

Some nematodes and acanthocephalans from exotic ornamental freshwater fishes imported into Germany

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Abstract. Five species of adult nematodes, unidentifiable nematode larvae, and three species of acanthocephalans, were found in freshwater ornamental fishes newly imported into Germany from Brazil, Colombia, Indonesia, Malaysia, Nigeria, Peru, Sri Lanka and Thailand. The following species were identified: Adult Nematoda: *Pseudocapillaria tomentosa*, Capillariidae gen. sp., *Dichelyne hartwichi* sp. n., *Procamallanus* (*Spirocamallanus*) *pintoi* and *Spinitectus allaeri*; Acanthocephala: *Pseudogorgorhynchus arii* gen. et sp. n., *Neoechinorhynchus* sp. and *Pallisentis* sp. The nematode *Dichelyne hartwichi* sp. n. (male only) from the intestine of *Chelonodon fluviatilis* (Hamilton) from Thailand is characterised mainly by the presence of minute cuticular spines on the tail tip, length of spicules (510 µm) and arrangement of caudal papillae. The acanthocephalan *Pseudogorgorhynchus arii* sp. n. from the intestine of *Ariopsis seemanni* (Günther) from Colombia represents a new genus *Pseudogorgorhynchus* gen. n., differing from other genera of the Rhadinorhynchidae mainly in possessing a small proboscis armed with markedly few (18) hooks arranged in six spiral rows. *Spinitectus macheirus* Boomker et Puylaert, 1994 and *Spinitectus moravecii* Boomker et Puylaert, 1994 are considered junior synonyms of *Spinitectus allaeri* Campana-Rouget, 1961.

Exotic ornamental fishes have become the subject of a profitable business. Besides their direct import from the countries of their origin into Europe and elsewhere, now they are often produced from large-scale breedings. Most of these fishes come from tropical countries. However, the aquarium-reared ornamental fishes are frequently infected with introduced helminth parasites (in addition to others) that may be the cause of a high mortality of infected fishes. For example, *Capillaria pterophylli* Heinze, 1933 and some other intestinal capillariids are known to cause a mass dying of aquarium-kept cichlids, cyprinids and catfishes. Camallanids (e.g., *Camallanus cotti* Fujita, 1927, *Procamallanus* spp.) may bring about problems in the breedings of poeciliids and some other fishes (Moravec 1998).

Although the problems of parasites in aquarium fishes in Europe have been dealt with in many papers (e.g., Heinze 1933, Lucký 1972, Grabda 1974, Petter et al. 1974, Stumpp 1975, Campana-Rouget et al. 1976, Lasserre and Meurillon 1976, Richard 1977a,b, Moravec and Gut 1982, Moravec et al. 1984, 1987, Müller et al. 1988, Steinhagen et al. 1988), special attention should be constantly paid to the newly imported fishes in order to record new species of parasites brought into the aquarium breedings.

In 1996-1997, a number of tropical freshwater fishes newly imported into Germany from different countries

were examined by one of the present authors (J. Wolter) for the presence of metazoan parasites. The systematic evaluation of nematodes and acanthocephalans recorded is the subject of this paper.

MATERIALS AND METHODS

The following fish species were examined:

Polypteriformes: Polypteridae: *Calamoichthys calabaricus* (Smith) (3 specimens; Nigeria); Osteoglossiformes: Pantomontidae: *Pantodon buchholzi* Peters (20; Nigeria); Mormyriiformes: Mormyridae: *Gnathonemus petersi* (Günther) (13; Nigeria); Cypriniformes: Characidae: *Cheirodon axelrodi* Schultz (19; Brazil), *Boehlkea fredcochui* Géry (9; Peru), *Petitella georgiae* Géry et Boutiere (2; Brazil); Cyprinidae: *Barbus tetrazona* Bleeker (41; Malaysia and Indonesia); Cobitidae: *Acanthopthalmus kuhlii* (Valenciennes) (17; Thailand), *Botia macracanthus* (Bleeker) (1; Indonesia); Siluriformes: Ariidae: *Ariopsis seemanni* (Günther) (37; Colombia); Doradidae: *Agamyxis pectinifrons* (Cope) (1; Colombia); Callichthyidae: *Corydoras guapore* Knaack (1; Brazil), *Corydoras julii* Steindachner (5; Brazil), *Corydoras reticulatus* Fraser-Brunner (4; Peru), *Corydoras schwarzi* Rössel (7; Brazil); Aspredinidae: *Bunocephalus* sp. (1; Colombia); Cyprinodontiformes: Poeciliidae: *Poecilia reticulata* Peters (58; Sri Lanka); Perciformes: Cichlidae: *Dicrossus filamentosus* (Ladiges) (5; Brazil); Belontiidae: *Betta splendens* Regan (1; Thailand); Tetraodontiformes: Tetraodontidae: *Chelonodon fluviatilis* (Hamilton).

Nematodes and acanthocephalans were fixed in 4% formalin. For examination, nematodes were cleared in glycerine. Acanthocephalans were stained in carmine, dehydrated through an ethanol series and mounted in Canada balsam as permanent slides. Drawings were made with the aid of a Zeiss microscope drawing attachment. For scanning electron microscopy (SEM), the nematodes were post-fixed in 1% OsO₄, dehydrated through an ethanol series and acetone, and then subjected to critical point drying. The specimens were coated with gold and examined with a JSM-6300 scanning electron microscope at an accelerating voltage of 15 kV. All measurements are given in micrometres unless otherwise stated. The scientific names of host fishes are according to Eschmeyer (1998).

SURVEY OF SPECIES

NEMATODA

Capillariidae Railliet, 1915

Pseudocapillaria tomentosa (Dujardin, 1843) Fig. 1

Syn.: *Trichosomum tomentosum* Dujardin, 1843; *T. cyprini* Diesing, 1851; *Trichosoma brevispiculum* Linstow, 1873; *Capillaria leucisci* Hesse, 1923; *C. catostomi* Pearse, 1924; *C. bakeri* Mueller et Van

Cleave, 1932, partim; *C. lewaschoffi* Heinze, 1933; *C. rutili* Zakhvatkin et Azeghanova, 1940; *C. ugui* Yamaguti, 1941; *C. amurensis* Finogenova, 1967; *C. gobionina* Lomakin, 1971; *C. pseudorasbora* Wang, Zhao et Chen, 1978; *Skrjabinocapillaria elopichthydis* Wang, 1982.

Male (1 specimen): Small nematode; two lateral bacillary bands, 18 wide, extending along body. Length of body 2,652, maximum width 48. Stichosome consisting of a single row of 26 large stichocytes with large nuclei. Oesophagus including stichosome 1,510 long, representing 57% of body length; muscular oesophagus 195 long. Nerve ring 66 from anterior extremity. Two wing-like cells present at oesophago-intestinal junction. Seminal vesicle 45 long and 30 wide. Spicule well sclerotized, 279 long and 9 wide at proximal end, 6 at middle and 4 at distal end; its proximal end with distinct folded, lobular margin, distal end rounded; spicule surface almost smooth. Spicular sheath nonspiny. Posterior end of body rounded, provided with two large, rounded ventrolateral postanal papillae. Cloacal opening subventral; length of tail 9.

Host: *Barbus tetrazona* Bleeker (Cyprinidae, Cypriniformes).

Site of infection: Intestine.

