A new species of *Comephoronema* (Nematoda: Cystidicolidae) from the squirrelfish *Holocentrus adscensionis* (Beryciformes: Holocentridae) off Brazil

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Abstract: A new nematode species, *Comephoronema multipapillatum* sp. n. (Cystidicolidae), is described from the anterior intestine and caecum of the squirrelfish *Holocentrus adscensionis* (Osbeck) (Beryciformes: Holocentridae) collected in Angra dos Reis, State of Rio de Janeiro, offshore Brazil. The new species was placed in *Comephoronema* Layman, 1933 by having an oval oral aperture, four submedian labia, four bilobed submedian sublabia, two narrow lateral pseudolabia and four single cephalic papillae, but mainly by numerous precloacal papillae in males (more than six pairs), in which it differs from species of the otherwise morphologically similar genus *Ascarophis* van Beneden, 1871. *Comephoronema multipapillatum* sp. n. can be easily distinguished from other congeners based on the high number of precloacal papillae in males (18 pairs + one unpaired) and also by the bidentate plate structure on the inner margin of pseudolabia, mature eggs with two long filaments on a single pole, body length of male (9.4–11.5 mm) and female (10.2–19.9 mm), left spicule size (222–278 µm) and length ratio of spicules (1 : 2.2–2.8). This is the fifth nominal species of *Comephoronema*, the first nematode registered parasitizing *H. adscensionis* and the first species of the genus in the Neotropical part of the Atlantic Ocean.

Keywords: parasitic nematodes, Neotropics, South Atlantic, marine fish, taxonomy

Cystidicolidae Skrjabin, 1946 is a nematode family that includes parasites of several groups of marine and freshwater fishes (Moravec and Justine 2010). The taxonomy and classification of this taxon are complicated, because its species are small and some important features are visible only by scanning electron microscopy; as a result, several species remain inadequately described (Moravec and Justine 2010).

To date, only five species of four genera of cystidicolid nematodes have been reported from fishes from Brazilian offshore, namely *Parascarophis sphyrnae* Campana-Rouget, 1955; *Ascarophis marina* Szidat, 1961; *A. brasiliensis* Magalhães-Pinto, Vicente et Noronha, 1984; *Neascarophis mariae* Pereira, Timi, Vieira et Luque, 2012; and *Pseudascarophis brasiliensis* Pereira, Pereira, Timi et Luque, 2013 (Luque et al. 2011, Pereira et al. 2012, 2013); none of these species were reported from beryciform fishes.

During helminthological examinations of some squirrelfish *Holocentrus adscensionis* (Osbeck) (Beryciformes: Holocentridae) collected in the coastal zone of the State of Rio de Janeiro, Brazil in July 2012, cystidicolid nematodes were recovered from the intestine and caecum of this host species. A detailed study based on light and

scanning electron microscopy (SEM) revealed that these specimens belong to an undescribed species.

Holocentrus adscensionis is a marine fish widely distributed in the western Atlantic from North Carolina to Brazil, and the eastern Atlantic from Gabon to Ascension Island of the British Overseas Territory (Froese and Pauly 2013). This nocturnal fish occurs in shallow coral reefs, but is also found in deeper offshore waters, feeding mainly on crabs and other small crustaceans and can cause poisoning if ingested by humans (Froese and Pauly 2013).

MATERIALS AND METHODS

Six specimens of *Holocentrus adscensionis* (two males 21.5–22.0 mm and four females 20.0–23.0 mm long) were caught by commercial trawlers in Angra dos Reis (23°00'S; 44°10'W), State of Rio de Janeiro, Brazil. Hosts were kept in thermal boxes filled with ice, transported to the laboratory and then immediately dissected. Stomachs, caeca and intestines were removed and examined individually using a stereoscopic microscope. Nematodes were fixed in AFA (95 parts 70% ethanol, 3 parts 40% formalin, 2 parts glacial acetic acid), stored in 70% ethanol and cleared in lactophenol. Drawings were made using a drawing tube attached to a light microscope Olympus BX 51. Photomicrographs were taken with the use of a differential interference contrast (DIC) in an Olympus BX 51 microscope with a digital

camera Olympus UC 30. Measurements are given in micrometres unless otherwise stated.

