In the "Investigator" collections it occurs at Sta 393, which extends its range to the north Indian Ocean and the Bay of Bengal. It appears to be an inhabitant of deep water; Wolfenden records it in depths ranging from 800 to 3,000 metres and in the Indian Ocean it has been taken at 400 fathoms.

The examples in the "Investigator" collections are, curiously, all males.

♂ Total length, 9.5 mm.

The proportional lengths of the cephalothorax and abdomen are as 14 to 5 and the proportional lengths of the abdominal segments are as follows :

Abdominal segments	1	2	3	4	5	Furca	
	16	25	19	15	13	12	=100.

The process on the posterior margin of the head in the mid-dorsal line is well marked. The posterior thoracic margin ends in a small blunt projection. The furcal rami are symmetrical and bear five marginal setae, of which the 2nd is the longest, and an accessory dorsal seta. The inner borders of the rami are fringed with hair.

With (1915, pp. 42-43) has called attention to the presence in members of this genus of certain perforated areas, which he terms " maculae cribrosae ", on the appendages. In my examples I have seen most of those mentioned by With and also certain others that appear to have escaped his observation.

Sars (1926, p. 16) has called attention to the fact that in the closely allied genus *Bathycalanus* the right antenna in the male is modified to form a grasping organ similar to that found in the Podoplea. He states, however, that in the genus *Megacalanus* the antennae in the male are similar to those of the female and are the same on the two sides of the body. This does not agree with my observations on specimens from Indian waters; in all the examples of the male that I have examined, four in all, the antennae on the two sides of the body are different, that on the right side being modified into a grasping organ that appears to be very similar in structure to the grasping antenna in the genus *Bathycalanus*. On the left side the antenna consists of twenty-five segments having the following proportional lengths :

Segment	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	
Sewell	32	46	29	26	31	32	85		41	44	48	54	54	54	55	55	55	54	41	39	41	38	23	23	= 1,000	
Wolfenden	27	43	27	23	30	30	33	27	30	38	42	47	55	53	56	56	57	57	57	42	38	42	37	25	28	= 1,000.

In the above table I have given the measurements taken by me and those given by Wolfenden, which I have converted into parts per 1,000 for the purpose of comparison, and, as can be seen, there is a very close agreement between the two sets of measurements. Segments 7, 8 and 9 are fused together though traces of a line of separation can be made out, especially between segments 8 and 9. On the right side, however, there is a considerable difference; in the first instance the antenna consists of only twenty-four segments instead of twenty-five and in this respect seems to agree with the condition present in *Bathycalanus*. Scott (1909, pl. i, fig. 12) also figures the 1st antenna as consisting of 25 segments. As in the female and in the left antenna of the male segments 7, 8 and 9 are fused together, and in addition so are segments 12 and 13, and these last two segments are armed with longitudinal rows of needle-like spines. There is a distinct elbow-joint between segments 18 and 19 and the terminal part of the antenna consists of six free segments. The proportional lengths of the segments are as follows :

Segment	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	33	46	29	28	32	32	32	26	30	41	44	52	56	58	58	58	56	41	49	51	41	26	26	= 1,000

With (1915, p. 41) calls attention to the clavate seta on segment 9; this is very clear in the present examples. He also calls attention to the imperfect jointing between segments 7

and 9. In his figure he shows these three segments as separated by imperfect joints, but in my Indian specimens the joint between segments 7 and 8 is completely absent and that between 8 and 9 is only partially indicated. The jointing between segments 12 and 13 also appears to be imperfect, as Wolfenden states. According to With there is a perforated area on the second segment; in my examples there are two such, one near the proximal end, oval in shape and consisting of 9 pores, and another about half way along the segment with nine pores in a circle and a tenth centrally.

In the 2nd antenna, basal 1 bears a single seta and a row of hairs; basal 2 bears two setae and, according to With, there is a "macula cribrosa" on the upper surface but I have failed to detect it in my specimens. The exopod bears a single seta. Endopod 1 bears a tuft of setae distally on its inner margin and has a "macula cribrosa" on the anterior surface at the base of the distal third; endopod 2 bears a tuft of setae on its border.

The mandible is strongly armed on its biting surface with 5 large cusped teeth and three pointed teeth, and a serrated spine arises from the posterior margin; along the base of the biting teeth runs a row of needle-like spines, the 1st basal also bears a group of needle-like spines on its margin near the joint with basal 2 and a tuft of hairs about half-way along the anterior margin of the masticatory lobe; basal 2 bears a single seta about the middle of its length and three setae distally on the prolongation of the segment that bears the endopod. The 1st joint of the endopod is produced in a rounded swelling and bears a tuft of hairs externally. The exopod is of the usual type. A "macula cribrosa" is situated on the basal portion of basal 1 and another is to be found on basal 2 near the articulation of the exopod; according to With there are two maculae in this situation each consisting of a ring of 7 pores, but in my specimen there are 14 pores arranged in an oval with three other pores enclosed within the ring.

In the maxilla the 2nd basal bears 4 setae, the 1st inner lobe bears 14 setae, the 2nd 5 and the 3rd 4; the 1st outer lobe carries 9 setae and the 2nd a single one. The endopod consists of two segments each bearing 7 setae, the exopod bears 11 setae and distally has a rounded swelling clothed with hair.

A "macula cribrosa" is situated near the base of the external lobe and, according to With, there is a second macula basally near the lateral margin of the exopod but I have failed to detect this one.

In the 2nd maxilla the 1st lobe bears 6 setae, the 2nd, 3rd and 4th lobes bear 3 setae each, the 5th lobe bears 3 setae and one hook, while the 6th lobe bears one large seta and three small ones. The 5th lobe is much the largest. The terminal joints bear 7 setae. All the setae bear stiff hairs set wide apart. A "macula cribrosa" is situated on the anterior surface of basal 1.

The maxilliped consists of a two-jointed basal portion and an endopod of four segments; these various parts have the following proportional lengths:

Basal 1	Basal 2	Endopod 1	•	2	3	4
80	60	15		17	8	9

In the 1st basal lobe 1 bears 1 seta, lobe 2 has 2 setae, lobe 3 has 4 and so has lobe 4; the 2nd basal bears a group of 3 setae on its inner border about the middle of its length and two others distally. There is a row of needle-like spines extending along its anterior

margin throughout the proximal half, as far as the group of setae. The arrangement of the setae on the segments of the endopod is as follows :—

On Exopod 1, 4 setae

„	2,	4	„	(1 short and 3 long.)
„	3,	3	„	(1 short and 2 long.)
„	4,	4	„	(1 short and 2 long internally and 1 externally.)
„	5,	4	„	(2 short and 2 long.)

Two “ maculae cribrosae ” are present on this appendage, one is situated on the 2nd basal and a second on endopod 4. Neither of these appear to have been seen by With.

In the 1st swimming leg the 1st basal bears a tuft of long hairs on its anterior aspect. Basal 2 carries the hook and bristle that are so characteristic of this species ; these are situated on the anterior aspect of the limb and not, as stated by Wolfenden, on the posterior side.

A “ macula cribrosa ” is situated on the anterior surface of the segment and rather towards the median side near the insertion of the endopod.

Both rami are three-jointed. Exopod 1 bears a single spine externally and one seta internally. Exopod 2 bears also one seta internally and a single marginal spine ; on the external margin just proximal to the spine is a tuft of hairs. A “ macula cribrosa ” is situated on the anterior aspect near the base of the marginal spine and a little to the inner side. Exopod 3 bears two spines and there are four setae on the inner margin ; the distal spine is extremely long. All the marginal spines are long and slender and are serrated on both borders and on the proximal side of each a tuft of hairs arises from the margin of the exopod. The proportional lengths of the three segments of the exopod and the distal spine are as 26 : 17 : 35 : 40. Endopod 1 bears a single seta ; endopod 2 bears 2 setae and there is a “ macula cribrosa ” on the anterior aspect about the middle of its length ; endopod 3 bears 6 setae. The external margin of both the 2nd and 3rd segments is fringed with hairs.

In the 2nd, 3rd and 4th swimming legs the 1st basal segment bears a “ macula cribrosa ” near the outer margin and there is a second on the 2nd basal segment situated just mesially to the articulation of the exopod ; both of these were noted by With. A third lies in the 1st segment of the exopod near the base of the marginal spine and a fourth is situated on endopod 2 near the distal margin. There is a tuft of fine needle-like spines on the anterior aspect of endopod 3 near the base of the proximal outer seta.

In the 5th swimming leg in the male I have been unable to detect a “ macula cribrosa ” on the 1st basal segment, but there is one on the 2nd basal near the articulation of the exopod, another “ macula ” is situated on the 2nd segment of the exopod near the distal outer angle and a third on the 3rd segment of the same ramus near the base of the 1st marginal spine.

Genus **BATHYCALANUS** G. O. Sars.

This genus was created in 1905 to accommodate a single species, *Bathycalanus richardi* Sars, that had been taken by the late Prince of Monaco in the Atlantic Ocean. Wolfenden (1911, p. 198) subsequently added to the genus a second species which he named *B. maximus*, but this appears to differ so slightly from the original species that it is doubtful if the two forms are really distinct. Finally, in 1925, Sars added a third form to the genus

under the name *B. rigidus*, but this last form, to judge by the description and figures, appears to be identical with the species previously described by Wolfenden (1906) under the name *Heterocalanus medius*.

Only one species of this genus has so far been detected in the "Investigator" collections.

Bathycalanus richardi Sars.

Bathycalanus richardi, Sars, 1905, p. 7.

Bathycalanus richardi, Wolfenden, 1911, p. 200, pl. xxiii, fig. 8.

Bathycalanus richardi, Sewell, 1913, p. 354.

Bathycalanus richardi, Sars, 1925, p. 16, pl. iv, and pl. v, figs. 1 to 6.

Two examples of this rare copepod were taken at "Investigator" station 393 in the Bay of Bengal at a depth of 0 to 450 fathoms; it has so far not been obtained at any lesser depth and would, therefore, appear to be a denizen of the deeper water. Both the examples were females and agree exactly with the description given by Sars; they show clearly the almost complete fusion of the 2nd and 3rd segments of the 1st swimming leg.¶

Genus **UNDINULA** A. Scott.

Undinula vulgaris (Dana).

Undinula vulgaris, A. Scott, 1909, p. 16.

Calanus vulgaris, Wolfenden, 1911, p. 193.

Undinula vulgaris, T. Scott, 1912, p. 529.

Undinula vulgaris, Sewell, 1912, pp. 315, 356.

Undinula vulgaris, Sewell, 1913, p. 357.

Undinula vulgaris, Sewell, 1914, p. 196.

Undinula vulgaris, Früchtl., 1924, pp. 15, 33.

Calanus vulgaris, Farran, 1929, p. 216.

Undinula vulgaris var. *plumulosus*, Sewell, 1912, p. 356.

Undinula vulgaris var. *plumulosus*, Wolfenden, 1906, p. 994, pl. xcvi, figs. 21, 22.

This is one of the most common species in Indian waters, occurring in nearly every tow-netting. In the "Investigator" collections it occurs at Stations 540, 541, 542, 552, 555, 556, 558, 577, 582, 614, and it has also been taken in the Malay Archipelago (A. Scott; Früchtl.; Cleve), the Mergui Archipelago and the coast of southern Burma (Sewell), in the Nicobars, on the Pearl Banks of Ceylon (Thompson and Scott; Sewell), in the Maldive Archipelago (Wolfenden) and off the east coast of Africa (Cleve; Brady), as well as in the Red Sea (A. Scott) and the open waters of the Indian Ocean (Thompson).

In the adult form the males differ from the female in possessing a thoracic margin that is uniformly rounded, whereas in the female the margin is produced into spines. The females, however, exhibit three quite distinct variations in the form of the posterior margin; in all cases the right margin ends in a single spine, the character of which varies in certain types, but the left margin exhibits a much greater difference. In the first type, to which I propose giving the name var. *typica*, both the right and left thoracic margins are prolonged backwards in a single curved and somewhat claw-like spine that projects at first backwards but later curves towards the ventral side; in the second, or var. *giesbrechti*,

the single claw on the left side is replaced by a double spine one of which, the upper, projects straight backwards and the lower is directed downwards; in the third type, *var. zeylanica*, the spine on the left side is also double, but in this case the whole of the posterior margin is very considerably thickened and dilated and at the same time the spine on the right posterior thoracic margin is thickened and projects straight backwards. These three types of margin appear to be absolutely distinct and I have never seen any intermediate gradations between the various forms. This modification in the posterior margin of the females appears only in the last moult between the 5th copepodid state and the adult.

Copepodid Stage III ; sex undetermined. (Text-fig. 5, *a-c.*)

Total length, 1.075 mm.

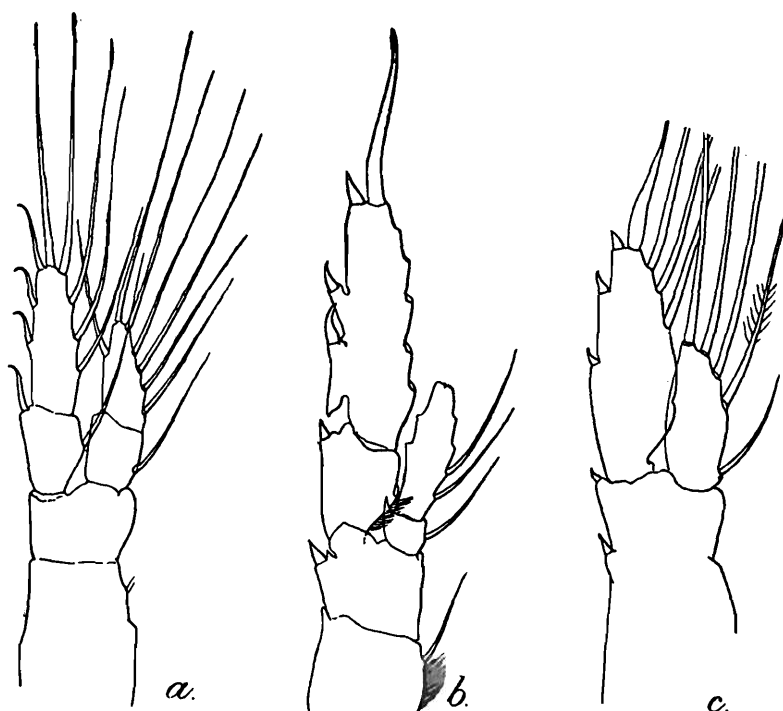
The proportional lengths of the cephalothorax and the abdomen are as 45 to 12, the length of the abdomen being thus contained 3.75 times in the length of the anterior region of the body.

At this stage of development the abdomen consists of only two segments, having with the furcal rami the following proportional lengths :—

$$\begin{array}{ccc} \text{Abdominal segment} & 1 & 2.5 & \text{Furca.} \\ & 25 & 50 & 25 \end{array} = 100.$$

The 1st antenna reaches back to beyond the tip of the furcal ramus by the last $3\frac{1}{2}$ segments. At this stage of development the segmentation appears to be nearly complete, there being 23 free joints in the appendage; segments 6 and 7 are, however, still fused together, as also are segments 8 and 9, but these latter segments remain fused throughout life. The various segments exhibit the following proportional lengths :—

Segment	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
	44	60	28	27	25	35		31		19	25	33	38	42	47	47	53	56	65	56	54	53	59	50	53 = 1,000.



TEXT-FIG. 5.—*Undinula vulgaris* (Dana) : Copepodid Stage III.

a. The 1st swimming leg.

b. The 2nd swimming leg.

c. The 5th swimming leg.

In the swimming legs, the 1st to the 4th pairs inclusive each consist of a two-jointed basal portion and two rami, the exopod and endopod, also each of two segments. The notch in the outer margin of the 2nd leg (text-fig. 5, *b*), that is so characteristic of the species, is already well marked. The proximal

spine on the distal segment of the outer ramus, that will in the adult be the marginal spine of the second segment, is comparatively small and does not reach to the base of the next spine.

The 5th pair of legs (text-fig. 5, c) are symmetrical and each consists of a two-jointed basal portion and an exopod and endopod, each of a single segment only. The exopod bears three small spines on its external margin and only three setae, situated on the distal half of the inner border. At about the junction of the proximal and middle thirds of the limb there is a shallow notch in the inner margin, indicating the future position of the articulation between the 1st and 2nd segments of the ramus. The endopod bears a small seta near the proximal end and four setae on the distal half of the inner border.

At this stage of development it appears to be impossible from a study of the external morphology to determine the sex of the individual. The chitinous exoskeleton of the whole body is thin and delicate and the limbs appear to be strengthened by a network of ribs and trabeculae.

Copepodid Stage IV. (Text-fig. 6, a-e.)

♀ Total length from 1.547 to 1.887 mm.

The proportional lengths of the cephalothorax and abdomen are as 29 to 8, the length of the abdomen is thus contained 3.63 times in that of the anterior region of the body.

The abdomen at this stage consists of three segments, that have, with the furcal rami, the following proportional lengths :—

Abdominal segment	1	2	3-5	Furca.
	25	20	35	20 = 100.

The 1st antenna still reaches well beyond the tip of the furcal ramus. The segmentation of the appendage is now complete, there being 24 free segments ; these have the following proportional lengths :—

Segment	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
	48	60	28	21	25	21	21	39	28	29	39	47	47	50	51	54	55	58	60	50	50	50	37	39	= 1,000.

The mouth-parts have already assumed the adult characters.

The swimming legs, however, are still of the same type as in the preceding moult, but the number of setae on the various segments has increased. In the 1st swimming leg (text-fig. 6, c) the rami are still two-jointed but the distal segment of the endopod now bears 9 setae instead of 7 ; similarly in the 2nd leg the number of setae on the endopod has increased from 8 to 9. The 5th pair of legs (text-fig. 6, e) are still composed of a two-jointed basal portion and a pair of unjointed rami ; but here again there is an increase in the number of the setae arising from the margin of the endopod, the number having been increased from 5 to 6 by the addition of a small seta that arises from the outer margin of the distal third.

While still possessing the same general features as in the earlier moult, the 5th pair of legs is now better developed and already begins to show traces of the difference in the structure of the appendage in the two sexes ; in the potential male the exopod of the left leg is now both longer and broader than the corresponding appendage of the right side, while the terminal spine is somewhat shorter.

Copepodid Stage V. (Text-fig. 7, a-f.)

♀ The individuals obtained at "Investigator" Station 614 that were in this stage of development fall into two distinct groups, differentiated, so far as I have been able to discover, merely by size, and these two groups appear to correspond to two different forms of adult, which I have termed *forma major* and *forma minor* respectively :—

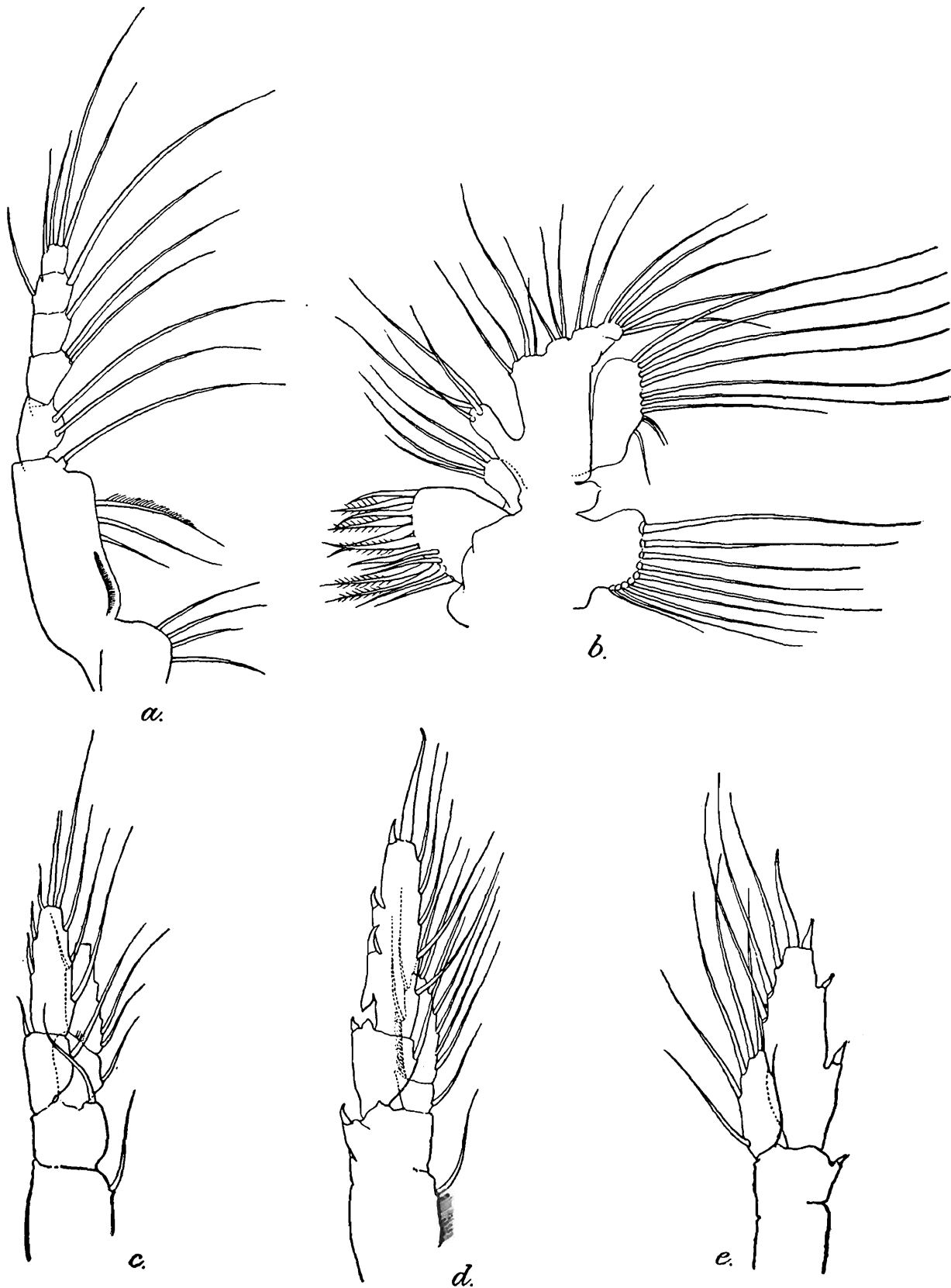
(a) *Forma major.*

Total length ranging from 1.717 to 1.924 mm.

(b) *Forma minor.*

Total length ranging from 1.547 to 1.698 mm.

I have been unable to detect any marked anatomical difference between these two groups.



TEXT-FIG. 6.—*Undinula vulgaris* (Dana): Copepodid Stage IV. ♀.

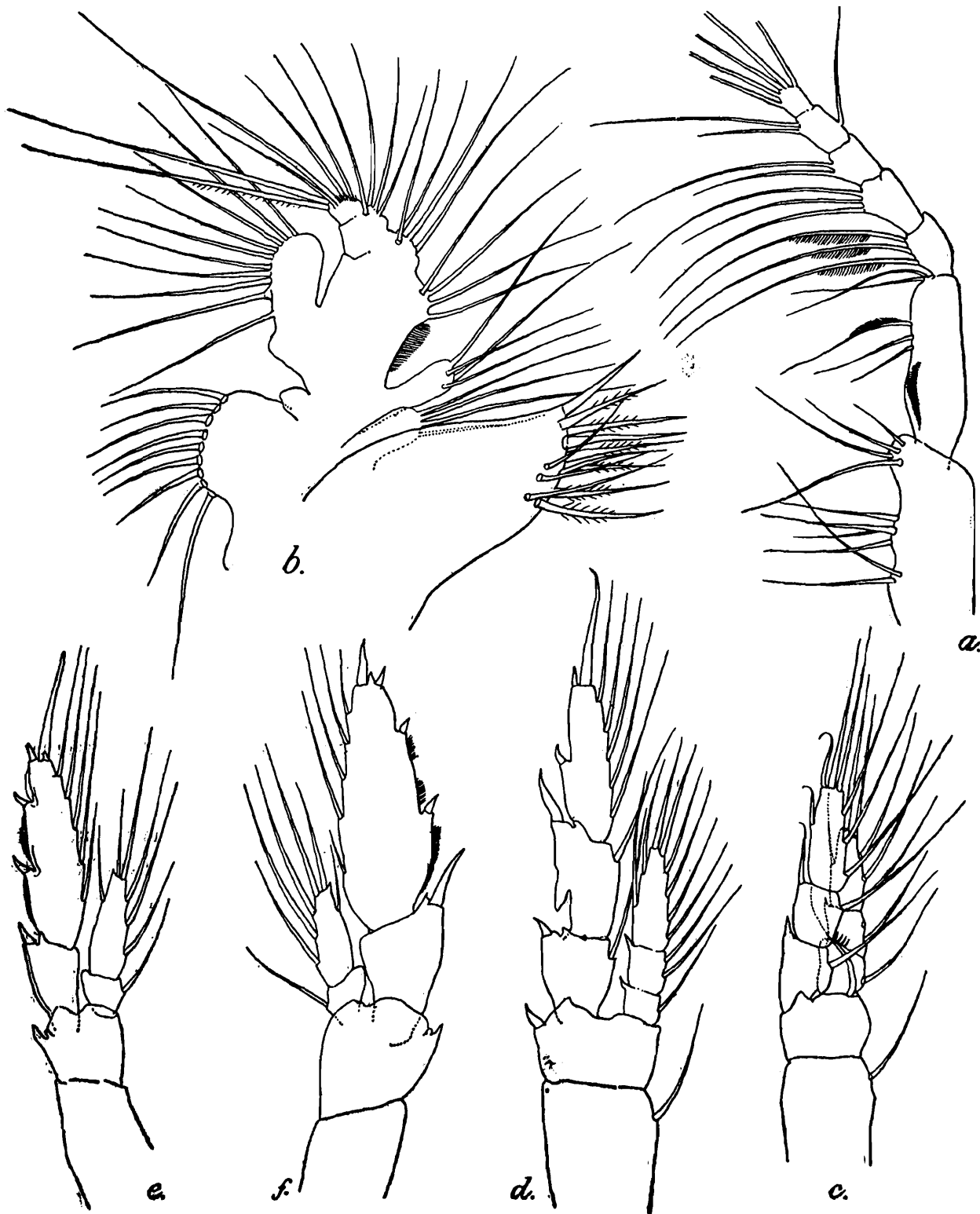
a. The maxilliped.
b. The 1st maxilla.

c. The 1st swimming leg.
d. The 2nd swimming leg.

e. The 5th leg.

The proportional lengths of the cephalothorax and abdomen are as 69 to 20; the abdomen is thus contained 3.45 times in the length of the anterior region of the body.

The head and 1st thoracic segment are fused but in certain cases the line of demarcation can still clearly be made out. With the exception of the segmentation of the abdomen these individuals closely



TEXT-FIG. 7.—*Undinula vulgaris* (Dana): Copepodid Stage V.

a. The maxilliped.	d. The 2nd swimming leg.
b. The 1st maxilla.	e. The 5th leg, right side, ♂.
c. The 1st swimming leg.	f. The 5th leg, left side, ♂.

resemble the adult, but there are no traces of any spine-like projection on the posterior thoracic margin, which is uniformly rounded as in the adult male.

The abdomen consists of four free segments, segments 4 and 5 still being fused together; the proportional lengths of the segments are as follows :—

Abdominal segment	1	2	3	4-5	Furca	
	25	18	17	22	18	= 100.

The 1st antenna still reaches beyond the tip of the furcal ramus by about the extent of the last segment. The proportional lengths of the various segments are as follows :—

Segment	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
	56	64	28	23	24	24	23	44	29	31	42	47	50	53	54	56	54	56	46	44	42	44	35	31	= 1,000.

In the 1st maxilla (text-fig. 7, b) there has been a slight increase in the number of setae borne on the terminal segments of the endopod, as follows :—

		Copepodid stage IV.	Copepodid stage V.
No. of setae on basal segment		4	4
Ditto	endopod 1	3	4
Ditto	endopod 2	2	4
Ditto	endopod 3	5	6

Similarly in the maxilliped (text-fig. 7, a) the number of setae on the various segments of the endopod, as well as those at the distal end of the 2nd basal joint, has increased :—

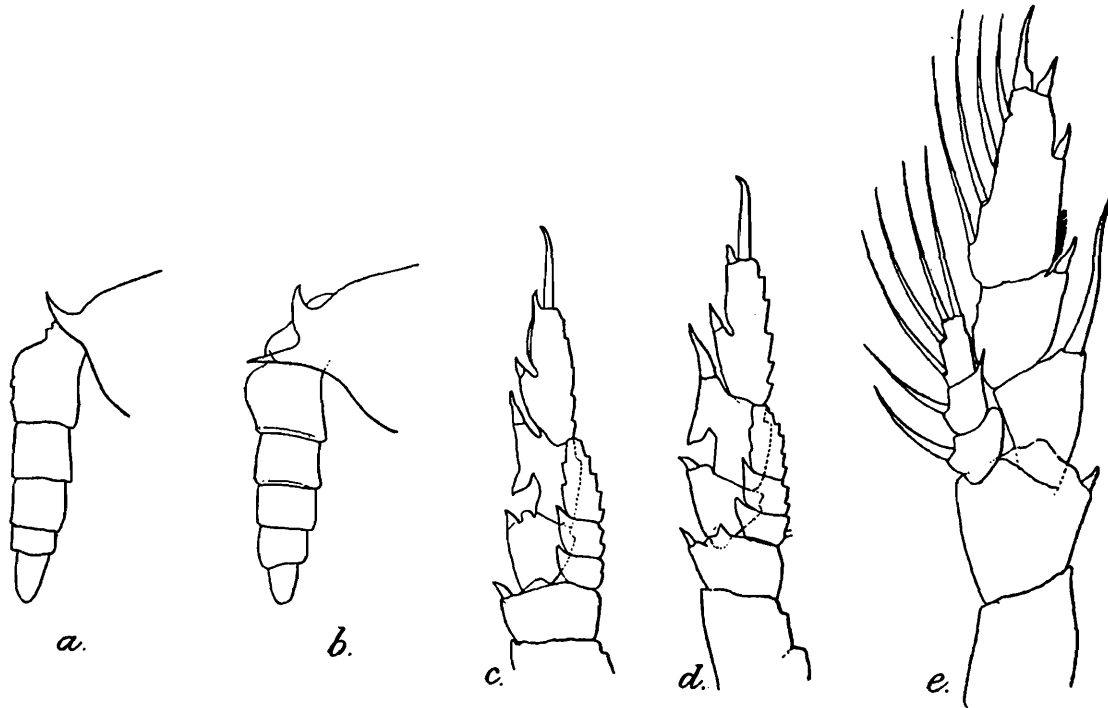
		Copepodid stage IV.	Copepodid stage V.
No. of setae on distal end of basal 2		1	2
Ditto	endopod 1	2	3
Ditto	endopod 2	2	3
Ditto	endopod 3	1	2
Ditto	endopod 4	1 (1 externally).	2 (1 externally).
Ditto	endopod 5	4	5

The 1st to the 4th pairs of swimming legs have now assumed the adult characters and both rami consist of three segments. In the 5th pair of swimming legs the two rami still consist of only two segments: in the exopod the proximal segment of the limb (exopod 1) has become differentiated and an additional spine has made its appearance on the external margin and thus indicates the level at which, in the next moult, the division between exopod 2 and 3 will appear. In the female both legs of the 5th pair are symmetrical but in the male (text-fig. 7, e, f) the differentiation between the legs of the two sides is now well marked; on the left side the limb is considerably longer and the exopod is broader, the marginal spine on exopod 1 has increased in size and the terminal spine is much shorter than on the right side.

Adult stage (Text-fig. 8, a-e).

♀ Among the specimens taken at "Investigator" Station 614 were a number of adult examples of this species that fall into two distinct groups in accordance with their size and I clearly had to deal with two distinct forms of the female, there being a clear separation between the two groups. There is little room for doubt that both these forms belong to the same species and, moreover, it seems more than probable that the two adult forms correspond to the two groups of the copepodid stage V, to which I have already called attention and, furthermore, the smaller form that I have termed *forma minor* appears to correspond to the members of the earlier stages of development, viz., copepodid stages III and IV that

occur in the same tow-netting; whereas in the case of the larger form, which I have termed *forma major*, I appear to have obtained only the immediately preceding stage of development, namely copepodid stage V



TEXT-FIG. 8.—*Undinula vulgaris* (Dana); Adult.

- a. Posterior thoracic margin and abdomen from left side; *forma minor* ♀.
b. Posterior thoracic margin and abdomen from left side; *forma major* ♀.

- c. The 2nd swimming leg; *forma minor*.
d. The 2nd swimming leg; *forma major*.
e. An abnormal 5th left leg, hermaphrodite form.

(a) *Forma major*.

Total length ranging from 2.208 to 2.623 mm.

The majority of examples of this form agree with the variation that I described from the Pearl Banks of Ceylon (*vide* Sewell, 1914, p. 197) and the left posterior thoracic margin was very considerably thickened and terminated in two spines, one directed backwards and the other downwards, as in the variety that I have termed *zeylanica*.

(b) *Forma minor*.

Total length ranging from 1.868 to 2.189 mm.

The majority of the members of this group agree closely with the description given by Giesbrecht (1892, p. 129, pl. vii, fig. 24). The posterior thoracic margin ends on each side in a well-marked, backwardly directed spine, as in var. *typica*.

The proportional lengths of cephalothorax and abdomen in both forms are 47 to 15; the abdomen being thus contained 3.12 times in the length of the anterior region of the body.

There appear to be certain minor differences between these two groups. In the larger examples the genital swelling on the ventral aspect of the 1st abdominal segment is more pronounced than in the smaller examples. There is also a slight difference in the structure of the 2nd pair of swimming legs and I have figured this in text-figure 8, c and d. The

main difference lies in the degree of development of the marginal spine on exopod 2. In the smaller examples this spine clearly falls short of the level of the proximal spine on the margin of exopod 3; whereas in the larger form it reaches to or even slightly beyond this level.

In the collection were a very few examples of what appear from their external characters to be hermaphrodite individuals. The occurrence of abnormal females in which certain male characters are partially developed has been recorded in a number of allied species belonging to the genera *Paracalanus* and *Acrocalanus*. The species in which this abnormality has so far been noticed are—

Paracalanus aculeatus Giesbrecht.

Paracalanus crassirostris Dahl.

Paracalanus parvus Giesbrecht.

Acrocalanus inermis Sewell.

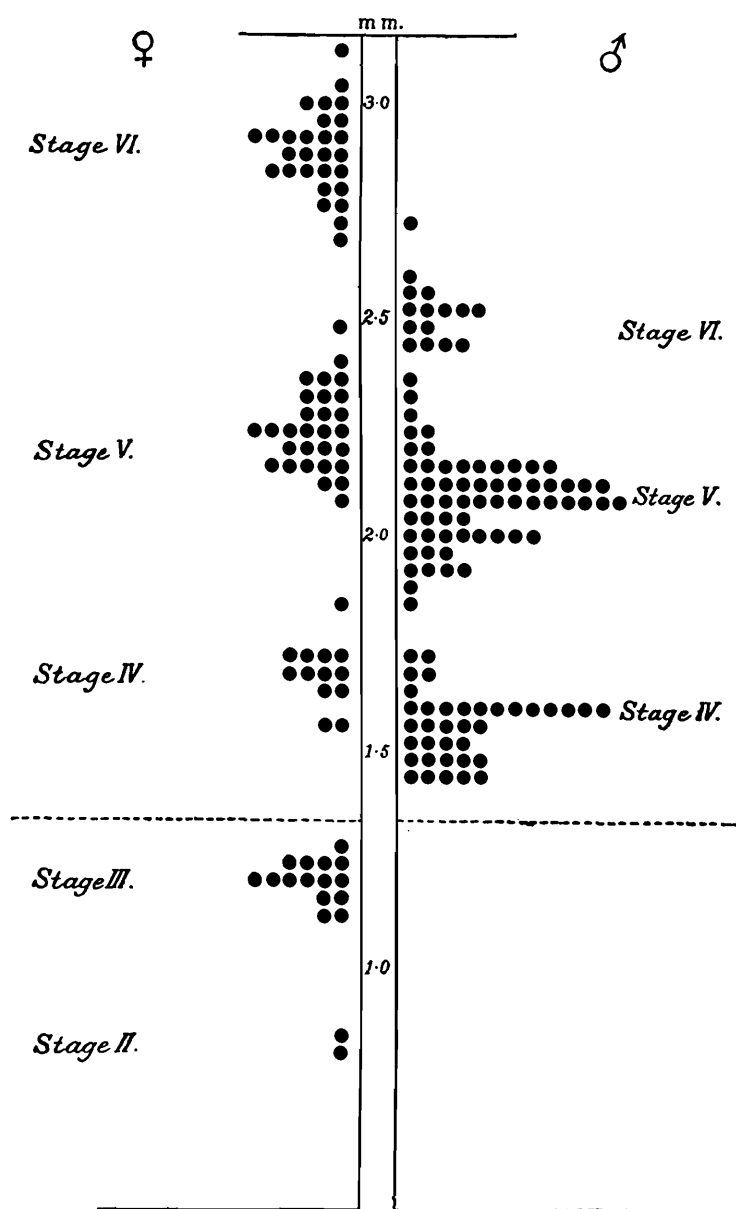
In all such cases the abdomen has resembled that of the female and in certain cases the individual has appeared to be a mature female with the addition of rudimentary 5th legs, such appendages being normally confined in these genera to the male sex. In the present individuals, however, the abdomen corresponded in the type of segmentation to the condition seen in the normal male and possessed five separate segments. On the other hand, however, the posterior thoracic margin exhibited the female type and was produced backwards on each side in a sharp ventrally-curving spine. Of the 5th pair of legs, that on the right side exhibited the typical female form, but on the left side the appendage was modified and showed a close resemblance to the left 5th leg of an immature male in the Vth copepodid stage of development. The resemblance is, however, only superficial, for a comparison of the two appendages shows that in the apparently hermaphrodite form both rami are three-jointed, though the actual division between exopod 2 and 3 appears to be incomplete (text-fig. 8, e). Exopod 1 bears a greatly enlarged marginal spine that reaches nearly to the level of origin of the proximal spine on exopod 3. In the endopod both the 1st and 2nd segments bear on their inner margin a thickened seta that clearly agrees with the corresponding seta in the mature female. Two specimens that showed this peculiarity measured 2.075 and 2.132 mm. respectively.

I have already pointed out (*vide supra*, p. 24) that in the case of *Nannocalanus minor* (Claus) we can trace certain interesting changes in the proportionate lengths of the antennal segments as we pass from the last copepodid stage to the adult, and in the present species I am fortunate enough to have examples of the last four stages of development and am thus in a position to trace these changes throughout the greater part of the life-history. At each successive moult the 1st antenna increases in length but at the same time the proportions of the antenna and the total body-length change somewhat, so that the appendage becomes relatively shorter. This relative shortening of the antenna is brought about by a steady reduction in length of the terminal segments. In the following table I have given the length of each segment in parts of 1,000th of the total length at each successive moult in the female. I have only given one set of measurements for the lengths of the antennal segments in the last two stages of the life-history, namely copepodid stage V and the adult, for, although I have already shown that we have two distinct groups in each of

these growth-stages, I have been unable to detect any difference in the proportional lengths of the segments in the two groups:—

Segment	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
Copepodid stage III	44	60	28	27	25	35	31	19	25	33	38	42	47	47	53	56	65	56	54	53	59	50	53		
Copepodid stage IV	48	60	21	21	25	21	39	28	29	39	47	47	50	51	54	55	58	60	50	50	50	37	39		
Copepodid stage V	56	64	28	23	24	24	23	44	29	31	42	47	50	53	54	55	56	56	46	44	42	44	35	31	
Adult stage	56	78	32	27	27	27	28	49	34	35	44	48	50	52	54	53	51	51	40	36	36	39	30	26	

It is clear from the above figures that the proximal segments exhibit a relative increase at each ecdysis and that the maximum increase in the length of the various segments occurs at about the level of segment 6 or 7 and from there more or less steadily diminishes, as we pass distally, till it reaches zero at segment 17; whereas from segment 18 on to the terminal segment there is a steadily increasing diminution in the relative length of the segment.



TEXT-FIG. 9.—Showing the length-measurement of 200 individuals of *Undinula vulgaris* (Dana) taken at "Investigator" Station 555.

In the tow-netting taken at "Investigator" station 555 a large number of examples of this species were taken in different stages of development. Two hundred of these were

picked out at random and were measured, the measurement taken being the total-length from the anterior margin of the forehead to the tip of the furcal ramus and the results obtained are shown in the accompanying diagram (text-fig. 9). It is clear that the specimens fall into definite groups according to their length and the average length-measurement of each group is given below in the following table and I have also given the calculated length-measurement and the corresponding growth-factor for each successive moult :—

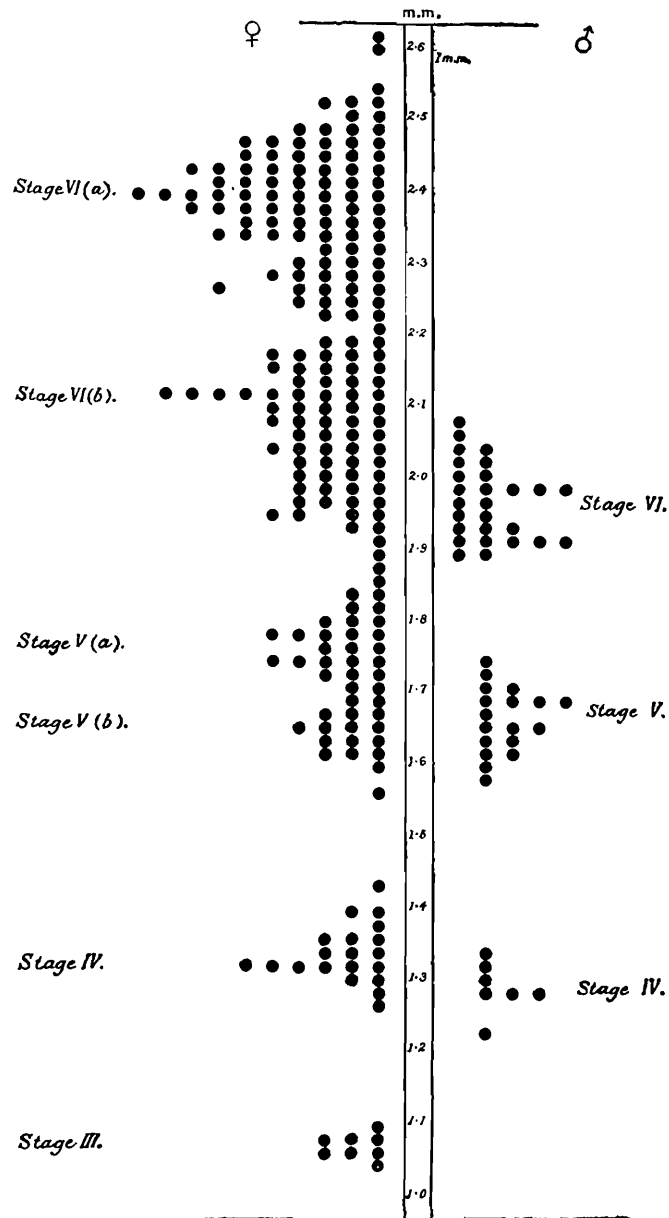
Sex.	Observed size.	Calculated size.	Growth-factor.
♀	mm.	mm.	
Copepodid stage II	0.86	0.86	1.397
Copepodid stage III	1.20	1.201	1.397
Copepodid stage IV	1.68	1.678	1.311
Copepodid stage V	2.24	2.20	1.311
Adult stage	2.89	2.885	..
♂			
Copepodid stage III	1.20	1.201	1.603 or 1.311
Copepodid stage IV	1.56	1.574	1.603
Copepodid stage V	2.14	1.925	..
Adult stage	2.51	2.514	..

From the above table it is clear that the females fall into five groups corresponding to the different growth-stages ; of these groups the two smallest, copepodid stages II and III, are composite and include members of both sexes, since it was found to be impossible to determine the sex in individuals so young as this. In examples of the smallest size the abdomen consisted of two segments only and the individuals appeared to correspond exactly with the second post-naupliar growth-stage, *viz.*, copepodid stage II, the adult form thus being stage VI, as has been shown to be the case in *Calanus finmarchicus* Gunnerus and other Calanoids.

Assuming that this species follows the same line of development as I have shown to happen in other copepods (*vide* Sewell, 1912, p. 316 *et seq.*) we find that there is a drop in the growth-factor when stage IV is reached ; in the earlier moults it is 1.397 but after stage IV, *i.e.*, presumably at that stage in the life-history of the individual when the changes that lead to the attainment of sexual maturity begin to influence the vegetative growth, there is a fall in the factor to 1.311. In the male sex it appears to be probable that from copepodid stage III the individual may follow one of two distinct life-histories ; either the individual may continue to have a growth-factor of 1.603, in which case it will reach to stage V by a single moult, or else the individual may for a single moult adopt the female growth-factor of 1.311 and thus pass to stage IV and then by a resumption of the male growth-factor of 1.603 pass to the adult stage.

A number of other examples, which were taken at "Investigator" station 614, were similarly measured as regards their total length and the results obtained are given in text-fig. 10. In the case of the females four distinct growth-stages were detected, but, as I have already mentioned, in the last copepodid stage and the adult form we appear to have two groups of individuals differing from each other in size and certain small anatomical details. A comparison of the results obtained from these measurements appears to indicate

that it is the smaller group in these two last stages of the life-history that correspond to the earlier growth-stages. In this series the youngest stage corresponds to copepodid stage III,



TEXT-FIG. 10.—Showing the length-measurement of 288 individuals of *Undinula vulgaris* (Dana) taken at "Investigator" Station 614.

the abdomen still consisting of only two segments. In the following table I give the average length-measurement and the corresponding growth-factor in each stage:—

Sex.	Observed size.	Calculated size.	Growth-factor.
♀	mm.	mm.	
Copepodid stage III	1.047	1.047	1.260
Copepodid stage IV	1.319	1.319	1.251
Copepodid stage V	1.634	1.650	1.251
Adult stage	2.067	2.064	
♂			
Copepodid stage III	1.047	1.047	1.510 or 1.251
Copepodid stage IV	1.272	1.321	1.510
Copepodid stage V	1.653	1.581	..
Adult stage	1.964	1.978	..

Here again the course of development appears to follow exactly the same lines as before. At stage III in the male sex the individual appears to be able to follow one of two different lines of development; either the individual can by adopting the male growth-factor pass direct to stage V, in which case it would appear probable that it never attains sexual maturity, or else by adopting the female growth-factor for a single moult it can pass to stage IV and then, reverting to the male growth-factor, passes to the adult stage. The occurrence of the apparently hermaphrodite individuals, that I have already described above, at first sight offers a difficulty in the life-history for these examples do not agree in size with any of the main groups; they are larger than the fully mature males but smaller than the mature females. It would appear possible that these individuals are really females that at the moult after copepodid stage IV, instead of exhibiting the female growth-factor like normal individuals, develop the male growth-factor of 1.510, as follows:—

	Observed size.	Calculated size.	Growth-factor.
Copepodid stage IV	1.319	1.319	1.510
Hermaphrodite stage	2.103	1.992	

I have hitherto been inclined to believe that the growth-factor was a constant for any given species but a comparison of the data given above seems to indicate that the growth-factor varies with the size of the adult individual and that the larger the size of the individual the larger will be the growth-factor.

With an average size of ♀ of 2.89 mm. the growth-factor is 1.397 or 1.311.

Ditto	♀ „ 2.067	Ditto	1.260 „ 1.251.
Ditto	♂ „ 2.51	Ditto	1.603 „ 1.311.
Ditto	♂ „ 1.964	Ditto	1.510 „ 1.251.

Undinula darwini (Lubbock).

Undinula darwini, A. Scott, 1909, p. 17.

Undinula darwini, Wolfenden, 1911, p. 193.

Undinula darwini, T. Scott, 1912, p. 529.

Undinula darwini, Sewell, 1912, p. 356.

Undinula darwini, Pesta, 1913, p. 30, fig. 13.

Undinula darwini, Sewell, 1914, p. 197.

Calanus darwini, Farran, 1929, p. 217.

This species is widely distributed throughout the whole of the Indian Ocean; it has now been recorded from the Malay Archipelago (Scott); the coast of southern Burma (Sewell); the Pearl Banks of Ceylon (Thompson and Scott); the Maldivé Archipelago (Wolfenden), the Arabian Sea, Gulf of Aden and Red Sea (A. Scott and others) and from the east coast of Africa (Cleve).

According to the description given by Lubbock, Giesbrecht and others the female of this species is characterised by a prolongation of the posterior thoracic margin on the left side backwards in a rounded or square flap, and by the presence of rows of spines on the posterior margin of the first two abdominal segments. Among the "Investigator" collections are a number of examples that I believe belong to this species, but which exhibit appreciable variations from the typical form, as well as others that conform to the original.

description. I have already pointed out that in the allied species, *Undinula vulgaris* Giesbrecht, the female exhibits three distinct varieties as regards the character of the left thoracic margin and it appears probable that *Undinula darwini* (Lubbock) is equally variable. The typical form, as mentioned above, exhibits a square prolongation of the posterior margin of the thorax on the left side, while the right side shows a border that is tapered to a blunt point, below which is a small indentation; I propose to term this form, forma *typica*. In a second form the right thoracic margin is similar to that in the forma *typica*, but the left thoracic margin is produced back in a triangular flap that is only from one-third to one-half the size of the corresponding flap in the typical form; and in the third form the margins of the thorax are symmetrical and both correspond to the condition of the right margin in the typical form. I have examined a large number of specimens, including examples of all three types, and have never seen any intermediate gradation between these forms and their differentiation would appear to be distinct.

The presence of spines on the abdominal segments appears to be a very variable character; in some examples spines were present in the typical manner along the posterior margins of both the first and second segments of the abdomen, but in other cases these spines were absent from the genital segment and present on the 2nd segment or they might be absent altogether, and I have been unable to trace any correlation between the arrangement of these spines and the variations of the posterior thoracic margin.

As regards the general structure of the body and appendages two of the forms mentioned above, namely forma *typica* and var. *intermedia*, appear to agree exactly, while the third type var. *symmetrica* exhibits certain interesting though slight differences.

Forma *typica*.

(Text-fig. 11, *a-j*.)

♀ Total length, 1.66 mm.

The proportional lengths of the cephalothorax and abdomen are as 35 : 9, the abdomen thus being contained 3.9 times in the length of the anterior region of the body.

The head and 1st thoracic segment are fused and together constitute rather more than one-half of the total length of the body. In the middorsal line, marking the level at which the fusion of the head and the next segment has taken place, is a small rounded backwardly-directed protuberance. The forehead is uniformly rounded and terminates below in a pair of long rostral spines. As mentioned above, the thoracic margin differs on the two sides of the body, that on the right side (text-fig. 11, *a*) being for the most part uniformly rounded but at the postero-inferior region it is slightly produced and immediately below this small prominence is an equally small notch; on the left side the thoracic margin is produced in a well-marked and usually square lappet, that covers at least three-fourths of the genital segment of the abdomen. The outline of the lappet is in some cases rounded instead of being square.

The abdomen consists of four segments having the following proportional lengths:—

Abdominal segments	1	2	3	4	5	Furca	
							
	33	19	18	9	21		= 100.

The 1st and 2nd free segments are stated to be armed with rows of spines running transversely across the segments near the posterior border, but as already mentioned these spines may be reduced or even absent altogether.



TEXT-FIG. 11.—*Undinula darwini* (Lubbock) forma typica.

a. Posterior thoracic margin and abdomen, right side, ♀.

b. The 2nd antenna.

c. The 2nd maxilla.

d. Maxilliped.

e. The 1st swimming leg.

f. The 2nd swimming leg.

g. An abnormal 2nd swimming leg; endopod of two segments only.

h. The 3rd swimming leg.

i. The 4th swimming leg.

j. The 5th leg, ♀.

The 1st antenna reaches back to the posterior margin of the 3rd abdominal segment. It consists of twenty-four free segments, segments 8 and 9 being fused. The proportional lengths of the various segments are as follows:—

Segment	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
	52	74	37	28	30	30	30	51	34	35	39	44	45	46	46	50	52	47	38	38	39	44	42	28	= 1,000:

A transverse row of small spinules runs across the surface of segments 6 and 7 near the distal margin.

The 2nd antenna and mouth-parts are of the usual Calanoid type and are very similar to those of *Undinula vulgaris* (Dana).

The first three pairs of swimming legs agree with the descriptions given by previous authors, but the 4th pair in these examples from Indian waters differ in that the external margin of the distal part of the third segment of the exopod is invariably smooth and shows no signs of any denticulation such as occurs in the 2nd and 3rd legs.

In the 5th pair of swimming legs (text-fig. 11, *j*) the marginal spine of exopod 1 is long, much longer than the corresponding spines on the 2nd, 3rd and 4th legs and reaches to the level of the base of the marginal spine of the 2nd segment of the exopod; the inner margin of the 1st basal segment is fringed with a row of small spinules about 40 in number, all of which are of approximately the same size.

Var. *symmetrica*.

The general structure of this form agrees exactly with that of the forma *typica*, except that the prolongation of the posterior margin of the last thoracic segment on the left side is entirely absent.

The proportional lengths of the antennal segments is the same or so little different that the discrepancy can be accounted for by individual variation; and the various other appendages appear to be identical. The sole distinguishing character of this form is to be found in the thoracic margin.

Var. *intermedia*.

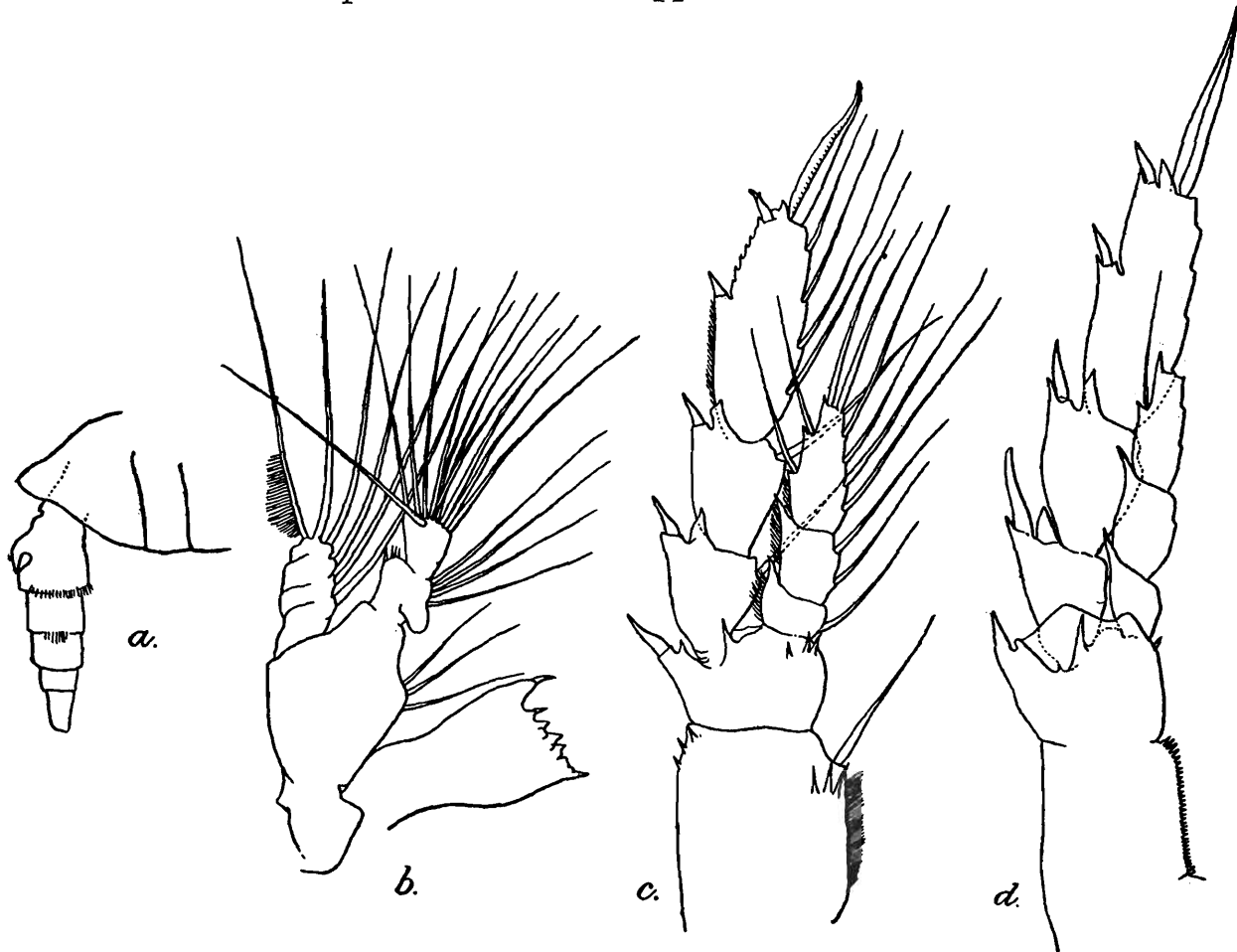
(Text-fig. 12, *a-d*.)

In this form the thoracic margin on the left side (text-fig. 12, *a*) is produced backwards in a flap that is suggestive of the corresponding flap in the forma *typica* but is much smaller and is triangular and not square; there are in addition certain small but apparently consistent differences in the structure of some of the appendages.

The total length and the proportions of the cephalothorax and abdomen are the same as in the typical form.

The 1st antenna consists, as in the typical form, of twenty-four segments, segments 8 and 9 being fused and the proportional lengths of the segments are the same. In this form a row of minute spinules has been detected running across the surface of segments 3 to 8 inclusive, whereas in the other form I have detected these only on segments 6 and 7. The mouth-parts and the first four pairs of swimming legs appear to be identical. The 5th swimming leg (text-fig. 12, *d*) shows distinct differences. The external marginal spine on the 1st segment of the exopod is very considerably smaller than in the forma *typica* and

only reaches about half-way to the level of the origin of the marginal spine on the 2nd segment, and the spines on the inner margin of the 1st basal segment are distinctly larger than in the forma *typica* and at the two ends of the row the spines are distinctly larger than the rest. There are about 30 spines in the row as opposed to 40 in the other form.



TEXT-FIG. 12.—*Undinula darwini* (Lubbock) var. *intermedia*.

a. Posterior thoracic margin and abdomen, left side, ♀.
b. Mandible.

c. The 3rd swimming leg.
d. The 5th leg, ♀.

It is possible that the form that I have described above is in reality the female of *Undinula caroli*. Wolfenden (1906a, p. 994) has given a very brief account of a female Calanoid that he suggested might be the female of *U. caroli* and he remarks that this female "while closely resembling the ♀ *C. Darwinii*, differs from it in the fact that the denticulation of the last joint of the exopodite of the 2nd feet (external margin) is absent, and also in the 3rd pair, and on the 1st basal joint of the 1st pair of feet possesses three or four very fine teeth. In other respects the animal agrees with *C. Darwinii*." I have previously pointed out (Sewell, 1914, p. 199) that in my opinion Wolfenden's examples were probably examples of *Calanus minor* and I have also shown that the sole distinguishing feature between the males *U. darwini* and *U. caroli* lies in the structure of the 5th pair of legs and I regard them as forms or varieties of the same species.

Family EUCALANIDAE.

Genus **EUCALANUS** Dana.

At the present time this genus contains ten species all of which occur in Indian waters, with the single exception of *Eucalanus dentatus* A. Scott, which was described from

specimens taken by the "Siboga" in the Malay Archipelago. Thompson in 1900 recorded the occurrence of *Eucalanus attenuatus* (Dana) from the Indian Ocean and a year later Cleve (1901) added the following to the list of species known to occur in this region:—

Eucalanus crassus Giesbrecht.

Eucalanus monachus Giesbrecht.

Eucalanus mucronatus Giesbrecht.

Eucalanus subcrassus Giesbrecht.

Eucalanus subtenuis Giesbrecht.

The same author in 1903 recorded all the above species from the Indian Ocean, Gulf of Aden and the Red Sea and in 1904 added to the list of species known to occur in these waters *Eucalanus elongatus* (Dana) from the east of Cape Colony. Thompson and Scott a year previously, in 1903, had recorded *Eucalanus pileatus* Giesbrecht from the Pearl Banks of Ceylon and in 1909 A. Scott described a hitherto unknown species *Eucalanus dentatus* from the Malay Archipelago. It is extremely interesting to note that A. Scott in his exhaustive report of the Copepoda of the Siboga expedition makes no mention of either *Eucalanus attenuatus* or *E. elongatus* as occurring in that region, and yet, so far as my own experience goes, these two species are remarkably common in tow-nettings taken in Indian waters at a depth of about 200 fathoms, and are even occasionally to be found at the surface.

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

Calanus attenuatus, Dana, 1849, p. 18.

Eucalanus attenuatus, Dana, 1852, p. 1081, pl. lxxv.

Calanella mediterranea, Claus, 1863, p. 176, pl. xxviii, figs. 6-11.

Eucalanus attenuatus, Brady, 1883, p. 38, pl. vi, figs. 1-8; pl. ii, figs. 8-10.

Eucalanus attenuatus, Giesbrecht, 1888, p. 333.

Eucalanus attenuatus, Giesbrecht, 1892, p. 131, pl. iii, fig. 1; pl. xi, figs. 1, 11, 13, 16, 18, 24, 40; pl. xxxv, figs. 3, 6, 17, 25, 34, 37

Eucalanus attenuatus, T. Scott, 1894, p. 28.

Eucalanus attenuatus, Giesbrecht, 1895, p. 248.

Eucalanus attenuatus, Giesbrecht and Schmeil, 1898, p. 16, fig. 12.

Eucalanus attenuatus, Thompson, 1900, p. 276.

Eucalanus attenuatus, Cleve, 1901, p. 6.

Eucalanus attenuatus, T. Scott, 1901, p. 207.

Eucalanus attenuatus, Cleve, 1903, p. 362.

Eucalanus attenuatus, Thompson and Scott, 1903, p. 242.

Eucalanus attenuatus, Cleve, 1904, p. 189.

Eucalanus attenuatus, Esterly, 1905, p. 133, fig. 7.

Eucalanus attenuatus, G. O. Sars, 1905, p. 2.

Eucalanus attenuatus, Pearson, 1906, p. 7.

Eucalanus attenuatus, Wolfenden, 1906 (a), p. 996.

Eucalanus attenuatus, Farran, 1909, p. 22.

Eucalanus attenuatus, van Breeman, 1908, p. 16, fig. 12.

Eucalanus attenuatus, O. Pesta, 1909, p. 21.

Eucalanus attenuatus, A. Steuer, 1910, p. 21.

- Eucalanus attenuatus*, Sharpe, 1911, p. 406.
Eucalanus attenuatus, Wolfenden, 1911, p. 204.
Eucalanus attenuatus, Sewell, 1912, p. 357
Eucalanus attenuatus, T. Scott, 1912, p. 529.
Eucalanus attenuatus, Sewell, 1913, pp. 354, 357.
Eucalanus attenuatus, Sewell, 1914, p. 200.
Eucalanus attenuatus, Brady, 1915, p. 136 [*nec Eucalanus attenuatus*? With, 1915, p. 52 text-fig. 10.]
Eucalanus attenuatus, G. O. Sars, 1925, p. 21.
Eucalanus attenuatus, Farran, 1929, p. 218.

This species is one of wide distribution, occurring in all the great oceans in the warmer tropical and sub-tropical regions and in the case of the North Atlantic occurring occasionally as far north as the west coast of Ireland. Wolfenden (1902, pp. 362-3) claimed this species as a member of the fauna of the Faroe Channel, having found it on one occasion in one of the samples from that locality, but he subsequently withdrew this on the ground that this sample must, in his opinion, have become contaminated with some material from the Indian Ocean.

In the "Investigator" collections this species has been taken in large numbers at Stations 393, 463, 670 and 682. It also occurs occasionally in the surface collections from the Moscos Archipelago, off the coast of Southern Burma and it has been taken on the Ceylon Pearl Banks.

***Eucalanus elongatus* (Dana).**

(Text-fig. 13, *a-c.*)

- Calanus elongatus*, Dana, 1849, p. 18.
Calanus elongatus, Dana, 1852, pl. lxxv, fig. 1, *a, b*.
Calanella hyalina, Claus, 1866, p. 8.
Eucalanus elongatus, Giesbrecht, 1888, p. 333.
Eucalanus elongatus, Giesbrecht, 1892, pp. 131, 149, pl. xi, figs. 2, 7, 12, 20, 25, 32, 36 and pl. xxxv, figs. 1, 2, 13, 23 and 24.
Eucalanus elongatus, Giesbrecht, 1895, p. 248.
Eucalanus elongatus, Giesbrecht and Schmeil, 1898, p. 20.
Eucalanus elongatus, T. Scott, 1901, p. 237.
Eucalanus elongatus, Wolfenden, 1902, pp. 362-3.
Eucalanus elongatus, Cleve, 1904, p. 189.
Eucalanus elongatus, Wolfenden, 1904, p. 127.
Eucalanus atlanticus, Wolfenden, 1904, p. 113, pl. ix, figs. 3 and 4.
Eucalanus elongatus, Esterly, 1905, p. 131, fig. 6.
Eucalanus elongatus, Farran, 1905, p. 30.
Eucalanus elongatus, G. O. Sars, 1905, p. 2.
Eucalanus elongatus, Farran, 1908, p. 21.
Eucalanus elongatus, van Breemen, 1908, p. 14, fig. 10.
Eucalanus elongatus, Farran, 1910, p. 93, pl. xiv.
Eucalanus elongatus, Esterly, 1911, p. 1.
Eucalanus elongatus, Wolfenden, 1911, p. 204.
Eucalanus elongatus, Sewell, 1913, p. 354.

Eucalanus elongatus, Lysholm and Nordgaard, 1921, p. 8.

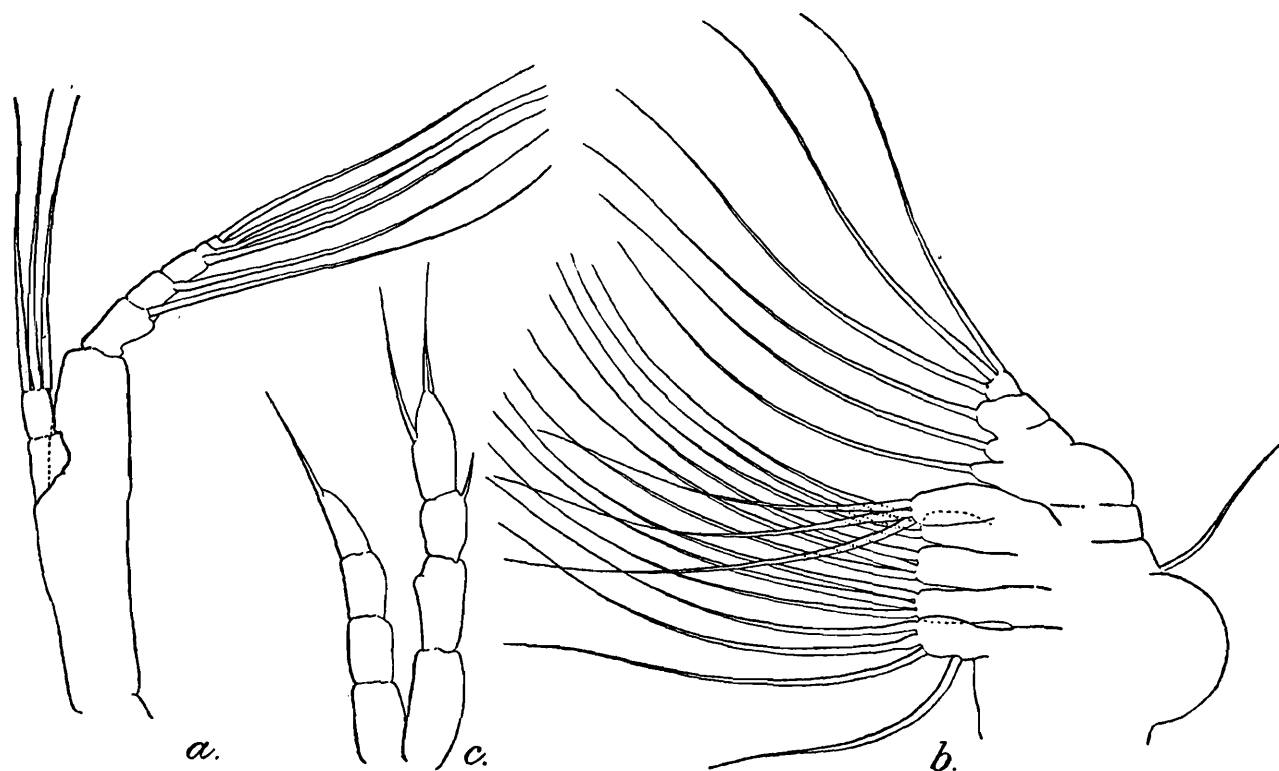
Eucalanus elongatus, G. O. Sars, 1925, p. 20.

Eucalanus elongatus, Farran, 1926, p. 230.

Eucalanus elongatus, Farran, 1929, p. 218.

This species is of wide distribution and has been taken in all the great oceans: as regards its distribution in the Atlantic region, it appears to spread more to the northwards than *Eucalanus attenuatus* and has been taken in large numbers in the Faroe Channel. Wolfenden (1911) also records its occurrence as far south as 47° in the Indian Ocean, and states (1904, p. 125) that in the Atlantic it occurs as far south as 51°

Wolfenden (1904, p. 113), in his account of the Copepoda of the Faroe Channel, describes a 'new' species under the name *E. atlantica* (♂). The sole differences between this form and the male of *E. elongatus* lie in the degree of development of the mouth-parts, which



TEXT-FIG. 13.—*Eucalanus elongatus* (Dana); Abnormal ♂.

a. Mandibular palp.

b. The 2nd maxilla.

c. The 5th pair of legs.

are not retrograded but entirely resemble those of the female, as also does the 2nd antenna. In Wolfenden's examples the 5th leg differed from that of the normal male of *E. elongatus* in that "the left fifth foot is only a little longer than the right, the first segment of the exopodite of each foot has a short marginal bristle, the last joint of the left side two distal bristles, the right foot three distal bristles." Among the examples taken by the "Investigator" are several specimens which agree very fairly with this description. To all appearance they are males of *E. elongatus*, but the mouth-parts show no sign of being suppressed or retrograded and resemble those of the female; but these specimens differ from Wolfenden's in that the 5th pair of legs is normal and agrees closely with the figure given by Giesbrecht except that the terminal segment of the left leg carried two setae, one at the distal end and the other on its inner margin, instead of only a single one distally as shown by

Giesbrecht. The abdomen consisted of four segments and the furca. I think there can be no doubt that *E. atlanticus* Wolfenden is merely a synonym of *E. elongatus* (Dana).

Eucalanus elongatus has been taken in large numbers at Stations 393, 614, 670 and 682, as well as occasionally on the surface.

***Eucalanus crassus* Giesbrecht.**

Eucalanus crassus, A. Scott, 1909, p. 19.

Eucalanus crassus, T. Scott, 1912, p. 529.

Eucalanus crassus, Sewell, 1912, p. 257.

Eucalanus crassus, Sewell, 1913, p. 357.

Eucalanus crassus, Sewell, 1914, p. 202.

Eucalanus crassus, With, 1915, p. 357

Eucalanus crassus, Sars, 1925, p. 22.

Eucalanus crassus, Farran, 1926, p. 231.

Eucalanus crassus, Farran, 1929, p. 220.

This species, though widely distributed, does not appear to be very common in Indian waters; it was taken at "Investigator" Stations 542, 555, 558, 582, 583, 587, 588, 591, 614, 672 (surface).

It has now been recorded from the Malay Archipelago (A. Scott), the coast of southern Burma (Sewell), the Nicobar Islands (Sewell), the Pearl Banks of Ceylon (Thompson and Scott), the Gulf of Aden and the Red Sea (Cleve), the Maldivé Archipelago (Wolfenden) and from the east coast of Cape Colony (Cleve).

***Eucalanus longiceps* Matthews.**

? *Eucalanus* sp., Wolfenden, 1908, p. 29.

? *Eucalanus attenuatus*, With, 1915, p. 52, fig. 10.

Eucalanus longiceps, Matthews, 1925, p. 127, pl. ix.

Eucalanus acus, Farran, 1929, p. 218, fig. 3, a-e.

This species was described by Matthews from specimens that had been taken by the "Challenger" expedition in the Antarctic and had been previously overlooked. The specimen described by With (1915) from the North Atlantic and which he tentatively referred to *Eucalanus attenuatus* (Dana) also appears to belong to the same species. In the "Investigator" collections is a single example, taken at Station 670 in the mid-water net at a depth of 0-200 fathoms, that appears to belong to the same species. The general shape of the head region is quite different from that of *Eucalanus attenuatus* Giesbrecht; the forehead is much more pronounced and elongated and does not taper to quite so sharp a point. Wolfenden (*loc. cit.*) records the occurrence of a species of *Eucalanus* from as far south as Lat. 56° in the collections made by the National Antarctic expedition. In size these examples agree exactly with *Eucalanus longiceps* Matthews, and from Wolfenden's description—"The head is very triangular, elongated and produced in front into a blunt point slightly bent downwards; there are lateral swellings as in *attenuatus*, the part behind is not, however, indented—" it would seem not improbable that he had before him examples of *Eucalanus longiceps* Matthews.

Eucalanus monachus Giesbrecht.

Eucalanus monachus, A. Scott, 1909, p. 20.

Eucalanus monachus, Wolfenden, 1911, p. 204.

Eucalanus monachus, Sharpe, 1911, p. 406.

Eucalanus monachus, Sewell, 1912, p. 357.

Eucalanus monachus, Sewell, 1914, p. 202.

Eucalanus monachus, Sars, 1925, p. 22.

This species is comparatively common in Indian waters. In the "Investigator" collections it occurs at Stations 541, 547, 552, 556, 558, 561, 562, 575, 577, 578, 581, 582, 583, 584, 587, 588, 591. It has previously been recorded from the Malay Archipelago (Cleve ; A. Scott), the Pearl Banks of Ceylon (Thompson and Scott ; Sewell), the coast of southern Burma (Sewell), the Arabian Sea, Gulf of Aden and the Red Sea (Cleve) and from the east of Cape Colony (Cleve).

Eucalanus mucronatus Giesbrecht.

Eucalanus mucronatus, A. Scott, 1909, p. 20.

Eucalanus mucronatus, Wolfenden, 1911, p. 204.

Eucalanus mucronatus, Sewell, 1914, p. 201.

Eucalanus mucronatus, Sars, 1925, p. 21.

Eucalanus mucronatus, Farran, 1929, p. 218.

This species, though widely distributed, does not appear to be common in Indian waters. It has been taken in the "Investigator" collections at Stations 614 and 682, and also occurs in Expedition Harbour in the central group of the Nicobars and in Macpherson Strait in the Andamans. It has been taken by previous workers in the Malay Archipelago (A. Scott ; Cleve) ; the Pearl Banks of Ceylon (Sewell) ; in the Maldivé Archipelago (Wolfenden) ; in the Indian Ocean, Red Sea and Gulf of Aden (Cleve) and from the east of Cape Colony (Cleve).

Eucalanus pileatus Giesbrecht.

Eucalanus pileatus, A. Scott, 1909, p. 21.

Eucalanus pileatus, Wolfenden, 1911, p. 204.

Eucalanus pileatus, Sewell, 1912, p. 357.

Eucalanus pileatus, Sewell, 1914, p. 202.

This species occurs in the "Investigator" collections at Stations 555 and 614. It has previously been recorded from Indian Seas in the Malay Archipelago (A. Scott) ; the coast of southern Burma (Sewell) ; the Pearl Banks of Ceylon (Thompson and Scott ; Sewell) ; the Maldivé Archipelago (Wolfenden) and the east coast of Cape Colony (Cleve).

Eucalanus subcrassus Giesbrecht.

Eucalanus subcrassus, A. Scott, 1909, p. 21.

Eucalanus subcrassus, Sewell, 1912, p. 358.

Eucalanus subcrassus, Pesta, 1912, p. 44, fig. 3.

Eucalanus subcrassus, Pesta, 1913, p. 31.

Eucalanus subcrassus, Sewell, 1914, p. 203.

Eucalanus subcrassus, Farran, 1929, p. 219.

In the swimming legs the general structure resembles that of the same stage in other closely allied species. The basal portion of the limb in all the legs consists of two segments and the rami consist of two segments in all but the last pair. In the 4th pair of legs the rami exhibit only a single segment.

Copepodid Stage IV. (Text-fig. 15, *a*, *b*.)

♀ Total length 1.358 mm.

The proportional lengths of the cephalothorax and abdomen are as 61 to 11, so that in this stage the abdomen is contained 5.55 times in the length of the anterior region of the body.

The abdomen now consists of three segments, the most posterior being still fused with the furcal rami. The proportional lengths of the segments are as follows:—

Abdominal segment	1-2	3	4-5	Furca.
	64	16	20	
	= 100			

The 1st antenna reaches back beyond the tip of the furcal ramus by about the last five segments. In this stage the 1st and 2nd segments are fused but segments 3 and 4 are now separate. Segments 8 and 9 are still fused. The proportional lengths of the segments are as follows:—

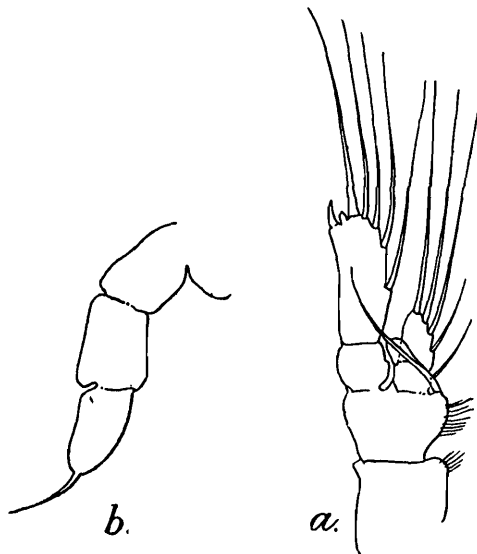
Segment	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	116	20	23	27	27	29	45	30	33	36	40	44	46	47	47	48	48	47	47	46	50	46	50		
	= 1000																								

The second antenna and the mouth-parts are as in the adult.

The swimming legs now all exhibit a division of the two rami into two segments but the division is incomplete in the case of the 1st leg.

♂ Total length 1.245 mm.

At this stage of development there is but little difference between the two sexes except as regards size and the presence in the male of a somewhat rudimentary 5th leg. The abdomen does not appear to be quite so well developed as in the female and I was only able to detect a trace of the line of separation of the 1st and second segments on the dorsal aspect. The proportional lengths of the various parts are as follows:—



TEXT-FIG. 15.—*Eucalanus subcrassus*
Giesbrecht: Copepodid Stage IV.

a, The 1st swimming leg. *b*, The 5th leg; ♂.

Abdominal segment	1-2	3-5	Furca.
	53	47	
	= 100		

The mouth-parts are exactly as in the female.

The swimming legs are the same as in the female; the 5th leg (text-fig. 15, *b*) consists of three segments, the terminal segment bearing distally a single seta that is about as long as the segment itself. The whole appendage reaches about half-way along the 1st basal segment of the 4th swimming leg.

Copepodid Stage V. (Text-fig. 16 *a-h*.)

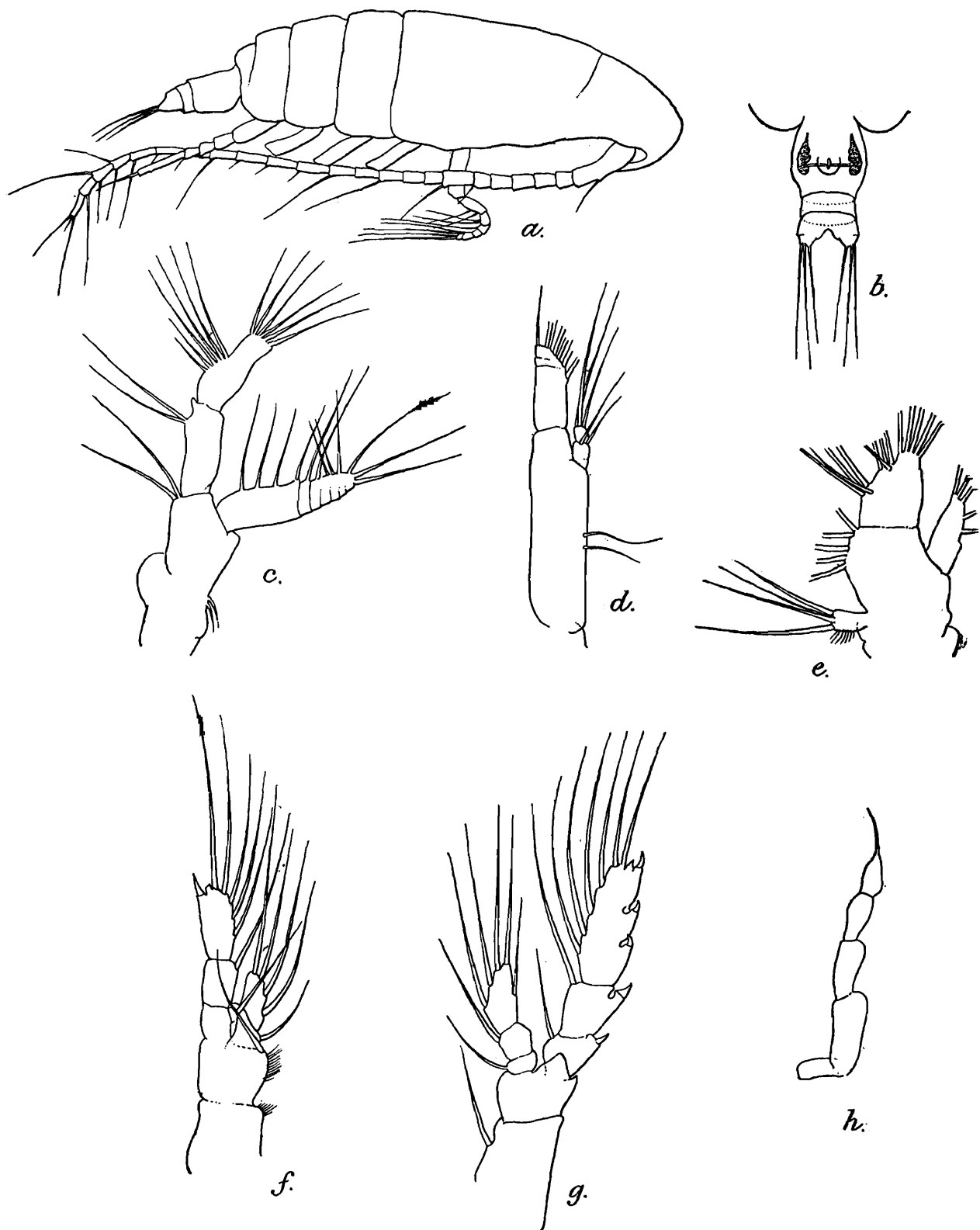
At this stage of development the female to all appearance is sexually mature and, apart from size, there appears to be nothing to distinguish it from the fully-grown adult.

♀ The total length ranges from 1.51 to 1.81 mm.

The proportional lengths of the cephalothorax and abdomen are as 96 to 14, so that the abdomen is now contained 5.43 times in the length of the cephalothorax.

The abdomen consists of three segments, the furcal rami being still fused with the anal segment. The proportional lengths of the segments are as follows :—

Abdominal segment	1-2	3	4-5	Furca.
	$\frac{57}{57}$	$\frac{15}{15}$	$\frac{30}{30}$	$\frac{30}{100}$



TEXT-FIG. 16.—*Eucalanus subcrassus* Giesbrecht : Copepodid Stage V.

a. The whole animal from the right side, ♀.

b. The abdomen, ventral aspect, ♀.

c. The 2nd antenna.

d. The mandibular palp.

e. The maxillary palp.

f. The 1st swimming leg.

g. The 2nd swimming leg.

h. The 5th leg, ♂.

All the appendages have now reached the adult condition.

♂ Total length 1.472 mm.

The proportional lengths of the cephalothorax and abdomen are as 64 to 14, so that the abdomen is now contained in the length of the anterior region of the body only 4.57 times.

The abdomen now consists of three segments, the furcal rami still being completely fused with the anal segment. The proportional lengths of the segments are as follows:—

Abdominal segment	1	2	3-5	Furca	
	54	15	31		= 100.

The 1st abdominal segment is about one and a quarter times as long as wide.

The 1st antenna reaches back beyond the tip of the furcal rami by the last five joints. The proportional lengths of the various segments are as follows:—

Segment	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	
	120	24	24	27	27	28		44		32	34	35	41	46	50	50	50	51	48	45	46	41	45	39	51	= 1000.

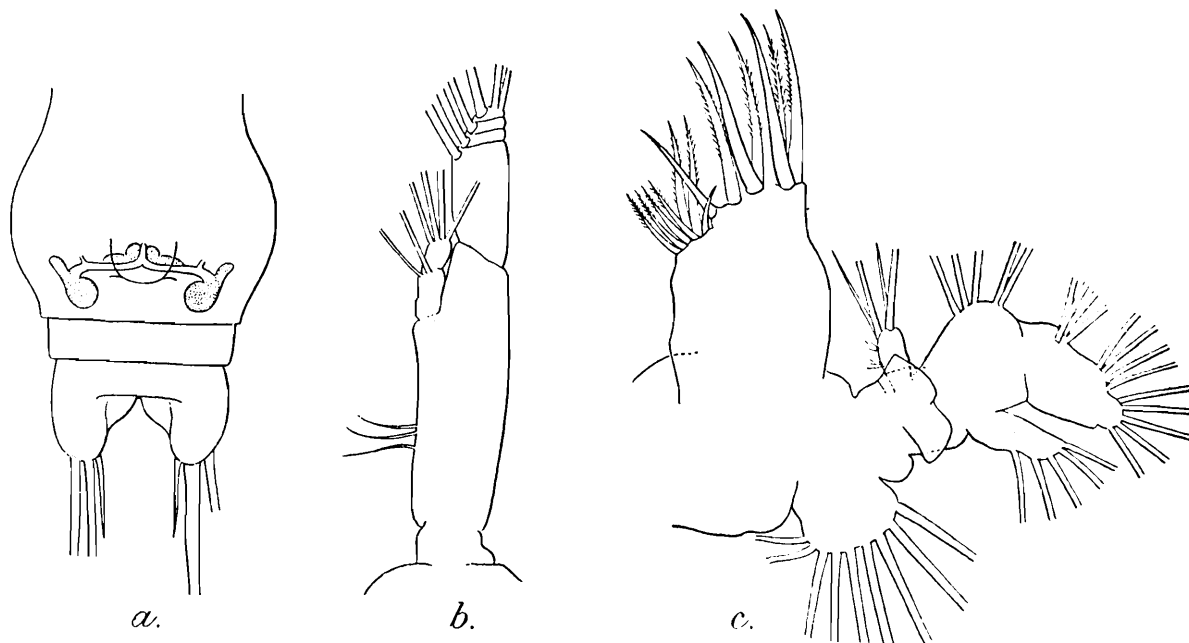
The 2nd antenna and mouth-parts are the same as in the female and there is at this stage of development no trace of the reduction of the mouth-parts that is present in the adult condition.

In the swimming legs the exopod is three-jointed, though in the 1st pair the segmentation between the 1st and 2nd segments is still incomplete. In the 1st leg the endopod consists of only two segments but in the 2nd to the 4th inclusive this ramus consists of the usual three joints.

The 5th leg (text-fig. 16, *h*) is moderately well-developed and now exhibits four separate segments, of which the 1st or proximal is the longest and the 2nd is somewhat shorter, while the third and fourth together are but little longer than the 1st. The distal seta is longer than the terminal segment and is somewhat curved.

Adult Stage. (Text-fig. 17, *a-c.*)

♀ Total length ranges from 1.925 to 2.113 mm.



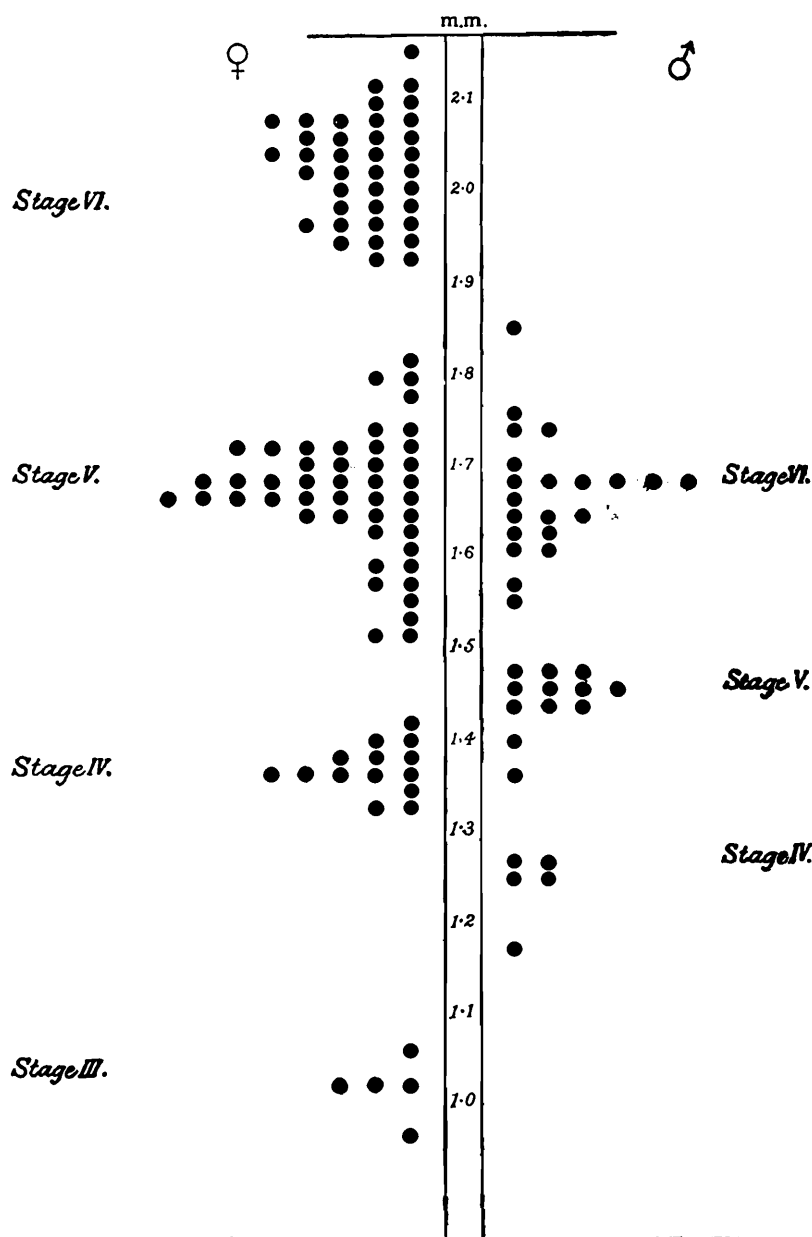
TEXT-FIG. 17.—*Eucalanus subcrassus* Giesbrecht: Adult., ♀.
a. The abdomen, from the ventral side. *b.* The mandibular palp.
c. The maxilla.

The proportional lengths of the cephalothorax and abdomen are as 96 to 16, so that the abdomen is contained 6 times in the length of the anterior region of the body.

The abdomen consists of three segments, the furcal rami being fused with the anal segment. The proportional lengths of the segments are as follows :—

Abdominal segment	1-2	3	4-5	Furca	
	<u>55</u>	18	<u>27</u>		= 100.

The genital segment is slightly wider than long, being 50 in length and 45 in breadth.



TEXT-FIG. 18.—*Eucalanus subcrassus* Giesbrecht.

Measurements of 140 examples in different stages of development.

The 1st antenna reaches back beyond the tip of the furcal rami by the last four or five segments. The proportional lengths of the various segments are as follows :—

Segment	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	
	<u>125</u>		<u>26</u>	<u>27</u>	<u>29</u>	<u>29</u>	<u>31</u>	<u>53</u>		<u>33</u>	<u>35</u>	<u>39</u>	<u>44</u>	<u>45</u>	<u>48</u>	<u>49</u>	<u>49</u>	<u>48</u>	<u>45</u>	<u>44</u>	<u>41</u>	<u>38</u>	<u>41</u>	<u>35</u>	<u>46</u>	=1000.

I have already referred to the changes that can be traced in the proportional lengths of the various segments of the 1st antenna during the course of development (*vide supra* pp. 9, 25) and in the case of this species we can trace identically the same process. In the

table below I have given the proportional lengths, in 1000ths of the whole appendage, of the various segments at each successive moult :—

Segment	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
Copepodid stage III	175				28	24	24		38	26	26	32	34	41	42	43	45	48	50	50	52	45	57	48	72
Copepodid stage IV	120		23	24	27	29	29		43	30	32	34	39	44	44	45	46	48	48	46	46	44	49	46	64
Copepodid stage V	123		26	27	28	30	30		51	32	34	37	42	45	45	45	46	48	45	44	44	40	42	40	56
Copepodid stage VI	125		26	27	29	29	31		53	33	35	39	44	45	48	49	49	48	45	44	41	38	41	35	46

Here again we see that the segments in the proximal portion of the antenna tend to increase in length at each successive moult, the greatest increase occurring at the level of the 8th and 9th segments, and from that point towards the distal extremity the change gets less and less till at the 18th segment we get no change throughout the whole life-history ; distally to this point the antennal segments tend to get relatively shorter as life progresses and the proportional lengths of the segments get less and less, the greatest change occurring in the terminal segment.

A study of the length measurements of a series of individuals in different stages of development indicates that once again we can trace the same life-history as we have already noted in several species. In text-figure 18 I have given the measurements of 140 individuals and these show clearly the manner in which the examples fall into definite groups, corresponding to the various moults in the post-larval development. In the table below I have given the average length-measurement in each group and have also given the calculated length-measurements and the growth-factors for the two sexes. The individuals in Copepodid stage III are too immature to allow of the determination of their sex :—

	Observed size mm.	Calculated size mm.	Growth- factor
♀			
Copepodid stage III	1.015	1.016	1.345
Copepodid stage IV	 1.365	1.365	1.218
Copepodid stage V	1.665	1.663	1.218
Adult stage	2.024	2.026	..
♂			
Copepodid stage III	 1.015	1.015	1.382 or 1.218
Copepodid stage IV	1.238	1.236	1.382
Copepodid stage V	1.440	1.403	..
Adult stage	1.666	1.708	

As before, we find that in the female the individuals in their development follow a straightforward course, the growth-factor dropping from 1.345 to 1.218 at that stage in which the development of the sexual organs begins to interfere with the ordinary vegetative growth of the body. In the male, however, individuals may follow one of two paths in their development ; they may, apparently, either continue to show the male growth-factor of 1.382 and so pass from Copepodid stage III to Copepodid stage V direct, in which case it appears doubtful if they ever become sexually mature, or else they may for a single moult adopt the female growth-factor of 1.218 and pass from Copepodid stage III to Copepodid stage IV and then by reverting to the male growth-factor of 1.382 pass to the sexually-adult stage.

Genus **RHINCALANUS** Dana.

Five species have been described as belonging to this genus, namely *Rhincalanus cornutus* Dana, *R. nasutus* Giesbrecht, *R. gigas* Brady, *R. grandis* Giesbrecht and *R. aculeatus* T. Scott. This latter species can, however, at once be disposed of; Scott himself (1894, p. 32) remarks that it "differs somewhat from the generic characters of *Rhincalanus* as described by Prof. Brady in the number of joints of the anterior antennae, the comparatively long terminal joint of the secondary branch of the posterior antennae, and in the form of the mandible, but it agrees with the other characters." It is now well recognised that this species is a synonym of *Arietellus setosus* Giesbrecht and does not belong to the genus *Rhincalanus* at all. Of the remaining species only two are so far known to occur in Indian water.

Rhincalanus cornutus Dana.

- Rhincalanus cornutus*, A. Scott, 1909, p. 23.
Rhincalanus cornutus, Wolfenden, 1911, p. 194.
Rhincalanus cornutus, T. Scott, 1912, p. 530.
Rhincalanus cornutus, Sewell, 1912, p. 358.
Rhincalanus cornutus, Sewell, 1913, p. 354.
Rhincalanus cornutus, Sewell, 1914, p. 203 (by a clerical error the name is given as *R. gigas*).
Rhincalanus cornutus, Brady, 1915, p. 136.
Rhincalanus cornutus, Sars, 1925, p. 22.
Rhincalanus cornutus, Farran, 1929, p. 220.

This species is of wide distribution throughout all the great oceans in the tropical and temperate zones; it has been recorded in the north Atlantic Ocean as far north as Lat. 52° and it was taken by the "Scotia" in Lat. 34° 21' South. In the Indian Ocean it has now been recorded from the Malay Archipelago (Scott), the Mergui Archipelago and the coast of southern Burma (Sewell), the Pearl Banks of Ceylon (Thompson and A. Scott), the Maldivé Archipelago (Wolfenden), the Gulf of Aden and the Red Sea (Cleve; A. Scott) and from the east coast of Africa (Cleve; Brady). While appearing fairly frequently at the surface it attains its greatest density at some distance below; at "Investigator" Station 393 between 0-400 fathoms over 90 examples were taken in the mid-water net. In the "Investigator" collections it also occurs at Station 614, 670 and 682.

Rhincalanus nasutus Giesbrecht.

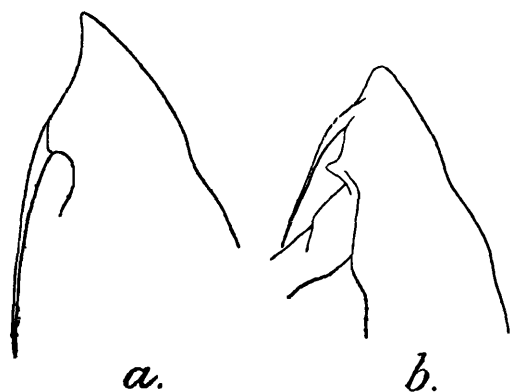
(Text-fig. 19, a, b.)

- Rhincalanus nasutus*, A. Scott, 1909, p. 24.
Rhincalanus nasutus, Farran, 1910, p. 18.
Rhincalanus gigas (in part), T. Scott, 1912, p. 530.
Rhincalanus nasutus, Sewell, 1913, p. 354.
Rhincalanus nasutus, Sewell, 1914, p. 204.
Rhincalanus nasutus, With, 1915, p. 44, pl. i, figs. 4, a-e.
Rhincalanus nasutus, Lysholm and Nordgaard, 1921, p. 9.
Rhincalanus nasutus, Sars, 1925, p. 23.
Rhincalanus nasutus, Farran, 1926, p. 232.
Rhincalanus nasutus, Farran, 1929, p. 232.

Like *Rhincalanus cornutus*, *R. nasutus* is widely distributed throughout the tropical and northern seas; Giesbrecht gives the southern limit of distribution of the species as Lat. 52° South, but I have been unable to check this reference. In the Indian Ocean it has now been recorded from the Malay Archipelago (A. Scott), the Pearl Banks of Ceylon (Thompson and A. Scott; Sewell), the Arabian Sea, Gulf of Aden and the Red Sea (Cleve) and the east coast of South Africa (Cleve).

Though examples are occasionally met with at the surface, *Rhincalanus nasutus* is normally an inhabitant of the deeper levels; Lysholm and Nordgaard give it as occurring at 400–1000 metres in the north Atlantic Ocean and Farran records that off the Irish Coast a few individuals occur at 50 fathoms but that it is comparatively abundant at 100 fathoms. In the Indian Ocean it occurs in large numbers in the sub-surface layers; thus at “Investigator” Station 393, depth 0–400 fathoms, over 140 examples were taken; the species is also well represented at Stations 463, 670 and 682.

These examples agree closely with the descriptions given by previous authors; in a



TEXT-FIG. 19.—a. The anterior end of *Rhincalanus nasutus* Giesbrecht.

b. The anterior end of *Rhincalanus gigas* Brady.

few examples the spine on the right side of the 4th thoracic segment is double and in another instance the spine on the dorsum of the 1st abdominal segment was similarly duplicated, there being two curved and claw-like spines present instead of the usual single one. The average size of examples of this species from the Indian Ocean ranges from 4.0 to 4.5 mm. in length. Wolfenden has obtained in the Faroe Channel two large examples of the species that measure respectively 5.1 and 5.4 mm. These are now in the British Museum (Natural History) collection and I have examined them carefully. I cannot find any structural differences to distinguish

them from the ordinary smaller form, and I consider that Wolfenden's diagnosis is correct. Both the examples are females and it is interesting to note that in one of them the usual single spine on the margin of the 4th thoracic segment is replaced by two spines on the left side and three on the right.

A considerable amount of uncertainty appears to exist regarding the specific identity of the three so-called species *Rhincalanus nasutus*, *R. grandis* and *R. gigas*. Giesbrecht (1902, pp. 18–19) and Wolfenden (1908, p. 13) are of opinion that *Rhincalanus gigas* and *R. grandis* are the same species. Giesbrecht points out that these two forms are very similar as regards their size; Brady gives 8.5 to 10.0 mm. for *Rhincalanus gigas* and *R. grandis* is said to have a length of 7.5 to 9.0 mm. according to Giesbrecht and 7.2 to 8.0 mm. according to Wolfenden. Wolfenden (*loc. cit.*) suggests that Brady's examples of *R. gigas* were immature and again in 1911 (1911, p. 193) he repeats his views, which are based on the examination of two specimens of *R. gigas* preserved in the British Museum. In 1908 (1908, p. 13) he remarks that “of the two preserved specimens at the British Museum which I have examined, one measured 5.8 mm. and another 6.0 mm. Both were immature females.” These two examples appear to be two mounted specimens; and apparently Wolfenden did not examine the other specimens in the British Museum that are preserved in spirit. In addition to the two mounted specimens there are among the spirit specimens

from "Challenger" station 156 several undoubted specimens of the form described by Giesbrecht as *R. grandis*; others occur in "Challenger" station 320. I have also examined the examples that were obtained by the National Antarctic Expedition and were identified by Wolfenden (1908) as *R. grandis* and I have no doubt that *R. gigas* and *R. grandis* are synonyms; Brady's description and his figures are poor and in certain points inaccurate but there is no doubt as to the examples themselves. The species *R. grandis* Giesbrecht must, therefore, be merged in *R. gigas* Brady.

The view has also been put forward that the species *Rhincalanus nasutus* Giesbrecht is also a synonym of the same species, namely *R. gigas* Brady. This was suggested by A. Scott (1909, p. 24) and I myself (Sewell, 1914, p. 204) was inclined to agree with him, but a further study of these forms has caused me to alter my opinion and I now believe that *R. nasutus* must be regarded as a distinct species.¹ In the table below I have given the main points of difference between the two forms and these are, I consider, sufficient to separate them as distinct species.

	<i>Rhincalanus gigas</i> Brady (= <i>R. grandis</i> Giesbrecht)	<i>Rhincalanus nasutus</i> Giesbrecht
1. Total length	7.5 to 10.0 mm.	3.8 to 5.4 mm.
2.	Lateral spines on thoracic segments 3 and 4 only.	Lateral spines on thoracic segments 2, 3 and 4.
3.	♀ Sub-dorsal spines on none of the thoracic segments. ♂ Sub-dorsal spines on thoracic segment 4 only.	Sub-dorsal spines on thoracic segments 2, 3 and 4. Sub-dorsal spines on thoracic segments 2, 3 and 4.
4.	♀ Abdominal segments devoid of spines on dorsal aspect. ♂ Dorsal aspect of genital segment armed with a pair of small spines.	Dorsal aspect of genital segment armed with a pair of small spines. As in the female.
5.	The anterior end of cephalon short and bluntly pointed.	The anterior end of cephalon long and sharply pointed.
6.	Body comparatively robust. Proportions of cephalothorax and abdomen 6.1.	Body comparatively slender. Proportions of cephalothorax and abdomen 5.1.
7.	Appears to be confined to southern Antarctic waters south of Lat. 37° S.	Widely distributed throughout Tropical and Northern waters.

Examples of *Rhincalanus gigas* Brady have been obtained as far north as Lat. 37° S. by both the "Challenger" and the "Gaus" but this appears to be about the northern limit of its distribution; Thompson (1900, p. 276) has recorded the occurrence of a single example of *R. gigas* Brady from Lat. 20° S. but I am inclined to think that this was in reality a specimen of *R. nasutus* Giesbrecht.

Genus **MECYNOCERA** Thompson.

Mecynocera clausi Thompson.

Mecynocera clausi, A. Scott, 1909, p. 25.

Mecynocera clausi, Sharpe, 1911, p. 406.

¹ The same opinion has recently been expressed by Farran (1929, p. 220).

Mecynocera clausi, Wolfenden, 1911, p. 202.

Mecynocera clausi, T. Scott, 1912, p. 530.

Mecynocera clausi, Sewell, 1914, p. 204.

Mecynocera clausi, Früchtl, 1924, p. 34.

Mecynocera clausi, Sars, 1925, p. 23.

Mecynocera clausi, Farran, 1926, p. 233.

Mecynocera clausi, Farran, 1929, p. 221.

This species is of wide distribution and appears to occur throughout the whole of the Indian seas from the Malay Archipelago to the east coast of Africa and in the Gulf of Aden and the Red Sea. In the "Investigator" collections I have up to the present time failed to discover any specimens though I have found examples in collections taken on the Pearl Banks of Ceylon.

Family PARACALANIDAE.

Genus **PARACALANUS** Boeck.

A certain degree of confusion appears to have arisen in this genus regarding the validity of various species and varieties that have been described and also with regard to the synonymy of some of the forms. Up to the present time five species have been described and recognised in Indian or neighbouring waters, viz., *Paracalanus aculeatus* Giesbrecht, *P. parvus* (Claus), *P. crassirostris* (Dahl), *P. serratipes* Sewell and *P. dubia* Sewell. Both these latter forms appear to be local in their distribution, whereas the other three are widespread. All five forms occur in the "Investigator" collections and I have in addition described below certain other forms that must in my opinion be given specific rank.

One difficulty that is met with in the correct determination of the taxonomy of this genus is the fact that in at least some of the species we appear to have two sexually-mature forms that differ from each other mainly as regards size. Farran (1926) has called attention to the fact that in the genus *Clausocalanus* we may have forms so alike structurally that it is a matter of very great difficulty to decide whether or not we are dealing with dimorphic forms or distinct races of the same species or with very closely related species; in the species *Clausocalanus arcuicornis* according to Farran and others we have two forms, a larger and a smaller, both of which must be referred to this species, and Farran (1926) has described a third form that differs only in small details but which he regards as a different species and to which he gives the name of *C. pergens*. In the genus *Paracalanus* I have in a previous paper (Sewell, 1912) called attention to the fact that we seem to have two sexually-mature forms of the male in the species *P. aculeatus*, and in certain other cases the anatomical differences between certain forms are so slight that one hesitates to award them definite specific rank; but since these differences appear to be constant I have thought it advisable to do so in certain instances.

The members of this genus can be divided into two groups differing from each other in the proportionate lengths of the body and abdomen, the character of the genital aperture of the female and in the length and the arrangement of the segments in the 1st antenna. Members of one group closely resemble *Paracalanus aculeatus* and those of the other *P. parvus*.

(a) THE ACULEATUS group.

Three different species in the "Investigator" collections can be recognised as belonging to this group, namely *Paracalanus aculeatus* Giesbrecht, *Paracalanus serratipes* Sewell and *Paracalanus denudatus*, sp. nov.

In all three forms the genital aperture on the ventral aspect of the 1st abdominal segment is so much alike that it is impossible to discriminate between them and the only distinguishing features lie for the most part in small details of structure, such as the length of the terminal segment of the 1st antenna, and even here the three species form a series, for in *Paracalanus denudatus* the terminal segment is 1.9 times the length of the ante-penultimate joint, in *P. aculeatus* it is 1.6 times and in *P. serratipes* the two segments are equal.

Paracalanus aculeatus Giesbrecht.

Paracalanus parvus, T. Scott, 1894, p. 26, pl. i, figs. 9-14.

Paracalanus aculeatus, A. Scott, 1909, p. 26.

Paracalanus aculeatus, Wolfenden, 1911, p. 203.

Paracalanus aculeatus, T. Scott, 1912, p. 531.

Paracalanus aculeatus, Sewell, 1912, pp. 326, 358.

Paracalanus aculeatus, Pesta, 1912, p. 44, fig. 4.

Paracalanus aculeatus, Sewell, 1913, p. 357.

Paracalanus aculeatus, Sewell, 1914, p. 205.

Paracalanus aculeatus, Früchtl, 1924, p. 35.

Paracalanus clevei, Früchtl, 1924, p. 35.

Paracalanus aculeatus, Farran, 1929, p. 222.

This species is very common throughout the whole of the Indian seas. It has now been recorded from the Malay Archipelago (A. Scott), the Aru Archipelago (Früchtl), the coast of southern Burma (Sewell), the Pearl Banks of Ceylon (Sewell), the Maldivé Archipelago (Wolfenden), the Arabian Sea, Gulf of Aden and the Red Sea (A. Scott) and the east coast of Africa (Cleve).

A comparison of the examples taken in the Indian Ocean with the description of the form described by T. Scott (1894), under the name *Paracalanus parvus*, leaves little room for doubt that he was in reality dealing with this species. Früchtl (*loc. cit.*) obtained certain examples in the Aru Archipelago that correspond to the form described by Cleve (1901) as the male of *Acrocalanus pediger* and which Carl (1907, p. 7) subsequently pointed out to be in reality a *Paracalanus*. Früchtl does not appear to have been acquainted with my paper (1914) in which I have shown this form to be the male of *Paracalanus aculeatus*.

In the "Investigator" collections this species is of common occurrence and examples have been identified from Stations 540, 541, 542, 543, 544, 545, 547, 552, 555, 556, 558, 561, 562, 574, 578, 581, 582, 583, 587, 589, 590, 591, 614, and from Expedition Harbour in the Central group of the Nicobars.

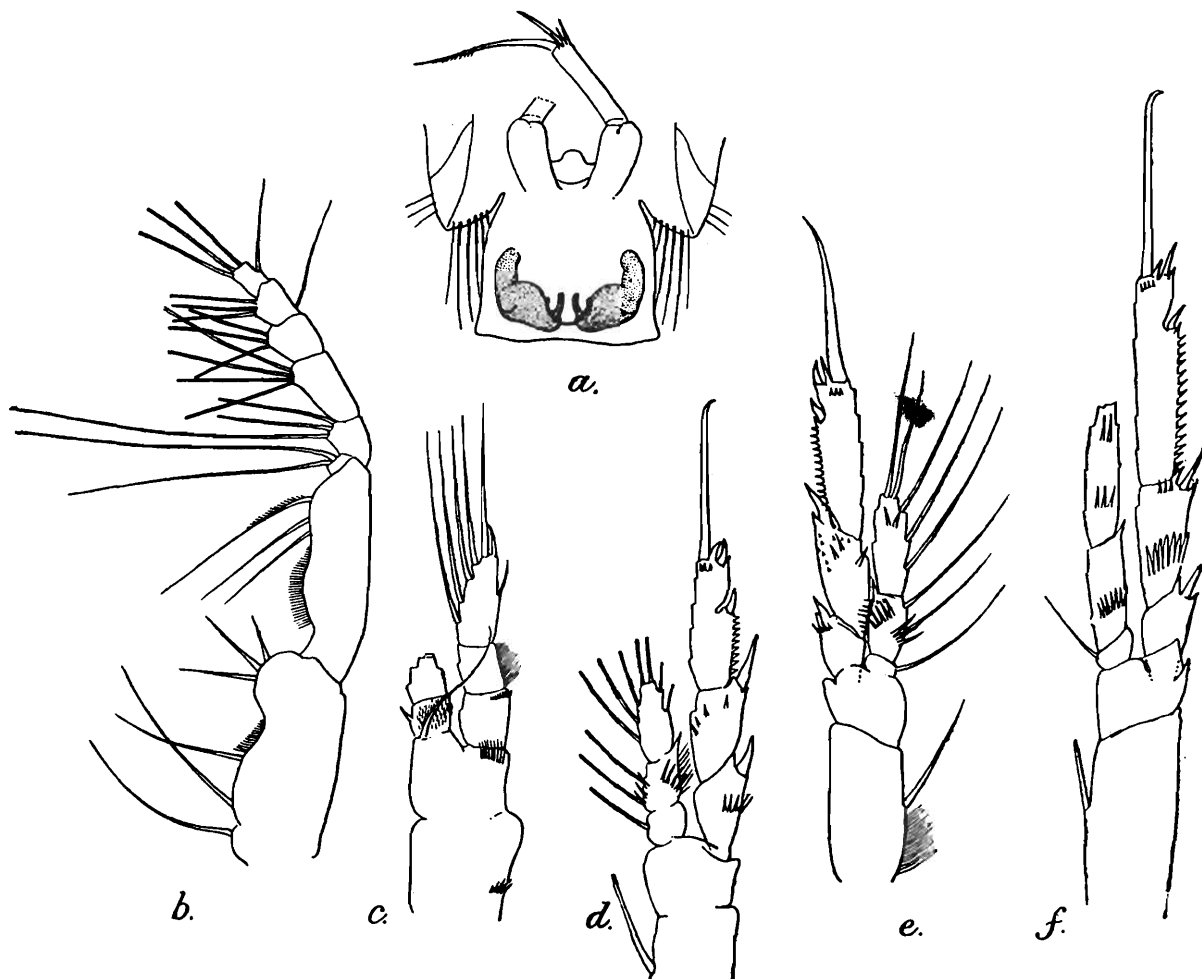
I have previously (Sewell, 1912, p. 326) pointed out that in this species we appear to have two distinct forms of the male, distinguished from each other only in size, and in the "Investigator" collections from Nankauri Harbour in the Nicobar Islands, Station 614, there are, correspondingly, two distinct forms of the female, both of which appear to be sexually mature and differ from each other, as in the case of the males, only in size.

(a) Forma **major**.

(Text-fig. 20, a-f.)

♀ Total length, 0·89 to 0·99 mm.

Examples from Nankauri Harbour, Station 614, are distinctly smaller than those from the Pacific, for which Giesbrecht gives a length measurement of 1·1 mm.

TEXT-FIG. 20.—*Paracalanus aculeatus* Giesbrecht, forma major. ♀.

a. The genital segment of the abdomen and the 5th pair of legs.

b. The maxilliped.

c. The 1st swimming leg.

d. The 2nd swimming leg.

e. The 3rd swimming leg.

f. The 4th swimming leg.

The proportional length of the cephalothorax and abdomen are as 36 to 11, so that the abdomen is contained 3·27 times in the length of the anterior region of the body. The cephalon and 1st thoracic segment are fused and their combined length forms two-thirds of the total length of the cephalothorax. The body is slightly humped. The posterior thoracic margin is rounded and is fringed with a number of long and delicate hairs.

The abdomen possesses four segments that have the following proportional lengths:—

Abdominal segment	1-2	3	4	5	Furca
	33	15	13	23	16 = 100

The 1st antenna reaches back to beyond the tip of the furcal ramus by about the extent of the last segment. There are twenty-three free joints in the appendage. Segments 1

and 2 and 8 and 9 being fused respectively. The proportional lengths of the segments are as follows :—

Segment	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	
	132	37	37	37	36	37	43	23	25	29	37	39	39	42	42	42	45	43	43	41	43	41	67	=1000

Wolfenden [1906 (a), pl. xcvi, fig. 12] has called attention to the presence in this species of rows of minute spinules on the segments of the antenna.

As regards the mouth-parts and swimming-legs, these examples agree exactly in structure with the description and figures given by Giesbrecht (1892).

There appears to be some evidence of a seasonal variation in the size of my examples for specimens taken in Nankauri Harbour in November, 1922, measured 0.99 mm. in length, whereas examples taken in the same locality in the month of January, 1923, were only 0.89 mm. in length; this may possibly be correlated with the changes in salinity that occur in this region, for in the month of January the salinity is considerably less than it is in November owing to the onset of the north-east monsoon and the consequent dilution of the surface-water by rain and river-water.

(b) Forma **minor**.

(Text-fig. 21, a-g.)

♀ Total length, 0.69 mm.

The proportional lengths of the cephalothorax and abdomen are as 55 to 18, the abdomen being thus contained only 3.06 times in the length of the anterior region of the body, instead of 3.27 times, as in the larger form.

The abdominal segments have the following proportional lengths :—

Abdominal segment	1-2	3	4	5	Furca
	33	14	11	23	19 = 100

The genital aperture agrees exactly with that of the larger form.

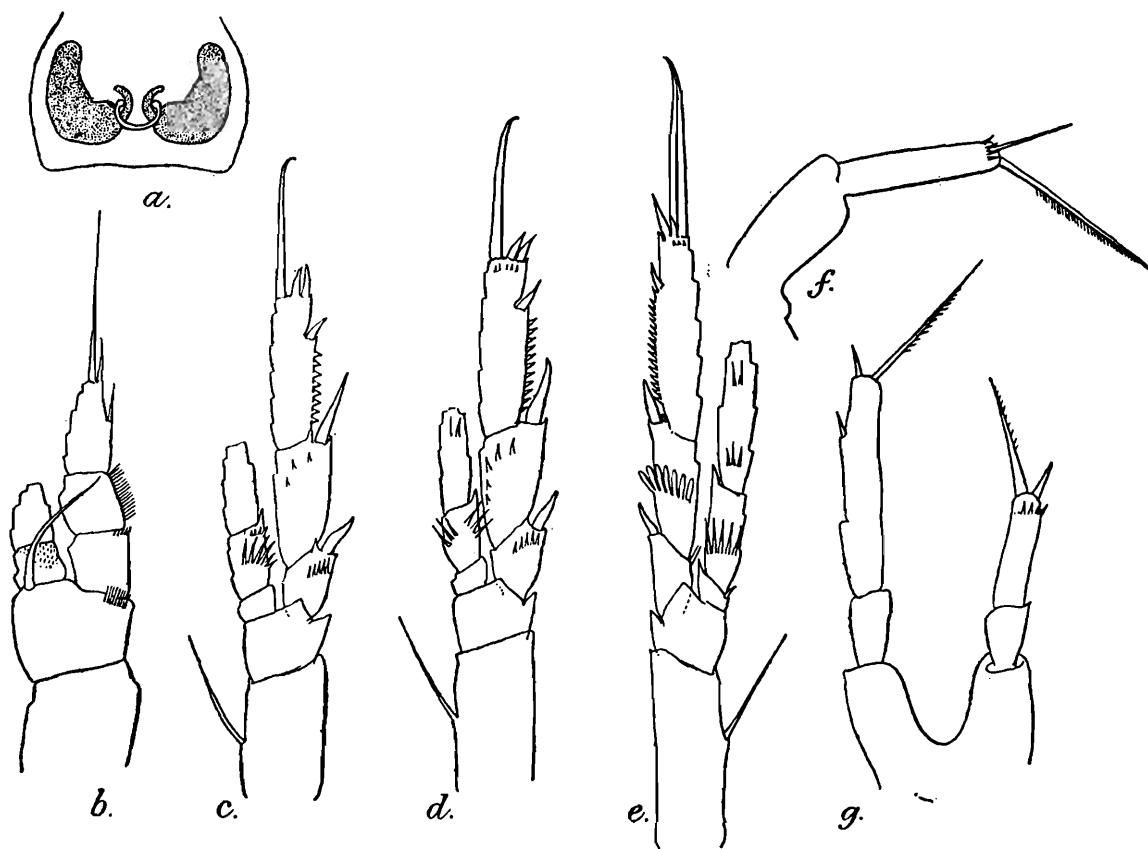
As in the larger form, the 1st antenna reaches beyond the tip of the furcal ramus by about the last segment. The proportional lengths of the segments are as follows :—

Segment	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	
	123	38	36	36	36	36	43	23	26	30	35	38	38	38	41	41	45	43	43	43	47	46	70	=1000

The various segments carry rows of small needle-like spinules as in the larger form, the rows on the proximal segments running transversely and the distal ones longitudinally. The last two segments are devoid of spines. I have already pointed out that during the process of development in the Copepoda (*vide supra*, p. 9) we can trace a definite change in the proportional lengths of the antennal segments, the proximal segments tending at each successive moult to get proportionately longer and the distal ones shorter, and a comparison of the lengths of the segments in these two forms of *Paracalanus aculeatus* reveals exactly the same change. For the purpose of comparison I have given the lengths in the two forms below :—

Segment	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	
f. <i>minor</i>	128	38	36	36	36	36	43	23	26	30	35	38	38	38	41	41	45	43	43	43	47	46	70	=1000
f. <i>major</i>	132	37	37	37	36	37	43	23	25	29	37	39	39	42	42	42	45	43	43	41	47	41	67	=1000

In these examples the differences are for the most part small but they indicate the probability that we are here dealing with two successive stages in the development of the species and not with two races.



TEXT-FIG. 21.—*Paracalanus aculeatus* Giesbrecht, forma *minor*. ♀.
 a. The genital segment of the abdomen. d. The 3rd swimming leg.
 b. The 1st swimming leg. e. The 4th swimming leg.
 c. The 2nd swimming leg. f. The 5th leg.
 g. An abnormal 5th pair of legs.

The swimming legs closely resemble those of forma *major* but in a few cases there appears to be a reduction in the number of spines on the surface of the segments; this is especially noticeable in the case of the leaf-like spines that are present on the posterior aspect of the 2nd segment of the exopod of the 4th leg.

Früchtl (1924, p. 20) has called attention to the occurrence in this species of an occasional individual that possesses the appearance of a female but in addition exhibits an abnormal 5th pair of legs, and he has given a figure of one of these examples (*vide loc. cit.*, p. 21, text-fig. 11). Exactly similar individuals have been discovered by me among the specimens taken at "Investigator" Station 614.

Such an example had a total length measurement of 0.80 mm.; and the proportional lengths of the cephalothorax and abdomen were as 32.5 to 10 so that the abdomen is contained 3.25 times in the length of the anterior region of the body.

The abdomen is as in the normal female and possesses four segments having the following proportional lengths:—

Abdominal segment	1-2	3	4	5	Furca
	33	16	14	21	16 = 100

The genital segment is as figured in text-fig. 21 (a), which is taken from a normal female.

The 1st antenna reaches to the posterior end of the abdomen and is also similar to that of a normal female, the segments having the following proportional lengths :—

Segment	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	
	125	40	40	37	35	38	48	23	24	26	33	37	38	40	40	43	44	45	45	45	49	45	60	≈1000

The swimming legs on the other hand resemble those of the male in that the external margin of the second segment of the exopod is armed with a row of small spines similar to those on the margin of exopod 3. There is a 5th pair of legs present that approximates to the normal type but is not so well developed.

In these individuals we have examples that, to judge from the characters of the abdomen and the genital segment, are functional females but which yet exhibit certain definite male characters, and it seems probable that these are cases where an individual has diverged from the normal line of development at copepodid stage IV and by the adoption of the male growth-factor has passed to the stage that I have in my diagram on p. 7 called stage X.

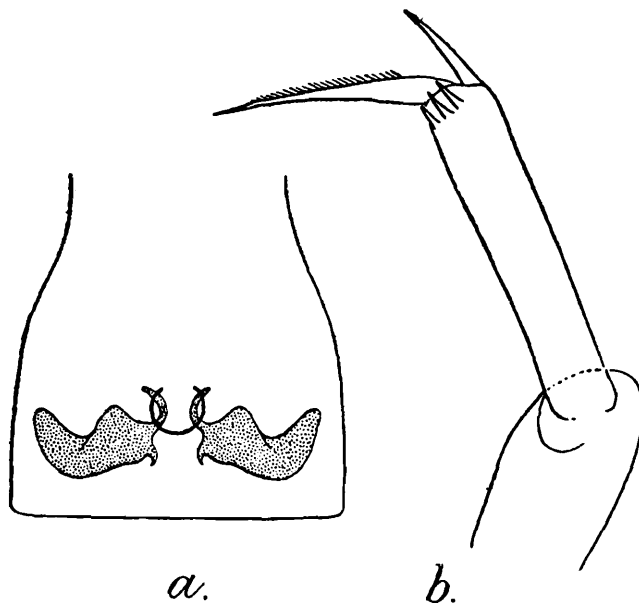
Paracalanus serratipes Sewell.

(Text-fig. 22, *a*, *b*.)

Paracalanus serratipes, Sewell, 1912, p. 332, pl. xv, figs. 6-10.

Paracalanus serratipes, Sewell, 1914, p. 208.

Examples of this species have been taken on the coast of southern Burma in the estuarine regions around the mouths of the Rangoon and Tavoy rivers, on the Pearl Banks of



TEXT-FIG. 22.—*Paracalanus serratipes* Sewell, ♀.
a. The genital segment of the abdomen. *b*. The 5th leg.

Ceylon, and in Expedition Harbour in the central group of the Nicobars. It would appear from its distribution to be a coastal and in the main an estuarine form.

Paracalanus denudatus, sp. nov.

(Text-fig. 23, *a-h*.)

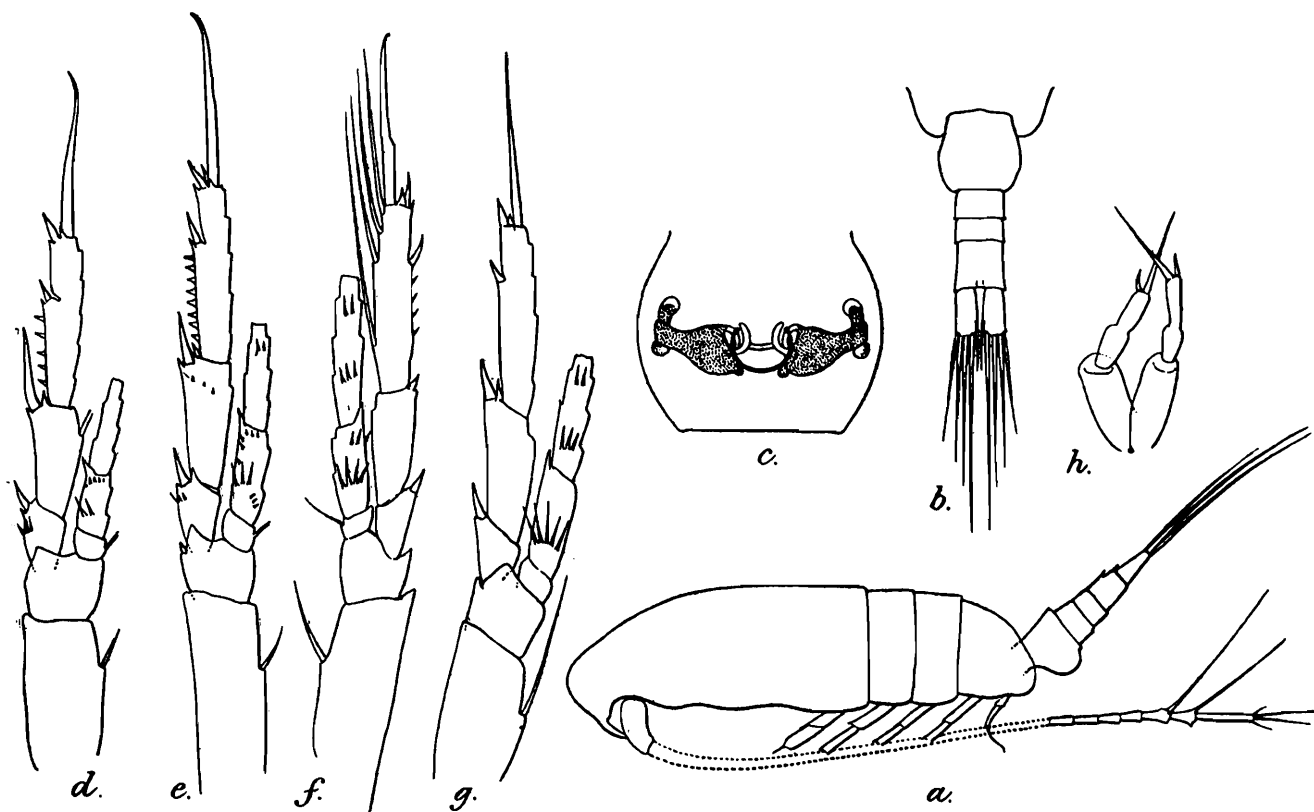
♀ Total length, 0.64 mm.

The proportional lengths of the cephalothorax and abdomen are as 53 to 16; the abdomen is thus contained 3.31 times in the length of the anterior region of the body. The

head and 1st thoracic segment are fused and the dorsal profile exhibits a slight hump about the middle of the fused mass, as is also seen in *Paracalanus aculeatus* Giesbrecht; the anterior region of the body is, however, slightly more slender in the present species and the fused mass of the cephalon and 1st thoracic segment is contained only 1.4 times in the length of the whole anterior region, whereas in *P. aculeatus* it is contained 1.5 times. The forehead is uniformly rounded and the rostral filaments are directed downwards and backwards. Thoracic segments 4 and 5 are fused and the posterior thoracic margin is rounded. The abdomen consists of four segments having the following proportional lengths:—

Abdominal segment	1-2	3	4	5	Furca.	
	31	15	13	21	20	=100

The furcal rami are nearly three times as long as broad, the proportions of length to breadth being 20 to 7. The inner furcal seta is delicate and is only about one-fourth the length of the next seta, thus closely resembling the condition found in *Paracalanus aculeatus*.



TEXT-FIG. 23.—*Paracalanus denudatus*, sp. nov., ♀.

- a. The whole animal from the left side.
 b. The abdomen, from above.
 c. The genital segment of the abdomen.
 d. The 2nd swimming leg.
 e. The 3rd swimming leg.
 f. The 4th swimming leg.
 g. The 4th swimming leg in another specimen.
 h. The 5th pair of legs.

The 1st antenna agrees in its general plan with that of *Paracalanus aculeatus*, forma *major*, segments 1 and 2 and 8 and 9 respectively being fused together. The appendage reaches beyond the tip of the furcal ramus by approximately the extent of the last segment. The proportional lengths of the segments are as follows:—

Segment	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	
	121	32	30	30	30	33	38	21	24	27	36	36	36	38	40	41	43	44	44	44	58	53	101	=1000

The length of the end segment of the antenna is thus very much greater than in *P. aculeatus*. The segments 10 to 23 all bear rows of minute spinules, running longitudinally as is the case in *P. aculeatus*, but I have been unable in this species to trace any rows of spines on the proximal segments 1 to 9. As in *P. aculeatus*, the two terminal segments are devoid of spines. Where the longitudinal rows of spines occur they are, as is also the case in *P. aculeatus*, broken in the middle of the segments by a short gap in the line.

The mouth-parts appear to be identical with those of *Paracalanus aculeatus*. The swimming legs are also very similar to those of that species but differ in small details that appear to be constant. The most striking difference is in the number of spines on the external margin of exopod 3 in all the legs, and in certain cases this reduction of the number of spines in the present species has proceeded so far that in some of the legs we may find that they have been totally suppressed. The row of leaf-like spines that is present on the posterior aspect of the 2nd joint of the exopod of the 4th leg in *Paracalanus aculeatus* appears to be always absent in the present species. The proportional lengths of the terminal segment of the exopod and the end-spine in the 2nd to 4th swimming legs inclusive is also different in the two species, and in the table below I have given the various measurements, that of the end segment being taken as 100 in each case :—

	<i>Paracalanus aculeatus</i>		<i>Paracalanus denudatus</i>	
	Exopod 3.	End-spine.	Exopod 3.	End-spine.
2nd Swimming leg	100	117	100	136
3rd Swimming leg	100	104	100	126
4th Swimming leg	100	93	100	103

These constant differences are in my opinion sufficient reason for making this a new species and I therefore propose the name *Paracalanus denudatus* for it. Examples have been taken in the surface tow-net at Station 614 (Nankauri Harbour) and in Macpherson Strait, Andaman Islands, and it would thus appear to be a free-swimming littoral form.

(b) The PARVUS group.

The individuals of this group differ from those of the *Aculeatus* group by possessing complete segmentation of the 1st antenna, all the segments being separate, whereas in the *Aculeatus* group segments 1 and 2, and 8 and 9 are respectively fused together; the length of the 1st antenna is also much shorter, reaching only to the end of the cephalothorax or to about the middle of the abdomen and never reaching beyond the tip of the furcal ramus. There is also a very marked difference in the structure of the genital swelling on the ventral aspect of the 1st abdominal segment.

In this group I include *Paracalanus parvus* (Claus), *P. nanus* G. O. Sars, *P. dubia* Sewell, *P. crassirostris* (Dahl), as well as a new species, *Paracalanus nudus*, all of which species are represented in the present Indian collections.

***Paracalanus parvus*. Giesbrecht.**

(Text-figs. 24, a-g and 25, a-e.)

Paracalanus parvus, Norman and Scott, 1900, p. 127.

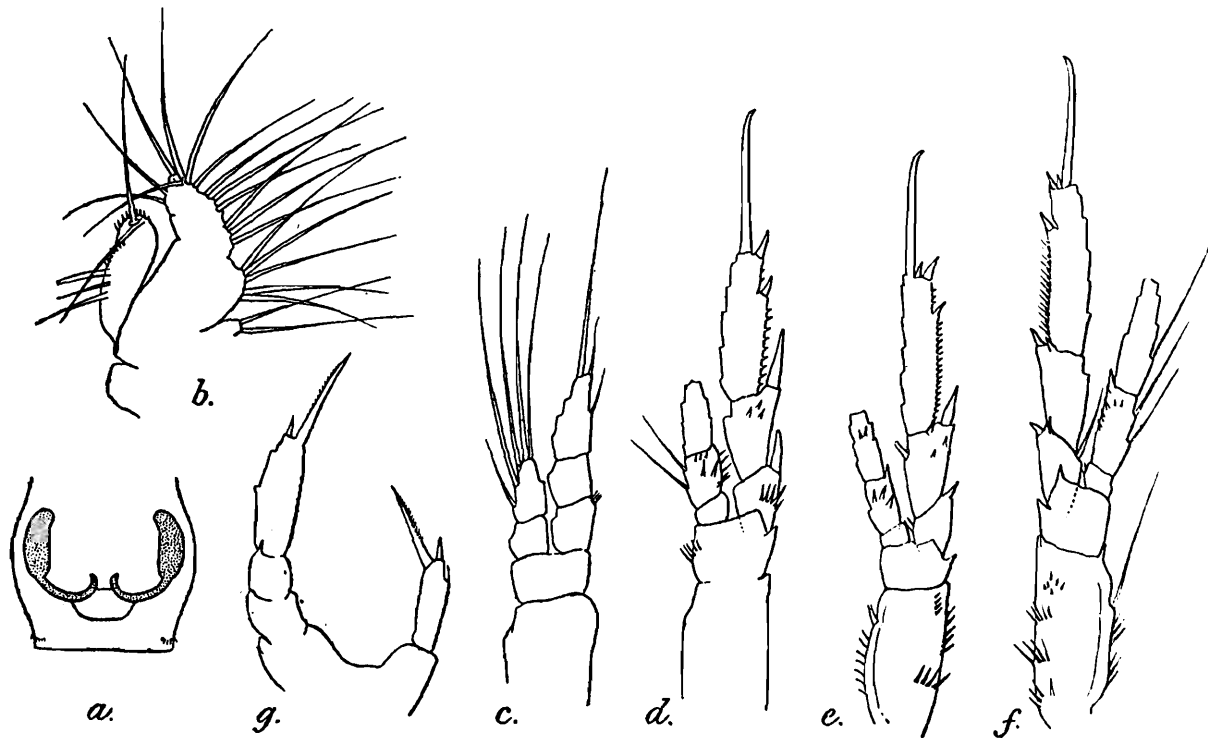
Paracalanus parvus var. *perplexus*, Norman and Scott, 1906, p. 127, pls. xii, figs. 1, 2; xiii, fig. 1; xiv, fig. 1.

- Paracalanus parvus*, A. Scott, 1909, p. 27.
Paracalanus parvus, Farran, 1910, p. 61.
Paracalanus parvus, Steuer, 1910, p. 22.
Paracalanus parvus, Sharpe, 1911, p. 406.
Piezocalanus lagunaris, Grandori, 1912, p. 97.
Paracalanus parvus, Sewell, 1912, p. 358.
Paracalanus parvus, Brady, 1914, p. 25.
Paracalanus parvus, Sewell, 1914, p. 208.
Paracalanus parvus, With, 1915, p. 54, text-fig. 12, a-f.
Paracalanus parvus, Früchtl, 1920, p. 8.
Paracalanus parvus, Früchtl, 1924, p. 35.
Paracalanus parvus, Sars, 1925, p. 24.
Paracalanus parvus, Farran, 1926, p. 233.
Paracalanus parvus, Gurney, 1927, p. 143, fig. 16-A.
Paracalanus parvus, Farran, 1929, p. 221.

♀ Total length, 0.76 mm.

The proportional lengths of the cephalothorax and abdomen are as 31 to 9; the abdomen being thus contained 3.44 times in the length of the anterior region of the body.

The body is comparatively robust and the forehead is uniformly rounded, terminating below in a pair of long and delicate rostral spines. The head and 1st thoracic segment



TEXT-FIG. 24.—*Paracalanus parvus* Giesbrecht, ♀.

- a. The genital segment of the abdomen. d. The 2nd swimming leg.
b. The maxillary palp. e. The 3rd swimming leg.
c. The 1st swimming leg. f. The 4th swimming leg.
g. An abnormal 5th pair of legs.

are incompletely fused, traces of the original line of separation being clearly visible across the dorsal surface. The posterior border of the thorax is slightly emarginate.

The abdominal segments have the following proportional lengths:—

Abdominal segment	1-2	3	4	5	Furca.	
	31	17	13	22	17	= 100

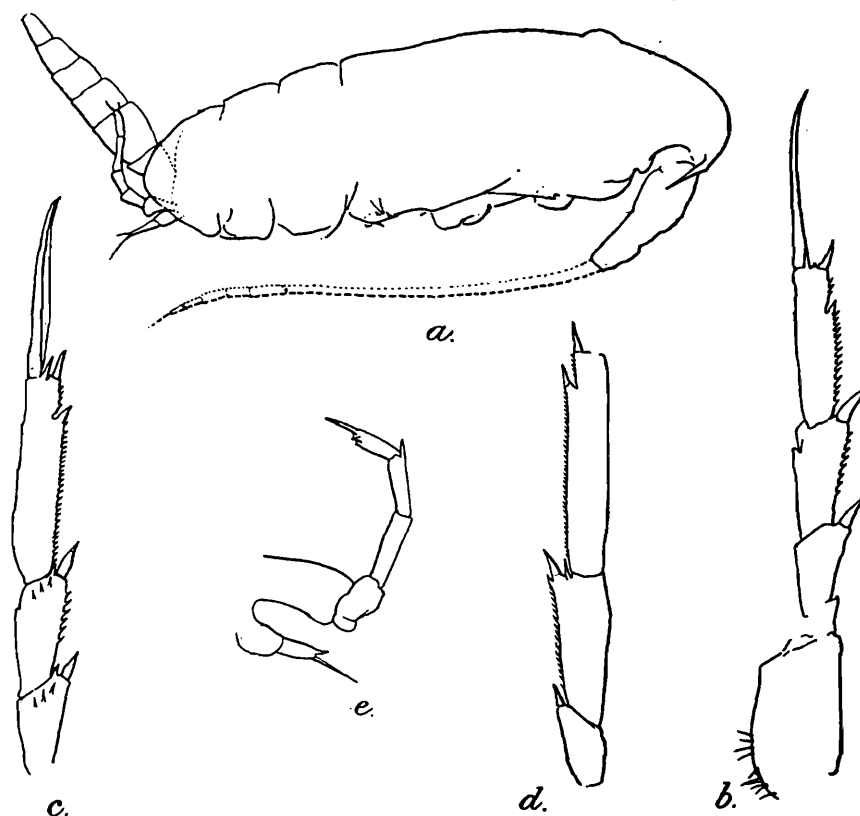
The 1st abdominal segment is armed with a row of small spinules that runs parallel to and close to the posterior margin, except on the ventral aspect. The genital aperture is somewhat angular and the arrangement of the ducts is as shown in text-fig. 24 (a).

The 1st antenna reaches back to the 2nd abdominal segment. The proportional lengths of the segments are as follows :—

Segment	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	
	76	57	34	34	34	34	34	28	25	27	28	31	37	39	40	40	45	43	45	45	45	45	45	40	53	=1000

Segment 12 bears a short oblique row of minute spinules and segments 13 to 23 inclusive each bear a longitudinal row of spinules along the proximal half of the segment.

Examples of the male of this species taken in Nankauri Harbour in the central group of the Nicobars ("Investigator" Station 614) agree exactly with the description given by Grandori (1912) of the male that he called *Piezocalanus lagunaris*.



TEXT-FIG. 25.—*Paracalanus parvus* Giesbrecht, ♂.

- a. The whole animal from the right side. c. The 3rd swimming leg; exopod.
 b. The 2nd swimming leg; exopod. d. The 4th swimming leg; exopod.
 e. The 5th pair of legs.

♂ Total length, 0.74 mm.

The proportional lengths of the cephalothorax and abdomen were as 28 to 11, the abdomen thus being contained 2.55 times in the anterior region of the body. The dorsal profile shows a uniform curve and there is present in the mid-dorsal line the same small transparent swelling that Gurney has figured in the male of *Acrocalanus gibber* (vide Gurney, 1927, p.147, fig. 18). The 4th and 5th thoracic segments are fused but the line of fusion can clearly be seen in the lateral region. The posterior thoracic margin is somewhat sharply rounded. The abdomen consists of five segments having the following proportional lengths :—

Abdominal segment	1	2	3	4	5	Furca	
	12	24	16	16	16	16	=100

The antennae, mouth-parts and swimming legs agree exactly with the description given by Grandori. In the 2nd, 3rd and 4th swimming legs the margin of the distal portion of the last segment, as well as the margin of the 2nd segment, of the exopod are fringed with small spines.

***Paracalanus nanus* G. O. Sars.**

(Text-fig. 26, *a-f.*)

Paracalanus nanus, Sars, 1907, p. 4.

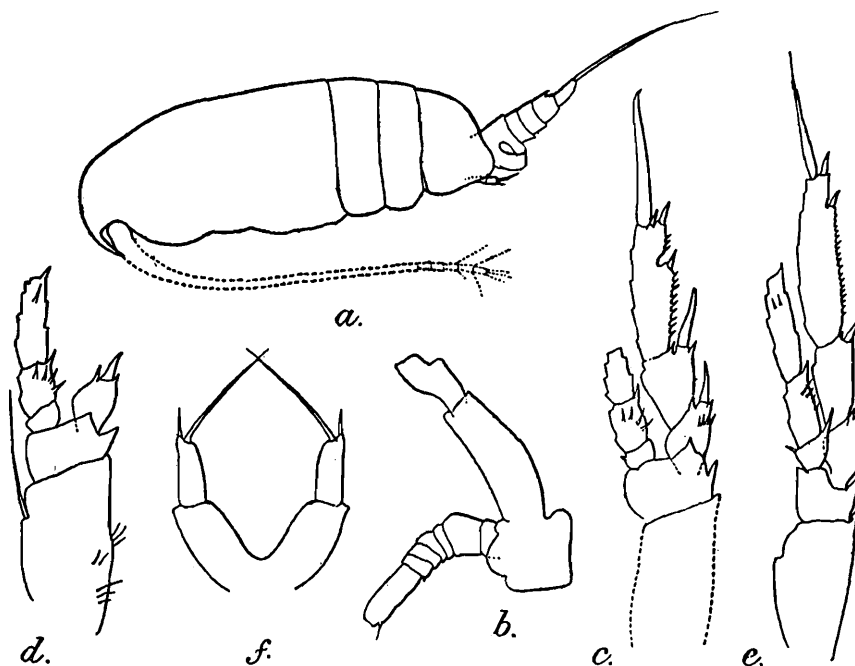
Paracalanus nanus, Sars, 1925, p. 26, pl. vi, figs. 10-17.

A single example of a *Paracalanus* that I believe to belong to this species was taken at "Investigator" Station 614.

♀ Total length, 0.62 mm.

The proportional lengths of the cephalothorax and abdomen were 27 to 6, so that the abdomen is contained 4.5 times in the length of the anterior region of the body; in *Paracalanus parvus* Giesbrecht it is contained only 3.5 times. The abdomen is, therefore, much shorter in the present species.

The forehead is rounded and terminates below in a pair of backwardly directed spines. The posterior thoracic margin is rounded and is somewhat produced in the postero-inferior region. The head and 1st thoracic segments are completely fused, and whereas in *Para-*



TEXT-FIG. 26.—*Paracalanus nanus* Sars, ♀.

a. The whole animal from the left side.	d. The 3rd swimming leg.
b. The 2nd antenna.	e. The 4th swimming leg.
c. The 2nd swimming leg.	f. The 5th pair of legs.

-calanus parvus traces of the line of fusion can be seen across the dorsal surface, no such trace was visible in the present specimen.

The abdominal segments have the following proportional lengths :—

Abdominal segment	1-2	3	4	5	Furca.	
	29	15	12	23	21	=100

The furcal rami are twice as long as broad. The structure of the genital aperture on the ventral aspect of the 1st abdominal segment very closely resembles that of *Paracalanus parvus*.

The 1st antenna barely reaches to the posterior margin of the thorax. The proportional lengths of the segments are as follows :—

Segment	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	
	76	55	33	33	34	34	34	31	28	28	28	28	34	36	38	41	45	45	45	45	45	45	48	45	48	=1000

There is thus but little difference between this species and *Paracalanus parvus* in the length of the antennal segments, but segments 8 and 9 appear to be slightly shorter.

The swimming legs were unfortunately badly damaged.

The 5th pair of legs exhibited a very short distal segment, as is shown in text-fig. 26, f.

This individual differs from *Paracalanus parvus* and resembles *P. nanus* Sars in the following particulars : (1) size, (2) the shortness of the abdomen, (3) the short antenna, and (4) the structure of the 5th pair of legs.

Paracalanus crassirostris Dahl.

(Text-fig. 27, a-b.)

Paracalanus crassirostris, Dahl, 1894, p. 21, pl. i. figs. 27-28.

Paracalanus crassirostris, Giesbrecht and Schmeil, 1898, p. 24.

Paracalanus crassirostris, Thompson and Scott, 1903, p. 243.

Paracalanus crassirostris, Sewell, 1913, p. 339.

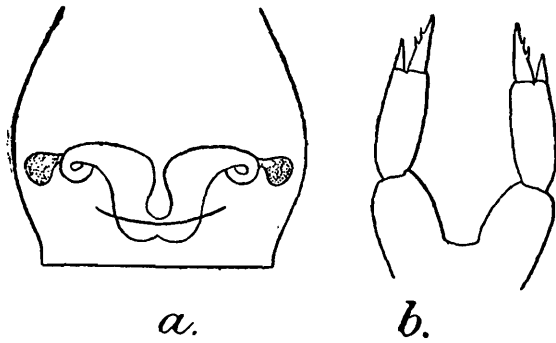
Paracalanus crassirostris, Pesta, 1916, p. 4.

Paracalanus crassirostris f. *typica*, Früchtl, 1924, p. 36.

Paracalanus crassirostris, Sewell, 1924, p. 780.

Früchtl (*loc. cit.*) has discussed the relationship of this species and various closely-allied, if not specifically identical, forms and he has reached the conclusion that the form recorded by T. Scott under the name of *Paracalanus pygmaeus* Claus (*vide* T. Scott, 1893, p. 27, pl. i, figs. 1 to 8) from the Gulf of Guinea, and the form described by me under the name *P. dubia* (*vide* Sewell, 1912, p. 330, pl. xv, figs. 1 to 5) from the mouth of the Rangoon River, are to be regarded as different forms of the one species, namely *P. crassirostris* Dahl, and he proposes the names forma *scotti* for the former and forma *sewelli* for the latter. Sars (1925, p. 24) considers that the form described originally by Claus under the name *Paracalanus pygmaeus* (*vide* Claus, 1863, p. 74) is in reality a valid species and that the specimens described by T. Scott from the Gulf of Guinea under this name were actually examples of that species. Früchtl does not appear to have been acquainted with my paper, published in 1924, in which I have myself remarked on the possibility of *Paracalanus dubia* being merely a variety or local race of *P. crassirostris*; but a subsequent study of both these forms has led me to conclude that they are in all probability distinct, though

very closely allied, species and they certainly seem to show perfectly constant, though slight, differences of structure, especially as regards the terminal spine on the 5th pair of legs and the form of the genital aperture on the 1st abdominal segment. I, therefore, prefer for the present to regard them as specifically distinct.



TEXT-FIG. 27.—*Paracalanus crassirostris* Dahl, ♀.

a. The genital segment of the abdomen.

b. The 5th pair of legs.

This species has now been taken in Indian waters on the coast of southern Burma (Sewell), in the Chilka Lake (Sewell) and on the Pearl Banks of Ceylon (Thompson and Scott); and I can now further record its presence in tow-nettings from "Investigator" Stations 556, 562, 614, and from

Expedition Harbour in the Nicobar Islands, as well as from Port Blair Harbour in the Andamans. From its distribution and from its prevalence in the Chilka Lake it would seem that this species is in the main an inhabitant of brackish-water rather than of the open sea.

♀ The total length of individuals of this species varies from 0.42 to 0.5 mm. in different localities; I have in a previous paper (1924) called attention to this and I attributed it to the salinity of the water in which the specimens were living.

In this species the antenna reaches back only to the level of the posterior thoracic margin. As in *Paracalanus parvus* Giesbrecht, segments 1 and 2 are separate but segments 8 and 9 on the other hand are fused as in *P. aculeatus* Giesbrecht. The antenna in this species still further resembles that of *P. aculeatus* in that on the various segments we find rows of minute spinules; those on segments 3 to 10 inclusive run transversely, but in the more distal segments from 12 to 23 inclusive they run longitudinally; the two terminal segments are devoid of spines. The proportional lengths of the various segments are as follows:

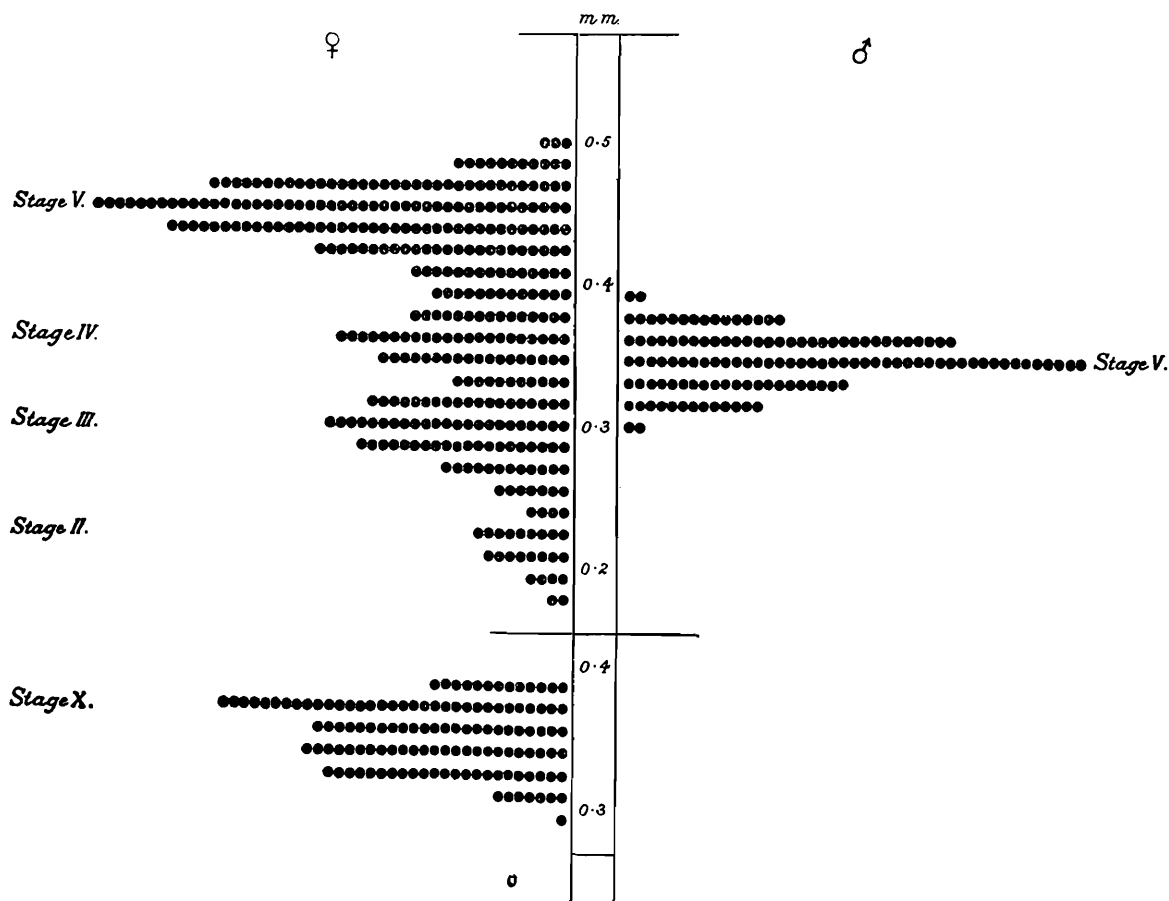
Segment	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	75	58	23	23	23	23	23	46	25	27	33	33	33	35	35	40	54	55	55	58	58	58	55	52	= 1000.