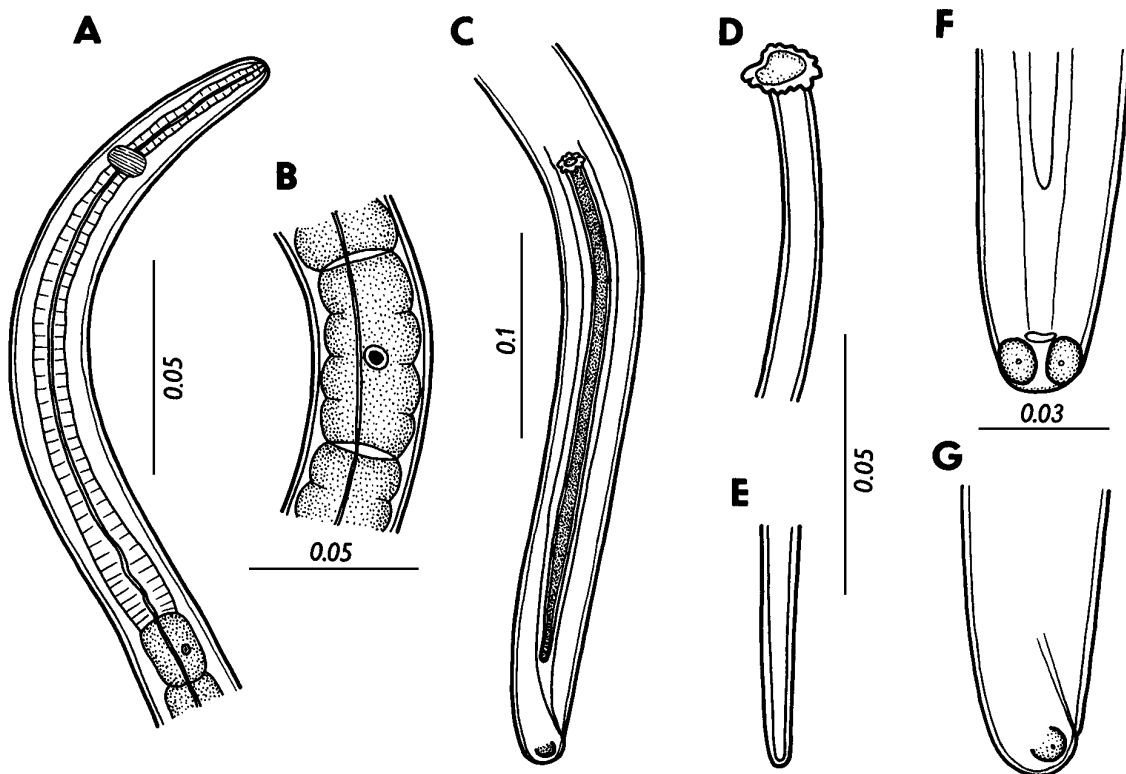


Fig. 1. *Pseudocapillaria tomentosa* (Dujardin, 1843), male from *Barbus tetrazona*. **A** – anterior end; **B** – stichocyte in middle of stichosome; **C** – posterior end; **D, E** – proximal and distal ends of spicule; **F, G** – caudal end, ventral and lateral views. Scales in mm.

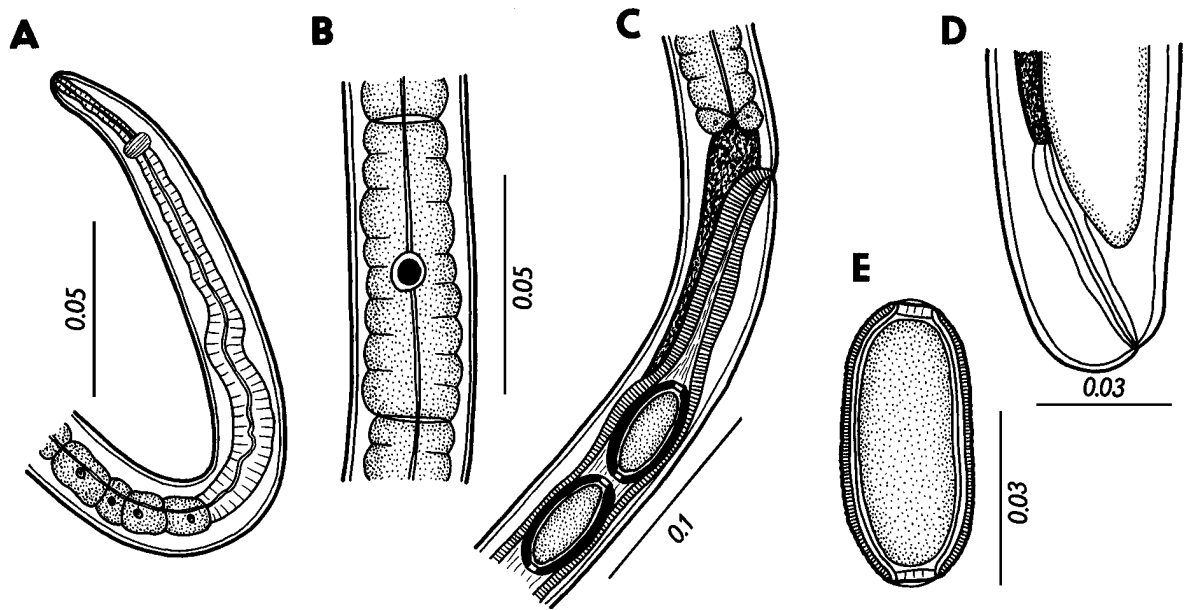


Fig. 2. Capillariidae gen. sp., female from *Gnathonemus petersi*. **A** – anterior end; **B** – stichocyte in middle of stichosome; **C** – region of vulva; **D** – caudal end; **E** – mature egg. Scales in mm.

Locality: Malaysia.

Prevalence and intensity: 8% (2 fishes infected / 26 fishes examined); 2 nematodes.

Comments: The morphology of the only available complete specimen is in a full agreement with the description of *Pseudocapillaria tomentosa*, a common parasite of many, mostly cyprinid, fishes of the Holarctic Region (Moravec 1987). In 1984, Moravec et al. recorded it (under the synonym *P. brevispicula*) from the exotic ornamental fish *Puntius* (= *Barbus*) *tetrazona* from an aquarium in the Czech Republic; they also mentioned that probably the previous record by Lucký (1972) of *Capillaria pterophylli* Heinze, 1933 from aquarium-kept *B. tetrazona* and *Tanichthys albonubes* L. from former Czechoslovakia concerned, in fact, *P. tomentosa*. They considered capillariid larvae, which were found encapsulated in the liver of *Hyphessobrycon* (= *Paracheirodon*) *innesi* Myers (family Characidae), to be conspecific with *P. tomentosa*.

The present record of this parasite from *B. tetrazona* imported from Malaysia indicates that it occurs as well in some countries of the Oriental Region. This is the first record of *P. tomentosa* from this Region.

The life cycle of *P. tomentosa* is probably direct, without an intermediate host, but freshwater oligochaetes may play a role of paratenic hosts (Moravec 1994). Capillariids are generally considered highly pathogenic parasites, causing sometimes the deaths of aquarium-kept exotic ornamental fishes.

Capillariidae gen. sp.

Fig. 2

Female (2 complete and 1 incomplete specimens): Medium sized nematodes; two distinct lateral bacillary bands, 18-21 wide, extending along whole body. Length of body 3,862-4,270 (7,752 in incomplete specimen), maximum width 51-66. Stichosome uniformly coloured, consisting of a single row of about 30 large stichocytes with distinct transverse annuli and inconspicuous cell nuclei. Oesophagus including stichosome 1,354-1,534 long in complete specimens, representing 35-36% of body length; muscular oesophagus 156-180. Nerve ring 75 from anterior extremity. Two wing-like cells present at oesophago-intestinal junction. Vulva situated 36-138 posterior to end of oesophagus. Uterus with eggs arranged in one file near vulva, more distant eggs in several rows. Egg wall two-layered; inner layer hyaline, outer layer with distinct punctation on surface. Content of egg uncleaved. Size of eggs 54-60 × 24-27, egg wall 1-2 thick; polar plugs 3-4 long and 6-8 wide, not protruding or only slightly protruding. Posterior end of body rounded, with subterminal anus; length of tail 6-9. Rectum 60-72 long.

Host: *Gnathonemus petersi* Günther (Mormyridae, Mormyriiformes).

Site of infection: Intestine.

Locality: Nigeria.

Prevalence and intensity: 40% (2 fishes infected / 5 fishes examined); 1 and 3 nematodes.

