

Morphology of the copepodid stage of three marine lernaeopodids (Crustacea : Copepoda) from the South-West Coast of India

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Abstract. Full illustrated descriptions are presented of the copepodid stage of *Pseudocharopinus narcinae* (Pillai), *Isobranchia appendiculata* Heegaard and *Brachiella trichiuri* Gnanamuthu. The structure of the copepodid of *P. narcinae* is similar to that of *P. dentatus* (Wilson). The copepodids of both *I. appendiculata* and *B. trichiuri* are identical with regard to the structure of the second antenna, first maxilla and second maxilla. This structural similarity of the copepodids of *I. appendiculata* and *B. trichiuri* indicate the phylogenetic position of the *Brachiella* and *Clavella* groups within the family Lernaeopodidae.

Keywords. Copepodid stage ; lernaeopodids ; copepoda ; *Pseudocharopinus narcinae* ; *Isobranchia appendiculata* ; *Brachiella trichiuri*.

1. Introduction

Adaptation to a parasitic mode of life has affected the life cycle of lernaeopodid copepods in such a way that the free swimming period is considerably shortened. In most cases, this stage is represented by the copepodid. So far, ontogenetic studies on lernaeopodids have been mainly confined to freshwater genera like *Achtheres* (Nordmann 1832; Claus 1862, Wilson 1911), *Basanistes* (Kollar 1835), *Tracheliastes* (Nordmann 1832; Vejdovsky 1877) and *Salmincola* (cf. Friend 1941; Kabata and Cousens 1972). Relatively little attention has been paid to the larval stages of marine Lernaeopodidae especially of the Indian seas. Among the marine lernaeopodids free-swimming copepodid stages have been described only in five species, namely, *Clavella uncinata* (Muller) (Gurney 1934; Heegaard 1947a), *Epibrachiella impudica* (cf. Gurney 1934), *Lernaeopoda galei* (cf. Gurney 1947) and *Pseudocharopinus dentatus* and *Nectobranchia indivisa* (cf. Kabata 1976). In the present paper the structure of the copepodid of three lernaeopodids, namely, *Pseudocharopinus narcinae* (Pillai 1962), *Isobranchia appendiculata* Heegaard (1947b) and *Brachiella trichiuri* Gnanamuthu (1951), occurring along the Indian coast is described.

2. Materials and methods

Live ovigerous females of *P. narcinae* were collected from the gill arches of *Narcine timlei* Bloch & Schn., of *I. appendiculata* from the gill arches of *Chirocentrus dorab* Forskal, and of *B. trichiuri* from the buccal cavity and symphyses of the gill arches of *Trichiurus savala* Cuvier. Egg sacs, containing mature eggs (yellowish brown in colour), were removed from the parasites and placed in petri dishes containing filtered sea water. They were then kept in a refrigerated bath at 20° C, for 24-48 hr. The sea water in the petri dishes was changed at frequent intervals. The hatched out free-swimming copepodids were carefully removed and preserved in 10% neutral-buffered formalin. Temporary mounts of the entire copepodids and their appendages were prepared in lactic acid. All the figures were drawn with the aid of a camera lucida. (Plumules of the setae of certain appendages are omitted from the drawings. However, the details of the armature are mentioned in the text).

3. Descriptions of the larval stages

3.1. *Pseudocharopinus narcinae*

Forebody (figures 1, 2) oval in dorsal view, with round anterior margin and slightly converging posterior margins. Cephalothorax with a crescentic groove in the mid region; lateral margin with a pair of sensory setules. Hind body narrower than the fore-body, consisting of four segments. First segment unarmed. Second segment with a pair of setules on the dorsal surface; third pair of legs attached to the postero-lateral surface. Third segment broader than long with straight anterior and posterior margins. Genito-abdomen sub-quadrangular with anal laminae on the posterior margin.

First antenna (figure 3) cylindrical, indistinctly segmented with two long unarmed setae on the anterior margin towards the base and a small apically blunt seta placed at about mid-length of the appendage. The number of sub-apical and apical groups of setae and their arrangement very much similar to that observed by Kabata (1976) in the first antenna of the copepodid of *P. dentatus*.