Specimens used for SEM observations were dehydrated in an ethanol series, dried by evaporation with hexamethyldisilazane, coated with gold and observed using a JEOL JSM 6460-LV. The identification of nematodes was based on Moravec (1998, 2007) and Anderson et al. (2009). Host identification was based on an illustrated key by Figueiredo and Menezes (1985); nomenclature and classification of fish are updated according to FishBase (Froese and Pauly 2013).

RESULTS

Family Cystidicolidae

Comephoronema multipapillatum sp. n. Figs. 1–4

Description: Medium-sized, whitish nematodes. Body markedly elongate, slender, tapering to anterior end. Cuticle thick, with marked transverse striations throughout most of body length. Cephalic end rounded (Fig. 3B), with four flattened submedian labia delimiting oval oral aperture, with lateral extensions (Fig. 3A). Four submedian sublabia, inside oral aperture as separated structure, elongated, slender and plate-shaped; bilobed, proximal lobe slightly shorter than distal one (Fig. 3A). Submedian sublabia delimiting much of internal margin of oral aperture (Figs. 1D, 3A). Two lateral and narrow pseudolabia, fused with oral aperture wall only at distal base, each provided with small, rounded, terminal and smooth protrusion (Figs. 1D, 3A,C); inner margins of both pseudolabia dorsoventrally straight, parallel to each other, forming a bidentate plate-like structure (Fig. 3A–C). Four single, bilobed cephalic papillae; two lateral inconspicuous amphids (Figs. 1D, 3A,C). Stoma (vestibule) long, ending in cuticular ring, with funnel-shaped prostom in lateral view (Fig. 1A–C). Oesophagus very long, glandular part 4–7 times longer than muscular. Nerve ring near anterior end of muscular oesophagus (Fig. 1A). Excretory pore at level or just posterior to nerve ring. Deirids small, simple (Figs. 1F,G, 3D), located between vestibule posterior end and nerve ring (Fig. 1A).

Male (holotype and five paratypes; mean followed by range inside parentheses): Length of body 10.4 (9.4–11.5) mm; width at level of nerve ring 92 (81–115), oesophago-intestinal junction 136 (109–171) and anus 107 (99–127). Anterior pseudolabial projections 6 (5–9) long. Vestibule including prostom 155 (140–165) long; prostom 21 (16–26) long and 16 (15–19) wide in lateral view. Length of muscular oesophagus 445 (400–510), maximum width 46 (32–50); length of glandular oesophagus 2.4 (2.1–2.9) mm, maximum width 71 (60–80); length ratio of muscular and glandular parts 1 : 5.2 (1 : 5.1–6.7). Length of entire oesophagus and vestibule representing 30.5% (29–32%) of total body length. Nerve ring, deirids and excretory pore situated at 198 (160–220), 175 (157–195) and 206 (200–232), respectively, from anterior end.

Posterior end of body ventrally curved, provided with broad subventral caudal alae (Figs. 2A, 3H, 4A). Cloacal aperture delimited by cuticular ring (Figs. 2A, 4A). Precloacal pedunculate papillae 37 in total; first papilla sublateral, unpaired, near base of caudal alae, followed by one pair sublateral; other 17 pairs arranged in couples of one subventral and one sublateral papilla (Figs. 2A,B, 3H, 4A). Postcloacal papillae: six pairs, including five pairs of pedunculate subventral papillae and one pair of minute sessile ventral papilla, located at level of last pair of pedunculate subventrals (Figs. 2A–D, 3G, H, 4A,E). Two phasmids with very small apertures located posterior to line of postcloacal sessile papillae (Figs. 2D, 3G, 4E).

