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SPRATELLOIDES DELICATULUS (BENNET) AS A POTENTIAL LIVE-BAIT FOR TUNA IN THE LACCADIVES

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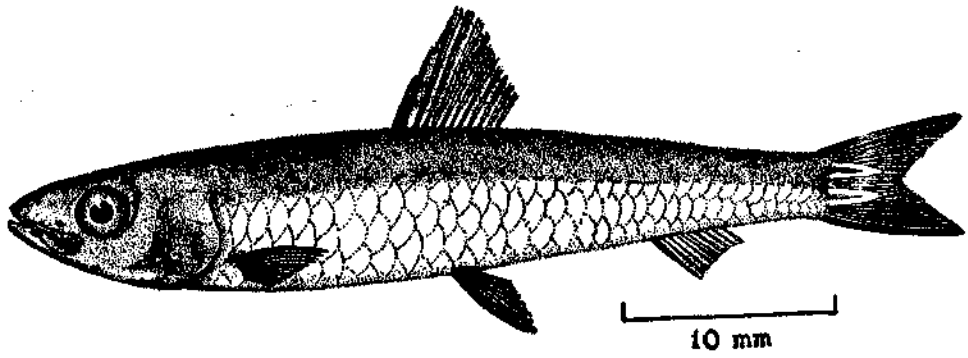
TUNA fishing on an organised scale exists only in Minicoy among the islands of the Laccadive Archipelago (Jones & Kumaran 1959). Though the oceanic skipjack, *Katsuwonus pelamis* is widely distributed in the Laccadive Sea, a fishery for it is non-existent in any of the other islands. One of the reasons attributed for this is the absence of suitable baitfish in the lagoons of these islands while the Minicoy Lagoon abounds in a variety of small fishes which are caught and utilised for the purpose (Jones 1958).

During the third cruise of R.V. *KALAVA* in the Laccadive Sea (Jones, 1959) the vessel was anchored just outside the reef at Bitra (Lat. 11°. 38′ N. Long. 72°. 13′ E) close to Station No. 445 on the night of 27-4-1959. The anchorage was about a mile from the island in about 7 fathoms of water. As darkness set in and the ship's lights were switched on the whole sea around became live with millions of small fish which actively darted about on the surface. Wherever the search light was directed the congregation became most dense and the fish leapt about in a state of frenzy with their silvery sides shimmering in the light. It was a most remarkable sight the like of which was not seen previously by any on board the vessel. This activity continued as long as the lights were on in spite of intrusion by other fishes.

Several samples were collected with scoop nets and it was found that they comprised of the white bait, *Spratelloides delicatulus* (Bennet) (vide text-figure). The range in length was from 31 mm. to 51 mm. Some specimens kept alive in a bucket with occasional change of water remained in good condition for over 36 hours after which they were accidently lost.



Spratelloides delicatulus (Bennet) from the Laccadiva Sea

On the next day (28-4-1959) the ship proceeded to Agathi and was anchored outside the reef (Lat. 10°. 51′ N. Long. 72°. 28′ E) for the night. There, only stray specimens of *S. delicatulus* were collected near the light along with other fishes

and the abundance was in no way comparable to that at the Bitra Anchorage on the previous day. This species has not been collected so far from the vicinity of any of the other islands in the Laccadives.

Spratelloides delicatulus (=*Stolephorus delicatulus*) is one of the Dussimeridae growing to about 8 cm. with a fairly wide distribution in the Indo-Pacific, having been recorded from South Africa, Mauritius, Indonesia, Philippines, Samoa, Australia and in the Central Pacific Region in and around the Hawaiian Islands. June and Reintjes (1953) refer to its occurrence in large numbers in the Leeward Islands where it could be captured by means of a lift-net after attracting the fish with a submarine light and recommend the species as an excellent live-bait for pole and line fishing.