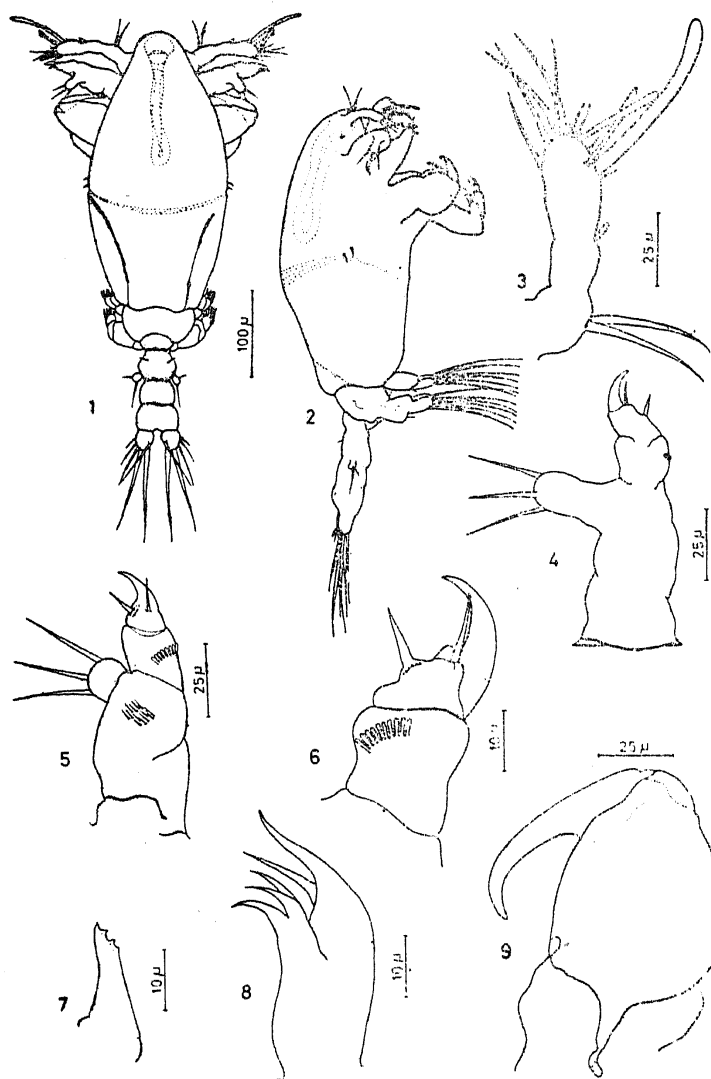
Second antenna (figure 4) biramous, sympod indistinctly two-segmented, basal segment unarmed, distal segment with a cluster of slender spines on the medial ventral surface (figure 5). Exopod with three long unarmed setae. Endopod (figure 6) identical with that of the copepodid of *P. dentatus* (cf. Kabata 1976).

Mandible (figure 7) small and slender, cutting edge irregularly toothed.

First maxilla (figure 8), second maxilla (figure 9) and maxilliped (figure 10) exactly similar to that of the copepodid of *P. dentatus* described by Kabata (1976).

Frontal filament (figure 11) moderately long, thick with single flexure more or less at mid-length of the filament.

First pair of legs (figure 12) biramous, sympod two-segmented; basal segment unarmed; distal segment with a slender seta on the lateral margin. Exopod with two short unarmed lateral setae followed by a long mono-pinnate seta and three pinnate ones on the distal margin. Endopod with seven pinnate setae.



Figures 1-9. *Pseudocharopinus narcinae*. 1. Entire copepodid, dorsal; 2. Same, lateral; 3. First antenna, ventral; 4. Second antenna, lateral; 5. Same, ventral; 6. Second antenna, endopod, medial; 7. Mandible, lateral; 8. First maxilla, lateral; 9. Second maxilla, medial.