Precloacal ventral cuticular ridges (area rugosa) in form of three longitudinal knurled striations, joining in one striation right anterior to cloacal aperture (Fig. 2A), or discontinuous at end (Fig. 4A), 920 long in holotype. Large (left) spicule 247 (222–278) long, with straight base and pointed distal tip, provided with ventral triangular outgrowth (Fig. 2F), poorly chitinized; spicule shaft 163 (148–196) long, representing 66% (60–70%) of overall length of spicule. Small (right) spicule 102 (96–112) long, with straight proximal base, median enlargement and distal tapered tip (Fig. 2E). Length ratio of spicules 1 : 2.4 (1 : 2.2–2.8). Tail conical, 172 (158–190) long, with rounded tip and small subterminal, semi-spherical protuberance, directed ventrally (Figs. 2D, 3G, 4E).

Female (allotype and two paratypes; mean followed by range inside parentheses): Length of body 14.7 (10.2–19.9) mm; width at level of nerve ring 111 (100–124), oesophago-intestinal junction 188 (150–260) and anus 136 (107–178). Anterior pseudolabial projections 8 (6–10) long (Fig. 1B). Vestibule including prostom 151 (140–162) long; prostom 22 (18–25) long and 16 (11–20) wide, in lateral view. Length of muscular oesophagus 468 (400–550), maximum width 64 (51–90); length of glandular oesophagus 3.2 (2.8–3.8) mm, maximum width 79 (75–82); length ratio of muscular and glandular parts 1 : 6.8 (1 : 6.5–7.0). Length of entire oesophagus and vestibule representing 27% (23–33%) of total body length. Nerve ring, deirids and excretory pore situated at 180 (177–184), 161 (152–180) and 164 (160–175), respectively, from anterior end.

Tail conical (Fig. 1H), 93 (88–100) long, with two terminal and semi-spherical papilla-like appendages, located sublaterally (Fig. 3F); each with minute phasmidial pore in centre (Fig. 3F). Vulva slightly postequaretorial, 8.4 (6.3–11.0) mm from anterior end of body, at 57% (55–61%) of body length. Muscular vagina directed posteriorly from vulva (Figs. 1E, 4B); vulval lips not elevated (Figs. 3E, 4B, C). Uterus amphidelphic. Fully developed eggs containing larvae, thick-walled with smooth surface; 35 × 25 (33–37 × 23–27). Embryonated and larvated eggs with two long filaments, up to 350 long, on one pole (Figs. 1I, 4D).

Fig. 1. *Comephoronema multipapillatum* sp. n., line drawings. **A** – anterior end of male, ventral view; **B** – cephalic end of female, lateral view; **C** – cephalic end of male, dorsoventral view; **D** – cephalic end of female, apical view; **E** – region of vulva containing larvated eggs, lateral view; **F**, **G** – deirid, apical and lateral views; **H** – caudal region of female, lateral view; **I** – larvated egg; filaments not shown completely.

Type host: Squirrelfish, *Holocentrus adscensionis* (Osbeck) (Holocentridae, Beryciformes).

Site of infection: Anterior intestine and caecum.

Type locality: Angra dos Reis Bay (23°00'S; 44°10'W), State of Rio de Janeiro, Brazil (collected in July 2012).

Prevalence and intensity of infection: 67%

(4 fish infected/6 fish examined); 3–7 (mean 5) nematodes per fish.

Deposition of specimens: Coleção Helminológica do Instituto Oswaldo Cruz – acronym CHIOC; Institute of Parasitology, Biology Centre of the ASCR, České Budějovice – acronym IPCAS. Holotype male (CHIOC 35879a); allotype

Fig. 2. *Comephoronema multipapillatum* sp. n., line drawings of male. **A** – posterior end, ventral view; **B** – posterior end, lateral view; **C** – caudal region, lateral view; **D** – terminal portion of tail, ventral view; **E** – right spicule; **F** – distal end of left spicule, lateral view.

female (CHIOC 35879b); paratypes 2 males (CHIOC 35881, 35882), female (CHIOC 35880), 2 males, 1 female (IPCAS N – 1015).

Etymology: The specific name *multipapillatum* refers to the high number of preloacal papillae in males.

