BOMOLOCHUS MULTISPINOSA, SP. NOV.: AN ERGASILID COPEPOD OBSERVED IN COPULATION.

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Eleven mature female Ergasilid parasites were collected from about eight young fishes (*Dussumiera acuta*) during February when several of these were examined for earlier stages of the Lernaepodid *Clavellisa dussumieria*. Each infested fish had two parasites inside its gill covers. It may be noted that though several fishes were examined, not one of the Ergasilid *Bomolochus acuta* collected three months earlier was found. Of the eleven female parasites found this time one had a male attached to the dorsal side of the posterior part of the body. As it has been stated by all authors, including Wilson and Bassett Smith, that the males of Ergasilidae are free-swimming throughout life and that the female copulates only during the free swimming stage, receiving enough spermatozoa to fertilise the eggs she will ever lay as a parasite, this find of a male attached to a female bearing eggs, inside the gill cover of the fish host is of interest. A photograph was taken and a camera lucida drawing was made to show the position and mode of attachment of male to female. As these eleven females and the male differ from all the Ergasilids described up-to-date and since so far the males of only three species of the genus *Bomolochus* have been described, a full description of the male and female of this new species is given in this paper.

Types.—The female holotype bearing the No. $C\frac{2757}{1}$ and the male allotype are deposited in the collections of the Zoological Survey of India. The paratypes are in the collection of the author.

Habitat.—Operculum of the Madras Rainbow Sardine, *Dussumieria acuta*.

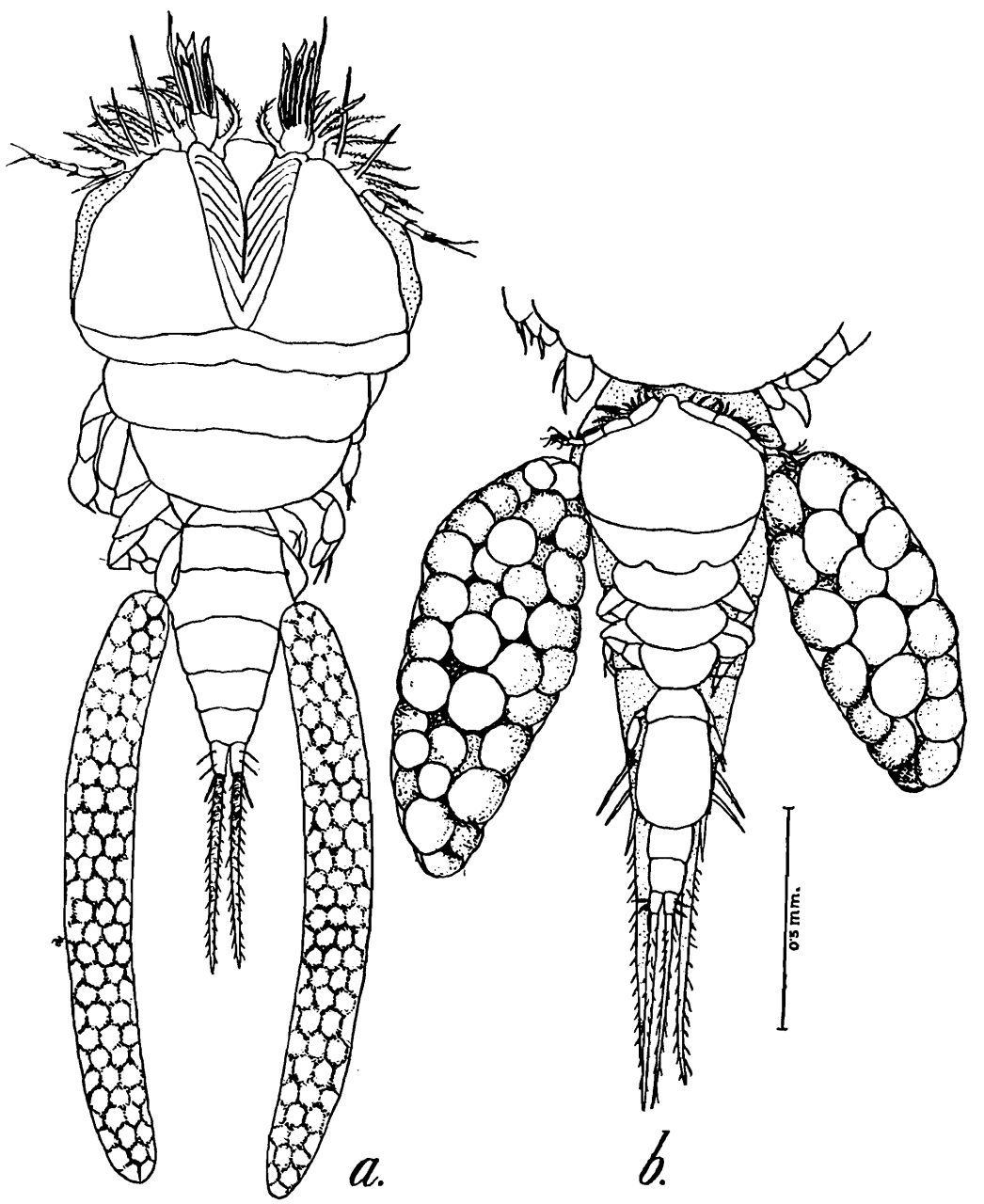
Bomolochus multispinosa, sp. nov.

