Paracapillaria (Paracapillaria) gastrica n. sp. (Nematoda: Capillariidae) from the marine fish Synodus variegatus Lacépède (Synodontidae, Aulopiformes) off New Caledonia

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František Moravec, Jean-Lou Justine. Paracapillaria (Paracapillaria) gastrica n. sp. (Nematoda: Capillariidae) from the marine fish Synodus variegatus Lacépède (Synodontidae, Aulopiformes) off New Caledonia. Systematic Parasitology, 2020, 97 (2), pp.157-163. 10.1007/s11230-020-09907-7 . hal-02558414

HAL Id: hal-02558414
https://hal.science/hal-02558414

Submitted on 29 Apr 2020

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Systematic Parasitology 97, 157-163 (2020)
DOI: 10.1007/s11230-020-09907-7
ZooBank: urn:lsid:zoobank.org:pub:8055FCC1-2B23-478F-BAE4-3B92A4A68AD8

***Paracapillaria (Paracapillaria) gastrica* n. sp. (Nematoda: Capillariidae) from the marine fish *Synodus variegatus* Lacépède (Synodontidae, Aulopiformes) off New Caledonia**

František Moravec * & · Jean-Lou Justine

Abstract

Based on light and scanning electron microscopical studies, a new nematode parasite, *Paracapillaria (Paracapillaria) gastrica* n. sp. (Capillariidae), is described from the stomach of the marine fish (variegated lizardfish) *Synodus variegatus* (Lacépède) (Aulopiformes: Synodontidae) from off New Caledonia. This species is mainly characterised by the length of the spicule (267 µm), the proximal spicule end expanded to form a conspicuous folded, lobular rim, the presence of a well-developed caudal bursa supported by two lateral projections (rays) not adhering to the posterior border of body and by the size of eggs (54–60 9 24–27 µm) with non-protruding polar plugs. *Paracapillaria gastrica* n. sp. is the first known capillariid species parasitic in a host belonging to the fish order Aulopiformes and the first species of this genus reported from fishes in New Caledonian waters and the South Pacific Ocean.

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Introduction

Capillariid nematodes (Capillariidae) are frequent parasites of marine fishes, but because the present system of their genera is principally based on the morphology of males (Moravec & Beveridge, 2017), the generic and species identification of these parasites is impossible if only females are found. Therefore, in the ichthyoparasitological literature, many capillariids from marine fishes are reported only as Capillariidae gen. sp. or within Capillaria Zeder, 1800 (sensu lato).

To date, only three nominal capillariid species are reported from marine fishes off New Caledonia, *Capillaria plectropomi* Moravec & Justine, 2014 from *Plectropomus leopardus* (Lacépède) (Serranidae, Perciformes), *Pseudocapillaria echenei* (Parukhin, 1967) from *Echeneis naucrates* Linnaeus (Echeneidae, Perciformes) and *Pseudocapillaria novaecaledoniensis* Moravec & Justine, 2010 from *Pristipomoides argyrogrammicus* (Valenciennes) (Lutjanidae, Perciformes) (Justine et al., 2010; Moravec & Justine, 2010, 2014). However, probably an additional seven unidentified species, mostly designated as Capillariidae gen. spp., were reported from bony fishes of the orders Aulopiformes (Synodontidae), Perciformes (Acanthuridae, Carangidae, Haemulidae and Siganidae) and Syngnathiformes (Fistulariidae), and from the shark *Stegostoma fasciatum* (Hermann) (Orectolobiformes, Stegostomidae) (Moravec, 2001a; Justine et al., 2010; Moravec & Justine, 2010; Moravec et al., 2016).

Recent examination of nematodes collected by J.-L. Justine and his students in the marine fish *Synodus variegatus* (Lacépède) from off New Caledonia in 2009 revealed the presence of a new species of *Paracapillaria* Mendonça, 1963 (Capillariidae), which is described below.