There does not appear to be any previous record of it from Indian waters. The specimens from the Laccadive Sea show the following meristic variations : D.ii, 10-11 ; P_1.i, 11-12 ; P_2. ii, 9 ; L.l. 35-38 ; Predorsal scales 10-11 ; gill-rakers on the lower limb of outer arch 24-29. Larval and juvenile stages of this collected from there are being described elsewhere.

In the Pacific various clupeoid fishes of the families Stolephoridae and Engraulidae are used as live-baits for skipjack fishing. The most important among these are *Cetengraulis mysticetus* in the Eastern Tropical Pacific from Mexico to Peru, *Engraulis japonicus* in Japan, and *Stolephorus purpureus* in Hawaii. In the Indian Ocean, live-baits are used for tuna fishing only in the Maldives and in Minicoy in the Laccadives, where they consist of a variety of nonclupeoids collected from the lagoons. It will therefore be interesting to study the extent of availability of *Spratelloides delicatulus* in the Laccadive Sea and experiment on its suitability as a bait-fish for tuna fishing.

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STUDIES ON INDIAN COPEPODS I. *PARALEPEOPSYLLUS MANNARENSIS*, A NEW GENUS AND SPECIES OF CYCLOPOID COPEPOD FROM THE GULF OF MANNAR*

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THOMPSON and Scott (1903) in their supplementary reports of the faunistic survey of the Pearl Oyster Fisheries of Ceylon reported on a number of copepods, many of which were new to science. Two of the new species, *typicus* and *ovalis*, both belonging to the genus *Lepeopsyllus*, which was also newly erected, were remarkable in their general resemblance to the members of the harpacticoid family Peltidiidae, especially in the shape of the body, in the posteriorward growth of the last prosomal segment and the complete overlapping of the urosome by the latter so that when viewed dorsally only the caudal rami are visible besides the prosomal region. A flattened oval or circular body as seen in *Lepeopsyllus* Thomp. and Scott is shared by many other cyclopoids and the prosomal segments may exhibit varying degrees of expanded growth posteriorly or laterally. But in all such instances the urosome is never fully covered over by the prosome. In *Lepeopsyllus*, however, the last prosomal segment grows over the urosome so that the latter is hidden by the former. Nevertheless a study of the various appendages of this copepod shows beyond doubt that it is a siphonostomous cyclopoid, very much related to dyspontiids, and understandably Thomspon and Scott placed this genus under Asterocheridae of Giesbrecht which in fact is included in the Siphonostoma by Sars (1918) wherein he groups together all those cyclopoids having a siphon in the oral region. Wilson (1932) included the genus *Lepeopsyllus* under the family Dyspontiidae Sars, and placed it very near *Dyspontius* Thorell and *Cryptopontius* Giesb. Nicholls (1944) follows Wilson and treats it in the same way. In his brief systematic review of the different genera that should be included in the family Dyspontiidae, he states that *Lepeopsyllus* Thomp. and Scott is 'recognisable as belonging to this family', with no further comments. In a latter part of this paper I have tried to draw attention to all the distinctive characters of this genus which distinguish it from a typical dyspontiid. The very close affinities that exist between *Lepeopsyllus* and the present form described below, and their distinctness from all other cyclopoids in certain important morphological features appear to suggest the creation of a new sub-family or family for their reception ; this point is considered later (*vide infra*).

Paralepeopsyllus Gen. Nov.

Body thin, scale-like, oval or circular ; prosome 3-segmented and urosome 4-segmented in both sexes ; in the female, however, the first two proximal segments may be only partially separated; the urosome is completely overlapped by the

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last prosomal segment ; the margin of all the prosomal segments thickly lined with papilla-like prolongations of irregular lengths, forming an ornamentation. Antennule 14-segmented in female, 12-segmented and geniculate in male. Antenna 5-segmented, the last segment carrying terminal spines ; the second segment carries a rudimentary endopod provided with terminal setae. Siphon rather short and shield-shaped, hardly reaching about two-third the length of first prosomal segment. Mandible consists of a thin linear blade and a 1-segmented palp carrying two terminal setae of unequal length. Maxillule with a bimerous basipod and two palpi of unequal length, both carrying tufts of setae at the apex. Maxilla 1-segmented, strongly built and carrying a stout terminal claw. Maxilliped 5-segmented and strongly built, the last segment having a strong apical claw. There are only three pairs of swimming legs ; the first and second pairs biramous and the last pair uniramous ; the rami of all the legs are 3-segmented. Caudal furca moderately divergent and cylinderical. Eggs carried in two ovisacs, attached on either side of the genital segment and covered over by the last prosomal segment.

