Capillostrongyloides arapaimae sp. n. (Nematoda: Capillariidae), a new intestinal parasite of the arapaima *Arapaima gigas* from the Brazilian Amazon

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A new nematode species, Capillostrongyloides arapaimae *sp. n.*, *is described from the intestine and pyloric caeca of the arapaima*, Arapaima gigas *(Schinz)*, *from the Mexiana Island*, *Amazon river delta*, *Brazil*. *It is characterized mainly by the length of the spicule (779-1,800 µm)*, *the large size of the body (males and gravid females 9.39-21.25 and 13.54-27.70 mm long, respectively) and by the markedly broad caudal lateral lobes in the male*. *It is the third species of genus* Capillostrongyloides *reported to parasitize Neotropical freshwater fishes*.

Key words: *Capillostrongyloides arapaimae* n. sp. - Nematoda - *Arapaima gigas* - fish - Brazil

During recent investigations on the helminth parasites of the wild and cultured arapaima *Arapaima gigas* (Schinz) in the Mexiana Island, Brazilian Amazon, conspecific capillariid nematodes referable to *Capillostrongyloides* Freitas and Lent were recovered from the anterior part of the intestine and caeca of this fish. Their detailed study has shown that they represent a previously undescribed species, which is described herein.

Arapaima gigas (Arapaimidae, Osteoglossiformes), often referred to as the largest freshwater fish (maximum body length 450 cm; weight up to 200 kg), is distributed in the Amazon river basin, South America (Froese & Pauly 2008).

MATERIALS AND METHODS

A total of 30 specimens of arapaimas were examined for the presence of helminth parasites. The small fish (total body length 6-15 cm; n = 19) were obtained from the breeding tanks of the fish farm and wild specimens (total body length 70-175 cm; n = 11) were caught by nets in the nearby natural canals at Fazenda Santo Ambrosio, Mexiana Island (Amazon river delta), state of Pará (Pirarucu Management Project, license IBAMA 005-2007). The capillariid nematodes recovered were washed in physiological saline and then fixed in hot 4% formaldehyde solution. For light microscopy, the nematodes were cleared with glycerine. Drawings were made with the aid of a Leica drawing attachment. After examination, the specimens were stored in vials with 70% ethanol. All measurements are in micrometres unless otherwise stated. Fish names follow FishBase (Froese & Pauly 2008).