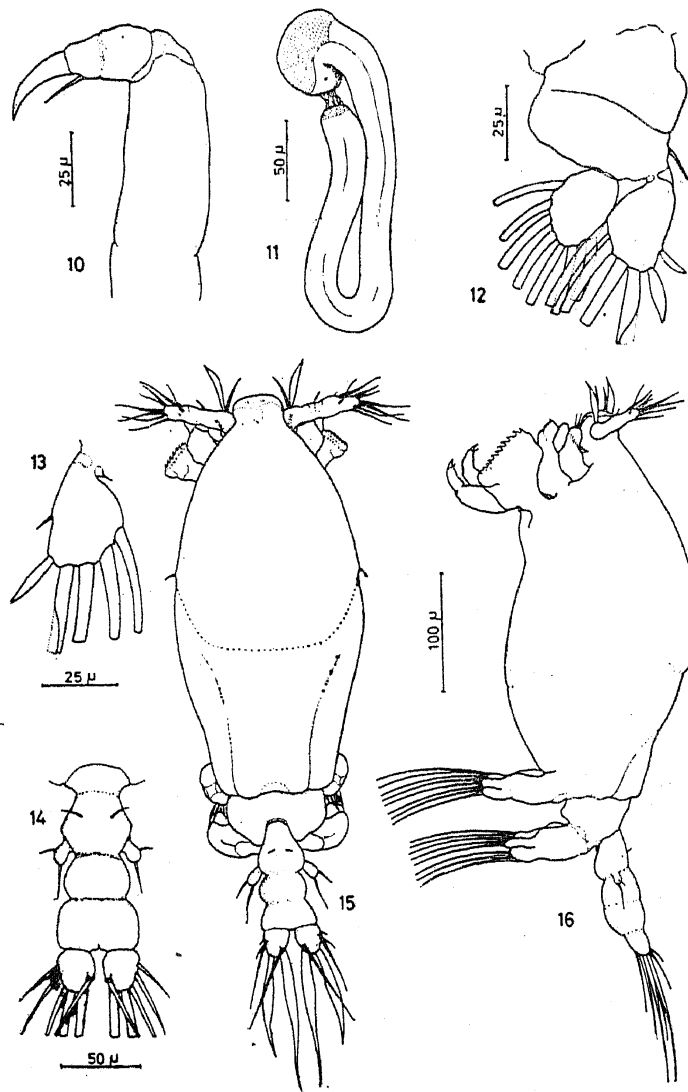
Second pair of legs similar to the first. Exopod (figure 13) with a spiniform seta on the lateral margin, a short unarmed seta on the disto-lateral corner, medial to it a mono-pinnate and three pinnate setae. Endopod with six pinnate setae.

Third pair of legs (figure 14) rudimentary, papilliform, with two slender unarmed setae.

Uropod (figure 14) with six elements: two large pinnate setae, three short unarmed setae and one dorsal long pinnate seta.

3.2. *Isobranchia appendiculata*

Cephalothorax (figures 15, 16) oval in dorsal outline, with slightly converging lateral margins and transverse posterior margin. Anterior end slightly produced above the base of the first antennae into a rostral lobe; transverse groove at about



Figures 10–16. *Pseudocharopinus narcinae* and *Isobranchia appendiculata*, 10. *P. narcinae*, Maxilliped, medial; 11. Frontal filament, lateral; 12. First leg, dorsal; 13. Second leg, exopod, ventral; 14. Posterior part of body, dorsal. 15. *I. appendiculata*, entire copepodid, dorsal; 16. Same, lateral.

mid-length of the cephalothorax, lateral margin of fore-body with sensory setule. Hind body narrower than fore body, four-segmented. First segment in dorsal outline nearly half the width of the widest part of the cephalothorax; broader than long, with converging lateral margins and round postero-lateral parts. The following segments exactly similar to that of the previous copepodid.