Genotype : *Paralepeopsyllus mannarensis* sp. nov.

Paralepeopsyllus mannarensis sp. nov.

Material examined : In the first week of August, 1960 eight females and five males of this copepod were obtained from the sponge washings from the Gulf of Mannar off Vedalai. None of the females in this collection was carrying egg-sacs. In the last week of the same month two egg-carrying females were obtained from the same locality, but this time from crinoid beds.

The generic name of the present species refers to its systematic relationship and the specific name to the locality of occurrence. The holotype, the allotype and the paratypes are deposited in the Reference Collection Museum of the Central Marine Fisheries Research Station, Mandapam Camp and bear the registered numbers J. 525/3, J. 526/3 and J. 527/3 respectively. All the drawings have been made with the aid of a camera lucida and the description and the diagrams are based on the examination of many specimens.

Description.

FEMALE

Colour. Freshly captured individuals were transparent with beautiful shining ornamentations along the prosomal margins. Formalin preserved specimens became opaque with a pale yellowish tinge ; darker shades are present along the thickened areas. *Body.* (Fig. I, 1)—The body consists of the prosome and the urosome but the latter is entirely hidden beneath the former which actually accounts for the whole size of the animal. The prosome is oblong-oval with a clear rostral prominence on the anterior side. It consists of only three segments, the margins of all of which are greatly ornamented with papilla-like growths. The ornamentation of one lateral half roughly corresponds to that of the other half. The ornamented area appears to be thicker than the non-ornamented part. The first prosomal segment is much larger, both in length and width, than the other two segments combined. The second segment is broader than the third but distinctly shorter than the latter ; it is rather crescent-like with the two lateral edges much