Financial support: Faperj, Grant Agency of the Czech Republic (n. 524/06/0170)
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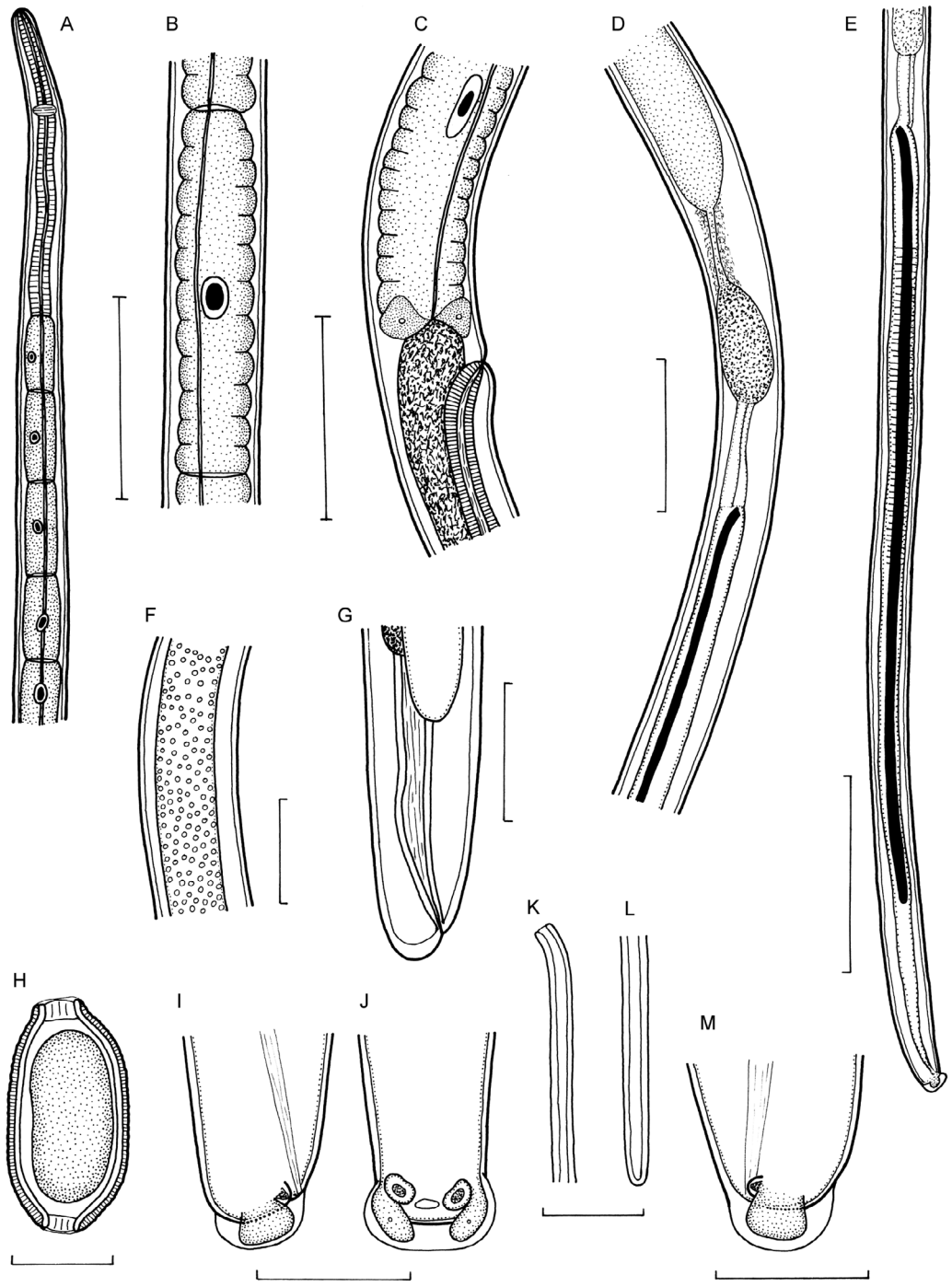
Received: 14 May 2008
Accepted: 9 June 2008

Capillostrongyloides arapaimae sp. n. (Figure)

General diagnosis: Capillariidae. Medium-sized filiform nematodes. Anterior end of body narrow, rounded; cephalic papillae indistinct. Two lateral bacillary bands distinct, fairly wide, extending along almost whole body length. Muscular oesophagus relatively short. Stichosome consisting of single row of about 38-40 stichocytes subdivided usually (mainly in posterior part of stichosome) into 10-15 transverse annuli; nuclei of stichocytes large. Nerve ring encircling muscular oesophagus at about its first third. Two wing-like cells present at oesophago-intestinal junction.

Male (2 specimens; measurements of holotype in parentheses): length of body (9.39) and 21.25 mm, maximum width (46) and 76. Maximum width of lateral bacillary bands (27) and 46. Length of entire oesophagus (5.73) and 8.55 mm, representing (61) and 40% of body length. Length of muscular oesophagus (266) and 368, of stichosome (5.46) and 8.18 mm; number of stichocytes about (38); stichocytes at posterior part of stichosome (118-141) and 256 long, and (32) and 36 wide. Nerve ring situated (80) and 118 from anterior extremity. Seminal vesicle oval, short. Spicule well sclerotized, (779) and 1,800 long, with almost smooth surface, representing (8.3) and 8.5% of body length. Proximal end of spicule simple, non-expanded, slightly dorsally curved, distal end rounded; width of spicule at middle (6). Spicular canal not developed. Surface of spicular sheath smooth, without spines; inner surface of withdrawn sheath transversely wrinkled. Tail rounded, (2) and 2 long, provided with short, well developed membranous bursa (6) wide in holotype. Bursa supported by 2 wide lateral lobes reaching posteriorly almost to posterior border of bursa; in ventral view, lobes narrower than in lateral view, with distal ends curved to median line. One pair of subventral papillae present at base of lateral lobes, at about level of cloacal opening. Lateral caudal alae absent.

