New data on the morphology of Procamallanus (Procamallanus) annulatus and Procamallanus (Spirocamallanus) monotaxis (Nematoda: Camallanidae) from marine fishes off New Caledonia

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New data on the morphology of *Procamallanus* (*Procamallanus*) *annulatus* and *Procamallanus* (*Spirocamallanus*) *monotaxis* (Nematoda: Camallanidae) from marine fishes off New Caledonia

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Summary

Two little-known nematode species of the family Camallanidae, intestinal parasites of marine perciform fishes, are reported from off New Caledonia: *Procamallanus* (*Procamallanus*) *annulatus* Yamaguti, 1955 from the golden-lined spinefoot *Siganus lineatus* (Valenciennes) (Siganidae) and *Procamallanus* (*Spirocamallanus*) *monotaxis* (Olsen, 1952) from the longspine emperor *Lethrinus genivittatus* Valenciennes and the slender emperor *Lethrinus variegatus* Valenciennes (both Lethrinidae). Detailed light and electron microscopical studies (the latter used for the first time in these species) revealed some taxonomically important, previously not observed features, such as the presence of deirids, six crescent-shaped elevations surrounding the mouth, three poorly developed protuberances on the female tail tip and circumcloacal papillae and phasmids on the male tail in *P. annulatus*, and the presence of a circumoral flange, only 12 (instead of 14 reported) cephalic papillae, the shape of deirids and similar numbers (14 – 17 and 14 – 15) of spiral ridges in the male and female buccal capsules in *P. monotaxis*. The fourth-stage larva of *P. annulatus* is described for the first time. First-stage larvae of both species were found to possess several digital processes at the tail tip. The present findings represent new host and geographical records of these parasite species.

Keywords: parasitic nematode; *Procamallanus* (*Procamallanus*); *Procamallanus* (*Spirocamallanus*); marine fish; *Siganus*; *Lethrinus*; New Caledonia; South Pacific Ocean

Introduction

Nematodes of the family Camallanidae seem to be frequent parasites of marine fishes in the South Pacific Ocean (Lester & Sewell, 1989; Rigby & Adamson, 1997; Rigby & Font, 1997; Rigby *et al*., 1997, 1998, 1999; Moravec *et al*., 2006a), but their species composition in this region remains insufficiently known. Only three nominal species of adult camallanids have so far been reported from marine fishes in New Caledonian waters: *Camallanus carangis* Olsen, 1954 from *Nemipterus furcosus* (Valenciennes) (Nemipteridae), *Parupeneus ciliatus* (Lacépède) and *Upeneus vittatus* (Forsskål) (both Mullidae); *Procamallanus* (*Spirocamallanus*) *guttatusi* (Andrade-Salas, Pineda-López et García-Magaña, 1994) (reported under the synonym *Spirocamallanus philippinensis* Machida et Taki, 1985) from *Digramma pictum* (Thunberg) (Haemulidae), and *Procamallanus* (*Spirocamallanus*) *variolae* Moravec, Justine et Rigby, 2006 from *Variola albimarginata* Baissac and *Epinephelus fasciatus* (Forsskål) (both Serranidae) (Baillon, 1991; Moravec *et al*., 2006a; Justine, 2010); however, in addition, Baillon (1991) recorded one unidentified *Camallanus* sp. from *D. pictum*, Moravec *et al*. (2006a) reported three unidentified *Procamallanus* (*Spirocamallanus*) spp. (only females available) from other fishes, and Sigura and Justine (2008) reported *Procamallanus* sp. from *Epinephelus cyanopodus* (Richardson). Two other species of camallanids, *Camallanus cotti* Fujita, 1927 and *Procamallanus* (*Procamallanus*) *pacificus* Moravec, Justine, Würtz, Taraschewski et Sasal, 2006 were reported from New Caledonian freshwater fishes (Moravec & Justine, 2006; Moravec *et al*., 2006b).