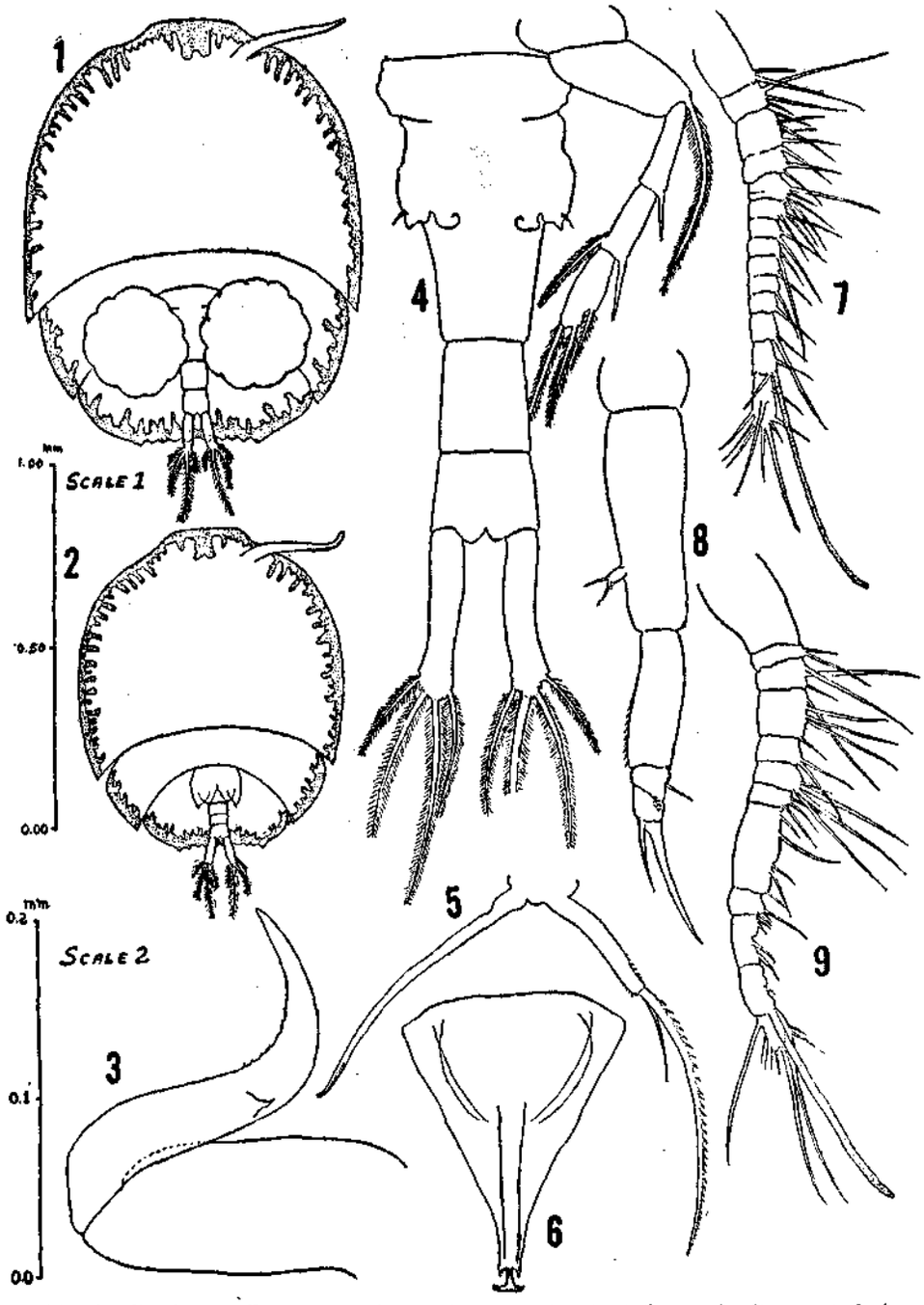

FIG. 1. *Paralepeopsyllus mannarensis* gen. et. sp. nov. 1. Adult female, habitus, ventral view. 2. Adult male, habitus, ventral view. 3. ♀ Maxilla. 4. ♀ Urosome with left third leg. 5. ♀ Mandible. 6. ♀ siphon. 7. ♀ Antennule. 8. ♀ Antenna. 9. ♂ Antennule. (The habitus of the adult male and female are drawn to scale 1, and all the appendages to scale 2).

thickened ; the ornamentation of this segment is broken from that of the first segment but appears to be continuous with that of the following segment. The last prosomal segment has a peculiar shape, with the highly convex anterior margin fitting into the concavity of the preceding segment and with the posterior margin being wavy ; the two lateral sides smoothly curve down to the posterior wavy margin which is less than half as long as the widest part of the same segment ; in the case of this segment the ornamentation is present both on the lateral and the posterior borders. The urosome consists of a genital segment and two abdominal segments ; the former, however, shows a partial division into first urosomal segment which in the related genus, *Lepeopsyllus*, bears the fifth pair of legs and the genital segment proper. It is longer than the two abdominal segments combined ; the genital segment proper exhibits a proximal wider and a distal narrower regions, a spine on either side being present at about the junction of the two. The genital segment carries a pair of ovisacs, one on each side. Of the two abdominal segments the proximal is the larger but they are of equal breadth. The last abdominal segment bears a pair of caudal rami which are cylindrical, rather elongated and slightly divergent. Each of them bears four setae of unequal lengths, the longest of them being only a little longer than the ramus itself.