First antenna (figure 17) cylindrical and obscurely segmented. Anterior margin with three unarmed setae: one long and sturdy, another broad and lamellate on the base and a third short and pointed, at about mid-length of the appendage. Sub-apical group consists of two long unarmed setae and one setule near the base of one of the setae on the anterior margin. Apical group with one anterior moderately long seta split nearly up to its base, two long setae (as long as the entire appendage) at the centre of the apex and two similar setae on the posterior surface.

Second antenna (figure 18) biramous, sympod robust, indistinctly two-segmented, and unarmed. Exopod bulbous with smooth surface, apex with three unarmed setae and a short claw-like sub-apical spine. Endopod two-segmented; basal segment unarmed; terminal segment with a prehensile hook, a short thick spine near base of the hook; ventral surface with three to four rows of curved sharp teeth. The whole surface resembles an oval denticulated pad.

Structure of the mandible not determined.

First maxilla (figure 19) distinctly biramous, endopod larger than exopod, latter with two short apical processes. Endopod with similar but larger processes on the apex.

Second maxilla (figure 20) unusual, roughly squarish. Body obscurely segmented, broad, flat, with pedunculate base; distally ends in a pad-like plate with dentiferous margin. Centre of the plate with a row of small denticles similar and parallel to the marginal ones. A short curved spine is positioned on the terminal end of the segment below the marginal denticles.

Maxilliped (figure 21) sub-chelate. Basal segment longer than broad, unarmed. Distal segment with a slender spine on the inner margin. Claw short, with fine curving tip.

Frontal filament (figure 22) short and stumpy with a broad terminal plug.

First pair of legs (figure 23) similar to that of the copepodid of *P. narcinae* except that the sympod is unsegmented and the exopod carries a tooth-like projection on the disto-lateral margin. Endopod with six pinnate setae.

Second pair of legs (figure 24) similar to the first. Exopod identical with that of the second leg in the copepodid of *P. narcinae*.

Third pair of legs (figure 25) vestigial with two slender unarmed setae.

Uropod (figure 25) with the usual six setae, the distal two pinnate setae robust.

