

New data on three gonad-infecting species of *Philometra* (Nematoda, Philometridae) from estuarine fishes in South Carolina, USA

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Abstract

The following three gonad-infecting species of *Philometra* Costa, 1845 (Nematoda, Philometridae) were recorded from offshore perciform fishes in South Carolina, USA: *Philometra carolinensis* Moravec, de Buron et Roumillat, 2006 from the southern kingfish *Menticirrhus americanus* (Linnaeus) (Sciaenidae) (new host record), *Philometra floridensis* Moravec, Fajer-Avila et Bakenhaster, 2009 from the red drum *Sciaenops ocellatus* (Linnaeus) (Sciaenidae), and *Philometra saltatrix* Ramachandran, 1973 from the bluefish *Pomatomus saltatrix* (Linnaeus) (Pomatomidae). Findings of the first two species represent the second records since their original descriptions and *P. floridensis* was for the first time recorded from South Carolina estuaries. Detailed study of these nematode species, using both light (LM) and scanning electron microscopy (SEM), revealed the presence of minute caudal projections in the gravid female of *P. carolinensis* and four pairs of caudal papillae in the conspecific male; the cephalic and caudal ends of this species were for the first time examined by SEM. The related species *P. carolinensis* and *P. floridensis*, both parasitizing sciaenid fishes, can be distinguished from each other mainly by the presence/absence of oesophageal teeth, lengths of spicules and body lengths of gravid females. The morphology of North American specimens of *P. saltatrix* was found to be identical with that of specimens from Europe, thus confirming their conspecificity.

Keywords

Parasitic nematode, *Philometra*, fish, *Menticirrhus*, *Sciaenops*, *Pomatomus*, estuary, South Carolina, USA

Introduction

The present knowledge of philometrid nematodes (Philometridae) parasitizing marine and brackish-water fishes in the western North Atlantic remains fragmentary. It concerns the species composition, taxonomy and morphology of these important fish parasites as well as the range of their hosts, host-parasite relationships, geographical distribution and life cycles (e.g., Clarke *et al.* 2006; Moravec 2006; Moravec and Salgado-Maldonado 2007; Moravec *et al.* 2007, 2008a, c; Bryan *et al.* 2008; Moravec and de Buron 2009; Perez *et al.* 2009). During recent helminthological investigations of some estuarine fishes of South Carolina, USA, three little-known gonad-infecting species of *Philometra* Costa, 1845 were found. New important data on these nematodes are presented herein.

Southern kingfish *Menticirrhus americanus* (Linnaeus) (Sciaenidae, Perciformes) (maximum size 50 cm, weight about 1 kg), red drum *Sciaenops ocellatus* (Linnaeus) (Sciaenidae, Perciformes) (maximum size up to 155 cm, weight 45 kg) and

bluefish *Pomatomus saltatrix* (Linnaeus) (Pomatomidae, Perciformes) (maximum size 130 cm, weight up to 14.4 kg) are important subtropical and tropical commercial and sport fishes, inhabiting mostly coastal waters; whereas both sciaenid species are distributed in the West Atlantic, *P. saltatrix* has a circumglobal distribution in tropical and subtropical waters (Froese and Pauly 2009).

Materials and methods

Fishes were captured using trammel netting in several estuaries: southern kingfish, *Menticirrhus americanus* (total body length 28–32 cm) (n = 5; collected 12 June and 29 September 2008); red drum, *Sciaenops ocellatus* (total body length 81–113 cm) (n = 24; collected 12 September–10 October 2008); and bluefish, *Pomatomus saltatrix* (total body length 27–85 cm) (n = 9; collected 30 April and 4 May 2007, and 3–7 May 2008). The fishes were transported on ice to the laboratory in

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Charleston and immediately examined. The nematodes recovered were washed in physiological saline and then fixed in hot 4% formaldehyde solution in saline. For light microscopy (LM), the nematodes were cleared with glycerine. Drawings were made with the aid of a Zeiss drawing attachment. Specimens used for scanning electron microscopy (SEM) were postfixed in 1% osmium tetroxide (via phosphate buffer), dehydrated through a graded acetone series, critical point dried and sputter-coated with platina; they were examined using a JEOL JSM-7401F scanning electron microscope at an accelerating voltage of 4 kV GB low. All measurements are in micrometres unless otherwise indicated. The names of fishes follow Nelson *et al.* (2004).

Results

Philometra carolinensis Moravec, de Buron et Roumillat, 2006 (Figs 1 and 2)

Description: Male (1 specimen). Body filiform, whitish, 2.71 mm long, maximum width at middle 48; width of cephalic end

36, of caudal end 30. Cuticle smooth. Cephalic end rounded. Oral aperture small, surrounded by indistinct cephalic papillae. Oesophagus 516 long, representing 19% of body length, with anterior inflation 18 long and 12 wide; posterior part of muscular oesophagus overlapped by well-developed oesophageal gland with large cell nucleus in middle. Oesophageal nucleus and nerve ring 420 and 168, respectively, from anterior extremity. Excretory pore not located. Posterior end of body blunt, with broad U-shaped mound. Four pairs (1 preanal and 3 post-anal) flat, hardly visible caudal papillae present; first two pairs of postanals formed by submedian and lateral papillae, third pair by submedian papillae. Phasmids not observed. Spicules slender, needle-like, with somewhat expanded proximal and sharply pointed distal ends; right spicule slightly longer than left spicule. Length of right spicule 81, of left spicule 78; length ratio of spicules 1:1.04; length of right spicule representing 2.99% of body length. Gubernaculum narrow, 75 long, with approximately its proximal half somewhat dorsally bent; length of anterior bent part 39, representing 52% of entire gubernaculum length; distal end of gubernaculum with distinct reflect dorsal barb. Length ratio of gubernaculum and right spicule 1:1.08.

