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A Parasitic Copepod, *Amplexibranchius bryconis* gen. et sp. nov. (Ergasilidae : Acusicolinae), from an Amazonian Fish and Remarks on the Importance of Leg Morphology in this Subfamily

by

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Abstract

The female of *Amplexibranchius bryconis* gen. et sp. nov. (Copepoda : Ergasilidae : Acusicolinae) is described from the gill filaments of an Amazonian fish, *Brycon cephalus* (GÜNTNER), obtained at Iquitos, Peru. The new genus differs from *Acusicola* CRESSEY, 1970, in having a more complex latching antenna in which a sleeve-like extension of the second segment nearly covers the third segment and claw. The new genus also differs from all known ergasiloids in having a 2-segmented first endopod without setae and pectinate, not plumose, setae on all other rami. These modifications imply a loss of swimming capacity which is linked to secure fixation on the gill filament. The first and second endopods of several Ergasilidae and Vaigamidae are compared with those of the new genus. It is shown that these structures are similar among those ergasiloids that can swim. It is proposed that the development of a secure antennal latch has made swimming unnecessary and has freed the legs to evolve for other functions. It is concluded that leg morphology may be useful in defining genera in Acusicolinae.

Key words: **Gill parasite, copepod, fishes, Amazon.**

Resumo

A fêmea de *Amplexibranchius bryconis* gen. et sp. nov. (Copepoda : Ergasilidae : Acusicolinae) é descrita dos filamentos branquiais de um peixe amazônico, *Brycon cephalus* (GÜNTNER) obtido em Iquitos, Peru. O novo gênero distingue-se de *Acusicola* CRESSEY, 1970, por ter um fecho antenal mais complexo no qual uma extensão tubular do segundo segmento quase cubre o terceiro segmento e a garra. O novo gênero também difere dos demáis ergasiloides conhecidos por ter um primeiro endopódito de dois segmentos e sem setas e por ter as setas das outras pernas pectinadas e não plumosas. Estas modificações implicam numa perda da capacidade de nadar que deve ser relacionada com a fixação segura no filamento branquial. O primeiro e segundo endopóditos de várias espécies de Ergasilidae e Vaigamidae são comparados. É demostrado que estas estruturas são parecidas entre os ergasiloides que podem nadar. É sugerido que o desenvolvimento de um fecho antenal seguro fez com que a habilidade de nadar ficou desnecessário e isso liberou as pernas a evoluir para outras funções. Sendo assím, a morfologia das pernas tornou-se útil na definição dos gêneros dentro da Acusicolinae.

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Introduction

The genus *Acusicola* was proposed by CRESSEY (1970, in CRESSEY & COLLETTE 1970) to contain *A. tenax* (ROBERTS 1965) as type and *A. cunula* CRESSEY, 1970. THATCHER (1984) redefined the genus, added the species *A. tucunarense* and proposed the subfamily Acusicolinae for the ergasilids having latching antennae. Since then, THATCHER & BOEGER (1983b, 1985) have added two more species to the genus, namely: *A. pellonidis* and *A. lycengraulidis*. The genus *Acusicola* (Acusicolinae) thus contains five species, four of which occur in the Amazon River system. The present study describes a related new genus of ergasilid copepods in the subfamily Acusicolinae and discusses the importance of leg morphology in the systematics of this group. This is also the first report of an ergasilid from Peru.

Material and Methods

The gills of fish hosts, purchased in the market at Iquitos, Peru, were fixed in 10 % formalin solution and the copepods were removed later from the gill filaments with needles under a dissecting microscope. The methods used in the preparation and study of the parasites were those described in THATCHER & BOEGER (1984b). Coloration was determined by reference to SMITHE (1974). Drawings were made with the aid of a camera lucida and measurements in micrometers (μm) with a measuring ocular. Figures 11 - 16 and 18 - 23 were redrawn by projection from THATCHER (1984) and THATCHER & BOEGER (1983a, b, 1984a, b, 1985). These figures are not to scale, but were drawn at a size similar to that of figures 10 and 17 for ease of comparison.

Systematic Section

Ergasilidae NORDMANN, 1832
Acusicolinae THATCHER, 1984
Amplexibranchius gen. nov.