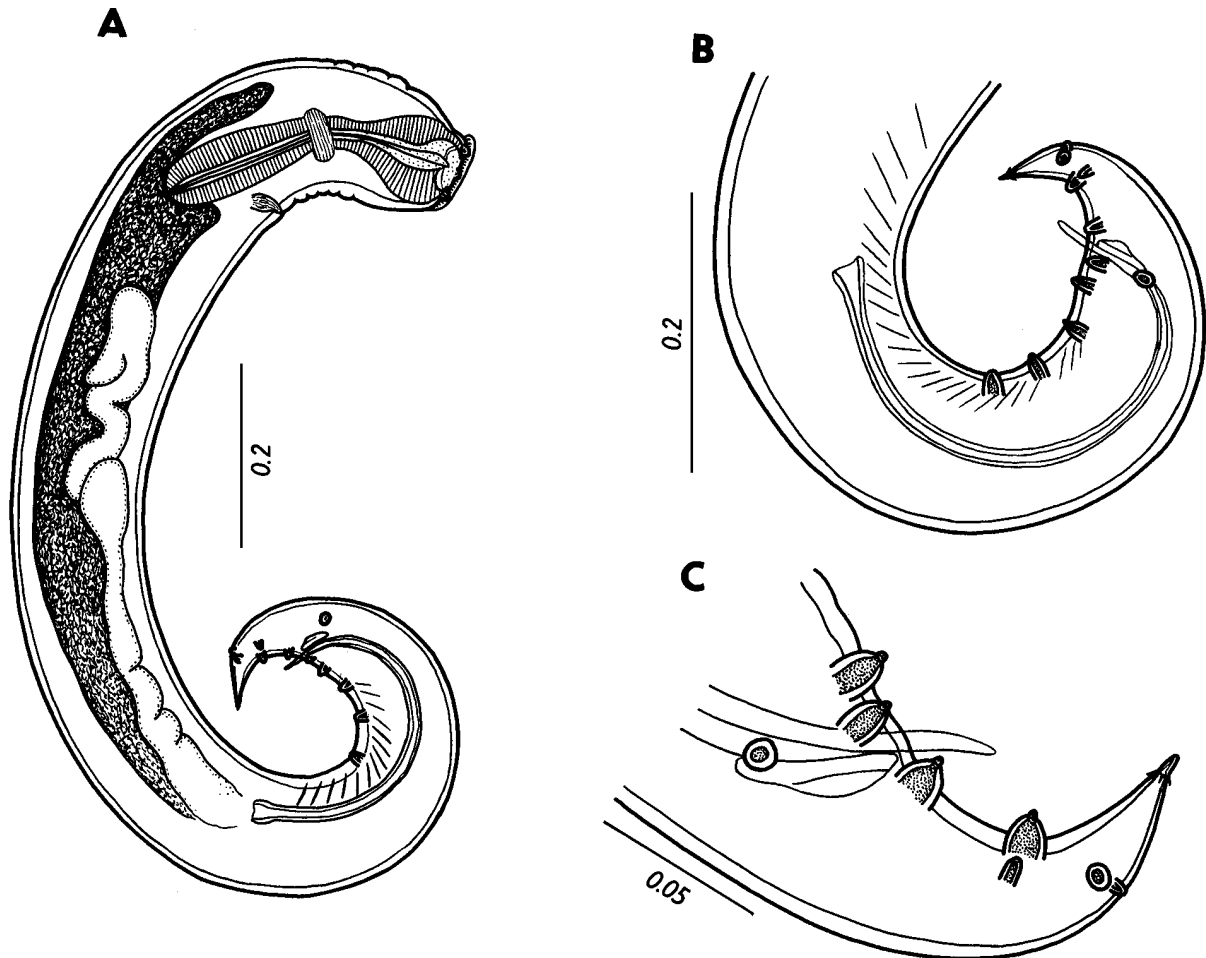


Fig. 3. *Dichelyne hartwichi* sp. n., male. A – general view; B – caudal end; C – tail. Scales in mm.

Comments: Without having the male, these nematodes cannot be identified to genus, because the morphology of most female capillariids is rather uniform. The general morphology suggests that they may belong to *Pseudocapillaria* Freitas, 1959. The only known capillariid from African freshwater fishes is *Capillostrongyloides fritschi* (Travassos, 1914) (syn. *Capillaria yamagutii* Tadros et Mahmoud, 1968), an intestinal parasite of catfishes in Zaire and Egypt (Moravec 1987).

Cucullanidae Cobbold, 1864

Dichelyne (Dichelyne) hartwichi sp. n. Fig. 3

Male (1 specimen; holotype): Small nematode with smooth, thick cuticle. Length of body 1,863, maximum width 190. Lateral alae absent. Cephalic end rounded. Oral aperture dorsoventrally elongate, surrounded by narrow flange (collarette) with one row of numerous minute spines along its base. Four submedian cephalic papillae and pair of lateral amphids present. Entire oesophagus 378 long (representing 20% of body

length), expanded at anterior end to form pseudobuccal capsule (oesophastome) 123 long and 108 wide, this being distinctly wider than posterior part of oesophagus. Posterior part of oesophagus somewhat expanded, its maximum width 72; minimum width of oesophagus in region of nerve ring 30. Oesophagus opening into intestine through large valve. Nerve ring encircling oesophagus near its mid-length, 150 from anterior extremity. Intestine broad at its anterior part, forming narrow dorsal caecum extending anteriorly almost to nerve ring; length of caecum 192, width 30. Small deirids and excretory pore 228 and 270 from anterior extremity, respectively. Anterior end of testis somewhat posterior to end of oesophagus. Spicules slender, equal, 510 long, representing 27% of body length. Length of gubernaculum 54. Precloacal sucker absent, numerous precloacal ventral oblique muscle bands present. Caudal papillae: 10 pairs; 4 pairs of preanal (all subventral), 2 pairs of adanal (1 subventral and 1 lateral), and 4 pairs (2 subventral and 2 lateral) of postanal papillae present; first lateral postanal pair at level of second postanal pair of subventrals, second lateral postanal pair somewhat

more posterior. Pair of papilla-like phasmids situated dorsoventrally at level of last postanal pair of caudal papillae. Tail conical, pointed, 120 long; base of tail tip surrounded by a ring of numerous minute spines.

Female: Unknown.

Type host: *Chelonodon fluviatilis* (Hamilton) (Tetraodontidae, Tetraodontiformes).

Site of infection: Intestine.

Prevalence and intensity: 6% (1 fish infected / 16 fishes examined); 1 nematode.

Type locality: Thailand.

Deposition of type: Institute of Parasitology, Academy of Sciences of the Czech Republic, České Budějovice (Cat. No. N-732).

Etymology: This species has been named in honour of the late Dr. Gerhard Hartwich, a well-known German helminthologist.

Comments: In accordance with the classification of cucullanids given by Petter (1974), the only available specimen belongs to the genus *Dichelyne* Jägerskiöld, 1902; the absence of the sucker and the number of preanal papillae show its appurtenance to the nominotypical subgenus *Dichelyne*.

At present, the subgenus *Dichelyne* (*Dichelyne*) includes 16 species parasitic in freshwater, brackish-water and marine fishes: *D. alatae* De et Maity, 1995, *D. dighaensis* Gupta et Masoodi, 1989, *D. diminutus* (Rasheed, 1968), *D. fastigatus* Chandler, 1935, *D. fossor* Jägerskiöld, 1902, *D. indentatus* (Rasheed, 1968), *D. lepisosteus* Casto et McDaniel, 1967, *D. leporini* Petter, 1989, *D. longispiculata* Wang et Ling, 1975, *D. mexicanus* Caspeta-Mandujano et al., 1999, *D. moraveci* Petter, 1995, *D. pimelodi* Moravec, Kohn et Fernandes, 1997, *D. pomadasysi* Vassiliades et Petter, 1981, *D. rasheedae* Petter, 1974, *D. robustus* (Van Cleave et Mueller, 1932) and *D. spinicaudatus* Petter, 1974 (Petter 1974, Vassiliades and Petter 1981, De and Maity 1995, Caspeta-Mandujano et al. 1999). Petter (1974) listed also *D. exiguus* (Yamaguti, 1954) and *D. lutjani* (Schmidt et Kuntz, 1969) but, considering their original descriptions (Yamaguti 1954, Schmidt and Kuntz 1969), they should be retained in the genus *Cucullanus* Müller, 1777 where they were originally listed.

Among these, minute cuticular spines on the male tail tip are present only in *D. alatae*, *D. longispiculata*, *D. mexicanus*, *D. rasheedae* and *D. spinicaudatus*. However, in contrast to *D. hartwichi* sp. n., *D. alatae* from India possesses caudal alae in the male and its deirids and excretory pore are in post-oesophageal region; *D. longispiculata* from China has much longer, unequal spicules (1.52-1.62 mm long); *D. mexicanus* from Mexico has conspicuously unequal spicules; males of *D. rasheedae* from Pakistan are distinctly larger (3-6 mm long) and its deirids and excretory pore are in post-

oesophageal region; and *D. spinicaudatus* from French Guyana possesses two equally long caeca, its males are much larger (4-4.5 mm long) with distinctly longer spicules (0.90 mm). Moreover, the new species differs from all species of this subgenus in many other features such as the number and arrangement of caudal papillae, location of deirids and the excretory pore, length of spicules, size and shape of the body, shape of the oesophagus and others.

D. hartwichi is the first species of this subgenus recorded from a tetraodontiform fish. Its host, *T. fluviatilis*, occurs in fresh waters or moderately brackish waters in south-eastern Asia (Sterba 1987).

The life cycle of this species is not known. It can be assumed that it is similar to the life cycle pattern of other *Dichelyne* species, utilizing fish fry as the intermediate host (Anderson 1992).