Remarks. The present material belongs to *Comephoronema* Layman, 1933 because of the general morphology of the cephalic end, with an oval oral aperture, four

submedian labia, four bilobed submedian sublabia, two narrow lateral pseudolabia and four single cephalic papillae, but mainly due to the possession of numerous preloacal papillae in males (Moravec and Klimpel 2007). Species of the most similar genus, *Ascarophis*, have at maximum four pairs of preloacal papillae, whereas *Comephoronema* spp. have at least six pairs (Moravec and Klimpel 2007).

Fig. 3. *Comephoronema multipapillatum* sp. n., scanning electron micrographs. **A–C** – cephalic end, apical and subapical views; arrow indicates bidentate plate in **C**; **D** – deirid; **E** – aperture of vulva; **F** – posterior end of female, subapical view; **G** – posterior end of male, ventral view; arrow indicates subterminal protuberance; **H** – posterior end of male, ventral view; arrows indicate caudal papillae, asterisk indicates damaged caudal papillae. *Abbreviations:* a – amphid; b – bidentate plate; c – cephalic papilla; d – caudal papilla; f – phasmidial pore; p – pseudolabium; s – submedian sublábium.

Fig. 4. *Comephoronema multipapillatum* sp. n., photomicrographs (differential interference contrast). **A** – posterior end of male, ventral view; arrow indicates cloacal aperture; **B** – vulva and uterus with eggs, lateral view; **C** – egg inside terminal portion of vulva, lateral view; **D** – egg after ejection from vulva; **E** – tail end of male, ventral view; arrow indicates subterminal protuberance. Abbreviation: f – phasmidial pore.

At present, *Comephoronema* comprises four valid species, two from freshwater fishes of Palearctic Eurasia, *C. werestschagini* Layman, 1933 and *C. oschmarini* Trofimenko, 1974, and two from marine fishes, *C. beatriceinsleyae* (Holloway et Klewer, 1966) in Antarctica and *C. macrochiri* Moravec et Klimpel, 2007 in the Mid-Atlantic Ridge (Moravec and Klimpel 2007).

The main distinctive feature of *C. multipapillatum* sp. n. is the high and invariable number of precloacal papillae in males, which easily distinguishes it from other congeners. In addition, the new species exhibits some features at the cephalic end that were not described from other *Comephoronema* species, such as bilobed cephalic papillae and a bidentate plate structure on the inner margin of pseudolabia.

Comephoronema multipapillatum sp. n. is morphologically most similar to *C. macrochiri* from *Halosauropsis macrochir* (Günther) (Notacanthiformes: Holosauridae) described by Moravec and Klimpel (2007). However, the latter species has fewer precloacal papillae pairs (six vs 18 and one unpaired), males are smaller (4.5–7.4 mm vs 9.4–11.5 mm), left spicule is longer (297–375 µm vs 222–278 µm) and higher spicule length ratio (1 : 3.3–3.7 vs 1 : 2.2–2.8) (Moravec and Klimpel 2007).

The new species differs from the marine species *C. beatriceinsleyae* because this former has filaments on a single egg pole, whereas the latter has filaments on both egg poles. Furthermore, *C. multipapillatum* sp. n. has a smaller left spicule (222–278 µm vs 485–571 µm) and different spicule ratio (1 : 2.2–2.8 vs 1 : 4.0–5.4) than *C. beatriceinsleyae*.

The two freshwater species, *C. werestschagini* and *C. oschmarini*, are markedly different from *C. multipapillatum* sp. n. because their mature eggs possess a tuft of numerous fine filaments on both poles. In addition, the former is markedly smaller than the new species (males 3.9–6.1 mm vs 9.4–11.5 mm; females 6.8–7.4 mm vs 10.2–19.9 mm) (Trofimenko 1974, Moravec and Klimpel 2007). *Comephoronema oschmarini* has deirids of different shape (bifurcated), excretory pore much posterior to nerve ring and ratio of vestibule-body length smaller than in the new species (males 20–24% vs 29–32%; females 14% vs 23–33%) (Moravec et al. 2007).