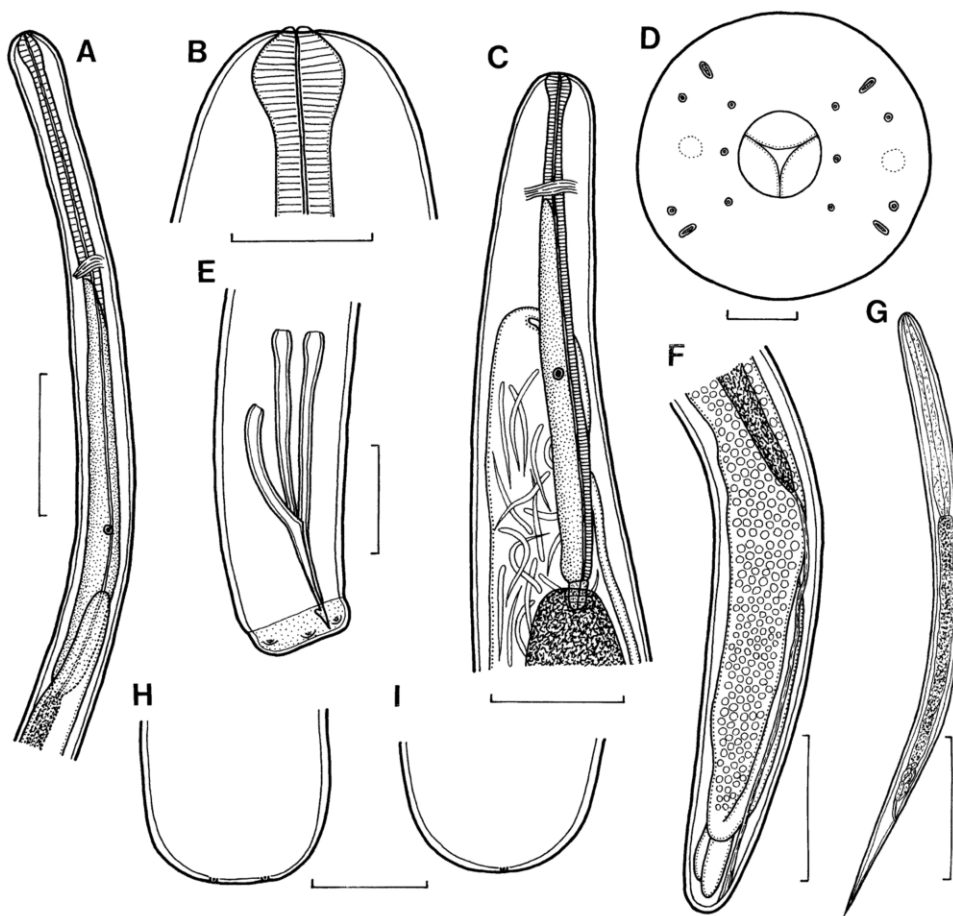


Fig. 1. *Philometra carolinensis* Moravec, de Buron et Roumillat, 2006: **A** – anterior end of male, lateral view; **B** – cephalic end of gravid female, lateral view; **C** – anterior end of gravid female, lateral view; **D** – cephalic end of subgravid female, apical view; **E** – posterior end of male, lateral view; **F** – posterior end of subgravid female, lateral view; **G** – larva from uterus, lateral view; **H** and **I** – caudal end of gravid female, dorsoventral and lateral views. Scale bars = 100 μ m (A, B, G, H, I); 300 μ m (C); 10 μ m (D); 30 μ m (E); 500 μ m (F)

Gravid female (3 complete specimens and 1 body fragment; measurements of body fragments of 3 subgravid specimens in parentheses): Body of fixed specimens filiform, brown-coloured, with distinct dark-brown intestine visible through cuticle, with rounded ends. Cuticle smooth. Body length 100–117 mm (body fragments 8–27 mm), maximum width 653–680 (394–530); maximum width/length ratio of body 1:147–172. Width of cephalic end 150–163 (136–150), of caudal end 163–190 (–). Cephalic papillae very small, indistinct when viewed laterally. Oral aperture large, almost circular, surrounded by 4 pairs of small submedian cephalic papillae of external circle and 6 single papillae (2 lateral and 4 submedian) of internal circle; each pair of external papillae consisting of one rounded and one more elongate papilla. Phasmids slightly outlined. Anterior ends of three oesophageal sectors protruding out of mouth as small oesophageal teeth. Oesophagus narrow, swollen near mouth to form bulb 72–75 (66) long and 72–75 (66–69) wide. Overall length of oesophagus 1.28–1.29 mm (1.14–1.18 mm), representing 1.1–1.3% (–) of body length; its maximum width 95 (82). Dorsal oesophageal gland well-developed, provided with large cell nucleus located in about its middle, 898–979 (843–857) from anterior extremity. Ventriculus 21–27 (27) long and 54–60 (54) wide. Nerve ring 313–367 (313–326) from anterior end of