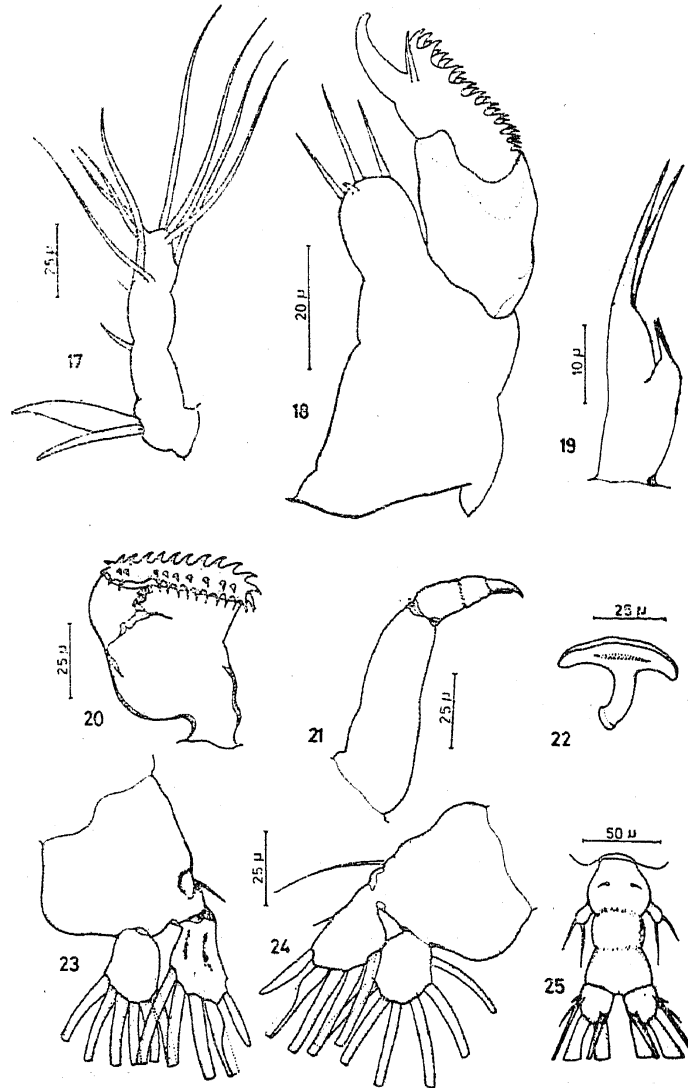
3.3. *Brachiella trichiuri*

Cephalothorax (figures 26, 27) roughly oval in dorsal outline, anterior end slightly produced above the bases of the second antennae in a disc-like fashion with a distinct notch on either side. Forebody with dorsal crescentic groove; sensory setule on lateral margins and ridge-like eminence on the postero-dorsal surface. The first segment of the hind body broad, with round lateral margins and regularly concave posterior margin. Soft region below this segment nearly cylindrical. The rest of the hind body very much similar to that of the previous two copepodids.

First antenna (figure 28) cylindrical and indistinctly segmented. Sub-apical group with a long aesthete, a slender seta and one setule a little behind the aesthete. Apical armature with two unarmed anterior setae (one blunt tipped), one moderately long apical seta, three long and unarmed setae on the posterior margin and one small seta on the posterior-sub-apical margin.

Second antenna (figure 29) similar to that of the copepodid of *I. appendiculata*. Surface of the exopod prominently hairy. Ventral surface of the distal segment of endopod sub-spherical in outline with 8-7 strong curved denticles on the margin.

Mandible (figure 30) short, with inflated base and without marginal serrations.



Figures 17-25. *Isobranchia appendiculata*, 17. First antenna, dorsal; 18. Second antenna, lateral; 19. First maxilla, lateral; 20. Second maxilla, medial; 21. Maxilliped, medial; 22. Frontal filament, dorsal; 23. First leg, dorsal; 24. Second leg, ventral; 25. Posterior part of body, dorsal.

First maxilla (figure 31) and second maxilla (figure 32) very much similar to that of the copepodid of *I. appendiculata*.

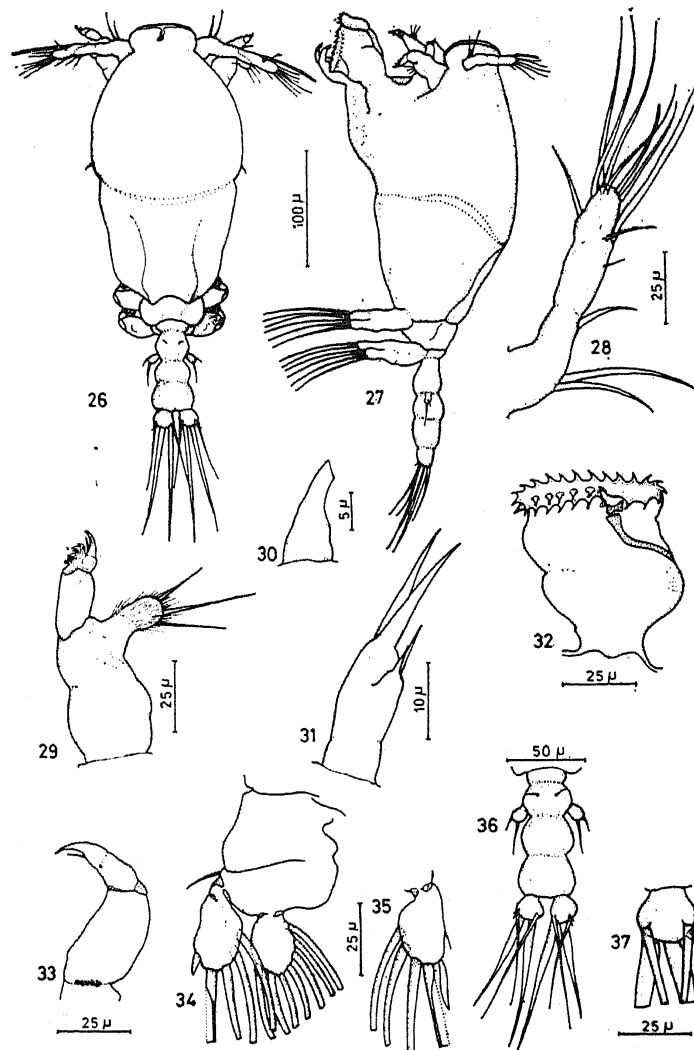
Maxilliped (figure 33) sub-chelate, smaller than that of the other two copepodids; claw short with fine tip.