DISCUSSION

The genus *Comephoronema* comprises five species, including the new one, inhabiting the digestive tract of fishes, of which two are from freshwater and three from marine environments (Moravec et al. 2007; present study). *Comephoronema werestschagini*, the type species of the genus, has been found in the digestive tract of scorpaeniform fishes (Abyssocotidae, Comephoridae, Cottocomephoridae) endemic to Lake Baikal (Siberia, Russia) in the Palearctic Region (Layman 1933). The other freshwater species, *C. oschmarini*, has been found only in *Lota*

lota (Linnaeus) (Gadiformes: Lotidae) through Europe and Siberia and seems to be specific of this host species (Trofimenko 1974, Moravec et al. 2007). It is interesting to note that both species have very similar eggs, which possess a tuft of numerous fine filaments on both poles; this feature is not present in any *Comephoronema* species parasitic in marine fishes.

The marine species of *Comephoronema* are represented by *C. beatriceinsleyae* parasitic in *Lycodictes* spp. (Perciformes: Zoracidae) from the McMurdo Sound and Weddell Sea in Antarctica (Holloway and Klewer 1966, Rocka 2002, 2004) and *C. macrochiri* found in the deep-sea fish *H. macrochir* from the Mid-Atlantic Ridge (Moravec and Klimpel 2007). Similarly as *C. multipapillatum*, these species exhibit a reduction of polar filaments on egg poles (two to four filaments); this synapomorphy may indicate close relatedness of all species from marine fishes. *Comephoronema multipapillatum* sp. n. represents the first record of the genus in the Neotropical part of the Atlantic Ocean and the first nematode species parasitizing *H. adscensionis*.

The taxonomy of genera within Cystidicolidae is unsatisfactorily resolved and complicated. To date, as many as 27 valid genera have been proposed (Moravec 2007, Moravec and Justine 2010, Moravec and Sobecka 2012). Several species of cystidicolids probably remain misclassified, mainly those assigned to *Ascarophis*, which represents a catchall genus in this nematode family (Ferrer et al. 2005, Moravec and Klimpel 2007). Chabaud (1975) synonymized *Comephoronema* with *Cystidicola* Fischer, 1978, but later Moravec and Nagasawa (1999) resurrected the genus and stated that it shows more affinities to *Salvelinema* Trofimenko, 1962 than to *Cystidicola*, mainly based upon the large number of precloacal papillae in males. In fact, Moravec and Klimpel (2007) said that both genera could be synonyms, but it needs to be clarified.

Life cycles of only nine species (of about more than 150) of cystidicolids are at least partially known in Eu-

rope and North America (Anderson 2000, Moravec 2007), being all of them represented by freshwater species (Gustafson 1939, Choquette 1955, Moravec 1971, Keppner 1975, De and Moravec 1979, Smith and Lankester 1979, Black and Lankester 1980, Jilek and Crites 1982a,b, Appy and Dadswell 1983, Saraiva et al. 2002).

Available data indicate that these heteroxenous parasites use various crustaceans as intermediate hosts, mainly those parasitizing marine fishes (Anderson 2000, Moravec 2007). Furthermore, two species of gammarids, *Pallasea quadrispinosa* Sars and *Echinogammarus bai-calensis* (Crustacea: Amphipoda) were found to be natural intermediate hosts of *C. oschmarini* in the former Soviet Union (Bauer 1987). This indicates that crustaceans may be suitable intermediate hosts for other species of *Comephoronema*.

No cystidicolids were previously reported from *H. adscensionis* or its congeners. *Ascarophis holocentri* Parukhin, 1984 (= *Ascarophis adioryx* Machida, 1981) has been reported in *Sargocentron spiniferum* (Forsskal), *S. punctatissimum* (Cuvier) and *Neoniphon samara* (Forsskal), all Holocentridae from Australian and Ethiopian regions, in Pacific and Indian oceans (Moravec and Justine 2009). However, *A. adioryx* clearly differs from *C. multipapillatum*, in the number and pattern of caudal papillae, all morphometric features and mainly the morphology of the anterior end, separating well these species into two different genera.