While investigating the copepodid fauna of the Chilka Lake I was able to examine a large number of examples of this species and to take their measurements and thus calculate the growth-factors at the different stages of development. In all I was able to measure large numbers belonging to four different stages and I found that the increase in the length measurement follows, in the main, the same course that I have already described in the case of *Paracalanus aculeatus* Giesbrecht. There are, however, certain extremely interesting differences. We have already seen that in the case of *P. aculeatus* the full development requires five ecdyses, so that there are in all six stages, but that the last two may both be sexually-mature. In the case of *P. crassirostris* the smallest examples appeared to belong to the 1st copepodid stage and possessed only a single segment in the abdomen, while the sexually-mature examples were in the 5th stage of development. In both sexes, therefore, there was shortening of the development by one stage, but the elimination of this stage seems to occur at different ends of the life-history in the two sexes. In the female it appears from the growth-factors that the last two stages, culminating in the attainment of sexual maturity, were in the present instance copepodid stages IV and V,

whereas in the case of *P. aculeatus* they are copepodid stages V and VI. In what I term the normal course of development it is at the IVth stage in the female sex that we find the antagonism between the attainment of sexual maturity on the one hand and the general vegetative increase in the body-size on the other, this antagonism being shown by a fall in the growth-factor. Furthermore, in the normal course this reduced growth-factor has to be repeated twice before the final large adult or forma *major* is reached although the Vth stage may in some instances become sexually mature and so give rise to the forma *minor*. In these examples of *P. crassirostris* this reduction in the growth-factor occurs at copepodid stage III, the growth-factor falling from 1.322 in the second ecdysis to 1.212 in the 3rd and 4th, the sexually-mature individual being therefore in the Vth copepodid stage, though corresponding to the forma *major* of other species. During the process of development, the alteration in the number of segments in the abdomen is as follows :

Copepodid Stage I possesses	1	abdominal segment.
Copepodid Stage II possesses	2	„ „
Copepodid Stage III possesses	3	„ „
Copepodid Stages IV and V possess	4	„ „

but, as is usual, in stage IV it is segments 4 and 5 that are still fused, whereas in stage V segments 4 and 5 are separate and 1 and 2 are fused. In most instances, during development, copepodid stages II and III each exhibit an abdomen composed of 2 segments, as



TEXT-FIG. 28.—*Paracalanus crassirostris* Dahl, the length-measurements of 609 individuals, in different stages of development, from the Chilka Lake.

has been shown to be the case in *Calanus finmarchicus* by Lebour (1916) : but in this case one of these stages has been dropped.

In the case of the male there also appears to be a reduction in the length of the life-history. In the earlier stages of development it is as usual impossible to distinguish between the sexes, but to judge from the average size of the later groups it is at copepodid stage III that we find the two subsequent possible lines of development; in the one line it seems that by adopting the male growth-factor of 1.289 individuals may pass to stage V and become at once sexually-mature; whereas in the other line a certain number may adopt the female growth-factor of 1.212 and pass to copepodid stage IV; if now these individuals revert, as appears to be possible from the life-history in certain other species, to the male growth-factor they would then attain an increased size and become sexually-mature in stage VI and form the high dimorph or forma *major* but this stage has so far not been discovered. Theoretically these individuals would attain a length of approximately 0.450 mm.

In the table below I have given the average size of the various groups from all localities as well as the calculated size and the corresponding growth-factors:

			Observed size.	Calculated size.	Growth- factor.
♀			mm.	mm.	
Copepodid Stage II	..	..	0.222	0.222	1.322
Copepodid Stage III	..	..	0.293	0.293	1.213 or 1.289
Copepodid Stage IV	..	..	0.355	0.355	1.213
Copepodid Stage V (adult)	..	..	0.431	0.430	....
Copepodid Stage X	..	..	0.379	0.378	....
♂					
Copepodid Stage III	..	..	0.293	0.293	1.289 or 1.213
Copepodid Stage IV	..	..	0.351	0.355	1.289
Copepodid Stage V (Adult)	..	..	0.369	0.377	...
Copepodid Stage VI (unknown)	..	..	...	0.458	..

I have already called attention to the occurrence in this genus of individuals that, while resembling the female in certain characters, yet show a tendency to approach the male especially in the possession of rudimentary 5th legs of the male type. In *Paracalanus crassirostris* the occurrence of individuals of this nature was particularly common in the Chilka Lake and wherever examples of this species were found I also obtained numbers of the abnormal form. A large number of measurements were taken of the total length of these individuals and the average gave a length of 0.379 mm. These individuals are thus smaller than the sexually-mature female but are larger than the adult male. Gurney (1927) has pointed out that these individuals are females and it seems probable that they originate from copepodid stage III by the assumption of the male growth-factor; I have shown that the average size of individuals of stage III is 0.293 mm. and we have seen that the male growth-factor is 1.289; this gives a calculated size for the moult of 0.378 mm. which agrees almost exactly with the observed size of 0.379 mm.

As I have previously pointed out the average length-measurement of this species varies somewhat in different localities and at different seasons of the year, probably in agreement with the salinity of the surrounding water. In the case of *Undinula vulgaris* (Dana) we

noted that the growth-factor varied with the size of the adult female and the same appears to be the case in the present species :

With a length measurement of 0.426 mm. the final ♀ growth-factor is 1.220.

„ „ „ 0.436 mm. „ „ „ „ „ 1.228.

„ „ „ 0.481 mm. „ „ „ „ „ 1.250.

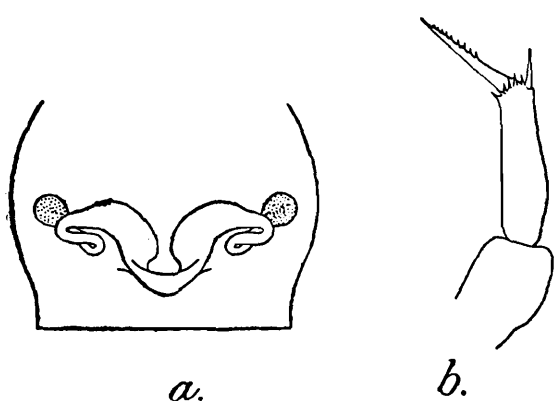
Paracalanus dubia Sewell.

(Text-fig. 29, *a-b*.)

Paracalanus dubia, Sewell, 1912, p. 330, pl. xv, figs. 1—5.

Paracalanus crassirostris, forma *Sewelli*, Früchtl, 1924, p. 36.

This species was described by me from specimens taken off the mouth of the Rangoon River in Burma in water that possessed a specific gravity of 1002. Früchtl (*loc. cit.*) has suggested that this form is in reality a variety or race of *Paracalanus crassirostris* and he has



TEXT-FIG. 29.—*Paracalanus dubia* Sewell, ♀.

a. The genital segment of the abdomen.

b. The 5th leg.

proposed to rename the form *Paracalanus crassirostris* forma *Sewelli*. That *Paracalanus crassirostris* and *P. dubia* are very nearly related there can be no doubt; but I am inclined to regard them as separate species rather than forms of one and the same species. In *Paracalanus dubia* the structure of the genital opening on the ventral aspect of the 1st abdominal segment is somewhat different from that in *P. crassirostris* (*cf.* figs. 27, *a* and 28, *a*) and the 5th pair of legs are also different; the terminal spines in *P. crassirostris* are both very short, the inner one being only twice the length of

the outer one and about one-half the length of the segment that bears them; the larger spine also exhibits a row of two or three small teeth along its edge. In *P. dubia* the terminal spines are markedly unequal, the inner one being about three times the length of the outer one and about two-thirds the length of the segment; the edge of the spine is also armed with a row of 10 to 12 spinules. As these differences appear to be constant, I think it as well, for the present at any rate, to regard these two species as distinct.

Paracalanus nudus, sp. nov.

(Text-fig. 30, *a-i*.)

♀ Total length, 0.45 to 0.48 mm.

The proportional lengths of the cephalothorax and abdomen are as 47 to 13, so that the abdomen is contained 3.61 times in the length of the anterior region of the body.

The body is slender and the forehead is rounded, terminating below in a pair of delicate rostral spines. The head and 1st thoracic segment are fused, as also are thoracic segments 4 and 5. The posterior thoracic margin is slightly emarginate and is furnished with a tuft of backwardly-directed hairs as in *Paracalanus aculeatus*. The abdomen consists of the

usual four segments, of which the 2nd and 3rd are short. The proportional lengths of the segments are as follows :

Abdominal segment	1-2	3	4	5	Furca.
	35	13	10	21	21
	=100.				

The genital segment is swollen ventrally and the genital orifice is guarded by a wide concentric flap. On the right side of the segment there is a group of small triangular spines.

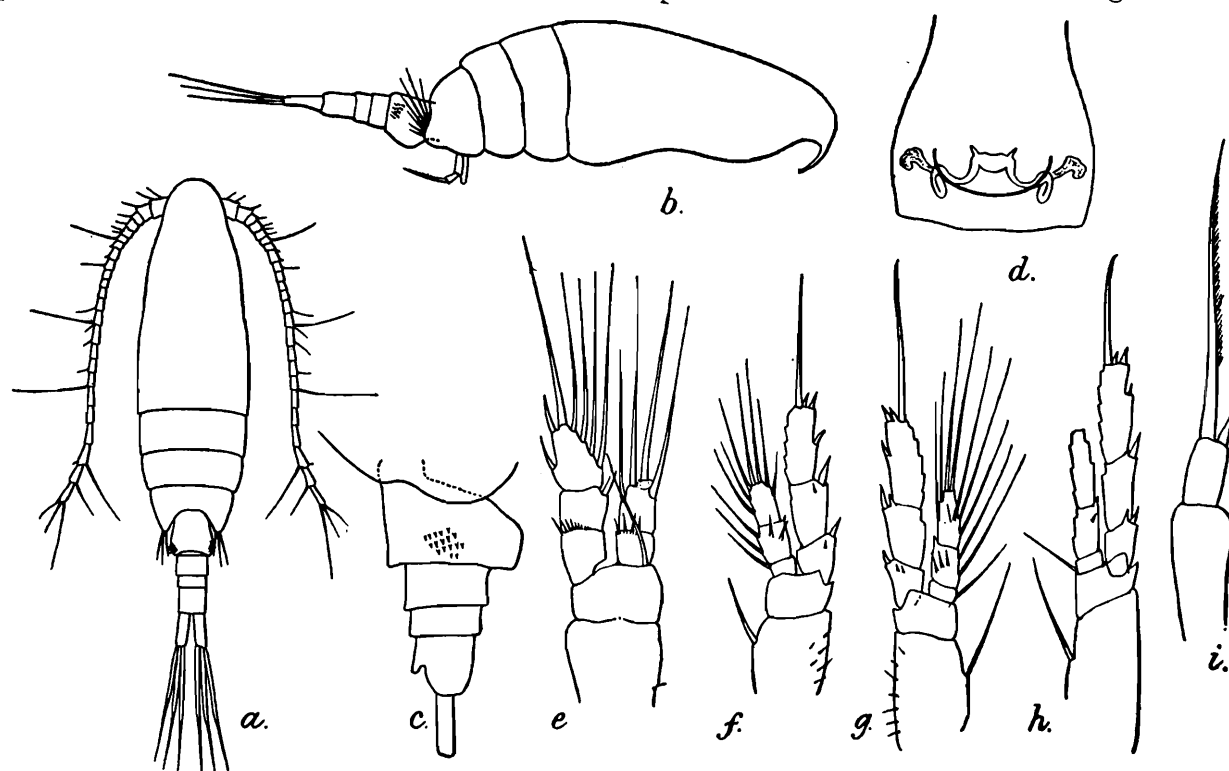
The 1st antenna reaches back only to about the level of the posterior thoracic margin. Segments 1 and 2 are separate but segments 8 and 9 are fused as in *Paracalanus crassirostris*. The various segments have the following proportional lengths :

Segment	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
	70	44	23	21	21	25	25	42	27	30	33	37	42	42	44	42	44	46	46	49	61	65	53	68
	=1000.																							

The 2nd antenna and mouth-parts appear to be the same as those of *Paracalanus parvus*.

The swimming legs differ from those of all previously described species in this genus by being totally devoid of all spinules on the external margin of the 3rd segment of the exopod.

The 1st swimming leg (text-fig. 30, *e*) has no spines on either of the two basal segments. Exopod 1 bears a row of transverse needle-like spines at the distal external angle. Exopod



TEXT-FIG. 30.—*Paracalanus nudus*, sp. nov., ♀.

- a.* The whole animal from above.
- b.* The whole animal from the right side.
- c.* The abdomen from the right side.
- d.* The genital segment of the abdomen.
- e.* The 1st swimming leg.
- f.* The 2nd swimming leg.
- g.* The 3rd swimming leg.
- h.* The 4th swimming leg.
- i.* The 5th leg.

2 has no marginal spine and exopod 3 bears two marginal spines of about equal length and a delicate end-spine, that is longer than the whole ramus. The proximal segment of the endopod, that consists of only two segments, bears a row of four long and needle-like spines.

The 2nd swimming leg (text-fig. 30, *f*) possesses a few delicate needle-like spines on the outer aspect of the 1st basal joint. The 1st segment of the exopod bears a marginal

spine and a small additional needle-like spine near the distal external angle. The 2nd segment of the exopod is similarly armed but the marginal spine is in this species very much less developed than in *Paracalanus aculeatus* or *P. parvus*. The 3rd segment of the exopod is comparatively short, being but little longer than the 2nd segment; the usual two marginal spines are present, but in this species the proximal spine divides the external margin into two very nearly equal parts, as in the genus *Acrocalanus*, whereas in most species of the genus *Paracalanus* the proximal part of the segment is twice as long as the distal portion. The end-spine is long and delicate and is nearly equal in length to the last two segments of the ramus. As mentioned above, there is a complete absence of spines on the external margin of the exopod. In the endopod, the 2nd segment bears a row of stout spines and the 3rd segment is comparatively short.

The 3rd swimming leg (text-fig. 30, *g*) closely resembles the 2nd, the endopod showing a slight increase in the number of spines on the face of the two distal segments; endopod 2 bears three needle-like spines and the terminal segment bears a pair.

The 4th swimming leg (text-fig. 30, *h*) is totally devoid of all spines on the anterior or posterior surfaces of the segments with the single exception of a small one on the 2nd segment of the endopod.

The 5th pair of legs (text-fig. 30, *i*) have the same general characters as those of other members of this genus and consist of a basal portion, a single free segment and a pair of unequal terminal spines. In this species the free segment is remarkably short, whereas the larger of the two end-spines is remarkably long and stout and is armed throughout the distal three-fourths with a row of spinules giving it a serrated margin. This spine is at least four times as long as the free segment that bears it. The outer spine is very short.

There can, I think, be no doubt that this is a new species. It is interesting to observe that in both the genera *Paracalanus* and *Acrocalanus* there is the same tendency to the reduction, in certain species, of the marginal spines on the exopod of the swimming legs. I have previously described this condition in *Acrocalanus inermis* and we find it again here in *Paracalanus nudus*.

Genus **ACROCALANUS** Giesbrecht.

At the present time five species can be recognised in the genus *Acrocalanus*, namely *Acrocalanus longicornis* Giesbrecht, *A. gracilis* Giesbrecht, *A. gibber* Giesbrecht, *A. monarchus* Giesbrecht and *A. inermis* Sewell. Wolfenden (1905, p. 1004, pl. xcvi, figs. 5, 10, 14-21) created a new species under the name *Acrocalanus gardineri* to accommodate certain specimens that were taken in the Maldivé Archipelago; these examples were all males and I have previously (Sewell, 1914, p. 211) pointed out that in my opinion these males belong to the species *A. gracilis* Giesbrecht; Gurney (1927, p. 149), however, thinks that they probably correspond to *A. longicornis* Giesbrecht. While, therefore, retaining the name for the present in order to accommodate certain males, the female of which has not yet been definitely determined, it must be recognised that in all probability the name, sooner or later, will have to be dropped, becoming a synonym of one or other of the species at present recognised, as soon as we are able to determine definitely to which of the female forms these males correspond. The species described by Cleve (1901, p. 33) under the name *Acrocalanus pediger*, as I have shown previously (Sewell, 1914, pp. 205, 210), does

not exist; Carl (1907, p. 7) pointed out that the supposed male does not belong to the genus *Acrocalanus* at all but is a *Paracalanus*, and I (*loc. cit.*) connected it with *P. aculeatus*; the female *Acrocalanus pediger* is a synonym of *A. gibber*.

***Acrocalanus gracilis* Giesbrecht.**

(Text-fig. 31, a-e.)

Acrocalanus gracilis, A. Scott, 1909, p. 29.

Acrocalanus gracilis, Wolfenden, 1911, p. 204.

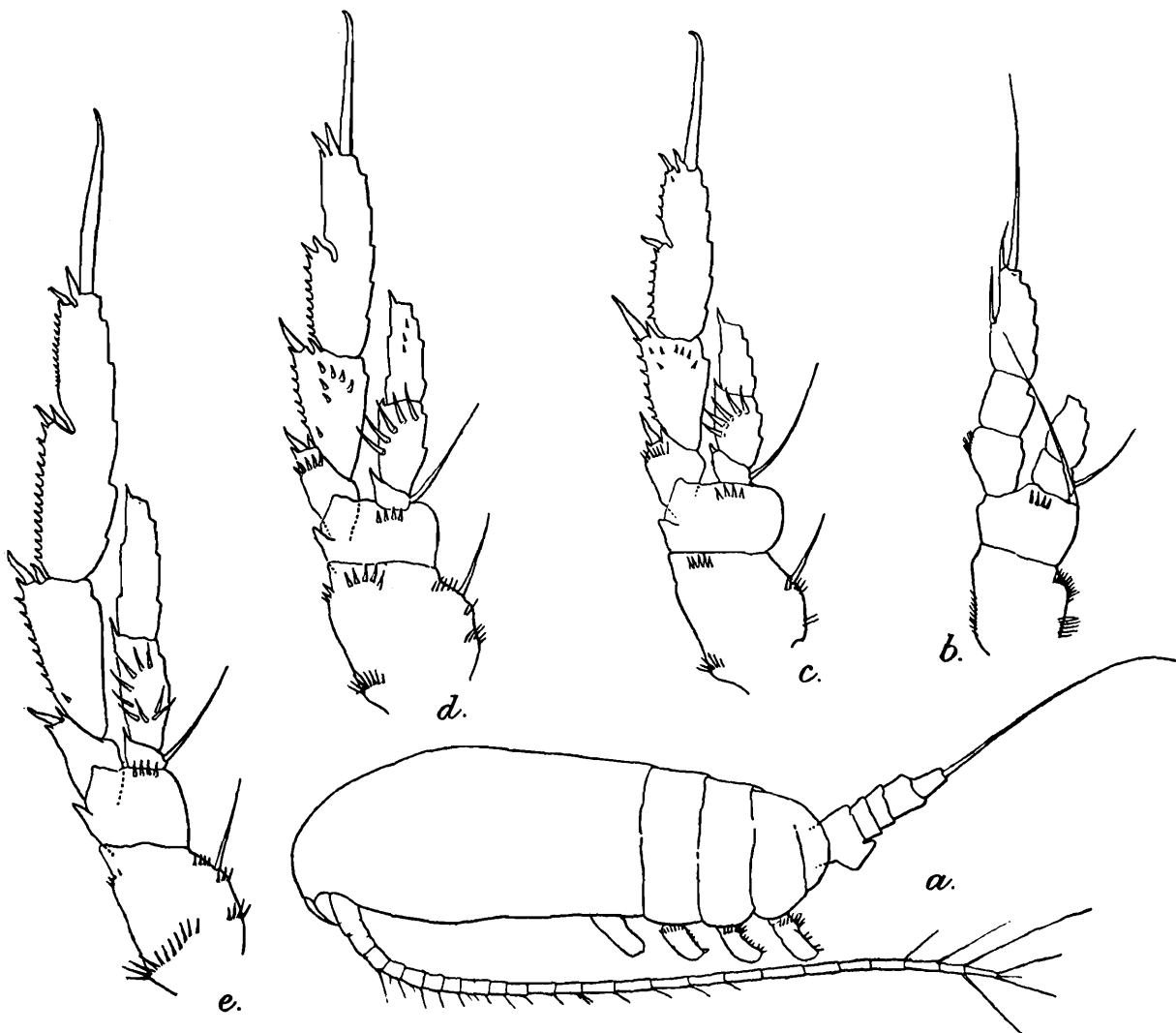
Acrocalanus gracilis, Sewell, 1912, p. 359.

Acrocalanus gracilis, Sewell, 1913, p. 357.

Acrocalanus gracilis, Sewell, 1914, p. 209.

Acrocalanus gracilis, Früchtl, 1924, p. 41 (63).

This species is widely distributed and has now been obtained from the Malay Archipelago (A. Scott; Früchtl), the coast of southern Burma (Sewell), the Pearl Banks of Ceylon



TEXT-FIG. 31.—*Acrocalanus gracilis* Giesbrecht, ♀.

a. The whole animal from the left side.

c. The 2nd swimming leg.

b. The 1st swimming leg.

d. The 3rd swimming leg.

e. The 4th swimming leg.

(Thompson and A. Scott; Sewell), the Maldive Archipelago (Wolfenden) and from the east-coast of Africa (Cleve).

Examples from the Nicobar region agree closely with the previous accounts.

♀ Total length, 1.0 mm.

The proportional lengths of the cephalothorax and abdomen are as 83 to 21, so that the abdomen is contained 3.95 times in the length of the anterior region. There is no trace of the line of fusion between the cephalon and the 1st thoracic segment.

The 1st antenna reaches beyond the tip of the furcal ramus by the last three segments. The proportional lengths of the segments are as follows :

Segment	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
	121	31	31	31	31	31	45	24	26	23	37	39	41	43	46	47	50	56	53	53	49	38	49	=1000.

The 1st and 2nd segments are completely fused and segments 8 and 9 are also partially fused but the line of demarcation between them can be easily detected.

Acrocalanus gibber Giesbrecht.

(Text-fig. 32, a-e.)

Acrocalanus gibber, A. Scott, 1909, p. 29.

Acrocalanus gibber, Sewell, 1912, pp. 315, 359.

Acrocalanus gibber, Sewell, 1914, p. 210.

Acrocalanus gibber, Brady, 1914(a), p. 25.

Acrocalanus gibber, Gurney, 1927, p. 147, fig. 18.

This species is widely distributed throughout the whole of Indian waters. It has now been taken in the Malay Archipelago (A. Scott), on the coast of southern Burma (Sewell), on the Pearl Banks of Ceylon (Thompson and A. Scott ; Sewell), in the Maldivé Archipelago (Wolfenden) ; in the Arabian sea, Gulf of Aden and the Red Sea (A. Scott ; Cleve) and in the Gulf of Suez (Gurney) ; while to the west it has been recorded from the east coast of Africa (Cleve ; Brady). It is one of the commonest species in the " Investigator " collections and occurs at Stations, 541, 542, 544, 545, 552, 555, 556, 558, 561, 562, 574, 575, 577, 578, 583, 583, 584, 587, 590, 591, and 614.

Gurney (1927, p. 147) has called attention to certain discrepancies in the various earlier accounts with regard to the length of the antenna ; Giesbrecht in his original description of the species stated that the 1st antenna extended beyond the tip of the furcal ramus by the last 1 or 2 segments.

Gurney in specimens taken from the Gulf of Suez and the Suez Canal finds that the antenna always extended beyond the tip of the furcal ramus by 1 to 3 joints ; Wolfenden (1906(a), p. 1003), however, states that in specimens from the Maldivé Archipelago the antenna did not reach the end of the abdomen and the same is true of specimens taken at " Investigator " Station 614 in which the antenna usually reaches to about the middle of the furcal ramus.

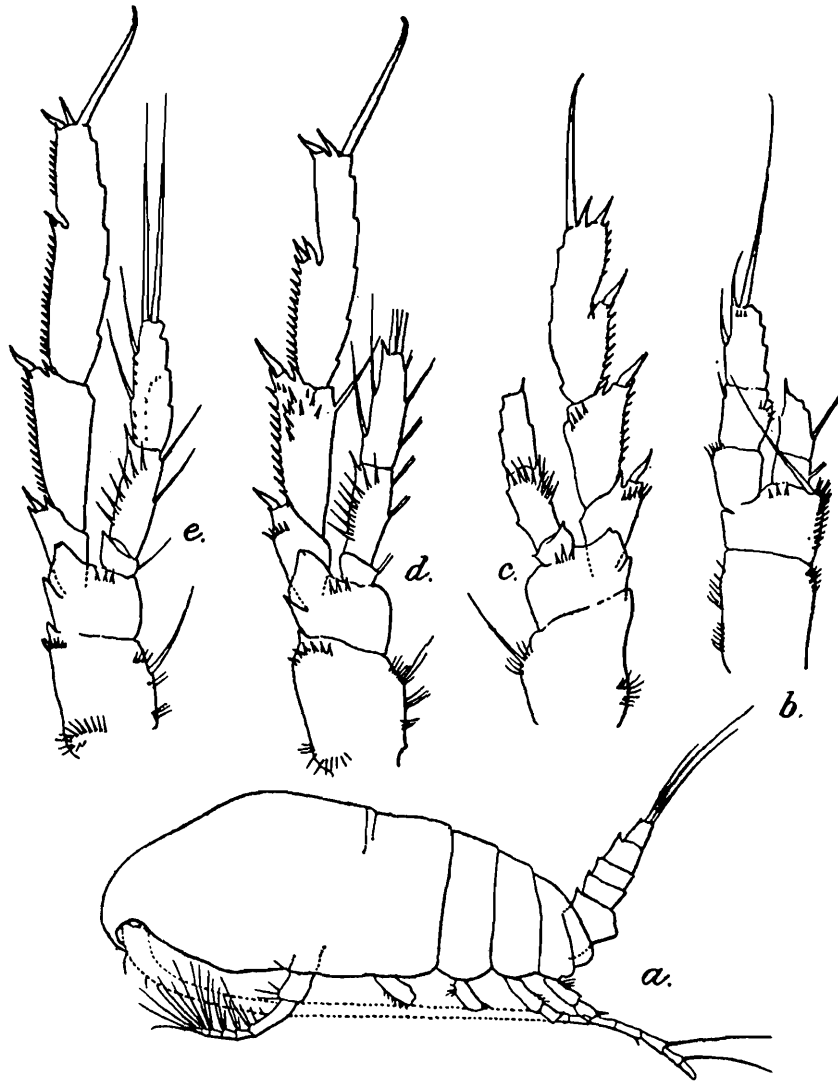
♀ Total length, 0.81 mm.

The proportional lengths of the cephalothorax and abdomen are as 33 to 10, the abdomen being thus contained 3.30 times in the length of the anterior region of the body.

The abdominal segments have the following proportional lengths :

Abdominal segment	1-2	3	4	5	Furca.	
	33	15	12	22	15	= 100

The furcal ramus is a little more than half as broad as long, the proportions being 1 to 1.9. The inner seta of the furcal ramus is very short and delicate.



TEXT-FIG. 32.—*Acrocalanus gibber* Giesbrecht, ♀.

- a. The whole animal from the left side. c. The 2nd swimming leg.
b. The 1st swimming leg. d. The 3rd swimming leg.
e. The 4th swimming leg.

The 1st antenna reaches to about the end of the abdomen. 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	25
	123	35	35	35	33	33	46	26	26	30	35	37	38	39	42	44	49	49	49	51	49	44	52

The 1st and 2nd segments are fused and so also are the 8th and 9th.

***Acrocalanus inermis* Sewell.**

Acrocalanus inermis, Sewell, 1912, pp. 334-336, pl. xvi, figs. 1-9.

Acrocalanus similis, Sewell, 1914, pp. 211-213, pl. xvii, figs. 3-5.

Acrocalanus inermis, Sewell, 1924, p. 781.

Acrocalanus inermis, Früchtl, 1924, p. 39 (61).

This species, though widely distributed throughout Indian waters, appears to be in the main an inhabitant of brackish-water and to be confined to the coastal regions. It has now been recorded from the coast of Burma and especially from the estuarine regions round

the mouths of the chief rivers, such as the Rangoon river ; the Chilka Lake ; the Pearl Banks of Ceylon and from the region of the central group of the Nicobars, where I have taken it in Expedition Harbour and in Nankauri Harbour. Früchtl (1924) records it from the Malay Archipelago.

***Acrocalanus longicornis* Giesbrecht.**

(Text-fig. 33, a-f.)

Acrocalanus longicornis, A. Scott, 1909, p. 28.

Acrocalanus longicornis, T. Scott, 1912, p. 531.

Acrocalanus longicornis, Sewell, 1912, p. 358.

Acrocalanus longicornis, Pesta, 1913, p. 13, fig. 14.

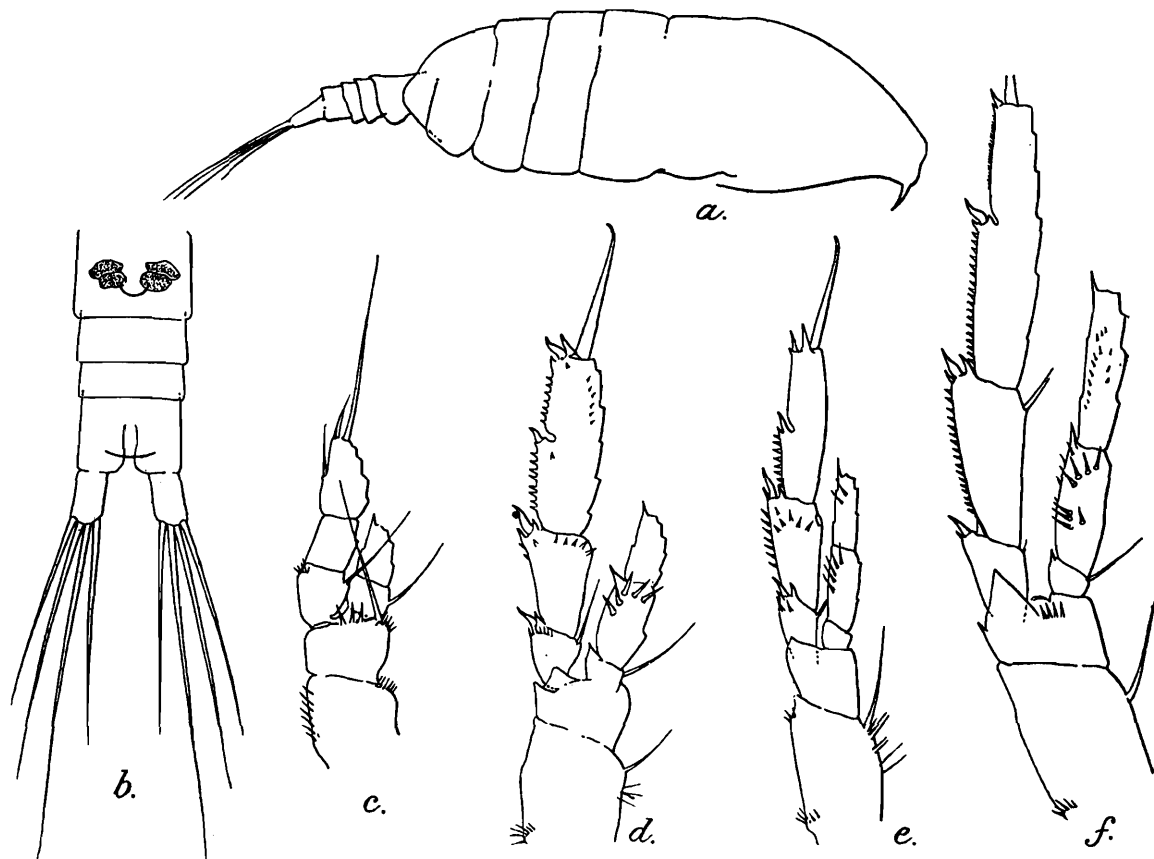
Acrocalanus longicornis, Sewell, 1913, p. 357.

Acrocalanus longicornis, Sewell, 1914, p. 209.

Acrocalanus longicornis, Brady, 1915, p. 135.

Acrocalanus longicornis, Farran, 1929, p. 222.

This species is widely distributed throughout Indian waters ; it has now been taken in the Malay Archipelago (Cleve ; A. Scott), off the coast of southern Burma (Sewell), on the Pearl Banks of Ceylon (Thompson and A. Scott ; Sewell), in the Maldivé Archipelago (Wolfenden), in the Persian Gulf (Pesta) and on the east coast of Africa (Brady). In the



TEXT-FIG. 33.—*Acrocalanus longicornis* Giesbrecht, ♀.

a. The whole animal from the right side.

b. The abdomen from below.

c. The 1st swimming leg.

d. The 2nd swimming leg.

e. The 3rd swimming leg.

f. The 4th swimming leg.

“Investigator” collection it occurs at Stations 547, 555, 614 and in Expedition Harbour in the Nicobars.

♀ Total length, 1.0 mm.

The proportional lengths of the cephalothorax and abdomen are as 21 to 6, so that the abdomen is contained 3.5 times in the length of the anterior region of the body. Gurney (1927, p. 147) states that *Acrocalanus gibber* is the only species in this genus that exhibits a partial separation of the cephalon from the 1st thoracic segment. He remarks "All the females (of *A. gibber*) are characterised by having a strikingly humped dorsal outline and a partial separation of the head from the 1st thoracic somite, two characters which separate *A. gibber* from the others described" In this he is mistaken; it is true that the dorsal hump is much more marked in *A. gibber* than in other members of the genus, but it is still noticeable in both *A. longicornis* and *A. inermis* and the partial separation of the cephalon and the 1st thoracic segment is clearly seen in Indian examples of *A. longicornis*, a distinct line of separation running across the dorsal region.

The abdomen consists of four segments having the following proportional lengths:

Abdominal segment	1-2	3	4	5	Furca.
	<u>31</u>	16	11	22	20
	= 100.				

The 1st antenna over-reaches the posterior end of the furca by at least the last three segments. 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	25
	52	42	26	26	24	24	26	40	23	24	30	37	42	44	48	50	52	60	67	61	58	52	39	53
	= 1000.																							

***Acrocalanus monachus* Giesbrecht.**

Acrocalanus monachus, A. Scott, 1909, p. 30.

Acrocalanus monachus, Sewell, 1912, p. 359.

Acrocalanus monachus, Sewell, 1914, p. 210.

This species is widely distributed throughout the whole of the Indian seas. It has now been taken in the Malay Archipelago (A. Scott); on the coast of southern Burma (Sewell); the Pearl Banks of Ceylon (Thompson and A. Scott; Sewell); the Maldivé Archipelago (Wolfenden) and on the east coast of Africa (Cleve).

***Acrocalanus gardineri* Wolfenden.**

Acrocalanus gardineri, Wolfenden, 1906(a), p. 1004, pl. xcvii, figs. 5, 10, 14-21.

Acrocalanus gardineri, Sewell, 1912, p. 359.

Acrocalanus gardineri, Sewell, 1914, p. 211.

Acrocalanus gardineri, Früchtl, 1924, p. 42 (64).

Wolfenden in 1906 under the name *Acrocalanus gardineri* described a male Acrocalanid from the Maldivé Archipelago. As I have mentioned above (*vide supra*; p. 78) I suggested that these examples were really the unknown male of *Acrocalanus gracilis*; Gurney (1927, p. 149) suggests that they are the male of *A. longicornis*. These examples have invariably been found in association with the females of other known species in the genus and there seems little reason to doubt that they are the male of one of the known species of females.

Examples have now been recorded from the Malay Archipelago, the coast of southern Burma, the Pearl Banks of Ceylon and the Maldivé Archipelago and in the "Investigator" collection I have found examples from the Nicobar Islands.

Up to the present time only three adult males have been described in this genus, namely those of *Acrocalanus gibber*, *A. inermis* and *A. gardineri*. Of these three *Acrocalanus inermis* need not concern us here, since it is quite easily distinguished from any other male by its size and by the absence of spinules on the margin of the segments of the swimming feet. Of the other two there seems no reason to doubt that the form described by Cleve in 1901 and subsequently partly figured and described by Gurney in 1927 is the true male of *Acrocalanus gibber*; but the situation is quite different as regards the form described by Woldenden under the name *A. gardineri*. Among the tow-nettings taken in Nankauri Harbour in the Nicobars ("Investigator" Station 614) are representatives of all five species of females and associated with these are a number of males, some of which appear to correspond to *Acrocalanus gibber*, while others seem to be nearly related and only differ in very minute details; but since these differences appear to be constant one is justified in concluding that we have here the males of more than one species and I have endeavoured to connect these males with the corresponding female. In doing this I have found it necessary to add yet another description of the male of *A. gibber* in spite of the detailed accounts given originally by Cleve and later by Gurney.

Acrocalanus gibber (Text-fig. 34, a-d.)

♂ Total length of present specimens, 0·943 mm. Cleve gives it as 1·0 to 1·2 in his examples and Gurney gives his specimens from the Gulf of Suez as measuring 0·85 to 1·06 mm. The proportional lengths of the cephalothorax and abdomen are as 19 to 6, so that the abdomen is contained 3·17 times in the length of the anterior region of the body. Cleve in his account gives the proportionate lengths as 8 to 3 or 9 to 3·5, so that in his examples the abdomen is contained 2·67 to 2·57 times in the cephalothorax. The abdomen in my examples would, therefore, appear to be considerably shorter than in the Malay examples.

The head and thorax form a uniformly rounded curve, the dorsal margin being gently convex. In the middle line near the anterior end of the cephalothorax is a small bubble-like swelling, that has been correctly figured by Gurney though he does not mention it in the text.

The abdomen consists of five segments having the following proportional lengths :

Abdominal segment	1	2	3	4	5	Furca.	
	13	25	17	17	16	12	= 100.

As in the account given by Cleve, the furcal segments are not as long as the anal segment; they are, however, not quite as broad as long, measuring 7·5 in length by 6·0 in breadth or 1·25 to 1. They are widely divergent.

The antennæ reaches back to just beyond the posterior margin of the thorax. The proportional lengths of the various segments are as follows :

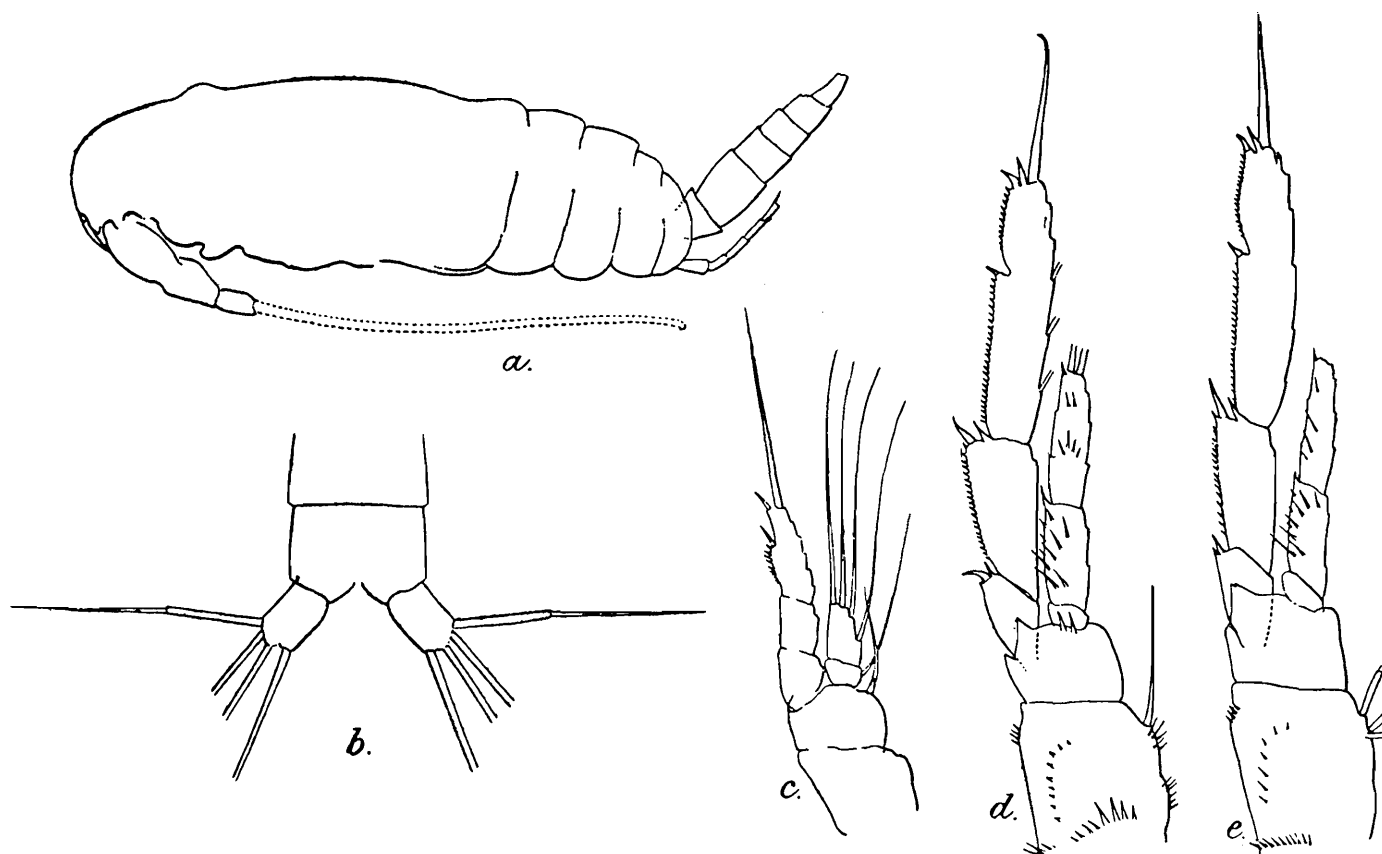
Segment	1-6	7-8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	270	64	25	26	28	35	40	40	40	42	42	45	45	47	47	45	50	42	27 = 1000.

The 2nd antenna and mouth-parts are as described by Cleve.

The 1st swimming leg (text-fig. 34, c) bears a comb of small teeth along the external margin of the proximal part of the 3rd segment of the exopod.

The 2nd to 4th swimming legs are as figured by Cleve and Gurney. It seems to be somewhat doubtful whether the actual structure of these appendages differs materially in

the various species in this sex, and almost the only difference that I have been able to trace, in what I believe to be different species, lies in the proportions of the various segments and



TEXT-FIG. 34.—*Acrocalanus gibber* Giesbrecht, ♂.

- a. The whole animal from the left side. c. The 1st swimming leg.
b. The posterior end of abdomen and furcal rami. d. The 4th swimming leg.
e. The 4th swimming leg of *A. gracilis* (?) ♂.

the terminal spine in these appendages and in the number of spines on the margins. I, therefore, give below in tabular form the proportions of these parts in the different legs :

				2nd leg.	3rd leg.	4th leg.
Exopod 2	..	..	..	24	26	27
„ 3, proximal part	..	..	..	20	21	23
„ 3, distal part	..	..	..	18	20	18
End-spine	..	..	..	38	33	32

The number of spinules on the different parts of the legs also appears to offer a clue to the separation of the various species. In the present species the number of teeth on the various parts of the different legs are as follows :

				2nd leg.	3rd leg.	4th leg.
Exopod 2	..	..	..	11	13	20 to 22
„ 3, proximal part	..	..	..	10	15	25
„ 3, distal part	..	..	..	7 to 8	14 to 15	10 to 11

The 5th leg reaches to the end of the 3rd or the middle of the 4th segment of the abdomen, when the various segments of the leg are fully extended. The proportional lengths of the various segments are, commencing from the base, 26, 12, 25, 22 and 15.

In the case of the female *Acrocalanus gibber* the proportions of the various segments of the swimming legs are as follows :

	2nd leg.	3rd leg.	4th leg.
Exopod 2	23	27	28
„ 3, proximal part	20	21	27
„ 3, distal part	20	22	19
End-spine	37	30	26

The number of spines on the various segments of the leg in the female are as follows :

	2nd leg.	3rd leg.	4th leg.
Exopod 2 ..	8	9 or 10	13 or 15
„ 3, proximal part	7	9	15 or 16
„ 3, distal part	4 or 5	0 ¹	6 to 8

Acrocalanus longicornis (= *Acrocalanus gardineri* Wolfenden ?)

♂ In this form the total length is 0.95 to 1.0 mm.

The proportional lengths of the cephalothorax and abdomen are as 3.41 to 1 in one specimen and 3.545 to 1 in another. The forehead is rounded but is more prominent than in the form that I take to be the male of *A. gibber*. There is the same rounded elevation in the mid-dorsal line on the cephalon, but apart from this the dorsal profile is rounded, as also are the posterior thoracic margins. The line of separation between the 4th and 5th thoracic segments can clearly be made out in the lateral region.

The proportions of the abdominal segments are as follows :

Abdominal segment	1	2	3	4	5	Furca.	
	12	22	15	15	20	16	= 100.

The furcal rami are widely divergent and are comparatively short, measuring 16 by 12, the proportions of length to breadth thus being 1.33 to 1.

The 1st antenna reaches back beyond the posterior margin of the last thoracic segment by the extent of the terminal three segments. The proportional lengths of the segments are as follows :

Segment	1-6	7-8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	250	63	24	29	32	39	39	44	44	44	44	49	49	44	44	49	44	25	= 1000.

The 1st swimming leg appears to differ in small details from that of the previously described form. The spinules of the margin of the proximal part of exopod 3 increase in size distally and the row turns inwards as it approaches the 1st marginal spine and is continued on the posterior face of the segment.

In the 2nd to 4th swimming legs the proportional lengths of the various segments are as follows :

	2nd leg.	3rd leg.	4th leg.
Exopod 2	22	27	27
„ 3, proximal part	20	21	24
„ 3, distal part	22	21	20
End-spine	36	31	29

¹In one case there was a row of small spines present on the distal part of exopod 3 on the left side; the number of these spines was 8.

The number of spines that are carried on the external margin of the various segments of the legs are as follows :

	2nd leg.	3rd leg.	4th leg.
Exopod 2	8 to 10	12	16 to 20
„ 3, proximal part	9 to 10	13	23 to 25
„ 3, distal part	7 to 8	15	15 to 20

The 5th leg reaches back when fully extended to the middle of the anal segment ; the proportional lengths of the various segments of the appendage being as follows :

Segment	1	2	3	4	5	
	23	14	25	20	18	= 100.

For the purpose of comparison I give below the measurements of the appendages of a female example of this species :

	2nd leg.	3rd leg.	4th leg.
Exopod 2	21	27	27
„ 3, proximal part	20	20	22
„ 3, distal part	22	24	24
End-spine	37	29	27

While exhibiting a certain amount of similarity to the measurements of the corresponding appendages in the male, the agreement is by no means so close as to be conclusively in favour of this form being the male of *A. longicornis*. When, however, we compare the proportions in the adult female and in an example of an immature male in the last copepodid stage we find that the agreement is considerably closer. In the table below I give the proportions in such an immature individual :

	2nd leg.	3rd leg.	4th leg.
Exopod 2 ..	20	24	24
„ 3, proximal part ..	19	20	25
„ 3, distal part ..	21	22	20
End-spine	40	34	30

The proportional lengths of exopod 2 are somewhat smaller and those of the end-spine somewhat larger in the immature male form than in the adult female, but this can be explained on the grounds of growth and I think that the agreement is sufficiently close to warrant the belief that this form is the male of *Acrocalanus longicornis*.

Acrocalanus gracilis ? (Text-fig. 34, e.)

♂ Total length from 0.80 to 1.0 mm.

The proportional lengths of the cephalothorax and abdomen are as 3.08 to 1. The posterior margin is rounded but is slightly emarginate at the apex of the curve. The line of division between the 4th and 5th segments of the thorax is clearly visible in the ventro-lateral region.

The segments of the abdomen have the following proportional lengths :

Abdominal segment	1	2	3	4	5	Furca.	
	13	26	17	15	16	13	= 100.

The furcal rami are not, as in other forms, widely divergent; on the contrary, they are nearly parallel to each other and are distinctly longer than wide in the proportions of 1.44 to 1.

The 1st antenna reaches back to beyond the level of the posterior thoracic margin by the extent of the last two segments. The proportional lengths of the segments are as follows :

Segment	1-6	7-8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	270	64	25	26	30	32	42	40	40	40	45	45	47	47	47	45	50	40	25

=1000.

The mouth-parts and the 1st pair of swimming legs closely resemble those of other members of the genus. The row of spines on the proximal part of exopod 3 of the 1st leg consists of ten spines and does not appear to bend on to the posterior face of the segment.

In the 2nd to 4th swimming legs the proportions of the various segments are as follows :

	2nd leg.	3rd leg.	4th leg.
Exopod 2	22	25	25
„ 3, proximal part	20	22	28
„ 3, distal part	19	20	17
End-spine	39	33	30

The number of spines on the external margin of the various segments of the appendages are as follows :

	2nd leg.	3rd leg.	4th leg.
Exopod 2	10 to 11	11 to 12	17
„ 3, proximal part ..	11	15	22
„ 3, distal part ..	8	14	17

The proximal four or five spines on the 2nd segment of the exopod are widely spaced with twice the interval between them than between the more distal spines.

The 5th leg when fully extended only reaches back to the posterior margin of the 2nd abdominal segment. The proportional lengths of the various segments of the limb are as follows :

Segment	1	2	3	4	5
	25	13	24	20	18

=100.

For the purpose of comparison I give below in tabular form the measurements of the appendages of a female example of this species :

	2nd leg.	3rd leg.	4th leg.
Exopod 2	22	26	26
„ 3, proximal part	20	22	23
„ 3, distal part ..	19	20	22
End-spine	39	32	29

Family PSEUDOCALANIDAE.

Genus **CALOCALANUS** Giesbrecht.

At the present time this genus comprises four species, three of which have been recorded from Indian waters, namely *Calocalanus pavo* (Dana), *C. plumulosus* (Claus), *C. styliremis* Giesbrecht, and I am now able to record the occurrence of a fourth species, *C. contractus* Farran from this region.

Calocalanus pavo (Dana).

- Calocalanus pavo*, A. Scott, 1909, p. 30.
Calocalanus pavo, Sharpe, 1911, p. 406.
Calocalanus pavo, Wolfenden, 1911, p. 203.
Calocalanus pavo, T. Scott, 1912, p. 531.
Calocalanus pavo, Sewell, 1912, p. 359.
Calocalanus pavo, Sewell, 1914, p. 214.
Calocalanus pavo, Früchtl, 1920, p. 10 (472).
Calocalanus pavo, Früchtl, 1924, p. 42.
Calocalanus pavo, Farran, 1929, p. 222.

This species occurs sparingly in the "Investigator" collections.

Calocalanus plumulosus (Claus).

- Calocalanus plumulosus*, A. Scott, 1909, p. 31.
Calocalanus plumulosus, Sharpe, 1911, p. 406.
Calocalanus plumulosus, Wolfenden, 1911, p. 203.
Calocalanus plumulosus, T. Scott, 1912, p. 531.
Calocalanus plumulosus, Sewell, 1912, p. 360.
Calocalanus plumulosus, Sewell, 1914, p. 214.
Calocalanus plumulosus, Früchtl, 1924, p. 43.
Calocalanus plumulosus, Farran, 1929, p. 223.

Both the above forms are widely distributed throughout the whole area of the Indian ocean, though they never appear to be present in any very large numbers. They have now been obtained from the Malay Archipelago, the coast of southern Burma, the Nicobar Islands, the Pearl Banks of Ceylon and the Maldivé Archipelago.

Calocalanus styliremis Giesbrecht.

- Calocalanus styliremis*, Giesbrecht, 1888, p. 333.
Calocalanus styliremis, Giesbrecht, 1892, p. 176, pl. ix, figs. 15, 18, 29; pl. xxxvi, figs. 46-48.
Calocalanus styliremis, Giesbrecht and Schmeil, 1898, p. 26.
Calocalanus styliremis, Wolfenden, 1906 (a), p. 999.
Calocalanus styliremis, Van Breemen, 1908, p. 23.
Calocalanus styliremis, Früchtl, 1923, p. 149, text-figs. 7-9.
Calocalanus styliremis, Sars, 1925, p. 27.
Calocalanus styliremis, Farran, 1926, p. 234, pl. v, figs. 5, 6.
Calocalanus styliremis, Farran, 1929, p. 222.

A few examples of this species were taken in the surface tow-net in Nankauri Harbour, Nicobars ("Investigator" Station 614).

Calocalanus contractus Farran.

(Text-fig. 35, a-d.)

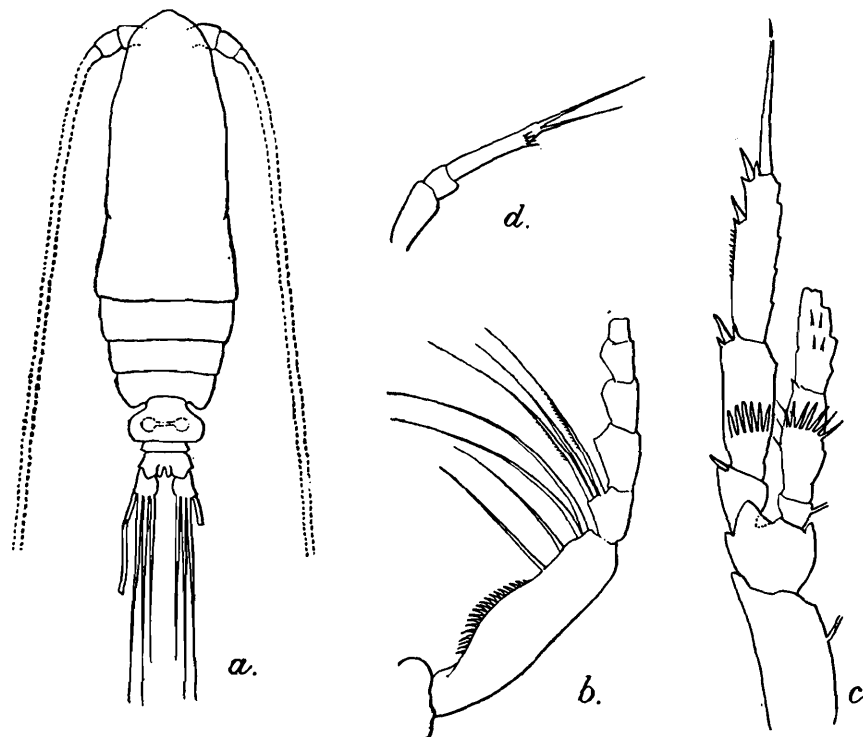
- Calocalanus contractus*, Farran, 1926, p. 234, pl. v, figs. 1-4.

This species was recently described by Farran from examples taken in the Bay of Biscay by the "Research" and it is extremely interesting to note that the same species occurs in Indian waters. This would suggest that it is a widely distributed species and probably occurs in all the great oceans but that it has hitherto been overlooked.

♀ Total length, 0.566 mm.

These examples are considerably smaller than the Bay of Biscay specimens, which, according to Farran, measure from 0.75 to 0.78 mm.

The proportional lengths of the cephalothorax and abdomen are as 51 to 9; the abdomen is thus contained 5.7 times in the length of the anterior region of the body.



TEXT-FIG. 35.—*Calocalanus contractus* Farran, ♀.

a. The whole animal from above.
b. The maxilliped.

c. The 4th swimming leg.
d. The 5th leg.

The abdomen consists of three segments, of which the 2nd is very short. The 1st or genital segment is wide and swollen, being considerably broader than long. The furcal rami are approximately as wide as long and are equal in length to the 3rd abdominal segment.

The 1st antenna reaches to well beyond the tip of the furcal ramus; unfortunately in all the specimens that I have been able to examine the terminal segments were broken off. I give below the length of those segments that still were left, but I have been unable to calculate their lengths in parts of 1,000 as in the case of other species:

Segment	1-2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17	18	19	20	21	22
	48	12	10	11	8	12	20	10	10	12	13	14	14	17	18	20	20	23	24	23

Farran (*loc. cit.*, p. 234) states that in his examples "the segmentation between joints 1-2 is distinct;" in these examples from Indian waters I was unable to detect it. With this exception my examples agree very well with Farran's description and figures and I have no hesitation in referring them to this species.

Genus **CLAUSOCALANUS** Giesbrecht.

Clausocalanus arcuicornis (Dana).

Clausocalanus arcuicornis, A. Scott, 1909, p. 32.

Clausocalanus arcuicornis, Sharpe, 1911, p. 406.

Clausocalanus arcuicornis, Wolfenden, 1911, p. 203.

Clausocalanus arcuicornis, T. Scott, 1912, p. 531.

- Clausocalanus arcuicornis*, Sewell, 1912, p. 360.
Clausocalanus arcuicornis, Sewell, 1913, p. 357.
Clausocalanus arcuicornis var. *plumulosus*, Sewell, 1913, p. 357.
Clausocalanus arcuicornis, Sewell, 1914, p. 214.
Calusocalanus arcuicornis, Früchtl, 1920, p. 474 (12).
Clausocalanus arcuicornis, Früchtl, 1923, p. 135.
Clausocalanus arcuicornis, Früchtl, 1924, p. 43.
Clausocalanus arcuicornis, G. O. Sars, 1925, p. 27.
Clausocalanus arcuicornis, Farran, 1926, p. 237, pl. vi, figs. 1-3.
Clausocalanus arcuicornis, Gurney, 1927, p. 150.
Clausocalanus arcuicornis, Farran, 1929, p. 223.

This species possesses one of the widest ranges of distribution of any known Copepod. It has been taken as far south as Lat. 84° 01' and as far north as the west coast of Ireland. It is widely distributed throughout the Indian Ocean and has now been recorded from the Malay Archipelago (Cleve; A. Scott); the coast of southern Burma (Sewell); the Pearl Banks of Ceylon (Thompson and A. Scott; Sewell); the Maldivé and Laccadive Archipelagoes (Wolfenden); the east coast of Africa (Cleve) and from the Gulf of Suez at the head of the Red Sea (Gurney).

So far as my experience goes this species is never very common but a careful search through a tow-netting will not infrequently reveal its presence.

Both Früchtl (1923) and Farran (1926) have called attention to the existence in this species of two forms, differing from each other in size and in certain small anatomical characters. As Farran (*loc. cit.*, p. 238) remarks "it is not impossible that we should see in the two groups included under *C. arcuicornis* a case of variation due to development in regions differing in temperature or some other environmental condition, such as has been demonstrated in Danish waters by Jespersen and Miss Adler (1920) . . . But against this view may be mentioned the fact that, judging by the large number of immature specimens present, development was proceeding *in situ*, and the probability that individuals brought from elsewhere by a surface drift would soon resume their normal vertical distribution."

The same two forms of this species occur in Indian waters in the same tow-netting at "Investigator" Station 614 (Nankauri Harbour, Nicobars) and it appears at least probable that a careful study would reveal their occurrence in every area of their known habitat. As mentioned above, in addition to the difference in size, there are certain differences in structure. Farran has called attention to the difference in the structure of the 5th pair of legs and there is in addition a difference in the proportional lengths of the segments of the 1st antenna. In this latter respect these two forms exhibit the same difference that we have already noticed in the proportional lengths in individuals of the same species in different stages of development, and it seems possible that we have here another instance of dimorphism, such as I have called attention to in previous papers, the two forms of *Clausocalanus arcuicornis* being different stages in the life-history of the individual rather than different races of the same species. I give below the proportional lengths of the antennal segments in the two forms:

Segment	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	
Small form	62	72	27	23	24	23	25	49	29	29	35	40	42	44	49	49	51	49	44	44	44	50	90		=1000.
Large form	64	77	32	27	29	25	31	53	33	33	36	42	48	51	53	51	49	42	38	30	30	43	71		=1000.

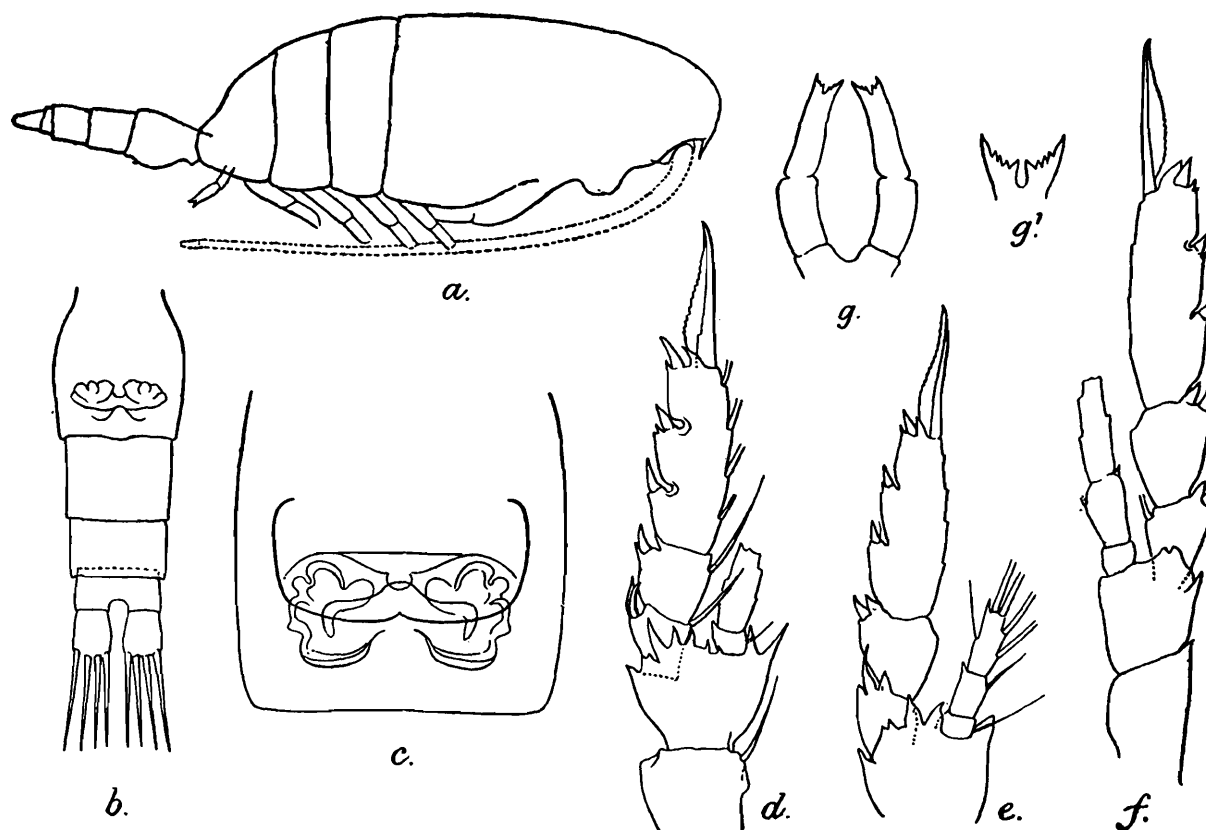
Here again we find that in the smaller form the segments from 1 to 17 inclusive are smaller relatively than the corresponding segments in the larger form, but at segment 18 we get a change and the segments distal to this in the smaller form are now proportionately longer than in the larger form.

Forma minor.

(Text-fig. 36, a-g.)

♀ Total length, 0.94 mm.

Proportional lengths of the cephalothorax and abdomen are as 19 to 6, so that the abdomen is contained 3.17 times in the length of the anterior region of the body.



TEXT-FIG. 36.—*Clausocalanus arcuicornis* (Dana), forma minor, ♀.

a. The whole animal from the right side.	e. The 3rd swimming leg.
b. The abdomen from below.	f. The 4th swimming leg.
c. The genital segment of the abdomen.	g. The 5th pair of legs.
d. The 2nd swimming leg.	g¹. Enlarged view of the end of distal segment;

The proportional lengths of the abdominal segments are as follows :

Abdominal segment	1-2	3	4	5	Furca.	
	42	20	18	8	12	=100.

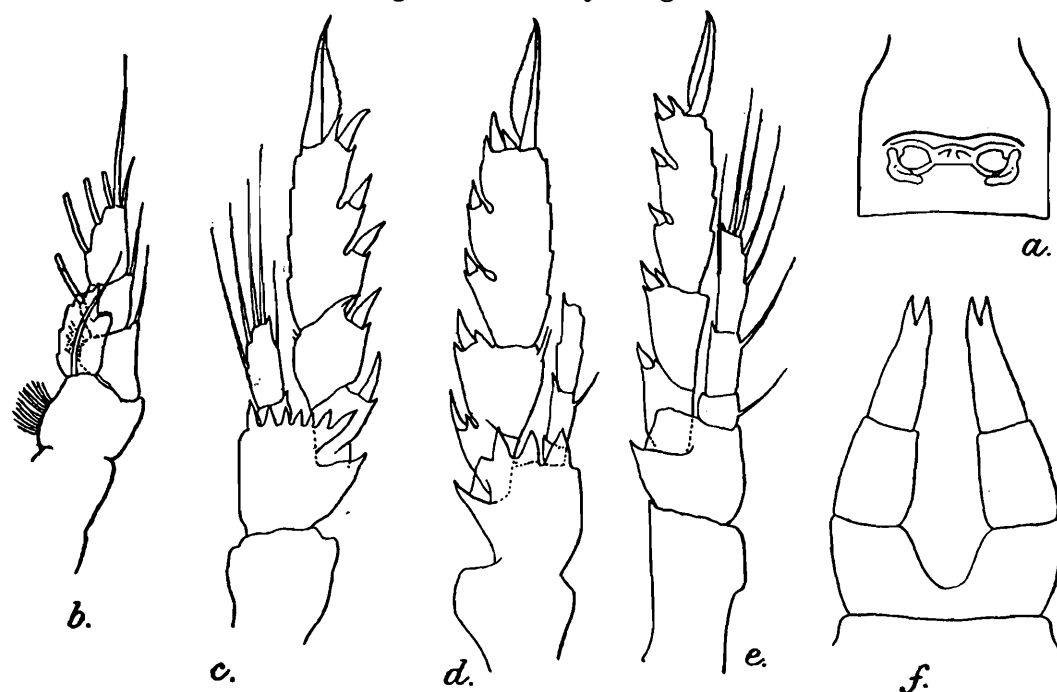
Forma major.

(Text-fig. 37, a-f.)

♀ Total length, 1.17 mm.

The proportional lengths of the cephalothorax and abdomen are as 23 to 8, so that the abdomen is contained 2.88 times in the length of the anterior region of the body. There

is thus a very considerable difference in the proportions of the body in these two forms, the abdomen in the larger form being considerably longer than in the smaller form. There



TEXT-FIG. 37.—*Clausocalanus arcuicornis* (Dana), forma major, ♀.

- a. Genital segment of the abdomen. d. The 3rd swimming leg.
b. The 1st swimming leg. e. The 4th swimming leg.
c. The 2nd swimming leg. f. The 5th pair of legs.

appears to be a slight difference also in the proportional lengths of the segments of the abdomen. In this form these are as follows :

Abdominal segment	1-2	3	4	5	Furca.	
	38	21	17	11	13	=100.

The 1st segment thus appears to be somewhat shorter and the 5th segment and the furcal rami slightly longer than in the small form.

***Clausocalanus furcatus* (Brady).**

Clausocalanus furcatus, A. Scott, 1909, p. 32.

Clausocalanus furcatus, Esterly, 1911, p. 223, pl. i, figs. 2, 7, 9 ; pl. ii, fig. 3 ; pl. iii, fig. 33 and pl. iv, figs. 36, 40, 44.

Clausocalanus furcatus, Wolfenden, 1911, p. 203.

Clausocalanus furcatus, T. Scott, 1912, p. 531.

Clausocalanus furcatus, Sewell, 1914, p. 215.

Drepanopus furcatus, Brady, 1914, p. 2.

Drepanopus furcatus, Brady, 1915, p. 135.

Clausocalanus furcatus, Früchtl, 1920, p. 12.

Clausocalanus furcatus, Früchtl, 1924, p. 44 (66).

Clausocalanus furcatus, G. O. Sars, 1925, p. 28.

Clausocalanus furcatus, Farran, 1929, p. 225.

This species is widely distributed throughout Indian waters and has now been recorded from the Malay Archipelago (Cleve ; A. Scott ; Früchtl) ; the Pearl Banks of Ceylon (Thompson and Scott ; Sewell) ; the Maldives and Laccadive Archipelagos (Wolfenden) and from the coast of Africa (Brady).

It occurs in the "Investigator" collections taken at Stations 555 and 614 and I have no doubt that further search would reveal its presence in many other collections.

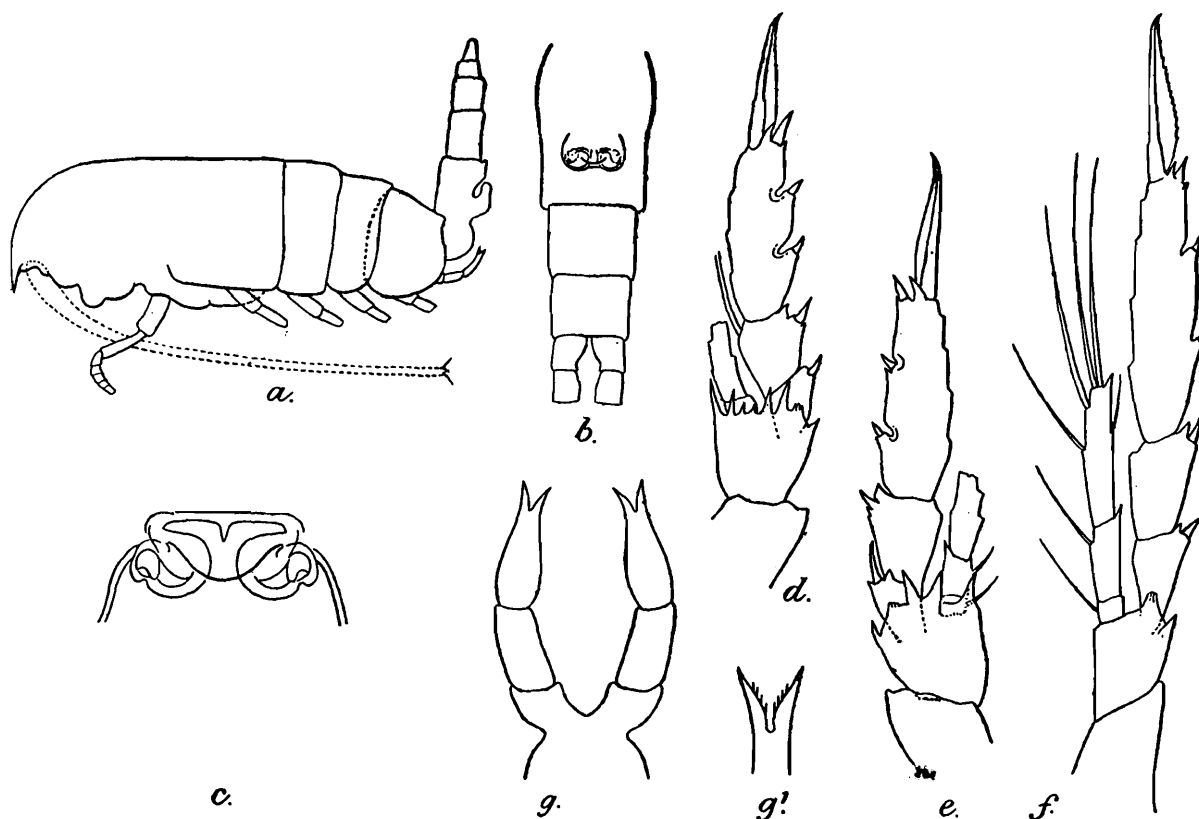
***Clausocalanus farrani*, sp. nov.**

(Text-fig. 38, a-g.)

♀ Total length, 0.87 to 1.08 mm.

The proportional lengths of the cephalothorax and abdomen are as 16 to 7, so that the abdomen is contained 2.29 times in the length of the anterior region of the body.

The forehead presents a uniform rounded appearance, when viewed from the side; it terminates below in a pair of rostral spines that are directed vertically downwards and above passes straight back into the line of the dorsal margin. The head and 1st thoracic segment are fused and so also are the 4th and 5th thoracic segments. The posterior thoracic margin is slightly produced at the upper angle but below this forms a uniformly rounded curve.



TEXT-FIG. 38.—*Clausocalanus farrani*, sp. nov., ♀.

a. The whole animal from the left side.	e. The 3rd swimming leg.
b. The abdomen from below.	f. The 4th swimming leg.
c. The genital opening.	g. The 5th pair of legs.
d. The 2nd swimming leg.	g¹. Enlarged view of the end of distal segment.

The abdomen consists of four segments that have, with the furcal rami, the following proportional lengths :

Abdominal segment	1-2	3	4	5	Furca.	
	37	23	19	9	12	= 100.

The furcal rami are thus one-third longer than the anal segment; they are also slightly longer than broad.

The genital aperture on the ventral aspect of the 1st abdominal segment is swollen and does not reach as far back as the posterior margin of the segment.

The 1st antenna reaches back to the posterior margin of the thorax. It consists of twenty-three separate joints; segments 8 and 9 and 24 and 25, respectively, being fused. The proportional length of the various segments are as follows:

Segment	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
	63	56	24	23	23	24	26	49	27	29	34	34	44	46	47	49	50	49	47	47	49	63	97
	=1000.																						

The mouth-parts and swimming legs do not present any very marked differences from those of *Clausocalanus arcuicornis* (Dana) and especially of the forma *minor*, though the 4th pair of legs are rather more slender in the present species. The 5th pair of legs closely resemble those of *C. pergens* Farran (1926, p. 239, pl. vi, figs. 4-6) but in the bifid end of the terminal segments the two points diverge, whereas in *C. pergens* they are nearly parallel.

This species very closely resembles *Clausocalanus pergens* Farran and when I first came across these examples in the tow-netting taken at "Investigator" Station 555 I was inclined to think that they were identical. Mr. Farran has, however, very kindly examined certain specimens that I sent him and he informs me that they are, in his opinion, specifically distinct. I, therefore, have much pleasure in dedicating this species to Mr. Farran.

Genus **SPINOCALANUS** Giesbrecht.

Spinocalanus magnus Wolfenden.

Spinocalanus magnus, Wolfenden, 1904, p. 118.

Spinocalanus magnus, Farran, 1906, p. 30, pl. iii, figs. 1-12.

Spinocalanus magnus, Pearson, 1906, p. 10.

Spinocalanus magnus, Wolfenden, 1906, p. 41.

Spinocalanus magnus, Damas and Koefoed, 1907, p. 409.

Spinocalanus latifrons, Sars, 1907, p. 5.

Spinocalanus magnus, Farran, 1908, p. 27.

Spinocalanus magnus, van Breemen, 1908, p. 29, fig. 29.

Spinocalanus magnus, Wolfenden, 1911, p. 216, pl. xxv, figs. 3-5, text-fig. 8 a, b.

Spinocalanus magnus, With, 1915, p. 72.

Spinocalanus magnus, Sars, 1925, p. 33, pl. ix, figs. 8-15.

Spinocalanus magnus, Farran, 1926, p. 243.

Spinocalanus magnus, Farran, 1929, p. 227.

A few examples of this species, all females, were taken by the "Investigator" at Station 682 at a depth of 0 to 200 fathoms. The major portion of the contents of the trawl came from the maximum depth of 200 fathoms and this distribution agrees very well with the depth at which Farran records the occurrence of the species off the west coast of Ireland.

Genus **MONACILLA** Sars.

(=*Oxycalanus* Farran.)

A. Scott (1909, p. 33, pl. ii, figs. 9-21) under the name *Oxycalanus semispinus* recorded the occurrence in the Malay Archipelago of the female of a species that he took to be new though closely related to *Oxycalanus spinifer* Farran; He also recorded a male example of a species of *Monacilla* and named it *M. dubia* (loc. cit., p. 35, pl. iii, figs. 17-20). Sars

(1925, p. 38) considers that the two forms described by Scott are the two sexes of the same species and he identifies them with the species briefly described by him in 1905 under the name *Monacilla typica*. Up to the present time I have not discovered any examples of this species in the "Investigator" collections but a second species was obtained from the Bay of Bengal.

Monacilla tenera Sars.

Monacilla tenera, Sars, 1907, p. 6.

Hypsicalanus gracilis, Wolfenden, 1911, p. 219, pl. xxv, figs. 6-11.

Monacilla tenera, Sars, 1925, p. 40, pl. xii, figs. 11-18.

Monacilla tenera, Farran, 1926, p. 245, pl. vi, figs. 13, 14.

Two examples, a female and an immature male, that clearly belong to this species were taken at "Investigator" Station 682. The female agrees exactly with the description and figures given by Sars. This species has now been recorded from the Atlantic and Indian Oceans.

Genus **DREPANOPSIS** Wolfenden.

This genus was created by Wolfenden (1911, p. 245) to accommodate a new species, which he named *Drepanopsis frigidus*. The genus is characterised, according to its author, by the absence of a rostrum or rostral filaments, the complete separation of the two last thoracic segments, the unequal branches of the 2nd antenna, the inner being longer than the outer, and the very small inner branch of the mandible; the 5th legs also consist of a single three-jointed ramus, the end-joint bearing a pair of spines. Sars (1920, p. 4) created the genus *Farrania* to accommodate a new species, which he termed *Farrania oblonga*. He subsequently (1924, p. 36, pl. xiii, figs. 1-14) described and figured the same species. It seems from the two accounts that Sars' genus *Farrania* is identical with Wolfenden's genus *Drepanopsis*, which has priority.

Drepanopsis frigidus Wolfenden.

(Text-fig. 39, a-f.)

Drepanopsis frigidus, Wolfenden, 1911, p. 245, text-fig. 29, a-b.

Drepanopsis frigidus, Farran, 1929, p. 232.

Wolfenden based his description of this species on examples that were taken by the "Gauss" in the south Indian Ocean at a depth of 1,200 metres and in the equatorial region of the Atlantic Ocean at a depth of 3,000 metres.

A single example of what seems to be this species was taken by the "Investigator" at Station 682.

The present specimen agrees closely with Wolfenden's description and figures, but as his description is not complete and as the present specimen exhibits certain characters not mentioned in the original description I have added a few notes regarding the structure below:

♀ Total length, 2.28 mm.

The proportional lengths of the cephalothorax and abdomen are as 98 to 23, the abdomen thus being contained 4.26 times in the length of the anterior region of the body.

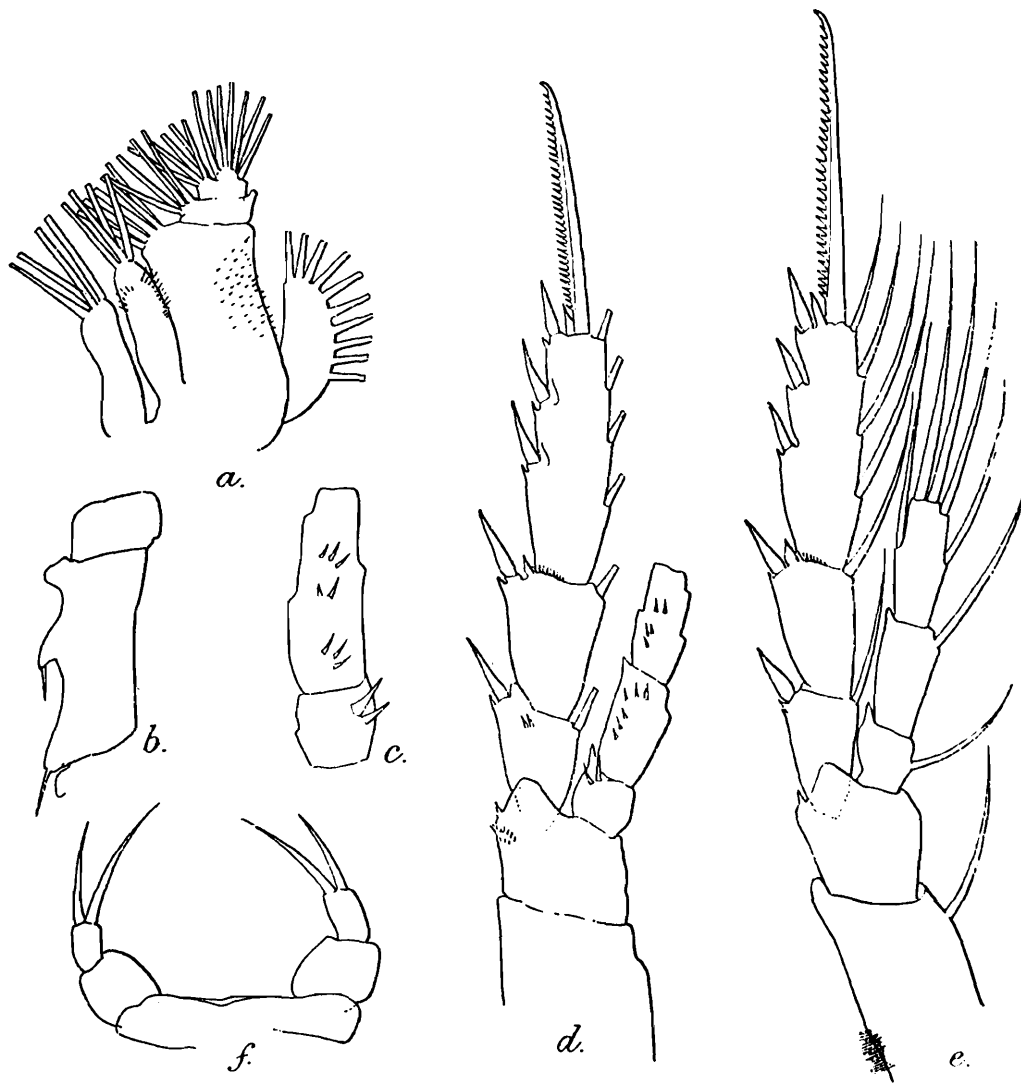
The head is rounded and terminates ventrally in a curved and backwardly-directed median spine instead of in a bifid rostrum. The head and 1st thoracic segment are fused.

Thoracic segments 4 and 5 are separate and the 5th segment is produced back in a sharply pointed wing.

The abdomen consists of four segments and the furcal rami which have the following proportional lengths :—

Abdominal segment	1-2	3	4	5	Furca.	
	<u>45</u>	9	9	14	23	=100.

In my example the abdominal segments are markedly telescoped, the full length of each segment being in the proportions 39 : 13 : 12 : 15 : 21. The furcal rami are some-



TEXT-FIG. 39.—*Drepanopsis frigidus* Wolfenden.

- a. The maxillary palp. d. The 3rd swimming leg.
 b. The proximal part of the exopod of the 2nd antenna. e. The 4th swimming leg.
 c. The endopod of the 2nd swimming leg. f. The 5th pair of legs.

what longer than the anal segment and the length is 1.75 times the breadth. There are a few scattered hairs on the inner margin of the ramus.

The 1st antenna reaches to the posterior thoracic margin, or about half way along the genital segment. It consists of 24 free segments, segments 8 and 9 being fused together. The proportional lengths of the segments are as follows ;

Segment	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	
	73	67	27	27	28	30	30	52	27	32	33	42	45	52	47	50	48	55	42	35	43	45	45	25	=1000.

In the 2nd antenna the two rami are of nearly equal length, the endopod being slightly the longer and the proportional lengths being 72 to 77. In the exopod the 1st and 2nd segments are separate, and the 2nd segment (text-fig. 39, *b*) bears three rounded prominences on its anterior margin, of which the 2nd and 3rd each bear a short stiff seta. The 1st basal segment bears a row of fine hairs.

The mandibular palp consists of a swollen basal segment and the usual two rami, of which the endopod is about half the length of the exopod and consists of two segments.

In the 1st maxilla (text-fig. 39, *a*) the 2nd and 3rd inner lobes each bear 4 setae and the 3rd lobe bears a number of hair-like spines on its anterior aspect. The basal segment bears 5 setae and is armed on its anterior and outer aspects with a number of short hair-like spines. The endopod is clearly marked off from the basal segment, and the three segments bear 4, 5 and 7 setae respectively; this is one more than the number given by Wolfenden. The exopod, as stated by Wolfenden, bears 11 setae.

In the 2nd maxilla the general structure is as described by Wolfenden. The 2nd, 3rd and 4th lobes each bear a row of spines. All the setae arising from the endopod are unmodified.

The maxilliped bears a row of needle-like spines on the proximal part of the anterior border of the 2nd basal segment.

The 1st swimming leg has a three-jointed exopod and a single-jointed endopod. Each segment of the exopod bears a single marginal spine, and the endopod possesses the usual swelling on its outer margin, which is crowned with a row of short spines.

In the 2nd swimming leg the exopod consists of three segments and the endopod is two-jointed; the 1st basal bears a number of hair-like spines on the posterior and outer aspects of the proximal third and a series of smaller spines along the outer aspect of the middle third. Basal 2 bears a series of small spines on its posterior aspect. The 1st segment of the endopod (text-fig. 39, *c*) bears two coarse spines, and the distal segment is armed with three groups of 3, 2 and 3 spines respectively.

In the 3rd swimming leg (text-fig. 39, *d*) the 1st basal segment bears a number of hair-like spines on the outer margin of the proximal third and a series of smaller spines along the margin of the middle third. The 2nd basal bears a number of small spines on its posterior aspect. The exopod and endopod each consist of 3 segments. All the marginal spines on the exopod are sub-equal. Exopod 1 bears 2 spines near the base of the marginal spine, and the distal margin of exopod 2 is armed with a row of small needle-like spines. The end-spine is considerably longer than the distal segment. The endopod bears 2 spines on the posterior aspect of the 1st segment; a curved row of spines, 6 in all, on the 2nd segment, and a group of 3 small spines proximally and a pair of larger spines distally on the 3rd segment.

The 4th swimming leg (text-fig. 39, *e*) closely resembles the 3rd in its general form but there are no spines on any of the segments, except a row of small needle-like spines along the distal margin of the 2nd segment of the exopod. The third segment of the exopod in the 2nd—4th swimming legs bears 4 setae.

The 5th pair of legs (text-fig. 39, *f*) agrees closely with the description and figures given by Wolfenden.

The above specimen agrees well with Wolfenden's description of *Drepanopsis frigidus* and, so far as it is possible to judge from his short account, seems to belong to the same species.

Family AETIDEIDAE.

Genus **AETIDEUS** Brady.

Four species belonging to this genus have up to the present time been recorded from Indian waters, namely—

- (1) *Aetideus armatus* (Boeck) ; from the Malay Archipelago (A. Scott) ; Indian Ocean (Thompson) ; the Gulf of Suez (Thompson and Scott) and south of Cape Colony (Cleve).
- (2) *Aetideus bradyi* A. Scott ; from the Malay Archipelago (A. Scott).
- (3) *Aetideus giesbrechti* Cleve ; from the Malay Archipelago (A. Scott) ; and the east of Cape Colony (Cleve). These last two species has since been removed by Sars (1925, p. 42) to his new genus *Euaetideus*.

Up to the present time I have detected only a single species in the "Investigator" collections.

Aetideus armatus (Boeck).

Aetideus armatus, A. Scott, 1909, p. 37, pl. iv, figs. 14-25.

Aetideus armatus, Steuer, 1910, p. 23.

Aetideus armatus, Farran, 1911, p. 81.

Aetideus armatus, Wolfenden, 1911, p. 209, text-fig. 4.

Aetideus armatus, With, 1915, p. 75, text-fig. 16, pl. ii, figs. 1a-i

Aetideus armatus, Früchtl, 1920, p. 15 (477).

Aetideus armatus, Sars, 1925, p. 41.

Aetideus armatus, Farran, 1926, p. 246.

Aetideus armatus, Farran, 1929, p. 228.

A single specimen of this species was taken at "Investigator" Station 682.

Genus **AETIDEOPSIS** Sars.

A. Scott (1909, p. 40, pl. v, figs. 13-24) has recorded the occurrence of *Aetideopsis rostrata* Sars from the Malay Archipelago. Up to the present time it has not been recorded from Indian waters proper and I have not detected it in the "Investigator" collections.

Genus **UNDINOPSIS** Sars.

(= *Bradyidius* Giesbrecht.)

Undinopsis armatus (Brady) has been taken in the Malay Archipelago by the "Siboga" and has been recorded by A. Scott (1909, p. 39, pl. vi, figs. 1-11) and its presence in the Indian Ocean and Red Sea has been recorded by Thompson (1900, p. 278). Wolfenden (1906(a), p. 1005) also records the presence of a small form, only half the size of the Atlantic species, in the Maldivé Archipelago. It does not occur in the "Investigator" collections.

Genus **CHIRIDIUS** Giesbrecht.

Chiridius poppei Giesbrecht has been recorded from the Malay Archipelago by A. Scott (1909, p. 41, pl. xi, figs. 10-17) and from the Agulhas Current by Cleve (1904, p. 187). A. Scott has also doubtfully recorded the occurrence of *Chiridius gracilis* Farran (*loc. cit.*, p. 42, pl. xi, figs. 1-9) and *C. obtusifrons* Sars (*loc. cit.*, p. 43, pl. xlv, figs. 1-3) from the Malay Archipelago. So far only a single species, *Chiridius gracilis*, has been detected in the "Investigator" collections.

Chiridius gracilis Farran.

Chiridius gracilis, A. Scott, 1909, p. 42, pl. xi, figs. 1-9.

Chiridius gracilis, With, 1915, p. 85, text-fig. 21, a-d.

Chiridius gracilis, Farran, 1926, p. 248.

Chiridius ? gracilis, Farran, 1929, p. 229, fig. 6.

A single example of this species was taken by the "Investigator" at Station 682. It measures in total length 2.2 mm., so that it is slightly smaller than Farran's examples that measured from 2.4 to 2.8 mm.; but this is usually the case with examples of the same species that are taken in Indian waters, the great majority being smaller than examples taken in the north Atlantic Ocean.

Genus **GAIDIUS** Giesbrecht.

Up to the present time two species belonging to this genus have been recorded from the Indian Ocean or neighbouring seas. A. Scott (1909) in the report of the "Siboga" collections records the occurrence of *Gaidius similis* (T. Scott) [= *Gaidius tenuispinus* (Sars)] and *Gaidius notacanthus* Sars in the Malay Archipelago. This latter species has since been removed by Sars from the genus *Gaidius* to his new genus *Pseudochirella*. The former of these species, as well as an example of *G. minutus* Sars, occurs in the "Investigator" collections.

Gaidius minutus Sars.

Gaidius minutus, Sars, 1907, p. 10.

Gaidius minutus, Sars, 1925, p. 49, pl. xiv, figs. 14-18.

A single specimen, a female, that appears to correspond exactly with the description given by Sars, was taken by the "Investigator" at Station 682.

Gaidius tenuispinus (Sars).

Chiridius tenuispinus, Sars, 1900, p. 67, pl. xviii.

Gaidius tenuispinus, Mrázek, 1902, pp. 512, 521, figs. 7-9.

Gaidius borealis, Wolfenden, 1904, p. 131.

Gaidius tenuispinus, van Breemen, 1908, p. 36, fig. 39.

? *Gaidius similis*, A. Scott, 1909, p. 51, pl. vii, figs. 1-11.

Gaidius tenuispinus, Esterly, 1911, p. 316, pl. xxviii, fig. 26; pl. xxix, fig. 64.

Gaidius tenuispinus, With, 1915, p. 89, text-figs. 23a-j; pl. ii, fig. 8a, and pl. iii, figs. 2a-n.

Gaidius tenuispinus, Sars, 1925, p. 46.

Gaidius tenuispinus, Farran, 1929, p. 231

A considerable degree of confusion appears to have existed regarding this species. Originally described by Sars in 1900, it is considered by A. Scott (1909) to be a synonym of *Gaidius similis* (T. Scott), the form described by this latter author in 1893 from the Gulf of Guinea under the name *Euchaeta hessei* var *similis* being the male of the species. Again the form described by Wolfenden in 1903 under the name *Gaidius borealis* was acknowledged by him in 1904 to be identical with *G. tennispinus* (Sars). Van Breemen (1908) also considers that the form recorded by Wolfenden in 1904 under the name *G. pungens* Giesbrecht, from the warm area of the Atlantic, is in reality the present species.

This species would appear to have a wide distribution. It has now been taken in the Malay Archipelago (A. Scott) and occurs also in the Atlantic Ocean, the North Sea and the Arctic Ocean. Two examples, a male and a female, were taken at "Investigator" Station 682. The length of the female was 3.1 mm.

Genus **GAIDIOPSIS** A. Scott.

This genus was created by A. Scott (1909, p. 52) to accommodate a single species, *Gaidiopsis crassirostris*, which occurs in the Malay Archipelago. So far no example has been detected in the Indian Museum collections.

Genus **CHIRIDIELLA** Sars.

A. Scott (1909, p. 79, pl. xxxvi, figs. 9-21) records the occurrence of a single specimen of *Chiridiella macrodactyla* Sars in the collections made by the "Siboga" in the Malay Archipelago; but up to the present I have not found this species in the "Investigator" collections from Indian waters.

Genus **GAETANUS** Giesbrecht.

A. Scott (1909) has recorded the following species belonging to this genus from the Malay Archipelago:—

Gaetanus armiger Giesbrecht.

Gaetanus caudani Canu.

Gaetanus hamatus A. Scott.

Gaetanus kruppi Giesbrecht.

Gaetanus latifrons G. O. Sars.

Gaetanus minor Farran.

Gaetanus miles Giesbrecht.

Previous to the "Siboga" expedition Cleve (1904) had recorded *Gaetanus armiger* and *G. miles* from the east coast of South Africa. The "Investigator" collections contain examples of all the above species, with the exception of *Gaetanus caudani* and possibly *Gaetanus hamatus* and, in addition, *Gaetanus pileatus* Farran and *Gaetanus rectus* Wolfenden.

Gaetanus armiger Giesbrecht.

Gaetanus armiger, A. Scott, 1909, p. 45, pl. viii, figs. 16-22.

Gaetanus armiger, Sewell, 1913, p. 354.

Gaetanus armiger, Sars, 1925, p. 59, pl. xviii, figs. 1, 2.

Examples of this species were taken by the "Investigator" at Station 393.

Gaetanus kruppi Giesbrecht.

Gaetanus kruppi, A. Scott, 1909, p. 48, pl. ix, figs. 9-15 and pl. x, figs. 1-9.

Gaetanus major, Wolfenden, 1911, p. 231.

Gaetanus kruppi, With, 1915, p. 97, pl. iii, figs. 3a-h, text-figs. 25 a-o.

Gaetanus kruppi, Sars, 1925, p. 61, pl. xviii, figs. 5-8.

Gaetanus major, Farran, 1926, p. 249.

I agree with Scott that *Gaetanus kruppi* and *G. major* are probably synonyms ; Farran (1926) is, however, doubtful on this point. This species has a wide distribution and has now been recorded from all the great oceans ; in the Atlantic Ocean its range appears to extend from Lat. 36° S. to as far north as the Faroe Channel. Several examples, all females, were taken by the " Investigator " at Station 670.

Gaetanus latifrons Sars.

Gaetanus holti, Wolfenden, 1908, p. 31.

Gaetanus latifrons, A. Scott, 1909, p. 49, pl. x, figs. 10-17.

Gaetanus holti, Wolfenden, 1911, p. 232, text-fig. 19.

Gaetanus latifrons, Sewell, 1913, p. 354.

Gaetanus latifrons, With, 1915, p. 108, pl. iii, figs. 5 a-g, text-figs. 27 a-e.

Gaetanus latifrons, Sars, 1925, p. 57, pl. xvii, figs. 7-9.

Gaetanus latifrons, Farran, 1926, p. 251.

This species is also one of wide distribution, having been taken in the Malay Archipelago, the Indian Ocean and in the Atlantic Ocean as far north as the west coast of Ireland. Wolfenden (*loc. cit.*, 1911) states that it occurs as far north as the west coast of Greenland

Examples were taken by the " Investigator " at Stations 393 and 670.

Gaetanus miles Giesbrecht.

Gaetanus miles, A. Scott, 1909, p. 44, pl. viii, figs. 1-8.

Gaetanus miles, Wolfenden, 1911, p. 231.

Gaetanus miles, Sewell, 1913, p. 354.

Gaetanus miles, With, 1915, p. 107, pl. iii, figs. 7 a-b.

Gaetanus miles, Sars, 1925, p. 54, pl. xvii, fig. 1.

Gaetanus miles, Farran, 1926, p. 251.

This species has now been recorded from as far south as Lat. 36°S. and as far north as the Faroe Channel. It occurs in all the three great oceans. Examples occur in the " Investigator " collections at Stations 393 and 670.

Gaetanus minor Farran.

Gaetanus minor, Farran, 1905, p. 34, pl. v, figs. 1-11.

Gaetanus minor, A. Scott, 1909, p. 47, pl. ix, figs. 1-8.

Gaetanus minor (? *minimus*), Wolfenden, 1911, p. 233, text-figs. 20 a-e.

Gaetanus minor, With, 1915, p. 103, pl. iii, fig. 4 a.

Gaetanus minor, Sars, 1925, p. 60, pl. xviii, figs. 3, 4.

Gaetanus minor, Farran, 1926, p. 250.

Gaetanus minor, Farran, 1929, p. 233.

Examples of this species were taken at " Investigator " Station 682.

Gaetanus pileatus Farran.

- Gaetanus pileatus*, Farran, 1903, p. 16, pl. xvii, figs. 1-11.
Gaetanus caudani, Wolfenden, 1904, p. 114, pl. ix, figs. 20-22.
Gaetanus pileatus, Farran, 1905, p. 33.
Gaetanus unicornis, Esterly, 1906, p. 57, pl. ix, fig. 3; pl. xii, fig. 54, and pl. xiii, fig. 76.
Gaetanus pileatus, Farran, 1908, p. 35.
Gaetanus caudani, van Breemen, 1908, p. 42, fig. 48.
Gaetanus caudani, A. Scott, 1909, p. 46, pl. viii, figs. 9-15.
Gaetanus pileatus, Wolfenden, 1911, p. 229, pl. xxvii, figs. 1, 2 and text-figs. 17 a-e.
Gaetanus pileatus, With, 1915, p. 104, pl. iii, fig. 6 a and text-figs. 26 a-e.
Gaetanus pileatus, Sars, 1925, p. 56, pl. xvii, figs. 3-6.
Gaetanus pileatus, Farran, 1926, p. 250.

As is clearly indicated by the reference list given above there has been a considerable degree of confusion regarding the synonymy of this species and a doubt whether the form described by Farran as *Gaetanus pileatus* is or is not identical with that described by Canu under the name *Gaetanus caudani*. A. Scott (1909) considers that the two forms are identical and he accounts for the discrepancies between the two by assuming that the three-jointed exopod of the 1st leg in Canu's form, which was an immature male, would become a two-jointed ramus in the final moult. I believe this assumption to be entirely unjustifiable and Scott's argument is completely discounted by the discovery by Farran himself of immature forms of *Gaetanus pileatus* in which the first leg possesses a two-jointed exopod that exactly resembles the corresponding appendage of the adult (*vide* Farran, 1908).

Examples of this species were taken at "Investigator" Station 670.

Gaetanus pileatus Farran, juv. (Text-fig. 40, a-g.)

Associated in the collection at Station 670 with adult examples of *G. pileatus* Farran were several examples of a species of *Gaetanus*, both males and females, that were still in the last immature stage. These examples I believe to be immature forms of *G. pileatus* Farran, but as they differ in one or two details of structure from the account given by Farran I have thought it advisable to give a somewhat full account of them.

♀ Total length, 4.1 mm.

The proportional lengths of the cephalothorax and abdomen are as 5 to 1, taking the length of the cephalothorax to include the frontal spine.

The 4th and 5th thoracic segments are fused and the 5th segment bears on each side a sharp spine as in the adult *G. pileatus*.

The abdomen consists in both immature sexes of four segments, of which the most posterior appears to consist of two segments that have as yet not become separated off from each other. The segments have the following proportional lengths:—

Abdominal segment	1	2	3	4-5	Furca.	
	27	20	13	22	18	= 100

The furca is nearly as broad as long; the 5th or external seta is extremely small. The posterior margins of the 2nd and 3rd segments of the abdomen are armed with minute spines.

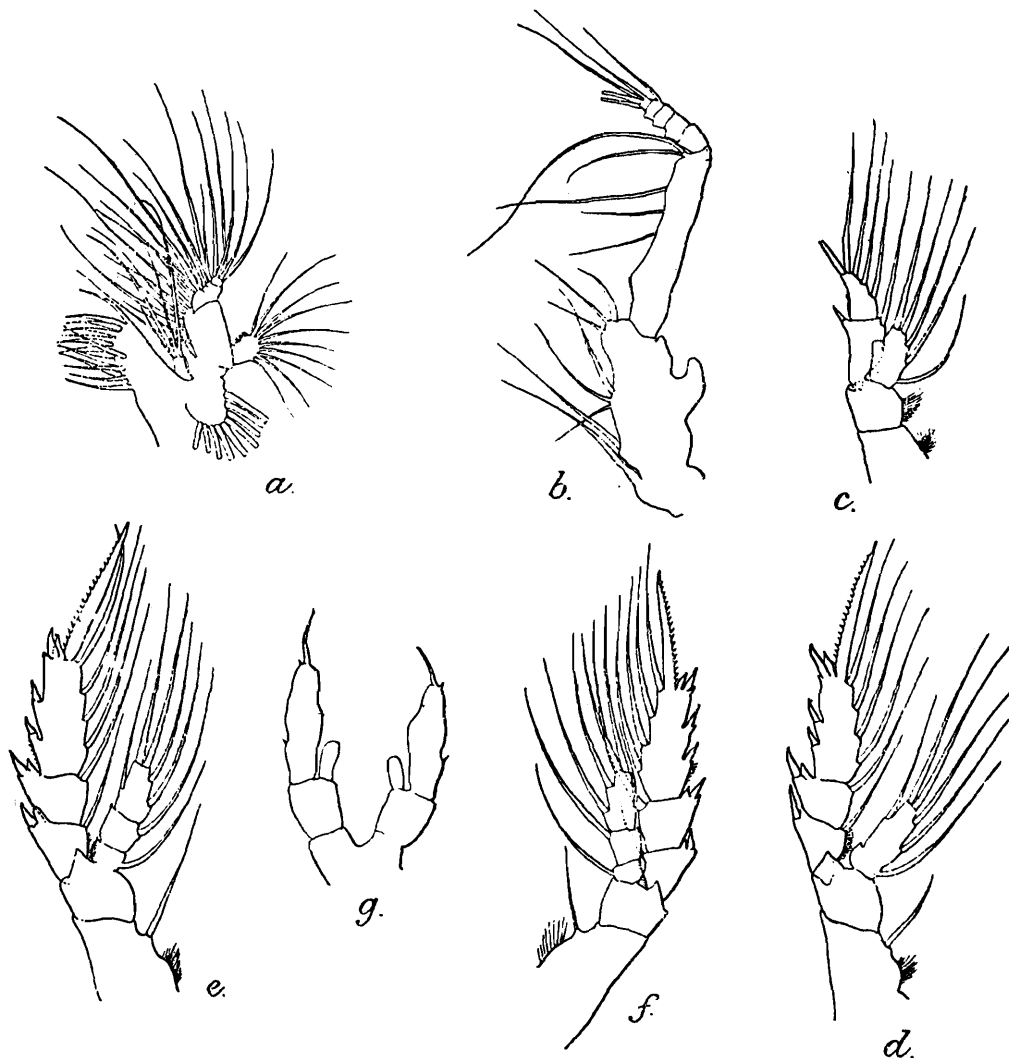
The 1st antenna reaches back beyond the tip of the furcal ramus by about the last seven segments; the whole antenna is nearly twice as long as the body, the proportions being 118

to 66. In the table below I have given the lengths of the various antennal segments and for the purpose of comparison I have also given those of the adult *Gaetanus pileatus* :—

Segment	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
Juv.	47	29	14	14	17	20	22	39	28	29	30	46	46	53	53	58	58	80	80	67	72	50	86	12
Adult	48	27	17	17	19	21	21	44	27	29	31	48	48	54	54	58	58	77	77	62	68	48	84	12

As in other instances in which we have been able to compare the length of the segments of the antenna in the immature and adult forms, we find that in the proximal segments from 1 to 18 there is a slight increase in the proportional lengths of the segments as we pass from the immature to the adult but that in the distal segments the length of these decreases in the adult. It will be noted from the above measurements that segments 8 and 9 are fused ; but that segments 24 and 25 are separate. Farran (1908) states that these are fused in the examples of *Gaetanus pileatus* that he obtained off the Irish Coast but in my examples from Indian waters they are distinctly separate.

The 2nd antenna and mandible are identical with these organs in *G. pileatus*.



TEXT-FIG. 40.—*Gaetanus pileatus* Farran ; Copepodid Stage V.

- a. The 1st maxilla.
- b. The maxilliped.
- c. The 1st swimming leg.
- d. The 2nd swimming leg.
- e. The 3rd swimming leg.
- f. The 4th swimming leg.
- g. The 5th pair of legs, ♂.

The maxilla (text-fig. 40 a) in its general form closely resembles that of the adult but differs in a few details. In these immature forms the three segments of the endopod bear

4, 4 and 6 setae respectively, whereas in the adult I find only 4, 3 and 6, which agrees with the number figured by Farran (1903, pl. xvii, fig. 6). In both the adult and immature forms the basal segment bears 5 setae and is fringed with hairs along its inner margin. In both forms also the 2nd inner lobe bears 3 setae. In the adult the 3rd inner lobe bears 4 setae and is described as being very much broader than the 2nd lobe, but in the present immature forms, while the number of setae agrees, the lobe is not very much broader than the 2nd. The exopod in these immature forms bears only 10 setae, whereas in the adult it bears 11.

The 2nd maxilla and maxilliped (text-fig. 40 *b*) appear to agree exactly with those in the adult, except as regards the lamella on basal 1 of the 2nd maxilliped which, as With (*loc. cit.* p. 106.) states, is shorter and more rounded than in the adult.

The 1st swimming leg (text-fig. 40 *c*) consists of a two-jointed exopod and a single jointed endopod, as in the adult. The 2nd swimming leg (text-fig. 40 *d*) possesses a three-jointed exopod and the endopod consists of only a single joint. The 3rd and 4th swimming legs are each composed of a three-jointed exopod and endopod, but in the 4th leg the 1st basal is merely fringed with fine hairs on its inner margin and appears to be without the characteristic row of hairs that is found across the face of the segment in the adult. There was no trace of any 5th pair of legs. The absence of this appendage is peculiarly interesting, in view of the statement made by Farran (1908, p. 35) that so far as he could ascertain "no distinction can be drawn between males and females at this stage, as both sexes appear to possess rudimentary fifth feet, which are lost by the female in the final ecdysis at any rate in this genus."

♂ In the young male the general structure of the body and appendages agrees closely with that of the females. The antennae, mouth-parts and swimming legs are identical with those of the female, but in addition there is present a rudimentary 5th pair of legs (text-fig. 40 *g*), which agree closely in shape with those described by T. Scott (1894, p. 72, pl. viii, fig. 26) in the young of *Gaetanus armiger*, and by With (1915, p. 105, fig. 26 *e*) in the case of this species, except that the exopod on each side bears a small spine on the external margin about the junction of the proximal and middle thirds of the limb in addition to the two unequal spines at the distal end.

These young males differ from the specimen described by Canu (1896, p. 424), under the name *Gaetanus caudani*, in having only two segments in the exopod of the 1st leg and thus agree with the form that Farran has already recorded as the young of *G. pileatus* and I have no doubt that they are the immature male of that species.

***Gaetanus rectus* Wolfenden.**

Gaetanus rectus, Wolfenden, 1911, p. 232, text-fig. 18 and pl. xxvi, figs. 14-16:

? *Gaetanus brevicornis*, Esterly, 1906, p. 56, pl. xi, fig. 4; pl. xii, fig. 55.

? *Gaetanus hamatus*, A. Scott, 1909, p. 50, pl. ix, figs. 16-22.

This species was first obtained by the "Gauss" in the tropical region of the North Atlantic Ocean. Several examples, of what I take to be this species, were obtained by the "Investigator" at Station 670. All the specimens were females, which is at present the only sex known.

In the collection there is a single immature female that I believe to belong to this species. In this specimen the abdomen, the narrowly-rounded thoracic margin and the upturned

stout lateral spines agree very closely with the description that A. Scott has given (*loc. cit.*, 1909) of an immature example that he believed to belong to a new species and named *Gaetanus hamatus*. The 1st swimming leg possesses, as in Scott's form, a two-jointed exopod, the proximal joint showing, as in the adult *G. rectus*, traces of the line of separation of segments 1 and 2 on its outer border. The endopod of the 2nd leg is two-jointed. In one respect the present example differs from the description given by Scott in that the 1st basal segment of the 4th pair of legs bears a row of hairs, 12 to 13 in number, whereas in Scott's examples the armature consists of seven spines. The size of the present specimen was also much smaller, measuring only 3.7 mm. in length. Scott does not describe the lamella on the 1st basal of the 2nd maxilliped in his specimen, but he remarks that "it appears to be similar to that of *Gaetanus latifrons*, but the preparation was slightly damaged during dissection, and the apex of the lamella was destroyed." In spite of these differences I am inclined to think that Scott's example was a young form of *Gaetanus rectus*.

It seems to me to be not unlikely that the species described by Esterly (*loc. cit.* 1906), under the name *Gaetanus brevicornis*, will eventually prove to be identical with *G. rectus* Wolfenden. Unfortunately Esterly gives only a very brief description and makes no mention whatsoever of the lateral thoracic spines; in both cases the 1st swimming leg is described as having an indistinctly divided proximal segment in the exopod. A. Scott (1909, p. 48) considers that *Gaetanus brevicornis* is identical with *Gaetanus kruppi* Giesbrecht; I cannot, however, agree with this for in my opinion the difference in the character of the lamella on the 1st basal joint of the 2nd maxilliped in the two forms is sufficient to negative this suggestion. Should Esterly's form prove to be identical with *Gaetanus rectus* his name *G. brevicornis* will, of course, take priority.

Genus **EUCHIRELLA** Giesbrecht.

The genus *Euchirella* is plentifully represented in Indian waters. In 1903 Thompson and A. Scott, in their report on the Copepoda of the Ceylon Pearl Banks, recorded the occurrence of *Euchirella messinensis* (Claus) from the neighbourhood of Minikoi and *E. rostrata* (Claus) from the Laccadive Sea region of the Indian Ocean. A year later Cleve (1904 (a)) also recorded the former species from the Agulhas Current and added *E. venusta* Giesbrecht to the list of species known to occur in the same area. The greatest contribution to our knowledge of the distribution of this genus in Indian waters came in 1909, when A. Scott published his report on the collections of the "Siboga"; in this report he records the occurrence of the following species in the Malay Archipelago:—

- Euchirella amoena* Giesbrecht.
- Euchirella curticauda* Giesbrecht.
- Euchirella galeata* Giesbrecht.
- Euchirella maxima* Wolfenden.
- Euchirella messinensis* (Claus).
- Euchirella pulchra* (Lubbock).
- Euchirella venusta* Giesbrecht.

Under the name *Euchirella hessei* he records the presence of *E. bella* Giesbrecht and he also added three new species, which he named *Euchirella granulata*, *E. dentata* and *E. dubia*;

of these last three, however, *E. dubia* must be transferred to the genus *Pseudochirella* Sars, and the same fate probably awaits the other two.

The true members of the genus *Euchirella* are, as has been pointed out by Sars (1925, p. 65), characterised by the great reduction of the endopod of the 2nd antenna, this ramus being less than one-half the length of the exopod; whereas in the genus *Pseudochirella* this ramus is at least half the length of the exopod. It is, however, very difficult to draw any hard and fast line between the two genera, for while in the majority of the true members of the genus *Euchirella* the endopod is much reduced, as for example is the case in—

Euchirella atlantica Wolfenden,
Euchirella bella Giesbrecht,
Euchirella brevis G. O. Sars,
Euchirella curticauda (Giesbrecht),
Euchirella galeata Giesbrecht,
Euchirella maxima Wolfenden,
Euchirella messinensis (Claus),
 and *Euchirella venusta* Giesbrecht,

in other species, that for other reasons are included in the same genus, the reduction of this ramus is very much less and in *Euchirella intermedia* With, *E. rostrata* (Claus) and *E. rostromagna* With, as well as in *E. orientalis*, sp. nov., the endopod is much less reduced and attains nearly to one-half the length of the exopod.

A second point of difference between the members of these two genera would appear to be the number of setae on the 2nd basal segment and the endopod of the maxilla. In members of the genus *Euchirella*, using the term in its restricted sense as defined by Sars, there is a great reduction in the number of these setae, and especially of those borne on the endopod. In the table below I have given the number of these setae in the majority of species :—

Species.		No. of setae on 2nd basal segment of 1st maxilla.	No. of setae on endopod of 1st maxilla.
<i>Euchirella rostrata</i> (Claus)		2	4
<i>Euchirella curticauda</i> (Giesbrecht)	.. ..	3	3
<i>Euchirella maxima</i> Wolfenden	.. ..	3	3 ?
<i>Euchirella rostromagna</i> Wolfenden	.. ..	3	3
<i>Euchirella simplex</i> Esterly	.. ..	3	3
<i>Euchirella bella</i> Giesbrecht	.. ..	3	4
<i>Euchirella bitumida</i> With	.. ..	3	4
<i>Euchirella galeata</i> Giesbrecht	.. ..	3	4
<i>Euchirella intermedia</i> With	.. ..	3	4
<i>Euchirella messinensis</i> (Claus)	.. ..	3	4
<i>Euchirella pulchra</i> (Lubbock)	.. ..	3	4 ?
<i>Euchirella venusta</i> Giesbrecht	.. ..	3	4
<i>Euchirella truncata</i> Esterly		3	4
<i>Euchirella brevis</i> Sars	.. ..	?	4

On the other hand many species that have been referred to the genus *Euchirella* show a very much greater number of these setae :

Species.		No. of setae on 2nd basal segment of 1st maxilla.	No. of setae on endopod of 1st maxilla.
<i>Euchirella dubia</i> A. Scott		5	14
<i>Euchirella dentata</i> A. Scott		5	15
<i>Euchirella elongata</i> Wolfenden	..	5	15
<i>Euchirella granulata</i> A. Scott	..	5	15
<i>Euchirella hirsuta</i> Wolfenden	..	5	15
<i>Euchirella spinosa</i> Wolfenden	..	5	15
<i>Euchirella wolfendeni</i> Farran	..	5	16

Of these species *Euchirella wolfendeni* Farran has already been shown by Sars (1925, p. 85), to be synonymous with the species described by him as *Undeuchaeta pustulifera*, and was later transferred to the genus *Pseudochirella*, and, as I shall show later, the same fate must be accorded to *Euchirella dubia* A. Scott; and it seems probable that all the above species will ultimately have to be transferred and that the possession of an increased number of setae on the maxilla is one of the generic characters of the genus *Pseudochirella*.

A point that seems worthy of mention is the tendency in the males of this genus for certain segments of the 1st antenna to become fused together; usually this fusion is to be found on the right side but in certain species it lies on the left. In every case segments 8 and 9 are fused together, but in the different species this fusion is to be found in other segments as well. In *Euchirella rostrata* segments 12 and 13 are partially fused and segments 20 and 21 are separate. In *E. messinensis* segment 10 is partially fused with segment 9, segments 12 and 13 are fused and so also are segments 20 and 21. In *E. intermedia* the fusion appears to have progressed a stage further and we now find that segments 8 and 9 are completely and 9 and 10 partially fused, while segments 12 and 13 and 14 and 15, respectively, are partially fused; With does not mention the condition of segments 20 and 21 but he states that the antenna resembles that of *E. messinensis*, so that presumably these segments are fused in this species also. In *E. orientalis*, sp. nov. segments 8 and 9 are completely fused and to this segment 10 is partially fused, segments 12 and 13 are partially fused as also are segments 14 and 15, and segments 20 and 21. Finally, in *E. curticauda* segment 7 is partially fused to segment 8; segments 8 and 9 are completely fused and segment 10 is partially fused with 9; segments 11 to 14 are partially fused and segments 20 and 21 completely so. Wolfenden does not describe the 1st antenna of *E. maxima* but states that it is like that of *E. curticauda*.

In all these species the fusion is in the right antenna, but in *E. pulchra* and *E. amoena* it occurs on the left side, though the extent to which it occurs is not stated. Giesbrecht, however (1902, pp. 242, 243), states that in the former species segments 20 and 21 are partially fused and *E. amoena* is said to resemble *E. pulchra* in this respect. Outside this genus the only case that I know of, in which a similar fusion of the antennal segments occurs, is in *Gaidius tenuispinus* Sars; Sars does not mention this in the text but he figures it clearly in his illustration.

Euchirella bella Giesbrecht.

Euchirella bella, Giesbrecht, 1888, p. 336.

Euchirella bella, Giesbrecht, 1893, p. 233, pl. xv, fig. 26.

Euchirella bella, Giesbrecht and Schmeil, 1898, p. 35.

Euchirella rostrata, Thompson and Scott, 1903, p. 244.

Euchirella bella var. *indica*, Wolfenden, 1905 (a), p. 1006, pl. xcvi, figs. 17-20.

Euchirella hessei, A. Scott, 1909, p. 54.

A. Scott (1909, p. 54) considers that *Euchirella bella* Giesbrecht is a synonym of *Euchirella hessei* Brady. I have examined the examples of *E. hessei* in the British Museum (Natural History) and it seems to me that Cleve (1901, p. 4) is correct in concluding that *E. hessei* is identical with *Euchirella rostrata*; and this view is also held by Sars (1925, p. 69). The male that Cleve (*loc. cit.*) describes and figures as the male of this species appears to me to belong to the genus *Undeuchaeta* rather than to *Euchirella*, the characters of the 5th pair of legs being quite different from those of this latter genus.

Euchirella brevis Sars.

Euchirella brevis, Sars, 1905 (a), p. 12.

Euchirella brevis, Wolfenden, 1911, p. 236, text-fig. 21.

Euchirella brevis, Sars, 1925, p. 71, pl. xxi, figs. 1-7.

Euchirella brevis, Farran, 1929, p. 234.

This species was described by Sars from specimens taken by the "Princesse Alice" in the North Atlantic Ocean. It has since been obtained by the "Gauss" in the South Atlantic and the occurrence of two examples in the "Investigator" collection at Station 670 extends its range to the Indian Ocean.

Euchirella curticauda Giesbrecht.

(Text-fig. 41, f.)

Euchirella curticauda, A. Scott, 1909, p. 55.

Euchirella curticauda, Wolfenden, 1911, p. 236.

Euchirella curticauda, With, 1915, p. 118, text-fig. 29 a-c, pl. iv, fig. 3 a-m and pl. viii, fig. 2 a-c.

Euchirella curticauda, Lysholm and Nordgaard, 1921, p. 15.

Euchirella curticauda, Sars, 1925, p. 72, pl. xxi, figs. 8-14.

Euchirella curticauda, Farran, 1926, p. 251.

This species is widely distributed and has been obtained in all the great oceans. The normal number of spines in the row on the basal joint of the 4th leg is twelve or thirteen; A. Scott (1909) notes that in this respect examples from the Faroe Channel exhibit no difference from specimens taken by the "Siboga" in the Malay Archipelago, in both localities the number of spines being the same, namely 12 to 13; Wolfenden (1904, p. 116) has, however, recorded the occurrence of what he considers to be a variety of this species from as far north as Lat. 54° 30', in which the number of spines was reduced to 6.

Two examples of this species were taken by the "Investigator" at Station 670 and in both instances the number of spines was 12. Both specimens exhibit a dichotomous branching of the setae of the furcal rami.

Euchirella galeata Giesbrecht.(Text-figs. 41, *a-e*.)*Euchirella galeata*, Giesbrecht, 1888, p. 336.*Euchirella galeata*, Giesbrecht, 1893, p. 233, pl. xv, fig. 18 ; pl. xxxvi, figs. 25, 26.*Euchirella galeata*, Giesbrecht and Schmeil, 1898, p. 36.*Euchirella galeata*, Esterly, 1905, p. 155, fig. 22.*Euchirella galeata*, A. Scott, 1909, p. 55.*Euchirella galeata*, Wolfenden, 1911, p. 241.*Euchirella galeata*, Sewell, 1913, p. 354.*Euchirella galeata*, Lysholm and Nordgaard, 1921, p. 16.

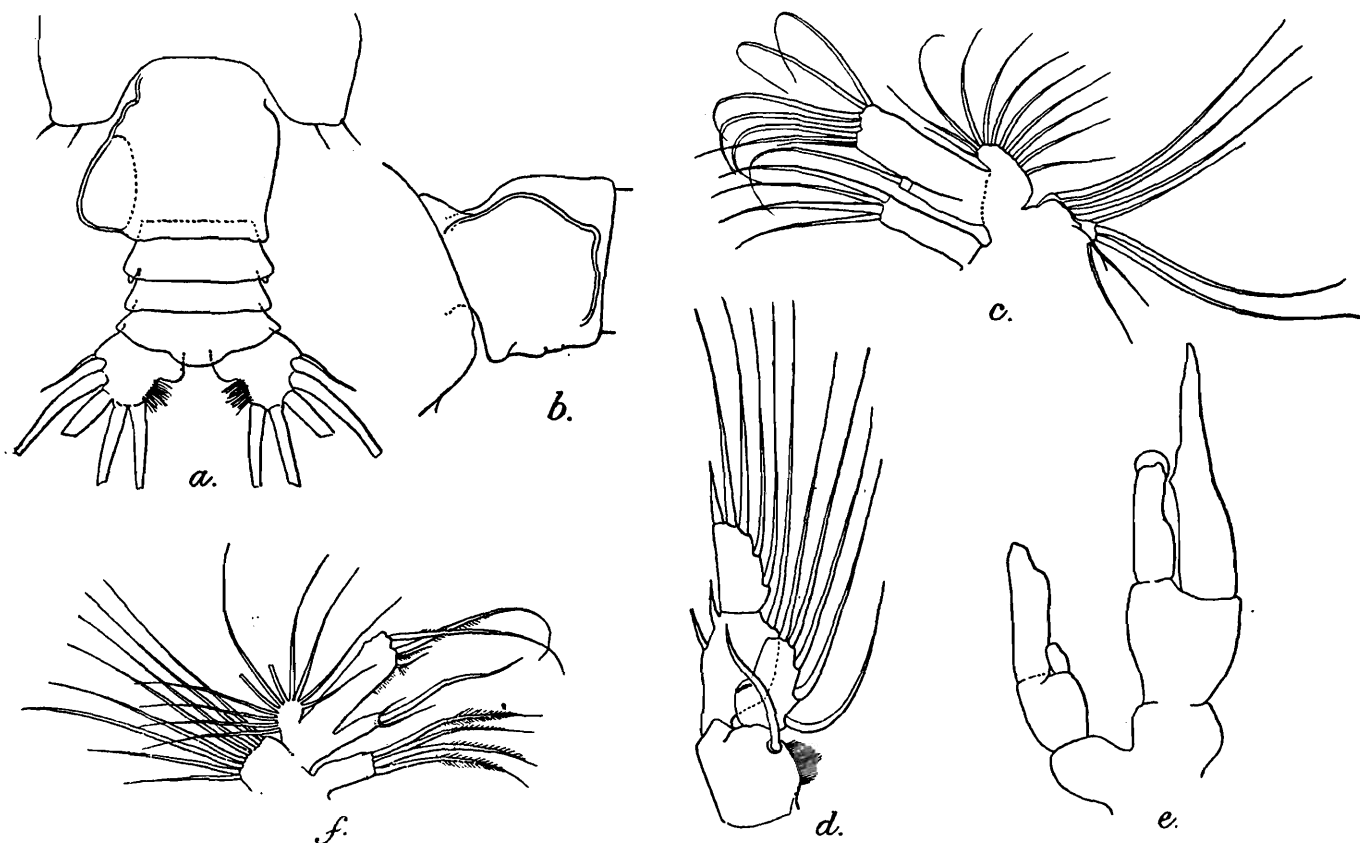
This species appears to have a wide range of distribution ; discovered originally in the Pacific Ocean between Lats. 36° S. and 35° N., its known range has now been extended to the Atlantic and Indian Oceans. It was taken in the South Atlantic in Lat. 32° S. by the "Gauss"; A Scott records its presence in the Malay Archipelago and specimens were taken by the "Investigator" at Stations 393 and 670. The depth at which this species has been obtained ranges from 1000 to 2000 metres in the south Atlantic, and between 400 fathoms and the surface in the Bay of Bengal.

At Station 670 several immature examples were taken along with specimens of the adult stage.

The examples in the "Investigator" collection agree closely with the description given by Giesbrecht, with the single exception of the shape of the genital segment of the abdomen. Giesbrecht figures this segment as having a marked dorsal projection or swelling. In the "Investigator" examples there is a marked protuberance on the left side of the segment, extending back to the posterior margin, but I have been unable to detect any other difference of sufficient importance to warrant the separation of the Indian form from the type.

In 1915 With, under the name *Euchirella bitumida*, described a form that is very closely related to *E. galeata* Giesbrecht but differs from it in certain small details, notably in the shape and position of the swellings on the genital segment of the abdomen. Prior to With's paper, this form had been recorded by both Sars (1905 (*a*), p. 4) and by Farran (1908, p. 37) under the name *E. galeata*. The distinction between *E. galeata* Giesbrecht and *E. bitumida* With is based on the shape of the genital segment. In the Pacific form, *E. galeata*, there is, according to Giesbrecht's original account, a marked swelling on the left side of the genital segment, while the segment itself possesses a high arched dorsal surface. The form described by Esterly (1905, p. 155, fig. 22) from the San Diego Region of the Pacific agrees closely with Giesbrecht's original account. According to With (1915, p. 131) in *E. bitumida* "the genital somite has in dorsal view a better marked convexity on the right than on the left side, and possesses, slightly in front of middle on each side, a rounded protuberance, bigger on the right side and with a shallow depression between the two." In the present examples from Indian Seas, the mass of the swelling on the genital segment is confined to the left side, but With (1915, pl. v, fig. 9 (*b*)) figures in *E. bitumida* a well-marked projection on the left side that corresponds very closely with the anterior part of the swelling found in the Indian form. Farran (1926, p. 253) believes that *E. bitumida* With is the Atlantic representative of the Pacific form *E. galeata* Giesbrecht and "that With is right in separating the two species." I, however, very much doubt the validity of this separation and, in the absence of

any other more important difference, would prefer to consider all three forms *G. galeata*, Giesbrecht from the Pacific Ocean, *E. bitumida* With from the Atlantic, and the present form from the Indian Ocean as belonging to a single species.



TEXT-FIG. 41.—*Euchiarella galeata* Giesbrecht.

- a. The posterior thoracic margin and abdomen from above. d. The 1st swimming leg.
 b. The genital segment from the left side. e. The 5th pair of legs (juv.), ♂
 c. The 1st maxilla. f. The 1st maxilla of *Euchiarella curticauda* Giesbrecht, ♀.

The immature females, obtained at Station 670, all belong to the last copepodid stage and have an average length measurement of 3.8 mm. In this stage of development the proportional lengths of the cephalothorax and abdomen are as 7.45 : 1, whereas in the adult it is 5.0 : 1. The head presents the typical crest and the posterior thoracic margin is uniformly rounded.

The abdomen consists of four segments, having the following proportional lengths:—

Abdominal segment	1	2	3	4-5	Furca.
	34	17	11	17	21 = 100

The genital segment is symmetrical and shows but little or no swelling on the ventral surface.

The 1st antenna reaches back to the middle of the abdomen and, as in the adult, consists of 23 free segments, segments 8 and 9 and 24 and 25, respectively, being fused. The proportional lengths of the various 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	24-25
Stage V.	63	40	26	23	23	23	23	40	26	26	26	50	50	70	66	72	66	66	56	46	43	36	40
Adult	70	42	29	25	25	25	25	42	29	29	29	42	45	62	60	68	60	64	53	47	47	39	47 = 1000

The 2nd antenna and mouth-parts have already assumed their adult character and in the maxilla the number of setae on the basal segment and on the endopod are few as in all the members of the genus (*vide supra*, p. 107).

The 1st and 2nd swimming legs are as in the adult. The 4th swimming leg still shows no trace of the characteristic spine on the 1st basal segment.

In the immature male the general structure closely resembles that of the immature female, but exhibit certain small differences. The 2nd antenna shows certain differences from the female, especially as regards the endopod, which in this sex is much longer and is of stouter build. A rudimentary 5th pair of legs is present, having the form shown in text-fig. 41, *e*. Each limb consists of two basal segments, a long exopod and a short endopod; the limb of the right side is well developed and is nearly twice the size of that of the left side; both endopod and exopod are well developed, the former being crowned by a crescentic plate, while the latter tapers to a point.

A comparison of text-fig. 41, *e* and that given by With (1915, p. 131, text-fig. 34) of the corresponding appendage in *Euchirella bitumida* shows how close is the similarity between the two forms.

***Euchirella maxima* Wolfenden.**

(Text-figs. 42, *a-d* and 43, *a-c*.)

Euchirella maxima, Wolfenden, 1905, p. 18, pl. vi, figs. 9-11.

Euchirella maxima, Farran, 1908, p. 38.

Euchirella maxima, A. Scott, 1909, p. 57, pl. xii, figs. 12-20.

Euchirella maxima, Wolfenden, 1911, p. 238, pl. xxviii, figs. 3-5.

Euchirella maxima, Sewell, 1913, p. 354.

Euchirella maxima, With, 1915, p. 127, text-fig. 33 *a-i*; pl. iv, fig. 5 *a-h*.

Euchirella maxima, Sars, 1925, p. 75, pl. xxii, figs. 1-7.

This species was first obtained in the Atlantic Ocean by the "Gauss"; its southern limit of distribution in this ocean, as at present known, is about Lat. 36° S. Farran (1908) has obtained specimens off the west coast of Ireland and A. Scott (1909) records its presence in the Malay Archipelago. Several examples, both adult and immature, were obtained by the "Investigator" at Stations 393 and 670.

Scott gives the length of his examples as 7.2 mm.; the "Investigator" specimens are slightly smaller than this, measuring from 6.1 to 6.5 mm.

Copepodid Stage IV. (Text-fig. 42, *a-d*).

Among the specimens taken at Station 670 were two examples of what I take to be the 4th copepodid stage: both examples were females.

♀ The total length was 4.0 mm. and the proportional lengths of the cephalothorax and abdomen are as 7 to 1.

The forehead shows the triangular crest that is characteristic of the adult. The rostrum is short and stout and between it and the crest is a small projection that bears two short hairs. The cephalon and 1st thoracic segment are fused but the line of fusion between them is clearly visible. Thoracic segments 4 and 5 are also fused together. The posterior margin is rounded, but in the lateral region, where in the adult stage there is a well-marked backwardly-directed flap, there is in this stage only a slight irregularity in the uniform curve of the margin and a thickening of the chitin.

The abdomen is short and consists of only three segments, which have, with the furcal rami, the following proportional lengths:—

Abdominal segment	1	2	3-5	Furca.	
	21	14	29	36	=100

The second segment is armed along the dorsal part of the posterior margin with a row of fine spines.

The 1st antenna closely resembles that of the adult, except that segments 24 and 25 have not yet become fused. Segments 8 and 9 are, as in the adult, also fused, so that there are 24 free joints in the appendage.

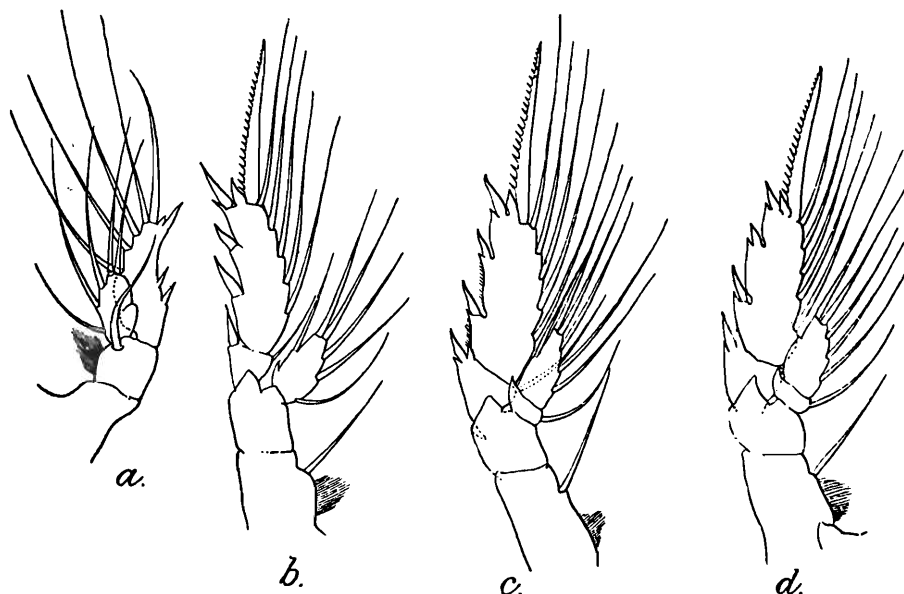
The proportional lengths of the segments are as follows :—

Segment	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
	67	59	22	20	20	20	20	36	24	24	29	44	44	59	59	66	59	68	59	49	44	44	44	15 = 1000

The 2nd antenna and mouth-parts in their general form closely resemble those of the adult ; the number of setae borne by the various appendages is, however, smaller.

In the mandible the exopod bears 6 setae as in the adult ; but the endopod appears to possess only 7.

In the 1st maxilla the 2nd inner lobe bears a single seta and the 3rd inner lobe three, of which one is large and the other two are small. The basal segment carries a single large seta and two small ones, and the endopod bears three setae, as in the adult. The outer lobe appears to have only five setae and the exopod bears only 9.



TEXT-FIG. 42.—*Euchiarella maxima* Wolfenden ; Copepodid Stage IV.

a. The 1st swimming leg.

b. The 2nd swimming leg.

c. The 3rd swimming leg.

d. The 4th swimming leg.

In the 1st swimming leg (text-fig. 42, a) both rami consist of only a single segment ; the exopod, however, bears on its outer margin three marginal spines, the proximal two of which are situated close together and are smaller than the distal.

In the 2nd swimming leg (text-fig. 42, b) the exopod consists of two segments, of which the proximal bears a single marginal spine and the distal bears three. The end-spine is about as long as the distal segment and is coarsely serrated. The endopod consists of a single segment.

In the 3rd (text-fig. 42, c) and 4th swimming legs (text-fig. 42, d) the exopod also consists of two segments and the endopod also possesses two. There is no trace of any spine on the 1st basal segment of the 4th leg.

Copepodid Stage V. (Text-fig. 43, a-c.)

Both sexes are represented in the collection. The average length of the examples is 5.1 mm.

In both sexes the general shape of the body is similar to that of the adult, but the posterior lappet on the thoracic margin is still only indicated by a slight irregularity of outline.

The abdomen in both sexes consists of four segments, that have the following proportional lengths :—

Abdominal segment	1	2	3	4-5	Furca.	
♀	28	17	13	17	25	=100
♂	28	14	10	19	29	=100

There would thus appear to be a slight difference in the lengths of the segments in the two sexes. Segments 2 and 3 are armed along the dorsal part of their posterior margins with a row of small spines.

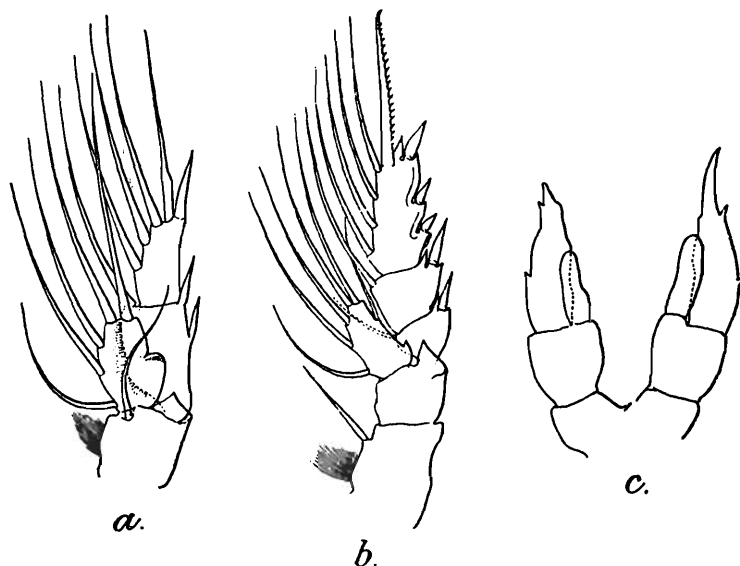
The 1st antenna now consists of only 23 segments, as, in addition to segments 8 and 9, segments 24 and 25 are also fused together. The proportional lengths of the segments in this stage are as follows :—

Segment	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	
	65	73	26	26	24	24	24	40	26	28	32	44	46	60	60	60	56	56	48	44	40	38	50	=1000

In the 2nd antenna both inner and outer lobes of the endopod bear only 5 setae, whereas in the adult they bear 7 setae on the inner lobe and 5, of which two are very small, on the outer lobe. With (1915, p. 130) gives three as the number present on the outer lobe but he has probably overlooked the two small setae.

The mouth-parts are very similar to those of the adult, although in certain parts they have not yet attained to the full number of setae.

In the 1st maxilla the exopod now bears 9 (10 ?) setae instead of 11 as in the adult.



TEXT-FIG. 43.—*Euchiarella maxima* Wolfenden ; Copepodid Stage V.

a. The 1st swimming leg.

b. The 2nd swimming leg.

c. The 5th pair of legs, ♂.

In the 1st swimming leg (text-fig. 43, a) the exopod now consists of two segments as in the adult stage, the proximal segment consisting of segments 1 and 2 fused together and bearing both marginal spines, while the distal segment bears a single marginal spine and the end-spine.

In the 2nd swimming leg (text-fig. 43, b) the exopod now possesses three separate segments, but the endopod still consists of only a single joint.

In the 3rd and 4th legs both exopod and endopod consist of three segments and their structure is identical with that of the adult, with the exception of the absence, even in this stage, of any spine on the 1st basal joint of the 4th leg of the female.

In the male the 5th leg (text-fig. 43, c) consists on each side of a single-jointed exopod and endopod as shown in the text-figure.

In this species we can again trace the changes that take place in the development of the individual as regards the proportional lengths of the segments of the 1st antenna. In the following table I have given the proportional lengths in both the 4th and 5th Copepodid stages and for the purpose of comparison I have given those of the adult:—

Segment	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	
Copepodid stage IV.	67	59	22	20	20	20	20	36	24	24	29	44	44	59	59	66	59	68	59	49	49	44	44	15	=1000
Copepodid stage V.	65	73	26	26	24	24	24	40	26	28	32	44	46	60	60	60	56	56	48	44	40	38	50		=1000
Adult stage	60	68	28	27	27	24	24	42	29	30	33	42	48	64	64	64	60	60	51	42	40	33	40		=1000

In segment 1 the length of the joint appears to steadily diminish but from segments 3 to 16 there is a steady increase in the length of the segment at each consecutive stage of development; in segments 17 and 18 there is but little change, but from segment 19 on to the end of the appendage the segments steadily get shorter at each moult.

Although the number of examples obtained is too few to enable one to be certain, this species appears to follow the usual life-history, the growth-factor for the last two ecdyses of the female being the same in each moult, viz., 1.274.

In the following table I have given the actual and calculated measurements and the growth-factor for the last three stages of development of the female:—

	Actual length.	Calculated length.	Growth-factor.
Copepodid stage iv	4.0	4.000	1.274
Copepodid stage v	5.1	5.096	1.274
Adult female	6.1—6.5	6.492	

***Euchirella messinensis* (Claus).**

(Text-fig. 44, *f*).

Euchirella messinensis, A. Scott, 1909, p. 56.

Euchirella messinensis, Wolfenden, 1911, p. 237.

Euchirella messinensis, With, 1915, p. 122, text-fig. 31 *a-f*, pl. iv, fig. 2, *a-c*.

Euchirella messinensis, Lysholm and Nordgaard, 1921, p. 16.

Euchirella messinensis, Sars, 1925, p. 63, pl. xix, figs. 6-13.

Euchirella messinensis, Farran, 1926, p. 252.

This species appears to have a wide distribution and has now been recorded from all the three great oceans. It, however, appears to be in the main more common in, if not actually restricted to, the tropical and northerly regions, for the greatest distance south that it has been taken is about Lat. 37° S. in the Atlantic.

A single male example was taken by the "Investigator" at Station 393. The size of this specimen is 4.88 mm., which is intermediate between the size given by Giesbrecht namely, 3.95 mm. and that given by With, 5.46 mm.

***Euchirella orientalis*, sp. nov.**

(Text-fig. 44, *a-e*.)

Euchirella pulchra, Sewell, 1913, p. 354 [*non Euchirella pulchra* (Lubbock).]

A number of examples of what appears to be a new species of *Euchirella* were taken at Station 393 by the "Investigator"

♀ Total length, 4.8 mm.

The proportional lengths of the cephalothorax and abdomen are as 3.53 to 1.

The head closely resembles that of *Euchirella intermedia* With. There is no frontal crest and the single pointed rostrum is stout and points vertically downwards. The posterior thoracic margin is rounded.

The abdomen consists of the usual four segments, the 1st or genital segment is as deep as long and is swollen in a rounded prominence on the dorsal aspect, the whole segment is symmetrical or but slightly asymmetrical in some cases, the left side being a little more prominent than the right; there is, however, no trace of any sac-like or lamelliform projection.

The 1st antenna reaches back to the middle of the 2nd abdominal segment. The proportional lengths of the various 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	24-25
	343	24	24	24	24	24	24	43	28	33	28	43	48	64	62	67	60	64	55	48	48	41	52
	=1000																						

Segments 3, 7, 9, 14 and 18 all bear long setae and segments 22 to 24 all bear posterior setae that increase in length distally.

In the 2nd antenna the two branches are very unequal, a condition that we have already seen to be characteristic of the genus. In the present species the proportional length of the two branches are as 15 to 51. The endopod reaches only half way along the 1st joint of the exopod. The terminal segment of the endopod bears 6 setae on each of its two lobes, as in *E. galeata*; *E. venusta*, which the present species resembles in several features, is said to bear only 5 and 4 setae and *Euchirella pulchra* is said to have 6 and 5. All the setae on the lobes of the endopod are short and the inner three on the inner lobe extremely so. The 1st segment of the exopod appears to be devoid of a seta, and is completely fused with the 2nd segment, which is also devoid of a seta; at the point of junction is a small rounded projection, exactly similar to that described by With (1915, p. 125, pl. viii, fig. 3) in *E. intermedia*.

In the mandible the basal segment appears to have no setae; the endopod bears 9 setae, of which the inner two are short. In other respects this appendage resembles that of other members of the genus.

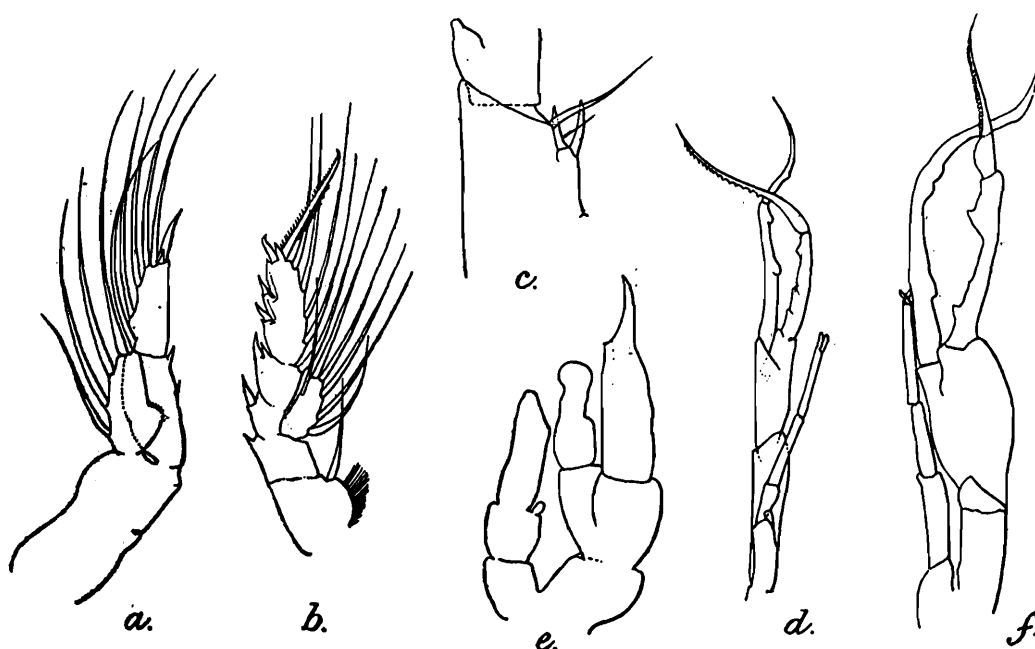
In the 1st maxilla the basal segment bears three setae, of which the inner two are short. The endopod bears 4 setae. Thus in this respect this species resembles both *Euchirella venusta* and *E. pulchra*, both of which species it also closely resembles in other respects. Of the inner lobes the 1st bears 13 (? 14) setae, the 2nd lobe 4 and the third lobe a single seta. The exopod carries 11 setae.

The 2nd maxilla closely resembles that of *Euchirella bitumida* With. Each of the lobes bears 3 setae and all have a fringe of needle-like spines distally. In the exopod the 1st segment bears 2 setae, the 2nd only one and the terminal segment 4.

The maxilliped closely resembles that of other members of the genus; in the 1st basal segment, lobe 1 bears 2 setae and lobe 2 carries 3, of which the 1st is short and plain, the 2nd is of medium size and is finely serrated and the 3rd is also of medium length but is coarsely serrated in its middle third; lobe 3 bears 3 setae and is, in addition, fringed with spinules or stout hairs. In the 2nd basal segment the posterior margin is sinuous; the anterior border bears 3 setae about the middle of its length and two unequal setae at its distal end;

the proximal half of the margin is armed with a row of fine needle-like spines. On the five segments of the endopod the number of setae are 4, 3, 3, 3, 4, respectively.

In the 1st swimming leg (text-fig. 44, *a*) both basal segments are fringed on their inner borders with long hairs and the 2nd segment carries the usual long seta at its inner distal angle. The exopod consists of two segments only, exopod 1 and 2 being fused, though the combined joint carries two marginal spines, of which the proximal is the more delicate. The margin between these two spines is indented and is perforated by a pore; this part of the external margin, as well as the proximal half of the margin of the distal segment, is fringed with hairs. The marginal spine of the distal segment is stout and is about three-fourths the length of the segment. The endopod reaches as far as the joint between the two segments of the exopod and the rounded swelling on the outer margin is fringed with short spines.



TEXT-FIG. 44.—*Euchiarella orientalis*, sp. nov.

a. The 1st swimming leg, ♀.	d. The 5th pair of legs, adult ♂.
b. The 2nd swimming leg, ♀.	e. The 5th pair of legs (juv.) ♂.
c. The basal part of the 4th swimming leg, ♀.	f. The 5th pair of legs of <i>Euchiarella messinensis</i> (Claus). ♂.

In the 2nd swimming leg (text-fig. 44, *b*) the 1st basal bears a single seta and the inner margin is fringed with hairs; basal 2 has a smooth inner margin. The exopod consists of three segments; in the 1st segment there is a marginal spine and the inner border is fringed with hairs and bears a small seta; the marginal spine on the 2nd segment may reach as far as the base of the proximal spine on the 3rd segment, the inner margin of this segment is smooth and bears a normal seta; in the 3rd segment the two proximal spines are sub-equal, while the distal spine is larger, the inner border bears four setae and the end-spine possesses 21 serrations on its margin. The endopod consists of a single segment, bearing a small seta on the outer margin, two at the distal end and three on the inner margin; there is a small spine-like projection on the outer margin near the proximal end.

In the 3rd swimming leg both exopod and endopod are three-jointed. Exopod 3 bears three equal marginal spines and the end-spine has 20 serrations on its outer border.

The 4th swimming leg (text-fig. 44, *c*) closely resembles that of *Euchiarella pulchra* and *E. venusta*, and in the great majority of cases bears two sub-equal spines on the 1st basal

segment; these spines reach as far as the level of the line of articulation between the two basal segments. In a few cases there are three spines.

In its general features this species very closely resembles both *Euchirella pulchra* and *E. ventusta*, especially as regards the spines on the 4th feet. It, however, differs in having no sac-like projection or lamella on the genital segment of the abdomen, no crest to the forehead and a different number of setae on the endopod of the 2nd antenna. The three species clearly are closely related to each other and probably represent diverging lines of evolution from a common stock.

Associated with these females were a number of immature males, and a single male adult was taken at Station 393.

♂ The characters of this adult individual are as follows:—

Total length 3.7 mm.

The cephalothorax is ovate and robust. The forehead is rounded and is devoid of any crest. The rostrum is strong and of moderate length and is directed ventrally. The cephalon and 1st thoracic segment are fused and thoracic segments 4 and 5 also appear to be partially fused. The posterior thoracic margin is rounded.

The abdomen appears to consist of only four segments owing to the anal segment being completely telescoped into the 4th segment. The posterior margins of segments 2 and 3 are armed across the dorsal aspect with a row of triangular spines. The furcal rami are short, being about three-fourths the length of the 4th segment of the abdomen.

The 1st antenna reaches back to about the middle of the abdomen. It consists of only 19 free joints; segments 8 and 9 are completely fused and the combined mass is partially fused to segment 10, the 12th and 13th segments appear to be partially fused, as also do segments 14 and 15. In the right antenna segments 20 and 21 are fused and on both sides segments 24 and 25 form a single joint. The proportional lengths of the various joints are as follows:—

Segment	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	
	58	46	23	23	23	23	26	66	31	72	110	63	66	61	63	99	49	46	52	=1000

The 2nd antenna possesses an endopod that is about half the length of the exopod. Exopod 1 and 2 are clearly separated off from each other, but the 1st segment bears no seta. The terminal segment of the endopod bears 6 setae on each of its lobes.

The 1st maxilla agrees closely with that of *Euchirella messinensis*.

In the 1st swimming leg the exopod consists of only two separate segments, exopod 1 and 2 being incompletely separated. The combined two proximal segments bear two very small marginal spines; the terminal segment bears a stout marginal spine that is about half the length of the segment. The endopod consists of a single segment that exhibits a rounded swelling on its external margin, this swelling being fringed with needle-like spines.

In the 2nd pair of legs the exopod is 3-jointed and the endopod is composed of a single joint. The marginal spine on the 2nd segment of the exopod does not reach as far as the base of the proximal spine on the 3rd segment.

The 5th pair of legs (text-fig. 44, d) very closely resemble that of *Euchirella messinensis*. There are, however, distinct differences, especially in the proportionate lengths of the different joints and in the extent of the interval between the teeth on the terminal segment of the exopod of the right foot. The appendage also closely resembles the corresponding appendage

in the male of *Euchirella pulchra*, described by Esterly (1905, p. 154, fig. 20), of *E. intermedia* With (1915, p. 126, fig. 32, e) and of *E. propria*, also described by Esterly (1911, p. 321, pl. xxx, fig. 83).

Genus **CHIRUNDINA** Giesbrecht.

The genus *Chirundina* was created by Giesbrecht to accommodate the single species, *Chirundina streetsi*, that he discovered in the Pacific Ocean in 1895. Wolfenden (1911) subsequently described two other species, that he attributed to this genus, under the name *Chirundina magna* and *C. antarctica*; both of these species were obtained by the "Gauss." It seems probable that at least the former of these two species will have to be transferred to Sars' new genus *Pseudochirella*, to which he has already transferred a number of species, described by himself or others, and attributed by them to the above genus.

Chirundina streetsi Giesbrecht has been obtained in numerous areas, including the Pacific Ocean, the Malay Archipelago and the Atlantic Ocean as far north as the Faroe Channel.

It was, therefore, to be expected that it would occur in the "Investigator" collection, but, so far, I have been unable to detect its presence. Its place, however, is taken by a closely-allied form to which I propose giving the name *Chirundina indica*.

Chirundina indica, sp. nov.

(Text-figs. 45 *a*, *b* and 46, *a-j*.)

Numerous examples of this species, that appears to be new, were obtained at "Investigator" Station 670.

♀ Total length, ranging from 4.19 to 4.75 mm.; the average being 4.55 mm.

The proportional lengths of the cephalothorax and abdomen are as 4.7 to 1.

The forehead is somewhat prominent, so that in side view the head has a truncated appearance. There is a low median crest that is very much less marked than in *Chirundina streetsi*. The rostrum is well developed and is directed downwards and forwards. The head and 1st thoracic segments, as also thoracic segments 4 and 5, are fused together. The posterior thoracic margin is produced slightly backwards and is rounded; it shows no trace of any projecting process such as is present in *C. streetsi*.

The abdomen consists of four segments, that have, with the furcal rami, the following proportional lengths:—

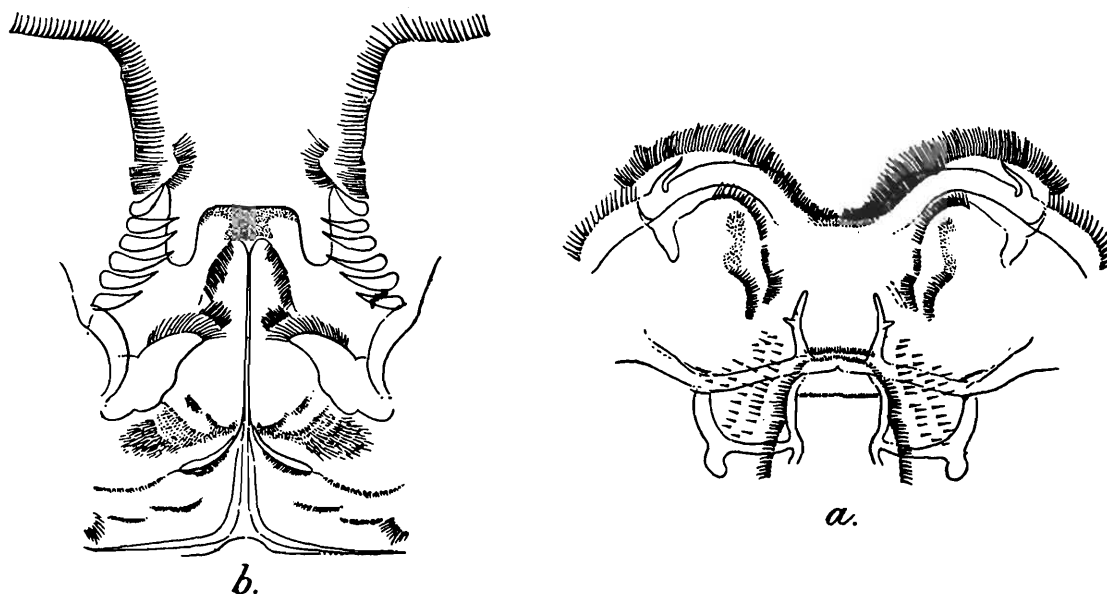
Abdominal segment	1-2	3	4	5	Furca.	
	<u>48</u>	20	13	6	13	=100.