Structure of the frontal filament not determined.

First pair of legs (figure 34) exactly similar to that of the copepod of *I. appendiculata*. Sympod indistinctly two-segmented. Endopod with 7 pinnate setae.

Second pair of legs similar to the first. Exopod (figure 35) identical with that of the second legs in the previous two copepodids. Endopod with six pinnate setae.

Third pair of legs (figure 36) rudimentary. The lateral two setae of the uropod short (figure 37).



Figures 26–37. *Brachiella trichiuri*, 26. Entire copepodid, dorsal; 27. Same, lateral; 28. First antenna, ventral; 29. Second antenna, lateral; 30. Mandible, lateral; 31. First maxilla, lateral; 32. Second maxilla, medial; 33. Maxilliped medial; 34. First leg, ventral; 35. Second leg, exopod, dorsal; 36. Posterior part of body, dorsal; 37. Caudal ramus, dorsal.

4. Discussion

Of the copepods studied here, *Pseudocharopinus narcinae* belongs to the “*charopinus* group”, *Isobranchia appendiculata* to the “*clavella* group” and *Brachiella trichiuri* to the “*Brachiella* group” of Lernaeopodidae (Kabata and Cousens 1972).

Despite small differences in the armament of certain appendages and in the size of the frontal filament, the gross morphological features and other structural details of the copepodid of *P. narcinae*, conforms to that of *P. dentatus* (Wilson) described by Kabata (1976).

Previous descriptions and illustrations of the copepodid stages of the “*Clavella* group”, represented by *Clavella uncinata* (Muller) (Gurney 1934, Heegaard 1947a,

Shotter 1971), and "Brachiella group" represented by *Epibrachiella impudica* (cf. Gurney 1934), are incomplete. Examination of the copepodids of *Isobranchia appendiculata* and *Brachiella trichiuri* reveals certain unique morphological features which seem to distinguish the copepodids of the *Clavella* and *Brachiella* groups from that of other groups of Lernaeopodidae.

As in the case of *C. uncinata*, the copepodid of *Isobranchia appendiculata* lacks an aesthete on the apical armature on the first antenna. However, the broad lamellate seta on the anterior basal margin of the first antenna is rather unusual among the copepodids of Lernaeopodidae. Contrary to this, the copepodid of *B. trichiuri* bears an aesthete on the apical armature of its first antenna. A similar aesthete has been reported by Gurney (1934) in the copepodid of *Epibrachiella impudica*.

The structure of the second antenna in its general outline is the same in both the copepodids of *I. appendiculata* and *B. trichiuri*. However, it differs from other copepodids of Lernaeopodidae in the presence of the denticulated pad on the ventral surface of the distal segment of the endopod. Heegaard (1947a) observed fine sensory hairs on the "forward-directed half" of the surface of the exopod in the second antenna of the copepodid of *C. uncinata*. But no such fine hairs were observed in the copepodid of *I. appendiculata*. On the other hand, the exopod surface of the second antenna in the copepodid of *B. trichiuri* is prominently hairy.