Female (3 complete gravid specimens and several body fragments; measurements of allotype in paren-



Capillostrongyloides arapaimae sp. n. A: anterior end of female; B: stichocyte at posterior part of oesophagus; C: region of vulva and oesophago-intestinal junction, lateral view; D: region of seminal vesicle and proximal end of spicule, lateral view; E : posterior end of male (holotype), lateral view; F: oesophageal region of body with marked lateral bacillary band; G: caudal end of female, lateral view; H: fully developed egg; I, J: caudal end of male (holotype), lateral and ventral views; K, L: proximal and distal end of spicule, respectively; M: caudal end of male (paratype), lateral view. Scale bars: A-D = 100 µm; E = 200 µm; F, G, K, L = 50 µm; H = 20 µm; I, J, M = 30 µm.

theses): body length of complete specimens 13.54-27.70 (13.54) mm, maximum width 46-60 (46). Maximum width of lateral bacillary bands 27-41 (27). Length of entire oesophagus 6.87-7.62 (6.87) mm, representing 28-51 (51)% of body length. Length of muscular oesophagus 230-238 (238), of stichosome 6.63-7.39 (6.63) mm; number of stichocytes about 40 (40); stichocytes at posterior part of stichosome 155-233 (155-233) long and 36-55 (46-51) wide. Nerve ring situated 85 (85) from anterior extremity. Vulva situated 18-60 (41) posterior to level of oesophago-intestinal junction; vulval lips not elevated. Eggs arranged in single file in uterus. Eggs

barrel-shaped, polar plugs not protruding; egg wall two-layered; inner layer hyaline, outer layer with distinct superficial net-like sculpture. Eggs including polar plugs 46-48 × 21-23 (46-48 × 21-26), thickness of egg wall 3 (3); polar plugs 2 (2) long and 5-7 (5-7) wide. Content of fully developed eggs uncleaved. Caudal end rounded, anus subterminal; tail 7-9 (9) long. Rectum formed by fairly long hyaline tube; its proximal end somewhat anterior to posterior border of ovary.

Type host - Arapaima fish (local name "pirarucú"), *Arapaima gigas* (Arapaimidae, Osteoglossiformes) (body length 7-140 cm).

Sites of infection - Anterior part of intestine and pyloric caeca.

Type locality - Natural canals and breeding tanks of fish farm at Fazenda Santo Ambrosio (00º05'30"S, 49º34'50"W), Mexiana Island (Amazon river delta), state of Pará, Brazil.

Prevalence and intensity - Cultured fish 26% (5 infected/19 examined), 1-4 (mean 2) per fish; wild fish 18% (2 infected/11 examined), 1 and 4 per fish.

Type data and depository - Intituto Oswaldo Cruz, Rio de Janeiro (holotype CHIOC 35.559a, allotype CHIOC 35.559b, and paratypes CHIOC 35.559c-d).

Etymology - The specific name of this species refers to the generic name of the fish host.

TAXONOMIC DISCUSSION

According to the classification system of trichinelloid nematodes reported by Moravec (2001a), all species of the Capillariidae are placed in 22 recognised genera. Of them, *Capillostrongyloides* Freitas and Lent, and *Paracapillaria* Mendonça include morphologically similar species, all parasitic in the digestive tract of their hosts. Whereas all species of *Capillostrongyloides* have been reported from fishes, those of *Paracapillaria* parasitize fishes and amphibians (subgenus *Paracapillaria* Mendonça), reptiles (snakes) (subgenus *Ophidiocapillaria* Moravec), and a single species, *P. philippinensis* (Chitwood, Velasquez and Salazar), is known from birds and mammals including man (subgenus *Crossicapillaria* Moravec) (see Moravec 2001a,b, Timi et al. 2007).