The genital segment is symmetrical and ventrally presents a well-marked swelling that appears to be identical with the similar swelling in *C. streetsi*, both as regards size and shape. The 2nd and 3rd segments are armed along their posterior margins with fine needle-like spines. The 4th segment bears a tuft of hairs ventrally. The furcal rami are as broad as long and bear only four setae, all of nearly equal length; both inner and outer margins are fringed with hair and the accessory seta is small.

The 1st antenna reaches back as far as the 3rd segment of the abdomen. The 8th and 9th segments are completely fused and the 24th and 25th segments partially so. 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	24-25	
	56	53	29	29	29	33	33	49	29	29	29	41	41	49	51	55	49	64	60	41	40	53	49	=1000

In the 2nd antenna the endopod is approximately half the length of the exopod; the distal segment bears 8 and 6 setae on its inner and outer lobes, respectively. The 1st segment of the exopod bears a single seta with a thickened base, and the 2nd segment bears near



TEXT-FIG. 45.—*Chiriundina indica*, sp. nov.

a. The labrum in oral view.

b. The lamina labialis.

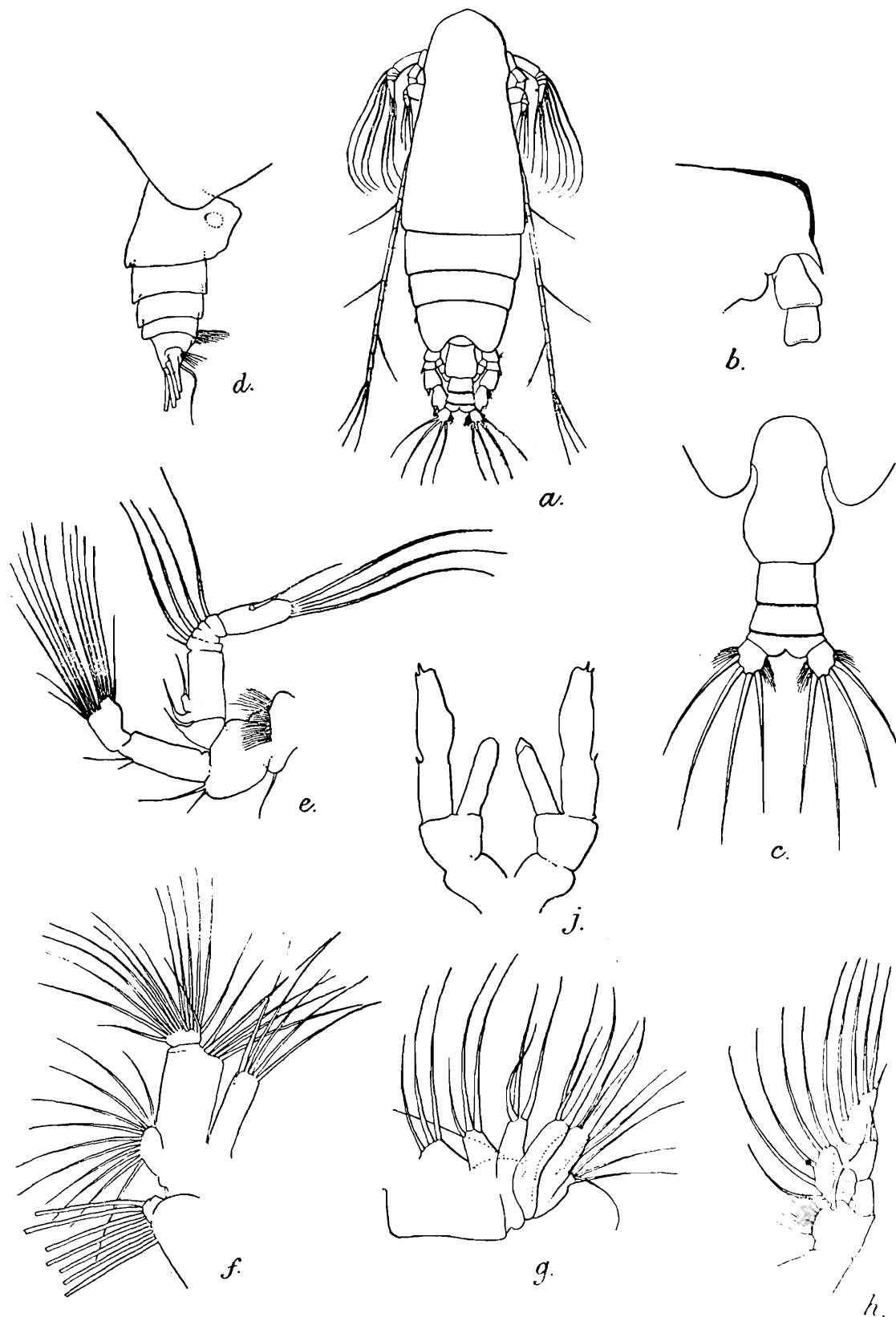
its proximal end two setae, of which the first possesses a swollen base and the 2nd arises from a small swelling. The distal segment of the exopod is as long as segment 2 and bears at its extremity three setae, while a fourth arises half way along its length. The 1st basal segment bears a line of long hairs.

The mouth-parts appear to be extremely like those of *C. streetsi*. The mandibular palp carries 9 setae on the endopod and 3 on the exopod. The 1st maxilla is as figured (text-fig. 46, f); the basal segment bears five setae of which one is considerably thicker than the rest; the endopod carries 15 setae and the exopod 11. The 3rd inner lobe bears 5 setae. The maxilliped is long and slender, the 2nd basal segment being greatly elongated and the terminal ramus comparatively short; the proportional lengths of the two basal segments and the ramus are 28 : 50 : 15.

The proximal part of the posterior margin of the 1st basal is armed with small spinules and is somewhat produced; distally there is a rounded projection with thickened chitin, as pointed out by With (1915, p. 142) in the case of *C. streetsi*. The 2nd basal segment has a transparent lamella along the posterior margin, the middle of its length being usually concave.

The 1st pair of legs (text-fig. 46, h) have the usual two-jointed basal part and the exopod is two-jointed, while the endopod consists of a single segment. The 1st basal segment projects markedly inwards towards the median line. In the exopod the 1st and 2nd segments of the ramus are fused together, though traces of the original joint between them can be

easily detected ; the marginal spine on the proximal segment has been completely suppressed, so that in this respect this species differs from *C. streetsi*.



TEXT-FIG. 46.—*Chirundina indica*, sp. nov. ♀.

a. The whole animal from above.	e. The 2nd antenna.
b. The anterior end from the right side.	f. The 1st maxilla.
c. The abdomen from above.	g. The 2nd maxilla.
d. The abdomen from the side.	h. The 1st swimming leg.
j. The 5th pair of legs, ♂ (juv.).	

The 2nd pair of legs possess a three-jointed exopod and an endopod that consists of only a single joint, though the outer margin bears a sharp spinous process that marks the limit of the originally-separate proximal segment.

The 3rd and 4th legs are similar and are each composed of a three-jointed exopod and endopod. There are no spines on the posterior surface of the 1st basal segment of the 4th leg.

The 5th pair of legs is absent.

One example was carrying an egg-sac, that was flattened dorso-ventrally and closely resembled those of the females of the genus *Euchaeta*. It contained 13 ova.

Associated with these adults in the collection made at Station 670 were a number of immature forms of both sexes, that I take to belong to this species, though it is very difficult to distinguish between the immature stages of the different genera in this group owing to the fact that the characteristic armature of the 4th leg of the female in certain genera is not developed till the adult stage is reached.

These immature females measure 3.4 to 3.5 mm. in length.

The proportional lengths of the cephalothorax and abdomen are as 4.6 to 1.

The forehead is prominent but bears no crest such as is found in the adult.

The rostrum is a single sharp spine. The cephalon and 1st thoracic segment are fused together. The posterior margin, instead of being rounded, is produced backwards in an angular projection, at the apex of which there is a small spine. In this respect, therefore, these examples resemble *Chirundina streetsi* rather than *C. indica*, and it is possible that they are young forms of the former species.

The abdomen consists of four segments. At this stage segments 1 and 2 are still separate, while segments 4 and 5 have not yet become differentiated from each other. The proportional lengths of the different segments are as follows:—

Abdominal segment	1	2	3	4-5	Furca.
	21	21	18	24	16
	= 100.				

The 1st antenna reaches back as far as the 4th abdominal segment. It consists of 23 separate joints, segments 8 and 9 being completely fused, as also are segments 24 and 25. The proportional lengths of the segments are as follows:

Segment	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
	55	44	28	28	28	28	28	50	28	28	28	40	41	50	50	55	50	68	61	44	50	60	58
	= 1000.																						

A comparison of these lengths with those in the adult shows that from segment 1 to 16 there is throughout an increase in the proportional lengths of the segments as we proceed from the immature to the mature stage; in segment 17 there is no change, but in the distal segments, from 18 to 25, the length of the segments decreases as we pass from the young to the mature form. This, as we have already seen, is a characteristic of the growth of the Copepoda and is, therefore, an indication that we may be dealing here with growth-stages of the same species.

The 2nd antenna closely resembles that of the adult in the length of the various parts; in this young form I have, however, been unable to detect the swollen seta that in the adult arises from the 1st segment of the exopod.

The mouth-parts have already assumed the characters found in the adult female.

The swimming legs also closely resemble those of the adult. In the 1st leg the fusion of segments 1 and 2 is complete, whereas in the adult one can detect traces of the line of separation; as in the adult, that part of the proximal segment of the exopod that corresponds to the 1st segment is devoid of any marginal spine.

Five examples of immature males were also obtained at Station 670. In their general form they agree with the immature females but they show the commencing development of the 5th pair of legs. A. Scott (1909, pl. xii, fig. 10) has given a description of the male of *Chirundina streetsi* and has shown that in this genus the type of this limb is more nearly symmetrical than in *Euchirella*, both sides possessing a well developed endopod. One would, therefore, expect to find that in the immature males the legs of the two sides were also nearly symmetrical, and that this is the case is shown clearly in these specimens (text-fig. 46, j.).

Wolfenden (1905, p. 19, pl. vi, figs. 1 and 2; and 1911, p. 235, pl. xxvii, figs. 3-7) has described under the name *Euchirella carinata* a copepod that very closely resembles *Chirundina streetsi* and both Farran (1905, p. 16) and van Breemen (1908, p. 46) have concluded that these two forms are synonymous. Wolfenden, unfortunately, gives but few details of this species and has, moreover, failed to deposit any specimens in the British Museum (Natural History) so that a comparison is impossible. He, however, states that in his specimens the median cephalic crest is more developed than in *Chirundina streetsi* and the thoracic margins are produced back in a sharp spine. The other characters that he mentions, namely, the 2nd antenna, the maxilla and the maxilliped agree closely with those of *Chirundina streetsi*, as also does the 4th swimming leg, in which there is no trace of any armature, either spines or hairs. I agree with Farran and van Breemen that this form is a *Chirundina* and a comparison of such facts as we possess seems to me to indicate that all three of the above forms tend to fall into a regular series, in which the degree of development of the cephalic crest steadily increases from *Chirundina indica*, in which it is very slight, through *C. streetsi* to *Chirundina carinata* (Wolfenden) and it is possible that all three represent variations of a single species. As, however, the structure of the 1st pair of swimming legs shows definite differences from the Atlantic form of *C. streetsi*, I have thought it best to give the Indian form a separate name.

Genus **UNDEUCHAETA** Giesbrecht.

From time to time a number of species have been described and included in this genus; as Sars (1925, p. 79) has pointed out, the great majority of these species really belong to other genera. As regards the species known to occur in the Indian Ocean, Thompson (1900, p. 278) recorded the occurrence of *Undeuchaeta major* Giesbrecht from the Indian Ocean and Bay of Bengal, Thompson and A. Scott (1903, p. 244) recorded *U. minor* Giesbrecht (= *U. plumosa* Lubbock) from the Indian Ocean and Cleve (1904 (a), p. 198) reported the occurrence of both these species in the Agulhas Current. Finally A. Scott (1909) records both species in the Malay Archipelago and describes a third, *U. intermedia*, from the same locality.

Several examples of a species of *Undeuchaeta* occur in the "Investigator" collection and a close examination shows that they are closely related to both *U. plumosa* and *U. intermedia* but differ in certain details. They appear to agree with the form described by Esterly under the name *Undeuchaeta bispinosa*, from the San Diego region of the Pacific.

Undeuchaeta bispinosa Esterly.(Text-figs. 47, *a-e* and 48, *a-d*.)*Undeuchaeta bispinosa*, Esterly, 1911, p. 318, pl. xxvi, fig. 4 ; pl. xxix, figs. 48, 56.

Several examples occur at "Investigator" Stations 393 and 670.

♀ Total length ranges from 3.56 to 4.25 mm., the average being 3.88 mm., which is somewhat smaller than Esterly's examples, measuring 4.5 mm.

The proportional lengths of the cephalothorax and abdomen are as 50 to 13, so that the abdomen is contained 3.85 times in the length of the anterior region of the body.

The forehead is rounded and is devoid of any crest ; when viewed in profile it much more resembles the head of *Undeuchaeta plumosa*, as figured by Sars (1925, pl. xxiii, fig. 3), than that of *U. intermedia* (vide A. Scott, 1909, pl. xxiii, fig. 2). The rostrum is well developed and is directed downwards and forwards. The posterior thoracic margin is as a rule very slightly asymmetrical and is in most cases produced backwards on both sides in a sharp point, as in *U. intermedia*, but in a few instances this projection was absent on one side of the body (text-fig. 47, *b*), the margin on the right side of the body being rounded and that on the left pointed, so that these examples agree exactly with the condition described by With (1915, p. 133, text-fig. 35 *b* and *c*) in specimens of *U. plumosa* examined by him. A group of small needle-like spines is situated on the postero-lateral margin in the dorso-lateral region.

The abdomen is composed of four segments, having the following proportional lengths :—

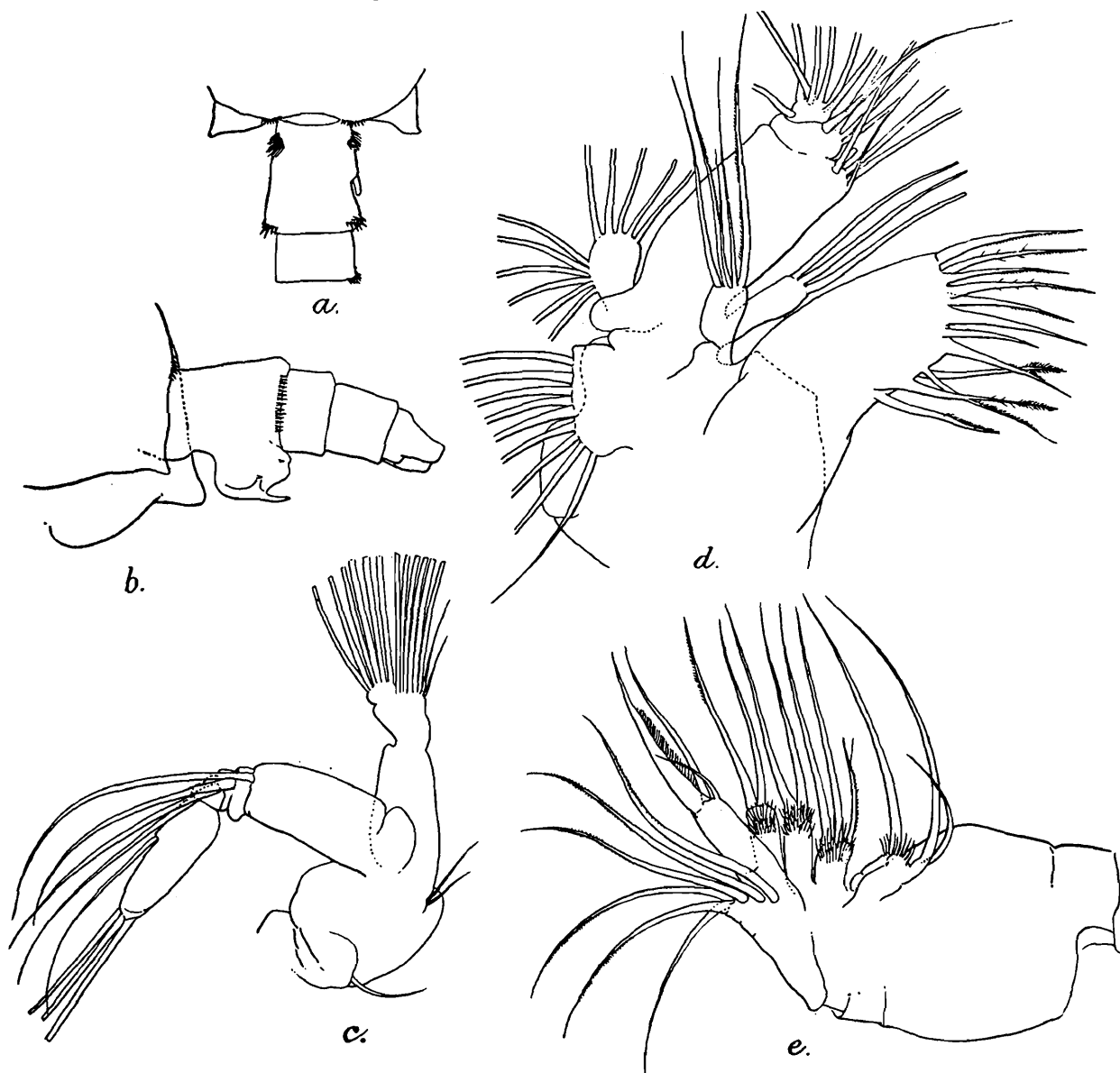
Abdominal segment	1-2	3	4	5	Furca.
	41	21	21	5	12 = 100.

From this it appears that the length of the genital segment in this species is exactly intermediate between that of *U. intermedia* and *U. plumosa*. In the latter species, according to Sars (1925, p. 80) "Le segment genital n'atteint pas la longueur des deux segments suivants reunis." Whereas, according to A. Scott (1909, p. 64) in *U. intermedia* "the genital segment is decidedly longer than the combined length of the next two segments." The genital segment is almost symmetrical but bears on its right side a short, blunt and straight spine or rod. The ventral genital protuberance (text-fig. 47, *b*.) is well marked and at the right side of the genital aperture is a sharp curved spine directed backwards, so that in this respect these examples agree with the description given of *U. intermedia*. On the left side of the genital aperture is a second and much smaller spine, also directed backwards. Scott makes no mention of any such spine in *U. intermedia*, but Esterly (1911, p. 318, pl. xxix, fig. 56) both describes and figures it in *U. bispinosa*. The posterior part of the genital segment is armed on the left side with a band of spines running along the margin and there is a patch of spines in the dorso-lateral region of the right side. A similar, though smaller, patch of spines is situated on the posterior margin of the 2nd segment on the right side (text-fig. 47, *a*).

The 1st antenna reaches back to the posterior thoracic margin and consists of 23 free joints, segments 8 and 9 and 24 and 25 respectively being fused. The proportional lengths of the segments are as follows :—

Segment	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
	66	49	30	30	31	31	34	45	29	30	20	45	43	55	69	62	45	59	54	42	40	42	48 = 1000.

A comparison of the porportional lengths of the segments in the three species of this genus indicates that there are slight differences between them. Giesbrecht has given (1902,



TEXT-FIG. 47.—*Undeuchaeta bispinosa* Esterly, ♀.

a. Posterior thoracic margin and the first two abdominal segments from above.

b. The abdomen from the left side.

c. The 2nd antenna.

d. The 1st maxilla.

e. The 2nd maxilla.

p. 224) the lengths of all the segments except the 1st, in both *Undeuchaeta plumosa* and *U. major*, and from these measurements I have calculated the proportional lengths per 1000 and in the table below I give these lengths in all three species.

Segment	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	
<i>bispinosa</i>	66	49	30	30	31	31	34	45	29	30	30	45	43	55	69	62	45	59	54	42	40	42	48	
<i>plumosa</i>	.	..	47	28	32	32	32	35	47	28	32	28	44	41	50	57	60	44	57	50	41	41	44	41
<i>major</i>	.	..	43	26	26	30	30	30	43	28	30	26	45	38	50	55	58	43	55	48	37	38	43	38

The first segment of the antenna bears a tuft of hairs on the posterior aspect. On the 2nd segment there are two tufts of hair on the posterior aspect and three on the anterior aspect on the proximal side of the base of the proximal three setae.

In the 2nd antenna (text-fig. 47, c) the endopod is comparatively short, being only about one-half the length of the exopod; eight setae arise from the outer lobe and six from the inner. The exopod consists of 7 segments.

The mandible is of the usual type.

In the 1st maxilla (text-fig. 47, *d.*) 12 setae arise from lobe 1 ; lobe 2 bears 4 long setae, of which two are thick and closely resemble the setae arising from lobe 1, and, in addition, a fifth delicate seta ; lobe 3 bears three setae. The basal segment bears 5 setae, endopod 1 bears 4 and endopod 2 and 3 together bear 7. The exopod bears 11 setae, which arise in two groups ; that at the extreme distal end is composed of 5 setae and from the outer margin arise 6. The outer lobe bears 5 large setae and 4 smaller ones.

In the 2nd maxilla (text-fig. 47, *e*) the proximal part of the basal segment is much constricted. Lobe 5 bears a stout serrated spine that is comparatively short, being but little more than the length of the lobe itself.

In the maxilliped the 2nd basal segment is more than twice as long as the first ; the proportional lengths of the various parts of the appendage are as follows :—

1st Basal	24
2nd Basal	55
Endopod	15

The number of setae borne on basal 1 are : lobe 1, 1 ; lobe 2, 2 ; lobe 3, 3 ; and lobe 4, 3. Basal 2 bears one seta about the middle of its length and 2 others at the junction of the third and fourth quarters ; the proximal half of the anterior border is fringed with a row of needle-like spines.

The 1st swimming leg consists of a two-jointed basal part in which both segments are fringed on their inner margins with long hairs ; basal 2 bears the usual inner seta. The exopod consists of only two free segments, segments 1 and 2 being fused, though a trace of the line of division between them can easily be seen. The marginal spine, corresponding to the proximal segment, has been completely suppressed, so the combined segment only bears a single spine at its distal angle. The endopod consists of a single joint with a well-marked swelling on its outer margin which is fringed with a row of small needle-like spines. The outer margin of the segment is fringed with long hairs ; five setae are borne on the margin.

♂ Associated with these females were a certain number of adult males, one at Station 393 and four others at Station 670, as well as several immature forms. The length of these adult examples was 3.62 to 3.69 mm.

These males resemble extremely closely the male of *Undeuchaeta plumosa* as described by A. Scott (1909, p. 62, pl. xxii, figs. 1-8) and by Sars (1925, p. 80, pl. xxiii, figs. 5, 6).

The 1st antenna in my specimens shows a distinct tendency towards the fusion of certain segments. Segments 8 and 9 are completely fused and segments 11 and 12 and 18 and 19 are partially so ; segments 24 and 25 are separate. The proportional lengths of the various segments are as follows :—

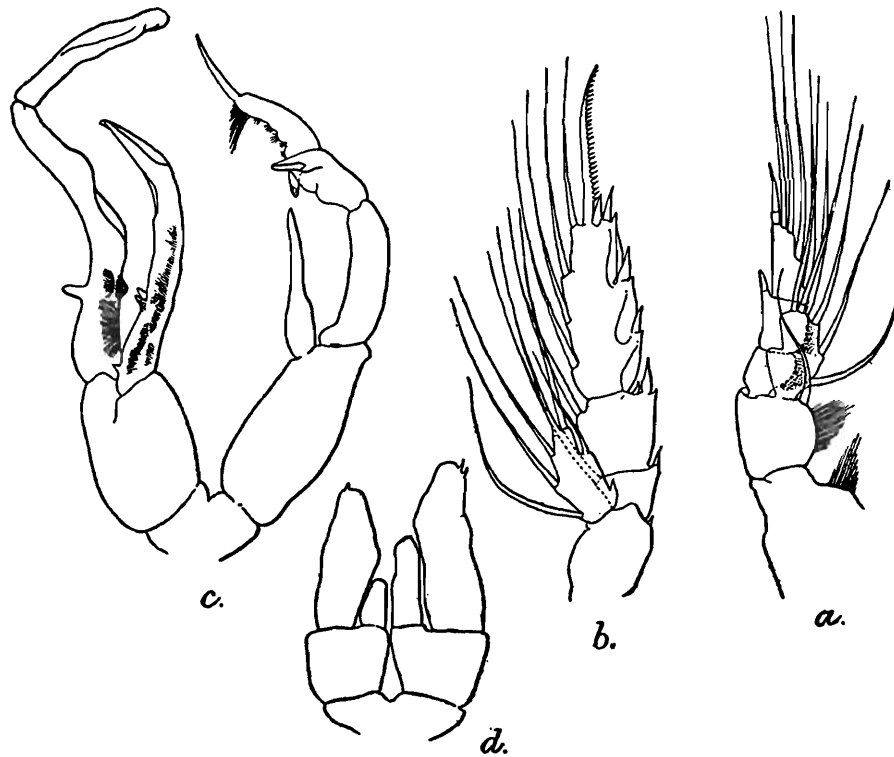
Segments	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	66	53	22	26	26	26	26	70	31	30	40	44	48	57	66	48	66	57	57	46	48	53	44	7

The mouth-parts are much reduced, as in the males of other species of this and allied genera.

The 1st swimming leg (text-fig. 48, *a*) possesses a three-jointed exopod, the lines of division between the segments being clearly visible ; but the proximal segment bears no marginal spine.

The 2nd—4th swimming legs are as in the female.

The 5th pair of legs (text-fig. 48, c) exhibit a close resemblance to the figures given by A. Scott and Sars. A. Scott states that in *U. plumosa* "the exopodite of the right and left



TEXT-FIG. 48.—*Undeuchaeta bispinosa* Esterly, ♂

a. The 1st swimming leg.

b. The 2nd swimming leg.

c. The 5th pair of legs, (adult), from the posterior aspect.

d. The 5th pair of legs (juv.).

foot is three-jointed": in this respect his account differs both from the present specimens and from Sars' figure in which the exopod of the right leg is composed of only two joints. In the right leg the 1st segment of the exopod bears a well-marked spine on its lateral border at about the junction of the proximal and middle thirds, and opposite this there is on the inner aspect a pair of small swellings. The inner aspect of the proximal third of the segment is finely etched with wavy parallel striae. The distal half of the segment is grooved, apparently for the reception of the endopod, which is curved to fit it. In the left leg the endopod reaches to the distal end of the 1st segment of the exopod, whereas in the males figured by Sars and A. Scott it is considerably shorter than this. The 2nd segment of the endopod bears a spinous process at its outer distal angle, and the inner proximal angle of the 3rd segment is produced in a retroverted process.

Genus **PSEUDOCHIRELLA** Sars.

This genus was created by Sars (1920, p. 5) to accommodate certain species that were intermediate in character between the genera *Undeuchaeta* and *Euchirella*, in that they possess a row of spines on the 1st basal segment of the 4th pair of legs in the female, thus resembling examples of the genus *Euchirella*, but differing from that genus in the much greater development of the internal ramus of the 2nd antenna, in which character they approach to the genus *Undeuchaeta*. The form of the 5th pair of legs in the male is another character in which they differ from *Euchirella* and approach *Undeuchaeta*.

In his original account of the new genus Sars included three species, but he has subsequently (1925) transferred to it a large number of other species that had been included by previous authors in the genera *Undeuchaeta*, *Chirundina*, *Gaidius*, *Euchirella* and *Bradyëtes*.

***Pseudochirella notacantha* Sars.**

Gaidius notacanthus, Sars, 1905, p. 9.

Gaidius notacanthus, Farran, 1909, p. 33, pl. iii, fig. 7.

Chirudina notacantha, With, 1915, p. 148.

Pseudochirella notacantha, Sars, 1925, p. 86, pl. xxiv, figs. 7-12.

Pseudochirella notacantha, Farran, 1929, p. 232.

A single example of this species, a female in the final copepodid stage, was taken by the "Investigator" at Station 682. No adult females of this species have as yet been captured and the present immature form agrees so closely with the examples described by previous authors, that I have no hesitation in referring it to this species.

***Pseudochirella cryptospina* Sars.**

Gaidius cryptospinus, Sars, 1905, p. 10.

Gaidius parvispina, Farran, 1908, p. 34, pl. ii, figs. 4-8.

Chirudina parvispina, With, 1915, p. 151, text-figs. 42 *a-g* and 43 *a-h*; pl. v, fig. 1*a*.

Pseudochirella parvispina, Sars, 1925, p. 88, pl. xxiv, figs. 13, 14.

Chirundina parvispina, Farran, 1926, p. 255.

A single specimen of a young female, in the 4th copepodid stage of development, that I take to belong to this species was taken at "Investigator" Station 670.

♀ Total length, 0.9 mm.

The proportional lengths of the cephalothorax and abdomen are as 5 to 1.

The rostrum consists of a single stout spine, directed vertically downwards. The cephalon and 1st thoracic segment are only partially fused, and segments 4 and 5 are separate. The posterior thoracic margin is rounded and bears in the dorso-lateral region a sharp backwardly-directed spine.

The abdomen consists of only three segments, having the following proportional lengths :

Abdominal segment	1	2	3-5	Furca.
	35	22	27	16 = 100.

The furcal rami are as broad as long and the 5th or outermost seta is short and delicate.

The 1st antenna consists of 24 free segments, segments 8 and 9 being fused together; and segments 12 and 13 are also partially fused. The segments have the following proportional lengths ;

Segment	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
	96	37	23	20	23	23	26	40	23	26	28	40	40	45	45	51	45	68	65	48	51	60	60	17 = 1000.

In the 2nd antenna the endopod is about half the length of the exopod. There is a well marked tuft of hairs on the 1st basal segment; basal 2 bears two setae. The exopod consists of 7 segments; segments 1 and 2 are separate. Segment 2 bears a small seta distally and segments 3 to 6 each bear a long seta; exopod 7 bears a seta about the middle of its length

and 3 long setae distally. The 1st segment of the endopod bears a single seta and the 2nd segment bears 7 setae on its inner and 6 on its outer lobe.

The mandible appears to resemble closely that of *Pseudochirella obtusa* Sars (= *Chirundina abyssalis* With) as figured by With (1915, pl. v, fig. 5, b), except that in the present specimen the exopod is slightly longer; the end of the 1st or upper tooth is in the present specimen broken off.

In the 1st maxilla the 1st inner lobe bears 14 setae, the 2nd lobe 3 (?), and the 3rd 4; the 2nd basal segment bears 3 setae; the endopod appears to consist of three segments, of which the 1st and 2nd segments each bear 3 setae and the 3rd bears 6; the exopod bears 9 setae, and the outer lobe 7 large setae and 2 small ones. The general shape of the maxilla is similar to that in examples of the genus *Chirundina*.

In the maxilliped the 2nd basal segment is long and slender and is armed with a row of irregular teeth on the proximal part of the shaft. There is no lamina on the 2nd basal. The 2nd basal segment is nearly twice as long as the 1st, the proportional length being as 13 to 20. Of the segments of the endopod the 2nd is much the longest.

In the 2nd swimming leg the 2nd basal segment is fringed with hairs on its internal margin. The two rami each consist of a single joint; the exopod bears three marginal spines, each of which reaches beyond the base of the next succeeding spine; the endopod presents on its outer margin the usual rounded prominence, which is beset with small spines.

In the 2nd—4th legs the exopod is two-jointed and the endopod consists of a single segment. In both the 2nd and 3rd legs the 1st basal segment is fringed with hair; in the 4th leg this segment possesses a smooth border. In all the legs the 1st segment of the exopod bears a single marginal spine and the 2nd carries 3 spines; in the 3rd and 4th legs the portion of the endopod corresponding to the distal segment bears 6 setae, whereas in the 2nd leg it bears only 5.

Both Sars and Farran, who described this species independently, ascribed it to the genus *Gaidius*; With, however, transferred it to the genus *Chirundina* and Sars finally classes it with his new genus *Pseudochirella*.

***Pseudochirella magna* (Wolfenden).**

(Text fig. 49, *a*, *b*).

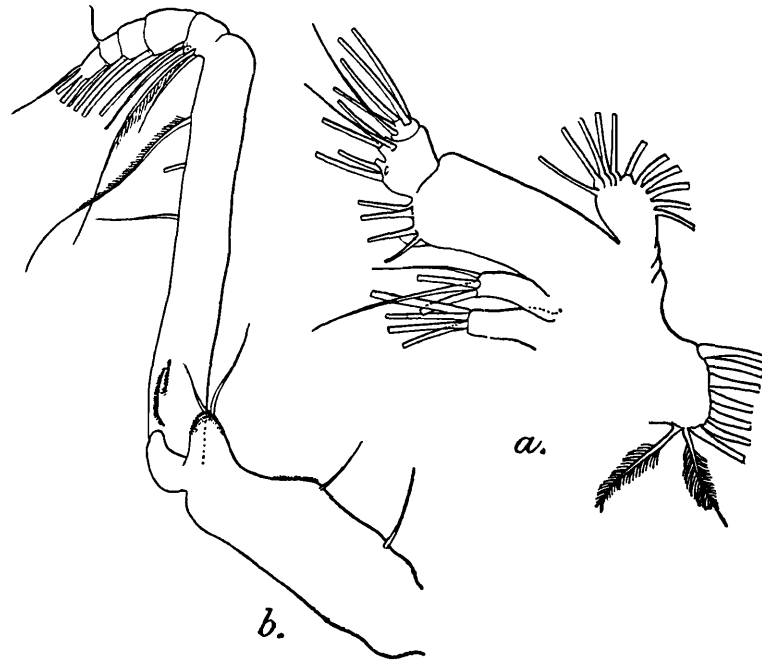
Chirundina magna, Wolfenden, 1911, p. 241, text-fig. 27 and pl. xxviii, figs. 10-13.

This species was described by Wolfenden from specimens taken by the "Gauss" in the tropical and southern parts of the Atlantic Ocean, occurring as far south as Lat. 35°. In the "Investigator" collection from Station 670 are two adults and five immature examples that I have no hesitation in referring to the same species. I have been unable to detect any structural difference between these specimens and Wolfenden's description and figures, except as regards the three-cornered projection that he figures on the left side of the posterior thoracic margin; in both of my adults as well as in all the immature forms the posterior thoracic margin is rounded and is symmetrical. These Indian specimens do not differ materially in size from the "Gauss" examples; Wolfenden gives the length of his specimens as 6.0 to 6.6 mm. and the two mature examples in my collection are 6.2 mm. in length.

The proportional lengths of the segments of the 1st antenna in the adult and the last immature stage (copepodid stage V) 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	
Adult	56	40	20	20	24	24	24	44	24	25	26	36	40	50	50	54	54	73	70	56	76	60	38	16	=1000.
Immature	56	39	18	18	24	24	24	41	22	24	25	32	35	48	48	52	54	75	73	59	82	66	43	18	=1000.

We thus here again have a clear illustration of the manner in which the proportional lengths of the segments of this appendage vary with increasing age. From segment 1 to segment 17 there is an increase in length ; segment 18 is the same length in the two stages of development ; and from segment 19 to 25 inclusive there is a diminution in the length of each segment as the animal passes from the immature to the adult stage.



TEXT-FIG. 49.—*Pseudochirella magna* Wolfenden, ♀.

a. The 1st maxilla.

b. The maxilliped.

The 2nd antenna bears a row of long hairs on the 1st basal segment, as figured by Wolfenden (1911, text-fig. 27, a, p. 242).

In the 1st maxilla (text-fig. 49, a) the 1st lobe bears 13 setae, the 2nd and 3rd inner lobes each bear 4 setae, the basal segment bears 4 and the endopod appears to carry 11 in my examples, 3, 3 and 5 respectively on the three segments. The exopod bears 11 setae and the outer lobe 9, the first two being small.

In the maxilliped (text-fig. 49, b) the 1st basal segment shows a rounded swelling at the proximal end of the posterior margin, but in this species it is smooth and is devoid of spines, such as are present on the corresponding swelling in *Chirundina indica*. The anterior margin is deeply concave between lobes 2 and 3 ; a single seta arises from lobe 2 and at its base and for a short distance on the further side of it the margin is armed with minute spinules. Lobe 3 is somewhat produced and bears 2 setae ; its surface is beset with small spinules. The 2nd basal segment bears a short row of spinules along its anterior margin near the proximal end ; these spinules are set in two or more rows of which those of the most anterior are the larger. The segments of the endopod bear respectively 4, 4, 3, 3, and 4 setae, and in addition a small seta arises from the external aspect of segment 4.

The swimming legs are as described by Wolfenden with this exception, that in the 4th leg in my examples there is a transverse row of hair-like spines running across the posterior aspect of the 1st basal segment; Wolfenden states that in his examples this segment was devoid of spines. A very similar row of spines has been described by Sars (1925, p. 95, pl. xxvi, fig. 9 and p. 96, pl. xxvi, fig. 13) in *Pseudochirella fallax* and *P. dubia* and by A. Scott (1909, p. 59, pl. xiii, fig. 12) in the form that he named *Euchirella granulata* but which is almost certainly a *Pseudochirella*.

As has been pointed out there is but little difference between the genera *Pseudochirella* and *Euchirella*; in the latter genus there is a marked reduction in the number of setae arising from the 2nd basal segment and endopod of the 1st maxilla, and the number of setae in these situations in the present species may be taken as indicating that it belongs to the former rather than to the latter genus. The structure of the 5th pair of legs in the immature male is also quite different from that found in the young stages of *Euchirella* and is much more like that of the genus *Chirundina* and *Undeuchaeta*. The presence of the row of spines on the 4th leg of the female indicates that the species belongs to the genus *Pseudochirella*.

***Pseudochirella obtusa* Sars.**

(Text-fig. 50, *a-d*.)

Undeuchaeta obtusa, Sars, 1905, p. 15.

Euchirella dubia, A. Scott, 1909, p. 60, pl. xiv, figs. 1-7.

Euchirella obtusa, Farran, 1909, p. 40.

Chirundina abyssalis, With 1915, p. 147; text fig. 40 *a-c*; pl. v, figs. *a-f*.

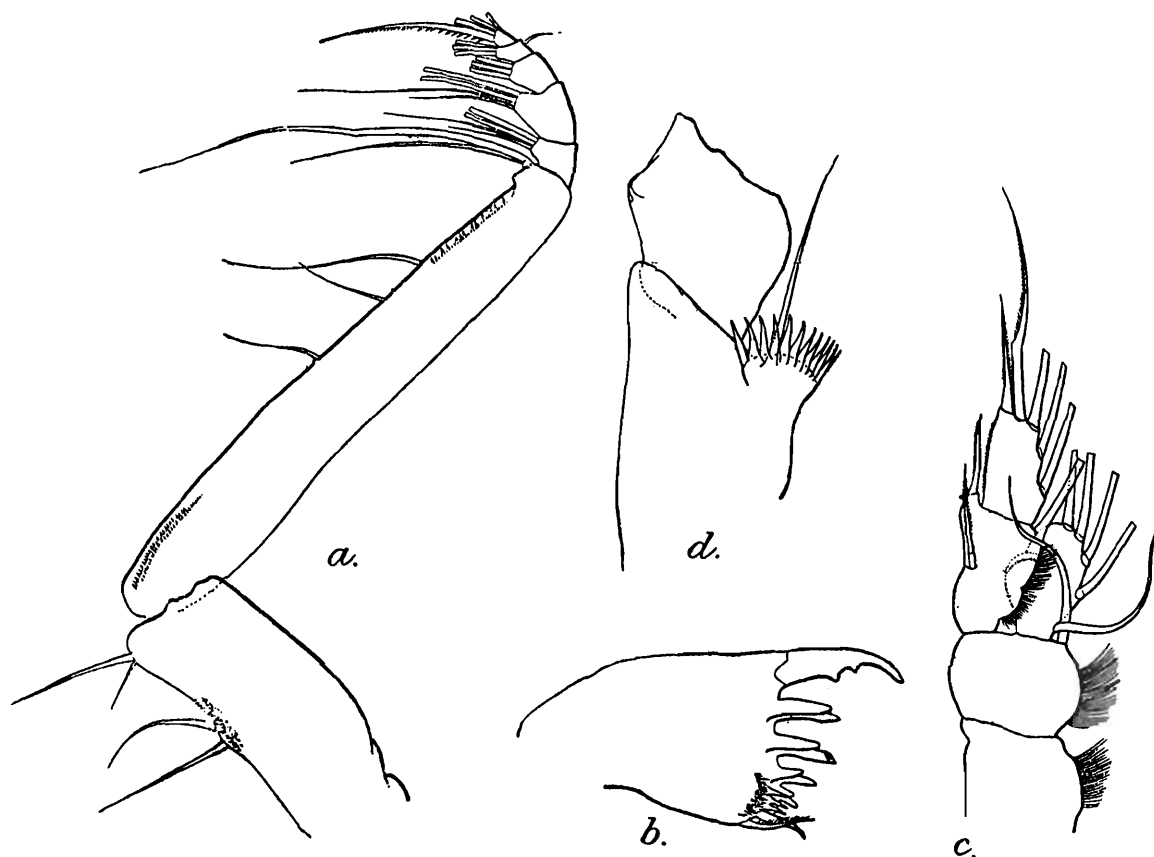
Pseudochirella obtusa, Sars, 1925, p. 83, pl. xxiv, figs. 1-4.

This species was first obtained by the late Prince Albert of Monaco in the Atlantic Ocean and a short preliminary description was published by Sars in 1905. Subsequently, the same species was taken off the coast of Ireland and was transferred by Farran in 1909 from its original genus *Undeuchaeta* to *Euchirella*. With in 1915 removed it once again and included it in the genus *Chirundina* and, finally, Sars (1925) classes it with others in his new genus *Pseudochirella*. In 1909 A. Scott under the name *Euchirella dubia* described a very similar, if not identical, species from the Malay Archipelago, where it had been taken by the "Siboga." So far as I can make out, the only marked difference between *Euchirella dubia* A. Scott and *Pseudochirella obtusa* Sars lies in the length of the 1st antenna. Sars describes this appendage as reaching a little beyond the anterior division of the body; Farran on the other hand states that in his specimens this appendage agrees with Sars' description but he figures it as being considerably shorter, while A. Scott describes it as reaching back to the end of the furca. In the present examples, which were taken by the "Investigator" at Station 682, the 1st antenna reaches back only to the middle of the abdomen, so that they are in this respect intermediate between Farran's and A. Scott's specimens.

The 2nd antenna bears a row of hairs on the 1st basal segment. The endopod bears 7 and 8 setae respectively on the inner and outer lobes.

In the maxilliped (text-fig. 50, *a*) on basal 1 there is a row of small spines along the anterior margin at the point of origin of the setae arising from lobe 2. On the 2nd basal segment there is a short double row of spinules near the proximal end of the anterior margin

and a second double row along the same margin near the distal end ; the characters of the spines and the position of the row agree exactly with the description given by With (1915) in his account of *Chirundina abyssalis* and there can, I think, be no doubt that he was dealing



TEXT-FIG. 50.—*Pseudochirella obtusa* Sars, ♀.

a. The mandible.
b. The maxilliped.

c. The 1st swimming leg.
d. The basal portion of the 4th swimming leg.

with the same species. There are certain differences in the accounts given by the different authors regarding the number of spines on the 1st basal segment of the 4th foot in the female. Sars states that his examples possessed 9 strong spines in this situation, A. Scott states that in his example there were 8 on one side and 10 on the other ; With figures 11 in his account of *Chirundina abyssalis* and in my specimens (text-fig 50, d) there are 12, so that this feature appears to be a variable one.

Family EUCHAETIDAE.

A. Scott (1909) in his report of the collections made in the Malay Archipelago by the "Siboga" separated the genus *Euchaeta* into two, *Euchaeta* (*sensu stricto*) and *Paraechaeta*. In the first genus he includes those forms that agree in structure with *Euchaeta marina* (Prestandreae) and in the second genus he groups all those forms that approximate to *Euchaeta norvegica* Boeck. In differentiating between these two genera Scott calls attention to the fact that "the armature of the spines on the apex of the first maxilliped (2nd maxilla) of the female, and the structure of the male fifth feet in Philippi's type, are decidedly different from what are found in *Euchaeta norvegica* Boeck." As he points out "in the females, two of the six apical spines on the first maxilliped (2nd maxilla), in addition to being furnished with rows of very short spinules, have also a number of moderately long and conspicuous spinules."

In both genera the long spine-like setae that arise from the endopod of the maxilliped are modified at their extreme tips, where the row of minute spinules that arms the whole of the length of the seta become replaced by three or four teeth arranged in a comb, these teeth being much larger and more widely spaced than the spinules. The extreme tip of the seta is rounded and is produced in a short pointed tip. A very similar modification occurs in one of the setae arising from the terminal segment of the 1st antenna in the genus *Pseudodiaptomus*. No other observer appears to have noticed this modification of the maxillipedal setae but I have found it to be present in the following species:—

<i>Euchaeta concinna</i> Dana.	<i>Paraeuchaeta gracillicauda</i> (A. Scott).
<i>Euchaeta media</i> Giesbrecht.	<i>Paraeuchaeta malayensis</i> nom. nov.
<i>Euchaeta tenuis</i> Esterly.	(= <i>Paraeuchaeta barbata</i> A. Scott).
<i>Euchaeta wolfendeni</i> A. Scott.	<i>Paraeuchaeta norvegica</i> (Boeck).
<i>Paraeuchaeta barbata</i> (Brady).	<i>Paraeuchaeta propinqua</i> (Esterly).
<i>Paraeuchaeta bisinuata</i> (Sars).	<i>Paraeuchaeta tonsa</i> (Giesbrecht).
<i>Paraeuchaeta californica</i> (Esterly).	<i>Paraeuchaeta weberi</i> A. Scott.

This modification appears to be confined to these two genera in this family; I have failed to find any trace of it in any member of the genus *Valdiviella*, nor does it occur in the genus *Phaena*.

Genus **VALDIVIELLA** Steuer.

The genus *Valdiviella* was created by Steuer in 1904 to accommodate a new species of copepod that had been obtained during the voyage of the "Valdivia" and which he named *V. oligarthra*. A second species of the same genus was briefly described by Sars in 1905 and more fully described and figured in 1925 under the name *V. brevicornis* and Farran added a third, *V. insignis*, from the west coast of Ireland. Finally a fourth species was described by Wolfenden (1911) from the "Gauss" collection, namely *V. minor*. The males of this genus appear to be comparatively rare and up to the present time only those belonging to *Valdiviella brevicornis* and *V. insignis* have been described.

In his report of the "Challenger" collection Brady, under the name *Euchaeta gigas*, described an immature copepod that A. Scott has shown should rightly be referred to this genus, though, being immature, it cannot be referred to either of the above-mentioned species.

In the "Siboga" collection from the Malay Archipelago there occurred examples of *Valdiviella brevicornis* and an immature form that A. Scott refers to as *Valdiviella gigas*, though as With (1915, p. 154) points out the size alone of Scott's specimen is sufficient to show that it cannot belong to the same species as Brady's example. In the "Investigator" collections all four species are represented and, in addition, there are two immature specimens that correspond to this genus and agree closely in their structure with *V. gigas*. Among this collection are examples of the hitherto unknown male of *Valdiviella oligarthra* Steuer and I attribute the two immature examples also to this species.

In most, if not in all, cases the males of this genus are characterised by possessing short spines on the posterior thoracic margin. A. Scott (1909, p. 78) described the posterior thoracic margin, in the example that he believed to be the male of *Valdiviella brevicornis*, as being "narrowly rounded"; in the "Investigator" collection is an example of what appears to be the same species, but which presents this difference from Scott's description, that the

thoracic margin is armed with a short spine. Scott has called attention to the reduction in the mouth-parts that occurs in the male of *V. brevicornis*; Sars has found the same condition in the male of *V. insignis* Farran and it is also present in my examples of *V. oligarthra* Steuer. It seems clear that this is a generic character and is developed at the final ecdysis, since in the immature examples, as for instance in *V. gigas*, the mouth-parts show the same full development as is found in the mature female. Again, in the mature males the segmentation of the anterior swimming legs is more complete than in the female, the exopod of the 1st pair in all cases consisting of three separate segments in the male, though only two are present in the female. Another interesting feature of the male is the structure of the 1st antenna. In all cases that I have examined the 20th and 21st segments of the appendage of the right side are fused together. In this respect this genus thus approximates to the genus *Euchirella*, in which, as we have already seen (*vide supra*, p. 108), there is great tendency towards the fusion of certain segments, among which are the 20th and 21st, in the 1st antenna of the male and this fusion is usually found on the right side, though in two species it is on the left.

At the present time the position of the genus is in dispute. Both Sars and A. Scott have classed it in the family Euchaetidae; whereas Steuer and With regard it as being a genus of the family Aetideidae.

Valdiviella brevicornis Sars.

Valdiviella brevicornis, Sars, 1905, p. 17.

Valdiviella brevicornis, A. Scott, 1909, p. 78, pl. xxii, figs. 27-35.

Valdiviella brevicornis, Wolfenden, 1911, p. 248.

Valdiviella brevicornis, Sewell, 1913, p. 354.

Valdiviella brevicornis, Sars, 1925, p. 101, pl. xxviii, figs. 11-17.

This species was first briefly described by Sars (1905) from specimens taken by the "Princesse Alice" in the north Atlantic Ocean in two hauls from 3,000 meters to the surface. In his first description Sars gave neither measurements nor figures. A. Scott (1909) attributes to this species a single male that was obtained by the "Siboga" in the Malay Archipelago, and another example of a male that appears to belong to the same species was taken by the "Investigator" at Station 393 at the mouth of the Bay of Bengal and a female at Station 682. As my example of the male differs somewhat from the account given by A. Scott I give a few details regarding its structure.

♂ Total length, 5.0 mm.

The abdomen consists of five segments, having the following proportional lengths:

Abdominal segment	1	2	3	4	5	Furca.
	21	22	22	17	3	15
	= 100.					

The 1st antenna shows the usual tendency to the fusion of certain segments; segments 8 and 9 are completely fused and 9 and 10 partially so; segments 24 and 25 are fused and in the appendage of the right side segments 20 and 21 are completely fused. 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	24-25
	60	45	28	32	40	44	44	77	18	21	27	29	44	50	53	53	61	95	50	61	68	=1000.

The 2nd antenna resembles that of *V. oligarthra*.

The mouth-parts, as in all the males of this genus, are very much reduced. The mandible possesses no biting edge and consists merely of the palp and a rounded basal

plate. The two maxillae are also reduced. The maxilliped is not so greatly affected as the preceding appendages, but it is more slender than in the female and the 1st basal segment bears only a spine-like seta at its distal end, while the 2nd basal is devoid of the row of spines on the anterior margin.

As already pointed out, the segmentation of the swimming legs is more clearly demarcated in the male than in the female.

In the 1st pair of legs the exopod is composed of three distinct segments, having the proportional lengths of 9 : 7 : 8. The endopod consists of only a single segment and reaches to the level of the joint between segments 2 and 3 of the exopod.

In the 2nd leg the exopod is three-jointed, a clear line of division occurring between segments 1 and 2. The endopod consists of a single segment.

In the 3rd and 4th legs both exopod and endopod consist of two segments, the proximal joint in each ramus consisting of the fused 1st and 2nd segments; in both limbs traces of the line of separation between these proximal segments can be detected but this partial separation is much more noticeable in the 4th pair.

The 2nd basal segment of the 2nd, 3rd and 4th legs bears on its outer margin a minute denticle or spine.

In the 5th pair of legs the appendages of the two sides are, as in other males of this genus, somewhat different. In my example the limbs agree exactly with the description and figures given by A. Scott (1909, pl. xxii, fig. 35).

Valdiviella insignis Farran.

(Text-fig. 51.)

Valdiviella insignis, Farran, 1908, p. 45, pl. iii, figs. 1-6; pl. iv, fig. 5.

Valdiviella insignis, Wolfenden, 1911, p. 247, pl. xl, figs. 6 and 7.

Valdiviella insignis, Sewell, 1913, p. 354.

Valdiviella insignis, With, 1915, p. 154, text-fig. 44 *a-d*; pl. vi, fig. 2 *a-e*.

Valdiviella insignis, Lysholm and Nordgaard, 1921, p. 18.

Valdiviella insignis, Sars, 1925, p. 98, pl. xxvii, figs. 1-16; pl. xxviii, figs. 1-10.

Up to the present time this species has only been recorded from various parts of the Atlantic Ocean, in which it has been taken in areas as wide apart as the west coast of Ireland, where it was first obtained, and the south Atlantic between Lat. 10° and 23° S.

Six females and two males were taken by the "Investigator" at Station 393, thus extending its known range to the Indian Ocean.

Sars has given a short account of the male and has figured it comparatively fully, but as he gives but little detail of the structure of the various appendages I have thought it well to include a full account of this sex here.

♂ Total length=8.7 mm.

The proportional lengths of the cephalothorax and abdomen are as 33 to 12, so that the abdomen is contained 2.75 times in the length of the anterior region of the body.

The head and 1st thoracic segment are fused and thoracic segments 4 and 5 are partially fused. The posterior thoracic margin is rounded and is armed with a short backwardly directed spine.

The abdomen consists of five segments having the following proportional lengths :

Abdominal segment	1	2	3	4	5	Furca.	
	18	25	24	17	5	11	=100.

Segments 2, 3 and 4 are armed across the dorsal aspect with a row of small spines on the posterior margin. I could not detect any tufts of hairs on the ventral aspects of any of the segments.

The 1st antenna reaches back nearly to the posterior thoracic margin. On both sides segments 8 and 9 are completely and 9 and 10 partially fused, and segments 24 and 25 are completely fused. The proportional lengths of the antennal segments are as follows :

Segment	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	
	44	30	22	30	38	38	38	48	14	18	20	26	30	50	65	71	63	73	65	57	50	50	80	=1000.

The mandible shows a complete absence of any biting jaw ; the 2nd basal segment and the two rami appear to be identical with those of the female.

The 1st maxilla is much reduced. The setae on the lateral lobes have been completely suppressed. The endopod bears 3 setae and the exopod carries 11, of which one is quite short.

The 2nd maxilla is also much reduced. Lobes 1, 2 and 3 are small and are devoid of setae ; lobe 4 bears 2 setae, one of which is very small ; and lobe 5 carries one seta and 2 spines. The endopod bears 5 setae.

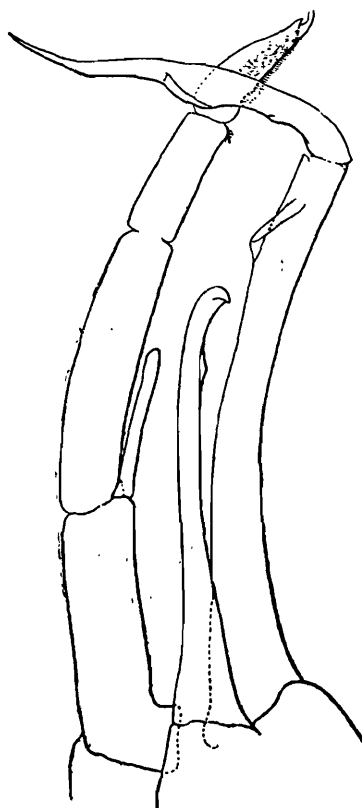
The maxilliped is not nearly so strong or well developed as in the female. The 1st basal segment is devoid of all setae ; it has at its distal extremity a short spinous process and the rounded margin at the base of the spine is beset with a patch of short spinules. The 2nd basal segment bears on its anterior margin three setae which increase in length and size, and at the extreme end a single seta arises. The fringe of hair-like spines that is present on the proximal part of the anterior margin in the female is absent in this sex. The endopod consists of five segments bearing the following number of seta, 3, 3, 2, 2 and 3, on the 1st to 5th segments respectively.

The 1st swimming leg differs from the corresponding appendage in the female in that there is a clear separation of the 1st and 2nd segments of the exopod. In this sex also a gland opens on the margin of segments 2 and 3, as With (1915, p. 155, pl. vi, fig. 2a) has described in the female.

In the 2nd swimming leg a trace of the line of separation between segments 1 and 2 of the exopod can be made out.

The 3rd and 4th pairs of legs resemble those of the female.

The 5th pair of legs (text-fig. 51) shows the same general structure as A. Scott (1909, p. 78) has described in the case of the male of *V. brevicornis*. My observations on this pair of legs differ somewhat from the account given by Sars (*loc. cit.*, 1925). In the right leg the exopod consists of two separate segments. The proximal segment is very long and tapers somewhat towards the distal end. About one-fifth of its length from the distal end this segment bears a projecting triangular plate



TEXT-FIG. 51.—*Valdiviella insignis*
Farran.
The 5th pair of legs, ♂

that is hollowed out into a groove. The distal segment tapers to a flexible point and about half way along it there is a projecting lamella that corresponds to the groove on the proximal segment. The two segments are completely separate and appear to be freely movable on each other, and it appears probable that, when the distal segment is fully flexed, the lamella on the distal segment fits into the groove on the proximal segment and thus forms a very efficient grasping organ. In the left leg the exopod consists of three segments of which the 1st is equal to half the length of the whole ramus and is cylindrical. The two distal segments are subequal in length. At the distal end of the inner margin of segment 2 there is a small rounded projection that is fringed with hairs. The terminal segment tapers to a flexible point and a short distance on the proximal side of it is a sharp triangular point or spine; the inner aspect of the segment is thickly fringed with short hairs. In this species the endopod of the right leg extends well beyond the distal end of the endopod of the left leg.

Valdiviella ignota, sp. nov.

(Text-fig. 52, a, b.)

At Station 393, along with undoubted examples of *Valdiviella insignis* Farran, the "Investigator" obtained a single example of what appears to be either a small form of the above species or else a hitherto-unknown form.

♂ The total length of this specimen was only 6.5 mm., whereas the male of *V. insignis* measures 8.7 to 9 mm.

The proportional lengths of the cephalothorax and abdomen are as 250 to 97, so that the abdomen is contained 2.6 times in the length of the anterior region, instead of 2.75 times as in *V. insignis*.

The head is very like that of *Valdiviella insignis*; at the extreme anterior end is a small projection which bears a pair of minute hairs. The rostrum is, however, not so strong. The posterior thoracic margin is produced backwards in a flap that covers half the length of the 1st abdominal segment, and at the postero-dorsal angle of this flap is a small spine that is directed backwards and upwards. The head and 1st thoracic segment are fused but traces of the line of fusion can be seen. Thoracic segments 4 and 5 are fused.

The abdomen consists of five segments, having with the furca the following proportional lengths:—

Abdominal segment	1	2	3	4	5	Furca.
	21	28	19	16	3	13

= 100.

Segments 2, 3 and 4 are armed across the dorsal aspect with a row of fine spines that runs along the posterior margin. The furcal rami are divergent and the outer seta is extremely small.

The 1st antenna reaches back to the posterior thoracic margin. As in other males, the 8th and 9th segments are completely fused and there is a partial fusion of the 10th segment also. The 24th and 25th segments are fused. The proportional lengths of the segments are as follows:

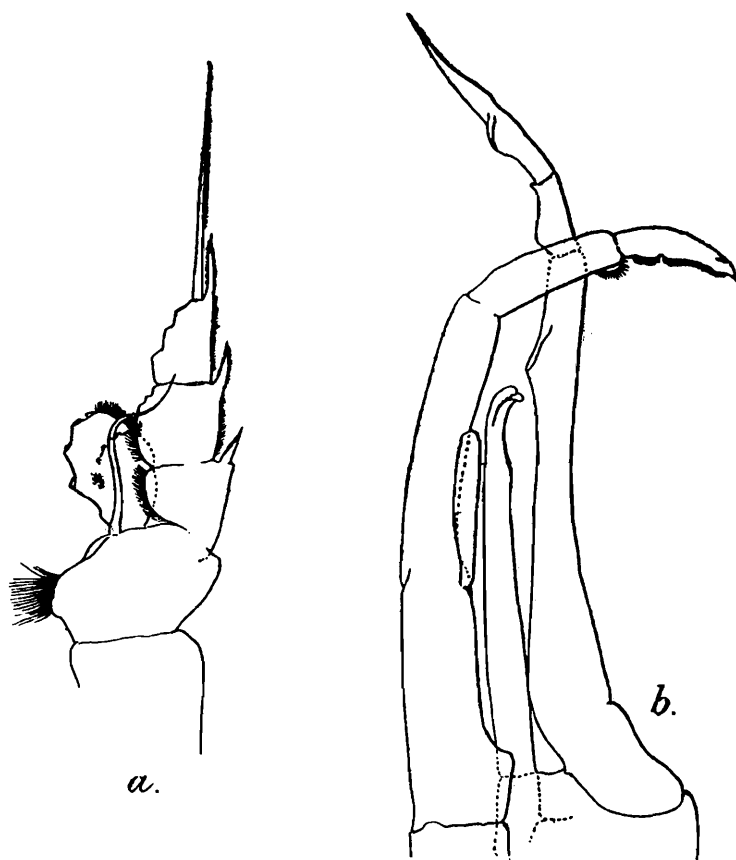
Segment	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24-25
	45	38	23	32	38	38	38	47	15	17	19	25	29	48	64	70	64	72	65	57	48	51	57

= 1000.

The 2nd antenna resembles that of *Valdiviella insignis* and *V. oligarthra*. The 1st basal segment bears a row of long hairs.

As in other males the mouth-parts are reduced. In the mandible the biting process has been completely suppressed; the 2nd basal segment bears no seta; the exopod bears 8 setae on its terminal segment and the endopod, which is composed of 4 segments, bears 6, one on each of the three first segments and 3 on the distal joint. In the 1st maxilla the biting lobe is reduced and bears no setae; the inner lobe is also devoid of setae; the 2nd basal segment carries 2 very small setae and the endopod 3 comparatively long ones; the outer lobe bears 11 setae of which the 1st is very small.

The 2nd maxilla and maxilliped are as in *V. insignis*.



TEXT-FIG. 52.—*Valdiviella ignota*, sp. nov. ♂.

a. The 1st swimming leg.

b. The 5th pair of legs.

In the 1st swimming leg (text-fig. 52, a) both basal segments are fringed on their inner margins with long hairs; basal 2 bears a seta at its distal inner angle. The exopod consists of three segments but the line of separation between the 1st and 2nd segments is incomplete. The endopod consists of a single segment; on the outer margin there is a rounded swelling that extends across the surface of the segment and on the margin of this swelling four glands appear to have their orifices; there is a small patch of minute hairs on the surface.

The other swimming legs resemble those of *V. insignis*.

The 5th pair of legs (text-fig. 52, b) closely resembles that of *V. insignis*.

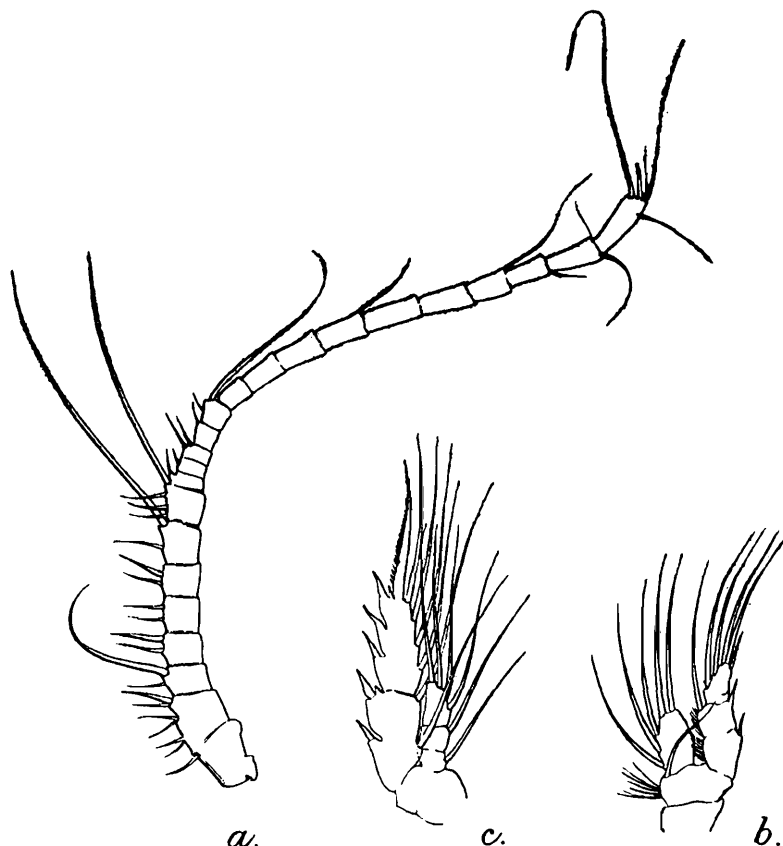
While agreeing very closely with *V. insignis* this specimen appears to differ in certain particulars, especially as regards size. The posterior thoracic margin also seems to be different and there is some difference in the proportional lengths of the abdominal segments.

Valdiviella minor Wolfenden.(Text-fig. 53, *a-c.*)*Valdiviella minor*, Wolfenden, 1911, p. 249, pl. xxix, figs. 8-11.

This species was first described by Wolfenden from a single specimen taken by the "Gauss" in the south Atlantic Ocean in about Lat. 11° S. at a depth of 1,200 metres. Two specimens that agree closely with Wolfenden's description and figures were taken by the "Investigator" at Station 393, between 400 fathoms and the surface. Both these examples are females.

♀ Total length, 4.0 mm. Wolfenden gives the length of the Atlantic specimens as 4.3 mm.

The head and the 1st thoracic segment are completely fused but traces of the line of fusion of the 4th and 5th thoracic segments can be detected. The posterior thoracic margin is rounded.

TEXT-FIG. 53.—*Valdiviella minor* Wolfenden, ♀.*a.* The 1st antenna.*b.* The 1st swimming leg.*c.* The 4th swimming leg.

The proportional lengths of the cephalothorax and abdomen are as 88 to 47, so that the abdomen is rather more than half the length of the anterior region.

The abdomen consists of 4 segments, which have the following proportional lengths :

Abdominal segment	1-2	3	4	5	Furca.
	35	23	19	9	14 = 100.

The 1st segment is crossed on its dorsal aspect by a thickened ridge of chitin ; the 1st, 2nd and 3rd segments are all armed across their dorsal aspect with rows of fine spines running along the posterior margins.

The 1st antenna (text-fig. 53, *a*) reaches to a little beyond the posterior margin of the 1st thoracic segment. Wolfenden is, I think, mistaken in saying that this appendage has only 20 separate segments; the 8th and 9th are fused, as in other members of the genus, and so also are the 24th and 25th. The 10th, 11th and 12th segments are very short but the lines of division between them can be clearly made out. The proportional lengths of the segments are, according to my observations, as follows:—

Segment	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	
	66	50	35	30	35	40	35	45	15	15	20	30	30	35	51	51	56	71	66	56	51	56	61	=1000.

The 2nd, 4th, 6th and 8th segments are armed with a single spine each.

The 2nd antenna and mouth-parts closely resemble those of *V. oligarthra*. The 1st pair of swimming legs (text-fig. 53, *b*) show a distinct trace of division between the 1st and 2nd segments of the exopod and each part is armed with a marginal spine.

The 2nd pair of legs, as noted by Wolfenden, shows also a line of demarcation between the 1st and 2nd segments of the exopod and similar traces of the line of separation between the 1st and 2nd segments of the endopod can equally be detected. The 2nd basal segment is armed on its outer margin with a small spine.

In the 3rd leg the proximal segments of the exopod are completely fused but the endopod consists of three segments, the division between the 1st and 2nd segments being quite clearly marked, if not actually functioning as a joint.

In the 4th pair of legs (text-fig. 53, *c*) the two proximal segments of the exopod are incompletely fused and again the endopod consists of three segments.

As in other members of the genus the 5th pair of legs is missing in this sex.

Valdiviella oligarthra Steuer.

(Text-fig. 54, *a*, *b*.)

Valdiviella oligarthra, Steuer, 1904, p. 593.

Valdiviella oligarthra, Wolfenden, 1911, p. 247.

Valdiviella oligarthra, Sewell, 1913, p. 354.

The adult female of this species was described by Steuer from material obtained by the "Valdivia" and subsequently Wolfenden obtained examples among the Copepoda taken by the "Gauss." Several examples of the female were taken by the "Investigator" at Stations 393 and 682; these agree closely with the description given by Steuer; it is, therefore, unnecessary for me to discuss the structure of the adult female, suffice it to say that the "Investigator" specimens were slightly smaller, as is usually the case, than those taken in other areas, their total length measuring only 7.2 mm. Among these females was an example of what I believe to be the hitherto-unknown male.

♂ Total length, 6.2 mm.

The proportional lengths of the cephalothorax and abdomen are as 53 to 25, so that the abdomen is a little less than half the length of the anterior region of the body.

The rostrum consists of two stout divergent points. The head and 1st thoracic segment are fused together but the line of fusion can be seen running across the dorsal aspect. The 4th and 5th segments are also fused. The posterior thoracic margin is rounded and bears a small backwardly-directed spine.

The abdomen consists of five segments having the following proportional lengths :

Abdominal segment	1	2	3	4	5	Furca.
	18	28	20	16	3	15 = 100.

Segment 5 is almost completely telescoped into segment 4. Segments 2, 3 and 4 are all armed with a row of small spines that runs across the posterior margin on the dorsal side.

In the 1st antenna the length of the various segments differs slightly on the two sides of the body, as also does the degree of fusion of certain of the segments. In the table below I give the proportional lengths of the segments in the two appendages :—

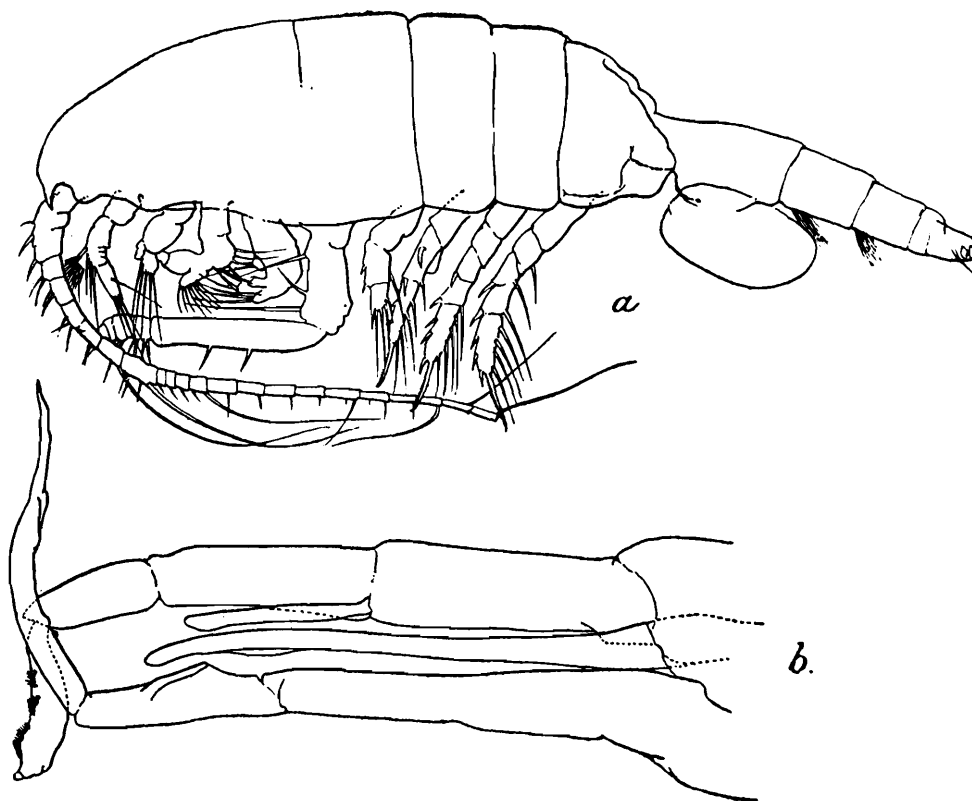
Segment	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17	18	19	20-21	22	23	24-25	
Right	60	34	23	30	38	45	45	62	15	21	27	27	34	49	59	63	59	68	97	43	46	55 =1000.	
Left	54	36	24	31	41	43	45	60	18	21	24	27	33	47	58	62	62	63	59	47	44	45	56 =1000.

In both cases the 8th and 9th segments and the 24th and 25th respectively are fused, and on the right side the 20th and 21st are fused in addition.

In the 2nd antenna the general structure closely resembles that of the corresponding appendage in *Valdiviella insignis* Farran ; the endopod bears 6 setae on its inner lobe and 7 on its outer.

The mandible is devoid of any biting edge. The endopod bears 6 setae and the exopod carries 9 setae, of which two are very short, on its second segment and none on its first.

The 1st maxilla is much reduced. The outer lobe bears 11 setae of which the 11th is very short, and the endopod 3 setae ; all the other parts are devoid of setae.



TEXT-FIG. 54.—*Valdiviella oligarthra* Steuer.

a. The whole animal from the left side, ♀.

b. The 5th pair of legs, ♂.

The 2nd maxilla is also vestigial ; in the basal segment the first three lobes are reduced to mere prominences devoid of setae ; the 4th and 5th lobes bear two setae each. The endopod carries 5 setae.

The maxilliped is as in the male of *V. insignis*. Basal 1 bears a short spine-like seta situated on a round prominence at the distal end and the base of this prominence is beset with small spines. Basal 2 bears three setae on its anterior margin and one at its distal end; the row of needle-like spines along the proximal part of the anterior margin, that is seen in the female, has completely disappeared. The segments of the endopod bear the same number of setae as in *V. insignis*, namely 3, 2, 2, 2 and 3 on the five segments respectively.

In the 1st swimming leg there is a distinct line of demarcation between segments 1 and 2 of the exopod, though the jointing appears to be incomplete. In the exopod there is a gland opening on the margin of both the 2nd and 3rd segments, exactly corresponding to the condition described by With (1915, pl. vi, fig. 2a) in *V. insignis*. The endopod consists of a single segment and a series of glands open along the ridge of the swelling on the posterior aspect, as in *V. insignis* and *V. ignota*.

In the 2nd swimming leg the 1st and 2nd segments of the exopod are fused; the endopod consists of a single segment and in the distal third a gland opens on the posterior aspect, the opening being surrounded with short hairs. With has also described a similar gland in *V. insignis* (*loc. cit.*, text-fig. 44, b).

In both the 3rd and 4th swimming legs the 1st and 2nd segments of the exopod are fused; the endopod consists of two joints, the 1st and 2nd segments being fused; the 3rd segment bears a gland opening on its posterior aspect and the surface is beset with short hairs.

The 5th pair of legs (text-fig. 54, b) closely resemble those of *Valdiviella insignis*, but show certain differences in detail. In the right leg the endopod reaches well beyond the triangular lamella and extends even beyond the joint between the 1st and 2nd segments of the exopod of the left leg, whereas in *V. insignis* it is much shorter than this. In the left leg the endopod is also much longer than in *V. insignis* and instead of being only about half the length of the 1st segment of the exopod is nearly as long as that segment.

“*Valdiviella gigas* (Brady).”

(Text-fig. 55, a-e).

Valdiviella gigas, Sewell, 1913, p. 354.

Brady, under the name *Euchaeta gigas*, described a species of Copepod obtained by the “Challenger” in the south Atlantic Ocean, and more recently A. Scott (1909) has ascribed certain examples taken by the “Siboga” to the same species, although his examples were very much larger in size, measuring 8.0 mm. in length, whereas Brady’s specimen only measured 5.0 mm. T. Scott (1894) also attributed certain examples obtained by the “Buccaneer” in the Gulf of Guinea to the same species, but in this he was undoubtedly mistaken. I have examined T. Scott’s specimen, that is preserved in the British Museum (Natural History), and it is undoubtedly an example of a *Gaetanus*. Of the specimens examined by him, Brady (*loc. cit.*, p. 66) remarks, “Very few specimens were seen and I am not quite certain as to the sex of some of these”; in one example a 5th pair of legs was present and as this individual also possessed a well developed mandible Brady admitted that the species would probably have to be referred to a different genus. A. Scott (1909),

pointed out that this species really belongs to the genus *Valdiviella* Steuer, but he has made the mistake of assuming that the "Siboga" example was a female, although the presence of a rudimentary pair of 5th legs should have prevented this. He remarks "The specimen was evidently a female and no doubt the rudimentary fifth pair of legs would disappear at the final ecdysis."

In the "Investigator" collection are several examples of immature stages of development of a species of *Valdiviella*, both sexes being present, and a comparison of these forms with Scott's and Brady's descriptions leaves no doubt in my mind that Scott's example is an immature male and that both forms clearly belong to the genus *Valdiviella*, though, as With points out (1915, p. 154), they cannot be referred to the same species owing to the great discrepancy in their size, Brady's specimen being much the smaller.

Copepodid Stage IV. From Station 682.

♀ Total length, 4.5 mm.

The proportional lengths of the cephalothorax and abdomen were as 33 to 15, so that the abdomen was a little less than half the length of the anterior region of the body.

The forehead is rounded and terminates below in a pair of short and stout rostral spines that are directed vertically downwards. The cephalon and 1st thoracic segment are partially fused, though the line of separation can be clearly made out; a similar condition is present as regards the 4th and 5th thoracic segments. The posterior thoracic margin is rounded and bears at the middle of the curve a small back wardly-directed spine.

The abdomen consists of only three segments that have the following proportional lengths:

Abdominal segment	1	2	3-5	Furca.
	21	28	32	18
	= 100.			

Segment 2 is armed with a row of small spines that runs across the dorso-lateral aspect of the posterior margin.

The 1st antenna reaches back to about the posterior margin of the 3rd thoracic segment. It consists of 23 free joints, segments 8 and 9, and 24 and 25 respectively being fused. The proportional lengths of the segments are as follows:

Segment	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
	66	34	29	29	41	41	33	41	12	15	19	27	27	37	46	55	56	71	68	56	60	62	75
	= 1000.																						

Segments 5, 15, 20 and 25 bear sensory organs.

In the 2nd antenna the endopod is about one-half the length of the exopod. The 1st basal segment bears a row of long hairs. Basal 2 carries a single seta. In the exopod the 1st segment is without a seta, segment 2 is only imperfectly separated from segment 3 and segments 3, 4, 5 and 6 each bear a long seta, the terminal segment bears three setae at its distal end. The endopod bears on its second segment 5 and 6 setae on the inner and outer lobes respectively.

The 1st maxilla is well developed; the 1st inner lobe is armed with 11 setae; the 2nd inner lobe bears 2 and the 3rd also 2. The 2nd basal segment bears only 2 setae and the endopod only three. The exopod bears 7 setae and the outer lobe 9.

In the 2nd maxilla there appear to be only four lobes; the 1st lobe appears to be missing. The 2nd lobe (*i.e.*, the most proximal) bears 3 setae, the 3rd and 4th each bear 2 and the 5th lobe, which is considerably the largest, bears 3; the endopod bears 5. There is a patch of hairs on that portion of the posterior margin of the segment that corresponds to lobe 5.

In the maxilliped, in basal 1 lobe 1 bears 2 setae and the other two lobes bear 3 each. Basal 2 bears 3 setae along its anterior margin and a row of hair-like spines runs along the proximal half of the

margin; 2 long setae arise from the extreme distal extremity of the segment. The endopod consists of 5 segments, of which the 1st bears 2 long equal setae, the 2nd 2 unequal setae, the 3rd and 4th 1 long seta each and the 5th carries 2 long and 2 short setae.

In the 1st swimming leg the basal part consists of two segments; basal 2 bears a seta at its distal inner angle and is fringed with a row of hairs along its inner margin. Both rami consist of only a single segment; the exopod bears three serrated marginal spines, the proximal pair being stout and sub-equal and the distal about twice as long; a slight notch in the inner margin indicates the limits of segments 1 and 2. The endopod shows a slight rounded projection on the outer margin and bears 5 setae.

In the 2nd swimming leg basal 1 bears an inner seta and basal 2 exhibits a small spine-like projection on its outer margin. Both rami are single-jointed. The exopod bears 4 marginal spines that are fringed with short hairs, but are not serrated; between spines 1 and 2, and 2 and 3 the outer margin is hairy, but between spines 3 and 4 the margin is produced in a thin keel-like plate with a reticular structure. The endopod bears 6 setae.

The 3rd swimming leg resembles the 2nd, but the endopod bears 7 setae instead of 6.

The 4th swimming leg resembles the 3rd, but has no seta on the inner margin of the proximal part of the exopod that corresponds to segment 1 of the limb; in both the 2nd and 3rd legs there is a single seta of rather smaller size than the others in this situation.

The 5th leg is entirely absent.

The absence of any trace of a 5th pair of legs would appear to indicate that this example is a female, but the presence of small spines on the posterior thoracic margin introduces the possibility that it may be a male in which the 5th pair of legs has not yet commenced to develop.

Copepodid Stage V. From Station 393.

♂ Total length, 6.0 mm. to 6.4 mm.

The proportional lengths of the cephalothorax and abdomen are as 67 to 34, so that in this case the abdomen is slightly longer than half the length of the anterior region.

The cephalothorax is oval in shape. The cephalon and 1st thoracic segment are fused but the line of demarcation between them can be seen; the 4th and 5th thoracic segments are separate. The posterior thoracic margins are produced in a small sharp triangular spine.

The abdomen consists of 4 segments having the following proportional lengths:

Abdominal segment	1	2	3	4-5	Furca.
	19	25	23	20	13
	= 100.				

Both the 2nd and 3rd segments are armed across the dorsal aspect of the posterior margin with a row of small spines. I was unable to detect any tufts of hairs on the ventral aspects of the segments.

The 1st antenna reaches to the posterior margin of the 2nd thoracic segment, as in *Valdiviella oligarthra* Steuer. The proportional lengths of the various segments are as follows:

Segment	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
	61	40	32	32	43	40	39	40	11	11	14	25	29	43	51	61	65	76	68	58	50	50	58
	= 1000.																						

The 8th and 9th segments are fused together, as also are the 24th and 25th. The proximal 5 segments are fringed along their posterior margins with hair.

The 2nd antenna agrees exactly with that of *Valdiviella insignis* Farran and *V. oligarthra* Steuer.

The mouth-parts at this stage of development show but little trace of degeneration. The mandible is apparently devoid of a biting edge, but this is the only portion of the mouth-parts that is absent; the basal segment of the mandibular palp bears a curved seta and a small straight spine-like seta about the middle of its length. The exopod is composed of 5 segments, of which the proximal four segments bear one seta each and the distal segment carries a pair. The endopod is 2-jointed, the proximal segment bearing 2 setae and the distal 8 (? 9).

The 1st maxilla (text-fig. 55, *a*) appears to have the same structure as in the adult female of *Valdiviella oligarthra* Steuer; as in that species, the outer lobe bears 7 setae of which the third is much thicker than the others.



TEXT-FIG. 55.—*Valdiviella gigas* Brady (? =immature stages of *V. oligarthra* Steuer); Copepodid Stage V.

a. The 1st maxilla.

c. The 1st swimming leg.

b. The maxilliped.

d. The 2nd swimming leg.

e. The 5th pair of legs, ♂.

The 2nd maxilla and the maxilliped (text-fig. 55, *b*) closely resemble the corresponding appendages in the adult females of *Valdiviella insignis* and *V. oligarthra*.

The swimming legs also are the same as in the adult females; in the 1st pair of legs (text-fig. 55, *c*) the exopod consists of only two segments and the endopod of a single segment, whereas in the adult males that have so far been examined the exopod invariably possesses three joints. In the 2nd pair of legs (text-fig. 55, *d*) the exopod also consists of only two free segments and the endopod of a single segment.

The 5th pair of legs (text-fig. 55, *e*) agree closely with the figures given by Brady and A. Scott, and differ slightly from the figure given by With (1915, text-fig. 44 *a*) of this appendage in the corresponding stage of development of *Valdiviella insignis* Farran.

It seems certain that this form is an immature male that has yet to undergo its final ecdysis before it will attain the characters of the adult. In this final moult the mouth-parts will become markedly degenerate and at the same time the swimming legs will undergo a progressive change; the segmentation of the 1st pair of legs will be completed and the exopod will assume its adult form of three free segments, instead of only two; while at the same time the 5th pair of legs will attain the adult type.

The only question that remains for consideration is that of the specific identity of this form, and of the smaller form in the 4th copepodid stage of development. *Valdiviella insignis* Farran and *V. oligarthra* Steuer are so alike in their general structure that one has but little

evidence on which to base any conclusions. As Farran (1908, p. 45) has pointed out, there are, however, differences between these two species in the proportional lengths of the segments of the 1st antenna. The length of these segments in the two immature specimens that we have been considering approximates more nearly to those of the segments in the adults of *Valdiviella oligarthra* Steuer and for the purpose of comparison I have given below the lengths in both adult and immature forms:

Segment	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
♀																							
Stage IV	66	34	29	29	41	41	33	41	12	15	19	27	27	37	46	55	56	71	68	56	60	62	75
Adult	64	34	33	33	38	38	33	41	12	15	18	29	31	40	59	65	63	72	68	52	50	52	59
♂																							
Stage V	61	40	32	32	43	40	39	40	11	11	14	25	29	43	54	61	65	76	68	58	50	50	58
Adult	54	36	24	31	41	43	45	60	18	21	24	27	33	47	58	62	62	63	59	47	44	45	56

I am of the opinion that the two stages are immature forms of *Valdiviella oligarthra*, the smaller form being an immature female and the larger form an immature male.

In the absence of any measurements of the antennal segments in both Brady's and A. Scott's examples it is impossible to assign them definitely to any particular species, but from their respective sizes it appears probable that Scott's form, measuring 8.0 mm. in length, belongs to *Valdiviella insignis* Farran, while Brady's specimen having a length of only 5.25 mm. may be an immature form of *V. oligarthra* Steuer.

Genus **EUCHAETA** Philippi.

At the present time eleven species belonging to this genus have been recorded from the Indian Ocean. In 1900 Thompson recorded the occurrence of *Euchaeta marina* Prestand. from the Indian Ocean and Bay of Bengal and a year later Cleve (1901) recorded *E. concinna* Dana and *E. longicornis* Giesbrecht from the Malay Archipelago. Thompson and A. Scott (1903) added *E. spinosa* Giesbrecht to the list of species known to occur in these waters and Cleve (1904 (a)) in his report on the Copepoda of the African coast added *E. acuta* Giesbrecht, *E. affinis* Cleve, *E. media* Giesbrecht, and *E. tonsa* Giesbrecht. Finally, in 1909 A. Scott added *E. tenuis* Esterly and *E. wolfendeni* A. Scott.

Euchaeta concinna Dana.

Euchaeta concinna, A. Scott, 1909, p. 65, pl. xix, figs. 21-27.

Euchaeta concinna, Wolfenden, 1911, p. 299.

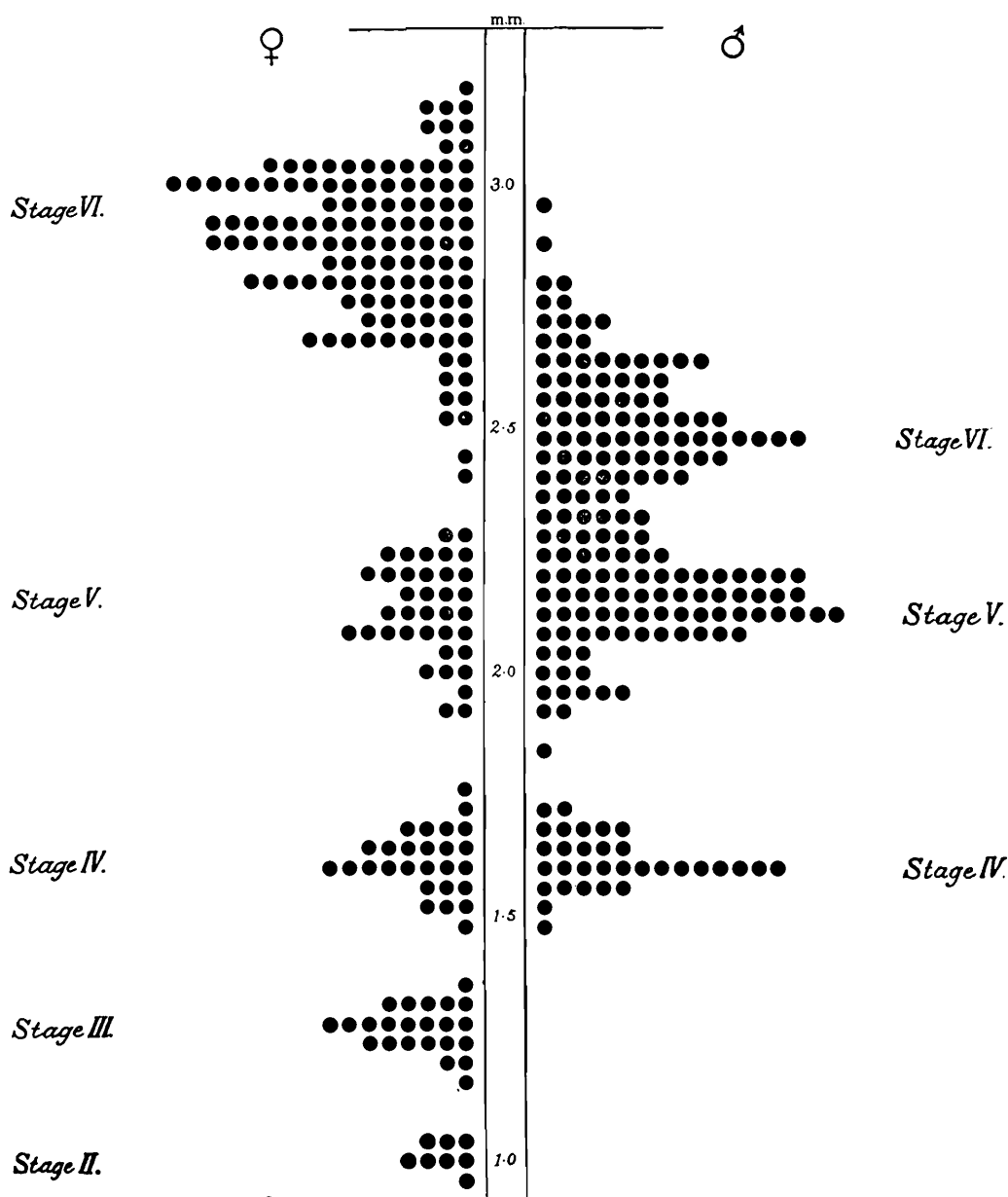
Euchaeta concinna, Sewell, 1912, p. 360.

Euchaeta concinna, Sewell, 1914, p. 216.

Probably this is the most common species of the genus in Indian waters. It has already been recorded from the Malay Archipelago, the Burma coast and the Pearl Banks of Ceylon. In the "Investigator" collections it occurs at the following Stations, frequently in large numbers, Station 547, 555, 556, 558, 559, 561, 562, 563, 575, 578, 580, 582, 614 and 672.

The tow-netting from Station 555* contained numerous examples of *Euchaeta concinna* Dana and a large number of these were measured, namely 199 females and 202 males, 401 examples in all. In this collection only the last four stages of development in the female and the last three in the male were represented, but in a further tow-netting taken in the same locality at Station 578 a further large collection of examples of this species were taken

including a still younger stage of development. In all cases the length was measured from the tip of the rostral spine to the end of the furcal ramus and the results have been plotted



TEXT-FIG. 56.—*Euchaeta concinna* Dana.

Measurements of 422 individuals of both sexes in different stages of development.

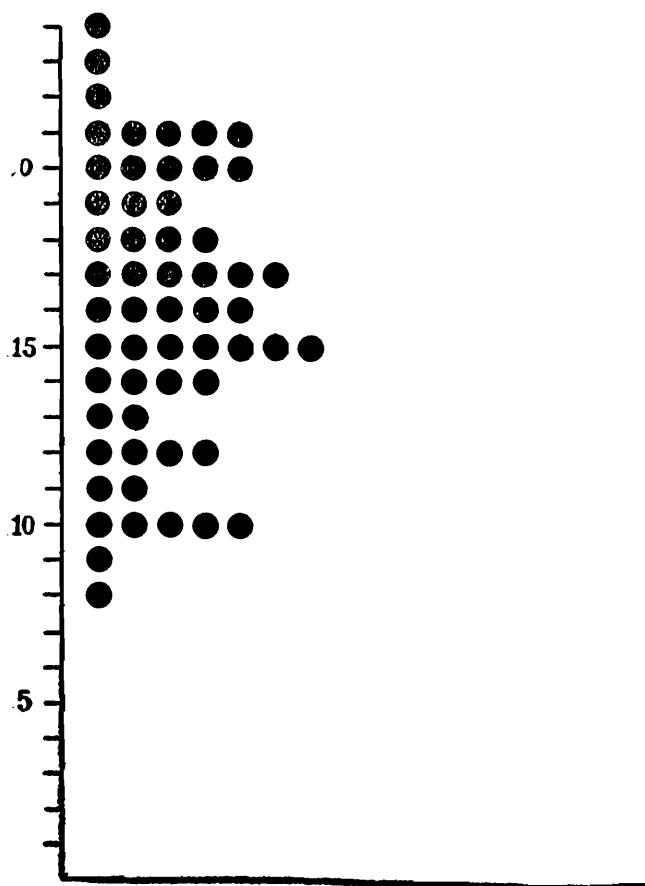
in text-fig. 56. The stages of development fall into five groups in the female and these correspond as regards their structure with Copepodid stages II to V and the final adult stage; in the male the last two Copepodid stages and the final adult stage are represented.

In the following table I have given the average length-measurements in each of the groups in the two sexes together with the growth-factors and the calculated sizes:

			Observed size, mm.	Calculated size, mm.	Growth- factor.
♀					
Copepodid Stage II	.	.	1.010	1.010	1.277
Copepodid Stage III	.	.	1.268	1.290	1.277
Copepodid Stage IV	.	.	1.613	1.647	1.277
Copepodid Stage V	.	.	2.125	2.103	1.277
Adult Stage VI	.	.	2.872	2.685	

	Observed size. mm.	Calculated size. mm.	Growth- factor.
♂			
Copepodid Stage III	1.268	1.268	1.584 or 1.277
Copepodid Stage IV	1.613	1.619	1.584
Copepodid Stage V	2.139	2.008	
Adult Stage VI	2.534	2.564	

From the above it appears that in the female sex the growth-factor remains unaltered throughout the life-history, instead of, as is more usual, exhibiting a decrease in the last two ecdyses. In the male the life-history appears to follow the usual course; at stage III an individual may either show the male growth-factor, which in this species appears to be 1.584, and so pass direct to stage V, remaining still immature, or may adopt the female growth-factor of 1.277 and pass to stage IV and then by a resumption of the male factor, 1.584, pass to the final sexually-mature stage VI.



TEXT-FIG. 57.—Showing the number of ova carried by 57 examples *Euchaeta concinna*, ♀.

Among the females in the collection were a large number who had, to judge from the remains of cement substance still adhering to the genital segment, either been recently ovigerous or who actually were bearing egg-sacs. Other examples were bearing spermatophores. It was clear that the breeding season was in full swing. It was noticed that there was a considerable degree of variation among these females in the size of the characteristic projection on the right side of the genital segment; this projection was much more evident in those examples that either were or had recently been carrying egg-sacs, and it seems possible that the act of oviposition may cause this prominence to become more pronounced. The number of ova carried by different individuals also showed a considerable range of variation and varied from as few as eight to as many as twenty-four, and in text-fig. 57 I have given the number carried by 57 individuals. It would, therefore, appear to be very doubtful

whether the number of ova carried by the female can be regarded as sufficiently constant to warrant it being considered a specific character.

***Euchaeta marina* (Prestandrea).**

Euchaeta marina, A. Scott, 1909, p. 67, pl. xix, figs. 9-20.

Euchaeta marina, Wolfenden, 1911, p. 299.

Euchaeta marina, T. Scott, 1912, p. 532.

Euchaeta marina, Pesta, 1912, p. 45.

Euchaeta marina, Sewell, 1912, p. 360.

Euchaeta marina, Pesta, 1913, p. 32.

Euchaeta marina, Sewell, 1913, p. 354.

Euchaeta marina, Sewell, 1914, p. 215.

Euchaeta marina, Brady, 1915, p. 135.

Euchaeta marina, Früchtl, 1924, p. 5.

Euchaeta marina, Sars, 1925, p. 104.

Euchaeta marina, Farran, 1929, p. 237.

Examples of this species occur in collections made by the "Investigator" at Stations 556, 562, 614, 670 and 682.

***Euchaeta media* Giesbrecht.**

Euchaeta media, A. Scott, 1909, p. 66, pl. xx, figs. 10-18.

Euchaeta media, Farran, 1929, p. 238.

A few examples of this species were obtained by the "Investigator" at Station 614, Nankauri Harbour, in the Nicobar Islands.

***Euchaeta spinosa* Giesbrecht.**

Euchaeta spinosa, Giesbrecht, 1892, pp. 246, 263, pl. xvi, figs. 12, 26, 34, and pl. xxxvii, figs. 31, 34, 35, 51.

Euchaeta spinosa, Giesbrecht and Schmeil, 1898, p. 39.

Euchaeta spinosa, Thompson and A. Scott, 1903, p. 244.

Euchaeta spinosa, Cleve, 1904 (a), p. 190.

Euchaeta spinosa, Esterly, 1905, p. 159, fig. 24.

Euchaeta spinosa, van Breemen, 1908, p. 52, fig. 58 a, b.

Euchaeta spinosa, Sars, 1925, p. 104, pl. xxx, figs. 1-6.

Euchaeta spinosa, Farran, 1926, p. 256.

A few examples of this species were taken at "Investigator" Station 614.

***Euchaeta tenuis* Esterly.**

(Text-fig. 58, a-j.)

Euchaeta tenuis, Esterly, 1906, p. 61, pl. ix, fig. 13, and pl. x, figs. 29, 30.

Euchaeta tenuis, A. Scott, 1909, p. 68, pl. xix, figs. 1-8.

Euchaeta solida, Esterly, 1911(b), p. 324, pl. xxvi, fig. 2, pl. xxviii, fig. 34, and pl. xxx, fig. 78.

This species was briefly described and figured by Esterly from a single specimen taken in the north Pacific Ocean. Other examples were obtained by the "Siboga" in the Malay Archipelago and were described by Scott (1909). In the "Investigator" collection made at Station 393 were two examples of the female of this species and associated with them were several examples of the hitherto-unknown male. As these females show certain small differences from the previously published accounts, I have given an account of them in full.

♀ Total length 4.9 mm., which is somewhat smaller than the specimen from the Pacific, which according to Esterly was 6.0 mm. in length, while the examples from the Malay Archipelago measured as much as 6.8 mm.

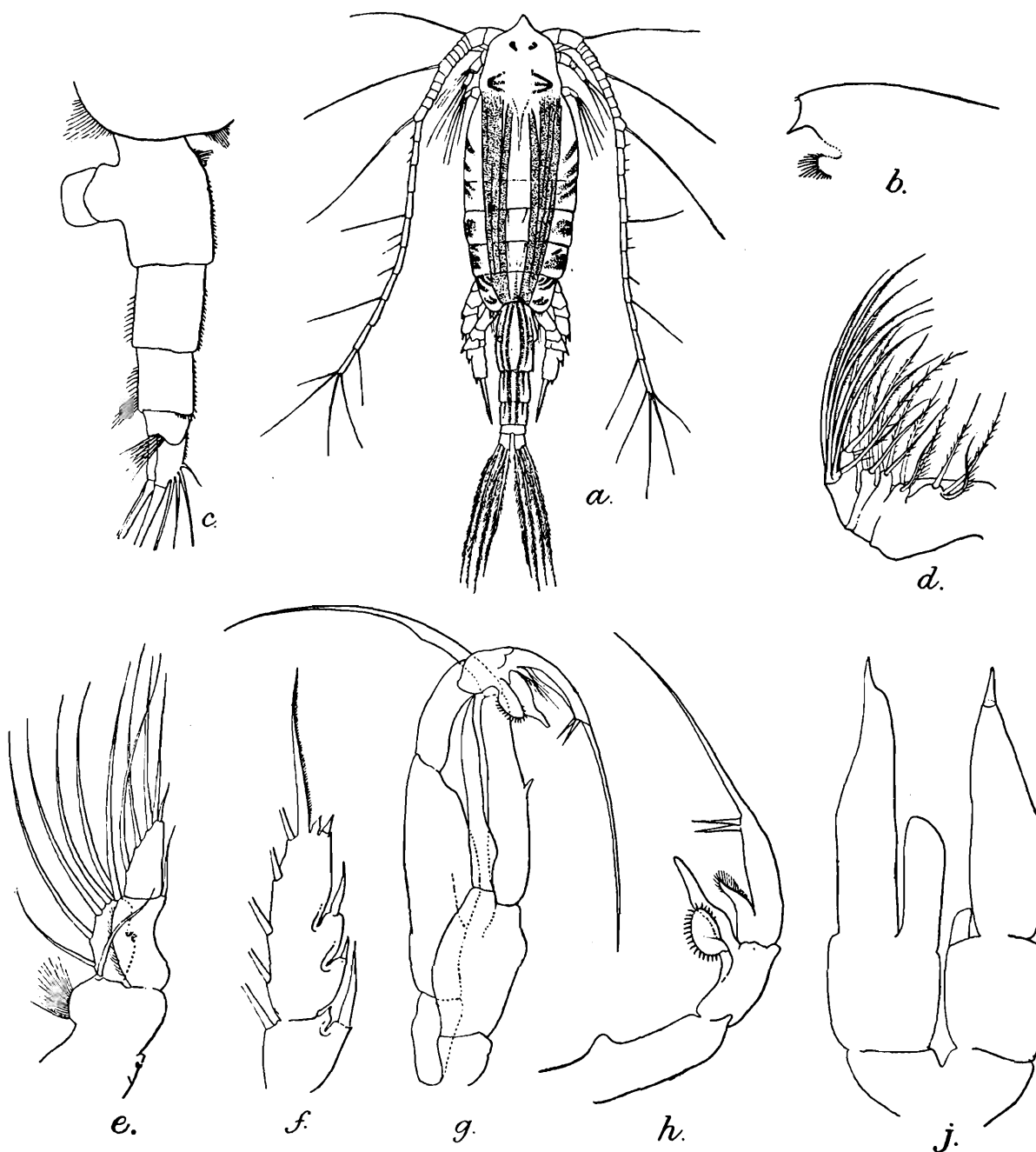
The proportional lengths of the cephalothorax and abdomen are as 54 to 25, so that the abdomen is a little less than half the length of the anterior region of the body.

The posterior margin of the thorax is rounded and is somewhat sparingly provided with hairs.

The abdomen consists of four segments having the following proportional lengths :

Abdominal segment	1-2	3	4	5	Furca.
	40	23	18	7	13 = 100.

The ventral region of the 1st segment is produced in a large prominence, which carries the genital opening and terminates in two unequal flaps, that on the right side being much



TEXT-FIG. 58.—*Euchaeta tenuis* Esterly.

- a. The whole animal from above, ♀.
- b. The anterior end from the left side.
- c. The abdomen from the left side.
- d. The 2nd maxilla.
- e. The 1st swimming leg.
- f. The exopod of the 2nd swimming leg.
- g. The 5th pair of legs, adult ♂.
- h. The left 5th leg, adult ♂.
- j. The 5th pair of legs, ♂ (juv.).

the larger. The right side of the segment is traversed by a transverse groove along which the chitinous exoskeleton is thickened. As A. Scott points out, there is a minute tubercle

on each side in the dorso-lateral region about the middle of the length of the segments. All the abdominal segments are clad in short hairs and there is a brush of long hairs on the ventral aspect of the 3rd segment, while on each side of the 4th segment, close to the articulation with the furcal ramus, is a tuft of similar long hairs. The 1st segment bears a tuft of hairs on its dorsal aspect anteriorly and both the 2nd and 3rd segments are armed along the dorsal side of the posterior margin with minute spinules. The furcal rami terminate obliquely and the 2nd furcal seta is much thicker than the others; unfortunately in both my specimens these, as well as the accessory setae, are broken.

The 1st antenna reaches to the furca and is composed of 23 segments; segments 8 and 9, and 24 and 25 being respectively fused. The proportional lengths of the segments are as follows:

Segment	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
	43	35	16	20	20	20	23	31	20	23	31	39	43	47	55	59	59	74	70	62	70	62	78
	=1000																						

The structure of the terminal setae on the 2nd maxilla (text-fig. 58, *d*) shows that the species is a true *Euchaeta* (*sensu stricto*).

In the 1st pair of swimming legs (text-fig. 58, *e*) the exopod consists of only two joints, the 1st and 2nd segments being completely fused; there is no marginal spine on the part of the combined joint that corresponds to exopod 1. The spine on the part corresponding to exopod 2 reaches to beyond the distal margin of exopod 3. The endopod consists of a single joint that shows a swelling on the outer margin and this swelling is crowned with a row of short hairs or hair-like spines.

In the 2nd pair of legs (text-fig. 58, *f*.) the spine on exopod 2 is large and reaches to the end, or very nearly to the end, of the proximal spine on exopod 3 and the middle spine on exopod 3 falls short of the base of the distal spine in my specimens; according to A. Scott in his examples "the second outer edge spine on the third joint reaches almost to the base of the 3rd outer edge spine." In this respect my examples agree more closely with Esterly's original description.

Associated with these females in the "Investigator" collection from Station 393 were several males that appear to belong to the same species.

♂ Total length, 5.0 mm.

The proportional lengths of the cephalothorax and abdomen are as 57 to 24, so that in this sex the abdomen is contained 2.375 times in the length of the anterior region of the body.

The forehead terminates anteriorly in a well marked rounded supra-rostral eminence and the rostrum, which is strong, projects downwards and slightly backwards. The posterior thoracic margins are rounded.

The abdomen consists of five segments, but owing to the complete manner in which the 5th segment is telescoped into the 4th, at first sight it appears as if there were only four; the proportional lengths of the segments and furcal rami are as follows:

Abdominal segment	1	2	3	4	5	Furca.
	22	29	23	13	2	11
	=100.					

The 2nd, 3rd and 4th segments are armed across the posterior dorsal margin with a row of coarse teeth. The 2nd furcal seta is about twice as long as the others and the accessory setae are also long but in all cases the extreme tip had been broken off.

The 1st antenna reaches back to the middle of the 3rd abdominal segment. The 8th, 9th and 10th segments are completely fused together and the 12th and 13th partially so. The proportional lengths of the segments are as follows :

Segment	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	
	64	36	16	16	22	22	27	55	22	27	40	40	47	54	54	58	67	67	58	67	64	77	= 1000

In the 2nd antenna the endopod bears 8 setae on the inner lobe and 6 on the outer.

In the mandible the exopod bears 6 setae and the endopod 9.

In the 1st maxilla the 1st inner lobe bears 11 setae, the basal segment bears 3 and the endopod carries 1 seta each on the 1st and 2nd segments and 3 on the 3rd. The 2nd and 3rd inner lobes each bear a single seta. The exopod bears 11 setae and the outer lobe 8.

In the female the 2nd basal segment of the maxilliped bears three setae on its anterior margin at the junction of the proximal and middle thirds of its length ; in the male, however, these appear to be completely absent. The distal end of this segment bears 2 unequal setae. In the endopod the various segments bear the following setae: endopod 1, 2 large and 2 unequal small setae ; endopod 2, 1 large and 2 unequal small ; endopod 3, 1 large and 1 small ; endopod 4, 1 large and 1 small on the anterior aspect and 1 small externally ; and endopod 5, 2 large and 2 small.

The 1st pair of swimming legs have a three-jointed exopod, of which the 1st segment bears a fine seta on its margin distally and the 2nd segment bears a spine that reaches a little beyond half-way to the base of the spine on exopod 3.

The 2nd pair of swimming legs bear three spines on the 3rd segment of the exopod ; the proximal spine is short but the second reaches about half-way to the base of the distal spine.

The 5th pair of legs (text-fig. 58, *g* and *h*) are of the true *Euchaeta* type, that is to say, the exopods of both right and left legs terminate in a long spiniform segment. The 2nd segment of the left leg bears a tooth-plate which is rounded and is armed around its circumference with a row of triangular teeth. This tooth-plate appears to be fused with the finger-like process at its base, the free portion of the digitiform process extending beyond the tooth-plate by nearly the same distance.

Esterly (1911, *b*) has very briefly described and figured, under the name *Euchaeta solida*, an adult male that is probably the same form as that described above. Unfortunately he does not differentiate between the genera *Euchaeta* and *Paraeuchaeta* and he gives no details of the structure of the 5th pair of legs, so that it is impossible to assign his form to either genus. The similarity between the tooth-plate of the left leg in Esterly's form and the above described specimens suggests that they are identical, in which case *Euchaeta solida* becomes a synonym of *E. tenuis*.

Copepodid Stage V.

♂ Total length, 4.4 mm.

The proportional lengths of the cephalothorax and abdomen in this stage of development are as 51 to 20, so that the abdomen is contained 2.55 times in the length of the anterior region, instead of 2.375 times as in the adult stage.

The rostrum is as in the adult. The head and 1st thoracic segment are fused but the line of demarcation is still visible across the dorsal region. Thoracic segments 4 and 5 are also fused but here again the line of union can be detected in the lateral region. The posterior thoracic margin is rounded and there is no tuft of hairs on the margin.

The abdomen consists of four segments, segments 4 and 5 not yet having separated. The segments have the following proportional lengths:

Abdominal segment	1	2	3	4-5	Furca.	
	26	21	21	18	14	=100.

There is no tuft of hairs on the ventral aspect of any of the segments. The 1st antenna reaches to the posterior margin of the 2nd abdominal segment. Segments 8 and 9 are fused but 10 is still separate. The proportional lengths of the segments are as follows:

Segment	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	
	53	34	17	17	19	19	24	34	22	24	31	38	41	48	55	55	57	74	69	62	67	62	78	=1000

A comparison of these measurements and those given above in the adult (*vide supra*, p. 152) shows that there has been but little change. There is no fringe of hair on the posterior margin of the proximal segments.

In the 2nd antenna the 2nd basal segment bears a tuft of long hairs. The endopod is considerably shorter than the exopod, which appears to consist of 7 segments; there is a rounded prominence on the outer margin of the 2nd segment. The endopod bears 7 setae on the inner lobe and 6 on the outer.

In the mandible the basal segment of the palp bears a stout seta and the exopod bears 6 setae and the endopod 8.

In the 1st maxilla the masticatory lobe bears 11 setae; lobe 2 bears a single seta; the basal segment carries 3 setae and the segments of the endopod bear 1, 1 and 3 setae respectively; the exopod bears 10 and the outer lobe 8 setae.

In the 2nd maxilla the various lobes bear the following number of setae: lobe 1, 3; lobe 2, 3; lobe 3, 2; lobe 4, 3; lobe 5, 3. The endopod bears 5 setae with only small spinules on them and a sixth which shows the characteristic long spines as in the adult females.

In the maxilliped basal 1 bears 3 setae on lobe 2, and 3 more at the distal end, *i.e.*, on lobe 3; there is a row of spinules near the base of lobe 2. Basal 2 is swollen in its proximal half and tapers distally; it bears three setae on its anterior margin at the junction of the distal and middle thirds of its length, the 1st and 3rd setae being long and the 2nd or middle one short; there is no trace of any setae at the junction of the proximal and middle thirds of the anterior margin. From the distal end of the 2nd basal segment two setae of unequal length arise. The endopod bears the following setae: endopod 1, 2 large and 1 small; endopod 2, 1 large and 1 small; endopods 3 and 4 are the same as segment 2; endopod 5 bears 2 large setae and 2 small. There is a small external seta on segment 4.

The swimming legs are as in the adult.

The 5th pair of legs (text-fig. 58, j) consist each of a two-jointed basal portion and an exopod and endopod each of a single segment. The two exopods are of equal size but the endopods are markedly unequal.

***Euchaeta wolfendeni* A. Scott.**

Euchaeta wolfendeni, A. Scott, 1909, p. 68, pl. xvii, figs. 1-12.

Euchaeta wolfendeni, Sewell, 1914, p. 216.

Examples of this species have now been found in collections from the Malay Archipelago (A. Scott); the Pearl Banks of Ceylon (Sewell); the Andaman and Nicobar Islands, the Ganjam coast and from the Maldives; and it appears to be both common and widely

distributed throughout Indian waters. Ovigerous females carry egg-sacs that contain from 5 to 7 eggs of a pale blue colour.

Sars (1925, p. 107) claims that the species recorded by him from the Atlantic Ocean under the name *Euchaeta pubera* is the same species and that, therefore, his name has priority. Although I have not seen any examples of *Euchaeta pubera* Sars, a comparison of the author's description and figures leaves no doubt in my mind that the two species are quite distinct; in Sars' form there is no trace of the very characteristic swelling on the right side of the posterior region of the genital segment that is found in *Euchaeta wolfendeni* A. Scott.

Genus **PARAEUCHAETA** A. Scott.

As I have already mentioned, this genus was created by A. Scott in 1909 to accommodate those species which had hitherto been classed in the genus *Euchaeta*, but in which the terminal setae of the 2nd maxilla are furnished with fine short spines only in the female and in the case of the male the 3rd joint of the exopod of the 5th left leg is short and vestigial. The reduction of this 3rd joint gives to this terminal portion of the limb an appearance of a hand with three fingers; the middle process exhibits a considerable range of variation in the various species, in certain examples it is short, being shorter than the tooth-plate, and in others it surpasses the tooth-plate in length. We can thus group the various species into two groups, as follows :—

Species in which the middle process
is short.

Paraeuchaeta antarctica (Giesbrecht).
Paraeuchaeta austrina (Giesbrecht).
Paraeuchaeta bisinuata Sars.
Paraeuchaeta dubia (Esterly).
Paraeuchaeta glacialis (Giesbrecht).
Paraeuchaeta hebes (T. Scott).
Paraeuchaeta spinifera (Scott).
Paraeuchaeta tonsa (Giesbrecht).

Species in which the middle process
is long.

Paraeuchaeta barbata (Brady).
Paraeuchaeta dentata A. Scott.
Paraeuchaeta gracilis Sars.
Paraeuchaeta investigatoris, sp. nov.
Paraeuchaeta norvegica (Boeck).
Paraeuchaeta sarsi (Farran) (= *Euchaeta barbata* With).
Paraeuchaeta scotti Farran.

In his account of the "Siboga" collections Scott (1909) records the occurrence of the following species of this genus from the Malay Archipelago :—

Paraeuchaeta bisinuata (Sars),
Paraeuchaeta californica (Esterly),
Paraeuchaeta dentata A. Scott,
Paraeuchaeta gracilicauda A. Scott,
Paraeuchaeta propinqua (Esterly),
Paraeuchaeta sarsi (Farran),

Paraeuchaeta sibogae A. Scott,
Paraeuchaeta spinifera (Esterly),
Paraeuchaeta tonsa (Giesbrecht),
Paraeuchaeta tuberculata A. Scott,
Paraeuchaeta weberi A. Scott,

and in addition, he described under the name *Paraeuchaeta barbata* (Brady) a further form that, while closely resembling Brady's species, differs from it in certain particulars and in my opinion is not the same species; I have therefore given it a new name, *Paraeuchaeta malayensis* (nom. nov.).

Undoubtedly all the above species will eventually be found in Indian waters but in the "Investigator" collections that have been made up to the present time only eight species are represented.

? ***Paraeuchaeta barbata*** (Brady).

(Text fig. 59, a-c.)

Paraeuchaeta barbata, Sewell, 1913, p. 354.

The species *Euchaeta barbata* was described by Brady from a single specimen obtained by the "Challenger" in Lat. 36° S. Unfortunately Brady's description and figures are insufficient to render the identity of this species beyond dispute and the type-specimen deposited in the British Museum (Natural History) is incomplete. It seems almost impossible to determine which of the many species of *Paraeuchaeta*, that have been identified as Brady's species only to be dethroned later, really represents Brady's original form. Farran (1909) has attempted to unravel the tangle and he points out that there are several distinct species that very closely resemble one another and have from time to time been identified as *Euchaeta barbata* Brady. We can summarise the various attempts to indentify Brady's species as follows :—

Euchaeta barbata T. Scott (1893).

= *Paraeuchaeta gracilis* Sars (1905-1925).

= *Euchaeta quadrata* Farran (1908).

Euchaeta barbata Wolfenden (1904).

= *Euchaeta sarsi* Farran (1909).

Euchaeta barbata Sars (1903).

= *Euchaeta farrani* With (1915).

Euchaeta barbata A. Scott (1909).

= *Paraeuchaeta malayensis* nom. nov.

Euchaeta barbata Farran (1909).

= ? *Euchaeta barbata* Brady (1883).

At the present time it seems to be accepted that the form described by Farran in 1908 under the name *Euchaeta barbata* is the same species as that originally described by Brady. This view has been adopted by both With (1915) and Sars (1925), though the former author appears to have had certain qualms about so doing, but justifies his action, even if it is wrong, by the plea that only thus can we avoid further confusion in the literature. Wolfenden (1911, p. 294), on the other hand, considers that *Euchaeta barbata* Brady must be regarded as an unknown species and under the name *Euchaeta robusta* (*loc. cit.*, p. 299) describes a form that he claims comes nearest to Brady's example.

In the "Investigator" collection from Station 393 there is a single example of a *Paraeuchaeta* that I believe to be identical with Brady's original specimen, in spite of a certain difference in size; but, as I have already pointed out, in a number of instances examples of the same species are usually, if not invariably, smaller in the Indian Ocean than in other waters, such as the Atlantic.

♀ The total length of this example is 7.25 mm., whereas Brady's specimen measured 8.4 mm.

The proportional lengths of the cephalothorax and abdomen are as 79 to 34.

The rostrum projects well forwards and immediately above it is a small supra-rostral eminence. The posterior thoracic margin (text-fig. 59, *a*) on the right side is sharply rounded, exactly as Brady figures it (*vide* Brady, 1883, pl. xxi, fig. 12), but on the left side the margin in the ventro-lateral region is brought to a very small point. On both sides there is the usual tuft of long hair.

The abdominal segments have the proportional lengths as follows :—

Abdominal segment	1-2	3	4	5	Furca.	
	43	22	21	4	10	=100.

This agrees exactly with the proportions in Brady's original specimen, and is so close to the proportions in Farran's examples, in which the lengths of the three anterior segments are as 42 : 24 : 24, or Wolfendens *Euchaeta robusta*, in which the measurements are 40 : 20 : 20, that it is impossible to draw any distinction. The 2nd and 3rd segments are armed dorsally with a row of spines and on the 3rd segment a few of the central spines are enlarged to about twice the size of the others. The ventral aspect of the 2nd and 3rd abdominal segments in the present example are devoid of hair but the 4th segment carries a tuft of long hairs; in this respect my example agrees exactly with Brady's specimen and differs from all other described forms, in which all three segments are described as being provided with such



TEXT-FIG. 59.—? *Paraeuchaeta barbata* Brady, ♀.

a. The posterior thoracic margin and genital segment of the abdomen from the left side.

b. The 2nd maxilla.

c. The maxilliped.

tufts. The shape of the genital segment agrees very closely with both Brady's and Farran's description so far as the genital swelling is concerned, but whereas in Farran's specimens there is a small additional swelling on the left side behind and above the main swelling, in my example there is no trace of such. Farran (1909, p. 41) states that "it was impossible to see whether the lateral tubercle on the genital segment was present or not." I have made a careful examination of Brady's type and can detect no trace of this small tubercle. In this respect, therefore, my example appears to resemble Brady's type and differs from Farran's specimens. There are considerable differences between Farran's examples and Brady's type in the proportional lengths of the furcal setae; unfortunately in my example the ends of these setae are broken.

The 1st antenna reaches to just beyond the posterior thoracic margin. In the table below I give the proportional lengths of the various segments in the present example and, for the purpose of comparison, the proportional lengths in Brady's type and in an example of Farran's form.

Segment	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
Present form	57	52	25	27	27	26	26	34	21	21	28	44	44	49	54	55	59	64	60	58	53	50	66 = 1,000
Farran's form	52	44	22	25	27	27	27	36	25	25	30	41	41	52	55	57	57	68	65	60	55	46	63 = 1,000
Brady's type	52	43	20	20	23	26	29	33	20	23	29	39	43	46	56	56	56	69	69	62	59	52	75 = 1,000

From the above it seems that in certain segments the present form comes nearer to Brady's type, while in other segments Farran's form is nearer; but with regard to the great majority of the segments there is but little difference. With (1915, p. 175) remarks that in Farran's form the 24th and 25th segments "are slightly longer than (not =) segment 19 and the segment 21 is almost 1.1 as long as 17 (not as long as)." According to my measurements, in both Farran's form and the present example segments 24-25 are together slightly shorter than segment 19, whereas in Brady's type these segments are longer. Again in both Farran's form and in the present example, the 21st segment is 1.053 times the length of the 17th, whereas in Brady's type it is 1.107. The outstanding difference between Brady's type and the other two forms is to be found in the much greater length of segments 24-25 in the former, in which it is 75, whereas in the other two it is only 63 and 66.

There appear to be certain small differences between all three forms in the number of setae on the outer lobe of the 1st maxilla. In Brady's type there are 7 setae on this lobe. According to With (1915, p. 175) there are in Farran's form 5 long setae and 2 shorter ones making 7 in all. In the present example there are 6 long setae and immediately posterior to the last there is a small rounded swelling that looks as if it had originally supported a seta, but there is no seta there now, though, as the specimen was somewhat damaged, it is impossible to be certain whether or not in life a seventh small seta was present. In *Euchaeta robusta* Wolfenden states that there are 6 setae in this position. In all cases the exopod bears 11 setae.

The 2nd maxilla (text-fig. 59, b) and maxilliped (text-fig. 59, c) appear to be identical in all three forms and in the present specimen are as figured.

There appears to be no difference in the 1st pair of swimming legs between Brady's type and Farran's examples and the present example agrees exactly with both these forms, as well as with *Euchaeta robusta* Wolfenden. The 1st and 2nd segments of the exopod are incompletely demarcated and there is a minute external spine, arising from the bottom of the concavity in the external margin; the marginal spine, arising from that portion of the proximal joint that corresponds to segment 2, is long and seta-like and reaches to the base of the marginal spine on the distal segment.

The 2nd leg in the present specimen very closely resembles those of both forms of *Paraeuchaeta barbata*, as well as those of *Paraeuchaeta gracilis* (Sars) (= *P. quadrata* (Farran)) and *P. rubicunda* (Farran). The external spine on the 2nd segment of the exopod is long and reaches to a point half-way along the proximal spine of the 3rd segment. The proximal spine on the 3rd segment is also longer than in certain other forms and very nearly reaches to the base of the 2nd spine. The 2nd spine is also long and, though the extreme tip is broken off in my specimen, it is clear that it must have reached very nearly, if not actually, to the extreme distal margin of the segment. The sinus at the base of the 2nd

marginal spine is deep and reaches as far as a line drawn between the base of the proximal spine and the point of origin of the 2nd seta on the internal margin. In this latter respect, therefore, this specimen agrees with Farran's form. In *Paraeuchaeta robusta*, which according to Wolfenden (1911, p. 299) comes nearest to Brady's type, the sinus divides the 3rd segment into proximal and distal parts in the proportion of 40 to 60; in my example the sinus is, if anything, even deeper than this, the proportional lengths of the two regions of the segment being 36 to 64.

***Paraeuchaeta bisinuata* (Sars).**

Euchaeta bisinuata, Sars, 1907 (a), p. 12.

Euchaeta bisinuata, Farran, 1908, p. 45, pl. iii, figs. 17-19; pl. iv, fig. 4.

Paraeuchaeta bisinuata, A. Scott, 1909, p. 70, pl. xvi, figs. 10-17.

Paraeuchaeta bisinuata, Sewell, 1913, p. 354.

Paraeuchaeta bisinuata, With, 1915, p. 183, pl. vi, figs. 11 a-c, text-fig. 54 a-j.

Paraeuchaeta bisinuata, Sars, 1925, p. 123, pl. xxxiii, figs. 16-22.

This species appears to have a fairly wide distribution; it has now been taken in the North Atlantic Ocean, the Malay Archipelago and in the Bay of Bengal. A single specimen was taken by the "Investigator" at Station 393.

***Paraeuchaeta californica* (Esterly).**

Euchaeta californica, Esterly, 1906, p. 60, pl. ix, fig. 11, pl. x, figs. 26, 34.

Paraeuchaeta californica, A. Scott, 1909, p. 71, pl. xv, figs. 1-8.

Paraeuchaeta californica, Sewell, 1913, p. 354.

Originally described by Esterly from a single female taken in the San Diego region of the Pacific Ocean, this species has now been found in the Malay Archipelago and the Bay of Bengal.

Six examples, all females, occur in the "Investigator" collection at Station 393 and others were taken at Station 670.

***Paraeuchaeta investigatoris*, sp. nov.**

(Text-fig. 60, a-d.)

Three examples of a male of a species of *Paraeuchaeta*, that appears to differ from other previously described forms, were taken by the "Investigator" at Station 393.

♂ Total length, 5.62 mm.

The proportional length of the cephalothorax and abdomen are as 2 to 1.

The forehead, as in most of the male forms in this genus, is rounded and the rostrum is directed downwards. The posterior thoracic margin is rounded and is produced backwards in a rounded lappet that is about three times the size on the left side of the body than it is on the right. On the dorso-lateral region there is a well developed spine-like projection. There are no hairy tufts on the posterior margins.

The abdomen consists of the usual five segments; the 5th or anal segment is extremely short and is telescoped into the 4th. The posterior margins of the 2nd, 3rd and 4th segments are armed across the dorsal part of the posterior margin with a row of coarse spines. The proportional lengths of the segments are as follows:—

Abdominal segment	1	2	3	4	5	Furca.	
	18	30	23	20	2	7	= 100

The furcal rami are but little longer than broad and the 2nd furcal seta is about one and a half times the length of the others; the accessory seta is short being only about one-half times the length of the rest.

The 1st antenna reaches back to the middle of the 2nd segment of the abdomen. Segment 20 is devoid of an "aesthetask," though segments 19 and 21 each bear one. The proportional lengths of the segments are as follows:—

Segment	1	2	3	4	5	6	7	8-10	11	12	13	14	15	16	17	18	19	20	21	22	23	24-25.
	44	42	21	21	24	29	35	72	23	30	39	40	47	53	51	55	63	64	60	59	52	76
	=1,000																					

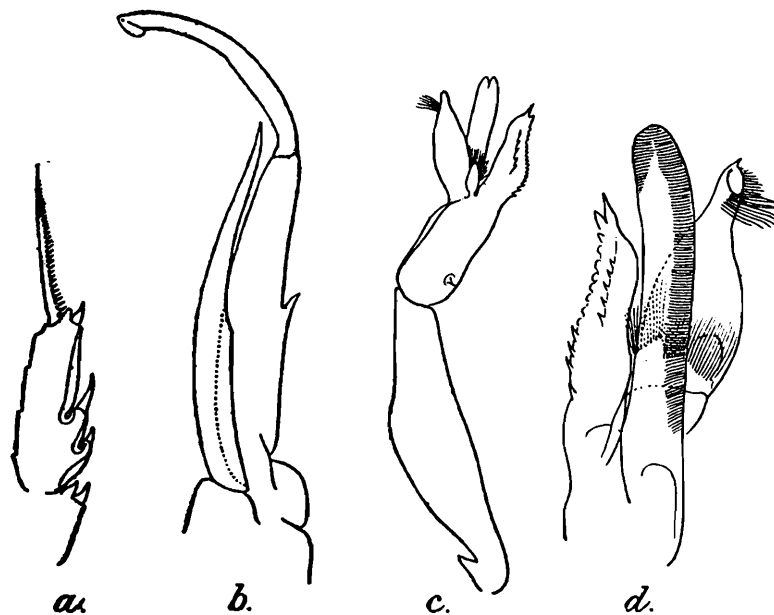
In the 2nd antenna the exopod is about one and a half times the length of the endopod. Basal 1 bears a well-marked tuft of hairs and externally is produced in a blunt rounded prominence, but is devoid of setae. The endopod bears 6 setae on the outer lobe and 7 on the inner.

In the mandibular palp the exopod consists of five segments, of which the 3rd is produced in a rounded lobe. The endopod is two-jointed and bears 9 setae at its distal end.

The 1st maxilla is much reduced. The basal segment and endopod together bear 5 setae and the exopod carries 10. The outer lobe bears 5 setae.

In the maxilliped the basal segment bears at its distal end a straight slender seta and a stout short process that is thickly haired.

The 1st swimming leg consists of a two-jointed basal part and the exopod has three segments; the endopod consists as usual of a single segment. There is no spine on the 1st segment of the exopod, a very small hair taking its place.



TEXT-FIG. 60.—*Paraeuchaeta investigatoris*, sp. nov., ♂.

a. The exopod of the 2nd swimming leg.
b. The right 5th leg.

c. The left 5th leg.
d. The distal portion of the left 5th leg.

The 2nd leg (text-fig. 60, a) in its structure and armature closely resembles the corresponding appendage in *Paraeuchaeta dentata* A. Scott and *P. dubia* A. Scott. The 2nd marginal spine on the 3rd segment of the exopod is comparatively short and does not reach the middle of the interval between it and the 3rd marginal spine.

The 5th pair of legs (text-fig. 60, b, c and d) have the form characteristic of the genus. The hand of the left leg is produced into a dentate lamella that is nearly as long as the palm.

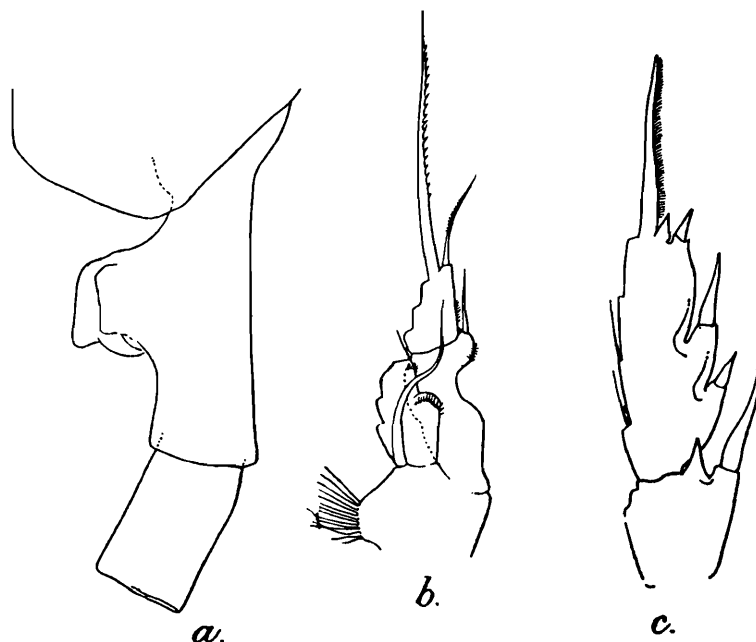
It bears a row of teeth on the outer margin and a line of five teeth on the inner border. The finger-like process is longer than the dentate plate and is transversely striated.

***Paraeuchaeta gracilicauda* A. Scott.**

(Text-fig. 61, *a-c.*)

Paraeuchaeta gracilicauda, A. Scott, 1909, p. 72, pl. xviii, figs. 9-16.

In the "Investigator" collection from Station 393 is a single example of *Paraeuchaeta gracilicauda* A. Scott. The total length of this example is 6.0 mm. and the proportional



TEXT-FIG. 61.—*Paraeuchaeta gracilicauda* A. Scott.

- a.* The posterior thoracic margin and genital segment of the abdomen from the left side.
b. The 1st swimming leg. *c.* The endopod of the 2nd swimming leg.

lengths of the cephalothorax and abdomen are as 1.786 to 1. The proportional lengths of the abdominal segments are as follows:—

Abdominal segment	1-2	3	4	5	Furca.	
	42	24	21	3	10	=100

The appendicular seta is very long.

The specimen appears to agree very well with Scott's description.

***Paraeuchaeta malayensis*, nom. nov.**

(Text-fig. 62, *a-j.*)

Paraeuchaeta barbata (non *Euchaeta barbata* Brady), A. Scott, 1909, p. 79, pl. xviii, figs. 1-8.

A. Scott in his report on the "Siboga" collections briefly described and figured, under the name *Paraeuchaeta barbata* (Brady), a species of copepod that he believed to be identical with the example recorded by Brady (1883) in the "Challenger" report and with the form described by Farran under this name and obtained by him off the west coast of Ireland. In the "Investigator" collections are several examples of a species of *Paraeuchaeta* that agree exactly with A. Scott's description and figures and I have no doubt that they are examples of the same species, but a comparison of these examples with specimens from the

Irish coast and identified by Farran as *Paraeuchaeta barbata* (Brady) and with Brady's original type in the British Museum (Natural History) has convinced me that, while these specimens from the Malay Archipelago and the Indian Ocean are the same species, they are not examples of *Paraeuchaeta barbata* (Brady), and I, therefore, propose the name *Paraeuchaeta malayensis* for the form described by A. Scott from the "Siboga" collection.

♀ Total length, 7.0 to 7.5 mm.

The proportional lengths of the cephalothorax and abdomen are as 201 to 95, so that the abdomen is contained 2.115 times in the length of the anterior region of the body.

The profile of the anterior end of the cephalothorax is curved and the rostrum is directed downwards and slightly forwards, but much more nearly vertically than in either Brady's type or in Farran's specimens. The posterior thoracic margin is rounded and is provided with the usual tuft of hairs.

The abdomen is of the usual type and the first three segments exhibit the same proportional lengths as in the other two forms, as follows:—

Abdominal segment	1-2	3	4	5	Furca.	
	41	22	22	5	10	=100

The 2nd and 3rd segments are armed along the posterior margin with a row of small spines and in the 3rd segment some of these in the mid-dorsal line are considerably enlarged. Segments 2, 3 and 4 are provided with tufts of hairs on their ventral surfaces.

There is no extra tubercle on the left of the genital orifice in the 1st abdominal segment.

The 2nd furcal seta and the accessory seta on both sides are considerably elongated, the proportional lengths of these and the ordinary setae are as follows:—

Length of ordinary seta	..	..	..	..	61
Length of 2nd seta		..	..	..	135
Length of accessory seta				..	257

The 1st antenna reaches back to the posterior thoracic margin. The segments have the following proportional lengths:—

Segment	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.	
	44	39	22	22	25	23	25	31	21	21	25	37	41	48	60	60	62	74	70	62	58	52	77	=1000

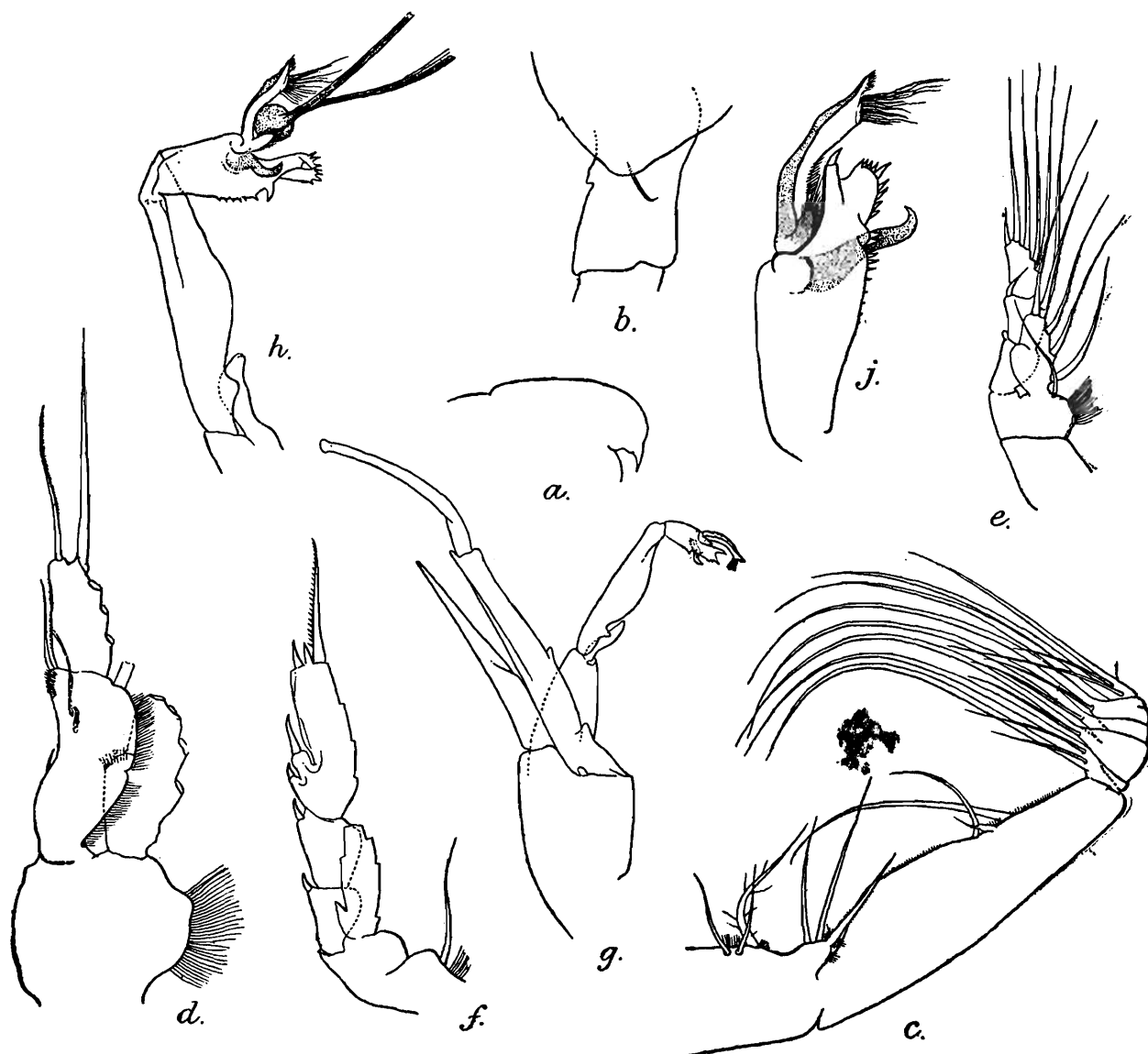
These lengths correspond very closely with the measurements of the segments in Brady's type-specimen of *Euchaeta barbata* (*vide supra*, p. 157).

In the 2nd antenna, basal 1 bears a row of long hairs and basal 2 carries a single seta. The exopod is longer than the endopod in the proportion of 31 to 25. The exopod consists of seven segments; segment 1 bears no seta, segment 2 has a small seta distally, segments 3 to 6 inclusive each bear a single long seta and the terminal segment has one seta about the middle of its length and a group of three at the extreme distal end.

The mandible is of the usual type.

In the 1st maxilla the masticatory lobe bears 13 setae; the basal segment appears to bear 5 setae and the endopod carries 8; the exopod has, in all, 11 setae, of these the proximal three are comparatively short but increase in length distally, then come 7 long setae and finally the distal seta is small; the distal portion of the inner border of the ramus is fringed with short hairs. The outer lobe bears 7 long and 2 short setae.

In the 2nd maxilla there is a patch of small spinules at the proximal end of the posterior margin ; in the basal segments all 5 lobes bear three setae and the first and second lobes are fringed with needle-like spines on the posterior aspect. The endopod bears 5 setae.



TEXT-FIG. 62.—*Paraeuchaeta malayensis* nom. nov.

a. The anterior end from the right side, ♂.	e. The 1st swimming leg, ♂.
b. The posterior thoracic margin and genital segment of the abdomen from the right side, ♂.	f. The 2nd swimming leg, ♂.
c. The maxilliped, ♀	g. The 5th pair of legs, ♂.
d. The 1st swimming leg, ♀.	h. The right 5th leg, ♂.
	j. The terminal part of the right 5th leg, ♂.

In the maxilliped (text-fig. 62, c) basal 1 has a thin fringe of short hairs on the proximal part of the posterior margin ; each of the lobes bears 3 setae ; at the base of the 2nd lobe there is a patch of needle-like spines along the anterior margin and another patch of needle-like hairs runs along the distal part of the 3rd lobe. On the 2nd basal segment there is a fringe of short needle-like spines along the proximal part of the anterior margin ; three setae arise from the region of the anterior border near the junction of the middle and distal thirds ; of these setae the middle one is, as usual, short and has a swollen basal part, the distal seta is somewhat longer than in the example of what I believe to be *Paraeuchaeta barbata* (Brady) and reaches back to the joint between the basal segments (cf. text-figs 59 (c) and

62 (c)). A row of long hair-like spines runs along the distal part of the anterior margin. Two unequal setae arise from the extreme distal end. The endopod consists of the usual 5 segments bearing the following setae:—

Endopod 1 bears 2 long and 2 shorter unequal setae.

„	2	„	1	„	„	2	„	„	„
„	3	„	1	„	„	1	„	seta.	
„	4	„	2	„	„	1	„	seta and an external seta.	
„	5	„	2	„	„	2	„	setae, one very small.	

In the 1st swimming leg (text-fig 62, *d*) basal 2 has its inner margin somewhat produced and fringed with long hairs; it bears the usual seta at the distal inner angle. In the exopod segments 1 and 2 are fused together but the line of separation is visible across the inner half of the joint. A minute spinule arises from the outer margin, corresponding to the marginal spine of segment 1. The outer border of the combined segment is moderately concave. Exopod 2 bears a slender marginal spine that does not quite reach to the base of the spine on exopod 3; there is a short comb of minute hair-like spines along the outer part of the distal border of the segment. The duct of a gland opens on the outer margin of exopod 3 and appears to be connected with a group of cells lying in the 2nd segment. The endopod is, as usual, one-jointed and the outer margin is produced in a rounded swelling that is crowned with short spines.

In the 2nd swimming leg basal 1 bears a seta on the distal part of the inner margin. Basal 2 has a plain inner border. Exopod 1 bears a short marginal spine and the inner border has a single seta and is fringed with hairs. The marginal spine on the 2nd segment is long and reaches to the tip of the proximal spine on the 3rd segment. A single seta arises from the inner margin. In the 3rd segment the proximal spine reaches half-way to the base of the 2nd spine and the 2nd spine reaches to the distal margin of the segment. The sinus at the base of the 2nd spine is deep, so that a line drawn between the base of the proximal spine and the bottom of the sinus and produced inwards cuts the inner margin well on the proximal side of the origin of the second seta.

The endopod consists of a single joint and the distal one-fourth is clad in short hairs.

The 3rd and 4th legs present no differences from other species. The terminal part of the 3rd segment of the endopod is, like the endopod of the 2nd leg, clad in short hairs.

In the same collection from Station 393 are several examples of a male *Paraeuchaeta* that appears to be slightly different from, though closely related to the forms described by T. Scott (1893, p. 60, pl. vi, figs. 20-23) from the Gulf of Guinea under the name *Euchaeta hebes* var. *valida* and that described by Esterly (1906, p. 63, pl. ix, fig. 7; pl. xi, fig. 36; pl. xvi, figs. 84, 85) from the San Diego region of the Pacific Ocean under the name *Euchaeta dubia*. According to van Breemen (1908, p. 54) T. Scott's example may be the male of *Paraeuchaeta barbata* (Brady), the occurrence of which in the same tow-netting Scott records. Farran has, however, pointed out that these female examples are in reality examples of *Paraeuchaeta gracilis* Sars (= *Paraeuchaeta quadrata* (Farran)) and were wrongly identified by Scott. It would thus appear probable that Scott's *Euchaeta hebes* var. *valida* is the male of *Paraeuchaeta gracilis* Sars and I am inclined to believe that the males taken by the "Investigator" at Station 393 are the males of *Paraeuchaeta malayensis*, which was mistaken by A. Scott for Brady's species.

♂ Total length, 5.6 mm. ; this agrees closely with the size of *Euchaeta hebes* var. *valida*, but is considerably smaller than *Paraeuchaeta dubia* (Esterly).

The cephalothorax and abdomen present the proportional lengths of 62 to 30, so that the abdomen is contained 2.066 times in the length of the anterior region of the body.

The anterior end of the body is rounded and the rostrum projects vertically downwards (text-fig. 62, *a*) ; as is also the case in *Paraeuchaeta dubia* (*vide* Esterly, 1906, p. 63) there is no eminence above the rostral base. The posterior margin of the thorax (text-fig. 62, *b*) is produced backwards somewhat and is rounded and in the dorso-lateral region bears a small spine-like projection.

The abdomen consists of five segments, of which the 5th is very short. The proportional lengths of the segments are as follows :—

Abdominal segment	1	2	3	4	5	Furca.	
	23	26	25	17	3	6	=100

The posterior margins of segments 2, 3 and 4 are armed dorsally with coarse teeth. The 1st segment (text-fig. 62, *b*) is crossed about the middle of its length by an overhanging ridge and furrow that runs transversely across the dorsal aspect and on the right side it bears a curved and thickened ridge of chitin that is very similar to that found in *Paraeuchaeta dubia* (Esterly). The 2nd furcal seta is about twice as long as the others, but the accessory seta is quite short, much shorter than the rest.

The 1st antenna reaches to at least the middle of the abdomen ; it consists of only 21 separate segments, segments 8, 9 and 10 being fused together, as also are segments 12 and 13, though in the case of these latter segments traces of the line of separation between them can be detected. In this respect these examples appear to differ from *Paraeuchaeta hebes* var. *valida* (T. Scott), though the proportional lengths of the various segments are somewhat similar in the two forms, as is shown in the following table :—

Segment	1	2	3	4	5	6	7	8-10	11	12	13	14	15	16	17	18	19	20	21	22	23	24-25	
<i>P. hebes</i> var. <i>valida</i>	44	44	18	22	25	29	33	69	22	29	40	36	47	51	55	58	69	69	58	58	55	69	=1,000
<i>P. malayensis</i>	44	40	19	21	25	25	32	64	21	25	39	39	48	57	57	60	71	67	60	60	53	75	=1,000

The mouth-parts, as is usual in the males of both *Euchaeta* and *Paraeuchaeta*, are somewhat reduced.

The 1st swimming leg (text-fig. 62, *e*) consists of a three-jointed exopod and a single-jointed endopod. The 2nd basal segment is somewhat produced internally and closely resembles the condition found in the female. Exopod 1 bears a minute external spine and the spine arising from exopod 2 is bent inwards across the posterior aspect of the 3rd segment.

The 2nd swimming leg (text-fig. 62, *f*), as is the case with many of the males of this genus, exhibits certain differences from the female in the development of the spines on the external margin of exopod 3. In the present form the middle marginal spine of exopod 3 is the largest, but even so it only reaches half-way to the base of the 3rd marginal spine. The marginal spines on the 1st and 2nd segments are small.

The 5th pair of legs (text-fig. 62, *g*, *h* and *j*) closely resemble those of *Paraeuchaeta dubia* (Esterly) ; indeed the only point of difference between them appears to be in small details in the character of the spinose lamella at the distal end of the "hand" of the left foot.

In the same collection were a number of immature forms that appear to belong to this species.

Copepodid Stage V.

♀ Total length ranging from 4.50 to 4.82 mm.

The proportional lengths of the cephalothorax and abdomen are as 27 to 9, so that in this stage of development the abdomen is contained 3 times in the length of the anterior region of the body.

The forehead and rostrum are well developed, the rostrum pointing forwards and only slightly downwards. The head and 1st thoracic segment are completely fused, all trace of the original line of separation having been obliterated. The 4th and 5th thoracic segments are fused and the posterior thoracic margin is produced backwards in a short plate, the apex of which is rounded.

The abdomen consists of four segments having with the furcal rami the following proportional lengths:—

Abdominal segment	1	2	3	4-5	Furca.	
	29	21	20	16	14	=100

The 2nd furcal seta on each side is much thicker than the others and is almost certainly much longer, but is unfortunately broken off short in all my examples. The accessory seta is well developed and is at least as long as the other setae. The posterior abdominal segments appear to be devoid of hair on their ventral aspects.

The 1st antenna reaches back to the posterior thoracic margin. Segments 8 and 9 and 24 and 25 respectively are fused together. The proportional lengths of the segments are as follows:—

Segment	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	
	52	38	19	19	24	24	24	33	21	21	33	38	40	49	54	56	59	71	66	64	59	56	80	=1,000

Segments 2 to 9 are fringed with hair on their posterior aspects.

The 2nd antenna closely resembles that of the adult. The exopod bears a small seta on the 2nd segment; a single large one on each of segments 3 to 6, and the terminal segment bears one seta about the middle of its length and a group of three distally. The endopod bears 7 setae on its inner lobe and 6 at its distal end.

The mandible and mandibular palp have the shape and proportions of the appendage in the adult. The exopod bears one seta on each of segments 1 to 4 and 2 on the 5th. The endopod is composed of two segments, the first bearing a single seta and the 2nd carrying 8.

In the 1st maxilla all the various parts of the appendage are well developed. The numbers of setae on the various parts are as follows: on the 1st inner or masticatory lobe, 13 setae; inner lobes 2 and 3 each bear 1; the basal segment bears 4 and endopod 1 and 2 together 6 setae; endopod 3 bears 3; the exopod bears 10 setae and the outer lobe 6.

In the 2nd maxilla the general condition is the same as in the adult form, but the number of setae on the various lobes is different. The actual numbers of setae present are as follows: on each of the five lobes 3 setae and on the endopod 6.

The maxilliped also closely resembles that of the adult but here again we find differences in the number of setae that arise from the segments; at the distal end of the 2nd basal segment are 2 setae of unequal length; endopod 1 bears 2 long and 1 short setae; endopod 2 bears 3 unequal setae and endopod 3 has 2; endopod 4 bears 2 unequal setae on its anterior margin and an extra one externally; and endopod 5 carries 3 unequal setae and 1 very short one in addition.

In the 1st swimming leg the basal portion consists of the usual two segments; the inner border of both being fringed with hair; segment 2 bears the usual S-shaped seta at its inner distal angle. The exopod in this stage of development consists of two separate joints. The proximal joint, which consists of segments 1 and 2 fused together, bears 2 marginal seta-like spines and the outer border, which is concave, is notched at the point where the 1st and 2nd segments are fused; the inner margin shows a similar indentation and the whole of the border is fringed with hair; it bears a single inner seta at its distal end. Exopod 3 bears a long seta-like marginal spine and the end-spine is also seta-like, but is serrated along its middle

third ; three inner setae arise from the segment. The endopod consists of a single joint ; its outer margin is produced in a rounded eminence that is crowned with a row of small needle-like spines and the margin bears 5 setae, 2 distally and 3 on the inner side.

In the 2nd swimming leg the basal portion is two-jointed ; basal 1 bears an inner seta and the inner border of both segments is fringed with hair. The exopod consists of three segments ; exopod 1 bears a short marginal spine and a short inner seta, the inner border being fringed with hair ; exopod 2 bears a long marginal spine that reaches to the apex of the proximal spine on exopod 3 ; the outer margin of the segment is fringed with hair and a single seta springs from the inner border distally ; exopod 3 bears three marginal spines, of which the proximal is small and the middle one is large and reaches to the end of the segment, as in the adult ; the sinus at the base of the 2nd spine does not in this stage of development reach as far as the line drawn between the base of the proximal spine and the point of origin of the 2nd seta ; four setae arise from the inner margin. The end-spine is serrated and between the individual large teeth there appear to be intermediate small ones. The endopod consists of a single joint, bearing 6 setae.

In the 3rd swimming leg the basal segments appear to resemble those of the 2nd leg but the inner margin of basal 2 seems to be smooth instead of hairy. The exopod is three-jointed, but the endopod is still composed of only a single joint, though traces of separation can now easily be seen, especially between the 2nd and 3rd segments.

The 4th swimming leg closely resembles the 3rd ; the endopod is, however, considerably longer, reaching well beyond the distal margin of exopod 2, whereas in the 3rd leg it falls just short of this point. The intervals between the marginal spines on exopod 3 are approximately equal.

There is no trace of any 5th pair of legs.

♂ In the male sex the general features are the same as in the female with a few slight differences.

The proportional lengths of the abdominal segments are somewhat different, being as follows :—

Abdominal segment	1	2	3	4-5	Furca.
	26	23	22	17	12
	= 100				

Apart from this difference the general shape and proportions of the body appear to be the same as in the adult.

The 1st antenna reaches back to the posterior thoracic margin and 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	24-25
	52	38	19	19	24	24	24	33	21	21	33	38	40	49	54	57	59	71	68	64	59	57	80
	= 1,000																						

Segments 2 to 13 inclusive are fringed with hair on their posterior aspect.

The 2nd antenna, mouth-parts and the first four pairs of legs appear to be identical with the corresponding appendages in the female.

The 5th pair of legs each consist of a two-jointed basal portion and two rami, each of a single joint. The two exopods are nearly symmetrical and each bears a minute spinule on its outer margin at about the junction of the proximal and middle-thirds and a second larger one at the distal end. The endopods are markedly unequal ; that on the right leg is large, reaching about half-way along the exopod, whereas that on the left side is much reduced and is only about one-third the length of the right endopod.

A few examples of a species of *Paraeuchaeta* in the 4th copepodid stage were also present. To judge from their size these do not belong to *P. malayensis*, but I give an account of them here for the purpose of comparison.

Copepodid Stage IV.

♀ Total length, 4.875 mm.

The proportional lengths of the cephalothorax and abdomen are as 57 to 17, so that the abdomen is, in this stage, contained 3.353 times in the length of the anterior region of the body.

The general shape of the anterior region of the body is very similar to that of *Paraeuchaeta malayensis*; the head and 1st thoracic segment are partially separated by a line that runs across the dorsal aspect; the 4th and 5th segments are fused. The posterior thoracic margin is produced slightly backwards and is sharply rounded when viewed from the side, but appears to be bluntly pointed when seen from the dorsal aspect.

The abdomen consists of only three segments, having with the furcal rami the following lengths:—

Abdominal segment	1	2	3-5	Furca.	
	28	28	29	15	=100

The furcal rami are fringed with hair along their inner margins. The furcal setae are very similar to those of *Paraeuchaeta malayensis*; the 2nd seta is much stouter and longer than the others and the accessory seta is well developed.

The 1st antenna reaches approximately to the posterior thoracic margin. Segments 8 and 9, and 24 and 25 are respectively fused. The proportional lengths of the segments are as follows:—

Segment	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17	18	19	20	21	22	24-25		
	73	38	20	20	20	23	23	31	18	20	25	36	41	46	48	53	56	71	66	64	64	59	85	=1000

Segments 3, 9 and 14 all bear long setae.