C a m a l l a n i d a e Railliet et Henry, 1915

Procamallanus* (*Spirocamallanus*) *pintoi (Kohn et Fernandes, 1988) Fig. 4

Syn.: *Spirocamallanus pintoi* Kohn et Fernandes, 1988.

Description: Small, brownish nematodes with finely striated cuticle. Mouth aperture circular, surrounded by eight submedian cephalic papillae arranged in two circlets and by two small lateral amphids. Buccal capsule orange-coloured, slightly longer than wide, with 7-10 spiral ridges in lateral view (1-4 incomplete) in posterior 1/2-3/4 of capsule length; basal ring indistinct. Glandular oesophagus approximately twice as long as muscular oesophagus; both parts of oesophagus clavate. Small deirids situated at level of buccal capsule in female and just posterior to buccal capsule in male. Nerve ring slightly anterior to mid-length of muscular oesophagus, excretory pore somewhat posterior to level of nerve ring. Intestine darkly coloured (brown-black). Tail conical, sharply pointed.

Male (1 specimen): Length of body 3,087, maximum width 204. Buccal capsule 60 long by 57 wide, with 7 spiral ridges (4 incomplete) in posterior half of capsule. Muscular oesophagus 299 long, maximum width 105; glandular oesophagus 530 long, maximum width 108; length ratio of both parts of oesophagus 1 : 1.8. Length of entire oesophagus and buccal capsule representing 29% of body length. Deirids, nerve ring and excretory pore 60, 144 and 170, respectively, from anterior extremity. Caudal alae absent. Four pairs of preanal and two pairs of postanal subventral papillae present; postanal pairs a short distance posterior to cloacal opening. Spicules short, almost equal, well sclerotised, 105 long. Gubernaculum absent. Tail 210 long, ending in sharp cuticular point.

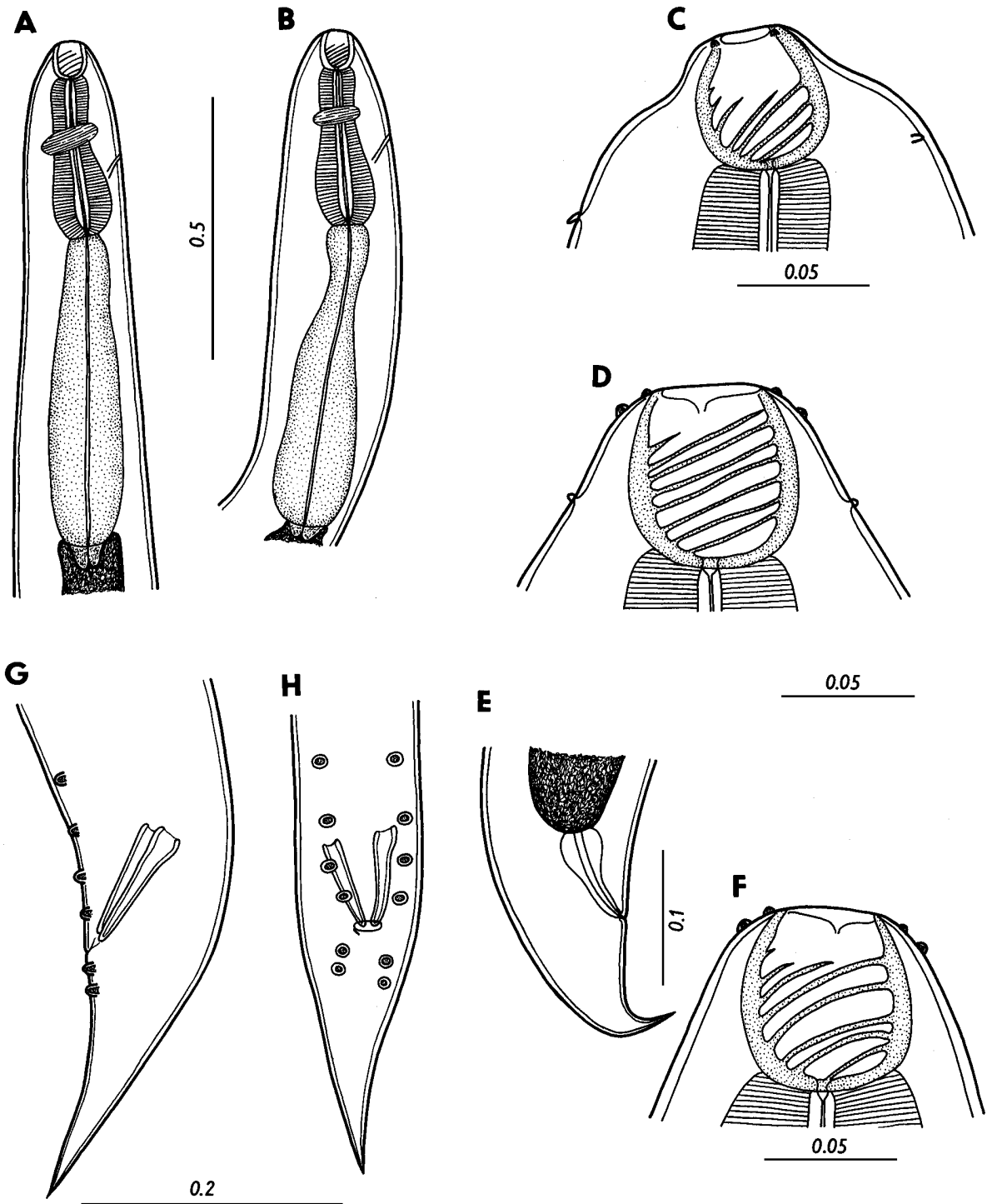


Fig. 4. *Procammallanus (Spirocamallanus) pinto* (Kohn et Fernandes, 1988) from *Corydoras reticulatus*. **A, B** – anterior end of female, lateral views (larger and smaller specimens with different shape of glandular oesophagus); **C** – buccal capsule of male, dorsoventral view; **D** – same of larger female; **E** – tail of larger female, lateral view; **F** – buccal capsule of larger female, lateral view; **G, H** – posterior end of male, lateral and ventral views. Scales in mm.

Female (2 nongravid specimens): Body 4,665-6,708 long, maximum width 299-476. Buccal capsule 78-81 long by 66-75 wide, with 8-10 spiral ridges (1-3 incomplete) reaching anteriorly to about 3/4 of capsule length. Muscular oesophagus 340 long, maximum width 135-141; glandular oesophagus 666 long, maximum width 168-201; length ratio of both parts of oesophagus 1 : 2.0. Length of entire oesophagus and buccal capsule forming 16-23% of body length. Deirids, nerve ring and excretory pore 60-63, 141-186 and 255, respectively, from anterior extremity. Vulva in posterior part of body (at 61-73% of body length), 1,238-2,638 from posterior extremity. Tail 105-228 long, ending in sharp cuticular point.

Host: *Corydoras reticulatus* Fraser-Brunner (Callichthyidae, Siluriformes).

Site of infection: Intestine.

Locality: Peru.

Prevalence and intensity: 50% (2 fishes infected / 4 fishes examined), 1 and 2 nematodes.

Comments: According to the key to Neotropical *Procamallanus* species given by Moravec (1998), the present specimens belong to *P. pinto*, a specific parasite of callichthyid armoured catfishes of the genus *Corydoras* Lacépède. Originally it was described by Kohn and Fernandes (1988) from *Corydoras paleatus* (Jenyns) from the Paraná River basin in Brazil; later conspecific young female specimens were reported from *C. aeneus* (Gill) from Venezuela by Moravec et al. (1997). The present finding in *C. reticulatus* from Peru represents the first host and geographical records.

The life cycle of *P. pinto* is not known. Other congeneric species utilize copepods as intermediate hosts.

***Camallanus cotti* Fujita, 1927**

Syn.: *Camallanus zacconis* Li, 1941; *C. fotedari* Raina et Dhar, 1972.

Host: *Poecilia reticulata* (Peters) (Poeciliidae, Cyprinodontiformes).

Site of infection: Intestine.

Locality: Sri Lanka.

Prevalence and intensity: 3% (2 fishes infected / 58 fishes examined); intensity 1 nematode.

Comments: Only one complete juvenile female of this species, with a typical markedly long tail, was obtained.

Camallanus cotti is widely distributed in freshwater fishes of different families and orders in eastern and southern Asia (Japan, Korea, Russian Far East, China, Vietnam, India) (Moravec and Sey 1988). It has also been reported from exotic ornamental fishes in Europe and Canada, particularly from *Poecilia reticulata* and *Xiphophorus helleri* (e.g., Stumpp 1975, Campana-Rouget et al. 1976, Moravec and Sey 1988). Recently it

has been reported by Font and Tate (1994) and Rigby et al. (1997) from *P. reticulata* and several other introduced or native fishes from natural waters in Hawaii. The present finding represents the first record of this parasite from Sri Lanka. This nematode species is considered to be a pathogenic parasite of aquarium fishes.

