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Article in *Journal of Aquatic Animal Health* · September 1998

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## Comparative Morphology of Three Native Lernaids (Copepoda: Cyclopoida) from Amazonian Fishes and Descriptions of Two New Genera

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**Abstract.**—Morphological studies were carried out on adult postmetamorphic females of three native South American genera of Lernaecidae (Crustacea: Copepoda: Cyclopoida) and these were compared with the imported species *Lernaea cyprinacea*. Two of the native species represent new genera, which are described as *Amazolernaea sanneriae* gen. et sp. nov. and *Bedsylernaea collaris* gen. et sp. nov. The third native species had already been described as *Perulernaea gamitanae* Thatcher and Paredes, 1985. *Amazolernaea sanneriae* from the cichlids *Cichla monoculus* and speckled pavon *C. temensis* was characterized as having four similar petal-like anchors, a long slender neck, thoracopods 1 and 2 close together, and a genital pore located equatorially in the well-developed hindbody. *Bedsylernaea collaris* differs from all known lernaids in having a large inflated head region with one bulbous anchor on either side, a slender neck, a stout hindbody with a large pregenital prominence, a genital pore that is anterior to the midpoint on the hindbody, and collar-like extensions on the anterior extremity of the hindbody. *Perulernaea gamitanae* has two large and two small unbranched anchors, a long neck with prominent glands, and an elongate hindbody with a genital pore that is posterior to the midpoint. In contrast, all valid species of *Lernaea* have four frequently branching anchors, a neck region and hindbody that are not well defined, a short abdomen, and a genital pore at or near the posterior extremity.

Lernaids comprise a family of Copepoda in which the small free-living adult females become parasitic after copulation, metamorphose, and grow to a relatively large size without molting. Thus, there are two kinds of adult females, known respectively as premetamorphic and postmetamorphic females. The latter are elongate forms in which the head is inserted into fish tissue, frequently within a blood vessel, and the rest of the body is free in the water. These parasites feed on

the blood of their hosts and are of considerable economic importance since they are capable of killing fish in pisciculture ponds.

Kabata (1983) reported 11 known genera of Lernaecidae and added two more genera from the fishes of India. Thatcher and Paredes (1985) described *Perulernaea gamitanae* from an important food fish of the Peruvian Amazon. The present study adds two new Amazonian genera for a total of 16 genera in Lernaecidae.

Most of the genera and species of Lernaecidae are known only from Eurasia and Africa. There are more than 40 species attributed to the type genus *Lernaea* Linnaeus, 1758, alone. The type species of the latter genus, *L. cyprinacea*, was also an old world form but it has been introduced into North and South America on imported fish (Figueira and Ceccarelli 1991).

In South America, in addition to *Lernaea* and *Perulernaea*, the genera *Taurocheros* Brian, 1924 (with two species), and *Areotrachelus* Wilson, 1924 (with one species), have been reported from Argentine freshwater fish. According to Yamaguti (1963), *Lernaea lagenula* (1865) from an unknown host occurs in Brazil. Additionally, Kabata (1979) listed *Lernaea argentinensis* Paggi, 1972, from Argentina.

### Methods

Copepods were dissected from the host tissue with needles and preserved in 70% alcohol. They were later cleared, stained, and mounted by means of the phenol-balsam method as explained in Thatcher (1991). Drawings were made with the aid of a camera lucida and by projection. Sizes were established by using a measuring ocular, and all measurements are given in millimeters except where indicated as micrometers ( $\mu\text{m}$ ).

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### Description of *Amazolernaea* gen. nov.

*Generic diagnosis:* Cyclopoida; Lernaecidae.

*Postmetamorphic female:* Body divisible into head, neck, and hindbody. Head bearing four small petal-like lobes, mouthparts, antennae, and first pair of thoracopods. Mouthparts: second maxillae bifurcate; maxillipeds with several terminal spines. Neck long, slender, cylindrical. One pair of thoracopods present on head and three on neck: first neck pair close to head pair. Hindbody subcylindrical, formed from fused genital segment and abdomen; genital pore near midpoint, pregenital prominence small. Egg sacs multiseriate.

*Male:* Unknown.

*Premetamorphic female:* Unknown.

*Type species:* *Amazolernaea sanneriae* sp. nov.