The 2nd antenna already closely resembles that of the adult. The 1st basal bears an internal prominence that is fringed with a row of long hairs. The endopod is a little more than half the length of the exopod; it bears 6 setae on each of the lobes of the distal segment. The exopod consists of 7 segments; the 2nd bears a small seta distally, segments 3 to 6 each bear a long seta and the terminal segment has one seta about the middle of its length and a group of three distally.

The mandible is already well developed. The basal portion of the palp bears a single stout seta and the two rami each bear 6 setae.

The 1st maxilla has the shape of the appendage in the adult; the number of setae, however, on certain parts of the appendage differ from those present in the adult stage. The distribution of the setae is as follows: the external lobe bears 8 setae; inner lobes 2 and 3 each a single seta; the basal segment bears 4 setae; and the endopod has 8, 5 on segments 1 and 2, and 3 on segment 3. The exopod bears 9, and the masticatory lobe 13 setae.

The 2nd maxilla closely resembles that of the adult; each of the lobes bears 3 setae and the endopod bears 5. The proximal three lobes are armed distally with groups of needle-like spines.

The maxilliped has the shape of the organ in the adult but the segments have not yet attained their full complement of setae. Endopod 1 bears 2 long spine-like setae; endopod 2 has 2 unequal setae; endopod 3 and 4 each have 1 long seta and in addition segment 4 carries an external marginal seta; endopod 5 bears 3 unequal setae and a single short external seta.

In the 1st swimming leg both basal segments are fringed on their inner margins with hairs and basal 2 carries the usual S-shaped seta at its distal inner angle. The exopod consists of a single segment that carries three marginal spines, increasing in size distally. The end-spine is long and seta-like. From the inner margin four setae arise and the proximal half of the border is fringed with hair. The endopod also consists of a single segment; the outer margin is produced in a rounded lobe that is crossed by a row of small spines and three setae arise from the inner margin and two from the distal end.

In the 2nd swimming leg the 1st basal segment bears a single inner seta and the inner margin is fringed with hairs; the 2nd basal has a smooth inner margin. The exopod consists of two joints; the proximal is much the smaller and bears a single external spine and a single seta internally; the distal segment bears three marginal spines, of which the proximal reaches about half-way to the 2nd and the 2nd two-thirds of the way to the distal spine, which is short. The end-spine is armed with stout teeth between which there appears to be interpolated a second series of smaller teeth, a condition that agrees very well with the condition described by T. Scott (1904, p. 60, pl. vi, fig. 21) in *Euchaeta hebes* var. *valida*. Five

inner setae arise from the inner margin of the segment. The endopod consists of a single joint, the inner margin bears three setae and two arise from the distal end; the outer margin exhibits a small spine-like projection at the junction of the 1st and 2nd quarters of its length and a small seta arises at about the junction of the middle and distal thirds.

In both the 3rd and 4th swimming legs the degree of development at this stage resembles that of the 2nd leg, the exopod consisting of two joints and the endopod of a single one. In the 4th leg the proximal segment of the exopod does not carry an inner seta, whereas such a seta is present on the corresponding segment of the 3rd leg.

There is no trace of any fifth pair of legs.

♂ Total length, 4.31 mm.

The proportional lengths of the cephalothorax and abdomen are as 53 to 16.

The forehead and rostrum are as in the female. The posterior thoracic margin is rounded but at the apex of the curve is produced in a small spinous projection.

The abdomen consists of only three segments that have the following proportional lengths:—

Abdominal segment	1	2	3-5	Furca.	
	29	27	27	17	=100

Unfortunately all the furcal setae are broken off short.

The 1st antenna reaches back to the posterior thoracic margin. The 8th and 9th segments and the 24th and 25th are respectively fused. The various segments have the following proportional lengths:—

Segment	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	
	75	36	21	21	23	23	23	30	19	21	26	33	36	41	46	52	54	75	72	67	64	57	85	=1000

Segments 3, 9 and 14 all bear long setae.

The mouth-parts and swimming legs are identical with those of the female.

The 5th pair of legs consist of a two-jointed basal portion; each ramus possesses one joint only. The legs of the two sides are symmetrical; the exopods being about twice the length of the endopods.

In this series of developmental forms we again see that the proportional length of the antennal segments tends to vary in the different stages of development. In the following table I have given the proportional lengths of the antennal segments in the three stages of development of both sexes:—

Segment	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
♀																							
Copepodid																							
Stage IV	73	38	20	20	20	23	23	31	18	20	25	36	41	46	48	53	56	71	66	64	64	59	85
Stage V	52	38	19	19	24	24	24	33	21	21	33	38	40	49	54	56	59	71	66	64	59	56	80
Adult	44	39	22	22	25	23	25	31	21	21	25	37	41	48	60	60	62	74	70	62	58	52	77
Segment	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
♂																							
Stage IV	75	36	21	21	23	23	23	30	19	21	26	33	36	41	46	52	54	75	72	67	64	57	85
Stage V	52	38	19	19	24	24	24	33	21	21	33	38	40	49	54	57	59	71	68	64	59	57	80
Stage VI	44	40	19	21	25	25	32	64	21	25	39	39	48	57	57	60	71	67	60	60	53	75	

In the proximal segments 1 to 18 there is a clear tendency for the length of each segment to become proportionally greater at each successive moult. This is particularly well seen in segments 1, 5, 7, and 13 to 18. In the distal segments 19 to 25 the proportional length of the segments steadily decreases at each ecdysis.

***Paraeuchaeta tuberculata* A. Scott.**

Paraeuchaeta tuberculata, A. Scott, 1909, p. 76, pl. xxi, figs. 1-8.

This species was taken originally by the "Siboga" in the Malay Archipelago and was described by A. Scott. Three examples that appear to be identical with Scott's species occur in the "Investigator" collection at Station 393. They measure 6.5 mm. in length.

***Paraeuchaeta weberi* A. Scott.**(Text-fig. 63, *a-f.*)*Paraeuchaeta weberi*, A. Scott, 1909, p. 74, pl. xv, figs. 9-16.*Paraeuchaeta weberi*, Sewell, 1913, p. 354.

This species has hitherto been recorded only from the Malay Archipelago, where it was taken by the "Siboga." Four adult females occur in the "Investigator" collection at Station 670 and associated with these are numerous examples of an immature *Paraeuchaeta* of both sexes that I believe to belong to this species. I have, therefore, taken the opportunity of giving a somewhat more detailed account of this species than that given by Scott, so that the growth-stages can be compared with one another.

Adult.

♀ Total length, 7.562 mm.

The proportional lengths of the cephalothorax and abdomen are as 81 to 40, the abdomen thus being almost exactly half the length of the anterior region.

The general shape and proportions of the body agree with Scott's description and figures. Scott states that the last thoracic segment has no tuft of hairs, but in these examples there is on the inner side of the last thoracic segment a distinct tuft of *short* hairs that does not project beyond the posterior thoracic margin.

The abdomen consists of four segments having the following proportional lengths:—

Abdominal segment	1-2	3	4	5	Furca.	
	42	25	18	4	11	= 100

The length of the abdomen in these examples appears to be rather longer in proportion to the cephalothorax than in Scott's examples. Scott gives the length as distinctly less than one-half the length of the cephalothorax, but in all my examples it is as nearly as possible half the length. The structure of the genital segment agrees exactly with Scott's description. The 2nd and 3rd joints are sparsely clad with long hairs on the ventral aspect. The 2nd furcal seta is two and a half times the length of the others and the accessory seta is much longer than the 2nd seta, but unfortunately in all my specimens the extreme tip had been broken off. The proportional lengths of these setae are as follows:—

Ordinary furcal seta	..	73
2nd furcal seta		173
Accessory seta	.	230+

The 1st antenna extends to about the middle of the genital segment. Segments 8 and 9 are fused, as also are segments 24 and 25, and the joint between segments 12 and 13 appears to be incomplete. The proportional lengths of the segments are as follows:—

Segment	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	
	81	49	21	21	23	25	25	33	21	23	30	38	39	43	54	56	56	69	66	59	54	48	66	= 1000

Segments 3, 7, 9, and 14 all bear long setae and segments 2 to 13 are fringed with hair on their posterior surfaces.

The 2nd antenna bears a row of long hairs on the posterior and inner aspect of the 1st basal segment. The endopod bears 6 and 8 (? 9) setae on the outer and inner lobes respectively of the distal segment.

The mandible has a single stout seta on the basal segment of the palp. The endopod is two-jointed, the proximal segment bearing a single seta and the distal having a row of

nine on its truncated extremity. The exopod consists of five segments, of which 1 to 4 inclusive each bear a single long seta and the 5th segment bears two smaller ones.

In the maxilla the masticatory lobe bears 13 setae and the 2nd and 3rd inner lobes one each. The basal segment bears 4 setae and the endopod bears 7 setae on segments 1 and 2, and 3 setae on segment 3. The exopod carries 11 setae and the outer lobe 10.

In the 2nd maxilla the various lobes bear the following number of setae :—

Lobe 1	..	3
Lobe 2	..	3
Lobe 3	..	3
Lobe 4	..	3
Lobe 5	...	3
Endopod	..	5 inner and 1 outer

The proximal three lobes are provided with a tuft of needle-like spinules on the distal part of the posterior aspect.

The maxilliped exhibits one of the characteristics of the genus in the absence of any setae on the anterior margin of the 2nd basal segment at the junction of the proximal and middle-thirds of its length. The numbers of the setae on the various parts of the appendage are as follows :—

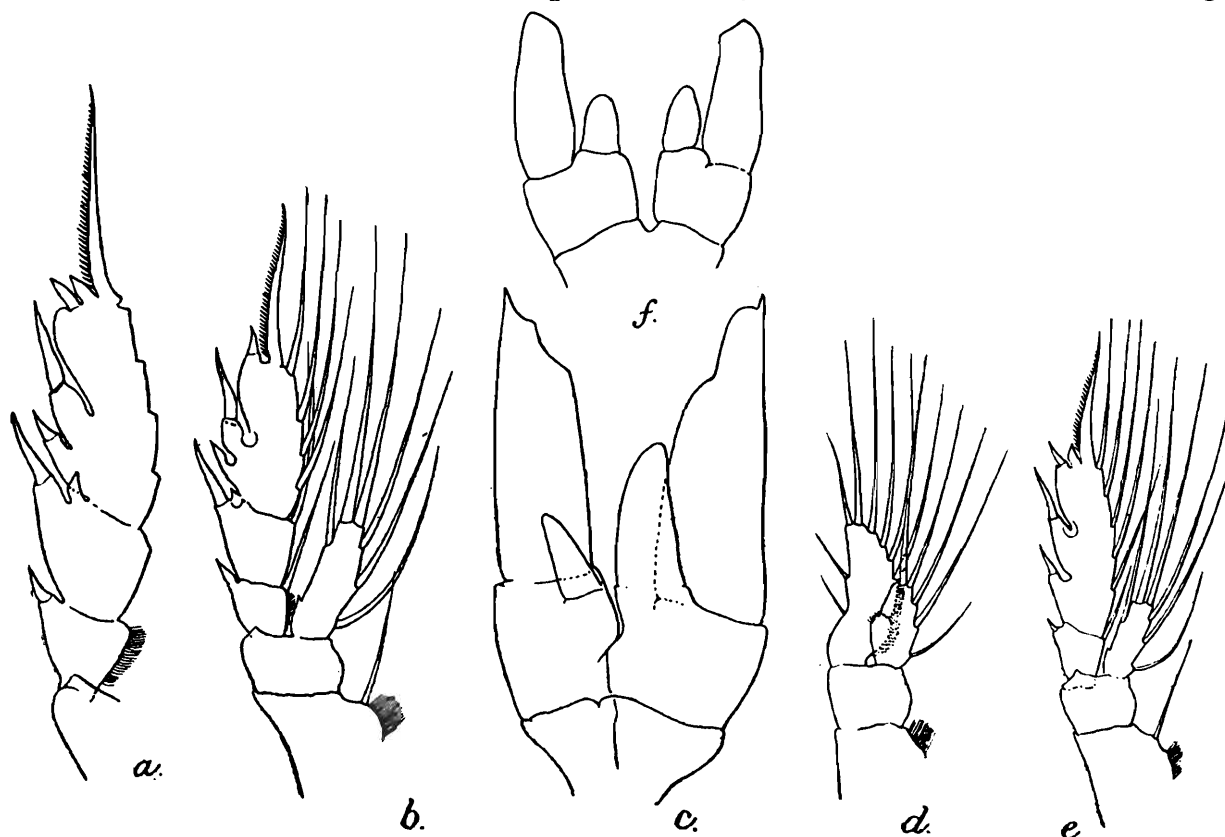
Distal extremity of basal 2	2 unequal setae.
Endopod 1.	2 large and 2 smaller unequal setae.
Endopod 2.	1 large and 2 smaller unequal setae.
Endopod 3.	1 large and 1 small seta.
Endopod 4.	1 large and 1 small seta and 1 external seta.
Endopod 5.	2 large and 2 small setae.

The 1st swimming leg possesses a two-jointed basal portion. Basal 1 is fringed with hair on its inner margin ; basal 2 is similarly fringed and carries an S-shaped seta at its distal inner angle. The exopod is imperfectly three-jointed ; the joint between exopod 1 and 2, though defined, is not complete. Each of the segments bears a seta-like marginal spine, that on the 1st segment being very small and delicate. The inner margin of segments 1 and 2 is fringed with hair. Exopod 2 carries a single seta and exopod 3 has three on their respective inner margins. The end-spine is long and seta-like and is serrated in its middle third. The endopod consists of a single segment ; the outer margin is produced in a rounded lobe, across which runs a row of needle-like spinules, and two setae arise from the distal end and three from the inner margin.

In the 2nd swimming leg (text-fig. 63, *a*) only the inner margin of the 1st basal segment is fringed with hair, that of the 2nd segment being naked. The exopod is three-jointed ; exopod 1 bears a short marginal spine and a single inner seta ; exopod 2 bears a long marginal spine, that reaches very nearly to the tip of the proximal spine on exopod 3, and a single inner seta ; the outer margin of the segment is fringed with hair ; exopod 3 bears three marginal spines of which the first is small and reaches only about half-way to the base of the second spine, which is long and reaches to the base of the 3rd spine ; the sinus at the base of the 2nd spine is deep and reaches to a line drawn between the base of the 1st marginal spine and the base of the 2nd inner seta ; four setae arise from the inner margin of the segment. The end-spine is coarsely serrated, a series of smaller single teeth alternating with the larger ones. The endopod consists of only a single joint ; a short spine-like projection

arises from the outer margin near the base and a small seta arises from the same margin distally. Two long setae arise from the distal end of the segment and three from its inner border.

In the 3rd swimming leg basal 1 bears an inner seta and the inner border of basal 2 is smooth and devoid of hairs. The exopod is three-jointed and the 1st and 2nd segments



TEXT-FIG. 63.—*Paraeuchaeta weberi* A. Scott.

a. The 2nd swimming leg; adult ♀.	d. The 1st swimming leg; Copepodid Stage IV, ♀.
b. The 2nd swimming leg; Copepodid Stage V, ♀.	e. The 2nd swimming leg; Copepodid Stage IV, ♀.
c. The 5th pair of legs; Copepodid Stage V, ♂.	f. The 5th pair of legs; Copepodid Stage IV, ♀.

each bear a single marginal spine and a single seta on the inner margin. Exopod 3 bears three spines and the interval between the 2nd and 3rd spines is about one and one-quarter times as long as that between the 1st and 2nd. The end-spine is serrated, as in the second leg, with a row of smaller spines between the larger ones. Four setae arise from the inner margin of the 3rd segment. The outer margin of the 2nd segment and the proximal part of the 3rd segment is fringed with hair. The endopod is composed of three segments; endopod 1 and 2 each have a small spine-like projection at the distal outer angle, that on endopod 2 being much the smaller. Each segment bears a single seta. Endopod 3 bears a single small seta on its outer margin, two long setae distally and 2 on its inner border.

The 4th swimming leg is like the third, but the interval between the marginal spines on the third segment of the exopod is subequal, and the endopod is slightly longer in proportion to the exopod.

There is no trace of any 5th pair of legs.

Copepodid Stage V.

♀ Total length, 4.938 mm.

The proportional lengths of the cephalothorax and abdomen are as 56 to 23, so that at this stage the abdomen is contained 2.4 times in the length of the anterior region.

The separation between the head and the 1st thoracic segment is indicated across the dorsal region ; thoracic segments 4 and 5 are completely fused. The rostrum points downwards and forwards and the posterior thoracic margin is produced in a sharp spine, as in the adult.

The abdomen consists of four segments, having with the furcal ramus the following proportional lengths :—

Abdominal segment	1	2	3	4-5	Furca.	
	26	20	25	16	13	=100

The 3rd abdominal segment bears a tuft of long hairs on its ventral aspect. The 2nd furcal seta is over three times the length of the others and the accessory seta is at least as long as the others. The furcal ramus is fringed with hairs on its inner margin and there are scattered hairs on its surface.

The 1st antenna reaches back to the posterior thoracic margin. The 3rd, 7th, 9th and 14th segments each bear a long seta and segments 4 to 12 inclusive have a fringe of hairs on their posterior aspects.

The proportional lengths of the segments are as follows :—

Segment	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	
	53	41	22	22	24	24	27	34	20	23	31	39	40	45	53	56	59	72	68	63	58	54	76	=1000

The 2nd antenna possesses the adult form ; the endopod reaches a little beyond half the length of the exopod, which consists of the usual 7 segments. The inner and distal lobes of the endopod bear 7 and 6 setae respectively.

The mandible is fully developed. The palp consists of a pyriform basal segment, bearing one stout seta ; the exopod bears one long seta on each of the proximal four segments and two on the 5th segment ; the endopod consists of two segments, the proximal having a single marginal seta and the distal bearing a row of 8 at its extremity.

The maxilla is fully developed except as regards the number of setae on certain of its lobes and segments. The actual number of setae present on the various parts is as follows :—on the 2nd and 3rd inner lobes 1 seta each ; the basal segment bears 4 ; the endopod bears only 5 setae on segments 1 and 2 together and 3 setae on segment 3 ; the exopod bears 10 setae and the outer lobe only 9.

The 2nd maxilla resembles that of the adult and already carries its full number of setae.

The maxilliped has the general shape and proportions of the appendage in the adult, the only difference being that the 1st segment of the endopod carries only 2 large setae and 1 small one, whereas in the adult there are two small ones, making four in all.

In the 1st swimming leg the basal portion consists of two segments. Basal 1 is devoid of setae and its inner margin is fringed with hairs. Basal 2 has a hairy inner margin and bears the usual S-shaped seta at its distal inner angle. The exopod consists of only two joints, segments 1 and 2 not being separated. The combined joint has a concave outer border and bears a delicate seta-like marginal spine at the bottom of the concavity and a second larger one at the distal angle. The inner margin is fringed with hairs and a single inner seta arises at the distal angle. Exopod 2 bears a seta-like marginal spine and the end-spine is long and seta-like and is serrated in its distal half ; three setae arise from the inner border of the segment. The endopod consists of a single joint ; the outer border is produced in a rounded process, which bears a row of small needle-like spinules. Two setae arise from the distal end and three from the inner margin.

In the 2nd swimming leg (text-fig. 63, *b*) the 1st basal segment bears an inner seta and the inner border is fringed with hairs. Basal 2 is devoid of a seta and the inner margin appears to be smooth. The exopod is three-jointed, as in the adult. Exopod 1 bears a short marginal spine and a comparatively short inner seta, while the inner margin is fringed with hair. Exopod 2 bears a long curved marginal spine, which reaches about half way along the proximal spine on exopod 3, the inner margin is smooth and a single seta arises from the distal inner angle. Exopod 3 bears three marginal spines, of which the proximal is short, whereas the 2nd is long and reaches to the base of the distal spine, which is also short ; the end-spine is

serrated and has the appearance of coarse teeth alternating with delicate fine ones. The sinus at the base of the 2nd marginal spine is much less deep than in the adult and does not nearly reach to the line drawn between the base of the proximal spine and the 2nd seta. Four setae arise from the inner border. The endopod consists of a single joint; there is a small spine-like projection on the outer margin near the base and a single seta arises from this border distally; two setae arise from the distal end of the segment and three from the inner margin. The outer margin is fringed with hair.

The 3rd and 4th swimming legs appear to be the same as in the adult and there is no trace of any 5th pair of legs.

♂ Total length, 4.81 mm.

The proportional lengths of the cephalothorax and abdomen are as 56 to 21, so that the abdomen is contained 2.67 times in the length of the anterior region.

The shape and general characters of the body are similar to those of the female at the same stage of development. The proportional lengths of the abdominal segments are, however, somewhat different, as follows:—

Abdominal segment	1	2	3	4-5	Furca.
	22	23	23	17	15
	= 100				

The 2nd furcal seta is thickened and much elongated; in the specimen examined the extreme tip was broken off but even so this seta was more than two and a half times the length of the others. The accessory seta is also longer than the others, the actual lengths being as follows:—

Ordinary furcal seta	..	..	..	..	..	51
2nd furcal seta		..	..	..	..	126+
Accessory seta	..	..	..	..	..	58

The 2nd abdominal segment is provided with a tuft of hair on its ventral aspect.

The 1st antenna reaches back to the posterior thoracic margin. The proportional lengths of the various segments are as follows:—

Segment	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
	53	41	22	22	24	24	24	34	22	24	34	38	38	43	53	55	58	72	70	62	58	55	74
	= 1000																						

A comparison of these figures with those given above for the female (*vide supra*, p. 172) reveals a very close agreement.

The 2nd antenna and mouth-parts are identical with those of the female at the corresponding stage of development.

The 1st pair of swimming legs closely resemble those of the female, but the concavity in the outer margin of the proximal segment of the exopod is considerably deeper.

The 2nd, 3rd and 4th pairs of legs are similar to those of the female.

A rudimentary 5th pair of legs (text-fig. 63, c) is present; at this stage the basal part consists of two segments and the rami are single-jointed. The endopod of the left leg is very much smaller than that of the right leg. Both exopods are constricted at about the junction of the third and last quarters and the narrow terminal portion ends in both legs in a small sharp point.

Copepodid Stage IV.

♀ Total length, 3.55 mm.

At this stage the proportional lengths of the cephalothorax and abdomen are as 45 to 13, so that the abdomen is contained 3.46 times in the length of the anterior region.

The fusion between the cephalon and the 1st thoracic segment is incomplete and the line of separation can be clearly traced across the dorsal region; segments 4 and 5 of the thorax are fused. The posterior thoracic margin is produced in a small pointed process.

The abdomen consists of only three segments, which have almost exactly the same length. The proportional lengths of the segments and the furcal rami are as follows :—

Abdominal segment	1	2	3-5	Furca.	
	28	27	27	18	= 100

Of the furcal setae the 2nd is considerably stouter than the others but in all my examples was broken off short. The accessory seta is at least as long as the rest.

The 1st antenna consists of twenty-three free segments ; segments 8 and 9 and 24 and 25 respectively being fused. The proportional lengths of the various segments are as follows :—

Segment	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	
	53	35	18	18	24	24	24	32	19	21	29	35	41	47	50	56	59	67	70	64	62	59	90	= 1000

Segments 3, 7, 9 and 14 all bear long setae.

The 2nd antenna has the shape and proportions of the appendage in the adult. The terminal segment of the endopod bears 6 setae on its outer lobe and 5 on the inner.

The mandible is as in the adult but the endopod bears only 7 setae.

The maxilla also possesses the general shape of the appendage in the adult but bears fewer setae ; the numbers on the various parts are : on the 1st inner or masticatory lobe, 12 setae ; the 2nd and 3rd inner lobes, 1 each ; the basal segment bears 4 ; endopod 1 and 2, 5 setae ; endopod 3, 3 setae ; the exopod bears 9 setae and the outer lobe 6.

The 2nd maxilla resembles that of the adult.

In the maxilliped the general shape is as in the adult but the number of setae on certain of the segments is less ; as follows :—

On the distal portion of basal 2	..	2 unequal setae.
Endopod 1		2 long setae.
Endopod 2	.. ..	1 long seta and 1 short one.
Endopod 3	..	1 long seta.
Endopod 4	.. ..	1 long seta and 1 external seta.
Endopod 5	.. ..	4 unequal setae.

In the 1st swimming leg (text-fig. 63, *d*) the basal portion is two-jointed ; both basal segments are fringed on their inner margins with long hairs and the 2nd basal bears an S-shaped seta at its distal inner angle. Both rami consist of only a single joint. The exopod bears three marginal spines, that increase in size distally, the end-spine is long and seta-like and is serrated in its middle third. Four setae arise from the inner border. The endopod is produced in the usual rounded lobe on its outer margin, the distal border of the lobe being armed with a row of small needle-like spines ; five setae arise from the distal and inner margins.

In the 2nd swimming leg (text-fig. 63, *e*) the 1st basal bears a seta on its inner border and the margin is fringed with hairs. The exopod consists of two joints ; exopod 1 bears a single marginal spine and one seta arises from its inner border ; exopod 2 bears three marginal spines, of which the middle one reaches to the base of the distal. The endopod consists of only a single joint.

In the 3rd and 4th swimming legs the basal segments are as in the 2nd leg. The exopod consists of two joints. In the 3rd leg exopod 1 bears a single seta on its inner margin but this is absent in the 4th leg. In both legs the distal segment of the exopod bears three marginal spines but their spacing on the margin is different in the two legs ; in the 3rd leg the spines are nearly equidistant, but in the 4th leg the interval between the 2nd and 3rd spines is two-fifths of that between the 1st and 2nd spines or between the base of the segment and the proximal spine. In both limbs the endopod consists of only a single joint.

There is no trace of any 5th pair of legs.

The male of this stage corresponds closely with the female, the sole difference between them being the presence of a rudimentary pair of 5th legs (text-fig. 63, *f*), in which each ramus consists of a single segment, and the limbs of the two sides are symmetrical.

In the female I have been able to examine and measure three different stages in the life-history and I give below the actual measurements and the calculated measurement and growth-factor in these stages:—

			Actual length. mm.	Calculated length. mm.	Growth- factor.
Copepodid Stage IV	..	..	3.55	3.55	1.458
„ „ V			4.938	5.176	1.458
Stage VI (Adult)			7.562	7.547	..

The change in the proportional lengths of the segments of the 1st antenna during successive stages of growth can be seen in the following table in which I have given the proportional lengths in Copepodid Stages IV and V and the adult of the female sex:—

Segment	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
Stage IV	53	35	18	18	24	24	24	32	19	21	29	35	41	47	50	56	59	67	70	64	62	59	90
„ V	53	41	22	22	24	24	27	34	20	23	31	39	40	45	53	56	59	72	68	63	58	54	76
„ VI	81	40	21	21	23	25	25	33	21	23	30	38	39	43	54	56	58	67	66	59	54	48	66

In the proximal segments the tendency to an increase in the length with progressing development of the individual is not so clearly marked as in some other species, though it is clearly seen in segments 1, 6, 10, 11 and 16. The decrease in the proportional lengths of the more distal segments is clearly indicated, especially in segments 20 to 25 inclusive.

Family PHAENNIDAE.

Genus PHAENNA Claus.

Phaenna spinifera Claus.

Phaenna spinifera, A. Scott, 1909, p. 80.

Phaenna spinifera, Pesta, 1909, p. 22.

Phaenna spinifera, Wolfenden, 1911, p. 285.

Phaenna spinifera, Pesta, 1912, p. 24.

Phaenna spinifera, With, 1915, p. 241, text-fig. 79, pl. vii, fig. 1 *a-e*.

Phaenna spinifera, Sars, 1925, p. 124.

Phaenna spinifera, Farran, 1926, p. 268.

Phaenna spinifera, Farran, 1929, p. 255.

Phaenna spinifera has now been recorded from several localities in the Indian Ocean as well as from the north and south parts of the Atlantic Ocean. Two examples, both females, occur in the "Investigator" collection at Station 670.

Genus AMALLOPHORA T. Scott.

The genus *Amallophora* contains only a single species, *Amallophora typica* T. Scott, the type on which the genus is founded. This species has been recorded from the Malay Archipelago, where it was taken by the "Siboga" (*vide* A. Scott, 1909, p. 83, pl. xxxvi, figs. 1-8), but up to the present time I have failed to find any specimens of it in the "Investigator" collection.

Genus **HETERAMALLA** Sars.

Like the preceding genus, the genus *Heteramalla* Sars is represented by a single species, namely *H. dubia* (T. Scott). This has been taken by the "Siboga" in the Malay Archipelago (*vide* A. Scott, 1909, p. 86, pl. xxxiii, figs. 1-9) but does not occur in the "Investigator" collections.

Genus **ONCHOCALANUS** Sars.

A. Scott (1909) has recorded two species belonging to this genus from the Malay Archipelago, namely *Onchocalanus cristatus* (Wolfenden) and *O. hirtipes* Sars. Scott appears to have regarded *Onchocalanus trigoniceps* Sars as a synonym of *Onchocalanus cristatus* (Wolfenden), whereas Sars (1925, p. 145) has stated that it is synonymous with *Xanthocalanus magnus* Wolfenden. From an examination of Scott's figures there seems little doubt that he was dealing with examples of *Onchocalanus cristatus* (Wolfenden) and not with *Onchocalanus trigoniceps* Sars. In the "Investigator" collection only this latter species is represented.

Onchocalanus trigoniceps Sars.

Onchocalanus trigoniceps, Sars, 1905 (a), p. 20.

Xanthocalanus magnus, Wolfenden, 1909, p. 32, pl. x.

Onchocalanus magnus, With, 1915, p. 225.

Onchocalanus trigoniceps, Sars, 1925, p. 144, pl. xl.

A single specimen, female, was taken by the "Investigator" at Station 682.

Genus **XANTHOCALANUS** Giesbrecht.

No example of this genus occurs in the "Investigator" collection, but A. Scott (1909, p. 80, pl. xxxii, figs. 10-18) has recorded the capture of *Xanthocalanus agilis* Giesbrecht by the "Siboga" in the Malay Archipelago, and Cleve (1904, pp. 198 and 209) records *X. fragilis* Aurivillius (= ? *X. borealis* Sars) from south of Cape Colony.

Genus **BRACHYCALANUS** Farran.

This genus was represented in the "Siboga" collections by a single immature male on which A. Scott founded a new species, namely *Brachycalanus gigas* A. Scott (1909, p. 81, pl. xxxv, figs. 10-18). No examples of this genus have up to the present time been found in the "Investigator" collections.

Genus **CORNUCALANUS** Wolfenden.

This genus was created by Wolfenden (1905, p. 20) to include two species, *Cornucalanus magnus* and *C. simplex*. In a footnote to his paper he calls attention to the form described by Thompson (1903, p. 21, pl. v, figs. 1-9) from the Atlantic under the name *Scolecithrix chelifera* and he remarks that it probably belongs to the new genus *Cornucalanus*. Most subsequent authors, among whom may be mentioned Farran, A. Scott, van Breemen, With and Sars, have claimed that *Cornucalanus magnus* Wolfenden is identical with *Scolecithrix chelifera* Thompson and that in consequence Thompson's name must be given priority. Wolfenden himself, however, (1911, p. 283, pl. xxxiii, figs. 1, and 2) appears to consider that Thompson's form is synonymous with *Cornucalanus simplex*.

Up to the present time, of the two known species, only *Cornucalanus simplex* has been recorded from the Indian Ocean, having been taken by the "Siboga" in the Malay Archipelago and recorded by A. Scott (1909). In the "Investigator" collection there is a young male that appears to belong to *Cornucalanus chelifer* (Thompson) (= *Cornucalanus magnus* Wolfenden), a single female of *C. simplex* and, in addition, a single specimen that does not agree with either of the two previously-described forms and which I have, therefore, described as a new species under the name *C. indicus*, sp. nov.

***Cornucalanus chelifer* (Thompson).**

(Text-fig. 64, a-f.)

Scolecithrix chelifer, Thompson, 1903, p. 21, pl. v, figs. 1-9.

Scolecithrix chelifer, Farran, 1905, p. 36, pl. vii, figs. 18-19.

Cornucalanus magnus, Wolfenden, 1905, p. 21, pl. vii.

Onchocalanus chelifer, Pearson, 1906, p. 19.

Cornucalanus chelifer, Sars, 1907, p. 27.

Cornucalanus chelifer, Farran, 1908, p. 49.

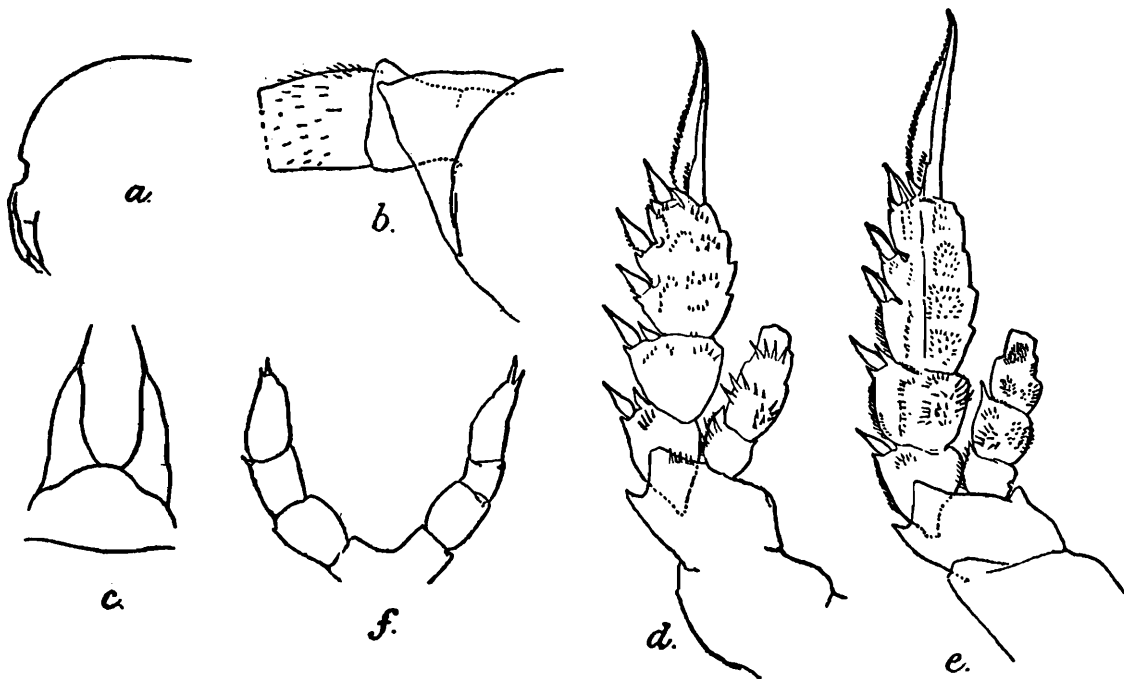
Onchocalanus chelifer, van Breemen, 1908, p. 65, fig. 76.

Cornucalanus magnus, Wolfenden, 1911, p. 281, text-fig. 45, pl. xxxii, figs. 1-10.

Cornucalanus chelifer, With, 1915, p. 222, pl. vii, fig. 4a-h, pl. viii, fig. 15a-g.

Cornucalanus chelifer, Sars, 1925, p. 151, pl. xlii, figs. 1-14.

A single young male that appears to belong to this species was taken at Station 682 by the "Investigator."



TEXT-FIG. 64.—*Cornucalanus chelifer* (Thompson).

a. The anterior end from the left side.

b. The posterior thoracic margin and anterior end of the abdomen from the left side.¹

c. The rostrum.

e. The 4th swimming leg.

d. The 2nd swimming leg.

f. The 5th pair of legs.

♂ (juv.). Total length, 5.4 mm. This agrees very well with the size of Thompson's original example that measured 6.0 mm.; as I have already pointed out examples of species from the Indian Ocean are almost always smaller than specimens from the Atlantic Ocean.

¹ This figure has, unfortunately, been inverted; the dorsal margin is below and the ventral above.

The proportional lengths of the cephalothorax and abdomen are as 141 to 45, the abdomen being thus contained 3.1 times in the length of the anterior region of the body.

The general form of the body closely resembles the figure of *Cornucalanus magnus* given by Wolfenden (1911, pl. xxxii, fig. 1). The posterior thoracic margin (text-fig. 64, b) is produced back in a triangular plate that bears a short spine-like projection at the extreme apex.

The abdomen consists of only four segments, segments 4 and 5 not yet having been differentiated. The proportional lengths of the different segments are as follows :—

Abdominal segment	1	2	3	4 5	Furca.
	24	30	22	13	11
	=100.				

The 2nd to 4th segments bear scattered hairs.

The 1st antenna reaches back to a point just beyond the posterior thoracic margin.

The proportional lengths of the segments are as follows :—

Segment	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
	59	64	24	24	24	24	24	43	18	24	27	35	58	61	61	58	55	49	43	36	46	55	87
	=1000.																						

The terminal segments are thus proportionally longer than in *Cornucalanus simplex*.

The 2nd antenna and mouth-parts appear to agree closely with those of the adult *C. magnus*. In the 2nd maxilla of *C. magnus* there are, according to Farran (1905), only 5 sensory appendages, or at least that is all that he figures, and van Breemen (1908) states that there are five; Wolfenden (1911, p. 282, pl. xxxii, fig. 2), however, states that there are seven clubbed sensory organs and one worm-like one, which is the case in the present example.

In the maxilliped the 2nd basal segment is armed along the proximal half of its length with a row of denticles that increase in size distally; this row is followed by a short gap and then comes a single large denticle, exactly as in the adult male of *C. magnus*.

In the swimming feet the spination of the various segments agrees closely with the figures given by Wolfenden (cf. 1911, pl. xxii, figs. 4, 5 and 6).

***Cornucalanus simplex* Wolfenden.**

(Text-fig. 65.)

Cornucalanus simplex, Wolfenden, 1905, p. 22.

Cornucalanus simplex, Sars, 1907, p. 14.

Cornucalanus simplex, A. Scott, 1909, p. 83, pl. xxxv, figs. 1-9.

Cornucalanus simplex, Sewell, 1913, p. 354.

Cornucalanus simplex, Sars, 1925, p. 153, pl. xlii, figs. 15-20.

A single adult female was taken by the "Investigator" at Station 463.

♀ Total length, 4.0 mm. This is rather smaller than the example recorded by A. Scott, who gives 5.0 mm. as the length, and by Sars, who states that his specimen measured 6.30 mm.

The proportional length of the cephalothorax and abdomen are as 161 to 51, the abdomen thus being contained 3.2 times in the length of the anterior region of the body.

The general shape agrees with the previous descriptions; there is no spine in the frontal region. The posterior thoracic margin is produced backwards in a triangular plate that is rounded at the apex.

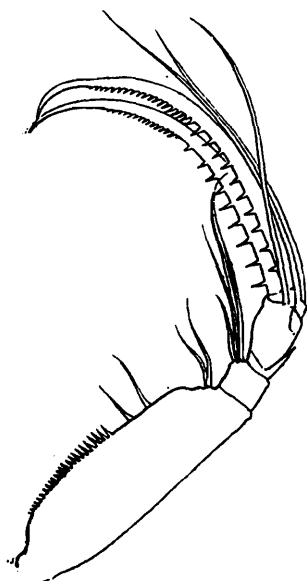
The abdomen consists of four segments, having with the furcal rami the following proportional lengths:—

Abdominal segment	1-2	3	4	5	Furca.	
	45	23	20	2	10	=100.

The genital swelling on the ventral aspect is but slightly enlarged. There are a few hairs on the ventral aspect of the genital segment. The rest of the abdomen is devoid of hairs.

The 1st antenna reaches to the posterior end of the thorax. The segments have the following proportional lengths:—

Segment	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	
	60	55	26	26	26	26	26	43	22	24	27	43	43	62	66	65	60	54	49	43	32	49	73	=1000.



TEXT-FIG. 65.—*Cornucalanus simplex* Wolfenden.
The maxilliped.

The 2nd antenna and mouth-parts agree with the descriptions and figures given by A. Scott and Sars. In the maxilliped (text-fig. 65) there is a row of spines on the 2nd basal joint, the spines increasing in size distally but there is no isolated large spine just beyond the end of the row as there is in *Cornucalanus chelifera* (Thompson). The general characters of the two claw-like spines on the 2nd and 3rd segments of the maxilliped are similar to those of *Cornucalanus chelifera* (Thompson), but the claws appear to be rather longer in the present species and the terminal portion, lying distal to the row of long spines and bearing a row of closely-set small spines, also seems to be longer.

***Cornucalanus indicus*, sp. nov.**

(Text-fig. 66, a-g.)

In the collection made by the "Investigator" at Station 393 is a single specimen that, while undoubtedly belonging to this genus, appears to be a new species or an intermediate form between *Cornucalanus chelifera* (Thompson) and *C. simplex* Wolfenden. The specimen was a female.

♀ Total length, 8.0 mm.

The proportional lengths of the cephalothorax and abdomen are as 2.8 to 1.0.

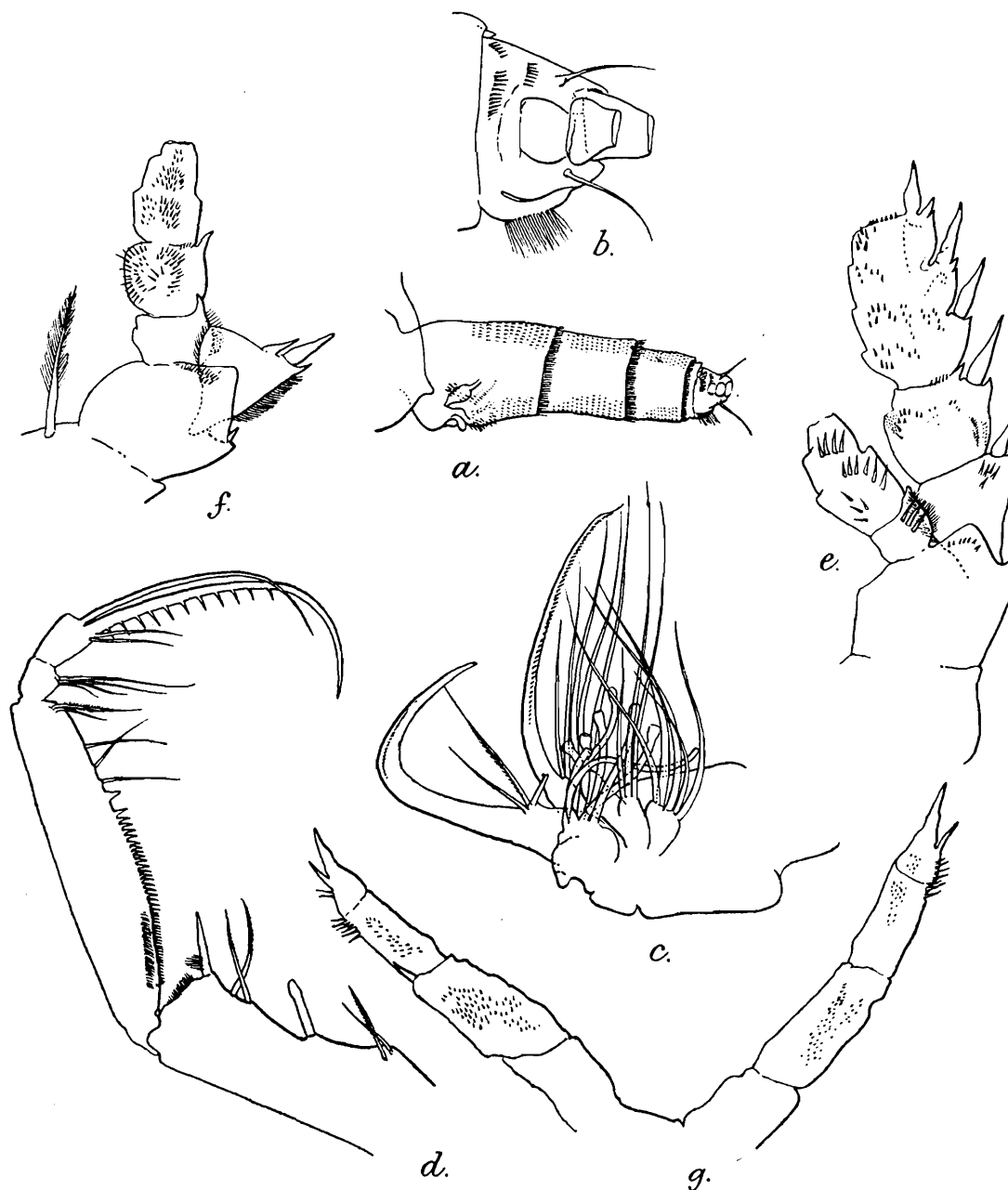
The head is separate from the 1st thoracic segment and thoracic segments 4 and 5 are also separate. The forehead shows a rounded curve with no trace of any median frontal spine; in this respect, therefore, the species resembles *Cornucalanus simplex* Wolfenden. The posterior thoracic margin (text-fig. 66, a) is produced backwards in a triangular plate that terminates in a short spine-like projection. The rostrum is strong and each spine terminates in a fine flagellum.

The abdomen consists of four segments, having the following proportional lengths:—

Abdominal segment	1-2	3	4	5	Furca.	
	46	27	17	3	7	=100.

The genital segment presents a uniformly rounded swelling ventrally; the ventral surface, posterior to the genital orifice, bears scattered hairs, and there is a patch of small scattered hairs on the lateral aspect. The furcal rami (text-fig. 66, b) are fringed with hairs

on their inner and ventral aspects, and dorsally are armed with short rows of needle-like spines. Abdominal segments 1 to 3 inclusive are either fringed with very fine hairs on their posterior aspects or else the marginal cuticle is finely striated. I am unable to determine which. Both dorsal and ventral aspects of these segments are covered with transverse rows of minute scale-like markings from most of which a minute hair still projects.



TEXT-FIG. 66.—*Cornucalanus indicus*, sp. nov.

- a. The posterior thoracic margin and abdomen from the left side.
 b. The anal segment and furcal ramus.
 c. The 2nd maxilla.
 d. The maxilliped.
 e. The 2nd swimming leg.
 f. The 4th swimming leg.
 g. The 5th pair of legs.

In the 1st antenna segments 8 and 9 are fused but segments 24 and 25 are distinctly separate, so that in this feature this species appears to differ from both previously described forms, in which the antenna consists of only 23 free segments. The proportional lengths of the segments are as follows :—

Segment	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
	44	50	26	22	24	22	22	37	24	31	37	48	46	66	70	74	66	57	53	44	29	40	53	15 = 1000.

In the 2nd antenna the 1st basal segment bears a row of long hairs on its base and a single seta distally. Basal 2 bears a single seta. The endopod consists of two segments; segment 1 bears a single marginal seta near its distal end and segment 2 bears 8 setae, of which the inner three are shorter than the rest, on its inner lobe and 6 setae on the outer lobe. The exopod consists of 7 segments, of which 1 and 2 are devoid of setae, segments 3 to 6 each carry a single seta and the terminal segment bears a single seta about the middle of its length and three at its apex.

In the mandible the 1st basal bears a stout tooth-process, the distal end of which is beset with hairs; basal 2 bears 2 setae. The endopod arises from the extreme end of the 2nd basal segment and consists of 2 segments, the 1st of which carries a single seta and the 2nd 9 setae. The exopod consists of 5 segments; segments 1 to 4 each bear a single seta and the 5th carries 2.

Thompson in his account of *Cornucalanus chelifer* has figured the 1st maxilla as the 2nd or anterior foot-jaw. In the present specimen the 2nd inner lobe bears 2 setae and the 3rd lobe 4; the basal segment possesses 5 setae and the endopod bears 3, 3 and 5 setae on its three segments; the external lobe is provided with 7 setae, 5 of which are long and the other 2 short.

In the 2nd maxilla (text-fig. 66, *c*) the 1st lobe bears 5 setae; the 2nd to 4th lobes inclusive each bear 3 setae; one of the setae arising from the 4th segment is much stouter than the others and is armed with a row of triangular teeth; the 5th lobe bears a stout sickle-shaped claw armed with small teeth along its 3rd quarter; three setae arise from the base of this claw, of these one is angulated and the other two are normal in character but are of unequal size. The extremity bears a lobe fringed with 7 sensory processes and a single seta. A. Scott in his account of *Cornucalanus simplex* states that this lobe in that species bears 6 sensory processes and two setae.

In the maxilliped (text-fig. 66, *d*) the 1st basal bears on the 1st lobe 1 seta; on the 2nd lobe 2 setae; on the 3rd, 1 seta and a sensory organ (or it may be a broken seta); lobe 4 possesses two setae and a stout spine. The distal truncated end of the 1st basal segment is fringed with fine spines. The proximal part of basal 2 is beset with fine spines and the middle part of the anterior margin bears a row of fine spines, which increase somewhat in size distally, and there is a single enlarged tooth, separated by a short interval from the others. In this latter feature this specimen agrees exactly with the condition found in *Cornucalanus chelifer* (Thompson). Distal to this isolated tooth three setae arise from the anterior margin and two setae arise distally. The 1st segment of the endopod bears four unequal setae; the 2nd segment bears two short, and a long and stout spine that is beset with isolated teeth, usually 11 in number, along the proximal two-thirds of its length and just beyond the distal tooth is a row of fine teeth, and distal to this stout spine arises from the same segment a second somewhat shorter and much more slender spine. The terminal portion of the maxilliped is unfortunately missing in my specimen.

In the 1st leg both basal segments are fringed with hairs; basal 1 has no seta and basal 2 carries a single seta on its inner margin. The exopod consists of three segments. Of these the first carries a marginal spine that is serrated and reaches well beyond the base of the second spine; the inner border of the segment is beset with hairs and bears no seta. The second segment bears a long marginal spine that is serrated, the outer margin of the

segment is beset with hairs, as also is the inner border; a single seta arises at the distal internal angle and at its base on the posterior surface is a group of needle-like spinules. The third segment bears a single serrated marginal spine and a long end-spine; the outer margin of the segment is beset with hairs; three setae arise from the inner margin and at the base of the distal two are a few small spinules on the posterior aspect of the segment. The endopod consists of a single segment and reaches to the level of the joint between segments 2 and 3 of the exopod; the outer margin shows the usual rounded swelling which is beset with fine spines, five setae arise from the segment.

In the 2nd leg (text-fig. 66, e) basal 2 bears a small marginal spine and a row of small teeth runs along the distal margin of the segment near the joint with the exopod. Exopod 1 bears a marginal spine and a single inner seta, a group of four or five spines is situated on the posterior aspect of the segment near the base of the marginal spine. Exopod 2 bears a marginal spine and an inner seta and the outer margin is beset with hairs, on the posterior aspect is a linear group of minute spines towards the outer margin and small spines are scattered over the surface. Exopod 3 bears three marginal spines and the outer border of the proximal part of the segment is fringed with hairs, the inner margin bears four setae and at the base of each is a row of spines that increase in size towards the margin, a corona of fine spines is situated near the insertion of the end-spine. The endopod consists of two joints; endopod 1 bears a single seta and there is a group of large spines on the posterior surface; endopod 2 bears five setae and there are two groups of large spines on the posterior surface. The outer margins of both segments are fringed with hairs.

In the 3rd leg the basal segments resemble those of the 2nd leg. The exopod is three-jointed; exopod 1 bears a marginal spine and the outer border is fringed with hairs, there is a row of spines near the outer border. In the second joint of the exopod on the posterior aspect there is a row of short lancet-shaped spines near the external margin, a linear group of needle-like spines internal to this, and another group at the base of the marginal spine; a group of spines is situated near the base of the inner seta and a row of spines runs along the distal border. The third segment bears three marginal spines; the proximal part of the outer margin is fringed with hairs; a group of small spines lies at the base of each marginal spine and a row of spines runs across the distal margin near the articulation of the end-spine; the inner margin bears four setae, at the base of each of which is a group of small spines. The end-spine is, unfortunately, broken off short but sufficient remains to show that, the marginal teeth are fused together in the middle of their length, their bases being separate so that there is a series of minute holes left between them. The endopod consists of three segments; endopod 1 bears a single seta and there is the usual group of small spines near its base; endopod 2 also bears a single seta with a similar group of small teeth at its base, from the posterior surface arises a row of 6 large teeth and a scattered group of curved needle-like teeth is situated near the base of the inner seta; both endopod 1 and 2 are produced in a marginal spine at the distal outer angle; endopod 3 bears 5 setae, on the posterior aspect is situated a curved row of large triangular spines opposite the 2nd seta and a group of small spines near the base of the 1st seta.

In the 4th leg (text-fig. 66, f), which closely resembles the third, the spines on the endopod are all of the same character. The 5th pair of legs (text-fig. 66, g) are slightly asymmetrical; each leg consists of three segments. The 2nd and 3rd segments are fringed

with scattered minute hairs. Running across the distal segment about one-third of its length from the distal end is a line of chitin that appears to indicate a fusion of two segments. The terminal segment is pointed, as in *Cornucalanus chelifera*, but the length of the segment is greater in the present species; the segment terminates in two spines of unequal size, the inner being much the larger, and the outer aspect bears a group of small needle-like teeth.

This species appears to be intermediate between *Cornucalanus chelifera* and *C. simplex*.

Family SCOLECITHRICIDAE.

Genus **SCOTTOCALANUS** Sars.

In this genus Cleve (1904a) recorded the occurrence of *Scottocalanus securifrons* (T. Scott) and *S. persecans* (Giesbrecht) from the Agulhas Current and A. Scott (1909) also records their occurrence in the collections made by the "Siboga" in the Malay Archipelago; he, however, identifies the former species with the form previously described by Lubbock (1856) under the name *Undina helenae*. He also added the following species to the list of those known from these waters.

Scottocalanus farrani.
Scottocalanus setosus,
Scottocalanus longispinus and
Scottocalanus thomasi.

In the "Investigator" collections from Indian waters I have been able to find examples of *Scottocalanus farrani*, *S. helenae* and *S. thomasi*, and, in addition, I have obtained examples of what appears to be a new species, to which I propose to give the name *Scottocalanus daughlihi*, as well as an unknown male which I have called *S. investigatoris*.

Scottocalanus farrani A. Scott.

Scottocalanus farrani, A. Scott, 1909, p. 106, pls. xxiv, figs. 1-9 (♀) and xxix, figs. 11-18 (♂).

Scottocalanus farrani, Sewell, 1913, p. 354.

A single specimen that appears to agree exactly with Scott's description and figures was obtained at "Investigator" Station 682.

Scottocalanus helenae (Lubbock).

Undina helenae, Lubbock, 1856, p. 25, pl. iv, fig. 4 and pl. vii, figs. 1-5.

Scolecithrix securifrons, T. Scott, 1893, p. 47, pl. iv (♂).

Undina helenae, Giesbrecht and Schmeil, 1898, p. 52.

Scolecithrix persecans, Farran, 1908, p. 58.

Scottocalanus helenae, A. Scott, 1909, p. 111, pl. xxvii, figs. 1-9.

Scottocalanus thorii, With, 1915, p. 215, pl. vi, fig. 14a-c and pl. viii, fig. 14a-b; and text-figs. 68a-i, 69a-d, 70a-d.

Scottocalanus thori, Farran, 1926, p. 266.

A. Scott, who examined specimens of this species taken by the "Siboga," concluded that it was identical with the form described by Farran (1908) under the name *Scolecithrix persecans* and he further regards it as identical with the form described and figured by Lubbock under the name *Undina helenae*. With (1915, p. 215) under the name *Scottocalanus*

thorii, sp. nov. described a form that, so far as the male is concerned, seems to be identical with *Scottocalanus helenae* (Lubbock). With agrees that his form is identical with the specimens recorded by Farran under the name *Scottocalanus persecans* and that of the male described by T. Scott under the name *Scolecithrix securifrons*, but he appears to have overlooked the fact that A. Scott (1909), believing this male to be identical with *Undina helenae* Lubbock, has recorded its occurrence under that name in the "Siboga" collections. After seeing Lubbock's paper and comparing his figures and those given by A. Scott with the present example in the "Investigator" collection I am inclined to agree with A. Scott that it is the same species. Lubbock's name, therefore, takes priority. Sars (1925, p. 157) considers that *Scottocalanus thorii* With is a synonym of *S. persecans* (Giesbrecht), but in this I think he is wrong.

The species is, evidently, one of wide distribution; it was first recorded from the North Atlantic, and since then its distribution has been extended to the South Atlantic, the Malay Archipelago and the northern part of the Indian Ocean. A single example was taken at "Investigator" Station 670.

Scottocalanus thomasi A. Scott.

Scottocalanus thomasi, A. Scott, 1909, p. 109, pl. xxvi, figs. 1-10 and pl. xxviii, figs. 10-17.

Four examples of this species were taken at "Investigator" Station 670.

♀ The body has the shape and general appearance as figured by Scott. The genital segment of the abdomen bears a finger-like, backwardly directed projection near the posterior margin a little to the left of the middle line.

The 1st antenna reaches beyond the tip of the furcal ramus by the last two segments.

The proportional lengths of the segments are as follows:—

Segment	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
	56	46	23	26	29	29	29	50	24	36	42	50	52	52	52	52	54	52	46	46	46	49	49	10 = 1000

In the 2nd antenna the 1st basal segment bears a row of curved setae. The endopod is about one-half the length of the exopod. The exopod consists of 6 segments; of these, the 1st has a rounded swelling on its inner border; the 2nd bears two unequal setae distally; the 3rd-5th inclusive each bear a single long seta; the 6th segment bears one seta at about one-fourth of its length and 3 long setae distally.

In the mandible the palp is well developed. Basal 1 bears a stout seta proximally and a second about half way along its length. The endopod consists of two segments; the 1st bears two setae on its inner border; the 2nd has 9 setae distally and is armed with curved spines on its outer margin. The exopod consists of 5 segments, of which the proximal four bear a single long seta and the terminal segment carries two unequal setae.

In the 1st maxilla the 2nd inner lobe bears 2 setae and the 3rd three. The 2nd basal segment carries 5 setae and is fringed with hair along the inner margin. The three segments of the endopod bear respectively 3, 4 and 4 setae and the exopod has 8. The outer lobe appears to have 9 setae.

In the 2nd maxilla the 1st lobe bears 4 setae; the 2nd, 3rd and 4th each bear 3 setae, and the 5th lobe bears 3 setae, of which one is very thick and stout. The terminal portion of the appendage carries, as in other members of the genus, two kinds of filaments, one kind being long and simple and the other shorter and swollen at the distal end.

In the maxilliped the 1st basal segment bears a sensory seta about the middle of its length ; at its distal end it bears three setae, of which the most distal is thickened and spine-like. The distal part of basal 1 and the whole length of basal 2 is armed with spinules. Basal 2 bears 2 setae about the middle of its length and 2 others distally. The endopod consists of the usual 5 segments, of which the 2nd is much the longest ; segments 1 and 2 each bear 4 setae, segments 3 and 4 bear 4 and the terminal segment bears 4 setae on its inner and distal aspects and a 5th on its outer aspect.

The 1st swimming leg consists of the usual two-jointed basal portion and an inner and outer ramus, of which the outer consists of three segments, while the inner is unjointed. The 1st segment of the exopod bears no seta on its inner margin but the inner border is produced in a rounded swelling which is fringed with hair ; the outer border bears distally a single marginal spine, which reaches about two-thirds the distance to the base of the spine on segment 2. In the 2nd segment the marginal spine arises from a distally-directed finger-like projection and extends nearly to the base of the marginal spine on segment 3 ; the inner border bears a single seta and is fringed with hair. The 3rd segment bears a marginal seta and a long and seta-like end-spine ; three setae arise from the inner margin. The outer margin of the terminal segment is fringed with hair in its proximal half. The endopod consists of a single joint, bearing 5 setae ; the outer margin is produced in a rounded lobe that is armed with needle-like spinules.

In the 2nd leg the 1st basal segment bears a minute spine-like projection on its outer border ; the inner margin is fringed with hair and bears a single seta. Basal 2 is produced in a sharp spine at its distal outer angle. The exopod consists of three segments and the endopod of two. The exopod bears 1, 1 and 3 marginal spines on the three segments respectively and the terminal segment also carries an end-spine ; all the marginal spines are sub-equal. In the 2nd segment of the exopod there is a horse-shoe of small spines, the two longitudinal rows consisting of somewhat larger spines than the transverse row across the distal part of the segment. The 3rd segment bears 4 inner setae and the surface is armed with two horse-shoe or U-shaped rows of spinules, those of the proximal set being much larger than the distal. The 1st segment of the endopod is produced in a spine-like projection at its distal outer angle and bears a single seta ; the 2nd segment bears 5 setae and carries on its surface three pairs of spines, those of the inner row decreasing in size proximally.

In the 3rd leg the 1st segment of the basal part bears a minute marginal spine on its outer border and the inner margin is curved and fringed with hair ; there is a single inner seta. The 2nd basal segment bears two unequal spines at its distal outer angle. Both the rami consist of three segments, bearing 1, 1 and 3 marginal spines respectively. Exopod 2 bears a curved row of spines along its distal border. Exopod 3, in addition to the three marginal spines, carries an end-spine, in which some of the teeth near the proximal end are reduced in size ; the marginal spine exhibits a corresponding swelling on its inner margin. The surface of the segment bears two curved rows of spinules, the distal row being composed of small spines. In the endopod both the 1st and 2nd segments are produced in a spine-like projection at the distal outer angle ; endopod 2 bears 2 pairs of spines, the outer spines being much the larger and the inner spine of the proximal pair being reduced to a minute spicule. Endopod 3 bears 5 setae and carries 2 pairs of spines, the outer of the proximal pair being much the larger.

In the 4th leg the 1st basal segment is not produced internally and the inner margin is smooth; there is no small spine on the outer margin. Basal 2 bears two unequal spines at its distal outer angle as in the 3rd leg. The rami consist each of three segments. The surface of segments 2 and 3 in the exopod are devoid of spinules. In the endopod the 2nd segment bears a small group of needle-like spines distally and the 3rd segment bears two groups of small spinules.

The 5th leg, as in other members of the genus, consists of a single segment, bearing a long curved spine. The distal end of the segment is produced in a finger-like process. Scott's description of the spine appears to be somewhat misleading; the spine is smooth and bare in its proximal third; then for a short distance it is armed with spinules that are arranged irregularly, but in the distal half of the length these spinules are arranged in two rows, an inner and an outer. The inner row ceases some little way from the end but in this situation those of the outer row are considerably increased in size. When viewed in profile these enlarged spinules give rise to the appearance of a V-shaped end to the spine, as figured by Scott.

♂ In the male the endopod of the 2nd antenna is a little more than one-half the length of the exopod; otherwise the appendage resembles that of the female. In the mouth-parts, the mandible, 1st maxilla and 2nd maxilla are as in the female; in the maxilliped the outer setae of the 4th and 5th segments of the endopod are much larger and are strongly plumose. The swimming legs are as in the female and the 5th pair of legs are as described by Scott.

Copepodid Stage V.

♀ The total length is 4.1 mm.

The proportional lengths of the cephalothorax and abdomen are as 26 to 7, so that the abdomen is contained 3.7 times in the length of the anterior region of the body.

The frontal crest is smaller than in the adult and is pointed. The posterior thoracic margin is produced in sharp, backwardly-directed points. The rostrum closely resembles that of *Lophothrix frontalis* (Giesbrecht).

In this stage of development the abdomen consists of only four segments, which have, together with the furca, the following proportional lengths:—

Abdominal segment	1	2	3	4-5	Furca.
	24	24	18	18	16
	= 100				

The 1st antenna, as in the adult, possesses twenty-four free segments, segments 8 and 9 being fused. The proportional lengths of the various segments are as follows:—

Segment	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
Stage V	60	43	21	24	28	28	28	43	21	30	39	47	47	51	54	54	54	54	47	47	51	56	60	13
Adult	56	46	23	26	29	29	29	50	24	36	42	50	52	52	52	52	54	52	46	46	46	49	49	10

For the purpose of reference I have given above the measurements in the adult and it is clear that in this species also we find that, as development proceeds, the proportional lengths of the segments vary, the segments of the proximal part of the appendage becoming proportionally longer in the more mature form, whereas in the distal region the exact opposite is the case. In this species the change occurs between the 18th and 19th segments. There is a row of curved hairs on the posterior aspect of the 1st segment near the distal margin.

In the 2nd antenna the two rami are of nearly equal length. The 1st basal segment bears the row of hairs that we have already noted in the adult. The 2nd basal bears 2 setae distally. The exopod consists

of 6 segments; exopod 1 and 2 each bear 2 unequal setae; exopod 3, 4 and 5 each bear a single seta; the terminal segment carries a single seta at the junction of the proximal and middle-thirds and 3 setae distally. The endopod has two segments; the proximal bears a single seta about one-fourth of its length from the distal end and the rounded projection at the inner side of the distal end is fringed with hairs. Endopod 2 bears 7 setae on its outer lobe and 6 on the inner; the inner border is fringed with hairs.

The mandible and 1st maxilla agree exactly with the corresponding appendage in the adult.

The maxilliped closely resembles that of the adult but there are certain differences in the number of setae borne by the segments of the endopod. In the adult segments 3 and 4 each bear 4 setae, whereas in this stage of development these segments carry only 2 setae, one of which is much stouter than the other.

The 1st swimming leg differs from that of the adult in that the segmentation of the exopod is markedly incomplete, neither of the segments being fully articulated.

The 2nd, 3rd and 4th swimming legs resemble those of the adult.

The 5th leg consists of a single segment articulated to a basal portion. Distally the segment appears to end in two unequal spines, the outer being short and the inner long, nearly as long as the segment itself, and slightly curved. This appendage in my examples agrees closely with the figure given by With (1911, p. 219, text-fig. 70e) in *Scottocalanus thorii*.

♂ Total length, 3.3 mm.

The proportional lengths of the cephalothorax and abdomen are as 42 to 11, so that the abdomen is contained 3.8 times in the anterior region of the body.

The posterior thoracic margin is produced in a sharp spinous process.

The abdomen, as in the female at the same stage of development, consists of only four segments that have the following proportional lengths:—

Abdominal segment	1	2	3	4-5	Furca.
	23	20	22	20	15 = 100

The 2nd antenna closely resembles that of the adult. The 1st basal segment bears a row of curved hairs. The exopod is proportionately large, the endopod being only about one-half its length. There are 6 segments in the exopod, and the endopod bears 6 setae on its inner lobe and 7 on the outer.

The 1st antenna, as in the female, consist of only 24 free segments, segments 8 and 9 being fused. The proportional lengths of the segments seem to differ slightly from those of the female; the lengths in the male being as follows:—

Segment	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
	68	42	26	26	29	29	29	45	24	29	36	43	43	47	50	52	53	53	46	47	52	59	60	17 = 1000

The mandible is also very like that of the adult, the only apparent difference being that in this stage of development the distal segment of the endopod bears 8 setae instead of 9.

The maxilliped resembles that of the female but the lobes on the 1st basal segment are more prominent.

The swimming legs resemble those of the female.

The 5th pair of legs consist of a basal portion from which arise the symmetrical legs. Each leg consists of two segments, of which the proximal is produced internally in a finger-like process, the rudiment of the endopod. The exopod is oval in shape and terminates in a short spine.

***Scottocalanus investigatoris*, sp. nov.**

(Text-fig. 67, a-f.)

A single example of a male *Scottocalanus* that appears to be new was taken by the "Investigator" at Station 670.

♂ Total length, 5.5 mm.

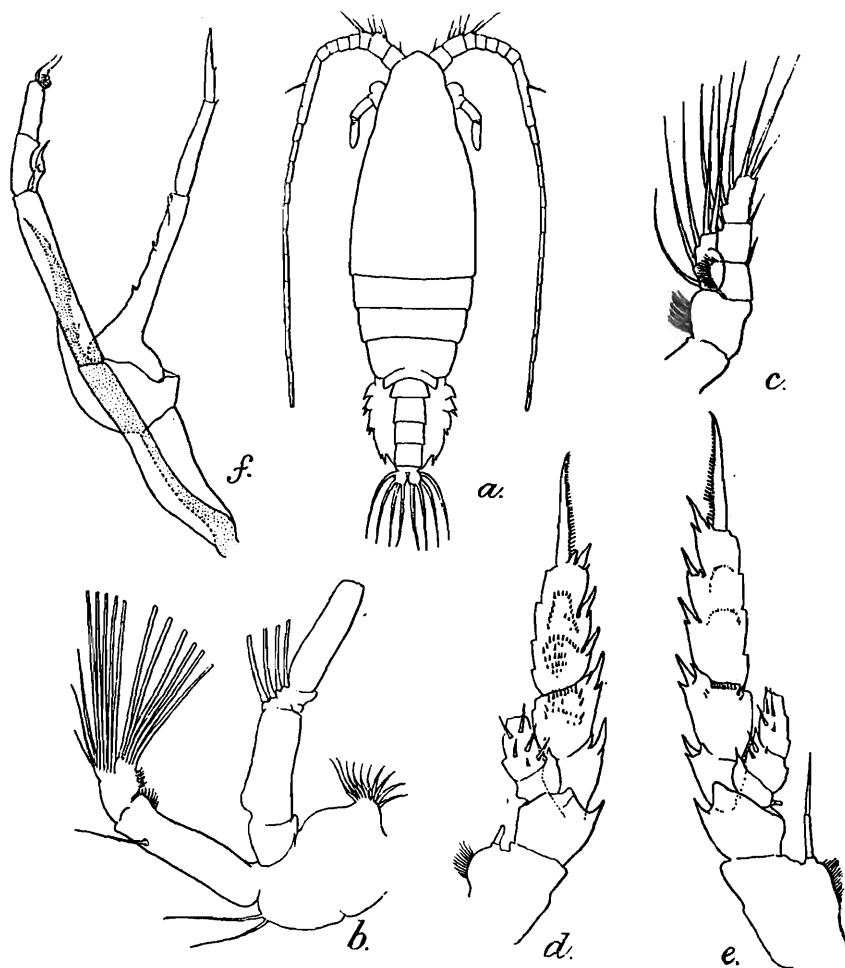
The proportional lengths of the cephalothorax and abdomen are as 3 to 1.

The head and 1st thoracic segment are fused together, as also are the last two thoracic segments, but between these two latter segments there is in the lateral region a deep indentation of the margin. There is no frontal crest. The rostrum consists of two stout spines, each tapering to a sharp point.

The abdomen consists of five segments, of which the 5th is very short. The proportional lengths of these segments and the furcal rami are as follows:—

Abdominal segment	1	2	3	4	5	Furca,
	20	23	17	22	8	10
	= 100					

The furcal rami are as broad as long. Abdominal segments 2 and 3 are armed along their posterior margins with rows of fine closely-set spines.



TEXT-FIG. 67.—*Scottocalanus investigatoris*, sp. nov., ♂.

a. The whole animal from above.

b. The 2nd antenna.

c. The 1st swimming leg.

d. The 2nd swimming leg.

e. The 3rd swimming leg.

f. The 5th pair of legs.

The 1st antenna is, unfortunately, broken off on both sides, the terminal four segments being missing; I am therefore unable to give the proportional lengths of the remaining segments in parts per thousand of the total appendage, as in other species; I, however, give below the actual lengths of those segments that remained:—

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

Segments 8 to 12 inclusive are fused together, though traces of the original lines of separation can be detected between them; and segments 20 and 21 also appear to be fused, as in *Scottocalanus daughlihi*, sp. nov.

The 2nd antennae (text-fig. 67, *b*) are extremely like those of *Amallothrix emarginata* (Farran); a tuft of curved setae or hairs arises from the basal segment.

The mouth-parts appear to be identical with the corresponding appendages in *Scottocalanus persecans* (Giesbrecht).

The 1st pair of swimming legs (text-fig. 67, *c*) consists each of a two-jointed basal portion, a three-jointed exopod and an unjointed endopod. Each segment of the exopod bears a single marginal spine, those on the proximal and middle segments being slender, while that on the distal segment is stout. The distal segment is clothed along the proximal half of its outer border with fine hair.

The 2nd swimming leg (text-fig. 67, *d*) has a three-jointed exopod and a two-jointed endopod. In its general structure it agrees closely with the corresponding appendage of *Scottocalanus persecans* (Giesbrecht), but there are rather more spinules on the surface of the 2nd and 3rd segments of the exopod.

The 3rd (text-fig. 67, *e*) and 4th pairs of legs each consist of a three-jointed exopod and endopod and also agree closely with those of *Scottocalanus persecans*.

The 5th pair of legs (text-fig. 67, *f*) also closely resembles those of *Scottocalanus persecans*; As Esterly first pointed out, the exopod of the right leg consists of three segments.

This specimen is very like an example of *Scottocalanus persecans* (Giesbrecht) as regards its general structure; it, however, differs from that species in its much larger size and in the absence of any crest on the head.

***Scottocalanus daughlihi*, sp. nov.**

(Text-figs. 68, *a-l*, and 69, *a-c*.)

A large number of examples of what appears to be a new species of *Scottocalanus* were obtained by the "Investigator" at Station 670, and a few examples at Station 373 also. At first sight these females are very liable to be taken for the females of *Scottocalanus persecans* (*vide* Esterly, 1905, p. 166) or of *S. farrani* (*vide* A. Scott, 1909, p. 106, pl. xxiv, figs. 1-9). The male also very closely resembles the form described by A. Scott (1909, p. 111, pl. xxvii, figs. 1-9) under the name *S. helenae*.

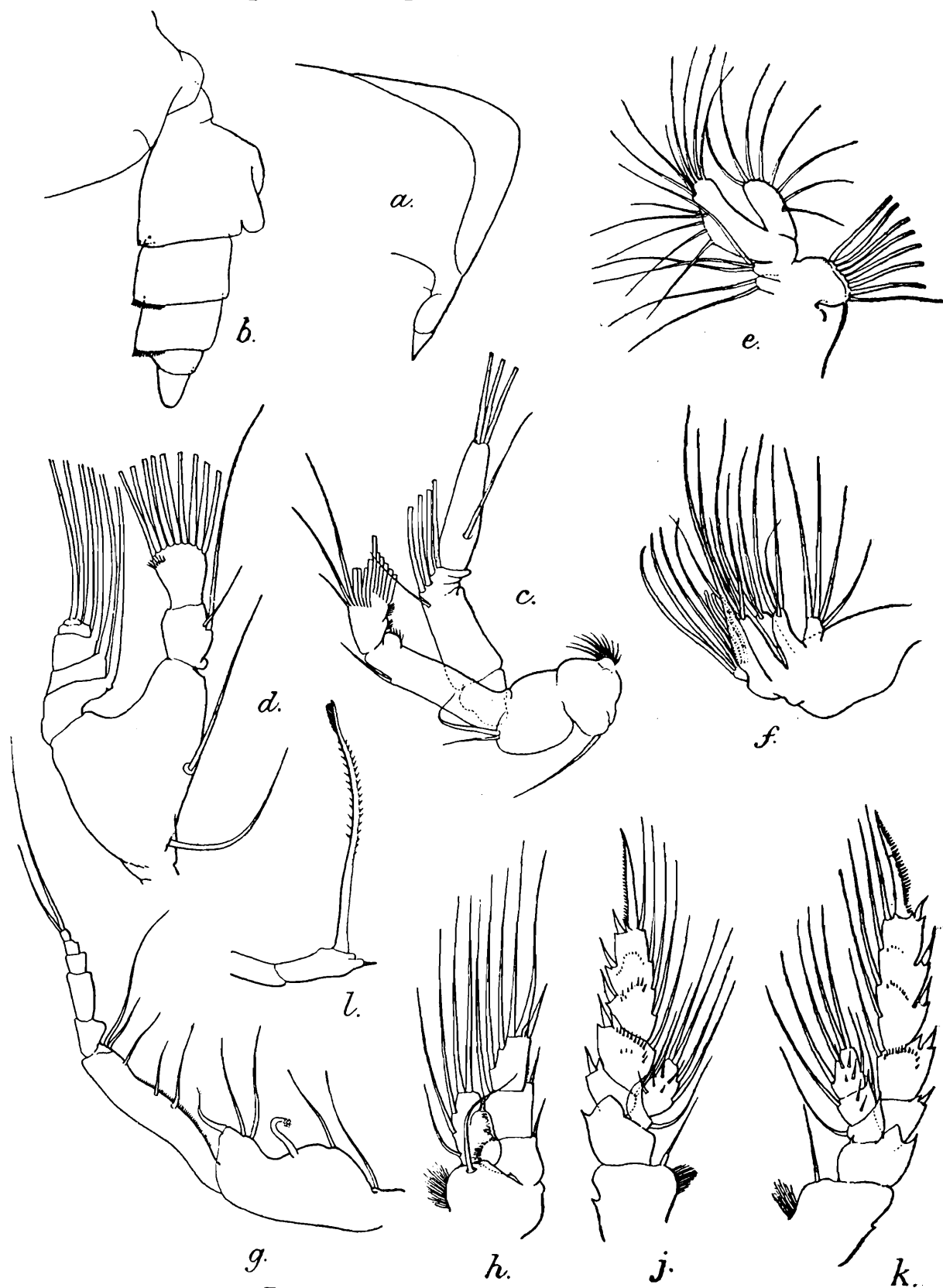
♀ Total length, 5.3 mm.

The proportional lengths of the cephalothorax and abdomen are as 69 to 16, so that the abdomen is contained 4.3 times in the length of the anterior region of the body. The head and 1st thoracic segment are fused together and thoracic segments 4 and 5 are also partially fused. The head is furnished with a high, almost triangular crest and the rostrum consists of two stout, sharply pointed spines. The posterior thoracic margin (text-fig. 68, *b*) is produced backwards in a rounded lappet on each side.

The abdomen consists of four segments, which have with the furca the following proportional lengths:—

Abdominal segment	1-2	3	4	5	Furca.	
	43	23	14	6	14	=100

The 4th segment is very short. Both segments 2 and 3 are armed with a row of short spines across the dorsal part of the posterior margin. The genital segment exhibits a



TEXT-FIG. 68.—*Scottocalanus daughishi*, sp. nov., ♀.

- a. The head and rostrum from the right side.
- b. The posterior thoracic margin and abdomen from the right side.
- c. The 2nd antenna.
- d. The mandibular palp.
- e. The 1st maxilla.

- f. The 2nd maxilla.
- g. The maxilliped.
- h. The 1st swimming leg.
- j. The 2nd swimming leg.
- k. The 3rd swimming leg.

l. The 5th leg.

prominent protuberance on the ventral aspect which slightly overlaps the following segment. The furcal rami are as broad as long; they bear only four normal setae, the 5th seta being so reduced as to be hardly noticeable. The accessory seta is also considerably reduced.

The 1st antenna reaches back to the end of the furcal ramus and consists of 24 separate segments, segments 8 and 9 being fused together. The various segments have the following proportional lengths:—

Segment	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	
	57	50	27	27	31	31	31	55	27	31	38	46	46	48	50	52	52	52	46	46	46	52	50	11	=1000

The 2nd antenna (text-fig. 68, c) closely resembles that of *Amallothrix emarginata* (Farran). The endopod is about one-half the length of the exopod. The 1st basal segment bears a row of curved setae on its inner aspect proximally and a single seta distally.

The mandible (text-fig. 68, d) is well-developed and the two branches of the palp are of approximately equal length.

The 1st maxilla (text-fig. 68, e) closely resembles that of *Amallothrix emarginata*.

The 2nd maxilla (text-fig. 68, f) is of the characteristic type; the 5th lobe is larger than the others and the terminal joint bears the usual characteristic appendages of two kinds.

The maxilliped (text-fig. 68, g) is similar to that of other members of the genus. The 1st basal joint bears a single sensory appendage about the middle of the length of the anterior margin. The 2nd basal segment is armed with a row of needle-like spines along the proximal two-thirds of the length of the anterior margin. The endopod consists of five segments, of which the 2nd is by far the longest.

The 1st pair of swimming legs (text-fig. 68, h) each consist of a three-jointed exopod and an unjointed endopod. The 1st and 2nd segments of the exopod bear slender marginal spines, while the marginal spine on the terminal segment is considerably stouter and equals the segment in length.

In the 2nd swimming leg (text-fig. 68, j) the exopod is three-jointed and the endopod consists of two segments. The distal segment of the endopod is armed with three pairs of spines, that are much stronger and coarser than the corresponding spines in *Scottocalanus farrani*. The 2nd segment of the exopod bears a curved row of spines across the distal part of its surface and, in addition, a short row of three minute spines a little beyond the middle of its length.

In the 3rd (text-fig. 68, k) and 4th swimming legs both rami consist of three segments.

The 5th pair of legs (text-fig. 68, l) closely resembles that of *Scottocalanus farrani*, but towards the end of the terminal spine the spinules become crowded together to form a definite comb.

♂ Total length, 4.6 mm.

The proportional length of the cephalothorax and abdomen are as 27 to 10, the abdomen being contained 2.7 times in the length of the anterior region of the body.

In its general shape and in the characters of the head and crest the male very closely resembles the female. The abdomen consists of five segments of which the 5th is very short; the proportional lengths of the segments are as follows:—

Abdominal segment	1	2	3	4	5	Furca.	
	18	24	23	21	5	9	=100

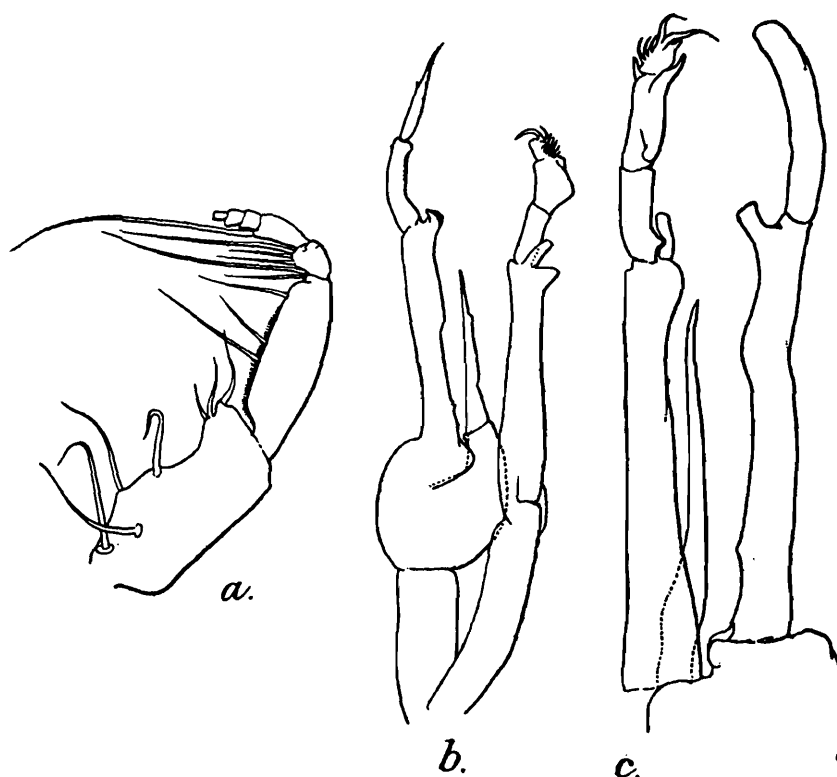
The 2nd and 3rd segments are each fringed across the dorsal part of the posterior margin with a row of minute spines.

The 1st antenna reaches beyond the posterior thoracic margin to the 3rd abdominal segment. The number of free joints in the antennae is considerably reduced by the fusion of a number of segments in the middle of its length. On the right side segments 8 and 9 are fused completely, and so also are segments 10, 11 and 12, and each of these composite joints are again fused together and segment 13 is also partially fused to the 12th; segments 14 and 15 are also fused together. On the left side the fusion of the segments is as on the right side with the additional fusion of segments 20 and 21. The proportional lengths of the segments in the two appendages are as follows:—

Segment	1	2	3	4	5	6	7	8-13	14-15	16	17	18	19	20	21	22	23	24	25
Right	62	49	27	27	27	27	29	174	89	58	58	58	56	40	40	53	62	51	13 = 1000
Left	62	49	27	27	27	27	29	174	89	58	58	58	56	80	53	62	51	13 = 1000	

The 2nd antenna and mouth-parts closely resemble those of the female with the single exception of the maxilliped (text-fig. 69, *a*), which in this sex is slightly reduced in size, the reduction specially affecting the 2nd basal and the segments of the endopod.

The swimming legs are the same as in the female.



TEXT-FIG. 69.—*Scottocalanus dauglishi*, sp. nov., ♂.

a. The maxilliped.

b. The 5th pair of legs.

c. The distal portion of the 5th pair of legs (enlarged).—

The 5th pair of legs (text-fig. 69, *b* and *c*) in their general structure very closely resembles the corresponding appendage in *Scottocalanus helenae* (Lubbock). The left leg is exactly similar, but in the right leg there are certain points of difference. In this latter leg the endopod is shorter than that in *S. helenae*, reaching only to about three-fourths of the length of the 1st segment of the exopod and it is straight instead of being sickle-shaped. The exopod consists of three segments, of which the 2nd and 3rd are sub-equal in length; the

2nd segment is curved and stout, but the terminal segment is flattened and spear-shaped and bears a small spine on its outer margin.

The female of this species very closely resembles *Scottocalanus farrani* A. Scott (1909, p. 106, pl. xxiv, figs. 1-9) but differs in small details such as the following:—

- (a) The frontal crest is larger and is continued further ventralwards than in *S. farrani*.
- (b) The spines on the endopods of the swimming feet are larger.
- (c) The arrangement of the spinules along the spine in the 5th foot is different.
- (d) The posteriorly directed lobe on the ventral aspect of the genital segment is wanting in *S. farrani*.

I have much pleasure in dedicating this species to Captain E. H. Daughlish, R.I.M., formerly the officer-in-charge of the Marine Survey of India.

Genus **LOPHOTHRIX** Giesbrecht.

Up to the present time only a single species of this genus has been recorded from Indian waters. A. Scott (1909) records the occurrence of *Lophothrix frontalis* Giesbrecht in the "Siboga" collection from the Malay Archipelago.

Lophothrix frontalis Giesbrecht.

(Text-figs. 70, 71, *a-n*, 72, *a-j*, and 73, *a-c*.)

Lophothrix frontalis, A. Scott, 1909, p. 99, pl. xxxvi, figs. 11-20 (female) and pl. xxix, figs. 1-10 (male).

Lophothrix frontalis, Wolfenden, 1911, p. 268.

Lophothrix frontalis, Sewell, 1913, p. 354.

Lophothrix frontalis, With, 1915, p. 211, text-figs. 66, *a-f* and 67, *a-d*; pl. vii, fig. 7, *a-d*.

Lophothrix frontalis, Lysholm and Nordgaard, 1921, p. 21.

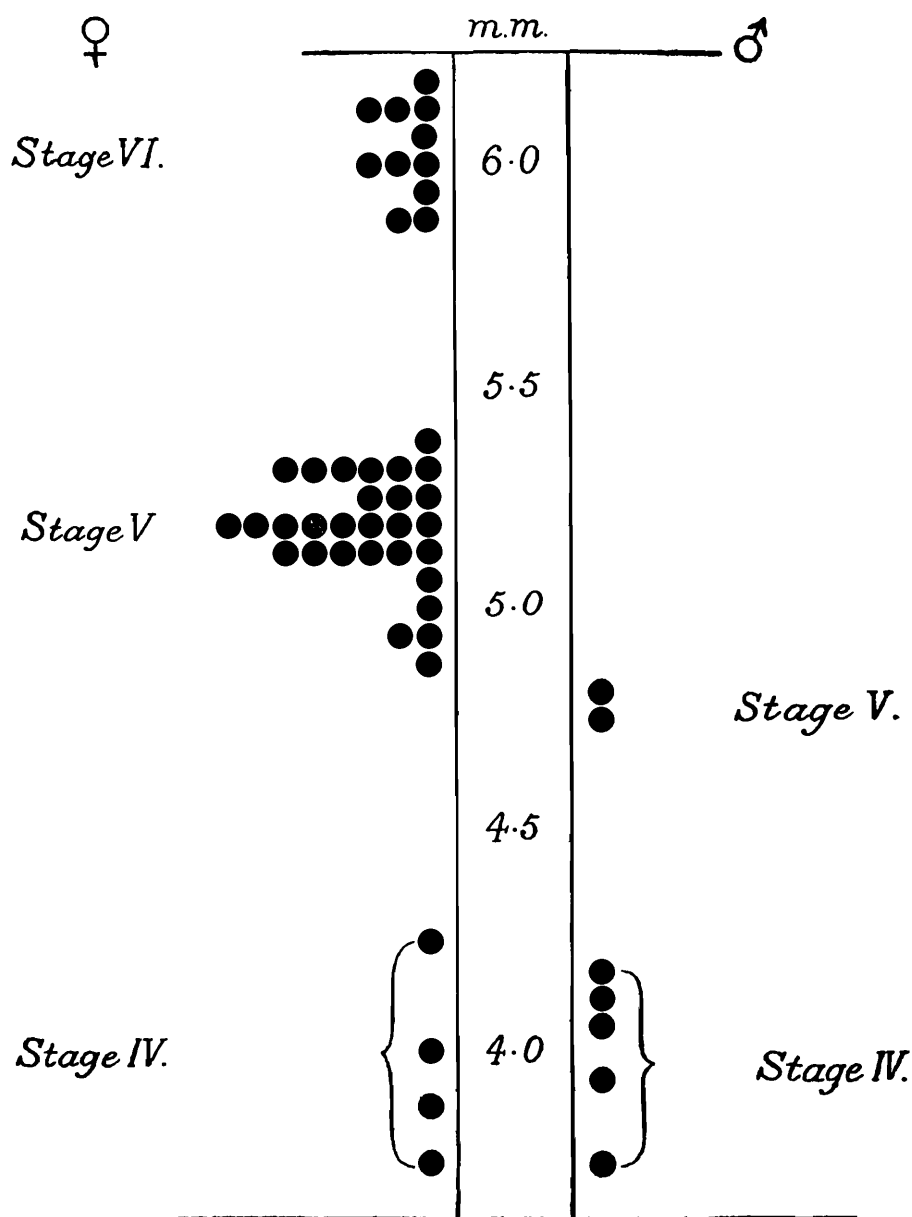
Lophothrix frontalis, Sars, 1925, p. 162, pl. xlv, figs. 9-21 and pl. xlvi, figs. 1-7.

Lophothrix frontalis, Farran, 1926, p. 267

There is considerable divergence among previous authors regarding the size of this species. Giesbrecht in his original description of the species states that the total length of his specimens was 6.6 mm., and Sars gives the measurement of specimens from the North Atlantic Ocean as 6.3 mm. Esterly (1906, p. 65), who recorded the occurrence of this form in the North Pacific Ocean, gives the length as 6.0 mm. A. Scott (1909), however, records examples from the Malay Archipelago that have a length as great as 7.4 mm. On the other hand Wolfenden (1911) in his account of examples, which he identified as belonging to this species, in the "Gauss" collection from the South Atlantic, remarks that these examples did not entirely agree with Giesbrecht's original description; they were smaller, measuring only 5.5 to 6.0 mm., and differed slightly in structure, having a more pointed head and showing slight differences in the spination of the appendages.

In the "Investigator" collections are numerous examples of what I believe to be this species that range in size from 4.875 mm. to 6.125 mm. These specimens fall into two clearly defined groups, as is shown in text-fig. 70, in which I have plotted the length-measurement of a number of examples; the smaller examples, corresponding to stage V, have an

average measurement of 5.174 mm. and the larger, stage VI, of 5.970 mm. The examples of the larger group seem to agree with the specimens recorded by Wolfenden from the South



TEXT-FIG. 70.—Showing the length-measurements of 51 examples of *Lophothrix frontalis* Giesbrecht, in different stages of development.

Atlantic and by A. Scott from the Malay Archipelago. They possess a more sharply rounded frontal crest than the smaller examples. There are also, as Wolfenden remarks, slight differences in the spination of the limbs.

The occurrence of these two groups raises the question.—Are we dealing with two distinct but very closely related species or do the two groups represent different stages in the life-history of one and the same species? Occurring with these adults were a few immature forms which I believe to belong to the same species, and from a careful study of both adult and immature forms I am of the opinion that we have here in a deep-sea species another instance of dimorphism such as I have already referred to in some of the more common littoral species in Indian waters (*vide supra*, p. 5 *et seq.*).

Forma **major**.(Text-fig. 71, *a-n*.)

The total length varies from 5.812 to 6.125 mm.; the average being 5.97 mm. The proportional lengths of the cephalothorax and abdomen are as 42 to 11, so that the abdomen is contained 3.82 times in the length of the anterior region of the body.

TEXT-FIG. 71.—*Lopholthrix frontalis* Giesbrecht, forma major.

a. The forehead and rostrum from the left side, ♀.	g. The 2nd swimming leg, ♀.
b. The posterior thoracic margin and genital segment from the left side, ♀.	h. The 3rd swimming leg, ♀.
c. The 1st maxilla, ♀.	j. The 3rd swimming leg, ♂.
d. The 2nd maxilla, ♀.	k. The 4th swimming leg, ♀.
e. The maxilliped, ♀.	l. The seta on basal 2 of the 4th swimming leg (enlarged).
f. The 1st swimming leg, ♀.	m. The 5th leg, ♀.
	n. The 5th pair of legs, ♂.

The general shape of the body agrees exactly with the descriptions given by previous authors. The abdomen consists of four segments and the furcal rami, and the proportional lengths of the several parts are as follows :—

Abdominal segment	1-2	3	4	5	Furca.	
	45	20	15	7	13	=100

The 1st antenna reaches back to the 3rd abdominal segment. The proportional lengths of the segments are as follows :—

Segment	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	
	46	57	23	23	23	25	27	57	27	37	43	50	54	50	50	57	57	54	50	42	37	48	40	23	=1000

The 1st and 2nd segments are partially fused and segments 8 and 9 completely so.

In the 2nd antenna there is a well-marked row of hairs on basal 1. The terminal segment of the exopod is short. The terminal segment of the endopod is fringed with a clump of curved hairs and there are 8 setae on the outer lobe and 6 on the inner.

The mandibular palp is well-developed and the exopod and endopod are sub-equal in length ; the endopod consists of two segments, of which the proximal bears 2 setae and the distal 9.

The 1st maxilla (text-fig. 71, c) has the usual structure. The 1st inner or masticatory lobe bears 13 setae in all the examples that I have examined ; With (1915, p. 211) states that there are 14. The 2nd inner lobe has only 2 setae and the 3rd lobe 4 ; With (*loc. cit.*) states that there are 5. The basal segment bears 5 setae and the endopod 7. The exopod carries 9 setae and there are 9 setae on the outer lobe.

The 2nd basal segment of the maxilliped (text-fig. 71, e) is armed along its anterior margin with a row of spinules ; the arrangement of these spinules differs in different parts of the row. Extending from the proximal part of the segment to half-way between the 1st and 2nd seta the row is a compound one and consists of several lines of spines, but from this point to beyond the 2nd seta and nearly to the base of the 3rd the line of spines consists of a single row of smaller spines. At this point there is a break in the armature of the segment, but just beyond the 3rd seta there is another linear row of spines extending to the distal end of the segment.

The swimming legs are as figured (text-fig. 71, f-n).

Forma **minor**.

(Text-fig. 72, a-j.)

♀ Total length ranging from 4·875 to 5·375 mm. ; the average being 5·174 mm.

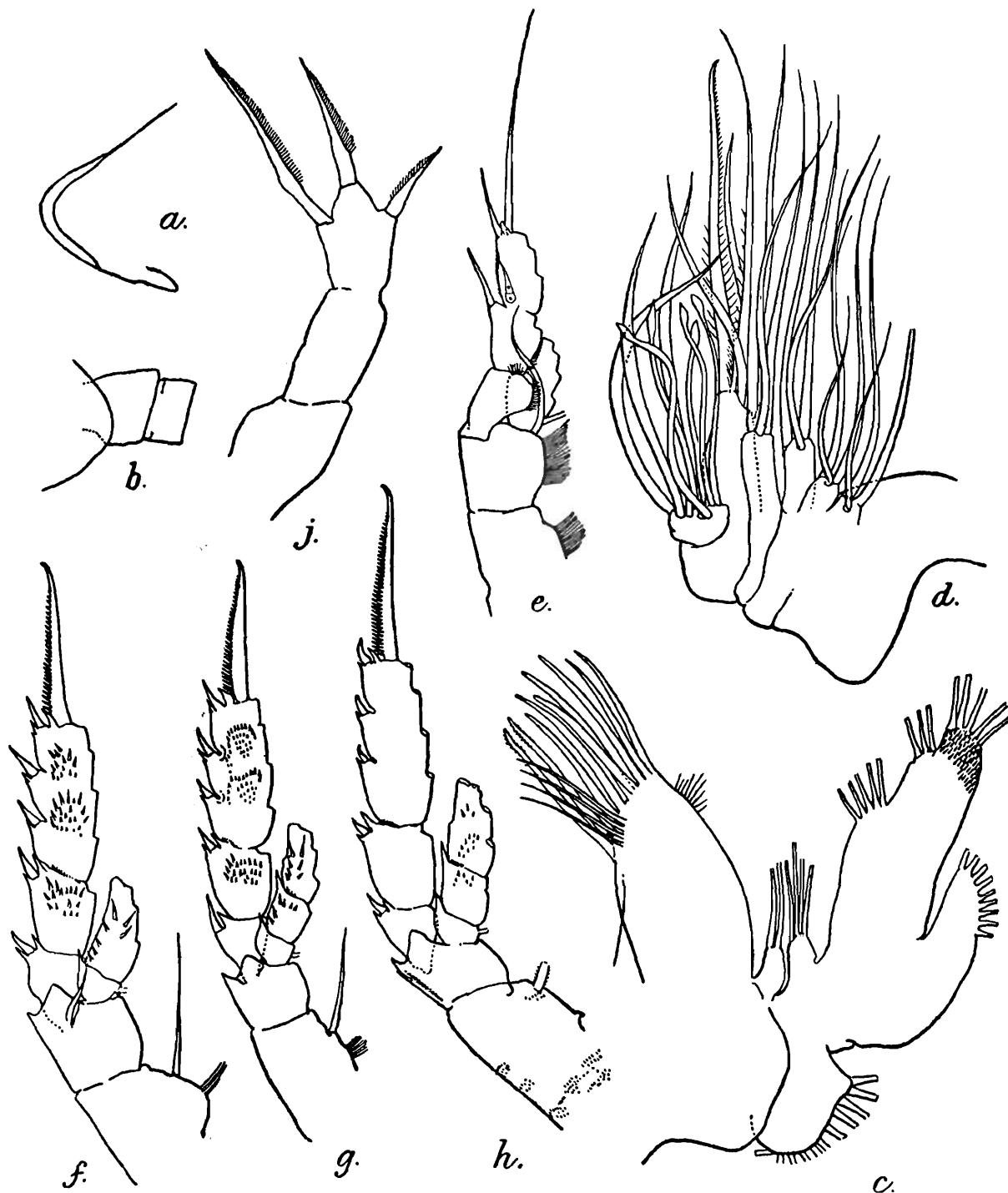
The proportional lengths of the cephalothorax and abdomen are as 79 to 16, so that the abdomen is contained 4·5 times in the length of the anterior region of the body.

Both the frontal crest and the posterior margin of the thorax are less sharply rounded than in Giesbrecht's original description. The posterior border of the thorax (text-fig. 72, b) reaches back half-way along the genital segment of the abdomen, and also appears to be less sharply rounded than in *forma major*.

The abdomen consists of four segments that have with the furcal rami the following proportional lengths :—

Abdominal segment	1-2	3	4	5	Furca.	
	42	19	15	9	15	=100

The genital swelling on the ventral aspect of the 1st segment seems to be slightly less prominent than in the larger form. The posterior margins of segments 1 to 3 inclusive are



TEXT-FIG. 72.—*Lophothrix frontalis* Giesbrecht, forma minor, ♀.

a. The frontal region and rostrum from the left side.

b. The posterior thoracic margin and genital segment from the left side.

c. The 1st maxilla.

d. The 2nd maxilla.

e. The 1st swimming leg.

f. The 2nd swimming leg.

g. The 3rd swimming leg.

h. The 4th swimming leg.

i. The 5th leg.

armed with a row of fine needle-like spines and, in addition, there is a row of fine needle-like spines across the dorsal aspect of segments 2 and 3 near the anterior border. The external furcal setae are short and delicate.

The 1st antenna extends back nearly to the posterior margin of the 3rd abdominal segment. Each consists of 24 free segments, segments 8 and 9 being fused. The proportional lengths of the segments are as follows:—

Segment	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
	47	50	25	25	27	27	27	58	31	35	43	49	47	49	51	53	55	53	43	43	37	51	47	27
	=1000																							

In the 2nd antenna the structure appears to be the same as in the larger form; the exopod bears 8 setae on the inner lobe and 6 on the outer.

In the 1st maxilla the masticatory lobe bears 13 setae, as in the forma *major*; the 2nd inner lobe bears 2 and the 3rd 4 setae; the basal segment carries 5 setae and the 3 segments of the endopod have 3 setae each; the outer lobe possesses 7 long setae and 2 shorter ones and the exopod carries 9 setae. The distal portion of the endopod is armed with rows of minute spines.

In the mandible the basal segment bears 3 setae; the exopod has 6 and the 1st segment of the endopod carries 2. Unfortunately, the 2nd segment was damaged during dissection; I am, therefore, unable to give the number of setae present on it.

The maxilliped closely resembles that of the larger form but the posterior margin of the basal segment seems to be more produced and more sharply pointed in the smaller form.

There are minute differences from the larger form in the spination of the swimming legs, that can best be seen in the figures given (text-fig. 72, *e-h*).

The 5th pair of legs (text-fig. 72, *j*) also closely resembles those of the larger form but in the smaller form the terminal segment of the leg is shorter in proportion to its breadth and in some examples the separation from segment 2 was incomplete.

Associated with these two apparently sexually-mature forms were several immature forms of both sexes in the 4th and 5th copepodid stages of development.

Copepodid Stage IV. (Text-fig. 73, *a-c*.)

♀ The total length ranges from 3.875 to 4.25 mm.; the average being 4.042 mm.

The cephalothorax resembles that of the forma *minor* described above. The abdomen consists in this stage of development of only four segments, segments 1 and 2 not being fused together and segments 4 and 5 not yet having become differentiated. The proportional lengths of the segments are as follows:—

Abdominal segment	1	2	3	4-5	Furca.
	22	24	15	24	15
	= 100				

The mouth-parts and swimming legs appear to have already assumed the form and structure seen in the forma *minor*. The 5th pair of legs (text-fig. 73, *b*) is also very similar but at this stage there is no separation, even partial, of segments 2 and 3.

Two immature stages of the male were present corresponding apparently to copepodid stages IV and V.

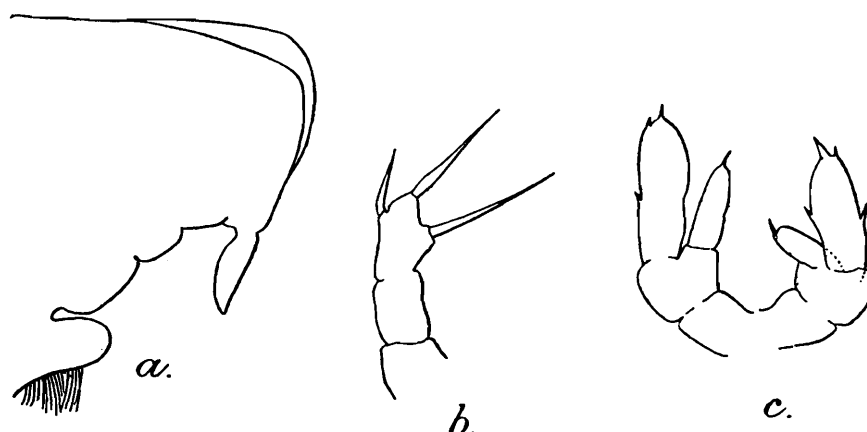
♂ *Copepodid Stage IV.*

Average total length, 4.012 mm.

The general condition of the body closely resembles that of the immature female. The abdomen consists of only four segments, segments 4 and 5 still being fused; the proportional lengths of the segments are as follows:—

Abdominal segment	1	2	3	4-5	Furca.
	20	20	17	26	17
	= 100				

At this stage of development the 5th pair of legs consist of a single-jointed exopod and endopod as figured.



TEXT-FIG. 73.—*Lophothrix frontalis* Giesbrecht: Copepodid Stage IV.

a. The forehead from the right side.

b. The 5th leg, ♀.

c. The 5th pair of legs, ♂.

The 1st antenna consists of 23 free segments, segments 8 and 9 and 24 and 25 respectively being fused. The proportional lengths of the segments are as follows:—

Segment	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	
	69	51	25	25	25	25	25	53	28	32	39	48	48	48	51	53	55	51	37	37	37	55	88	=1000.

♂ Copepodid Stage V.

Average length, 4.782 mm.

The general condition of the structure at this stage appears to be similar to that of copepodid stage IV, except as regards size and a few details, such as the degree of segmentation of the 1st antenna.

In the 1st antenna segments 1 and 2 appear to be fused together; the proportionate lengths of the segments are as follows:—

Segment	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	
	108	27	27	27	27	27	50	27	38	41	48	48	48	52	56	56	56	37	37	35	54	77	=1000.

The structure of the 5th pair of legs is identical with that of copepodid stage IV (text-fig. 73, c).

The various growth-stages that I have so far been able to trace in this species appear to point to there being two sexually-mature stages in the female, corresponding to copepodid stages V and VI. In the following tables I have given the average lengths of the various stages of development that occur in the "Investigator" collections and the growth-factors for each stage:—

♀				Observed size.	Calculated size.	Growth- factor.
				mm.	mm.	
	Copepodid Stage IV	..	..	4.042	4.120	1.203
	Copepodid Stage V (forma minor)	..	..	5.174	4.963	1.203
	Stage VI (forma major)	..	..	5.970	5.970	
♂						
	Copepodid Stage III	..	..	..	3.335	1.450 or 1.203
	Copepodid Stage IV	..	..	4.012	4.012	1.450
	Copepodid Stage V	..	..	4.782	4.84	
	Stage VI (adult)	..	..	..	5.817	

As in other species the growth-factor for the male between copepodid stages III and IV appears to be the same as in the two final moults of the female.

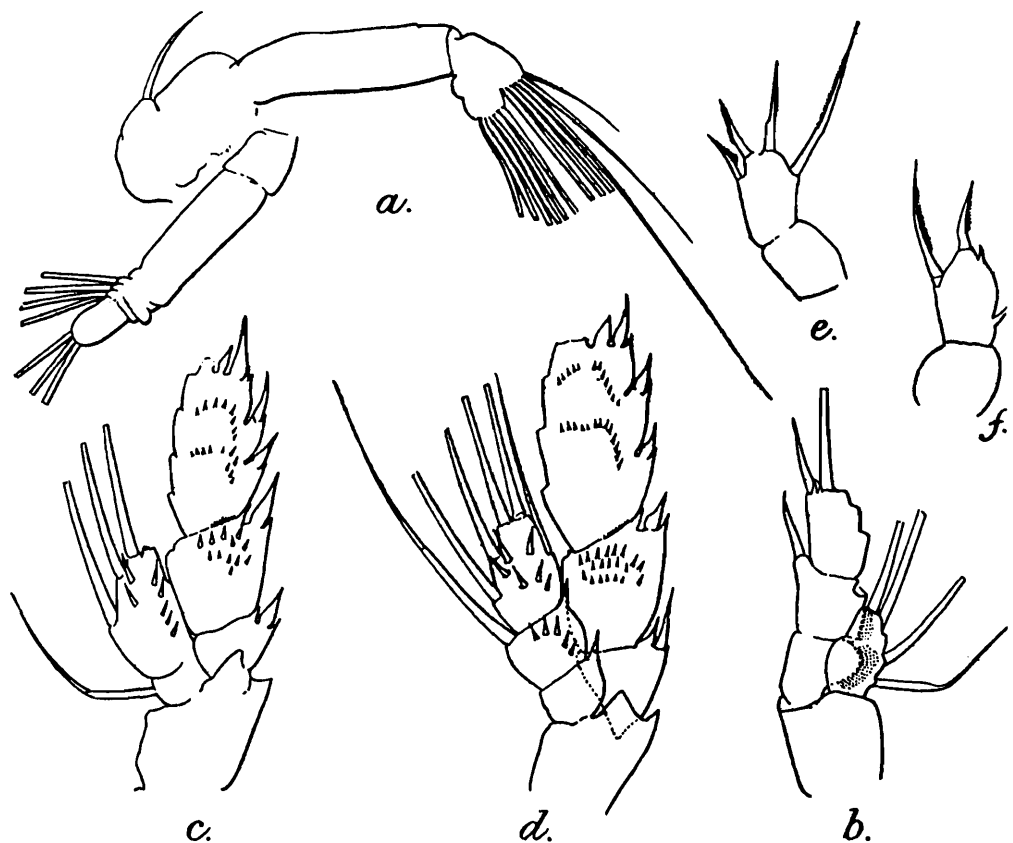
***Lophothrix quadrispinosa* Wolfenden.**

(Text-fig. 74, a-f.)

Lophothrix quadrispinosa, Wolfenden, 1911, p. 269, pl. xxxiv, fig. 3.

The first record of this species was from the "Gauss" collection, specimens having been taken in the south Atlantic Ocean in about Lat. 33° S. In the "Investigator" collections are one adult and one immature stage from Station 670 and a second immature stage from Station 393.

According to Wolfenden (1911) this species differs from *Lophothrix frontalis* Giesbrecht in the shape of the head and frontal crest and in the structure of the 5th pair of feet. The difference in the shape of the head is extremely slight, if we compare this form with the larger



TEXT-FIG. 74.—*Lophothrix quadrispinosa* Wolfenden, ♀.

a. The 2nd antenna.	d. The 3rd swimming leg.
b. The 1st swimming leg.	e. The 5th leg.
c. The 2nd swimming leg.	f. The 5th leg (immature).

form of *L. frontalis*. In the immature stages the head and frontal crest are more sharply rounded than in the adult, so that in this species, as in *L. frontalis*, we get slight changes of shape in the different growth-stages but in the opposite direction.

♀ The total length is 5.1 mm. and the proportional lengths of the cephalothorax and abdomen are as 66 to 15, so that the abdomen is contained 4.4 times in the length of the anterior region of the body.

The abdomen consists of four segments that with the furca have the following proportional lengths :—

Abdominal segment	1-2	3	4	5	Furca.	
	39	19	17	11	14	=100.

The mouth-parts and swimming legs agree closely with the corresponding appendages in *L. frontalis*, but there are distinct differences in the number and arrangement of the spines on the surfaces of the swimming legs.

The 5th pair of legs (text-fig. 74, e) bear, as the specific name indicates, four spines instead of three.

Copepodid Stage V.

Both examples of this immature stage measure 4.4 mm. in length. The proportional lengths of the cephalothorax and abdomen are as 9 to 2, so that the abdomen is contained 4.5 times in the length of the anterior region of the body.

The anterior region of the body closely resembles that of the adult, except that the frontal crest and head are somewhat more sharply rounded. The abdomen consists of four segments but in this case it is segments 4 and 5 that are fused. The proportional lengths of the segments are as follows :—

Abdominal segment	1	2	3	4-5	Furca.	
	22	20	18	25	15	=100.

The 1st antenna reaches to the posterior end of the abdomen. There are 24 free segments; segments 8 and 9 being fused together, as in the adult. The proportional lengths of the segments are as follows :—

Segment	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	
	66	57	23	23	28	26	26	52	28	30	40	47	47	47	47	54	54	54	42	42	38	56	52	23	=1000.

In the 5th pair of legs (text-fig. 74, f) there is a somewhat swollen basal segment and an oval free segment that bears on its inner border a single spine, that is slightly longer than the segment; from the distal end arises a shorter and stouter spine and immediately external to this is a small spinous projection; a somewhat similar spinous projection is situated on the external margin near its proximal end.

Genus **MACANDREWELLA** A. Scott.

This genus was created by A. Scott (1909, p. 100) to accommodate the species *Macandrewella joanae*, obtained by the "Siboga" in the Malay Archipelago. Scott also included in the genus the copepod that Giesbrecht (1896, p. 321, pl. v, figs. 16-22) has described from the Red Sea under the name *Scolecithrix chelipes*. In the "Investigator" collection I have been able to identify an example of *Macandrewella chelipes* (Giesbrecht) as well as examples of what appear to be a new species.

Macandrewella chelipes (Giesbrecht).

(Text-fig. 75.)

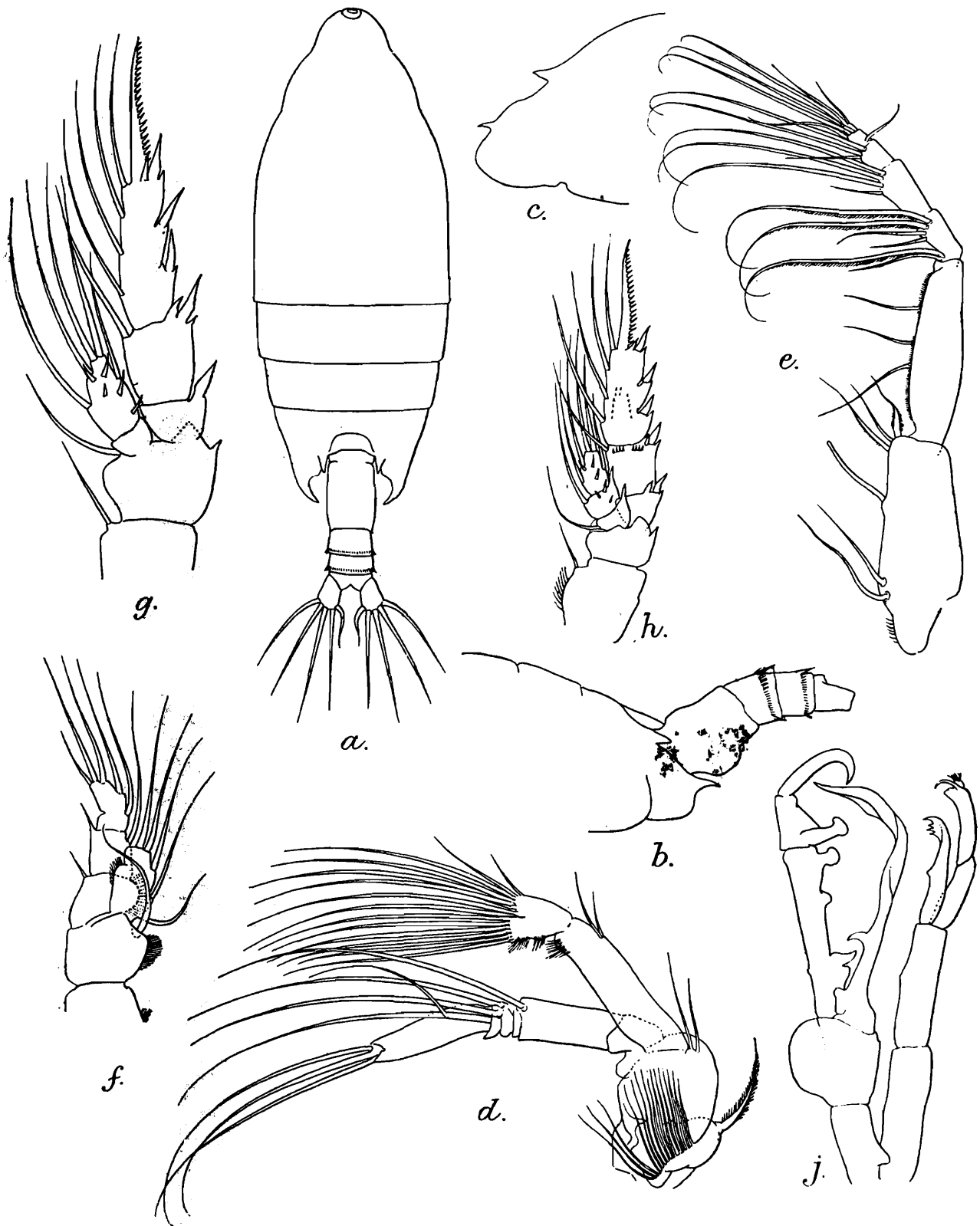
Scolecithrix chelipes, Giesbrecht, 1896, p. 321, pl. v, figs. 16-22.

Scolecithrix chelipes, Thompson and A. Scott, 1903, p. 245.

Segment	1	2	3	4	5	6	7	8-10	11	12	13	14	15	16	17	18	19	20	21	22	23	24-25
	63	68	99	81	90	29	29	81	30	84	48	48	49	49	49	51	53	51	50	50	50	54

= 1000.

In the 2nd antenna (text-fig. 76, *d*) the exopod is nearly twice the length of the endopod. The distal end of the 1st segment of the endopod is swollen and is provided with a tuft of hairs, as also is the outer margin of the distal segment. The endopod consists of 6



TEXT-FIG. 76.—*Macandrewella scotti*, sp. nov.

a. The whole animal from above, ♀.	e. The maxilliped, ♀.
b. The posterior thoracic margin and abdomen from the left side, ♀.	f. The 1st swimming leg, ♀.
c. The posterior thoracic margin, right side, ♀.	g. The 2nd swimming leg, ♀.
d. The 2nd antenna, ♀.	h. The 3rd swimming leg, ♀.
i. The 4th swimming leg, ♀.	j. The 5th pair of legs, ♂.

segments. The 1st basal segment bears a stout fringed seta at its distal external angle and in addition there is a line of long curved hairs across the inner aspect.

The mandible and maxillae appear to have a structure similar to that of the corresponding organs in the genus *Scottocalanus*.

The maxilliped (text-fig. 76, e) is of the usual type. It bears along the proximal part of the anterior margin of the 1st basal segment a short row of curved spines. The 2nd basal segment is armed with a long row of fine needle-like spines along the proximal two-thirds of the anterior margin and a second row of slightly larger spines runs along the anterior margin of the distal fourth of the segment. The endopod consists of five segments of which the 2nd is the longest.

The 1st swimming leg (text-fig. 76, f) consists of a two-jointed basal part, a three-jointed exopod and a single-jointed endopod. In the exopod the 1st segment is considerably larger than either of the other two and is swollen internally, the internal margin being fringed with hairs; at the distal external angle it bears a delicate seta-like spine that reaches about half-way to the base of the spine on exopod 2, which is of about the same size and delicacy. The 3rd segment of the exopod has a notched outer border and appears to be bent outwards; the marginal spine is twice the length of the spines on the other two segments and the terminal spine is delicate and seta-like.

In the 2nd swimming leg (text-fig. 76, g) the exopod is three-jointed and the endopod consists of two segments. The 1st basal segment bears an inner seta and the 2nd basal is produced at its outer distal angle in a spine-like process. The marginal spines on the three segments of the exopod are sub-equal. The 2nd segment of the endopod bears two rows of spines, an outer row of three spines, all of about the same size, and an inner row of two unequal spines, the proximal being much smaller than the distal.

The 3rd (text-fig. 76, h) and 4th swimming legs each have a three-jointed exopod and endopod. The 2nd basal segment is, as in the 2nd leg, produced in a sharp spine-like process at its distal outer angle. In the exopod the 2nd segment is armed with a row of small spines across the surface near the distal border. The 3rd segment bears a U-shaped row of small spines in the middle of its length. The end-spine is of about the same length as the 3rd segment and bears a number of separate teeth along its outer margin; at the proximal end these teeth are reduced in size.

The 5th pair of legs is completely absent. In this respect the present species differs from that described by Scott, in which he describes a fifth pair of legs as being present.

♂ As in the female the head and 1st thoracic segment are fused and the posterior thoracic margin bears a short stout spine on each side.

The abdomen consists in this sex of five segments, of which the 3rd is much shorter than either the preceding or the following segments. Segments 2 and 3 are armed on their posterior margins with coarse spinules. The proportional lengths of the segments are as follows :—

Abdominal segment	1	2	3	4	5	Furca.	
	24	24	14	23	9	6	= 100.

The anal segment bears a number of scattered hairs.

The 1st antenna differs on the two sides of the body; on the right it consists of 17 separate segments and on the left of 18. On both sides segments 8 to 13 and 14 and 15

are respectively fused together, as also are segments 24 and 25; and in addition on the right side segments 20 and 21 are fused. The proportional lengths of the segments are as follows:—

Segment	1	2	3	4	5	6	7	8-13	14-15	16	17	18	19	20-21	22	23	24-25	
Right	58	58	24	24	24	27	30	171	88	56	56	56	58	100	54	56	58	= 1000
Left	58	58	24	24	24	27	30	171	88	56	56	56	58	54	46	54	56	58 = 1000.

The 2nd antenna and mouth-parts, with the exception of the 2nd maxilla, are similar to those of the female; in the case of the 2nd maxilla the sensory organs on the terminal segment appear all to be of one kind, and are simple and vermiform.

The swimming legs are as in the female.

The 5th pair of legs (text-fig. 76, *j*) have the same general structure as in the other two members of the genus. The 2nd basal of the right leg is dilated at its base and bears a long and curved endopod, as in *Macandrewella joanae*; the exopod possesses two free segments, the 1st apparently being fused with the 2nd basal segment. The fused 2nd basal and exopod 1 is produced in a series of projections and processes on its inner aspect; there is a well-developed wing-like projection near the proximal end; about the junction of the middle and distal thirds is a small rounded lobe, and near the distal end there is a club-shaped prominence. The 1st free segment is produced at its base in a strong inwardly-directed blunt process that is about equal in length to the whole segment; the 2nd free segment is simple and sickle-shaped. The left leg consists of a two-jointed, elongate basal portion, from which arise a single-jointed endopod and a two-jointed exopod; the endopod is curved and bears at its distal end a row of serrations, the distal segment of the exopod terminates in a claw-like process and bears a tuft of hairs.

Genus **SCAPHOCALANUS** Sars.

A. Scott (1909) has recorded the occurrence of three species belonging to this genus, namely *Scaphocalanus magnus* (T. Scott), *S. major* (T. Scott) and *S. elongatus* A. Scott from the Malay Archipelago.

Up to the present I have observed *Scaphocalanus magnus* (T. Scott) and *S. elongatus* A. Scott in the "Investigator" collections; and in addition I have also come across examples of *Scaphocalanus affinis* Sars and *S. medius* Sars, which may possibly prove to be identical with *S. major* (T. Scott).

Scaphocalanus affinis Sars.

Amallophora affinis, Sars, 1905, p. 21.

Scaphocalanus affinis, Sars, 1925, p. 171, pl. xlviii, figs. 15-23.

Scaphocalanus affinis, Farran, 1929, p. 248.

A few examples, which I believe to belong to this species, were taken at "Investigator" Stations 670 and 682.

Scaphocalanus elongatus A. Scott.

(Text-fig. 77, *a-k*.)

Scaphocalanus elongatus, A. Scott, 1909, p. 98, pl. xxxii, figs. 10-16.

Two examples of this species were taken at "Investigator" Station 670, a third occurs in the collection at Station 393 and a single example, of what I think must also be the

above species, was taken at Station 682, though this individual presents certain slight differences from the description given by A. Scott.



TEXT-FIG. 77.—*Scaphocalanus elongatus* A. Scott, ♀.

- a. The whole animal from the left side.
- b. The rostrum.
- c. The 2nd antenna.
- d. The 1st maxilla.
- e. The 2nd maxilla.

- f. The maxilliped.
- g. The 1st swimming leg.
- h. The 2nd swimming leg.
- j. The 5th pair of legs.
- k. An abnormal 5th pair of legs.

♀ Total length varies from 2.55 to 2.92 mm.

The proportional lengths of the cephalothorax and abdomen are as 119 to 36, so that the abdomen is contained 3.3 times in the length of the anterior region of the body.

The forehead bears a linear crest, as in *Scaphocalanus magnus* (T. Scott) and *S. affinis* Sars; A. Scott (1909) in his figure of this species shows no crest on the forehead, but in his description he remarks that "the forehead is faintly thickened in the middle line, which may indicate a very weak crest, but the material was too limited to make certain."

The posterior thoracic margin is produced backwards and ends in a pointed process.

The head and 1st thoracic segment are fused as also are the 4th and 5th thoracic segments.

The proportional lengths of the abdominal segments are as follows:—

Abdominal segment	1-2	3	4	5	Furca.	
	35	23	18	6	18	= 100

The furcal ramus is about twice as long as wide.

In the structure of the appendages this species agrees closely with *Scaphocalanus affinis* Sars, but there is a clear difference in the 5th pair of legs. Sars in his description of *S. affinis* (*loc. cit.* pl. xlviii, fig. 23.) figures the terminal segment as bearing four spines, one on each margin and two markedly unequal ones at the distal end, the spines on the inner and outer margins arising opposite each other. In *S. elongatus* there are only three spines on this segment, *viz.*, one on each border and a single one at the distal end. The spines on the inner and outer borders do not arise opposite each other, the outer marginal spine being markedly distal to the inner spine.

There is a very close resemblance between *Scaphocalanus elongatus* A. Scott, *S. affinis* Sars and *S. gracilis* Wolfenden. Sars (1925, p. 171) in his description of *S. affinis* remarks, "Les deux formes mentionnées par A. Scott et Wolfenden respectivement sous les noms de *Scaphocalanus elongatus* et *Amallophora gracilis* ne me semblent pas différer essentiellement de l'espèce présente." Wolfenden states that *Amallophora gracilis* possesses a crest, and such a crest appears to be present in both *S. affinis* and *S. elongatus*. *Scaphocalanus affinis*, in addition to the difference noted above in the 5th pair of legs, also appears to be somewhat larger than *S. elongatus*, being according to Sars 3.6 mm. in length, whereas *S. elongatus* is only from 2.6 to 2.9 in length.

In the example of this species that was taken at Station 682 the characters of the 5th pair of legs (text-fig. 77, *k*) show certain differences from the usual condition; the terminal segment in this case carries only two spines, one on the inner margin and a second at the distal extremity, and the inner border of the segment is produced in a rounded lobe. In their general characters these legs agree exactly with the corresponding appendage in Giesbrecht's genus *Racovitzanus* (*vide* Giesbrecht, 1902, p. 26, pl. v, fig. 5). Farran (1909, p. 53, pl. vi, fig. 4) has previously called attention to the occurrence of a similar abnormal 5th leg in an example of his species *Scolecithrix gracilipes* and also in *Scolecithrix valida*.

***Scaphocalanus magnus* (T. Scott).**

Scaphocalanus magnus, A. Scott, 1909, p. 97.

Amallophora magna, Wolfenden, 1911, p. 262.

Amallophora magna, Stephensen, 1913, p. 313.

Scaphocalanus magnus, With, 1915, p. 189, pl. vii, fig. 8 *a-d*; pl. viii, fig. 6 *a-g*, text-fig. 58 *a-k*.

Scaphocalanus magnus, Lysholm and Nordgaard, 1921, p. 20.

Scaphocalanus magnus, Sars, 1925, p. 169.

Scaphocalanus magnus, Farran, 1926, p. 257.

This species is widely distributed throughout the great oceans ; it was first discovered in the Gulf of Guinea and since then it has been taken as far north as 60 degrees in the Atlantic and Sars records it as being of common occurrence in the Polar basin. It also occurs in the " Gauss " collection as far south as the ice belt and several examples, including one male, were taken in the " Investigator " collection at Stations 393, 670 and 682. Sars contended that this species was " undoubtedly of true arctic origin " but in view of its wide distribution this cannot be accepted. As regards its vertical distribution this species seems to have a very extended range ; in the Polar basin it is recorded as being " rather abundant up to the very surface," in the " Gauss " collection it occurs at depths ranging from 1200 to 3000 metres and Farran records it in almost every tow-netting taken off the Irish coast in depths between 280 and 1,150 fathoms.

♀ The total length of the examples in the " Investigator " collection is 4·9 mm. and the proportional lengths of the cephalothorax and abdomen are 30 : 9.

***Scaphocalanus medius* Sars.**

? *Scolecithrix major*, T. Scott, 1894, p. 52, pl. iii, figs. 24-26, pl. v, figs. 44, 45.

Amallophora media, Sars, 1907, p. 16.

? *Scaphocalanus major*, A. Scott, 1909, p. 97.

Scolecithrix gracilipes, Farran, 1909, p. 68, pl. vi, figs. 1-4.

Scaphocalanus medius, Sars, 1925, p. 173, pl. xlix, figs. 1-8.

Two examples, both females, were taken at Station 682.

The various appendages agree closely with the description given by Sars, but Sars seems to have overlooked the fact that the 2nd, 3rd and 4th legs are covered on their anterior faces with innumerable minute spinules. In the 2nd and 4th legs these appear to be in the main restricted to the 2nd basal segment and the segments of the exopod, but in the 3rd leg they are also present on the segments of the endopod.

The form described by Farran (*loc. cit.* 1909) under the name *Scolecithrix gracilipes* appears to me to be identical with that recorded by Sars in 1907 under the name *Amallophora media* and in consequence Sars' name takes priority.

A comparison of the accounts given by T. Scott (1893) and A. Scott (1909) of *Scaphocalanus major* with that of *Scaphocalanus medius* as given by Sars (1925) seems to me to indicate that the two forms are identical. T. Scott gives the size of his example as 3·0 mm., which is a shade larger than A. Scott's examples from the Malay Archipelago, the size of which is given as 2·9 mm. ; Sars' specimens measured only 2·4 mm. In both *Scaphocalanus major* and *S. medius* the general characters appear to be identical and in each case the 5th leg consisted of two segments, the terminal one having a long inner spine, a somewhat shorter terminal spine and a quite short external spine that arises near the base of the terminal spine and distal to the line of origin of the inner spine. The 5th leg figured by Van Breemen (1908, p. 79, fig. 92) refers not to *S. major* but to *S. magnus* and is clearly copied from T. Scott's figure of that species given in pl. iv fig. 9 of his account.

Should *Scaphocalanus major* (T. Scott) and *S. medius* Sars prove to be identical the former name will have priority.

Genus **SCOLECITHRIX** Brady.

Up to the time of the publication of Sars' Monograph on the Crustacea of Norway (1902) the genus *Scolecithrix* contained a large number of forms that showed *inter se* certain differences of structure and were clearly not a homogeneous group. In this monograph Sars subdivided the group into two genera, *viz.* *Scolecithrix* (*sensu stricto*), in which a 5th pair of legs is completely absent in the female, and *Scolecithricella*, in which a 5th pair of legs is present in the female. He, later, in his important monograph on the Copepoda obtained by S. A. S. Prince Albert of Monaco (1925), still further subdivided the latter genus into *Amallothrix*, in which the segments of the 5th pair of legs in the female are all cylindrical and the 2nd maxilla bears certain bud-like sensory organs, and *Scolecithricella* (*sensu stricto*), in which the terminal segment of the 5th pair of legs in the female is broad and lamelliform, and the sensory organs of the 2nd maxilla are all of one unmodified type.

In Indian waters the genus *Scolecithrix* (*sensu stricto*) is represented by three species. Thompson and A. Scott (1903) have recorded the presence of *Scolecithrix bradyi* from the Arabian Sea and *Scolecithrix danae* from the Ceylon Pearl Banks, and in the account of the collections made by the "Siboga" in the Malay Archipelago A. Scott (1909) also records the occurrence of this latter species in that area. In the "Investigator" collections I have been able to find examples of *Scolecithrix danae* and, in addition, I have discovered a new species that I propose to call *S. nicobarica*, after the region in which it was found.

Scolecithrix danae (Lubbock).

Scolecithrix danae, A. Scott, 1909, p. 88.

Scolecithrix danae, Wolfenden, 1911, p. 250.

Scolecithrix danae, Sewell, 1912, p. 360.

Scolecithrix danae, T. Scott, 1912, p. 532.

Scolecithrix danae, Sewell, 1914, p. 217.

Scolecithrix danae, Brady, 1915, p. 135.

Scolecithrix danae, Sars, 1925, p. 175.

Scolecithrix danae, Farran, 1929, p. 243.

This species is widely distributed throughout Indian seas. It has now been recorded from the Malay Archipelago (A. Scott); the coast of southern Burma (Sewell); the Bay of Bengal and the central portion of the Indian Ocean (T. Scott); the Ceylon Pearl Banks (Thomson and A. Scott; Sewell); the Maldive and Laccadive Archipelagoes (Wolfenden); the Arabian Sea (Cleve); south of Madagascar (Wolfenden); the east coast of Africa (Brady) and the Gulf of Aden (A. Scott). In addition to the above records, examples have been taken at "Investigator" Stations 470, 614, 670, 672.

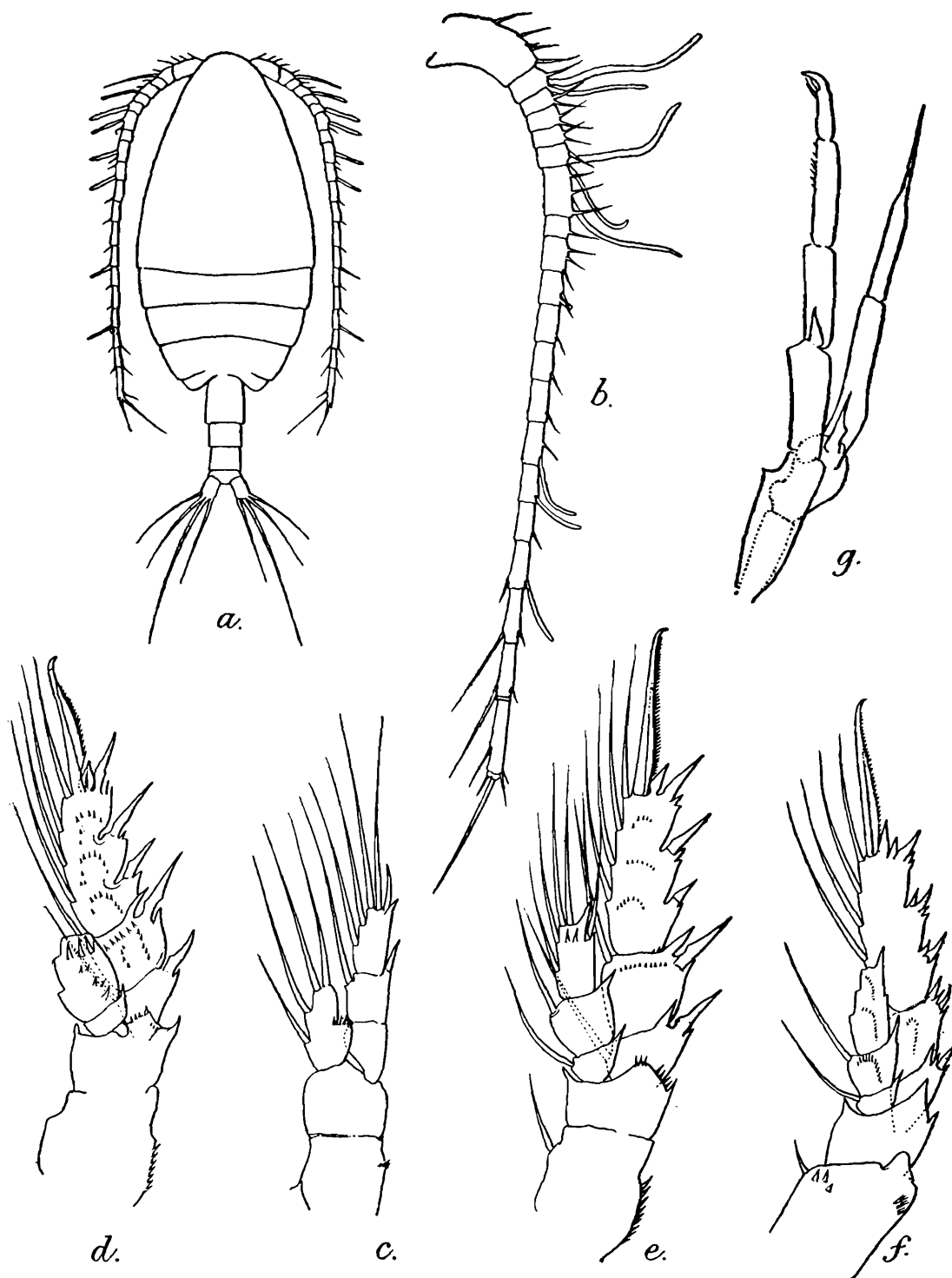
Scolecithrix nicobarica, sp. nov.

(Text-fig. 78, *a-g.*)

Examples of both sexes of this species were taken in Nankauri Harbour in the central group of the Nicobar Islands.

♀ Total length, 1.08 mm.

The proportional lengths of the cephalothorax and abdomen are as 46 to 11, so that the abdomen is contained 4·2 times in the length of the anterior region of the body. The cephalothorax is moderately robust and tapers somewhat towards the anterior end, the broadest



TEXT-FIG. 78.—*Scolecithrix nicobarica*, sp. nov.

a. The whole animal from above, ♀.	d. The 2nd swimming leg.
b. The 1st antenna, ♀.	e. The 3rd swimming leg.
c. The 1st swimming leg.	f. The 4th swimming leg.
g. The 5th pair of legs, ♂.	

part being in the neighbourhood of the posterior margin of the 1st thoracic segment. The cephalon and 1st thoracic segment are fused, as also are the 4th and 5th thoracic segments.

The rostrum is composed of two short stout spines, each terminating in a fine flagellum. The posterior thoracic margin is curved and is slightly indented.

The abdomen consists of four segments that have the following proportional lengths :

Abdominal segment	1-2	3	4	5	Furca.	
	37	23	18	6	16	= 100

The furcal rami are short and broad and bear four setae on their distal margin, of which the 2nd is twice as long as the 3rd.

The 1st antenna (text-fig. 78, b) reaches back to slightly beyond the posterior margin of the thorax and consists of only 20 free segments. Segments 1 and 2 are fused together and so are segments 8 to 10 and segments 12 and 13 ; segments 24 and 25 are also fused. The segmentation of the antenna in this species thus exactly agrees with that found in *Scolecithricella vittata*. The proportional lengths of the segments are as follows :

Segment	1-2	3	4	5	6	7	8-10	11	12-13	14	15	16	17	18	19	20	21	22	23	24-25	
	104	25	21	21	21	21	54	21	51	46	50	50	54	58	50	50	54	62	83	104	= 1000

Segment 3 bears a long and a short " aesthetask," as also does segment 7 ; segment 9 bears a single long sensory filament and segments 18, 19 and 21 each bear a short sensory filament.

In the 2nd antenna the exopod is twice the length of the endopod.

The 1st swimming leg (text-fig. 78, c) possesses a three-jointed exopod and a single jointed endopod. The 1st basal segment bears a row of fine spines across its outer surface. The 1st segment of the exopod is devoid of a marginal spine ; exopod 2 and 3 each bears a marginal spine, the two being subequal, and the end-spine is long and slender and is more than the length of the two end-segments. Exopod 3 bears only three setae. The endopod exhibits on its outer margin a rounded swelling which is fringed with needle-like spines.

The 2nd, 3rd and 4th swimming legs (text-fig. 78, d, e and f) are armed with numerous spines on the surface of the segments as shown in the text-figures.

The 5th pair of legs is completely absent in this sex so that this species falls within the definition of the genus *Scolecithrix*.

♂ Total length, 1.08 mm., being the same as in the female.

The proportional lengths of the cephalothorax and abdomen are in this sex 43 to 14, so that the abdomen is contained only 3.1 times in the length of the anterior region of the body. The general form of the body is as in the female.

The abdomen consists of five segments that have the following proportional lengths :

Abdominal segment	1	2	3	4	5	Furca.	
	19	31	19	21	2	8	= 100

The swimming legs are as in the female.

The 5th pair of legs (text-fig. 78, g) are similar in type to those of *Scolecithrix vittata*, *S. dubia* and *S. tenuiserrata*.

Genus **SCOLECITHRICELLA** Sars.

The genus *Scolecithricella* was created by Sars (1902-3) to include a number of species that had previously been included in the genus *Scolecithrix*. As Sars pointed out, the type species of the genus *Scolecithrix* was *S. danae* (Lubbock), in which there is a complete absence of a 5th pair of legs in the female ; clearly then species in which this appendage was present

could not strictly be referred to the same genus. He, therefore, separated off those species that possessed a 5th pair of legs and included them all in the new genus *Scolecithricella*. In 1925, however, he again separated off a number of species, that had been included in this latter genus, in a new genus that he termed *Amallothrix* and he defined the distinguishing characters of the two groups as: (1) the presence in *Amallothrix* of a button-like sensory appendage on the terminal segment of the 2nd maxilla, and of only worm-like appendages in this segment in *Scolecithricella*, (2) the 5th pair of feet in the female are cylindrical in *Amallothrix* and are flattened and plate-like in *Scolecithricella*.

A study of the numerous species that have up to the present time been described and referred to the genus *Scolecithrix* (*sensu lato*) leads one to doubt whether the distinctive features as given above are sufficient grounds for the separation of the forms into two groups and it appears probable that, if the original genus *Scolecithricella* is to be divided up, it will in the end be necessary to create still more genera. In a certain number of species the 5th legs in the female are cylindrical in shape and terminate in two, or sometimes three, spines and the sensory appendages at the end of the 2nd maxilla are all of the same type and are worm-like; these species clearly belong to the genus *Scolecithricella* (*sensu stricto*) as defined by Sars. Others, however, possess one or more of these appendages modified so that the tip forms a bud-like swelling, and the 5th pair of legs are cylindrical, so that they clearly conform to the definition of the genus *Amallothrix*. Certain other species, however, while exhibiting a cylindrical form in the 5th legs, do not show any modification of the sensory appendages of the 2nd maxilla, such species are *Scolecithrix aequalis* Wolfenden, *S. polaris* Wolfenden and *S. magnus* Wolfenden, in which the 5th leg bears two unequal spines, as in many examples of the genus *Amallothrix*, and *Scolecithrix acutus* Wolfenden and *S. medius* Wolfenden, in which the 5th pair of legs resembles those of members of the genus *Scaphocalanus*.

In 1883 Brady reported the occurrence of *Scolecithricella minor* from the Indian Ocean in the region to the west of Crozet Island. In 1903 Thompson and A. Scott added *Scolecithricella auropecten* (Giesbrecht) and *S. tenuipes* (T. Scott) to the list of species known to occur in the Red Sea. A. Scott (1909) in his account of the Copepoda from the Malay Archipelago, in addition to those species mentioned already, added the following to the list of species known to inhabit Indian waters, namely:—

<i>Scolecithricella abyssalis</i> (Giesbrecht),	<i>Scolecithricella longifurca</i> (Giesbrecht),
<i>Scolecithricella ctenopus</i> (Giesbrecht),	<i>Scolecithricella marginata</i> (Giesbrecht),
<i>Scolecithricella longicornis</i> (T. Scott),	<i>Scolecithricella profunda</i> (Giesbrecht).

In 1914 I described a new species, *Scolecithricella pearsoni*, from the Pearl Banks of Ceylon.

***Scolecithricella ctenopus* (Giesbrecht).**

(Text-fig. 79, a-g.)

Scolecithrix ctenopus, Giesbrecht, 1893, p. 285, pl. xiii, figs. 36-38 and pl. xxxvii, fig. 15.

Scolecithrix ctenopus, T. Scott, 1894, p. 48, pl. v, figs. 2-9.

Scolecithrix ctenopus, Giesbrecht and Schmeil, 1898, p. 46.

Scolecithricella ctenopus, A. Scott, 1909, p. 91.

The occurrence of this species in the Malay Archipelago was recorded by A. Scott (1909) and a single example of the male was taken by the "Investigator" at Station 682. Associated with this male was a single female that I have no hesitation in referring to this species.

♀ Total length, 1.26 mm.

The proportional lengths of the cephalothorax and abdomen are as 110 to 23, the abdomen being thus contained 4.8 times in the length of the anterior region of the body.

The body is moderately robust and when viewed from above is oval in shape, tapering towards both ends. The head and 1st thoracic segment are fused, but a slight trace of the line of fusion can be detected in the mid-dorsal region. Thoracic segments 4 and 5 are also fused, but a well-marked notch in the ventro-lateral margin indicates the limit of each segment. The posterior thoracic margin is produced backwards and terminates on each side in a small curved spine.

The abdomen is very short in the present specimen owing to the various segments being considerably telescoped into each other. The proportional lengths of the segments are as follows:—

Abdominal segment	1	2	3	4	Furca.
	47	16	14	5	18 = 100

The rostral filaments are delicate and are difficult to see, owing to their being in close approximation to the swollen basal segments of the 1st antennae.

The 1st antennae reach back to the tip of the furcal rami. They consist, as in *Scolecithricella longicornis* (T. Scott), of 23 segments, that 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	25
<i>S. ctenopus</i> . . .	60	53	24	24	26	27	27	68	24	30	41	44	49	62	55	55	55	55	55	55	55	51	41	32	= 1000
<i>S. longicornis</i> . . .	57	40	28	28	28	28	28	66	19	28	39	39	47	56	47	56	56	56	56	56	56	56	47	39	= 1000

For the purpose of comparison I have given in the above table the proportional lengths of the segments in *Scolecithricella longicornis* (T. Scott) as calculated from the data given by T. Scott. From these figures it will be seen that there is a reasonably close agreement between the two series. In both species the length of the appendage and the number of segments is the same and segments 8 to 10 are fused.

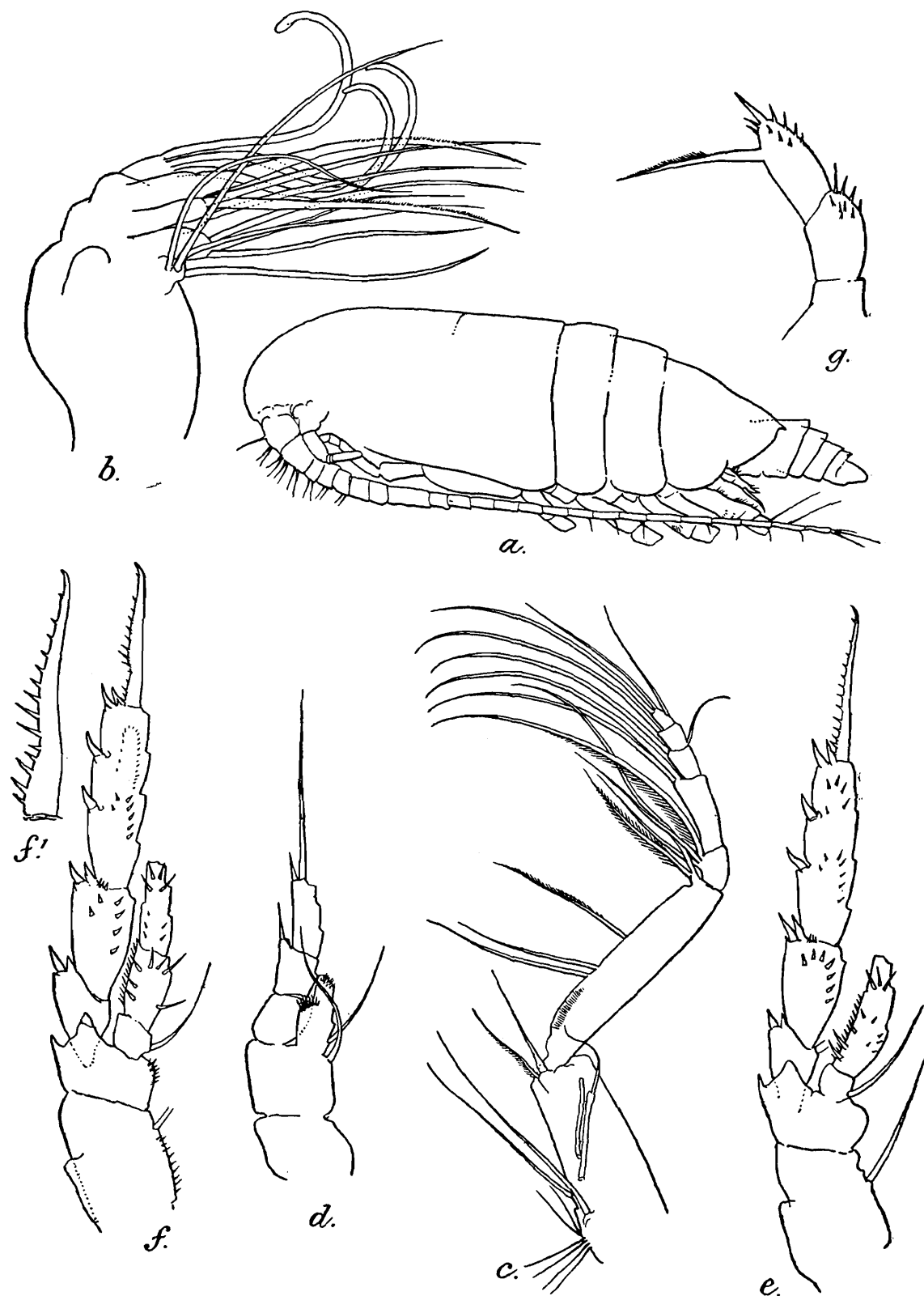
In the 2nd antenna the endopod is only $\frac{3}{4}$ ths the length of the exopod.

In the 2nd maxilla (text-fig. 79, b) the terminal segment bears a number of sausage-shaped filaments, but I was unable to determine the exact number.

The maxilliped (text-fig. 79, c) is comparatively small; the 1st basal segment bears a row of setae along its anterior margin near the proximal end. From the middle lobe spring two setae, of which the proximal is dilated about half-way along its length and then appears to terminate in a delicate flagellum. The 2nd joint of the endopod is at least twice as long as the 1st segment and is equal to the length of the last three segments, as is the case, according to T. Scott, in *Scolecithricella longicornis*.

The 1st swimming leg (text-fig. 79, d) possesses the usual three-jointed exopod and a single-jointed endopod. Both basal segments are devoid of spines. The endopod exhibits a rounded swelling about half-way along the length of the external margin and the swelling is crowned with a row of needle-like spines; there are a number of scattered spines on the terminal portion of the joint.

In the 2nd swimming leg (text-fig. 79, e) basal segments 1 and 2 are devoid of spines. Basal 1 shows a well-marked notch on its outer margin. The exopod consists of three seg-



TEXT-FIG. 79.—*Scolecithricella ctenopus* (Giesbrecht), ♀

a. The whole animal from the left side.	e. The 2nd swimming leg.
b. The 2nd maxilla.	f. The 3rd swimming leg.
c. The maxilliped.	f. ¹ The terminal spine enlarged.
d. The 1st swimming leg.	g. The 5th leg.

ments and both the 2nd and 3rd are armed with strong spines on their posterior aspects. The endopod consists of two segments and the distal one is armed with spines on

the surface and there is a comb of small spines along the external margin, a condition that exactly corresponds with the condition in the male. The end-spine of the exopod is also slightly distorted as in the male.

In the 3rd swimming leg (text-fig. 79, *f*) basal 1 bears a number of spines on or near its inner margin, while the outer margin exhibits a clearly-marked indentation. Basal 2 bears a group of small curved spines on the distal portion of its inner border; this agrees exactly with the condition figured by T. Scott in *Scolecithricella longicornis* (*vide* T. Scott, 1890, pl. v, fig. 26). The terminal spine is distorted, exactly as in the manner described by T. Scott (*loc. cit.*, p. 48), and is furnished with widely-spaced teeth of varying size; T. Scott does not mention the number of teeth on the end-spine but to judge from the figure that he gives there were from 17 to 18; in the present example there are 14. Unfortunately in my example of the male the end-spines of the third leg are missing so that comparison is impossible.

The surface of the segments of the rami of the swimming legs is armed with rows of exceedingly minute spinules, running down the length of the segments. I have not figured these in my illustrations, but they are clearly shown in T. Scott's illustrations of the male of *Scolecithricella ctenopus*.

The 5th leg (text-fig. 79, *g*) consists of a basal segment and two free segments of approximately equal length. The proximal segment bears a number of spines on the distal part of the external margin. The distal segment terminates in a sharp spine-like projection around the base of which are a number of sharp spines; a single spine-like seta, with a serrated margin, arises from the inner aspect at the junction of the middle and distal thirds. A comparison of text-fig. 79, *g* with the corresponding appendage in *Scolecithricella longicornis* (*vide* T. Scott, 1898, pl. v, fig. 27) reveals a close degree of similarity.

***Scolecithricella pearsoni* Sewell.**

Scolecithricella pearsoni, Sewell, 1914, p. 217, pl. xvii, figs. 6, 7 and pl. xviii, figs. 1-4.

This species was originally described from the Pearl Banks of Ceylon, where it had been taken by Dr. T. Southwell in the surface tow-net. Several examples of the same species have since been taken by the 'Investigator' in the surface-waters of Nankauri Harbour in the Nicobars, Station 614.

Genus **AMALLOTHRIX** Sars.

The genus *Amallothrix* was created by Sars (1925) to accommodate a number of species that had previously been included in the genera *Scolecithrix* and *Scolecithricella*. Of the species that can be attributed to this genus A. Scott (1909) in his account of the Copepoda of the Malay Archipelago records the occurrence in that region of the following:—

Amallothrix curticauda (A. Scott),
Amallothrix gracilis Sars,
Amallothrix obtusifrons Sars,
Amallothrix tydemani (A. Scott), and
Amallothrix valida (Farran).

Unfortunately some confusion has arisen regarding the distribution of *Amallothrix obtusifrons* Sars. Farran (1905) recorded the occurrence of a species of *Scolecithrix* from the North Atlantic under the name *S. emarginata*. Shortly before the appearance of this paper Sars had given brief descriptions of a number of new species, one of which was extremely like Farran's species. Farran, therefore, submitted examples of his species to Sars who pronounced them to be identical with the form described by him under the name *Scolecithricella obtusifrons*; later, in 1925, however, Sars has come to the conclusion that the two forms are not identical and that Farran's species is a valid one. In the meantime A. Scott has recorded the occurrence of *Scolecithricella obtusifrons* Sars from the Malay Archipelago and in the list of synonymy gives Farran's reference. It is, therefore, impossible without an examination of Scott's specimens to be absolutely certain which of these two species was present in the "Siboga" collection, though from the figures that he gives it would appear that he was dealing with Farran's species.

Up to the present time in the "Investigator" collections I have been able to identify examples of *Amallothrix emarginata* (Farran), *A. arcuata* Sars and *A. valida* (Farran); and, in addition, there are in the collection examples of what appears to be either a new species or else a small form of *A. emarginata*, but as there are certain differences in structure and in the spination of the swimming feet I have thought it best to describe this form as a new species under the name *A. indica*.