body. Posterior end of intestine atrophied, forming ligament attached ventrally to body wall near caudal end; length of ligament 0.53–2.60 (–) mm. Caudal end rounded, with pair of minute, hardly visible lateral papilla-like protrusions. Ovaries narrow, long, reflected. Uterus occupies most of body, being filled with first-stage larvae and eggs (only with eggs); larvae ($n = 5$) from uterus 447–528 long, maximum width 18–21; length of their oesophagus 147–168 (31–34% of body length), that of tail 75–87 (16–17% of body length).

Host: Southern kingfish, *Menticirrhus americanus* (Sciaenidae, Perciformes).

Site of infection: Gonads.

Localities: Estuaries of Romain harbour and Ashepoo-Combahee-Edisto (ACE) basin, South Carolina, USA (collected 12 June and 29 September 2008, respectively).

Prevalence and intensity: 2 fish infected/2 fish examined in June. Intensity 2 and 8 nematode specimens.

Deposition of voucher specimens: Helminthological Collection of the Institute of Parasitology, BC ASCR, in České Budějovice (Cat. No. N-855) and US National Parasite Collection, Beltsville, Maryland (Cat. No. USNPC 101511).

Comments: The general morphology and measurements of the present specimens are similar to those of *Philometra carolinensis* Moravec, de Buron et Roumillat, 2006, a philome-

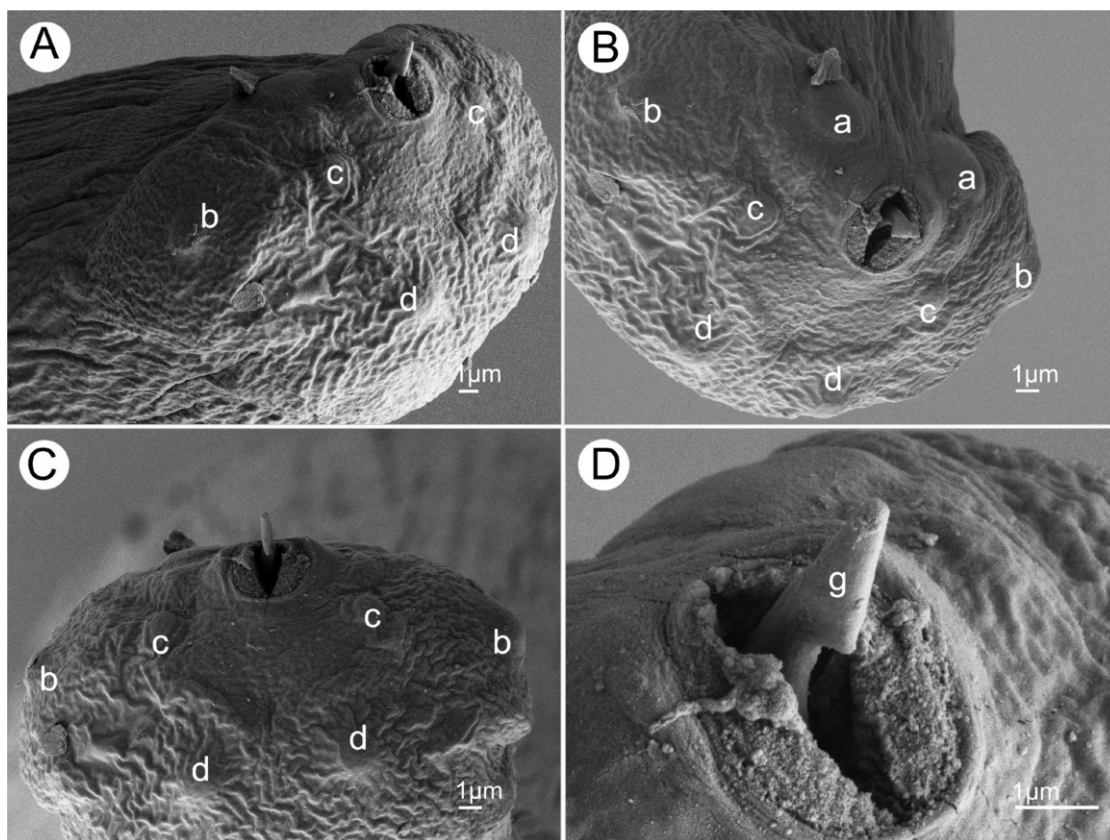


Fig. 2. *Philometra carolinensis* Moravec, de Buron et Roumillat, 2006, SEM micrographs of male: **A** – caudal end, sublateral view; **B** – caudal end dorsolateral view; **C** – caudal end, dorsal view; **D** – cloacal aperture, subapical view. **Abbreviations:** a – submedian preanal papilla, b – lateral postanal papilla, c – anterior submedian postanal papilla, d – posterior submedian postanal papilla, g – distal tip of gubernaculum with distinct dorsal barb