Generic diagnosis: Ergasilidae. Acusicolinae. Female: cephalothorax inflated, or not. Abdomen 3-segmented. Antennule 5-segmented. Antenna 4-segmented, but fourth segment (claw) greatly reduced; first and third segments short; segment two long, with anterior cuticular extension which partially encloses segment three. Maxillipeds absent. Legs 1 - 4 biramous; all setae pectinate; first endopod subcylindrical, without setae (but may have few vestigial spinules or setules; terminal segments of endopods 2 - 4 sharply tapering, setae small; fourth exopod 2-segmented, other rami 3-segmented. Leg 5 represented by one or two simple setae. Leg 6 absent. Male: unknown, but presumably free-living. Female parasitic on gill filaments of freshwater fishes.
Type species: *Amplexibranchius bryconis* sp. nov.

Amplexibranchius bryconis sp. nov.
(Figs. 1 - 10, 17)

Host: *Brycon cephalus* (GÜNTHER) = *B. erythropterum* (COPE).
Site: Gill filaments.
Localities: Amazon River, near Iquitos, Peru, and Manaus, Brazil.
Holotype (female): Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus, Amazonas, Brazil.

Paratypes (females): INPA, Universidad Nacional Agraria, Lima, Peru and University of Nebraska State Museum, Lincoln, Nebraska.
Male: Unknown.
Etymology: The generic name comes from the Latin "amplexus" meaning to embrace or surround and branchius from the Latin "branchio", a gill. The specific name is derived from the host genus.

Species diagnosis (based on 17 specimens studied and 10 measured: Tables I and II). Cephalothorax little inflated, rounded anteriorly (Fig. 1). Eye prominent, smalt blue (color 70 of SMITHE 1975). Spectrum blue (color 69) pigmentation widely scattered ventrally in body (dark spots in Fig. 1).

Antennule (Fig. 2) 5-segmented; first segment larger than others; setal formula = 10 : 4 : 4 : 2 : 6, total = 26. Antenna (Figs. 6, 9) 4-segmented; first segment short, with terminal spine; second segment more than four times the length of segments 3 and 4 together, with pore-like sensillum medially and cuticular extension distally which partially encloses segment 3; third segment deeply indented mid-way on its length; segment 4 (claw) small.

Thorax (Fig. 1) of five free segments; legs 2 - 5 on free segments. Genital segment (Fig. 5) subspherical.

Abdomen (Fig. 5) of three segments. Uropod subcylindrical, with two longer and two shorter setae terminally.

Mouthparts (Fig. 7): mandible bifid and 2-segmented, terminal segment with bristles laterally and slender denticles medially; mandibular palp slender, bristled posteriorly; first maxilla reduced (no setae observed); second maxilla 2-segmented, with spinous tip.

Legs (Figs. 3, 8, 10, 17). Spines and setae as shown in figures and in Table 3. Leg spines reduced in number and size. Setae on legs 1 - 4 pectinate. Lateral surfaces of all rami of legs 1 - 3 covered with knob-like protuberances. First endopod 2-segmented; second segment subcylindrical, terminating in three small points; fourth exopod 2-segmented; other rami 3-segmented. Leg 5 (Fig. 3) of two simple setae, one longer than other.

Egg sac (Fig. 4) elongate, multiseriate.

Discussion

The Acusicolinae THATCHER, 1984, differ from other ergasilids in having evolved antennae which encircle the gill filament and latch in place. The latching device is composed of the grooved third segment and the claw (here considered to be a fourth segment). When the antennae are latched, each claw fits into a groove on the third segment of the opposite antenna. *Acusicola pellonidis* THATCHER & BOEGER, 1983, is an example of the simplest latch and in this type, the points of the claws are completely exposed. In some species presently considered to belong to *Acusicola* (such as: *A. cunula* CRESSEY, 1970, and *A. lycengraulidis* THATCHER & BOEGER, 1985) there is a small cuticular flap from the distal end of the second segment which partially covers the tip of the claw. *Amplexibranchius* gen. nov. differs from the known species of *Acusicola* in having a more complex antennal latch. In the new genus, a sleeve-like extension of the second segment covers most of the third (Fig. 9) so that when the antennae are latched, the claws are almost completely covered. Furthermore, the claws of the new genus are greatly reduced in size as compared to the species of *Acusicola*. Apparently, the claw is of less importance for latch strength in this genus and may serve as a sort of safety catch.