Freitas and Lent (1935) erected *Capillostrongyloides* to accommodate the species *Capillostrongyloides zederi* Freitas and Lent, and *Capillostrongyloides minima* (Travassos, Artigas and Pereira), and they characterized it by the generally small measurements of the body and a small number of eggs in the uterus in females. However, according to Moravec (1982), these characters cannot be taken for generic criteria. Nevertheless, keeping consistently to the principle of type species, he considered this genus valid, differentiating it from *Paracapillaria* by the structure of the male caudal end. Later both *C. minima* and *C. zederi* were synonymized with *Capillostrongyloides sentinosa* (Travassos) and the latter became the type species of the genus (Moravec 1987). Moravec (2001a) retained the validity of *Capillostrongyloides* and *Paracapillaria*, distinguishing them solely by the shape of the caudal lobes supporting the male membranous bursa. However, recent studies indicate that there is certain interspecific variability in this feature and, sometimes, it is difficult to decide whether the species belongs to one or the other genus. Consequently, it cannot be excluded that, on the basis of subsequent studies, *Paracapillaria* will be synonymized with *Capillostrongyloides* in the future.

In having the stichosome consisting of a single row of stichocytes, the absence of lateral caudal alae in the male, presence of a well-developed bursa supported by two short and broad lateral lobes, each of them bearing a papilla at its base, and with a nonspiny spicular sheath, the new species from *A. gigas* can be placed in *Capillostrongyloides*. At present this genus comprises a total of seven species parasitizing freshwater and marine fishes in South America, Africa, Australia and Europe (see Moravec 2001a). All species, except for *Capillostrongyloides tandani* (Johnston and Mawson), can be easily distinguished from the new species by a considerably shorter spicule not exceeding 370 µm (vs. 779- 1,800 µm), different structure of the male caudal bursa, particularly the shape of the caudal lobes, and by the length of gravid females not exceeding 12 mm (vs. 13-27 mm). The male of *C. tandani* is unknown; this species reported from a South Australian freshwater catfish was placed tentatively in *Capillostrongyloides* by Moravec (1987) and can be distinguished from *C. arapaimae* sp. n. by considerably shorter gravid females (7.1-8.6 mm) with the terminal anus and by the stichocytes without distinct transverse annuli (see Moravec 1987).

C. arapaimae sp. n. differs from *Paracapillaria* spp. in having markedly broad caudal lobes in the male. In addition, all twelve species (see Moravec 2001a, Timi et al. 2007) of the subgenus *Paracapillaria* have a considerably shorter spicule not exceeding 500 µm, smaller body, and individual species also differs in some morphological features. For differences of members of the subgenera *Crossicapillaria* and *Ophidiocapillaria* see Moravec (2001a).

A remarkable feature of *C. arapaimae* sp. n. is the range of the spicule lengths. Depending on the body size of the respective male, the spicule may be 779-1,800 µm long; however, in both cases it forms about 8% of the body length. Although the length of the spicule is generally a good taxonomic feature in capillariids, it seems to range considerably in the species possessing a very long spicule, such as some *Paracapillaria* (*Ophiocapillaria*) spp. from snakes [e.g., 2.0-4.6 mm in *P. longispicula* (Sonsino); 1.8-2.3 mm in *P. najae* De; 0.9-3.3 mm in *P. sonsinoi* (Parona)] or *Capillaria gracilis* (Bellingham) (0.98-1.38 mm) from marine fishes (see Moravec 2001a).

C. arapaimae sp. n. is the third species of this genus reported from Neotropical freshwater fishes. Two other species are *C. sentinosa* from the stomach of characiform fishes in Brazil, and *C. ancistri* Moravec, Gelnar and Řehulka from the intestine of aquarium-cultured armoured catfishes (*Ancistrus* spp.) in Europe (imported from South America) (Vicente et al. 1985, Moravec 2001a).

ACKNOWLEDGEMENTS

To Dr Luiz Rabelo from Grupo Reicon for the facilities and support provided in field work.

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