trid recently described from the ovary of *Cynoscion nebulosus* (Cuvier) in the estuaries of South Carolina, USA (Moravec *et al.* 2006). Also since the site of infection (gonads) in the host is identical and the hosts of both forms, belonging to the same fish family (Sciaenidae), are sympatric in the estuaries, the specimens from *Menticirrhus americanus* are considered to belong to *P. carolinensis*. Small biometrical differences recorded between these two forms may be considered to be within the limits of intraspecific variability of this species. In contrast to the present study, Moravec *et al.* (2006) did not observe minute caudal papilla-like projections in *P. carolinensis* gravid females from *C. nebulosus*, but these are hardly visible under the light microscope. They reported only three pairs of caudal papillae in the only available male studied by LM, whereas four pairs were found by SEM in this study; the male papillae of philometrids are extremely difficult to observe by LM and these data may not be reliable. The same number (4 pairs) and distribution of caudal papillae has recently been reported by Sokolov and Kazakov (2008) for *Philometra rischta* Skryabin, 1923. On the other hand, the present specimens exhibit most characteristic taxonomic features of *P. carolinensis*, such as the presence of a dorsal reflect barb on the gubernaculum and distinct oesophageal teeth in the gravid female, as well as the body length of the gravid female.

For the first time in this species, the male morphology has been examined by SEM; this made it possible to study a detailed structure of the male cephalic and caudal ends. Among gonad-infecting *Philometra* spp., *P. carolinensis* resembles only *P. floridensis* Moravec, Fajer-Avila et Bakenhaster, 2009 in having a dorsal reflect barb on the gubernaculum; the latter species has only recently been described from another sciaenid fish, *Sciaenops ocellatus* (Linnaeus), off Florida (Gulf of Mexico), USA (Moravec *et al.* 2009), and subsequently it has been recorded from the same host species in South Carolina (present study). Both species differ from each other mainly in the body length of gravid females, presence/absence of oesophageal teeth, and in the length of spicules.

The present finding of *P. carolinensis* in *Menticirrhus americanus* represents a new host record for this nematode parasite.

***Philometra floridensis* Moravec, Fajer-Avila et Bakenhaster, 2009 (Fig. 3)**

Description: Male (6 specimens). Body filiform, whitish, 2.43–3.24 mm long, maximum width at middle 75–93; width of cephalic end 30–33, of caudal end 24–30. Cuticle smooth. Cephalic end rounded. Oral aperture triangular, very small, surrounded by 14 minute cephalic papillae arranged in two circles: external circle formed by 4 submedian pairs of papillae, internal circle by 4 submedian and 2 lateral; amphids slightly outlined. Oesophagus 360–465 long, forming 13–18% of body length, somewhat inflated at anterior end; posterior part of muscular oesophagus overlapped by well-developed oesophageal gland with large cell nucleus in middle. Oesophageal nucleus and nerve ring 255–348 and 114–198, respectively,

from anterior extremity. Excretory pore 147–240 from anterior end. Posterior end of body somewhat narrowed, blunt, with poorly developed flat lateral and subdorsal lobes; 1 pair of preanal, 1 pair of adanal, and 1 pair of postanal, very flat and hardly visible caudal papillae present. Spicules slender, needle-like, with somewhat expanded proximal and sharply pointed distal ends; right spicule usually slightly longer than left spicule, rarely both spicules equal in length. Length of right spicule 141–207, of left spicule 138–204; length ratio of spicules 1:1.00–1.21; length of right spicule representing 5.81–7.54% of body length. Gubernaculum narrow, 75–87 long, with approximately its proximal half somewhat dorsally bent; length of anterior bent part 36–42, representing 45–50% of entire gubernaculum length; distal end of gubernaculum with distinct reflect dorsal barb. Length ratio of gubernaculum and right spicule 1:1.88–2.38.

Subgravid female (2 anterior and 1 posterior body fragments): Body of fixed specimens brownish, with smooth cuticle; body length not determined; width of cephalic end 150 and 163, of posterior end 150. Cephalic end rounded, cephalic papillae very small, indistinct when viewed laterally. Oral aperture large, oval, surrounded by 4 pairs of submedian cephalic papillae of external circle and 6 single papillae (2 lateral and 4 submedian) of internal circle; each external pair consisting of one rounded and one elongate papilla when viewed apically. Pair of lateral amphids slightly outlined. Oesophagus including anterior bulbous inflation 1.20 and 1.27 mm long; bulb moderately developed, 57 and 69 long, and 60 and 66 wide. Oesophageal gland well-developed, with distinct cell nucleus in middle. Maximum width of oesophagus including oesophageal gland 95 and 109. Nerve ring 231 and 313 from anterior end of body. Small ventriculus 27 and 35 long, 68 and 82 wide. Intestine dark brown, ending blindly, its posterior end attached by ligament ventrally to body wall near caudal end. Ovaries long. Uterus occupying most space of body, filled with numerous eggs 15–27 in diameter. Posterior end of body rounded, 150 wide, without caudal projections.

Host: Red drum, *Sciaenops ocellatus* (Sciaenidae, Perciformes).

Site of infection: Gonads.

Localities: Estuaries of Charleston harbour and Winyah Bay, South Carolina, USA (collected 12 September–10 October 2008).