### Description of *Amazolernaea sanneriae* sp. nov.

(Figures 1A, 2A, D, 3B, C, F, 4A)

*Hosts:* *Cichla monoculus* and speckled pavon *C. temensis* Humboldt, 1833 (Cichlidae).

*Site:* Inner surface of mouth and gill filaments.

*Localities:* Paciva River, Venezuela, and Jatapu River, Amazonas State, Brazil.

*Type material:* Female holotype (INPA-CR 544) and one female paratype (INPA-CR 545) deposited in the Invertebrate Collection of the Instituto Nacional de Pesquisas da Amazônia, Manaus, Amazonas, Brazil.

*Etymology:* The generic name refers to Amazonia and the specific name honors Ms. Carol Sanner, who collected the first specimens in Venezuela.

*Species diagnosis* (based on three whole specimens and three hindbodies, all females): See description of the genus. Measurements are in Table 1. Head anchors petal-like with anterobasal, spherical swelling (Figure 1A). Four pairs of similar thoracopods present (Figure 3F); one pair on head and three on neck with the first two pairs close together; fourth pair distant from hindbody. A fifth pair not observed. Hindbody elongate, tapered. Hindbody about 48% of total body length. Neck diameter about 20% of hindbody width. Egg sacs short. Two-segmented uropods present; caudal filaments short (Figure 4A).

### Diagnosis of *Bedsylernaea* gen. nov.

*Generic diagnosis:* Cyclopoida; Lernaecidae.

*Postmetamorphic female:* Body divisible into head, neck, and hindbody. Three pairs of thoracopods observed. Head bearing two large bulbous anchors, mouthparts, and antennae. Mouthparts:

second maxillae bifurcate, maxillipeds with five terminal spines. Neck long, slender, and cylindrical with two pairs of thoracopods. Hindbody subcylindrical, short, stout, formed from fused genital segment and abdomen; with collar-like anterolateral projections, one on either side of neck; one pair of thoracopods present (probably the fourth pair) between projections; genital pore anterior to midpoint, pregenital prominence large. Egg sacs multiseriate.

*Male:* Unknown.

*Premetamorphic female:* Unknown.

*Type species:* *Bedsylernaea collaris* sp. nov.

### Description of *Bedsylernaea collaris* sp. nov.

(Figures 2B, E, 3A, 4B, 5)

*Host:* *Trahira Hoplias malabaricus* (Bloch, 1974) (Erythrininae).

*Site:* Gill filaments.

*Locality:* Trombetas River, Pará State, Brazil.

*Type material:* Female holotype (INPA-CR 546) and one female paratype (INPA-CR 547) deposited in the Invertebrate Collection of the Instituto Nacional de Pesquisas da Amazônia, Manaus, Amazonas, Brazil.

*Etymology:* The generic name is in honor of Dr. Bedsy E. Dutary in recognition of her unique contributions to parasitology. The specific designation refers to the collar-like anterior extension of the hindbody of the parasite.

*Species diagnosis* (based on two whole female specimens): See description of the genus. Measurements are in Table 1. Mouth within funnel-like depression in bulbous bilobed head anchor; head width 64% of total body length (Figure 5). First pair of thoracopods not observed; second and third pairs on neck; fourth pair of thoracopods on hindbody; fifth thoracopods not observed. Hindbody represents 40% of total body length: neck width equals about 12% of hindbody width. Egg sacs slender. Two-segmented uropods present; caudal filaments short (Figure 4B).

### Description of *Perulernaea* Thatcher and Paredes, 1985

*Generic diagnosis* (modified after Thatcher and Paredes 1985): Cyclopoida; Lernaecidae.

*Postmetamorphic female:* Body divisible into head, neck, and hindbody. Head bearing two large blunt lateral lobes and two small ventral lobes, mouthparts, antennae, and first pair of thoracopods. Mouthparts: second maxillae bifurcate; maxilliped with five terminal claws. First anten-