***Amallothrix emarginata* (Farran).**

- Scolecithrix emarginata*, Farran, 1905, p. 36, pl. vii, figs. 6-17.
 ? *Scolecithrix inornata*, Esterly, 1906, p. 67, pl. xi, fig. 37; pl. xiii, figs. 65, 73.
Amalophora obtusifrons, Pearson 1906, p. 17.
Scolecithrix obtusifrons, Farran, 1908, p. 54.
Scolecithrix obtusifrons, van Breemen, 1908, p. 75, fig. 87.
Scolecithricella obtusifrons, A. Scott, 1909, p. 92, pl. xxxi, figs. 1-9.
 ? *Scolecithrix aequalis*, Wolfenden, 1911, p. 255, text-fig. 33 a-c.
Scaphocalanus obtusifrons, With, 1915, p. 194, pl. vii, fig. 9 a-d; pl. viii, fig. 8 a-c, text-figs. 60 a-c and 61 a-d.
Scolecithricella emarginata, Sars, 1920, p. 9.
Scaphocalanus obtusifrons, Lysholm and Nordgaard, 1921, p. 21.
Amallothrix emarginata, Sars, 1925, p. 181, pl. 1, figs. 17-23.

A considerable confusion has arisen regarding the nomenclature of this species. Farran first described the species from examples taken in the north Atlantic in 1905; he later referred examples to Sars who informed him that they were identical with the species that he had just previously described very briefly under the name *Amalophora obtusifrons*. In 1925, however, Sars reaches the conclusion that Farran's species, of which he examined examples in 1906, is not the same as his own species *Amalophora obtusifrons*. In the "Siboga" collection from the Malay Archipelago A. Scott records the occurrence of a number of examples of a species of *Scolecithricella* that he considers to be identical with Farran's species; certainly the two forms agree very closely, though Farran states that in his specimens from the North Atlantic there is no sensory appendage on the 1st joint of the 2nd maxilla, while such is present in the Malay examples; and, moreover, judging from the figures that

Scott gives, the surface of the exopods of the swimming feet bear many more spines in the Malay examples than in the N. Atlantic form. Examples of this species were subsequently recorded under the name *Scaphocalanus obtusifrons* by With and by Lysholm and Nordgaard and it seems probable that the form described by Wolfenden from the "Gauss" collections, under the name *Scolecithrix aequalis*, is also identical with Farran's species.

A number of examples of this species were taken by the "Investigator" at Station 670.

[Amallothrix arcuata Sars.

Scolecithricella arcuata, Sars, 1920, p. 10.

Amallothrix arcuata, Sars, 1925, p. 185, pl. li, figs. 14-21.

Four examples, that I have no hesitation in referring to this species, were taken by the "Investigator" at Station 682. Hitherto this species had only been recorded by Sars from the Atlantic Ocean; its occurrence in the present collection extends its known distribution to the Indian Ocean.

Amallothrix valida (Farran)

(Text-fig. 80, *a-f.*)

Scolecithrix valida, Farran, 1908, p. 56, pl. v, figs. 14-17, pl. vi, fig. 7.

Scolecithricella valida, A. Scott, 1909, p. 92, pl. xxxii, figs. 1-9.

Amallothrix valida, Sars, 1925, p. 186, pl. li, figs. 22-28.

Scolecithrix valida, Farran, 1929, p. 244.

A single example of what I take to be this species was obtained by the "Investigator" at Station 682. Farran (*loc. cit.* p. 56) remarks that it is somewhat difficult to distinguish between the present species and *Amallothrix gracilis* Sars (= *Scolecithrix globiceps* Farran). In the case of the present example it is particularly difficult to decide which is the correct determination, since it resembles *Amallothrix valida* in certain respects and in others comes near to *Amallothrix gracilis*.

♀ The total length is 2.66 mm. The example is thus markedly smaller than examples of *Amallothrix valida* from the N. Atlantic, the length of which according to Farran ranges from 3.8 to 3.9 mm., and still more so than *A. gracilis*, the size of which is 4.3 to 4.5 mm. A. Scott gives the size of examples taken by the "Siboga" in the Malay Archipelago as 3.24, which is exactly intermediate between the sizes of the Atlantic and Indian specimens.

The proportional lengths of the cephalothorax and abdomen are as 113 to 28, the abdomen being thus contained 4 times in the length of the anterior region of the body. In *Amallothrix valida* it is said to be contained $3\frac{2}{3}$ rd times and in *A. gracilis* $3\frac{1}{2}$ times.

The general form of the body resembles that of *Amallothrix valida* and is less robust than *A. gracilis*. The rostrum consists of the usual two processes, each process exhibiting a swollen basal portion and a terminal filament that is long and delicate; Sars (1925, pl. li, fig. 24) figures this terminal filament as being remarkably short.

The abdomen consists of the usual four segments, that have the following proportional lengths:

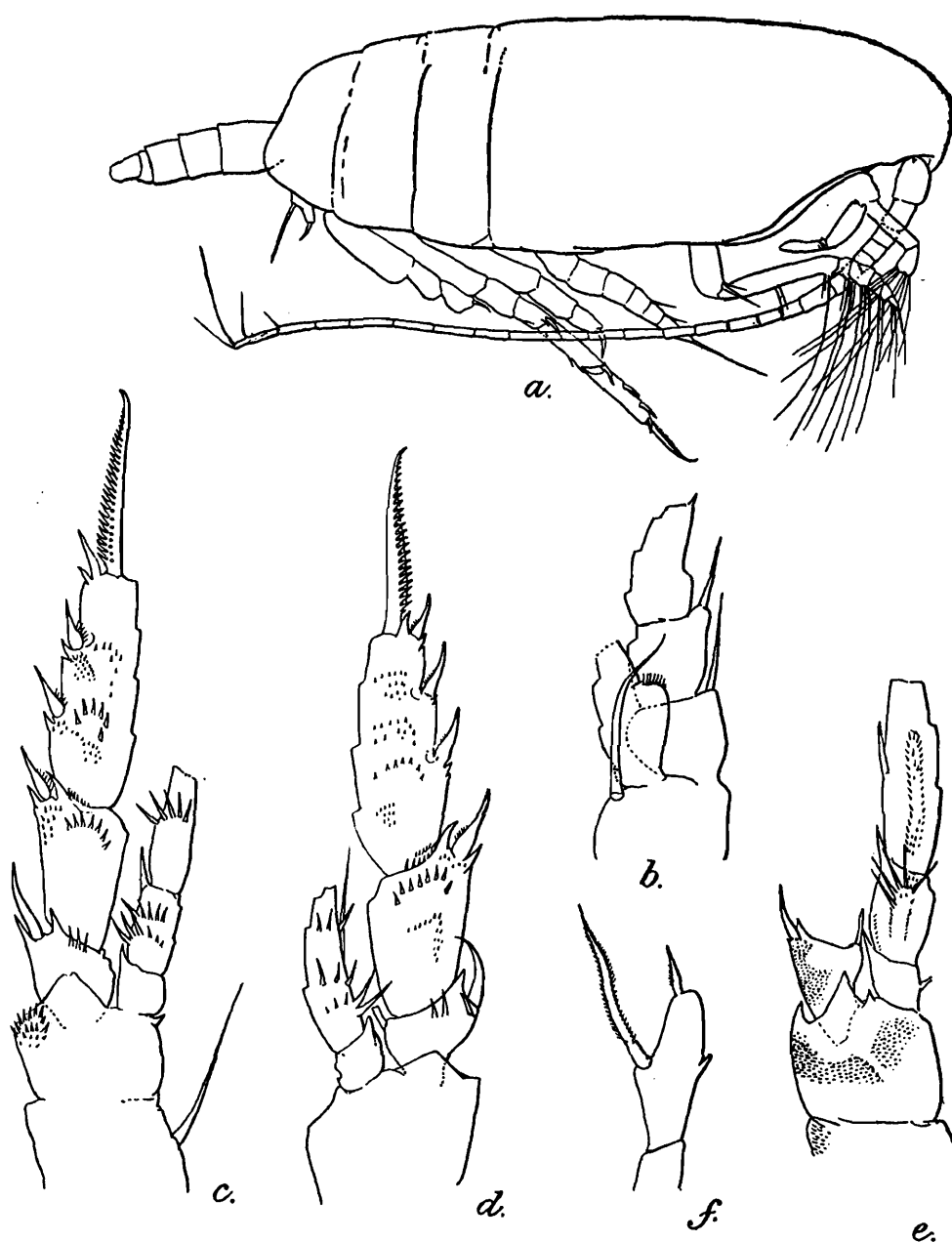
Abdominal segment	1-2	3	4	5	Furca.
	41	21	17	4	17 = 100

The furcal rami are, as in *A. valida*, about $1\frac{1}{2}$ times as long as broad.

The 1st antenna reaches beyond the posterior thoracic margin by the last two segments, thus more nearly resembling Farran's account of this appendage in *A. gracilis*, in which species it is said to reach beyond the posterior margin by the last segment, whereas in *A. valida* it is stated to reach the posterior end of the 2nd abdominal segment. The segments have the following proportional lengths:—

Segment	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
	68	49	23	23	23	23	23	45	22	22	23	40	43	47	57	59	59	55	56	57	45	65	73= 1000

Unfortunately, Farran in his account does not give the proportional lengths of the segments in this appendage in either *Amallothrix valida* or *A. gracilis*.



TEXT-FIG. 80.—*Amallothrix valida* (Farran), ♀.

a. The whole animal from the right side.

b. The 1st swimming leg.

c. The 2nd swimming leg.

d. The 3rd swimming leg.

e. The basal portion and endopod of the 4th swimming leg.

f. The 5th leg.

The 2nd antenna is as in *A. valida*, and the mouth-parts are also identical with those in that species.

The 1st swimming leg (text-fig. 80, *b*) closely resembles that of *A. gracilis*. The marginal spine on the 1st segment of the exopod reaches well beyond the base of the spine on exopod 2.

The 2nd swimming leg (text-fig. 80, *c*) appears to resemble that of *A. valida*, the curved spine on exopod 1 being nearly half as long as the 2nd segment of the ramus. The 1st segment of the exopod bears two small spines near the distal margin. The 2nd segment is armed with a curved transverse row of spines of medium size near the distal margin and a patch of minute spines about half-way along its length, while there are a few small spines near the base of the marginal spine; on the anterior aspect is a row of needle-like spines along the extreme distal margin. The 3rd segment bears on its posterior aspect near the origin of the proximal inner seta a patch of minute spines, a curved row of spines of medium size on a level with the base of the 1st marginal spine, a crescentic patch of small spines between the levels of the 1st and 2nd marginal spines and a third patch of small spines on a level with and slightly distal to the base of the 2nd marginal spine. The endopod bears three rows of large spines on the 2nd segment; in the proximal row the outer two spines are much larger than the inner three as figured by Farran (1909, pl. v, fig. 16.) The terminal spine of the exopod agrees exactly with Farran's description of the end-spine in *A. valida*.

In the 3rd swimming leg (text-fig. 80, *d*) the 2nd basal segment bears a group of curved spines at its distal external angle, as in *A. gracilis*. Exopod 1 bears 2 or 3 spines on its posterior aspect near the distal external angle. Exopod 2 bears a curved row of spines of medium size and there is a patch of small spines at its external angle. Exopod 3 bears two rows of curved spines of medium size and near the base of each of the two proximal marginal spines is a patch of minute spines that spreads inwards over the posterior aspect of the ramus. The end-spine is as in the 2nd leg and resembles that of *A. valida*. The endopod has two rows of large spines on the 2nd segment and a single row on the 3rd; in this respect this example appears to differ from both *A. valida* and *A. gracilis* in which, according to Farran, "the first and second joints of the endopodite have each two transverse rows of large spinules"

The 4th leg resembles that of *A. gracilis*.

The 5th leg (text-fig. 80, *f*) exactly agrees with that of *A. valida* and bears no spinules on its outer aspect.

***Amallothrix indica*, sp. nov.**

(Text-fig. 81, *a.-g.*)

Associated with several examples of *Amallothrix emarginata* (Farran) in the "Investigator" collection from Station 670 were several specimens that at first sight I took to be examples of that species. They are, however, considerably smaller and a careful study of the appendages indicates that they may represent a species hitherto unknown.

♀ Total length, 3.06 mm.

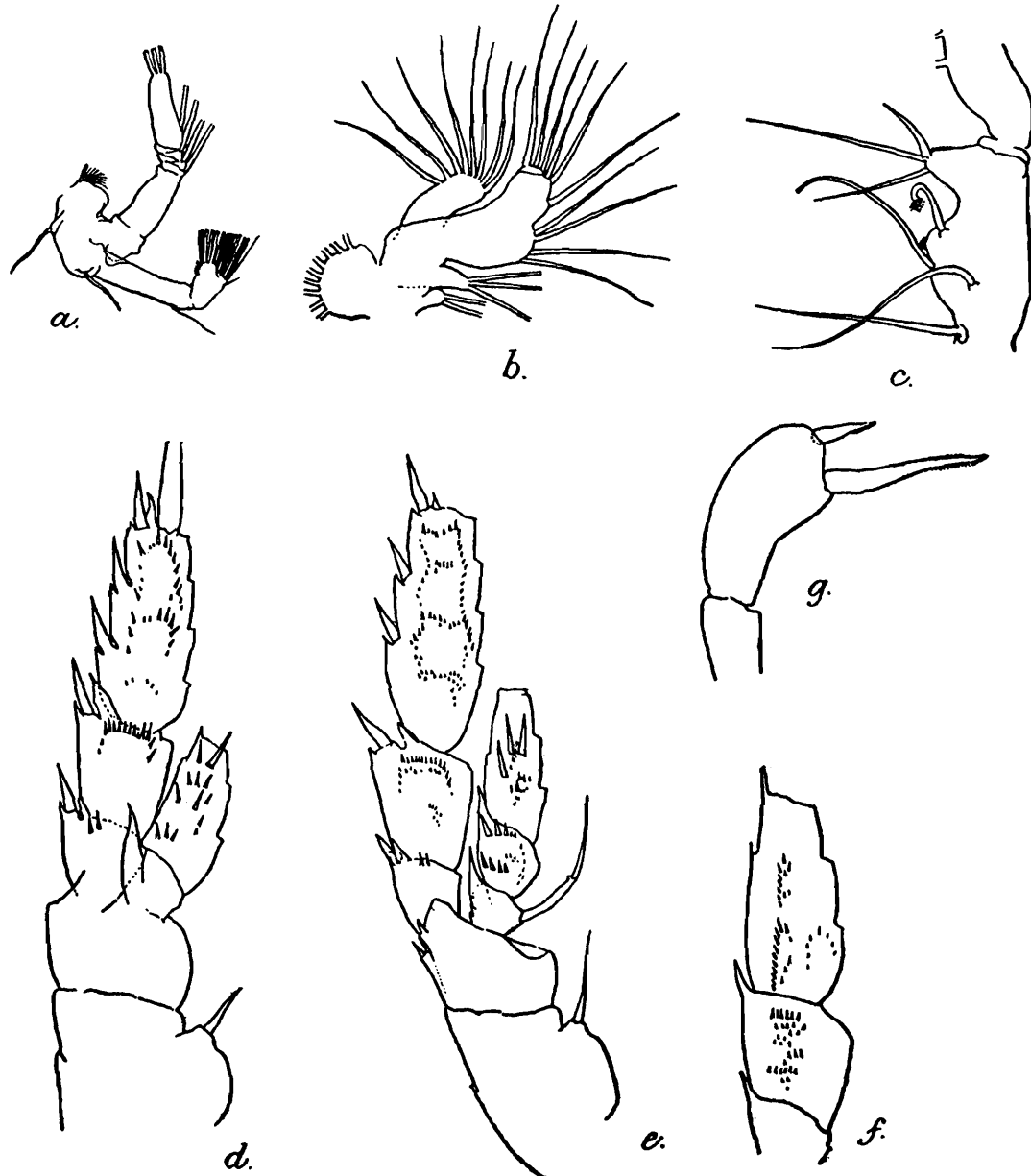
The proportional lengths of the cephalothorax and abdomen are as 5 to 1. The head and 1st thoracic segment are fused and so also are thoracic segments 4 and 5. The forehead is uniformly rounded and terminates below in a rostrum consisting of a papilliform basal portion and a pair of delicate rostral filaments. The posterior thoracic margin is somewhat indented and closely resembles the form found in *Amallothrix emarginata* (Farran).

The abdomen is short and consists of four segments, of which the 1st is slightly longer than the combined lengths of the 2nd and 3rd, and the 4th is extremely short. The proportional lengths of the segments are as follows :—

Abdominal segment	1-2	3	4	5	Furca.
	43	21	19	4	13 = 100

The 1st antenna reaches back to the posterior margin of the 2nd abdominal segment. It consists of 23 separate segments ; segments 8 and 9 being completely fused and segments 24 and 25 partially so. The proportional lengths of the segments are as follows :—

Segment	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
	66	58	26	26	26	26	26	52	26	26	34	42	45	47	50	50	50	47	47	47	52	60	58	13 = 1000



TEXT-FIG. 81.—*Amallothrix indica*, sp. nov., ♀.

a. The 2nd antenna	d. The 2nd swimming leg.
b. The maxillary palp	e. The 3rd swimming leg.
c. The 1st basal segment of the maxilliped.	f. The endopod of the 4th swimming leg.
g. The 5th leg.	

The 2nd antenna (text-fig. 81, a) closely resembles those of other members of the genus. A row of long hairs is present on the 1st basal segment on its inner and posterior aspect.

The endopod is more than one and a half times as long as the exopod and there is a small blunt knob-like projection on the outer aspect of the proximal segment; a similar knob is present in the same position in the corresponding appendage of *Amallothrix emarginata* (Farran).

The maxilla (text-fig. 81, *b.*) presents certain differences as regards the number of setae arising from the different parts; the outer lobe bears 9 setae; the 2nd inner lobe bears 2 and the 3rd, 3 setae; the basal segment and the 1st and 2nd segments of the endopod appear to be more or less fused and there is no clear line of demarcation between these different parts; the portion of the inner margin corresponding to the 2nd basal segment carries 4 setae, that corresponding to the 1st segment of the endopod has 1 and the part corresponding to the 2nd segment 2; the 3rd segment, which is clearly separate, bears 3 setae. The exopod bears 8 setae. According to Farran's figure (1905, pl. vii, fig. 11) there are in *Amallothrix emarginata* only 7 setae on the outer lobe, but in my examples there are actually 9, of which the anterior 7 are stouter than the rest.

The number of setae on the various parts of this appendage in this and certain other species of the genus are shown in the following table:—

Species.	3rd inner lobe.	2nd basal joint.	Endopod 1.	Endopod 2 and 3.	Exopod	Outer lobe.
<i>A. obtusifrons</i> Sars	4	4	2	5	.. 9	.. 9
<i>A. emarginata</i> (Farran)	4	4	2	5	.. 8	.. 7(9)
<i>A. indica</i> sp. nov.	3	4	1	5	.. 8	.. 9

Wolfenden (1911, p. 255), under the name *Scolecithrix aequalis*, has described a form that is closely allied to, if not identical with *Amallothrix emarginata* (Farran), but with the exception of the remark that "the maxilla has a somewhat elongated inner lobe, longer than the hooks. The inner branch and the basal joint bear 7 and 5 setae," he gives no details and one is, therefore, unable to compare this species with the others of the series.

The maxilliped closely resembles that of *Amallothrix obtusifrons* Sars but the basal segment (text-fig. 81, *c*) seems to be considerably shorter than in that species and deeper in the antero-posterior direction; there is a well-developed brush-like sensory organ on the anterior margin about the middle of the length of the segment.

The swimming legs appear to be almost identical with the corresponding appendages in *Amallothrix emarginata* (Farran), but there are certain small differences in the spination of the segments and in the proportional lengths of the terminal segments and the end-spines.

Amallothrix indica may be only a growth-stage of *Amallothrix emarginata* (Farran), similar to the two stages that we appear to have present in *Lophothrix frontalis* (*vide supra*, p. 193), but more examples and especially immature forms are necessary before we can get any definite indications as to whether this is the case or not.

MEMOIRS

of the

INDIAN MUSEUM

Vol. X (*continued*).

The Copepoda of Indian Seas.

Calanoida.

By

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THE COPEPODA OF INDIAN SEAS.

CALANOIDA.

By R. B. SEYMOUR SEWELL, *Lt.-Col., I.M.S., Sc.D., F.Z.S., F.L.S., F.A.S.B.,*
Director, Zoological Survey of India.

Tribe HETERARTHANDRIA.

In the previous instalment of this work, published in 1929, I dealt with those families that have been grouped by Giesbrecht in the Tribe Amphaskandria, and in the present work I have dealt with the families of the other Tribe Heterarthrandria. Sars (1925, p. 16) advocates the abolition of this subdivision of the Calanoida into two Tribes, as originally proposed by Giesbrecht, on the ground that in the genus *Bathycalanus*, which has been classed with the rest of the Tribe Amphaskandria, the right 1st antenna is in the male transformed into a grasping organ that is in every way exactly comparable with the grasping antenna of the Heterarthrandria; he remarks, "en effet, ce cas semble annuler complètement la validité de la classification binaire des Calanoidés proposée par Giesbrecht et généralement admise par les carcinologues." I have previously pointed out (*vide supra*, p. 28) that the same modification is present in yet another genus of the Amphaskandria, namely in the males of the genus *Megacalanus*. While agreeing that this modification of the 1st antenna in certain genera of the Tribe Amphaskandria invalidates this particular character as a means of differentiating between the two Tribes I would point out that I have previously (*vide supra*, pp. 9, 10) shown that in a large number of species of genera that have been hitherto included in the Tribe Amphaskandria there is a brush of long hairs on the inner aspect of the 1st basal segment of the 2nd antenna and up to the present time I have failed altogether to detect any such brush in any member of the Tribe Heterarthrandria, and I, therefore, tentatively suggested that this might prove to be characteristic feature of the Tribe Amphaskandria. Under the circumstances I have, therefore, thought it advisable to retain these tribal divisions.

The presence of small glands opening on the surface through pores in the chitinous covering has been noted and recorded by several observers in the past. Ficker¹, Haeckel, Claus,² Fric,³ Rehbürg, Hartog,⁴ Richard⁵ and others have from time to time called attention to the unicellular glands that occur in various species. These glands occur partly on certain segments of the body and partly on the limbs and other appendages. Giesbrecht (1892) and With (1915) have both recorded their presence on the swimming legs

¹ Ficker, G., "Ueber ein bisher unbekanntes Abscheidungsorgan bei *Sapphirina*." *Zool. Anzeiger*, Vol. for 1879, Pt. 39, p. 515 (1879).

² Claus, C., "Neue Beiträge zur Kenntniss der Copepoden." *Arb. Zool. Inst. Wien*, Vol. III, p. 313 (1881).

³ Fric, J. A., "Note préliminaire sur l'Ontogenie de nos Copepodes d'eau douce." *Zool. Anzeiger*, p. 498 (1882).

⁴ Hartog, M. M., "The Morphology of *Cyclops* and the Relations of the Copepoda." *Trans. Linn. Soc. London*, (2nd Series), Vol. V, Pt. 1 (1888).

⁵ Richard, J., "Recherches sur le Systeme Glandulaire et sur le Systeme Nerveux des Copepodes libres d'eau douce." *Ann. Sci. Naturelles, Zoologie* (Series VII), Vol. XII, p. 113 (1891).

of certain species belonging to the Calanoida and With (*loc. cit.*, p. 5) states that they are poorly developed in the Scolecithricidae and show their greatest development in the genus *Euchirella*, and I have also recorded their presence in this situation in certain other genera. With the exception of the authors noted above, I know of no observer who has recorded the presence of similar glands on the various segments of the body itself; Fric has shown that they are to be found on certain parts of the cephalothorax and the furcal rami of *Cyclops* and Hartog has demonstrated their presence on the segments of the abdomen and states that their position is constant in *Cyclops viridis*. Rehbürg has found them to be present in *Cyclops strenuus* and *Canthocamptus staphylinus*. Richard has shown that they are also present in *Bradya edwardsi* and in *Eurytemora lacinulata*, though very rare in this latter species, and are in all probability entirely absent in *Diaptomus castor* and *D. coeruleus*. That these glands are not confined to species that frequent fresh water is shown by the fact that they have been found to be present in *Centropages typicus* Kröyer, *Temora longicornis* (Müller) and *Temora stylifera* (Dana) by Claus, in *Sapphirina* by Ficker, and in *Sapphirina* and *Sapphirinella* by Haeckel. During my studies of the members of the Tribe Heterarthrandria I have discovered the presence of similar glands scattered over both the cephalothorax and abdomen in a number of species and it seems probable that they are far more common than one might think from a study of the literature, but that owing to their small size they have not attracted the attention that they deserve. I have been able to detect the presence of such pores in members of the Families Temoridae, Metridiidae, and Heterorhabdidae.

SYSTEMATIC LIST OF SPECIES.

*The species marked * occur in the Indian Museum Collections.*

Tribe Heterarthrandria.

Family Centropagidae.

Genus *Centropages* Herrick.

- 172. **Centropages alcocki* Sewell.
 - 173. *Centropages calaninus* (Dana).
 - 174. *Centropages chierchiae* Giesbrecht.
 - 175. **Centropages dorsispinatus* Thompson and A. Scott.
 - 176. **Centropages elongatus* Giesbrecht.
 - 177. **Centropages furcatus* (Dana).
 - 178. **Centropages gracilis* (Dana).
 - 179. **Centropages kroyeri* Giesbrecht.
 - 180. **Centropages orsinii* Giesbrecht.
 - 181. *Centropages ponticus* Karawiew.
 - 182. *Centropages tenuicornis* Brady.
 - 183. **Centropages tenuiremis* Thompson and A. Scott.
 - 184. **Centropages trispinosus* Sewell.
 - 185. *Centropages typicus* Kröyer.
 - 186. **Centropages violaceus* (Claus).
- Genus *Isias* Boeck.
- 187. **Isias tropica* Sewell.

Family Diaptomidae.

Genus *Pseudodiaptomus* Herrick.

Group 1.

- 188. **Pseudodiaptomus clevei* A. Scott.
- 189. **Pseudodiaptomus hickmani* Sewell.
- 190. **Pseudodiaptomus salinus* Giesbrecht.
- 191. **Pseudodiaptomus serricaudatus* (T. Scott).
- 192. **Pseudodiaptomus burckhardti*, sp. nov.
- 193. **Pseudodiaptomus masoni*, sp. nov.

Group 2.

- 194. **Pseudodiaptomus annandalei* Sewell.
- 195. **Pseudodiaptomus aurivillii* Cleve.
- 196. **Pseudodiaptomus binghami* Sewell.
- 197. **Pseudodiaptomus tollingeri* Sewell.
- 198. **Pseudodiaptomus mertoni* Früchtl.
- 199. **Pseudodiaptomus daughlishi*, sp. nov.

Family Temoridae.

Genus *Temora* Baird.

- 200. **Temora discaudata* Giesbrecht.
- 201. *Temora longicornis* Müller.
- 202. **Temora stylifera* (Dana).
- 203. **Temora turbinata* (Dana).

Genus *Temoropia* T. Scott.

204. *Temoropia mayumbaensis* T. Scott.

Family Metridiidae.

Genus *Metridia* Boeck.

205. **Metridia boeckii* Giesbrecht.

206. **Metridia brevicauda* Giesbrecht.

207. **Metridia curticauda* Giesbrecht.

208. *Metridia longa* Lubbock.

209. *Metridia lucens* Boeck.

210. **Metridia macrura* Sars.

211. **Metridia princeps* Giesbrecht.

212. **Metridia venusta* Giesbrecht.

Genus *Pleuromamma* Giesbrecht.

213. **Pleuromamma abdominalis* (Lubbock).

214. **Pleuromamma gracilis* (Claus).

215. **Pleuromamma indica* Wolfenden.

216. **Pleuromamma quadrangulata* (Dahl).

217. **Pleuromamma xiphias* Giesbrecht.

Genus *Gaussia* Wolfenden.

218. **Gaussia princeps* (T. Scott).

Family Lucicutiidae.

Genus *Lucicutia* Giesbrecht.

219. *Lucicutia aurita* Cleve.

220. **Lucicutia bicornuta* Wolfenden (= *L. aurita* Sars).

221. *Lucicutia bradyana* Cleve.

222. **Lucicutia challengerii*, sp. nov.

223. **Lucicutia clausi* Giesbrecht.

224. **Lucicutia flavicornis* (Claus).

225. *Lucicutia lucida* Farran (= *L. pera* A. Scott).

226. **Lucicutia maxima* Steuer.

227. **Lucicutia ovalis* Wolfenden.

228. *Lucicutia philyra* A. Scott.

Family Heterorhabdidae.

Genus *Heterorhabdus* Giesbrecht.

229. *Heterorhabdus abyssalis* (Giesbrecht).

230. *Heterorhabdus austrinus* Giesbrecht.

231. **Heterorhabdus clausi* (Giesbrecht).

232. **Heterorhabdus papilliger* (Claus).

233. **Heterorhabdus spinifrons* (Claus).

234. *Heterorhabdus tanneri* Giesbrecht.

235. **Heterorhabdus viperu* (Giesbrecht).

Genus *Heterostylites* Sars.

236. **Heterostylites longicornis* (Giesbrecht).

237. **Heterostylites major* (Dall).

Genus *Hemirhabdus* Wolfenden.

238. **Hemirhabdus grimaldii* (Richard).

239. **Hemirhabdus truncatus* (A. Scott).

Genus *Mesorhabdus* Sars.

240. **Mesorhabdus angustus* Sars.

Genus *Disseta* Giesbrecht.

241. **Disseta palumboi* Giesbrecht.

242. *Disseta scopularis* (Brady).

Family Augaptilidae.

Genus *Euaugaptilus* Sars.

Group 1.

243. **Euaugaptilus indicus*, sp. nov.

244. **Euaugaptilus nodifrons* Sars.

Group 2.

245. **Euaugaptilus filigerus* (Claus).

246. **Euaugaptilus laticeps* Sars.

247. **Euaugaptilus magnus* (Wolfenden).

248. **Euaugaptilus oblongus* Sars.

249. **Euaugaptilus tenuispinus* Sars.

Group 3.

250. **Euaugaptilus angustus* Sars.

251. **Euaugaptilus facilis* (Farran).

Group 4.

252. **Euaugaptilus latifrons* Sars.

253. **Euaugaptilus hecticus* (Giesbrecht).

Genus *Augaptilus* Giesbrecht (*sensu stricto*).

254. *Augaptilus longicaudatus* (Claus).

255. **Augaptilus megalurus* Giesbrecht.

Genus *Centraugaptilus* Sars.

256. **Centraugaptilus horridus* (Farran).

257. **Centraugaptilus ratrayi* (T. Scott).

Genus *Haloptilus* Giesbrecht.

258. **Haloptilus chierchiae* Giesbrecht.

259. *Haloptilus longicornis* (Claus).

260. **Haloptilus ornatus* (Giesbrecht).

261. *Haloptilus plumosus* (Claus).

262. *Haloptilus spiniceps* (Giesbrecht).

Genus *Pontoptilus* Sars.

263. **Pontoptilus ovalis* Sars.

Family Arietellidae.

Genus *Arietellus* Giesbrecht.

264. *Arietellus aculeatus* (T. Scott).

265. **Arietellus setosus* Giesbrecht.

266. **Arietellus simplex* Sars.

Genus *Paraugaptilus* Wolfenden.

267. *Paraugaptilus similis* A. Scott.

Genus *Metacalanus* Cleve.

268. **Metacalanus aurivillii* Cleve.

Genus *Phyllopus* Brady.

- 269. *Phyllopus bidentatus* Brady.
- 270. *Phyllopus giesbrechti* A. Scott.
- 271. *Phyllopus helgae* Farran.
- 272. *Phyllopus impar* Farran.

Family Pseudocyclopidae.

Genus *Pseudocyclops* Brady.

- 273. *Pseudocyclops latens* Gurney.
- 274. *Pseudocyclops obtusatus* Brady and Robertson.
- 275. **Pseudocyclops obtusatus* var. *latisetosus*, nov.
- 276. **Pseudocyclops simplex*, sp. nov.
- 277. *Pseudocyclops umbraticus* Giesbrecht.

Genus *Suezia* Gurney.

- 278. *Suezia canalis* Gurney.

Family Candaciidae.

Genus *Candacia* Dana.

- 279. **Candacia aethiopica* (Dana).
- 280. *Candacia bipinnata* (Giesbrecht).
- 281. **Candacia bispinosa* (Claus).
- 282. **Candacia bradyi* A. Scott.
- 283. **Candacia catula* (Giesbrecht).
- 284. **Candacia curta* (Dana).
- 285. **Candacia discandata* A. Scott.
- 286. *Candacia inermis* Cleve.
- 287. *Candacia longimana* (Claus).
- 288. **Candacia norvegica* Boeck var. *tropica*, nov.
- 289. **Candacia pachydactyla* (Dana).
- 290. *Candacia simplex* Giesbrecht.
- 291. *Candacia tenuimana* Giesbrecht.
- 292. **Candacia truncata* (Dana).
- 293. *Candacia varicans* (Giesbrecht).
- 294. **Candacia magna*, sp. nov.

Family Pontellidae.

Genus *Calanopia* Dana.

- 295. *Calanopia americana* Dahl.
- 296. **Calanopia aurivillii* Cleve.
- 297. **Calanopia elliptica* (Dana).
- 298. **Calanopia herdmani* A. Scott.
- 299. *Calanopia media* Gurney.
- 300. **Calanopia minor* A. Scott.
- 301. **Calanopia thompsoni* A. Scott.

Genus *Anomalocera* Templeton.

- 302. *Anomalocera patersoni* Templeton.

Genus *Labidocera* Lubbock.

- 303. *Labidocera acutifrons* (Dana).
- 304. **Labidocera acuta* (Dana).
- 305. **Labidocera bataviae* A. Scott.
- 306. **Labidocera detruncata* (Dana).
- 307. **Labidocera euchaeta* Giesbrecht, forma *major*.
**Labidocera euchaeta* Giesbrecht, forma *minor*.
- 308. **Labidocera inermis* (Brady).
- 309. **Labidocera kroyeri* (Brady).
- 310. **Labidocera kroyeri* (Brady) var. *bidens* Sewell.
- 311. **Labidocera kroyeri* (Brady) var. *burmanica* Sewell. *
- 312. **Labidocera kroyeri* (Brady) var. *gallensis* Thompson and A. Scott.
- 313. **Labidocera kroyeri* (Brady) var. *stylifera* Thompson and A. Scott.
- 314. **Labidocera laevidentata* (Brady).
- 315. **Labidocera minuta* Giesbrecht.
- 316. **Labidocera madurae* A. Scott.
- 317. **Labidocera pavo* Giesbrecht.
- 318. **Labidocera pectinata* Thompson and A. Scott.
- 319. *Labidocera wollastoni* (Lubbock).

Genus *Pontella* Dana.

- 320. *Pontella alata* A. Scott.
 - 321. **Pontella andersoni* Sewell.
 - 322. *Pontella atlantica* Milne-Edw. ?
 - 323. *Pontella cerami* A. Scott.
 - 324. **Pontella danae* Giesbrecht.
 - 325. **Pontella danae* Giesbrecht var. *ceylonica* Thompson and A. Scott.
 - 326. **Pontella denticauda* A. Scott.
 - 327. **Pontella fera* Dana.
 - 328. *Pontella forficula* A. Scott.
 - 329. **Pontella investigatoris* Sewell.
 - 330. *Pontella mediterranea* (Claus) var. *indica* Wolfenden.
 - 331. *Pontella natalis* Brady.
 - 332. **Pontella princeps* Dana.
 - 333. **Pontella securifer* Brady.
 - 334. **Pontella spinipes* Giesbrecht.
- Genus *Pontellopsis* Brady.
- 335. **Pontellopsis armata* (Giesbrecht).
 - 336. **Pontellopsis herdmani* Thompson and A. Scott.
 - 337. **Pontellopsis krameri* (Giesbrecht).

338. **Pontellopsis macronyx* A. Scott.
 339. **Pontellopsis perspicax* (Dana).
 340. *Pontellopsis peza* A. Scott.
 341. **Pontellopsis regalis* (Dana).
 342. *Pontellopsis strenua* (Dana).
 343. **Pontellopsis villosa* Brady.
 344. **Pontellopsis scotti*, sp. nov.

Genus *Pontellina* Dana.

345. **Pontellina plumata* (Dana).

Family Parapontellidae.

Genus *Bathypontia* Sars.

346. *Bathypontia spinifera* A. Scott.

Genus *Neopontella* A. Scott.

347. *Neopontella typica* A. Scott.

Family Acartiidae.

Genus *Acartia* Dana.

Group 1. Acartiae arostratae.

Sub-genus *Acartiura* Steuer.

348. *Acartia (Acartiura) clausi* Giesbrecht.

Sub-genus *Acartiella* Sewell.

349. **Acartia (Acartiella) tortaniformis* Sewell.
 350. **Acartia (Acartiella) kemp* Sewell.
 351. **Acartia (Acartiella) graveli* Sewell.
 352. **Acartia (Acartiella) major* Sewell.
 353. **Acartia (Acartiella) minor* Sewell.

Group 2. Acartiae rostratae.

Sub-genus *Euacartia* Steuer.

354. **Acartia (Euacartia) southwelli* Sewell.

Sub-genus *Paracartia* Steuer.

355. *Acartia (Paracartia) dubia* (T. Scott).
 356. *Acartia (Paracartia) latisetora* (Kricyagin).

Sub-genus *Acanthacartia* Steuer.

357. **Acartia (Acanthacartia) chilkaensis* Sewell.

358. *Acartia (Acanthacartia) fossae* Gurney.

359. **Acartia (Acanthacartia) pietschmani* Pesta.

360. **Acartia (Acanthacartia) plumosa* T. Scott.

Sub-genus *Odontacartia* Steuer.

361. **Acartia (Odontacartia) amboinensis* Carl.

362. **Acartia (Odontacartia) bispinosa* Carl.

363. **Acartia (Odontacartia) centrura* Giesbrecht.

364. **Acartia (Odontacartia) erythraea* Giesbrecht.

365. *Acartia (Odontacartia) erythraea* Giesbrecht var. *valdiviae* Steuer.

366. *Acartia (Odontacartia) erythraea* Giesbrecht var. *brehmi* Früehlt.

367. **Acartia (Odontacartia) pacifica* Steuer.

368. **Acartia (Odontacartia) pacifica* var. *mertoni* Steuer.

Sub-genus *Planktacartia* Steuer.

369. **Acartia (Planktacartia) danae* Giesbrecht.

370. **Acartia (Planktacartia) negligens* Dana.

Family Tortanidae.

Genus *Tortanus* Giesbrecht.

Sub-genus *Tortanus*, nov.

371. **Tortanus (Tortanus) forcipatus* (Giesbrecht).

372. **Tortanus (Tortanus) barbatus* (Brady).

373. **Tortanus (Tortanus) gracilis* (Brady).

Sub-genus *Atortus*, nov.

374. *Tortanus (Atortus) brevipes* A. Scott.

375. *Tortanus (Atortus) murrayi* A. Scott.

376. *Tortanus (Atortus) recticauda* (Giesbrecht).

377. **Tortanus (Atortus) tropicus*, sp. nov.

Family CENTROPAGIDAE.

Genus **CENTROPAGES** Herrick.

In 1901 Cleve recorded the occurrence in the Malay Archipelago of four species, namely, *Centropages calaninus* (Dana), *C. furcatus* (Dana), *C. gracilis* (Dana) and *C. orsinii* Giesbrecht. A year later, in 1902, A. Scott recorded the occurrence in the Red Sea and the Arabian Sea of the first two and the last of these species and added *Centropages elongatus* Giesbrecht to the list of species of this genus that are known to inhabit Indian waters. In 1903 Thompson and A. Scott in their account of the Copepoda of the Pearl Banks of Ceylon also recorded the occurrence of all the above species in that locality and added *Centropages violaceus* Claus, *C. kroyeri* Giesbrecht and *C. chierchiaie* Giesbrecht to the list of species previously known to inhabit these waters, while in addition they described two new species, namely,

Centropages tenuiremis and *C. dorsispinatus*. These two last species were almost simultaneously and independently recorded and described by Cleve (1903) under the names *Centropages arabicus* and *C. notoceras* respectively. In 1905 Cleve reported the occurrence of *Centropages chierchiae* from S. African waters and *Centropages furcatus* and *C. typicus* Kröyer from the Agulhas current. In 1912 I described *Centropages alcocki* from the surface water of the coast of southern Burma and in 1914 I added *Centropages trispinosus* from the Ceylon Pearl Banks, and in the same or the following year Brady recorded from Durban Bay *Centropages chierchiae* Giesbrecht, *C. furcatus* (Dana), *C. orsinii* Giesbrecht and *C. violaceus* (Claus), giving in addition a very brief account of what he thought to be a new species under the name *C. tenuicornis*. Gurney (1927) has recorded *Centropages furcatus* (Dana), *C. typicus* Kröyer, and *C. ponticus* Karawiew from the Suez Canal. Fifteen species belonging to this genus are thus known to have their habitat in Indian waters.

Claus¹ has described the presence in *Centropages typicus* Kröyer [*Ichthyophorba* (*Centropages*) *denticornis* Claus] of a number of small pores connected with superficial glands on the first two segments of the abdomen of the female, and he suggests that these are connected with the process of copulation and secrete a cement substance that assists in the fixation of the male spermatophore on the female body. He also describes a glandular aperture on the furcal ramus near the base of the 4th seta. I have been unable to convince myself of the presence of glands or pores on the anterior segments of the abdomen in either *Centropages furcatus* (Dana) or *C. dorsispinatus* Thompson and A. Scott; but on the other hand there is a well-marked pore on the furcal ramus near its proximal end on the ventro-lateral aspect.

Centropages alcocki Sewell.

Centropages alcocki, Sewell, 1912, p. 338, pl. xvii, figs. 1-7.

This species was described by me from a single specimen taken at the mouth of the Rangoon river. Up to the present time no further specimens have been obtained.

Centropages calaninus (Dana).

Centropages calaninus, A. Scott, 1909, p. 112.

Centropages calaninus, T. Scott, 1912, p. 533.

Centropages calaninus, Sewell, 1913, p. 367.

Up to the present time examples of this species have only been recognised by me in the "Investigator" collection at Sta. 393 and its occurrence in Indian waters rests mainly on the identification of Cleve, who records its presence in the Malay Archipelago, and of A. Scott, who also records its presence in the same locality in his report on the "Siboga" collection.

Centropages dorsispinatus Thompson and A. Scott.

Centropages dorsispinatus, Thompson and A. Scott, 1903, p. 247, pl. i, figs. 19-25.

Centropages notoceras, Cleve, 1903, pp. 359, 373, pl. xvii, figs. 2-10, pl. xviii, fig. 1.

Centropages notoceras, Sewell, 1912, p. 360.

Centropages dorsispinatus, Sewell, 1914, p. 222.

¹ Claus, C., "Neue Beiträge zur Kenntniss der Copepoden." *Arb. Zool. Inst. Wien*, Vol. III, pp. 8, 9, pl. ii, figs. 5-8 (1881).

I was, when I first examined examples of this species in 1912, somewhat doubtful as to whether the form described by Cleve from the Persian Gulf was the same as that recorded by Thompson and A. Scott from the Ceylon Pearl Banks. I have since then been able to examine specimens from various parts of the Indian region and I have no doubt that they are identical. The species is widely distributed in Indian seas and has been taken on the coast of Burma, on the Ceylon Pearl Banks and in the Persian Gulf.

***Centropages elongatus* Giesbrecht.**

Centropages elongatus, A. Scott, 1909, p. 113.

Centropages elongatus, Sewell, 1914, p. 222.

This species, which was first recorded by Giesbrecht (1895) from the Red Sea, appears to be of wide distribution, though of rare occurrence, in Indian waters. Up to the present time it has been recorded from the Malay Archipelago (A. Scott); the Pearl Banks of Ceylon (Sewell); the Maldive and Laccadive Archipelago (Wolfenden); and from the Red Sea (Giesbrecht).

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

Centropages furcatus, A. Scott, 1909, p. 113.

Centropages furcatus, Wolfenden, 1911, p. 356.

Centropages furcatus, Pesta, 1912, p. 46, fig. 5.

Centropages furcatus, T. Scott, 1912, p. 532.

Centropages furcatus, Sewell, 1912, pp. 315, 360.

Centropages furcatus, Pesta, 1914, p. 32.

Centropages furcatus, Sewell, 1914, p. 220.

Centropages furcatus, Brady, 1915, pp. 314, 315.

Centropages furcatus, Gurney, 1927, p. 150.

Centropages furcatus, Farran, 1929, p. 255.

Centropages furcatus, var., Carl, 1907, pp. 8, 16, pl. i, figs. 6, 7.

Centropages furcatus, var., *carli*, Früchtl, 1923, p. 452.

Centropages furcatus, var., *carli*, Früchtl, 1924, p. 45.

This species is by far the most common member of the genus in the "Investigator" collections, and has a wide distribution throughout the tropical belt. In Indian waters it has now been recorded from the Malay Archipelago (Cleve, A. Scott, Früchtl); the Pearl Banks of Ceylon (Thompson and A. Scott, Sewell); the coast of Burma (Sewell); the Maldive and Laccadive Archipelagoes (Wolfenden); the Arabian Sea and Persian Gulf (Pesta); Durban Bay (Brady); and from the Red Sea (A. Scott). I have also taken numerous examples in the Andamans and Nicobars and from the Cochin back-waters. A variety of the male was described by Carl (1907) from Amboina in the Malay Archipelago and has subsequently been recorded from the Aru Archipelago in the same region by Früchtl. The majority, if not all, of the males in the "Investigator" collections belong to this variety.

***Centropages gracilis* (Dana).**

Centropages gracilis, A. Scott, 1909, p. 114.

Centropages gracilis, Wolfenden, 1911, p. 356.

Centropages gracilis, Sewell, 1914, p. 223.

This species is of rare occurrence. Scott (1909) states that at the time of his writing his report on the Copepoda of the "Siboga" collection it had only been obtained in the Indian and Pacific Oceans; but since then its distribution has been extended to the south Atlantic Ocean for the "Gauss" obtained examples in that ocean in Lat. 28° S. In addition to the previous record of the occurrence of this species in the "Investigator" collection, a single example, a female, was taken at "Investigator" Station 682, and another on the Ceylon Pearl Banks.

Centropages kroyeri Giesbrecht.

Centropages kroyeri, Giesbrecht, 1892, p. 303, pl. xvii, figs. 24, 25, 40, 47; pl. xviii, fig. 10; pl. xxxviii, figs. 6, 8, 11, 14.

Centropages kroyeri, Thompson and A. Scott, 1903, p. 247.

Centropages kroyeri, Sars, 1925, p. 206.

In the Indian Museum collection there is a single example from Kuala, Kuran River, Perak, presented by Mr. Cedric Dover.

Centropages orsinii Giesbrecht.

Centropages orsinii, A. Scott, 1909, p. 115.

Centropages orsinii, Pesta, 1912, p. 46, figs. 6a-e.

Centropages orsinii, Sewell, 1912, pp. 315, 362.

Centropages orsinii, Pesta, 1913, p. 32.

Centropages orsinii, Sewell, 1914, p. 221.

Centropages orsinii, Brady, 1915, pp. 314, 315.

Centropages orsinii, Früchtl, 1924, p. 44 (66).

The distribution of this species appears to be the same as that of *Centropages furcatus* (Dana). It has now been recorded from the Malay Archipelago (Cleve, A. Scott, Früchtl); the coast of Burma (Sewell); the Ceylon Pearl Banks (Thompson and A. Scott, Sewell); the Maldive and Laccadive Archipelagoes (Wolfenden); the Arabian Sea and Persian Gulf (Pesta), and Durban Bay (Brady).

Centropages tenuiremis Thompson and A. Scott.

(Text-fig. 82.)

Centropages tenuiremis, Thompson and A. Scott, 1903, p. 247, pl. i, figs. 1-18.

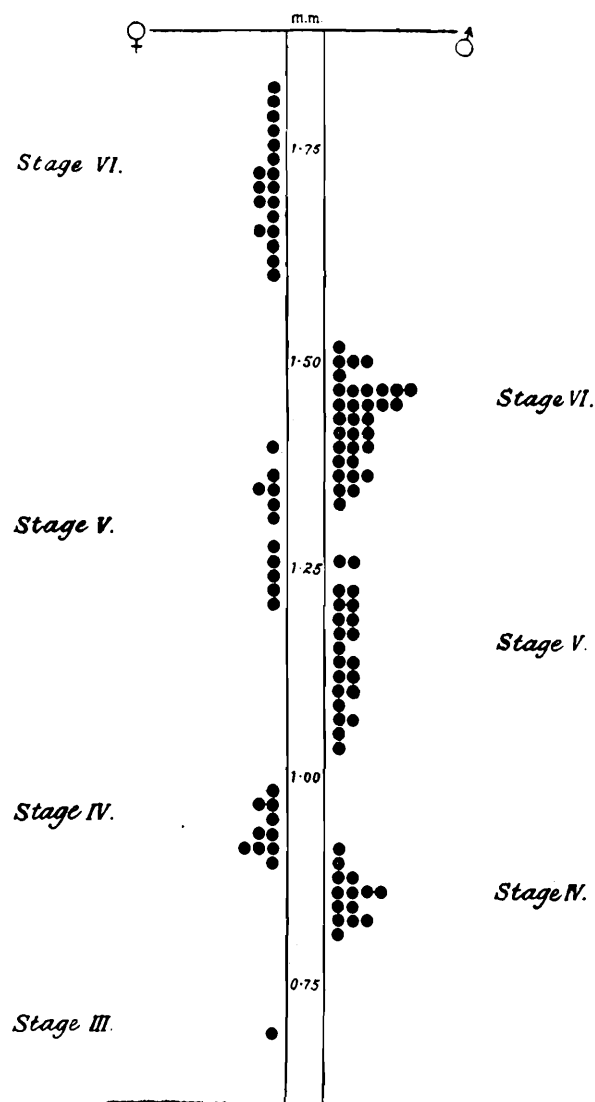
Centropages arabicus, Cleve, 1903, p. 371, pl. xvi, figs. 1-9; pl. xvii, fig. 1.

Centropages tenuiremis, Sewell, 1912, p. 363, pl. xxiv, figs. 6, 7.

Centropages tenuiremis, Sewell, 1914, p. 220.

This species was first described by Thompson and A. Scott from examples taken at various stations in the Arabian Sea and around the Pearl Banks of Ceylon. I have also been able to examine specimens from this latter locality and, in addition, have examined specimens from the coast of Burma and the northern part of the Bay of Bengal. A number of examples in various stages of development were taken by the late Dr. N. Annandale off Puri on the east coast of India and I have carefully examined and measured a number of these specimens. I have been able to recognise five developmental stages, including the adult, in the female, and four in the male. The results of the measurement of 109

individuals are shown graphically in text-fig. 82. The individual of the smallest group corresponded in its degree of development to Copepodid Stage III. In the following table I have given the average observed length of the body in each of the groups and have shown the calculated size and the growth factor for each successive moult.



TEXT-FIG. 82.—Showing the length measurements of 109 individuals of *Centropages tenuiremis* Thompson and A. Scott in various stages of development, taken off Puri, Orissa.

					Observed size.	Calculated size.	Growth Factor.
♀					mm.	mm.	
Copepodid Stage III	.	.	.	.	0.690	0.690	1.37
Copepodid Stage IV	.	.	.	.	0.945	0.945	1.37
Copepodid Stage V	.	.	.	.	1.300	1.295	1.32
Copepodid Stage VI (adult)	.	.	.	.	1.710	1.709	..
♂							
Copepodid Stage IV	.	.	.	.	0.857	0.857	1.66 or 1.32
Copepodid Stage V	.	.	.	.	1.152	1.131	1.66
Copepodid Stage VI	.	.	.	.	1.428	1.423	..

It thus appears that in the female the growth factor in the earlier stages of development is 1.37 but that with the onset of sexual development this factor tends to be reduced

and at the moult between the Copepodid Stage V and the sexually-mature form becomes 1.32. In the case of the male it again appears probable that development can take place along two different lines, thus on reaching Copepodid Stage IV an individual may pass with the typical male growth factor of 1.66 direct to the sexually-mature form, or may adopt for a single moult the growth factor that is characteristic of the final moult of the female, namely 1.32, and so pass to Copepodid Stage V. In both sexes it would appear probable from the table that the sexually-mature forms hitherto discovered are the low dimorph and that we may expect in the future to discover a high dimorph derived from preceding stage V by a moult with the male growth factor 1.66.

The average size of these adults from Puri is somewhat less than the measurement given by Thompson and A. Scott for their specimens from the Ceylon Pearl Banks, being only 1.710 instead of 2.00 mm. in the females and 1.428 instead of 1.80 mm. in the males. This is probably associated with the decrease in salinity of the sea-water in the northern part of the Bay of Bengal as compared with the salinity of the water of the Pearl Banks.

***Centropages trispinosus* Sewell.**

Centropages trispinosus, Sewell, 1914, p. 223, pl. xviii, figs. 5-8.

Since this species was first described by me from Kilakarai, South India, no further examples have been obtained.

***Centropages violaceus* (Claus).**

Ichthyophorba violacea, Claus, 1863, p. 199, pl. xxxi.

Centropages violaceus, Giesbrecht, 1892, p. 304, pl. iv, fig. 5; pl. xvii, figs. 29, 30, 44; pl. xviii, figs. 1, 8; pl. xxxviii, figs. 16, 18.

Centropages violaceus, Giesbrecht and Schmeil, 1898, p. 57.

? *Centropages violaceus*, Wolfenden, 1911, p. 357.

Centropages violaceus, T. Scott, 1912, p. 533.

Centropages violaceus, Brady, 1915, pp. 134, 135.

Centropages violaceus, Sars, 1925, p. 206.

Centropages violaceus, Farran, 1929, p. 255.

This species appears to be extremely rare in Indian waters. A single example was obtained in the surface tow-net by the "Investigator" at Sta. 614. Farran (1929) has pointed out that in the account of *Centropages violaceus* that Brady has given in the "Challenger" Report (Vol. VIII, p. 82, pl. XXVII, figs. 1-14) he has confused two species, the true *Centropages violaceus* (Claus) and *Centropages bradyi* Wheeler. Since Wolfenden in the "Gauss" report refers to the species as *Centropages violaceus* Brady it is doubtful to which species his note refers. Brady (1915) records its occurrence in small numbers in Durban Bay.

Genus *ISIAS* Boeck.

Up to the year 1924 this genus was represented by a single species, *Isias clavipes* Boeck, which appears to be limited in its distribution to the North Atlantic Ocean and its offshoots. In that year I described a second species, *Isias tropica* from the Chilka Lake.

Isias tropica Sewell.

Isias tropica, Sewell, 1924, p. 782, pl. xlv, fig. 1.

Since the discovery of this species in the Chilka Lake, no further examples have been obtained.

Family DIAPTOMIDAE.

Genus **PSEUDODIAPTOMUS** Herrick.

In the genus *Pseudodiaptomus* it is a matter of some considerable difficulty to decide what species can rightly be termed marine.

The genus is one that has a wide distribution and has penetrated from the sea into brackish and even into fresh water ; in consequence of this migration it is a matter of some difficulty to decide which species should be included in the present paper that purports to deal with the fauna of Indian Seas. As a result of the migration of the genus a number of species have been evolved and are now to be found especially in littoral and estuarine regions. I have therefore, in the following account included all those species that have been taken either in the sea or in brackish water areas that are directly connected with the sea, and have omitted all further reference to the purely fresh water form, *Pseudodiaptomus lobipes* Gurney.

I have previously (Sewell, 1922, p. 784) attempted to separate the species of this genus into two groups according to the character of the 5th pair of legs in the female. While fully recognising that such a separation does not indicate any degree of relationship between the various species, yet with the steadily increasing number of species in the genus, it will, I think, be useful to have some such method of separating the species into groups so as to simplify the process of identification. In the 1st group I include all those forms in which the terminal spines of the 5th pair of legs in the female are all of approximately equal length and are short in comparison with the total length of the leg ; in this group we can place :—

Pseudodiaptomus clevei A. Scott,
Pseudodiaptomus hickmani Sewell,
Pseudodiaptomus salinus Giesbrecht,
Pseudodiaptomus serricaudatus (T. Scott),
Pseudodiaptomus stuhlmanni (Poppe and Mrazek),
Pseudodiaptomus burckhardti, sp. nov., and
Pseudodiaptomus masoni, sp. nov.

In the second group one of the terminal spines of the end segment in the 5th leg is much longer than the others and is nearly equal in length to the whole appendage.

The 2nd group is a composite one and can be sub-divided into several sub-groups :—

(a) In the 1st sub-group can be placed the following species :—

Pseudodiaptomus lobipes Gurney,
Pseudodiaptomus binghami Sewell,
Pseudodiaptomus forbesi Poppe and Mrazek,
Pseudodiaptomus tollingeri Sewell,
Pseudodiaptomus poppei Stingelin,

Pseudodiaptomus smithi Wright, and
Pseudodiaptomus inopinus Burckhardt.

Closely related to the group but separated from it by other characters is *Pseudodiaptomus annandalei* Sewell. As Stillman Wright (1928, p. 594) has pointed out "*Pseudodiaptomus smithi* shows characters which link it with *P. poppei*, *P. forbesi*, *P. inopinus*, *P. tollingeri*, *P. binghami* and *P. lobipes*. These seven species have a number of peculiarities in common. This group may be designated the Lobipes group, since that species is probably the most primitive."

(b) In the 2nd sub-group we may include the following :—

Pseudodiaptomus aurivillii Cleve,
Pseudodiaptomus mertoni Früchtl, and
Pseudodiaptomus daughlihi, sp. nov.

Other species that can be included in the group are :—

Pseudodiaptomus richardi (Dahl),
Pseudodiaptomus acutus (Dahl),
Pseudodiaptomus gracilis (Dahl), and
Pseudodiaptomus hessei (Mrazek).

As I pointed out in 1924 the members of the 1st group are almost entirely marine in their habitat and the same is true of the members of sub-group (b) of the 2nd group ; on the other hand the members of sub-group (a) of the 2nd group are almost entirely fresh or brackish water in their habitat.

An interesting feature in the structure of certain members of this genus is the presence on the 3rd last segment of the 1st antenna of a modified seta, in which there is a comb-like formation. This modified seta was first noted by Poppe and Mrazek (1901) who recorded its presence in the antennae of the female and also in the unmodified antenna in the male in *Pseudodiaptomus serricaudatus*, *P. stuhlmanni* and *P. hessei* ; Mrazek (1901) subsequently found this modified seta to be present in *P. richardi*. I have also found it to be present in *Pseudodiaptomus hickmani*, *P. masoni* and *P. salinus*. It thus appears that this modification is not confined to any one group or sub-group in the genus.

In 1901 Cleve described *Pseudodiaptomus aurivillii* from the Malay Archipelago. A year later in 1902 A. Scott recorded the occurrence of *Pseudodiaptomus serricaudatus* (T. Scott) from the Red Sea. In 1903 Thompson and A. Scott recorded both these species from the Pearl Banks of Ceylon, while within the next two years Cleve recorded the former species from the Indian Ocean and the east coast of Africa. In 1909 A. Scott confirmed the occurrence of *Pseudodiaptomus aurivillii* Cleve in the Malay Archipelago and described a new species *P. clevei* from the same region. Since that date the number of species known to inhabit Indian waters has increased very considerably ; in 1912 I added *Pseudodiaptomus hickmani* and *P. binghami* and in 1919 *P. annandalei* and *P. tollingeri* to the list of known species. In 1924 Früchtl described *P. mertoni*, that had in all probability been previously confused with *P. aurivillii* Cleve, from the Aru Archipelago and in 1927 Gurney recorded *Pseudodiaptomus salinus* Giesbrecht from the Suez Canal. This, however, by no means exhausts the number of species that have their habitat in the Indian region and in the present paper I have described three additional new species, namely *Pseudodiaptomus burkhardti*, *P. daughlihi* and *P. masoni*.

GROUP 1.

***Pseudodiaptomus clevei* A. Scott.**

Pseudodiaptomus clevei, A. Scott, 1909, p. 116, pl. xxxvii, figs. 1-8.

Pseudodiaptomus clevei, Früchtl, 1924, p. 48, figs. 29, 30.

Examples of this species were taken in the surface tow-net at "Investigator" Station 558.

***Pseudodiaptomus hickmani* Sewell.**

Pseudodiaptomus hickmani, Sewell, 1912, p. 364, pl. xxii, figs. 1-7.

Pseudodiaptomus hickmani, Sewell, 1924, p. 786.

This species has now been taken off the coast of Burma and in the Chilka Lake, and would appear to be a denizen of brackish water.

***Pseudodiaptomus salinus* Giesbrecht.**

Pseudodiaptomus salinus, Giesbrecht, 1896, p. 322, figs. 23-28.

Pseudodiaptomus salinus, Giesbrecht and Schmeil, 1898, p. 65.

Pseudodiaptomus salinus, Thompson and A. Scott, 1903, p. 248, pl. ii, figs. 21-23.

Pseudodiaptomus salinus, Gurney, 1927, p. 150.

This species has previously been recorded from the Suez Canal, the Gulf of Suez and the Red Sea. Thompson and A. Scott (*loc. cit.*, p. 248) in their account of the Copepoda of the Pearl Banks of Ceylon state that this species was found at three stations in the Indian Ocean; a reference to their list of stations shows, however, that all the stations at which this species was taken by Prof. Herdman are situated either in the Gulf of Suez or in the Suez Canal itself. The occurrence of a specimen at "Investigator" Station 616 in the Nicobars thus greatly increases its known range of distribution.

***Pseudodiaptomus serricaudatus* (T. Scott).**

Pseudodiaptomus serricaudatus, A. Scott, 1902, p. 404, pl. i, fig. 6.

Pseudodiaptomus serricaudatus, Cleve, 1903, p. 368.

Pseudodiaptomus serricaudatus, Thompson and A. Scott, 1903, p. 248.

Pseudodiaptomus serricaudatus, Cleve, 1904, p. 196.

Pseudodiaptomus serricaudatus, Sewell, 1914, p. 226.

Pseudodiaptomus serricaudatus, Sewell, 1924, p. 785.

This species appears to have a wide distribution; originally taken in the Gulf of Guinea on the west coast of Africa, it has now been recorded in Indian waters from the Chilka Lake (Sewell); the Ceylon Pearl Banks (Thompson and A. Scott, Sewell); the west coast of India (Cleve) and the Red Sea (A. Scott).

***Pseudodiaptomus burckhardti*, sp. nov.**

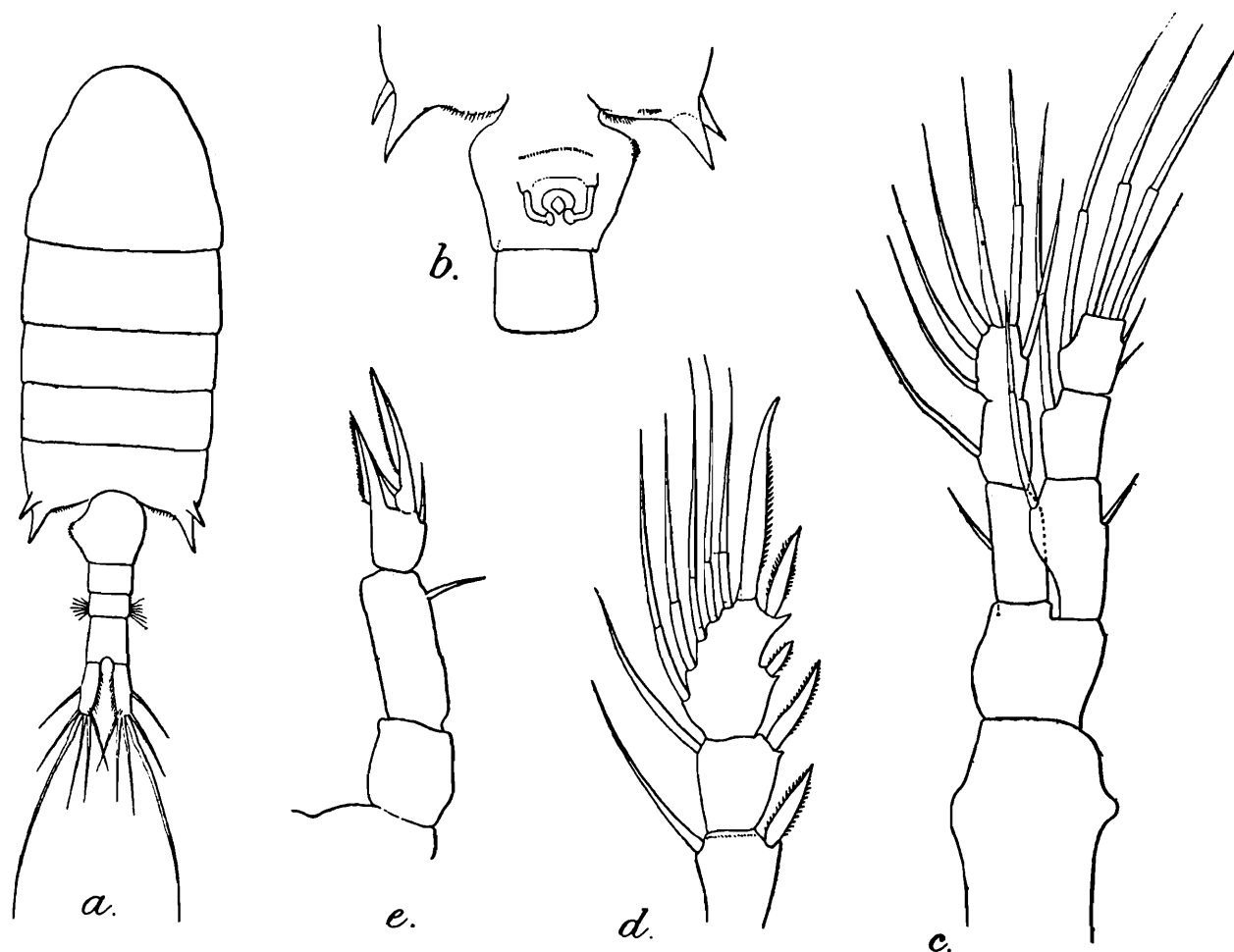
(Text-fig. 83, *a-e.*)

A single example of what appears to be a new species of *Pseudodiaptomus* was discovered in the "Investigator" collection from the surface-waters of Nankauri Harbour, Nicobar Islands (Station 614): and further examples were subsequently obtained from Macpherson

Strait, Andaman Islands. At first sight this species is very likely to be mistaken for either *Pseudodiaptomus clevei* A. Scott, *P. salinus* Giesbrecht or *P. merton* Früchtl.

♀ Total length, 1.07 mm.

The lengths of the cephalothorax and abdomen are in the proportion of 53 to 25, so that the posterior region of the body is contained very nearly twice in the length of the anterior region.



TEXT-FIG. 83.—*Pseudodiaptomus burckhardti*, sp. nov.

a. The whole animal from the dorsal side.

b. The genital segment of the abdomen from below.

e. The 5th leg.

c. The 1st swimming leg.

d. The 3rd swimming leg, exopod.

Viewed from above (text-fig. 83, a) the animal presents a close resemblance to *Pseudodiaptomus clevei* A. Scott. The head and 1st thoracic segment are separate, but segments 4 and 5 are fused together. The posterior thoracic margin is produced backwards in a sharp spine and a second smaller spine is situated in the dorso-lateral region, a little in front of the actual margin of the segment; in addition, the posterior margin extending from the lateral spine towards the dorsum bears a row of minute spinules, exactly similar to those described by Früchtl (1924, p. 48) in the case of *Pseudodiaptomus clevei*.

The abdomen consists of the usual four free segments and the furcal rami. The proportional lengths of these segments are, however, somewhat different from those of the corresponding parts in *Pseudodiaptomus clevei*. In the present species the proportional lengths are as follows:—

Abdominal segment	1-2	3	4	5	Furca	
	29	13	10	24	24	= 100.

The genital segment in this species is thus somewhat longer than in *P. clevei*, for A. Scott (1909, p. 117) states that in the latter species it is slightly shorter than the following two segments. The genital segment is swollen, especially on the left side, where it is produced in a rounded prominence covered with a group of small spines; a row of small spines runs across the ventral aspect of the segment in front of the genital aperture, very similar to that present in *Pseudodiaptomus salinus* Giesbrecht. The posterior margins of segments 1 and 2 are devoid of spines; the 3rd segment bears on each side a tuft of long hair-like spines. The anal segment is considerably longer than either of the preceding two, being almost exactly equal to their combined length. The furcal rami are as long as the anal segment and are symmetrical. They are three times as long as broad and are fringed with hair on their inner margins. The 2nd distal seta is the longest and is five times as long as the furcal segment; in *Pseudodiaptomus clevei* it is shown to be one and a half times as long (*vide* A. Scott, 1909, pl. xxxvii, fig. 1); in *P. aurivillii* it is also one and a half times and in *P. mertoni* it is twice as long (*vide* Früchtl, 1924, p. 51).

The 1st antenna consists of 25 segments and reaches back to about the posterior border of the 2nd abdominal segment; the proportional lengths of the segments are as follows:—

Segment	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	23	23	26	24	21	26	34	47	53	53	49	49	49	49	51	55	55	46	34	35	31	39	34	=1000.

The seta of the third last segment seems to be modified into a comb-like structure.

The swimming legs are of the usual type. In the 1st swimming leg (text-fig. 83, *e*) the 1st basal segment is produced on its outer margin in a rounded swelling; the two rami are of nearly equal length; exopod 1 bears a delicate marginal spine; exopod 2 is devoid of any spine; and exopod 3 possesses two very delicate marginal spines and an end-spine that is also very delicate and is approximately equal in length to the combined 2nd and 3rd segments.

In the 2nd, 3rd and 4th swimming legs the proximal marginal spine on exopod 3 is markedly reduced in size (*vide* text-fig. 83, *d*).

The 5th pair of legs (text-fig. 83, *e*) closely resembles the corresponding appendage in *Pseudodiaptomus hickmani* Sewell.

While closely resembling several species in the genus, this form is distinguished from the others by the possession of two marginal spines on each side of the 5th thoracic segment and by the fine spines that run along the posterior margin, as well as by the proportionate lengths of the abdominal segments.

No male example has, as yet, been discovered.

I have much pleasure in dedicating this species to Mr. G. Burckhardt, in recognition of his valuable contribution to our knowledge of the Zoo-plankton of the inland waters of east and south-east Asia.

***Pseudodiaptomus masoni*, sp. nov.**

(Text-fig. 84, *a-g*.)

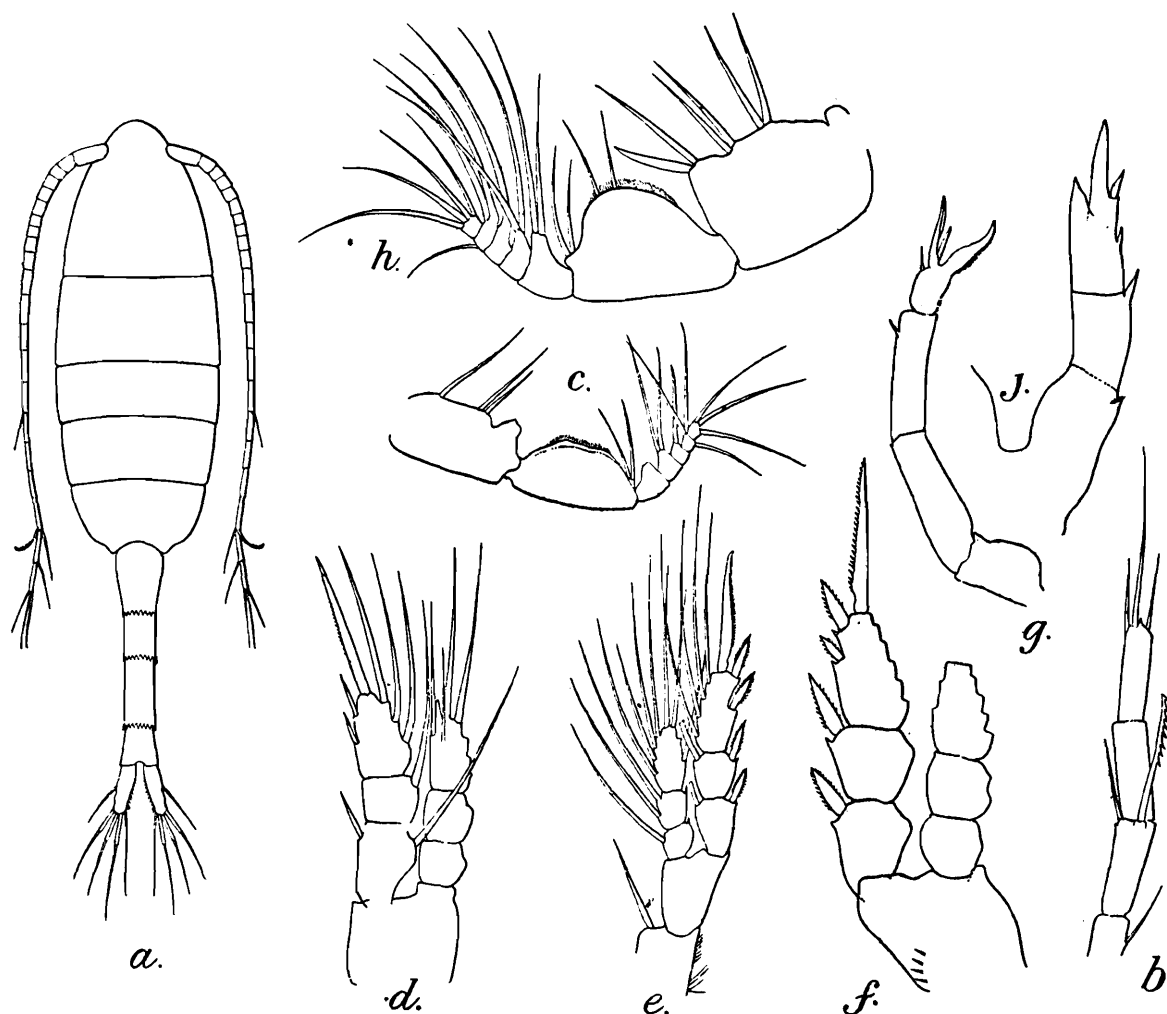
Several examples of a species of *Pseudodiaptomus* that appears to be new were obtained from tow-nettings taken at or near the surface in Port Blair Harbour and in Macpherson Strait in the Andaman Islands. I have much pleasure in dedicating this species to Mr. Mason, formerly Chief Forest Officer of the Andaman Islands, as a token of my apprecia-

tion of his kindness and the assistance that he gave me during a tour of the Andaman Islands in 1928.

♀ Total length, 0.943 mm.

The proportional lengths of the Cephalothorax and Abdomen are as 3 to 2, the abdomen being thus contained 1.5 times in the length of the anterior region of the body.

When viewed from the side this species very closely resembles *Pseudodiaptomus acutus* (Dahl), the forehead being prominent and arched; but there are in the present species no spinous processes on the posterior thoracic margin as in *P. acutus*. The head and 1st thoracic segment appear to be partially fused together, though the line of demarcation of the two parts can clearly be seen crossing the dorsal aspect. The rostral spines are delicate and are curved downwards and backwards. The posterior thoracic margin is rounded and bears no spines, nor are there any hairs or spinules present.



TEXT-FIG. 84.—*Pseudodiaptomus masoni*, sp. nov.

- a. The whole animal from the dorsal side. d. The 1st swimming leg.
b. The terminal segments of the 1st antenna. e. The 3rd swimming leg.
c. The maxilliped. f. The 4th swimming leg.

g. The 5th leg.

Pseudodiaptomus sp., juv.

h. The maxilliped.

j. The 5th leg.

The abdomen consists of four segments, that have with the furcal rami the following proportional lengths :—

Abdominal segment	1-2	3	4	5	Furca	
	23	20	26	13	18	= 100.

The genital segment is symmetrical and is but little longer than the following segment ; the fourth segment is of considerable length, being nearly half as long again as the 3rd. Segments 2, 3 and 4 are all fringed around their posterior margins with a row of somewhat coarse spines. The furcal rami are nearly one-and-a-half times the length of the anal segment and are two-and-a-half times as long as broad ; they are fringed on their inner margins with somewhat sparse hairs.

The 1st antenna reaches back to about the posterior margin of the genital segment of the abdomen, though in some specimens it is a little shorter than this, only passing the posterior margin of the thorax by the last segment. It consists of twenty-one free segments that have the following proportional lengths :—

Segment	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	
	67	40	24	27	27	33	20	20	33	47	50	60	74	74	74	64	53	53	50	57	53	= 1000.

The setae arising from the segments are feebly developed, but that arising from the third last segment (text-fig. 84, *b*) is modified and exhibits the same comb-like structure that has been previously noted in the case of this seta in *Pseudodiaptomus serricaudatus* (T. Scott), *P. stuhlmanni* (Poppe and Mrazek), *P. hessei* (Mrazek), and others (*vide supra*, p. 234).

The 2nd antenna has the usual form, the exopod being nearly twice the length of the endopod.

The mouth-parts are very similar to those of other members of the genus.

In the 1st pair of swimming legs the rami are very nearly equal in length. The 1st segment of the exopod bears a needle-like marginal spine and a single inner seta. Exopod 2 is devoid of a marginal spine ; while exopod 3 bears two sub-equal needle-like marginal spines and a stout end-spine.

In the 2nd, 3rd and 4th pairs of legs the 1st segment of the basal region bears scattered needle-like spines on its outer aspect.

In the 5th pair of legs (text-fig. 84, *g*) there are the usual basal part and three free segments ; of these latter the proximal segment appears to be unusually long and is nearly as long as the 2nd free segment. The terminal segment has the usual claw-like shape and the spinous processes are comparatively short, so that this species falls into the same group as *Pseudodiaptomus salinus*, *P. serricaudatus*, etc.

In a tow-netting, taken in the Perak River in the Malay Archipelago by Mr. Cedric Dover, I found one or two examples of an immature stage of development of a *Pseudodiaptomus* that I believe to be this species.

Copepodid Stage V. Total length, 1.082 mm. (Text-fig. 84, *h, j*.)

The proportional lengths of the cephalothorax and abdomen are as 39.5 to 20, so that the abdomen is, in this stage of development, contained 1.97 times in the length of the cephalothorax.

As in the adult *Pseudodiaptomus masoni*, the forehead is arched and is produced forwards in a rounded eminence. The head and 1st thoracic segment are separate, and the rostrum consists of two delicate spines. The posterior thoracic margins are rounded and are devoid of spines.

In this stage of development, the abdomen consists of only three segments, that have with the furcal rami the following proportional lengths :—

Abdominal segment	1	2	3-5	Furca	
	38	17	22	23	= 100.

The genital segment is somewhat wider in its anterior part than at its posterior margin. Both the 1st and 2nd segments are fringed around their posterior margins with a row of spines. The furcal rami are about two and a half times as long as wide. The external furcal seta is stout and spine-like.

The 1st antenna reaches to the posterior margin of the 1st segment of the abdomen; it consists of twenty-one segments, as in the adult. The proportional lengths of these segments are as follows:—

Segment	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
	67	41	24	29	26	38	19	19	34	48	53	57	65	65	67	60	53	53	55	60	67

=1000.

In the 1st swimming leg the endopod and exopod are of equal length. The marginal spines on exopod 1 and 3 are small and slender; exopod 2 possesses no marginal spine. The end-spine is nearly as long as the two distal segments together and is comparatively stout.

For the purpose of comparison I give below the proportional lengths of the segments in the 1st antenna of each stage—

Segment	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
Stage V	67	41	24	29	26	38	19	19	34	48	53	57	65	65	67	60	53	53	55	60	67
Adult	67	40	24	27	27	33	20	20	33	47	50	60	74	74	74	64	53	53	50	57	53

If I am right in thinking that these two stages are part of the same life-history, then during the process of development there would appear to be but little change in the lengths of the antennal segments. Between segments 1 and 13 there is practically no change; segments 15 to 19 show a certain degree of increase in length as we pass from the immature to the mature stage and in the more distal segments, namely segments 22 to 25, there is a distinct diminution in the proportional lengths of the segments with advancing development.

GROUP 2.

***Pseudodiaptomus annandalei* Sewell.**

Pseudodiaptomus annandalei, Sewell, 1919, p. 5, pl. x, fig. 9.

Pseudodiaptomus annandalei, Sewell, 1924, p. 787, pl. xlv, fig. 2.

This species has now been taken in the Chilka Lake and in the Salt Lakes, Calcutta, and would thus appear to be an inhabitant of brackish-water.

***Pseudodiaptomus aurivillii* Cleve.**

(Text-fig. 85, a.)

Pseudodiaptomus aurivillii, A. Scott, 1909, p. 116.

Pseudodiaptomus aurivillii, Sewell, 1912, p. 363.

Pseudodiaptomus aurivillii, Sewell, 1914, p. 224.

Pseudodiaptomus aurivillii, Früchtl, 1924, pp. 51-53.

This species has been recorded from the Malay Archipelago (Cleve, A. Scott and Früchtl); the coast of southern Burma (Sewell); and the Pearl Banks of Ceylon (Thompson and A. Scot, Sewell). I have also taken examples from the Andaman and Nicobar regions. While in the main a denizen of the littoral and coastal areas, it is an inhabitant of salt-water.

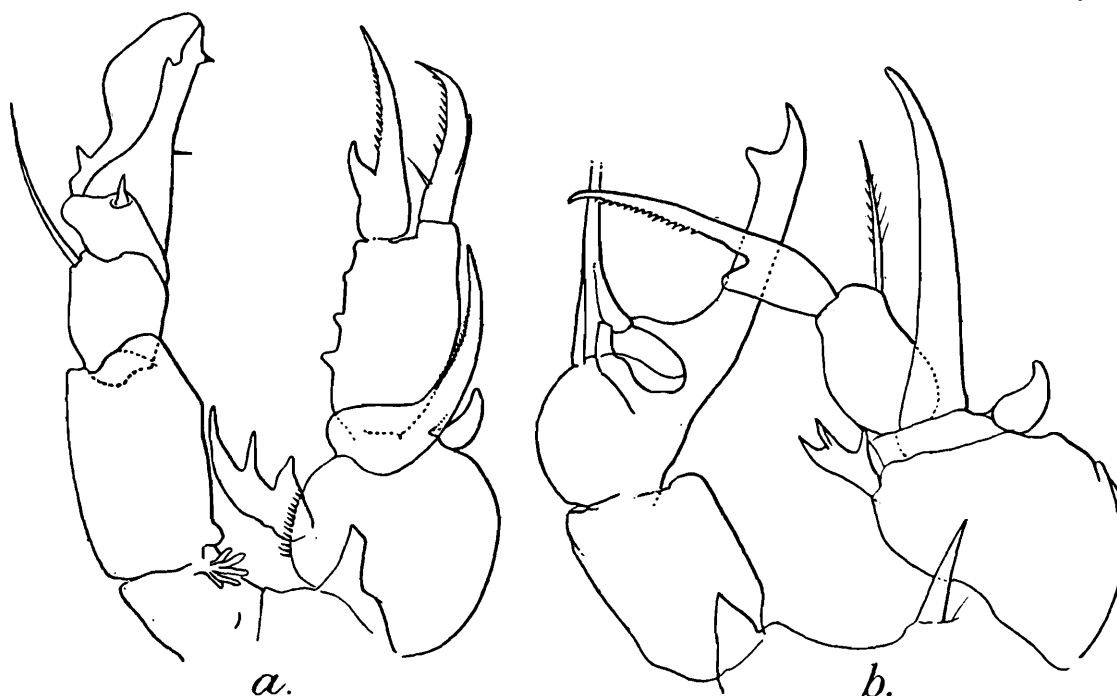
***Pseudodiaptomus binghami* Sewell.**

Pseudodiaptomus binghami, Sewell, 1912, p. 337, pl. xvii, figs. 8-11.

Pseudodiaptomus binghami, Sewell, 1919, p. 7.

Pseudodiaptomus binghami, Sewell, 1924, p. 786, pl. xlv, fig. 2.

This species appears to be confined entirely to brackish-water ; it has now been taken in the Rangoon River estuary and in the Chilka Lake on opposite sides of the Bay of Bengal.



TEXT-FIG. 85.—*a.* 5th pair of legs, *Pseudodiaptomus aurivillii* Cleve.
b. 5th pair of legs, *Pseudodiaptomus mertoni* Früchtl.

***Pseudodiaptomus mertoni* Früchtl.**

(Text-fig. 85, *b.*)

Pseudodiaptomus mertoni, Früchtl, 1924, p. 49, figs. 31-36.

This species was described by Früchtl from examples taken in the Aru Archipelago. Till the publication of Früchtl's account this species had in all probability been confused with *Pseudodiaptomus aurivillii* Cleve, which it very closely resembles. The chief difference between the two forms lies in the structure of the 5th pair of legs in the male ; for the purpose of reference I have given figures of these appendages in the two species (*cf.* text-fig. 85, *a* and *b*). A few examples of this species were obtained in a small collection of Copepoda that was sent to me by Mr. Cedric Dover and that had been taken by him in the Karun River, Perak.

***Pseudodiaptomus tollingeri* Sewell.**

Pseudodiaptomus tollingeri, Sewell, 1919, p. 2, pl. x, fig. 8.

Pseudodiaptomus tollingeri, Sewell, 1924, p. 787, pl. xlv, fig. 3.

Up to the present time this species, also, has only been taken in brackish-water ; it has now been obtained in the Chilka Lake, at Port Canning in Lower Bengal, and in the Salt Lakes, Calcutta.

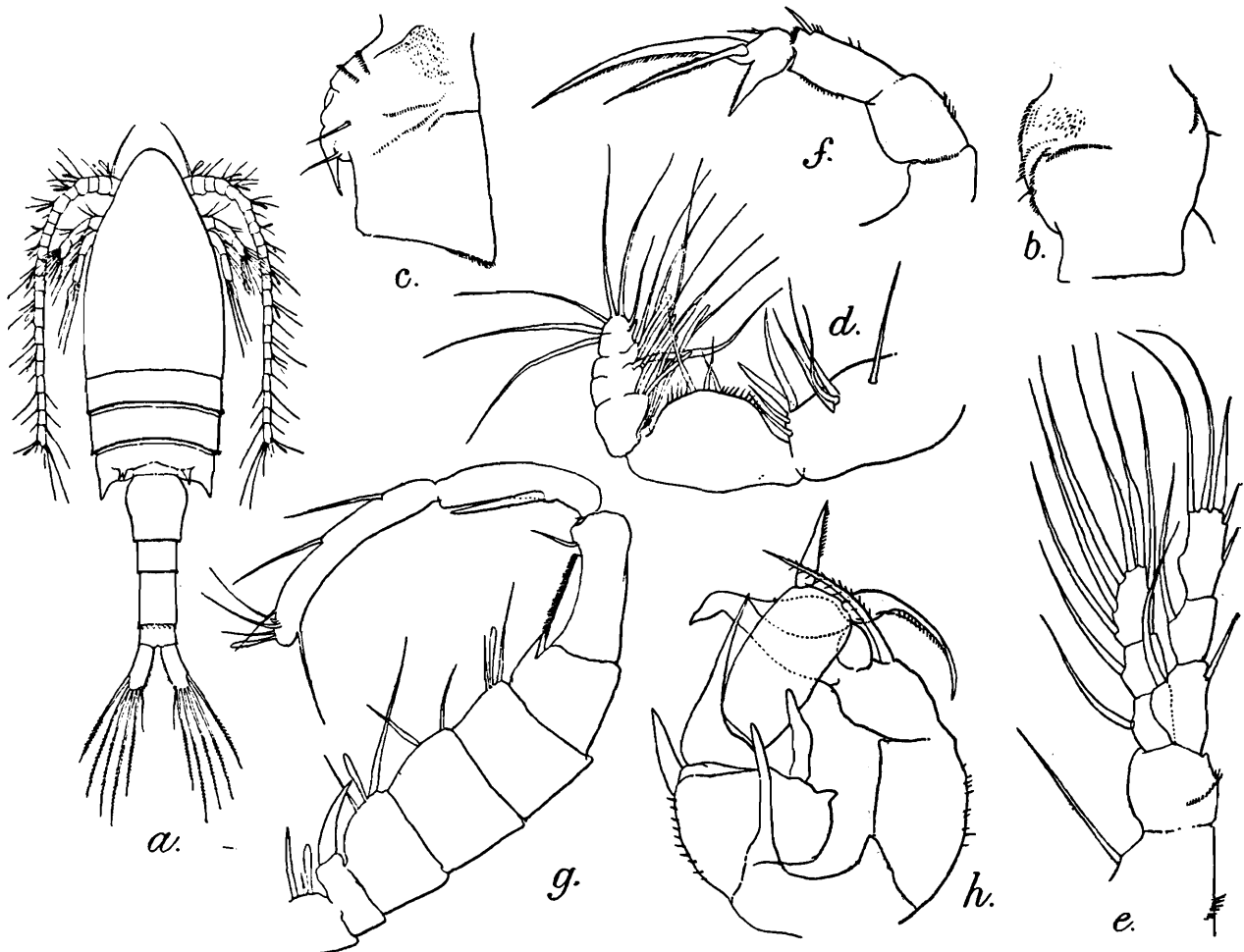
***Pseudodiaptomus daughlihi*, sp. nov.**

(Text-fig. 86, *a-h.*)

A number of examples of a species of *Pseudodiaptomus*, that comes very near to *P. stuhlmanni* Poppe and Mrazek, were taken in the surface tow-net in Kuala Kuran, Perak,

F. M. S. by Mr. Cedric Dover. In their general bodily structure these specimens are almost indistinguishable from that species ; but as they differ in certain important details I have thought it best to regard them as a new, though very closely related, species.

♀ Total length, 1·03 mm.



TEXT-FIG. 86.—*Pseudodiaptomus daughlishi*, sp. nov.

a. The whole animal from the dorsal side.	e. The 1st swimming leg.
b. The genital segment of the abdomen, dorsal view.	f. The 5th leg female.
c. The genital segment of the abdomen, lateral view.	g. The grasping antenna male.
d. The maxilliped.	h. The 5th pair of legs male.

The proportional lengths of the cephalothorax and abdomen are as 36 to 18·5, so that the abdomen is contained almost exactly twice in the length of the anterior region of the body.

The head (text-fig. 86, a.) is somewhat sharply rounded anteriorly. The head and 1st thoracic segment are fused, as also are segments 4 and 5, though a line of demarcation between these last two portions can clearly be seen crossing the dorsal aspect. On either side of the middle line and situated on the line of demarcation between segments 4 and 5 is a sharp backwardly directed spine that from its situation must rightly belong to the 4th thoracic segment ; in one example that I examined this spine was double on the left side of the body, though the corresponding spine on the right side was single, as usual. The posterior thoracic margins are symmetrical and are produced backwards into sharp points.

The abdomen consists of four free segments, segments 1 and 2 being, as usual, fused together into the genital segment. The proportional lengths of the segments are as follows :—

Abdominal segment	1-2	3	4	5	Furca	
	30	17	24	8	21	= 100.

The genital segment when viewed from the dorsal aspect (text-fig. 86, *b*) is seen to be slightly asymmetrical. The surface of the segment is covered with an elaborate system of minute spinules. In front of the genital orifice on the ventral aspect (text-fig. 86, *c*) two rows of spinules, interrupted in the middle line, run across the ventral aspect. Commencing on either side of the genital orifice a single row runs at first outwards and then turns upwards and forwards on the lateral aspect; on the left side this row ends between two other rows that commence in this region, the one in front and the other behind. The anterior row is confined entirely to the lateral aspect, but the posterior row commences in the lateral region and is continued round to the dorsal aspect. There is a patch of scattered spinules on the anterior portion of the left side. The genital orifice is guarded on each side by a stout backwardly-directed spine, and laterally to these spines a fine seta arises. Ovigerous females bear a single egg-capsule, that contains approximately 14 ova. The posterior margins of segments 2 and 3 are fringed with fine spines.

The 1st antenna reaches back almost to the posterior margin of the thorax; it consists of 20 separate segments, that have the following proportional lengths :—

Segment	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20-21	
	73	46	56	40	53	36	30	40	46	53	53	56	56	56	56	46	46	46	53	65	= 1000.

Segments 1, 2, 3, 4, 6, 8, 9, 10, 11, 13, 15, 18 and 21 all bear sensory filaments. This distribution is slightly different from the distribution of the sensory filaments in *Pseudodiaptomus stuhlmanni*, as given by Poppe and Mrazek.

The 2nd antenna resembles that of other members of the genus. The terminal segment of the endopod bears three setae at its distal extremity, one of which is thickened and bayonet-like.

In the maxilliped (text-fig. 86, *d*) the 1st basal segment bears a single seta on lobe I; three setae on lobe 2; and the 3rd lobe bears three setae and a stiff straight spine. The 2nd basal segment is swollen and bears three setae in the middle of its anterior margin, while two others arise from a small papilla near the distal end. The proximal part of the anterior margin as far as the three middle setae is beset with small spinules and a second row of spinules, longer and more needle-like, arises from the margin on the distal side of the setae. The endopod consists of five segments. Some of the setae arising from segments 1, 2 and 3 are modified; from a stout base each seta divides into two branches of which one is slender and tapering, while the other is blunt and rod-like. Endopod 1 bears two of these modified setae and endopod 2 and 3 bear one each. This modification of the setae is also found in *Pseudodiaptomus stuhlmanni* Poppe and Mrazek. Poppe and Mrazek (1894, p. 125, pl. i, figs. 1-9) in their account of the latter species state that this modification occurs in the setae of the 2nd maxilla, but it is perfectly clear from the figure that they give that they refer to the maxilliped.

The swimming legs are similar to those of other members of the genus.

The 5th pair of legs possesses the usual structure. The 1st basal segment bears a row of fine spines along its distal margin. The 2nd basal segment is also armed with a few needle-

like spines on its outer margin. Exopod 1 bears a short straight marginal spine at its distal outer angle ; there are small spinules along the inner margin and a row of spines runs across the outer part of the distal margin, while several spines are scattered over the outer border. The terminal segment bears three spines and ends in a sharp process that is toothed along its external border. Of the spines the proximal is very small and delicate ; the 2nd is straight and serrated on both borders and is approximately equal in length to the two distal segments together ; the 3rd spine is stout and slightly curved and is considerably longer than the 2nd, being nearly equal in length to the whole appendage ; it is serrated along its inner margin only.

♂ Total length from 0.877 to 0.915 mm.

The proportional lengths of the cephalothorax and abdomen are as 123 to 67, so that the abdomen is contained 1.82 times in the length of the anterior region of the body.

The abdomen consists of five segments and the furcal rami, that have the following proportional lengths :—

Abdominal segment	1	2	3	4	5	Furca	
	12	21	18	20	8	21	= 100.

The 1st segment bears a transverse row of minute spines on each side. Segments 2 and 3 are armed with spines along their posterior margins as in the female, but the spines are larger in the present sex.

As in other members of the genus the 1st antenna on the left side resembles that of the female, while the right antenna is modified to form a grasping organ (text fig. 86, *g.*). In the modified antenna segments 10 and 12 bear a seta and a club-shaped sensory filament (aesthetask) ; segment 11 bears a spine only ; segment 13 is slightly swollen and bears a stout curved spine ; segments 14 to 17 are considerably swollen ; segment 14 bears 2 setae and an " aesthetask " ; segment 15 bears two setae ; segment 16 bears two setae and an " aesthetask " and segment 17 is produced along its anterior margin in a crest that terminates distally in a sharp spine ; segment 18 bears a straight tooth-plate armed along its margin with fine needle-like teeth. Between segments 18 and 19 lies the hinge-joint. Segments 19 and 20 are fused ; segment 19 bears a long straight spine, that reaches to the end of the segment ; segments 21 to 25 are fused together into a single joint, that is slightly curved and terminates in a bluntly rounded end bearing several setae and an " aesthetask "

The mouth parts and swimming legs are as in the female and the 5th pair of legs are as figured (text-fig. 86, *h.*).

Family TEMORIDAE.

Genus **TEMORA** Baird.

This genus is represented in Indian waters by four species. In 1900 Thompson in his report on two collections of Plankton from the Indian Ocean records the occurrence of *Temora stylifera* (Dana), *T. discaudata* Giesbrecht and *T. longicornis* Müller. Familiar as Thompson was with the North Atlantic forms, it seems impossible to believe that he was mistaken in the identity of this last species ; it occurred in the collections from three different stations, two off the east coast of Africa and one in the Bay of Bengal. It is, however, curious that no subsequent observer has recorded its presence in these waters.

In 1901 Cleve recorded *Temora discaudata* Giesbrecht and *T. stylifera* (Dana) from the Malay Archipelago, and in 1902 A. Scott recorded them from the Red Sea. A year later Thompson and A. Scott recorded both these, as well as *Temora turbinata* (Dana), from the Pearl Banks of Ceylon. Since that date all three species have been taken in a number of different localities in Indian and neighbouring waters. All three species occur in the "Investigator" collections.

There has been some confusion regarding the species that occur in these waters owing to the work of Brady. In 1856 Lubbock under the name *Diaptomus dubius* described a species of Copepod from the Atlantic Ocean. Brady (1883) in his report of the Copepoda of the "Challenger" expedition recorded examples of what he took to be the same species and transferred it to the genus *Temora*. Giesbrecht, however, (1894) maintains that *Temora dubia* is a synonym of *Temora stylifera*, and that Brady in his "Challenger" report has failed to discriminate between *Temora stylifera* and *T. discaudata*. In 1914 Brady protests against Giesbrecht's views and maintains that *Temora dubia* is a valid species and that he obtained examples from Durban Bay that show exactly the characters on which the species was founded and which he also found in the "Challenger" specimens. In the same paper Brady also describes a further new species of *Temora* under the name *Temora africana*; but though his description and figures are poor, there is, I think, little doubt that these last examples are in reality representatives of the species *Temora turbinata*.

The occurrence of small glands which open through pores on the surface of the body has already been noted in members of this genus by Claus in *Temora stylifera* (Dana) and *T. longicornis* (Müller). Not only are these glands present on the swimming legs and the furcal rami; there are others present also on the cephalon and the posterior segments of the thorax. On the cephalon a pair open in the lateral region near the base of the 1st antennae; a second pair opens, also in the lateral region, about the middle of the length of the segment and a smaller pair open on the dorsal aspect not far from the posterior margin and near the middle line. On the 1st thoracic segment a pair open in the lateral region. On the 2nd and 3rd segments a pair open in the dorsolateral region and there is also a pore present on the outer side of the base of the spinous projection of the 5th thoracic segment. I could not detect any pores on the abdominal segments but a single one opens on the outer margin of the furcal ramus about one third along its length and there appear to be small pores near the extreme tip of the ramus.

***Temora discaudata* Giesbrecht.**

Temora discaudata, A. Scott, 1909, p. 118.

Temora discaudata, Pesta, 1912, p. 47, fig. 7.

Temora discaudata, Sewell, 1912, p. 365, pl. xxii, figs. 8, 9.

Temora discaudata, Sewell, 1914, p. 227.

Temora discaudata, Früchtl, 1924, p. 53.

Temora discaudata, Gurney, 1927, p. 151.

This species has now been taken from the Malay Archipelago (Cleve, A. Scott, Früchtl); the coast of southern Burma (Sewell); the Ceylon Pearl Banks (Thompson and A. Scott, Sewell); the Maldivé and Laccadive Archipelagoes (Wolfenden); the Persian Gulf (Pesta); the Red Sea (A. Scott); and Suez Canal (Gurney).

Temora stylifera (Dana).

- Temora stylifera*, Thompson, 1899, p. 280.
Temora stylifera, Cleve, 1901, p. 9.
Temora stylifera, A. Scott, 1902, p. 404.
Temora stylifera, Cleve, 1903, p. 369.
Temora stylifera, Thompson and A. Scott, 1903, p. 249.
Temora stylifera, Cleve, 1904, p. 198.
Temora stylifera, Wolfenden, 1906, p. 1023.
Temora stylifera, T. Scott, 1912, p. 533.
Temora stylifera, Gurney, 1927, p. 151.
Temora stylifera, Sewell, 1912, p. 366.
? *Temora dubia*, Brady, 1914, p.
Temora stylifera, Sewell, 1914, p. 227.
Temora stylifera, Sars, 1925, p. 193.
Temora stylifera, Farran, 1927, p. 257.

This species is widely distributed throughout the whole of the Indian region. It has now been recorded from the Malay Archipelago (Cleve); the coast of Southern Burma (Sewell); the Pearl Banks of Ceylon (Thompson and A. Scott, Sewell); the Maldivé and Laccadive Archipelagoes (Wolfenden); the Arabian Sea (Cleve); the Red Sea (A. Scott); the Suez Canal (Gurney) and possibly the region of Durban Bay (Brady).

Temora turbinata (Dana).

- Temora turbinata*, A. Scott, 1909, p. 118.
Temora turbinata, Pesta, 1912, p. 48, fig. 8.
Temora turbinata, T. Scott, 1912, p. 534.
Temora turbinata, Sewell, 1912, p. 366.
Temora turbinata, Pesta, 1913, p. 32.
Temora turbinata, Sewell, 1914, p. 227.
Temora turbinata, Früchtl, 1924, p. 54.
Temora turbinata, Sars, 1925, p. 193.
Temora turbinata, Farran, 1929, p. 258.
? *Temora africana*, Brady, 1914, p.

Like the preceding species this is also widely distributed throughout the Indian Ocean. It has now been recorded from the Malay Archipelago (A. Scott, Früchtl); the coast of Southern Burma (Sewell); the Pearl Banks of Ceylon (Sewell); the Arabian Sea and the Persian Gulf (Pesta). In all probability the form described by Brady from the region of Durban Bay on the east coast of Africa, under the name *Temora africana*, is also the same species.

Genus **TEMOROPIA** T. Scott.

A. Scott (1909, p. 119) has recorded the occurrence in the Malay Archipelago of *Temoropia mayumbaensis* T. Scott, and Thompson and A. Scott (1903, p. 248) had previously recorded the same species from the Gulf of Suez. It seems certain, therefore, that it is an inhabitant of Indian waters, but up to the present time I have been unable to detect any examples in the "Investigator" collections.

Family METRIDIIDAE.

In all three genera of the Family Metridiidae, namely, *Metridia*, *Gaussia* and *Pleuromamma*, there is an elaborate system of glands and pores scattered over the surface of the body, on both the cephalothorax and abdomen. A careful search has revealed in every species that I have examined a large number of such pores but one cannot be certain that others have not escaped detection. The number of pores present appears to be most numerous in the genus *Metridia* and least numerous in *Pleuromamma*, the genus *Gaussia* being intermediate, though more nearly approaching *Metridia*. The pores are connected with small glands, each composed of a number of pyriform cells, that open through narrow ducts at a common pore. In the case of the heavily pigmented species *Gaussia princeps* the pores are in a number of cases surrounded by a circular clear area that considerably assists in their recognition.

Genus **METRIDIA** Boeck.

In 1900 T. Scott recorded the occurrence of *Metridia longa* Lubbock from several stations between Madagascar and the African mainland. In 1904 Cleve recorded the occurrence of three other species of the genus *Metridia*, namely *M. brevicauda* Giesbrecht, *M. princeps* Giesbrecht and *M. venusta* Giesbrecht, from the Agulhas Current and in 1909 A. Scott reported the presence of the same three species, as well as *Metridia boeckii* Giesbrecht and *M. macrura* Sars, in the collections made by the "Siboga" in the Malay Archipelago. In the "Investigator" collections I have been able to identify *Metridia curticauda* Giesbrecht and *M. venusta* Giesbrecht in addition to the other species. According to Sars (1925, p. 199) *Metridia lucens* Boeck has been recorded from the Red Sea. It would thus appear that there are at least seven species of this genus in Indian waters.

In text-fig. 87, *a* and *b* I have indicated the approximate position of the cutaneous glands that I have been able to locate in *Metridia princeps* Giesbrecht and *M. boeckii* Giesbrecht. In addition to those on the body there are also a number on the various appendages. In the 1st swimming leg two pores are present on the outer margin of the 1st basal segment. One pore is present on the 2nd basal segment near the articulation with the exopod. There is a single pore on the posterior surface of the 3rd segment of the endopod. In the 2nd leg there is a group of two or three pores at the distal lateral angle of the 1st basal segment. Two pores are situated on the lateral margin of the 1st segment of the exopod; one on the outer margin of the 2nd segment, and a single one near the base of each marginal spine on the 3rd segment. The arrangement of pores on the 3rd and 4th legs appears to be similar; two are situated at the outer distal angle of the 1st basal segment and one near the outer angle of the 2nd basal; there are two pores on the outer margin of both the 1st and 2nd segments of the exopod and a single pore near the base of each marginal spine on exopod 3. In the 5th leg a pore is situated on the outer margin of exopod 2 and another on the anterior aspect of exopod 3.

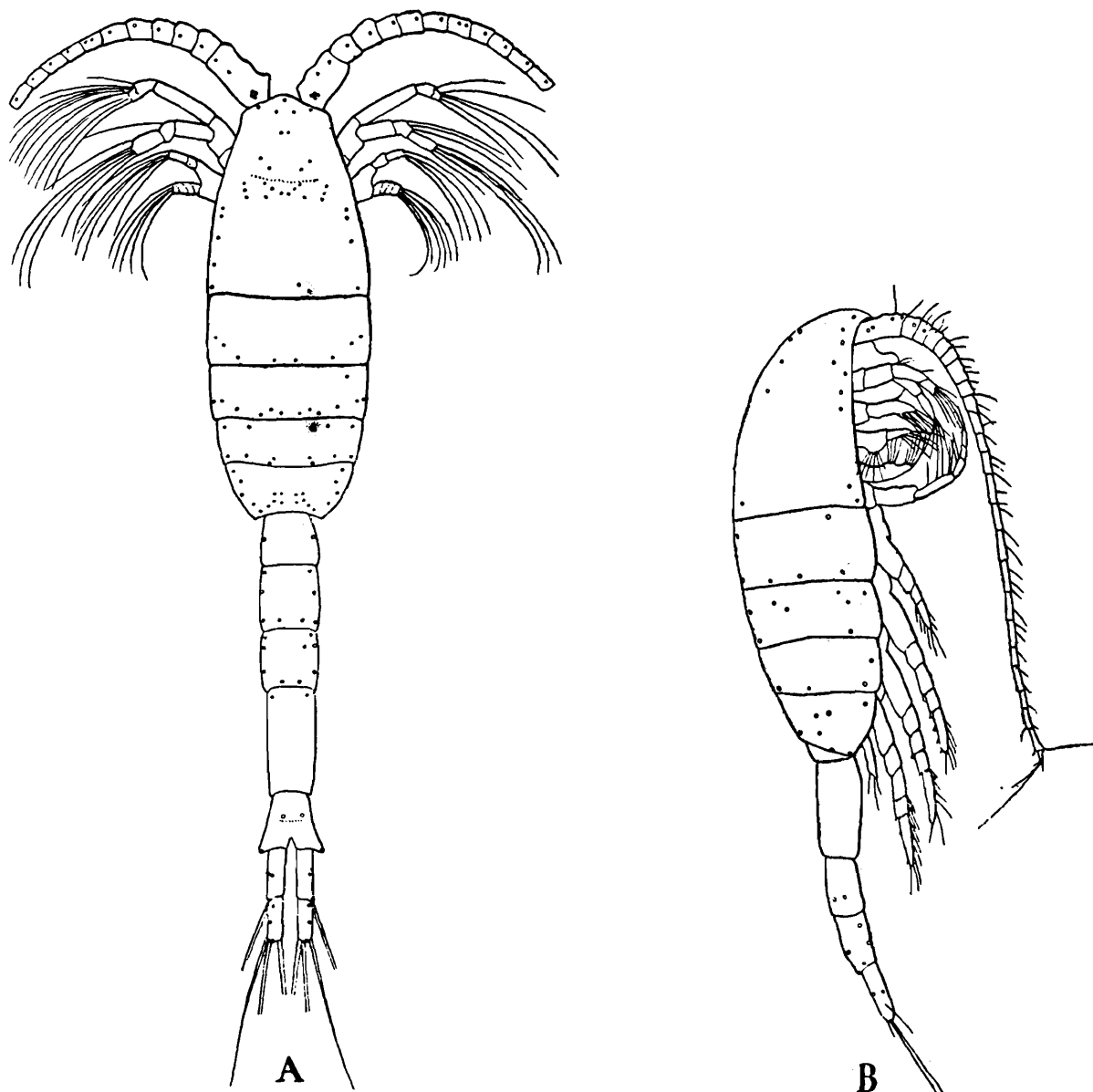
Metridia boeckii Giesbrecht.

Metridia boeckii, A. Scott, 1909, p. 120, pl. xxxvii, figs. 12-14.

Metridia boeckii, Sars, 1925, p. 199, pl. liv, figs. 8-11.

This species, which was first taken in the Pacific Ocean by Giesbrecht, has since been obtained from the Malay Archipelago and in the Atlantic Ocean. It thus appears

to have a wide distribution. It occurred in the "Investigator" collection at Station 682.



TEXT FIG. 87.—Showing the cutaneous pores in
 A. *Metridia princeps* Giesbrecht, dorsal view. B. *Metridia boeckii* Giesbrecht, lateral view.

***Metridia brevicauda* Giesbrecht.**

Metridia brevicauda, A. Scott, 1909, p. 120, pl. xxxvii, figs. 9-11.

Metridia brevicauda, Farran, 1926, p. 271.

This species also occurs throughout all the three great Oceans. It occurred in the "Investigator" collection at Station 682.

***Metridia curticauda* Giesbrecht.**

Metridia curticauda, Giesbrecht, 1889, p. 24.

Metridia curticauda, Giesbrecht, 1892, p. 340, pl. xxxiii, figs. 4, 15 and 33.

Metridia curticauda, Giesbrecht and Schmeil, 1898, p. 108.

Metridia curticauda, Wolfenden, 1911, p. 286.

Metridia curticauda, Farran, 1929, p. 259.

A single specimen, that agrees exactly with the description of this species, was taken by the "Investigator" at Station 682.

***Metridia macrura* Sars.**

Metridia macrura, Sars, 1905, p. 7.

Metridia macrura, A. Scott, 1909, p. 121, pl. xxxviii, figs. 8-11.

Metridia princeps (in part), Wolfenden, 1911, p. 287.

Metridia macrura, Sewell, 1913, p. 354.

Metridia macrura, Sars, 1925, p. 197, pl. liv, figs. 1-7.

This species was first briefly described by Sars from examples taken in the collections of the "Princesse Alice" in the North Atlantic Ocean; it has since been recorded from the Malay Archipelago by A. Scott (1909), who detected it among the collections made by the "Siboga", and it also occurred in the collections made by the "Gauss". Unfortunately, Wolfenden (1908, 1911) has fallen into the error of thinking that this species and *Metridia princeps* Giesbrecht are identical, and in his account of the "Gauss" collections has recorded both forms under the latter name; it is thus impossible to say in what areas the two forms occurred in the regions investigated by this expedition. Both *Metridia macrura* Sars and *M. princeps* Giesbrecht are present in the "Investigator" collections and though they closely resemble each other in many particulars, they differ in certain details and I agree with Sars in regarding them as true species. Several examples of both sexes, as well as others in the 5th Copepodid stage, occurred at "Investigator" Stations 393 and 682.

♀ Total length, 7.78-9.11 mm.

The proportional lengths of the cephalothorax and abdomen are as 1.17 to 1.

The head terminates anteriorly in a bifid rostrum, bearing a pair of rostral spines that are slender and plumose. Thoracic segments 4 and 5 are fused and the posterior thoracic margin is rounded. The abdomen consists of three segments and the furcal rami. The proportional lengths of the abdominal segments are as follows:—

Abdominal segment	1-3	4	5	Furca	
	40	24	10	26	= 100.

The genital segment is moderately swollen ventrally. Segments 4 and 5 each bear a tuft of long hair on the anterior part of the ventral aspect. The anal segment is somewhat produced laterally in a rounded lobe. The furcal rami are slightly asymmetrical, that of the right side being a trifle longer than that of the left. The furcal rami are six times as long as broad and are 2.6 times the length of the anal segment; in this respect this species differs markedly from *Metridia princeps* Giesbrecht, in which they are only twice the length. The rami are fringed with fine hair throughout the whole length of the inner border and there is a row of hairs on the proximal part of the outer border.

The 1st antenna over-reaches the posterior end of the abdomen by about the last three or four segments. Segments 7, 8 and 9 are fused together and in some specimens segment 10 appears to be partly fused to segment 9; segments 12 and 13 are partly fused and segments 24 and 25 completely so. The proportional lengths of the segments are as follows:—

Segment	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	
	59	20	21	22	24	24	66	30	42	42	56	59	60	62	63	59	64	42	40	48	51	56	56	= 1000

The anterior margin of segment 1 carries three short spines ; segment 2 bears a single larger spine ; segment three is devoid of a spine and segments 4, 5 and 6 each bear a single spine. These spines are less marked than in *Metridia princeps* Giesbrecht.

In the 2nd antenna the endopod and exopod are of equal length. The mandible resembles that of other members of the genus. The 1st maxilla possesses the usual structure. The basal segment bears 5 setae ; the 2nd inner lobe possesses 5, and the 3rd lobe 4 ; in the endopod the 1st segment carries 6 setae, and the 2nd and 3rd 5 each ; the outer lobe has 8 setae and the exopod bears 11.

The maxilliped also resembles that of other species. On the 1st basal segment there is a group of fine spines at the distal anterior angle ; basal 2 bears three setae on its anterior margin and 2 distally ; a row of needle-like spines runs along the anterior margin as far as the 2nd lobe. The endopod consists of 5 segments, bearing respectively 4, 4, 4, 3 and 4 setae.

The 1st leg differs from that of *Metridia princeps* Giesbrecht in the relative lengths of the endopod and exopod. In *M. princeps* the endopod reaches beyond the joint between segments 2 and 3, whereas in the present species the endopod reaches only just to the joint. Again, in *M. macrura* the proportional lengths of the terminal spine to the combined length of the last two segments of the exopod are as 48 to 36, and as 48 to 31 to the 3rd segment. Both the 2nd segment and the proximal part of the 3rd segment of the exopod are fringed with fine hairs.

The 3rd and 4th legs appear to be the same as in *Metridia princeps*.

The 5th pair of legs are composed of a basal part and three free segments ; the proportional lengths of these segments are as 15, 11 and 5. The proximal segment bears a well-developed marginal seta ; the 2nd segment carries a small marginal seta distally and the terminal segment bears three setae of nearly equal length. The basal segment carries a tuft of long hairs on its posterior aspect.

♂ Total length 8.9 mm.

The proportional lengths of the cephalothorax and abdomen are as 1.04 to 1.

The 4th and 5th segments of the thorax are fused together.

The abdomen possesses five segments that have the following proportional lengths :—

Abdominal segment	1	2	3	4	5	Furca	
	10	17	17	21	9	26	= 100.

The furcal rami are thus nearly three times the length of the anal segment and are six times as long as wide ; they bear 5 setae, 4 being at the distal end, and a single one arises from the external margin. The right ramus bears a fringe of hairs on the proximal part of its margin.

The 1st antenna is asymmetrical on the two sides ; it reaches to just beyond the tip of the furcal ramus. On the right side the antenna resembles that of the female ; segments 7 and 8 are completely and 8 and 9 partially fused ; the 1st, 2nd, 4th 5th and 6th segments all bear small spines that are less developed than in *Metridia princeps* Giesbrecht. The left antenna is modified to form a grasping organ. The proportional lengths of the segments in the two appendages are as follows :—

Segment	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
Right	66	20	22	22	23	23	45 25	31	30	44	47	58	58	61	61	63	66	42	39	48	50	35	15
Left	98	24	24	26	26	60	23	30	30	60	62	65	68	56	60	120	117	88	13				

In the left antenna segments 1 and 2 are fused together as also are segments 7, 8 and 9 ; the spines on the proximal segments are weak. The knee-joint is situated between segments 18 and 19, in the usual situation. The 17th segment bears a toothed plate, which is produced distally over the 18th segment and is armed with small teeth. The 18th segment is also armed with a toothed plate, that bears about 55 curved teeth ; the plate is not as long as the segment and is not upturned at the end, as in *Metridia princeps*. The 19th to 21st segments are fused together into a single piece from which two tooth plates arise near the proximal end ; of the two plates the proximal is armed with small teeth, while the distal is plain. Segments 22 and 23 are fused together and are not separate as in *Metridia princeps*.

The 5th pair of legs closely resembles that of *Metridia princeps*. Each leg consists of a basal portion and four free joints. In the left leg the proportional lengths of these free segments are as follows : 27, 13, 19, and 41. The 1st segment bears a single seta and internally is rounded at its distal end, the prominence being fringed with hair. The 2nd segment is fringed with hair internally. The 3rd segment bears a small spine on its external border and is fringed with hair on its inner margin. The 4th segment is spoon-shaped and bears two small spines distally, as well as a small spine on its outer and posterior margin. The basal segment bears a scattered tuft of hairs on its posterior aspect ; this tuft appears to be absent in *Metridia princeps*. On the right side the proportional lengths of the segments are as 32, 12, 19 and 37. The 1st segment bears a single seta posteriorly ; the 2nd segment carries a small external marginal spine and a long curved process internally ; the 3rd segment has a small spine anteriorly and the 4th segment is spoon-shaped and bears a small spine on its external and anterior aspect and two small spines distally.

Copepodid Stage V.

A single female was taken at "Investigator" station 393 that was apparently not quite sexually mature and was in all probability in the 5th Copepodid stage.

♀ Total length, 7.00 mm.

The proportional length of the Cephalothorax and abdomen are as 102 to 81, so that the abdomen was contained 1.259 times in the length of the anterior region of the body.

The forehead is somewhat flattened, as Easterly (1906, Pl. IX, fig. 20) figures it in *Metridia ignota*, and terminates in a bifid plumose rostrum, having a swollen base. The 4th and 5th thoracic segments are fused and the posterior thoracic margin is rounded.

The abdomen in this example possesses only four segments, as segments 4 and 5 do not appear to have as yet separated. The proportional lengths of the segments and the furcal rami are as follows :—

Abdominal segment	1	2	3	4-5	Furca
	13	17	18	24	28=100.

The furcal rami are six times as long as broad, as in *Metridia macrura*.

The 1st antennae are not quite symmetrical. On the right side this appendage consists of 25 free segments, whereas on the left side segments 8 and 9 are fused together. The 1st segment bears three straight spines, of which the middle one is the shortest. The 2nd segment bears a single spine that is considerably larger than the others ; the 3rd segment is devoid of any spines and the 4th and 5th segments each bear a single spine. The proportional length of the segments are as follows :—

Segment	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
	69	16	18	19	22	19	18	18	21	27	39	39	54	55	57	61	61	62	70	45	43	55	58	39	15

The mouth-parts appear to resemble those of other members of the genus.

In the 1st pair of Swimming legs, basal 1 bears a single inner seta ; basal 2 carries an S-shaped inner seta and the inner border is devoid of hair and shows no rounded swelling. Both rami consist of three

segments and the endopod reaches as far as the joint between segments 2 and 3 of the exopod. Exopod 1 bears a long and slender marginal spine that reaches well beyond the base of the spine on segment 2 ; a single seta arises from the inner margin and a row of fine and very small spines runs across the distal margin. In exopod 2 the outer margin is armed with a row of very fine spinules and bears a slender marginal spine that reaches beyond the base of the proximal spine on the 3rd segment, the inner margin bears 2 (?) setae. In exopod 3 the whole outer margin is armed with fine teeth and bears two long slender spines, across the distal border, where the end-spine is attached, runs a row of small spinules ; the inner margin bears 4 setae. The end-spine is long and slender and its length in proportion to the last two segments of the exopod is as 18 ; 23 ; 57 ; which corresponds very closely with the proportional lengths in the adult, viz., 18 ; 25 ; 57. In the endopod the 1st segment bears a single seta on its inner border and the external margin is fringed with hair ; a row of needle-like spines runs across its anterior surface. Endopod 2 bears two inner setae and endopod 3 carries in all five setae.

In the 3rd Swimming leg basal 2 is devoid of setae ; the inner margin is produced in a rounded swelling, but there is no trace of any group of spinules on the outer aspect. In exopod 1 the outer margin is smooth and bears a single leaf-like spine ; the inner border is fringed with hair and carries a single seta ; there is a small group of spinules at the base of the segment. In exopod 2 the outer margin is produced in a lamellar crest and bears a single leaf-like marginal spine ; the inner border is fringed with hair and carries a single seta. In exopod 3 the outer margin is produced in a crest but only the proximal part is fringed with hair ; the three marginal spines are leaf-like ; the inner border bears 5 setae. The end-spine is serrated externally and is 2.2 times the length of the terminal segment of the exopod. Endopod 1 bears the characteristic double hook on its inner margin and the single spine basally ; the outer border is fringed with fine hairs throughout its length. Endopod 2 bears two inner setae and its outer margin is fringed, as is the proximal segment ; endopod 3 carries in all 8 setae.

In the 3rd and 4th pairs of legs basal 2 bears no seta. Exopods 2 and 3 are both produced in a lamellar crest along their outer margins and this crest is fringed with hair along the whole length of exopod 2 and the proximal part of exopod 3. The end-spine bears to the distal segment in the two legs the proportional lengths of 3.06 and 3.71 to 1 respectively ; thus the proportional lengths of the end-spine regularly increases as we proceed from the 2nd to the 4th leg.

The 5th pair of legs at this stage closely resembles that of *Metridia princeps*, but the basal part is long and is without the tuft of long hairs on its posterior aspect. The three free segments and the base have the proportional lengths of 33, 31, 22, 14, whereas in the adult the free segments have the proportional lengths of 30, 22, 10. The 1st segment bears a long external seta ; the 2nd segment possesses a marginal spine at its distal end, and the 3rd segment carries three setae, of which the inner is the longest.

***Metridia princeps* Giesbrecht.**

(Pls. III and IV and Text-fig. 88 a-d.)

Metridia princeps, Wolfenden, 1908, p. 15, pl. iii, figs. 3-5.

Metridia princeps, A. Scott, 1909, p. 121, pl. xxxviii, figs., 1-7.

Metridia princeps (in part), Wolfenden, 1911, p. 287, pl. xl, figs. 8-13.

Metridia princeps, Sewell, 1913, p. 354.

Metridia princeps, Lysholm and Nordgaard, 1921, p. 24.

Metridia princeps, Sars, 1925, p. 194, pl. liii.

Metridia princeps, Farran, 1926, p. 271.

Metridia princeps, Farran, 1929, p. 258.

This species is of wide distribution and has now been recorded from all the great oceans ; its range extends from the Antarctic seas through the Tropics to as far north as the west

coast of Ireland. Examples of both sexes were taken at "Investigator" stations 393, 463 and 670.

♀ Average total length, 7.75 mm.

The proportional lengths of the cephalothorax and abdomen are as 24 to 19, so that the abdomen is contained only 1.26 times in the length of the cephalothorax in these specimens. Wolfenden (1908, p. 16) gives the proportions as 1.5 to 1.

The head terminates anteriorly in a plumose bifid rostrum. Thoracic segments 4 and 5 are fused together and the posterior thoracic margin is not produced backwards.

The abdomen consists of three segments, that have with the furcal rami the following proportional lengths :—

Abdominal segment	1-3	4	5	Furca	
	36	28	12	24	= 100.

The anal segment on each side is produced outwards and backwards in a rounded prominence that overlaps the base of the furcal ramus. The furcal rami are only a little more than twice the length of the anal segment and are 4.9 times as long as broad. Each ramus bears a single seta on its external border and four setae distally; there is also a fine delicate accessory seta on the dorsal aspect. The whole of the inner border, and the proximal part of the outer margin, as far as the point of origin of the external seta, is fringed with hairs.

The 1st antenna consists of 25 segments, of which the 7th, 8th and 9th are fused, as well as the 24th and 25th. Giesbrecht (1893) in his account of this species states that segments 1 and 2 are fused together to form a single basal segment; he however states that a trace of the division can be made out on the margin posteriorly; according to his figure this combined joint bears three marginal spines and thus corresponds with what, according to my calculation, is segment 1. The 2nd segment bears a single spine and the 3rd is devoid of any such projection. Segments 4, 5, and 6 each bear a small stout spine. With the exception of the trace of a division that Giesbrecht figures, my examples correspond exactly with his figure of the basal part of the appendage. If Giesbrecht were right then there would be 26 segments in the antenna and the three segments that are fused together would be segments 8, 9 and 10 in the female, while in the male the hinge joint of the modified antenna would be situated between segments 19 and 20.

The proportional lengths of the segments are as follows :—

Segment	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	
	63	19	22	22	23	24	63	31	42	43	54	55	56	59	59	59	64	45	43	50	52	52	52	= 1000

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

The 1st swimming leg consists of the usual basal part and three-jointed exopod and endopod. In the basal portion the 1st segment bears a single inner seta but has no marginal spine; basal 2 bears a delicate spine having a serrated inner border, an inner S-shaped seta and also a tuft of hairs distally on its curved inner margin. In the exopod the 1st segment carries a long and slender marginal spine, that is fringed with hairs on its inner side, and a single internal seta; the inner border of the segment is fringed with long hairs and a row of minute spines runs horizontally across the outer half of the distal margin. Exopod 2 bears a single internal seta and the proximal part of the inner margin is fringed with fine hair; externally it bears a delicate marginal spine and the outer border is finely serrated and is

fringed with hair ; a row of small spines runs across the surface transversely near the distal border. Exopod 3 carries two slender marginal spines and the outer border is serrated ; the terminal spine is long and slender and is fringed with hair internally ; the inner margin bears four setae. The proportional lengths of the distal two segments of the exopod and the terminal spine are as 19 ; 27 ; 54 ; whereas in *Metridia macrura* they are as 18 ; 25 ; 57, so that in this respect there is little or no difference between the two species. The 1st segment of the endopod bears a single inner seta ; the outer margin is fringed with hair and a row of needle-like spines runs across the anterior aspect. Endopod 2 bears two inner setae and endopod 3 carries five.

In the 2nd swimming leg basal 1 bears a single inner seta ; basal 2 bears a scattered group of small spines on its external surface and is produced internally in a rounded prominence. Both exopod and endopod consist of three segments. Exopod 1 bears a marginal spine that is short and leaf-like ; the inner margin is fringed with hairs on its distal three-fourths and carries a single seta, a group of small spines is present near the base. In exopod 2 the outer border is produced as a thin chitinous lamella that is fringed with hair ; the marginal spine is leaf-like ; internally there is a single seta and the proximal part of the margin is fringed with hair ; exopod 3 bears three marginal spines and the outer margin is thin and lamellar ; the terminal spine is broad and is finely serrated on its outer margin ; there are five inner setae. The proximal segment of the endopod, bears the characteristic double recurved hook on its inner border and there is another hook-like spine, directed externally near the base ; in this species the two distal hooks are of nearly equal size, whereas in *Metridia macrura* one distal spine is at least twice the size of the other. Endopod 2 bears two inner setae and the outer margin of the segment is fringed with hair. Endopod 3 carries eight setae and the proximal part of the outer margin is fringed with hair.

In the 3rd and 4th swimming legs the 1st basal segment bears a plumose seta on its inner margin, and basal 2 is devoid of spines and setae. Exopod 1 bears a single leaf-shaped marginal spine and the inner margin is fringed with hair. Exopod 2 is very similar to exopod 1. Exopod 3 exhibits certain differences in the two legs ; in the 3rd swimming leg there are three leaf-like marginal spines the terminal spine is finely serrated and five setae arise from the inner margin ; in the 4th leg this segment is similar but there are slight differences in the relative lengths of the terminal spines and the end segment ; in the 3rd leg the proportions of the segment and spine are as 3.74 to 1, whereas in the 4th leg they are as 4.35 to 1. In both legs the endopod reaches as far as the level of the joint between segments 2 and 3 of the exopod ; endopod 1 bears a single seta and endopod 2 bears a couple ; in the 3rd leg endopod 3 bears seven setae, whereas in leg 4 it carries eight. In both legs the outer margin of the two proximal segments is fringed with hair.

The 5th leg consists of a basal part and three free segments that have the proportional lengths of 13, 27, 32. The basal segment bears posteriorly a tuft of long hairs ; the 1st free segment carries a long seta and the 2nd bears a small marginal spine ; the distal segment bears three setae, of which the inner is the longest.

Total length, 7.4 mm.

The proportional lengths of the cephalothorax and abdomen are as 23 to 18, so that the abdomen is contained 1.27 times in the length of the anterior region of the body. Segments 4 and 5 of the thorax are fused.

The abdomen consists of five segments that have with the furca the following proportional lengths :—

Abdominal segment	1	2	3	4	5	Furca	
	13	19	18	19	10	21	= 100

In this sex the furcal rami are but little more than twice as long as the anal segment.

The 1st antennae are asymmetrical ; that on the left side being modified to form a grasping organ. In this latter case segments 1 and 2 are fused completely ; segments 7, 8 and 9 are partially fused and segments 19-21 are fused. The knee-joint occurs between segments 18 and 19, as usual. The proportional lengths of the segments are as follows :—

Segment	1-2	3	4	5	6	7-8-9	10	11	12	13	14	15	16	17	18	19-21	22	23	24	25
	94	24	24	26	26	466	26	34	41	53	63	60	63	53	50	120	60	62	43	13

The combined segments 1 and 2 carries a series of spinous projections on its anterior aspect ; the spine arising from that part that corresponds to segment 2 being by far the largest. Segment 3 bears no spine ; but segments 4, 5, and 6 each bear a spine. Segment 17 bears a spine that extends along the anterior margin and overlaps the base of segment 18. Segment 18 bears a tooth-plate on its anterior border ; this plate is about equal in length to the whole segment and is armed with about 20 claw-like teeth of unequal size, while the distal free end of the plate is bent upwards. Segment 19 bears two plates on its proximal half, each terminating in a free, spine-like projection.

In the 5th pair of legs each is composed of four segments ; on the right side the proportional lengths of these segments are as 28, 11, 21, 40. The 1st segment bears a seta at its distal external angle ; the 2nd segment carries a long curved process on its inner margin, as well as a small external spine ; the 3rd segment has a small internal spine about the middle of its length ; and the terminal segment is spoon-shaped, bearing one small spine on its anterior aspect at about the junction of the 3rd and 4th quarters of its length and two others at its distal end. In the left leg the proportional lengths of the segments are as 30, 8, 17, 45. The 1st segment is somewhat produced at its inner distal angle and this rounded projection is fringed with hair ; it bears a long seta posteriorly ; the 2nd segment bears a minute spine externally ; the 3rd segment also bears a minute spine externally and, in addition, has a small seta on its inner margin ; both the 2nd and 3rd segments are fringed with hair on their inner margins ; the 4th segment bears a small spine on its anterior margin and another at its distal end. The basal segment is quite short and is provided with a tuft of long hairs.

A number of immature examples of *Metridia princeps* were taken at "Investigator" Station 670. The smaller examples already possessed three segments in the abdomen and were, therefore, in all probability in the 4th Copepodid stage. The larger specimens appeared to be in Stage 5.

Copepodid Stage IV.

♀ Average total length, 4.6 mm.

The proportional lengths of the cephalothorax and abdomen are as 43 to 24, so that the abdomen is contained 1.375 times in the length of the anterior region of the body.

The head and 1st thoracic segment of the body are fused together, but a well-marked groove runs across the dorsal aspect at the point of union. The forehead slopes downwards and forwards and terminates in a bulbous swelling from which spring the two slender rostral spines ; above this rostral swelling in the middle line is a small projection from which springs a single short sensory hair. The line of separa-

tion between the 2nd and 3rd thoracic segments is visible across the dorsal aspect. The 4th and 5th segments are fused and the posterior thoracic margin is rounded.

The abdomen consists of three segments, of which the third is the longest ; on each side this segment is produced backwards in a short bluntly rounded process that overlaps the articulation of the furcal rami. The furcal rami are longer than the last abdominal segment and are symmetrical.

The 1st antenna overreaches the tip of the furcal ramus by the last five segments. The 1st segment is large and bears three claw-like spines, of which the distal is the largest ; the 2nd, 4th and 6th segments each bear a single spine. The 8th and 9th segments are completely and the 9th and 10th partially fused. The joint between the 12th and 13th segments appears to be less perfect than those between the other segments. The proportional lengths of the segments are as follows :—

Segment	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
	67	15	17	18	19	20	19	38	21	30	38	50	52	52	55	61	61	71	55	55	61	61	46	15 = 1000

The 2nd antenna and mandible are already very similar to those of the adult.

The 1st maxilla is well-developed, but in certain parts of the appendage the full complement of setae has not yet been developed. In the table below I have given the number of setae on the various parts of the appendage in the different stages of development that I have been able to examine ;

									4th Copepodid Stage.	5th Copepodid Stage.	Adult Stage.
Lobe 2	.	.	.	.	.	.	.	.	5	5	5
Lobe 3	.	.	.	.	.	.	.	.	4	4	4
Basal 2	.	.	.	.	.	.	.	.	3	4	5
Endopod 1	.	.	.	.	.	.	.	.	4	5	6
Endopod 2	.	.	.	.	.	.	.	.	4	5	6
Endopod 3	.	.	.	.	.	.	.	.	5	5	5
Exopod	.	.	.	.	.	.	.	.	9	10	11

Thus we see that, although on the inner lobes 2 and 3 and in Endopod 3 the number of setae remain the same, there is a progressive increase in each succeeding stage in the other parts of the appendage, an additional seta being added at each moult.

The 2nd maxilla and the maxilliped are also already well-developed and in their major features are identical with that of the adult ; but in the maxilliped the number of setae on certain segments is less and, furthermore, there appears to be certain differences in this respect in the two sexes. The number of setae arising from the different parts is given in the table below :—

		4th Copepodid Stage.		5th Copepodid Stage.		Adult Stage.
		♀	♂	♀	♂	Both Sexes
Basal 1—						
Lobe 1	.	.	.	.	.	2
Lobe 2	.	.	.	.	.	4
Lobe 3	.	.	.	.	.	4
Basal 2—						
Inner border	.	.	.	.	.	3
Distal end	.	.	.	.	.	2
Endopod 1	.	.	.	.	.	4
Endopod 2	.	.	.	.	.	4
Endopod 3	.	.	.	.	.	3
Endopod 4	.	.	.	.	.	3
Endopod 5	.	.	.	.	.	4

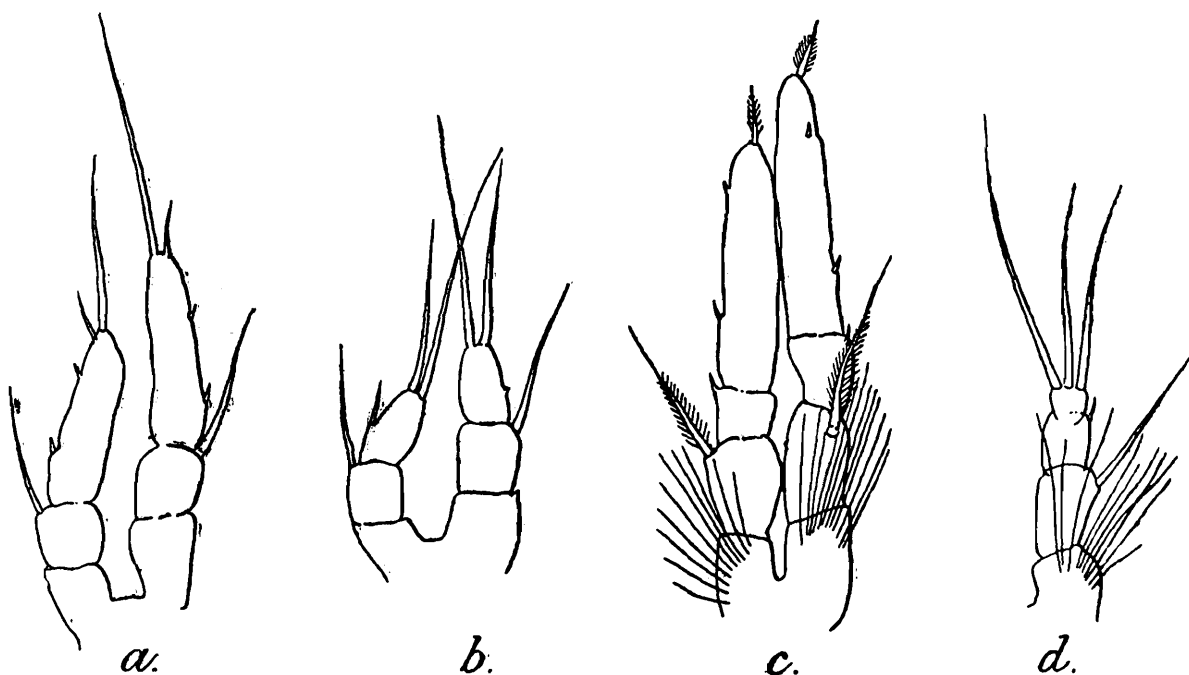
The development of the swimming legs is still incomplete. In the 1st swimming leg both rami consist of only two free segments. The 1st basal segment bears a single plumose seta on its inner margin and the 2nd bears a delicate seta on its external margin and an S-shaped seta at its distal inner angle. In the exopod the proximal segment, which corresponds to exopod 1, bears a long and delicate marginal spine and a single inner seta; the distal segment, which corresponds to exopod 2 and 3 together, bears three delicate marginal spines, a long end spine and 4 setae on its inner margin. The endopod also consists of only two segments; endopod 1 bears a single seta and near its distal margin is traversed by a row of delicate needle-like spines; endopod 2-3 bears seven setae, 1 on its outer border, 2 distally and 4 on its inner margin.

In all the other swimming legs, the 2nd to 4th inclusive, the 1st basal segment bears a plumose seta on its inner margin, while the 2nd basal segment seems to be devoid of a seta.

In the 2nd leg the exopod consists of only two segments. The proximal segment, corresponding to exopod 1, bears a short marginal spine and a single seta on its inner border; the distal segment, corresponding to exopods 2 and 3 together, bears three marginal spines and an end-spine and carries five setae on its inner border. The endopod at this stage consists of only a single segment; near the proximal end it bears the curved hooks that are characteristic of this genus and its relative *Pleuromamma*; on the distal two-thirds of the segment are situated nine setae, of which 5 arise from the inner margin, 2 from the distal end and 2 from the outer border.

The 3rd and 4th legs closely resemble each other; in both cases the exopod is composed of two separate segments, while the endopod possesses only a single joint. The proximal segment of the exopod bears a single marginal spine and in the 3rd leg it also carries a seta on its inner margin, but this seta is absent in the 4th leg; the distal segment in both legs is armed with three marginal spines and an end-spine, and carries five setae on the inner border. The endopod in the 3rd leg carries nine setae, whereas in the 4th it bears only eight.

The 5th leg already closely resembles that of the adult as regards its shape, but at this stage of development each limb consists of a basal portion and only two free segments, as shown in text-fig. 88, b.



TEXT-FIG. 88.—*Melridia princeps* Giesbrecht.

a. 5th leg, male. Copepodid Stage IV.

b. 5th leg, female. Copepodid Stage IV.

c. 5th leg, male. Copepodid Stage V.

d. 5th leg, female. Copepodid Stage V.

♂ As regards their general shape and the proportions of the body the individuals of this sex closely resemble the females. There are, apparently, slight differences in the proportional lengths of the various

segments of the abdomen, the 2nd segment in this sex being slightly longer and the furcal rami somewhat shorter, but I had too few examples to be quite certain on this point.

The 1st antenna already begins to exhibit differences in structure on the two sides of the body ; not, however, as regards the actual segmentation but in the proportional lengths of certain of the segments. The antenna on the right side closely resembles that of the female, but that on the left side which in the adult is modified to form a grasping organ, shows a distinct diminution in length of segments 15 to 19 and a lengthening of segments 22 and 23. I give below the relative lengths of the segments in the antennae on the two sides :—

Segment	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
Right	67	14	15	17	17	21	20	35	23	32	38	49	54	55	59	61	61	71	55	55	61	61	46	14 =1000
Left	67	14	15	16	17	21	19	37	21	31	38	52	55	52	57	57	52	63	55	57	70	70	49	15 =1000

As in the female, segments 8 and 9 are completely and 9 and 10 are partially fused.

The mouth-parts appear to be the same as those of the female in the corresponding stage of development, except as regards the number of setae on certain segments of the maxilliped, to which I have already referred.

The 5th pair of legs, as in the female, consist of only a single basal segment and two free joints ; but in this sex the distal free segment is long and narrow, and bears two spines on its outer margin and two setae distally.

Copepodid Stage V.

A number of examples of the 5th Copepodid stage of development were also obtained.

♀ Total length, 5.6 mm.

The proportional lengths of the cephalothorax and abdomen in this stage of development are as 27 to 18 or 1.5 to 1. The head and 1st thoracic segment are fused, though a groove running across the dorsal aspect indicates the line of fusion of the two areas. Thoracic segments 4 and 5 are also fused. The abdomen consists of four segments, of which the 4th is the longest; the proportional lengths are as follows ;

Abdominal segment	1	2	3	4-5	Furca	
	14	19	17	24	26	=100

The 1st antennae are symmetrical and consist of 23 free segments. Segments 8 and 9 are completely and 9 and 10 partially fused. The proportional lengths of the segments are as follows ;

Segment	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
	63	17	17	19	21	21	19	40	28	38	40	53	57	57	58	61	60	66	52	50	55	55	40	14 =1000

The 2nd antenna and mandible are as in the adult.

The 1st maxilla, as shown in the table given above (*vide supra*, p. 256), has advanced a stage in its development and has acquired additional setae on certain of its segments.

The maxilliped has also developed additional setae (*vide supra*, p. 256).

The swimming legs have now attained the characters that are found to be present in the adult and, with the increasing sub-division of the rami, additional spines have been formed and setae developed on the segments.

In the 1st pair the three segments of the exopod bear 1, 1, and 3 marginal spines and 1, 1, and 4 setae respectively, while the three segments of the endopod bear 1, 1, and 5 setae.

In the 2nd leg the segments of the exopod bear, 1, 1, and 3 marginal spines and 1, 1, and 5 setae respectively ; in the endopod the hooks on the inner margin of the proximal segment have become more strongly developed and the two distal segments bear 2 and 8 setae respectively.

The 3rd and 4th legs are very similar ; each exopod bears 1, 1, and 3 marginal spines respectively on the three segments ; the endopod carries 1, 2, and 8 setae on the three segments in the 3rd leg and 1, 1, and 7 setae in the 4th leg.

The 5th pair of legs has now nearly acquired the adult form. Each limb consists of four segments, of which the basal bears a tuft of long hairs on the posterior aspect ; the 1st free segment carries a long

plumose seta on its external margin ; the 2nd a short spine at its distal outer angle ; and the 3rd segment carries three plumose setae, of which the inner is the longest.

♂ In the male the general shape of the body still closely agrees with that of the female, though in the abdomen the 2nd segment is on the average somewhat longer and the 4th somewhat shorter.

The 1st antenna at this stage is slightly asymmetrical, though the modification of the left one is not yet well-marked. The proportional length of the segments on the two sides are as follows :—

Segment	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	
Right	67	18	18	18	21	21	18	38	26	34	41	52	60	60	61	61	60	67	49	48	54	54	40	14	=1000
Left	67	18	18	21	23	21	21	39	23	33	41	57	59	59	62	57	52	55	48	48	62	62	41	14	=1000

As in the female, segments 8 and 9 are completely fused and 9 and 10 partially so. Differences in the proportional lengths of certain other segments has now made its appearance, thus segments 4 and 5, 7, 13, 22 and 23 are longer on the left side than on the right, while segments 10, 17, 18 and 19 are shorter.

The 2nd antenna and mouth-parts are similar to those of the female in the corresponding stage of development, except in the case of the maxilliped, in which there are slight differences in the number of setae arising from certain segments, as I have shown above in the table on page 256.

The swimming legs resemble those of the female.

The 5th legs are each composed of a single ramus, which is, however, nearly twice the length of that of the female (*cf.* text-figs. 88, *c* and *d*). Each limb consists of a basal portion and three free segments, of which the distal is by far the longest. The basal segment bears a tuft of long hairs on its posterior aspect ; the 1st free segment carries a plumose seta ; the 2nd a minute spine at its distal outer angle and the 3rd, or distal, segment bears two small marginal spines and a single plumose seta at its extreme end.

A study of the proportional lengths of the various parts of the body during the last two ecdyses reveals certain very interesting changes. In the accompanying table I have given the proportional lengths in the last three stages of development of the various segments of the body, the total length being taken as 1000.

♂			Cephalo- thorax.	Abdomen.	Abdominal segments.					Furcal ramus.
					1	2	3	4	5	
Adults—										
1	.	.	541	459	47	87	82	87	52	104
2			546	454	44	84	88	88	44	106
3	.	.	550	450	46	83	83	91	46	101
4	.	.	555	445	45	85	85	90	45	100
5	.	.	556	444	48	85	77	89	44	101
Average	.	.	549.6	450.4	46.0	84.8	83.0	89.0	46.2	102.4
Stage V—										
1	.	.	582	418	55	88	77	93		105
2	.	.	585	415	57	90	68	97		103
3	.	.	586	414	53	86	75	92		109
4	.	.	593	407	58	81	70	87		111
5	.	.	602	398	57	79	69	91		102
Average	.	.	589.6	410.4	55.8	84.8	71.8	92.0		106
Stage IV—										
1	.	.	639	361	54	77		115		115
2	.	.	649	351	55	70		109		117
Average			644.0	356.0	54.5	73.5		112.0		116.0

♀			Cophalo- thorax.	Abdomen.	Abdominal segments.					Furcal ramus.
					1	2	3	4	5	
Adults—										
1	.	.	.	545	455		174	122	53	106
2			.	570	430		176	105	44	105
3				571	429		174	103	45	107
4	.	.	.	574	426		174	96	43	113
5	.			579	421		175	92	44	110
Average	.	.	.	567.8	432.2		174.6	103.6	45.8	108.2
Stage V—										
1		.		572	428	65	77	72	107	107
2	.		.	592	408	54	76	70	98	110
3	.	.	.	602	398	57	79	68	86	108
4	.			602	398	54	70	70	97	107
5				608	392	52	79	68	90	103
Average	.	.		595.2	404.8	56.4	76.2	69.6	95.6	107.0
Stage IV—										
1		.		639	361	54	69	115		123
2				649	351	55	70	109		117
Average	.	.		644.0	356.0	54.5	69.5	112.0		120.0

It is interesting to note that as growth proceeds there are very distinct alterations in the relative proportions of the different parts of the animal's body. In both sexes the length of the cephalothorax becomes relatively shorter and that of the abdomen longer as each succeeding moult takes place. I have previously pointed out that there is a certain amount of evidence to show that at succeeding ecdyses the total length of the animal tends to increase by a definite percentage; this view was definitely formulated by Fowler (1909) who defined Brooks' Law in the words "The total length of the animal increases at each moult by a fixed percentage of its length that is approximately constant for the species and the sex." While I am convinced that the Copepoda follow this law, it is clear that, since the proportional lengths of the different parts of the body change from moult to moult the process is by no means a simple one. Although the relative length of the abdomen steadily increases at each moult it is clear from the figures given above that this increase in length is not carried out uniformly. At any given moult, when a segment undergoes division into two daughter-segments, the combined length of these two segments is considerably greater than the length of the parent segment. As we pass in the female from Stage IV to Stage V, the proportional length of the cephalothorax decreases from 644 to 595.2, or by 7.75 per cent; in the abdomen the 3rd or most posterior segment in Stage IV divides and gives rise to segments 3 and 4 in Stage V; simultaneously, the length of this region increases from 112 to 69.6 plus 95.6, or a total of 165.2, an increase of 53.2 or 47.5 per cent. At the same time we can detect an increase also in the relative lengths of the two anterior segments. Segment I increasing by 1.9 per cent and segment 2 by 6.7 per cent; on the other hand the structure lying most posteriorly, in other words the furcal ramus, exhibits a marked *decrease* in length from 120 to 107 or a diminution of 10.8 per cent. At the ecdysis between Stages V and VI there is

a complete rearrangement of the segments of the abdomen; Segments 1, 2 and 3 now become completely fused together so as to form the genital segment and segments 4 and 5, which were previously fused, have now become differentiated. During these changes we find that, as before, the total length of the cephalothorax has decreased from 592.5 to 567.8 or 4.17 per cent. The total length of the genital segment of the abdomen, now composed of segments 1—3 fused together, is in Stage VI 174.6, whereas previously the three separate segments measured together 202.2; there has thus been a decrease of 27.6 or 13.65 per cent. Segments 4 and 5 are now separate and their combined lengths come to 149.4, whereas in Stage V the single segment from which they are derived measured only 95.6; there has, therefore, been an increase of 53.8 or 44.72 per cent. In the furcal ramus there has been but little appreciable change, though there seems to have been a slight increase. In the following table I have given the percentage increase or decrease in the various regions of the body in the last two ecdyses.

	Cephalothorax.	Abdominal segments.					Furca.
		1	2	3	4	5	
Stage IV-V	-7.75	+3.49	+9.64	+47.5			-10.83
Stage V-VI	-4.17	-13.65		+56.3			+1.13

In the development of the male we see that similar changes are taking place; thus as we pass from Stage IV to Stage V the length of the cephalothorax decreases from 644.0 to 589.6, a diminution of 54.4 or 8.447%. Segment 1 of the abdomen increases slightly from 54.5 to 55.8, an increase of 1.3, or 2.385%; segment 2 increases in length from 73.5 to 84.8 *i.e.*, by 11.3 or 15.374%; and segments 3, 4 and 5, which are fused in Stage IV alter in length from 112.0 to 163.8, an increase of 51.8 or 46.25%; the furca however, decreases slightly from 116 to 106, or by 8.621%. Between Stages V and VI we find very similar differences; the cephalothorax decreases by 4° or 6.784% the 1st segment of the abdomen has decreased in length by 9.8 or 17.563%; in the 2nd segment there is no difference but in the 3rd segment there is an increase in length from 71.8 to 83, *i.e.*, 11.2 or 15.696%; segments 4 and 5 have altered in length from 92 to 135.2, *i.e.*, by 43.2, an increase of 46.956%; and finally the furca has increased in length by 3.6 or 3.396%. As I have already pointed out, however, I am of the opinion that Stage VI in the male is not derived directly from Stage V. but from Stage IV and similarly Stage IV is derived from Stage III, so that in this case, if this be so we are not dealing with the changes that actually take place in single ecdysis. Nevertheless, for the purpose of comparison with the changes in the female I have given these differences below in tabular form.

	Cephalothorax.	Abdominal segments.					Furca.
		1	2	3	4	5	
Stage IV-V	-8.447	+2.385	+15.374	+46.250			-8.621
Stage V-VI	-6.784	-17.563	0.0	+15.596	+46.956		+3.396

If in this species the male follows the same course of development as I have previously postulated for other species, it would appear that the proportional changes in the

various lengths of the segments of the body in the moult from Stage IV to Stage VI are as follows :—

	Cephalothorax.	Abdominal segments.					Furca.
		1	2	3	4	5	
Stage IV to VI	—14·658%	—16·364%	+15·374%	+106·2%			—11·724%

There thus appears to be clear evidence that there is a focus of maximum growth at or near the 4th abdominal segment and that as we proceed forwards or backwards from this segment the rate of growth steadily becomes less and less so that eventually in the region of the 1st abdominal segment or the junction of the cephalothorax and abdomen the rate of growth becomes less than the average and in consequence the anterior regions of the body become relatively shorter, and the same may occur in the furca rami.

During development we can again trace the changes that take place in the proportional lengths of the segments of the 1st antenna. For purpose of reference I have given below in tabular form the proportional lengths of the segments in the last three stages in the female ;

Segment	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
Stage IV	67	15	17	18	19	20	19	38	21	30	38	50	52	52	55	61	61	71	55	55	61	61	46	15
Stage V	62	17	17	19	21	21	19	40	28	38	40	52	57	57	57	61	60	66	52	50	55	55	40	14
Stage VI	63	19	22	22	23	24	63		31	42	43	54	55	56	59	59	59	64	45	43	50	52	52	

Here we see that between stages IV and V there is a diminution in the length of segment 1, similar to that which we have already found in *Euchaeta weberi* ; segment 2 increases in length but segment 3 shows no change ; segments 4 to 15 all exhibit an increase which has its maximum in segment 11 ; in segment 17 there is again no change ; but from then on to the end of the appendage there is a diminution in length that is at its maximum at segments 22 and 23. During the moult from stage V to stage VI we appear to get no change in length in segment 1 ; segments 2 to 13 all show an increase that has its maximum at segment 3 ; segments 14 and 15 appear to show a slight diminution but segment 16 shows a small increase ; from that point to the end of the appendage the segments all show a decrease in length that is greatest at segments 20 and 21. In the male we find in the right antenna, that remains unmodified throughout the life history, very similar changes to those that occur in the female ; in the following table I have given the measurements in the last three stages of development :—

Segment	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
Stage IV	67	14	15	17	17	21	20	35	23	32	38	49	54	55	59	61	61	71	55	55	61	61	46	14 =1000
Stage V	67	18	18	18	21	21	18	38	26	34	41	52	60	60	61	61	60	67	49	48	54	54	40	14 =1000
Stage VI	63	19	20	20	23	24	63		31	42	43	54	55	56	61	61	59	64	45	43	50	52	52	

Between stages IV and V we here get no change in the length of segment 1 ; segments 2 to 5 increase in length with the maximum change at segments 2 and 5 ; in segment 6 there is no change ; segments 7 to 16 all increase in length, with the maximum change at segment 14 ; there is no change in segment 17 ; but from segment 18 to the end of the appendage the segments all decrease in length with the greatest change at segment 21. During the moult from stage V to stage VI there is a distinct shortening of segment 1 ; segments 2 to 13 all increase in length, with the maximum increase at segment 11 ; segments 14 and 15 decrease in length but in segments 16 and 17 there seems to be no change ; segments 18 to 25 all decrease, the maximum difference being at segment 21. On the left side the antenna becomes modified to form a grasping organ and we should, therefore, expect to find that the

changes in the proportional lengths of the segments is somewhat different. I have given these changes in the Table below :—

Segment	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
Stage IV	67	14	15	16	17	21	19	37	21	31	38	52	55	52	57	59	52	63	55	57	70	70	49	14
Stage V	67	18	18	21	23	21	21	39	23	23	41	57	59	59	62	57	52	55	48	48	62	62	41	14
Stage VI	94		24	24	26	26	66		26	34	41	53	63	60	63	53	50	120			60	62	43	13

In this sex the changes that occur in the proportional lengths of the segments will depend on the way in which the developmental changes take place. As I have already pointed out I believe that Stage IV gives rise to Stage VI, Stage V being derived from Stage III. If this be so, then we see that at the ecdysis between Stages IV and VI segments 1 and 2 become fused and simultaneously the total length of these two segments increase ; segments 3 to 16 all increase, the greatest increment occurring at segments 3 and 5, and again in segments 15, 16. Segments 7 and 8-9 become fused, but even so there is an increase in length exactly comparable to the increase in the segments on both the proximal and distal sides of the point of fusion ; segment 17 and those distal to it decrease in length, the greatest decrease taken place in the combined length of segments 19-21, which in the adult stage become fused together.