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REFERENCES

- ANDERSON R.C. 2000: Nematode Parasites of Vertebrates: Their Development and Transmission. Second Edition. CAB Publishing, Wallingford, 650 pp.
- ANDERSON R.C., CHABAUD A.G., WILLMOT S. 2009: CIH Keys to the Nematode Parasites of Vertebrates: Archival Volume. Commonwealth Agricultural Bureaux, Wallingford, 480 pp.
- APPY R.G., DADSWELL M.J. 1983: Transmission and development of *Capillospirura pseudargumentosa* (Appy and Dadswell, 1978) (Nematoda: Cystidicolidae). Can. J. Zool. 61: 848–859.
- BAUER O.N. (Ed.) 1987: [Key to the Parasites of Freshwater Fishes of the USSR. Vol. 3. Parasitic Metazoa, Part 2]. Nauka, Leningrad, 583 pp. (In Russian.)
- BLACK G.A., LANKESTER M.W. 1980: Migration and development of swim-bladder nematodes, *Cystidicola* spp. (Habronematodea), in definitive hosts. Can. J. Zool. 58: 1997–2005.
- CHABAUD A.G. 1975: Keys to the Genera of the Order Spirurida. Part 2. Spiruroidea, Habronematodea and Acuarioidea. In: R.C. Anderson, A.G. Chabaud and S. Willmott (Eds.), CIH Keys to the Nematode Parasites of Vertebrates. No. 3. Commonwealth Agricultural Bureaux, Farnham Royal, pp. 29–58.
- CHOQUETTE L.P.E. 1955: The life history of the nematode *Metabronema salvelini* (Fujita, 1920) parasitic in the speckled trout, *Salvelinus fontinalis* (Mitchill) in Quebec. Can. J. Zool. 33: 1–4.
- DE N.C., MORAVEC F. 1979: Some new data on the morphology and development of the nematode *Cystidicoloides tenuissima* (Zeder, 1800). Folia Parasitol. 26: 231–237.
- FERRER E., AZNAR F.J., BALBUENA J.A., KOSTADINOVA A., RAGA J.A., MORAVEC F. 2005: A new cystidicolid nematode from

