

## Neotropical Monogenea. 12. Dactylogyridae from *Serrasalmus nattereri* (Cypriniformes, Serrasalminidae) and Aspects of Their Morphologic Variation and Distribution in the Brazilian Amazon

WALTER A. BOEGER<sup>1</sup> AND DELANE C. KRITSKY<sup>2</sup>

<sup>1</sup> Instituto Nacional de Pesquisas da Amazônia, Manaus, Amazonas, Brazil, and Department of Biological Sciences, Idaho State University, Pocatello, Idaho 83209 and

<sup>2</sup> Department of Allied Health Professions and Idaho Museum of Natural History, Idaho State University, Pocatello, Idaho 83209

**ABSTRACT:** The gills of *Serrasalmus nattereri* (Kner) were examined for Dactylogyridae from 2 distant locations in the Brazilian Amazon to determine species composition and morphologic variation. Three new genera are proposed. *Amphithecium* gen. n. is characterized in part by species possessing 2 dorsal bilateral vaginal pores. *Notothecium* gen. n. is distinguished by species having a vagina looping the left intestinal caecum and opening sinistrodorsally. The vagina in species of *Notothecium* gen. n. loops the right intestinal caecum and opens on the dextrodorsal surface of the trunk. The following species are described: *Anacanthorus thatcheri* sp. n., *A. maltae* sp. n., *A. reginae* sp. n., *A. rondonensis* sp. n., *A. sp.*, *Amphithecium calycinum* sp. n., *A. camelum* sp. n., *A. brachycirrum* sp. n., *A. falcatum* sp. n., *A. junki* sp. n., *A. catalaoensis* sp. n., *Notothecium mizellei* sp. n., *N. aegidatum* sp. n., *Notothecium penetrarum* sp. n., and *N. minor* sp. n. Two morphologic forms of *Amphithecium camelum* (*A. camelum* forma amazonas and *A. camelum* forma rondonia) are reported from the Brazilian states of Amazonas and Rondônia, respectively. The community structure of the Dactylogyridae from *S. nattereri* differs somewhat with respect to species present between Amazonas and Rondônia, although some species occur at both locations. A hypothesis for the terminal phylogeny of species of *Amphithecium*, *Notothecium*, and *Notothecium* is presented.

**KEY WORDS:** Dactylogyridae, Ancyrocephalinae, *Amphithecium* gen. n., *Nothothecium* gen. n., *Notothecium* gen. n., *Anacanthorus thatcheri* sp. n., *Anacanthorus maltae* sp. n., *Anacanthorus reginae* sp. n., *Anacanthorus rondonensis* sp. n., *Amphithecium calycinum* sp. n., *Amphithecium camelum* sp. n., *Amphithecium brachycirrum* sp. n., *Amphithecium falcatum* sp. n., *Amphithecium junki* sp. n., *Amphithecium catalaoensis* sp. n., *Notothecium mizellei* sp. n., *Notothecium aegidatum* sp. n., *Notothecium penetrarum* sp. n., *Notothecium minor* sp. n., Cypriniformes, Serrasalminidae, *Serrasalmus nattereri*, piranha cajú, cladistics, phylogenetic analysis, morphologic variation, distribution, Brazilian Amazon.

The piranha cajú, *Serrasalmus nattereri* (Kner), is widely distributed in South America, being absent only west of the Andes, south of the 37th parallel, and in the small eastern coastal streams between the Rio São Francisco and the mouth of the Rio de la Plata (Fig. 1). The fish is considered the most dangerous of the piranhas and is the most filmed and written about in popular accounts. Despite its vicious reputation, the piranha cajú, like other piranhas, is an important food source especially to low-income families in Brazil (Braga, 1976).

Most studies on parasites of fishes from the Amazon are local or are based on specimens collected from hosts held in aquaria. However, evidence of geographic variation in ectoparasitic communities in the Amazon was provided by Thatcher and Boeger (1983, 1984), who observed distinct parasitic species of *Brasergasilus* (Copepoda) on the same host obtained from 2 distant Amazonian localities. In a broader study,

Brooks et al. (1981), utilizing helminth species collected from the Magdalena, Maracaibo, Orinoco, Amazon, and Paraná-Rio de la Plata drainage systems, tested hypotheses of evolutionary origins of their hosts, freshwater stingrays (Potamotrygonidae), in South America. The purpose of the present study was to determine variation in monogenean communities occurring on the gills of *Serrasalmus nattereri* in ulterior Amazonian locations.

### Materials and Methods

Fish hosts were collected during 1983–1984 from 6 sites (Fig. 1, Table 1). Methods for collection and preparation of Monogenea for study, measurement, and illustration are those described by Kritsky et al. (1986). Length of the accessory piece of the copulatory complex of *Amphithecium*, *Notothecium*, and *Notothecium* species represents the interval between parallel lines on the respective drawings. Measurements are in micrometers; the mean is followed by the range in parentheses. Classification of Amazonian rivers (white

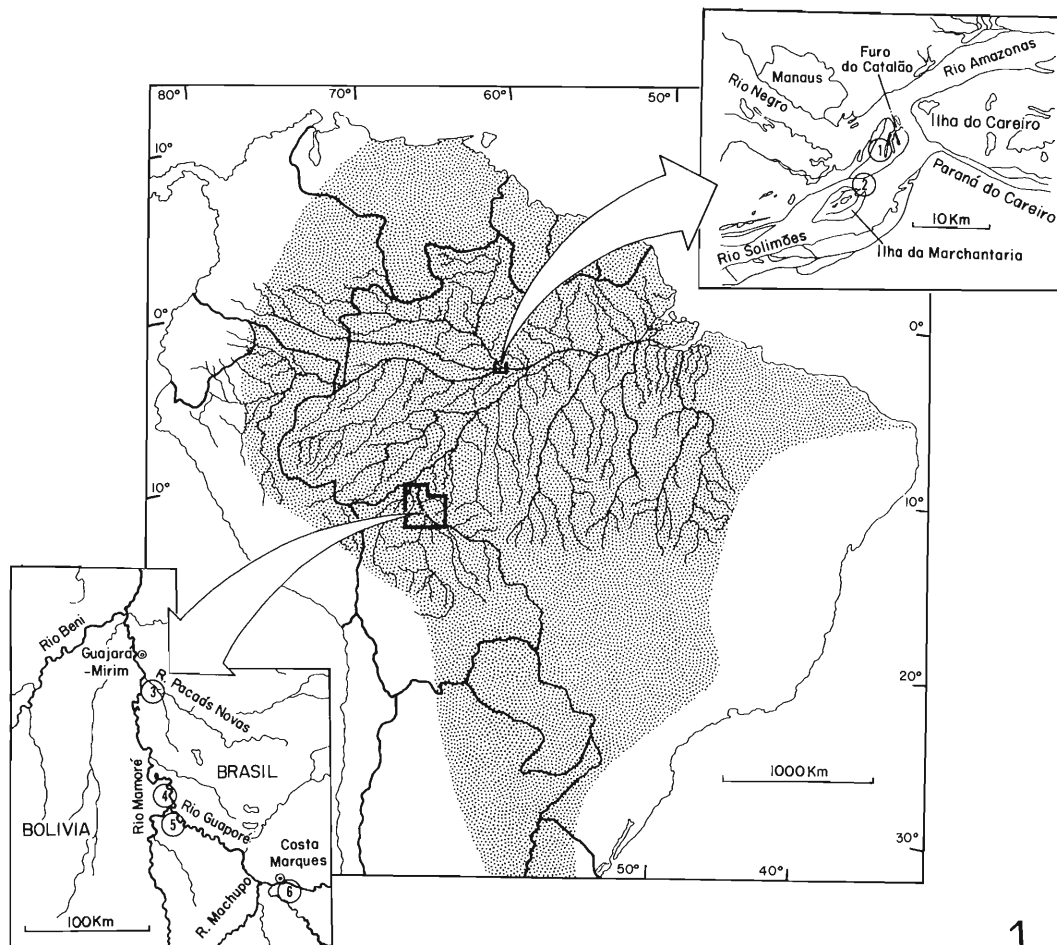


Figure 1. Map of northern South America showing collection sites (circled numbers) and distribution (modified from Braga, 1976) of *Serrasalmus nattereri* (shaded area). See Table 1 for specific identification of collection sites.

water, clear water, black water) follows that proposed by Geisler et al. (1973) and is based on respective physical and chemical characteristics.

Initial hypotheses on evolutionary relationships for species of *Amphithecium*, *Notothecium*, and *Notozothecium* were constructed using Hennigian argumentation (Hennig, 1966; Wiley, 1981) and tested with PAUP (D. L. Swofford, Illinois Natural History Survey, Champaign). Eighty character states comprising 36 homologous series were used in the analysis. Polarization within each series was determined by outgroup comparison (Wiley, 1981); functional outgroups as defined by Watrous and Wheeler (1981) were used when character states were entirely within the species group considered in the analysis. The dactylogyrid genus, *Urocleidoides* Mizelle and Price (sensu Kritsky et al., 1986) was used as the outgroup. Character states within homologous series represented by ratios were defined as groups of values with intervening distances greater than 0.15. Thus, some series utilizing ratios

were not useful in the analysis because it was not possible to define more than 1 character state.

Homologous series utilized in the analysis are listed below; numbers listed in parentheses refer to the locations of change in character state in the cladogram (Fig. 125). Body length: plesiomorphy = <1 mm (1); apomorphy = >1 mm (44). Body shape: plesiomorphy = fusiform (2); apomorphies = strongly flattened (61), ventrally concave (82). Dorsal body hump: plesiomorphy = absent (3); apomorphy = present (83). Tegument: plesiomorphy = scaled (4); apomorphies = smooth (45, 76), papillated (84). Esophagus: plesiomorphy = absent (5); apomorphy = present (70). Eyes: plesiomorphy = present (6); apomorphy = absent (60). Number, position of vaginal apertures: plesiomorphy = 2, bilateral (7); apomorphies = 1, dextral (35), 1, sinistral (58). Sclerotized plate around vaginal pore: plesiomorphy = absent (8); apomorphy = present (41, 68). Vaginal duct: plesiomorphy = sclerotized (9); apomorphy = nonsclerotized (51). Seminal receptacle: ple-

**Table 1. Localities from which collections of *Serrasalmus nattereri* (piranha cajú) were made during 1983–1984.**

Locality number	Location	Dates of collection	No. fish	Water type
1	Furo do Catalão, near Manaus, Amazonas, Brazil	11/27/84 11/23/84	10	Mixed white/black water
2	Ilha da Marchantaria, Rio Solimões, near Manaus, Amazonas, Brazil	8/15/84 11/25/84	19	White water
3	Rio Pacaás-Novos, near Guajará-Mirim, Rondônia, Brazil	11/28/83	1	Clear water
4	Rio Mamoré, near Surpresa, Rondônia, Brazil	6/19/84	2	Mixed white/clear water*
5	Rio Guaporé, near Surpresa, Rondônia, Brazil	6/16/84	9	Clear water
6	Rio Guaporé, near Costa Marques, Rondônia, Brazil	11/22/83	3	Clear water

\* Site 4 is at the confluence of the Rio Mamoré and Guaporé, therefore the water type is considered mixed.

siomorphy = present (10); apomorphy = absent (71). Ovary: plesiomorphy = with regular margins (11); apomorphy = with irregular margins (85). Vitellaria: plesiomorphy = randomly distributed (12); apomorphy = fimbriated (86). Prostatic reservoirs: plesiomorphy = 2 (13); apomorphy = 1 (46). Seminal vesicle: plesiomorphy = fusiform (14); apomorphy = C-shaped (62). Cirrus: plesiomorphy = coiled (15); apomorphy = straight (52). Number of cirral rami: plesiomorphy = 1 (16, 67); apomorphy = 2 (53). Relative length of cirral rami: plesiomorphy = subequal (54); apomorphy = unequal (57). Shape of cirral rami tips: plesiomorphy = pointed/pointed (50); apomorphies = pointed/funnel (75), pointed/reduced (56). Cirral aperture: plesiomorphy = terminal (17); apomorphy = diagonal (69). Cirral tip sclerotization: plesiomorphy = absent (18); apomorphy = present (80). Shape of accessory piece: plesiomorphy = T-shaped (19); apomorphy = otherwise (72, 77). Distal end of accessory piece: plesiomorphy = blunt (20); apomorphies = pointed (63), hooked (74), ornamented (36). Accessory piece flap: plesiomorphy = absent (21); apomorphy = present (64, 81). Size of accessory piece flap: plesiomorphy = about ½ length of distal portion of accessory piece (79); apomorphy = small (59). Ratio (hook pr. 5 length to cirral length): plesiomorphy =  $\leq 0.1$  (22); apomorphies = 0.2–0.5 (42, 73), 0.6–0.8 (55). Cleft on ventral bar: plesiomorphy = absent (23); apomorphy = present (87). Anteromedial projection on ventral bar: plesiomorphy = absent (24); apomorphy = present (34). Dorsal bar: plesiomorphy = projection absent (25); apomorphy = projection present (66). Anchor base: plesiomorphy = without proximal sclerotization (26); apomorphy = with proximal sclerotization (47). Ratio (ventral anchor length to dorsal anchor length): plesiomorphy =  $< 1.2$  (27); apomorphy =  $> 1.4$  (40, 88). Ratio (anchor point length to anchor shaft length): plesiomorphy =  $> 0.2$  (28); apomorphy =  $< 0.2$  (65, 78). Ratio (hook pr. 5 to hook pr. 2 length): plesiomorphy = 1.0 (29); apomorphy =  $< 0.8$  (37). Ratio (hook pr. 5 length to hook pr. 3 length): plesiomorphy =  $< 0.8$  (30); apomorphy = 1.0 (48). Ratio (hook pr. 5 length to hook pr. 4 length): plesiomorphy = 0.46–0.61 (31); apomorphies = 0.78 (43), 1.0 (38). Ratio (hook pr. 5 length to hook pr. 6 length): plesiomorphy =  $< 0.85$  (32); apomorphy = 1.0 (39). Ratio (hook pr. 5 length to hook

pr. 7 length): plesiomorphy =  $< 0.8$  (33); apomorphy = 1.0 (49).

Type specimens are those collected from the type locality and were used in the description of species. Types and vouchers (specimens collected from other localities) were deposited in the helminth collections of the Instituto Nacional de Pesquisas da Amazônia (INPA), the U.S.N.M. Helm. Coll. (USNM), and the University of Nebraska State Museum (HWML). For comparative purposes, the following specimens of previously described species were examined: *Anacanthorus anacanthorus*, holotype (USNM 60459), paratype (HWML 21539); *Anacanthorus brazilensis*, holotype (USNM 60460), 6 paratypes (HWML 21538); *Anacanthorus neotropicalis*, holotype, paratype (USNM 60461), 2 paratypes (HWML 21537); *Cleidodiscus amazonensis*, holotype, paratype (USNM 60462), paratype (HWML 21289); *Cleidodiscus piranhus*, holotype (USNM 60463), paratype (HWML 21290); *Cleidodiscus serrasalmus*, holotype (USNM 60464); *Urocleidus crescentis*, holotype (USNM 60465); and *Urocleidus orthus*, holotype (USNM 60466).