Cystidicolidae Skrjabin, 1946

***Spinitectus allaeri* Campana-Rouget, 1961 Figs. 5-7**

Syn.: *Spinitectus macheirus* Boomker et Puylaert, 1994; *S. moravec* Boomker et Puylaert, 1994.

Description: Whitish, small sized nematodes with thick cuticle. Cephalic end rounded, posterior end conical. Body surface provided with transverse rings of small conical spines; rings interrupted at both sides of body by lateral lines, some more posterior rings incomplete. First 5-6 rings somewhat raised, first two rings close to each other. Largest spines (6-9 long) present in anterior 5-6 rings (Figs. 5C, 7A); spines gradually diminish posteriorly, smallest spines on posterior part of body. Female body with spines up to posterior extremity (Fig. 7B), posterior end of male without spines. First ring consists of 27-30 spines (Figs. 5B, 6B). Mouth aperture oval, dorsoventrally elongated, surrounded by four poorly developed, low submedian labia, two subdorsal and two subventral, with broad base (Fig. 6A,B), forming dorsolateral and dorsoventral margins of oral opening. One simple, narrow, sclerotised structure ("sublabium" in terminology of Margolis 1977), with a somewhat thickened free margin, attached by its base to inner surface of each labium. Lateral pseudolabia rather large, projecting anteriorly beyond labia. In apical view, flat inner parts of pseudolabia covering partly oral opening are dorsoventrally expanded, forming two (one laterodorsal and one lateroventral) triangular extensions with sharp corners on each pseudolabium. Inner margins of both pseudolabia dorsoventrally straight, parallel to each other (Fig. 6B). Narrow, inner part of each pseudo-labium continues posteriorly into thickened pulp bearing two elongate submedian cephalic papillae and small amphid. Vestibule straight or S-shaped, thin-walled, with anterior end distended to form small funnel-shaped prostom in lateral view. Excretory pore below fourth ring of spines.

Male (3 specimens): Length of body 2,761-3,468, maximum width 90-120. Maximum length of cuticular spines 6. Length of vestibule including prostom 72-84. Muscular oesophagus 159-186 long, its maximum width 15-18; glandular oesophagus 490-585 long, maximum width 36-48. Length ratio of both parts of oesophagus 1:2.7-3.2. Nerve ring and excretory pore 90-102 and 105-132, respectively, from anterior extremity.

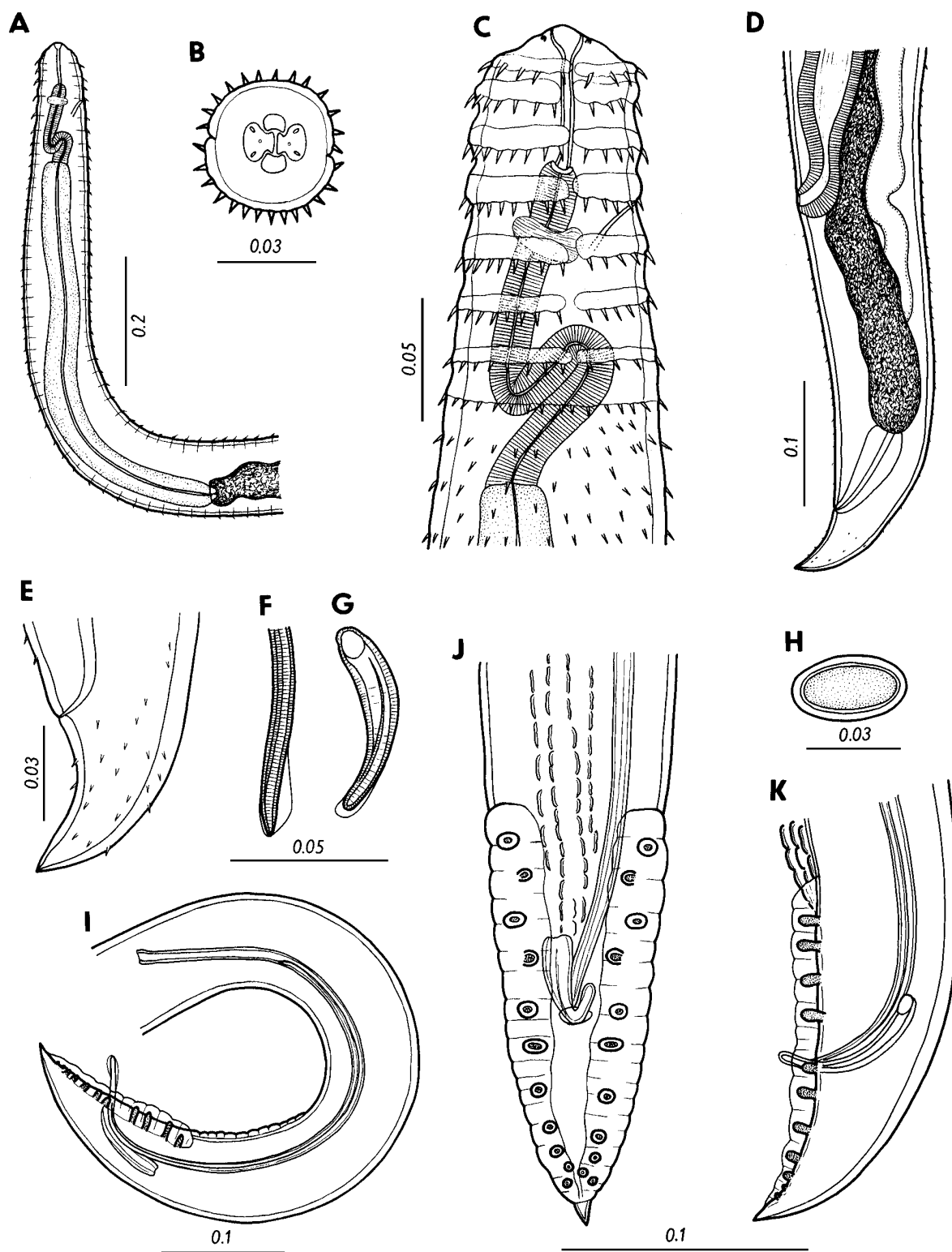


Fig. 5. *Spinitectus allaeri* Campana-Rouget, 1961 from *Pantodon buchholzi*. **A** – oesophageal part of body of gravid female; **B** – cephalic end, apical view; **C** – anterior end of gravid female, lateral view; **D** – posterior end of young female; **E** – tail of young female; **F** – distal end of left spicule; **G** – right spicule; **H** – immature egg; **I** – posterior end of male; **J**, **K** – caudal end of male, ventral and lateral views. Scales in mm.