Until now, leg morphology has proven to be of little value in defining genera and families of ergasiloids. Since the work of WILSON (1911), it had been thought that only legs 1 and 4 of female Ergasilidae were modified for parasitism. In truth, legs 2 and 3 of most ergasilids are swimming legs with plumose setae and they closely resemble the same appendages of free-living copepods. As for the modifications of leg 4, they can not be accepted as adaptations for the parasitic way of life since they are merely reductions in the number of segments, setae and spines. Since the fourth pair of legs is the last of the swimming legs to develop in the copepodid stages, the presence of two-segmented rami on leg 4 of adult females may represent a juvenile feature which has been held over. In which case, the modifications seen in these appendages may be considered as neotenic characters.

As for the modifications in the ergasiloid first leg, the most evident change was a reduction in the number of segments in the endopod from three to two. The two-segmented first endopod evolved as a result of the failure of segments 2 and 3 to separate. Two-segmented rami are normal for the copepodid stage so the retention of this feature can be considered as another neotenic character. ROBERTS (1970) indicated that a two-segmented first endopod is unusual in North American ergasilids since only five of the twenty known species from that continent have it. In our studies of Amazonian ergasiloids, however, we have found that the 2-segmented first endopod is far more common than the 3-segmented type. Not only do most species of *Ergasilus* from this region show this feature (Fig. 13), but so do other genera (*Acusicola*; Figs. 11, 12, 14: *Brasergasilus*; Fig. 15) and even another family (Vaigamidae, *Gamispinus*; Fig. 16).

The first endopods of *Ergasilus, Brasergasilus* and *Gamispinus* are almost monotonously similar here (Figs. 13, 15, 16). All have one plumose seta on the first segment and five on the second. They all have two terminal spines as well, although the latter can be seen to differ slightly in size and form. These rami also have either spinules or serrations on their lateral surfaces. Such small differences can only be of specific value, but these genera are clearly distinct by other criteria.

The first endopods of *Acusicola* (Figs. 11, 12, 14) also show great similarity to those of *Ergasilus* and, in most cases, they have the same number of spines and setae. A reduction in the size of the setae is immediately apparent, however, and in *A. lycengraulidis* (Fig. 14) the number is also reduced. The reduction or loss of plumose setae necessarily decreases the swimming capacity of these animals and is probably linked to the evolution of latching antennae. The security provided by this type of antennae has apparently made swimming unnecessary.

The second and third endopods of the Amazonian ergasiloids studied so far are also similar. They typically have a first segment with one seta, a second with two and a terminal segment with four setae and one spine. This condition prevails in the species of *Ergasilus* (Fig. 20), *Acusicola* (Figs. 18, 19, 21), *Brasergasilus* (Fig. 22) and *Gamispinus* (Fig. 23). The same arrangement is seen in *Amplexibranchius* gen. nov. (Fig. 17) but the setae are all pectinate instead of plumose and they are greatly reduced in size. The terminal spine is minute and this segment itself is tapered to a point.

Although the first endopod of *Acusicola* resembles that of other ergasiloids, except for a reduction in the size of the setae, that of *Amplexibranchius* gen. nov. is structurally different from all the others. The new form has no setae on the first endopod and the only spine-like projections are small and terminal. The setae of all the rami of legs 1 - 4 differ from those of other ergasiloids in that they are pectinate, not plumose. It would appear that all the legs of the new genus are adapted to or by the parasitic way of life.

We propose that the legs of most ergasiloids are not modified for parasitism but are tied to a swimming function. Some species of *Ergasilus* detach readily from the host gills and swim actively. Ovigerous females of *Ergasilus* and Vaigamidae are not infrequently found in plankton samples. *Gamispinus* (Vaigamidae) has also been observed to swim rapidly when dissected from the nasal mucous. It is possible that ergasiloids use this swimming ability to move from one gill filament to another, or to change hosts. After the latching antennae of Acusicolinae evolved, the necessity of moving was eliminated and the legs were freed from their swimming function. As a result, the legs have evolved other functions related to the parasitic way of life and have modified their morphology accordingly. Therefore, leg morphology may prove to be useful in defining the genera of this group.