## Results

### Dactylogyridae Bychowsky, 1933

#### Anacanthorinae Price, 1967

#### *Anacanthorus thatcheri* sp. n.

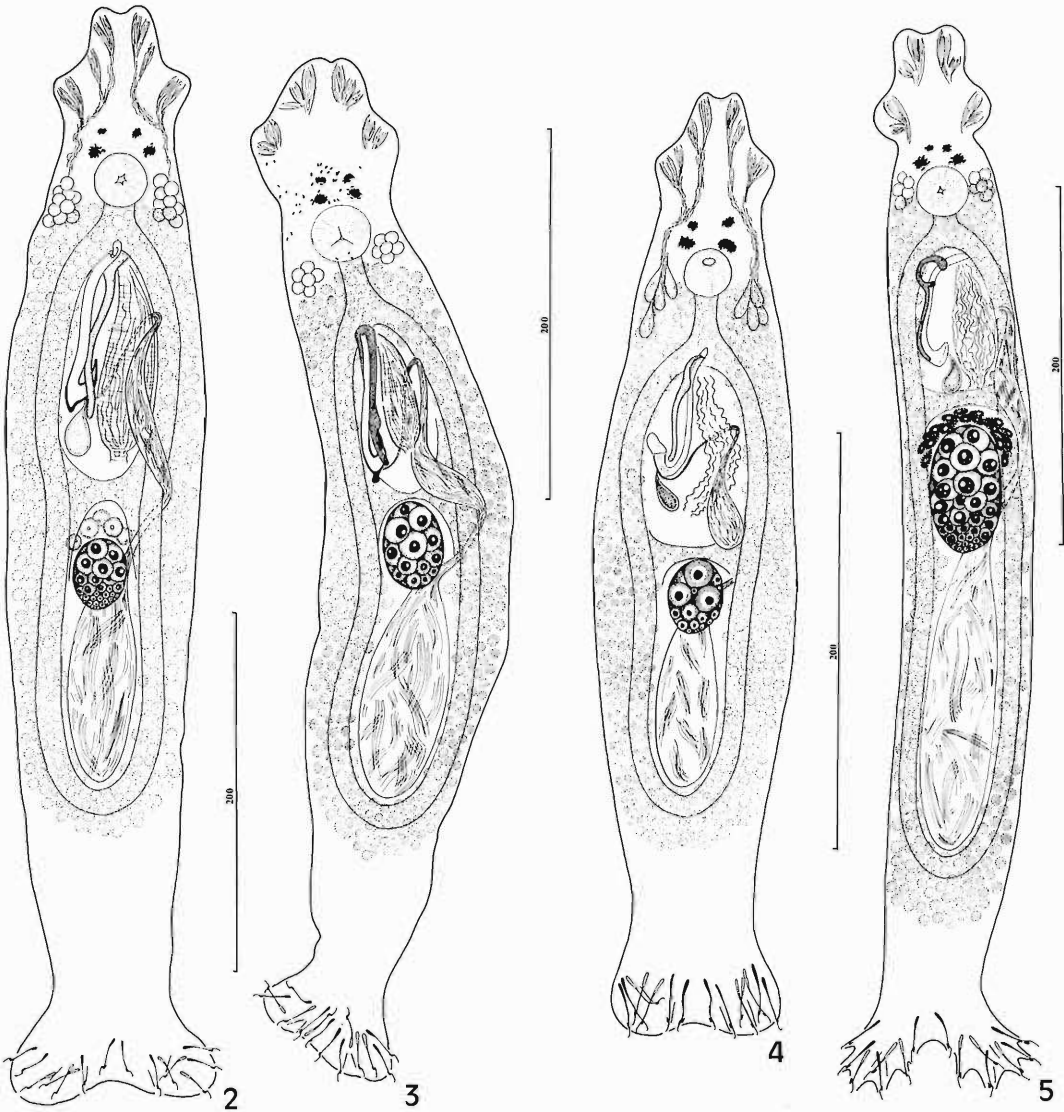
(Figs. 2, 6–11)

TYPE LOCALITY: Rio Solimões, Ilha da Marchantaria near Manaus, Amazonas, Brazil (Locality 2).

OTHER RECORDS: Localities 1, 3, 4–6.

SPECIMENS DEPOSITED: Holotype, INPA PA300-1; paratypes, INPA PA300-2–10, USNM 79196, HWML 23370; vouchers, USNM 79203, 79213, 79219, 79223, 79237, 79286, HWML 23376, 23385, 23391, 23395.

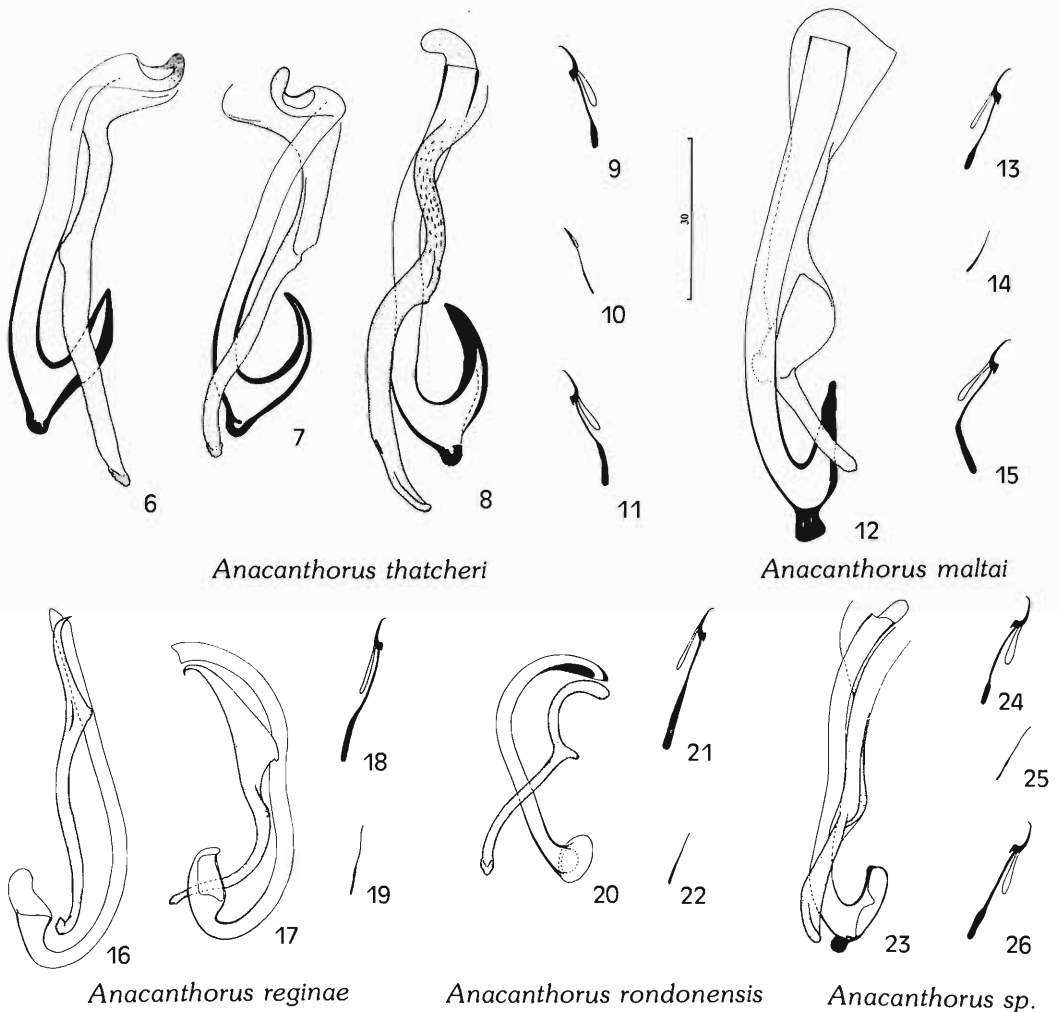
DESCRIPTION (based on 65 specimens): Body fusiform, 684 (607–804) long; greatest width 126 (103–156) near midlength or in anterior trunk. Two terminal, 2 bilateral cephalic lobes well de-



Figures 2-5. Whole-mount illustrations (ventral) of *Anacanthorus* spp. 2. *Anacanthorus thatcheri* (holotype). 3. *Anacanthorus maltai* (holotype). 4. *Anacanthorus reginae* (holotype). 5. *Anacanthorus rondonensis* (holotype).

veloped; head organs large, generally 5 pairs lying in cephalic lobes and adjacent areas; cephalic glands lying near posterolateral margin of pharynx. Members of posterior pair of eyes larger, usually farther apart than members of anterior pair; granules of variable size, elongate ovate; accessory granules absent or few in proximity of eyes. Mouth subterminal; pharynx spherical, 36 (32-44) in diameter; esophagus short. Peduncle broad, moderately long; haptor bilobed, 57 (39-79) long, 128 (108-160) wide. Large hooks similar; each with short recurved point, depressed

thumb, shank expanded proximally; hook 1-3, 6, 7-21 (19-23) long; hook 4, 5-24 (23-27) long; filamentous hook loop (FH loop) 0.5 shank length. Small hook splinter-like, 13 (11-15) long; FH loop 0.3 shank length. Testis ovate, 148 (120-178) long, 52 (30-67) wide; seminal vesicle elongate, a slight dilation of vas deferens; prostatic reservoir with thick wall. Cirrus 76 (68-83) long, J-shaped, base with anterior pointed process, cirrus tip with subterminal aperture and spathulate distal projection. Accessory piece 85 (80-94) long, not articulated to cirrus, with small expansion



Figures 6–26. Sclerotized structures of *Anacanthorus* spp. Figures 6–11. *Anacanthorus thatcheri*. 6–8. Copulatory complexes. 9. Hook 1, 3, 5–7. 10. Small hook. 11. Hook 2, 4. Figures 12–15. *Anacanthorus maltai*. 12. Copulatory complex. 13. Hook 1, 3, 5–7. 14. Small hook. 15. Hook 2, 4. Figures 16–19. *Anacanthorus reginae*. 16, 17. Copulatory complexes. 18. Large hook. 19. Small hook. Figures 20–22. *Anacanthorus rondonensis*. 20. Copulatory complex. 21. Large hook. 22. Small hook. Figures 23–26. *Anacanthorus* sp. 23. Copulatory complex. 24. Hook 1, 3, 5–7. 25. Small hook. 26. Hook 2, 4.

near midlength. Ovary ovate to subspherical, 73 (48–99) long, 43 (37–55) wide; ootype immediately anterior to ovary; uterus with moderately sclerotized distal wall; vagina, seminal receptacle absent. Vitellaria coextensive with caeca; vitelline commissure anterior to ootype.

**ETYMOLOGY:** This species is named for Dr. Vernon E. Thatcher, INPA, in recognition of his contributions in tropical parasitology.

**REMARKS:** Based on the morphology of the cirrus, this species resembles *A. anacanthorus* Mizelle and Price, 1965, and *A. maltai* sp. n.

*Anacanthorus thatcheri* sp. n. is easily differentiated from these species by having a spatulate cirrus tip.

***Anacanthorus maltai* sp. n.**  
(Figs. 3, 12–15)

**TYPE LOCALITY:** Rio Mamoré near Surpresa, Rondônia, Brazil (Locality 4).

**OTHER RECORDS:** Localities 3, 5, 6.

**SPECIMENS DEPOSITED:** Holotype, INPA PA301-1; paratypes, INPA PA301-2–5, USNM

79185, HWML 23359; vouchers, USNM 79210, 79224, 79246, HWML 23383.

**DESCRIPTION** (based on 24 specimens): Body fusiform, 636 (461–815) long; greatest width 128 (57–152) near midlength. Cephalic lobes well developed, 2 terminal, 2 bilateral; head organs well developed, generally 5 pairs in cephalic lobes; cephalic glands lying near posterolateral margin of pharynx. Members of posterior pair of eyes farther apart, larger than those of anterior pair; accessory granules absent, few or numerous in cephalic region. Mouth subterminal; pharynx spherical, 34 (27–42) in diameter; esophagus elongate. Peduncle broad, elongate; haptor bilobed, 72 (42–104) long, 89 (55–144) wide. Large hooks similar; each with short recurved point, depressed thumb, tapered shank; hook 22 (19–27) long; FH loop about 0.5 shank length. Small hook splinter-like, 11 (10–12) long. Testis elongate ovate, 159 (112–202) long, 67 (37–90) wide; seminal vesicle a sigmoid dilation of vas deferens; prostatic reservoir not observed. Cirrus 93 (86–99) long, J-shaped, with elongate base possessing conspicuous posterior heel-like projection. Accessory piece 90 (85–95) long, not articulated to cirrus base, twisted near midlength, proximal portion rod-shaped, distal portion spatulate. Ovary ovate to subspherical, 69 (60–80) long, 43 (25–60) wide; ootype immediately anterior to ovary; uterus muscular, with sclerotized distal wall; vagina, seminal receptacle absent. Vitellaria dense, coextensive with caeca; vitelline commissure anterior to ovary.

**ETYMOLOGY:** *Anacanthorus maltai* sp. n. is named for José Celso de Oliveira Malta, who kindly provided the hosts from Rondônia.

**REMARKS:** The general morphology of the copulatory complex and hooks indicate a close relationship between *A. maltai* and *A. thatcheri*. *Anacanthorus maltai* differs from *A. thatcheri* by having a larger posterior heel-like projection on the cirrus base, a nonspatulate tip of the cirrus tube, and an elongate flattened distal portion on the accessory piece.

***Anacanthorus reginae* sp. n.**  
(Figs. 4, 16–19)

**TYPE LOCALITY:** Rio Solimões, Ilha da Marçantaria near Manaus, Amazonas, Brazil (Locality 2).

**OTHER RECORDS:** Localities 1, 3–6.

**SPECIMENS DEPOSITED:** Holotype, INPA PA293-1; paratypes, INPA, PA293-2–5; USNM

79190, HWML 23364; vouchers, USNM 79204, 79209, 79220, 79221, 79236, HWML 23377, 23382, 23392, 23393, 23406.

**DESCRIPTION** (based on 35 specimens): Body fusiform, 443 (289–499) long; greatest width 107 (89–144) near midlength. Cephalic lobes well developed, 2 terminal, 2 bilateral; head organs large, generally 4 pairs lying in cephalic lobes; cephalic glands posterolateral to pharynx. Eyes equidistant, members of posterior pair larger; eye granules variable in size; accessory granules absent to numerous in cephalic area and anterior trunk. Mouth subterminal; pharynx spherical, 25 (22–32) in diameter; esophagus elongate. Peduncle broad; haptor bilobed, 48 (34–72) long, 81 (44–123) wide. Large hooks similar; each with short recurved point, depressed thumb, shank tapering distally; hook 28 (23–34) long; FH loop 0.5 shank length; small hook splinter-like, 11 (9–13) long. Testis ovate, 92 (73–120) long, 45 (34–62) wide; seminal vesicle a pyriform dilation of vas deferens; prostatic reservoir with thick wall. Cirrus 67 (57–76) long, J-shaped, with simple base. Accessory piece 59 (42–67) long, not articulated to cirrus base, rod-shaped, with variable subterminal expanded area (compare Figs. 16, 17). Ovary ovate to subspherical, 44 (31–55) long, 29 (25–37) wide; ootype inconspicuous; uterus with sclerotized distal wall; vagina, seminal receptacle absent. Vitellaria dense, coextensive with caeca; vitelline commissure anterior to ovary.