The outstanding feature in the morphology of the copepodids of both *I. appendiculata* and *B. trichiuri*, is the nature of the second maxilla, which in both cases is strikingly similar. Other species of Lernaeopodidae which are known to possess a similar type of second maxilla in their copepodids are *Clavella uncinata* (cf. Gurney 1934, Shotter 1971) and *Epibrachiella impudica* (cf. Gurney 1934). The first maxilliped described by Heegaard (1947a) for the copepodid of *Clavella uncinata* corresponds in location with the second maxilla described by Gurney (1934) and Shotter (1971) and the second maxilla of the present two species. But the "terminal claw and four circles of short, slightly curved, chitinous teeth" (Heegaard 1947a) are not discernible in the present two cases.

From the above mentioned facts it would appear that the copepodids of *Isobranchia appendiculata* and *Brachiella trichiuri* are identical with regard to the structure of the second antenna, first maxilla and, above all, the second maxilla. This structural similarity is suggestive of their close relationship within the family Lernaeopodidae lending some support for the views on lernaeopodid phylogeny proposed by Kabata (1966) that the *Clavella* group of Lernaeopodidae evolved from *Brachiella* like ancestors.

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References

- Claus C 1862 Ueber den Bau und die Entwicklung von *Achtheres percarum*; *Z. Wiss. Zool.* **11** 287-308 (Pls. 23-24)
- Friend G F 1941 The life history and ecology of the salmon gill-maggot *Salmincola salmonea* (L.) (copepod crustacean); *Trans. R. Soc. Edinburgh* **60** 503-541
- Gnanamuthu C P 1951 *Brachiella trichiuri* n. sp. a copepod parasitic in the mouth cavity of the ribbon fish; *Spolia Zeyl.* **26** 13-15
- Gurney R 1934 The development of certain parasitic copepoda of the families Caligidae and Clavellidae; *Proc. Zool. Soc. (London)* **105** 177-217
- Gurney R 1947 Some notes on parasitic copepoda; *J. Mar. Biol. Ass. (UK)* **27** 133-137
- Heegaard P 1947a Contribution to the phylogeny of the arthropods. Copepoda; *Spolia Zool. Mus. Hauniensis Kobenhavn* **8** 1-236
- Heegaard P 1947b A new lernaeopodid (*Isobranchia appendiculata* nov. gen., nov. sp.) from the Iranian Gulf; *Danish. Sci. Invest. Iran* **4** 239-245
- Kabata Z 1966 Comments on the phylogeny and zoogeography of Lernaeopodidae (Crustacea : Copepoda); *Proc. First Int. Congr. Parasitol.* **2** 1082-1083 (Abstract)
- Kabata Z 1976 Early stages of some copepods (Crustacea) parasitic on marine fishes of British Columbia; *J. Fish. Res. Board Canada* **33** 2507-2525
- Kabata Z and Cousens B 1972 The structure of the attachment organ of Lernaeopodidae (Crustacea : Copepoda); *J. Fish. Res. Board Canada* **29** 1015-1023
- Kabata Z and Cousens B 1973 Life cycle of *Salmincola californiensis* (Dana, 1852) (Copepoda : Lernaeopodidae); *J. Fish. Res. Board Canada* **30** 881-903
- Kollar V 1835 Beitrage zur Kenntniss der Lernaenartigen Crustacean; *Ann. Wiener Mus.* **1** 81-92 (Pls. 9-10)
- Nordmann A von 1832 Mikrographische Beitrage zur Naturgeschichte der wirbellosen Thiere; *Zweites Heft Berlin* p. 150
- Pillai N K 1962 Copepods parasitic on South Indian fishes. Families Lernaeopodidae and Naobranchidae; *J. Mar. Biol. Assn. India* **4** 58-94
- Shotter R A 1971 The biology of *Clavella uncinata* (Muller) (Crustacea : Copepoda); *Parasitology* **63** 419-430
- Vejdovsky F 1877 Untersuchungen uber die Anatomie und Metamorphose von *Tracheliastes polycolpus* Nordmann; *Z. Wiss. Zool.* **29** 15-46 (Pls. 2-4)
- Wilson C B 1911 North American parasitic copepods—Part 9. The Lernaeopodidae. Development of *Achtheres ambloplitis* Kellicott; *Proc. U.S. Natl. Mus.* **39** 189-226