Prevalence and intensity: 63% (15 fish infected/24 fish examined); only mature females of fish were infected (15 out of 16 dissected), none of the 6 males dissected were infected. Intensity ranged from 1 to several nematode specimens per fish (all worms found in October were dead and formed thick large dark masses).

Deposition of voucher specimens: Helminthological Collection of the Institute of Parasitology, BC ASCR, in České Budějovice (Cat. No. N-921) and US National Parasite Collection, Beltsville, Maryland (Cat. No. USNPC 101510).

Comments: The morphology and measurements of the present specimens from South Carolina are, more or less, in agreement with the original description of *P. floridensis* given

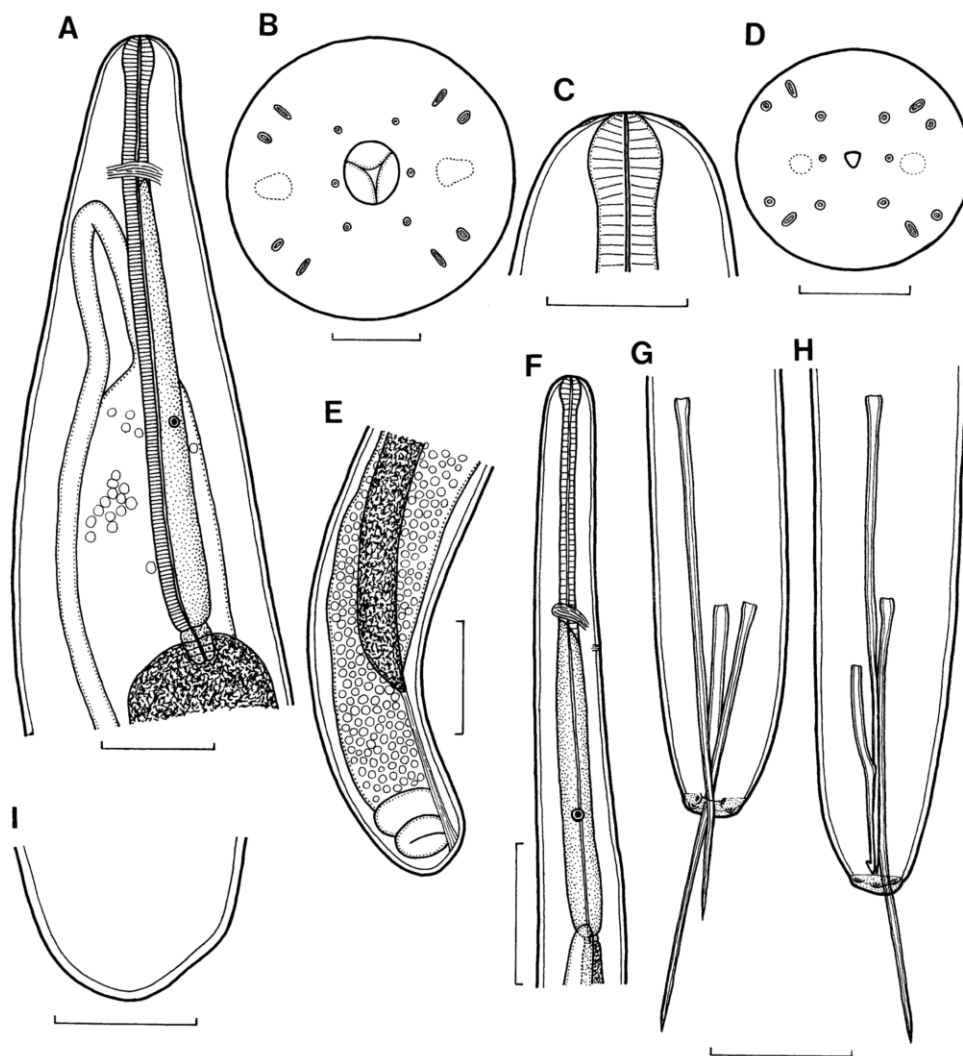


Fig. 3. *Philometra floridensis* Moravec, Fajer et Bakenhaster, 2009: **A** – anterior end of subgravid female, lateral view; **B** and **C** – cephalic end of subgravid female, apical and lateral views; **D** – cephalic end of male, apical view; **E** – posterior end of subgravid female, lateral view; **F** – anterior end of male, lateral view; **G** and **H** – caudal end of male, ventral and lateral views; **I** – caudal end of subgravid female, lateral view. Scale bars = 200 μ m (**A**, **E**); 20 μ m (**B**); 100 μ m (**C**, **F**, **I**); 30 μ m (**D**); 50 μ m (**G**, **H**)

by Moravec *et al.* (2009); some small negligible biometrical differences may be considered to be within the limits of intra-specific variability of this species. *Philometra floridensis* differs distinctly from the most related species *P. carolinensis* (see above) mainly in the absence of oesophageal teeth, conspicuously longer spicules (138–213 μ m) and much longer gravid females (nearly to 1 m).

Previously this species was found in Florida, USA (Moravec *et al.* 2009). The present finding of *P. floridensis* in waters of South Carolina represents a new geographical record, indicating that this nematode parasite is widespread in the West Atlantic, following the distribution of its fish host.