Parasitological examinations of marine fishes off the coast of New Caledonia yielded, among other helminths, two intestinal camallanid species of *Procamallanus* Baylis, 1923 parasitizing the golden-lined spinefoot *Siganus lineatus* (Valenciennes) (Siganidae), the longspine emperor *Lethrinus genivittatus* Valenciennes and the slender emperor *Lethrinus variegatus* Valenciennes (both Lethrinidae), that were not previously reported from this region. Their detailed light microscopy (LM) and scanning electron microscopy (SEM) examination made it possible to find some new, taxonomically important features of these hitherto little-known nematode species and to redescribe

them. Results of this study are presented herein.
Siganus lineatus (maximum body length 43 cm), *Lethrinus genivittatus* (up to 25 cm) and *L. variegatus* (up to 20 cm) are tropical, reef-associated marine fishes with Indo-West Pacific distributions (Froese & Pauly, 2010).

Materials and methods

Fish were collected by fishing with hook and line (*Lethrinus* spp.), or by spear-fishing and from the fish market of Nouméa (*Siganus* spp.). All fish were measured, weighted and photographed, and assigned an unique registration number (JNC). The nematodes for morphological studies were fixed in hot 4% formaldehyde solution, sometimes in 70 % ethanol. For light microscopical examination, they were cleared with glycerine. Drawings were made with the aid of a Zeiss microscope drawing attachment. Specimens used for scanning electron microscopy were postfixed in 1 % osmium tetroxide, dehydrated through a graded acetone series, critical point dried and sputter-coated with gold; they were examined using a JEOL JSM-7401F scanning electron microscope at an accelerating voltage of 4 kV GB low. All measurements are in micrometres unless otherwise stated. Fish names follow FishBase (Froese & Pauly, 2010).

Results

Family Camallanidae Railliet et Henry, 1915

Procamallanus (*Procamallanus*) *annulatus* Yamaguti, 1955 (Figs. 1, 2)