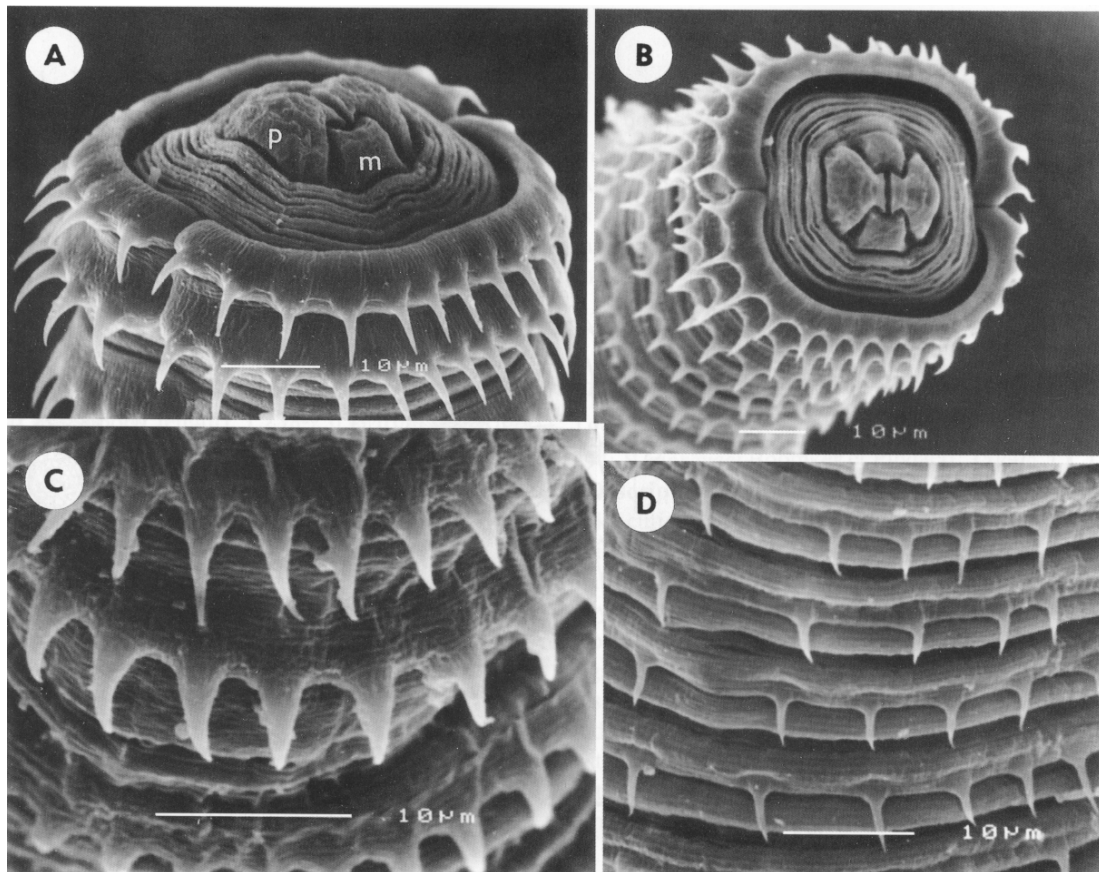


Fig. 6. *Spinitectus allaeri* Campana-Rouget, 1961, SEM micrographs. **A** – cephalic end, sublateral view; **B** – same, subapical view; **C** – cuticular spines of first two rings; **D** – cuticular spines at middle of body. Abbreviations: m – subventral submedian labium; p – pseudolabium.

Posterior end of body spirally coiled, provided with narrow vesiculated subventral alae reaching posteriorly almost to end of tail. Caudal papillae: 4 pairs of preanals of which papillae of first and third pairs being located more laterally than those of second and fourth pairs (Figs. 5J, 7C); 1 pair of adanals; 5 pairs of postanals. In addition, pair of small papilla-like phasmids located posterior to last pair of postanal papillae present. Ventral precloacal cuticular ridges (area rugosa) well developed, consisting of several longitudinal rows composed of short cuticular elevations (Fig. 7C,E). Large (left) spicule slender, 480-660 long, with narrow distal tip covered by cuticular membrane; its shaft 120-168 long, forming 20-25% of whole spicule length. Small (left) spicule boat-shaped, 69-74 long, with narrowed distal end provided with cuticular membrane. Length ratio of spicules 1 : 7.0-7.9. Tail conical, 78-90 long, ending in sharp cuticular spike.

Female (1 complete and 1 incomplete specimens with immature eggs): Length of body 4,647 (length of 4 juvenile specimens 1,746-2,557), maximum width 150-153. Maximum length of cuticular spines 9. Length of

vestibule including prostom 72. Muscular oesophagus 210-225, maximum width 18-21; glandular oesophagus 609-654 long, maximum width 51-54. Length ratio of both parts of oesophagus 1 : 2.9. Nerve ring and excretory pore 93-114 and 90-138, respectively, from anterior extremity. Vulva in complete specimen situated 354 from posterior extremity, 294 anterior to anal opening. Muscular vagina directed anteriorly from vulva. Uterus opposed. Only not fully mature eggs (without larvae) present in uteri; eggs oval, thick-walled, 39-42 × 24, thickness of wall 3. Tail conical, 63 long, pointed, bearing small, irregularly scattered cuticular spines.

Host : *Pantodon buchholzi* Peters (Pantodontidae, Osteoglossiformes).

Site of infection : Intestine.

Locality : Nigeria.

Prevalence and intensity : 20% (4 fishes infected / 20 fishes examined); 1-4 (mean 3) nematodes per fish.

Comments : The morphology of specimens of the present material corresponds, more or less, to the original description of *S. allaeri* Campana-Rouget, 1961

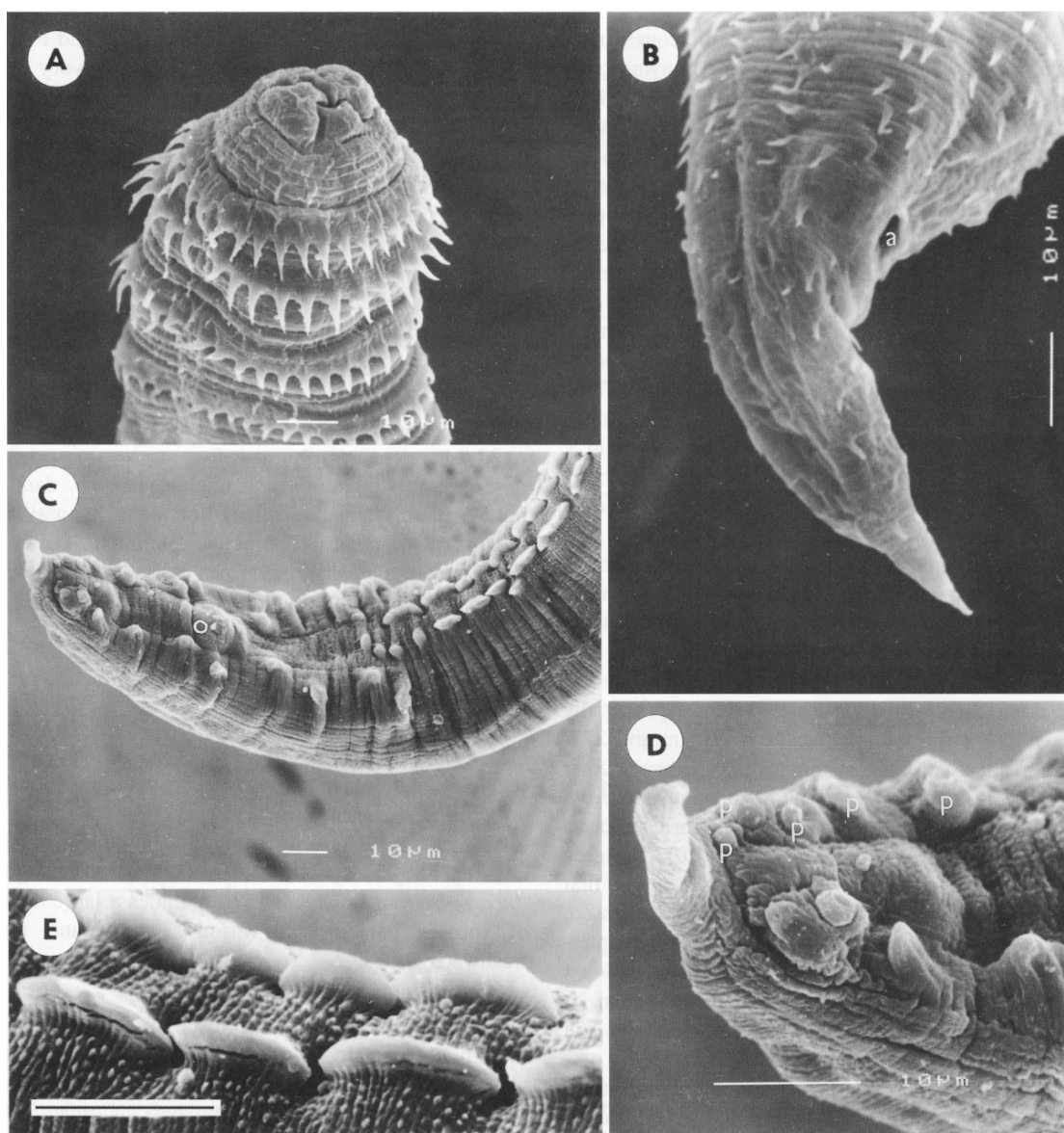


Fig. 7. *Spinitectus allaeri* Campana-Rouget, 1961, SEM micrographs. **A** – anterior end of body; **B** – tail of female; **C** – caudal end of male; **D** – distal end of male tail; **E** – preloacal cuticular ridges of male (scale bar = 10 µm). Abbreviations: a – amphid; o – cloacal opening; p – postanal papilla.

and, consequently, they are considered to belong to this species.