FEMALE.

Size.—The parasite measured 2·75 mm. long, from the tips of the antennal setae in front to the hind ends of the egg-sacs behind. The widest part of the body, the cephalothorax, measures 0·82 mm. with the free thoracic segments, the genital segments and the abdomen forming the tapering posterior part of the body.

The Carapace or cephalothoracic shield, which is convex above and concave below, has its edge extended ventrally in the antero-lateral regions into a thin flexible hyaline plate which helps in the adhesion to the host. The concavity of the ventral surface appears to be due, as in all species of *Bomolochus*, to a ventral reduplication of the undersurface carrying the maxillipedes to a position anterior to the maxillae and mandibles. The cephalothorax is semicircular in outline being widest

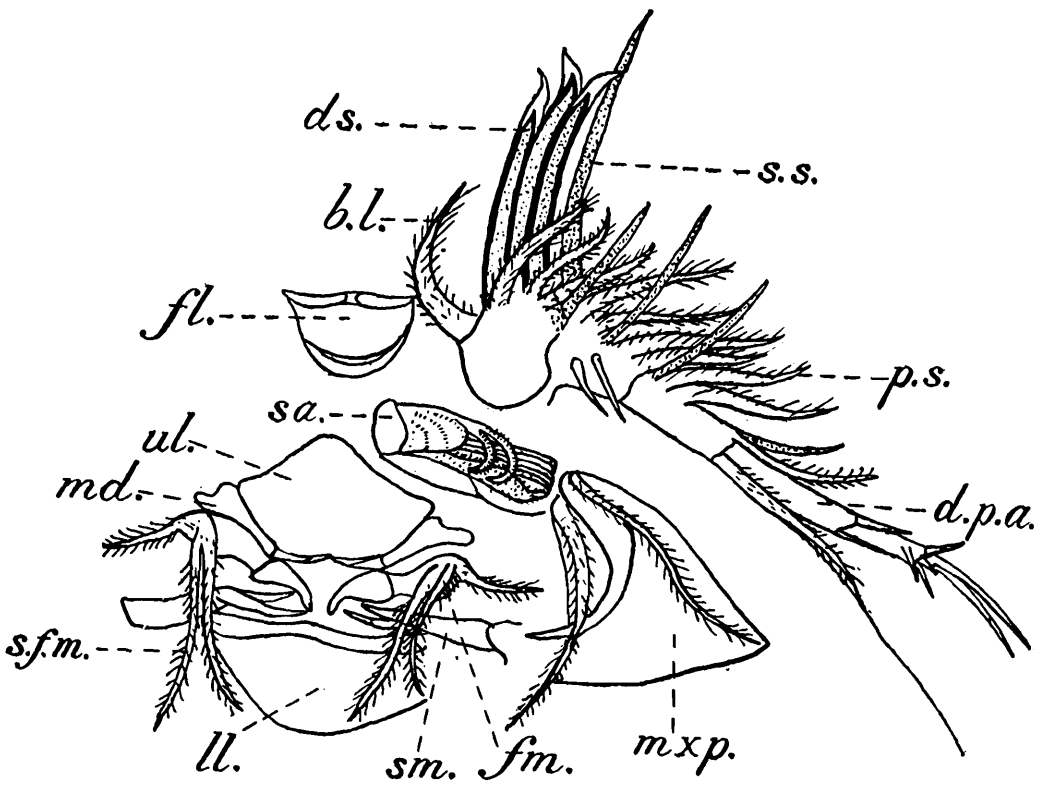
at its posterior margin where the first thoracic segment has fused with it. The frontal margin is re-entrant medially rendering the bases of the



TEXT-FIG. 1. *Bomolochus multispinosa*, sp. nov.
a. Dorsal view, female: × 50.
b. Dorsal view, male, attached to posterior part of the body of female.

antennae conspicuous. To the hind edge of the notch so formed an almost orbicular frontal plate is attached and folded down transversely. The lower free edge is entire. The carapace is marked dorsally by a median furrow running forwards from its hind edge and widening in such a way that the two edges of the furrow form two divergent ridges ending in raised swollen prominences on the frontal margin of the carapace. Medially the furrow opens out into the region of the median eye

and the rostral lobe. Through the thin carapace in this depressed area, the muscles moving the antennae can be seen.