***Philometra saltatrix* Ramachandran, 1973 (Figs 4 and 5)**

Description: Male (1 specimen). Body filiform, whitish, 2.45 mm long, maximum width 51; width of cephalic end 27, of

caudal end 30. Cuticle smooth. Cephalic end rounded. Oral aperture circular, very small, surrounded by 14 small cephalic papillae arranged in two circles: external circle formed by 4 submedian pairs of papillae; internal circle by 4 submedian and 2 lateral single papillae. Oesophagus 366 long, representing 15% of body length, with anterior inflation 18 long and 18 wide; posterior part of oesophagus with well-developed oesophageal gland with large cell nucleus in middle. Oesophageal nucleus and nerve ring 276 and 132, respectively, from anterior extremity. Posterior part of oesophagus overlapped by anterior end of testis. Excretory pore 180 from anterior end of body. Posterior end of body blunt, with two broad, lateral lobular mounds curved dorsally, but separated from each other on dorsal side, and with one pair of adanal and two pairs of postanal, very flat, hardly visible caudal papillae. Spicules slender, needle-like, equally long, with somewhat expanded proximal and sharply pointed distal tips;

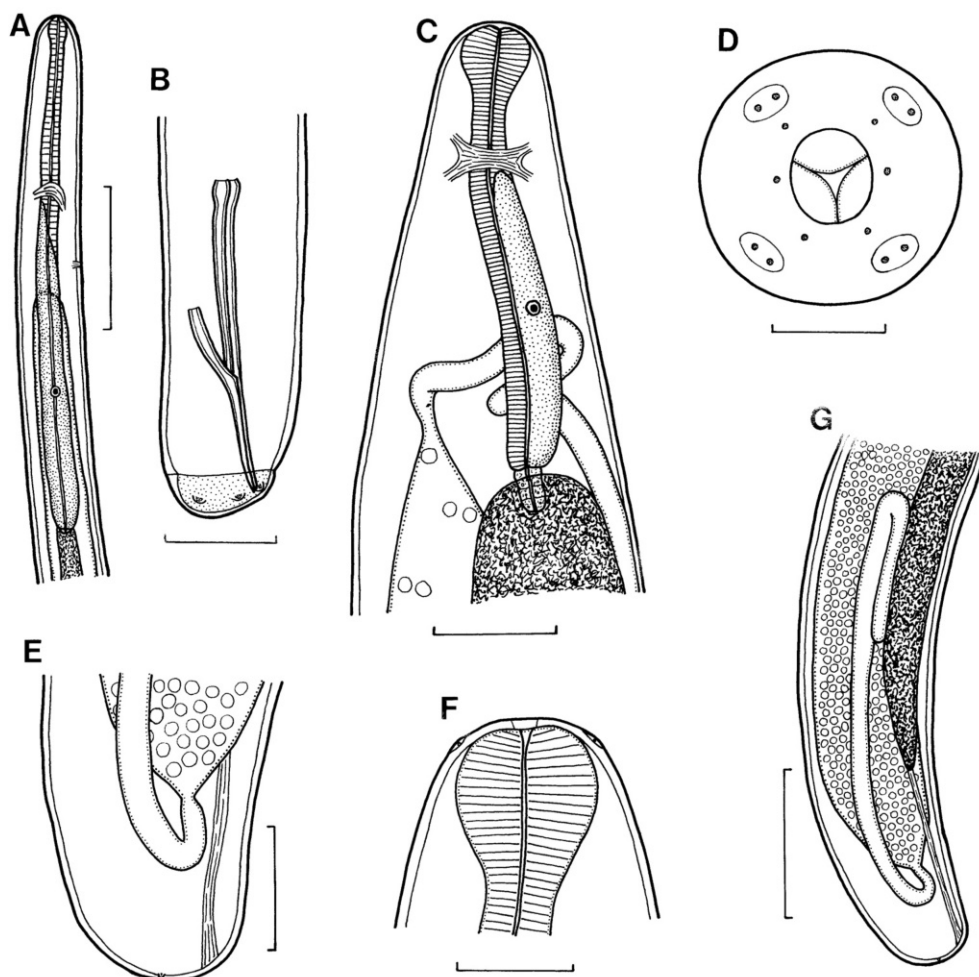


Fig. 4. *Philometra saltatrix* Ramachandran, 1973: **A** – anterior end of male, lateral view; **B** – caudal end of male, lateral view; **C** – anterior end of subgravid female, lateral view; **D** – cephalic end of subgravid female, apical view; **E** – caudal end of subgravid female, lateral view; **F** – cephalic end of subgravid female, lateral view; **G** – posterior end of subgravid female, lateral view. Scale bars = 100 μ m (A, F); 30 μ m (B); 200 μ m (C, E); 50 μ m (D); 500 μ m (G)

length of spicules 96, representing 4% of body length. Gubernaculum narrow, 60 long, with approximately its proximal half somewhat dorsally bent; length of anterior bent part 27, representing 45% of entire gubernaculum length. Detailed structure of distal end of withdrawn gubernaculum indistinct; reflect dorsal barb absent. Length ratio of gubernaculum and spicules 1:1.6.