**ETYMOLOGY:** This species is named for Regina T. Boeger, wife of the senior author.

**REMARKS:** This species differs from all previously described species of *Anacanthorus* by possessing a rod-shaped accessory piece with a variable subterminal expansion. It is apparently related to *A. neotropicalis* Mizelle and Price, 1965, based on the comparative morphology of the large haptoral hooks.

***Anacanthorus rondonensis* sp. n.**  
(Figs. 5, 20–22)

**TYPE LOCALITY:** Rio Mamoré near Surpresa, Rondônia, Brazil (Locality 4).

**OTHER RECORDS:** Localities 3, 5, 6.

**SPECIMENS DEPOSITED:** Holotype, INPA PA298-1; paratypes, INPA PA298-2–4, USNM 79194, HWML 23368; vouchers, USNM 79222, 79245, HWML 23394.

**DESCRIPTION** (based on 63 specimens): Body fusiform, 588 (497–692) long; greatest width 108 (78–173) near midlength. Cephalic lobes well de-

veloped, 2 terminal, 2 bilateral; head organs large, generally 4 pairs lying in cephalic lobes; cephalic glands unicellular, lying lateral to pharynx. Members of anterior pair of eyes smaller, usually closer together than those of posterior pair; accessory granules absent or few in proximity of eyes. Mouth subterminal; pharynx spherical, 29 (25–32) in diameter; esophagus short. Peduncle broad; haptor bilobed, 79 (41–83) long, 98 (63–132) wide. Large hook with short recurved point, depressed thumb, shank expanded proximally; hook 26 (23–31) long; FH loop 0.5 shank length; small hook 11 (10–13) long, splinter-like. Testis elongate ovate, 168 (110–212) long, 53 (42–65) wide; seminal vesicle an elongate fusiform dilation of vas deferens; prostatic reservoir with thick wall. Cirrus 44 (41–47) long, sickle-shaped, with subcircular base and thick-walled distal end. Accessory piece 42 (39–45) long, not articulating to cirrus base, with C-shaped distal portion. Ovary ovate, 57 (45–63) long, 32 (24–37) wide; ootype immediately anterior to ovary; uterus large with moderately sclerotized distal wall; vagina, seminal receptacle absent. Vitellaria dense, coextensive with caeca; vitelline commissure anterior to ovary.

**ETYMOLOGY:** The specific name reflects the Brazilian state from which the specimens were collected.

**REMARKS:** This species is similar to *Anacanthorus neotropicalis* Mizelle and Price, 1965, from which it differs by possessing an accessory piece with an elongate proximal arm and distinct C-shaped termination.

***Anacanthorus* sp.**  
(Figs. 23–26)

**RECORDS:** Localities 1, 2.

**SPECIMENS DEPOSITED:** Vouchers, INPA PA305-1, 2; USNM 79197, HWML 23371.

**REMARKS:** The collections of this species were insufficient to provide a detailed description. Nonetheless, they apparently represent an undescribed species that is closely related to *Anacanthorus thatcheri* and *A. maltae*. The undescribed species lacks the acute anterior process on the base of the accessory piece, characteristic of the latter 2 species.

**Ancyrocephalinae Bychowsky, 1937**

***Amphithecium* gen. n.**

**DIAGNOSIS:** Body divisible into cephalic region, trunk, peduncle, haptor. Tegument thin,

smooth, scaled, or papillate. Two terminal, 2 bilateral cephalic lobes; head organs, unicellular cephalic glands present. Four eyes. Mouth subterminal, midventral; pharynx muscular, glandular; esophagus present; intestinal caeca 2, confluent posterior to testis, lacking diverticula. Gonads intercaecal, overlapping; testis dorsal to ovary. Vas deferens looping left caecum; seminal vesicle a simple dilation of vas deferens. Two prostatic reservoirs; prostates comprising 2 bilateral glandular areas lying dorsal to caeca. Genital pore midventral near level of caecal bifurcation. Copulatory complex comprising an accessory piece, biramous cirrus; accessory piece articulated to cirrus base. Two dorsal bilateral vaginae united medially by common nonsclerotized duct; seminal receptacle absent. Vitellaria coextensive with caeca, commissure anterior to ovary. Haptor armed with pairs of dorsal and ventral anchors, dorsal and ventral bars, 7 pairs of hooks with ancyrocephaline distribution. Hook with shank of 2 distinct parts. Parasites of gills of Serrasalmidae.

**TYPE SPECIES:** *Amphithecium calycinum* sp. n. from *Serrasalmus nattereri*.

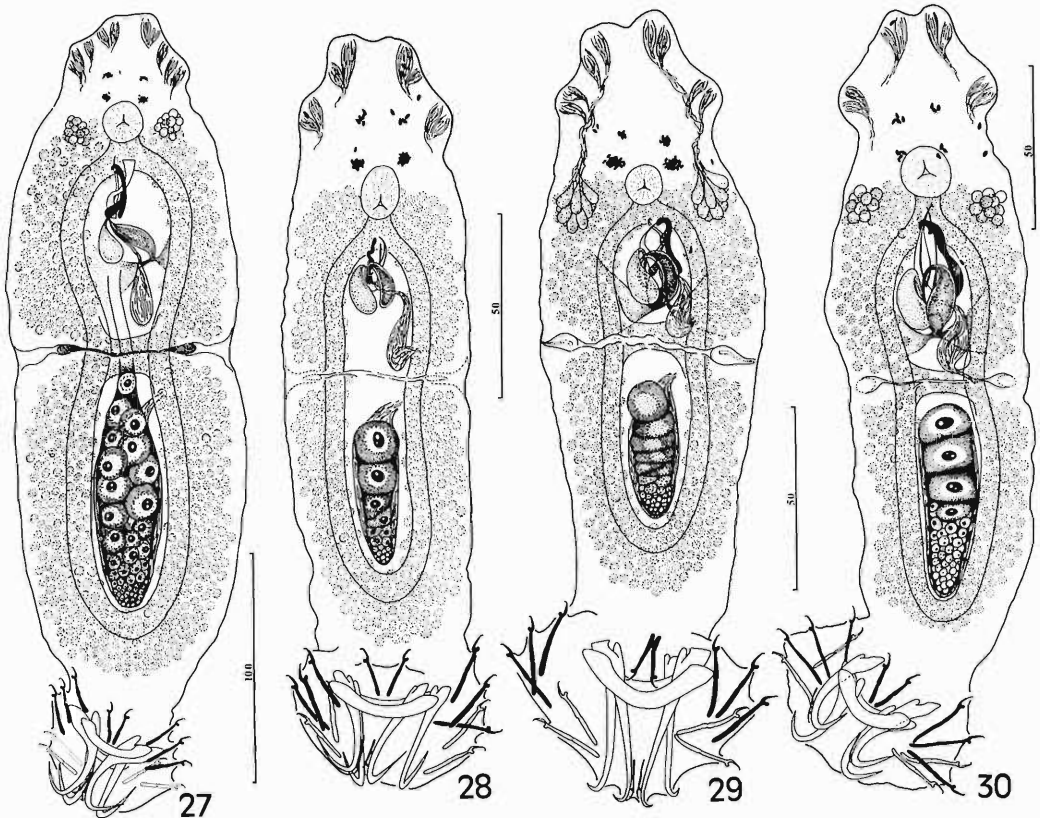
**OTHER SPECIES:** *A. brachycirrum*, *A. camelum*, *A. catalaoensis*, *A. falcatum*, and *A. junki* spp. n., all from *Serrasalmus nattereri*.

**OTHER POSSIBLE MEMBER:** *Cleidodiscus amazonensis* Mizelle and Price, 1965, from *Serrasalmus nattereri*.

**ETYMOLOGY:** The generic name is from Greek (*amphis* = on both sides + *theke* = case) and refers to the dorsal bilateral vaginae.

**REMARKS:** *Amphithecium* gen. n. provides an example of the significance of the internal morphology in systematic studies of the Dactylogyridae. If the subsequent descriptions included details of only the sclerotized parts of the haptor and copulatory complex, all species, including those of the following 2 new genera, *Notothecium* and *Notozothecium*, would be included in the same generic taxon. Indeed, the placement of the previously described ancyrocephaline species from *Serrasalmus nattereri* by Mizelle and Price (1965) into *Cleidodiscus* and *Urocleidus* is likely a result of incomplete knowledge of internal anatomy. Although the haptoral structures of species of *Amphithecium* can be considered morphologically generalized for dactylogyrids, the new genus is unique in its character of the double unsclerotized vaginal apertures. Other combined features that characterize the genus are the bi-





Figures 27–30. Whole-mount illustrations (ventral) of *Amphithecium* spp. 27. *Amphithecium calycinum* (holotype). 28. *Amphithecium brachycirrum* (holotype). 29. *Amphithecium junki* (holotype). 30. *Amphithecium falcatum* (holotype).

ramous cirrus, overlapping gonads, accessory piece articulated to the cirrus base, and hooks with shanks of 2 distinct parts.

Gussev (1978) considered paired vaginae as an extraordinary character for dactylogyrideans and indicated *Neodactylodiscus* Kamegai, 1971, and *Dactylogyrus obscurus* Gussev, 1955 (= *Bivaginogyrus obscurus* (Gussev, 1955) Gussev and Gerasev, 1986), as the only taxa where this character is present. The functional relationship between the double vaginae and the biramous cirrus of *Amphithecium* species is not clear. In most of the specimens examined, the duct uniting the 2 vaginae is filled with sperm indicating that it functionally replaces the seminal receptacle.

Kritsky and Thatcher (1983) suggested that the previously described monogenes from *Serrasalmus nattereri* assigned by Mizelle and Price (1965) to *Cleidodiscus* and *Urocleidus* are members of unique and undefined Neotropical genera. Our examination of the holotypes and paratypes

of these species indicated that one, *C. amazonensis*, may belong to *Amphithecium*. The cirrus of this species possesses 2 well-developed rami (Fig. 89), a characteristic of *Amphithecium*. However, because the internal morphology of this species could not be determined from the unstained and cleared types, it is provisionally retained in *Cleidodiscus* until recollected and its internal anatomy defined; the species is clearly not a member of *Cleidodiscus* as defined by Beverley-Burton (1984).

*Amphithecium calycinum* sp. n.  
(Figs. 27, 31–39)

TYPE LOCALITY: Rio Guaporé near Surpresa, Rondônia, Brazil (Locality 5).

OTHER RECORDS: Localities 1–4, 6.

SPECIMENS DEPOSITED: Holotype, INPA PA295-1; paratypes, INPA PA295-2–4, USNM 79192, HWML 23366; vouchers, INPA PA296-1, USNM 79198–79202, HWML 23372–23375.



**DESCRIPTION** (based on 44 specimens): Body fusiform, length 290 (250–341); greatest trunk width 110 (90–122) at level of gonads. Tegument smooth. Cephalic lobes well developed; usually 4 pairs of head organs, 1 additional pair occasionally present; cephalic glands lateral to pharynx. Members of anterior pair of eyes smaller, usually closer together than members of posterior pair; eye granules elongate ovate, variable in size; accessory granules absent or few in proximity of eyes. Pharynx spherical, 18 (17–21) in diameter; esophagus short. Peduncle broad. Haptor subhexagonal, 44 (35–50) long, 60 (50–73) wide. Anchors similar; each with elongate superficial root, evenly curved shaft, recurved point; ventral anchor 27 (25–30) long, base 13 (12–16) wide; dorsal anchor 28 (25–31) long, base 15 (14–16) wide. Ventral bar 26 (23–30) long, with subterminal expansions; dorsal bar 25 (24–28) long, undulating. Hook 2–4, 6, 7 similar; each with erect thumb, slightly curved shaft, short point, inflated shank; hook 1, 5 with slender shank; hook 1–14 (13–16) long; hook 2, 6–16 (15–18) long; hook 3, 4, 7–21 (19–24) long; hook 5–12 (11–14) long. FH loop 0.8 length of distal portion of shank. Cirrus 31 (26–40) long, with needle-like and funnel-shaped rami, base variable. Accessory piece 21 (18–26) long, with hooked distal process, flexible proximal process articulating to cirrus base. Testis elongate ovate, 64 (49–82) long, 28 (22–34) wide; seminal vesicle pyriform, small; prostates well developed; prostatic reservoirs with heavy walls. Ovary elongate ovate, 67 (51–88) long, 29 (18–48) wide; ootype consisting of large cells lying immediately anterior to common vaginal duct. Vitellaria dense.

**ETYMOLOGY:** The specific name is from Neolatin (*calycin/o* = cuplike) and refers to the shape of the largest cirral ramus.

**REMARKS:** *Amphithecium calycinum* is the type species for the genus.

***Amphithecium brachycirrum* sp. n.**

(Figs. 28, 40–47)

**TYPE LOCALITY:** Furo do Catalão near Manaus, Amazonas, Brazil (Locality 1).

**OTHER RECORDS:** Localities 2–6.

**SPECIMENS DEPOSITED:** Holotype, INPA PA302-1; paratypes, INPA PA302-2, USNM 79186, HWML 23360; vouchers, USNM 79206–79208, 79232, 79238, HWML 23379–23381, 23402.

**DESCRIPTION** (based on 10 specimens): Body

fusiform, length 204 (196–217); greatest width 62 (54–72) near midlength. Tegument scaled on trunk, peduncle. Cephalic lobes well developed; generally 4 pairs of head organs. Members of anterior pair of eyes smaller, usually closer together than members of posterior pair; eye granules ovate; accessory granules usually present in cephalic region. Pharynx ovate, 12 (11–13) wide; esophagus short. Peduncle broad. Haptor subovate, 39 (37–45) long, 55 (53–57) wide. Anchors similar; each with well-developed roots, recurved point; ventral anchor 27 (25–28) long, with evenly curved shaft, base 12 (11–13) wide; dorsal anchor 27 (26–28) long, with straight shaft, base 11–12 wide. Ventral bar 30 (27–32) long, with subterminal anterior expansions; dorsal bar 29 (27–30) long, broadly U-shaped. Hook 1–4, 6, 7 with erect thumb, slightly curved shaft, short point, inflated shank; hook 5 with slender shank, small proximal inflation; hook 1, 5–13 (12–14) long; hook 2–19 (17–21) long; hook 3, 7–21 (20–23) long; hook 4–23 (21–24) long; hook 6–16 (15–17) long; FH loop 0.8 length of distal portion of shank. Cirral rami needle-like; cirrus 17 (14–21) long. Accessory piece 13 (9–16) long, variable. Testis elongate ovate, 32 (28–35) long, 11 (9–12) wide; seminal vesicle sigmoid. Prostates poorly developed; prostatic reservoirs with thick walls. Ovary elongate ovate, 36 (35–37) long, 13 (11–15) wide; ootype, uterus not observed. Vitellaria dense.

**ETYMOLOGY:** The specific name is from Greek (*brachys* = short) and refers to the small size of the copulatory complex.

**REMARKS:** Based on the morphology of the anchors, hooks, and bars, *Amphithecium brachycirrum* resembles the type species, *A. calycinum*. It is easily differentiated from this species by lacking a hook-shaped termination of the accessory piece.