TEXT-FIG. 2. Ventral view of cephalothoracic appendages of female *Bomolochus multispinosa*, sp. nov. : × 200.

bl. basal lobe of first antenna ; *dpa.* distal part of first antenna ; *ds.* digitate spine of frontal cluster ; *fl.* frontal lobe ; *fm.* first maxilla ; *ll.* lower lip ; *md.* mandible ; *mxp.* maxillipede ; *ps.* plumose setae ; *sm.* second maxilla ; *sfm.* setae of first maxilla ; *ss.* sensory spine of frontal cluster ; *sa.* second antenna ; *ul.* upper lip.

Appendages : The most striking feature of the parasite is a cluster of long formidable spines on the *first antenna* which is seven-jointed with distinct constriction of the first or basal joint to bear these four long spines. The outermost spine in the cluster appears to be longest but is of the simple kind occurring elsewhere on the antennae while the others which arise close together appear to be more complex. They have a transparent vitreous outer sheath ending in an accuminate tip with a denser core terminated by a more obtuse tip, a little short of the outer point. If the simple straight spines of the antennae are tactile in function, it is probable that these peculiar spines help in attachment by being inserted into the soft skin lining the inner side of the operculum. There are ten other simple spines in addition to the long one in the cluster and twelve plumose setae, arranged along the remaining six joints of the first antenna. The basal joint bears four long stout curved plumose setae of which the innermost is conspicuous in the frontal region. The succeeding two segments are bent outward as in all species of the genus and make the antennae sweep out to the side in front of the edge of the cephalothorax. These two segments bear six plumose setae curving outwards and forwards and three of the simple setae thrust forwards.

The outer distal edge of the fourth segment bears two plumose setae, one dorsal and one ventral, extending horizontally over and under the next two segments. These two segments are more slender and bear two simple straight spines thrust forward and two other shorter spines thrust outward. The last or terminal segment bears two long spines and four short ones.

The second antenna is three-jointed. The first two joints extend inward while the third, which is rounded, bends the antenna back on itself to bear the fourth joint which points outward. The third joint is covered with minute prickle-like teeth and bears a long claw directed back. The last joint also is covered with such prickles densely arranged on ribbon-like extensions of chitin. Four stout needle-like spines with curved pointed tips are borne by the terminal joint. The labrum is rhomboidal in shape being wider than long and having an obtuse tip in front and behind. The labium is a broad semicircular flap. Both are smooth.