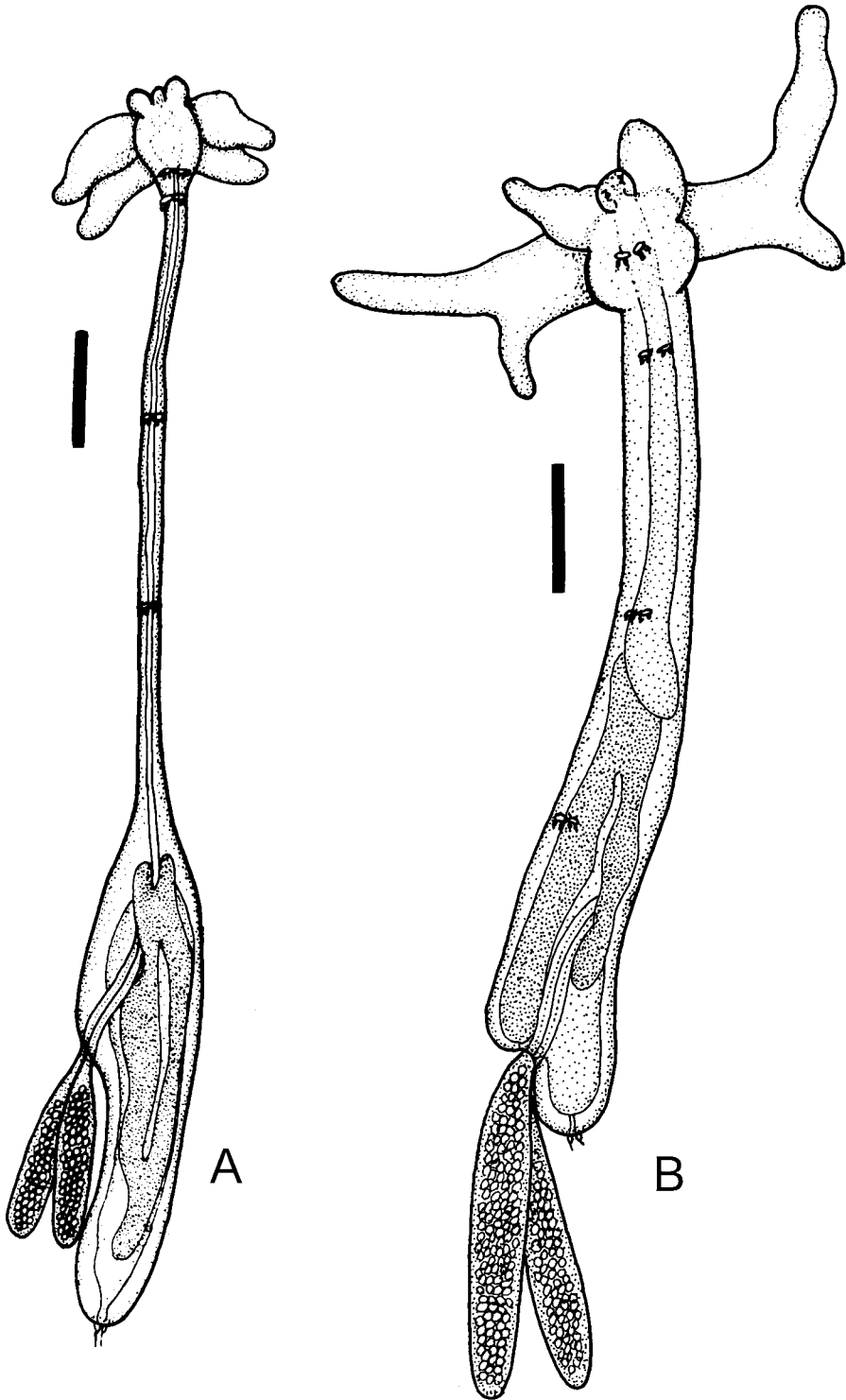


FIGURE 1.—(A) *Amazolernaea sanneræ* gen. et. sp. nov. (bar = 1 mm); and (B) *Lernæa cyprinacea* L. (bar = 1 mm).