Antennule (Fig. I, 7)—Compared with the size of the body the antennule is rather small and consists of fourteen segments. The first five segments as a whole, are distinctly wider than the next nine and the fifth segment shows a partial division. While the segments 6-11 are subequal, other segments are of varying lengths, with the first segment as the longest. All the segments are provided with setae, often many of them on a single segment. But the arrangement of the setae does not appear to give any clue to the number of original segments that would have fused together in the formation of the present condition. The thirteenth segment bears a fairly long aesthetask. The proportionate lengths of the antennular segments are as follows :

1	2	3	4	5	6	7	8	9	10	11	12	13	14	
16·4	6·5	10·0	5·3	6·4	4·7	4·7	4·4	4·7	4·1	5·0	7·3	8·2	12·3	= 100

Antenna (Fig. I, 8). This is 5-segmented. The basal two segments form the basipod and the next three segments the endopod ; the exopod is represented by a bud-like structure that arises from anterior margin of the second basipod segment ; the first basipod segment does not bear any accessory structure. The first endopod segment is devoid of any seta or spine but are provided with very small spinules along its distal anterior margin ; second endopod segment bears a slender spine on its posterior margin and the last segment two terminal spines of unequal length ; there are a few small spinules arranged obliquely along its length on this last segment. *Siphon* (Fig. I, 6). This is rather short and pyriform, hardly reaching the two-third length of the first prosomal segment. Its distal part is very narrow, about one-tenth of the wide proximal. The former bears a club-shaped structure at the middle of its concave tip. *Mandible* (Fig. I, 5). Consists of a masticatory blade and a palp which is less than half the length of the former ; the palp has its distal one-third margin ciliated and bears two terminal setae ; one of the setae is slender and short while the other is quite large, equal in length to the masticatory blade and bearing sharp spinules along its entire length on one side. The masticatory blade is slender and long, the thick basal part gradually diminishing in width to the distal tip which is serrated. *Maxillule* (Fig. II, 10). Is composed of a basipod which is indistinctly divided into two segments and a pair of lobes arising from it. One

of the lobes is much larger being about two and a half times thicker and longer than the other ; the former bears four setae which are graduated in length and the latter five setae of varying lengths. Along the inner margin of the larger lobe there is a row of spinules. *Maxilla* (Fig. I, 3). Maxilla is peculiar in being uniarticulated with no trace of division. It is large, cylindrical and devoid of any seta or spine except the terminal claw ; the latter is very large and stout and has a characteristic shape in the form of a reversed ' S '. There are a few minute spinules on its distal inner margin and a separate miniature claw just beyond its middle bent. *Maxilliped* (Fig. II, 11). Fairly large and consists of five segments, the fifth segment bearing two terminal spines, one of which is much larger than the other. The segments are uneven in their lengths ; second segment is the largest and the fourth the smallest ; the latter bears a small spine on its inner margin.