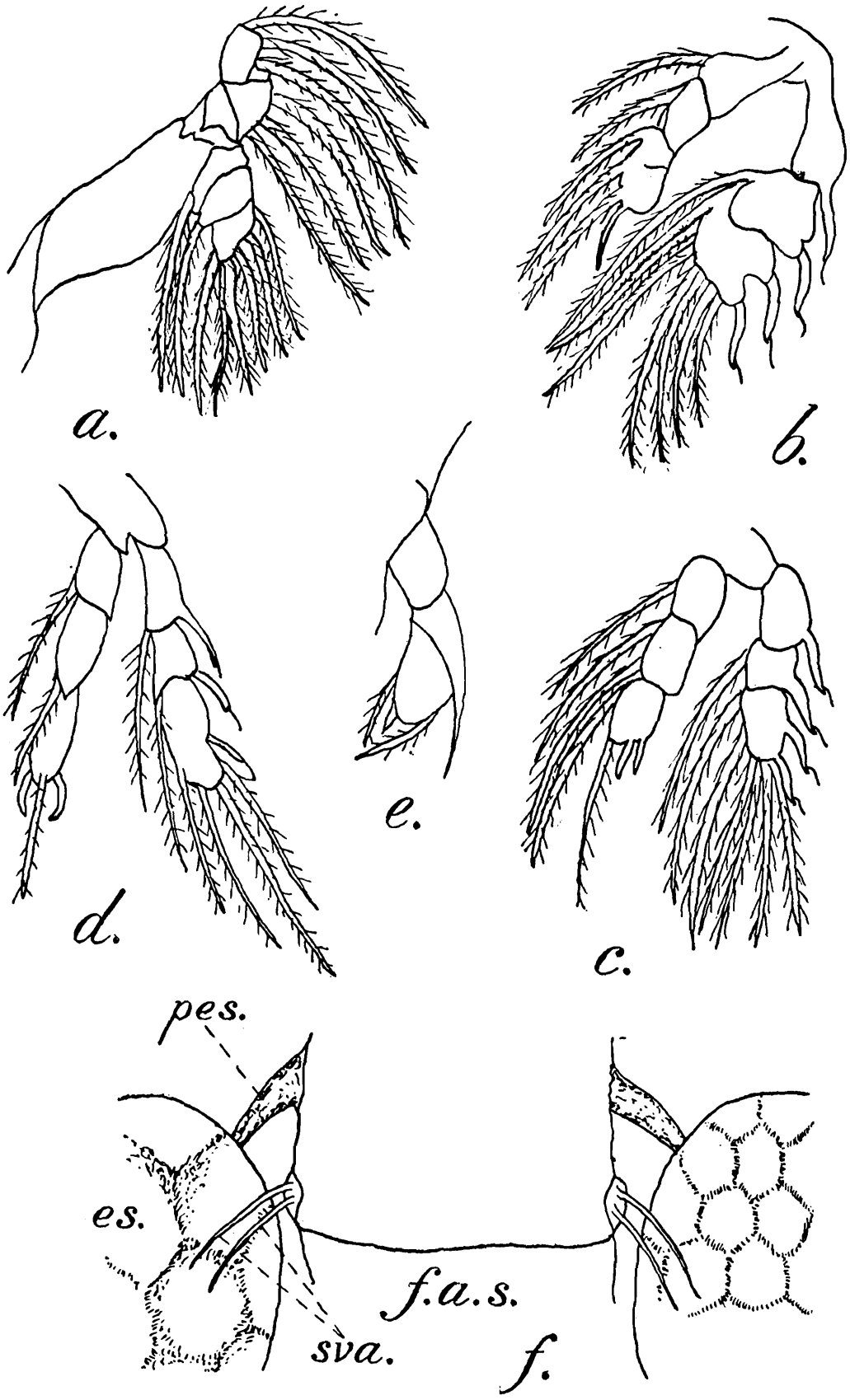
The mandible is four-jointed. The basal joint which forms the attachment is directed backwards and outwards while the second is directed inwards to bear the two single-jointed rami which are sharp-pointed and meet their fellow medially and are free from setae.

The first maxillae are three-jointed ; a basal joint forming the attachment is followed by a short joint and a terminal joint which bears three plumose setae. A two-jointed palp extends close behind the mandible but its distal joint is destitute of setae and directed backwards.

The second maxilla is four-jointed ; the basal joint providing the attachment is bent inward, the middle as well as the two terminal rami also are directed medialward. The rami are single-jointed, sharp-tipped and glabrous.

The maxillipedes are turned forward outside the other mouth-parts. They are three-articled, the basal joint being the longest and the middle joint roughly triangular in shape, bearing at its anterior apex the stout terminal claw. This claw is of a simple curved form and does not have any accessory teeth, but has, at its base, two plumose setae of which the inner is longer and stouter than the one on the outside.

Thoracic segments. A well marked groove indicates the union of the first segment of the thorax. This segment is as broad as the cephalothorax. The second segment is four-fifths as broad as the first. The third thoracic is four-fifths of the second in width but a third longer and has a more convex posterior margin. The fourth segment is less than half the width of the third and about a fourth in length. The fifth is as wide as the fourth segment but nearly thrice as long. The sixth or genital segment is as large as the fifth and bears the two long egg-sacs. The egg-sacs are 1·4 mm. long and 0·25 mm. at their widest. When packed to their fullest capacity they extend about 0·5 mm. behind the tip of the anal setae. They contain six to seven rows of eggs, each row having about 26 eggs. In several of the forms examined, the egg-sacs were partially or wholly empty, only a few had replete egg-sacs. In one



TEXT-FIG. 3. *Bomolochus multispinosa*, sp. nov.

a. first leg. *b*. second leg. *c*. third leg. *d*. fourth leg. *e*. fifth leg. *f*. vestigial sixth leg.

es. egg sac ; *fas*. first abdominal segment ; *gs*. genital segment ; *pes*. peduncle of egg-sac ; *sva*. setae of vestigial appendage.

of the specimens, a large number of the eggs had just hatched, the nauplii emerging independently from the eggs. A microphotograph of this was taken as this differed from Wilson's observation that the "egg tube ruptures in one or two places only and all the nauplii issue through the same opening."