***Amphithecium junki* sp. n.**

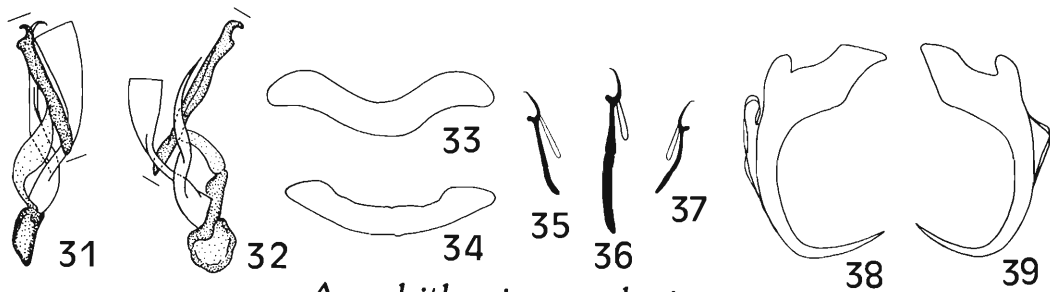
(Figs. 29, 48–55)

**TYPE LOCALITY:** Furo do Catalão near Manaus, Amazonas, Brazil (Locality 1).

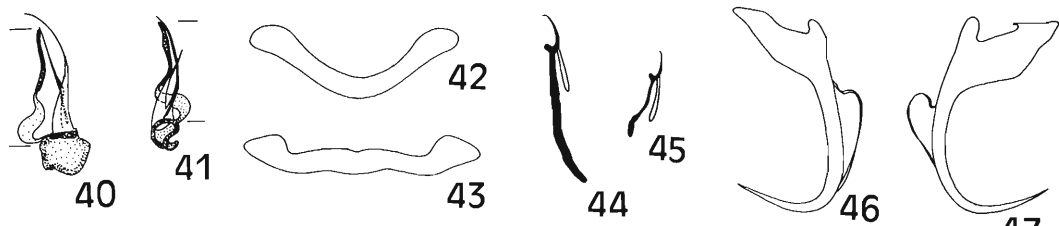
**OTHER RECORDS:** Localities 2–6.

**SPECIMENS DEPOSITED:** Holotype, INPA PA294-1; paratypes, INPA PA294-2–5, USNM 79191, HWML 23365; vouchers, USNM 79214, 79215, 79217, 79231, 79239, HWML 23386, 23387, 23389, 23401.

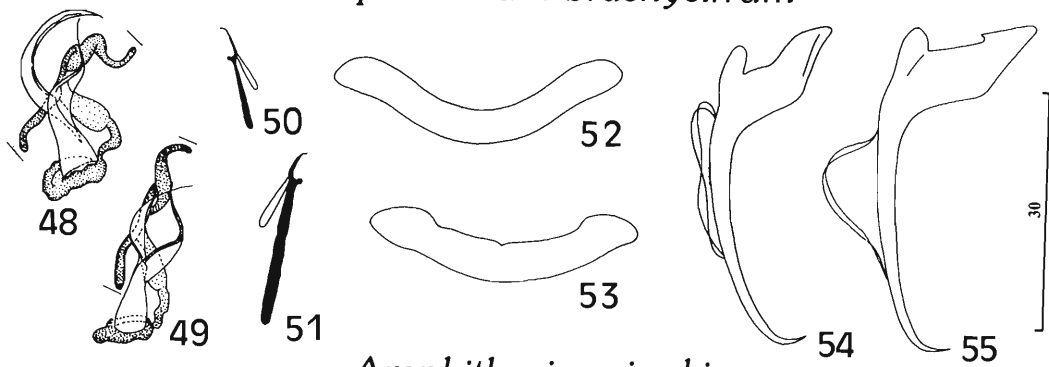
**DESCRIPTION** (based on 46 specimens): Body fusiform, length 228 (195–282); greatest width



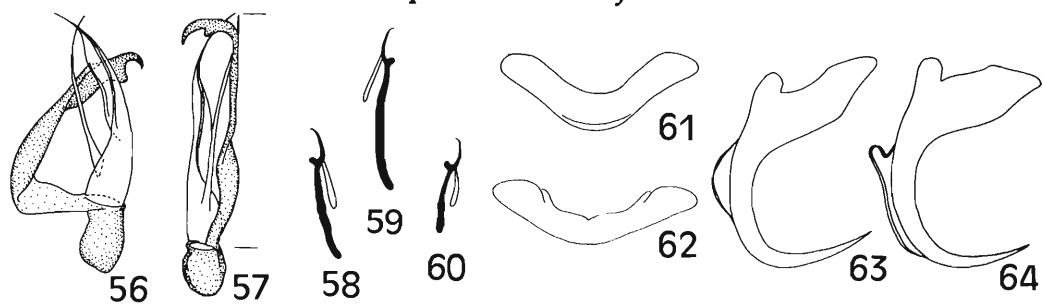
*Amphithecium calycinum*



*Amphithecium brachycirrum*



*Amphithecium junki*



*Amphithecium falcatum*

Figures 31–64. Sclerotized structures of *Amphithecium* spp. Figures 31–39. *Amphithecium calycinum*. 31. Copulatory complex. 32. Copulatory complex (dorsal). 33. Dorsal bar. 34. Ventral bar. 35. Hook pair 1. 36. Hook 2–4, 6, 7. 37. Hook 5. 38. Dorsal anchor. 39. Ventral anchor. Figures 40–47. *Amphithecium brachycirrum*. 40, 41. Copulatory complexes (dorsal). 42. Dorsal bar. 43. Ventral bar. 44. Hook 1–4, 6, 7. 45. Hook 5. 46. Dorsal anchor. 47. Ventral anchor. Figures 48–55. *Amphithecium junki*. 48, 49. Copulatory complexes (dorsal). 50. Hook 1. 51. Hook 1–4, 6, 7. 52. Dorsal bar. 53. Ventral bar. 54. Dorsal anchor. 55. Ventral anchor. Figures 56–64. *Amphithecium falcatum*. 56. Copulatory complex. 57. Copulatory complex (dorsal). 58. Hook 1. 59. Hook 2–4, 6, 7. 60. Hook 5. 61. Dorsal bar. 62. Ventral bar. 63. Dorsal anchor. 64. Ventral anchor.

66 (46–81) near midlength or in anterior trunk. Tegument scaled on trunk, peduncle. Cephalic lobes well developed; usually 4 pairs of head organs; cephalic glands lying posterolateral to pharynx. Members of anterior pair of eyes smaller, usually closer together than members of posterior pair; eye granules ovate; accessory granules absent or few in proximity of eyes and anterior trunk. Pharynx spherical, 12 (9–14) in diameter; esophagus short. Peduncle broad. Haptor sub-pentagonal, 47 (38–59) long, 65 (54–81) wide. Anchors similar, each with robust superficial root, elongate shaft, short point; ventral anchor 42 (40–43) long, base 17 (14–19) wide; dorsal anchor 40 (38–43) long, base 15 (14–17) wide. Bars similar, broadly U-shaped; ventral bar 35 (34–36) long, dorsal bar 34 (30–37) long. Hook 1–4, 6, 7 with erect thumb, slightly curved shaft, inflated shank; hook 5 with shank tapering distally; hook 1, 2–20 (19–22) long; hook 3–24 (22–25) long; hook 4, 7–26 (24–28) long; hook 5–12 (11–14) long; hook 6–21 (17–22) long; FH loop 0.8 length of distal part of shank. Cirral rami bladeli-like, base variable; cirrus 26 (23–34) long. Accessory piece 20 (17–24) long, comprising blunt terminal, variable proximal portions. Testis elongate ovate, 36 (32–45) long, 16 (13–19) wide; seminal vesicle sigmoid. Prostates well developed; prostatic reservoirs with thick wall. Ovary elongate ovate, 42 (36–55) long, 15 (10–21) wide; oviduct, ootype, uterus not observed; distal portions of vaginae bulbous. Vitellaria dense.

**ETYMOLOGY:** This species is named for Dr. Wolfgang J. Junk, Max Planck Institute für Limnologie, in recognition of his contributions in aquatic ecology of the Amazon region.

**REMARKS:** The anchors of *Amphithecium junki* are similar to those of *A. catalaoensis* sp. n. *Amphithecium junki* differs from this species by possessing bladeli-like cirral rami and hooks with shorter shanks.

***Amphithecium falcatum* sp. n.**  
(Figs. 30, 56–64)

**TYPE LOCALITY:** Furo do Catalão near Manaus, Amazonas, Brazil (Locality 1).

**OTHER RECORDS:** Localities 2–6.

**SPECIMENS DEPOSITED:** Holotype, INPA PA304-1; paratypes, INPA PA304-2, 3, USNM 79188, HWML 23362; vouchers, USNM 79211, 79212, 79216, 79218, 79241, HWML 23384, 23388, 23390.

**DESCRIPTION** (based on 18 specimens): Body

fusiform, length 224 (193–238); greatest width 80 (54–93) near midlength or in anterior trunk. Tegument scaled on peduncle, trunk. Cephalic lobes well developed; usually 4 pairs of head organs lying in cephalic lobes; cephalic glands posterolateral to pharynx. Eyes equidistant, subequal, comprising few granules; eye granules ovate; accessory granules infrequent in cephalic area. Pharynx spherical, 15 (13–16) in diameter; esophagus short. Peduncle broad. Haptor sub-hexagonal, 40 (33–45) long, 63 (57–73) wide. Anchors similar, each with robust superficial root, short shaft, curved point; ventral anchor 28 (27–32) long, base 17 (15–18) wide; dorsal anchor 30 (27–35) long, base 17 (14–18) wide. Bars similar, broadly U-shaped; ventral bar 28 (27–29) long; dorsal bar 26–27 long. Hooks similar; each with erect thumb, slightly curved shaft, short point, shank with proximal portion of variable length among hook pairs; hook 1–17 (15–19) long; hook 2–21 (18–24) long; hook 3, 7–24 (21–26) long; hook 4–26 (24–28) long; hook 5–13–14 long; hook 6–19 (18–21) long; FH loop 0.8 length of distal portion of shank. Cirrus comprising 2 dissimilar rami: primary ramus bladeli-like, secondary ramus needle-like; cirrus 40 (30–48) long. Accessory piece 33 (25–39) long, with hooklike termination. Testis elongate ovate, 44 (39–47) long, 21 (17–23) wide; seminal vesicle sigmoid. Prostates well developed; prostatic reservoirs with thick walls. Ovary elongate ovate, 48 (40–64) long, 19 (15–22) wide; oviduct, ootype, uterus not observed; vitellaria dense.

**ETYMOLOGY:** The species name is from Latin (*falcatus* = sickle-shaped) and refers to the termination of the accessory piece.

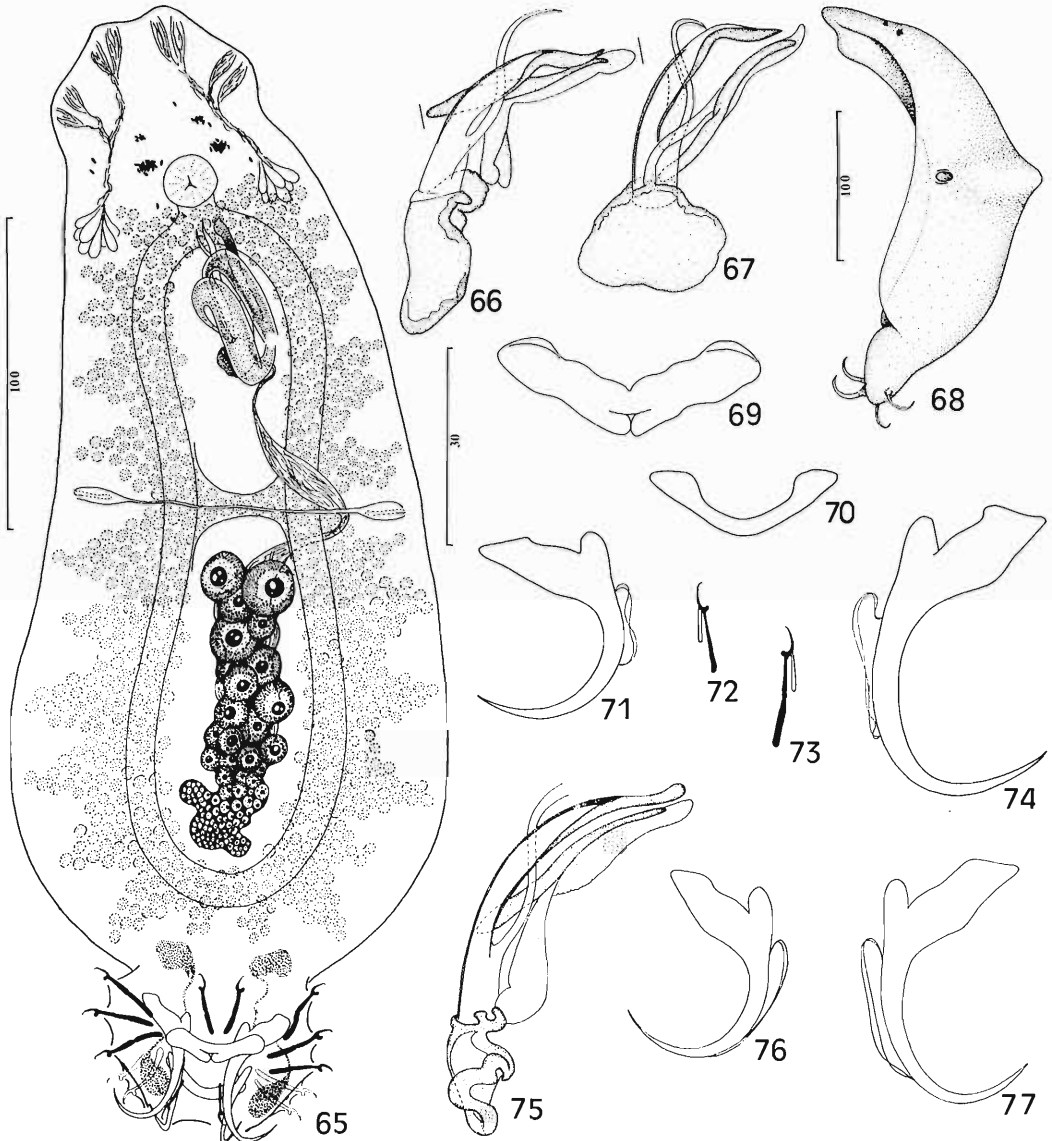
**REMARKS:** *Amphithecium falcatum* resembles *A. calycinum* in that the sclerotized structures of the haptor are similar and both possess hooklike terminations of the accessory piece. They differ most significantly by the accessory piece of *A. falcatum* lacking a posteriorly directed branch near its midlength.

***Amphithecium camelum* sp. n.**  
(Figs. 65–77, 90, 91)

**TYPE LOCALITY:** Rio Solimões, Ilha da Marchantaria near Manaus, Amazonas, Brazil (Locality 2, forma amazonas).

**OTHER RECORDS:** Localities 1 (forma amazonas); 3–6 (forma rondonia).

**SPECIMENS DEPOSITED:** Holotype, INPA PA299-1; paratypes, INPA PA299-2–10, USNM



Figures 65–77. *Amphithecium camelum*. Figures 65–74. *Amphithecium camelum* forma *amazonas*. 65. Holotype (ventral). 66. Copulatory complex (dorsolateral). 67. Copulatory complex. 68. Specimen (lateral view). 69. Ventral bar. 70. Dorsal bar. 71. Dorsal anchor. 72. Hook 5. 73. Hook 1–4, 6, 7. 74. Ventral anchor. Figures 75–77. *Amphithecium camelum* forma *rondonia*. 75. Copulatory complex. 76. Dorsal anchor. 77. Ventral anchor. All figures are to the same scale (30 µm) except Figures 65 and 68 (respective 100-µm scales).