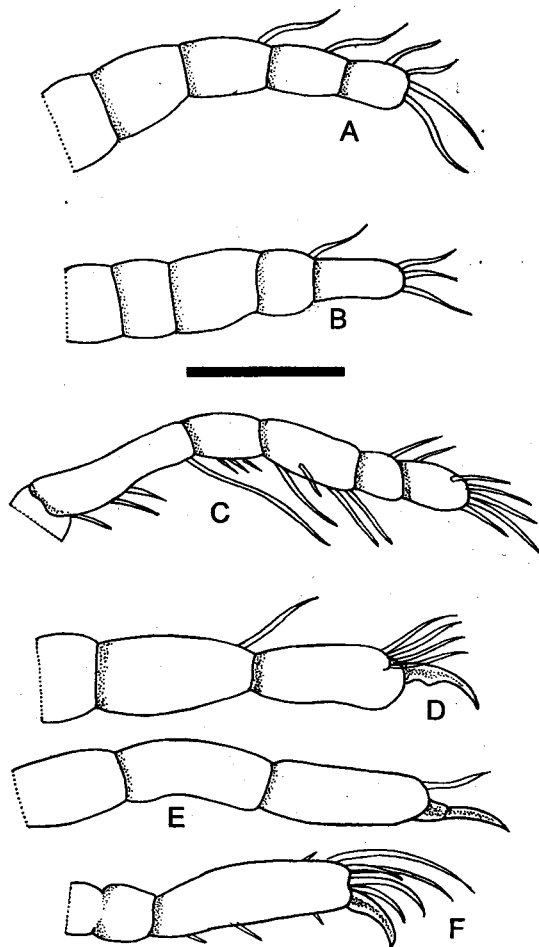


FIGURE 2.—First antennae: (A) *Amazolernaea sanneriae*; (B) *Bedsylernaea collaris*; and (C) *Perulernaea gamitanae*. Second antennae: (D) *A. sanneriae*; (E) *B. collaris*; and (F) *P. gamitanae* (bar = 50  $\mu$ m).

nae five- or six-segmented, provided with simple setae. Second antennae two- or three-segmented; terminating in stout claw and several setae. Four pairs of biramous thoracopods present; all rami three-segmented and provided with spines and setae. Neck subcylindrical; about two-thirds of total body length; containing numerous large glands anteriorly. Hindbody formed from fusion of last leg-bearing thoracic segment with genital segment and abdomen; genital pore posterior to mid-point in hindbody. Egg sacs multiseriate.

*Male*: Unknown.

*Premetamorphic female*: Unknown.

*Type species*: *Perulernaea gamitanae* Thatcher and Paredes, 1985.

TABLE 1.—Comparative body part measurements of three postmetamorphic female Lernaeidae from Brazil and Venezuela.

Body part	Length (mm)	Width (mm)
<i>Bedsylernaea collaris</i> gen. et sp. nov. from <i>Hoplias malabaricus</i>		
Body	13–16	
Head and anchors	1.7–1.9	7.2–10.2
Neck	6.0–8.2	0.20–0.25
Hindbody	5.0–6.5	1.6–2.0
Genital pore to posterior	3.0–3.7	
Egg sac	3.5–4.0	0.33–0.37
Egg	0.13–0.14	0.09–0.10
<i>Amazolernaea sanneriae</i> gen. et sp. nov. from <i>Cichla temensis</i> and <i>C. monoculus</i>		
Body	8.5–10.8	
Head and anchors	0.83–0.85	1.5–1.6
Neck	3.5–5.2	0.16–0.20
Hindbody	4.0–4.5	0.79–1.0
Genital pore to posterior	2.2–2.5	
Egg sac	1.6–1.9	0.25–0.30
Egg	0.10–0.12	0.06–0.07
<i>Perulernaea gamitanae</i> from <i>Colossoma macropomum</i> <sup>a</sup>		
Body	18–22	
Head and anchors	1.1–1.2	4.5–5.0
Neck	12–15	0.32–0.93
Hindbody	5.0–5.5	1.0–1.2
Egg sac	2.0–4.0	0.43–0.63
Egg	0.10–0.11	0.10–0.11

<sup>a</sup> After Thatcher and Paredes (1985).

### Description of *Perulernaea gamitanae*

Thatcher and Paredes, 1985

(Figures 2C, F, 3D, E, G, H, 4C, 6)

*Host*: Tambaquí *Colossoma macropomum* (Cuvier, 1818) (Serrasalminidae).

*Sites*: Nasal fossae, interior of mouth and opercula, tongue, and gill filaments.

*Localities*: Iquitos, Peru, and Manaus, Amazonas, Brazil.

*Type material*: Female holotype (INPA-CR 196) deposited in the Invertebrate Collection of the Instituto Nacional de Pesquisas da Amazônia, Manaus, Amazonas, Brazil. Two female paratypes deposited, respectively, in the collections of the Universidad Agraria, Lima, Peru, and the University of Nebraska State Museum, Lincoln, Nebraska (HWML 23107).

*Etymology*: See Thatcher and Paredes (1985).