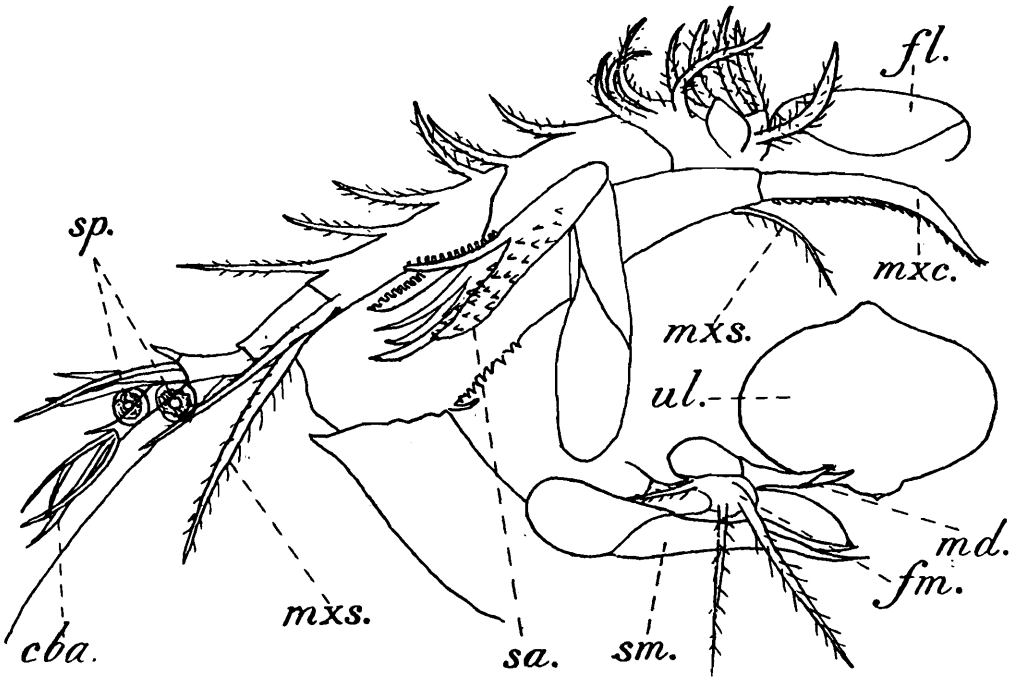
The abdomen consists of three segments of nearly equal length but of decreasing width so that the abdomen tapers posteriorly to half its anterior width. The two anal laminae are as long as the last abdominal segment. Each lamina bears a long stout plumose seta at its tip. This seta is longer than the abdomen and anal laminae put together. At the base of this seta, the posterior edge of the lamina bears a short slender spine. In addition to these, each lamina bears two shorter thinner spines on its outer aspect.

The thoracic appendages. The first swimming feet are biramous. The exopod is biarticulate, both joints bearing three long plumose setae each. The endopod is three-jointed, the first two joints bearing one plumose seta each and the distal joint bearing six. The basal joint is so attached to the median ventral surface that only the tips of the setae are seen dorsally, projecting beyond the carapace. The second, third and fourth swimming feet are biramous and similar. The basipod is single-jointed. The exopods are four-jointed but the last two joints being fused, only three joints are seen. The endopods are three-jointed. The two rami, especially the exopod, bear long plumose natatory setae as well as simple spines. The setae and the spines are distributed as follows :— II Endopod 1—0, 1—0, 3—1, Exopod 0—1, 1—1, 7—2, III Endopod 1—0, 2—0, 2—2, Exopod 0—1, 1—1, 6—2, IV Endopod 1—0, 1—0, 1—2, Exopod 1—1, 1—1, 5—1. The spines on the outer aspect of the exopod are noteworthy because of their taxonomic importance. Each spine is stout and short and acute tipped and bear subterminally a long bristle. The serrate teeth borne by spines of *B. denticulatus* and *B. acuta* are absent. The fifth swimming leg is different from the previous four in being short and uniramous as in all Ergasilids. It is three-jointed; the first joint is short and cylindrical. The next is short and has its distal edge produced into a long external spine, while the third or distal joint is large and stout and bears three long setae. Vestiges of the sixth pair of appendages can be made out on the sides of the genital segment just in front of the attachment of the egg-sacs. Each vestige consists of a swollen papilla bearing two long smooth setae.