79195, HWML 23369; vouchers, USNM 79205, 79233–79235, 79242, HWML 23378, 23403–23405.

**DESCRIPTION** (based on 168 specimens): Body ovate, flattened dorsoventrally, ventral surface concave; mature specimens with dorsal hump-like protuberance near midlength (Figs. 68, 90). Tegument papillate (Fig. 91). Cephalic lobes well

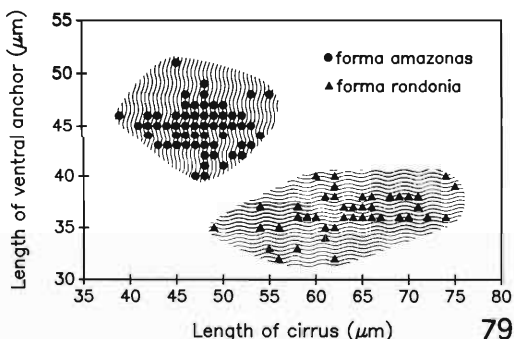
developed; generally 4 pairs of head organs lying in cephalic lobes; cephalic glands posterolateral to pharynx. Members of anterior pair of eyes smaller, usually closer together than those of posterior pair; eye granules ovate; accessory granules absent or distributed throughout cephalic region. Pharynx ovate; esophagus short. Peduncle short, broad. Haptor subhexagonal with 2 pairs of

	GUAPORE-C.MARQUES forma rondonia	GUAPORE-SURPRESA forma rondonia	CATALAO forma amazonas
MARCHANTARIA forma amazonas	Len Cir Acp Dal	Len Cir Acp Dal	Len Cir Acp Dal
	Daw Dap Val Vaw	Daw Dap Val Vaw	Daw Dap Val Vaw
	Vap Dbr Vbr Ho1	Vap Dbr Vbr Ho1	Vap Dbr Vbr Ho1
	Ho2 Ho3 Ho4 Ho5	Ho2 Ho3 Ho4 Ho5	Ho2 Ho3 Ho4 Ho5
Ho6 Ho7	Ho6 Ho7	Ho6 Ho7	
Cirrtip	Cirrtip	Cirrtip	
	10%	10%	78%
CATALAO forma amazonas	Len Cir Acp Dal	Len Cir Acp Dal	
	Daw Dap Val Vaw	Daw Dap Val Vaw	
	Vap Dbr Vbr Ho1	Vap Dbr Vbr Ho1	
	Ho2 Ho3 Ho4 Ho5	Ho2 Ho3 Ho4 Ho5	
Ho6 Ho7	Ho6 Ho7		
Cirrtip	Cirrtip		
	21%	5%	
GUAPORE-SURPRESA forma rondonia	Len Cir Acp Dal		
	Daw Dap Val Vaw		
	Vap Dbr Vbr Ho1		
	Ho2 Ho3 Ho4 Ho5		
Ho6 Ho7			
Cirrtip			
	63%		

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Figure 78. Comparison of characters between specimens of the 2 morphologic forms of *Amphithecium camelum* from 4 localities. Numerical values were compared by an ANOVA followed by the Tukey test. Characters significantly different ( $P < 0.01$ ) appear shaded. Percent of similarity (number of characters not significantly different/total number of characters considered) is provided in the small squares at the bottom of each comparison. LEN = total body length; CIR = cirrus length; ACP = accessory piece length; DAL = dorsal length; DAW = dorsal anchor base width; DAP = DAL/DAW; VAL = ventral anchor length; VAW = ventral anchor base width; VAP = VAL/VAW; DBR = dorsal bar length; VBR = ventral bar length; H01-H07 = hook length of respective pairs; CIRRTIP = shape of the distal end of the primary ramus of the cirrus.

haptoral glands. Ventral anchor with well-developed roots, curved shaft, recurved point; dorsal anchor with evenly curved shaft and point, roots well developed. Ventral bar robust, broadly V-shaped, with expanded ends and mediopos-



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Figure 79. Scatter diagram of length of the ventral anchor versus length of the cirrus for the 2 forms of *Amphithecium camelum*.

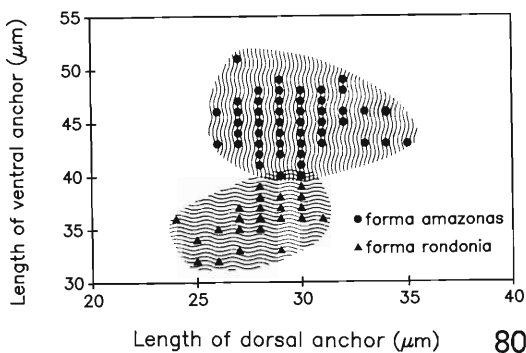


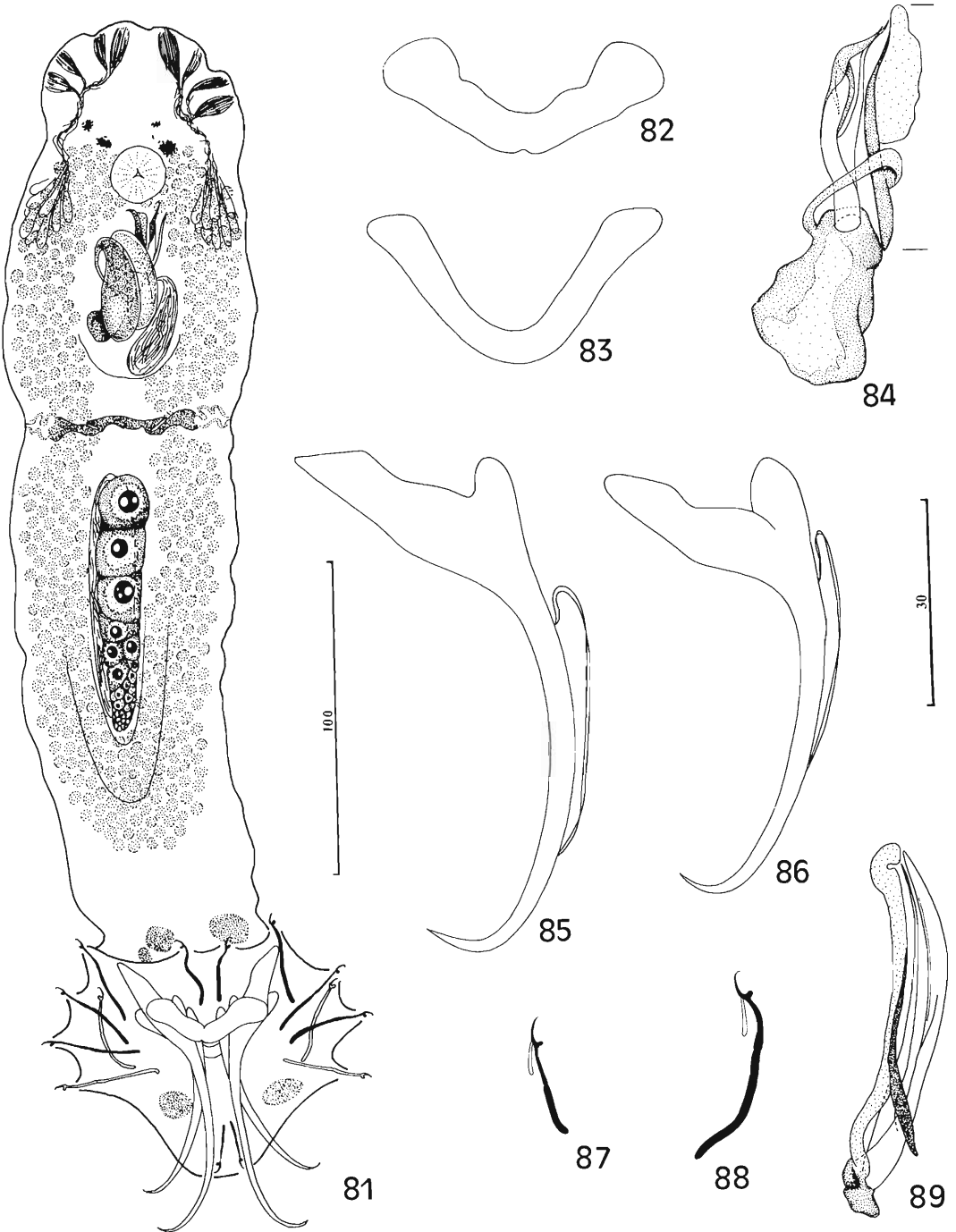
Figure 80. Scatter diagram of length of the ventral anchor versus length of the dorsal anchor for the 2 forms of *Amphithecium camelum*.

terior cleft. Dorsal bar with slightly expanded ends, broadly U-shaped. Hooks similar; each with erect thumb, slightly curved shaft, short point; FH loop 0.8 length of distal portion of shank. Primary cirral ramus heavily sclerotized, secondary ramus needle-like. Accessory piece comprising a distal rodlike portion with marginal distal flap, articulating to cirral base by variable proximal process. Testis elongate, irregular; seminal vesicle sigmoid. Prostatic reservoirs elongate, with thick walls; prostates not observed. Ovary irregular; oviduct, uterus not observed. Vitellaria dense, laterally fimbriated. Egg ovate with short filament.

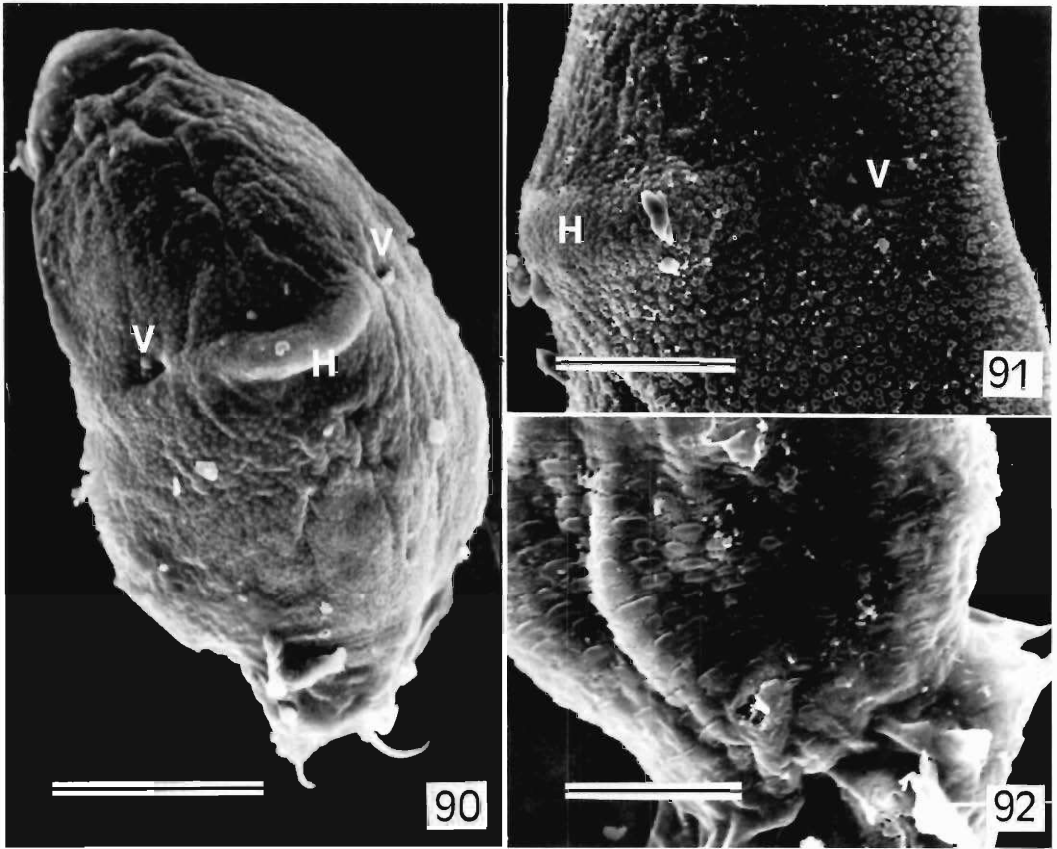
ETYMOLOGY: The specific name is from Greek (*kamelos* = camel) and refers to the presence of a dorsal hump in mature specimens.

REMARKS: *Amphithecium camelum* is the only known species of the genus possessing a dorsal trunk protuberance, gonads with irregular margins, anchors of noticeably different size, and laterally fimbriated vitellaria. The structure of the copulatory complex suggests a relationship to *A. catalaoensis* sp. n.

Two morphologic forms of *Amphithecium camelum* were recognized: *A. camelum* forma amazonas (Figs. 65-74) collected in the Central Amazon (Localities 1, 2) and *A. camelum* forma rondonia (Figs. 75-77) from the southwestern collection sites (Localities 3-6). Figures 65-80 and Table 2 provide the differentiation of the 2 forms: (1) the primary cirral ramus of *A. camelum* forma amazonas is acute, and in *A. camelum* forma rondonia it is blunt; (2) the copulatory complex is significantly longer in *A. camelum* forma rondonia, and the haptoral structures are generally smaller (Fig. 79); and (3) the ratio between the size of the dorsal and ven-



Figures 81-88. *Amphithecium catalaoensis*. 81. Holotype (ventral). 82. Ventral bar. 83. Dorsal bar. 84. Copulatory complex. 85. Ventral anchor. 86. Dorsal anchor. 87. Hook 5. 88. Hook 1-4, 6, 7. Figure 89. *Cleidodiscus amazonensis* Mizelle and Price, 1965. Copulatory complex from holotype. All figures are to the same scale (30  $\mu$ m) except Figure 81 (100  $\mu$ m).



Figures 90–92. Scanning electron micrographs of new dactylogyrid species. 90. Specimen of *Amphithecium camelum* (dorsal) showing the double vaginal apertures (V) and the humplike protuberance (H). Scale = 100  $\mu\text{m}$ . 91. Lateral view of *A. camelum* at the level of the right vaginal pore. Scale = 50  $\mu\text{m}$ . 92. Dorsal view of peduncle of *Notothecium* sp. Scale = 15  $\mu\text{m}$ .

tral anchor among species of the 2 forms shows substantial difference (Fig. 80).

***Amphithecium camelum* forma amazonas**  
(Figs. 65–74, 90–91)

RECORDS: Localities 1, 2 (type).

DESCRIPTION: With characters of species. Measurements, based on 223 specimens, are provided in Table 2. Both cirral rami terminally acute. *Amphithecium camelum* forma amazonas is the type form for the species.

***Amphithecium camelum* forma rondonia**  
(Figs. 75–77)

RECORDS: Localities 3–6.

DESCRIPTION: With the characters of species. Measurements, based on 75 specimens, are provided in Table 2. Primary ramus of cirrus terminally blunt; secondary ramus terminally truncate.

***Amphithecium catalaoensis* sp. n.**  
(Figs. 81–88)

TYPE LOCALITY: Furo do Catalão near Manaus, Amazonas, Brazil (Locality 1).

SPECIMENS DEPOSITED: Holotype, INPA PA297-1; paratypes, USNM 79193, HWML 23367.