Materials and methods

Fish were caught by line and hook. Nematodes were collected by the wash method (Justine et al., 2012a). The nematodes were fixed in hot 4% formalin and 100% ethanol. For light microscopical examination (LM), they were cleared with glycerine. Drawings were made with the aid of a Zeiss microscope drawing attachment. Specimens used for scanning electron microscopical examination (SEM) were post-fixed in 1% osmium tetroxide (in phosphate buffer), dehydrated through a graded acetone series, critical-point- dried and sputter-coated with gold; they were examined using a JEOL JSM-7401F scanning electron microscope at an accelerating voltage of 4 kV (GB low mode). All measurements are in micrometres unless otherwise indicated. The fish nomenclature adopted follows FishBase (Froese & Pauly, 2019).

Family Capillariidae Railliet, 1915
Genus *Paracapillaria* Mendonça, 1963

***Paracapillaria gastrica* n. sp.**

Type-host: *Synodus variegatus* (Lacépède) (Aulopiformes: Synodontidae), variegated lizardfish.
Type-locality: Near Récif Toombo, off Nouméa, New Caledonia (collected 23.ii.2009).
Type-material: Holotype and allotype (mounted on SEM stub) in the Helminthological Collection of the Institute of Parasitology, Biology Centre of the Czech Academy of Sciences, České Budějovice (Cat. No. N– 1207); paratypes in the Muséum National d'Histoire Naturelle, Paris (MNHN JNC3117A and JNC3117B).
Prevalence, intensity and details about fish: 1 fish infected out of 8 fish examined; 18 nematode specimens. The infected fish, parasitological number JNC3117, was 290 mm in total length and 108 g in weight. The fish specimen was sent to the Museum and Art Gallery Northern Territory, Darwin, Australia, and was registered in the collections under number S.17127-001.
Site in host: Stomach.
Etymology: The species name *gastrica* (*gastricus* = gastric, stomachal) is a Latin adjective and relates to the fact that this nematode is parasitic in the host's stomach.

Description (Figs. 1, 2)

General. Small filiform nematodes. Anterior end narrow, rounded; exact number and distribution of cephalic papillae not established, probably 12 papillae arranged in 2 circles present as in some related species (Fig. 2A). Cuticle finely transversely striated (Fig. 2B). Two lateral bacillary bands distinct, fairly wide, extending along almost whole body length (Figs. 1H, 2F). Muscular oesophagus relatively long (Fig. 1A). Stichosome consisting of 32–42 stichocytes subdivided usually (mainly in posterior part of stichosome) into several transverse annuli; nuclei of stichocytes large; some stichocytes darker than others, this difference being indistinct in cleared specimens (Fig. 1B, C). Nerve-ring encircling muscular oesophagus at about its 1st fourth. Two small wing-like cells present at oesophago-intestinal junction (Fig. 1B).

Male [Based on 1 specimen, holotype.] Length of body 6.17 mm, maximum width 63. Width of lateral bacillary bands 15. Length of entire oesophagus 2.64 mm (43% of body length). Length of muscular oesophagus 324, of stichosome 2.31 mm; number of stichocytes 36. Nerve-ring situated 90 from anterior
extremity. Seminal vesicle elongate, 384 long (Fig. 1F). Spicule well sclerotised, with almost smooth surface, 267 long (Fig. 1F, G). Proximal end of spicule distinctly expanded and

provided with folded, lobular rim, distal end rounded (Fig. 1K–M); width of spicule at proximal and distal ends 7 and 6, respectively. Spicular canal not developed. Surface of spicular sheath smooth, without spines. Tail rounded, long, provided with cuticular membrane forming bursa. Bursa supported by 2 wide lateral digital projections (rays) curved to median line in ventral view. One pair of large spherical subventral papillae present at base of lateral projections, at about level of cloacal opening (Figs. 1D–G, 2C–E) Length of whole bursa in ventral view 15, its maximum width 42. Lateral caudal alae absent.