*Species diagnosis* (modified after Thatcher and Paredes 1985, based on four additional whole specimens and five hindbodies): See description of the genus. Measurements are in Table 1. Post-metamorphic female: Mouthparts and antennae between ventral anchors. Neck expanded anteriorly with 4–10 prominent glands on anterior half;

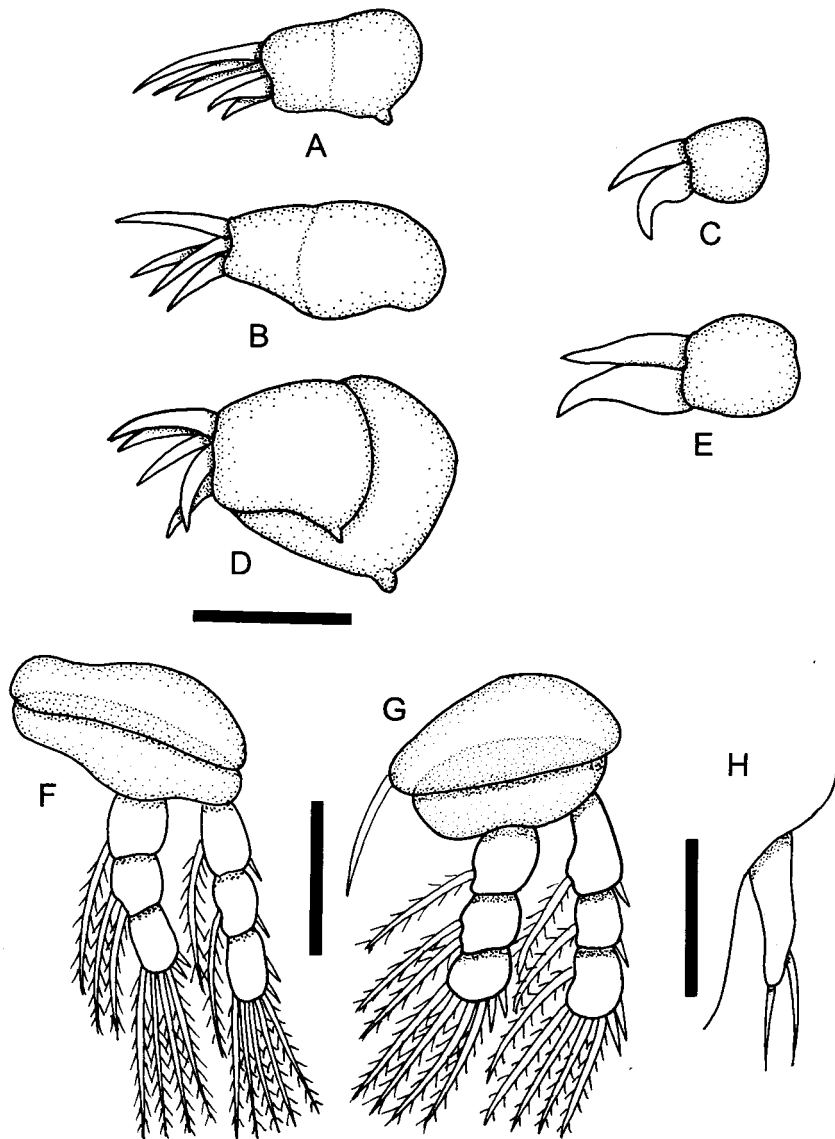


FIGURE 3.—Mouthparts (bar = 50  $\mu$ m): (A) maxilliped of *Bedsylernaea collaris*; (B) maxilliped of *Amazolernaea sannerae*; (C) second maxilla of *A. sannerae*; (D) maxilliped of *Perulernaea gamitanae*; and (E) second maxilla of *P. gamitanae*. Thoracopods (bars = 50  $\mu$ m): (F) second thoracopod of *A. sannerae*; (G) second thoracopod of *P. gamitanae*; and (H) fifth thoracopod of *P. gamitanae*.

neck represents about 67% of body length. Hind-body fusiform; pregenital prominence present; bears fourth and fifth pair of thoracopods and uropods. First antenna six-segmented, provided with simple setae. Second antenna two-segmented; first segment without spines or setae; second segment with one lateral spine and three medial spine-like sensilla on shaft and one large claw and five setae terminally. Mouthparts (Figure 3D,