DESCRIPTION (based on 7 specimens): Body fusiform, length 383 (286–465); greatest width 90 (63–107) near midlength or in anterior trunk. Tegument scaled on trunk, peduncle. Cephalic lobes well to poorly developed; usually 4 pairs of head organs lying in cephalic lobes; cephalic glands posterolateral to pharynx. Distance between members of eye pairs variable, anterior pair smaller; eye granules ovate, small; accessory granules absent or few in proximity of eyes. Pharynx spherical, 19 (17–21) in diameter; caeca indistinct. Peduncle broad. Haptor subpentagonal, 75 (64–93) long, 90 (75–105) wide; 2 pairs of



Table 2. Measurements of *Amphithecium camelum* from 4 different localities.\*

	Forma amazonas		Forma rondonia	
	Marchantaria	Catalão	Guaporé-Surpresa	Guaporé-C. Marques
Length	387 (290-569) (N = 71)	401 (338-518) (N = 41)	521 (418-575) (N = 14)	459 (362-502) (N = 6)
Greatest width	136 (99-165) (N = 10)	—	162 (152-181) (N = 4)	—
Cirrus length	47 (39-53) (N = 110)	49 (45-55) (N = 52)	64 (55-75) (N = 45)	58 (49-64) (N = 12)
Accessory piece length	31 (28-38) (N = 100)	32 (30-37) (N = 49)	41 (36-49) (N = 43)	38 (34-43) (N = 12)
Dorsal anchor length	29 (26-34) (N = 100)	30 (27-35) (N = 48)	29 (26-31) (N = 42)	26 (24-28) (N = 11)
Dorsal anchor base width	18 (16-20) (N = 87)	18 (16-21) (N = 47)	16 (15-19) (N = 40)	15 (14-17) (N = 11)
Ventral anchor length	45 (40-51) (N = 127)	45 (40-49) (N = 52)	37 (33-40) (N = 47)	35 (32-37) (N = 11)
Ventral anchor base width	21 (18-25) (N = 126)	22 (19-25) (N = 54)	20 (17-22) (N = 44)	18 (17-19) (N = 11)
Dorsal bar	34 (27-44) (N = 67)	35 (31-42) (N = 39)	31 (27-34) (N = 15)	29 (25-31) (N = 6)
Ventral bar	43 (35-49) (N = 77)	44 (39-49) (N = 46)	36 (33-38) (N = 13)	34 (30-38) (N = 9)
Hook 1	18 (16-20) (N = 95)	18 (16-20) (N = 45)	16 (15-18) (N = 29)	15 (14-16) (N = 6)
Hook 2	20 (17-22) (N = 111)	20 (18-23) (N = 50)	19 (17-20) (N = 36)	18 (17-19) (N = 10)
Hook 3	23 (20-28) (N = 101)	23 (20-26) (N = 43)	21 (19-23) (N = 29)	20 (19-22) (N = 11)
Hook 4	26 (23-29) (N = 90)	26 (24-31) (N = 45)	25 (22-27) (N = 27)	23 (21-26) (N = 11)
Hook 5	15 (14-19) (N = 60)	16 (14-19) (N = 27)	15 (14-16) (N = 26)	14 (13-15) (N = 6)
Hook 6	19 (15-21) (N = 69)	19 (16-22) (N = 29)	18 (16-20) (N = 25)	18 (16-19) (N = 10)
Hook 7	23 (22-27) (N = 45)	25 (23-29) (N = 21)	22 (20-24) (N = 24)	21 (20-23) (N = 9)
Pharynx diameter	22 (17-26) (N = 10)	—	25 (22-28) (N = 4)	—
Haptor length	54 (42-66) (N = 10)	—	52 (48-60) (N = 4)	—
Haptor width	81 (71-97) (N = 10)	—	52 (48-60) (N = 4)	—
Testis length	67	—	—	—
Testis width	36	—	—	—
Ovary length	98 (67-116) (N = 9)	—	170 (162-177) (N = 3)	—
Ovary width	30 (18-45) (N = 9)	—	46 (41-50) (N = 3)	—
Egg length	65 (60-71) (N = 2)	—	—	—
Egg width	45 (44-47) (N = 2)	—	—	—

\* The average is followed by the range and number of specimens measured, in separate parentheses.

haptoral glands. Anchors similar; each with elongate superficial root, long shaft, short point; ventral anchor 72 (71-74) long, base 34 (33-35) wide; dorsal anchor 61 (58-65) long, base 29 (28-30) wide. Ventral bar 45 (41-49) long, broadly U-shaped, with inflated ends; dorsal bar 44 (37-52) long, U-shaped. Hooks similar; each with erect thumb, slightly curved shaft, short point, variable shank; hook 1, 2-27 (25-28) long; hook 3, 7-29 (27-30) long; hook 4-31 (30-33) long; hook 5-16-17 long; hook 6-22 (20-24) long; FH loop 0.6 length of distal portion of shank. Cirrus comprising 2 dissimilar rami: primary ramus heavily sclerotized, secondary ramus needle-like; cirrus 54 (53-55) long. Accessory piece 36 (34-37) long, rodlike, with a marginal distal flap, articulated to cirrus base by variable proximal process. Testis elongate ovate, 57 (46-67) long, 27 (25-30) wide; seminal vesicle pyriform. Pros-

tatic reservoirs with thick walls; prostates not observed. Ovary elongate ovate, 75 (51-96) long, 23 (15-33) wide; ootype, oviduct, uterus not observed. Vitellaria dense.

ETYMOLOGY: The specific name is derived from the type locality.

REMARKS: *Amphithecium catalaoensis* resembles *A. camelum* in the comparative morphology of the copulatory complex and *A. junki* by possessing elongate anchor shafts. It differs from *A. camelum* by lacking a conspicuously cleft ventral bar and by having an elongate hook shank in pairs 1-4, 6, and 7. It differs from *A. junki* by lacking bladeli-like cirral rami.

#### *Notothecium* gen. n.

DIAGNOSIS: Body divisible into cephalic region, trunk, peduncle, haptor. Tegument thin, scaled. Two terminal, 2 bilateral cephalic lobes;

head organs present; cephalic glands unicellular, lateral or posterolateral to pharynx. Eyes absent. Mouth subterminal, midventral; pharynx muscular, glandular; esophagus short or absent; intestinal caeca 2, confluent posterior to gonads, lacking diverticula. Gonads intercaecal, overlapping; testis dorsal to ovary. Vas deferens looping left caecum; seminal vesicle a dilation of vas deferens, C-shaped, looping dextrally; copulatory complex comprising articulated cirrus, accessory piece. Seminal receptacle present; vagina sinistrodorsal, dilated, looping left caecum; genital pore midventral near level of caecal bifurcation. Vitellaria coextensive with caeca. Haptor armed with pairs of dorsal and ventral anchors, dorsal and ventral bars, 7 pairs of hooks with ancyrocephaline distribution. Hooks with shank of 2 distinct parts. Parasites of gills of Serrasalminae.

TYPE SPECIES: *Notothecium mizellei* sp. n. from *Serrasalmus nattereri*.

OTHER SPECIES: *Notothecium aegidatum* sp. n. from *Serrasalmus nattereri*.

ETYMOLOGY: The generic name is from Greek (*notos* = back + *theke* = case) and reflects the dorsal position of the vagina.

REMARKS: *Notothecium* includes species morphologically similar to those of *Amphithecium*. *Notothecium* is distinguished from all genera of Ancyrocephalinae by the combination of the following characters: (1) a single vagina opening sinistrodorsally and looping the left caecum internally; (2) overlapping gonads; and (3) a C-shaped seminal vesicle.

***Notothecium mizellei* sp. n.**  
(Figs. 93–100)

TYPE LOCALITY: Furo do Catalão near Manaus, Amazonas, Brazil (Locality 1).

OTHER RECORDS: Localities 2–6.

SPECIMENS DEPOSITED: Holotype, INPA PA292-1; paratypes, INPA PA292-2–5, USNM 79189, HWML 23363; vouchers, USNM 79225–79228, 79244, HWML 23396–23398.

DESCRIPTION (based on 33 specimens): Body flattened dorsoventrally, length 230 (185–263); greatest width 77 (67–98) near midlength. Tegument scaled on trunk, peduncle (Fig. 92). Cephalic lobes well developed; generally 4 pairs of head organs lying in cephalic lobes; cephalic glands lateral to pharynx. Eyes absent; elongate ovate accessory granules infrequently present in cephalic region. Pharynx ovate, 13 (11–15) wide;

esophagus short or absent. Peduncle broad, short. Haptor subpentagonal, 61 (53–67) long, 81 (58–105) wide. Anchors similar; each with well-developed roots, elongate shaft, short recurved point; ventral anchor 47 (45–49) long, base 20 (18–21) wide; dorsal anchor 45 (43–48) long, base 16 (15–17) wide. Bars similar, broadly V-shaped; ventral bar 40 (36–44) long; dorsal bar 35 (30–44) long, with short acute projection on postero-medial margin. Hook 1–4, 6, 7 similar; each with erect thumb, slightly curved shaft, short point, expanded shank; hook 5 reduced, with short shank slightly expanded; hook 1–21–22 long; hook 2–27 long; hook 3, 4–30 (29–32) long; hook 5–16 (15–17) long; hook 6–23 (22–24) long; hook 7–34 (30–37) long; FH loop about equal to length of distal portion of shank. Cirrus 24 (22–26) long, conical, curved, with incipient secondary ramus. Accessory piece 23 (21–24) long, rodlike, distally hooked, with subterminal flap, articulated to cirrus base by flexible proximal process. Testis elongate ovate, 45 (35–53) long, 22 (17–26) wide. Prostate representing a large mass of unicellular gland cells lying dorsal to copulatory complex immediately beneath the dorsal surface of trunk; prostatic reservoirs with thick walls. Ovary conical, 43 (30–60) long, 17 (12–25) in greatest width; oviduct, ootype, uterus not observed. Vagina nonsclerotized, greatly expanded proximally. Vitellaria dense; vitelline commissure usually not visible in mature specimens.

ETYMOLOGY: The species is named for Dr. J. D. Mizelle in recognition of his contributions in systematics of the Monogenea.

REMARKS: *Notothecium mizellei* is the type species for the genus.

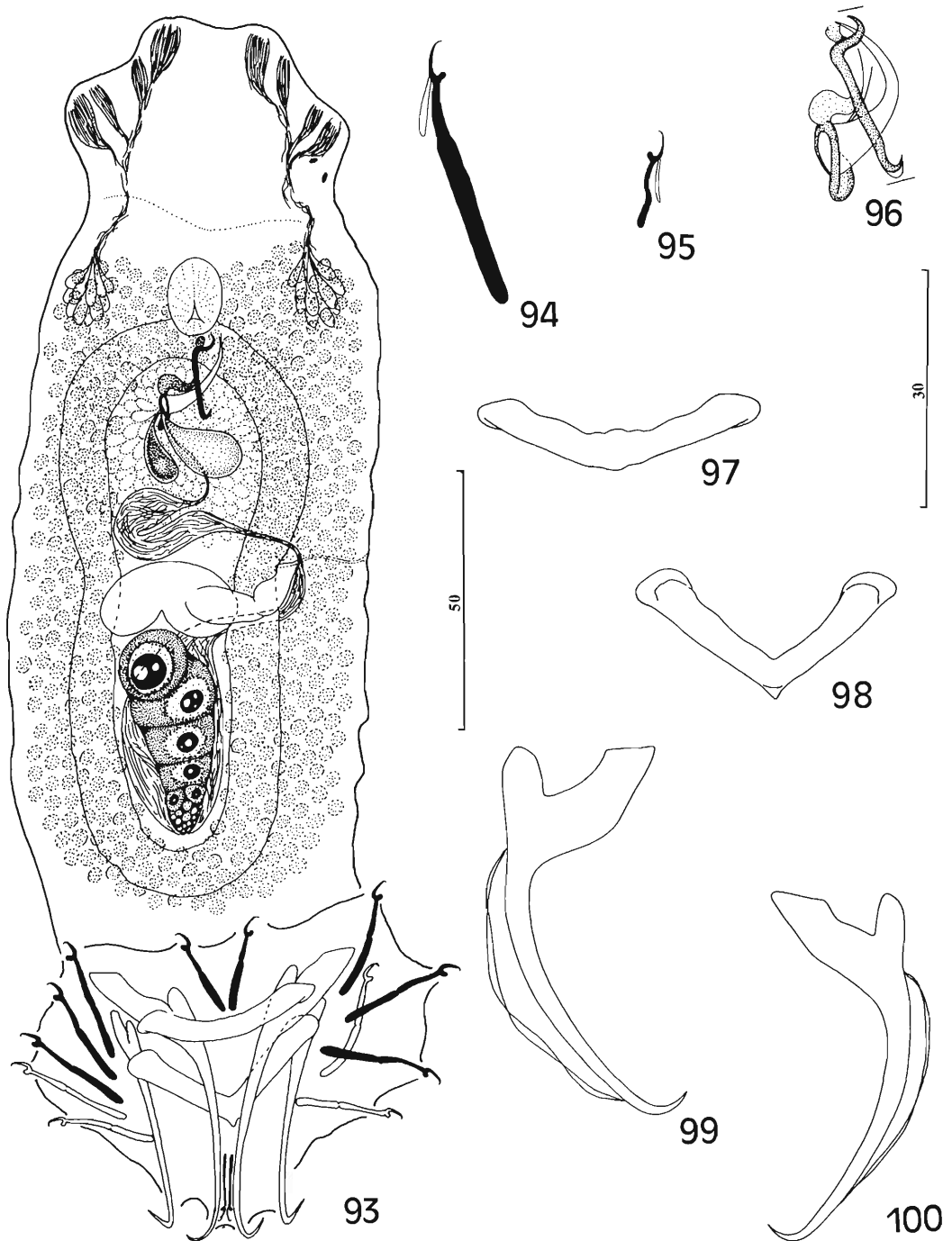
***Notothecium aegidatum* sp. n.**  
(Figs. 101–109)

TYPE LOCALITY: Furo do Catalão near Manaus, Amazonas, Brazil (Locality 1).