According to Boomker and Puylaert (1994), a total of 16 species of *Spinitectus* Fourment, 1883 have been reported from Africa; these are *S. allaeri*, *S. macheirus* Boomker et Puylaert, 1994, *S. macilentus* Boomker et Puylaert, 1994, *S. maleficus* Boomker et Puylaert, 1994, *S. micropectus* Boomker et Puylaert, 1994, *S. minusculus* Boomker et Puylaert, 1994, *S. monstruosus* Boomker et Puylaert, 1994, *S. moraveci* Boomker et Puylaert, 1994, *S. mormyri* Campana-Rouget, 1961, *S. mucronatus* Boomker et Puylaert, 1994, *S. petterae*

Boomker, 1993, *S. polli* Campana-Rouget, 1961, *S. thurstonae* Ogden, 1967 and *S. zambezensis* Boomker, 1993 from fishes, and *S. camerunensis* Vaucher et Durette-Desset, 1980 and *S. menzalei* Hugot, 1979 from amphibians (frog) and mammals (otter shrew), respectively. However, many of these are very similar to each other and, considering a high degree of intraspecific variability in such features as the number of cuticular spines per ring or the length of the left spicule in some *Spinitectus* species and possible inaccuracies in observations, the validity of some of these species appears to be doubtful.

In our opinion, it is necessary to consider *S. macheirus* and *S. moraveci* as junior synonyms of *S. allaeri*; both these species have been reported to have six pairs of postanal papillae instead of seven, but the group of a few last pairs formed by very small papillae hardly visible under the optical microscope can be reliably recorded only by SEM. In fact, the seventh pair, reported in some *Spinitectus* species, apparently represents papilla-like or pore-like outlets of phasmids (Moravec 1996, present study). The left spicule is slightly shorter (405–471 µm) or longer (616–776 µm) in *S. moraveci* and *S. macheirus*, respectively, as compared to *S. allaeri* (545 µm), but this can be considered within the intraspecific variability of this species. For example, Moravec (1979) found the length of the left spicule in *S. inermis* (Zeder, 1800) to range, depending on the body size of the male, from 663 µm up to 1,068 µm. The only difference between *S. allaeri* and *S. moraveci* might be a somewhat nearer situation of the vulva to the anus in the latter, but subsequent studies based on a more extensive material will undoubtedly show that this is within the intraspecific variability of this species.

Subsequent studies may show that also *S. macilentus* and *S. minusculus*, differing from *S. allaeri* principally in the length of the left spicule (265–363 µm and 277–322 µm, respectively) are synonyms of *S. allaeri*. Other African species of *Spinitectus* can be distinguished from *S. allaeri* by the position of the excretory pore, structure of eggs, considerably smaller (less than 20) or higher (more than 40) numbers of cuticular spines in the first ring and some other features. It should be stressed, however, that there may exist a considerable intraspecific variability in the number of spines of the first ring in some *Spinitectus* species (e.g., 48–83 in *S. inermis*, a specific parasite of *Anguilla anguilla* [L.] in Europe – Moravec 1996).

SEM study of *S. allaeri* of the present material shows clearly that the structure of the mouth is typical of freshwater *Spinitectus* spp. (cephalic papillae and amphids situated on well developed pseudolabia – Petter 1984) and that *S. allaeri* is another species of *Spinitectus* in which sublabia are present, as in *S. jamundensis* Thatcher et Padilha, 1977 and *S. inermis* (Petter and Morand 1988, Moravec 1996). The more lateral situation of caudal papillae of the first and the third preanal pairs as compared to those of the second and the fourth pairs (Figs. 5J, 6C), as found in *S. allaeri*, has also been observed by SEM in *S. inermis* (Moravec 1996).

Spinitectus allaeri seems to be a widely distributed parasite of freshwater fishes of different families (*Malapterurus*, *Alestes*, *Bagrus*, *Clarias*, *Eutropius*, *Lates*, *Mormyrus*, *Synodontis*, *Xenoclaris*) in Africa. Originally it was described from Zaire (Campana-Rouget 1961), later it was recorded by Khalil and Thurston

(1973) and Moravec (1974) from fishes in Uganda and Egypt, respectively. Boomker and Puylaert (1994) reported it (as *S. macheirus*) from Ivory Coast. The present finding of *S. allaeri* in *Pantodon buchholzi* from Nigeria represents new host and geographical records (see Khalil and Polling 1997).

The life cycle of *S. allaeri* is unknown. Congeneric species utilize larvae of aquatic insects (mainly mayflies) or shrimps as intermediate hosts.

***Spinitectus* sp.**

Host: *Ariopsis seemanni* (Günther) (Ariidae, Siluriformes).

Site of infection: Intestine.

Locality: Colombia.

Prevalence and intensity: 3% (1 fish infected / 37 fishes examined); 1 nematode.

Comments: The only available, heavily damaged female of this nematode does not make it possible to identify it to species. The genus *Spinitectus* comprises many species parasitising various marine and freshwater fishes (less often also amphibians) in all continents.

***Ascarophis* sp.**

Host: *Ariopsis seemanni* (Günther) (Ariidae, Siluriformes).

Site of infection: Intestine.

Locality: Colombia.

Prevalence and intensity: 5% (2 fishes infected / 37 fishes examined); 1 nematode.

Comments: The only available gravid female does not enable a specific identification. The genus *Ascarophis* van Beneden, 1870 includes a large number of species parasitic in various marine and rarely freshwater fishes.

* * *

In addition to adult forms, various small, un-identifiable nematode larvae, encapsulated in the gut-wall or free in the abdominal cavity, were recorded from *Acanthopthalmus kuhlii* (Thailand), *Calamoichthys calabaricus* (Nigeria), *Corydoras schwarzei* (Brazil), and *Cheirodon axelrodi* (Brazil).

ACANTHOCEPHALA

Rhadinorhynchidae Travassos, 1923

***Pseudogorgorhynchus* gen. n.**

Diagnosis: Rhadinorhynchidae, Gorgorhynchinae. Trunk long and slender, armed with many uniform spines arranged in transverse rings, forming one field on anterior end of trunk. Proboscis short and claviform; hooks few with simple roots, arranged in spiral rows; middle hooks distinctly broader than anterior and posterior hooks; posterior hooks about same length as middle hooks. Proboscis receptacle longer than proboscis, with cephalic ganglion at its base. Lemnisci markedly longer than proboscis receptacle. Testes near