- Mullus surmuletus* (Perciformes: Mullidae) from the western Mediterranean. J. Parasitol. 91: 335–344.
- FIGUEIREDO J.L., MENEZES N.A. 1985: Manual de Peixes Marinhos do Sudeste do Brasil III. Teleostei (2). Universidade de São Paulo, São Paulo, 90 pp.
- FROESE R., PAULY D. (Eds.) 2013: FishBase. World Wide Web electronic publication, www.fishbase.org, 02/2013.
- GUSTAFSON P.V. 1939: Life cycle studies on *Spinitectus gracilis* and *Rhabdochona* sp. (Nematoda: Thelaziidae). J. Parasitol. 25 (Suppl.): 12–13.
- HOLLOWAY H.L., KLEWER H.L. 1966: *Rhabdochona beatriceinsleyae* n. sp. (Nematoda: Spiruridae: Rhabdochonidae), from the Antarctic zoarcid, *Rhigophila dearborni*. Trans. Am. Microsc. Soc. 88: 460–471.
- JILEK R., CRITES J.L. 1982a: The life cycle and development of *Spinitectus carolini* Holl, 1928 (Nematoda: Spirurida). Am. Midl. Nat. 107: 100–106.
- JILEK R., CRITES J.L. 1982b: The life cycle and development of *Spinitectus gracilis* (Nematoda: Spirurida). Trans. Am. Microsc. Soc. 101: 75–83.
- KEPPNER E.J. 1975: Life cycle of *Spinitectus micracanthus* Christian, 1972 (Nematoda: Rhabdochonidae) from the bluegill, *Lepomis macrochirus* Rafinesque, in Missouri with note on *Spinitectus gracilis* Ward and Magath, 1917. Am. Midl. Nat. 93: 411–423.
- LAYMAN E.M. 1933: [Parasitic worms of fishes of Lake Baikal.] Trudy Baikalskoi Limnologicheskoi Stantsii 4: 5–99 (In Russian.)
- LUQUE J.L., AGUIAR J.C., VIEIRA F.M., GIBSON D.I., SANTOS C.P. 2011: Checklist of Nematoda associated with the fishes of Brazil. Zootaxa 3082: 1–88.
- MORAVEC F. 1971: On the life history of the nematode *Cystidicoloides tenuissima* (Zeder, 1800). Acta Soc. Zool. Bohemoslov. 35: 43–55.
- MORAVEC F. 1998: Nematodes of the Freshwater Fishes of the Neotropical Region. Academia, Prague, 464 pp.
- MORAVEC F. 2007: Some aspects of the taxonomy and biology of adult spirurine nematodes parasitic in fishes: a review. Folia Parasitol. 54: 239–257.
- MORAVEC F., HANZELOVÁ V., GERDEAUX D. 2007: New data on the morphology of *Comephoronema oschmarini* (Nematoda, Cystidicolidae), a little-known gastrointestinal parasite of *Lota lota* (Teleostei) in Palearctic Eurasia. Acta Parasitol. 52: 135–141.
- MORAVEC F., JUSTINE J.L. 2009: Two cystidicolids (Nematoda, Cystidicolidae) from marine fishes off New Caledonia. Acta Parasitol. 54: 341–349.
- MORAVEC F., JUSTINE J.L. 2010: Two new genera and species of cystidicolids (Nematoda, Cystidicolidae) from marine fishes off New Caledonia. Parasitol. Int. 59: 198–205.
- MORAVEC F., KLIMPEL S. 2007: A new species of *Comephoronema* (Nematoda: Cystidicolidae) from the stomach of the abyssal halosaur *Halosauropsis macrochir* (Teleostei) from the Mid-Atlantic Ridge. J. Parasitol. 93: 901–906.
- MORAVEC F., NAGASAWA K. 1999: Morphology and taxonomy of *Salvelinema* species (Nematoda: Cystidicolidae), swimbladder parasites of Pacific area salmonids. Folia Parasitol. 46: 123–131.
- MORAVEC F., SOBECKA E. 2012: *Collarinema eutriglae* n. sp. (Nematoda: Cystidicolidae), a new gastric parasite of the scorpaeniform fish *Eutrigla gurnardus* (Osteichthyes: Triglidae) in the North Sea, with remarks on the systematic status of *Collarinema* Sey, 1970. Syst. Parasitol. 81: 71–77.
- PEREIRA A.N., TIMI J.T., VIEIRA F.M., LUQUE J.L. 2012: A new species of *Neoscaraphis* (Nematoda: Cystidicolidae) parasitic in *Mullus argentinae* (Perciformes: Mullidae) from the Atlantic coast of South America. Folia Parasitol. 59: 64–70.
- PEREIRA F.B., PEREIRA A.N., TIMI J.T., LUQUE J.L. 2013: *Pseudascaraphis brasiliensis* sp. n. (Nematoda: Cystidicolidae) parasitic in the Bermuda chub *Kyphosus sectatrix* (Perciformes: Kyphosidae) from southeastern Brazil. Mem. Inst. Oswaldo Cruz, Rio de Janeiro 108: 476–480.
- ROCKA A. 2002: Nematodes of fishes of the Weddell Sea (Antarctic). Acta Parasitol. 47: 294–299.
- ROCKA A. 2004: Nematodes of the Antarctic fishes. Pol. Polar Res. 25: 135–152.
- SARAIVA A.M., MORAVEC F., PEREIRA A., CRUZ C. 2002: Development of *Spinitectus inermis* (Nematoda: Cystidicolidae), a parasite of eel, *Anguilla anguilla*, in Europe. Folia Parasitol. 49: 118–126.
- SMITH J.D., LANKESTER M.W. 1979: Development of swim bladder nematodes (*Cystidicolda* spp.) in their intermediate hosts. Can. J. Zool. 57: 1736–1744.
- TROFIMENKO V.YA. 1974: [New data on nematodes of the genera *Cottocomephoronema* and *Comephoronema* parasites of burbot.] Trudy GELAN 24: 199–207 (In Russian.)

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