Metridia venusta Giesbrecht.

Metridia venusta, A. Scott, 1909, p. 122, pl. xxxvii, figs. 15-20.

Metridia venusta, Sars, 1925, p. 200, pl. liv, figs. 12-16.

Metridia venusta, Farran, 1926, p. 271.

This species was originally obtained by Giesbrecht in the Pacific Ocean between Lat. 5° and 16°N. It has since been taken by the "Siboga" in the Malay Archipelago and by the late Prince of Monaco in the Atlantic. Farran also records its occurrence in the "Research" collection from the Bay of Biscay. It thus appears to be widely distributed and its occurrence in the "Investigator" collection is not a matter for surprise ; a single specimen was taken at Station 682.

Genus **PLEUROMAMMA** Giesbrecht.

In 1901 Cleve recorded the occurrence of *Pleuromamma abdominalis* (Lubbock) and *P. gracilis* (Claus) from the Indian Ocean and the Malay Archipelago and a year later A. Scott (1902) obtained both species from the Red Sea, while in 1903 Thompson and A. Scott recorded them from the Arabian Sea. In 1904 Cleve (1904a) recorded the occurrence of *Pleuromamma abdominalis* (Lubbock) and *P. robusta* (Dahl) from the seas "east and west of Cape Colony", *P. gracilis* (Claus) from "round Cape Colony" and *P. xiphias* Giesbrecht from the Agulhas Current. In 1905 Wolfenden (1905a) recorded *Pleuromamma abdominalis* (Lubbock), *P. gracilis* (Claus) and *P. xiphias* Giesbrecht, as well as a new species that he named *Pleuromamma indica*, from the Maldives and Laccadive Archipelagoes. Since that date A. Scott (1909) has noted the occurrence of *Pleuromamma abdominalis*, *P. gracilis* and *P. xiphias* in the collections of the "Siboga" from the Malay Archipelago. In the "Investigator" collections the genus is represented by all six species.

In this genus, as in the other genera of the family Metridiidae, the cephalothorax and abdomen, as well as the basal segments of the 1st antenna, bear a number of minute pores.

through which small glands open to the surface. In text-fig. 91 I have given the arrangement, so far as I have been able to work it out, of these glands in *Pleuromamma xiphias*. While not so numerous in this species as in the others of the family that I have investigated, yet these glands form a striking feature of the external anatomy.

***Pleuromamma abdominalis* (Lubbock).**

Pleuromamma abdominalis, A. Scott, 1909, p. 123.

Pleuromamma abdominalis, Wolfenden, 1911, p. 289.

Pleuromamma abdominalis, T. Scott, 1913, p. 534.

Pleuromamma abdominalis, Sewell, 1913, p. 354.

Pleuromamma abdominalis, Lysholm and Nordgaard, 1921, p. 24.

Pleuromamma abdominalis, Sars, 1925, p. 201.

Pleuromamma abdominalis, Farran, 1926, p. 272.

Pleuromamma abdominalis, Farran, 1929, p. 259.

This species appears to be of almost world-wide distribution ; it has now been recorded from the Pacific, Indian and Atlantic Oceans and its range in the latter is from 36° S. to the Faroe Channel. While usually living at some depth below the surface it is occasionally taken in the uppermost stratum. Several examples of this species occurred at "Investigator" stations 393, 463, 670 and 682. As A. Scott (1909) has pointed out, Brady in his description of this species (1883, p. 46) has confused both *Pleuromamma gracilis* Claus and *Metridia lucens* Boeck with it.

***Pleuromamma gracilis* (Claus).**

Pleuromamma gracilis, A. Scott, 1909, p. 123.

Pleuromamma gracilis, Wolfenden, 1911, p. 289.

Pleuromamma gracilis, Sewell, 1913, p. 354.

Pleuromamma gracilis, Sars, 1925, p. 204.

Pleuromamma gracilis, Farran, 1929, p. 260, figs. 23 (a) and 24 (a).

This species also appears to be one of wide distribution ; it is, however, rare in the "Investigator" collections, for only a single specimen occurs in the collection at Station 393 and another example was taken in the tow-net at a depth of only 10 fathoms at Station 614, Nankauri Harbour, Nicobars. Both these examples agree with Claus's original description. The form described by Esterly (1905) under this name and subsequently considered to be a variety by T. Scott (1913, p. 535, pl. xiii, figs. 8—10), who named it var. *esterlyi*, has been identified by Farran (1929, p. 262) as *P. borealis* (Dahl).

***Pleuromamma indica* Wolfenden.**

(Text-fig. 89 a-f.)

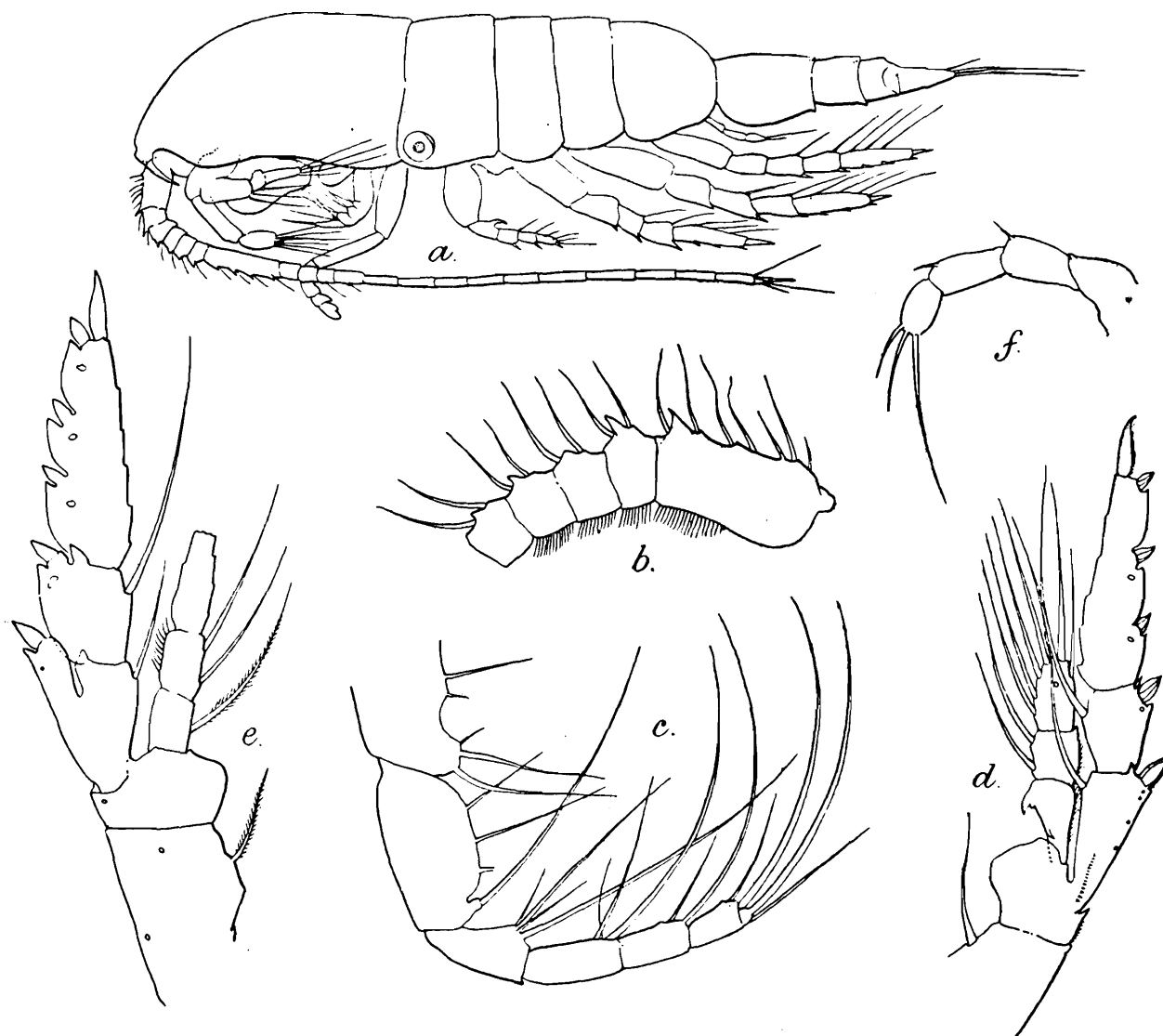
Pleuromamma indica, Wolfenden, 1906, p. 1011, pl. xcvi, figs. 24, 25, 26, 31, 32, 33.

Pleuromamma indica, Pesta, 1913, p. 17, fig. 15.

Several examples of a species of *Pleuromamma* that appears to correspond exactly, except as regards size, with the form that Wolfenden described under the name *P. indica* from the Maldivé and Laccadive Archipelagoes, were taken by the "Investigator" or Stations 670 and 682, and one specimen also occurred in a surface tow-netting at Station 614.

♀ Total length, 1.7 to 2.0 mm.

The proportional lengths of the cephalothorax and abdomen (text-fig. 89, *a*) are as 32 to 13, so that the abdomen is contained 2.46 times in the length of the anterior region of the



TEXT-FIG. 89.—*Pleuromamma indica* Wolfenden.

- a.* The whole animal from the left side.
b. The proximal segments of the 1st antenna.
c. The maxilliped.

- d.* The 2nd swimming leg.
e. The 3rd swimming leg.
f. The 5th leg.

body. The anterior end of the cephalon slopes downwards to the base of the rostrum and below this bears a double prominence, of which the lower carries two small hairs; the rostral spines are directed downwards and backwards. The 4th and 5th thoracic segments are fused together and the posterior thoracic margin is rounded. The pigment-knob may be situated on either the right side or the left.

The abdomen consists of three free segments and the furcal rami, these have the following proportional lengths:—

Abdominal segment	1-3	4	5	Furca	
	42	24	17	17	=100

The genital segment presents a uniform rounded genital swelling on its ventral aspect. The anal segment and the furcal ramus are of the same length. The furcal ramus bears five setae, of which the outermost arises from the lateral margin about half-way along its length.

The 1st antenna reaches back nearly to the posterior margin of the genital segment ; it consists of twenty-two free joints. The proximal segment, as usual, consists of the 1st and part of the 2nd segment fused together ; segments 7 to 11 are fused into a single solid piece. The proportional lengths of the segments are as follows :—

Segment	1, 2a, 2b,	2c.	3	4	5	6	7-10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
	104	23	25	25	25	28	113	40	37	39	45	46	49	52	58	59	41	40	40	46	46	19	=1000

The distal end of the first joint (corresponding in Giesbrecht's notation to segment 2b) bears a single spine that is not quite so prominent as in *Pleuromamma abdominalis* (Lubbock) and, moreover, is not retroverted. The 2nd segment (2c) bears a single spine directed distally ; segment 3 has no spine and segment 4 bears a single small spine. Thus, except as regards the direction of the proximal spine the characters of this portion of the antenna closely resembles that of *Pleuromamma abdominalis* (Lubbock). There are, however, certain differences in the proportional lengths of the segments of the antennae in the two species. For the purpose of comparison I give below the proportional lengths in the segments of *Pleuromamma abdominalis* :—

Segment	1-2b	2c	3	4	5	6	7-10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	95	20	22	22	27	24	80	39	35	43	51	56	56	57	54	62	45	39	52	56	43	17

Thus the basal segment and the fused segments 7-10 are considerably shorter in *P. abdominalis*, whereas segments 13 to 16 are considerably longer. In both species segments 12 and 13 are partially fused.

The 2nd antenna and mouth-parts appear to be similar to those in *P. robusta*, as described by Sars.

In the 1st swimming leg the 2nd basal segment bears the usual spinous process on its posterior aspect. Each ramus consists of three segments.

The remaining appendages agree with Sars' account of the structure of *Pleuromamma robusta*.

***Pleuromamma quadrangulata* (Dahl).**

(Text-fig. 90, a-e.)

Pleuromamma quadrangulata, Dahl, 1893, p. 105.

Pleuromamma quadrangulata (sic), Wolfenden, 1911, p. 289, text-fig. 47.

This rare species was first described and recorded by Dahl (*loc. cit.*) from specimens taken by the "Plankton" Expedition in the Atlantic Ocean between Lats. 8° S. and 43° N. It has since been obtained by the "Gauss", again in the Atlantic Ocean. Its occurrence in the "Investigator" collections extends its known range of distribution to the Indian Ocean. It was taken at "Investigator" Stations 393, 463 and 670.

♀ Total length 3.0 mm. to 3.62 mm.

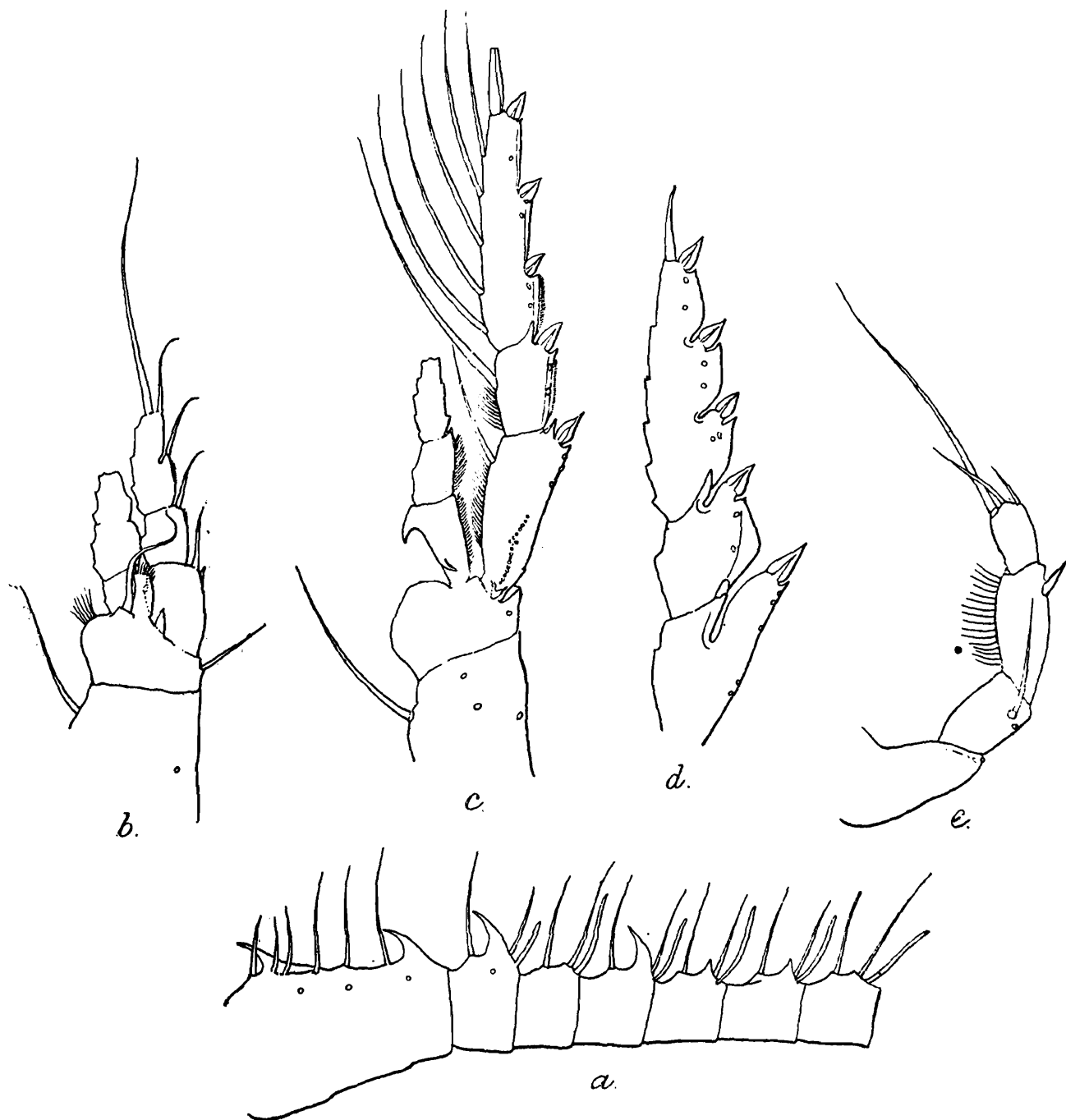
The proportional lengths of the cephalothorax and abdomen are as 66 to 31 ; so that the abdomen is contained 2.1 times in the length of the anterior region of the body.

The forehead terminates in a rostrum that has a swollen base and consists of a pair of slender spines. Thoracic segments 4 and 5 are fused together. The posterior margin of the thorax is rounded.

The abdomen consists of three free segments, that have the following proportional lengths :—

Abdominal segment	1-3	4	5	Furca	
	36	28	23	13	=100

The third free segment (anal) is produced laterally in short rounded processes, directed outwards and backwards. The furcal rami are symmetrical ; the inner margins are clad with



TEXT-FIG. 90.—*Pleuromamma quadrangulata* (Dahl).

- a. The proximal segments of the 1st antenna.
 b. The 1st swimming leg.
 c. The 2nd swimming leg.

- d. The exopod of the 3rd swimming leg.
 e. The 5th leg.

hair and there are five furcal setae, of which the 5th or outer seta is inserted into the middle of the outer margin of the ramus, while the remainder are terminal.

The 1st antenna (text-fig. 90, a) reaches to the middle of the furcal ramus. Segments 7, 8 and 9 are fused together and segment 10 is partially fused to segment 9; segments 12 and 13 are also fused. Segment 1 bears two claw-like spines that are recurved towards the proximal end. Of these one is situated near the base and the other distally. There are three cutaneous pores near the anterior margin of the segment. One being at the base of the proximal spine, another at the base of the distal spine and the third approximately mid-way between. Segments 2 and 4 each carry a single recurved spine and there is a single pore on segment 2 near the base of the spine. Segment 3 is devoid of a spine but segments 5 and 6 each have a small spinous process on their anterior margin. The proportional lengths of the segments are as follows :—

Segment	1	2	3	4	5	6	7-9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	117	26	25	24	29	26	71	28	44	39	49	53	53	56	56	55	53	35	32	35	39	43	12 = 1000

The 2nd antenna and mouth-parts are similar to those of *Pleuromamma xiphias* Giesbrecht.

In the 1st swimming leg (text-fig. 90, b) basal 1 bears a single internal seta and there are a few hairs on the inner margin; basal 2 bears the usual S-shaped internal seta and there is a tuft of hairs distally on the inner margin. Each ramus consists of three segments. Exopod 1 and 2 each bear a single seta and an external marginal spine. Exopod 3 bears two long marginal spines on its outer border and four setae on its inner margin. All the marginal spines are delicate and seta-like. The end-spine is long and does not appear to be serrated. Endopod 1 bears a single seta internally and is armed with a row of needle-like spines that runs across its anterior aspect. Endopod 2 has a fringed outer margin and bears two setae. Endopod 3 bears five setae, of which the outer is small. There is a pointed process on the posterior aspect of the 2nd basal segment similar to that present in *Pleuromamma xiphias* Giesbrecht.

In the 2nd swimming leg (text-fig. 90, c) basal 1 bears an inner seta but no marginal spines; there are three cutaneous pores on its anterior surface. Basal 2 bears a group of scattered, very minute spinules on its outer surface. In the 1st segment of the exopod there is a stout spinous projection near the base on the anterior aspect and running upwards from this is a row of small triangular spines; the segment bears a single marginal spine that is leaf-like, and a single small inner seta. Exopod 2 also bears a single leaf-like marginal spine and a stout inner seta and, in addition, both margins are fringed with hairs, which are minute on the outer border but long on the inner. Exopod 3 has three leaf-like marginal spines and the outer border is fringed with hair; the inner margin carries five setae. The end-spine is finely serrated. The 1st segment of the endopod bears the hook-like recurved spines that are characteristic of this genus and its near relation *Gaussia*; but the distal spine in this species appears to be single and not bifid as in other members of the genus; the outer margin is fringed with hair. The endopod consists of three free segments and reaches as far as the joint between the 2nd and 3rd segments of the exopod. Exopod 2 possesses two setae on its inner margin; the outer margin bears a spinous projection at its distal inner angle and is fringed with hair. Exopod 3 carries eight setae. Numerous cutaneous pores are scattered over the whole limb. On the 1st basal segment there are three pores opening on the anterior aspect; in the 2nd basal segment there is a single pore near the distal external angle. Three pores.

open to the exterior on the outer margin near the base of the external spine. On exopod 2 one pore opens on the outer margin about the middle of the length of the segment and a second near the base of the marginal spine. In exopod 3 two pores open near the margin between the proximal end of the segment and the 1st marginal spine, a second opens near the base of the 2nd marginal spine and a third near the outer margin about mid-way between the 2nd and 3rd marginal spines.

In the 3rd swimming leg (text-fig. 90, *d*) basal 1 bears a single inner seta and there are a few scattered short needle-like spines on the outer aspect of the segment. Basal 2 bears no spine or seta. The 1st segment of the exopod is characterised by a long extension of its outer distal angle at the apex of which the leaf-like marginal spine is situated ; this process is separated from the rest of the segment by a deep notch ; a single seta arises from the inner border. Exopod 2 bears a single leaf-like marginal spine and a single inner seta ; the outer margin is crest-like and has an angular outline. Exopod 3 bears three leaf-like marginal spines and five setae. The end-spine is comparatively short and is about equal in length to the interval between the 2nd and 3rd marginal spines. Endopod 1 bears a single inner seta. Endopod 2 bears two setae and endopod 3 has six. The outer margins of the 1st and 2nd segments are fringed with hair. Two pores open on the 1st basal segment near the distal outer angle ; on the 2nd basal segment there is a single pore near the articulation of the exopod. In the 1st segment of the exopod five pores open on the outer margin ; two about the middle of the length of the segment ; one about the middle of the length of the process and two near the base of the marginal spine. Two pores open near the outer margin of the second segment and two on the proximal side of each of the three marginal spines on the 3rd segment.

The 4th swimming leg closely resembles the 3rd but the outer part of the 1st segment of the exopod is not produced.

The 5th pair of legs (text-fig. 90, *e*) is symmetrical and each consists of a basal segment and three free segments. The 1st free segment bears a long seta on its outer margin and a single pore opens near its articulation. The 2nd free segment has a stout spine at its distal outer angle and the inner margin possesses a row of long hairs. The 3rd free segment bears three setae that arise from its distal aspect ; of these setae the outermost is comparatively short and delicate and the inner is stout and is equal in length to the whole free portion of the limb.

***Pleuromamma xiphias* (Giesbrecht).**

(Text-fig. 91.)

Pleuromamma xiphias, A. Scott, 1909, p. 124.

Pleuromamma xiphias, Wolfenden, 1911, p. 289.

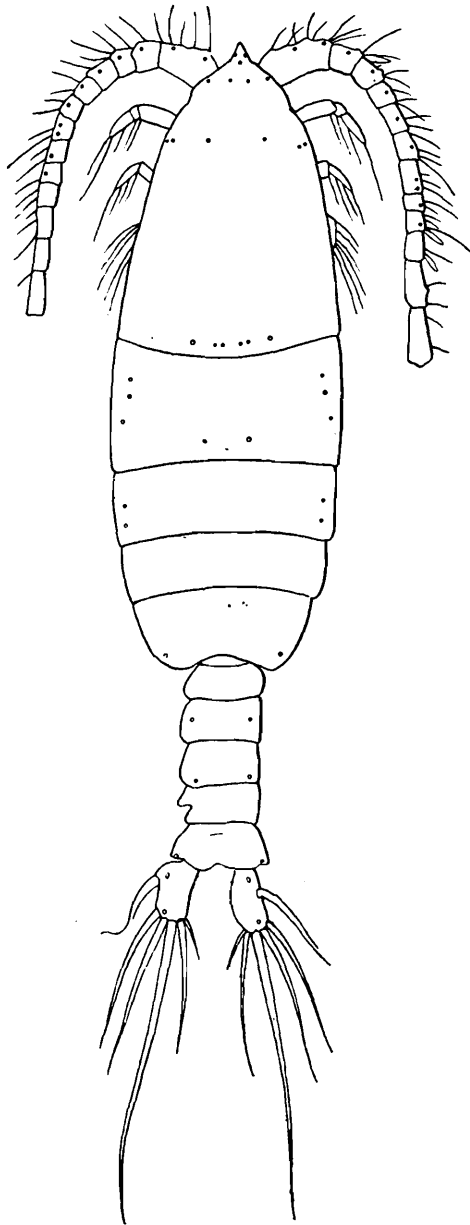
Pleuromamma xiphias, Sars, 1925, p. 202, pl. IV.

Pleuromamma xiphias, Farran, 1926, p. 273.

Pleuromamma xiphias, Farran, 1929, p. 260.

This species is of wide distribution, occurring throughout the Pacific, Indian and Atlantic oceans. It is by far the most common species of this genus in the "Investigator" collec-

tions, numerous examples of both sexes occurring at Stations 393, 463 and 670, especially the latter.



TEXT-FIG. 91.—Showing the arrangement of the cutaneous pores in *Pleuromamma xiphias* Giesbrecht.

Genus **GAUSSIA** Wolfenden.

Gaussia princeps (T. Scott).

(Pls. V and VI and text-figs. 92, 93).

Pleuromma princeps, T. Scott, 1894, p. 42, pl. iii, figs. 8-12.

Metridia scotti, Giesbrecht, 1897, p. 254.

Gaussia melanotica, Wolfenden, 1905, p. 5, pl. ii.

Gaussia scotti, Wolfenden, 1908, p. 290.

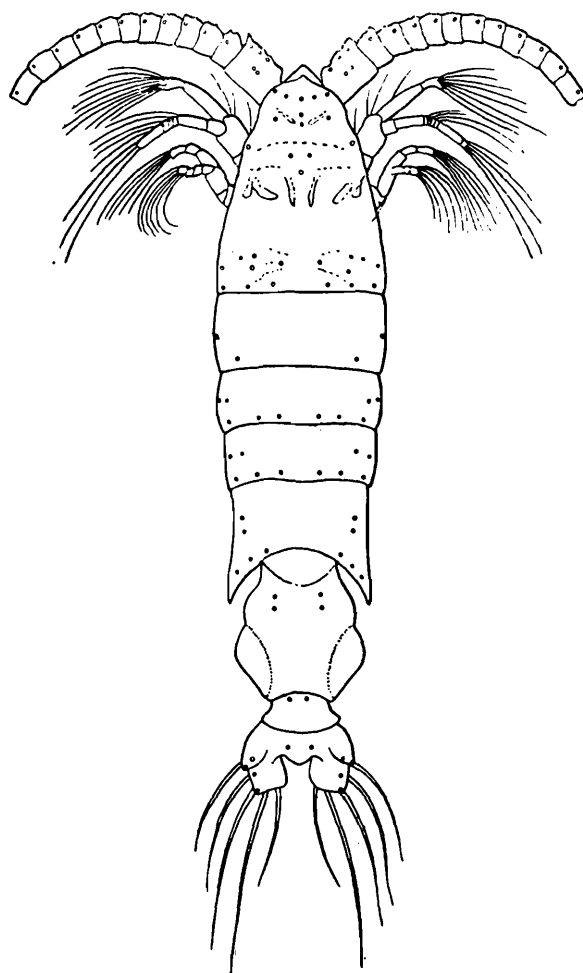
Gaussia scotti, Wolfenden, 1911, p. 290, pl. xxxiii, figs. 3-12.

? *Metridia atra*, Esterly, 1906, p. 70, pl. ix, figs. 15, 16; pl. xi, figs. 39, 40; pl. xiii, fig. 78; pl. xiv, fig. 95.

Metridia scotti, Sewell, 1913, p. 354.

This species was first described by T. Scott from the male only under the name *Pleuromma princeps*. Giesbrecht later removed it from the genus *Pleuromamma* (*Pleuromma*) to the genus *Metridia*; owing to the fact that there was already in this genus a species, previously described by Giesbrecht himself, with the name *Metridian princeps*, it was necessary to find a new name for Scott's species and Giesbrecht proposed the name *Metridia scotti*. In 1905 Wolfenden created the genus *Gaussia* for a species that he termed *Gaussia melanotica*, but subsequently he found that this was identical with the species described by Scott; in his later papers he, therefore, refers to the species by the specific name that Giesbrecht had conferred upon it, namely as *Gaussia scotti*. If Wolfenden is right, as I think he is, in creating a new genus for this species, then clearly the proper name of the species must be *Gaussia princeps* (T. Scott).

Esterly (1906, p. 70) under the name *Metridia atra* has described a species that so closely resembles *Gaussia princeps* that I am inclined to believe that they are identical, and Wolfenden (1911) appears to have reached the same conclusion. Such slight differences as appear to exist between this form and Wolfenden's examples and those that I have examined in the "Investigator" collections do not warrant the creation of a new species for the Pacific form, and it should be regarded, at the most, as a variety.



TEXT-FIG 92.—Showing the arrangement of the cutaneous pores in *Gaussia princeps* (T. Scott).

In the "Investigator" collections are numerous examples of both sexes in several stages of development. They were taken at "Investigator" stations 393, 462, 463 and 670.

In text-fig. 92 I have given the general arrangement of the cutaneous pores of the female of this species. In the various swimming legs, there are, so far as I have been able to discover, the following pores present.

In the 1st swimming leg there is a single pore on the 2nd basal segment near the distal external angle just proximal to the articulation of the exopod; there is also a single pore on the distal part of exopod 3 near the base of the end-spine. In the 2nd leg, the 1st basal segment possesses a pore near the distal external angle; close to the articulation of the exopod with the 2nd basal segment there is a single pore. Both the 1st and 2nd segments of the exopod have a single pore near the base of the marginal spine. In the 3rd segment of the exopod there is a pair of pores, one on each aspect of the appendage near the base of the 1st marginal spine; a single pore is situated near the base of the 2nd and 3rd marginal spines. The 3rd and 4th legs are identical; in each there is a single pore on the outer margin of basal 1; a single pore near the distal external angle of basal 2; two pores close together on the outer margin of exopod 1 near the base of the marginal spine; two pores on the margin of exopod 2, one near the middle of the segment and the other near the base of the marginal spine; on exopod 3 there are two pores situated close together near the base of each marginal spine.

In the 5th leg in the female there is a single pore on the 1st segment of the exopod near the outer distal angle and a second on the third segment near the base of the outer spine.

The colouration of this species is particularly striking. The anterior part of the head is devoid of pigment, but the rest of the cephalothorax is coloured a dense black, the degree of pigmentation varying, however, in different individuals. A black pigmented mass is present on each side of the genital segment of the female; the abdomen of the male is, however, devoid of pigment. The 1st antenna is colourless in its proximal half but the terminal segments, from the 16th to the 25th, are all pigmented black. The 2nd antenna is free from pigment and so is the mandibular palp, but the rest of the mouth-parts and the four pairs of swimming-legs are heavily pigmented. The 5th pair of legs are heavily pigmented in the female, but in the male only traces of this pigmentation are present. The immature forms are not nearly so heavily pigmented as the adults.

♀ Total length from 9.0 to 9.5 mm.

The proportional lengths of the cephalothorax and abdomen are as 36 to 15, so that the abdomen is contained 2.4 times in the length of the anterior region of the body.

Anteriorly the forehead is continued forwards in a stout spine and the rostrum consists of two long tapering spines, fringed with short hairs. The 4th and 5th segments of the thorax are fused together and the lateral angles of the latter segment are produced backwards in stout spinous processes (*vide* pl. v, fig. 1).

The abdomen consists of three segments, having with the furca the proportional lengths of 52; 9; 18; 21. The 1st or genital segment is symmetrical and in all the mature females obtained by me bears a dense black mass laterally; I have not been able to determine whether this is an integral part of the segment itself or is merely a mass of adherent cement substance, such as is found in certain other groups of the Copepoda, as the Pontellidae; at the antero-lateral angle the segment is produced in a pair of small anteriorly-directed mammilliform processes. The anal segment bears on each side a backwardly directed process that extends

as far as the base of the outer furcal seta ; between the furcal rami on the dorsal aspect the segment bears a bluntly rounded anal plate.

The furcal rami are as broad as long, and there is a tuft of long hairs on the outer margin near the base and proximal to the outermost seta. The furcal setae are as shown in pl. v, fig. 1 ; the inner accessory dorsal seta is very slender.

The 1st antenna (pl. v, fig. 2) reaches well beyond the tip of the furcal ramus and consists of 23 free segments. Of these the terminal segment is quite short and is articulated to the penultimate one by an oblique joint that is somewhat difficult to see ; the 7th, 8th, and 9th segments are fused together into a single joint ; the degree of fusion varies, however, in different specimens ; in some examples it is nearly complete, but in others, although there appears to be no actual jointing between the segments, the limits of each component can clearly be made out.

The proportional lengths of the segments are as follows :—

Segment	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	
	65	23	22	23	22	22	22	19	21	30	39	36	48	56	57	60	62	62	70	47	42	47	52	39	13	=1000.
							62																			

A reference to the description given by Scott (1893, p. 42) shows that these measurements agree very closely with those given by him. Esterly in his description of *Gaussia atra* (Esterly, 1906, p. 70) states that in that species the 1st antenna consists of 23 segments but he makes no mention of the condition of segments 7, 8 and 9, so that one is uncertain whether these segments are similarly fused. The 1st, 2nd, and 4th to 6th segments all carry short stout spines on their anterior margins, as is the case in the genus *Metridia*.

The 2nd antenna, mandible and 1st maxilla are similar to those of members of the genus *Metridia*. The 2nd maxilla is as described by Scott (*loc. cit.*, 1893, pl. iii, fig. 15.)

The maxilliped (pl. vi, fig. 3) is of the usual type and is armed with a row of delicate spines along the margin of the 2nd basal segment. Neither Scott nor Esterly mention this feature in the examples described by them, possibly owing to the fact that, as a result of the dense pigmentation of this appendage, these spines are very difficult to see.

In the 1st pair of swimming legs (pl. v, fig. 4), the 1st basal segment carries a stout inner marginal seta. The 2nd basal segment bears an S-shaped seta at its inner distal angle, a delicate external seta and a tuft of long hairs on the distal part of the inner margin. Both rami consist of three segments. Exopod 1 bears a long marginal spine that is fringed with hair on its inner side and reaches to the base of the spine on exopod 2 ; the outer margin is armed distally with a few small claw-like teeth ; the distal margin of the anterior surface bears a row of lancet-like spines and the inner margin is fringed with hair and bears a single seta. Exopod 2 bears a single marginal spine that is finely serrated on both borders and reaches well beyond the base of the next spine ; the external margin is furnished with small claw-like spines and is also fringed with hair ; a row of lancet-like spines runs along the distal margin on the anterior aspect ; the inner margin is fringed with hairs and bears a single seta. Exopod 3 bears two marginal spines, that are also finely serrated on both borders, and the whole of the outer border is fringed with hair ; the inner margin carries four plumose setae. The terminal spine is finely serrated externally and its length is equal to the combined lengths of the two last segments of the ramus. Endopod 1 bears a single seta ; the outer margin is fringed with hair and there is a row of hairlike spines on the

anterior aspect. Endopod 2 bears a single seta and is clad on its anterior aspect and outer border with fine hair. Endopod 3 carries five setae.

In the 2nd swimming leg (pl. v, fig. 5), basal 1 bears an inner seta. Basal 2 bears an inner seta and presents a rounded projection on its inner margin that is fringed with long hair; on its external anterior aspect it is armed with a scattered group of small denticles. Both rami are three jointed. Exopod 1 carries a broad marginal spine that is leaf-shaped and has finely serrated edges; the inner margin is fringed with hair and bears a single seta; there are some small spinules on its inner anterior aspect near the base. Exopod 2 bears a single marginal spine similar to that on the proximal segment. The outer margin is fringed with a row of small hair-like spines; the inner border is fringed with hair and carries a single seta. Endopod 3 bears three leaf-like marginal spines and the outer margin is fringed with minute spines, which, however, do not extend along the extreme distal part of the margin; the inner border carries five setae. The terminal spine is short and broad, and is only one-third the length of the terminal segment; it is finely serrated along its outer border. The 1st segment of the endopod bears the characteristic double, recurved hooks on its inner margin and a single one near the base; the outer margin is fringed with hair along its distal three-fourths. Endopod 2 bears two inner setae and the outer margin is fringed with hair. Endopod 3 is also fringed with hair on its outer margin and bears eight setae.

The 3rd and 4th swimming legs (pl. v, figs. 6, 7) are similar; the minute spines that are present on the external margin of the exopod in the more anterior legs are here replaced by short hairs; the end-spines are quite short and are less than half the length of the terminal segment of the exopod.

The 5th legs (pl. vi, fig. 5) are symmetrical and are composed of a basal part and four free segments that have the following proportional lengths; 33; 33; 22; 12. In this respect the present form differs from those of Wolfenden (1911, p. 291, pl. xxxiii, fig. 12 and Esterly (1906, p. 70, pl. xiii, fig. 78), both of whom state that there are only three free segments in this appendage: the condition described and figured by them agrees exactly with that found by me to be present in the 5th Copepodid stage. The 3rd free segment bears a single long seta on its inner aspect, and the 4th or terminal segment bears two setae of which the inner is the longer. In the forms described by previous authors the terminal segment bears three setae, so that the third free segment clearly corresponds to the last two in the present species.

Examples taken in the month of October, 1911, were clearly breeding; some of the females were carrying spermatophores. The spermatophore is torpedo-shaped and is about 3 mm. in length; it is attached by a narrow pedicle to the under aspect of the genital segment near the genital aperture.

♂ The total length of the male appears to exhibit a greater range of variation than that of the female and in examples taken at Station 393 varied from 8.0 to 9.5 mm. (pl. vi, fig. 1).

The proportional lengths of the cephalothorax and abdomen are as 34 to 13, so that in this sex the abdomen is contained 2.6 times in the length of the anterior region of the body.

The 4th and 5th thoracic segments are fused together and the posterior thoracic margin is produced backwards in a spinous process.

The abdomen consists of five segments, having with the furcal rami proportional lengths as follows :—

Abdominal segment	1	2	3	4	5	Furca	
	25	18	13	10	17	17	=100.

In this sex the 1st antennae are asymmetrical ; that of the left side resembles that of the female and consists of 23 free segments having the following proportional lengths :—

Segment	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	
	66	24	24	24	25	24	64			29	37	37	46	52	57	61	62	61	69	46	42	48	52	38	12	=1000.

The right antenna (Pl. vi, fig. 2) is modified to form a grasping organ, the knee-joint being, as usual, situated between segments 18 and 19.

The proportional lengths of the segments are as follows :—

Segment	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	
	99	28	28	28	28	32	22	20	21	25	35	35	63	59	68	65	75	20	80	103	42	14	=1000.
																		100					

Segments 1 and 2 are fused together completely. Segments 7, 8 and 9 are separate ; segments 19, 20 and 21 are fused but in certain specimens traces of the division between segments 19 and 20 can be made out ; segments 22 and 23 are also fused. The 17th segment bears on its anterior aspect a lamellar crest, that is produced distally over the following segment. The 18th segment bears a lamellar plate that is equal to the length of the segment itself. The fused mass of the 19th-21st segments carries two lamellar plates and is produced distally in a short spine ; segment 22-23 bears a short spine at its distal end.

The 2nd antenna, mouth-parts and swimming legs 1 to 4 are similar to those of the female.

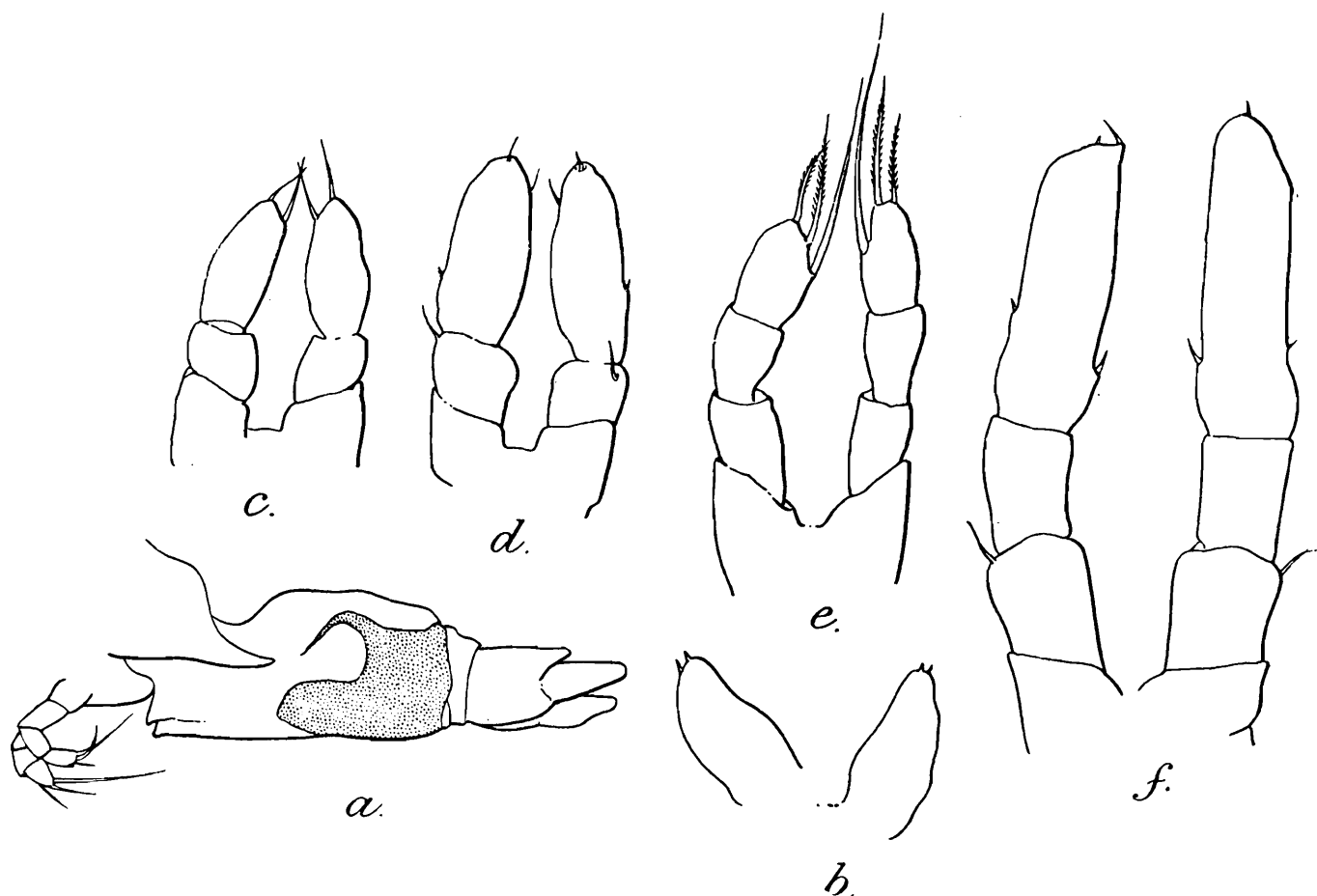
In the 5th pair of legs (pl. vi, fig. 4), that on the left side consists of a basal part and 4 free segments. Segment 1 is narrow at the base but widens out considerably at the distal end ; it bears a single small seta near the distal external angle. Segment 2 is produced at its distal internal angle in a small rounded process. Segments 3 and 4 appear to be partially fused but a clear line of demarcation can be traced between them. Segment 3 bears a long and narrow spine near its inner proximal angle. Segment 4 bears a long narrow spine on its inner aspect at the junction of the proximal and 2nd quarter of its length and a smaller, but otherwise similar, spine about half-way along its inner margin ; the extreme tip of the segment is narrowly rounded. In the right leg the 1st free segment bears a small seta at its distal outer angle. Segment 2 is devoid of any setae. Segment 3 is produced on its inner aspect in two digitiform processes, of these the proximal is directed towards the base and overlaps the 2nd segment by half to the whole of its length, the distal process is directed distally and extends as far as the end of the segment. The retroverted process and the inner margin of the segment is clad with a band of hairs, that at its distal end curves round across the surface of the segment. Segment 4 presents a low rounded lobe on its inner surface and bears a short spine about the middle of its length. Both limbs closely resemble the accounts given by Wolfenden and T. Scott, but in the present specimens the division between segments 3 and 4 appears to be more complete in both legs.

Copepodid Stage III.

A single example of the 3rd Copepodid stage of this species was taken at Station 670. It is just possible that a careful examination and comparison of the two sexes might reveal sufficient differences to enable one to recognise them, but as I have only a single specimen I am unable to assign it to either sex.

Total length, 4.125 mm.

The proportional lengths of the cephalothorax and abdomen in this stage of development are as 51 to 15; so that the abdomen is contained 3.4 times in the length of the anterior region of the body.



TEXT-FIG. 93.—*Gaussia princeps* (T. Scott).

- a. Abdomen of adult female from the left side.
 b. 5th pair of legs. Copepodid stage III.
 c. 5th pair of legs. Copepodid Stage IV, female.
 d. 5th pair of legs. Copepodid Stage IV, male.
 e. 5th pair of legs. Copepodid Stage V, female.
 f. 5th pair of legs. Copepodid Stage V, male.

The forehead already possesses a well-developed ~~crest~~ and the rostrum, as in the adult, consists of a pair of slender spines arising from a swollen base. The ~~cephalon~~ cephalon and 1st thoracic segment are separate and the 4th and 5th segments are also partially separate. The posterior thoracic margin is rounded.

The abdomen is short and consists of only two segments, of very nearly equal length. The proportional lengths of these segments and the furcal rami are as follows :—

Abdominal segment	1	2-5	Furca	
	35	35	30	=100.

The posterior segment is on each side produced in a digitiform process, that in this stage of development only reaches half-way to the base of the external seta of the furcal ramus; on the dorsal aspect is a crescentic anal plate.

The 1st antenna reaches beyond the tip of the furcal ramus by the last four segments; it consists of 23 free joints, the 1st and 2nd and again the 3rd and 4th segments, respectively, being fused together.

The proportional lengths of the segments are as follows :—

Segment	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	
	80	29	22	18	18	15	15	19	26	37	42	47	48	51	57	58	76	67	61	64	73	55	22	=1000.

The 1st joint (segments 1-2) bears on its anterior margin two spines, of which the distal is much the larger. The 2nd joint (segments 3-4) is devoid of a spine, but a well-developed one is present on the 3rd (segment 5). The 6th, 7th and 8th joints are fused together but the line of demarcation between them can be detected. The separation between 10th and 11th joints is also incomplete.

The 2nd antenna in its general shape and proportions closely resembles that of the adult; the basal portion bears a stout seta on its proximal segment, and two unequal setae at the distal end of the outer margin of the 2nd segment. The exopod already carries its full complement of setae, but in the endopod these are not yet developed; the numbers of setae present on the two lobes of the distal segment in the different stages of development are as follows:—

	3rd Copepodid Stage.	4th Copepodid Stage.	5th Copepodid Stage.	Adult Stage.
Outer lobe	7	7	7	8
Inner lobe	6	7	7	8

The mandible is well developed, but the full number of setae on the endopod has, as yet, not been developed. In the Table below I have given the number of setae on the palp of this appendage in the various stages of development:—

Mandibular palp.	3rd Copepodid Stage.	4th Copepodid Stage.	5th Copepodid Stage.	Adult Stage.
Basal 1	4	4	1	1
Basal 2			3	3
Exopod 1	1	1	1	1
Exopod 2	1	1	1	1
Exopod 3	1	1	1	1
Exopod 4	1	1	1	1
Exopod 5	2	2	2	2
Endopod 1	3	4	4	4
Endopod 2	6	7	7	10

The 1st maxilla, in general, resembles that of the adult but on some of the various parts the number of setae is not yet complete. I have given the number of setae on all the different parts in the following Table:—

1st Maxilla.	3rd Copepodid Stage.	4th Copepodid Stage.	5th Copepodid Stage.	Adult Stage.
Lobe 2	4?	5	5	?
Lobe 3	4	4	4	?
Basal 2	4	4	5	5
Exopod	8	9	10	11
Endopod 1	3	4	5	6
Endopod 2	3	4	5	6
Endopod 3	5	5	5	5

The 2nd maxilla already closely resembles that of the adult in all but the number of setae arising from the 1st lobe. In this stage, as in the adult, there are four large setae and one very short one arising from the distal extremity of the lobe and two from the proximal border. At each successive moult one extra small seta is added to these two, so that in the adult there are five in all.

The maxilliped, at this stage, has only four segments in the endopod and the number of setae arising from some of the segments is less than in the adult or in succeeding stages. In the following table I have given the number of setae in the different stages of development :—

Maxilliped.	3rd Copepodid Stage.	4th Copepodid Stage.	5th Copepodid Stage.	Adult Stage.
Basal 1, Lobe 1 . . .	2	2	2	2
Basal 1, Lobe 2	4	4	4	4
Basal 1, Lobe 3 . . .	4	4	4	4
Basal 2, inner border . .	3	3	3	3
Basal 2, distal end	2	2	2	2
Endopod 1	1	2	3	4
Endopod 2	1	2	3	4
Endopod 3	} 1	{ 1	2	3
Endopod 4		{ 1	2	3
Endopod 5	3	4	4	4

The 1st pair of legs consist of a two-jointed basal part and two rami, each of two joints. Basal 1 bears an outer seta and basal 2 carries the usual S-shaped setae at its distal inner angle. The 1st joint of the exopod, corresponding to segment 1, bears a single elongate marginal spine and the distal segment, corresponding to segments 2 and 3 together, bears three similar marginal spines and the usual end-spine; the outer margin of the distal segment is cut into fine teeth. The endopod also consists of two joints; the proximal one, corresponding to segment 1, bears a transverse row of needle-like spines and carries a single inner seta; the distal joint, corresponding to segments 2 and 3, bears seven setae.

The 2nd pair of swimming legs each consist of a two-jointed basal part, but, whereas the exopod consists of two joints, the endopod has only one. Basal 1 bears an inner seta and the distal basal segment has a short spine-like projection on its outer margin. Exopod 1 bears a single leaf-like spine and an inner seta. Exopod 2 bears three marginal spines, which are also leaf-like, an end-spine and five setae. The endopod consists of only a single joint, but the characteristic hooks have already been developed, and on the distal two-thirds of the joint there are eight setae.

The 3rd swimming legs have a two-jointed basal part. The exopod consists of two joints; of which the proximal bears one and the distal two leaf-like marginal spines and there are four setae on the inner margin of the distal joint. The endopod consists of a single segment and bears only six setae.

The 4th swimming legs are even more rudimentary than the 3rd. Each ramus consists of only a single joint. The exopod bears three leaf-like marginal spines and three setae on its inner border, as well as the terminal end-spine. The endopod is undivided and bears only six setae.

The 5th legs are represented by small single-jointed processes at the distal end of which arise two minute setae.

At this stage of development the only portions of the animal that show any black pigment are the anterior, cardiac portion of the stomach and the lips of the mouth

Copepodid Stage IV.

Associated with fully adult stages there were at several stations examples of the last two stages of development.

In the 4th Stage of development the two sexes can be distinguished by the relative size of the 5th pair of legs.

♀ Total length, 5.75 mm.

The proportional lengths of the cephalothorax and abdomen in this stage are as 141 to 43; so that the abdomen is contained 3.28 times in the length of the anterior region of the body.

The abdomen now consists of three segments having the following proportional lengths.

Abdominal segment	1	2	3-5	Furca	
	34	15	27	24	= 100.

The forehead is armed with a crest that terminates in a forwardly directed process, as in the adult ; the rostral spines arise from a swollen basal mass and are long and tapering, each spine is fringed with sparse hair. Thoracic segments 4 and 5 are fused and the posterior thoracic margin is produced back in a small rounded lobe. The only trace of the black pigmentation that is so characteristic of the adult is at this stage a large dense black mass in the region of the gastric cavity.

The 1st antenna reaches back to beyond the level of the tip of the furcal ramus ; each consists of 24 separate joints, segments 8 and 9 being fused together. The proportional lengths of the segments are as follows :—

Segment	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	
	69	13	15	15	22	22	21	37	24	31	37	46	50	55	57	60	60	75	75	50	55	66	45	18	= 1000.

The 2nd antenna and mouth-parts now resemble those of the adult, except as regards the differences in the number of setae that I have specified above (*vide* Tables on p. 277).

The maxilliped closely resembles that of the adult except as regards the differences in the number of setae to which I have already called attention. It is interesting to note that in this species we do not, apparently, get any differences in the number of the setae arising from the various parts in the two sexes such as we found to be present in *Metridia princeps* (*vide supra* p. 256).

The 1st swimming leg consists of a two-jointed basal part and a pair of two-jointed rami. Basal 1 bears a plumose seta on its inner margin ; basal 2 carries an S-shaped seta at its distal inner angle and a delicate seta on its outer margin. Exopod 1 bears a long slender marginal spine and a single seta arises from its inner border ; a transverse row of small needle-like spines crosses the surface of the joint near the articulation with the distal segment. The distal joint of the ramus, corresponding to segments 2 and 3, bears three slender marginal spines and a slender end-spine, while four setae arise from the inner border. The outer margin of the distal segment is cut into fine claw-like teeth. The proximal segment of the endopod is armed with a transverse row of fine needle-like teeth and bears a single seta internally. The distal segment, corresponding to segments 2 and 3, bears seven setae, namely one on the outer margin, two distally and four on the inner border.

The 2nd swimming leg consists of a two-jointed basal part, of which only the proximal segment bears a seta on its inner margin. The exopod is two-jointed. Exopod 1 bears a single leaf-like spine on its outer margin and a single seta on its inner border. Exopod 2, corresponding to segments 2 and 3, bears three leaf-like marginal spines and a stout serrated end-spine ; it carries five setae on its inner margin ; the outer margin of the joint, proximal to the 1st marginal spine, is cut into fine spinules. The endopod is a single joint and bears the usual hooks at the junction of the proximal and middle thirds of the segment ; distally it bears nine setae, two on its outer margin, two distally and five on the inner border. The 3rd and 4th swimming legs closely resemble each other at this stage. As in the other legs the basal part consists of two segments, of which the proximal bears a single seta on its inner margin. The exopod is in each limb two-jointed. Exopod 1 bears a single leaf-like marginal spine and an inner seta and exopod 2, corresponding to segments 2 and 3, bears three marginal spines and an end-spine, as well as five setae on its inner border. In both limbs the endopod consists of a single joint ; but in the 3rd leg this bears nine setae (two on its outer margin, two distally and five on the inner border), whereas in the 4th leg there are only eight setae, there being only four setae on the inner margin.

The 5th pair of legs is nearly symmetrical. Each leg consists of a basal segment and two free segments, of which the distal is much the larger and bears two small plumose setae at its distal extremity.

♂ Total length, 5.355 mm.

The proportional lengths of the cephalothorax and abdomen are as 61 to 20, so that the abdomen is contained 3.05 times in the length of the anterior region of the body.

The general structure of the body agrees with that of the female in the same stage of development, and the abdomen is composed of only three segments. Even at this stage of development differences in the lengths of certain segments of the 1st antenna foreshadows the modification that is going to be assumed in the final moult, thus the appendage on the right side differs from that on the left, which resembles the appendage of the female, in that segments 14 and 15 are somewhat longer and segments 19 and 20 considerably shorter. The proportional lengths of the segments on the two sides of the body are as follows :—

Segment	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	
Left	72	13	18	13	22	22	20	35	22	31	36	45	49	53	57	63	60	74	56	52	56	67	46	18	=1000.
Right	70	14	18	16	23	22	21	36	20	28	35	45	52	57	59	63	65	67	50	50	57	67	48	17	=1000.

The 2nd antenna and mouth-parts appear to be the same as in the female. As I have pointed out (*vide supra* p. 256), in the case of the closely allied species, *Metridia princeps* Giesbrecht there seem to be differences between the two sexes in regard to the number of setae on certain segments of the maxilliped but I have been unable to trace any corresponding differences in this species.

The swimming legs have the same structure as in the female.

The 5th pair of legs in this sex show slight but distinct differences from the form of the appendage in the female. As in that sex, each limb consists of a basal portion and two free segments. The distal segment is considerably larger in the male and bears a small spine on its outer border about one-third along the length of the segment. The proximal free segment also bears a small seta on its outer margin, which does not appear to be present in the female.

All the examples of this stage of development were taken at Station 462.

Copepodid Stage V.

Examples of the 5th Copepodid stage of development were taken at Stations 373 and 670.

♀ Total length 7.75 mm.

The proportional lengths of the cephalothorax and abdomen are as 91 to 33, so that the abdomen is contained 2.76 times in the length of the anterior region of the body.

The shape and structure of the cephalothorax correspond closely to that of the adult. The 5th thoracic segment is now produced backwards on each side in a sharp spine, and the rostrum and frontal crest is well-developed.

The abdomen consists of four free segments, segments 4 and 5 still being fused. The proportional lengths of the segments are as follows :—

Abdominal segment	1	2	3	4-5	Furca	
	29	19	11	21	20	=100.

The length, as given above, of the posterior segment is the length between the anterior margin and the line of articulation of the furcal ramus ; the segment is produced backwards on each side in rounded prominences similar to those already noted in the adult and in the middle there is also a well developed anal plate that somewhat projects backwards.

The degree of pigmentation has at this stage considerably increased, not so much in the actual body itself as in the appendages ; the two antennae are devoid of pigment and the mandibular palp is only slightly tinged, but the maxilla, and especially the three inner lobes and the setae arising from the various parts are heavily pigmented. The 2nd maxilla and the maxilliped are also considerably pigmented.

The degree of pigmentation of the swimming legs gradually decreases from before backwards ; the 1st pair of legs is heavily pigmented but the 5th pair are devoid of pigment.

The 1st antenna, as noted in the previous stage of development, reaches back beyond the furcal ramus ; it consists of only twenty-one completely free segments, for segments 8 and 9 are completely fused and

segment 10 is partially fused with segment 9 ; segments 12 and 13 are partially fused together and the joint between segments 24 and 25 is incomplete. The proportional lengths of the segments are as follows :—

Segment	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	
	76	19	20	19	22	22	22	40	28	37	38	47	53	56	58	58	58	69	49	46	50	58	40	15	=1000.

The 2nd antenna and mandible have already assumed the adult form.

The 1st maxilla, as I have already noted above, still differs from that of the adult in the number of setae rising from certain segments.

The 2nd maxilla is as in the adult, but the maxilliped still lacks certain setae, as is shown above in the table on p. 278.

The swimming legs have now developed their adult characters and both exopod and endopod consist of three segments throughout the series. The hooks on the 1st segment of the endopod of the 2nd leg are very like those of the adult, though the outwardly directed spine near the proximal end of the segment is still comparatively feeble.

The 5th pair of legs now consist of a basal portion and three free segments, the most distal of which bears three plumose setae, the innermost being the longest. This stage of development in this limb agrees extremely closely with the account given by Wolfenden (1911, p. 291) and by Esterly (1906, p. 70) of the appendage in the examples examined by them.

♂ Total length, 6.69 mm.

The proportional lengths of the cephalothorax and abdomen are as 78 to 29, so that the abdomen is contained 2.69 times in the length of the anterior region of the body. The general shape and structure of the body agrees closely with that of the female, except that the posterior thoracic margin is only produced in short spines.

The abdomen consists of four segments only, segments 4 and 5 still being fused. The segments and the furcal rami possesses the following proportional lengths :—

Abdominal segment	1	2	3	4-5	Furca
	30	17	11	19	23

= 100.

The 1st antenna shows certain differences on the two sides of the body. While that on the left side agrees fairly closely with that of the female, the appendage on the right side exhibits an increase in length in segments 15 to 18 and a reduction in segments 19 and 20. There are also certain small differences in the jointing of the segments, thus on the left side segments 8 and 9 are fused and the joints between segments 11 and 12, and 12 and 13 appear to be incomplete ; in the right antenna segments 8 and 9 are fused and so also are segments 11 and 12, while segment 13 is partly fused with segment 12. In both antennae segments 24 and 25 are partially fused. The proportional lengths of the segments are as follows :—

Segment	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		
Left	66	18	18	19	19	21	23	40	28	35	39	49	57	57	60	64	65	72	49	45	45	55	40	16	=1000.
Right	72	19	19	19	24	25	23	40	23	29	32	44	53	61	65	69	69	59	44	44	50	53	59		=1000.

The 2nd antenna, mouth-parts and swimming legs are as in the female.

The 5th pair of legs is very nearly symmetrical, and in this stage each leg consists still of a basal portion and three free segments, of which the 1st possesses a small marginal seta ; in each limb the 3rd or distal segment bears a small marginal spine on its outer border and a larger spine on its inner margin.

Although the actual number of examples in different stages of development, that I have been able to examine, is comparatively few, yet it is, I think, sufficient to give us some indication of the manner of development in this species. In the following table

I have given in tabular form the average length measurements in both sexes of the last four stages.

Growth Stage.	Actual measurement.	Calculated measurement.	Growth-factor.
♀ Copepodid Stage III . . .	4.125 mm.	4.125 mm.	1.394
Copepodid Stage IV	5.750 mm.	5.750 mm.	1.270
Copepodid Stage V	7.750 mm.	7.303 mm.	1.270
Adult Stage VI	9.25 mm.	9.274 mm.	
♂ Copepodid Stage III	4.125 mm.	4.216 mm.	1.655 or 1.270
Copepodid Stage IV	5.355 mm.	5.355 mm.	1.655
Copepodid Stage V	6.69 mm.	6.978 mm.	
Adult Stage VI	9.00 mm.	8.863 mm.	

From the above it appears that this species, judging from the figures arrived at by the actual measurement of the specimens and those reached by calculation, shows a close degree of agreement with the other species whose developmental stages I have been able to examine, and that in the female the major line of development takes place in a straight line each succeeding stage being derived from that preceeding it by a moult, whose growth-factor in the earlier stages is 1.394 but which drops at the moult following Copepodid Stage IV to 1.270; whereas, in the male it appears from a mathematical study of the different sizes that Copepodid Stage III may give rise by a growth factor of 1.655 to Copepodid Stage V, or by the adoption of the female growth-factor of 1.270 may pass to Copepodid Stage IV and then by a subsequent moult, having the typical male growth-factor of 1.655, may attain to the fully adult condition of Stage VI.

A study of the proportional lengths of the cephalothorax and the various abdominal segments at different stages of development reveals that there are some very interesting features in the rate of growth of the several parts. In the following Table I have given the proportional lengths of these parts, calculated in 1000ths of the total length, in a number of examples of both sexes at different stages of growth.

	Cephalothorax	Abdominal segments					Furca.
		1	2	3	4	5	
♂ Copepodid Stage IV—							
No. 1	731	91	45		79		54
No. 2	744	81	42		68		65
Average	737.5	86.0	43.5		73.5		59.5
		1	2	3	4	5	
Copepodid Stage V—							
No. 1	702	94	53	30	58		63
No. 2	719	91	47	31	44		68
No. 3	735	70	46	28	57		64
Average	718.6	85.0	48.6	29.6	53.0		65.2

						Cephalothorax.	Abdominal segments.					Furca.
							1	2	3	4	5	
Adult Stage VI—												
No. 1	.	.	.	.	.	629	111	61	53	36	55	55
No. 2	.	.	.	.	.	652	100	64	47	32	54	51
No. 3	.	.	.	.	.	660	101	57	51	29	49	53
No. 4	.	.	.	.	.	671	105	53	42	29	47	53
No. 5	.	.	.	.	.	675	91	55	44	33	50	52
No. 6	.	.	.	.	.	676	106	52	40	24	48	54
No. 7	.	.	.	.	.	682	84	56	49	34	48	47
No. 8	.	.	.	.	.	692	86	46	46	28	47	55
Average	.	.	.	.	.	667.2	98.0	55.5	46.5	30.5	49.8	52.5
							1	2	3	4	5	
♀ Copepodid Stage III—												
No. 1	.	.	.	.	.	783	76					65
Copepodid Stage IV—												
No. 1	.	.	.	.	.	759	82	36				59
Copepodid Stage V—												
No. 1	.	.	.	.	.	681	98	55	43			59
No. 2	.	.	.	.	.	696	74	60	34			60
No. 3	.	.	.	.	.	703	91	56	32			54
No. 4	.	.	.	.	.	714	90	48	28			56
No. 5	.	.	.	.	.	724	78	46	27			59
No. 6	.	.	.	.	.	728	82	52	32			54
No. 7	.	.	.	.	.	747	64	62	23			49
No. 8	.	.	.	.	.	774	73	40	22			48
Average	.	.	.	.	.	720.9	81.2	52.4	30.1			54.9
Adult Stage—												
No. 1	.	.	.	.	.	628		224		27	64	57
No. 2	.	.	.	.	.	655		209		34	53	49
No. 3	.	.	.	.	.	660		206		29	48	57
No. 4	.	.	.	.	.	675		175		46	44	60
No. 5	.	.	.	.	.	684		194		22	43	47
No. 6	.	.	.	.	.	685		200		23	46	46
No. 7	.	.	.	.	.	687		203		20	38	52
No. 8	.	.	.	.	.	694		193		24	41	48
No. 9	.	.	.	.	.	707		160		27	59	47
Average	.	.	.	.	.	675.0		207.1		28.0	48.5	51.4

A study of the above data shows that here, as in the case of *Metridia princeps* Giesbrecht, there is between each stage of development a change in the proportional lengths of the cephalothorax and abdomen, the former decreasing in length and the latter showing an increase. Furthermore, it is clear that this increase in the relative length of the abdomen does not occur uniformly, but that there are certain regions in which growth is more rapid than in others. I have already pointed out that in my opinion development in the male does not take place along a straight line, each stage succeeding the last in a progressive series,

but that at Stage III we may get development preceding along two lines, either by passing from Stage III to Stage IV and thence to Stage VI, or by a direct moult passing from Stage III to Stage V. Following the lines of development as suggested above, as we pass from Stage III to Stage IV we find that segment 1 of the abdomen increases in length by 13.2%; the combined lengths of segments 2 to 5 increases by 54% while the furcal ramus *decreases* by 10%. Between Stages III and V, segment 1 increases by 11.8%; the combined lengths of segments 2 to 5 increases by 72.6%, while the furcal ramus remains almost unchanged. Between stages IV and VI, segment 1 increases by 14.0%; segment 2 increases by 27.6%, segments 3 to 5 together increase by 72.1% and the furcal ramus decreases by 11.8%. In the case of the female the determination of the proportional increase or decrease of the lengths of the segments is rendered difficult owing to the fusion of certain of the anterior segments in the process of development. In this sex I believe that development takes place in a straight line, Stages III, IV, V and VI succeeding one another. Between stages III and IV segment 1 increases by 8.0%; segments 2 to 5 together increase by 31.6% while the furca *decreases* by 9.2%. Between stages IV and V segment 1 remains almost unchanged, segment 2 increases by 11.1%; segments 3 to 5 together increase by 41.6% and the furcal ramus *decreases* by 7.5%. Between stages V and VI segments 1 to 3 which now become fused together, increase by 26.5% while segments 4 and 5, which were fused in Stage V but are separate in Stage VI, have increased by 26.4% while the furca has *decreased* by 6.4%. It will thus be seen that the greatest increases in length occur somewhere about the region of the third or fourth abdominal segment, while the furca shows a steady decrease in length at almost each moult. These changes agree very well with what we have already seen to be the case in *Metridia princeps* Giesbrecht and it is probable that the same type of change occurs in many other species, if not in all. Certainly, these changes are in agreement with the changes that Shaw * found to occur during development in the proportional lengths of the abdominal segments of the crab *Inachus dorsettensis*.

During the process of development the same changes that we have already noted in other species occur here also in the proportional lengths of the segments of the 1st antenna. In the table below I have given these lengths, in parts of a 1,000, of the various segments in the last four stages of the female.

Segment	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
Stage 3	79	29	22	18	19	15	15	19	26	37	42	47	48	51	57	58	76	67	61	64	73	55	22		
Stage 4	69	13	15	15	22	22	21	37	24	31	37	46	50	55	57	60	60	75	57	50	55	66	45	18	
Stage 5	76	19	20	19	22	22	22	40	28	37	38	47	53	56	58	58	58	69	49	46	50	58	40	15	
Adult	65	23	22	20	25	22	22	19	21	30	39	36	48	56	57	60	62	62	70	47	42	47	52	39	13

In this series of developmental changes, we see that as we pass from the earliest stage obtained, Stage III, to the next we get a separation of the proximal segments, that is, as usual, accompanied by an increase, though in this case but a slight one, in length and this increase is continued on to Stage V and, with the exception of the first segment, even to the adult stage. Segment 5 shows no change in its proportional length throughout the whole series. In the more distal segments the length tends to be proportionally greater at each successive moult in all segments up to the 18th, and beyond this point there is a

* Shaw, M. E., "A contribution to the study of relative growth of parts in *Inachus dorsettensis*." *British Journ. Exper. Biol.* Vol. VI, p. 145 (1929).

steady and progressive diminution in length throughout the whole course of development, the diminution in length being most marked at segment 20. Exactly similar changes are met with in the male in the unmodified left antenna. In this sex the proportional lengths of the segments are as given below :—

Segment	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
Stage 3	80		29		22	17	19	15	15	19	26	37	42	47	48	51	57	58	76	67	61	64	73	55	22
Stage 4	72	13	18	13	22	22	20	35	22	22	31	36	45	49	53	57	62	61	74	56	51	56	67	46	18
Stage 5	66	18	18	19	19	21	23	40		28	35	39	49	57	57	60	64	65	72	49	45	45	55	40	16
Adult	66	24	24	24	25	24	64			29	37	37	46	52	57	61	62	61	69	46	42	48	52	38	12

Here again there is a distinct increase in the proportional lengths of the proximal segments, with the single exception of segment 1 ; in the moult between Stage III and Stage IV the total length of segments 1 and 2, which are fused in the earlier stage but which become separate at Stage IV, increases from 80 to 85, but at the next moult the 1st segment decreases from 72 to 66 and, thereafter, suffers no change. The greatest increase in length occurs at segment 10 ; in segment 12 there appears to be little or no change, but on the distal side of this segment there is again an increase in length that has a second maximum at segment 16. Between segments 18 and 19 there is a change, for whereas segment 18 increases slightly, segment 19 decreases, and from this point on to the distal extremity the length of all segments decreases. The greatest decrease occurs at segment 22.

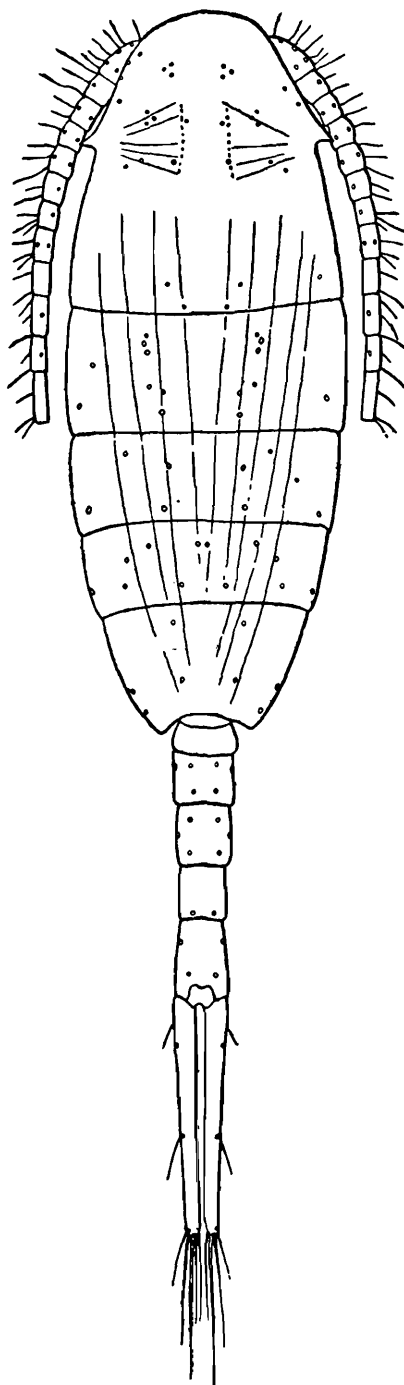
Family LUCICUTIDAE.

Genus **LUCICUTIA** Giesbrecht.

A. Scott (1902) first recorded the occurrence of any species belonging this genus from Indian waters ; the species then recorded was *Lucicutia flavicornis* (Claus), and he obtained examples from the Red Sea and the Arabian Sea. A year later Thompson and A. Scott (1903) recorded the same species from the Ceylon Pearl Banks. In 1904 Cleve in his account of the Copepoda of the South African Seas recorded the occurrence in the Agulhas Current of *Lucicutia flavicornis* (Claus) and *L. clausi* Giesbrecht and in the same paper describes two new species under the names *Lucicutia aurita* and *L. bradyana* respectively. In 1909 A. Scott in his account of the collections made by the "Siboga" in the Malay Archipelago recorded the occurrence of *Lucicutia bicornuta* Wolfenden (= *L. aurita* Sars ; non *L. aurita* Cleve.), *L. clausi* Giesbrecht, *L. flavicornis* (Claus), *L. longiserrata* Giesbrecht and *L. maxima* Steuer and, in addition, described two new species *L. pera* and *L. phillyra*, the former of which, however, is according to Sars synonymous with *L. lucida* Farran. In 1912 I recorded the occurrence of *Lucicutia flavicornis* (Claus) from the coast of southern Burma and in 1913 *Lucicutia bicornuta* Wolfenden, *L. clausi* (Giesbrecht) and *L. maxima* Steuer in a mid-water trawl from the southern part of the Bay of Bengal (Station 393). It is thus clear that the genus is well represented in the Indian Ocean.

As in the preceding genera, the species of this genus are provided with a large number of cutaneous glands that open through small pores to the exterior in the various regions of the body. In text-fig. 94 I have shown the arrangement of these pores on the dorsal aspect of a male *Lucicutia maxima*. These pores are not confined to the body but are also found to be present on certain of the oral appendages and the legs, as well as on the proximal segments of the 1st antenna. In the 1st maxilla I have been able to locate two such

pores, one near the distal end of the 1st or biting inner lobe and a second near the outer proximal angle of the exopod. In the maxilliped there is a single pore at the distal outer angle of the first four segments of the endopod. The legs are provided with a large number of these pores. In the 1st Swimming leg there is on basal 1 a single pore near the outer distal angle. Basal 2 appears to be devoid of any pores. In the 1st and 2nd segments of the exopod there is a pore on the posterior aspect near the base of the marginal spine. In the 3rd segment of the exopod there is a single pore on the anterior aspect near the base of the 1st marginal spine but slightly distal to it on the anterior aspect and a second near the base of the 2nd marginal spine on the posterior aspect. A single pore opens on the



TEXT-FIG. 94.—Showing the arrangement of the cutaneous pores on the dorsal aspect of *Lucicutia maxima* Steuer.

posterior aspect of the 3rd segment of the endopod. In the 2nd swimming leg basal 1 has a pore on the posterior aspect near the outer proximal angle. In this leg, as in the

1st leg, there appears to be no pore on the 2nd basal segment. In the 1st and 2nd segments of the exopod there is a pore near the base of the marginal spine on the posterior aspect and in addition the 2nd segment has a pore in the same position on the anterior aspect. In the 3rd segment a pore opens on each aspect near the base of the 1st marginal spine ; one near the base of the 2nd marginal spine on the posterior aspect ; and a second one on the posterior surface of the segment midway between the level of the base of the 2nd spine and the end of the segment. A single pore opens on the 3rd segment of the endopod. In the 3rd and 4th swimming legs the arrangement of the pores appears to be very similar. In the 1st basal segment there is a pore near the outer proximal angle on the posterior aspect and a second near the base of the inner seta. Basal 2 has one near the base of the outer seta and a second near the distal inner corner. In the 1st segment of the exopod there is a pore near the base of the marginal spine on each aspect. On the 2nd segment there is a pore in a similar situation on each aspect in the 3rd leg but I have only been able to detect the pore on the anterior aspect in the 4th leg. In the 3rd segment there is a pore near the base of the 1st marginal spine on each aspect ; one near the base of the 2nd marginal spine on the posterior aspect, but in the 4th leg this is some distance from the spine on a line drawn between the base of the spine and the base of the 1st inner seta, at about one-fourth of the distance from the marginal spine ; and one on the posterior aspect at a point midway between the level of the 2nd marginal spine and the end of the segment. In the 5th leg there is a pore on the anterior aspect near the proximal outer angle and a second near the distal outer angle. In the exopod on the 1st segment there are three pores near the outer margin, the third being situated near the base of the marginal spine ; in the 2nd segment there is a single pore on the posterior aspect near the base of the marginal spine ; and in the 3rd segment one pore is situated on the posterior aspect near the base of the 1st marginal spine and one on each aspect near the base of the 2nd marginal spine. In every case these pores are connected with a small and usually pyriform group of cells that readily take a stain and are obviously secretory in function.

Wolfenden (1911, p. 314) has attempted to sub-divide the various species of this genus into two sub-groups according to (1) the number of segments in the endopod of the 1st Swimming leg, and (2) the size of the species. As regards this latter character he arbitrarily selects 2.0 mm. as the dividing line between the groups and in the group of small species, " not over 2.0 mm. in length," he includes.

Lucicutia clausi (Giesbrecht),
Lucicutia curta Farran,
Lucicutia frigida Wolfenden,
Lucicutia flavicornis (Claus),
Lucicutia gemina Farran,
Lucicutia longiserrata Giesbrecht, and
Lucicutia ovalis Wolfenden.

In the group of larger species, " over 3.0 mm. in length," he included ;—

Lucicutia aurita Cleve,
Lucicutia bicornuta Wolfenden,
Lucicutia bradyana Cleve,
Lucicutia grandis Giesbrecht,

Lucicutia intermedia Sars,
Lucicutia lucida Farran,
Lucicutia macrocera Sars,
Lucicutia magna Wolfenden (= *L. atlantica* Wolfenden and *L. gracilis* Sars),
Lucicutia major Wolfenden,
Lucicutia maxima Steuer, and
Lucicutia tenuicauda Sars.

The species *Lucicutia simulans* Sars is intermediate between the above two groups, being 2.40 mm. in total length.

Such a size classification, while possibly of some assistance in the taxonomic identification of the various species, is very unsatisfactory and unscientific; the genus clearly falls into two natural groups, according to the structure of the endopod of the 1st Swimming leg, namely :—

- (1) Those species in which the endopod of the 1st leg possesses a two-jointed endopod; namely :—

Lucicutia atlantica Wolfenden,
Lucicutia clausi (Giesbrecht),
Lucicutia longiserrata Giesbrecht,
Lucicutia macrocera Sars,
Lucicutia magna Wolfenden,
Lucicutia ovalis Wolfenden,
Lucicutia simulans Sars, and
Lucicutia tenuicauda Sars.

- (2) Those species in which the endopod of the 1st leg possesses a three-jointed endopod, namely :—

Lucicutia aurita Cleve,
Lucicutia bicornuta Wolfenden,
Lucicutia bradyana Cleve,
Lucicutia challengerii, sp. nov.,
Lucicutia curta Farran,
Lucicutia flavicornis (Claus),
Lucicutia frigida Wolfenden,
Lucicutia gemina Farran,
Lucicutia grandis Giesbrecht,
Lucicutia intermedia Sars,
Lucicutia longicornis Giesbrecht,
Lucicutia lucida Farran (= *L. pera* A. Scott),
Lucicutia major Wolfenden, and
Lucicutia maxima Steuer.

Leaving aside Group 1, which is represented in the "Investigator" collections solely by *Lucicutia ovalis* Farran, there are in Group 2 a number of forms that are closely related to each other, if not actually identical, on the one hand, and certain so-called species that in my opinion are identical on the other.

A very considerable degree of confusion appears to have arisen regarding certain species in this genus. Brady (1883, p. 50, pl. xv, figs. 1-9, 16), under the name *Leuckartia flavicornis* Claus, described and figured a form that had been obtained by the "Challenger" in the Pacific Ocean and which he attributed to this species in spite of the fact that it was very much larger, measuring 6.0 mm. in length, than examples of the true *Leuckartia flavicornis* from the Atlantic Ocean, in which the total length is only 2.0 mm. As Giesbrecht (1892, p. 389) pointed out, Brady's form shows certain structural differences in the segments of the abdomen from the Atlantic examples, for in the Pacific form segments 3 and 4 of the abdomen are much smaller and narrower than either the genital segment (segments 1-2) or the anal segment (segment 5). Cleve (1904, p. 204, pl. vi, figs. 33, 34) under the name *Lucicutia bradyana* described a species of this genus that was taken in the Agulhas Current off the South African Coast. He remarks that "the variation in the forms of the group of *L. clausi* is, according to Giesbrecht, considerable, and it therefore seems very probable that *Leuckartia flavicornis* Brady (*non* Claus), *Lucicutia grandis* Giesbrecht and *Lucicutia bradyana* Cleve represent only variations in one and the same species." Wolfenden (1905, p. 22) was of the opinion that the female described by him in 1904 (*loc. cit.* p. 121) under the name *Lucicutia grandis* (nov. sp.)?, which he had taken in the Atlantic Ocean, was identical with the species *Lucicutia grandis* that Giesbrecht (1895, p. 258) had described from the male only and which had been taken in the Pacific, as well as with the form described by Steuer from the female only, taken in the "Valdivia" collection, under the name *Lucicutia maxima*. Farran (1908, p. 62) was also of the opinion that *Lucicutia grandis* (Giesbrecht) is synonymous with *Lucicutia maxima* Steuer. There seems to me to be no reason whatsoever for associating the female *Lucicutia grandis* Wolfenden obtained in the Atlantic Ocean, with the male *Lucicutia grandis* (Giesbrecht) taken in the Pacific. Wolfenden had no males in his collection and Giesbrecht had no females. Sars (1925, p. 208, pl. lvi) under the name *Lucicutia grandis* (Giesbrecht) again records Wolfenden's form from the Atlantic Ocean, but this time associated with the females were certain males that are clearly *not* identical with the form described by Giesbrecht from the Pacific. There is thus little doubt in my mind that the Atlantic and Pacific forms are not identical, and since Giesbrecht's name for the Pacific form has undoubted priority, the form described by Wolfenden and Sars from the Atlantic Ocean must be given a different name and I, therefore, propose the name *Lucicutia wolfendeni*.

In the "Investigator" collections from Station 682 are several examples of both sexes of a species of *Lucicutia* that appears to correspond with the form described by Brady (1883) under the name *Leuckartia flavicornis*. This species does not agree with either *Leucicutia grandis* Giesbrecht or *Lucicutia maxima* Steuer and I have, therefore, named it *Lucicutia challengerii*.

Group I.—

***Lucicutia clausi* (Giesbrecht).**

Lucicutia clausi, A. Scott, 1909, p. 126.

Lucicutia clausi, Sars, 1925, p. 208.

Lucicutia clausi, Sewell, 1913, p. 354.

Lucicutia clausi, Farran, 1929, p. 263.

This species is widely distributed and has been recorded from the Malay Archipelago (A. Scott); the southern end of the Bay of Bengal (Sewell); and from the Agulhas Current (Cleve). Examples were taken by the "Investigator" at Station 393.

***Lucicutia ovalis* Wolfenden.**

Lucicutia ovalis, Wolfenden, 1911, p. 319, text-fig. 61a-c, pl. xxxv, fig. 6.

Lucicutia ovalis, Farran, 1929, p. 263, fig. 25.

Lucicutia flavicornis (in part), Sewell, 1912, p. 366.

This species was first described by Wolfenden (*loc. cit.* 1911) from material obtained by the "Gauss" in the North Atlantic. The same species has since been recorded by Farran from the Atlantic Ocean and off New Zealand. During the preparation of the present paper I have been revising my previous identifications of species from different parts of the Indian Ocean and I have discovered that a number of examples that I had previously regarded as belonging to the species *Lucicutia flavicornis* (Claus) are in reality examples of Wolfenden's new species. These specimens have been taken for the most part off the coast of Southern Burma and off the Crocodile Rocks.

Group 2.—

***Lucicutia bicornuta* Wolfenden.**

Lucicutia bicornuta, A. Scott, 1909, p. 126, pl. xxxix, figs. 1-11.

Lucicutia bicornuta, Wolfenden, 1911, p. 321, text-fig. 63a-c.

Lucicutia bicornuta, Sewell, 1913, p. 354.

Lucicutia bicornuta, Sars, 1925, p. 214, pl. lviii, figs. 1-3.

This species, which was originally obtained by the "Gauss" in the South Atlantic Ocean in about Lat. 23°S, has since been taken in the Mediterranean Sea by the "Princesse Alice" and in the Malay Archipelago by the "Siboga." Numerous examples occur in the "Investigator" collection at Station 393.

***Lucicutia challenger*, sp. nov.**

(Text-fig. 95; a-j.)

Leuckartia flavicornis, Brady, 1883, p. 50, pl. xv, figs. 1-6, 16.

(non *Lucicutia flavicornis* Claus).

Several examples of both sexes were taken at "Investigator" Stations 393 and 682.

♀ Total length 5.54 mm. These examples are slightly smaller than those examined by Brady, for he states that they measured 6.0 mm.

The proportional lengths of the cephalothorax and abdomen are as 32 to 17, so that the abdomen is contained 1.88 times in the length of the anterior region of the body.

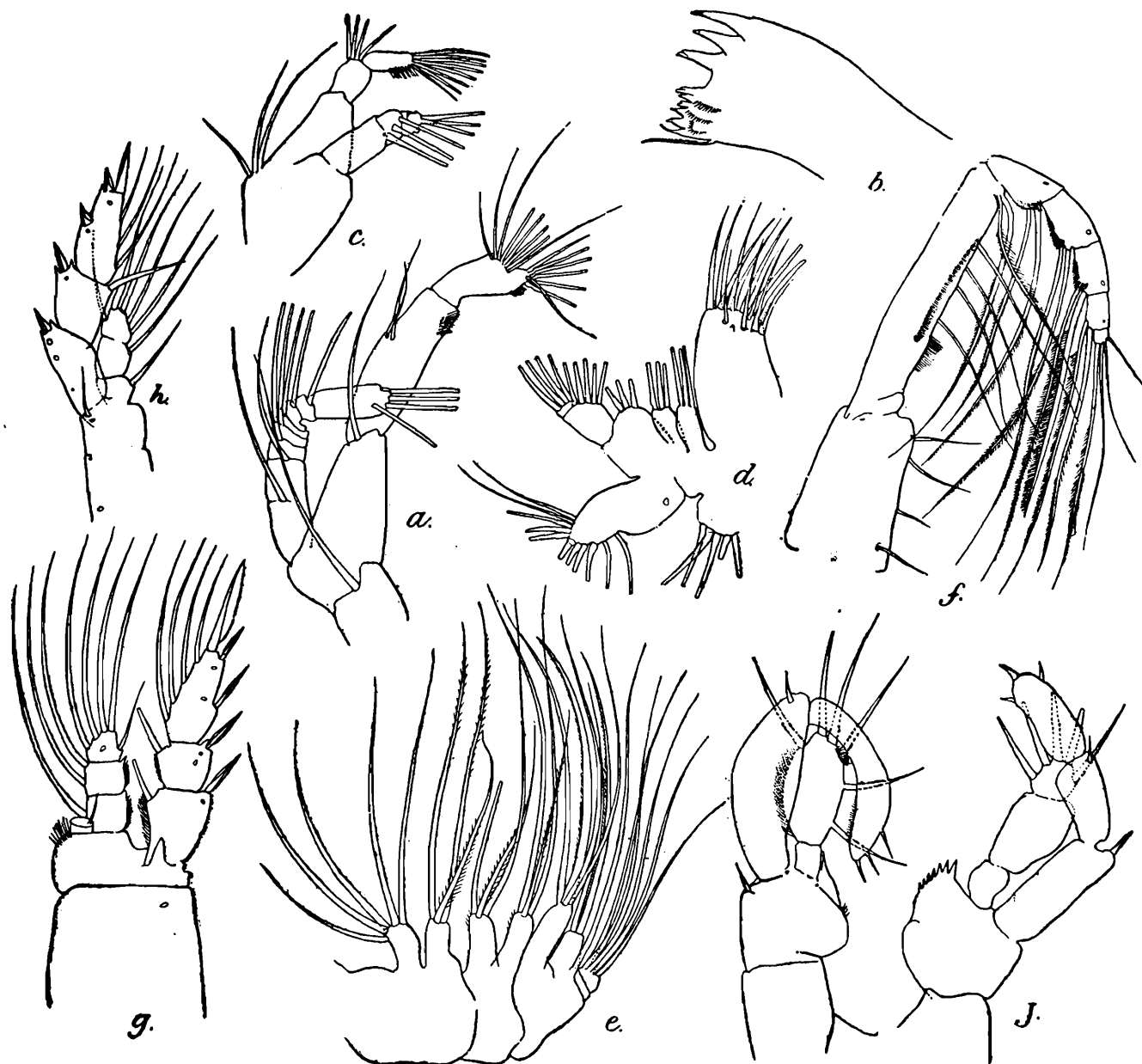
The forehead is rounded and is provided with a pair of delicate rostral filaments that arise from a swollen base. On each side of the head there is a stout triangular spine. The posterior thoracic margin is bluntly rounded.

The abdomen consists of four free segments, segments 1 and 2 being fused in the genital segment. The two middle segments, segments 3 and 4, are much narrower than

either the genital or anal segment. The proportional lengths of the segments are as follows :—

Abdominal segment	1-2	3	4	5	Furca	
	22	12	12	24	30	=100.

Thus the furcal ramus is only one-and-a-quarter times as long as the anal segment, whereas in *Lucicutia maxima* Steuer, the rami are equal in length to the two last abdominal segments. The 2nd furcal seta is long and stout and is equal in length to the whole abdomen, including the furcal ramus.



TEXT-FIG. 95.—*Lucicutia challengerii*, sp. nov.

- a. The 2nd antenna.
 b. The biting lobe of the mandible.
 c. The mandibular palp.
 d. The 1st maxilla.
 e. The 2nd maxilla.

- f. The maxilliped.
 g. The 1st swimming leg.
 h. The 5th leg, female.
 j. The 5th pair of legs, male.

The 1st antenna reaches back nearly to the middle of the furcal ramus. The proportional lengths of the segments are as follows :—

Segment	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	
	73	16	21	22	22	23	22	22	21	22	28	30	44	49	57	61	61	66	69	52	47	48	61	50	23	=1000.

In the 2nd antenna the two rami are of equal length but, owing to the different levels at which they are articulated with the basal segment, the endopod appears to be much the longer. Basal 1 bears a single long seta; basal 2 also bears a single seta. The exopod consists of eight segments; segments 1 to 7 each bear a single seta and segment 8 bears one seta at about one-fifth of its length from the distal end and three setae distally. The endopod consists of two segments. Segment 1 bears two unequal setae about the middle of its length and has a patch of hair-like spines along its distal half. Segment 2 bears a corresponding patch of hairs on the distal part of its inner margin; the outer lobe bears eight setae and the inner seven, of which one is quite small.

In the mandible the biting process is armed with strong teeth and agrees with the figure published by A. Scott (1909, pl. xli, fig. 7) of this appendage in the male that he attributes to the species *Lucicutia maxima* Steuer.

In the 1st maxilla the biting lobe bears thirteen spines; lobe 2 bears three setae as also do lobe 3 and the 2nd basal segment; endopod 1 has four setae and the terminal segments bear five setae. The exopod possesses eleven setae and the outer appears to have five.

In the 2nd maxilla lobe 1 bears five spines; lobes 2 to 5 each bear three and lobe 6 bears two. The endopod carries six setae.

The maxilliped has the usual form. Basal 1 is shorter and much stouter than basal 2, which is nearly five times as long as wide. The proportional lengths of the several parts are as follows:—

$$\frac{\text{Basal 1}}{28} \quad \frac{\text{Basal 2}}{36} \quad \frac{\text{Endopod}}{36} = 100.$$

Basal 2 bears four setae on its anterior margin and two at its distal end; a line of fine needle-like spines runs along the greater part of the length of the segment. Endopod 1 to 4 each bear two setae; and endopod 5 bears four.

In the 1st swimming leg both rami are three-pointed. Basal 2 bears a cylindrical process at its inner distal angle, from which springs a short seta. In the exopod the marginal spines are long, each reaching to a point beyond the base of the next spine. The three segments bear respectively 1, 1 and 2 marginal spines and 1, 1 and 4 setae. The end-spine is strong and is finely serrated. The endopod reaches to a point opposite the level of the joint between segments 2 and 3 of the exopod; the segments bear 1, 2 and 5 setae respectively.

The 2nd to 4th swimming legs are similar to those of other members of the genus.

In the 5th swimming leg basal 1 possesses a small pore, opening to the exterior near the distal outer angle; basal 2 also has a corresponding pore in nearly the same situation and in addition carries a small outer seta. In the exopod the 1st segment is considerably longer than the 2nd and is devoid of any inner seta; a small pore opens near the base of the marginal spine; exopod bears the usual stout inner seta and there is spore near the base of the marginal spine; exopod 3 bears two marginal spines, at the base of each of which opens a small pore.

In several species of *Lucicutia* the structure of the appendages is so similar that it is extremely difficult to detect anything that can be utilised for the purpose of taxonomic discrimination. A study of the proportional lengths of the various segments in the swimming legs seems to indicate that there are differences that can be utilised for this purpose. I

therefore give below the proportional lengths of the three segments and the end-spine in the five pairs of legs.

	P. 1.	P. 2.	P. 3.	P. 4.	P. 5.
Exopod 1	36	47	48	46	60
Exopod 2	24	31	38	41	38
Exopod 3	45	85	97	89	53
Endspine	51	48	50	48	30

♂ Total length 3.905 mm. to 4.60 mm.

The proportional lengths of the cephalothorax and abdomen are as 119 to 88, so that the abdomen is contained 1.352 times in the length of the anterior region of the body. The head is produced on either side in a well developed spine. The posterior thoracic margin is rounded. The rostrum consists of a pair of tapering filaments.

The proportional lengths of the abdominals segments are as follows :—

Abdominal segment	1	2	3	4	5	Furca	
	11	15	15	13	13	33	=100.

The furcal rami are five times as long as broad and the 2nd furcal seta is as long as the whole abdomen and is three times the length of the other furcal setae. The outer seta is short and spine-like and arises from the outer margin one-seventh of the length of the whole ramus from the proximal end. The inner margin of the furcal rami are fringed with hairs.

The 1st antenna reaches to the posterior margin of the anal segment; that on the left side is modified to form the usual grasping organ. The proportional lengths of the various segments are as follows :—

Segment	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	
Right	74	16	16	16	22	22	22	22	22	22	26	29	47	47	55	58	61	63	67	55	50	55	57	50	26	=1000.
Left	92		16	22	22	22	22	24	18	19	84			43	65	70	70	76	131			119		43	27	=1000.

In the right antenna all the segments are separate but in the grasping antenna on the left side segments 1 and 2 are completely fused; segments 10 and 11 are partially fused; segments 11, 12 and 13 are fused, though in some specimens the limits of each segment can be detected; segments 19-21 and 22-23 respectively are completely fused.

In the 2nd antenna the two rami are of equal length. The 1st basal bears a single long seta. Basal 2 bears a single seta. The exopod consists of eight segments; segments 1 to 7 each bear a single seta and segment 8 bears a single seta at about four-fifths of its length and three setae distally. The proximal segment of the endopod bears two unequal setae about the middle of its length and has a patch of hair-like spines on its distal half. The distal segment bears a patch of hair-like spines on its distal half and the inner and outer lobes bear seven and eight setae respectively, one of the setae on the inner lobe being small.

In the mandible the biting process is armed with stout teeth and agrees with the figure given by A. Scott (1909, pl. xli, fig. 8) of this appendage in *Lucicutia maxima*.

In the 1st maxilla the biting lobe (lobe 1) bears thirteen spines; lobe 2 and lobe 3 each bear three setae. The 2nd basal segment carries three setae. Endopod 1 bears four setae and endopod 2-3 carries five. The exopod bears eleven setae and the outer lobe has five.

The maxilliped has the usual form. Basal 1 is shorter and much stouter than basal 2, which is nearly five times as long as wide; the proportional lengths of the several parts are as follows; Basal 1, 28; Basal 2, 36; Endopod, 36. Basal 2 bears four setae on its

anterior margin and two at its distal end ; a line of fine needle-like spines runs along the greater part of the length of the segment. The endopod consists of 5 segments bearing 2, 2, 2, 2 and 4 setae respectively. Endopod 1-3 are all armed with fine needle-like spines.

In the 1st swimming leg both the rami are three-jointed. Basal 2 bears a cylindrical process at its distal inner angle, from which springs a small seta. In the exopod the marginal spines are long, each reaching to a point beyond the base of the next spine. The segments bear 1, 1, and 2 marginal spines respectively and 1, 1, and 4 setae on their inner margins. The end-spine is strong and finely serrated. The endopod reaches to the level of the joint between exopod 2 and 3. The segments bear 1, 2, and 5 setae respectively.

The 2nd-4th swimming legs are similar to those of other members of the genus. The proportional lengths of the various segments and the end-spine of the exopod of the several legs are as follows :—

	P. 1.	P. 2.	P. 3.	P. 4.
Exopod 1	36	44	45	44
Exopod 2	24	31	37	39
Exopod 3	46	86	96	94
End-spine	51	50	55	47

The 5th pair of legs agree closely with the description and figures given by Brady (*loc. cit.*). In the right leg basal 2 is swollen on its inner face and bears a few small spines ; at its outer distal angle it carries a small spine-like seta. The exopod consists of two segments. Exopod 1 bears a small but stout marginal spine at its distal outer angle. Exopod 2-3 bears a short spine on its inner margin at about one-third of its length ; there is a single spine on the outer margin about three-fourths of the length from the proximal end, and two other spines arise near the distal extremity. The endopod is two-jointed ; the distal segment is oval in outline and reaches nearly to the level of the joint between the two segments of the exopod ; the outer margin is fringed with hair and the distal and inner margins carry six setae altogether. In the left leg basal 2 is swollen and on its inner face bears a row of seven spines that increase in size distally. Both rami are three-jointed. Exopod 1 bears a stout marginal spine. Exopod 2 bears a slender marginal spine and exopod 3 bears three spines, one on each margin near the distal extremity and one distally. The third segment of the exopod is short and stout and measures in length only about the same as the second segment.

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

Lucicutia flavicornis, A. Scott, 1909, p. 125.

Lucicutia flavicornis, Wolfenden, 1911, p. 323.

Lucicutia flavicornis, Sewell, 1912, p. 366.

Lucicutia flavicornis, Sewell, 1914, p. 228.

Lucicutia flavicornis, Sars, 1925, p. 207.

Lucicutia flavicornis, Farran, 1926, p. 274.

Lucicutia flavicornis, Farran, 1927, p. 262.

(non *Leuckartia flavicornis*, Brady, 1883).

This species has a wide distribution. It has now been recorded in Indian waters from the Malay Archipelago (Cleve ; A. Scott) the coast of Burma (Sewell) ; the Ceylon Pearl Banks (Thompson and A. Scott, Sewell) ; the Maldivé and Laccadive Archipelagoes (Wol-

fenden); the Agulhas Current and the S. African coast (Cleve) and the Red Sea (A. Scott). Examples have been taken by the "Investigator" at Stations 555, 558 and 614.

***Lucicutia maxima* Steuer.**

(Text-figs. 94, 96a-e).

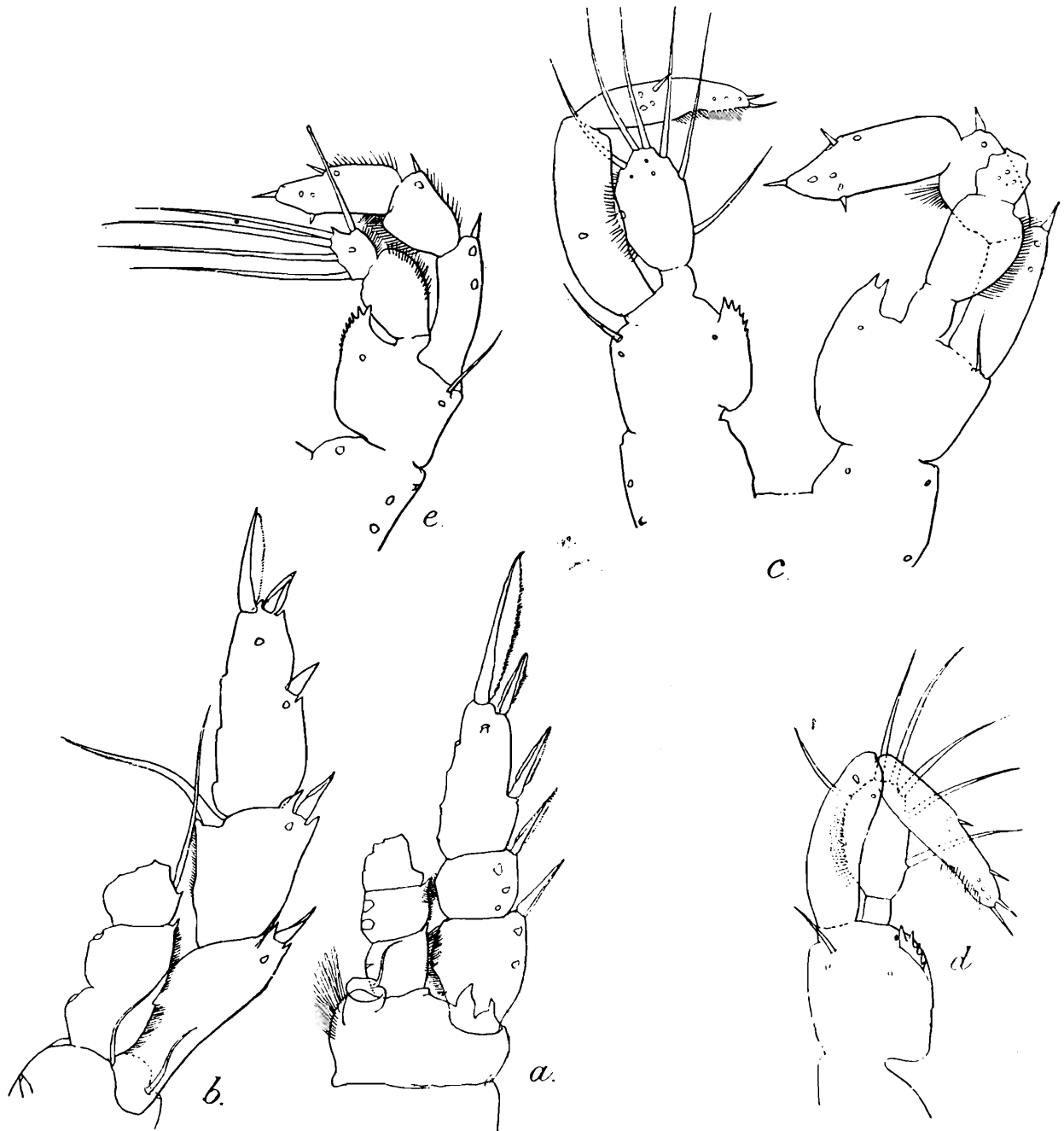
Lucicutia maxima, Steuer, 1904, p. 596, fig. 4.

Lucicutia maxima, A. Scott, 1909, p. 127, pl. xli, figs. 1-10.

Lucicutia maxima, Sewell, 1913, p. 354.

(non *Lucicutia maxima*, Sars, 1925).

A number of examples of a species of *Lucicutia*, both males and females, were taken by the "Investigator" at Station 393. The females agree closely with the description given



TEXT-FIG. 96.—*Lucicutia maxima* Steuer.

- a. The 1st swimming leg.
- b. The 5th leg, female.
- c. The 5th pair of legs, male.

- d. The right 5th leg of another example, male.
- e. The left 5th leg of another example, male.

by Steuer, and the males with the description and figures given by Scott; there can, therefore be little doubt that they belong to the above species. The form described by Sars under the same name, from the Atlantic, appears however to be different. The furcal rami of the female are considerably longer than in *Lucicutia maxima* and the general characters of the 5th pair of legs in the male also differ considerably from Scott's and the present examples.

♀ Total length 7.49 mm.

The proportional lengths of the cephalothorax and abdomen are as 90 to 71, so that the abdomen is contained 1.268 times in the length of the anterior region of the body.

The head and 1st thoracic segment are separate and thoracic segments 4 and 5 are fused. There is a well developed triangular spine present on each side of the head. The posterior thoracic margin is rounded.

The abdomen consists of four free segments, segments 1 and 2 being fused to form the genital segment. The furcal rami are symmetrical. The proportional lengths of the abdominal segments are as follows:—

Abdominal segment	1-2	3	4	5	Furca	
	23	13	12	15	37	=100.

The furcal rami are thus very nearly equal, in length to the last three segments of the abdomen. Sars in his description of the Atlantic form, which he considered to belong to this species, states that the furcal rami "sont beaucoup plus allongées occupant la demi-longueur de la queue." If this were so the proportional length would be in the neighbourhood of 50 instead of only 37.

The 1st antenna reaches back to the posterior end of the furcal ramus. Each antenna consists of 25 separate segments, having the following proportional lengths:—

Segment	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	
	13	15	19	23	24	23	22	22	22	23	26	29	47	53	59	63	65	65	68	53	50	50	50	44	22	=1000.

Open pores, connected apparently with gland cells contained within the segments of the antenna, are to be found on the proximal segments. Two are situated on the 1st segment and one each on the 2nd to 13th segments inclusive; they open on the posterior aspect.

The 2nd antenna and mouth-parts closely resemble those of the preceding species.

The swimming legs also closely resemble those of *Lucicutia maxima* Steuer but there are certain differences in the proportional lengths of the segments and terminal spine of the exopods. In the table below I have given the proportional lengths of these several parts;

	P. 1.	P. 2.	P. 3.	P. 4.	P. 5.
Exopod 1	35	49	49	48	58
Exopod 2	25	34	42	41	39
Exopod 3	51	87	98	94	54
End-spine	45	42	45	41	30

A comparison of these measurements with those given above (*vide supra*, p. 293) shows that there is little difference in the actual proportional lengths of the segments but the end-spine in all the legs except the 5th is appreciably shorter in the present species.

Associated with these females were certain males that agree closely with the description and figures given by A. Scott (1909). There seems to be a certain degree of variation in the character of the 2nd basal segment of the 5th left leg. According to Scott "the 2nd joint

of the basipodite of the left fifth foot is produced internally. The distal end of the process is furnished with two very stout teeth. The inner margin of the second joint of the basipodite of the right foot is similarly inflated, and bears four short teeth." In certain examples in the "Investigator" collection there is below the two stout teeth mentioned by Scott on the inner margin of the 2nd basal segment of the left leg a series of small teeth that may vary in number from a single one to as many as seven (*cf.* text-figs. 94 and 96). In all other respects the examples appear to agree, and I conclude that the species is variable in this character.

Copepodid Stage V.

Associated with the above adults were several immature examples in the 5th Copepodid stage of development. These I believe to belong to the same species.

Total length 6.05 mm.

The proportional lengths of the Cephalothorax and abdomen in this stage of development are as 71 to 54, so that the abdomen is contained 1.315 times in the length of the anterior region of the body.

The abdomen consists of only four segments; segments 4 and 5 have not yet become differentiated. The proportional lengths of the abdominal segments and the furcal rami are as follows:—

Abdominal segment	1	2	3	4.5	Furca
	13	14	13	23	37 = 100.

The general characters of the thorax and anterior region are similar to those of the adult.

The 1st antenna consists as in the adult of 25 free segments. These have the following proportional lengths:—

Segment	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Stage V	73	14	17	17	21	21	21	21	21	23	27	32	49	54	61	68	68	71	75	64	56	59	
Adult	63	15	19	23	24	23	22	22	22	23	26	29	47	53	59	63	65	65	68	53	50	50	50

For the purpose of comparison I have given the proportional lengths in the corresponding segments of the antenna in the adult; from these it will be seen that in the 1st segment there is a considerable decrease in the length in all the segments, between 2 and 10 there is a slight increase in size and distal to this point the lengths of the segments slightly decreases, the actual amount of this decrease being greatest about the 20th segment.

The 2nd antenna in its general form and proportions agrees with that of the adult, but there are differences in the number of setae that arise from the lobes of the distal segment of the endopod; in this stage there are 7 setae arising from the outer lobe and 6 from the inner instead of 8 and 7 respectively, as in the adult.

The mandible appears to have already assumed its adult form.

In the 1st maxilla the biting lobe bears 13 setae. The 2nd inner lobe bears 3 setae and the 3rd inner lobe and the 2nd basal each bear 3 setae; endopod 1 carries 4 and the rest of the endopod 5 setae. There are 9 setae on the exopod. Unfortunately the outer lobe was damaged during the process of dissection, I am, therefore, unable to state the number of setae present on it.

In the 2nd maxilla the 1st lobe bears 4 setae; the 2nd lobe bears 2 setae 3rd and 4th lobes each bear 3 setae.

The maxilliped is as in the adult; the proportional lengths of the two basal segment and the endopod are as 90; 128; 118. Basal 2 is four times as long as broad. In the endopod the proximal four segments each bear 2 setae and the terminal segment carries three long and a small external setae.

The anterior four pairs of legs have already assumed their adult characters. The 5th pair of legs possesses both rami that are composed of two segments only, segments 2 and 3 not yet having become

differentiated. The proportional lengths of the segments of the exopod and the end-spine in the legs are as follows :—

	P. 1.	P. 2.	P. 3.	P. 4.	P. 5.
Exopod 1 .	38	50	48	47	58
Exopod 2	24	32	39	38	} 84
Exopod 3	48	86	96	92	
End-spine .	45	45	51	46	39

Family HETERORHABDIDAE.

During recent years attempts have been made to divide this family into several genera, in order to accommodate species that showed clear evidence of affinity ; originally the only two genera in the family were *Heterorhabdus* Giesbrecht and *Disseta* Giesbrecht, but in 1905 G. O. Sars created the genus *Mesorhabdus* to accommodate the form *Mesorhabdus annectens* that has been taken by the “Princesse Alice” in the Atlantic Ocean ; A. Scott in 1909 added a second species, *M. truncatus* from the collections of the “Siboga” in the Malay Archipelago. The definition of the genus, as given by Sars, is as follows. “Genus intermediate between *Heterorhabdus* and *Disseta*, distinguished from the former by the structure of the mandibles and specially by that of the anterior maxillipeds (2nd maxillae), of which all the lobes are well-developed and furnished with setae, of which two only are transformed into claw-like spines.” In 1911 Wolfenden attempted to further subdivide the family and created the genera *Alloiorhabdus* and *Hemirhabdus*. The main character on which he based the separation of the genera is the number of setae arising from the segments of the endopods of the swimming feet. These he gives in the various genera of the family as follows :—

	<i>Heterorhabdus</i> .	<i>Alloiorhabdus</i> .	<i>Hemirhabdus</i> .	<i>Disseta</i> .
1st foot	1 2 4	1 2 5	1 2 5	1 2 5
2nd foot	1 2 5	1 2 7	1 2 7	1 2 8
3rd foot	1 2 6	1 2 8	1 2 7	1 2 8
4th foot	1 2 5	1 2 7	1 2 7	1 2 8
5th foot	1 1 4	1 1 6	1 1 6	1 1 6

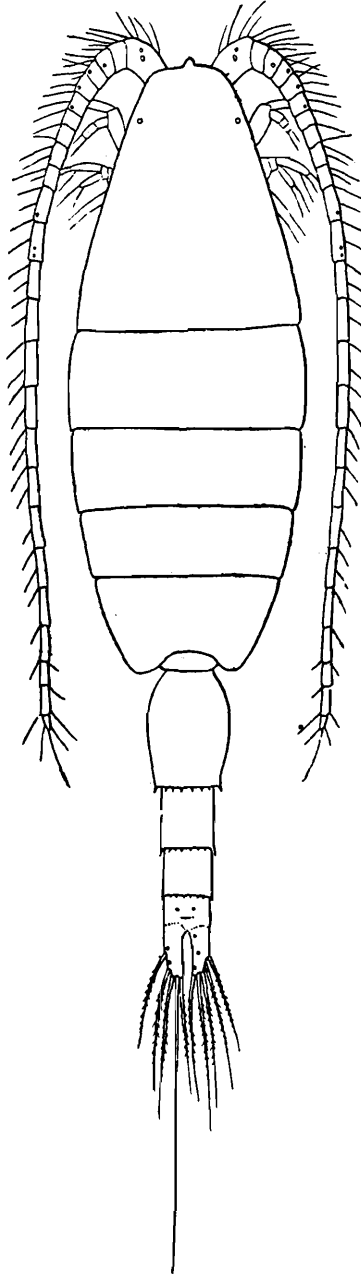
As in preceding families, the body is provided with cutaneous glands and pores but the number of such gradually decreases in the various genera as we pass from *Hemirhabdus* through *Heterorhabdus* and *Heterostylites* to *Disseta*.

Genus **HETERORHABDUS** Giesbrecht.

Cleve (1901) was the first to record the occurrence of *Heterorhabdus papilliger* (Claus) in the Malay Archipelago and in 1903 he also recorded it from the Gulf of Aden. In the latter year Thompson and A. Scott reported its occurrence in the Arabian Sea and added *H. spinifrons* (Claus), *H. abyssalis* (Giesbrecht) and *H. clausi* (Giesbrecht) from the same locality. In 1905 Cleve recorded *Heterorhabdus abyssalis* and *H. papilliger* from the Agulhas Current and also *H. tanneri* Giesbrecht and *H. austrinus* Giesbrecht from the same area. A. Scott in 1909 recorded the occurrence of *Heterorhabdus clausi*, *H. spinifrons* and *H. papilliger* from the “Siboga” collection in the Malay Archipelago.

In the genus *Heterorhabdus* there are but few cutaneous pores in the body ; in *Heterorhabdus papilliger* (Claus) I have only been able to discover a single pair of pores in the anterior region of the body, situated near the base of the 1st antenna in the lateral

region ; there are, however, several pores on the anal segment of the abdomen and on the furcal ramus, as shown in text-fig. 97. In addition to those on the dorsal aspect of the furcal rami there is a pair on the ventral aspect near the inner margin, the proximal being



TEXT-FIG. 97.—*Heterorhabdus papilliger* (Claus) showing the pores on the cephalon and the anal segment and furca.

near the base of the ramus and the distal about half-way along its length. There are two pores on the posterior aspect of the 1st segment of the 1st antenna and one each on segments 3-6 and 11, 12.

***Heterorhabdus clausi* (Giesbrecht).**

(Text-fig. 98 c, d).

Heterorhabdus clausi, A. Scott, 1909, p. 130.

Heterorhabdus clausi, Wolfenden, 1911, p. 303.

Two examples of this species, both females, were taken at "Investigator" Station 393. The species appears to be of wide distribution and has now been recorded from all three of the great oceans.

Heterorhabdus papilliger (Claus).

(Text-fig. 97).

Heterorhabdus papilliger, A. Scott, 1909, p. 131.*Heterorhabdus papilliger*, Wolfenden, 1911, p. 302.*Heterorhabdus papilliger*, T. Scott, 1912, p. 535.*Heterorhabdus papilliger*, Sewell, 1913, p. 354.*Heterorhabdus papilliger*, Sars, 1925, p. 229, pl. lxii, figs. 13-19.*Heterorhabdus papilliger*, Farran, 1926, p. 282.*Heterorhabdus papilliger*, Farran, 1929, p. 265.

This species is widely distributed throughout Indian waters. It has now been described from the Malay Archipelago (Cleve, A. Scott); the Arabian Sea (Thompson and A. Scott); the Gulf of Aden (Cleve) and the Agulhas Current (Cleve). Examples of this species occur in the "Investigator" collections from Stations 670 and 682.

Heterorhabdus spinifrons (Claus).*Heterorhabdus spinifrons*, A. Scott, 1909, p. 130.*Heterorhabdus spinifrons*, Wolfenden, 1911, p. 302.*Heterorhabdus spinifrons*, Sars, 1925, p. 227, pl. lxii, figs. 9-12.*Heterorhabdus spinifrons*, Farran, 1926, p. 282.*Heterorhabdus spinifrons*, Farran, 1929, p. 264.

The range of occurrence of this species appears to be co-extensive with that of the preceding species, *H. papilliger*. Examples have been taken by the "Investigator" at Stations 670 and 682.

Heterorhabdus vipera (Giesbrecht).*Heterochaeta vipera*, Giesbrecht, 1889, p. 812.*Heterochaeta vipera*, Giesbrecht, 1892, p. 373, pl. xxx, figs. 5, 6, 12, 13, 18, 20, 27; pl. xxxix, fig. 41.*Heterorhabdus vipera*, Giesbrecht and Schmeil, 1898, p. 116.*Heterorhabdus vipera*, Wolfenden, 1911, p. 303.*Heterorhabdus vipera*, Farran, 1926, p. 284.

This species has already been recorded from the Pacific and Atlantic Oceans; its occurrence in Indian waters is, therefore, not surprising. A single specimen, a female, was taken at "Investigator" Station 682.

Genus **Heterostylites** Sars.

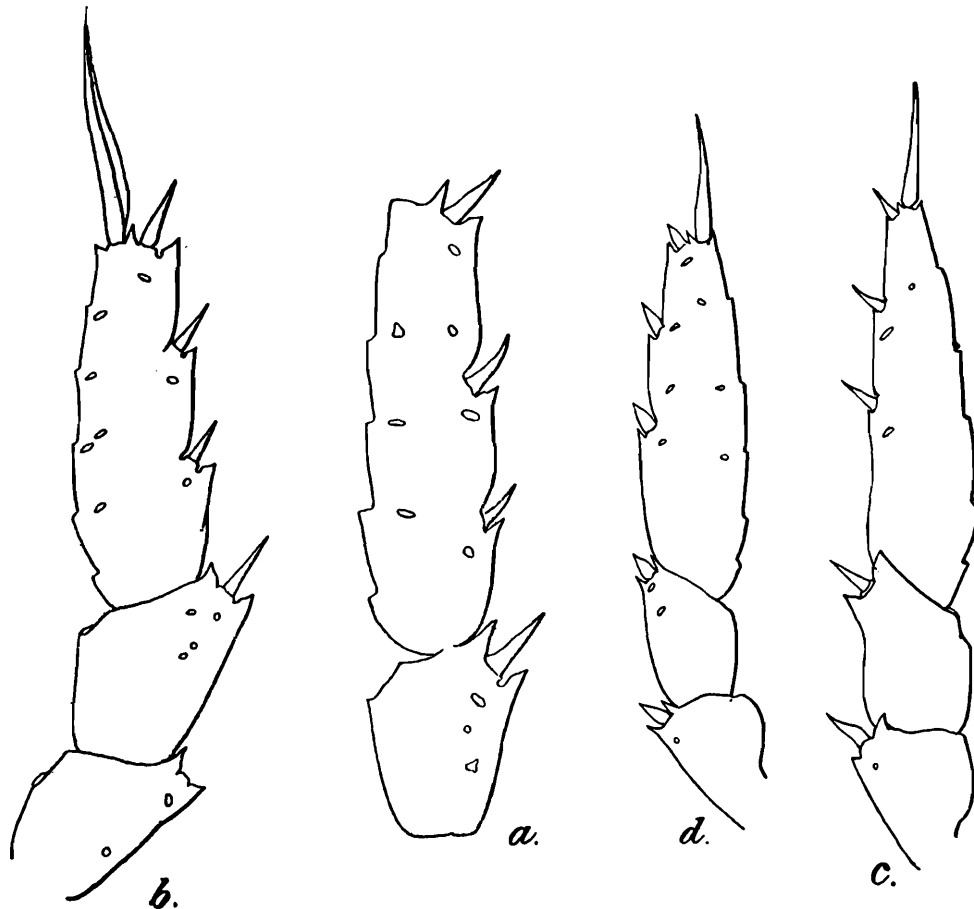
This genus was created by Sars in 1920 to accommodate two species that had hitherto been classed with the genus *Heterorhabdus*, namely *Heterostylites longicornis* (Giesbrecht) and *H. major* (Dahl). Up to the present time only the first of these species has been recorded from Indian waters. A. Scott (1909) recorded the occurrence of *Heterostylites longicornis* from the collections made by the "Siboga" and the same species occurs in the "Investigator" collections.

Heterostylites longicornis (Giesbrecht).

(Text-fig. 98 a-b).

Heterorhabdus longicornis, A. Scott, 1909, p. 131.*Heterorhabdus longicornis*, Wolfenden, 1911, p. 302.*Heterorhabdus longicornis*, Sewell, 1913, p. 354.*Heterostylites longicornis*, Sars, 1925, p. 238, pl. lxxvii, figs. 1-16.*Heterorhabdus longicornis*, Farran, 1926, p. 283.*Heterostylites longicornis*, Farran, 1929, p. 267.

This species is one of wide distribution, having now been taken in the Pacific Ocean, the Malay Archipelago, the Indian Ocean and in the Atlantic Ocean and its off shoots. Examples appear to be very variable as regards size; the female is usually stated to have a length measurement of 3.0 mm.; Farran, however, (1929, p. 267) gives the length of a specimen taken by the "Terra Nova" in the South Atlantic in Lat. 22° 6' at the surface as only 1.32 mm. Specimens taken by the "Investigator" measure 3.19 mm.; but Sars gives the size of his examples from the North Atlantic as 3.0 mm. Among the examples in the Norman Collection in the British Museum (Nat Hist.) are several examples of this species, most of which have an average length of 3.1 mm. but three other examples are con-

TEST-FIG. 98.—*Heterostylites longicornis* (Giesbrecht).

a. Exopod of 2nd swimming leg.

b. Exopod of 3rd swimming leg.

Heterorhabdus clausi (Giesbrecht).

c. Exopod of 2nd swimming leg.

d. Exopod of 3rd swimming leg.

siderably larger and measure 4.4 mm. This agrees with the results obtained by Farran (1908), who has found that off the West Coast of Ireland examples of this species fall into two

definite groups as regards size ; a smaller group having a length measurement of 3.0 to 3.5 mm. and a larger measuring about 4.5 mm. He states that he could detect no difference structurally between the members of these two groups.

In this species there is a large number of pores present on certain parts of the body and its appendages. In the body itself I have been able to detect two such pores on the anal segment of the abdomen, one situated laterally on the dorsal aspect near the articulation of the furcal ramus and the second in the ventro-lateral region at about the junction of the proximal and 2nd quarter of its length. Two other pores are situated on the furcal ramus, one on the dorsal aspect at the junction of the proximal and middle thirds of the length and the second near the base of the external seta. Pores are present on the basal segments of the 1st antenna ; on the 1st segment there are two pores on the anterior aspect at the junction of the proximal and middle thirds and a third pore lies on the posterior surface near the distal margin ; there is a single pore on each of the segments 3 to 6.

A single pore is present on basal 2 of the 2nd antenna. In the mandible there are two pores on the 2nd basal segment, one lying near the level of attachment of the exopod and the second a little more distal. In the 1st maxilla a single pore is present on the basal segment. In the 2nd maxilla basal 1 bears two pores near the posterior margin ; basal 2 has a single pore and there is a single pore on lobe 5. The maxilliped possesses a pore on basal 2 near the posterior margin at the junction of the proximal and middle thirds of its length. The number of pores on the segments of the swimming legs is also somewhat increased ; in most of the legs there are pores at the base of each of the marginal spines on the segments of the exopod and, further, in the 2nd, 3rd and 4th legs there are also pores opposite the origins of setae 2, 3 and 4 on the inner margin. In exopod 2 there are in the 2nd and 3rd legs several pores near the outer margin.

Heterostylites major (Dahl).

Heterochaeta major, Dahl, 1894, p. 79.

Heterorhabdus major, Giesbrecht and Schmeil, 1898, p. 117.

Alloiorhabdus medius, Wolfenden, 1911, p. 306, figs. 55a-i.

Heterostylites major, Sars, 1925, p. 239, pl. lxxvii, figs. 17, 18.

Heterostylites major, Farran, 1929, p. 267.

A single example of a male *Heterostylites* was taken by the "Investigator" at Station 463. This specimen measured as much as 5.0 mm. in total length, which agrees with the recorded size of Dahl's species. A careful examination, however, failed to reveal any structural difference between this large specimen and the smaller examples of *Heterostylites longicornis*, and I am very doubtful as to the validity of *H. major* (Dahl) as a true species.

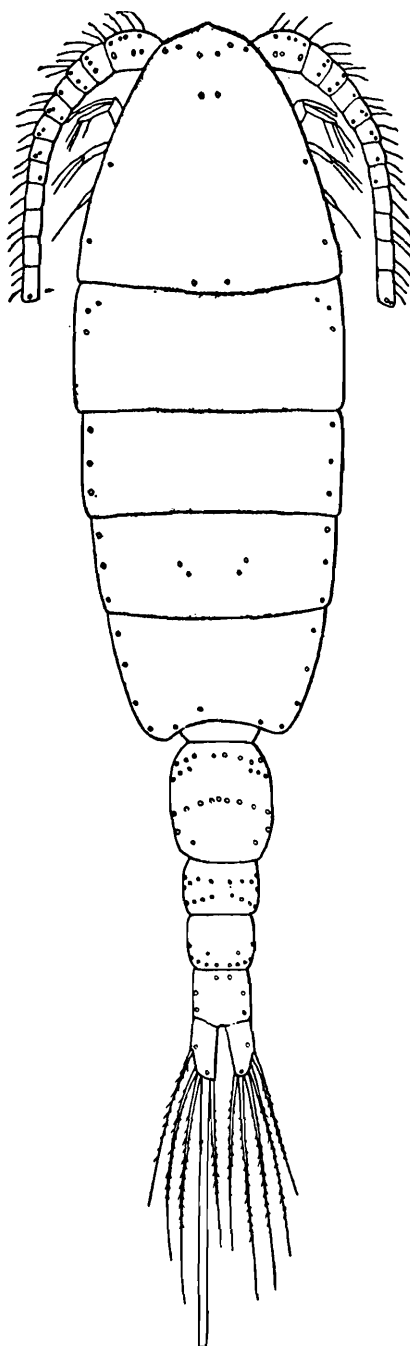
Genus **HEMIRHABDUS** Wolfenden.

Wolfenden (1911, p. 308) created the genus *Hemirhabdus* to include *Hemirhabdus grimaldii* (Richard) and a new species which had been taken by the "Gauss" and for which he proposed the name *H. falciformis*. He based his separation of this genus upon certain characters of the maxilla and maxilliped and, as already mentioned, on the number of setae arising from the endopods of the swimming legs. Sars in 1920 (p. 11) created a genus, which he termed *Macrorhabdus*, to accommodate the two species, *M. grimaldii* and

M. latus, but in his Monograph, published in 1925, he acknowledges the priority of Wolfenden's genus.

According to Wolfenden, the members of this genus possess the following number of setae on the segments of the swimming legs.

	Segments of endopod.		
	1	2	3
1st leg	1	2	5
2nd leg	1	2	7
3rd leg	1	2	7
4th leg	1	2	7
5th leg	1	2	6



TEXT-FIG. 99.—*Hemirhabdus grimaldii* (Richard) from the dorsal side, showing the distribution of the cutaneous pores.

He also states that this was the number of setae present in his examples of *Hemirhabdus grimaldii* and *H. falciformis*; Sars, however, in his figures of both *Hemirhabdus grimaldii* and *H. latus* (*loc. cit.* Pl. lxiii, fig. 12 and Pl. lxiv, fig. 13) shows the number of setae

on the segments of the 3rd swimming leg in both species as 1, 2, 8 and this is also the case in the specimens examined by me and obtained by the "Investigator" It would appear, therefore, that either Wolfenden is wrong in supposing that the setal formula for this appendage is 1, 2, 7 or that the number of setae is liable to variation.

In 1909 A. Scott under the name *Mesorhabdus truncatus* described from the Malay Archipelago a species that clearly belongs to this genus and is either identical with or very closely related to *Hemirhabdus latus* Sars.

In this genus, as in the preceding ones, the body is provided with a number of cutaneous glands and pores that open on the various segments of the body. In the anterior region the number of such pores is comparatively small and for the most these are situated in the lateral region of the cephalon and the thoracic segments. The abdomen and furcal rami are, however, provided with numerous pores that open on both the lateral and dorsal aspects. I have shown the distribution of these pores in *Hemirhabdus grimaldii* (Richard) in Text-fig. 99.

***Hemirhabdus grimaldii* (Richard).**

(Text-figs. 99, 100 a-f).

Heterochaeta grimaldii, Richard, 1893, p. 151.

Heterorhabdus grimaldii, Giesbrecht and Schmeil, 1898, p. 117.

Heterorhabdus grimaldii, Wolfenden, 1905, p. 10, pl. iv, figs. 3-5.

Heterorhabdus grimaldii, Farran, 1908, p. 66.

Hemirhabdus grimaldii, Wolfenden, 1911, p. 309, text-fig. 56.

Heterorhabdus grimaldii, Sewell, 1913, p. 354.

Macrorhabdus grimaldii, Sars, 1920, p. 11.

Hemirhabdus grimaldii, Sars, 1925, p. 230, pl. lxiii.

Hemirhabdus grimaldii, Farran, 1926, p. 284.

Up to the present time this rare species has only been recorded from the Atlantic Ocean. A single example was taken by the "Investigator" at Station 393.

♀ Total length 9.21 mm.

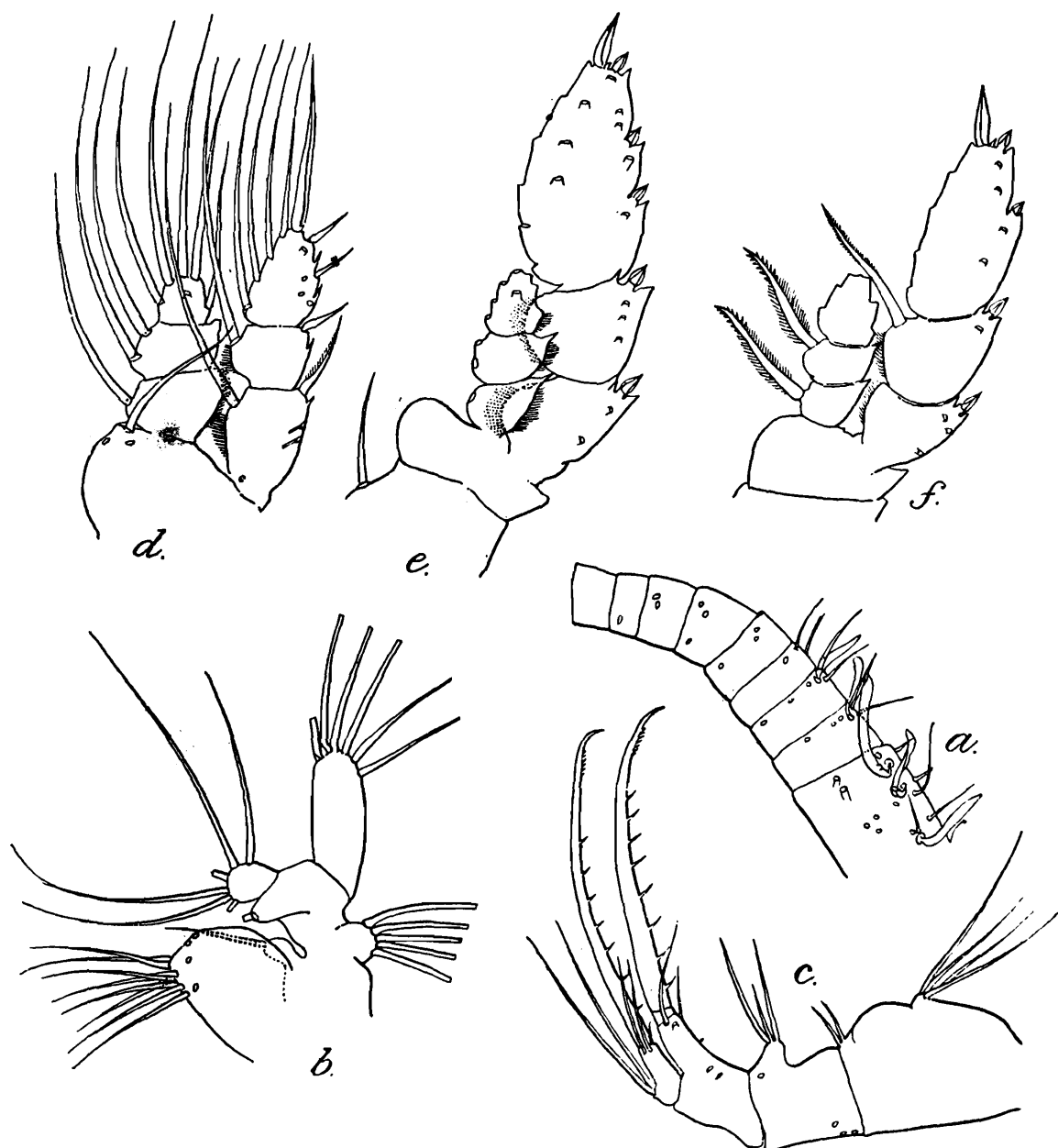
The proportional lengths of the cephalothorax and abdomen are as 265 to 121, so that the abdomen is contained 2.19 times in the length of the anterior region of the body.

The proportions of the abdominal segments are as follows :—

Abdominal segment	1-2	3	4	5	Furca	
	48	23	20	20	22	=100.

On the segments of the abdomen are several series of pores connected with gland cells lying within the segments. On the 1st segment (segment 1-2) there are a number of these pores arranged in a pattern as shown in Text-fig. 99. A single pore is situated in the middle dorsal line and on either side are least 16 others. On the 2nd free segment (segment 3) three pores, two close together anteriorly and a single one more posteriorly, lie in the lateral line and on the dorsal-lateral aspect are three pairs arranged antero-posteriorly. On the 4th segment near the posterior margin is a line of six pores, three on either side of the middle line, and a single pore lies on each side at the junction of about the anterior and middle thirds of the segment, while a pair open on each side laterally. In the 5th segment there are two pores near the anterior margin, one on either side of the middle line, and an antero-posteriorly arranged pair is situated on the lateral aspect. Two pores open on the dorsal aspect of the furcal ramus. It is possible that, in addition to those mentioned,

there may be others; for these pores are by no means easy to detect. A number of pores are also situated on the segments of the thorax, as I have indicated in the figure.



TEXT-FIG. 100.—*Hemirhabdus grimaldii* (Richard).

- a. The proximal segments of the 1st antenna.
b. The 1st maxilla.
c. The 2nd maxilla.

- d. The 1st swimming leg.
e. The 4th swimming leg.
f. The 5th leg.

The 1st antenna reaches to beyond the posterior end of the abdomen by the last four segments. Each antenna consists of 25 free segments that have the following proportional lengths :—

Segment	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	
	61	16	21	17	20	18	18	16	16	20	21	22	41	46	55	59	62	66	73	68	71	62	61	52	18	=1000.

The proximal segments bear numerous pores for small glands situated within the segment; of these there are 8-10 on segment 1; 3 on segments 2; 1 and 3 on segment 4; 3 on segment 5; 2 on segment 6; 2 on segment 7 and 1 on segment 8 and 1 on segment 12. Their respective positions are shown in Text-fig. 99.

The specimen from Indian waters appears to agree closely with those from the Atlantic Ocean.

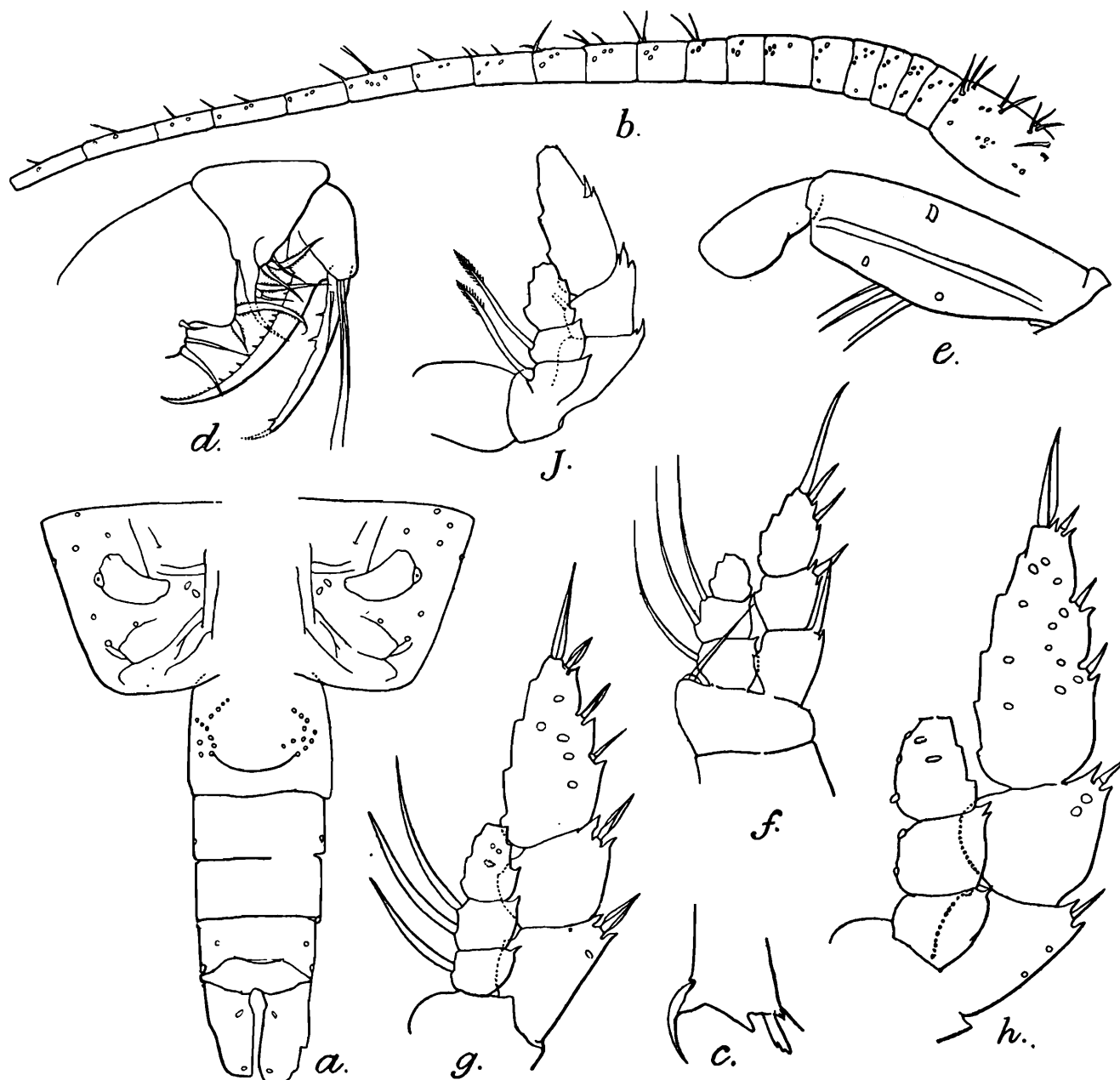
Hemirhabdus truncatus (A. Scott).

(Text-fig. 100 a-j).

Mesorhabdus truncatus, A. Scott, 1909, p. 132, pl. xxxix, figs. 12-21.? *Hemirhabdus latus*, Sars, 1925, p. 232, pl. lxiv.

A single example of this species was taken by the "Investigator" at Station 393 and two others at Station 682. All three are females.

♀ Total length 7.44 mm. This is rather larger than the measurement given by A. Scott for the type specimen, which measured only 7.0 mm. The proportional lengths of the cephalothorax and abdomen are as 99 to 38, the abdomen being thus contained 2.6 times in the length of the anterior region of the body.

TEXT-FIG. 101.—*Hemirhabdus truncatus* (A. Scott).

- a. The last thoracic and abdominal segments from the dorsal aspect.
- b. The proximal segments of the 1st antenna.
- c. The tooth-plate of the mandible.
- d. The 2nd maxilla.

- e. The 2nd basal segment of the maxilliped.
- f. The 1st swimming leg.
- g. The 2nd swimming leg.
- h. The 3rd swimming leg.
- j. The 5th leg.

The body is robust and the greatest diameter lies towards the anterior end near the suture between the cephalon and the 1st thoracic segment. The forehead is broadly rounded and is produced below in the middle line in a small papilla, from which arise the two long and delicate rostral filaments. The head and 1st thoracic segment are separate, but the 4th and 5th thoracic segments are fused. When viewed from the dorsal aspect the posterior thoracic margin appears to be somewhat truncated, as Scott has described, but when viewed from the side it is broadly rounded.

The abdomen consists of four segments, that have with the furcal rami the following proportional lengths :—

Abdominal segment	1-2	3	4	5	Furca	
	36	15	13	20	16	=100.

The genital segment is symmetrical. The furcal rami are slightly asymmetrical ; they are of equal length but the left ramus is slightly the wider. As in other members of the genus the 2nd seta on the left ramus is much elongated and is stronger than the others, though in this species its diameter is not much greater.

The various segment of the thorax and the abdominal segments bear a number of pores communicating with small gland-cells contained in the segments. There are at least ten pores on the ventro-lateral aspect of the fused 4th and 5th thoracic segments. On the ventral aspect of the genital segment there is on each side of the genital aperture a close group of pores extending in an arc on either side of the genital opening. The 3rd segment bears a single pore on the lateral aspect near the posterior margin of the segment. Segment 4 appears to be devoid of pores but the anal segment bears a pair in the ventro-lateral aspect and a more distally situated pair on the lateral margins. Each furcal ramus has two pores, one near the base on the inner side of the ventral aspect and the second near the extreme tip of the ramus.

The 1st antenna reaches back to about the posterior end of the genital segment. Each consists of 25 separate segments, which have the following proportional lengths :—

Segment	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	
	81	22	25	25	28	28	28	22	25	32	32	32	47	47	47	49	52	52	62	57	52	49	47	42	17	=1000.

The antennal setae are short and delicate. The segments of the appendage are thickly provided with pores, which are arranged in two series in the proximal segments. Segment 1 bears 10 or 11 pores ; segment 2 has 4 ; segment 3, 6 ; segment 4, 5 ; segment 5, 6 ; segment 6, 4 ; segment 7, 5 ; segment 8, 3 ; segment 9-14 each have 3 ; segment 15, 5 ; segment 16, 17 each 3 ; segment 18-19 each 2 ; segment 20, 1.

The 2nd antenna possesses unequal rami, the exopod reaching only two-thirds of the way along the length of the endopod.

The mandible and 1st maxilla agrees closely with those described by Scott. The 2nd maxilla closely resembles that of *Hemirhabdus latus* Sars ; lobes 1 to 4 bear respectively 3, 2, 3 and 3 setae, as figured by Sars (1925, pl. lxiiv, fig. 9) ; whereas A. Scott only shows two setae on each of these lobes. The third setae on lobes 1, 3 and 4 are, however, very small and may have been overlooked. Lobes 5 and 6 each bear a single stout claw armed with small spines along their margin.

The maxilliped agrees with that of *Hemirhabdus truncatus* as described by Scott. The 2nd basal segment of the maxilliped bears three pores on its inner aspect.

The 1st swimming leg closely resembles that of Scott's specimen. The 2nd basal segment bears a stout seta on its distal inner angle. Both rami are three-jointed. Exopod 1 bears a long slender marginal spine, that reaches well beyond the base of the spine on the 2nd segment, and a single seta arises from its inner margin. Exopod 2 bears a moderately long spine, that does not reach the base of the proximal spine on the 3rd segment; a single seta arises from the inner margin. Exopod 3 bears two marginal spines, on the proximal side of each of which the outer margin is produced in a claw-like process, and a long serrated end-spine that is considerably longer than the segment; four setae arise from the inner border. The endopod consists of three segments of which the 1st and 2nd are produced at their outer distal angles in short spine-like processes; the number of setae arising from the segments are 1, 2, 5.

The 2nd and 3rd swimming legs are very similar and closely resemble those of other members of the genus. They differ from each other in the number of setae that arise from the third segment of the endopod. In the 2nd leg the setae arising from the segments of the inner ramus are 1, 2 and 7, whereas in the third leg their number is 1, 2 and 8.

The 4th swimming leg closely resembles the third, but the number of setae arising from the endopod is 1, 2 and 7, as in the 2nd leg.

The 5th legs are well developed, but are somewhat smaller than the 4th. Each leg consists of a 2-jointed basal part and 3-jointed rami. The 1st segment of the exopod bears no seta. The 2nd segment bears a single seta that is, however, little, if at all, stouter than the setae arising from the third segment; the seta tapers to a fine point and its distal half is fringed with minute spinules. The distal segment of the exopod bears only two marginal spines. The endopod is three jointed and bears 1, 1 and 6 setae. The setae arising from the 1st and 2nd segments are coarse and spine-like, and are furnished in their distal quarter with rows of coarse teeth, while the proximal part is plumose.

Genus **MESORHABDUS** Sars.

This genus was created by Sars (1905, p. 9) to accommodate a species which he termed *M. annectens* to indicate that the species formed a connecting link between *Heterorhabdus* and *Disseta*. Since then the same author has described two other species, namely *gracilis* and *angustus*, from the North Atlantic Ocean. The original species has been shown to be synonymous with the species described by Wolfenden under the name *Heterorhabdus brevicaudatus*. In the present collections only a single species is present, namely *Mesorhabdus angustus* Sars.

Mesorhabdus angustus Sars.

Mesorhabdus angustus, Sars, 1907, p. 19.

Mesorhabdus angustus, Sars, 1925, p. 236, pl. lxvi, figs. 14-20.

A single specimen that appears to agree with Sars description and figures was taken by the "Investigator" at Station 682.

Genus **DISSETA** Giesbrecht.

Some confusion has arisen in the nomenclature of certain forms in this genus. Giesbrecht in 1889 described *Disseta palumboi* from the Pacific Ocean from the female only. In 1904 Wolfenden under the name *Heterorhabdus grandis* described what he considered to

be a new form from the West coast of Ireland, and subsequently in 1905 again under the same name described and figured both sexes, and it was not till 1909 that A. Scott recognised that this species is in reality a member of the genus *Disseta*. In the meantime Esterly had in 1906 described, under the name *Disseta grandis* a form that he took to be different from Giesbrecht's *Disseta palumboi* and which he had obtained in the San Diego region of the Pacific. In 1911 from the same region Esterly obtained and described examples of what he took to be Wolfenden's *Heterorhabdus grandis* under the name *Disseta* sp. and in the same paper described and figured a female *Disseta* that because of its large size he terms *Disseta maxima*. Finally in 1911 Wolfenden gave the name *Disseta atlantica* to the form that he had obtained in the Atlantic ocean. A. Scott (1909) and Sars (1925) are both of the opinion that Wolfenden's form is identical with Giesbrecht's *Disseta palumboi* and in this I concur. *Disseta maxima*, however, appears to me to be in all probability a different species, though very closely related; in this latter species the external spine on the 2nd segment of the exopod of the 5th swimming leg in the female is twice the length of the corresponding spine in *Disseta palumboi*. The form described by Brady in the "Challenger" Report in 1883 under the name *Leuckartia scopularis* is, as A. Scott (1909) has pointed out, in reality a member of this genus.

In this genus, or more properly speaking in *Disseta palumboi* Giesbrecht, since this is the only species in the genus that I have been able to examine, there are a few pores in the anterior region of the body and others on the various segment of the abdomen, as shown in text-fig. 102.

***Disseta palumboi* Giesbrecht.**

(Text-figs. 102, 103 *a-d*).

Disseta palumboi, Giesbrecht, 1893, p. 369, pls. xxix, xxx.

Disseta palumboi, A. Scott, 1909, p. 133, pl. xli, figs. 11-21.

Disseta atlantica, Wolfenden, 1911, p. 313.

Disseta palumboi, Sars, 1925, p. 221, pl. ix.

Disseta palumboi, Farran, 1929, p. 279.

This species appears to be one of wide distribution and, as is only to be expected, specimens taken from different localities exhibit considerable range of size. A similar variation in the measurements occurs in certain species belonging to neighbouring genera, notably *Heterostylites longicornis* Giesbrecht and *Mesorhabdus truncatus* A. Scott. Several examples of both sexes occur at Stations 393, 463 and 682.

♀ Total length 7.0 mm. These specimens from the "Investigator" collection agree closely in length with examples taken by Esterly in the Pacific Ocean. The length measurement of examples from the Atlantic Ocean is given by various observers as ranging from 5.7 mm. (Giesbrecht and Schmeil), 6.36-6.95 mm. (Farran) and 7.0 mm. (Sars), while specimens from the Malay Archipelago measured as much as 8.0 mm.

The proportional lengths of the cephalothorax and abdomen are as 201 to 116, so that the abdomen is contained 1.733 times in the length of the anterior region of the body. The forehead is somewhat truncated at the anterior end and there is a well developed medial swelling from which the two delicate rostral spines arise.

The head is crossed from side to side by a well marked groove forming a neck. The head and 1st thoracic segment are separate, but thoracic segments 4 and 5 are fused. The

posterior thoracic margins are rounded and that of the left side projects very slightly further backwards than that on the right.

The abdomen consists of four free segments and the furcal rami. The proportional lengths of the abdominal segments are as follows :—

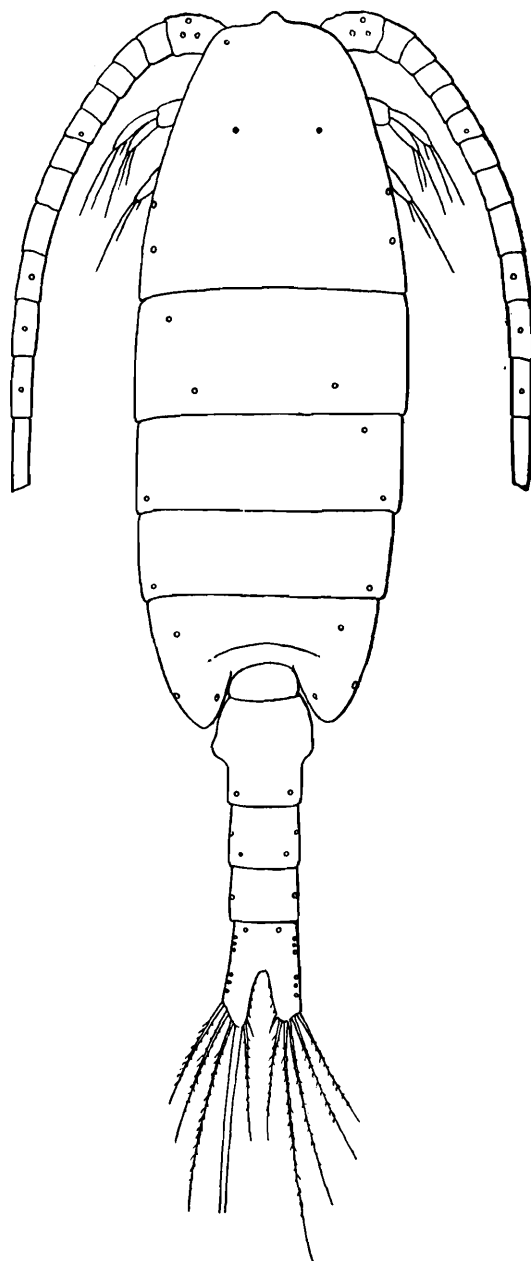
Abdominal segment	1-2	3	4	5	Furca	
	36	18	15	11	20	=100.

The genital segment is slightly asymmetrical. There is a swelling on each side in the proximal half of the segment but that on the right side is somewhat less rounded than that on the left and projects slightly further backwards. The posterior borders of the anterior three free segments is fringed with a row of needle-like spines.

The 1st antenna over-reaches the furca by the last three or four segments. The proportional lengths of the segments are as follows :—

Segment	1	2	3	4	5	6	7	8-10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
	53	14	14	14	17	17	17	48	22	22	40	46	56	67	76	82	77	66	58	48	65	58	23	=1000.

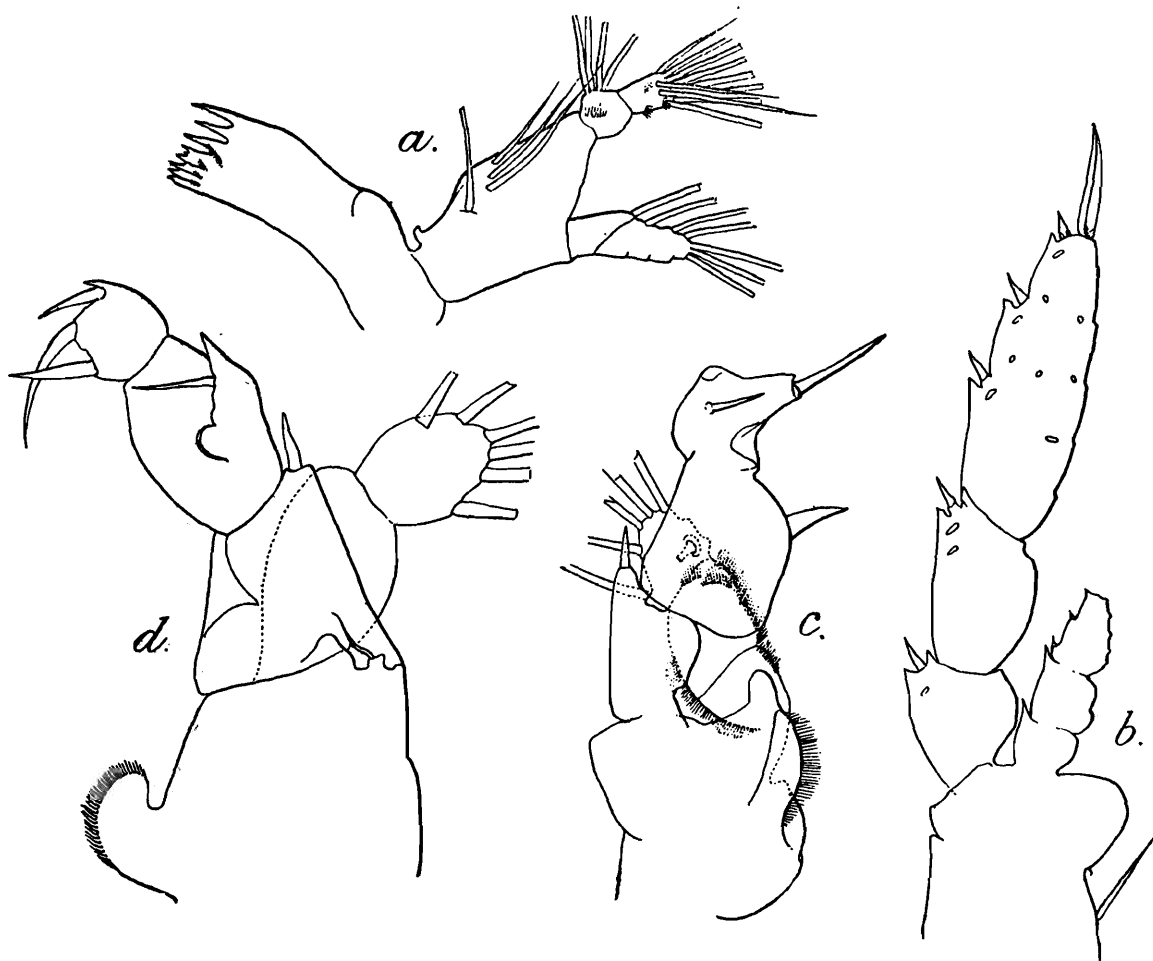
There are three pores on the 1st segment ; one on the 6th and one each on the 10th, 11th and 12th segments.