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Table 1: Measurements (μm) of 10 Adult Females of *Amplexibranchius bryconis* gen. et sp. nov.

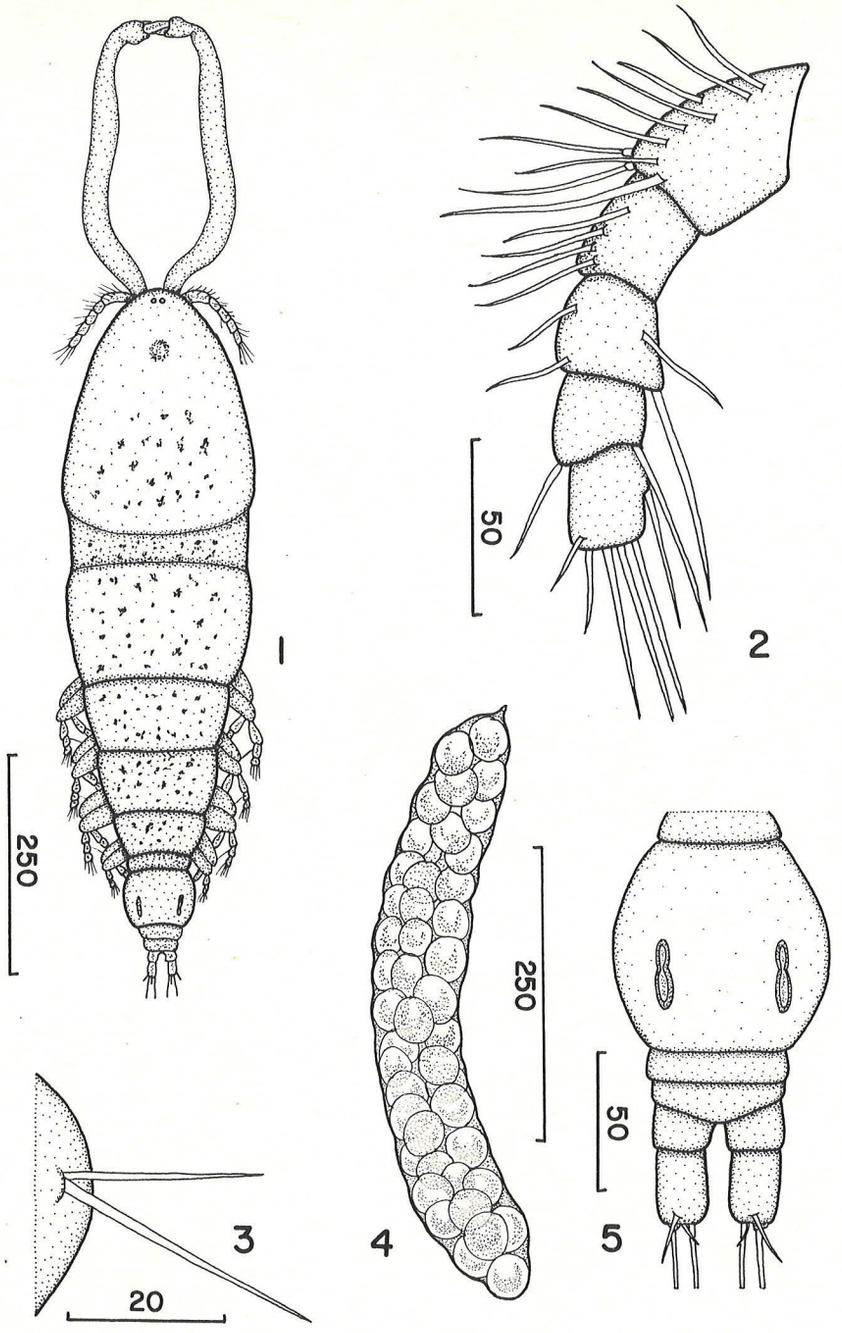
	Length	Width
Body (less caudal setae)	825 - 1,075 (945)	250 - 340 (295)
Cephalothorax	350 - 440 (396)	250 - 340 (295)
Thoracic segments		
II	82 - 150 (122)	160 - 310 (260)
III	75 - 110 (100)	120 - 230 (182)
IV	68 - 100 (82)	95 - 190 (140)
V	48 - 78 (60)	62 - 115 (97)
VI	25 - 55 (30)	48 - 80 (68)
VII (genital)	55 - 82 (75)	68 - 110 (100)
Abdominal segments		
I	10 - 15 (13)	50 - 68 (60)
II	10 - 13 (12)	40 - 65 (56)
III	20 - 32 (24)	38 - 62 (48)
Uropod	35 - 48 (42)	15 - 25 (21)
Caudal setae	40 - 52 (48)	–
Egg sac	480 - 620 (542)	70 - 85 (78)