Subgravid female (3 specimens): Body of fixed specimens brownish, with smooth cuticle; body length 75–100 mm, maximum width 666–748; width of cephalic end 163–190, of caudal end 272–326; posterior part of body somewhat narrower than anterior part. Cephalic end rounded, cephalic papillae very small, indistinct when viewed laterally. Oral aperture large, oval, surrounded by 4 pairs of submedian cephalic papillae of external circle and 6 single papillae (2 lateral and 4 submedian) of internal circle; each external pair of papillae situated on slightly elevated lobe. Oesophagus including anterior bulbous inflation 857–938 long; bulb 122–136 long and 136 wide. Oesophageal gland well-developed; large oesophageal gland

nucleus 544–598 from anterior extremity. Nerve ring 258–272 from anterior end of body. Small ventriculus 27–42 long and 66–75 wide. Intestine dark brown, ending blindly, its posterior end attached by ligament ventrally to body wall near caudal end; length of ligament 544–748. Ovaries long. Uterus occupying most space of body, filled with numerous eggs. Caudal end rounded, with two very small, hardly visible lateral papilla-like projections.

Host: Bluefish, *Pomatomus saltatrix* (Pomatomidae, Perciformes).

Site of infection: Ovary.

Localities: Estuaries of Ashepoo-Combahee-Edisto (ACE) basin and Charleston harbour, South Carolina, USA (collected 30 April and 4 May 2007, and 3–7 May 2008).

Prevalence and intensity: 56% (5 fish infected/9 fish examined). Intensity ranged from 1 to several nematode specimens per fish.

Deposition of voucher specimens: Helminthological Collection of the Institute of Parasitology, BC ASCR, in České Bu-

dějovice (Cat. No. N-809) and US National Parasite Collection, Beltsville, Maryland (Cat. No. USNPC 101512).

Comments: This species was inadequately described by Ramachandran (1973) from the gonads of the bluefish, *Pomatomus saltatrix*, off the Atlantic coast of the USA (Connecticut) and the original description contains some inaccuracies and evident errors. In North America (Northwest Atlantic, USA: off New York, North Carolina and South Carolina), *Philometra saltatrix* was later recorded from the same host species by Cheung *et al.* (1984), Clarke *et al.* (2006) and Moravec *et al.* (2008a), but no redescription of this parasite was pro-

vided. *Philometra saltatrix* has recently been redescribed from specimens collected from *P. saltatrix* from the Mediterranean Sea off Italy and Turkey (Moravec and Genc 2004, Moravec *et al.* 2008b), but these European specimens somewhat differed morphologically and biometrically from the original species description. In contrast to Ramachandran's (1973) data, no microscopic bosses were observed on the cuticle of the male, the spicules were found to be distinctly longer than those reported in the original description, and the male oesophagus was conspicuously longer. The present study shows that the morphology of the North American specimens of this nematode