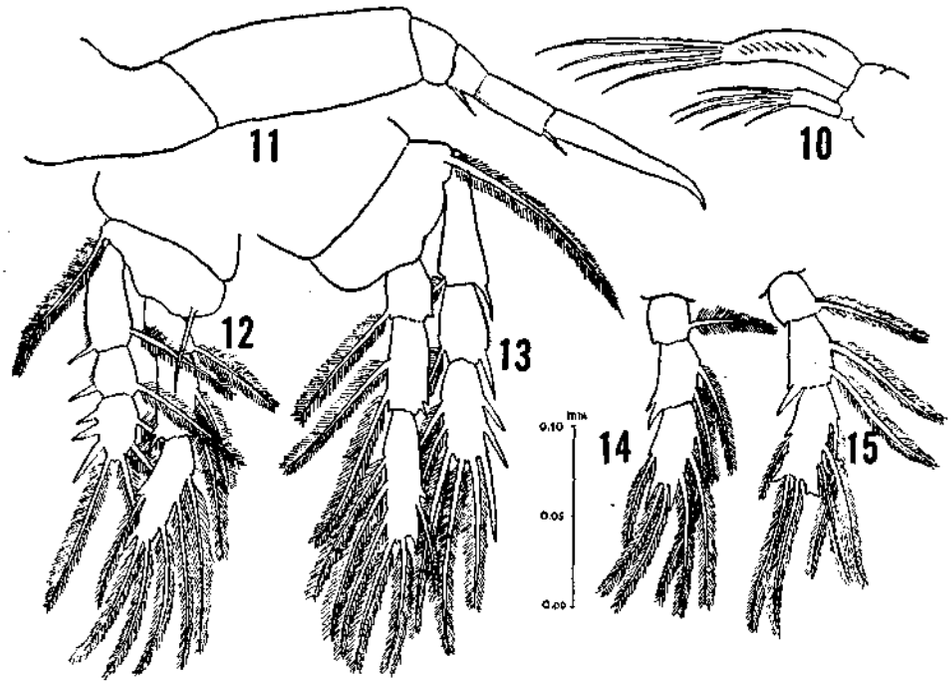

FIG. II. *Paralepeopsyllus mannarensis* gen. et. sp. nov. (contd.) 10. ♀ Maxillule. 11. ♀ Maxilliped. 12. ♀ First swimming leg. 13. ♀ Second swimming leg. 14. ♂ Endopod of first swimming leg. 15. ♂ Endopod of second swimming leg.

Swimming legs (Fig. II, 12, 13). There are only three pairs of swimming legs. Fourth and fifth legs are entirely lacking. They are borne by the three prosomal segments. The first two pairs of legs are biramous while the third is only uniramous. Each ramus is composed of three segments. In the first two pairs of legs, constituting segments are rather elongate ; even when it is short, the segment is distinctly longer than wide. In the first leg the exopod is shorter than the endopod while in the second leg the reverse situation is true. The basipods in both cases are stumpy and broad, the first basal bearing no setae or spine and the second basal bearing one

seta and one spine in the case of first pair of legs, and one seta alone in the case of second and third pairs of legs. In the third leg the endopod is entirely lacking; the exopod is rather slender, the segments subequal; in the basipod the basal one is short and broad while the basal two is quite long bearing the exopod almost at right angles to its length. The setal formula for the swimming legs is given below:

Following Sewell (*loc. cit.*) I have used Arabic numerals to indicate setae and Roman numbers for spines.

	Basipod				*Endopod*							*Exopod*						
	1		2		1		2		3			1		2		3		
	Si	Se	Si	Se	Si	Se	Si	Se	Si	St	Se	Si	Se	Si	Se	Si	St	Se
P^1	0	0	1	1	1	0	1	0	3	2	1	1	1	1	1	3	1	III
P^2	0	0	0	1	1	0	2	0	3	2	1	1	1	1	1	3	2	III
P^3	0	0	0	1	Absent							0	1	1	1	0	1	I+1

The absence of the fourth pair of legs is the consequence of the absence of fourth prosomal segment. However, the fifth legs also are entirely lacking although the fifth leg-bearing segment is present in partial union with the following genital segment. The length of the female is 1·2 mm.

MALE

The male (Fig. 1, 2) is much smaller than the female and shows sexual dimorphism in the structure of antennule, urosome and in the endopods of first and second pairs of legs. The urosome is clearly 4-segmented; the first of these segments is the result of the fusion of the original fifth leg-bearing segment and the genital segment. The next three segments constitute the abdomen and are postgenital in origin. The first segment is three times wider and three times longer than the abdominal segments combined. It is barrel-like and carries a pair of spines on each of its posterior corners. The abdominal segments are subequal, the last of them bearing the caudal rami. The latter in male appears to be as long as the last two abdominal segments combined, while in the female it is definitely shorter.

Antennule (Fig. 1, 9). Is geniculate and consists only of twelve segments. First segment is the largest and may be compared to the corresponding segment in the female. The last two segments also are comparable to their female counterparts for, the penultimate segment here also bears the aesthetask. The identity of other segments are not clear. All the segments are provided with setae, while segments 9-11 also carry a few spines. The proportionate lengths of the various segments are given below:

1	2	3	4	5	6	7	8	9	10	11	12
17·7	3·8	5·5	9·1	5·3	4·8	4·3	16·8	5·0	10·0	10·0	7·7 = 100

The variations in the structure of the endopods of the male first and second legs (Fig. II, 13, 14) are not very profound. In the first endopod it consists in the presence of spinous growths on either distal corner of the third segments while in the female this spinous process is present only on the outer corner. In the second endopod the male has its distal corners of the third segment produced into peculiar structures, the outer of these is conical and serrated on the outer margin while the inner is irregular ; in the female there is no structure corresponding to this latter ; but the outer conical process is the counterpart of the spine in a similar position in the female.