MALE.

So far only three males have been recorded among the species of *Bomolochus*. Bassett Smith's description of the male of *B. megaceros* is incomplete and even Wilson's accounts of the males of *B. soleae* and *B. concinnus* leave much to be desired. Hence a full description of the male of *B. multispinosa* is given in this paper. Further, its being found attached to the body of a female already having eggs in its egg-sacs and parasitic within the gill chamber of the fish host, invests this male with special interest, for, its copulation with the female after she had become

parasitic, may turn out to be a usual feature in other species of the genus as well. The male is 1·36 mm. long. the anal laminae and their setae forming nearly a third of this length. The ventral side of the male is applied to the dorsal side of the female which is nearly 2·75 mm. As the anterior border of the body of the male is just over that of the genital segment of the female, the posterior tips of the anal setae of the male extend as far as those of the female. The two creatures were so firmly attached that considerable resistance was encountered when the male was forcibly dislodged by pushing it behind with the tip of a fine camel-hair brush. It is safe to assume that the hold of the male was as secure as that of the female on the fish host. Nevertheless, careful examination of the two *in copula* showed no hooking *over* of the appendages of the male, while a close scrutiny of the ventral surface of the male, after its separation, showed that the mode of adhesion must be as in the female, being specially facilitated by the much longer toothed claw of the maxi-