Female [Based on 10 ovigerous specimens; measurements of allotype in parentheses.] Body length 11.74–15.87 (13.72) mm, maximum width 72–102 (90). Width of lateral bacillary bands 36–45 (36). Entire oesophagus 3.33–4.36 (3.93) mm, forming 25–29 (29)% of body length. Length of muscular oesophagus 282–387 (384), of stichosome 3.05–3.99 (3.55) mm; stichocytes 32–45 (41) in number. Nerve- ring 81–105 (84) from anterior extremity. Vulva situated 30–81 (51) posterior to level of esophagointestinal junction at 3.44–4.39 (3.97) mm from anterior extremity, representing 26–29 (29)% of entire body length; vulval lips not elevated or anterior lip slightly elevated (Fig. 1B). Eggs arranged usually in single file in uterus, rarely in 2 files. Eggs oval, slightly narrowed equatorially, polar plugs not protruding; egg wall 3-layered; inner layer hyaline, outer layer of eggs in uterus with fine, almost indistinct sculpture on surface (Fig. 1J). Size of eggs 54–60 x 24–27 (57–60 x 24–27), thickness of egg wall 3 (3); polar plugs 3–6 (5–6) long and 5–6 (6) wide. Content of fully developed eggs uncleaved. Caudal end rounded, anus slightly subterminal; tail 3–6 (3) long (Figs. 1I, N, 2F, G). Length of rectum 45–90 (45).

Remarks

According to Moravec & Beveridge (2017), ten capillariid genera comprise parasites of freshwater, marine and brackish-water teleost fishes and elasmobranchs: *Capillaria* Zeder, 1800 (sensu stricto); *Capillostrongyloides* Freitas & Lent, 1935; *Freitascapillaria* Moravec, 1982; *Gessyella* Freitas, 1959; *Lobocapillaria* Moravec & Beveridge, 2017; *Paracapillaria* Mendonça, 1963; *Paracapillaroides* Moravec, Salgado-Maldonado & Caspeta-Mandujano, 1999; *Piscicapillaria* Moravec, 1982; *Pseudocapillaria* Freitas, 1959; and *Schulmanela* Ivashkin, 1964. Nevertheless, *Capillostrongyloides* and *Paracapillaria* are distinguished solely by the shape of the caudal lobes supporting the male membranous bursa (Moravec, 1982, 2001a; Moravec & Beveridge, 2017). However, as indicated by recent studies, 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 synonymised with *Capillostrongyloides* (see Santos et al., 2008). 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 lateral digital processes (rays), each of them bearing a

papilla at its base, and with a non- spiny spicular sheath, the specimens of the present material belong to *Paracapillaria*.

Species of the genus *Paracapillaria* parasitise fishes and amphibians (subgenus *Paracapillaria* Mendonça, 1963), reptiles (snakes) (subgenus *Ophidiocapillaria* Moravec, 1986) and a single species, *P. philippinensis* (Chitwood, Velasquez & Salazar, 1968), is known from birds and mammals including man (subgenus *Crossicapillaria* Moravec, 2001) (Moravec, 2001a, b). To date, a total of 13 species and one subspecies are assigned to *Paracapillaria (Paracapillaria)*. Of them, *P. spratti* (Moravec & Sey, 1986) and *P. malayensis* Moravec, Modrý & Jirků, 2007 were described from the small intestine of anuran amphibians in Papua New Guinea and the Malayan Peninsula, respectively (Moravec & Sey, 1986; Moravec et al., 2007), whereas all others have been reported as parasites of fishes. Three species of the subgenus *Paracapillaria*, *P. piscicola* (Travassos, Artigas & Pereira, 1928), *P. plectroplites* (Johnston & Mawson, 1940) and *P. rhamdiae* Moravec, Gonzalez-Solis & Vargas-Vazquez, 1995, are gastrointestinal parasites of fresh- water fishes in Brazil, Australia and Mexico, respectively (Moravec, 1987, 2001a; Moravec et al., 1995). Two species and one subspecies, *P. teixeirafreitasi* (Caballero, 1971), *P. teixeirafreitasi pacifica* Moravec, Salgado-Maldonado & Caspeta-Mandujano, 1999 and *P. xenentodoni* De & Maity, 1994, are reported as gastrointestinal parasites of brackish-water (estuarine) fishes in Mexico and India (Caballero, 1971; De & Maity, 1994; Moravec et al., 1999) and six species, *P. argentinensis* Timi, Rossin, Lanfranchi & Etchegoin, 2007, *P. epinepheli* Moravec, Mendoza-Franco & Vargas-Vazquez, 1996, *P. gibsoni* Moravec, 1987, *P. helenae* (Layman, 1930), *P. parophrysi* (Moravec, Margolis & McDonald, 1981) and *P. sesokoensis* Hasegawa, Williams & Bunkley-Williams, 1991, are described from the stomach or intestine of marine fishes in the Atlantic or Pacific regions (Layman, 1930; Moravec et al., 1981, 1996; Moravec, 1987; Hasegawa et al., 1991; Timi et al., 2007).