E): second maxillae scissors-like, points straight or curved; maxillipeds two-segmented, first with blunt spine-like process posteriorly and second with one sharp spine posteriorly and five claws terminally. Thoracopods 1–4 similar (Figure 3G) except that the first bears only a single seta on the second exopodal segment. Fifth thoracopods represented by small papillae each with two simple setae (Figure 3H). Uropods two-segmented,

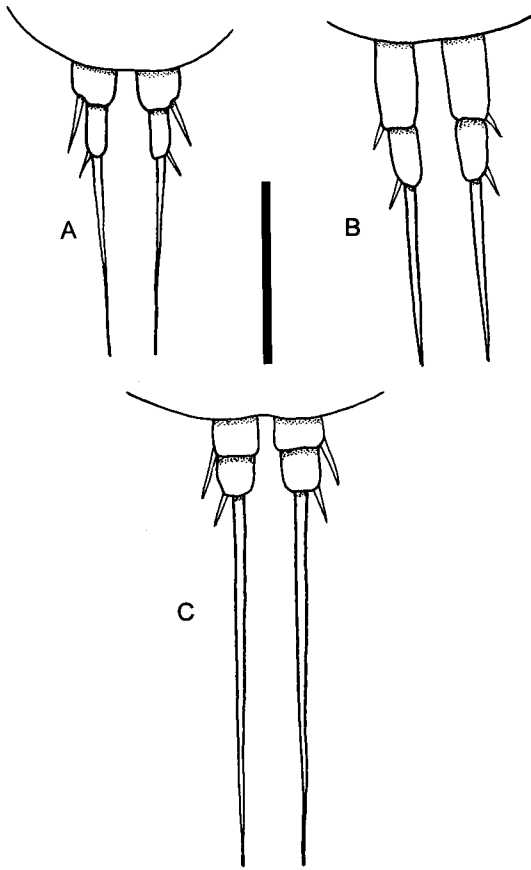


FIGURE 4.—Uropods (bar = 100  $\mu$ m): (A) *Amazolernaean sannerae*; (B) *Bedsylernaean collaris*; and (C) *Perulernaean gamitanae*.

each with two spines and a terminal seta (Figure 4C).

#### Discussion

*Amazolernaean sannerae* gen. et sp. nov. may be characterized as having four similar petal-like anchors; thoracopods 1 and 2 close together; a neck that is long and slender; a well-defined hindbody and an elongate abdomen which places the genital pore about midway on the hindbody. *Bedsylernaean collaris* gen. et sp. nov. is distinguished from all other known lernaeids by having a large inflated head region with a bulbous anchor on either side; a stout hindbody with a large genital prominence; anterolateral collar-like extensions on either side of the slender neck, and a genital pore anterior to the midregion of the hindbody. *Perulernaean gamitanae* Thatcher and Paredes, 1985, is seen to have two large and two small undivided anchors; a long, slender neck with prominent glands in the anterior

half; an elongate hindbody with a moderate genital prominence and a genital pore posterior to the midregion of the hindbody.

In contrast to these Amazonian lernaeids, the imported *Lernaean cyprinacea* has four elongate and frequently branching anchors and a neck region that expands gradually towards the posterior so that neither neck nor hindbody are clearly defined. The abdomen is short in all recognized species of *Lernaean* and is often bent dorsally. This results in a genital pore that is at or near the posterior extremity and egg sacs that project well beyond the body (Figure 1B).

In comparing the first antennae of the three lernaeids (Figure 2A–C), no striking difference is noted except for that of *Perulernaean*, which is more slender and has an elongate basal segment. The second antennae, on the other hand (Figure 2D–F) demonstrate some differences in the terminal claw.

No important differences could be discerned among the thoracopods and uropods of the three forms (Figures 3F, G and 4A–C, respectively). This is not surprising, because Kabata (1979) had already pointed out that the morphology of the appendages is so similar among members of this family as to be of little taxonomic value.

With respect to the two South American species attributed to *Lernaean*, namely *L. argentinensis* Paggi, 1972, and *L. lagenula* (Heller, 1868), Kabata (1979) considered the former to be valid and the latter to be doubtful. It has not yet been possible to obtain specimens of *L. argentinensis*, but given the published description and figures of Paggi (1972), the species cannot belong to *Lernaean* and may represent a new genus. The status of *L. lagenula* is complicated because it was reported only once and without host or locality. Apparently, no one has seen this form since. According to the figures reproduced in Yamaguti (1963), the species plainly does not belong to the genus *Lernaean* as currently defined. This form may represent an additional species of *Amazolernaean* since it has a well-defined neck and hindbody and a centrally located genital pore and the first two pairs of thoracopods are close together. It differs from *A. sannerae* sp. nov., however, in its body proportions. For example, in *L. lagenula* the hindbody is 58% of the body length and the neck is 42% as wide as the hindbody. These values for *A. sannerae* are 41% and 16%, respectively.