Table 2: Antennal Measurements (μm) of 10 Adult Females of *Amplexibranchius bryconis* gen. et sp. nov.

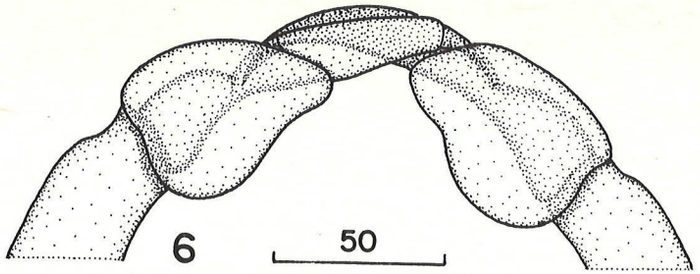
	Length	Width
Antennule	125 - 202 (145)	12 - 32 (24)
Antenna		
Segment 1	60 - 90 (70)	40 - 58 (49)
2	310 - 440 (383)	35 - 50 (42)
3	58 - 72 (63)	15 - 22 (17)
4	12 - 18 (15)	–

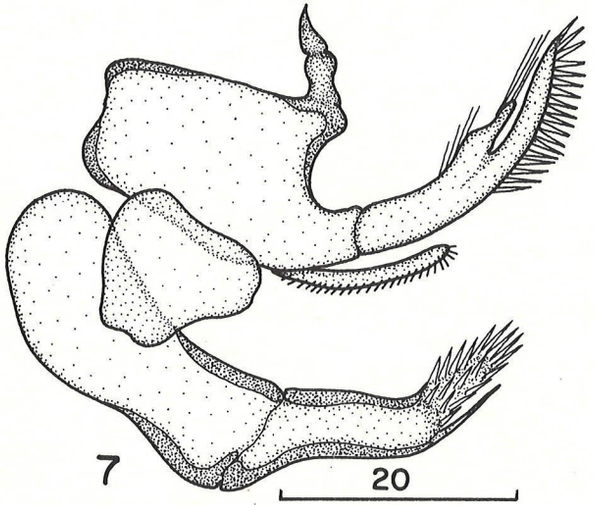
Table 3: Relationship of Spines to Setae on the Legs of *Amplexibranchius bryconis* gen. et sp. nov.

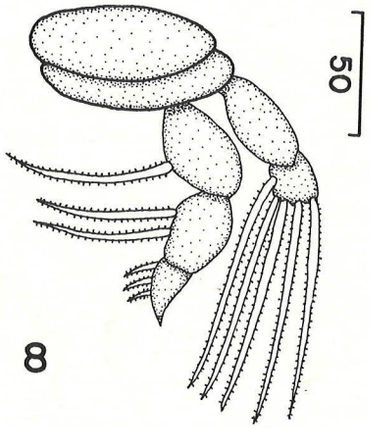
Leg	Endopod	Exopod
1	0 - 0, I - 0	I - 0, 0 - 1, II - 5
2	0 - 1, 0 - 2, I - 4	I - 0, 0 - 1, 0 - 6
3	0 - 1, 0 - 2, I - 4	I - 0, 0 - 1, 0 - 6
4	0 - 1, 0 - 2, I - 3	0 - 0, 0 - 5

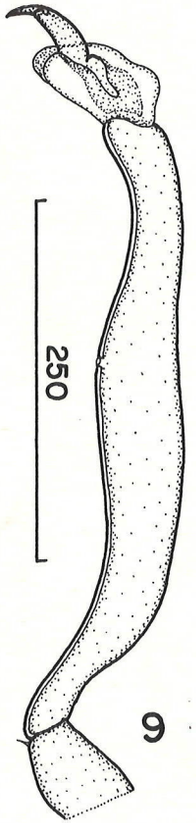


Figs. 1 - 5:
Amplexibranchius bryconis gen. et sp. nov. (female).
1: Entire specimen (dorsal). **2:** Antennule. **3:** Leg 5. **4:** Egg sac. **5:** Genital segment, abdomen and uropods.