As compared with the six *Paracapillaria (Paracapillaria)* species parasitising marine fishes, the spicule of *P. gastrica* n. sp. is distinctly longer (267 µm) than that of *P. epinepheli* (180–195 µm), *P. helenae* (203 µm) and *P. sesokoensis* (95–100 µm), or distinctly shorter than in *P. gibsoni* (450–480 µm). By the spicule length, *P. argentinensis* (250–370 µm) and *P. parophrysi* (281–373 µm) are somewhat similar to the new species, but both of them have larger eggs (58–70 x 23–30 µm and 64–71 x 25–30 µm, respectively, vs 54–60 x 24–27 µm) and their caudal bursa is short, with short lateral lobes adhering to the posterior border of body (vs caudal bursa longer, with lateral digital projections (rays) curved to the median line in ventral view).

The spicule lengths of *Paracapillaria (Paracapillaria)* species from brackish-water fishes are similar to that of *P. gastrica* n. sp., but *P. xenentodoni* differs from the new species in having smaller eggs (40–49 21–26 µm) and a short bursa with short lateral lobes adhering to the posterior border of body. The gravid females of *P. teixeirai* and P. *teixeirai pacifica* are at most 7.5 mm long (vs 11.7–15.9 mm in the new species) and these have usually

smaller eggs.

Regarding the three species of the subgenus *Paracapillaria* from freshwater fishes, *P. rhamdiae* distinctly differs from the new species in having a conspicuously short spicule (87 µm long), whereas the gravid females of *P. plectroplites* and *P. piscicola* are at most about 8 mm long and they have usually smaller eggs. Each of the two *Paracapillaria (Paracapillaria)* species parasitic in amphibians, *P. malayensis* and *P. spratti*, possesses a somewhat longer spicule (336 µm and 309 µm, respectively vs 267 µm), their caudal bursa is short, with short lateral lobes adhering to the posterior border of body, the female tail is distinctly subterminal (vs almost terminal) and their eggs are with protruding polar plugs (vs eggs with non-protruding polar plugs). In contrast to all *Paracapillaria (Paracapillaria)* spp. except for *P. malayensis*, the proximal spicule end of *P. gastrica* n. sp. is expanded to form a conspicuous folded, lobular rim. For differences of *Paracapillaria* species belonging to the subgenera *Crossicapillaria* and *Ophidiocapillaria* see Moravec (2001a).

Paracapillaria gastrica n. sp. is so far the only nominal capillariid species known to parasitise a host of the fish order Aulopiformes and the first species of this genus recorded from marine fishes in New Caledonian waters. In New Caledonia, Moravec & Justine (2010) reported capillariid females designated as Capillariidae gen. sp. 2 from the congeneric host *Synodus dermatogenys* Fowler, which most probably belonged to this new species.

Acknowledgements We wish to thank Eva Řehulková and Nadia Musilová who helped for the parasitological survey of infected fish; other students and colleagues involved in the parasitological survey were listed in Justine et al. (2010, 2012b). The infected fish was identified by Barry Russel, Charles Darwin University, Australia. Thanks are also due to the Laboratory of Electron Microscopy, Institute of Parasitology, Biology Centre CAS, institution supported by the MEYS CR (LM2015062 Czech-BioImaging) for their support with obtaining scientific data presented in this paper, and to Blanka Škoríková of the same Institute for help with the illustrations.

Funding This study was partly supported by the institutional support of the Institute of Parasitology, BC AS CR (585110/ 9500).

Conflict of interest The authors declare that they have no conflict of interest.