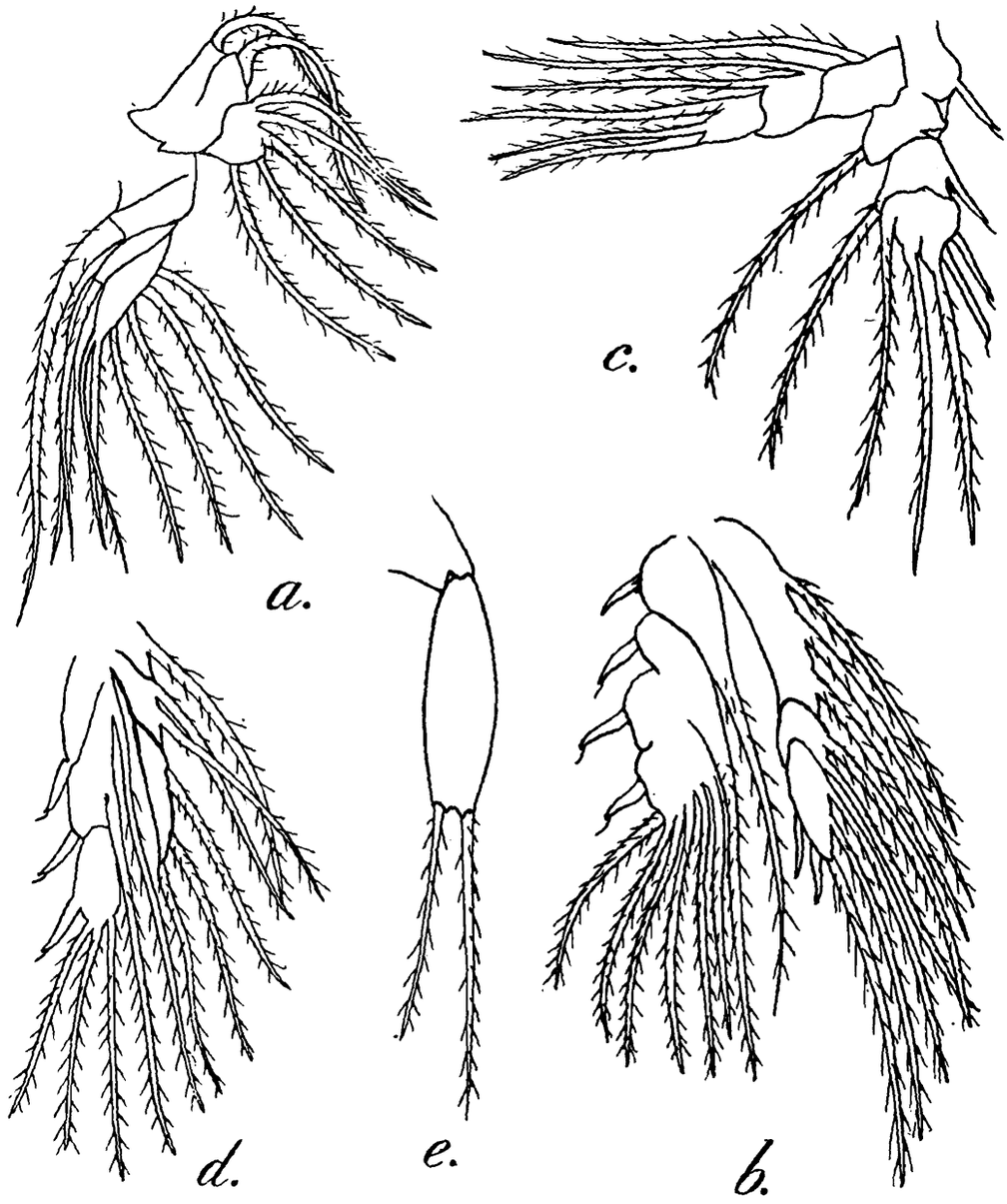


TEXT-FIG. 4. Ventral view of cephalothoracic appendages of male *Bomolochus multispinosa* ; × ca. 470.

cba. clinging bristles of first antenna ; *fl.* frontal lobe ; *fm.* first maxilla ; *mxc.* claw of maxillipede ; *mxs.* seta of maxillipede ; *md.* mandible ; *sa.* second antenna ; *sm.* second maxilla ; *sp.* spermatophore ; *ul.* upper lip.

llipede. The body is much more slender, being only 0·36 mm. broad at the cephalothorax, than in the female. As in *B. solea* described by Wilson, not only are the six segments of the thorax distinct but even the segment which had fused with the cephalon to form the cephalothorax appears indicated by a faint groove. The first thoracic segment behind the cephalothorax is well marked by a distinct groove in front and by a notched edge behind. The second, third and fourth segments decrease in width so that the fourth is only half as broad as the first. This fourth segment is however slightly longer and is marked by a more convex posterior margin. The fifth thoracic segment is of a different form, being narrow in front and wide behind and leads to the wider genital segment.

If the widening of the fifth segment is from 4 to 6 micrometer divisions the genital segment widens from 7 to 9 divisions. The abdomen is two-segmented, the missing third segment is probably indicated by a transverse groove on the first segment. Anteriorly the first segment is only three-fifths of the width of the genital segment. Posteriorly two segments taper behind to half the breadth of this front boundary. The two anal laminae taper still further and bear two long stout stiff plumose setae. In addition, each lamina bears, on its outer aspect, two slender short bristles, and one on its outer posterior edge.



Text-fig. 5. *Bomolochus multispinosa*, sp. nov.
a. first leg of male. *b*. second leg of male. *c*. third leg of male. *d*. fourth leg of male. *e*. fifth leg of male.

Appendages. The first antennae are seven-jointed as in the female and bear the same number of plumose setae but the cluster of four conspicuous spines on the lobe of the basal segment of the female is striking in its absence in the male. Interspersed among the dozen plumose

setae are about five flexible bristles representing the rigid straight simple spines of female. The distal three-segmented part of the antenna is more slender than in the female and bears a number of flexible bristles in the place of spines. There are three short spines, one at the dorsal distal edge of each segment and four long bristles at the tip of the last segment and four at the end of the penultimate segment. The weakly plumose character of the pointed setae, and the clinging character of the bristles of the distal part of the antennae are less suited for swimming than the corresponding structures in the female. The *second antenna* is four-jointed, the first two joints forming a proximal half and the rest forming the distal part. When the male was dislodged, the proximal half was found rotated forward and the distal portion opened outward as shown in figure. The tip of the distal joint bears four sharp curved needle-like setae held between two sheath-like chitinous strips beset with numerous short teeth. The *labrum, labium, mandibles* and the *maxillae* are of the same form as in the female. The *maxillipedes*, however, are the most conspicuous appendages of the male. Proportionate to the size of the body of the male, this appendage is several times larger than in the female. It is probable that it is the organ of adhesion *par excellence* in the male and can hold on the groove in front of the genital segment of the female. It is of three joints. The basal joint which is attached behind the other mouth-parts extends outward and forward so that the second joint which is longest reaches very nearly the front edge of the carapace and extends inwards close to the frontal lobe. The third joint consists of a stout pointed claw whose inner edge is beset with fine teeth. This claw is so long that it extends across the middle line to the opposite side. Thus the maxillipedes, which by the nature of the joints and their length can be swung forwards and outwards beyond the front edge of the body, are well suited for prehension because of their pointed toothed claws. When the prehensile nature of the maxillipedes is considered, along with the feeble natatory character of the setae and the clinging type of bristles of the first antennae, and the adhesive character of the second antennae one doubts their fitness for a free swimming mode of life which has been ascribed to the males by earlier authors.