The other lernaeids reported from Argentina are *Areotrachelus truchae* (Brian, 1902) from creole perch *Percichthys trucha*; *Taurocheros salminisii*

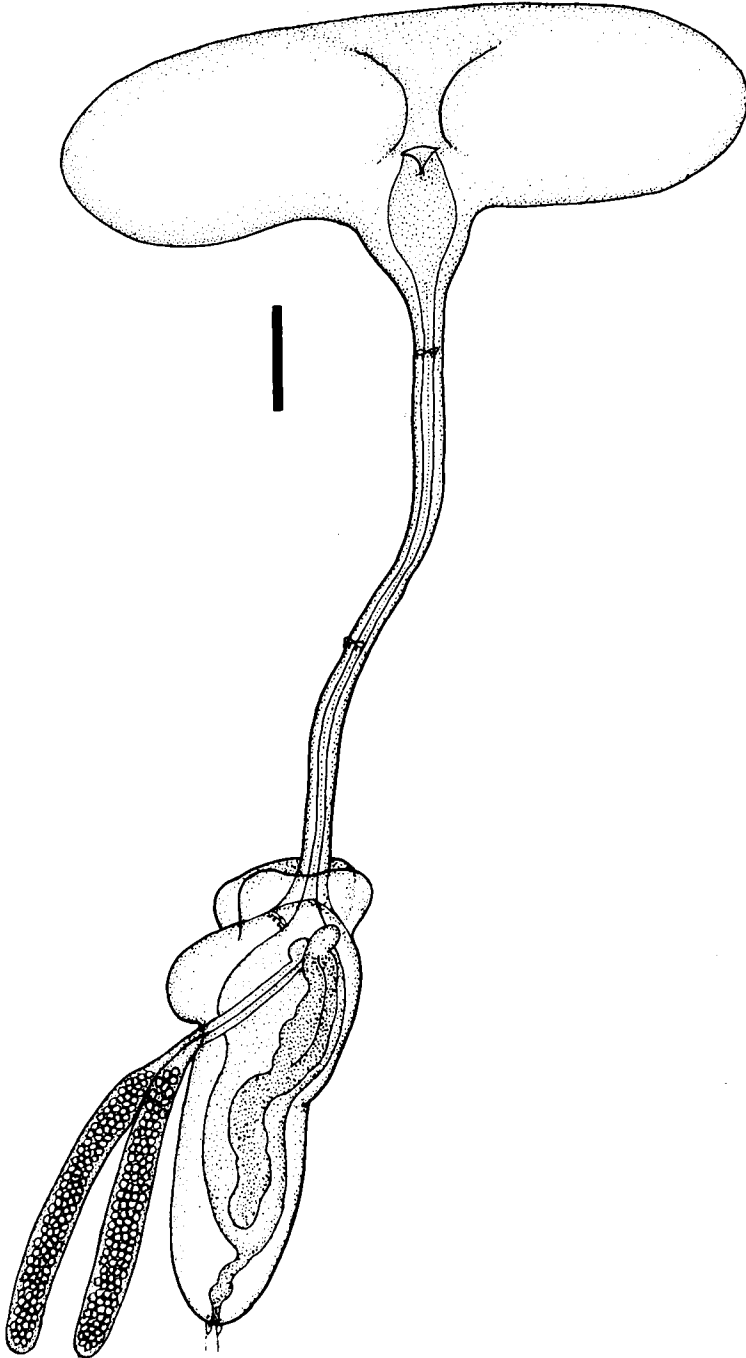


FIGURE 5.—*Bedsylernaea collaris* gen. et. sp. nov. (bar = 1 mm).

Brian, 1924, from dorado *Salminus maxillosus*; and *T. tarangophilus* described by Paggi (1976) from trahira *Hoplias malabaricus*. The former has a neck that is expanded anteriorly and a very long, tapered

hindbody. *Taurocheros* has two extremely long anchors that arise between the first two pairs of thoracopods. Neither of these forms would appear to be closely related to the Amazonian genera.