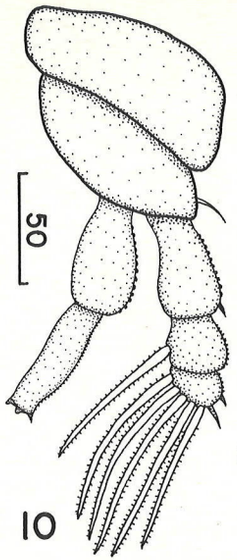


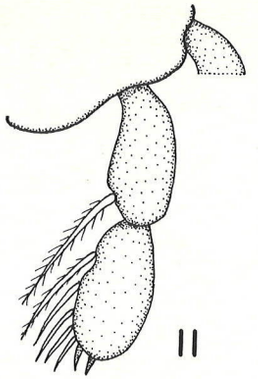


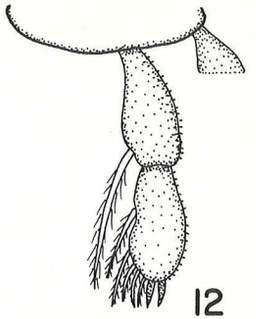


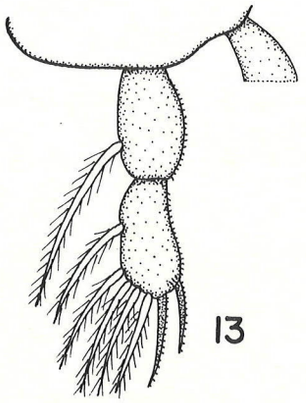


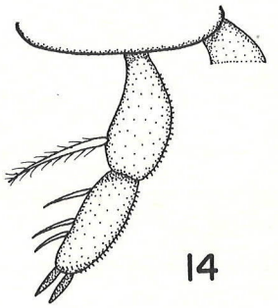
Figs. 6 - 9:
Amplexibranchius bryconis gen. et sp. nov. (female).
6: Antennal latch (dorsal). **7:** Mouthparts. **8:** Leg 4. **9:** Antenna.