Discussion

There are a number of characters which the present genus shares with the genus *Lepeopsyllus* Thom. & Scott. Some of these are peculiar to these two genera while some other features are exhibited by the members of one or other related families. The characters shared by these two genera are indeed substantial, the most notable of them being the exceedingly large development of the prosomal segment, especially the last one. The nearest approach to this condition is apparently met with in the genus *Micropontius* Gooding, 1957 (Family Micropontiidae). But the differences between *Micropontius* on the one hand and *Lepeopsyllus* and *Paralepeopsyllus* on the other, are too many to establish any real relationship between them. Among other siphonostomous cyclopoids an expanded growth of the prosomal segments is possessed, to some extent, by the members of the families Dyspontiidae, Artotrogidae and Cancerillidae ; but in all these cases the last prosomal segment always remains small and inconspicuous. However, in the genus *Discopontius* Nicholls, 1944 (Dyspontiidae) the prosome is very large and the last prosomal segment grows posteriorwards, covering not only the first urosomal segment but also a part of the genital segment. This tendency of *Discopontius* to a backward development of the last prosomal segment seems to indicate a genuine kinship with *Lepeopsyllus* and *Paralepeopsyllus*, for there are a number of other features which also point to this conclusion.

In *Lepeopsyllus*, the prosome is 4-segmented, each segment bearing a pair of swimming legs. First segment is far larger than the entire remainder of the body ; next in size comes the last segment which, although only half the size of the first segment, still constitutes a major part of the body and grows over the urosome, fully covering the latter ; second and third segments are rather thin strips, inserted between the first and the last segments. In *Paralepeopsyllus*, a similar situation exists, but the process of reduction has gone still further with the result that there are only three segments in the prosome, each bearing a pair of swimming legs. In size, the first segment remains the largest, accounting for more than half of the body, while the last segment is the next larger and covers the entire urosome dorsally ; the second segment forms a crescent-shaped strip of body between the first and the third segments.

The marginal ornamentation of the prosomal segments also deserves some comments : this character is peculiar to these two genera among the cyclopoids ; a nearest comparable feature found among other genera, such as *Micropontius*, is the thickening of the edges and margins of the prosomal segments. Both are probably for imparting strength to the region, but their morphological history appears to be different. Another character not usually known for the siphonostomous

cyclopoids but is noticed in the present genus is the slight structural modifications of the first and second swimming legs of the male. The terminal segment of the endopods of these legs exhibits an expanded development as is described in an earlier part of this paper. Unfortunately this point cannot be discussed as the male is yet to be known for the related genus, *Lepeopsyllus*.

It has been pointed out earlier that both Wilson (*loc. cit.*) and Nicholls (*loc. cit.*) have included *Lepeopsyllus* under Dyspontiidae. One should presume that this was done so only because of the absence of a different family suitable for its reception, rather than by its agreement with the genuine features of a typical dyspontiid. In dyspontiid, the antennule consists of a reduced number of segments and is not divided into a proximal wider and a distal narrower region, except in *Discopontius* where the first two segments are distinguished from the rest by their larger size. In fact, the division of antennule into a proximal wider and a distal narrower region is a condition usually found in Asterocheridae. Further, the geniculate male antennule of the members of Dyspontiidae contains usually an equal or a larger number of segments than the corresponding structure of the female. But in Asterocheridae and in the present genus the reverse is true, namely, the geniculate male antennule is composed of a smaller number of segments than the corresponding organ of the female sex. The structure of the antenna is still more striking. It is 5-segmented both in *Lepeopsyllus* and *Paralepeopsyllus* (although Thompson and Scott state that it is 4-segmented, their diagrams clearly show 5-segments) as it is in most of the asterocherids, while in all dyspontiids it invariably consists of four or less number of segments. The resemblance of these two genera with asterocherids in the structure of the antenna becomes complete when one takes into account the proportionate lengths of the constituting segments. In these forms, the second segment which bears rudimentary exopod is the largest, being equivalent to or larger than the combined size of the next three segments ; while the third and first segments come next in order of size, the last two segments are extremely small and subequal ; the terminal segment bears one or more strong spines. In dyspontiids the last two segments are never so small compared to the size of other segments. Further, although the second segment is still the largest, it is not equal to or longer than the combined length of the two following segments, the only exception, again, being *Discopontius* Nicholls.