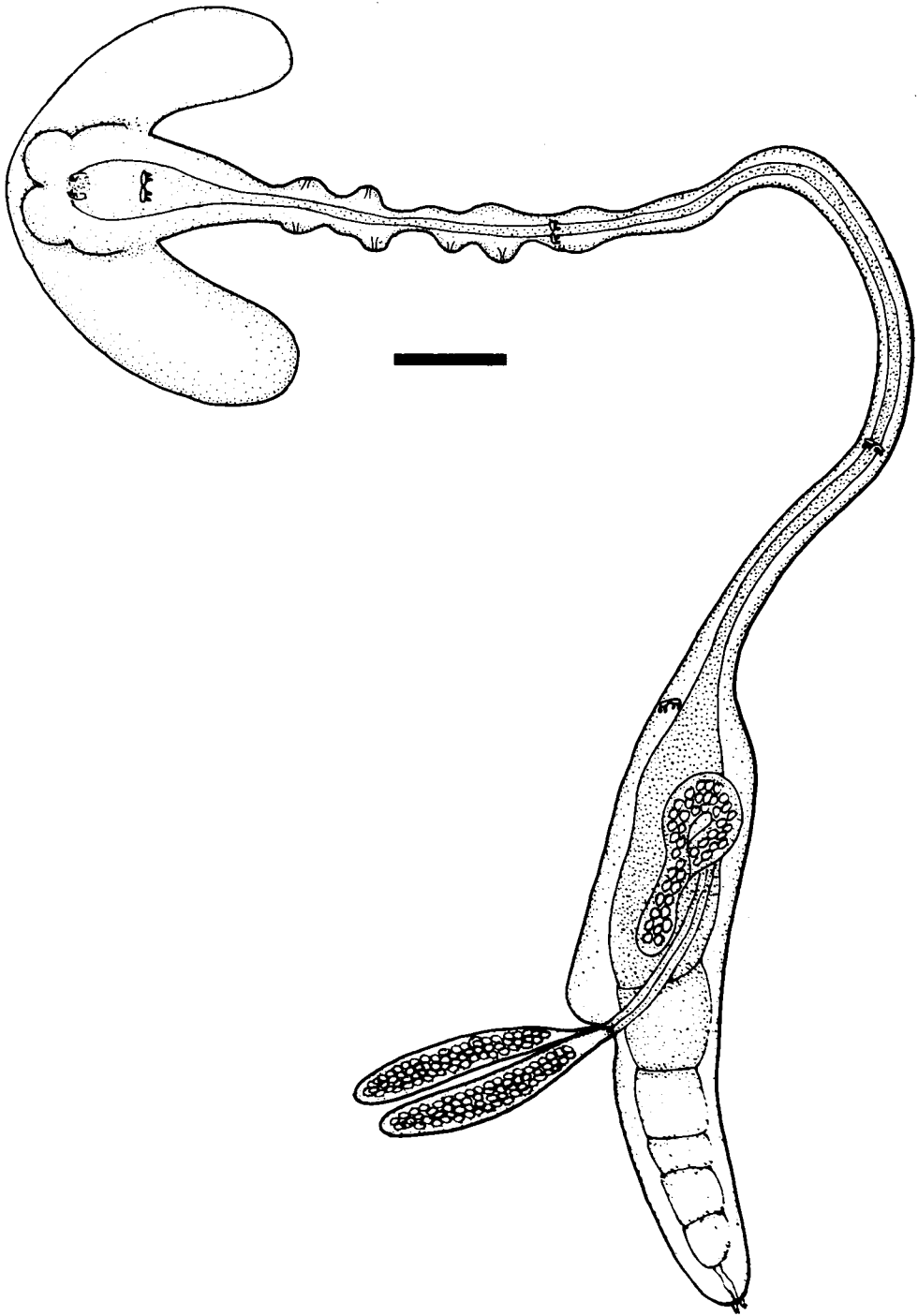


FIGURE 6.—*Perulernaea gamitanae* Thatcher and Paredes, 1985 (bar = 1 mm).

It was not possible to describe all of the appendages of the new genera in detail because of the limited number of specimens available. However, publication of the present study should alert others to the presence of these forms so that more material may become available in the near future.

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Received July 24, 1996  
Accepted December 9, 1997