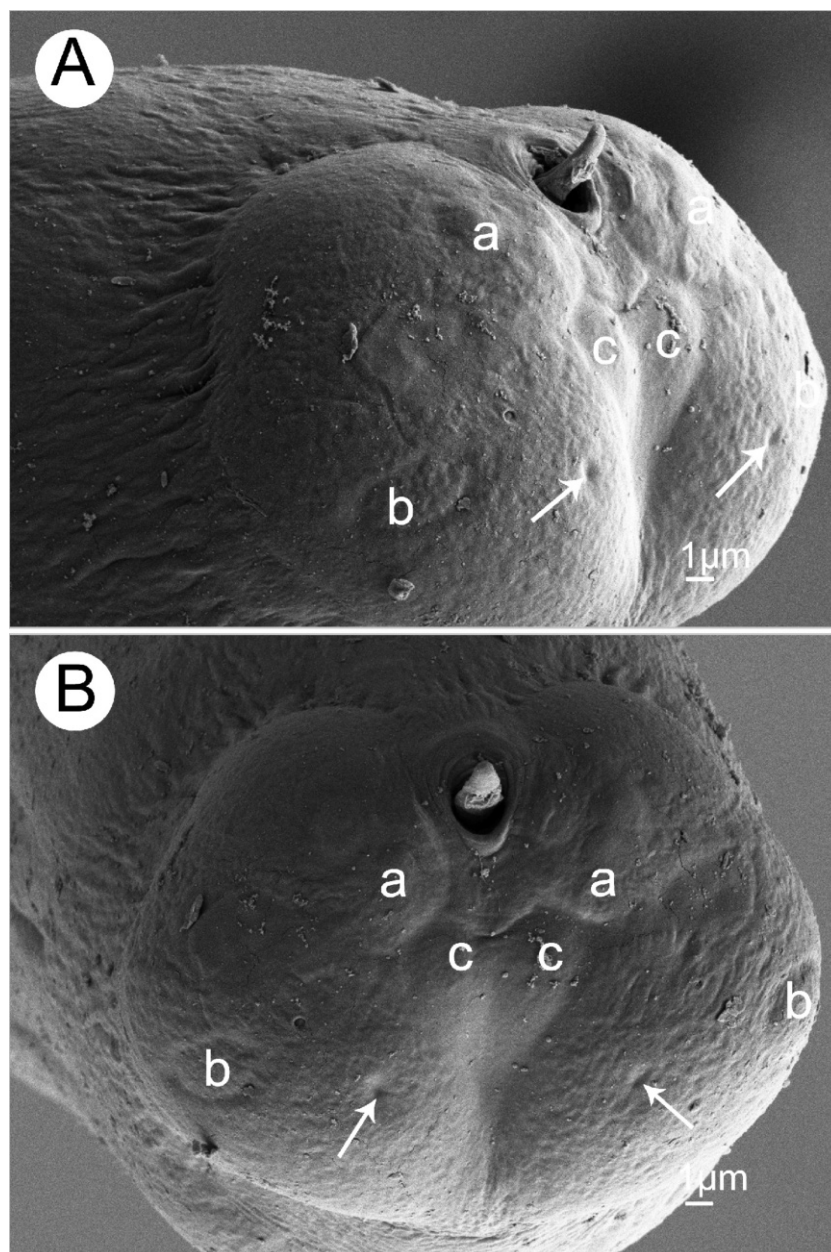


Fig. 5. *Philometra saltatrix* Ramachandran, 1973, SEM micrographs of male: **A** – caudal end, sublateral view (arrowheads indicate phasmids); **B** – caudal end, apical view (arrowheads indicate phasmids). **Abbreviations:** a – adanal subventral papilla, b – lateral postanal papilla, c – subventral postanal papilla

species is identical with that of European specimens, as described by Moravec and Genc (2004) and Moravec *et al.* (2008b), thus confirming their conspecificity. Since only a single male specimen with a withdrawn gubernaculum was available, a detailed structure of the gubernaculum distal end could not be studied by SEM to confirm its characteristic annulation, previously found by Moravec *et al.* (2008b).

A single specimen (sub gravid female 15 mm long) of *Philometra saltatrix* has already been recorded from *P. saltatrix* in South Carolina (Cape Romain Estuary) collected in April 2007 (Moravec *et al.* 2008a). The finding of much larger females (up to 100 mm long) at the beginning of May suggests that *P. saltatrix* has a pronounced annual maturation cycle, as previously found in some other *Philometra* spp. of the temperature zone (Moravec 2006, Perez *et al.* 2009), that is probably seasonally synchronous with the bluefish spawning cycle (Clarke *et al.* 2006).

Conspecific with *P. saltatrix* is probably also *Philometra* sp. reported by Rego *et al.* (1983) from *Pomatomus saltatrix* off the Brazilian coast (see Cárdenas *et al.* 2009). According to recent information provided by Prof. Anna Kohn, she re-examined the complete gravid female (containing larvae) of this material deposited in the Instituto Oswaldo Cruz, Rio de Janeiro; the body length of this stained specimen mounted in Canada balsam was 140 mm. However, the species identification of Brazilian specimens can only be confirmed when conspecific males are also available.

Discussion

To date, 14 species of philometrid nematodes (Philometridae) have been reported from marine and brackish-water fishes in the western North Atlantic, including representatives of five genera: *Caranginema* Moravec, Montoya-Mendoza et Salgado-Maldonado, 2008; *Dentiphilometra* Moravec et Wang, 2002; *Philometra* Costa, 1845; *Philometroides* Yamaguti, 1935 and *Spirophilometra* Parukhin, 1971 (see Moravec 2006; Moravec and de Buron 2006, 2009; González-Solís *et al.* 2007; Moravec *et al.* 2007, 2008a, c, 2009; Moravec and Salgado-Maldonado 2007). Previous records of *Philometra globiceps* (Rudolphi, 1819) and *P. lateolabracis* (Yamaguti, 1935) from marine fishes of this region (Linton 1901, 1907; Martínez and Ventosa 1982) were evidently misidentifications (see Petter and Radujković 1989, Moravec 2006). Of all species reported, only five *Philometra* spp. are gonad-infecting parasites, whereas all other remaining species have other locations in the host. In addition to the three species dealt with in this paper, *Philometra margolisi* Moravec, Vidal-Martínez et Aguirre-Macedo, 1995 and *P. mexicana* Moravec et Salgado-Maldonado, 2007 were described from the ovaries of groupers, *Epinephelus morio* (Valenciennes) and *E. adscensionis* (Osbeck), respectively, from the southern Gulf of Mexico (Moravec *et al.* 1995, Moravec and Salgado-Maldonado 2007). However, from the northern West Atlantic, unidentified philometrids have been reported from many fish species of different families (e.g., Lin-

ton 1907, Rees 1970), so that it can be assumed that there are still many undescribed species of philometrids in this region, including those parasitizing fish gonads.

Because of a considerable morphological uniformity of philometrids, especially of the gonad-infecting species, their species identification based on morphological features remains rather difficult (Moravec 2006). Nevertheless, as indicated by some recent papers (e.g., Sokolov and Kazakov 2007, 2008; Moravec *et al.* 2008a, b, 2009; Quiazon *et al.* 2008a, b) and by the present study, a detailed examination of males by SEM may prove to be very helpful. Although the number and arrangement of their cephalic papillae seem to be rather uniform, there may be distinct interspecific differences in the structure of the distal tip of the gubernaculum and in the shape of lobes (mounds) on the caudal end of the body, and in the numbers and arrangement of genital papillae. Therefore, a detailed examination of males by SEM is very important for the taxonomy of philometrids. Unfortunately, most philometrid species were described solely from large-sized females, whereas minute conspecific males remain unknown.

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