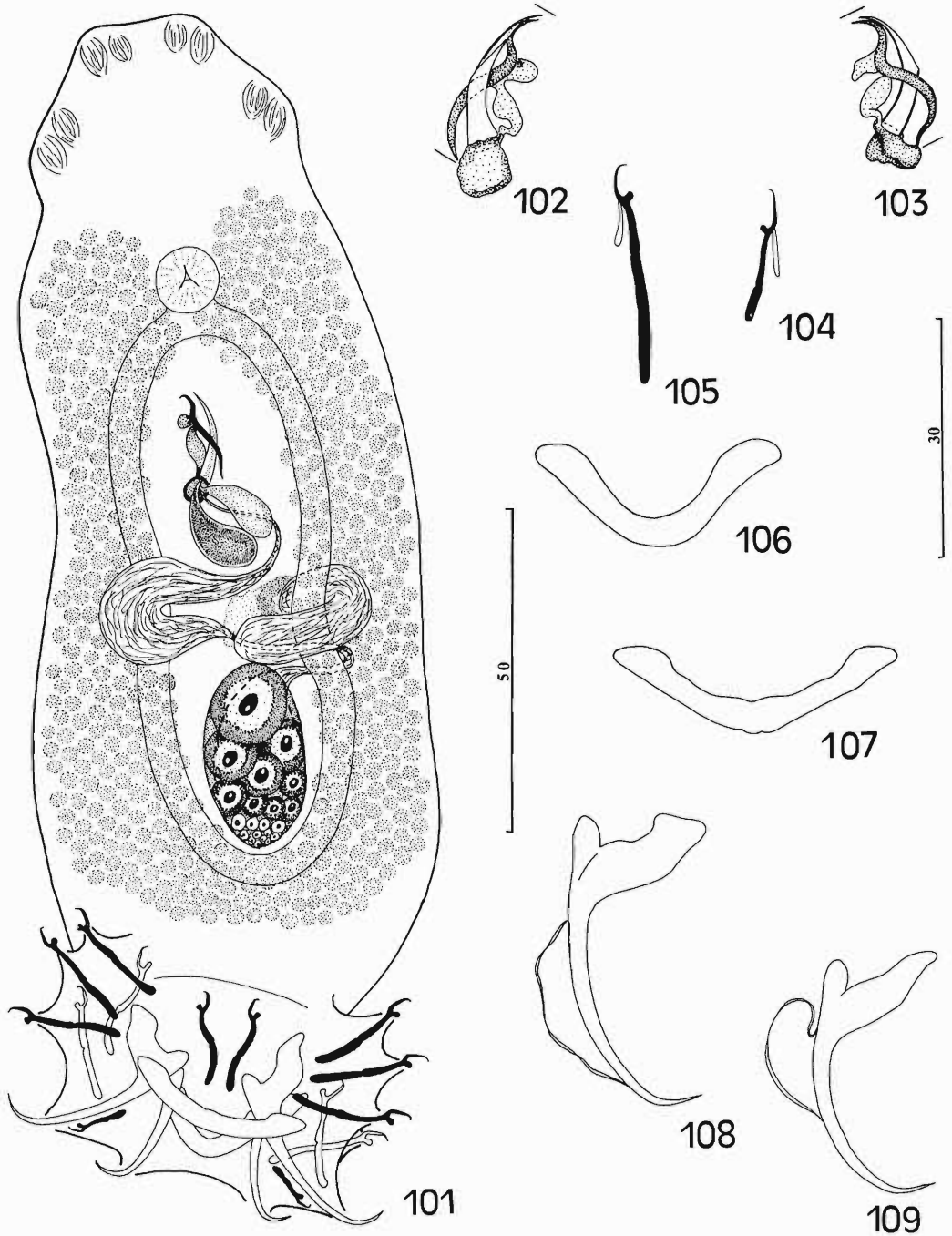
OTHER RECORDS: Localities 2, 4–6.

SPECIMENS DEPOSITED: Holotype, INPA PA303-1; paratypes, INPA PA303-2, 3, USNM 79187, HWML 23361; vouchers, USNM 79229, 79230, 79240, 79243, HWML 23399, 23400.

DESCRIPTION (based on 16 specimens): Body flattened dorsoventrally, length 213 (191–247); greatest width 78 (63–112) near midlength or in posterior trunk. Tegument scaled on trunk, peduncle (Fig. 92). Cephalic lobes well developed; generally 4 pairs of head organs lying in cephalic



Figures 93–100. *Notothecium mizellei*. 93. Holotype (ventral). 94. Hook 1–4, 6, 7. 95. Hook 5. 96. Copulatory complex. 97. Ventral bar. 98. Dorsal bar. 99. Ventral anchor. 100. Dorsal anchor. All figures are to the same scale (30  $\mu$ m) except Figure 93 (50  $\mu$ m).



Figures 101–109. *Notothecium aegidatum*. 101. Holotype (ventral). 102. Copulatory complex (dorsal). 103. Copulatory complex. 104. Hook 1–4, 6, 7. 105. Hook 5. 106. Dorsal bar. 107. Ventral bar. 108. Ventral anchor. 109. Dorsal anchor. All figures are presented at the same scale (30  $\mu\text{m}$ ) except Figure 101 (50  $\mu\text{m}$ ).

lobes; cephalic glands not observed. Eyes, eye granules absent. Pharynx ovate to spherical, 14 (12–19) in diameter; esophagus short. Peduncle broad. Haptor subquadrate, 48 (34–58) long, 87 (75–96) wide. Anchors similar; each with well-developed roots, long shaft, short curved point; ventral anchor 38 (32–42) long, base 17 (16–18) wide; dorsal anchor 34 (30–38) long, base 14 (13–15) wide. Bars similar, broadly U-shaped; ventral bar 39 (36–41) long; dorsal bar 39 (38–42) long. Hook 1–4, 6, 7 similar; each with erect thumb, slightly curved shaft, short point, expanded shank; hook 5 with short proximal portion of shank; hook 1–20 (18–21) long; hook 2–23 (22–24) long; hook 3, 4–28 (26–29) long; hook 5–15 (14–16) long; hook 6–21–22 long; hook 7–33 (32–35) long; FH loop 0.7 length of distal portion of shank. Cirral termination diagonally truncate, cirrus 21 (19–24) long; accessory piece 18 (16–20) long, spicular, with acute terminations, subterminal distal flap, articulated to cirrus base by flexible proximal process arising near midlength. Testis ovate, 32 (25–40) long, 20 (18–23) wide; seminal vesicle large. Prostate inconspicuous; prostatic reservoirs with thick walls. Ovary ovate, 32 (25–36) long, 18 (11–25) wide; oviduct, ootype, uterus not observed; vagina with terminal superficial sclerotization around margin of pore in mature specimens. Vitellaria dense; vitelline commissure usually not visible.

**ETYMOLOGY:** The specific name is from Latin (*aegidis* = a shield + *atus* = provided with) and refers to the sclerotization around the vaginal pore of adult specimens.

**REMARKS:** *Notothecium aegidatum* resembles *N. mizellei*, from which it differs by having: (1) a vaginal pore surrounded by a superficial sclerotization of the body surface, (2) a cirrus lacking a secondary ramus, (3) a more proximal subterminal flap of accessory piece, (4) a dorsal bar lacking a medioposterior pointed projection, and (5) smaller anchors and hooks.

#### *Notothecium* gen. n.

**DIAGNOSIS:** Body divisible into cephalic region, trunk, peduncle, haptor. Tegument thin, smooth or scaled. Two terminal, 2 bilateral cephalic lobes; head organs present; cephalic glands unicellular, lateral or posterolateral to pharynx. Eyes present. Mouth subterminal, midventral; intestinal caeca 2, confluent posterior to gonads, lacking diverticula. Gonads intercaecal, overlap-

ping; testis dorsal to ovary. Vas deferens looping left caecum; seminal vesicle a sigmoid dilation of vas deferens; copulatory complex comprising articulated cirrus, accessory piece. Cirrus coiled, with counterclockwise ring(s); accessory piece with distal ornate termination. Seminal receptacle present immediately anterior to ovary; vagina dextrodorsal, comprising a lightly sclerotized tube winding around right caecum; genital pore midventral near level of caecal bifurcation. Vitellaria coextensive with caeca. Haptor armed with pairs of dorsal and ventral anchors, dorsal and ventral bars, 7 pairs of hooks with ancyrocephaline distribution. Hook with shank of 2 distinct parts. Parasites of gills of Serrasalmidae.

**TYPE SPECIES:** *Notothecium penetrarum* sp. n. from *Serrasalmus nattereri*.

**OTHER SPECIES:** *Notothecium minor* sp. n. from *Serrasalmus nattereri*.

**ETYMOLOGY:** The generic name is derived from Greek (*notos* = back + *zotheke* = chamber) and refers to the position of the vaginal aperture.

**REMARKS:** *Notothecium*, *Amphithecium*, and *Notothecium* are morphologically similar groups. Characteristics that distinguish *Notothecium* from *Amphithecium* include the presence of a coiled cirrus and a single dorsal vaginal opening. The genus is most similar to *Notothecium*, from which it differs by possessing a vagina looping the right instead of the left intestinal caecum and by lacking a C-shaped seminal vesicle. It is emphasized that separation from the latter genus is not based on the position of the vaginal aperture but on the fact that the vaginal tube loops opposite caeca.

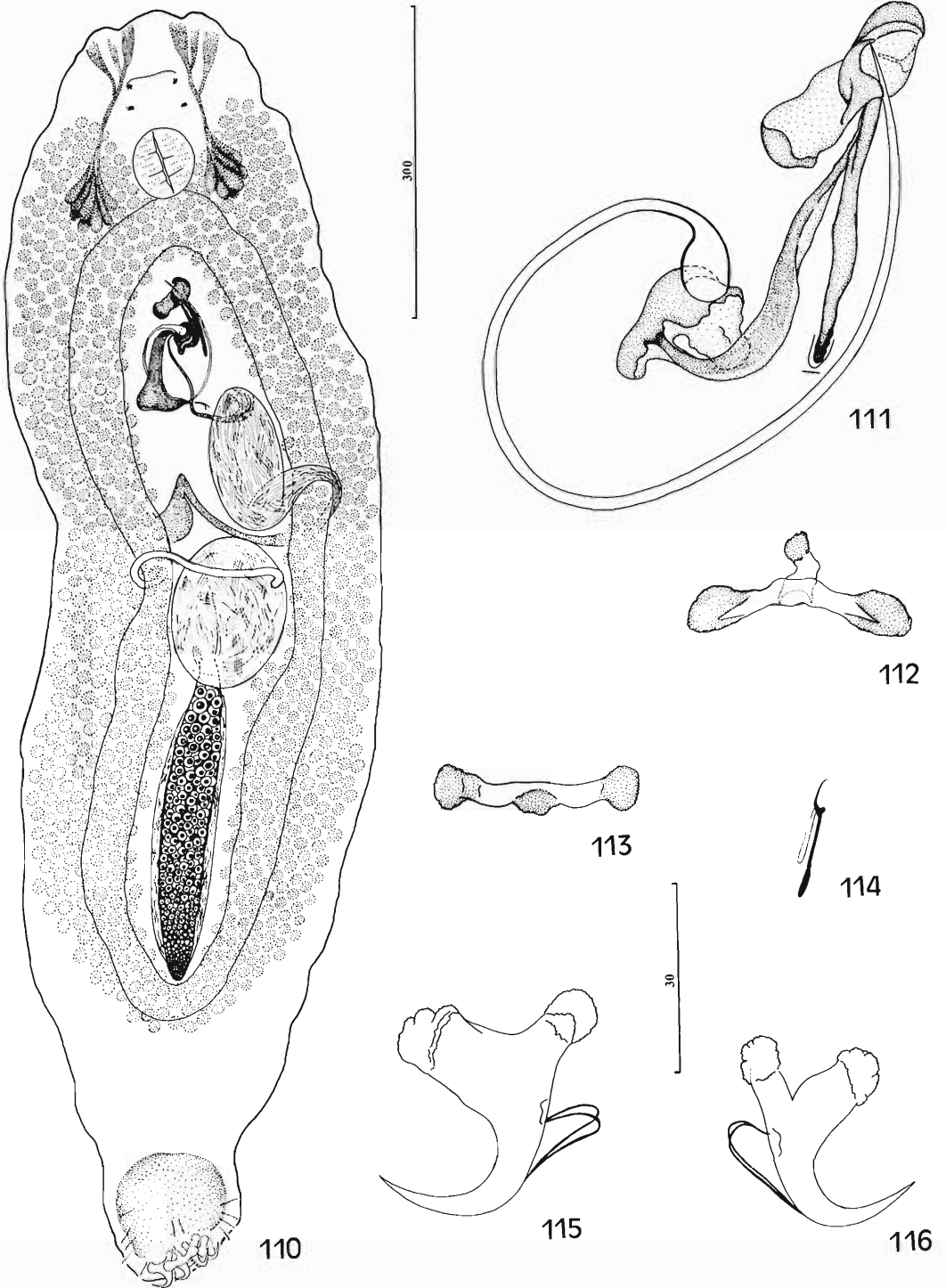
#### *Notothecium penetrarum* sp. n. (Figs. 110–116)

**TYPE LOCALITY:** Rio Guaporé near Surpresa, Rondônia, Brazil (Locality 5).

**OTHER RECORDS:** Localities 1, 2, 4.

**SPECIMENS DEPOSITED:** Holotype, INPA PA306-1; paratypes, INPA PA306-2, USNM 79808, HWML 23666; vouchers, USNM 79809–79811, HWML 23665.

**DESCRIPTION** (based on 16 specimens): Body foliiform, flattened dorsoventrally, length 1,250 (1,010–1,348); greatest width 343 (304–385) near midlength. Tegument smooth. Cephalic lobes poorly developed; 3 or 4 pairs of head organs; cephalic glands lateral to pharynx. Eyes subequal; members of anterior pair slightly closer together than those of posterior pair; granules



Figures 110–116. *Notozothecium penetrarum*. 110. Holotype (ventral). 111. Copulatory complex. 112. Ventral bar. 113. Dorsal bar. 114. Hook. 115. Ventral anchor. 116. Dorsal anchor. All drawings are to the 30- $\mu$ m scale except Figure 110 (300  $\mu$ m).

small, ovate; accessory granules absent. Pharynx ovate, 68 (59–79) in greatest width; esophagus absent. Peduncle broad, tapered posteriorly; haptor globose, 133 (94–172) long, 127 (90–163) wide. Anchors similar; each with large roots provided with bulbous tips, short shaft, stout evenly curved point; ventral anchor 33 (31–36) long, base 28 (27–29) wide; dorsal anchor 32 (28–35) long, base 25 (23–28) wide. Ventral bar 37 (34–44) long, with enlarged ends, anteriorly directed process originating from posteromedial margin of bar; dorsal bar 35 (31–42) long, with expanded ends, posteromedial knob. Hooks similar, 18 (16–20) long; each with erect thumb, delicate shaft and point, shank with short proximal enlargement. FH loop extending to distal limit of proximal enlargement of shank. Cirrus 208–209 long, comprising a coil of about 1 ring, ring diameter 62 (55–72). Accessory piece 60 (53–68) long,  $\pi$ -shaped, with 1 basal arm articulating to cirral base. Testis elongate, fusiform, 162 (146–179) long, 40 (31–49) wide. Prostatic reservoir pyriform; seminal vesicle sigmoid, lying to left of midline. Ovary fusiform, 263 (183–336) long, 52 (35–80) wide; oviduct, ootype, uterus not observed; seminal receptacle large, lying on midline immediately anterior to ovary. Vitellaria dense; vitelline commissure immediately anterior to seminal receptacle.

**ETYMOLOGY:** This species is named for its means of attachment to the host's gill.

**REMARKS:** *Notozothecium penetrarum* is the type species for the genus. Adults appeared to have penetrated the host's tissue with the haptor, resulting in relatively permanent attachment to the gill.

#### *Notozothecium minor* sp. n.

(Figs. 117–124)

**TYPE LOCALITY:** Furo do Catalão near Manaus, Amazonas, Brazil (Locality 1).

**OTHER RECORDS:** Localities 4, 5.

**SPECIMENS DEPOSITED:** Holotype, INPA PA307-1; paratypes, USNM 79805, HWML 23663; vouchers, USNM 79806, 79807, HWML 23662, 23664.