The other appendages are of the same natatory character as in the female, but are of distinctly weaker build. The first thoracic leg has two, three-jointed rami. The exopod bears a plumose seta, one on each of the two joints and five on its distal joints. The endopod bears nine such plumose setae, six on the distal, two on the second and one on the proximal joint. Both the exopod and the endopods are flattened as in the female. The second thoracic is also flattened but less broad. The exopod is of four segments but owing to the fusion of the last two segments, it appears to be three-jointed. Each exopod joint bears on the outside a short pointed spine provided with a subterminal cirrus. On their inner aspect, the three joints bear seven plumose setae ; the first and second bearing one each and the distal double joint bearing five. The endopod is narrower and longer. It is clearly three-jointed, the proximal joint bears four plumose setae, the middle joint bears two

plumose while the distal joint bears two plumose setae as well as two spines. The third thoracic leg is of the same biramose form. The exopod bears four short stout spines on the outer margin of its three joints and five plumose setae on the inside. Of these the distal joint bears three and the other two joints one setae each. The three-jointed endopod bears six plumose setae, one on the first, two on the second and three on the last. The fourth thoracic leg has an endopod, like the third, but its exopod bears only two of the external spines. The fifth leg is slender, uniramous, two jointed and bears two terminal setae ; there being three joints and three terminal setae in the female is a feature of sexual difference. No trace of the vestigial sixth appendage, present in the female, was observed.

Systematics.

This parasite belongs to the genus *Bomolochus* of the sub-family Bomolochinae. An application of the artificial key Wilson has framed for the species of the genus, brings out the importance of the maxillipedes in being turned forward outside the other mouth parts, their claws not having any teeth or branches, and the claws being of a simple curved form. Further, the frontal margin of the carapace being deeply notched, the basal joint of the first antenna being distinct and heavily armed with stout and digitate spines, the maxillipedes having two large plumose setae, the carapace being but little wider than the first free segment, lead us to two species *B. parvulus* and *B. teres*. But in the second free segment not being swollen and not overlapping the third, the present species differs from *B. parvulus* while in the abdominal joints being of equal size it differs from *B. teres*. The distinctive characters of the four species recorded from the Indo-tropical area, *B. megaceros*, *B. triceros*, *B. denticulatus* and *B. hirsutus*, are such as do not cover the present species which is therefore described as new. The diagnostic features of this species are the presence of over ten simple spines, three stout conspicuous digitate spines, as well as over dozen sharp plumose setae on the first antenna, which is seven-jointed ; the second antennae having four spines ; the mandibles and second maxillae being biramous ; the first maxilla having three plumose setae ; the maxillipedes having a simple claw with two plumose setae ; the fourth free thoracic segment forming a narrow waist ; the genital segment being broad and long ; the egg-sacs being long slender containing nearly 23 eggs in a row ; the anal lamina having a single terminal seta ; the abdomen having three equal joints in female, two in male ; and the fifth leg being three-jointed in female, two-jointed in male.

References.

Bassett-Smith, P. W., 1898.—A systematic description of parasitic copepods found on fish with an enumeration of the known species. *Proc. Zool. Soc. London*, pp. 438-507.

———1898.—Some new parasitic copepods found in fish at Bombay. *Ann. Mag. Nat. Hist.* (7) I, pp. 1—17.

Bassett-Smith, 1898.—Further new parasitic copepods found on fish in the Indo-tropical region. *Ibid.*, pp. 77-98.

————1898.—Some new or rare parasitic copepods found on fish in the Indo-tropical region. *Ibid.* II, pp. 357-372.

Brian, A. 1906.—Copepod parassiti der Pesci d'Italia. Genoa.

Gnanamuthu, C. P. 1948.—*Bomolochus acuta* n. sp. A copepod parasitic on the gills of *Dussumieria acuta*. *Proc. Ind. Acad. of Sci.* XXVII, pp. 18-25.

Heller, C. 1868.—Zoologischer Thiel, Zweiterband. III. Crustacea Wien, pp. 1—280.

Scott, T. A. 1913.—British Parasitic Copepods, 2 vols. *Ray Soc. London.*

Thompson, I. C. & Scott, T. A. 1903.—On copepods. *Rep. Pearl Oyster Fisheries, Ceylon. London*, pt. I, p. 293.

Wilson, C. B. 1922.—North American Ergasilidae. *Proc. U. S. Nat. Mus.* XXXIX, pp. 263—398.