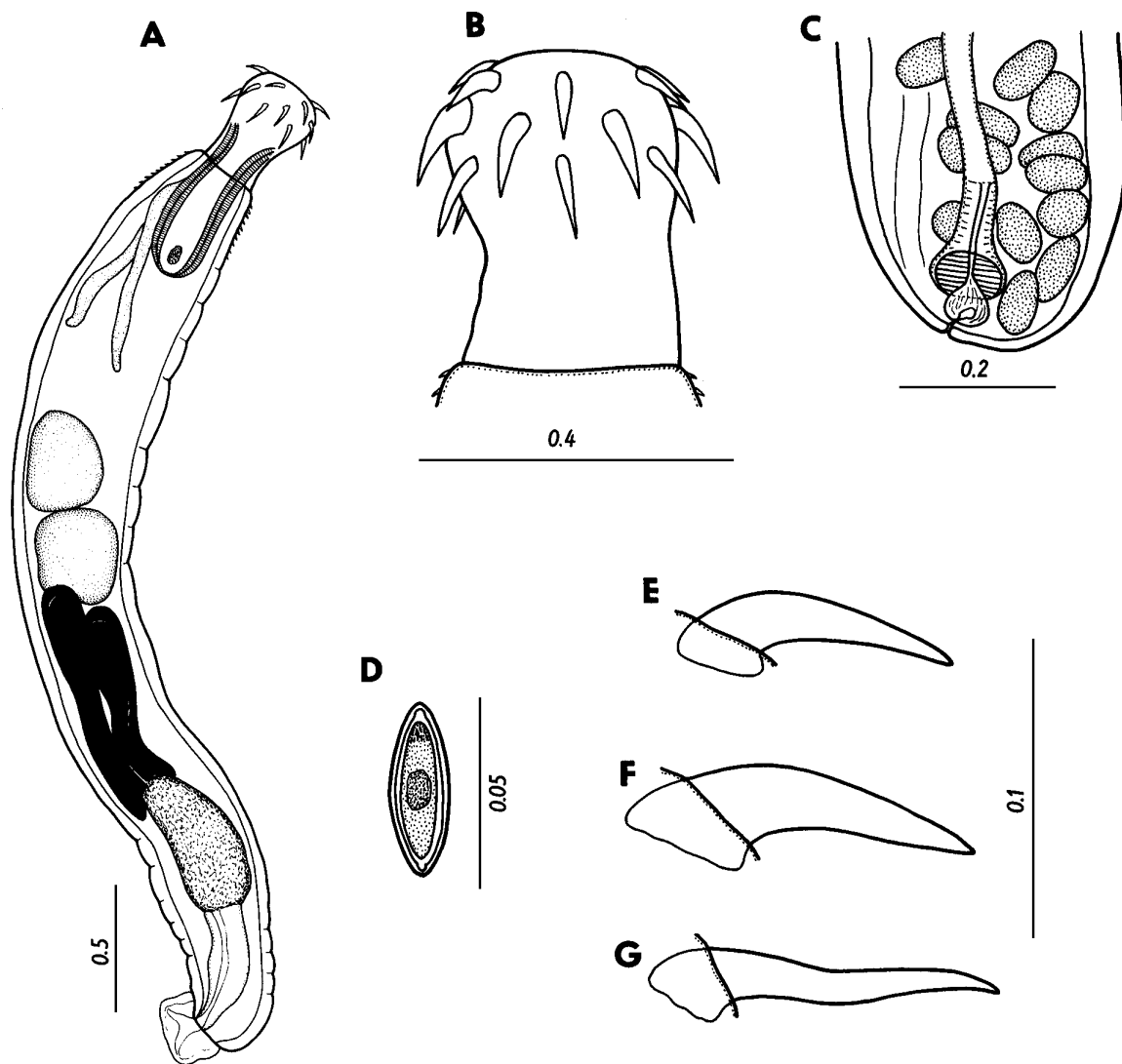


Fig. 8. *Pseudogorgorhynchus arii* sp. n. from *Ariopsis seemanni*. **A** – general view of male; **B** – proboscis of female; **C** – posterior end of female; **D** – egg; **E, F, G** – anterior, middle and posterior hook. Scales in mm.

middle of body; cement glands 4; seminal vesicle, cement ducts and Saeftigen's pouch prominent. Egg fusiform with polar prolongation of fertilization membrane. Gonopore nearly terminal.

Type species: *Pseudogorgorhynchus arii* sp. n.

***Pseudogorgorhynchus arii* sp. n.**

Fig. 8

Description: Gorgorhynchinae. Trunk cylindrical, of medium size, somewhat wider at its anterior part. Anterior trunk spines present, of uniform size, arranged in 9-13 complete transverse rings around body in single field. Proboscis small, somewhat claviform, armed with 18 hooks arranged in six spiral rows of 3 hooks each. Hooks of anterior two transverse rows similar in shape, rather thick and distinctly curved posteriorly, with

moderately developed roots; hooks of middle transverse row distinctly larger than those of anterior row. Hooks of posteriormost transverse row slender, more or less straight, slightly curved at middle; their length usually slightly smaller than that of middle hooks or equal, sometimes even slightly longer than middle hooks. Proboscis receptacle two-layered, extending into neck to base of proboscis, somewhat longer than proboscis; cephalic ganglion situated near its base. Lemnisci narrow, markedly longer than proboscis receptacle.

Male (6 specimens; measurement of holotype in parentheses): Length of trunk 2,992-5,712 (5,712), maximum width 449-734 (734). Trunk spines 9-12 (12) long, in 10-13 (13) transverse rings. Proboscis including neck 381-476 (476) long, maximum width 272-340

(340); neck 190-245 (245) long. Anterior, middle and posterior hooks 87-105 (87-90), 102-141 (135-141) and 93-129 (126-129) long, respectively. Proboscis receptacle not reaching posteriorly to testes, length 544-857 (857), maximum width 190-313 (313). Lemnisci 680-1,401 (1,401) long and 54-68 (54) wide. Testes oval, near middle of body, contiguous or almost so; anterior testis 272-544 × 231-394 (544 × 394), posterior testis 272-544 × 245-435 (367 × 435). Four elongate cement glands just posterior to testes. Gonopore subterminal; bursa 150-367 (367) long by 245-435 (435) wide.

Female (6 gravid specimens; measurements of allotype in parentheses): Trunk 4,420-7,589 (7,589) long, maximum width 680-830 (830). Trunk spines 9-12 (12) long, arranged in 9-10 (10) transverse rings. Proboscis including neck 449-462 (462) long and 340-367 (340) wide; length of neck 272-299 (299). Anterior, middle and posterior hooks 90-114 (93-102), 120-147 (132) and 111-141 (117-120) long, respectively. Length of proboscis receptacle 702-707 (707), maximum width 245-313 (313). Lemnisci 1,129-2,040 long and 54-68 (68) wide. Whole body filled in with eggs and ovarian balls. Spherical vaginal sphincter distinct, subterminal. Eggs spindle-shaped, 45-51 × 15-18 (45-51 × 15-18), with polar prolongation of fertilization membrane.

Type host: *Ariopsis seemanni* (Günther) (Ariidae, Siluriformes).

Site of infection: Intestine.

Type locality: Colombia.

Prevalence and intensity: 51% (19 fishes infected / 37 fishes examined); 1-4 (mean 1.4) nematodes per fish.

Deposition of types: Holotype, allotype and paratypes in the helminthological collection of the Institute of Parasitology, ASCR, in České Budějovice (Cat. No. A-63).

Etymology: The specific name of this acanthocephalan species is derived from the generic name of its type host.

Comments: The general morphology of the present specimens (particularly the two-layered proboscis receptacle, anterior spination of the trunk, structure of the body wall, character of cement glands, structure of eggs) shows that they belong to the family Rhadinorhynchidae, subfamily Gorgorhynchinae (see Petrochenko 1956, Yamaguti 1963, Golvan 1969, Amin 1987, 1998). According to Amin (1985), the Gorgorhynchinae includes the following 13 genera: *Australorhynchus* Lebedev, 1967, *Cleaveius* Subramanian, 1927, *Gorgorhynchoides* Cable et Linderoth, 1963, *Gorgorhynchus* Chandler, 1934, *Hanuman-tharaorhynchus* Chandra, 1983, *Leptorhynchoides* Kostylev, 1924, *Metacanthocephaloides* Yamaguti, 1959, *Metacanthocephalus* Yamaguti, 1959, *Micra-canthorhynchina* Strand, 1936, *Paracanthorhynchus* Edmonds, 1967, *Pseudauchen* Yamaguti, 1963, *Pseudoleptorhynchoides*

Salgado-Maldonado, 1976 and *Sclerocollum* Schmidt et Paperna, 1978. The new genus differs considerably from all of them in possessing markedly few proboscis hooks, their shape and structure and arrangement in spiral rows, as well as in some other features.

The closest genus seems to be *Gorgorhynchus*, whose type species, *Gorgorhynchus medius* (Linton, 1908), was also described from catfishes of the genus *Arius* (from *A. felis* from the Gulf of Mexico). However, in contrast to *Pseudogorgorhynchus* gen. n., its proboscis is rather long, armed with many similar hooks arranged in numerous longitudinal rows (22-24 rows in type species), and the cephalic ganglion is located in 1/3 of the length of the proboscis receptacle instead of near its base. Other genera differ also in such characters as the absence of trunk spines (*Leptorhynchoides*, *Metacanthocephaloides*, *Metaleptocephalus*) or only ventral trunk spines are present (*Pseudauchen*) or spines are separated in two fields (*Cleaveius*), the cephalic ganglion being in the middle of the proboscis receptacle (*Micracanthorhynchina*), presence of double lemnisci (*Australorhynchus*) or the bulboid swelling on the body (*Gorgorhynchoides*), among others. Therefore, we consider it necessary to create a new genus to accommodate the new species.

Neoechinorhynchidae Van Cleave, 1919

***Neoechinorhynchus* sp.**

Host: *Corydoras julii* Steindachner (Callichthyidae, Siluriformes).

Site of infection: Intestine.

Locality: Brazil.

Prevalence and intensity: 20% (1 fish infected / 5 fishes examined); 2 specimens.

Comments: As only two considerably damaged specimens were available, species identification was not possible. *Neoechinorhynchus villoldoi* Vizcaino, 1992 is known to occur in *Corydoras paleatus* (Jenyns) in Argentina (Vizcaino 1992).

***Pallisentis* sp.**

Host: *Barbus tetrazona* (Bleeker) (Cyprinidae, Cypriniformes).

Site of infection: Encapsulated in liver and on intestine.

Locality: Indonesia.

Prevalence and intensity: 65% (15 fishes infected / 23 fishes examined); 1 specimen per fish.

Comments: Only two, encapsulated juvenile specimens were available for study whose species identification was impossible. Adults of *Pallisentis* species are common parasites of snakeheads (*Channa* spp.) and some other freshwater fishes in southern Asia. Small cyprinids serve probably as only the paratenic hosts.

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