It may be noted that the genus *Paralepeopsyllus* tends to exhibit certain similarities with the Artotrogidae and Cancerillidae, especially in the reduction of the posterior pairs of legs. The Artotrogidae differs from Dyspontiidae essentially in the total absence of the fourth pair of legs, in this respect approaching the Cancerillidae ; the latter is, however, distinguishable very easily by the enormous development of antennae which are unlike those in any other siphonostomous family. The reduction in the number of legs, however, need not be taken as a close relationship between *Paralepeopsyllus* and Artotrogidae, for they are quite separated in many other morphological features.

This tendency has been prevalent even in Dyspontiidae where the fifth leg is highly reduced in all the genera ; and the endopod of fourth leg is entirely lacking in a number of genera such as *Dyspontius* Thorell, 1859, and *Cryptopontius* Giesbrecht, 1889, while in some others like *Bradypontius* Giesb. 1895, *Arctopontius* Sars, 1915, *Discopontius* Nicholls, 1944, *Sestropontius* Giesb. 1899, *Metapontius* Hansen, 1923 and *Cribropontius* Giesb. 1899 the endopod is reduced in size. In

the genus *Pteropontius* Giesb. 1895 not only is the endopod of fourth leg absent but the rami of the first legs are only 2-segmented, thus exhibiting a tendency for the reduction of other appendages also. It may be only contended that this tendency for a reduction in the number of the swimming legs or their constituting segments has been present in the evolution of different groups of siphonostomous cyclopoids.

Thus it appears clear that the genera *Lepeopsyllus* and *Paralepeopsyllus* constitute a natural group, sharing many peculiar features distinct from those of all other siphonostomous cyclopoids. These two genera retain many characters of the family Asterocheridae found in such structures as the antennule and the antennae and combine them with those of the family Dyspontiidae. However, this is a little known group ; *Lepeopsyllus* is known only from two species, *typicus* and *ovalis*, both based on one or two individuals and *Paralepeopsyllus* is a monotypic genus. Until more species and genera related to these are known it would probably be unfair to erect a new family for accommodating them, although their distinctness is clear enough.

Discopontius referred to above may also be briefly considered here. As pointed out earlier this genus deviates from the definition of typical dyspontiids in a number of ways : (*a*) in the tendency of the prosomal segments to grow posterior-wards over the urosome ; (*b*) in the apparent division of antennule into a wider proximal and a narrower distal region ; and (*c*) in the proportionate lengths of the antennal segments. In all these features the genus tends more towards *Lepeopsyllus* and *Paralepeopsyllus* than to any other member of the family Dyspontiidae. Probably these three genera are not true dyspontiids at all ; or the family Dyspontiidae need to be redefined to include them all.

Summary

Paralepeopsyllus mannarensis, a new genus and species of cyclopoid copepod is described in detail ; it is an inshore-dwelling form, living in association with invertebrates such as sponges and crinoids ; the species is known from both the sexes.

The genus is related to *Lepeopsyllus* Thompson & Scott and its systematic position is very near to that genus. The very close affinities that exist between these two genera and their distinctness from other cyclopoids appear to justify their inclusion in a separate family. The arguments in favour of and against this postulation are discussed.

Acknowledgements

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