TEXT-FIG. 102.—Showing the arrangement of the cutaneous pores on the dorsal aspect of *Disseta palumboi* Giesbrecht.

In the 2nd antenna the exopod is somewhat shorter than the endopod. Basal 1 bears no seta ; basal 2 bears two setae at its distal end. The exopod consists of 8 segments of which segments 1 to 7 each bear a single seta and segment 8 carries three setae at its distal end and a single seta at about four-fifths of its length. The endopod is slightly longer than the exopod ; two unequal setae arise from the outer margin of exopod 1 about half way along its length and at their base a pore opens to the exterior. The inner aspect of both the 1st and 2nd segments are fringed with hairs.

The tooth-plate of the mandible (text-fig. 103 *a*) agrees exactly with the figure given by Giesbrecht (1892, pl. xxix, fig. 14). In the palp the 2nd basal segment bears 4 setae. The exopod is longer than the endopod and consists of five segments, of which segments 1-4 each bear a single seta and segment 5 has 3. Endopod 1 bears 4 setae and is also armed with a tuft of small spines ; endopod 2 bears ten setae and is similarly armed with delicate spines on its inner aspect, while a row of fine needle-like spines runs across the distal end close to the bases of the setae.



TEXT-FIG. 103.—*Disseta palumboi* Giesbrecht.

a. The mandible.

b. The 3rd swimming leg.

c. The right 5th leg.

d. The left 5th leg.

The 1st maxilla has the usual characters. The 1st or biting inner lobe bears 13 spines : lobe 2 has only 1 and lobe 3 bears 3. The 2nd basal segment carries 4 setae ; endopod 1 has 3 and the fused segments endopod 2 and 3 bear respectively 4 and 5, thus agreeing with Giesbrecht's description of *Disseta atlantica*. The exopod carries 5 small and 6 large setae and between the bases of the 5th and 6th of the latter a pore opens to the exterior. The outer lobe has 6 (?) setae.

In the 2nd maxilla the various lobes bear the following number of spines or setae ; lobe 1 bears 6, of which one is very small and spine-like ; lobes 2, 3 and 4 each bear 3 ; lobe 5 bears 3 setae and a stout toothed spine, and the distal aspect of the lobe is fringed with delicate hairs. The endopod carries 10 setae.

In the maxilliped, basal 1 bears 1 seta on lobe 1 and 3 setae on each of lobes 2 and 3 ; lobe 3 is covered with small spines on its distal aspect. Basal 2 bears 3 setae on its anterior margin and 2 distally ; the proximal one-third of the anterior margin is fringed with long hairs and a band of spines runs along the segment as far as the base of the third seta. The endopod consists of 5 segments bearing respectively 3, 3, 3, 3 and 4 setae. Endopod 1 to 4 are all armed with needle-like spines.

In the 1st swimming leg the marginal spines of the exopod are all of the type figured by Esterly (1911, pl. xxx, fig. 80 and pl. xxi, fig. 100).

The 5th pair of legs agrees with Giesbrecht's figures (1892, pl. xxix, fig. 24).

♂ Total length 6.44 mm.

The proportional lengths of the cephalothorax and abdomen are as 19 to 10, so that the abdomen is contained in this sex 1.9 times in the length of the anterior region of the body. The right posterior thoracic margin is more sharply rounded than the left and projects slightly further backwards. As in the female the posterior margins of the abdominal segments are fringed with fine spines and the furcal rami are asymmetrical, that on the left side being the larger.

Of the 1st antennae that on the left side is modified to form a grasping organ, whereas that on the right side retains its female character. The proportional lengths of the segments are as follows :—

Segment	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	
Right	53	14	15	16	16	16	16	49			23	26	43	49	57	64	72	77	73	59	54	55	64	61	27	=1000.
Left	80		27	24	24	25	27	21	21	21	21	24	35	53	70	80	75	48	101		130			62	31	=1000.

In the grasping antenna segments 1 and 2 are fused, but segments 8, 9 and 10 are separate. The knee joint is in the usual situation between the 18th and 19th segments and beyond this joint the distal part of the antenna is composed of four segments, segments 19 and 20, and 21 to 23 respectively being fused.

The 2nd antenna, mouth-parts and swimming legs appear to be similar to those of the female.

The 5th pair of legs are as figured (text-fig. 103 *c, d*) and agree closely with the description and figures given by Sars (1925) and A. Scott (1909).

Family AUGAPTILIDAE.

Farran, writing in 1908, drew attention to the difficulty of correctly identifying the various species in this family and of forming any clear idea of their mutual relationships. As he remarked, of all the species known at that time only nine had been figured. Farran himself added four new species to the already existing thirty-one, and since then A. Scott has added two, and Wolfenden four additional species. In a number of instances the published descriptions, especially those given by Sars in his preliminary account of thirteen new species taken by the "Princesse Alice" in the Atlantic and Mediterranean waters, were so unsatisfactory that it was very difficult to be certain that the same species had not

been described by different authors under different names, and, owing to the extraordinary range of size to which individuals attain, examples of this family appear to be particularly liable to this. Farran has recorded that examples of *Euaugaptilus nodifrons* Sars taken off the west coast of Ireland measured from 5.4 mm. to 7.1 mm.; Sars gives the length measurement of his original examples as 5.2 mm., and of two males that I obtained in the "Investigator" collections the sizes are respectively 4.8 mm. and 5.75 mm. Again *Euaugaptilus filigerus* (Claus) is stated to have a length measurement of 4.9 mm.; but one example in the "Investigator" collection measured 6.6 mm. Such an excessive range of length measurement is extremely likely to betray authors into the belief that they are dealing with new species and I am inclined to believe that this has indeed happened.

In 1920 Sars created the genus *Euaugaptilus* to accommodate a number of species that had previously been referred to the genus *Augaptilus* and he also separated off a second genus *Centraugaptilus* to accommodate the anomalous species *Centraugaptilus rattrayi* (T. Scott) and two other closely-allied species. Even so, in the genus *Euaugaptilus* he includes twenty-nine species and there are several others that he does not mention that must also be included. The chief structural differences on which Sars bases the separation of *Euaugaptilus* from *Augaptilus* (*sensu stricto*) are to be found in the very great reduction of the mandibular palp and the maxilla in the latter genus and their more perfect development in the former. He remarks (*loc. cit.*, 1925, p. 261). "Ces deux appendices montrent cependant en leurs détails assez de variation, et fournissent ainsi des caractères spécifiques excellents." A study of the numerous members of this new genus seems to me to indicate that there should be still further subdivision, if not into actual new genera at least into subgenera or groups. The reduction of the mouth parts, to which Sars has drawn attention, is also accompanied by changes in the 2nd antenna and one can distinguish a progressive series of groups, commencing at one end of the series with forms in which all the various parts of the 1st maxilla are present and bear setae, the mandibular palp possesses both exopod and endopod and the exopod of the 2nd antenna is fully developed and consists of 8 segments; then passing through different stages in which, first, the endopod of the 1st maxilla is suppressed, after which the suppression affects in turn the 3rd inner lobe and then the 2nd inner lobe; later, the endopod of the mandible disappears; and finally the exopod of the 2nd antenna is reduced to 4 segments. It is difficult to devise any method of separation into groups that does not, to some extent, appear to separate forms that in certain respects closely resemble one another, but for the practical purposes of taxonomy any scheme of separation of this unwieldy group into smaller groups must be of considerable service, even though it does represent the not genetic relationships.

Group 1.—Maxilla of normal type, endopod and lobes 1, 2 and 3 present. Mandibular palp possesses two rami. Exopod of 2nd antenna consists of 6-8 segments;

(a) 8 segments in exopod of 2nd antenna

Euaugaptilus nodifrons Sars.

Euaugaptilus indicus, sp. nov.

(b) 7 segments in exopod of 2nd antenna;

Euaugaptilus elongatus Sars.

Euaugaptilus farrani Sars.

Euaugaptilus maxillaris Sars.

- (c) 6 segments in exopod of 2nd antenna ;

Euaugaptilus simplex Wolfenden.

Euaugaptilus humilis Farran seems to be an aberrant form in which the mandible and 2nd antenna possess the characteristics of group 1, but in which the maxilla has begun to show signs of reduction ; lobe 2 is absent and lobe 3 bears only a single seta, but the endopod is present. A second aberrant form, that agrees with group 1 in the possession of a two-branched mandibular palp and a well-developed exopod on the 2nd antenna, having 8 segments ; but in which lobes 2 and 3 of the maxilla have been suppressed, though the endopod is still present, is represented by *Euaugaptilus penicellatus* Sars.

Group 2.—Maxilla shows partial suppression, the endopod is missing but lobes 2 and 3 are present. The mandibular palp possesses two rami. The exopod of the 2nd antenna consists of 3 to 8 segments ;

- (a) 8 segments in exopod of 2nd antenna—

Euaugaptilus laticeps Sars.

Euaugaptilus squamatus (Giesbrecht).

Euaugaptilus subfiligerus (Wolfenden).

- (b) 7 segments in exopod of 2nd antenna ;

Euaugaptilus antarcticus (Wolfenden).

Euaugaptilus filigerus (Claus).

Euaugaptilus magnus (Wolfenden).

Euaugaptilus oblongus Sars.

? *Euaugaptilus rostratus* Esterly.

Euaugaptilus tenuispinus Sars.

- (c) 3 segments in exopod of 2nd antenna ;

Euaugaptilus fungiferus Steuer.

Group 3.—Maxilla still further reduced ; both endopod and lobe 3 absent ; lobe 2 present. Rami of mandibular palp equally developed. Exopod of 2nd antenna of 4 to 8 segments.

- (a) 8 segments in exopod of 2nd antenna.

Euaugaptilus affinis Sars.

Euaugaptilus angustus Sars.

Euaugaptilus facilis (Farran).

Euaugaptilus gracilis Sars.

Euaugaptilus grandicornis Sars.

Euaugaptilus propinquus Sars.

Euaugaptilus palumboi (Giesbrecht).

- (b) 7 segments in exopod of 2nd antenna ;

Euaugaptilus digitatus Sars.

- (c) 4 segments in exopod of 2nd antenna ;

Euaugaptilus clavatus Sars.

Euaugaptilus gibbus Wolfenden.

An aberrant form in this group, in which the mandibular palp has become reduced and now only bears an exopod, is represented by *Euaugaptilus longicirrhus* Sars.

Group 4.—In the maxilla the endopod and lobes 2 and 3 are absent and the masticatory lobe is also considerably reduced, bearing only 2-5 setae.

A. The endopod of the mandibular palp present but may be considerably reduced. Exopod of 2nd antenna consisting of 7-8 segments.

(a) 8 segments in exopod of 2nd antenna ;

Euaugaptilus bullifer (Giesbrecht).

Euaugaptilus truncatus Sars.

(b) 7 segments in exopod of 2nd antenna—

Euaugaptilus longimanus Sars.

Euaugaptilus vicinus Sars.

B. Endopod of mandibular palp absent altogether or represented only by a seta. Exopod of 2nd antenna of 8 segments ;

Euaugaptilus latifrons Sars.

Euaugaptilus hecticus (Giesbrecht).

Euaugaptilus rigidus Sars.

Euaugaptilus tenuicaudis Sars.

Group 5.—Genus *Augaptilus* (*sensu stricto*). Maxillary palp bears only a single seta on the masticatory lobe ; lobes 2 and 3 and endopod absent. Exopod of mandibular palp absent and the whole structure reduced to a triarticulate process. Exopod of 2nd antenna of 4 segments only ;

Augaptilus anceps Farran.

? *Augaptilus cornutus* Wolfenden.

Augaptilus glacialis Sars.

Augaptilus longicaudatus (Claus).

Augaptilus megalurus Sars.

Augaptilus spinifrons Sars.

A. Scott unfortunately gives no details of the maxilla in either of the two species *Augaptilus placitus* and *A. validus*, described by him from the Malay Archipelago. In both the mandibular palp bears two well developed rami. He states that *E. placitus* comes near to *E. squamatus*, while *E. validus* would seem to come near to *E. magnus* (Wolfenden).

In this family the number of cutaneous pores is still further reduced. In the genus *Euaugaptilus* and, so far as I have been able to make out, in the genus *Haloptylus* also, there is a pair of pores on the lateral aspect of the head and two on each side of the labrum. In the anal segment of the abdomen there is a pair of pores in the dorso-lateral region near the margin of the anal flap, and a pair of minute openings are present on the ventral aspect of the furcal ramus. I have been unable to detect any pores on the antennae or mouth-parts. In the 1st swimming leg there are two openings on the lateral margin of the 2nd segment of the exopod and a single aperture on the margin of the 3rd segment. Pores appear to be completely absent from the 2nd swimming leg. In the 3rd and 4th swimming legs there is a large pore near the base of the marginal spine on the 2nd segment of the exopod and a similar one near the distal end of the 3rd segment. I could detect no pores on the 5th leg.

Genus **EUAUGAPTILUS** Sars.

Cleve (1904, a.) recorded *Euaugaptilus palumboi* (Giesbrecht) from the Agulhas Current and in 1909 A. Scott recorded seven species in the "Siboga" collections from the Malay Archipelago, namely *Euaugaptilus bulbifer* (Giesbrecht), *E. filigerus* (Claus), *E. heticus* (Giesbrecht), *E. longicaudatus* (Claus), *E. palumboi* (Giesbrecht), *E. placitus* (A. Scott) and *E. validus* (A. Scott).

In the "Investigator" collections I have been able to recognise up to the present time eleven species, belonging to the genus *Euaugaptilus*, and among these are representatives of each of the four groups, into which I propose to subdivide this genus.

GROUP I.

***Euaugaptilus nodifrons* Sars.**

(Text-fig. 104, a-j).

Augaptilus nodifrons, Sars, 1905, p. 13.

Euaugaptilus nodifrons, Farran, 1908, p. 72.

Euaugaptilus nodifrons, Sars, 1925, p. 267, pl. lxxxii.

? *Augaptilus simplex*, Wolfenden, 1911, text fig. 76 a-d.

This species would appear to be one of wide distribution. Sars (1925) gave the then known distribution as "Ocean Atlantique et Pacifique,"; but I have been unable to trace any record of its occurrence in the latter region. It is to be presumed that Sars himself has recognised this species in some collection other than those of the "Princesse Alice" from the Mediterranean and Atlantic regions. The form described by Wolfenden (*loc. cit.*) from the "Gauss" collection from the Southern Atlantic Ocean under the name *Augaptilus simplex* is clearly a member of Sars' new genus and shows a very close resemblance to *Euaugaptilus nodifrons*. There are one or two small differences between the two accounts; as for instance in the number of segments in the exopod of the 2nd antenna; Sars figures 7 segments in *E. nodifrons*, whereas Wolfenden states that there are 6 in *Augaptilus simplex*, but the 1st segment of Wolfenden's form would seem to correspond to the proximal two segments in Sars' species. In all important respects the two forms agree and I am inclined to regard them as the same species, in which case Sars' name has priority.

Examples of both sexes were taken by the "Investigator" at Stations 670 and 682.

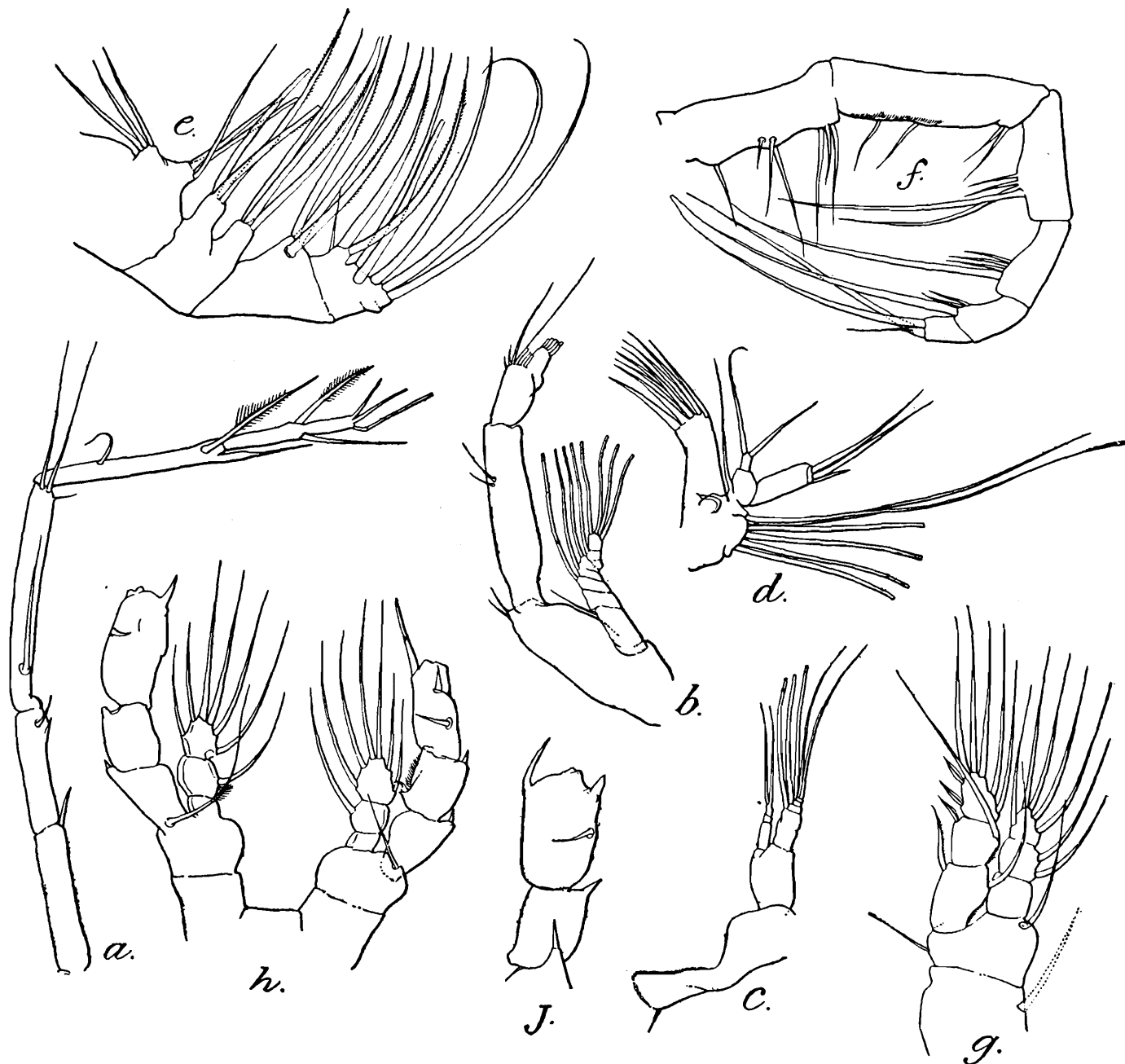
♂ Total length 4.8 mm. and 5.75 mm. respectively in the two examples.

The proportional lengths of the cephalothorax and abdomen are as 61 to 16, so that the abdomen is contained 3.81 times in the length of the anterior region of the body. The cephalic segment is decidedly longer than the thoracic segments together. The head and 1st thoracic segments are separate but thoracic segments 4 and 5 are fused. The posterior thoracic margin is rounded. The forehead closely resembles that of *Euaugaptilus latifrons* Sars it is rounded and in the middle line below bears two unequal tuberosities, the upper of which is the smaller, while the lower, over which the chitin is thickened, corresponds to the base of the rostrum. There are no rostral filaments.

The abdomen consists of five segments, which have with the furcal rami the following proportional lengths :—

Abdominal segment	1	2	3	4	5	Furca
	27	13	12	12	16	20=100.

The furcal rami are nearly twice as long as broad and bear five setae, of which the outer two arise from the external margin and are considerably shorter than the others. As Sars (1925, p. 268) notes these two outer setae are plumose, while the others appear to be smooth.



TEXT-FIG. 104.—*Euauaptilus nodifrons* Sars, male.

a. Distal segments and knee-joint of left 1st antenna.

b. 2nd antenna.

c. Mandibular palp.

d. 1st maxilla.

e. 2nd maxilla.

f. Maxilliped.

g. 1st swimming leg.

h. 5th pair of legs.

j. Distal segments of exopod of right 5th leg.

The 1st antenna on the right side is unmodified and consists of 24 separate segments, segments 1 and 2 being partially fused. The proximal segments are crowded with large numbers of sensory filaments and the setae arising from the segments are long and slender.

The whole appendage reaches back to about the level of the tip of the furcal ramus. The proportional lengths of the various segments are as follows :—

Segment	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
	59	15	18	18	21	21	27	32	39	44	56	58	55	53	62	64	64	59	41	43	37	44	40	30=1000.

On the left side the antenna is modified to form a grasping organ ; the proximal segments here also are crowded with setae and sensory filaments. The knee-joint lies between the 18th and 19th segments and the segments 19-21 and 22-23 are fused together. The proportional lengths of the terminal joints are as follows :—

Segment	17	18	19-20	22-23	24	25
	70	59	121	102	45	27

The 2nd antenna possesses very unequal branches : the outer ramus arises from the proximal part of the 2nd basal segment and is about half the length of the inner ramus ; it consists of 7 segments, of which the 1st is by far the longest but appears to bear no setae. Segments 2 to 6 each bear a single long seta and the distal segment bears three setae terminally and a fourth on its margin. The distal segment of the inner ramus is about one-half the length of the proximal segment and bears five long setae on its outer lobe and eight setae, of which the inner three are short, on its inner lobe. Wolfenden in his description of *Euaugaptilus simplex* states that there are only six segments in the inner ramus, but as the appendage appears to agree in every other respect I am inclined to think that he must be in error.

The mandible consists of a well-developed biting part, in which the teeth in the specimen examined were, unfortunately, missing. The palp is well-developed and consists of a basal part and two rami ; the inner ramus is of slender build, and is somewhat reduced though three segments appear to be present. It bears two moderately long setae on its terminal segment. The outer ramus is fully developed.

The 1st maxilla has a well-developed masticatory lobe that bears eight setae on its distal extremity. Sars (1905, p. 14) in his original account of the species states that there is only a single " submaxillary lobule " Farran (1909, p. 72), however, found all three lobes to be present in the specimens from the Irish Coast that he examined, though they were small. Sars' later account (1925, p. 268, pl. lxxxii, fig. 7) agrees exactly with Farran's and the structure of the maxilla in my examples is also in agreement. Wolfenden describes the condition present in *Euaugaptilus simplex* as consisting of two lobes, each with a terminal seta, so that in this respect his species agrees exactly with *E. nodifrons*. The rest of the appendage in my examples agrees exactly with the description given by Sars. The outer lobe bears six setae, whereas Wolfenden states that in *E. simplex* there are only five.

The 2nd maxilla and the maxilliped agree with the descriptions given by Sars and Wolfenden.

The 1st swimming leg consists of a two-jointed basal part and three jointed rami. The 1st basal segment appears to have a seta on its inner margin ; in my example the seta itself is missing but its place of attachment is clearly visible. The 2nd basal bears a slender seta on its outer border and a stouter one at the distal inner angle. The 1st segment of the exopod carries a moderately long and stout seta-like marginal spine. Exopod 2 bears a single, and exopod 3 two equal marginal spines.

The 2nd swimming leg closely resembles that of *Euaugaptilus filigerus* (Claus) as regards the manner in which the marginal spines on the terminal segments are sunk in the outer borders.

The 5th pair of legs are of the usual type and agree exactly with Sars' figure (*loc. cit.* 1925, pl. lxxxii, fig. 14). The two outer setae arising from the terminal segment are in each limb much smaller than the others.

***Euaugaptilus indicus*, sp. nov.**

(Text-fig. 105, *a-j*.)

Two examples were taken by the "Investigator" at Stations 670 and 682 respectively of what appears to be a new species.

♀ Total length, 6.68 mm.

The proportional lengths of the cephalothorax and abdomen are as 43 to 12, so that the abdomen is contained 3.6 times in the length of the anterior region of the body.

The forehead is rounded and is produced below in a rounded prominence, bearing two long and delicate rostral spines; at the base of this prominence is a small angular projection. The head and 1st thoracic segment are separate; thoracic segments 4 and 5 are fused together. The posterior thoracic margin is slightly emarginate.

The abdomen is symmetrical and consists of the usual three segments and the furca. The proportional lengths of the segments are as follows:—

Abdominal segment	1-3	4	5	Furca
	41	8	20	31=100.

The above measurement does not however, represent the full extent of the middle segment (segment 4) as nearly one-half of its length was telescoped into the genital segment. The genital aperture exhibits a well-marked rounded projection on the ventral aspect of the segment.

The 1st antenna reaches back to a little beyond the tip of the furcal ramus, overlapping it by about the last segment. The proportional lengths of the segments are as follows:—

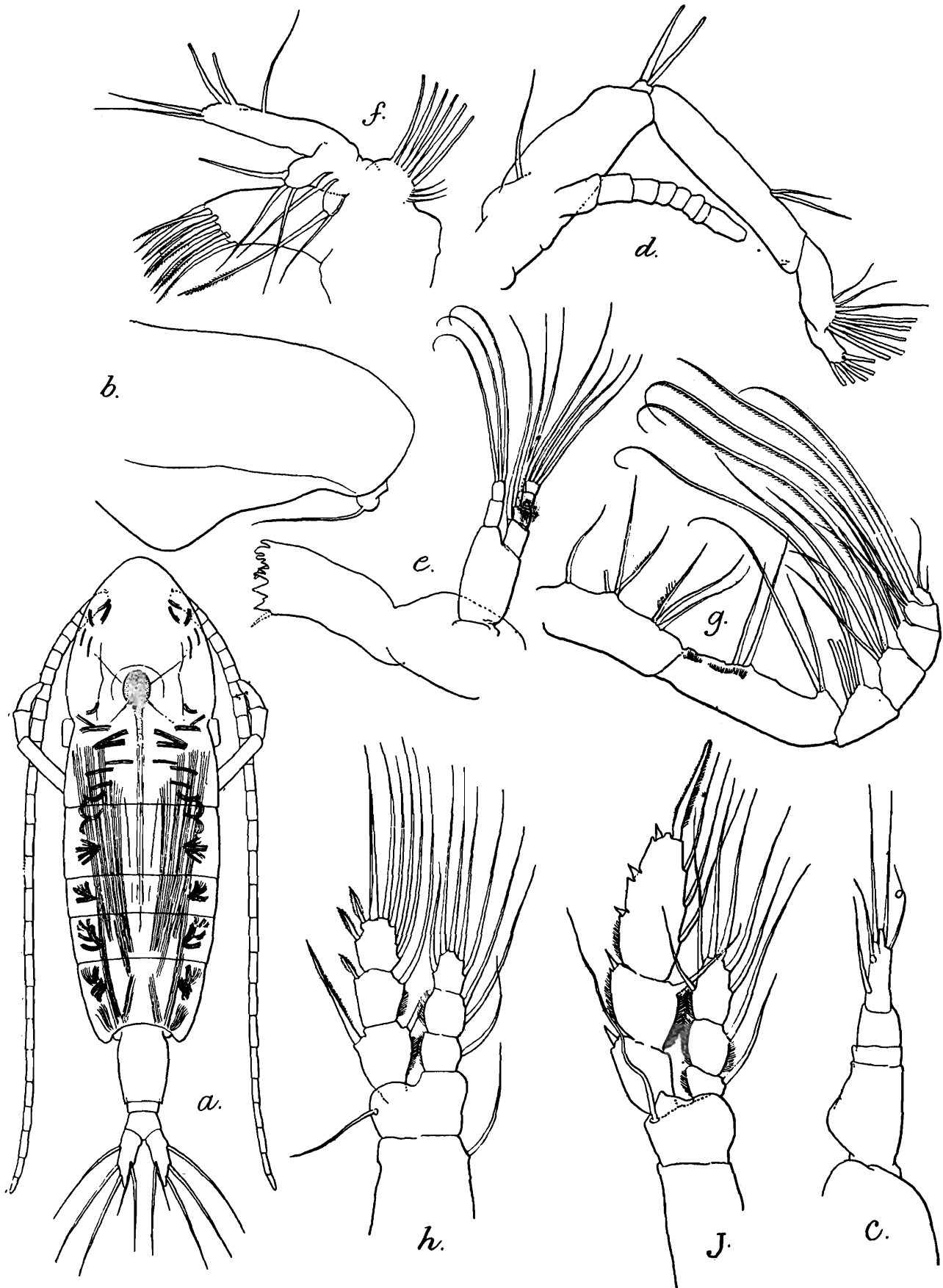
Segment	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	67	19	22	22	22	22	24	26	29	31	34	45	50	53	54	56	56	56	57	46	46	42	50	48	25=1000.

There are 25 free segments in the appendage; segments 1 and 2 being separate, whereas in *Euaugaptilus nodifrons* Sars they are partially fused. The segments of the antenna bear long and delicate setae.

The 2nd antenna closely resembles that of *Euaugaptilus truncatus* Sars. The endopod consists of the usual two segments, of which the 1st is about twice as long as the 2nd. The exopod possesses eight segments.

The mandible possesses a well-developed biting edge, furnished with 8 teeth, very similar to those of *Euaugaptilus simplex* (Wolfenden). In the palp, which is well-developed, the endopod consists of two segments only and is shorter than the exopod, which has 4 segments; of these segments 1 to 3 each bear a single seta, but in the example examined the seta on segment 2 arises as a single one, and after a short distance bifurcates into two. The terminal segment of the exopod bears 4 setae and that of the endopod 3.

The 1st maxilla is fully formed. The 1st inner or masticatory lobe bears 9 serrated spines. The 2nd lobe carries a long serrated spine and a shorter seta. The 3rd lobe bears

TEXT-FIG. 105.—*Euaugaptilus indicus*, sp. nov.

- a. The female from the dorsal aspect.
 b. The head from the right side.
 c. The abdomen from the right side.
 d. The 2nd antenna.

- e. The mandible.
 f. The 1st maxilla.
 g. The maxilliped.
 h. The 1st swimming leg.

- j. The 5th leg.

a single seta. Basal 2 bears two setae and there is a very small endopod, bearing a single seta. The exopod is elongated and bears 5 setae; and the outer lobe carries 6 long setae and 3 smaller ones.

The maxilliped resembles that of *Euaugaptilus elongatus* Sars, but the setae arising from the segments of the endopod are fringed with hairs and bear no "buttons."

The 1st swimming legs resemble those of *Euaugaptilus laticeps* Sars. The marginal spine of the 1st segment of the exopod is long and serrated and reaches to the level of the 1st marginal spine on segment 3 of the exopod. The marginal spines on the 3rd segment are of equal size and are slightly longer than the spine on segment 2; all three are serrated on both borders. The terminal spine on the 3rd segment is nearly as long as the whole ramus.

The 2nd to 4th swimming legs present no unusual features.

The 5th pair of legs differ from the corresponding appendage in any other member of the genus in that the 3rd segment of the exopod bears three marginal spines instead of the usual two. The distal spine is equal in length to two-thirds of the distal segment and is finely serrated along its outer margin, while the distal one-fifth of the inner margin bears a row of 4 or 5 somewhat stouter teeth.

GROUP II.

***Euaugaptilus filigerus* (Claus).**

Augaptilus filigerus, A. Scott, 1909, p. 136.

Augaptilus filigerus, Wolfenden, 1911, p. 341.

Euaugaptilus filiger, Sars, 1925, p. 279, Pl. XC.

Euaugaptilus filigerus, Farran, 1929, p. 269.

A single example, female, that appears to belong to this species, was taken by the "Investigator" at Station 670. The chief interest of this Indian example lies in its size. Giesbrecht and Schmeil (1898, p. 121) give the length of the female as 4.9 mm. Farran's example from the collection of the "Terra Nova," taken off New Zealand, measured 5.75 mm., while Sars' examples from the North Atlantic were as large as 6.8 mm. The example from Station 670 measured 6.6 mm.; and the proportional lengths of the cephalothorax and abdomen are as 4.5 to 1. I have carefully examined this individual and compared the appendages with the descriptions and figures given by previous authors and can detect no difference; furthermore, the proportional lengths of the segments in the 1st antenna agree closely with those given by Giesbrecht. I have, therefore, no hesitation in referring it to this species.

***Euaugaptilus laticeps* Sars.**

Augaptilus laticeps, Sars, 1905, p. 11.

Augaptilus laticeps, Farran, 1908, p. 72.

Augaptilus laticeps, van Breemen, 1908, p. 133.

Augaptilus antarcticus, Wolfenden, 1911, p. 269.

Euaugaptilus laticeps, Sars, 1925, p. 264, Pl. ixxx.

Euaugaptilus laticeps, Farran, 1926, p. 289.

Euaugaptilus laticeps, Farran, 1929, p. 269.

This species clearly possesses a wide distribution ; Sars gives it as " The Atlantic Ocean, Mediterranean and Pacific Ocean." It was originally taken in the North Atlantic and Mediterranean but Farran has recorded its occurrence in the " Terra Nova " collections from the Antarctic. Although this species was not taken by the " Siboga " in the Malay Archipelago, its occurrence in Indian waters is not to be wondered at. Several examples of the female were taken at " Investigator " Station 682.

Euaugaptilus magnus (Wolfenden).

Augaptilus magnus, Wolfenden, 1904, p. 122.

Augaptilus magnus, Farran, 1908, p. 77.

Augaptilus magnus, van Breemen, 1908, p. 138.

Augaptilus magnus, Wolfenden, 1911, p. 341, Pl. xxxvii, figs. 4-9, text-fig. 73 a, b.

Euaugaptilus magnus, Sars, 1925, p. 262, Pl. lxxix.

Euaugaptilus magnus, Farran, 1926, p. 289.

Ten examples of this species were taken at " Investigator " Station 682. The present record extends the distribution of this species to Indian waters.

Euaugaptilus oblongus Sars.

Augaptilus oblongus, Sars, 1905, p. 11.

Euaugaptilus oblongus, Sars, 1925, p. 266, Pl. lxxxi.

Sars (*loc. cit.*, 1925) gives the distribution of this species as being the Atlantic and Pacific Oceans. The occurrence of a single specimen taken by the " Investigator " at Station 682 extends its known range to Indian waters.

Euaugaptilus tenuispinus Sars.

Augaptilus tenuispinus, Sars, 1920, p. 16.

Euaugaptilus tenuispinus, Sars, 1925, p. 290, Pl. xcvi.

A single specimen of the above species was taken by the " Investigator " at Station 682, thus extending its known range to the Indian Ocean.

GROUP III.

Euaugaptilus angustus Sars.

Augaptilus angustus, Sars, 1905, p. 10.

Euaugaptilus angustus, Sars, 1925, p. 281, Pl. xci.

A single example was taken by the " Investigator " at Station 682, thus extending the known range of the species to Indian waters.

Euaugaptilus facilis (Farran).

Augaptilus facilis, Farran, 1909, p. 73, Pl. iii, figs. 23, 24 ; Pl. viii, figs. 1-6.

Augaptilus facilis, Wolfenden, 1911, p. 343, Pl. xxxviii, figs. 1, 2, text-fig. 75 a, b.

Euaugaptilus facilis, Sars, 1925, p. 273, Pl. lxxxvi.

This species was first taken by Wolfenden in the North Atlantic Ocean ; Farran also obtained it in the same locality and, according to Sars, it has also been taken in the Pacific Ocean. A single example was taken by the " Investigator " at Station 682.

GROUP IV.

Euaugaptilus hecticus (Giesbrecht).*Augaptilus hecticus*, A. Scott, 1909, p. 136.*Augaptilus hecticus*, Wolfenden, 1911, p. 339.*Euaugaptilus hecticus*, Farran, 1926, p. 288.*Euaugaptilus hecticus*, Farran, 1929, p. 269.

A single example of this species was taken by the "Investigator" at Station 682.

Euaugaptilus latifrons Sars.(Text-fig. 106, *a-h.*).*Augaptilus latifrons*, Sars, 1907, p. 22.*Euaugaptilus latifrons*, Sars, 1925, p. 295, Pl. ci.

This species was briefly described by Sars (1907) from a single example taken by the "Princesse Alice" in the North Atlantic Ocean and was later more fully described and figured by him in his Monograph (1925). In the "Investigator" collections from Station 670 are three examples (two females and one male) that I have no doubt belong to this species. Sars' description of the female agrees almost exactly with the present examples, but as his account is very brief I take this opportunity of giving some additional details and figures.

♀ Total length, 4.8 mm. to 5.3 mm.; these examples are thus somewhat larger than the North Atlantic specimens, which, according to Sars, measured 4.7 mm.

The proportional lengths of the cephalothorax and abdomen are as 66 to 19, so that the abdomen is contained 3.47 times in the length of the anterior region of the body.

The head and 1st thoracic segment are separate and the length of the cephalon is longer than that of the combined thoracic segments in the proportion of 9 to 7. Sars in his description states that the anterior region of the head, when viewed in profile, is truncated; in my examples the forehead is uniformly rounded, and situated below in the middle line are two rounded prominences of which the upper is small, while the lower is large and prominent and possesses thickened chitin. There is no trace of any rostral filaments. The 4th and 5th thoracic segments are fused together and the posterior thoracic margin is rounded.

The abdomen consists of three segments. The genital segment is long and symmetrical and bears on its ventral aspect, about the middle of its length, a well marked genital protuberance. The 2nd segment is short. The anal segment is nearly as long as the genital segment. The proportional lengths of the segments are as follows:—

Abdominal segment	1-3	4	5	Furca
	38	12	33	17

= 100.

The furcal rami are comparatively short, being about half the length of the anal segment; their length is about twice their breadth. Of the five setae arising from them the inner one is shorter and more slender than the outer four, and the most external seta arises from the outer margin at about the junction of the proximal and middle thirds.

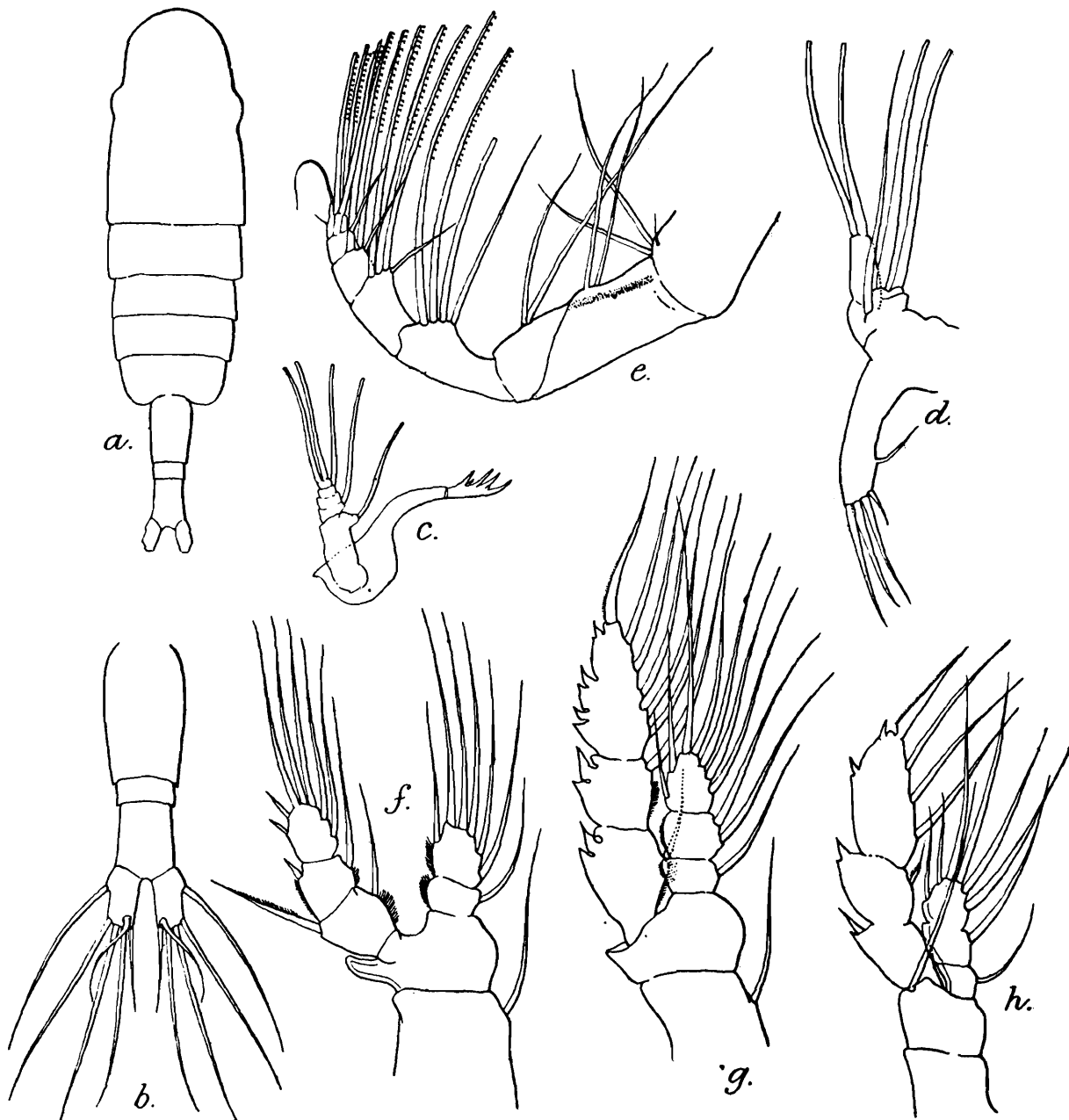
The 1st antenna is slightly longer than the body and consists of twenty-five free segments, having the following proportional lengths:—

Segment	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
	54	10	19	19	22	25	29	30	33	36	41	47	58	55	55	55	61	61	54	39	37	36	48	41	36

= 1000.

The appendage is well provided with long and delicate setae.

The 2nd antenna consists of a short exopod of 7 segments, arising from the proximal end of the basal segment, and a somewhat longer endopod, that arises distally. The exopod reaches only about half way along the length of the endopod.



TEXT-FIG. 106.—*Euaugaptilus latifrons* Sars.

- a. The female from the dorsal aspect.
- b. The abdomen from the dorsal aspect.
- c. The Mandible.
- d. The 1st maxilla.

- e. The maxilliped.
- f. The 1st swimming leg.
- g. The 2nd swimming leg.
- h. The 5th leg.

The mandible has a slender, curved biting lobe, and the teeth agree with the figure given by Sars (1925, Pl. ci, fig. 6). The palp is short; the internal ramus is rudimentary and is reduced to a single seta; the external ramus is well-developed.

The 1st maxilla agrees closely with the description given by Sars (1925). The masticatory lobe is short and bears only four spines at its distal end, a fifth, however, arises from the posterior border. The 2nd and 3rd lobes have been completely suppressed. The basal segment and the endopod are fused into a single elongated lobe bearing two long setae at

its distal end. The outer lobe bears 3 setae, one of which is much shorter and more slender than the other two.

The 2nd maxilla is well-developed. Three simple setae arise from the distal end of the 1st basal segment; from the 2nd basal and endopod arise a remarkable number of setae, some 35 in all, though they are so crowded together that I have been unable to determine the exact number; all of these setae are crowded with "buttons"

The maxilliped is large. The 1st basal segment bears three setae, one of which is quite small, at its distal end. The 2nd basal segment bears two setae about the middle of its length and a further two near the distal end. There is a band of small spines running along the aspect of the segment as far as the base of the proximal pair of setae. The 1st and 2nd segments of the endopod each bear three large and one small setae. The 3rd and 4th segments each bear two large and one small setae and the terminal segment bears two small setae. All the large setae are crowded with "buttons"

The 1st swimming leg consists of the usual two-jointed basal part, a three-jointed exopod and a two-jointed endopod. The 1st basal segment bears a seta on its inner border. The 2nd segment is produced, as Sars has pointed out, in a rounded digitiform lobe on its outer aspect. The 1st segment of the exopod bears a long straight marginal spine, that equals in length the next two segments. The 2nd segment bears a single small spine and the 3rd carries a pair of similar and subequal spines. The endopod possesses only two segments of which the 1st bears a single seta and the distal carries six.

In the 2nd-4th swimming legs the character of the endopod is normal, consisting of three segments.

The 5th pair of legs closely resemble those of *Euaugaptilus similis* (Wolfenden). The 2nd basal joint bears a long and delicate seta. The 1st and 2nd segments of the exopod each bear a single short marginal spine and the 1st segment is devoid of any inner seta. The terminal segment bears two short marginal spines. The inner seta arising from the 2nd segment of the exopod is much smaller than the others.

Genus **AUGAPTILUS** Giesbrecht (*sensu stricto*).

I have already pointed out that this genus was founded by Giesbrecht (1889) to contain "*Hemicalanus filigerus* Claus, *H. longicaudatus* Claus and certain related forms" Giesbrecht did not name any one species as the type of his new genus but by the rules of nomenclature the type of the genus is the first species mentioned; both in 1889 and again in 1892 Giesbrecht places the species *Augaptilus filigerus* (Claus) first in his account of the genus. Sars is, therefore, not justified in claiming that "*A. longicaudatus* Claus doit être considéré comme le type du genre, cette espèce étant en effect celle qui a été décrite en premier lieu"

Up to the present time, of the various species referred by Sars to the restricted genus only one has been recorded from Indian waters, namely *Augaptilus longicaudatus* (Claus), examples having been obtained by the "Siboga" in the Malay Archipelago (*vide* A. Scott, 1902). I am now able to record a second.

Augaptilus megalurus Giesbrecht.

Augaptilus megalurus, Giesbrecht, 1889, p. 814.

Augaptilus megalurus, Giesbrecht, 1892, p. 400, Pl. xxvii, fig. 28 ; Pl. xxviii, fig. 7 ; Pl. xxix, fig. 20 ; Pl. xxxix, fig. 47.

Augaptilus megalurus, Giesbrecht and Schmeil, 1898, p. 123.

Augaptilus megalurus, Farran, 1908, p. 80.

Augaptilus megalurus, Wolfenden, 1911, p. 339.

Augaptilus megalurus, Sars, 1925, p. 257, Pl. lxxvii, figs. 1-9.

This species appears to have a wide distribution. It was first taken in the Pacific Ocean ; but has since been recorded from the Tropical and Northern regions of the Atlantic Ocean. The discovery of a single specimen taken by the " Investigator " at Station 682 extends its known range to the Indian Ocean.

Genus **CENTRAUGAPTILUS** Sars.

This genus was created by Sars to accommodate the species *Centraugaptilus rattrayi*, (T. Scott) and certain other closely-allied species.

Centraugaptilus rattrayi T. Scott.

Augaptilus rattrayi, T. Scott, 1893, p. 36, Pl. ii, figs. 25-37.

Augaptilus rattrayi, van Breemen, 1908, p. 134, fig. 152.

Augaptilus rattrayi, Farran, 1908, p. 78, Pl. viii, fig. 21.

Augaptilus rattrayi, Wolfenden, 1911, p. 341.

Augaptilus rattrayi, Lysholm and Nordgaard, 1921, p. 26.

Centraugaptilus rattrayi, Sars, 1925, p. 304, Pl. cvi.

Centraugaptilus rattrayi, Farran, 1926, p. 290.

? *Augaptilus macrodus*, Esterly, 1911, p. 332, Pl. xxvii, fig. 18, Pl. xxix, fig. 24 ; Pl. xxx, figs. 72, 74 ; Pl. xxxii, fig. 112.

This species appears to have a wide distribution ; it was originally described from the Gulf of Guinea and has since been taken in various localities in the North Atlantic Ocean. It is not improbable that the form briefly described by Esterly (1911) from the San Diego region under the name *Augaptilus macrodus* is the same species. Scott's original specimen measured 4.9 mm. in length, while specimens from the north Atlantic Ocean appear to be slightly larger ; Sars gives the length of his examples as 6.0 mm. *Augaptilus macrodus* Esterly is said to have a length measurement of 5.3 mm.

A single example, female, of what I take to be this species was taken by the " Investigator " at Station 682. The specimen is slightly smaller than the Atlantic examples and measured only 4.8 mm., thus closely agreeing with Scott's type.

Centraugaptilus horridus Farran.

(Text-fig. 107, a-g.)

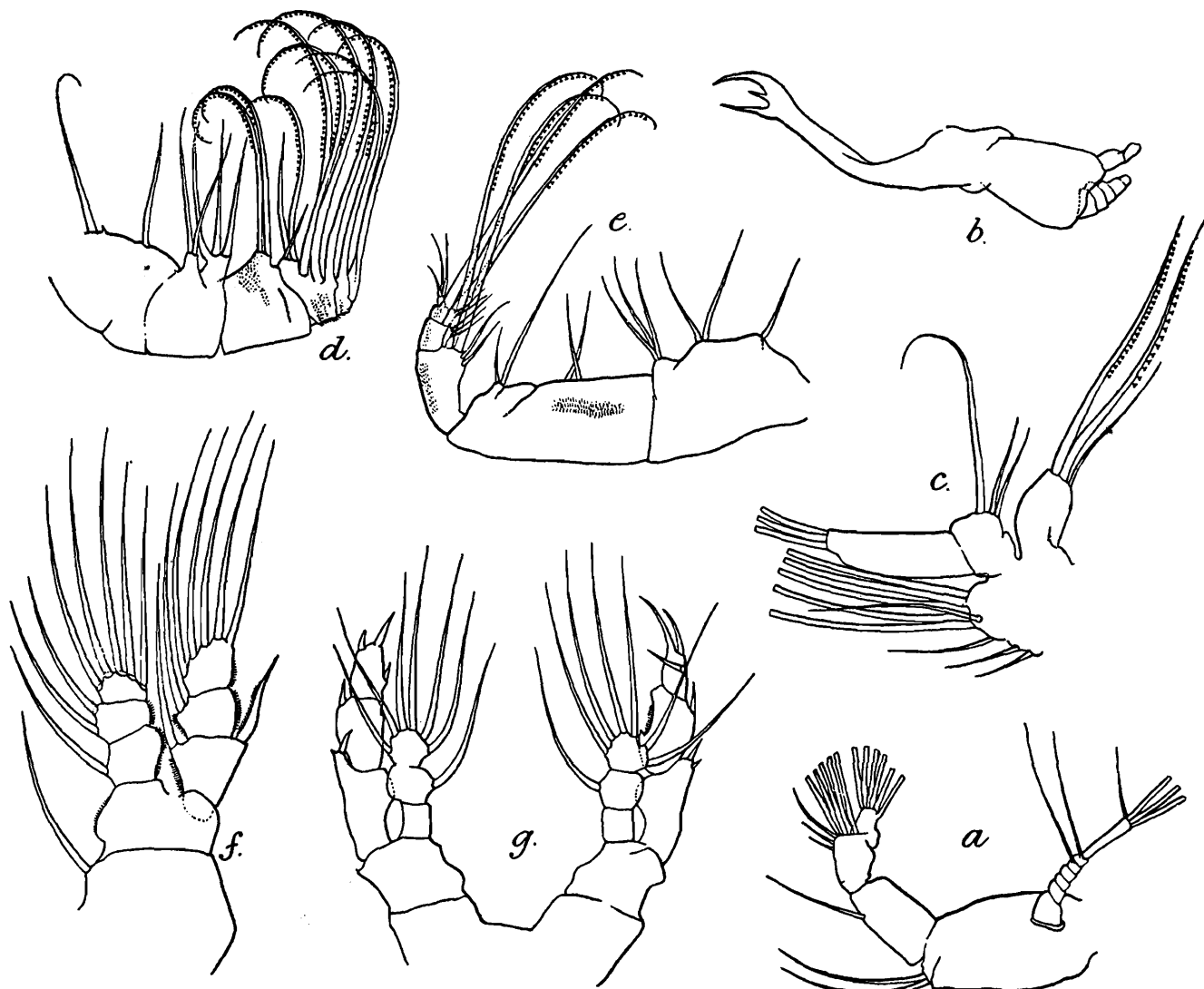
Augaptilus horridus, Farran, 1908, p. 78, Pl. viii, fig. 20.

Augaptilus pyramidalis, Esterly, 1911, p. 334, Pl. xxvi, figs. 1, 9 ; Pl. xxx, fig. 69 ; Pl. xxxii, fig. 106.

Augaptilus horridus, Sewell, 1913, p. 354.

Centraugaptilus horridus, Sars, 1925, p. 307, Pl. cvii, figs. 11-18.

This species differs from *Centraugaptilus rattrayi* (T. Scott) in the degree of prominence of the forehead and in small details of structure, such as the length of the two terminal segments of the endopod of the maxilliped. It is also a considerably larger species.



TEXT-FIG. 107.—*Centraugaptilus horridus* (Farran), male.

a. The 2nd antenna.

b. The mandible.

c. The 1st maxilla.

d. The 2nd maxilla.

e. The maxilliped.

f. The 1st swimming leg.

g. The 5th pair of legs.

A single example of an adult male and a second immature specimen were taken by the "Investigator" at Station 393.

♂ Total length 8.4 mm. This specimen is somewhat smaller than those from the Atlantic, for Farran gives the length as 10.0 mm. and Sars as 9.6 mm.; but both these measurements refer to the female.

The abdomen consists of five segments and the furcal rami, that have the following proportional lengths;—

Abdominal segment	1	2	3	4	5	Furca	
	22	14	13	12	17	22	= 100.

The furcal rami are short and broad; their proportions of length to breadth being as 19 to 16.

The 1st antenna consists, as in *Centraugaptilus rattrayi*, of twenty-four free segments, segments 1 and 2 being fused together. Their proportional lengths are as follows :—

Segment	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
	84	24	26	26	26	26	34	37	40	47	55	59	62	60	58	58	61	51	31	32	26	26	32	19=1000.

A comparison of the lengths of the segments in the antennae of *Centraugaptilus rattrayi* and *C. horridus* shows that between these two species there is the same difference in the lengths of the segments as we have already seen to exist between the various stages of development in a single species. For the purpose of comparison I have converted the measurements of the antennal segments as given by T. Scott (1894, p. 36) for *Centraugaptilus rattrayi* into 1000ths of the total length of the whole appendage and I give these below together with those of *Centraugaptilus horridus* :—

Segment	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
<i>C. rattrayi</i>	62	26	21	21	21	21	23	36	36	33	44	52	55	51	54	56	62	58	49	51	41	43	48	37
<i>C. horridus</i>	84	24	26	26	26	26	34	37	40	47	55	59	62	60	58	58	61	51	31	32	26	26	32	19

From the above measurements it is clear that in the larger species the segments in the proximal part of the appendage are proportionally longer than in the smaller species but that at about 18-19th joint there is a change and from this point to the end of the appendage the segments in the larger species are very considerably shorter proportionally than in the smaller species.

Genus **HALOPTILUS** Giesbrecht.

In 1909 A. Scott recorded the occurrence of four species of this genus in the "Siboga" collections from the Malay Archipelago, namely, *Haloptilus longicornis* (Claus), *H. ornatus* (Giesbrecht), *H. plumosus* (Giesbrecht) and *H. spiniceps* (Giesbrecht).

In the "Investigator" collections from Indian waters I have, up to the present time only recognised two species.

Haloptilus chierchiae Giesbrecht.

Hemicalanus chierchiae, Giesbrecht, 1889, p. 813.

Haloptilus chierchiae, Giesbrecht, 1892, p. 384, Pls. xxvii, figs. 16, 17 and xlii, fig. 2.

Haloptilus chierchiae, Giesbrecht and Schmeil, 1898, p. 118.

Haloptilus chierchiae, Wolfenden, 1911, p. 324.

Haloptilus chierchiae, Sars, 1925, p. 245, Pl. lxx.

Originally described from the Pacific Ocean, this species has since been taken in the Atlantic and it is, therefore, not surprising that it should also occur in the Indian Ocean; indeed, it would be very surprising if it did not. A single example was taken by the "Investigator" at Station 682.

Haloptilus ornatus (Giesbrecht).

Hemicalanus ornatus, Giesbrecht, 1892, p. 384, Pls. xxvii, figs. 1, 6, 7, 21, 28; xlii, figs. 1, 9 and 19.

Haloptilus ornatus, Giesbrecht and Schmeil, 1898, p. 120.

Haloptilus ornatus, A. Scott, 1909, p. 141.

Haloptilus ornatus, Wolfenden, 1911, p. 323.

Haloptilus ornatus, Sars, 1925, p. 247, Pl. lxxiii, figs. 1-5.

Three examples of this species were taken by the "Investigator" at Station 682.

Genus **PONTOPTILUS** Sars.

Previous to this paper no species belonging to this genus has been recorded from Indian waters. In the collections of the "Investigator" the genus is represented by *Pontoptilus ovalis* Sars.

Pontoptilus ovalis Sars.

Pontoptilus ovalis, Sars, 1907, p. 25.

Pontoptilus ovalis, Sars, 1925, p. 316, Pl. cxi, figs. 9-13.

A single female example of this species was taken by the "Investigator" at Station 682.

Family **ARIETELLIDAE**.Genus **ARIETELLUS** Giesbrecht.

A. Scott (1909) in his account of the "Siboga" collections from the Malay Archipelago records the occurrence of *Arietellus aculeatus* (T. Scott), *A. setosus* Giesbrecht and *A. simplex* Sars. Up to the present time only the latter two species have been found among the "Investigator" collections.

Arietellus setosus Giesbrecht.

Arietellus setosus, A. Scott, 1909, p. 142, Pl. xlv, figs. 8-13.

Arietellus setosus, Wolfenden, 1911, p. 329, Pl. xxxvi, fig. 3.

Arietellus setosus, Esterly, 1911, p. 335, Pl. xxvii, figs. 22, 23 ; Pl. xxx, figs. 81, 82.

Arietellus setosus, Sars, 1925, p. 328, Pl. cxviii.

Arietellus setosus, Farran, 1929, p. 269.

A single example of the male of this species was taken by the "Investigator" at Station 670. The species has a wide distribution and has now been recorded from all the three great Oceans.

Arietellus simplex Sars.

Arietellus simplex, A. Scott, 1909, p. 143, Pl. xlv, figs. 14-18.

Arietellus simplex, Wolfenden, 1911, p. 331, Pl. xxxvi, fig. 5 ; text-fig. 68.

Arietellus simplex, Sars, 1925, p. 334, Pl. cxx, figs. 7-12.

A single specimen, female, was taken by the "Investigator" at Station 670. The distribution of this species appears to be the same as that of the preceding species.

Genus **PARAUGAPTILUS** Wolfenden.

This genus was created by Wolfenden to accommodate a species that had been taken in the Atlantic Ocean. A. Scott (1909, p. 144, Pl. XLIII, figs. 11-19) subsequently described a further species, *Paraugaptilus similis*, from the collections of the "Siboga" in the Malay Archipelago. So far no examples of any species of this genus have been detected among the collections of the "Investigator."

Genus **METACALANUS** Cleve.

At the present time this genus is represented by a single species *Metacalanus auriwillii* Cleve.

Metacalanus aurivillii Cleve.

Metacalanus aurivillii, Cleve, 1901, p. 43, Pl. iv, figs. 16-25; Pl. v, figs. 1-6.

Metacalanus aurivillii, Thompson and A. Scott, 1903, p. 243. Pl. ii, figs. 18-20.

Metacalanus aurivillii, A. Scott, 1909, p. 146.

Metacalanus aurivillii, Sewell, 1914, p. 228.

This species is widely distributed throughout Indian waters. It has now been recorded from the Malay Archipelago (Cleve, A. Scott); the Ceylon Pearl Banks (Thompson and A. Scott, Sewell); and I have also taken examples of it in the surface tow-net in Nankauri Harbour in the Nicobar Islands (Station 614), as well as from stations 541, 558, 583, 587, 590 and 591.

Genus **PHYLLOPUS** Brady.

This genus is represented in Indian waters by four species, namely, *Phyllopus bidentatus*, Brady, *P. helgae* Farran, *P. impar* Farran and *P. giesbrechti* A. Scott, all of which were taken by the "Siboga" in the Malay Archipelago. So far no examples have been detected in the "Investigator" collections.

Family PSEUDOCYCLOPIDAE.

Genus **PSEUDOCYCLOPS** Brady.

Thompson and A. Scott (1903) have recorded the occurrence of *Pseudocyclops obtusatus* Brady from the Arabian Sea and Ceylon Pearl Banks. Gurney (1927) records *Pseudocyclops umbraticus* from Port Said and the Suez Canal and he also describes a new species *P. latus* from the canal waters.

Pseudocyclops obtusatus Brady and Robertson.

Pseudocyclops obtusatus, Brady and Robertson, 1873, p. 128, pl. viii, figs. 4-7.

Pseudocyclops obtusatus, Brady, 1878, p. 84, pl. xii, figs. 1-13.

Pseudocyclops obtusatus, Giesbrecht and Schmeil, 1898, p. 126.

Pseudocyclops obtusatus, Sars, 1903, p. 131, Pl. lxxxviii.

Pseudocyclops obtusatus, van Breemen, 1908, p. 144, fig. 162.

Pseudocyclops obtusatus, Norman and T. Scott, 1906, p. 131.

var. **latisetosus**, nov.

(Text-fig. 108, a-f).

♂ Total length, 0.78 mm.

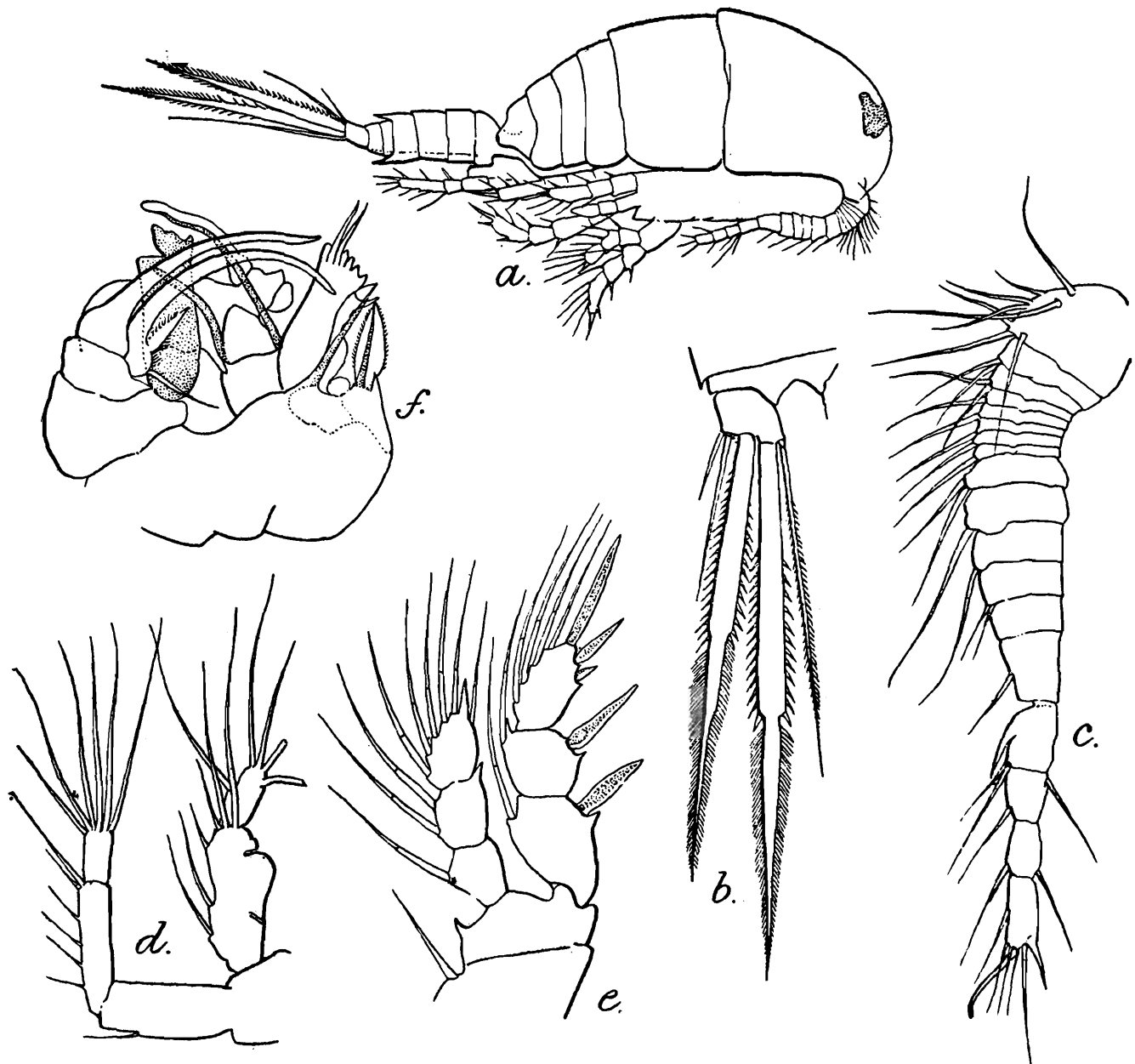
The proportional lengths of the cephalothorax and abdomen are as 41 to 16, so that the abdomen is contained 2.56 times in the length of the anterior region of the body.

The cephalon and 1st thoracic segment are fused; thoracic segments 4 and 5 are separate. The forehead is rounded and terminates below in a single stout spine. There is a well-marked median eye-spot. The posterior thoracic margin is rounded and is produced somewhat posteriorly.

The abdomen consists of five segments and the furcal rami; the various segments have the following proportional lengths:—

Abdominal segment	1	2	3	4	5	Furca
	22	22	19	19	7	11 = 100.

In the type form the furcal setae are of the usual type, the 2nd and 3rd setae being longer than the others but not appreciably stouter. In the present variety these two setae are



TEXT-FIG. 108.—*Pseudocyclops obtusatus* Brady and Robertson var. *latisetosus*, nov.

a. The male from the right side.

b. The furcal ramus and furcal setae.

c. The 1st right antenna.

d. The 2nd antenna.

e. The 1st swimming leg.

f. The 5th pair of legs.

very considerably thickened and flattened; about half way along their length their width is suddenly diminished. The lateral margins of the proximal portions of the setae are armed with numerous small spines, while the distal part is plumose.

The 1st antenna is short and reaches back to a little beyond the posterior margin of the cephalon. Each appendage consists of 18 segments and that on the right side is modified to form grasping organ. Segments 3 to 8 are very short.

In their general structure the appendages agree with those of the normal individual.

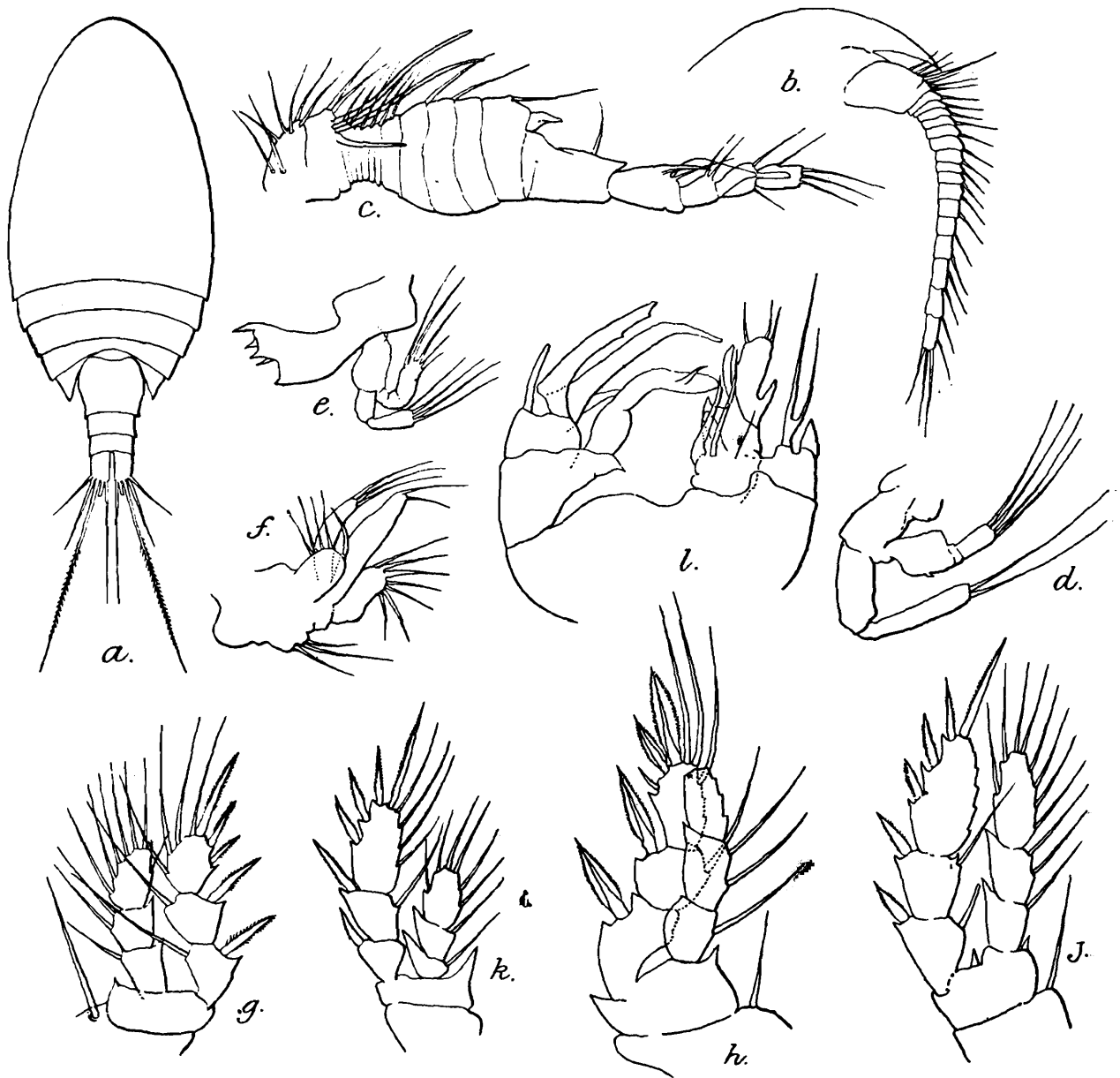
The 5th pair of legs shows certain small differences of structure from that of the typical form; but in the main character they agree with sufficient closeness to render it undesirable to create a new species for this form.

Pseudocyclops simplex, sp. nov.

(Text-fig. 109, a-l.)

♀ Total length, 0.5 mm.

The proportional lengths of the cephalothorax and abdomen are as 32 to 13, so that the abdomen is contained 2.46 times in the length of the anterior region of the body.

TEXT-FIG. 109.—*Pseudocyclops simplex*, sp. nov.

a. The female from the dorsal side.	f. The 1st maxilla.
b. The rostrum and 1st antenna, female.	g. The 1st swimming leg.
c. The right 1st antenna, male.	h. The 2nd swimming leg.
d. The 2nd antenna.	i. The 3rd swimming leg.
e. The mandible.	j. The 5th leg, female.
	k. The 5th leg, male.
	l. The 5th pair of legs, male.

The forehead is rounded and terminates anteriorly and below in a stout ventrally directed rostrum that is triangular in shape with a single point. The head and 1st thoracic segment are fused together; in this respect this species differs from all the others in the genus. The 4th and 5th thoracic segments are separate in the lateral region and the posterior thoracic margin is produced back in a pointed wing.

The abdomen appears at first sight to consist of only three segments and the furcal rami; the 4th segment is completely telescoped into the 3rd. The lengths of the segments are as follows:—

Abdominal segment	1-2	3	4	5	Furca
	39	18	18	5	20 = 100.

The furcal rami are one-and-a-half times as long as broad. The furcal setae resemble those of *Pseudocyclops obtusatus* Brady and Robertson.

The 1st antenna reaches back to about two-thirds the length of the cephalic segment; it appears to consist of only 17 segments, instead of the usual 18.

The mouth-parts and swimming legs closely resemble those of *Pseudocyclops obtusatus*.

The 5th pair of legs differs from that of *Pseudocyclops obtusatus* in certain details of structure. The 2nd basal segment is produced at its inner distal angle in a well-developed pointed process. The exopod resembles that of *Pseudocyclops obtusatus* but the endopod is clearly different. In this ramus both the 1st and 2nd segments are produced at their distal outer angles in a sharp process and the terminal segment bears six normal setae.

♂ Total length, 0.72 mm.

The proportional lengths of the cephalothorax and abdomen are as 11 to 5, so that the abdomen is contained 2.20 times in the length of the anterior region of the body.

As in the female the cephalon and the 1st thoracic segment are fused and the 4th and 5th thoracic segments are separate in the lateral region.

The abdomen here also appears to consist of only four segments owing to the manner in which the anal segment is telescoped into the 4th. The proportional lengths of the segments and the furcal rami are as follows:—

Abdominal segment	1	2	3	4	5	Furca
	22	22	18	13	7	18 = 100.

The 2nd segment of the abdomen is swollen on the left side. The posterior margins of the furcal rami are oblique and bear five setae, of which the 2nd and 3rd are considerably thickened.

The 1st antenna is short and barely reaches back one-half of the length of the cephalic segment. The right antenna is modified to form a grasping organ. Each antenna consists of 18 segments. Of these segments 1 and 2 are partially fused. Segments 3 to 8 are very short and are considerably narrower than those on either side. The 9th to 13th free segments are considerably swollen and the 13th segment bears at its distal end a well developed spinous process. The knee-joint occurs between the 14th and 15th segments. The 15th segment bears a spinous process and also appears to be produced in a flask-shaped projection that reaches as far as the middle of the terminal segment.

The mouth-parts and swimming legs appear to resemble those of the female.

The 5th pair of legs possesses the same general type as those of *Pseudocyclops obtusatus*, but differ in small details.

Genus **SUEZIA** Gurney.

Under the above name Gurney (1927, p. 457) has described a new genus, that is closely related to *Pseudocyclops*, to accommodate a single species, *Suezia canalis*, that had been taken in the Suez Canal. No further examples have up to the present time been taken in Indian waters.

Family CANDACIIDAE.

Genus **CANDACIA** Dana.

The genus *Candacia* is well represented in Indian waters, no less than sixteen species having now been obtained in one area or another.

In 1896 Giesbrecht recorded the presence of *Candacia catula* (Giesbrecht) and *C. curta* (Dana) from the Red Sea, and in 1900 Thompson added *Candacia aethiopica* (Dana) to the list of Indian species. A year later Cleve obtained examples of *Candacia catula* (Giesbrecht) from the Malay Archipelago. In 1902 A. Scott added *Candacia bispinosa* (Claus), *C. truncata* (Dana) and *C. bradyi* A. Scott to the list of species from the region of the Arabian Sea and Red Sea and in 1903 Thompson and A. Scott obtained examples of *Candacia longimana* (Claus), *C. pachydactyla* (Dana), *C. simplex* (Giesbrecht) and *C. truncata* (Dana) from the Arabian Sea and the Pearl Banks of Ceylon. Cleve in 1904 recorded the occurrence of *Candacia bipinnata* (Giesbrecht) from the west coast of Australia and the south of Cape Colony, and *Candacia inermis* Cleve, *C. tenuimana* (Giesbrecht) and *C. varicans* (Giesbrecht) from the Agulhas Current. In 1906 Wolfenden, in his report of the collections made by Stanley Gardiner in the Maldivé and Laccadive Archipelagoes, records the presence of *Candacia catula* (Giesbrecht), *C. curta* (Dana), *C. truncata* (Dana), *C. pachydactyla* (Dana) and what he took to be a new species, *C. tuberculata*; this latter is, however, a synonym of *C. bradyi* A. Scott. In 1909 A. Scott in his report of the "Siboga" collections recorded the occurrence of twelve out of the above thirteen species and in the "Investigator" collections from various regions of the Indian Waters I have obtained the majority of these species and have also added *Candacia norvegica* Boeck and a new species, *C. magna* to the Indian fauna.

Candacia aethiopica (Dana).

Candacia aethiopica, A. Scott, 1909, p. 151.

Candacia aethiopica, T. Scott, 1912, p. 537.

Candacia aethiopica, Sewell, 1912, p. 366.

Candacia aethiopica, Sewell, 1914, p. 228.

Candacia aethiopica, Sars, 1925, p. 350.

Candacia aethiopica, Farran, 1929, p. 537.

This species is of world-wide distribution. It has now been recorded in Indian waters from the Malay Archipelago (A. Scott); the coast of southern Burma (Sewell); the Indian Ocean and Bay of Bengal (Cleve); the Pearl Banks of Ceylon (Thompson and A. Scott, Sewell) and the Arabian Sea (A. Scott).

Candacia bispinosa (Claus).

Candacia bispinosa, A. Scott, 1909, p. 151.

Candacia bispinosa, Wolfenden, 1911, p. 357.

Candacia bispinosa, T. Scott, 1912, p. 537.

Candacia bispinosa, Sars, 1925, p. 352.‡

Candacia bispinosa, Farran, 1929, p. 272.

This species has now been recorded from all three great Oceans; it does not, however, appear to be of common occurrence in Indian waters.

Candacia bradyi A. Scott.

Candacia bradyi, A. Scott, 1909, p. 156, pl. xlvii, figs. 1-9.

Candacia bradyi, Pesta, 1912, p. 49, fig. 9.

Candacia bradyi, Sewell, 1912, p. 366, pl. xxiii, figs. 6, 7.

Candacia bradyi, Sewell, 1914, p. 229.

This species has now been recorded from Amboina and the Phillipines (Carl); the Malay Archipelago (A. Scott); the coast of southern Burma (Sewell); the Ceylon Pearl Banks (Thompson and A. Scott, Sewell); the Persian Gulf (Pesta); the Gulf of Aden (A. Scott) and, under the name *Candacia tuberculata*, the Maldivé and Laccadive Archipelagoes (Wolfenden).

Examples were taken at "Investigator" Stations 556, 562, 583, 584, 587, 588, 590 and 591.

Candacia catula (Giesbrecht).

Candacia catula, A. Scott, 1909, p. 152.

Candacia catula, Sewell, 1912, p. 367.

Candacia catula, Sewell, 1914, p. 229.

This species is of wide distribution and has now been recorded from the Malay Archipelago (Cleve, A. Scott); the coast of southern Burma (Sewell); the Ceylon Pearl Banks (Thompson and A. Scott, Sewell); the Arabian Sea and Red Sea (A. Scott); the Maldivé and Laccadive Archipelagoes (Wolfenden) and the east coast of Africa (Cleve).

Wolfenden (1906, p. 1012) has recorded the occurrence in the Maldivé and Laccadive Archipelagoes of a variety of this species, for which he proposes the name var. *similis*. No examples of this variety have up till now come under my notice.

Candacia curta (Dana).

Candacia curta, A. Scott, 1909, p. 152.

Candacia curta, Wolfenden, 1911, p. 357.

Candacia curta, T. Scott, 1912, p. 536.

Candacia curta, Sars, 1925, p. 351.

Candacia curta, Farran, 1929, p. 272.

Candacia curta, Brady, 1915, p. 135.

A single specimen was taken at "Investigator" Station 473.

Candacia discaudata A. Scott.

Candacia bradyi (♀ only), Carl, 1907, p. 9, pl. i, figs. 8-10, 12-13.

Candacia discaudata, A. Scott, 1909, p. 157, pl. xlvii, figs. 10-20.

Candacia discaudata, Sewell, 1912, p. 367.

Candacia discaudata, Sewell, 1914, p. 230.

As I have already pointed out (Sewell, 1914) the female of the species was first described by Carl (1907); who attributed it to *Candacia bradyi*, the female of which was at that time still unknown. The female of *Candacia bradyi* A. Scott was described by me in 1912. In 1909 A. Scott redescribed the female and gave the first account of the male, giving the name *C. discaudata* to the species.

This species has now been recorded from Amboina (Carl) ; the Malay Archipelago (A. Scott) ; the coast of southern Burma (Sewell) and the Ceylon Pearl Banks (Sewell.)

Examples have been taken at " Investigator " Stations 540, 541, 543, 555, 556, 582 and 583.

Candacia norvegica Boeck.

(Text-fig. 110, *a-d.*)

Candacia norvegica, Boeck, 1864, p. 11.

Candacia norvegica, Giesbrecht and Schmeil, 1898, p. 131.

Candacia norvegica, Sars, 1903, p. 134, pls. lxxxix and xc.

Candacia norvegica, Farran, 1905, p. 46.

Candacia norvegica, van Breemen, 1908, p. 147, fig. 165.

Candacia norvegica, Farran, 1908, p. 85.

Candacia norvegica, Sewell, 1913, p. 354.

Candacia norvegica, Lysholm and Nordgaard, 1921, p. 27.

Up to the present time this species has only been recorded from the Atlantic Ocean and the Norwegian Sea.

Lysholm and Nordgaard (1921) give the distribution of the species in the North Atlantic as lying between 600 and 1000 metres depth. They regard it as a North Atlantic species that is carried into the Norwegian Fjords by currents, and hence its occurrence in this latter locality as being only temporary.

Var. **tropica**, nov.

In the collection from " Investigator " Station 682 are two examples of a *Candacia* that I believe to be a variety of this species. Both examples were females.

♀ Total length, 2.28 mm.

The proportional lengths of the cephalothorax and abdomen are as 73 to 25, so that the abdomen is contained 2.92 times in the length of the anterior region.

The head and 1st thoracic segment are separate but as is usual in this genus thoracic segments 4 and 5 are fused. The head terminates anteriorly in a rostrum that consists of two rounded bosses. The posterior thoracic margins are produced backwards into sharp processes that reach back to about the middle of the length of the genital segment of the abdomen. The cephalic segment is considerably longer than the rest of the thorax; the proportions being as 43 to 30.

The abdomen consists of three segments and the furcal rami. These have the following proportional lengths :—

Abdominal segment	1-3	4	5	Furca
	43	25	13	19 = 100.

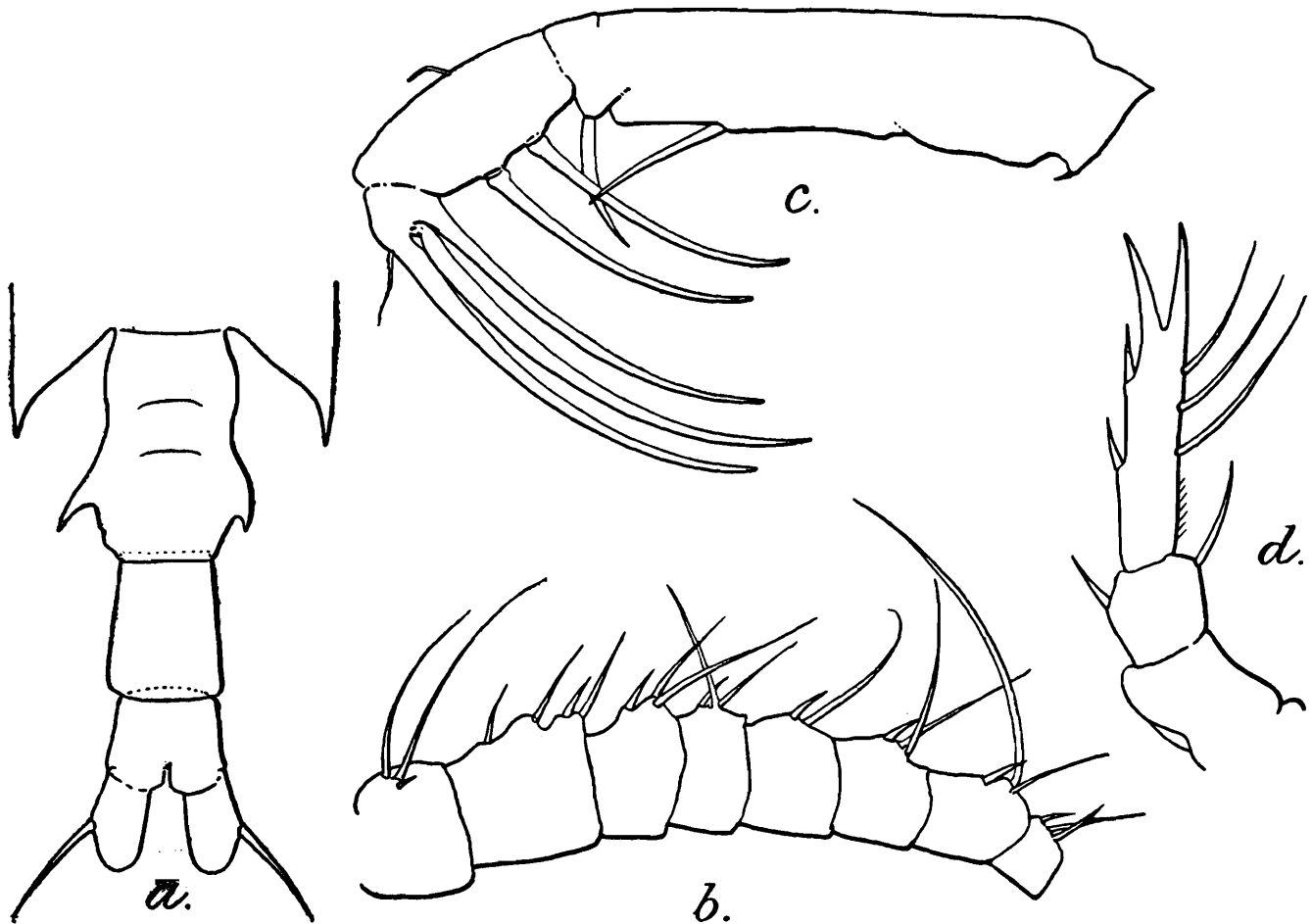
The genital segment is slightly assymetrical. On each side there is a projection bearing a bifid spine; the spine and the prominence on the left side is considerably longer and stouter than that on the right side.

The 1st antenna reaches back to beyond the tip of the furcal rami. Each consists of a stout basal portion consisting of 7 segments and a more slender distal portion of 14 free segments.

The proportional lengths of the segments are as follows :—

Segment	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
	71	47	23	23	31	33	37	23	23	23	25	36	44	45	50	52	57	57	61	57	39	35	47	61 = 1000.

The mouth-parts appear to be identical with those of *Candacia norvegica*.



TEXT-FIG. 110.—*Candacia norvegica* Boeck var. *tropica* nov.

a. The abdomen from the dorsal aspect, female.
b. The proximal segments of the 1st antenna.

c. The 2nd maxilla.
d. The 5th leg.

In the swimming feet the spine on the terminal segment of the exopod of the 3rd leg is modified as in *Candacia norvegica*.

The 5th pair of legs exhibits certain slight differences from those of the type form. The 2nd basal segment bears a delicate seta on its outer margin and a somewhat stouter spine at the distal inner angle. The terminal segment bears only two small spines on its outer margin, whereas in the type form there are three, one about the middle of the length of the segment and two close together near the distal end; in the present form this pair is represented by a single spine. From the distal end arise two large spines of approximately equal size, whereas in the type form the outer one is nearly twice as long as the inner. Three setae arise from the inner margin.

***Candacia pachydactyla* (Dana).**

Candacia pachydactyla, A. Scott, 1909, p. 153.

Candacia pachydactyla, Wolfenden, 1911, p. 358.

Candacia pachydactyla, T. Scott, 1912, p. 536.

Candacia pachydactyla, Sewell, 1912, p. 368.

Candacia pachydactyla, Sewell, 1914, p. 230.

Candacia pachydactyla, Sars, 1925, p. 351. ■

Candacia pachydactyla, Farran, 1929, p. 272.

This species is of world wide distribution. It has now been recorded in Indian waters from the Malay Archipelago (Cleve, A. Scott); the coast of southern Burma (Sewell); the Ceylon Pearl Banks (Thompson and A. Scott, Sewell); the Arabian Sea (Thompson and A. Scott); the Maldiva and Laccadive Archipelagoes (Wolfenden) and from the east of Cape Colony (Cleve).

Candacia simplex (Giesbrecht).

Candacia simplex, A. Scott, 1909, p. 154.

Candacia simplex, Wolfenden, 1911, p. 357.

Candacia simplex, Sars, 1925, p. 351.

Candacia simplex, Farran, 1929, p. 273.

This species appears to be somewhat rare in Indian waters. A single example was taken by the "Investigator" at Station 682.

Candacia truncata (Dana).

Candacia truncata, A. Scott, 1909, p. 155.

Candacia truncata, Sewell, 1912, p. 368.

Candacia truncata, Sewell, 1914, p. 231.

This species is widely distributed throughout Indian waters. It has been recorded from the Malay Archipelago (Cleve, A. Scott); the coast of southern Burma (Sewell); the Indian Ocean and Bay of Bengal (Thompson); the Pearl Banks of Ceylon (Thompson and A. Scott, Sewell); the Maldiva and Laccadive Archipelagoes (Wolfenden) and from the east coast of Africa (Cleve).

Candacia varicans (Giesbrecht).

Candacia varicans, Giesbrecht, 1892, p. 424, pl. xxi, figs. 3, 4, 11; pl. xxii, figs. 10, 25; pl. xxxix, figs. 2, 23.

Candacia varicans, Giesbrecht and Schmeil, 1898, p. 129.

Candacia varicans, Wolfenden, 1911, p. 357.

Candacia varicans, Farran, 1929, p. 273.

This species was originally recorded from the North Atlantic Ocean and the western part of the Mediterranean Sea. Farran has reported its presence off New Zealand. A single specimen, female, was taken by the "Investigator" at Station 682.

Candacia magna, sp. nov.

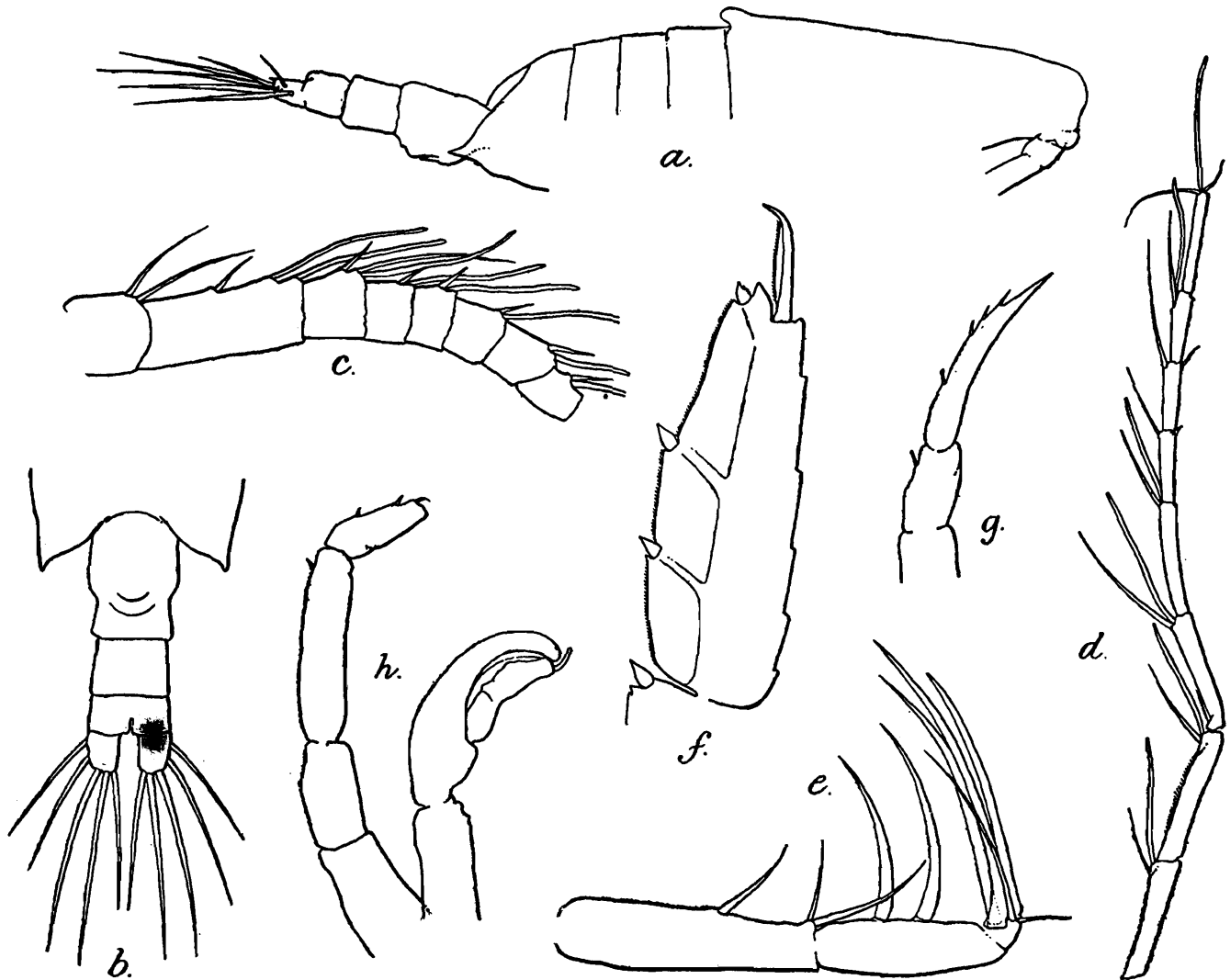
(Text-fig. 111, a-h.)

♀ Total length, 4.16 mm.

The proportional lengths of the cephalothorax and abdomen are as 138 to 41, so that the abdomen is contained 3.366 times in the length of the anterior region of the body.

The cephalon and 1st thoracic segment are separate but thoracic segments 4 and 5 are fused. The cephalon is long and exceeds the length of the combined thoracic segments in the proportions of 80 to 58. There is a well-marked rounded swelling on the posterior margin of the cephalon in the mid-dorsal line. The forehead is truncated and terminates

below in a pair of bluntly rounded bosses, representing the rostral projections. The posterior thoracic margins are produced backwards in spine-like prominences.



TEXT-FIG. 111.—*Candacia magna*, sp. nov.

- a. The female from the right side.
- b. The last thoracic segment and abdomen, female.
- c. The proximal segments of the 1st antenna.
- d. The distal segments of the grasping antenna, male.
- e. The 2nd maxilla.
- f. The terminal segment of the endopod of the 3rd leg.
- g. The 5th leg, female.
- h. The 5th pair of legs, male.

The abdomen consists of three segments and the furcal rami. The genital segment is symmetrical and is slightly longer than the next two segments combined. The proportional lengths of the segments are as follows :—

Abdominal segment	1—3	4	5	Furca	
	44	24	17	15	=100.

The 1st antenna reaches back to about the end of the furcal ramus. The most characteristic feature of this appendage is the great length of the 2nd segment, which is nearly twice as long as the 1st and more than three times as long as the third segment. The proportional lengths of the segments are as follows :—

Segment	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	
	45	82	25	19	24	27	27	28	26	25	27	42	50	52	58	63	63	63	58	51	29	28	35	53	=1000.

The 2nd antenna and mouth-parts closely resemble those of *Candacia longimana* Claus.

The swimming legs have the usual characters. Unfortunately all the end spines on the terminal segment of the exopods are missing.

The 5th pair of legs (text-fig. 111, *g*) appears to be characteristic. The 2nd basal segment bears a short marginal seta. The terminal segment bears a small spine on the outer margin about one-third of its length; in the distal quarter are three small spines at equal distances from each other and terminally there is a single long and stout spine. There are no setae on the inner margin.

♂ Total length, 3.70 mm.

The proportional lengths of the cephalothorax and abdomen are as 121 to 38, so that the abdomen is contained 3.184 times in the length of the anterior region of the body.

The general characters of the cephalothorax are the same as in the female.

The abdomen consists of five segments and the furcal rami. The 1st segment is produced on its right side in a rounded prominence. The proportional lengths of the segments are as follows :—

Abdominal segment	1	2	3	4	5	Furca	
	21	21	21	13	8	16	= 100.

The 1st antennae reach back to about the posterior end of the furcal rami. That of the left side resembles that of the female; the right antenna is, as usual, modified to form a grasping organ. As in the female, the 2nd segment is of considerably greater length than those on either side of it. The middle segments are not markedly thickened. Segment 18 bears a row of small teeth. Segments 19 and 20 are separate and segment 19 bears a short tooth-plate armed with needle-like teeth.

The 2nd antennae and mouth-parts resemble those of the female.

In the swimming legs the general structure resembles that of *Candacia longimana*; the end-spine of the 3rd swimming leg is also modified as in that species.

The 5th pair of legs closely resembles that of *Candacia norvegica* Boeck.

This species is, I think, undoubtedly new and clearly belongs to the group of the genus that is represented by *Candacia norvegica*, *C. longimana*, *C. tenuicauda* and *C. gracillima*.

A single example of the male was taken at Station 393 and of the female at Station 670. As no further specimens have been obtained I have given in the above account only such characters as could be made out without actually dissecting the specimens.

Family PONTELLIDAE.

Genus **CALANOPIA** Dana.

This genus is extremely well represented in Indian waters, no less than seven species being present. Of these the first to be recorded from this region was *Calanopia elliptica* (Dana), which was recorded by Giesbrecht (1896) from the Red Sea. The same species was recorded by Thompson in 1900 from the Red Sea, the east coast of Africa and the Bay of Bengal. In 1901 Cleve reported the finding of *Calanopia elliptica* (Dana) and *C. auri-villii* Cleve in the Malay Archipelago and a year later A. Scott obtained examples of *Calanopia minor* A. Scott from the Red Sea and the Arabian Sea. In 1903 Thompson and A. Scott recorded the presence of *Calanopia elliptica* (Dana), *C. minor* A. Scott and *C. auri-villii* Cleve from the Pearl Banks of Ceylon and in the following year Cleve again recorded the

occurrence of the two former species from the Red Sea, the Gulf of Aden and the Arabian Sea. In 1906 Wolfenden recorded *Calanopia elliptica* (Dana) and *C. minor* A. Scott from the Maldivé and Laccadive Archipelagces. In 1909 A. Scott described two new species, *Calanopia thompsoni* and *C. herdmani*, as well as recording the occurrence of *Calanopia elliptica* (Dana), *C. minor* A. Scott and *C. aurivillii* Cleve from the "Siboga" collections from the Malay Archipelago. In 1912 I reported the occurrence of *Calanopia elliptica* (Dana), *C. minor* A. Scott and *C. thompsoni* A. Scott from the coast of southern Burma and in 1914 I confirmed the presence of *Calanopia elliptica* (Dana), *C. aurivillii* Cleve and *C. minor* A. Scott on the Ceylon Pearl Banks and added *C. thompsoni* to the list of species known to occur in that locality. In 1927 Gurney recorded a new species, *C. media*, from the Suez Canal.

Of the seven species so far recorded from the Indian Ocean and its offshoots, five occur in the "Investigator" collections.

***Calanopia aurivillii* Cleve.**

Calanopia aurivillii, A. Scott, 1909, p. 181, pl. xlviii, figs. 16-20.

Calanopia minor (in part), Sewell, 1912, p. 368.

Calanopia aurivillii, Sewell, 1914, p. 232.

Calanopia aurivillii, Farran, 1929, p. 273.

This species is widely distributed throughout Indian waters and has now been recorded from the Malay Archipelago (Cleve, A. Scott); the coast of southern Burma (Sewell) and the Pearl Banks of Ceylon (Thompson and A. Scott, Sewell).

It occurs in the "Investigator" collections at Stations 555, 556, 558, 583, 587, 588, 590 and 591.

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

Calanopia elliptica, A. Scott, 1909, p. 176.

Calanopia elliptica, Pesta, 1912, p. 50, fig. 12.

Calanopia elliptica, Sewell, 1912, p. 368.

Calanopia elliptica, Pesta, 1913, p. 32.

Calanopia elliptica, Sewell, 1914, p. 231.

Calanopia elliptica, Gurney, 1927, p. 154.

This species appears to be confined for the most part to the region of the Western Pacific Ocean and the Indian Ocean. It has now been shown to be widely distributed throughout the whole of the Indian region and has been recorded from the Malay Archipelago (Cleve, A. Scott); the coast of southern Burma (Sewell); the Bay of Bengal; the Ceylon Pearl Banks (Thompson and A. Scott, Sewell); the Maldivé and Laccadive Archipelagoes (Wolfenden); the Arabian Sea (A. Scott, Cleve); the Persian Gulf (Pesta); the Suez Canal (Gurney) and the east coast of Africa (Thompson).

In the "Investigator" collections examples of this species occur at Stations 540, 541, 542, 544, 547, 555, 556, 558, 561, 574, 575, 578, 582, 583, 584, 587, 588, 590 and 614.

***Calanopia herdmani* A. Scott.**

Calanopia herdmani, A. Scott, 1909, p. 197, pl. xiiix, figs. 9-16.

This species has hitherto only been recorded by A. Scott from the Malay Archipelago where it was taken by the "Siboga."

A few specimens were obtained by the "Investigator" at Station 614.

Calanopia minor A. Scott.

Calanopia minor, A. Scott, 1909, p. 177, pl. xlviii, figs. 6-10.

Calanopia minor, Pesta, 1912, p. 51.

Calanopia minor (in part), Sewell, 1912, p. 51.

Calanopia minor, Sewell, 1914, p. 232.

This species is widely distributed throughout Indian waters, but appears on the whole to be rare. It has now been recorded from the Malay Archipelago (A. Scott); the coast of southern Burma (Sewell); the Pearl Banks of Ceylon (Thompson and A. Scott, Sewell); the Arabian Sea (Thompson and A. Scott); the Persian Gulf (Pesta) and the Red Sea (Cleve, A. Scott). It occurs in the "Investigator" collections at Station 614.

Calanopia thompsoni A. Scott.

(Text-fig. 112, *a-f.*)

Calanopia thompsoni, A. Scott, 1909, p. 178, Pl. XLIX, figs. 1-8.

Calanopia thompsoni, Sewell, 1912, p. 368.

Calanopia thompsoni, Sewell, 1914, p. 232.

This species was first described by A. Scott (1909) from the Malay Archipelago, and it has since been taken off the coast of Southern Burma and on the Pearl Banks of Ceylon. A large number of examples were taken by the "Investigator" at Stations 587 and 614; it is interesting to note that these examples exhibit *inter se* certain differences, especially in the structure of the 5th pair of legs in the female, but in spite of this I have no hesitation in referring all the forms to the same species.

♀ Total length, 2.303 mm. At first sight the examples from the two stations mentioned above appeared to fall into two groups, a large form from Station 614 and a smaller form from Station 587. Subsequent measurement of a number of examples from each station, however, showed that no distinction could be made between them on this ground.

The proportional lengths of the cephalothorax and abdomen are as 37 to 15, so that the abdomen is contained 2.47 times in the length of the anterior region of the body. The side of the head bears, as described by Scott, a sharp spinous process and the posterior thoracic margins are produced into sharp points.

The abdomen consists of only two segments, that have with the furcal rami the following proportional lengths:—

Abdominal segment 1-3	4-5	Furca
46	31	23=100.

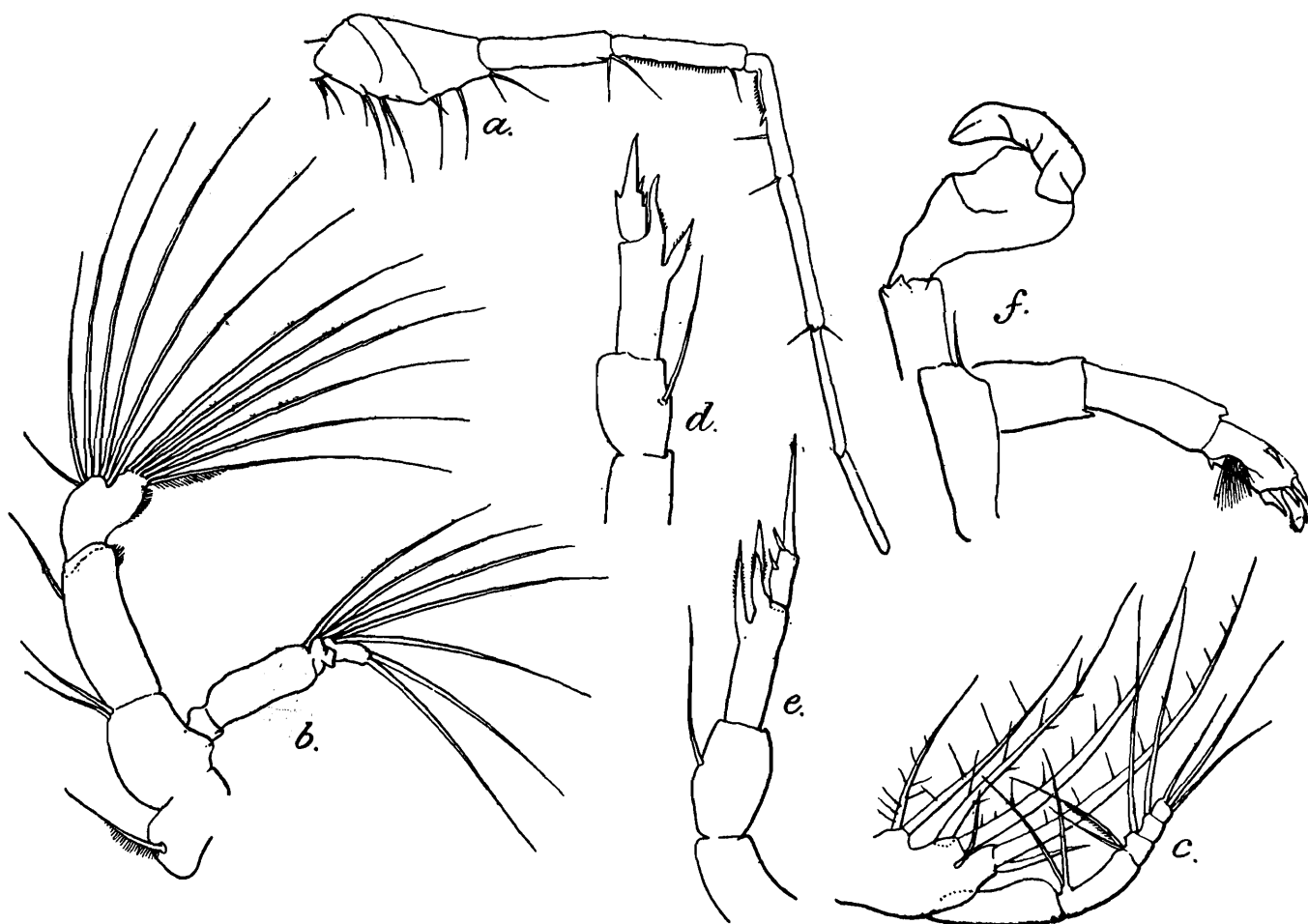
Specimens from Stations 614 and 587 exhibit an interesting difference in the structure of the genital segment; in the examples from the former station there is a well marked hemispherical swelling, measuring 0.07 mm. in diameter, on the right side of the segment about three-fifths of its length from the anterior end. A. Scott makes no mention of any such

swelling in this position in his examples but he states that "the ventral surface is produced posteriorly at the distal end in a rounded knob (Pl. xlix, fig. 2)" This ventral prominence is present in the examples from Station 614 but is situated close to the posterior margin of the segment and, therefore, somewhat further back than as figured by Scott. In examples from Station 587 the abdomen was slightly asymmetrical, the right side being rather more full than the left but there was no rounded prominence either on the ventral aspect or the right side.

The 1st antenna consists of 19 free segments and reaches to the middle of the genital segment. The proximal 8 free segments considerably stouter than the distal segments. The proportional lengths of the segments are as follows:—

Segment	1	2-5	6	7	8-9	10	11-12	13	14	15	16	17	18	19	20	21	22	23	24-25
	54	85	8	26	43	28	34	27	29	44	83	93	95	97	59	49	63	67	71=1000. ■

In one instance segments 16 and 17 of the right antenna were fused, the combined length of the joint being 142, whereas the length of the separate segments in the normal individual are together equal to 176.



TEXT-FIG. 112.—*Calanopia thompsoni* A. Scott (adult).

a. The segments of the knee-joint in the 1st right antenna, male.

b. The 2nd antenna.

c. The maxilliped.

d. The 4th leg, forma typica, female.

e. The 5th leg, variety from Station 587, female.

f. The 5th pair of legs, male.

The 2nd antenna, mouth-parts and the first four pairs of swimming legs appear to be similar to those of *Calanopia elliptica* (Dana).

The 5th pair of legs exhibit an interesting difference in examples from Station 587. In specimens from Stations 590, 614 and from the Pearl Banks of Ceylon the structure of this

appendage agrees exactly with the description and figures given by A. Scott (1909, Pl. xlix, fig. 5). In the examples from Station 587, this leg appears to be considerably more slender than usual and the terminal spine is nearly twice the length that it is in the normal form.

♂ Total length, 2.226.

The proportional lengths of the cephalothorax and abdomen are as 73 to 33, so that the abdomen is contained 2.212 times in the length of the anterior region. The general characters of the body are as in the female. The abdomen consists of five segments that have the following proportional lengths :—

Abdominal segment	1	2	3	4	5	Furca
	20	20	18	12	6	24=100.

The left resembles that of the female ; the proportional lengths of the several segments being as follows :—

Segment	1	2-5	6	7	8-9	10	11-12	13	14	15	16	17	18	19	20	21	22	23	24-25
	61	36	9	28	43	29	37	32	32	42	80	91	92	95	52	45	61	65	75 =1000.

In this sex the jointing of the antenna is slightly different from that in the female since segments 7 to 9 are fused together, but traces of the division of segments 7 and 8 can be detected. The right antenna is modified into a grasping organ and agrees with A. Scott's description.

In all other respects these examples agree with those taken by A. Scott in the Malay Archipelago and I have been unable to trace any differences in the males from Station 587 from those taken in any other locality.

Copepodid Stage III. (Text-fig. 113, d.)

In this stage of development I have only been fortunate enough to obtain examples of the male sex.

♂ Total length, 0.942 mm.

The proportional lengths of the cephalothorax and abdomen are as 59 to 23, so that the abdomen is contained 2.565 times in the length of the anterior region of the body.

The general structure of the cephalothorax already closely resembles that of the adult. The cephalon and 1st thoracic segment are separate and thoracic segments 4 and 5 are fused. The lateral hooks on the cephalon are present but are more slender than in the full-grown individual. The posterior thoracic margins are produced backwards in small pointed spinous processes.

The abdomen consists of only three segments, that have, with the furcal rami, the following proportional lengths ;

Abdominal segment	1	2	3-5	Furca
	26	22	28	24=100.

The 1st antenna consists of only sixteen free segments, that have the following proportional lengths ;

Segment	1	2-5	6	7-9	10	11-13	14	15-16	17	18	19	20	21	22	23	24-25
	56	34	10	56	22	61	22	84	72	78	100	72	67	83	88	100 =1000.

The 2nd antenna and mouth-parts appear already to have assumed the adult characters.

The swimming legs in each case consist of a two jointed basal portion, an exopod of two segments and a single-jointed endopod.

The 5th pair of legs (Text-fig. 113, d) consist of a basal segment and on each side a ramus of a single segment.

Copepodid Stage IV. (Text-fig. 113, a-c, e, f.)

♀ Total length, 1.281 mm.

The proportional lengths of the cephalothorax and abdomen are in the proportion of 5 to 2, so that the abdomen is contained 2.5 times in the length of the anterior region of the body.

The cephalothorax closely resembles that of the adult but the posterior thoracic margins are not so markedly produced as in the final stage of development.

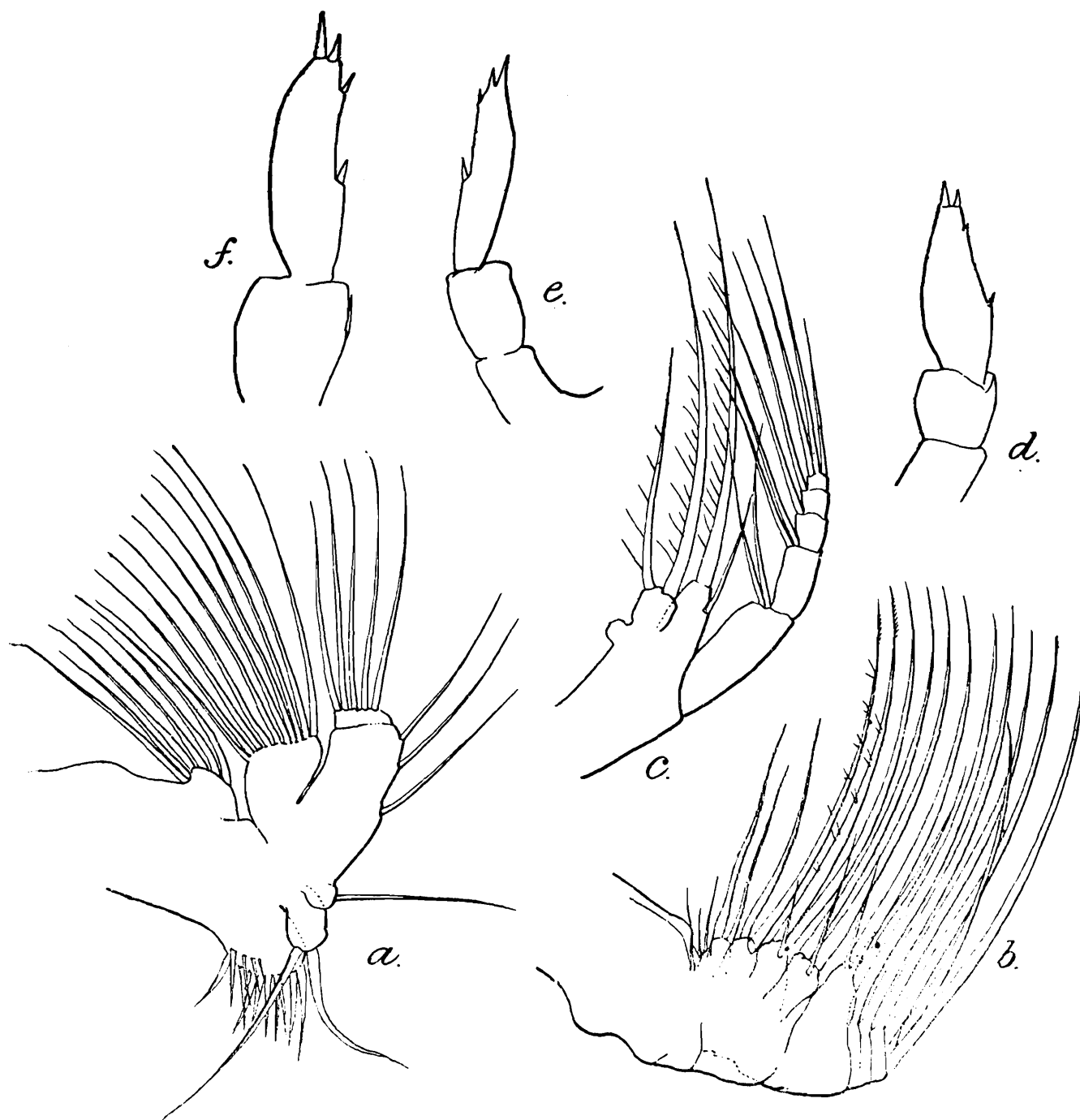
The abdomen consists of only two segments and the furcal rami, abdominal segments 1 and 2, and 3 to 5 respectively being fused together. The proportional lengths of the various segments are as follows :—

Abdominal segment	1-2	3-5	Furca
	44	31	25=100.

The 1st antenna reaches back to about the posterior margin of the anterior abdominal segment. It still consists of only sixteen free segments, which have the following proportional lengths :—

Segment	1	2-5	6	7-10	11-13	14	15	16	17	18	19	20	21	22	23	24-25
	61	36	8	89	61	24	34	53	79	85	101	67	59	77	81	85 = 1000.

The 2nd antenna and mouth-parts (text-figs. 113, a-c) closely resemble those of the adult.



TEXT-FIG. 113.—*Calanopia thompsoni* A. Scott (immature).

- a. The 1st maxilla. Copepodid Stage IV.
- b. The 2nd maxilla. Copepodid Stage IV.
- c. The maxilliped. Copepodid Stage IV.

- d. The 5th leg. Copepodid Stage III, male.
- e. The 5th leg. Copepodid Stage IV, female.
- f. The 5th leg. Copepodid Stage IV, male.

In the swimming legs the rami have already assumed the adult characters ; in the 1st to the 4th legs the exopod consists of a two-jointed basal portion, an exopod of three segments and an endopod of two segments.

The 5th pair of legs (text-fig. 113, e) are still immature and consist of a basal portion bearing the two legs, each of which possesses only two free segments. The rami are symmetrical and the distal joint bears a stout spine on its outer margin about half-way along its length and a group of three at the distal end of the outer margin.

♂ Total length, 1.241 mm.

The proportional lengths of the cephalothorax and abdomen are as 41 to 15, so that the abdomen is contained 2.40 times in the length of the anterior region of the body.

The cephalon exhibits the same characters as in the preceding stage.

The abdomen consists of three free segments, having, with the furcal rami the following proportional lengths :—

Abdominal segment	1	2	4-5	Furca
	23	23	30	24=100.

The 1st antenna consists of eighteen free joints, their proportional lengths being as follows :—

Segment	1	2-5	6	7-9	10	11-12	13	14	15	16	17	18	19	20	21	22	23	24-25
	60	37	0	65	19	29	24	27	40	70	80	87	94	59	51	75	84	90 = 1000.

The 2nd antenna and mouth-parts are as in the adult.

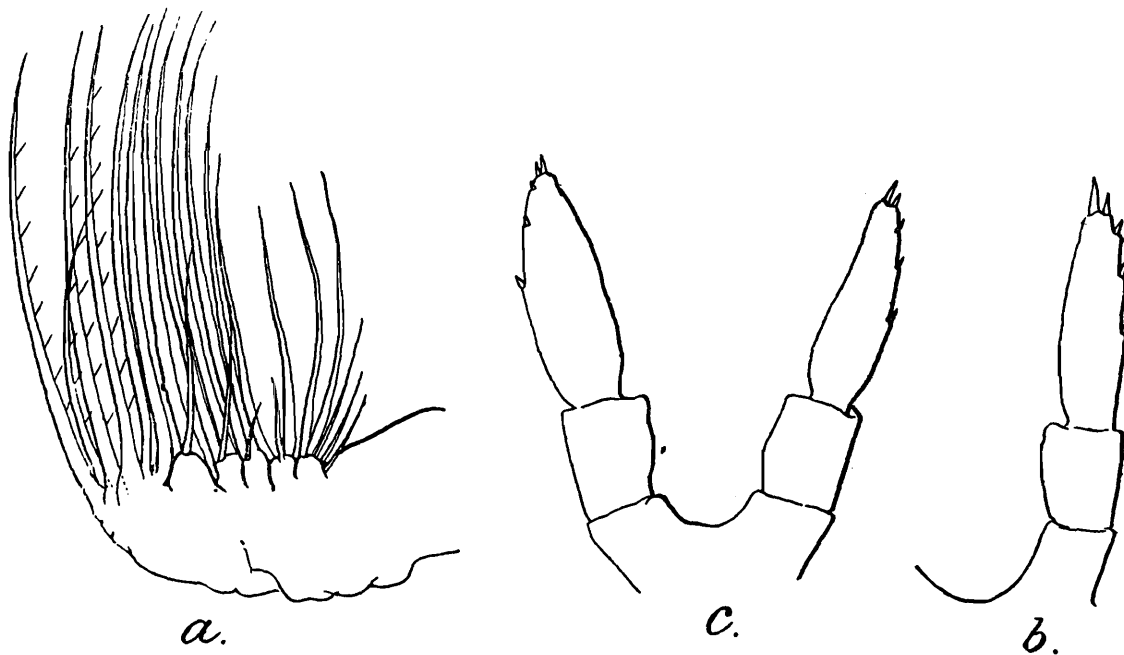
The swimming legs in this sex differ from those of the female in the corresponding stage of development ; in each case in the 1st to the 4th pair the exopod consists of only two free segments, segments 2 and 3 not yet having become differentiated, and the endopod consists of a single joint. The condition thus agrees with the state of development in the male of the 3rd Copepodid stage.

The 5th pair of legs (text-fig. 113, f) are very similar to those of the female in the same stage of development, but with this difference, that in the present sex the legs of the two sides are not quite symmetrical.

Copepodid Stage V. (Text-fig. 114, a-c.)

♀ Total length 1.681 mm.

The proportional lengths of the cephalothorax and abdomen are as 53 to 20, so that the abdomen is contained 2.65 times in the length of the anterior region of the body.



TEXT-FIG. 114.—*Calanopia thompsoni* A. Scott (immature).

a. The 2nd maxilla. Copepodid Stage V.

b. The 5th leg, female. Copepodid Stage V.

c. The 5th pair of legs, male. Copepodid Stage V.

The cephalothorax closely resembles that of the adult.

The abdomen consists of two free segments only, having the following proportional lengths :—

Abdominal segment	1-2	3-5	Furca
	45	32	23=100.

In this stage the proportional lengths of the abdominal segments are almost exactly the same as in the preceding stage ; it is probable that there has been no rearrangement of the segments and that, as before, it is segments 1-2 and 3-5 respectively that are fused.

The 1st antenna consists of seventeen free segments, that have the following lengths :—

Segment	1	2-5	6	7-10	11-12	13	14	15	16	17	18	19	20	21	22	23	24-25
	61	35	8	77	29	24	30	39	70	83	89	98	63	54	75	80	84=1000.

The 2nd antenna, mouth-parts and swimming legs resemble those of the adult.

In the 5th pair of legs (Text-fig. 114, b) each appendage consists of a basal segment and two free segments that are symmetrical. The distal segment now bears three small spines on the outer margin and two at the distal extremity.

♂ Total length, 1.668 mm.

The proportional lengths of the cephalothorax and abdomen are as 51 to 21, so that the abdomen is contained 2.429 times in the length of the anterior region of the body.

The general character of the cephalothorax is as in the adult.

The abdomen consists of four free segments that have the following proportional lengths :—

Abdominal segment	1	2	3	4-5	Furca
	22	22	17	16	23=100.

The 1st antenna already exhibits a commencement of the differentiation that will in the next moult give rise to the grasping antenna on the right side. The right appendage consists of 19 free segments whereas that on the left side possesses only 18. The proportional lengths of the segments are also different on the two sides as is shown below :—

Segment	1	2-5	6	7-8	9	10	11-12	13	14	15	16	17	18	19	20	21	22	23	24-25
Left	62	39	8	58	21		30	23	21	39	70	81	89	96	58	51	79	86	89=1000.
Right	65	44	8	55	20	20	32	20	20	35	60	78	95	64	35	42	106	100	103=1000.

The 2nd antenna and mouth-parts appear to be as in the adult.

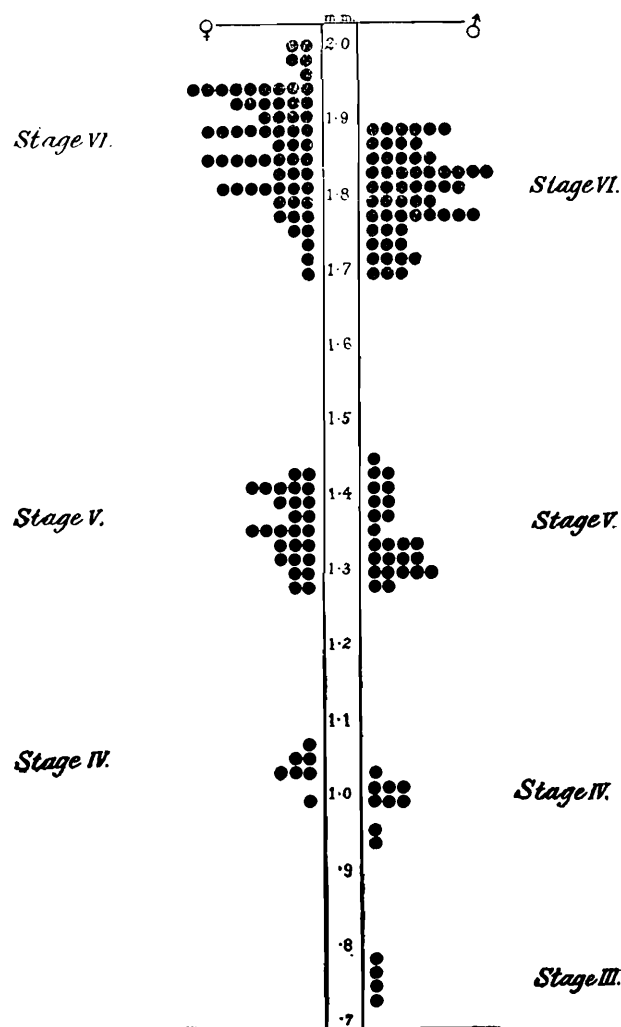
The swimming legs now consist of a two-jointed basal part a three-jointed exopod and a two-jointed endopod.

The 5th pair of legs (text-fig. 114, c) generally resemble those of the female but are slightly asymmetrical.

At Station 614 a large number of examples of this species, in the later stages of development and of both sexes, were obtained and the opportunity was taken of measuring a number of these individuals in order to work out the growth-factors and the changes in the proportional sizes of the various parts of the body during the last moults. The results of these measurements of the total length are given in text-fig. 115.

Stage of development.		Observed size. mm.	Calculated size. mm.	Growth-factor.
♀	Stage IV	1.281	1.281	1.341
	Stage V	1.681	1.718	1.341
	Stage VI (Adult)	2.303	2.304	..
♂	Stage III	0.942	0.938	1.770 or 1.341
	Stage IV	1.241	1.258	1.770
	Stage V	1.668	1.660	..
	Stage VI (Adult)	2.226	2.226	..

In the above table I have given the average size of both sexes in the different stages of development. Unfortunately, I have not been able to discover any stage in the female



TEXT-FIG. 115.—The length measurements of 193 examples of *Calanopia thompsoni* A. Scott from Station 614.

younger than Stage IV. It is thus impossible to discover whether there is a decrease in the growth-factor in the later moults such as I have found to be present in most of the species of which I have been able to work out the life history. The growth-factor of the last two moults in the female of the present species is apparently 1.341. In the male the course of development would appear to follow that which I have previously suggested as the characteristic feature of the male development, namely, that an example may pass from stage III, either to Stage IV by the female growth-factor or to Stage V by the male growth-factor and from Stage IV to Stage VI by the male growth-factor. In the present species the characteristic male growth-factor appears to be 1.770. It is, however, possible that the course of development may be a straight one, examples passing in succession through the various stages. If this be so the growth factor would appear to be that given in the table below :

Stage of development.	Observed size.	Calculated size.	Growth- factor.
	mm.	mm.	
Stage III	0.942	0.942	1.332
Stage IV	1.241	1.255	1.332
Stage V	1.668	1.671	1.332
Stage VI (Adult)	2.226	2.226	—

When studying the development of *Metridia princeps* Giesbrecht and *Gaussia princeps* (T. Scott) I have shown that there is a progressive change in the proportions of the thorax and abdomen, as well as of the various segments of the abdomen itself, with each successive moult. An exactly similar change occurs in the case of the present species and in the following table I have given the proportional lengths of the cephalothorax and the segments of the abdomen in parts per thousand of the total body-length in each growth stage :—

Stage of development.		Cephalothorax.	Abdominal segments.					Furcal ramus.
			1	2	3	4	5	
♀	Stage IV	726	121		84			69
	Stage V	726	123		88			63
	Stage VI (Adult).	713	132		89			66
♂	Stage III	719	73	63	77			68
	Stage IV	716	66	66	84			68
	Stage V	706	65	66	49	47		67
	Stage VI (Adult).	674	65	77	60	42	15	67

From the above table it is clear that there is a progressive decrease as development proceeds in the proportional length of the cephalothorax, the length of the abdomen proportionately increasing. This increase in the length of the abdomen is not, however, uniform throughout its entire length. In the female the anterior free segment of the abdomen increases in length between Stages IV and VI by 9.1 per cent., whereas the posterior free segment only increases by 5.95 per cent. At the same time the furcal ramus seems to decrease slightly in length. In the male the proportional decrease in the length of the cephalothorax is more marked, being between Stages III and VI 6.3 per cent., and there is a proportionately greater increase in the length of the abdomen. In this sex also there is a slight decrease to the extent of 11 per cent. in the proportional length of the 1st abdominal segment between Stages III and VI. The 2nd abdominal segment, however, shows an increase during the same course of development of 22.2 per cent. The posterior segments exhibit also an increase in length at the successive moults but this is to some extent masked by the simultaneous differentiation of the segments at succeeding moults; between Stages III and IV the fused segments 3-5 increase in length by 9.05 per cent.; and in the following moult segment 3 is separate off from the combined segments 4-5, this change being accompanied by an increase in the total length of this part of the abdomen of 14.3 per cent. In the final moult the 3rd segment shows an increase in length of 24.45 per cent. and the fused segments 4-5 become differentiated and show a simultaneous increase of 21.28 per cent. At the same time there is a slight decrease in the proportional length of the furcal ramus. It is thus clear that during development there is heterogonic growth in the various parts of the body, with the most rapid development in the region of the 3rd abdominal segment and that from this point the rate of growth diminishes as we pass either anteriorly or posteriorly.

The development of the 1st Antenna also exhibits different rates of growth in the various segments. In the following table I have given the proportional lengths of these segments in parts per thousand of the whole appendage in each sex in the different stages of growth :—

♀	Segment	1	2-5	6	7	8-9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24-25
	Stage IV	61	36	8	89			61			24	34	53	79	85	101	67	59	77	81	85
	Stage V	61	35	6	77			28	24	30	39	70	83	89	98	63	54	75	80		84
	Stage VI	54	35	8	26	43	23	34	27	29	44	83	93	95	97	59	49	63	67		71
♂	Stage III	56	34	10	56	22			61	22	84			72	78	100	72	67	83	83	100
	Stage IV	60	37	9	65	19			29	24	27	40	70	80	87	94	59	51	75	84	90
	Stage V	62	35	8	58	21			30	23	21	39	70	81	89	96	58	51	79	86	89
	Stage VI (left).	61	36	9	28	43	29	37	32	32	42	80	91	92	95	52	45	61	65		75

In this species it appears that there is but little change in the proportional lengths of the more proximal segments; in segments 7 to 10, in which there is, as development proceeds, a separation of one undivided segment in the early stages of the female to three separate segments or in the male from two segments to three, there is, as one would expect, an increase in the total length of these segments. In segments 14 to 18 there is clear evidence of an increase in length which is at a maximum at the level of segment 16. From segment 19 to the end there is equally clear evidence of a decrease in the length of the segments which has its maximum at about the level of the 21st or 22nd segment.

Genus **ANOMALOCERA** Templeton.

Anomalocera patersoni Templ. has on two occasions been recorded from the Indian Ocean. The first report of its occurrence in these waters is that by Thompson (1900, p. 283), who records the presence of a single specimen in the Wyse collection from a sample taken near the southern extremity of Africa. The position at which the sample was taken is given as “ 20° S ; 38° 40' E. Taken after 24 hours running, from bath-room tap, which leads from a tank on top deck, kept full for flushing and other purposes.” Were this the only record it would have to be regarded with some degree of suspicion, for there is no means of ascertaining the position or time at which the individual specimen was pumped from the sea into the tank on the top-deck. There is, however, a second record of the occurrence of this species in Indian seas, namely, that given by Wolfenden (1906, p. 1020) of its presence in the collections made by Prof. Stanley Gardiner in the Maldivé and Laccadive Archipelagoes. It thus appears probable that the species is of occasional, though rare, occurrence in these regions. Up to the present time no example has been taken in the “ Investigator ” or other collections that I have examined.

Genus **LABIDOCERA** Lubbock.

The first record of the occurrence of any species of this genus in the Indian Ocean or its offshoots is that by Giesbrecht in 1899, in which he mentions the taking of *Labidocera acuta* (Dana), *L. minuta* Giesbrecht, *L. orsinii* Giesbrecht and *L. pavo* Giesbrecht in the Red Sea. A year later Thompson (1900) recorded the occurrence of *Labidocera acuta* (Dana) and *L. acutifrons* (Dana) from the western region of the Indian Ocean. Cleve (1901) reported *Labidocera acuta* (Dana) and *L. minuta* Giesbrecht from the Malay Archipelago and the Arabian Sea, and *L. kroyeri* (Brady) *L. nerii* Krøyer and *L. pavo* Giesbr. from the former

region. A. Scott in 1902 confirmed the occurrence of *Labidocera acuta* (Dana) and *L. minuta* Giesbr. in the Red Sea and in collaboration with Thompson in the Report of the Ceylon Pearl Fisheries in 1903 records the occurrence in that area of *Labidocera acuta* (Dana), *L. minuta* Giesbr., *L. detruncata* (Dana), *L. pavo* Giesbr., *L. kroyeri* (Brady), together with two varieties, var. *stylifera* and var. *gallensis*, and *L. pectinata* Thompson and A. Scott. In 1904 Cleve recorded *Labidocera acuta* (Dana) and *L. minuta* Giesbr. from the Red Sea, the Gulf of Aden and the Arabian Sea, and *L. pavo* Giesbr. from the Gulf of Suez and the Arabian Sea; from the latter region, he also recorded under the name *L. similis*, the species that Thompson and A. Scott had previously described as *L. pectinata* from the Ceylon Pearl Banks. Two years later in 1906 Wolfenden reported the occurrence in the Maldives and Laccadive Archipelagoes of *Labidocera acuta* (Dana), *L. wollastoni* (Lubbock), *L. minuta* Giesbr., a variety of *L. detruncata* (Dana) and *L. laevidentata* (Brady). In 1909 A. Scott in his account of the collections of the "Siboga" in the Malay Archipelago recorded the presence in that area of *Labidocera acuta* (Dana), *L. detruncata* (Dana), *L. kroyeri* (Brady), *L. laevidentata* (Brady), *L. minuta* Giesbr., *L. bataviae* A. Scott and *L. madurae* A. Scott. In 1911 Wolfenden recorded the presence of *Labidocera acuta* (Dana) at a depth of 400 metres in the Indian Ocean and at the surface in Port Natal on the east coast of Africa. In 1914-15 Brady recorded *Labidocera detruncatum* (Dana), *L. acuta* (Dana), *L. kroyeri* (Brady), *L. trispinosa* Esterly, *L. inermis* (Brady) and *L. chubbi* (Brady) from the East Coast of Africa. This latter species, however, appears to me to be merely an example of the male of *L. minuta* Giesbr. In 1912 I recorded *Labidocera acuta* (Dana), *L. euchaeta* Giesbr., *L. kroyeri* (Brady) and its varieties *stylifera*, *burmanica* and *bidens*, *L. minuta* Giesbr. and *L. pectinata* Thompson and A. Scott, from the coast of southern Burma. In 1912-13 Pesta recorded the occurrence of *Labidocera acuta* (Dana), and *L. minuta* Giesbr. from the Arabian Sea and Persian Gulf. In 1914 I recorded *Labidocera acuta* (Dana), *L. kroyeri* (Brady), with its varieties *stylifera* and *burmanica*, *L. minuta* Giesbr., *L. pavo* Giesbr., and *L. pectinata* Thompson and A. Scott from the Ceylon Pearl Banks and in 1924 *Labidocera pavo* Giesbr. from the Chilka Lake. In 1924 Früchtl recorded *Labidocera acutifrons* (Dana), *L. acuta* (Dana), *L. laevidentata* (Brady) and *L. minuta* Giesbr. from the Aru Archipelago; and, finally, Gurney in 1927 recorded *Labidocera pavo* Giesbrecht and *L. minuta* Giesbrecht from the Suez Canal.

Thus seventeen species and varieties in this genus have been recorded from various regions of the Indian Ocean and of these as many as fourteen are present in the "Investigator" collections.

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

(Text-figs. 116, 117.)

Labidocera acuta, A. Scott, 1909, p. 164.

Labidocera acuta, Wolfenden, 1911, p. 361.

Labidocera acuta, Pesta, 1912, p. 51, fig. 13.

Labidocera acuta, Sewell, 1912, p. 368.

Labidocera acuta, Pesta, 1913, p. 32.

Labidocera acuta, Sewell, 1914, p. 232.

Labidocera acuta, Früchtl, 1924, p. 77.

This species has a wide distribution throughout the whole extent of Indian waters ; it has now been recorded from the Malay Archipelago (Cleve ; A. Scott, Früchtl) ; the coast of Burma (Sewell) ; the Ceylon Pearl Banks (Thompson and A. Scott, Sewell) ; the Maldivé and Laccadive Archipelagoes (Wolfenden) ; the Arabian Sea (Cleve, Pesta) ; the Persian Gulf (Pesta) ; the Red Sea (Giesbrecht, A. Scott) ; the east coast of Africa (Wolfenden, Brády) and the Agulhas Current (Cleve). In the " Investigator " collections this species occurs at the following stations ; 542, 543, 552, 555, 556, 558, 559, 582, 583, 587, 588, 590, 591, 614.

I have previously called attention to certain changes that take place during development in this species (*vide* Sewell, 1912, p. 369) and I give below certain measurements in order to demonstrate the changes in the proportions of the body and certain of the appendages during the later moults.

♀ Total length, 3.07 mm.

The proportional lengths of the cephalothorax and abdomen are as 97 to 35, so that the abdomen is contained 2.771 times in the length of the anterior region of the body.

The abdomen consists of three segments and the furcal rami : these have the following proportional lengths :—

Abdominal segment	1-3	4	5	Furca	
	40	26	14	20	= 100

The 1st antenna reaches back to about the posterior end of the 2nd free segment of the andomen. It consists of twenty-two free segments, segments 6 to 8 being fused together, though the line between segments 7 and 8 can be detected, as well as segments 24 and 25. The proportional lengths of the segments are as follows ;—

Segment	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	
	91	71	12	9	10	21	12	25	22	18	41	46	52	57	73	73	82	82	56	50	33	33	31	= 1000

Copepodid Stage IV. (Text-fig. 116, a-d.)

♀ Total length, 1.721 mm.

The proportional lengths of the cephalothorax and abdomen are as 183 to 67, so that the abdomen is contained 2.731 times in the length of the anterior region.

The median frontal spine is only very slightly developed and forms an insignificant short crest ; the posterior thoracic margins are produced backwards in pointed processes. The 4th and 5th segments are partially fused together, but the line of junction can be detected.

The abdomen consists of only three segments, that have, with the furcal rami, the following proportional lengths :—

Abdominal segment	1	2	3-5	Furca	
	23	18	31	28	= 100

The second and third furcal setae show no signs of the modification that is present in the adult.

The 1st antenna consists of twenty-three free segments, segments 8 and 9, and 24 and 25 respectively being fused together. These segments have the following proportional lengths :—

Segment	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	
	88	61	10	10	11	21	8	23	16	13	37	36	40	43	55	55	77	88	68	65	60	60	55	= 1000

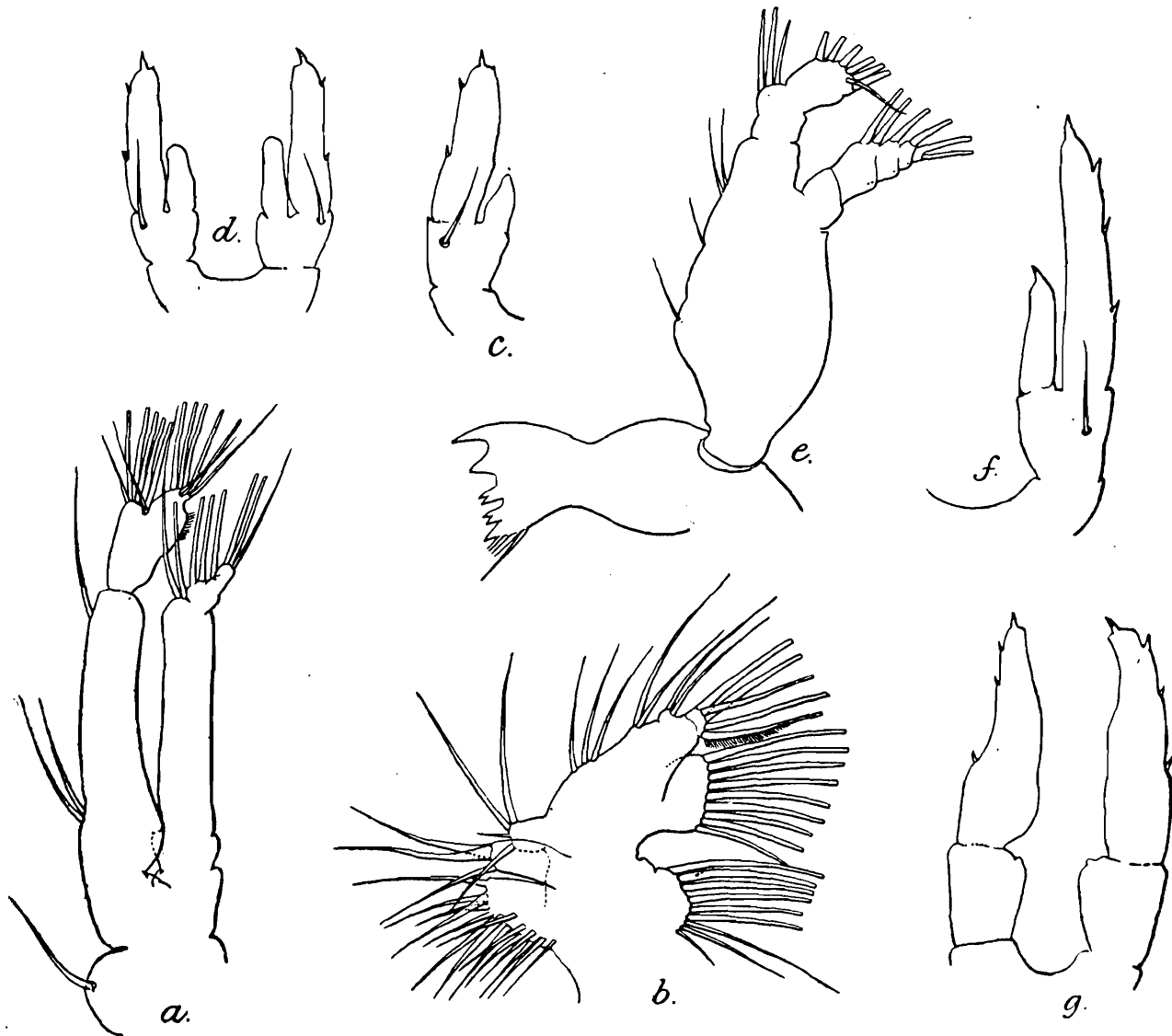
The 2nd antenna (text-fig. 116, a) already possesses the characters of the adult appendage, the sole difference, that I have been able to detect, being in the number of setae that arise from the inner lobe of the terminal segment of the endopod ; at this stage of development there are only 7 setae on this lobe, whereas in the next copepodid stage there are 8.

The mouth-parts (text-fig. 116, *b*) have already assumed the adult characters.

In the 1st swimming leg the exopod consists of only two free segments, segments 2 and 3 not yet being differentiated; these two joints bear 1 and 3 marginal spines respectively. The proximal spine on segment 2 is half as long again as the 2nd and 3rd spines. The number of setae on the inner margins of the joints are 1 and 4. The endopod consists of only a single segment that bears nine setae.

In the 2nd swimming leg the segmentation of the rami is as in the preceding leg. The proximal spine on the 2nd segment is long and reaches as far as the base of the 2nd marginal spine. The endopod bears ten setae.

The 3rd swimming leg closely resembles the 2nd but differs in the degree of development of the 1st marginal spine on the 2nd segment of the exopod, which does not reach as far as the base of the 2nd spine, and in the number of setae on the endopod, which in this leg are only nine in number.



TEXT-FIG. 116.—*Labidocera acuta* (Dana), immature.

- a. The 2nd antenna. Copepodid Stage IV.
 b. The 1st Maxilla. Copepodid Stage IV.
 c. The 5th leg. Copepodid Stage IV, female.

- d. The 5th pair of legs. Copepodid Stage IV, male.
 e. The Mandible. Copepodid Stage V.
 f. The 5th leg. Copepodid Stage V, female.

- g. The 5th pair of legs. Copepodid Stage V, male.

In the 4th swimming leg the exopod consists of two segments and the endopod of only one. The endopod bears only eight setae.

The 5th pair of legs (text-fig. 116, *c*) are symmetrical and both endopod and exopod are well developed.

♂ Total length, 1.558 mm.

The proportional lengths of the cephalothorax and abdomen are as 23 to 8, so that the abdomen is contained 2·875 times in the length of the anterior region of the body.

At this stage of development the anterior spine in the frontal region of the head is only slightly developed.

The abdomen consists of three segments and the furcal rami; these have the following proportional lengths :—

Abdominal segment	1	2	3-5	Furca	
	23	18	30	29	=100

The 1st antenna consists of twenty-three segments, segments 6 and 7 and 24 and 25 being respectively fused. The proportional lengths of the segments are similar to those of the female.

The mouth-parts and swimming legs are also similar to those of the female.

The 5th pair of legs (text-fig. 116, *d*) closely resemble those of the female. The endopod is still present but is slightly smaller than in the female and is fused with the 2nd basal segment.

Copepodid Stage V. (Text-fig. 116, *e-g*.)

♀ Total length, 2·279 mm.

The proportional lengths of the cephalothorax and abdomen are as 70 to 28, so that the abdomen is contained 2·5 times in the length of the anterior region of the body.

The cephalon and the various thoracic segments are all separate. The forehead bears a prominent spine that exactly agrees with that of the adult. The posterior thoracic margin is symmetrical and is produced in a sharp backwardly-directed process.

The rostrum is formed of two stout spines and the eyes are small, as in the adult female. There is a well-marked, depressed groove across the neck region of the cephalon.

The abdomen consists of three segments and the furcal rami. The proportional lengths of the segments are as follows :—

Abdominal segment	1-3	4	5	Furca	
	38	24	14	24	=100

There is no trace of the lateral process found on the genital segment in the adult.

The 1st antenna reaches back to about the middle of the second free segment of the abdomen. Each appendage consists of twenty-two free segments. Segments 6 and 7 and 8 and 9 are respectively fused together, as well also as segments 24 and 25. The proportional lengths of the segments are as follows :—

Segment	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	
	93	70	12	9	13	21	10	25	18	17	40	40	47	53	69	69	83	87	61	57	37	37	32	=1000

The 2nd antenna has already attained the adult characters and the inner lobe of the terminal segment of the endopod bears 8 setae instead of 7, as in the preceding stage; the distal lobe bears 7 setae.

The mouth-parts are as in the adult.

In the 1st swimming leg the exopod is now 3-jointed. The marginal spines are 1, 1, 2 on the respective segments and the number of setae on the inner margins of the segments are 1, 1, 4. The endopod consists of two joints, bearing respectively 3 and 6 setae.

The 2nd and 3rd swimming legs are very similar; in both the exopod consists of 3 segments and the endopod of two. The number of marginal spines on the various segments of the exopod are 1, 1, 3 and the setae on their inner margins 1, 1, 5. The setae on the two segments of the endopod number 3 and 8 respectively. Almost the only difference between the two legs lies in the degree of development of the marginal spine on the 2nd segment of the exopod, which is somewhat longer in the 2nd leg.

In the 4th swimming leg the exopod is three-jointed and the endopod two-jointed as before and, as in the preceding two pairs of legs, the segments of the exopod carry respectively 1, 1 and 3 marginal spines and 1, 1 and 5 setae; but the endopod carries only 3 and 7 setae on the two segments instead of 3 and 8 as in the other two appendages.

In the 5th leg (text-fig. 116, *f*) both exopod and endopod are well-developed. The exopod is about twice the length of the endopod and bears three small spines on its outer margin and a single larger spine at the distal end. The endopod also terminates in a well-marked spine. Both legs are symmetrical.

♂ Total length, 2.277 mm.

The proportional lengths of the cephalothorax and abdomen are as 89 to 36, so that the abdomen is contained 2.472 times in the length of the anterior region of the body.

The cephalothorax resembles that of the female. The eyes still possess the same proportional size as in the female, though in the next moult at the attainment of adult life these become greatly increased. The posterior thoracic margin is nearly symmetrical and is produced back in well-developed pointed spinous processes, that on the right being slightly the longer.

The abdomen consists of four segments and the furcal rami; segments 4 and 5 have not yet become differentiated. The proportional lengths are as follows :—

Abdominal segment	1	2	3	4-5	Furca	
	22	19	20	14	25	=100

The 1st antenna consists, as in the female, of twenty-three joints. The appendages of the two sides are not quite symmetrical, as the right antenna already shows a commencement of the modification that at the next moult will convert it into a grasping organ and segments 13 to 18 are somewhat swollen. In the unmodified appendage the segments have the following proportional lengths :—

Segment	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	
	81	66	12	9	12	21	11	24	19	14	40	35	43	50	63	63	81	88	61	59	52	49	47	=1000

The 2nd antenna, mouth-parts and swimming legs are similar to those of the female.

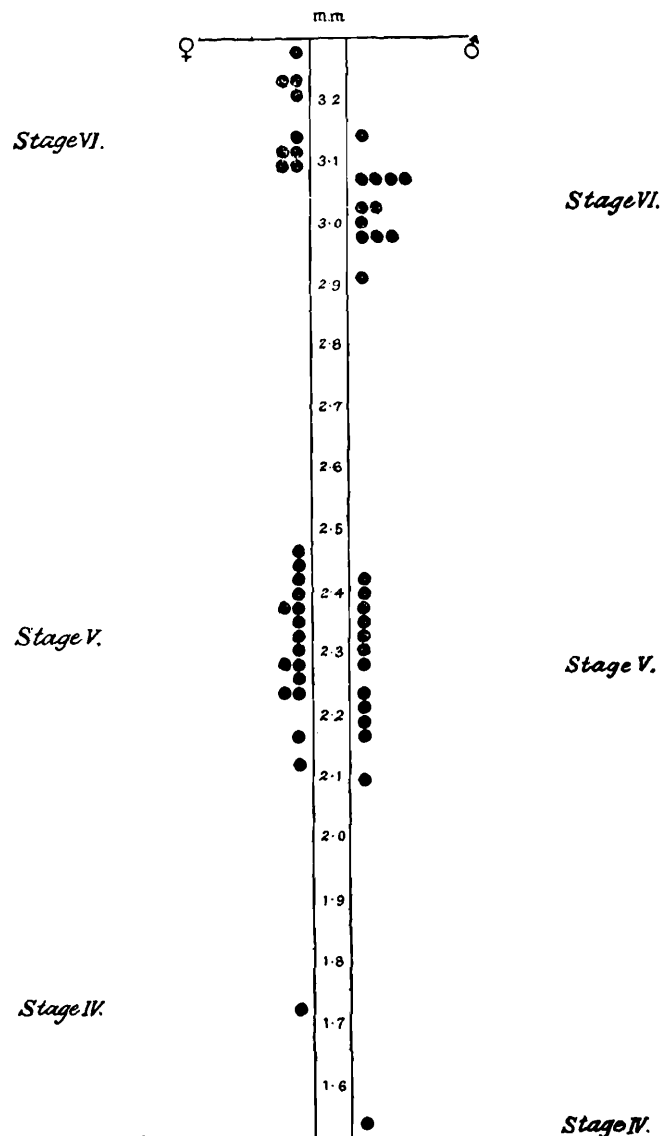
The 5th pair of legs (text-fig. 116, *g*) has already become modified. The endopod is almost completely suppressed and is represented by a minute rounded prominence on the distal inner margin of the 2nd basal segment. The exopods are well developed and are slightly asymmetrical, that on the left side being bent inwards towards the middle line at its distal part. Each exopod bears three small marginal spines and a somewhat larger distal spine.

Although this species is comparatively common and is widely distributed throughout Indian waters, I have up to the present time been able to obtain examples of only the last three stages of its development, namely Stages IV, V and VI, in each sex. So far as one can judge from these stages this species follows the same line of development as *Labidocera euchaeta* Giesbrecht. In the following table I have given the observed body-lengths in all three stages in each sex, as well as the growth-factor and the theoretical length calculated from this. The actual measurements are shown in text-fig. 117.

Stage of development.	Observed size.	Calculated size.	Growth-factor.
♀	mm.	mm.	
Stage IV	1.721	1.724	1.355
Stage V	3.328	2.336	1.355
Stage VI	2.165	3.165	
♂			
Stage III		1.216	1.837 or 1.355
Stage IV	1.558	1.648	1.837
Stage V	2.277	2.257	
Stage VI	3.027	3.027	

The growth-factor for the female is considerably higher than that of most other species; in the case of the male, if, as I believe, the final stages in the two possible lines of develop-

ment (*vide supra*, p. 7) to wit Stages V and VI, are reached respectively from Stages III and IV, the growth-factor, namely 1.837, appears so high as to lead one to doubt whether



TEXT-FIG. 117.—Showing the length measurements of 51 examples of *Labidocera acuta* (Dana).

it can be correct; in those cases, which I have previously examined and in which the male appears to follow the same line of development, the characteristic growth-factor for the attainment of the last stages has, however, been found in every case to be somewhere in the neighbourhood of the square of the growth-factor for the last two moults of the female and the same holds good in the present instance, the square of 1.355, the female factor, being 1.836, which agrees extremely closely with the growth-factor for the male as given above, namely 1.837. If, however, the male development is similar to that of the female, each stage succeeding the other in a direct sequence, *i.e.*, Stage V following Stage IV and Stage VI following Stage V, the male growth-factor would appear to be 1.394 and the observed and calculated size at each moult would be as follows:—

	Observed size.	Calculated size.	Growth-factor.
	mm.	mm.	
♂			
Stage IV .	1.558	1.557	1.394
Stage V .	2.277	2.171	1.394
Stage VI	3.027	3.037	..