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Fig. 1 *Paracapillaria gastrica* n. sp. A, Anterior end of female; B, Region of vulva, lateral view; C, Stichocyte at posterior part of female stichosome; D, E, Caudal end of male, ventral and lateral views, respectively; F, Posterior end of male, ventral view; G, Posterior end of male, ventral view (larger magnification); I, Posterior end of female, lateral view; J, egg; K–M, Proximal end, middle part and distal end of spicule, respectively, lateral views; N, Caudal end of female, lateral view

Fig. 2 *Paracapillaria gastrica* n. sp., scanning electron micrographs. A, Cephalic end of female, sublateral view (arrows indicate cephalic papillae); B, Transverse striations on cuticle at anterior portion of body; C, D, Caudal end of male, ventral and sublateral views; E, Posterior end of male, ventral view; F, Posterior end of female, lateral view (note minute cuticular bosses of lateral bacillary band); G, Caudal end of female, lateral view. Abbreviations: a, anus; b, caudal bursa; c, cloacal aperture; p, adanal papilla

Figure 1

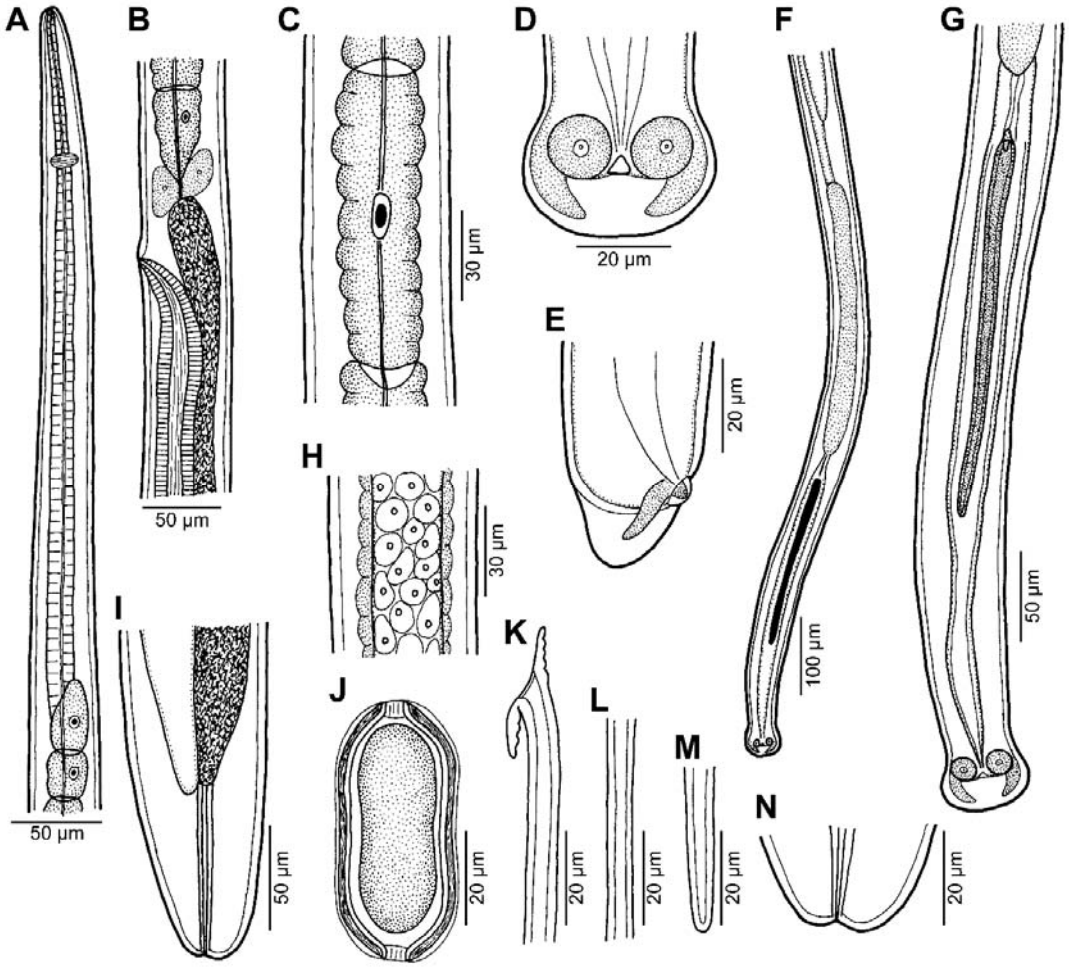
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Figure 2