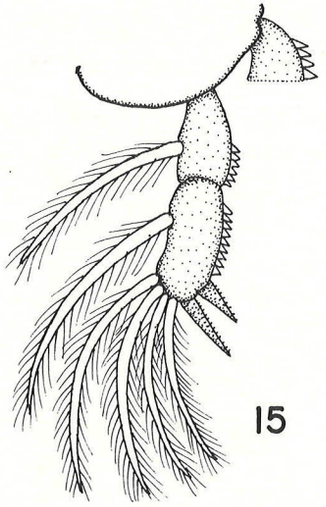


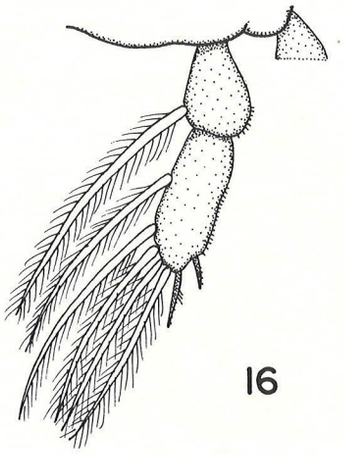




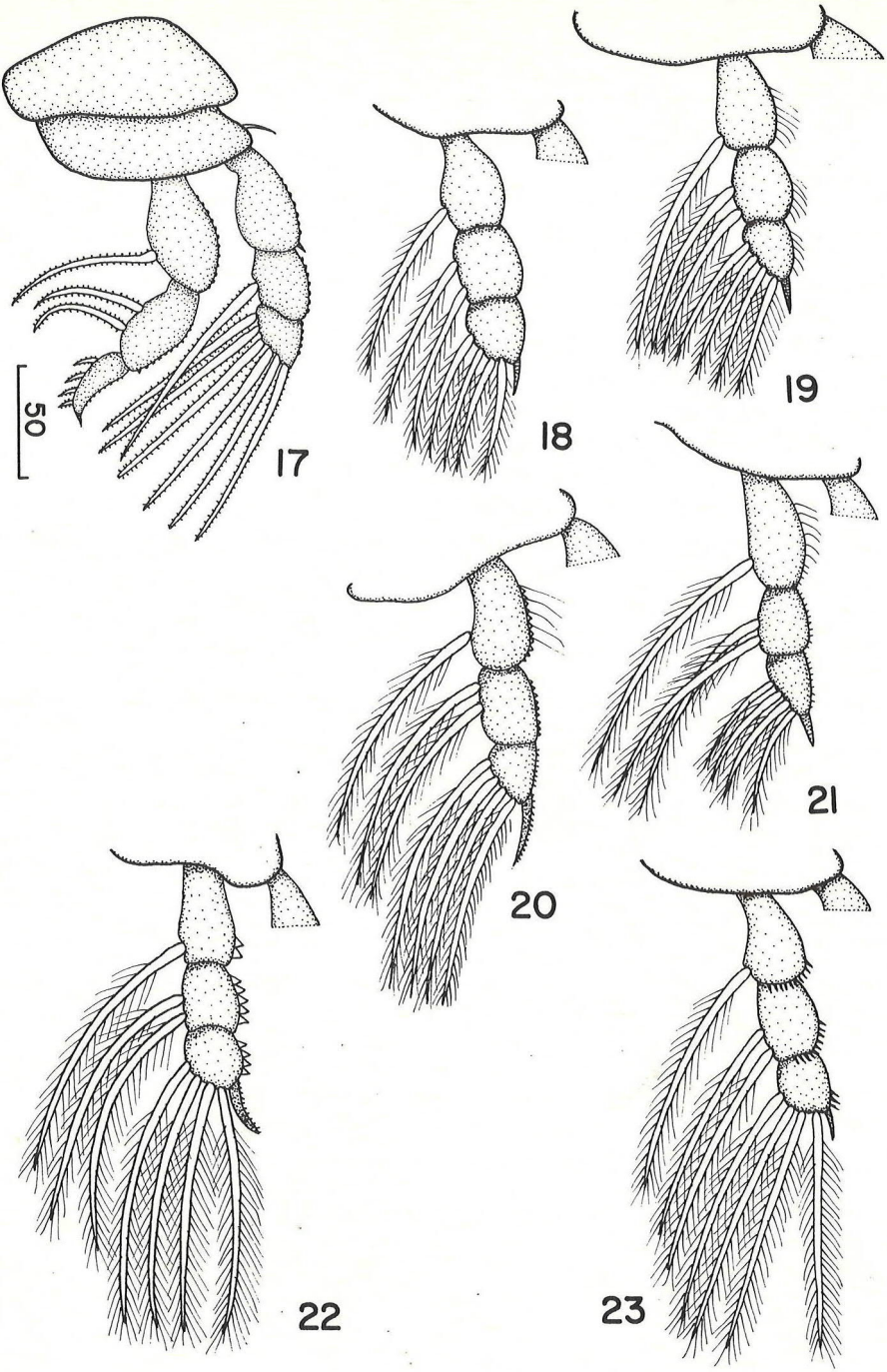








Figs. 10 - 16:
Comparative Morphology of Female Ergasiloid First Endopods.
10: *Amplexibranchius bryconis* gen. et sp. nov. **11:** *Acusicola tucunarense.* **12:** *Acusicola pellonidis.* **13:** *Ergasilus callophysus.* **14:** *Acusicola lycengraulidis.* **15:** *Brasergasilus jaraquensis.* **16:** *Gamispinus diabolicus.*



Figs. 17 - 23:
Comparative Morphology of Female Ergasiloid Second Endopods.
17: *Amplexibranchius bryconis* gen. et sp. nov. **18:** *Acusicola tucunarense.* **19:** *Acusicola pellonidis.* **20:** *Ergasilus callophysus.* **21:** *Acusicola lycengraulidis.* **22:** *Brasergasilus jaraquensis.* **23:** *Gamispinus diabolicus.*