In the accompanying Table I have given the proportional lengths of the various segments of the cephalothorax and abdomen in the last three stages of development ; with the exception of the measurements of the earliest stage (Stage IV) in both sexes, in which I had only a single specimen of each, the others are the average of several examples, at least five and in some cases more. It seems clear that the rate of growth is not the same in any of the segments and that there are two regions of the body in which the rate of growth attains a maximum, namely about the 2nd thoracic segment and the 4th segment of the abdomen, while at the two extremities of the body, namely the cephalon and the furcal rami, the rate of growth is less than the average. In the female there is a slight decrease in the length of the cephalon between stages IV and VI, though there appears to be a slight increase in the proportional length in Stage V. In the 1st thoracic segment this condition is reversed and, although there is a decrease in the proportional length between stages IV and VI, there is a marked decrease between stages IV and V, followed by an increase between Stages V and VI. In segment 2 of the thorax there is a steady increase in the proportional length throughout the whole period of life that I have examined, the increase between Stages IV and V being 14.15% and between Stages V and VI 14.69%, or an average of 14.42%. In segment 3 of the thorax there is also a steady increase in length throughout the period, this amounting between Stages IV and V to 16.36% and between Stages V and VI to 6.9%, or an average of 11.63%. Thoracic segments 4 and 5 together show a decrease in their proportional length, that is most marked in segment 4 between Stages IV and V, where the decrease amounts to as much as 22.9%, while in segment 5 between the same stages there is actually an increase of 22.2% ; throughout the whole period the proportional decrease in the combined length of these two segments amounts to 12.1%. In the abdominal region there is but little change in the proportional length of the 1st three segments throughout the period ; in Stage IV the 3rd-5th segments are fused but segments 1 and 2 are separate, their combined lengths amounting to 110 and at Stage V these latter segments have become fused and together measure 111.5, while at Stage VI they measure 109.2. Segments 3, 4 and

Stage of development	Cephalon.	Thoracic segments.					Abdominal segments					Furcal ramus.
		1 2 3 4 5					1 2 3 4 5					
Stage IV ♀	353.0	157.0	65.0	66.0	63.0	28.0	62.0	48.0	82.0		76.0	
Stage V . .	363.4	114.4	74.2	76.8	49.2	34.2	111.5	68.9		36.5	70.5	
Stage VI (Adult) .	349.2	127.1	85.1	82.1	80.1		109.2	71.6		41.6	56.2	
Stage IV ♂	378.0	160.0	58.0	63.0	43.0	30.0	57.0	49.0	74.0		78.0	
Stage V . .	359.6	128.0	71.8	77.2	43.2	32.4	60.6	56.0	58.2	39.8	73.2	
Stage VI (Adult)	337.4	131.8	84.6	84.6	77.8		52.6	53.4	60.0	33.0	19.8	65.0

5 in Stage IV are fused and together measure 82.0 : at the next moult segment 3 becomes differentiated from segments 4-5 and the combined length of the two joints has increased to

105.4, an increase of 28.5 per cent. Between Stages V and VI segment 3 increases still further from 68.9 to 71.6, an increase of 3.9 per cent., and segments 4-5 have increased from 36.5 to 41.6, an increase of 14.0 per cent. At the same time the furcal ramus decreases between Stages IV and V from 76.0 to 70.5, a decrease of 7.9 per cent.; and between Stages V and VI from 70.5 to 56.2, a decrease of 20.3 per cent.

Turning now to the male, the cephalon shows a steady decrease in its proportional length throughout the whole period, the decrease between stages IV and V being 9.5%, and between Stages V and VI being 6.2%. The 1st thoracic segment, as in the female, shows a marked decrease in length between Stages IV and V, followed by a slight increase in length between Stages V and VI. In segments 2 and 3 there is a steady increase in length at each moult though this is more marked in segment 2, in which the increase in length between Stages IV and V is 23.8% and between Stages V and VI is 17.8%, or an average of 20.8%, whereas in segment 3 between Stages IV and V the increase in length is 22.5% and between Stages V and VI is 9.6% or an average of 16.05%. In segments 4 and 5 there is a very small increase at each moult amounting to approximately 3.23%.

In the abdominal region the greatest increase in length again takes place towards the posterior end. Segment 1 exhibits only a small variation, increasing by 6.3% of its length between Stages IV and V and decreasing again by 13.2% between Stages V and VI. Segment 2 also appears to exhibit a similar reversal of its growth and increases by 14.3% between Stages IV and V and then decreases again by 4.64% between Stages V and VI. In the three posterior segments there is a very considerable increase in length; in the earliest stage, Stage IV, the combined length of these segments, that are then fused together, is 74, but between Stages IV and V this has increased to 98 and at the same time segment 3 has become separated off, this segment showing a length of 58.2. This increase in length amounts to as much as 13.24%. At the next moult, between Stage V and VI, the third segment increases in length from 58.2 to 60.0, an increase of 3.1% only, whereas the 3rd and 4th segments, which now become separate, increase from 39.8 to a combined length of 52.8 or an increase of 32.66%. The greatest increase in length thus clearly takes place at about the level of the 4th segment. On the other hand the furcal ramus during the same period of life decreases in length from 78.0 at Stage IV to 73.2 at Stage V, a decrease of 6.15%, and between Stages V and VI from 73.2 to 65.0, a decrease of 11.2%.

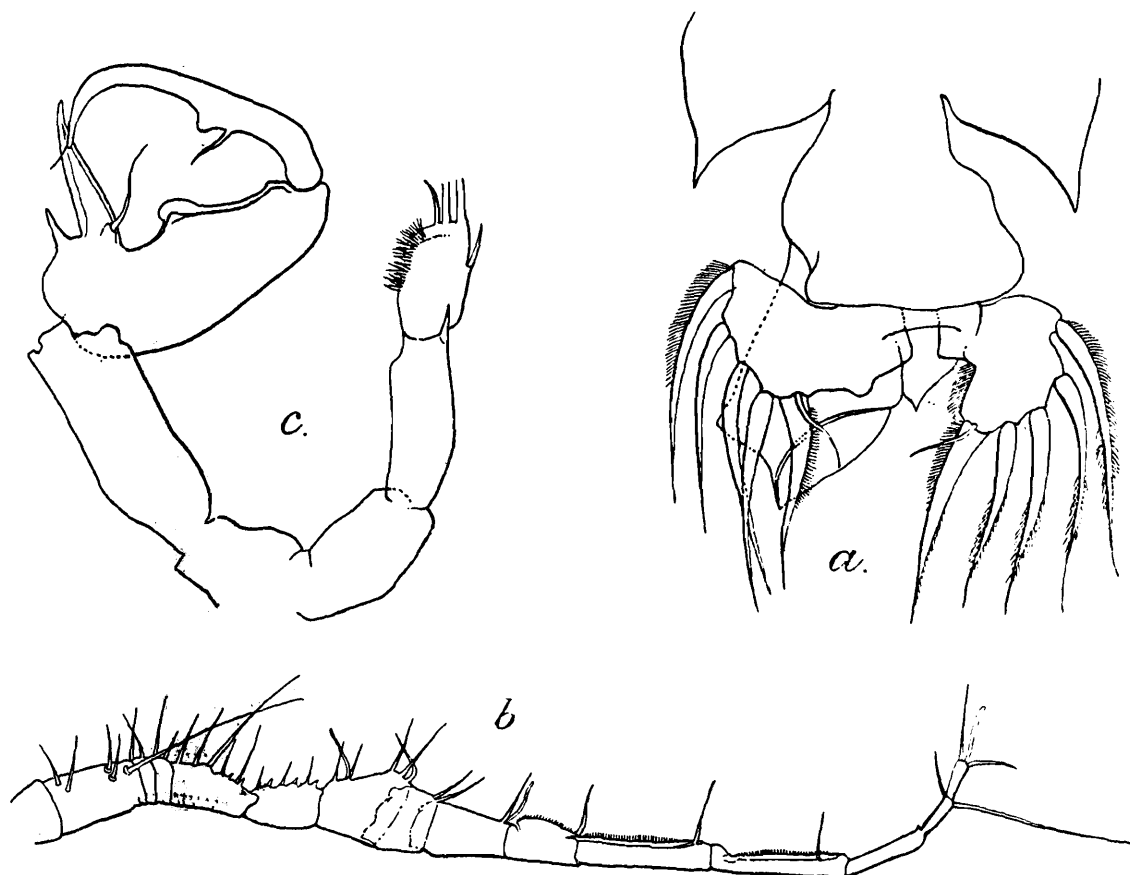
During the same period of the life history the 1st Antenna undergoes changes similar to those that we have seen in other species. I give below the proportional lengths of the various segments at each stage, the whole antenna being taken as measuring 1000.

Segment	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
Stage IV	88	61	10	10	11	21	8	23	16	13	37	36	40	43	55	55	77	88	68	65	60	60	55
Stage V	92	70	12	9	13	21	10	25	18	17	40	40	47	53	69	69	83	87	61	57	37	37	32
Stage VI	91	71	12	9	10	21	12	25	22	18	41	46	52	57	73	73	82	82	56	50	33	33	31

There is thus but little change in segment 1, but segments 2 and 3 increase slightly in length. Segments 4-6 remain practically unchanged; segments 7 to 18 show a steady increase in length at each moult which is greatest at segments 7, 10, 11 and 15; at segment 19 this increase is changed to a decrease that steadily gets greater till the terminal segment; segments 24-25 show a decrease in length of 43.6%.

Labidocera bataviae A. Scott.(Text-fig. 118, *a-c.*)*Labidocera bataviae*, A. Scott, 1909, p. 168, pl. 1, figs. 1-8.

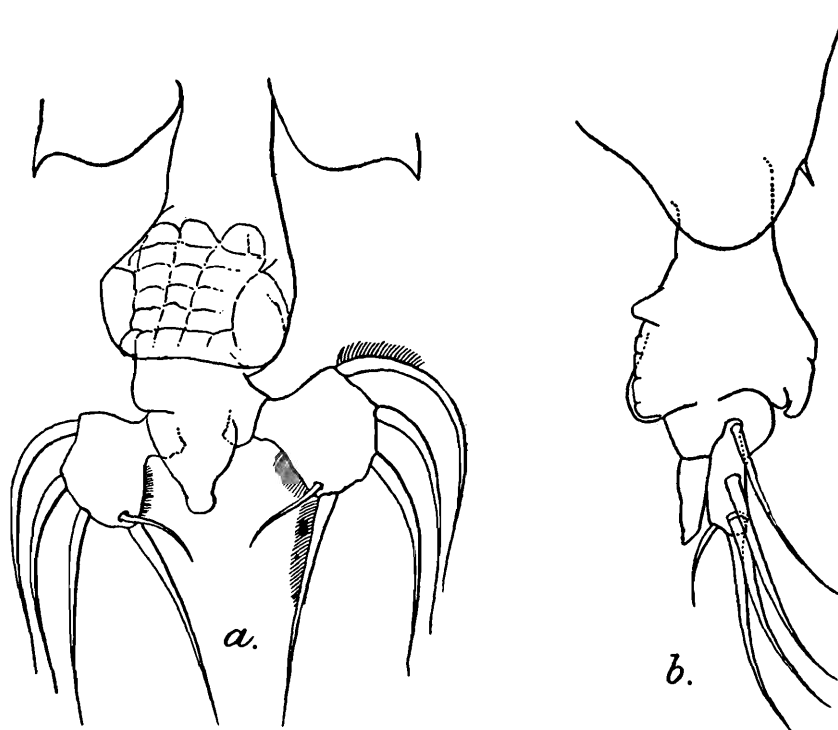
A number of examples of this species were taken at "Investigator" Stations 614 and 625. These agree closely with the description and figures given by A. Scott. The male examples in this collection exhibit a slight asymmetry of the posterior thoracic margin; the spine on the right side being about twice the size of that of the left.

TEXT-FIG. 118.—*Labidocera bataviae* A. Scott.*a.* The abdomen from the dorsal aspect female.*b.* The grasping antenna of the male.*c.* The 5th pair of legs, male.**Labidocera detruncata** (Dana).(Text-fig. 119, *a, b.*)*Labidocera detruncata*, A. Scott, 1909, p. 165.*Labidocera detruncatum*, Brady, 1914, p. 135.

This species, as has been already noted by A. Scott (*loc. cit.* p. 165), appears to be rare in Indian waters. A few examples have been taken by the "Investigator" at Stations 614 and 393.

Labidocera euchaeta Giesbrecht.*Labidocera euchaeta*, Giesbrecht, 1889, p. 27.*Labidocera euchaeta*, Giesbrecht, 1892, p. 446, pl. xxiii, figs. 13, 38; pl. xxv, fig. 30; pl. xli, figs. 6, 11 and 39.*Labidocera euchaeta*, Sewell, 1912, pp. 316, 339, 369.*Labidocera euchaeta*, Sewell, 1914 (*a*), p. 494.

This species appears to have a wide distribution around the coasts of India and Burma. It is essentially a brackish-water inhabitant and occurs in the estuarine regions of most,



TEXT-FIG. 119.—*Labidocera detruncata* (Dana).

The abdomen from the dorsal side, female.

b. The abdomen from the lateral aspect, female.

if not all, of the main rivers. In the "Investigator" collections it occurs at Stations 563, 574, 575, 577 and 578; I have previously (*loc. cit.* 1912) recorded its occurrence at the mouth of the Ramree river, the Tavoy river and from Chittagong on the east side of the Gangetic Delta. It has also been taken at the mouth of the Tenasserim river in Southern Burma and near the mouth of the Hoogli River on the west of the Gangetic Delta.

In my account of this species (Sewell, 1912, p. 316; 1914, p. 494 *et seq.*) I have pointed out that there appear to be two distinct and dimorphic forms in each sex and that the process of development follows the course indicated above (*vide supra*, p. 7). In the first series examined the average size of the various stages in the two sexes were as follows:—

Stage of development.	Observed size.	Calculated size.	Growth-factor.
♀	mm.	mm.	
Stage I	0.593	0.593	1.4
Stage II	0.844	0.830	1.4
Stage III	1.168	1.162	1.4
Stage IV	1.620	1.627	1.27
Stage V	2.054	2.066	1.27
Stage VI	2.639	2.624	
♂			
Stage II	0.844	0.844	1.5
Stage III	1.295	1.266	1.5 or 1.27
Stage IV	1.611	1.608	1.5
Stage V	1.880	1.899	
Stage VI	2.429	2.412	..

In a subsequent series, of which I gave an account in 1914, that was obtained from the mouth of the Ramree river on the coast of Burma, the observed sizes of the various stages were as follows :—

Stage of development.	Observed size.	Calculated size.	Growth-factor.
♀	mm.	mm.	
Stage III	1.191	1.193	1.4
Stage IV . . .	1.595	1.666	1.27 or 1.5
Stage V . . .	2.071	2.116	1.27
Stage X	2.314	2.499	
Stage VI	2.787	2.688	
♂			
Stage III	1.191	1.214	1.5 or 1.27
Stage IV	1.542	1.542	1.5 or 1.27
Stage V .	1.861	1.821	
Stage X	1.924	1.958	
Stage VI	2.551	2.313	..

If I am right in thinking that all the above stages represent part of the same life-history it is clear that the female factor for the last two stages of development, namely 1.27, may appear at two different stages in the development of the male. In the first instance this factor may appear at the moult after Stage III, some individuals reaching Stage V by adopting the characteristic male growth-factor of 1.5, whereas others pass to Stage IV by the female factor and then, by a subsequent adoption of the male factor 1.5, pass to Stage VI. In the second case it would appear that certain individuals at Stage IV may show the female growth factor and pass to Stage X, which is larger than the low, sexually mature dimorph, namely Stage V, but in which the individuals never attain sexual maturity. A corresponding appearance in the female of the characteristic male growth factor of 1.5 in certain individuals at Stage IV gives or appears to give rise to a sexually immature form, Stage X, that again is intermediate in size between the two sexually mature dimorphs.

One has, however, to bear in mind that I possess no actual proof that all these Stages do, without any possibility of doubt, represent stages in one and the same life-history. Up to the present time the occurrence of these large sexually immature forms, which I have designated Stage X, have been obtained only in the present instance and in the corresponding case of *Paracalanus crassirostris* Dahl (*vide supra*, p. 72).

Forma **major**.

Labidocera euchaeta, Stage I, Sewell 1912, p. 339, pl. xviii, figs. 1-9.

♀ Total length varies from 2.52 to 2.94 mm.

The proportional lengths of the cephalothorax and abdomen are as 11 to 3, so that the abdomen is contained 3.667 times in the length of the anterior region of the body.

The abdomen consists of two segments only, that have, with the furcal rami, the following proportional lengths :—

Abdominal segment	1.3	4.5	Furca	
	62	11	27	= 100

The furcal rami are symmetrical and the 2nd seta is somewhat thickened in its proximal part.

The 1st antenna reaches back to about the middle of the genital segment. It consists of 21 free segments, segments 6 and 7, 8 and 9 and 24 and 25 being respectively fused together; and in some instances segment 11 is also partially fused with segment 10. The proportional lengths of the segments are as follows :—

Segment	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	
	95	93	20	13	13	33	48	26	22	35	44	40	44	59	59	68	68	48	44	44	40	42	=1000

Forma **minor**.

Labidocera euchaeta, Stage II, Sewell, 1912, p. 341, pl. xix, figs. 1-3.

♀ Total length 1.8 to 2.4 mm.

The proportional lengths of the cephalothorax and abdomen are as 35 to 11, so that the abdomen is contained 3.182 times in the length of the anterior region of the body.

The abdomen consists of three segments and the furcal rami. The abdomen is symmetrical but the 3rd segment and the left furcal ramus are fused. The furcal rami are slightly asymmetrical, that on the left side being slightly broader than that on the right. The proportional lengths of the segments of the abdomen are as follows :—

Abdominal segment	1-2	3	4-5	Furca	
	39	30	11	20	=100

The 1st antenna reaches back to about the posterior margin of the genital segment. It consists of 23 free segments; segments 6 and 7 are separate but segments 8 and 9, and 24 and 25 respectively are fused together. The proportional lengths of the segments are as follows :—

Segment	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	
	58	69	11	9	11	16	11	35	27	22	47	44	42	55	73	65	76	74	49	49	56	56	45	=1000

A comparison of the proportional lengths of the antennae in these two forms is given below :—

Segment	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
<i>f.minor</i>	58	69	11	9	11	16	11	35	27	22	47	44	42	55	73	65	76	74	49	49	56	56	45
<i>f.major</i>	95	93	20	13	13	33	48	26	22	35	44	40	44	59	59	68	68	48	44	44	40	42	

In this instance we find that the differences between the proportional lengths of the segments in the two stages are very different from what we have usually found to be the case in other species, in which we have been able to examine various stages of development. In the present case the segments distal to 13 all show at least some degree of diminution in size as we pass from the smaller to the larger form, whereas in other species this decrease in the proportional length does not occur till we reach segment 19.

Such a difference from the normal leads one to suspect that one is not dealing with two stages in the same life-history, but a final decision on this point must be left for future investigation.

Labidocera kroyeri (Brady).

Labidocera kroyeri, A. Scott, 1909, p. 165.

Labidocera kroyeri, Sewell, 1912, p. 369.

Labidocera kroyeri, Sewell, 1914, p. 233.

Labidocera kroyeri, Brady, 1914, p. 135.

This species is widely distributed in Indian waters ; examples have now been taken by the " Investigator " at Stations 556, 558, 562, 563, 575, 577, 582 and 614.

The females collected at Station 563 all exhibit an interesting variation. The abdominal segments, as usual, bear numerous processes, but in these specimens these are all rounded at the ends and do not terminate in sharp points, as in examples taken in other regions.

The species has now been recorded from the Malay Archipelago (Cleve, A. Scott); the coast of southern Burma (Sewell) ; the Ceylon Pearl Banks (Thompson and A. Scott, Sewell) and the east coast of Africa (Brady).

Labidocera kroyeri (Brady) var. **gallensis** Thompson and A. Scott.

L. kroyeri var. *gallensis*, Thompson and A. Scott., 1903, p. 251, pl. ii, figs. 6, 7.

A few examples of this variety were taken at Station 614.

Labidocera kroyeri (Brady) var. **stylifera** Thompson and A. Scott.

L. kroyeri var. *stylifera*, Thompson and A. Scott, 1903, p. 252, pl. ii, figs. 8, 9.

L. kroyeri var. *stylifera*, Sewell, 1912, p. 369.

L. kroyeri var. *stylifera*, Sewell, 1914, p. 233.

Examples of this variety have been taken at the following stations :—445, 545, 556, 552, 562, 578, 582, and 614.

Labidocera kroyeri (Brady) var. **burmanica** Sewell.

L. kroyeri var. *burmanica*, Sewell, 1912, p. 369, pl. xxiii, figs. 4, 5.

L. kroyeri var. *burmanica*, Sewell, 1914, p. 233.

In addition to the original locality, this variety has now been taken on the Ceylon Pearl Banks and at " Investigator " Stations 563, 577.

Labidocera kroyeri (Brady) var. **bidens** Sewell.

Labidocera kroyeri var. *bidens*, Sewell, 1912, p. 369, pl. xxiv, fig. 8.

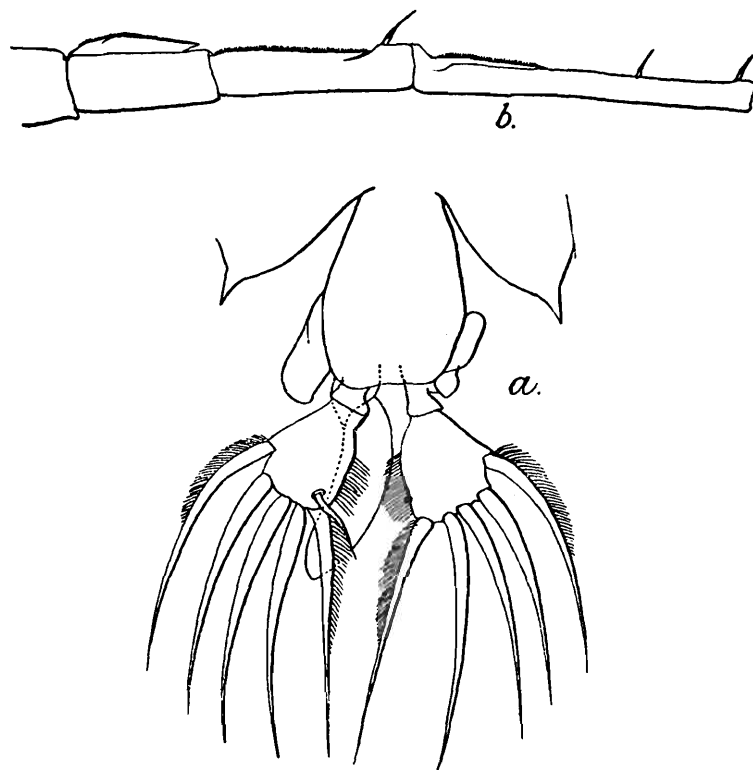
This variety was recorded by me from the region of the mouth of the Tavoy river. No further examples have come under my notice.

Labidocera madurae A. Scott.

(Text-fig. 120, *a*, *b*.)

Labidocera madurae, A. Scott, 1909, p. 169, pl. I, figs. 9-16.

This species was first described by A. Scott from examples taken in the Malay Archipelago. Several examples have been taken by the " Investigator " at Station 614. These agree exactly with Scott's description.

TEXT-FIG. 120.—*Labidocera madurae* A. Scott.

a. The abdomen from the dorsal aspect, female.

b. The knee-joint of the grasping antenna, male.

Labidocera laevidentata* (Brady).Labidocera kroyeri*, var. *similis*, Wolfenden, 1906, p. 1016, pl. xcvi, figs. 22, 23, 33.*Labidocera laevidentata*, A. Scott, 1909, p. 166, pl. li, figs. 1-10.*Labidocera laevidentata*, Früchtl, 1924, p. 77.

A few examples of this species have been taken by the "Investigator" at Station 614 and in the Maldivé Archipelago.

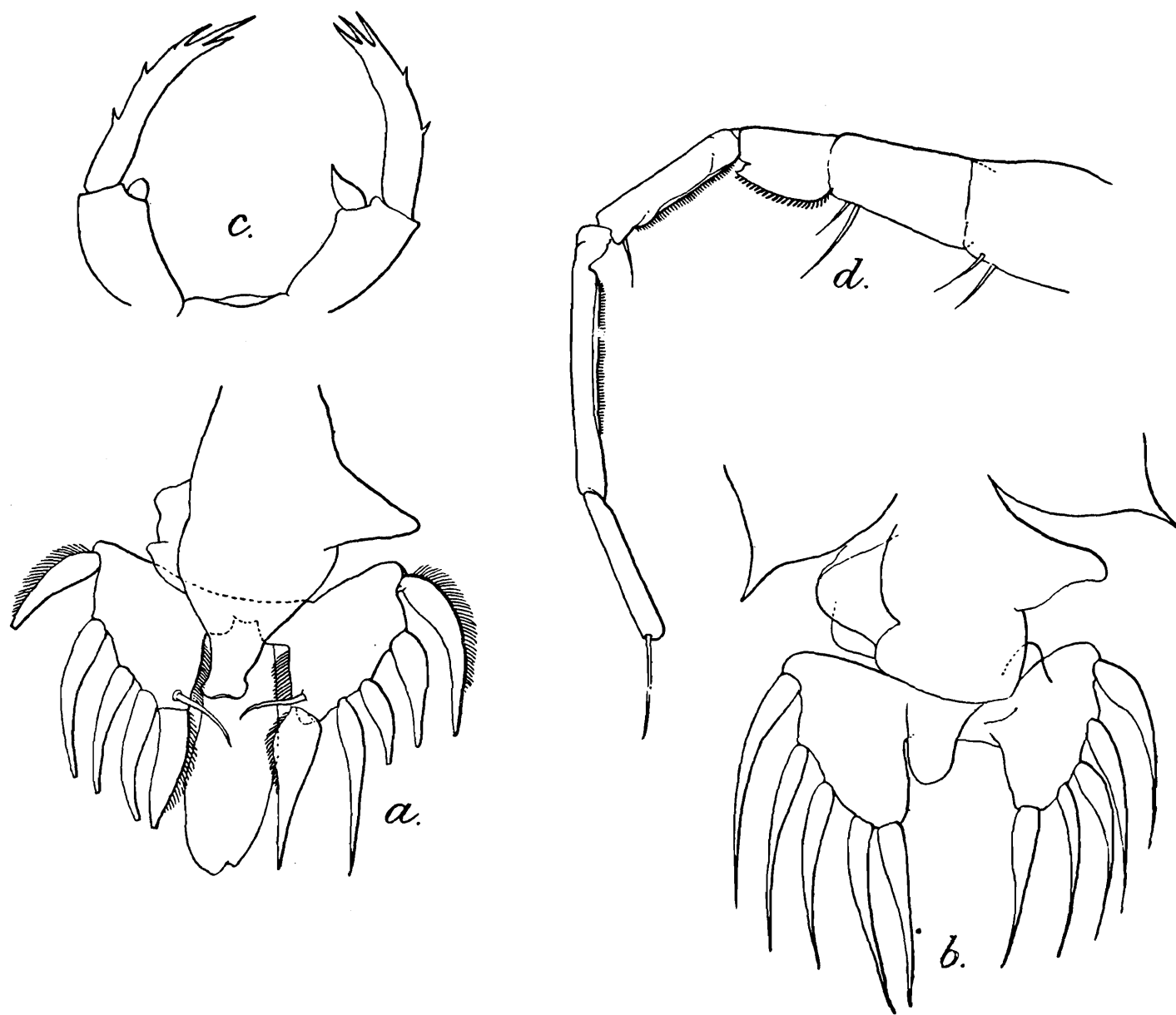
Labidocera minuta* Giesbrecht.Labidocera minuta*, A. Scott, 1909, p. 167.*Labidocera minuta*, Pesta, 1912, p. 53, fig. 14.*Labidocera minuta*, Sewell, 1912, p. 370.*Labidocera minuta*, Sewell, 1914, p. 234.*Labidocera minuta*, Früchtl, 1924, p. 78.*Labidocera minuta*, Gurney, 1927, p. 154.

This species is widely distributed throughout Indian waters. It has now been recorded from the Malay Archipelago (Cleve, A. Scott, Früchtl); the coast of southern Burma (Sewell); the Ceylon Pearl Banks (Thompson and A. Scott, Sewell); the Maldivé and Laccadive Archipelagoes (Wolfenden); the Persian Gulf (Pesta); the Red Sea (A. Scott); the Suez Canal (Gurney) and Arabian Sea (Cleve).

Numerous examples occur in the "Investigator" collections from Stations 540, 541, 542, 543, 544, 545, 552, 555, 556, 558, 562, 577, 578, 582, 583, 584, 587, 588, 590, 591, 614.

***Labidocera pavo* Giesbrecht.**(Text-figs. 121, *a-d* and 122, *a-g*.)*Labidocera pavo*, Sewell, 1914, p. 234, pl. xxi, figs. 1-3.*Labidocera pavo*, Sewell, 1924, p. 789.*Labidocera pavo*, Gurney, 1927, p. 154.

This species appears to be widely distributed throughout Indian seas and has also been taken in brackish-water areas such as the Chilka Lake, in which it appeared to be actually breeding. Gurney has recorded its occurrence in the Suez Canal.

TEXT-FIG. 121.—*Labidocera pavo* Giesbrecht.*a.* The abdomen, female, from Ceylon Pearl Banks.*c.* The 5th pair of legs, female.*b.* The abdomen, female, from Station 614.*d.* The grasping antenna, male.

There is a very close resemblance between *Labidocera pavo* Giesbrecht, *L. bataviae* A. Scott and *L. madurae* A. Scott. Examples of this species occur at "Investigator" Stations 544 and 614.

Copepodid Stage III. (Text-fig. 122, a-c.)

Total length, 1.009 mm.

The proportional lengths of the cephalothorax and abdomen are as 79 to 17, so that the abdomen is contained 4.70 times in the length of the anterior region of the body.

The forehead is rounded and the rostrum is formed of a pair of long spines, without any trace of a rostral lens. Thoracic segments 4 and 5 are fused together and, as yet, there is no trace of the spine on the lateral thoracic margin, which is slightly produced in a rounded prominence.

The abdomen consists of only two segments and the furcal rami. Their proportional lengths are as follows :—

Abdominal segment	1	2-5	Furca	
	23	43	34	=100

The 1st antenna reaches back to a little beyond the posterior thoracic margin. It consists of only twenty-one free segments; segments 6 and 7, and 10-12 are fused together, as well as segments 24 and 25. The proportional lengths of the segments are as follows :

Segment	1	2	3	4	5	6-7	8	9	10-12	13	14	15	16	17	18	19	20	21	22	23	24-25	
	109	62	14	11	11	22	12	15	34	30	29	34	43	49	68	82	71	71	81	76	76	=1000

The 2nd antenna and mouth-parts are already in an advanced state of development, though they do not appear to have the complete number of setae.

The 1st swimming leg possesses a two-jointed exopod and a single-jointed endopod; the segments of the exopod bear 1 and 2 marginal spines, and 1 and 4 setae respectively. Of the marginal spines the first or proximal on the 2nd segment reaches to a point just beyond the base of the 2nd spine, and this in turn reaches as far as the distal margin of the segment. All three spines are delicate and needle-like. The endopod bears nine setae.

The 2nd swimming leg (text-fig. 122, b) also consists of a two-jointed exopod and a single-jointed endopod. The marginal spines on the exopod are stout and well-developed: there is a single one on the proximal segment and three on the distal, of which the proximal reaches beyond the base of the second. The two segments bear 1 and 5 setae respectively. The endopod bears nine setae.

The 3rd swimming leg (text-fig. 122, a), while resembling the 2nd in possessing a two-jointed exopod and a single-jointed endopod, differs from that leg in having only two marginal spines on the distal segment of the exopod. The two segments of the outer ramus bear 0 and 4 setae respectively. The endopod bears eight setae.

The 4th swimming leg possesses only a single segment in both exopod and endopod. The exopod bears 3 marginal spines and 3 setae, these latter being situated close together on the distal half of the inner margin. The endopod bears five setae.

The 5th pair of legs (text-fig. 122, c) are extremely rudimentary and are represented by short oval plates that appear to be neither segmented nor separated from the basal plate.

I have been unable to distinguish between the two sexes in this stage of development.

Copepodid Stage IV. (Text-fig. 122, d, e.)

♀ Total length, 1.396 mm.

The proportional lengths of the cephalothorax and abdomen are as 45 to 11, so that the abdomen is contained 4.09 times in the length of the anterior region of the body.

The general features of the cephalothorax are similar to those of the adult, except that the spine on the posterior thoracic margin is much less pronounced.

The abdomen consists of three segments that have with the furca the following proportional lengths :—

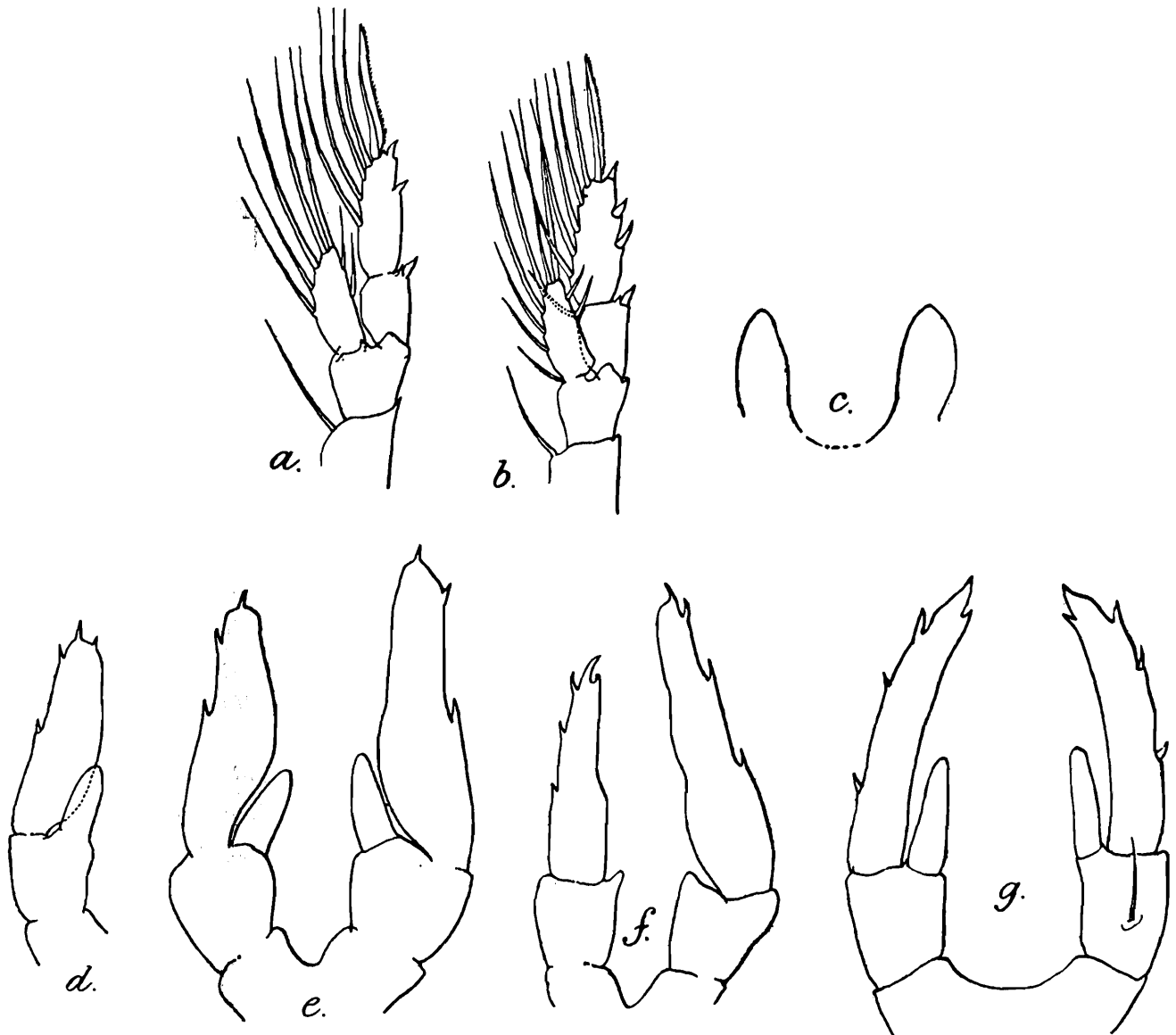
Abdominal segment	1	2	3-5	Furca	
	20	18	27	35	=100

The 1st antenna reaches back almost to the level of the posterior margin of the 2nd abdominal segment. It consists of twenty-three free segments; segments 6 and 7 are completely fused and segments 8 and 9 partially so; segments 24 and 25 are also fused. The proportional lengths of the various segments are as follows:

Segment	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	
	98	75	12	10	14	24	14	14	14	20	31	31	35	38	55	58	74	70	58	58	74	62	62	=1000

The 5th pair of swimming legs (text-fig. 122, *d*) consists of a basal portion and single-jointed exopod and endopod, the latter not yet having completely separated from the 2nd basal segment.

♂ Total length, 1.248 mm.



TEXT-FIG. 122.—*Labidocera pavo* Giesbrecht, immature.

- a. The 3rd leg, Copepodid Stage III. d. The 5th leg, female, Copepodid Stage IV.
 b. The 2nd leg, Copepodid Stage III. e. The 5th pair of legs, male, Copepodid Stage IV.
 c. The 5th leg, Copepodid Stage III. f. The 5th pair of legs, male, Copepodid Stage V.
 g. The 5th pair of legs, female Copepodid Stage V.

The proportional lengths of the cephalothorax and abdomen are as 194 to 51, so that the abdomen is contained 3.804 times in the length of the anterior region of the body.

The general features of the body in this stage of development of the male are as in the female.

The abdomen consists of three free segments and the furcal rami, segments 3 to 5 being still undifferentiated. The proportional lengths of the segments are as follows:

Abdominal segment	1	2	3-5	Furca	
	24	20	23	33	=100

The 1st antenna consists, as in the female, of 23 free segments that have approximately the same proportional lengths.

The 5th pair of legs already begin to show traces of the differentiation that will ultimately distinguish these appendages in the adult. The limbs on the two sides are not quite symmetrical, that on the right side being slightly longer than that on the left (text-fig. 122, e).

Copepodid Stage V. (Text-fig. 122, f. g.)

♀ Total length, 1.769 mm.

The proportional lengths of the cephalothorax and abdomen are as 24 to 5, so that the abdomen is contained 4.8 times in the length of the anterior region of the body.

The rostrum consists of two long spines and there is no trace of any rostral lens. The posterior thoracic margins are symmetrical and are produced backwards in a small upwardly curved spine.

The abdomen consists of three segments, having with the furcal ramus the following proportional lengths :

Abdominal segment	1-3	4	5	Furca	
	44	13	12	31	=100

The genital segment is symmetrical.

The 1st antenna reaches back to the level of the posterior thoracic margin ; it consists of 22 free segments, having the following proportional lengths :

Segment	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	
	98	85	16	13	16	31	44	22	19	38	38	38	44	63	63	74	74	44	47	52	41	41	=1000

Segments 6 and 7, and 24 and 25 are completely fused together and segments 8 and 9 are partially fused.

The 2nd antenna and mouth-parts are as in the adult.

In the 1st swimming leg the 1st basal bears an inner marginal seta. The exopod consists of three segments, bearing respectively 1, 1 and 2 marginal spines and 1, 1 and 4 setae ; the marginal spine on the 2nd segment is considerably longer than those on the other segments and reaches nearly as far as the base of the 1st marginal spine on the distal segment. The endopod consists of two segments bearing 3 and 6 setae respectively.

The 2nd and 3rd swimming legs closely resemble each other. Each consists of a three-jointed exopod and a two-jointed endopod. The segments of the exopod bear 1, 1 and 3 marginal spines and 1, 1 and 5 setae respectively. The endopod bears 3 and 8 setae on the two segments. The marginal spine on the 2nd segment of the 2nd leg is slightly longer than that of the 3rd leg and reaches as far as, or even slightly beyond, the tip of the proximal spine on the distal segment.

The 4th swimming leg, like the preceding pairs, consists of a three-jointed exopod and a two-jointed endopod. The segments of the exopod bear 1, 1 and 3 marginal spines and 1, 1 and 5 setae. Of the marginal spines on the distal segment the proximal is somewhat smaller than the other two. The endopod bears 3 and 7 setae.

The 5th pair of legs (text-fig. 122, g) are symmetrical and each consists of a well-developed exopod and endopod, the latter being nearly half the length of the outer ramus. Each exopod bears three small marginal spines and a very unequal pair of terminal spines, the outer being at least three or four times the size of the inner.

♂ Total length, 1.536 mm.

The proportional lengths of the cephalothorax and abdomen are as 8 to 2, so that the abdomen is at this stage of development contained exactly 4 times in the length of the anterior region of the body. The general characters of the cephalothorax are as in the adult.

The abdomen consists of only four free segments and the furcal rami, segments 4 and 5 not yet being differentiated. Their proportional lengths are as follows :—

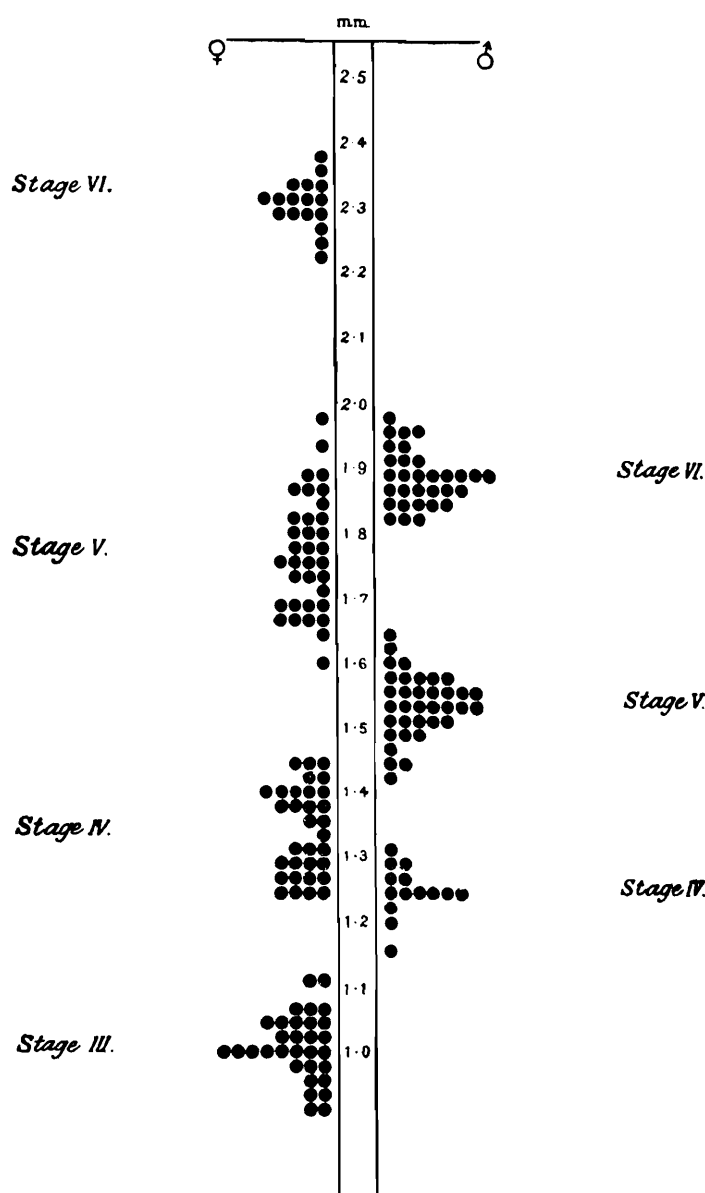
Abdominal segments	1	2	3	4-5	Furca	
	19	19	18	14	30	=100

The 1st antenna reaches back to the posterior margin of the thorax. Already the antennae of the two sides begin to show differences that foreshadow the modification of the right appendage into a grasping organ. In the appendage of the right side segments 12-15 are somewhat swollen. The proportional lengths of the segments of the two sides also show small differences as is indicated in the following table :—

Segment	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	
Left	100	71	14	12	14	29	17	26	19	19	36	36	36	42	62	63	72	76	53	49	59	46	49	=1000
Right	101	72	14	13	14	30	19	24	20	20	33	33	33	44	63	64	85	63	46	49	63	47	50	=1000

The 2nd antenna and mouth-parts are as in the female.

The swimming legs closely resemble those of the female.



TEXT-FIG. 123.—Length measurements of 195 examples of *Labidocera pavo* Giesbr., from the Chilka Lake.

In the 5th pair of legs (text-fig. 122, *f*) the appendages of the two sides are markedly asymmetrical, that of the right side being considerably longer than that of the left. Each appendage consists of a basal

portion of two segments and a single free segment representing the exopod. The endopod is reduced to a small rounded prominence on the distal inner angle of the 2nd basal segment.

While studying the fauna of the Chilka Lake I was able to sort out and measure a number of examples of *Labidocera pavo* Giesbr. in the last four stages of development. The results of these measurements are shown graphically in text-fig. 123 ; and in the following table I have given the average length measurement in each of these stages, as well as the calculated measurement and the growth factor :—

Stage of development.	Observed size.	Calculated size.	Growth-factor.
♀	mm.	mm.	mm.
Stage III . . .	1.009	1.009	1.386
Stage IV	1.396	1.398	1.285
Stage V	1.769	1.797	1.285
Stage VI	2.304	2.304	..
♂			
Stage III	1.009*	0.967	1.517 or 1.285
Stage IV . .	1.248	1.243	1.517
Stage V	1.536	1.467	..
Stage VI	1.885	1.885	..

* As this figure is based on measurements of both sexes it is in all probability too large for the male sex alone.

In the above Table I have assumed that during the development of the male individuals pass through the course indicated by me above on p. 7, and that examples may pass from Stage III to Stage V, or from Stage IV to Stage VI ; if, however, the males follow, as in the female, a straight course and pass successively through stages III to IV and then from IV to V, finally reaching Stage VI, the growth-factor for each successive moult will of course be different from those given above ; this I have shown in the following table :

Stage of development.	Observed size.	Calculated size.	Growth-factor.
♂	mm.	mm.	mm.
Stage III . . .	1.009	1.009	1.237
Stage IV . . .	1.248	1.248	1.231
Stage V	1.536	1.536	1.227
Stage VI	1.885	1.885	..

In this series, if this represents the actual line of development, there is a steady diminution in the growth-factor with each successive moult.

As I have already pointed out in certain species, there is during development a considerable change in the proportional lengths of some of the segments of the body and thorax. In the following table I have given the proportional lengths, in parts per thousand of the total body-length, of the various segments in the last three growth stages of the male and the IVth and Vth stages of the female. I have not given the proportional lengths in the final or adult stage of the female as owing to the changes that occur and the consolidation

of the abdominal segments it is not possible to form an accurate estimate of the length of the individual parts.

Stage of development.	Cephalon.	Thoracic segments.					Abdominal segments.					Furcal ramus.
		1	2	3	4	5	1	2	3	4	5	
Stage IV ♂	361	152	81	89	113		49	40	48			67
Stage V	345	164	82	95	114		37	37	36	29		61
Stage VI (Adult)	316	155	84	106	138		43	40	39	21	10	48
Stage IV ♀	354	164	87	93	109		38	35	51			68
Stage V	360	157	88	97	108		83		25		23	59

In the male the cephalon steadily decreases in length, the difference between Stages IV and VI amounting to 12·465%. The 1st thoracic segment however appears to remain more or less unaltered. The 2nd thoracic segment shows a slight but steady increase amounting to 3·704%. Segment 3 increases considerably; between Stages IV and V this amounts to 6·74% and between Stages V and VI to 11·58%. Segments 4 and 5, which are fused together, show but little change in the earlier moult but between stages V and VI increase in length by 21·05%, this, however, is due in the main to the backward prolongation of the lateral margin and the marginal spine. In the abdomen the 1st segment undergoes but little change but, if anything, slightly decreases in length; segment 2 also probably remains constant throughout. As before, the greatest increase in length is to be found in the posterior segments. Segments 3-5 are fused at Stage IV and together measure 48 but in the subsequent moult segment 3 becomes separated off and the combined length of this and the following segment 4-5 is as much as 65, an increase of 35·42%. In the final moult segment 3 increases in length by 8·33%, while segments 4 and 5 become separate and increase in their total length from 29 to 31, or 6·90%. The furcal ramus, on the other hand, decreases in length between stages IV and V by 8·96% and between Stages V and VI by 21·31%.

In the case of the female owing to the condensation and fusion of the abdominal segments as well as the alteration in shape of the furcal rami I have been unable to take measurements that would correspond to those taken on the segments in the earlier stages. *I have, therefore, confined my attention to Stages IV and V in this sex. At the moult between these stages there is a slight increase in the length of the cephalon, thus contrasting with the change in the opposite sex. The 1st thoracic segment exhibits a decrease in length of 4·27%. Segment 2 remains practically unchanged. Segment 3 shows an increase in length of 4·27%. Segments 4 and 5 appear to remain practically unchanged. In the abdomen segments 1 and 2 in Stage IV together measure 73, whereas the fused segments 3-5 measure 51. In the following moult there is a complete rearrangement of the segments; segments 1-3 are now fused, while segments 4 and 5 are separate; it is thus very difficult to arrive at any estimate of the change in length. It is clear, however, that there is a big increase in the length of the more posterior segments since in Stage V the last two segments together measure 48, which is but little less than the combined length of the last three segments in the previous stage. The furcal rami show a decrease in length of 13%.

As in the case of other species that we have considered, we find that the proportional lengths of the various segments of the 1st Antenna undergo very considerable changes during development. I have given below for convenience of reference, the proportional lengths in parts per 1000 of the segments in the last four stages of development of the female :

Segment	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
Stage III	109	62	14	11	11	22	12	15	34			30	29	34	48	49	68	82	71	71	81	76	76
Stage IV	98	75	12	10	14	24	14	14	14	20	31	31	35	38	55	58	74	70	58	58	74	62	62
Stage V	98	82	16	13	16	31	44	22	19	38	38	38	44	63	63	74	74	47	47	52	41	41	41
Stage VI (adult).	87	85	16	12	15	30	51	24	22	39	39	39	47	67	67	75	75	42	44	49	38	38	38

From the above it is clear that the 1st segment shows a marked diminution in length ; segments 2 to 18 all show a degree of increase, that appears to be greatest about the region of the 8-12 segments, beyond which it at first decreases and then again increases to the 16th ; from this point the increase steadily diminishes to the 18th segment and in the 19th segment is replaced by a reduction in length that also steadily increases to the terminal segments.

Labidocera pectinata Thompson and A. Scott.

(Text-fig. 124, a-d.)

Labidocera pectinata, Thompson and A. Scott, 1902, p. 252, pl. ii, figs. 10-14.

Labidocera similis, Cleve, 1903, pp. 364, 378, pl. xix, figs. 4-6.

Labidocera pectinata, Sewell, 1912, p. 370, pl. xxiii, figs. 8, 9.

Labidocera pectinata, Sewell, 1914, p. 236.

Numerous examples of this species were taken at Stations 541, 555, 563, 574, 575, 577, 578, 587, 590, and at Vendurutti and in Cochin backwaters.

♂ Total length, 1.70 mm.

The proportional lengths of the cephalothorax and abdomen are as 3 to 1.

The cephalon and 1st thoracic segment are separate but thoracic segments 4 and 5 are fused together. The head is armed with sidehooks, the eye-lenses are large, as is usual in this sex, and the rostrum consists of a pair of spines ; there is no rostral or ventral lens. The posterior thoracic margins are asymmetrical ; on the left side the margin is armed with a single simple backwardly-directed spine, whereas on the right side it is produced in a prominent lobe-like process that terminates in three unequal spines, so that in this respect this species closely resembles the male of *Labidocera kroyeri* (Brady) and of *Labidocera trispinosa* Esterly.

The abdomen consists of five segments having the following proportional lengths :—

Abdominal segment	1	2	3	4	5	Furca
	30	17	23	10	5	15 = 100

The furcal rami are symmetrical and bear the usual five setae, of which four are distally placed and the fifth arises from the external margin at the junction of the middle and distal thirds. The 2nd seta is about twice the length of the others. The 1st segment of the abdomen is armed on the right side, distally, with a straight spine.

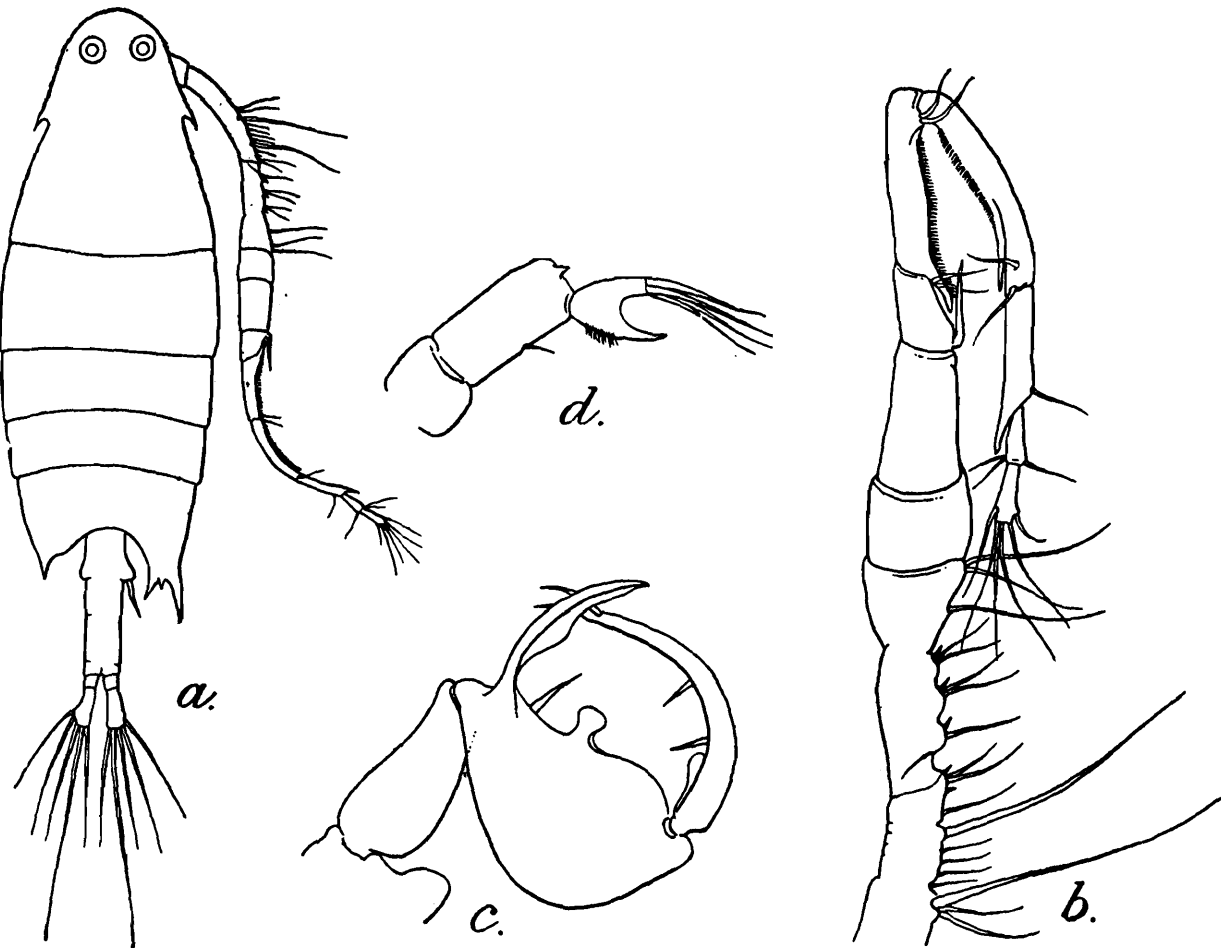
The 1st antenna on the left side is unmodified and consists of the usual twenty-three free joints ; the segments have the following proportional lengths :—

Segment	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
	76	76	12	9	11	28	15	34	24	20	40	42	46	50	66	66	76	72	50	50	50	46	46 = 1000

The right antenna (text-fig. 124, *b*) is modified to form a grasping organ and the middle joints are somewhat swollen; the knee joint is, as usual, situated between the 18th and 19th segments. The various segments have the following proportional lengths :—

Segment	1	2	3	4	5	6-7	8-12	13	14	15	16	17	18	19-21	22	23	24-25
	60	76	12	9	9	20	98	23	40	66	88	70	124	130	82	44	44
	=1000																

The 17th segment bears on its upper surface a claw-like process bent sharply at a right-angle near its base. The 18th segment is armed with a toothed plate, carrying a number



TEXT-FIG. 124.—*Labidocera pectinata* Thompson and A. Scott.

- a. The whole animal from the dorsal aspect, male. c. The right 5th leg, male.
b. The grasping antenna, male. d. The left 5th leg, male.

of subequal needle-like teeth; this plate is prolonged proximally over the 17th segment and terminates distally in a sharp point. The 19-21st segment bears a delicately curved toothed plate, that bears needle-like teeth in its proximal three-fourths and terminates distally in a sharp spine-like point that reaches to the end of the segment. The 22nd segment is prolonged distally in a spinous process. The whole arrangement of the grasping antenna very closely resembles that of *Labidocera kroyeri* (Brady).

The mouth-parts resemble those of other members of the genus.

In the 1st swimming leg the 1st basal segment bears a single internal seta. The exopod consists of three segments that bear 1, 1 and 2 marginal spines and 1, 1 and 4 setae respectively; the end-spine is long, measuring one and a half times the length of the distal segment, and is finely serrated. The endopod consists of two segments, bearing respectively

3 and 6 setae ; the endopod reaches as far as the level of the joint between segments 1-2 and 3.

The 2nd and 3rd swimming legs closely resemble each other. In both the exopod consists of three segments and the endopod of two only. The segments of the exopod bear 1, 1 and 3 marginal spines and 1, 1 and 5 setae respectively ; while the segments of the endopod bear 3 and 8 setae respectively. The marginal spine on the 2nd segment of the exopod of leg 2 is large and reaches as far as, or even slightly beyond, the base of the proximal spine on exopod 3.

In the 5th pair of legs the right leg (text-fig. 124, *c*) is modified to form a claw. The 2nd joint bears a claw-like process proximally and is considerably swollen ; on the upper margin there is a single straight spine near the base of the claw-like process and a single tooth, shaped like a champagne cork, about the middle of its length. The 3rd segment is curved and tapering and terminates in two unequal seta-like processes. The left leg (text-fig. 124, *d*) ends in a segment that is almost like a hand ; on the inner aspect is a curved process, on the proximal side of which lies a swollen prominence clad in hairs. Distally the segment bears a long slender spinous process and three others, more seta-like. The penultimate segment is rectangular and forms a projection distally, owing to the terminal segment being articulated at the distal inner angle ; a small spine is situated at the distal outer angle and a small seta arises from the inner margin about the middle of its length.

Genus **PONTELLA** Dana.

The first record of the occurrence of any species of *Pontella* in Indian waters is that of *Pontella spinipes* Giesbr. in the Bay of Bengal by Thompson (1900). In 1902 A. Scott added *Pontella fera* Dana from the Red Sea and in the following year in collaboration with Thompson recorded *Pontella danae* Giesbr., var. *ceylonica*, *P. fera* Dana, *P. securifer* Brady, *P. princeps* Dana and *P. tenuiremis* Giesbr. from the Pearl Banks of Ceylon. In 1904 Cleve recorded *Pontella securifer* Brady from the Agulhas Current. In 1906 Wolfenden recorded the presence of *Pontella fera* Dana, *P. securifer* Brady, *P. spinipes* Giesbr., and *P. mediterranea* (Claus), var. *indica* from the Maldivé and Laccadive Archipelagoes. A. Scott in 1909 from the collections made by the "Siboga" in the Malay Archipelago added *Pontella alata*, *P. denticauda*, *P. forficula* and *P. cerami* to the list of species known to belong to this genus and at the same time recorded *Pontella danae* Giesbr., *P. fera* Dana, *P. princeps* Dana and *P. securifer* Brady in the same region. In 1911 Wolfenden records the taking of examples of *Pontella atlantica* Milne-Edw. in the Indian Ocean off Port Natal ; so far as I know, this is the only record of the occurrence of this species in Indian waters and it is possible that Wolfenden has confused *Pontella atlantica* and *P. princeps* Dana, and that in reality his examples belonged to the latter species. In 1912 I added *Pontella andersoni* and *P. investigatoris* to the known species in the genus and also recorded *P. danae* Giesbrecht var. *ceylonica* Thompson and A. Scott, *P. princeps* Dana, *P. securifer* Brady and *P. spinipes* Giesbrecht from the coast of southern Burma ; and in 1914 I recorded *Pontella investigatoris* Sewell *P. fera* Dana and *P. securifer* Brady from the Ceylon Pearl Banks. Brady in 1915 recorded *Pontella fera* Dana and *P. natalis* from Durban Bay, East Africa.

Pontella andersoni Sewell.

Pontella andersoni, Sewell, 1912, pp. 323, 344 and 370, pl. xx, figs. 1-6.

This species was recorded by me from the coast of Burma in 1912. Since then further specimens have been obtained at Stations 552, 562, 563, 569, 574, 587, 588 and 590, as well as off Hainguy Island, Burma.

Pontella danae Giesbrecht.

Pontella danae, A. Scott, 1909, p. 159.

A single male, that appears to be quite typical, was taken by the "Investigator" at both Stations 575 and 614.

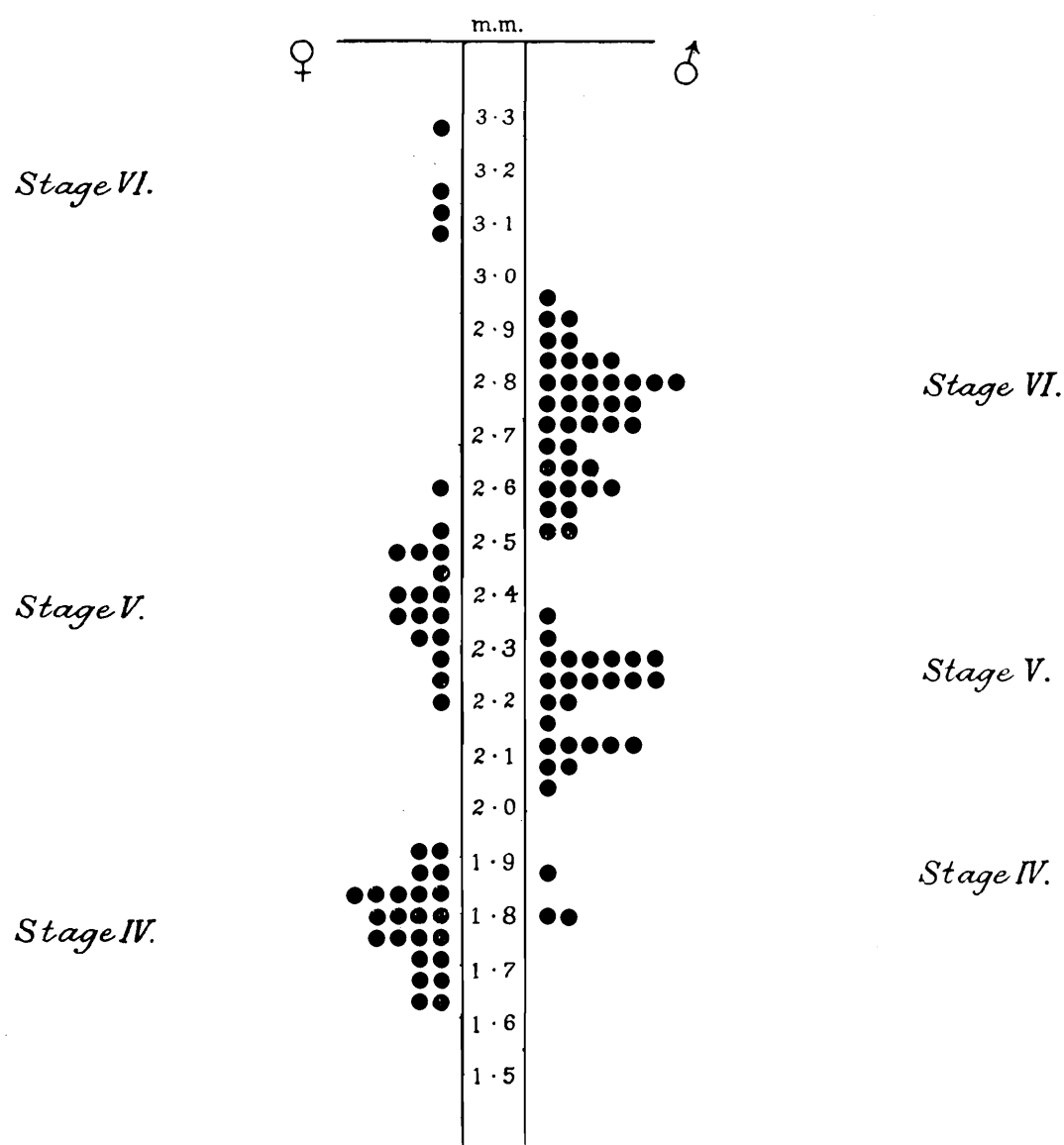
Pontella danae var. **ceylonica** Thompson and A. Scott.

Pontella danae var. *ceylonica*, Thompson and A. Scott, 1903, p. 252, pl. ii, figs. 1-5.

Pontella danae var. *ceylonica*, Sewell, 1912, p. 370.

Pontella danae var. *ceylonica*, Sewell, 1914, p. 236.

The typical form of this species was obtained by Giesbrecht in the Pacific Ocean. As I have previously pointed out (Sewell, 1912, p. 371), the examples taken by the "Siboga"



TEXT-FIG. 125; length measurements of 44 examples of *Pontella danae* var. *ceylonica* Thompson and A. Scott and 67 examples of *Pontella investigatoris* Sewell.

in the Malay Archipelago are intermediate in structure between the Pacific form and the var. *ceylonica* of the Indian coasts and thus appear to form a connecting link.

I have, also, in a previous paper (Sewell 1914, p. 236) called attention to the close degree of similarity that exists between *Pontella danae* var. *ceylonica* and *P. investigatoris* and I was inclined to regard these two forms as being respectively the females and males of one single species. During the survey season 1913-14 I was able to make a careful examination of a number of examples of both forms and to take certain measurements, of both males and females, in several stages of development. The results of these measurements are given in text-fig. 125 and the average size of each group, together with the calculated size, is given in the following table :—

	Observed length. Calculated length. Growth-factor.		
	mm.	mm.	mm.
♀ <i>Pontella danae</i> var. <i>ceylonica</i> .			
Stage IV .	1.79	1.79	1.335
Stage V	2.39	2.38	1.335
Stage VI	3.20	3.16	
♂ <i>Pontella investigatoris</i> .			
Stage III	..	1.498	1.474 or 1.221
Stage IV	1.83	1.829	1.474
Stage V	2.21	2.208	..
Stage VI	2.74	2.696	..

It will be seen from the above that in the case of the male at Stage III development may, if my views are correct, proceed along one of two lines ; in the first case the growth-factor is 1.221 and the individual advances to Stage IV, from which with a growth-factor of 1.474 it proceeds to Stage VI ; whereas in the second it proceeds direct to Stage V with the growth-factor 1.474. According to my previous studies the growth-factor of 1.474 must be regarded as the characteristic male growth-factor, whereas the smaller factor of 1.221 would correspond to the female growth-factor and should agree with the growth-factor in the last two moults of the female. The growth-factor for the female *Pontella danae* var. *ceylonica* is, however, much larger than this and is 1.335. It would thus appear that these males cannot correspond to the females and *Pontella investigatoris* must still be regarded as a separate species.

Examples of this variety were taken at "Investigator" Stations 542, 544, 556, 563, 574, 577, 583, 587, 588 and 591.

***Pontella denticauda* A. Scott.**

Pontella denticauda, A. Scott, 1909, p. 161, pl. lii, figs. 1-12.

A number of examples of this species were taken at Station 614. These specimens agree closely with Scott's original description.

♀ Total length, 3.093 mm.

The proportional lengths of the cephalothorax and abdomen are as 25 to 8, so that the abdomen is contained 3.125 times in the length of the anterior region of the body.

The abdomen consists of two segments which have with the furca the following proportional lengths :—

Abdominal segment	1-4	5	Furca	
	62	15	23	=100

The 1st antenna consists of twenty-two free segments having the following proportional lengths :—

Segment	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
	98	105	19	19	19	19	26	26	26	45	45	39	45	58	58	68	64	49	45	49	39	39
																						39
																						=1000

The 5th pair of legs differ slightly from the figure given by Scott (1909, pl. lii, fig. 5) in the following characters :—

- (1) The three external marginal spines on the exopod are serrated.
- (2) The tip of the endopod appears to terminate in a single point, without any trace of bifurcation such as Scott mentions.
- (3) There is a small spine at the point of origin of the seta on the 2nd basal segment.

♂ Total length, 2.674 mm.

The proportional lengths of the cephalothorax and abdomen are as 47 to 16, so that the abdomen is contained 2.938 times in the length of the anterior region of the body.

The abdomen consists of five segments that have with the furcal rami the following proportional lengths :—

Abdominal segment	1	2	3	4	5	Furca
	19	16	17	10	9	29
						=100

The 1st antenna reaches back to about the level of the posterior margin of the 3rd thoracic segment. The left antenna is unmodified but the segmentation is not quite the same as in the female. There are only seventeen free joints in the whole appendage, whereas in the female there are twenty-two. The cause of the difference is the greater degree of fusion met with in the proximal segments. Segments 2 to 8 are completely fused, segments 9 and 10 are fused and segments 11 and 12 are partially fused. The proportional lengths of the free segments are as follows :—

Segment	1	2-8	9-10	11	12	13	14	15	16	17	18	19	20	21	22	23	24-25
	113	262	24	19	34	34	30	33	49	51	60	60	55	45	51	40	40
																	40
																	=1000

The appendages are as described and figured by A. Scott (1909).

***Pontella fera* Dana.**

(Text-fig. 126.)

Pontella fera, A. Scott, 1909, p. 159.

Pontella fera, Sewell, 1914, p. 237.

♀ Total length, 2.605 mm.

The proportional lengths of the cephalothorax and abdomen are as 45 to 11, so that the abdomen is contained 4.09 times in the length of the anterior region of the body.

The cephalon and 1st thoracic segment are separate, as also are the 4th and 5th thoracic segments. The posterior thoracic segment is produced back in a well-marked wing on each side.

The abdomen consists of two free segments and the furcal rami. The genital segment is produced ventrally in a pair of rounded processes. The proportional lengths of the segments are as follows :—

Abdominal segment	1-4	5	Furca
	56	12	32
			=100.

The 1st antenna reaches back to about the posterior margin of the 3rd thoracic segment. It consists of 21 free segments; segments 2 and 3, 8 and 9, 10 and 11, and 24 and 25 are, respectively, fused together. 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	24-25
	93	110	19	22	19	19	27	52	39	41	41	45	60	60	68	66	45	44	49	37	44

=1,000

Segments 1 to 13 bear a fringe of hairs on their posterior margins.

The 2nd antenna, mouth-parts and swimming legs resemble those of other members of the genus.

The 5th pair of legs are as described by Giesbrecht (1892, pl. xxiv, fig. 36).

♂ Total length, 2.605 mm.

The proportional lengths of the cephalothorax and abdomen are as 85 to 27, so that the abdomen is contained 3.148 times in the length of the anterior region of the body.

The abdomen consists, as usual, of five segments that have with the furca the following proportional lengths:—

Abdominal segment	1	2	3	4	5	Furca
	33	14	17	10	7	29

=100

In the unmodified left antenna there are eighteen free joints. The proportional lengths of the segments are as follows:—

Segment	1	2-4	5	6	7	8	9	10	11	12	12	14	15	16	17	18	19	20	21	22	23	24-25
	104	102	20	20	20	20	24	24	24	39	39	39	43	59	63	74	67	43	47	51	39	39

=1,000

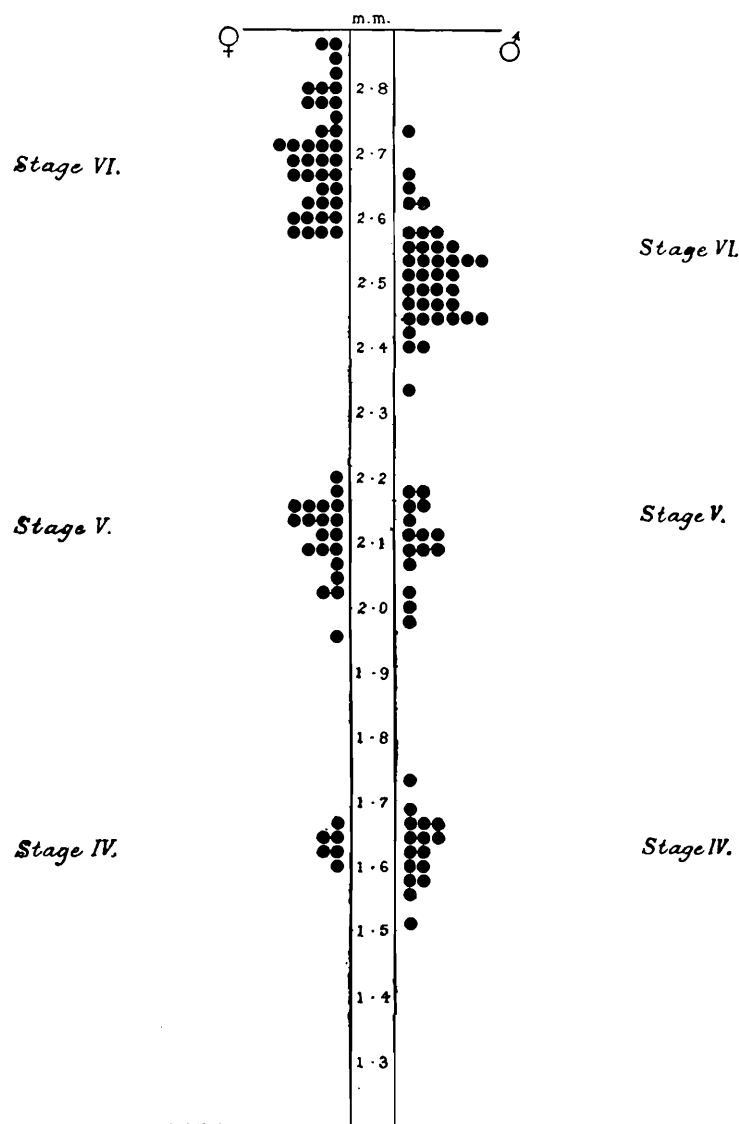
Segments 2 to 8 are fused together, but it is possible to make out the limits of segments 5 to 8 with more or less exactitude from the arrangement of the hairs on the posterior margin of the fused joint, there being a gap in the line of the hairs corresponding to the line of division between the various segments.

The grasping antenna and the 5th pair of legs in my examples agree exactly with figures given by Giesbrecht (1892, pl. xxiv, figs. 14, 31, 34).

In a tow-netting from the Pearl Banks of Ceylon a large number of examples of this species in various stages of development were obtained and advantage was taken to measure and compare a number of specimens in the last three stages of growth. The actual length measurements of these examples are given in text-fig. 126. In the Table below I give the average length measurement of each of the developmental stages in both sexes.

Stage of development.				Observed size.	Calculated size.	Growth-factor.
♀				mm.	mm.	mm.
Stage III	.	.	.	..	1.287	1.269
Stage IV	.	.	.	1.626	1.634	1.269
Stage V	.	.	.	2.091	2.073	1.269
Stage VI	.	.	.	2.631	2.631	..
♂						
Stage III	.	.	.	..	1.287	1.544 or 1.269
Stage IV	.	.	.	1.626	1.633	1.544
Stage V	.	.	.	2.098	1.987	..
Stage VI	.	.	.	2.511	2.522	..

These examples appear to follow the same course of development as the species that we have previously considered. In the case of the female it would appear that there is no diminution of the growth-factor between stages IV and V, such as I have shown to occur in most species with the onset of sexual maturity, and in this respect the present species



TEXT-FIG. 126.—Length measurements of 136 examples of *Pontella fera* Dana from the Ceylon Pearl Banks.

agrees with the other species in the genus, the life history of which I have been able partially to work out, namely, *Pontella andersoni* (*vide* Sewell, 1912, p. 323). In the male it again appears that individuals may pass by a single moult from Stage III to Stage V, in which case the growth-factor is that characteristic of the male, namely 1.544, or by adopting the female growth-factor of 1.269 may pass to stage IV and thence, by a second moult with the characteristic male-factor, to Stage VI.

An examination of the proportional lengths of the various segments of the body and abdomen in the different stages of development shows clearly that, although the individual as a whole increases according to Brook's law, the various segments may exhibit a proportional increase or decrease in length. In the following table I have given the measurements, in 1000ths of the total length of the whole animal, of the various segments in the two sexes. In the female we find that the major changes in the proportions of the segments occur in the abdominal region and the proportional length of the abdomen itself also increases with age;

thus, at Stage IV it is 22.3 per cent. of the total length, whereas in Stages V and VI it has increased to 23.6 per cent. Between Stages IV and V the cephalon remains practically unchanged in length, the small difference observed being in all probability due to error of measurement. The 1st thoracic segment exhibits a marked decrease in length, from 162.5 to 141.2, or a diminution of 13.1 per cent.; segment 2 also decreases somewhat, from 93.5 to 91.1, or 2.56 per cent. The 3rd thoracic segment appears to remain unchanged, the observed difference being so slight that it is probably explainable as an experimental error. Segments 4-5 together show a considerable increase, namely from a proportional length of 70.5 to 78.9, or 11.91 per cent. In the abdominal region owing to the re-arrangement of the seg-

♀

Stage IV.

No. of specimen—	Cephalon.	Thoracic Segments.				Abdominal Segments.					Furcal ramus.
		1	2	3	4-5	1	2	3	4	5	
1 . . .	357	160	93	93	67	59					87
2 . . .	351	165	94	100	74	53					88
Average	354	162.5	93.5	96.5	70.5	56					87.5

Stage V.

No. of specimen—

						1-2	3	4-5	
1	371	132	90	95	79	79	48	27	79
2	362	135	99	93	83	80	46	26	76
3	366	124	88	98	77	86	51	30	30
4	341	148	95	101	80	82	46	30	76
5	340	160	90	100	70	83	47	31	78
6	345	155	93	98	81	72	46	30	80
7	366	134	83	93	82	79	47	32	84
Average	355.7	141.2	91.1	96.9	78.9	80.1	47.3	29.4	79.0

Stage VI.

No. of specimen—

						1 2 3	4-5	
1	358	140	90	101	78	117	35	81
2	354	142	80	94	79	132	36	83
3	362	139	86	98	82	119	36	78
4	355	145	104	97	81	110	33	75
5	343	132	93	101	82	135	35	76
Average	354.4	139.6	90.6	98.2	80.4	122.6	35	78.6

Stage IV.

	Cephalon.	Thoracic Segments.				Abdominal Segments.					Furcal ramus.
		1	2	3	4-5	1	2	3	4	5	
No. of specimen—											
1 . . .	365	135	88	88	74	58	36	63			80
2 . . .	369	134	89	89	76	62	34	56			91
3 . . .	391	140	84	84	77	57	30	55			82
4 . . .	388	117	86	86	79	58	33	66			87
5 . . .	368	136	86	86	79	58	35	64			88
6 . . .	349	148	87	87	81	57	38	63			90
7 . . .	354	157	82	91	82	56	36	61			81
8 . . .	345	158	86	93	80	55	35	62			86
9 . . .	373	127	87	93	80	61	36	58			85
10 . . .	370	130	82	89	82	58	39	61			89
Average . . .	367.2	138.2	85.7	88.6	79	58	35.2	60.9			86.7

Stage V.

	No. of specimen—						1	2	3	4 5		
1 . . .	352	128	85	96	85	56	33	44		33		88
2 . . .	371	113	93	93	72	61	33	46		33		85
3 . . .	376	97	86	97	81	59	31	41		34		80
4 . . .	367	120	94	94	74	58	33	43		34		83
5 . . .	353	126	88	93	66	54	40	47		40		93
Average . . .	363.8	116.8	89.2	94.6	75.6	57.6	34	44.2		34.8		85.8

Stage VI.

No. of specimen—																
1	.	.	.	369	122	87	91	70	54	39	50	25	17	76		
2	.	.	.	354	135	84	88	71	56	41	50	26	19	76		
3	.	.	.	354	133	92	96	75	51	37	46	24	18	74		
4	.	.	.	355	132	88	92	78	53	39	48	25	18	72		
5	.	.	.	356	127	81	97	76	58	38	52	25	20	75		
Average				.	.	357.6	129.8	86.4	92.8	70	53.4	38.8	49.2	25	18.4	74.6

ments the proportional changes in the individual segments are obscured, but between stages V and VI segments 1-3 together decrease in their proportional length from 127.4 to 122.6 or 3.77 per cent.; on the other hand segments 4 and 5 together increase from 29.4 to 35.0 or 19.05 per cent. During the three stages from IV to VI, the furcal ramus decreases in length, but the whole of this change appears to take place between stages IV and V in which the ramus decreases in length from 87.5 to 79.0 or 9.77 per cent. Between Stages V and VI the proportional lengths of the segments of the anterior region of the body change considerably. The cephalon appears to remain unaltered. Segment I of the thorax decreases slightly in length from 141.2 to 139.6 or 1.13 per cent. Segment 2 also decreases very slightly in length, if we can trust the measurements, namely from 91.1 to 90.6 or 0.55 per cent. The

posterior segments on the other hand appear to increase slightly in length; segment 3 increases from 96.9 to 98.2 or 1.31 per cent. and segments 4-5 increase from 78.9 to 80.4 or 1.9 per cent.

In the case of the male we meet with similar differences in the proportional growth of the various segments. In this sex the length of the abdomen, in proportion to the total length, increases from 24.08 per cent. in Stage IV to 25.64 per cent. in Stage V and to 25.94 per cent. in Stage VI. Here again the greatest proportional change is to be found in the segments of the abdomen. In the anterior region of the body if the change is from Stage IV to Stage VI, as I believe to be the case, the cephalon decreases from 367.2 to 357.6 or 2.67 per cent. The 1st thoracic segment decreases from 138.2 to 129.8 or 6.08 per cent. Segment 2 increases from 85.7 to 86.4 or 0.81 per cent. and segment 3 from 88.6 to 92.8 or 4.53 per cent. Segments 4-5, on the contrary, show a clear diminution in length from 79 to 70 or 11.39 per cent. The 1st abdominal segment decreases from 58 to 53.4 or 7.93 per cent. Segment 2 increases from 35.2 to 38.8 or 10.23 per cent.; and segments 3-5 increase from 60.9 to 92.6 or 52.05 per cent. The furca on the other hand decreases from 86.7 to 74.6 or 13.95 per cent.

This species, though apparently not common, is widely distributed throughout Indian waters. It has now been recorded from the Malay Archipelago (A. Scott); the Nicobar Islands (Sewell); the Pearl Banks of Ceylon (Thompson and A. Scott, Sewell); the Maldive and Laccadive Archipelagoes (Wolfenden) and the Red Sea (A. Scott).

***Pontella investigatoris* Sewell.**

Pontella investigatoris, Sewell, 1912, p. 371, Pl. xxiii, figs. 1-3.

Pontella investigatoris, Sewell, 1914, p. 236.

This species was described by me from the male only and up to the present time I have failed to discover the associated female. As I have already mentioned (*vide supra*, p. 376). I was at one time inclined to regard this form as possibly the male that corresponded to the female *Pontella danae*, var. *ceylonica* Thompson and A. Scott, but a study of the growth and development of the two forms renders this very doubtful. Examples of this male have been taken at Stations 563, 577, 578, 583, 587, 590, 591 and in the Cochin backwaters.

***Pontella princeps* Dana.**

(Text-fig. 127, a-d).

Pontella princeps, A. Scott, 1909, p. 160.

Pontella princeps, Sewell, 1912, p. 372.

This species is one of the largest surface-frequenting Calanoids: a number of examples were taken at Station 614.

♀ Total length, 5.87 mm.

The proportional lengths of the cephalothorax and abdomen are as 20 to 7, so that the abdomen is contained 2.857 times in the length of the anterior region.

The head is furnished with side hooks. The rostrum is bifid, terminating in a pair of stout spines; a well-developed rostral lens is present. The cephalon and 1st thoracic seg-

ment are fused ; thoracic segments 4 and 5 are separate and the posterior thoracic margin is produced backwards on each side in a stout spine. The colouration of this species is striking ; the general colouration of the body is a deep blue and on thoracic segments 1 to 3 in the mid-dorsal line is a deep blue spot surrounded by a halo of opaque silvery white ; the terminal 5 or 6 segments of the 1st antenna are chocolate brown. There are also some scattered white spots on the dorsal aspect of the swollen abdominal segment.

The 1st antenna consists of twenty-four free joints, segments 8 and 9, 11 and 12 and 24 and 25 being, respectively, fused together, as is usual in this genus. The proportional lengths of the segments are as follows :—

Segment	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	
	77	57	16	16	21	21	19	19	28	28	28	41	41	41	54	60	60	76	78	55	47	47	35	45	=1,000

The proximal thirteen segments bear a fringe of hairs on their posterior margin and the 14th segment carries a stout process.

The 2nd antenna is of the usual type, but the exopod is considerably shorter than in some of the other members of the genus.

The mouth-parts and swimming legs have the usual structure.

The 5th pair of legs closely resemble those of *Pontella atlantica*, Milne-Edw.

♂ Total length, 5.349 mm.

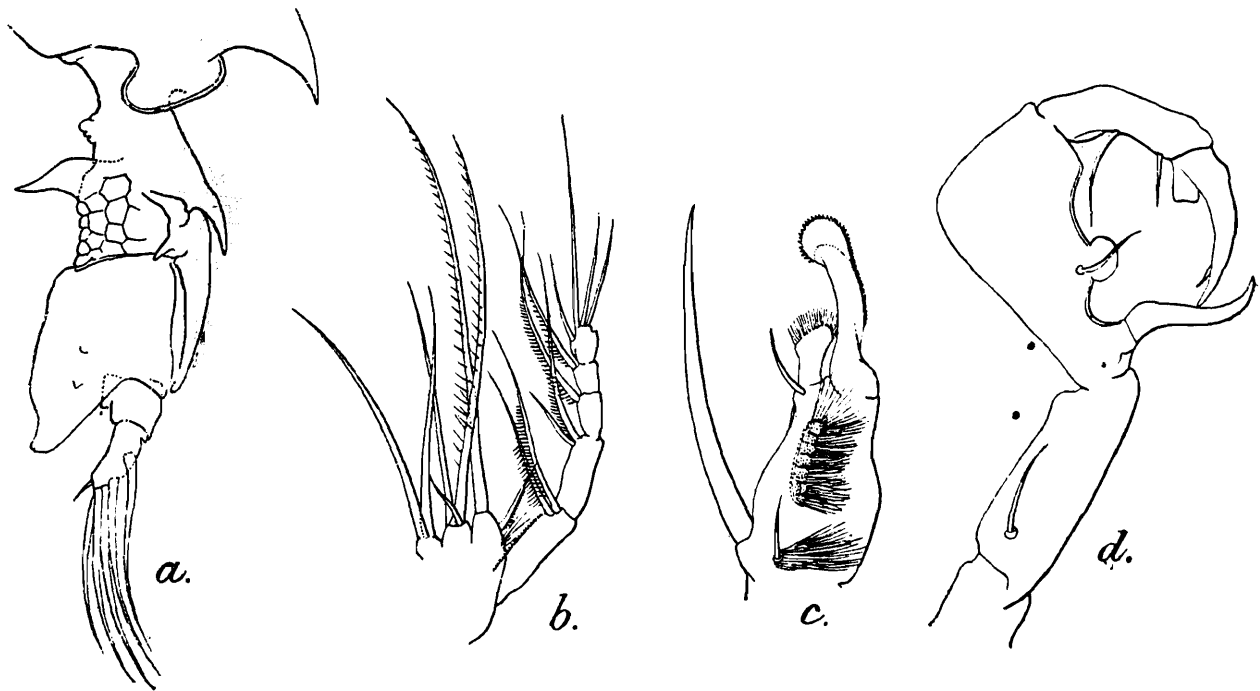
The proportional lengths of the cephalothorax and abdomen are as 16 to 7, so that the abdomen is contained 2.286 times in the length of the anterior region of the body.

The cephalothorax resembles that of the female.

The abdomen consists of five segments and the furcal rami. Their proportional lengths are as follows :—

Abdominal segment	1	2	3	4	5	Furca	
	21	14	19	10	9	27	=100

The right 1st antenna is modified to form a grasping organ ; the left antenna is unmodified and resembles that of the female. The left antenna consists of twenty-two free



TEXT-FIG. 127.—*Pontella princeps* Dana.

a. Abdomen, from the right side, female.

b. Maxilliped : terminal segments.

c. Terminal segment, 5th leg, male.

d. 5th leg, right side : male.

segments ; segments 8 and 9, and 11 and 12 respectively being fused either completely or partially. The length of the antennal segments are as follows :—

Segment	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	
	83	59	17	17	20	20	20	20	26	26	26	40	40	40	46	56	56	72	80	53	50	53	40	40	=1,000

A comparison of these measurements with those given above for the lengths of the segments in the female shows a very close agreement.

Pontella securifer Brady.

Pontella securifer, A. Scott, 1909, p. 160.

Pontella securifer, Sewell, 1912, p. 372.

Pontella securifer, Sewell, 1914, p. 238.

Pontella securifer, T. Scott, 1912, p. 539.

Pontella securifer, Farran, 1929, p. 277.

Pontella spinipes, ♂, Wolfenden, 1906, p. 1020.

Although widely distributed throughout Indian waters this species nowhere appears to be very common. Examples were taken at Stations 552, 614.

Pontella spinipes Giesbrecht.

Pontella spinipes, Giesbrecht, 1889, p. 28.

Pontella spinipes, Giesbrecht, 1892, p. 462, Pl. xxiv, fig. 30 ; Pl. xl, figs. 2, 23, 24.

Pontella spinipes, Giesbrecht and Schmeil, 1898, p. 142.

Pontella spinipes, T. Scott, 1912, p. 539.

Pontella spinipes, ♀, Wolfenden, 1906, p. 1020. (nec. *P. spinipes* ♂).

Pontella spinipes, Sewell, 1912, p. 373, Pl. xxiv, figs. 1-4.

This species, like the preceding one, is widely distributed but is not very common. Examples have been taken at Stations 542, 544, 556, 577, 582, 590, 591.

Genus **PONTELLOPSIS** Brady.

At the present time ten species belonging to this genus are known to occur in Indian waters. In 1896 Giesbrecht recorded the occurrence of *Pontellopsis krameri* (Giesbrecht) from the Red Sea. In 1900 Thompson recorded the presence of *Pontellopsis regalis* (Dana) from the Bay of Bengal. In 1901 Cleve recorded *Pontellopsis armata* (Giesbrecht), *P. regalis* Dana and *P. strenua* (Dana) from the Malay Archipelago. The work of Thompson and A. Scott in 1902 greatly increased the number of species from the Indian region and added *Pontellopsis armata* (Giesbrecht), *P. strenua* (Dana), *P. perspicax* (Dana), and *P. herdmani* Thompson and A. Scott to the list of species known from Indian waters. In 1906 Wolfenden recorded *Pontellopsis armata* (Giesbrecht) and *P. krameri* (Giesbrecht) from the Maldive Archipelago. In 1909 A. Scott in his account of the collections obtained by the "Siboga" from the Malay Archipelago recorded all the above, with the single exception of *P. herdmani*, and added *Pontellopsis villosa* Brady, *P. pexa* A. Scott and *P. macronyx* A. Scott to the list of species from that region. In 1912 I recorded the occurrence of *Pontellopsis herdmani* Thompson and A. Scott, *P. krameri* (Giesbrecht) and *P. regalis* (Dana) from the coast of southern Burma ; while in 1914 I was able to confirm the occurrence of *Pontellopsis armata* (Giesbrecht), *P. herdmani* Thompson and A. Scott, *P. krameri* (Giesbrecht), *P. perspicax* (Dana) and *P. regalis* Dana from the Ceylon Pearl Banks.

In 1915 Brady recorded the occurrence of what he regarded as a new species of *Pontellopsis*, under the name *P. speciosus*, from Durban Bay in East Africa, but this appears to be identical with *Pontellina plumata* (Dana).

***Pontellopsis armata* (Giesbrecht).**

Pontellopsis armata, A. Scott, 1909, p. 170.

Pontellopsis armata, Sewell, 1914, p. 238.

This species is widely distributed throughout Indian waters; it has now been recorded from the Malay Archipelago (Cleve, A. Scott); the Ceylon Pearl Banks (Thompson and A. Scott, Sewell); the region of the Maldives (Thompson and A. Scott, Wolfenden) and examples have been taken by the "Investigator" in Nankauri Harbour in the Nicobars (Station 614).

***Pontellopsis herdmani* Thompson and A. Scott.**

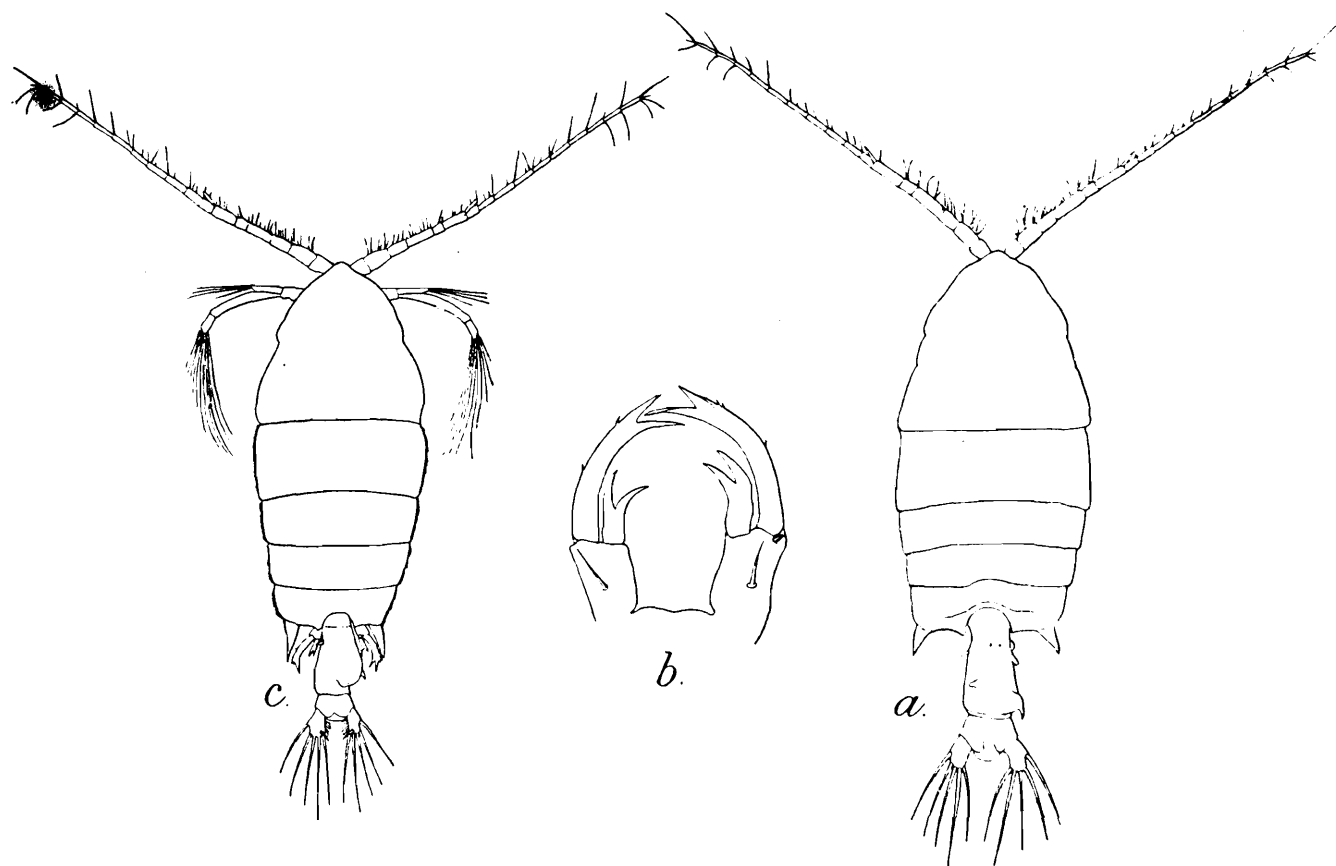
(Text-fig. 128, *a*, *b*).

Pontellopsis herdmani, Thompson and A. Scott, 1903, p. 253, pl. ii, figs. 15-17.

Pontellopsis herdmani, Sewell, 1914, p. 238.

(non *Pontellopsis herdmani* Sewell, 1912, p. 375, pl. xxiv, fig. 5).

This species appears to be somewhat rare. In my previous papers on the Copepoda of the Bay of Bengal I have recorded the occurrence of examples of what I then believed



TEXT-FIG. 128.—*Pontellopsis herdmani* Thompson and A. Scott.

a. The female from the dorsal aspect.

b. The 5th pair of legs, female.

Pontellopsis macronyx A. Scott.

c. The female from the dorsal side.

to be this species, but a further examination of this and further material has convinced me that I was mistaken. The characters of the true *Pontellopsis herdmani* are as follows:—

♀ Total length, 2.111 mm. This is slightly larger than the figure given by Thompson and A. Scott, who state that the length is only 1.9 mm.

The proportionate lengths of the cephalothorax and abdomen are as 71 to 29, so that the abdomen is contained 2.448 times in the length of the anterior region of the body.

The two last thoracic segments, 4 and 5, (text-fig. 128, a) are partially fused and the line of fusion can clearly be detected running across the dorsal aspect. The 5th thoracic segment terminates on each side in a sharp spine that is not so long as in *Pontellopsis macronyx* and is symmetrical, thus being unlike the corresponding spines in the hitherto unknown form that I have described below (*vide infra*, p. 388).

The abdomen consists of two segments, of which the anterior is by far the larger. The proportional lengths of these two segments are as follows:—

Abdominal segment	1-3	4-5	Furca	
	59	22	19	= 100.

As I have already noted (*vide* Sewell, 1914, p. 239) the genital segment of the female of this species frequently bears on its dorsal aspect, slightly to the left of the middle line, a small spinous projection, in addition to the two on the right side that have been described by Thompson and A. Scott. There is also a small spine on the left side near the proximal end of the segment, corresponding to the one on the right described and figured by the original authors. The furcal rami are fringed on their inner margins with delicate hairs but the furcal setae are not in my examples non-plumose but are fringed with delicate hairs.

The 1st abdominal segment and the thoracic segments are all smooth and are devoid of hairs in my examples, whereas in the examples of *Pontellopsis macronyx* that I have examined these segments of the body are covered with fine hairs arranged in the anterior thoracic segments in transverse bands, in a manner very similar to that described by A. Scott (1909, p. 173, pl. liv, fig. 11) in the case of *Pontellopsis pexa*.

The 1st antenna consists of 16 segments that have the following proportional lengths:—

Segment	1	2-5	6-7	8	9-11	12	13-14	15	16	17	18	19	20	21	22	23	24-25	
	83	75	42	21	98	27	57	33	42	48	63	89	63	60	70	63	64	= 1,000

Segments 2-5, and 6-7 are completely fused together and segment 8 is partially fused to segment 7; segments 9-11 and 13 and 14 are completely fused, as also are segments 24 and 25.

Segment 14 bears a well-developed spine.

The 5th pair of swimming legs (text-fig. 128, b) are exactly as described and figured by Thompson and A. Scott (*vide* 1903, pl. ii, fig. 17).

***Pontellopsis krameri* (Giesbrecht).**

Pontellopsis krameri, A. Scott, 1909, p. 171.

Pontellopsis krameri, Sewell, 1912, p. 376.

Pontellopsis krameri, Sewell, 1914, p. 239.

This species is widely distributed throughout Indian waters. It has now been recorded from the Malay Archipelago (A. Scott); the coast of southern Burma (Sewell); the Ceylon Pearl Banks (Sewell); the Maldiva and Laccadive Archipelagoes (Wolfenden) and the Red Sea (Giesbrecht, Thompson and A. Scott).

Examples occurred in the "Investigator" collections from Stations 542, 569 and 582.

***Pontellopsis macronyx* A. Scott.**

(Text-fig. 128, c).

Pontellopsis macronyx, A. Scott, 1909, p. 137, pl. liv, figs. 1-10.(non *Pontellopsis herdmani*, Sewell, 1912, p. 375, pl. xxiv, fig. 5).

A few specimens of what appears without doubt to be the above species were taken in Port Blair Harbour, Andaman Islands.

♀ Total length, 1.733 mm. A. Scott gives the total length of his examples from the Malay Archipelago as 1.97 mm.

The proportional lengths of the cephalothorax and abdomen are as 73 to 27, so that the abdomen is contained 2.704 times in the length of the anterior region.

The 4th and 5th thoracic segments are fused together and the posterior thoracic margin of the 5th segment is produced on each side in a sharp spine, that is distinctly longer than the corresponding spine in *Pontellopsis herdmani* Thompson and A. Scott and reaches back to the middle of the length of the 1st abdominal segment.

The abdomen consists of two segments that have with the furcal rami the following proportional lengths :—

$$\frac{\text{Abdominal segment} \quad 1-3 \quad \quad 4-5 \quad \quad \text{Furca}}{58 \quad \quad 17 \quad \quad 25} = 100.$$

The 1st abdominal segment presents some variation from the account given by A. Scott (*loc. cit.* p. 173, pl. liv, fig. 1), for in some instances there were only three spines, two being at the proximal end of the segment, while distally there was only a single small spine situated on the summit of a rounded eminence on the right side; the corresponding spine on the left side was missing. In one example the thoracic segments and the outer part of the posterior thoracic spines are clothed with a series of bands of fine short hairs, thus closely resembling the condition described by Scott in *Pontellopsis pexa* (*vide* A. Scott, 1909, p. 173, pl. liv, fig. 11); in a second specimen, however, there was no trace of this hirsute covering on the thoracic segments. The posterior marginal spines are comparatively short, as figured by Scott, and the proportional lengths of the abdominal segments are

$$\frac{\text{Abdominal segments} \quad 1-4 \quad \quad 5 \quad \quad \text{Furca}}{57 \quad \quad 23 \quad \quad 20} = 100$$

The 1st antenna consists of 17 segments but several of these are partially fused together. The proportional lengths of the segments are as follows :—

$$\begin{array}{cccccccccccccccccccc} \text{Segment} & 1 & \underbrace{2-5} & \underbrace{6-8} & \underbrace{9-11} & 12 & 13 & 14 & 15 & 16 & 17 & 18 & 19 & 20 & 21 & 22 & 23 & \underbrace{24-25} \\ \hline & 88 & 77 & 55 & 85 & 37 & 40 & 26 & 29 & 44 & 51 & 66 & 77 & 59 & 55 & 73 & 66 & 70 \end{array} = 1,000.$$

Segments 2-5 are completely fused together and in this case segments 6 to 8 also appear to be completely fused, segments 9-11 are completely fused and in addition segments 12, 13 and 14 are fused with segment 11, though traces of the lines of separation can still be made out.

The 5th pair of legs are as described by A. Scott (*loc. cit.*, p. 174, pl. liv, fig. 6).

Pontellopsis perspicax* (Dana).Pontellopsis perspicax*, A. Scott, 1909, p. 171.*Pontellopsis perspicax*, Sewell, 1914, p. 239.*Pontellopsis perspicax*, Farran, 1929, p. 280.*Pontellopsis perspicax*, T. Scott, 1912, p. 539.

This species has now been recorded from the Malay Archipelago (A. Scott) and the Ceylon Pearl Banks (Thompson and A. Scott, Sewell).

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

Pontellopsis regalis, A. Scott, 1909, p. 171.

Pontellopsis regalis, Wolfenden, 1911, p. 362.

Pontellopsis regalis, T. Scott, 1912, p. 539.

Pontellopsis regalis, Sewell, 1912, pp. 315, 376.

Pontellopsis regalis, Sewell, 1914, p. 239.

Pontellopsis regalis, Sars, 1925, p. 354.

Pontellopsis regalis, Farran, 1929, p. 280.

This species has now been recorded from the Malay Archipelago (Cleve, A. Scott.); the coast of southern Burma (Sewell); the Bay of Bengal (Thompson) and the Ceylon Pearl Banks (Thompson and A. Scott, Sewell).

Examples occur in the "Investigator" collections from Stations 582, 614 and 642.

***Pontellopsis scotti*, sp. nov.**

(Text-fig. 129, *a-f*).

Pontellopsis herdmani, Sewell, 1912, p. 375, pl. xxiv, fig. 5.

(non *Pontellopsis herdmani*, Thompson and A. Scott).

At several stations on the Burma coast a number of examples were taken of a species that closely resemble *Pontellopsis macronyx* A. Scott and *Pontellopsis herdmani* Thompson and A. Scott. In my previous report (*loc. cit.*) I was inclined to regard these forms as intermediate between these two species but the further examination of a number of additional specimens has convinced me that at present it is advisable to regard them as a new species, at the same time bearing in mind that they may ultimately prove to be a dimorphic form (*forma minor*) of *Pontellopsis macronyx*.

♀ Total length, 1.511 mm. These examples are thus considerably smaller than the females of *Pontellopsis macronyx*, which in my examples measured 1.755 mm., while Scott gives the length of his examples as 1.97 mm.

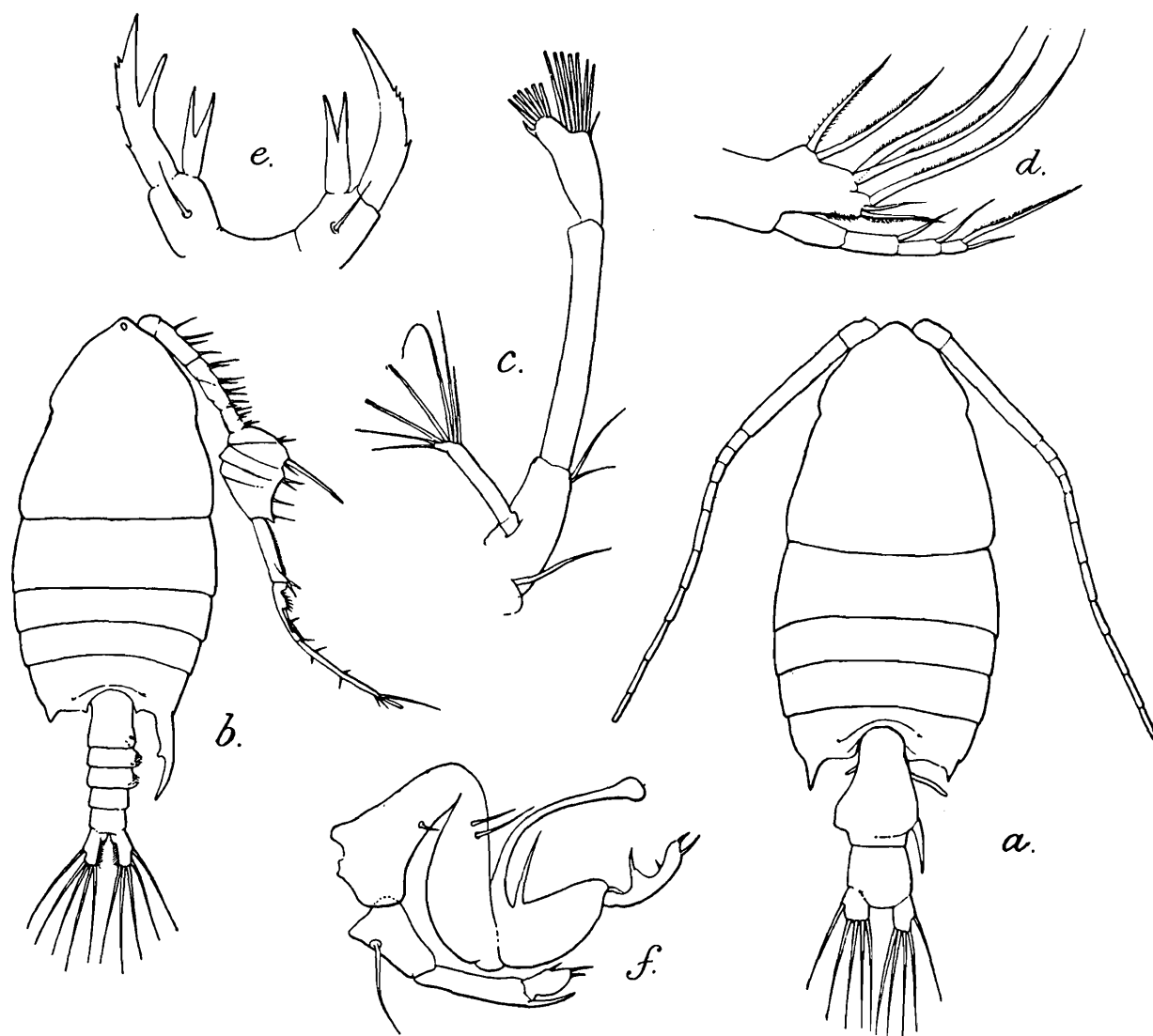
The proportional lengths of the cephalothorax and abdomen are as 2.09 to 1. The segments of the cephalothorax are devoid of any hirsute covering. The posterior thoracic segment (text-fig. 129, *a*) bears on each side a small marginal spine; these spines are slightly asymmetrical, that on the left side being appreciably larger and longer than that on the right; in this respect this species agrees with the condition recorded by A. Scott (1909, p. 173) in *Pontellopsis macronyx*.

The abdomen consists of two segments, having with the furcal rami the following proportional lengths:—

Abdominal segment	1.3	4.5	Furca	
	57	31	12	=100.

The proximal segment is somewhat asymmetrical, as in *P. macronyx* A. Scott; at its proximal end it bears on each side a rod-like spine, that on the right side being usually considerably longer than that on the left; at the distal end there is a swelling on the left side, that in some examples is produced in a small papilla, while in others it is produced into a long and tapering process. Certain examples bear a rod-like spine on the right side, as figured

by A. Scott (1909, pl. liv, fig. 1) in *P. macronyx* but in the majority of individuals this is absent. The posterior segment of the abdomen is considerably longer than in either



TEXT-FIG. 129.—*Pontellopsis scotti*, sp. nov.

- a. The female from the dorsal side.
b. The male from the dorsal side.
c. The 2nd antenna.

- d. The maxilliped.
e. The 5th pair of legs, female.
f. The 5th pair of legs, male.

Pontellopsis macronyx A. Scott or *P. herdmani* Thompson and A. Scott. The furcal rami are short and the furcal setae plumose. The right furcal ramus extends slightly further backwards than the left, owing to a slight degree of asymmetry in their point of origin from the anal segment.

The 1st antenna consists of 16 free segments, that have the following proportional lengths :—

Segment	1	2-5	6-8	9-11	12	13-14	15	16	17	18	19	20	21	22	23	24-25	
	79	74	55	72	27	68	34	40	49	68	91	65	57	73	68	74	=1,000.

Segments 2 to 5 are completely fused ; segments 6, 7 and 8 are partially fused, the lines of separation, however, being visible ; segments 9 to 11, and 13 and 14 are respectively fused ; and segments 24 and 25 are, as usual, fused. The 14th segment bears a stout and thick spine that extends beyond the distal end of the 15th segment.

The 5th pair of legs (text-fig. 129, e) closely resemble those of *Pontellopsis macronyx* A. Scott.

♂ Total length, 1.419 mm.

The proportional lengths of the cephalothorax and abdomen are as 2.286 to 1. As in the female, the 4th and 5th thoracic segments are fused together, though the line of fusion can be detected running across the middle line of the dorsal aspect. The 5th thoracic segment (text-fig. 129, *b*) is asymmetrical; on the left side there is a short and blunt spine but on the right side the segment is produced into a large stout spine that extends back to the level of the middle of the 4th abdominal segment. About half way along its length this spine becomes suddenly attenuated and there is a short projection on its inner aspect. The thoracic segments are devoid of any hirsute covering.

The abdomen consists of five segments that have the following proportional lengths:—

Abdominal segment	1	2	3	4	5	Furca	
	23	13	13	13	13	25	= 100.

The 1st segment bears a small spine on its right side; the 2nd and 3rd segments are each produced on the right side in a rounded swelling, that is crowned with numerous small spines; the 4th segment is also slightly produced in certain specimens but has no spines. The furcal rami are about twice as long as broad and the furcal setae appear for the most part to be devoid of hairs, though in some there are traces of the usual plumose condition near their base.

The 1st antennae are, as usual, asymmetrical, that on the right side being modified into a powerful grasping organ that appears exactly to resemble that of the male of *Pontellopsis macronyx* A. Scott (1909, p. 174, pl. liv, fig. 7). The left antenna is unmodified and consists of 15 free segments that have the following proportions:—

Segment	1	2-5	6-8	9-13	14	15	16	17	18	19	20	21	2	23	24-25	
	78	93	76	117	26	30	45	53	61	90	60	60	275	65	70	= 1,000.

Segments 2-5 and 6-8 are fused, as in the female; segments 9 to 13 are all fused, though the dividing line between segments 11, 12 and 13 can be detected. In the manner of fusion of these proximal segments the male thus differs slightly from the female.

The 2nd antenna and mouth-parts (text-fig. 129, *c-d*) closely resemble those of other members of the genus.

The 5th pair of legs (text-fig. 129, *f*) bears a distinct resemblance to those of *Pontellopsis macronyx* A. Scott, but the projection at the base of the 1st segment of the right exopod is not nearly so long and terminates in a flattened lamella.

***Pontellopsis villosa* Brady.**

Pontellopsis villosa, A. Scott, 1909, p. 172.

Pontellopsis villosa, T. Scott, 1912, p. 539.

Pontellopsis villosa, Sars, 1925, p. 155.

This species appears to be rare in Indian waters; a single specimen, male, was detected in a tow-netting taken at the surface at "Investigator" Station 614.

Genus **PONTELLINA** Dana.

This genus is represented by only a single species, *Pontellina plumata* (Dana).

Pontellina plumata (Dana).

Pontellina plumata, A. Scott, 1909, p. 175.

Pontellina plumata, Wolfenden, 1911, p. 362.

Pontellina plumata, T. Scott, 1912, p. 539.

Pontellina plumata, Sewell, 1912, p. 354.

Pontellina plumata, Sewell, 1914, p. 240.

Pontellina plumata, Früchtl, 1924, p. 28.

Pontellina plumata, Sars, 1925, p. 355.

Pontellina plumata, Farran, 1929, p. 280.

This species is widely distributed throughout Indian waters. It has now been taken in the Malay Archipelago (Cleve, A. Scott, Früchtl); off the coast of southern Burma (Sewell); on the Pearl Banks of Ceylon (Thompson and A. Scott, Sewell); in the Maldivé and Laccadive Archipelagoes (Wolfenden); the Arabian Sea (Thompson and A. Scott); the Red Sea (A. Scott) and off the east coast of Africa and in the Agulhas Current (Cleve).

Family PARAPONTELLIDAE.

Genus **BATHYPONTIA** Sars.

This genus was created by Sars in 1905 to accommodate a species, *Bathypontia elongata*, taken in the Atlantic Ocean; since then two other species have been added from the same region and a fourth *Bathypontia spinifera*, was recorded by A. Scott (1909, p. 183, pl. iii, figs. 1-16) in the collections of the "Siboga" from the Malay Archipelago. Up to the present time no examples of this genus have been taken by the "Investigator" in Indian waters.

Genus **NEOPONTELLA** A. Scott.

This genus was created by A. Scott to accommodate a species, *Neopontella typica*, described by him (1909, p. 185, Pl. lv, figs. 1-15) from the "Siboga" collection. No examples have been seen in the collections in the Indian Museum.

Family ACARTIIDAE.

Genus **ACARTIA** Dana.

The first record of the occurrence of examples of this species in Indian waters is that of Giesbrecht in 1895, in which he reports the occurrence of *Acartia centrura* Giesbrecht, *A. erythraea* Giesbr. and *A. negligens* Dana in the surface waters of the Red Sea. In 1900 T. Scott recorded *Acartia erythraea* Giesbr. from the Indian Ocean and added *A. clausi* Giesbr. to the list of those already known from this region, with a distribution from the east coast of Africa, through the Indian ocean into the Bay of Bengal and the Red Sea. In 1901 Cleve added *Acartia spinicauda* Giesbr. and *A. tonsa* Dana to the list of species that inhabit Indian waters and recorded *A. erythraea* Giesbr., *A. spinicauda* Giesbr. and *A. tonsa* Dana from the Malay Archipelago and *Acartia negligens* Dana from the Indian Ocean. A year later A. Scott (1902) again recorded *Acartia erythraea* Giesbr. and *A. negligens* Dana from the Red Sea. In 1903-4 Cleve recorded *Acartia erythraea* Giesbr. and *A. negligens* Dana from the Red Sea and Arabian Sea, *A. spinicauda* Giesbr. and *A. tonsa* Giesbr. from the Arabian Sea and *Acartia danae* Giesbrecht sparingly from the east of south Africa. Wolfenden in 1905 reported finding *Acartia danae* Giesbr., *A. erythraea* Giesbr., *A. negligens*

Dana and *A. tonsa* Dana in the collections made by Stanley Gardiner in the Maldive and Laccadive Archipelagoes. In 1907 Carl recorded the occurrence of *Acartia erythraea* Giesbr. at Amboina in the Malay Archipelago and described two new species, namely *A. amboinensis* and *A. bispinosa* from the same region. A. Scott two years later (1909) only recorded the occurrence of *Acartia danae* Giesbr., *A. erythraea* Giesbr., *A. negligens* Dana and *A. spinicauda* Giesbr. among the collection of the "Siboga" from the Malay Archipelago. In 1912 Pesta described *Acartia pietschmani* from the Persian Gulf. In 1912 I noted the presence of *Acartia danae* Giesbr., *A. erythraea* Giesbr. and *A. spinicauda* Giesbr. from the coast of southern Burma and in 1914 I identified *Acartia centrura* Giesbr., *A. danae* Giesbr., *A. erythraea* Giesbr., *A. negligens* Dana, *A. spinicauda* Giesbr., *A. bispinosa* Carl, *A. amboinensis* Carl, *A. pietschmani* Pesta and a new species *A. southwelli* from the Ceylon Pearl Banks; and in 1915 Brady described *Acartia nana* and *A. longisetosa* from Durban Bay, E. Africa. Früchtl in 1924 records from the Aru Archipelago in the Malay region the occurrence of *Acartia pacifica* Steuer var. *mertoni* Steuer, *A. erythraea* var. *valdiviae* Steuer and var. *brehmi* Früchtl and *A. negligens* Dana; and finally, Gurney in 1927 recorded *Acartia clausi* Giesbr., *A. centrura* Giesbr., *A. latisetosa* (Kricyagin) and a new species *A. fosoae* from the Suez Canal. In addition to the above I have described several new species of a form closely allied to, though differing in certain features from the genus *Acartia*, as defined by Dana. In 1914 I created a new genus, *Acartiella*, for these species, of which the following have up to the present time been recorded, *Acartiella kempi* Sewell, *A. tortaniformis* Sewell, *A. gravellyi* Sewell, *A. major* Sewell and *A. minor* Sewell. The vast majority of these appear to be brackish-water forms, though *A. kempi* was described from a tow-netting taken in the Gulf of Mannar. I have, however, included them here for convenience of reference.

In 1923 Steuer published a monograph on the genus *Acartia*. In this he divides the genus into two groups *Acartiae arostratae* and *Acartiae rostratae*, under both of which he places a number of subgenera, as follows:—

Acartiae rostratae

Subgenus *Acartiura* Steuer.

„ *Acartiella* Sewell.

Acartiae rostratae.

Subgenus *Euacartia* Steuer.

„ *Paracartia* T' Scott.

„ *Hypoacartia* Steuer.

„ *Acanthacartia* Steuer.

„ *Odontacartia* Steuer.

„ *Planktacartia* Steuer.

ACARTIAE AROSTRATAE.

Subgenus **Acartiella** Sewell.

This genus was created by me in 1914 to accommodate the two species *Acartiella kempi* and *A. tortaniformis*. Of these the first had been taken in a tow-netting at Kilakarai on the south coast of India and the second had been obtained off the Burma coast and at the mouth of the Rangoon river. Since then other species that belong to this subgenus have

been taken, namely, *Acartiella gravelyi* Sewell from the backwaters of Cochin and *A. major* and *A. minor* from the Chilka lake. In the main the members of this subgenus are inhabitants of brackish-water but may occur also in the sea, especially around the mouth of rivers.

***Acartia (Acartiella) tortaniformis* Sewell.**

Acartia tortaniformis, Sewell, 1912, p. 346, pl. xxi, figs. 1-10.

Acartiella tortaniformis, Steuer, 1923, p. 100.

Since this species was taken at the mouth of the Rangoon river, other examples have been obtained from a tow-netting off Hainguy island, Burma coast, and in large numbers and various stages of development in a tow-netting from the river at Chittagong, east Bengal. The species also occurs in the Hoogli River above Calcutta.

***Acartia (Acartiella) gravelyi* Sewell.**

Acartiella gravelyi, Sewell, 1919, p. 10, pl. ix, fig. 7 ; pl. x, figs. 1, 4 and 5.

Since this species was first obtained no further examples have been taken.

***Acartia (Acartiella) kemp* SEWELL.**

Acartiella kemp, Sewell, 1914, p. 246, pl. xx, figs. 1-5 ; pl. xxi, fig. 4.

Acartiella kemp, Steuer, 1923, p. 101, figs. 48-51.

Since this species was first discovered no further examples have been secured.

***Acartia (Acartiella) major* Sewell.**

Acartiella major, Sewell, 1919, p. 13, pl. ix, fig. 8 ; pl. x, figs. 2, 3-6.

Acartiella major, Sewell, 1924, p. 791, pl. xlvi, fig. 1.

This species was first recorded from the Chilka Lake and further examples have subsequently been obtained from the Salt Lakes, Calcutta.

***Acartia (Acartiella) minor* Sewell.**

Acartiella minor, Sewell, 1919, p. 15, pl. ix, fig. 6 ; pl. x, fig. 7.

Acartiella minor, Sewell, 1924, p. 791, pl. xlvi, fig. 2:

Like the preceding species this was first taken in the Chilka Lake and has since been obtained from the Salt Lakes, Calcutta.

ACARTIAE ROSTRATAE.

Sub-genus ***Euacartia*** Steuer.

***Acartia (Euacartia) southwelli* Sewell.**

Acartia southwelli, Sewell, 1914, p. 244, pl. xix, figs. 8, 9.

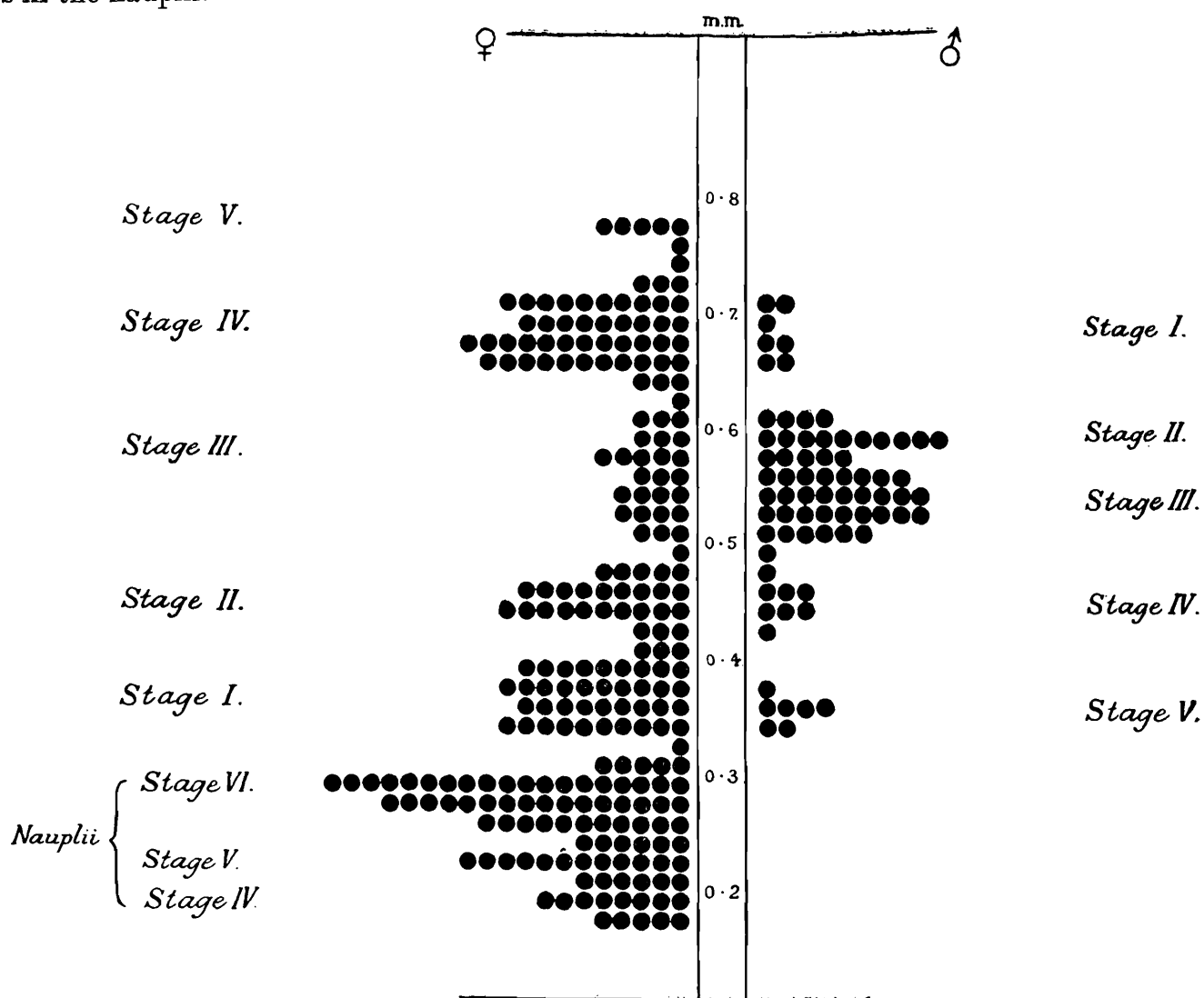
Acartia southwelli, Sewell, 1924, p. 790, pl. xlv, fig. 6.

Acartia (Euacartia) southwelli, Steuer, 1923, p. 102, figs. 52, 53.

Up to the present time this species has only been found in tow-nettings from the Ceylon Pearl Banks and the Chilka Lake.

In one tow-netting from the Chilka Lake almost the whole of the catch consisted of examples of this species in various stages of development, including three stages of the nauplii. The opportunity has been taken of measuring a number of these examples with a view to determining the growth-factors and, if possible, of tracing the probable lines of development, and the results obtained are shown in text-fig. 130. In the following table

I have given the average lengths in the various stages of development in both sexes, as well as in the nauplii.



TEXT-FIG. 130.—Length measurements of 314 examples of *Acartia* (*Euacartia*) *southwelli* Sewell, from the Chilka Lake.

Nauplii.	Observed size.	Calculated size.	Growth-factor.
	mm.	mm.	mm.
Stage 4	0.171	0.172	1.246
Stage 5	0.214	0.214	1.246
Stage 6	0.267	0.267	1.290 (?)
Copepodid Stage I		0.344	

N.B.—I have assumed that there are six naupliar stages in this species.

Post naupliar stages.

♀			
Stage I	0.355	0.355	1.246
Stage II	0.440	0.443	1.246
Stage III	0.551	0.551	1.184
Stage IV	0.677	0.653	1.184
Stage V (Adult)	0.773	0.773	
♂			
Stage I	0.342	0.344	1.290
Stage II	0.437	0.444	1.290 or 1.184
Stage III	0.525	0.525	1.290
Stage IV	0.579	0.573	..
Stage V (Adult)	0.680	0.678	..

From the above it seems clear that this species follows exactly the same general line of development that we have already found to exist in other species, except that here we appear to have only five post naupliar stages, instead of the usual six; and it is a matter of considerable interest to note that exactly the same curtailment of the normal development was found to be present in the examples of *Paracalanus crassirostris* (Dahl) from the same locality (*vide supra*, p. 73 *et seq.*). In the female sex each stage gives rise at a moult to the next largest stage and at stage III there is a drop in the growth-factor from 1.246 to 1.184. In the male sex the typical growth-factor would appear to be 1.290, but at stage II an individual may follow one of two lines of development; he may either, with an increase of size that exhibits the characteristic male growth-factor, pass to stage IV or he may for a single moult assume the female growth-factor of 1.184 and pass to stage III and at a subsequent moult with the characteristic male-factor of 1.290 pass to stage V and become sexually adult.

The nauplii also appear to exhibit a change in the growth-factor, though it is interesting to note that these factors appear to be identical with one or other of the growth-factors of the Copepodid stages. At each moult between naupliar stages IV and V, and V and VI respectively the growth-factor in the present instance appears to be 1.246, which is the same as that in the earlier moults of the female copepodid; but during the change from the last naupliar stage to the 1st copepodid stage the growth-factor in the present series seems to change to that which is characteristic of the male copepodid, namely 1.290, and this would seem to suggest that the nauplii that I was examining would all ultimately have become members of the male sex.

Sub-genus **Acanthacartia** Steuer.

Acartia (Acanthacartia) chilkaensis Sewell.

Acartia chilkaensis, Sewell, 1919, p. 9, pl. ix, figs. 1-5.

Acartia chilkaensis, Sewell, 1924, p. 790.

This species was first recorded by me from the Chilka Lake; further examples have been taken in the Salt Lakes near Calcutta, of which it appears to be a normal inhabitant.

Acartia (Acanthacartia) pietschmani Pesta.

Acartia pietschmani, Pesta, 1912, p. 54, figs. 18, *a-d*.

Acartia pietschmani, Pesta, 1913, p. 33.

Acartia pietschmani, Sewell, 1914, p. 242.

Acartia (Acanthacartia) pietschmani, Steuer, 1923, p. 109.

This species has now been recorded from the Persian Gulf, the Arabian Sea and the Pearl Banks of Ceylon.

Acartia (Acanthacartia) plumosa T. Scott.

Acartia plumosa, T. Scott, 1894, p. 66, pl. vii, figs. 22-31.

Acartia (Acanthacartia) plumosa, Steuer, 1923, p. 112 (24), figs. 110-114.

Examples of this species have been taken in the Salt Lakes, Calcutta. The species has previously been reported from the Bananah Creek, Congo River and from Loanda Harbour by T. Scott and again from the Congo by Steuer. Its occurrence in the Salt Lakes in Calcutta greatly increases its known range.

Sub-genus **Odontacartia** Steuer.

Acartia (Odontacartia) amboinensis Carl.

Acartia amboinensis, Carl, 1907, p. 12, pl. i, figs. 3-5.

Acartia amboinensis, Sewell, 1914, p. 242, (♂ only).

Acartia (Odontacartia) amboinensis, Steuer, 1923, p. 120, figs. 151-6.

This species was first recorded from the Malay Archipelago. It has since been obtained on the Ceylon Pearl Banks and was also taken by the "Valdivia" at Station 269.

It occurs in small numbers in the tow-nettings from "Investigator" Stations 545, 562, 575 and 577.

Acartia (Odontacartia) bispinosa Carl.

Acartia bispinosa, Carl, 1907, p. 13, pl. i, figs. 1,2.

Acartia bispinosa, Pesta, 1912, p. 54, fig. 17.

Acartia bispinosa, Sewell, 1914, p. 242.

Acartia amboinensis (♀) Sewell, 1914, p. 243, pl. xix, figs. 1-7.

Acartia (Odontacartia) bispinosa, Steuer, 1923, p. 121, figs. 157-165.

The only regions in Indian waters where I have up to the present time obtained examples of this species are the Ceylon Pearl Banks and Macpherson Strait, Andaman Islands. Steuer points out that the female that I described in 1914 and attributed to *Acartia amboinensis* Carl is in reality the female of *A. bispinosa* Carl.

Acartia (Odontacartia) centrura Giesbrecht.

Acartia centrura, Giesbrecht, 1892, p. 508, pl. xxx, figs. 26, 31 ; 3l. xliii, figs. 9, 16.

Acartia centrura, Giesbrecht, 1895, p. 318.

Acartia centrura, Thompson and A. Scott, 1903, p. 254.

Acartia centrura, Sewell, 1914, p. 240.

Acartia centrura, Sewell, 1924, p. 790.

Acartia (Odontacartia) centrura, Steuer, 1923, p. 115, figs. 126-129.

This species has now been recorded from the coast of southern Burma (Sewell) ; and the Ceylon Pearl Banks (Thompson and A. Scott, Sewell). It has also been taken at "Investigator" Stations 540, 541, 542, 543, 544, 547, 552 and 562. It would appear, therefore, to be widely distributed throughout Indian waters.

Acartia (Odontacartia) erythraea Giesbrecht.

Acartia erythraea, A. Scott, 1909, p. 187.

Acartia erythraea, Pesta, 1912, p. 53, fig. 16.

Acartia erythraea, Sewell, 1912, p. 377.

Acartia erythraea, Pesta, 1913, p. 32.

Acartia erythraea, Sewell, 1914, p. 241.

Acartia (Odontacartia) erythraea, Steuer, 1923, p. 118, figs. 142-45.

Acartia (Odontacartia) erythraea, Früchtl, 1924, p. 58.

This species is widely distributed throughout Indian waters ; it has been recorded from the Malay Archipelago (A. Scott, Cleve, Carl) ; the coast of southern Burma (Sewell) ; the Ceylon Pearl Banks (Thompson and A. Scott, Sewell) ; the Maldive and Laccadive Archipelagoes (Wolfenden) ; the Persian Gulf (Pesta) ; the Arabian Sea (Pesta, Cleve) ; the Red

Sea (Giesbrecht, A. Scott) and Durban Bay, E. Africa (Brady). Examples have been taken at "Investigator" Stations 542, 543, 544, 555, 556, 558, 559, 562, 582, 583, 591 and 614.

Acartia (Odontacartia) pacifica Steuer.

Acartia (Odontacartia) pacifica, Steuer, 1923, p. 28, figs. 134-137.

A few examples of this species were obtained in a tow-netting taken off Penang and have been sent to me for identification.

Acartia (Odontacartia) spinicauda Giesbrecht.

Acartia spinicauda, A. Scott, 1909, p. 188.

Acartia spinicauda, Sewell, 1912, pp. 315, 377.

Acartia spinicauda, Sewell, 1914, p. 241.

This species has been taken in the Malay Archipelago (Cleve, A. Scott, Carl); the coast of southern Burma (Sewell); the Ceylon Pearl Banks (Sewell) and the Arabian Sea (Cleve).

Examples were taken at "Investigator" Stations 558, 574, 575, 583, 584, 587, 590, 614 (Nankauri Harbour) and in Expedition Harbour in the Nicobar Islands.

Sub-genus **Planktacartia** Steuer.

Acartia (Planktacartia) danae Giesbrecht.

Acartia danae, A. Scott, 1909, p. 187.

Acartia danae, Wolfenden, 1911, p. 357.

Acartia danae, Sewell, 1912, p. 376.

Acartia danae, Sewell 1914, p. 240.

Acartia danae, T. Scott, 1912, p. 540.

Acartia (Planktacartia) danae, Steuer, 1923, p. 123, figs. 166-169.

Acartia danae, Farran, 1929, p. 282.

This species has been taken in the Malay Archipelago (A. Scott, Carl.); the coast of southern Burma (Sewell); the Ceylon Pearl Banks (Sewell) and the Maldive and Laccadive Archipelagoes (Wolfenden). It would appear, therefore, to be a widely distributed species. A. Scott (*loc. cit.*, p. 187) remarks " *Acartia danae* appears to be rather limited in its distribution. It has been recorded from the Atlantic and Pacific Oceans and from the Mediterranean ". Since then it has been taken in several areas of the Indian Ocean and Farran reports it to be very common off New Zealand. Its distribution would appear, therefore, to be wide, but so far as my experience goes it is, as a rule, far from common.

Acartia (Planktacartia) negligens Dana.

Acartia negligens, A. Scott, 1909, p. 188.

Acartia negligens, Wolfenden, 1911, p. 357.

Acartia negligens, T. Scott, 1912, p. 540.

Acartia negligens, Sewell, 1914, p. 241.

Acartia (Planktacartia) negligens, Steuer, 1923, p. 123, figs. 170-173.

Acartia negligens, Farran, 1929, p. 281.

This species has now been recorded from the Malay Archipelago (Cleve, A. Scott, Carl); the Ceylon Pearl Banks (Thompson and A. Scott, Sewell); the Maldive and Laccadive Archipelagoes (Wolfenden) and the Red Sea (A. Scott). Examples have also been taken at "Investigator" Stations 542 and 559.

Family TORTANIDAE.

Genus **TORTANUS** Giesbrecht.

At the present time this species is represented in Indian waters by six species. Of these the first to be recorded was *Tortanus barbatus* (Brady); owing to small differences of structure, especially in the spines on the terminal segment of the 5th left leg and the seta arising from the external margin of the right furcal ramus, Giesbrecht regarded certain examples, that he examined, as representing a different species and accordingly named them *T. denticulatus*; A. Scott and Früchtl are however both convinced that both forms are in reality specifically identical. *Tortanus gracilis* (Brady) was first recorded from these waters by Cleve in 1901, who obtained specimens from the Malay Archipelago: the distribution of this species was subsequently extended to the Ceylon Pearl Banks by Thompson and A. Scott in 1903 and to the Maldive and Laccadive Archipelagoes by Wolfenden in 1906. In 1909 A. Scott, in his account of the collections of the "Siboga" in the Malay Archipelago, recorded the occurrence of both these species and added *Tortanus murrayi* and *T. brevipes*, two new species, to the list of those occurring in the Indian region. *Tortanus forcipatus* (Giesbrecht) was reported from the Ceylon Pearl Banks by Thompson and A. Scott in 1903 and later by me from the same area in 1914. Gurney (1927) has recorded the presence of *Tortanus gracilis* Brady in the Suez Canal. Among the "Investigator" collections are representatives of yet another species that appears to be new.

A survey of the various known species in this genus appears to me to indicate that they can be grouped into two sub-genera. (1) Sub-genus *Tortanus* nov. To this sub-genus I attribute the following species:—

Tortanus (*Tortanus*) *forcipatus* (Giesbrecht),

Tortanus (*Tortanus*) *barbatus* (Brady) (= *Tortanus denticulatus* Giesbrecht), and

Tortanus (*Tornatus*) *gracilis* (Brady).

In these species the 4th and 5th thoracic segments are separate; the abdomen is very considerably elongated, the cephalothorax and abdomen having the proportional lengths of approximately 1.5 : 1.0. The abdomen consists of three segments, seven setae on the last segment of the endopod of the 3rd and 4th legs. (2) Sub-genus *Atortus*, nov. In this sub-genus I place the following species:—

Tortanus (*Atortus*) *recticauda* (Giesbrecht),

Tortanus (*Atortus*) *murrayi* A. Scott,

Tortanus (*Atortus*) *brevipes* A. Scott, and

Tortanus (*Atortus*) *tropicus*, sp. nov.

This sub-genus is characterised by the fusion of segments 4 and 5 of the thorax; the possession of a comparatively short abdomen, the proportional lengths of the cephalothorax and abdomen being approximately 3 : 1. The presence of only two segments in the abdomen. Only six setae on the last segment of the endopod of the 3rd and 4th swimming legs.

Sub-genus **Tortanus**, nov.**Tortanus** (**Tortanus**) *gracilis* (Brady).

Tortanus gracilis, A. Scott, 1909, p. 190.

Corynura gracilis, Wolfenden, 1911, p. 364.

Tortanus gracilis, Sewell, 1912, p. 377.

Tortanus gracilis, Sewell, 1914, p. 248.

Tortanus gracilis, Früchtl, 1924, p. 86.

Tortanus gracilis, Gurney, 1927, p. 158.

This species is widely distributed throughout Indian waters and has been recorded from the Malay Archipelago (Cleve, A. Scott, Früchtl); the coast of southern Burma (Sewell); the Ceylon Pearl Banks (Thompson and A. Scott, Sewell); the Maldivé and Laccadive Archipelagoes (Wolfenden); the Arabian Sea (Cleve) and the Red Sea (A. Scott). Examples were taken at "Investigator" stations 561, 587 and 591.

***Tortanus (Tortanus) forcipatus* (Giesbrecht).**

Corynura forcipata, Giesbrecht, 1892, p. 525, pl. xxi, figs. 7, 9, 10, 12, 15; pl. xlii, figs. 34, 38.

Tortanus forcipatus, Thompson and A. Scott, 1903, p. 254.

Tortanus forcipatus, Sewell, 1914, p. 249.

Tortanus forcipatus, Früchtl, 1924, p. 85.

Up to the present time the only regions of the Indian area in which this species has been recorded are the Malay Archipelago (Früchtl) and the Pearl Banks of Ceylon (Thompson and A. Scott, Sewell). Examples were taken at "Investigator" Stations 542, 574, 577, 578, 583, 587, 588 and 590.

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

[= *TORTANUS DENTICULATUS* (Giesbrecht).]

Tortanus barbatus, A. Scott, 1909, p. 189, pl. lv, figs. 16-18.

Tortanus barbatus, Sewell, 1912, p. 377.

Tortanus barbatus, Früchtl, 1924, pp. 37, 83; figs. 6-8, 41.

A. Scott (1909, p. 189) from his examination of the examples of this species taken by the "Siboga" in the Malay Archipelago was inclined to regard the forms described under the names *Tortanus barbatus* and *T. denticulatus* as being identical. I was formerly doubtful of the advisability of combining the two forms under one specific name; but the subsequent work of Früchtl has, I think, made it clear that they are in reality synonymous.

The species appears to exhibit a considerable range of variation, not only as regards the presence or absence of the whip-like ends to the spines on the 5th left leg, but also as regards the seta that arises from the outer margin of the right furcal ramus. In his table II (1924, p. 38) Früchtl points out that in the form hitherto regarded as *T. barbatus* the outer seta of the furca was stated to be long, reaching to the end of the ramus, whereas in *T. denticulatus* it was described as being short. In the examples before me, the spines on the margin of the left 5th leg are all long and terminate in hair-like processes; the outer seta of the left furcal ramus is on the other hand invariably short, thus agreeing with the figures given by A. Scott (1909, pl. lv, fig. 16) and Früchtl (1924, fig. 7); in several cases, to wit, three examples from the coast of Burma, which I had before me in 1912, there is in each case a long seta arising from the right margin of the furca, exactly as figured by Früchtl (1924, fig. 7) and reaching nearly to the distal end of the ramus, but in a number of specimens from Port Blair in the Andamans there is no seta on the right margin. The occasional presence of a long seta on the right margin of the furcal ramus, which Früchtl terms "eine lange anormale

(uberzahlige) Borste " is not confined to this species for in two examples of *Tortanus gracilis* from the Burma coast I find the same character. In this latter species in the vast majority of examples the setae arising from the outer margins of the furcal rami are short, equal in length and arise nearly opposite each other ; but in these two specimens the seta on the right side is much longer than that on the left and reaches nearly to the end of the furca, at the same time having its point of origin distinctly proximal to that of the short seta on the left side. It seems clear that no reliance can be placed on this feature as a diagnostic character and I agree with Scott and Früchtl that the two species must be considered synonymous.

Sub-genus **Atortus**, nov.

The species that I refer to this sub-genus all possess a short abdominal region, composed of only two segments and the furcal rami, which are also short and thus afford a great contrast to the elongated furcal rami in the other sub-genus. Of the four species that I include here, the first to be described was *Tortanus recticauda* (Griesbrecht) which was taken in the Red Sea ; A. Scott described two other species, *T. murrayi* and *T. brevipes* from the " Siboga " collections in the Malay Archipelago and I have, in the " Investigator " collection from Nankauri Harbour in the Nicobar Islands, examples of what appears to be a further new species. In both *Tortanus murrayi* and *T. brevipes* A. Scott mentions the presence of a small triangular spine under each eye, visible when the animal is placed on its side and the same spines are present in the new species ; Griesbrecht, however, does not mention the occurrence of any such spines in *Tortanus recticauda* ; so that I am unable to say whether this feature is a sub-generic character, though it appears probable that it is so.

Only the one species has so far been obtained in the " Investigator " collections.

Tortanus (Atortus) tropicus, sp. nov.

(Text-fig. 131, a-g.)

♀ Total length, 2.71 mm.

The proportional lengths of the cephalothorax and abdomen are as 93 to 29, so that the abdomen is contained 3.172 times in the length of the anterior region of the body.

The forehead (text-fig. 131, a) is produced forwards in a rounded prominence, very similar to that of *Tortanus (Atortus) murrayi* A. Scott ; indeed, there is a close degree of resemblance between these two species. The head and 1st thoracic segment are separate, but thoracic segments 4 and 5 are fused together. When viewed from the side a well-marked groove can be seen to pass across the dorsal neck region. The posterior thoracic margins are rounded and devoid of any spines, that on the right side being produced backwards in a wing-like process.

The abdomen consists of only two segments ; segments 1-4 being fused together. Segment 5 is fused with the furcal rami. The genital opening forms a well-marked rounded prominence on the ventral aspect of the anterior abdominal segment. The furcal rami are somewhat asymmetrical, that on the left being distinctly stouter at its base than that on the right. Of the five furcal setae the 2nd is considerably stouter than the others and about twice the length. The outer seta arises from the external margin about two-thirds from the base. The proportional lengths of the parts of the abdomen are as follows :—

Abdominal segment	1-4	5=Furca	
	59	41	= 100.

The 1st antenna reaches back to about the middle of the furcal ramus.

The mandible (text-fig. 131, *b.*) closely resembles that of *Tortanus recticauda*.

The 1st (text-fig. 131, *c.*) and 2nd maxillae closely resemble those of *Tortanus forcipatus*.

The maxilliped (text-fig. 131, *d.*) agrees closely with that of *Tortanus recticauda*, in that there are only two long setae present on the 1st segment; in this respect these two species form a distinct group from *Tortanus forcipatus*, and *T. denticulatus* and *T. gracilis* in which there are four. According to A. Scott, this appendage in *Tortanus murrayi* and *T. brevipes* agrees with that of *T. gracilis*.

In the swimming legs the general structure agrees with that of *Tortanus gracilis*, but the terminal segment of the endopod of the 2nd, 3rd and 4th legs bears only six setae, whereas in all the species of the other sub-genus there are seven.

Unfortunately, in his account of the two species *Tortanus murrayi* and *T. brevipes*, Scott gives no details of the structure of the appendages, with the exception of the 5th pair of legs; he states that in both species the structure of the mouth-parts and swimming-legs is similar to those of *Tortanus gracilis*.

The 5th pair of legs (text-fig. 131, *e.*) are asymmetrical, the appendage of the left side being considerably larger than that of the right. Each consists of a basal segment and a single long free segment or exopod; about half-way along the outer margin of this segment there is a sharp constriction, the distal part from this point on being narrower than the proximal part. Each segment is capped by a long spine and at the extremity of the free segment of the left leg there is an additional small triangular spinous process.

♂ Total length, 2.289 mm. The proportional lengths of the cephalothorax and abdomen are as 72 to 31, so that the abdomen is contained 2.326 times in the length of the anterior region.

The cephalothorax closely resembles that of the female.

The abdomen is composed of 4 segments, that have with the furcal rami the following proportional lengths :—

Abdominal segment	1	2	3	4	Furca	
	20	17	15	12	36	= 100.

The posterior thoracic margins are rounded and symmetrical. The 2nd abdominal segment bears on its right side a posteriorly-directed spinous process. The furcal rami are elongated but symmetrical; they are considerably broader at their distal extremities than at the base. The furcal setae are all of uniform thickness.

The 1st antenna on the right side is, as is usual, modified to form a grasping organ, while that on the left resembles that of the female. In the latter case the proportional lengths of the segments are as follows :—

Segments	1-7	8-11	12	13	14	15	16-17	18-19	20	21	22	23	24-25	
	86	206	52	52	60	74	82	82	70	64	68	70	34	= 1,000

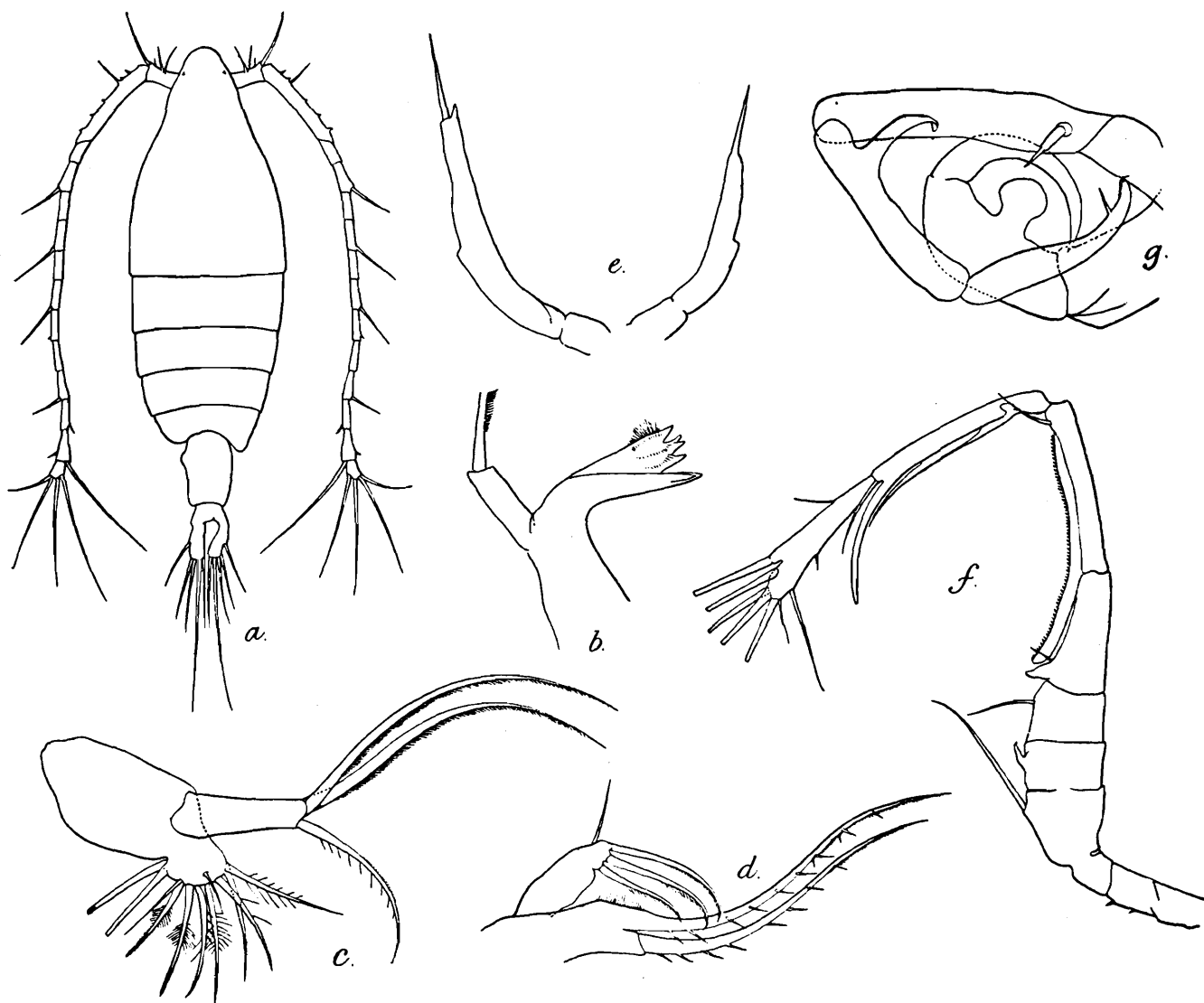
In the grasping antenna (text-fig. 131, *f.*) segments 14-17 are somewhat swollen and segments 15 and 17 each bear a stout spinous process on their anterior margins, that on segment 17 being situated at the proximal end of the joint. Segment 18 bears a very elongated tooth-plate, that is extended proximally along nearly the whole length of segment 17 and comes into close relationship at its extremity with the spinous process on that segment. Segment 19-21 bears two tooth plates that are, however, devoid of any denticulations; the distal

tooth-plate is prolonged for a considerable distance beyond the distal extremity of the segment. The terminal three segments, 22-25, are fused together.

The 2nd antennae, mouth-parts and swimming-legs appear to resemble those of the female.

The 5th pair of legs (text-fig. 131, *g*) closely resembles that of *Tortanus* (*Atortus*) *recticauda* (Giesbrecht). On the left side basal 2 is a short and almost cylindrical segment and is succeeded by a three-jointed ramus of which the 1st segment is considerably longer than either the second or third; a stout seta arises from its inner aspect near the proximal end. The 2nd segment is produced near its base into a long and curved process that is nearly half the length of the segment itself. The 3rd or distal segment is curved and bears at its tip a row of small recurved spines; on the proximal side of this row arises a single small seta. On the right side the 2nd basal segment appears to be fused with basal 1. The free ramus consists of only two segments, segments 2 and 3 being fused together. The 1st segment is considerably thickened and bears on its inner aspect a rounded lobe; segments 2 and 3 together form a curved tapering process.

Examples of this species were taken at "Investigator" Station 614 in the surface tow-net.



TEXT-FIG. 131.—*Tortanus* (*Atortus*) *tropicus*, sp. nov.

a. Whole animal, female, from dorsal side.

b. Mandible.

c. 1st maxilla.

d. Maxilliped.

e. 5th pair of legs; female.

f. Grasping antenna; male.

g. 5th pair of legs; male.

ALPHABETICAL INDEX OF SPECIES.

(New Species and varieties are indicated by an asterisk.)

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