**DESCRIPTION** (based on 5 specimens): Body flattened dorsoventrally, length 217 (181–243); greatest width 79 (70–84) near midlength or in anterior half; cephalic area broad. Tegument scaled on peduncle, trunk. Cephalic lobes poorly developed; 4 pairs of head organs; cephalic glands lying lateral to pharynx. Members of posterior

pair of eyes larger, farther apart than those of anterior pair; granules elongate ovate; accessory granules absent. Pharynx spherical, 15 (12–17) in diameter. Peduncle short, broad; haptor sub-pentagonal, 53 (45–66) long, 71 (63–78) wide. Anchors similar, each with large truncate superficial root, short deep root, evenly curved shaft and point; ventral anchor 45 (43–49) long, base 18 (16–20) wide; dorsal anchor 31–32 long, base 13–14 wide. Ventral bar 44 (43–45) long, with enlarged ends, short anteromedial process. Dorsal bar broadly V-shaped, 29 (28–30) long. Hooks similar, each with erect thumb, delicate shaft and point, shank slightly enlarged proximally; hook 1, 2, 5, 6–18 (16–20) long, hook 3, 4, 7–23 (21–26) long; FH loop extending to level of enlarged portion of shank. Cirrus comprising about 1 ring, 17 (16–18) in diameter; cirrus 74–75 long. Accessory piece T-shaped, 26–27 long, articulating to cirral base by short process originating about  $\frac{1}{3}$  the distance from proximal end. Testis elongate ovate, 42–43 long, 19–20 wide; seminal vesicle sigmoid; 2 large pyriform prostatic reservoirs. Ovary ovate, 43 (38–49) long, 18 (16–21) wide; oviduct, uterus, ootype not observed; vaginal pore lightly sclerotized, tube delicate; seminal receptacle spherical, lying immediately anterior to ovary; vitellaria dense; vitelline commissure lying ventral to seminal receptacle.

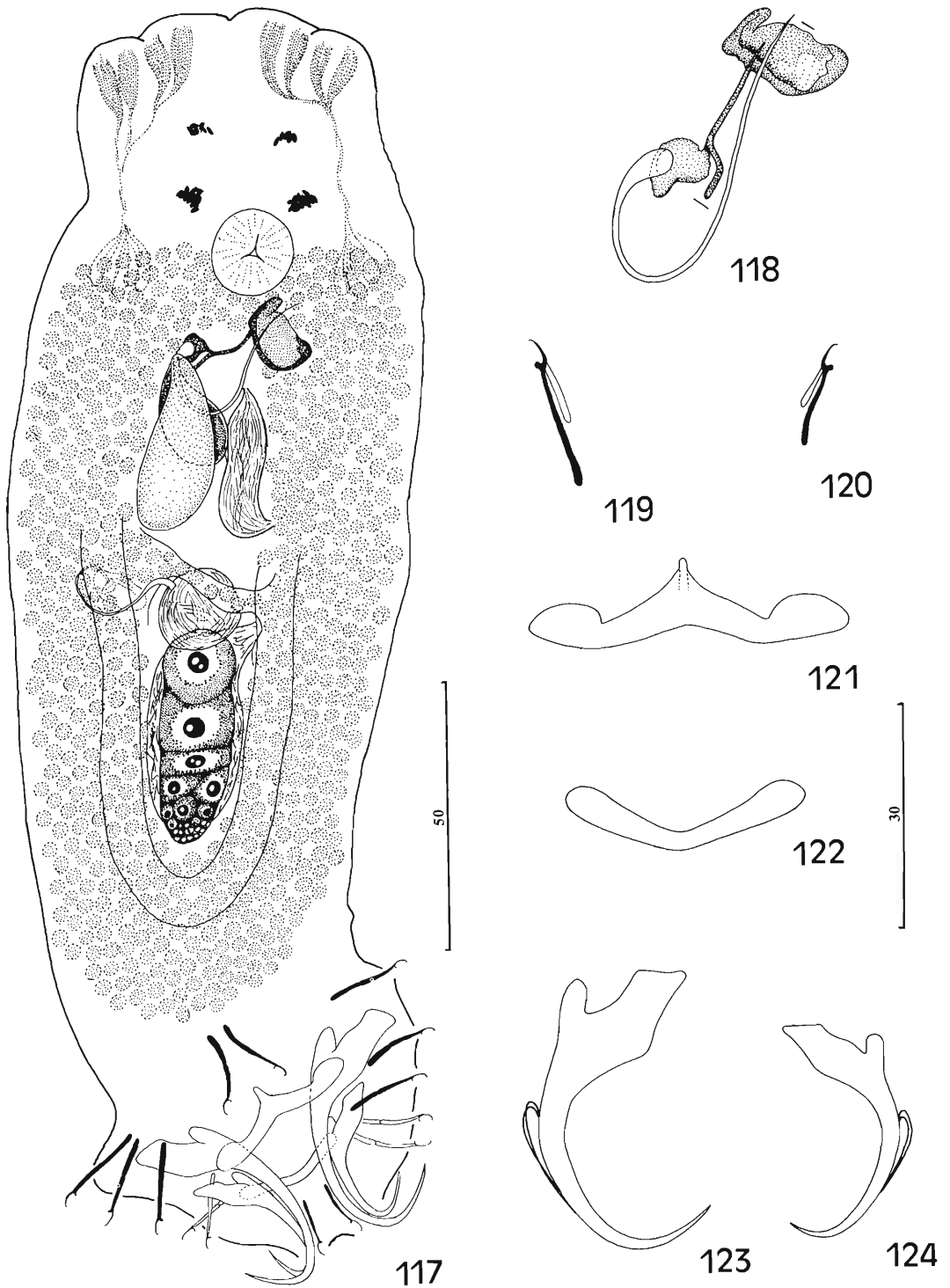
**ETYMOLOGY:** The specific name is from Latin (*minor* = smaller) and reflects the species' small size.

**REMARKS:** This species differs from the type species by being smaller, possessing more generalized anchors, lacking 2 well-developed proximal arms of the accessory piece, and having a scaled tegument.

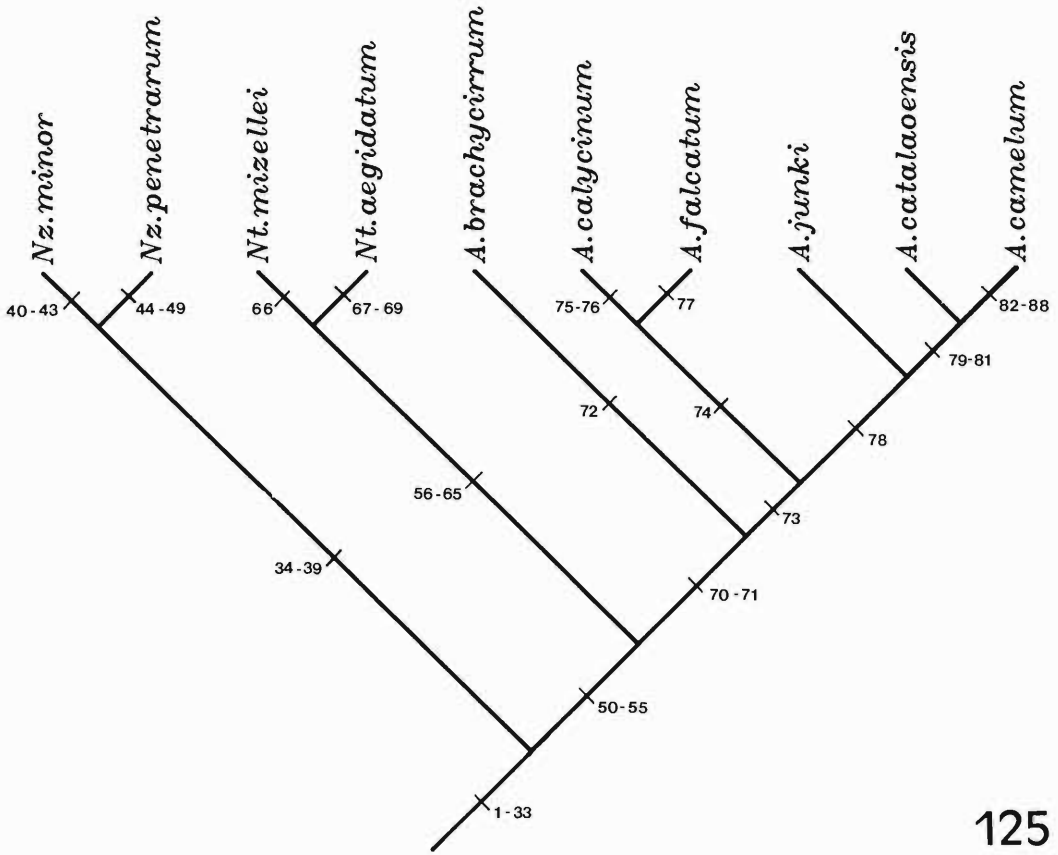
#### Phylogenetic Analysis

Phylogenetic analysis of species of *Amphithecium*, *Notozothecium*, and *Notozothecium* suggests that the 3 genera form a monophyletic group (Fig. 125). The cladogram has a consistency index of 83% indicating a low degree of homoplasy. The monophyly for this group of species is best defined by the following derived characters: dorsal vagina(e), T-shaped accessory piece, and scaled tegument. A double vagina is also considered a synapomorphy of the group even though placement of the character in the cladogram as a synapomorphy for *Amphithecium* spp. only is equally parsimonious. The dorsal vaginal aperture(s) and the vaginal tube(s) looping 1 or both of the





Figures 117–124. *Notozothecium minor*. 117. Holotype (ventral). 118. Copulatory complex. 119. Hook 1–4, 6, 7. 120. Hook 5. 121. Ventral bar. 122. Dorsal bar. 123. Ventral anchor. 124. Dorsal anchor. All figures of sclerotized structures are drawn to the 30-μm scale; Figure 117 to the 50-μm scale.



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Figure 125. Cladogram showing relationships of the ancyrocephaline species infesting *Serrasalmus nattereri*. Characters are denoted by numbers and identified in the Materials and Methods.

intestinal caeca suggests that the conditions present in *Notothecium* and *Notozothecium* are derived states from the more primitive condition of double dorsal vaginal apertures exhibited in *Amphithecium*.

Synapomorphies for the 3 generic taxa are provided in Figure 125 (6 for *Notozothecium*, 10 for *Notothecium*, and 2 for *Amphithecium*). *Notothecium* and *Amphithecium* are defined as sister groups by 6 synapomorphies, of which the presence of double cirral rami is the most significant. In *Notothecium*, species exhibit secondary reduction or loss of 1 ramus. Further, the unusual seminal receptacle present in *Notothecium* spp. appears to be a derived state from the vaginal ducts of the common ancestor, which lacked a seminal receptacle. The latter condition remains expressed in *Amphithecium* spp. Thus, the absence of a well-defined seminal receptacle would also serve as a diagnostic synapomorphic char-

acter of the group comprising species of *Amphithecium* and *Notothecium*.

The character with the lowest consistency index (C.I. = 0.33) in the analysis is the shape of the anchors as defined by the ratio between the lengths of the point and shaft. Wide differences in this character occur in species of many ancyrocephaline genera, and it is expected, therefore, that a high degree of homoplasy would occur within the species group studied as well as in other nonrelated genera.

Discussion

None of the monogenean species previously described from the gills of *Serrasalmus nattereri* by Mizelle and Price (1965) were found in our collections, and these workers did not specify a type locality within the Amazon Basin for their species. A high geographic variation of the composition of the monogenean community from

*Serrasalmus nattereri* could explain this finding. However, the data obtained in the present study indicate that despite some variation in community structure, a complete community replacement is unlikely. Eight of the 15 species reported herein were collected from all 6 localities in the Amazon Basin, representing intervening distances between extreme sites of greater than 1,000 km (air) and 1,600 km (river). Myers (1972) and Fink and Fink (1979) indicate that the classification of the piranhas is confused, with species identification often difficult. Based on the state of piranha classification during the 1960's and on the general high host specificity of the Dactylogyridae, it is possible that Mizelle and Price (1965) were working with a species of piranha other than *S. nattereri*.

The limited distribution of 4 of the 15 species reported in this study (*Anacanthorus* sp., *A. maltai*, *A. rondonensis*, and *Amphithecium catalaoensis*), and of the 2 morphologic forms of *Amphithecium camelum*, permit the clustering of the collection localities into 2 major areas: the central Amazon (Furo do Catalão and Ilha da Marchantaria) and southwestern Amazon (Rio Pacaás-Novos, Rio Mamoré, Rio Guaporé near Surpresa, and Rio Guaporé near Costa Marques). The sporadic occurrence of *Notozothecium penetrarum* (Localities 1, 2, 4, 5) and *N. minor* (Localities 1, 4, 5) is assumed to be the result of insufficient sampling. Therefore, these species are not considered important in defining major areas.

The monogenean community of *Serrasalmus nattereri* from the central Amazon is characterized by the presence of *Anacanthorus* sp. and *Amphithecium camelum* forma amazonas. *Anacanthorus maltai* and *A. rondonensis* are absent. In spite of sharing of these characteristics, the monogenean community of piranhas from the Furo do Catalão appears to bear some degree of uniqueness in that *Amphithecium catalaoensis* was collected only there. Significant size differences ( $P < 0.01$ ) were also found between specimens of *A. camelum* collected in these 2 localities (Table 2, Fig. 78). Whereas species of carnivorous piranhas are apparently rare or absent from blackwater rivers with low biologic productivity, as is the case for the Rio Negro (Goulding, 1980), it is unlikely that the specimens of piranha collected in the Furo do Catalão were originally members of populations inhabiting this river. The short distance (about 15 km)

and the lack of an apparent physical barrier between Furo do Catalão and Ilha da Marchantaria suggest that the monogenean communities are not isolated. Therefore, the detected differences in the size of the anchors, cirrus, and hook 7 (Fig. 78) of the 2 forms of *A. camelum* are not genotypic. Also, *A. catalaoensis* is rare on piranhas from the Furo do Catalão, which may indicate that *S. nattereri* is a suitable but not a required host for this parasite. Its presence on this host could be the result of species exchange from parasitic communities from other piranhas, perhaps from the Rio Negro, because this species was not detected on piranha cajú from the Ilha da Marchantaria.

The monogenean community of piranha cajú from the southwestern Amazon is characterized by *Anacanthorus maltai*, *A. rondonensis*, and *Amphithecium camelum* forma rondonia. No compositional differences were observed between the collection sites of this area. The absence of *N. aegidatum* from the Rio Pacaás-Novos (Locality 3) cannot be considered significant because only 1 host specimen was available from this location.

Ectoparasitic Monogenea are in direct contact and consequently under constant influence of the environment during their entire life cycle. In the Amazon Basin, the distribution of aquatic organisms is primarily influenced by the seasonal variation of the water level, consequent changes in water quality, and the general hydrochemical characteristics of the rivers' water type (Fittkau et al., 1975; Junk et al., 1983). Our data do not indicate the affects of these factors on distribution of monogenean species from piranha cajú, although the presence or absence of certain species in the respective communities could be influenced by them. All collections from the southwestern Amazon represent primarily clearwater populations, whereas those of the central Amazon are white water. Also, the large distances between respective regions could be involved in the development of unique monogenean communities by providing a mechanism of isolation. This isolation may be enhanced by the behavioral characteristics of the host. By being non-migratory and a fish of small horizontal displacement (Braga, 1976), the contact between neighboring groups of *Serrasalmus nattereri* is reduced.

Certainly, additional factors are involved in determining the species composition of the

monogenean community of *Serrasalmus nattereri*. Further research is needed on the biology and distribution of both host and parasites before the effect of these factors on the Monogenea is fully understandable.

#### Acknowledgments

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