Description
General: Medium-sized nematodes with finely transversely striated cuticle (Fig. 2A, D). Body of live specimens reddish, of fixed specimens light grey to brown. Mouth aperture circular, surrounded by six flat, crescent-shaped elevations and four submedian cephalic papillae (Figs. 1C, 2A, C). Pair of small lateral amphids present (Figs. 1C, 2A, B). Buccal capsule orange-brown, thick-walled, barrel-shaped, slightly longer than wide, with well developed basal ring; basal, narrowed part of buccal capsule proper anterior to basal ring somewhat thickened, forming conspicuous circular ledge. Inner surface of capsule smooth, without any spiral ridges (Fig. 1A, B). Muscular oesophagus somewhat shorter than glandular oesophagus; both parts of oesophagus slightly expanded near their posterior ends (Fig. 1A). Intestine brown, narrow. Deirids small, simple, with rounded end, situated some distance anterior to level of nerve ring or, sometimes, at about mid-way between posterior end of buccal capsule and nerve ring (Figs. 1A, B, I, 2D). Excretory pore somewhat posterior to junction of both parts of oesophagus (Fig. 1A). Tail of both sexes conical, with blunt tip.
Male (6 specimens; measurements of 1 additional, juvenile specimen in parentheses): Length of body 16.99-19.94 (8.96) mm, maximum width 367 – 490 (231). Buccal capsule including basal ring 117 – 129 (99) long, its width 99 – 108 (93); basal ring 12 – 18 (12) long and 63 – 69 (66) wide; circular ledge 15 – 18 (9) high. Maximum width/length ratio of buccal capsule 1:1.14 – 1.30 (1:1.06). Length of muscular oesophagus 408-490 (408), maximum width 69 – 90 (60); length of glandular oesophagus 530 – 680 (490), maximum width 63 – 78 (63); length ratio of muscular and glandular oesophagus 1:1.3 – 1.5 (1:1.2). Length of entire oesophagus and buccal capsule representing 6 – 7 (11) % of body length. Nerve ring, deirids and excretory pore 272 – 354 (258), 228 – 270 (270) and 558 – 734 (490), respectively, from anterior extremity. Posterior end of body ventrally bent, provided with wide, vesiculated caudal alae supported by pedunculate papillae; alae anteriorly interconnected by mound, forming thus a kind of pseudosucker, and posteriorly reaching to tail tip (Figs. 1D, 2E, F). Preanal papillae: 3 pairs of equally spaced subventral pedunculate papillae; postanal papillae: 5 pairs of anterior subventral papillae and 1 pair of posterior lateral phasmids; additional 2 pairs of small transversely elongate sessile ventral papillae surrounding cloacal opening (Fig. 1D, J, K). Spicules similar in shape, unequal, with pointed distal ends; large (right) spicule 321 – 387 (285) long, with narrowed, ventrally bent, alate distal tip; small (left) spicule somewhat less sclerotized, 231 – 299 (201) long. Length ratio of spicules 1:1.07 – 1.47 (1:1.42). Gubernaculum well sclerotized, conspicuous, 135 – 165 (138) long (Fig. 1D, J, K). Tail conical, 153 – 300 (190) long, with rounded tip.
Female (5 gravid specimens; measurements of 2 subgravid specimens in parentheses): Length of body 37.97 – 46.76 (33.05 – 42.12) mm, maximum width 707 – 938 (680 – 802). Buccal capsule including basal ring 138 – 153 (150 – 153) long and 126 – 132 (120 – 132) wide; basal ring 15 – 21 (15 – 21) long and 84 – 99 (84 – 87) wide; circular ledge 15 – 18 (15 – 18) high. Maximum width/length ratio of buccal capsule 1:1.10 – 1.21 (1:1.21 – 1.25). Length of muscular oesophagus 517 – 639 (476 – 544), maximum width 102 – 122 (93); length of glandular oesophagus 707 – 911 (721 – 748), maximum width 81 – 122 (81); length ratio of muscular and glandular oesophagus 1:1.3 – 1.5 (1:1.4 – 1.5). Length of entire oesophagus and buccal capsule representing 3 – 4 (3 – 4) % of body length. Nerve ring, deirids and excretory pore 326 – 449 (340 – 381), 282 – 300 (300 – 306) and 748 – 1142 (748), respectively, from anterior extremity. Vulva pre-equatorial, 15.40 – 17.50 (13.10 – 1485) mm from anterior extremity, at 36 – 41 (35 – 40) % of body length. Anterior vulval lip somewhat elevated. Vagina muscular, directed posteriorly from vulva. Uterus filled with larvae 555 – 609 (-) long and 21 – 24 (24) wide; oesophagus 120 – 132 long (20 – 22 % of body length), tail 111 – 126 long (19 – 22 % of body length); tail tip of larva bearing several minute digit-like processes (Fig. 1G, H). Tail of female conical, 408 – 558 (367 – 435) long; tail tip blunt, with three slightly outlined protuberances (Fig. 1L, M).
Female fourth-stage larva (1 specimen): Body whitish, 7.93 mm long, maximum width 245. Buccal capsule co-

lourless, 84 long including basal ring, and 84 wide; basal ring 9 long and 45 wide; circular ledge slightly outlined, 12 high (Fig. 1E). Maximum width/length ratio of buccal capsule 1:1. Length of muscular oesophagus 367, maximum width 60; length of glandular oesophagus 408, maximum width 78; length ratio of muscular and glandular oesophagus 1:1.1. Length of entire oesophagus and buccal capsule representing 11 % of body length. Nerve ring, deirids and excretory pore 225, 171 and 571, respectively, from anterior extremity; deirids conical, pointed. Vulva pre-equatorial, 2.45 mm from anterior extremity (at 36 – 41 (31% of body length), still covered by cuticle. Uterus

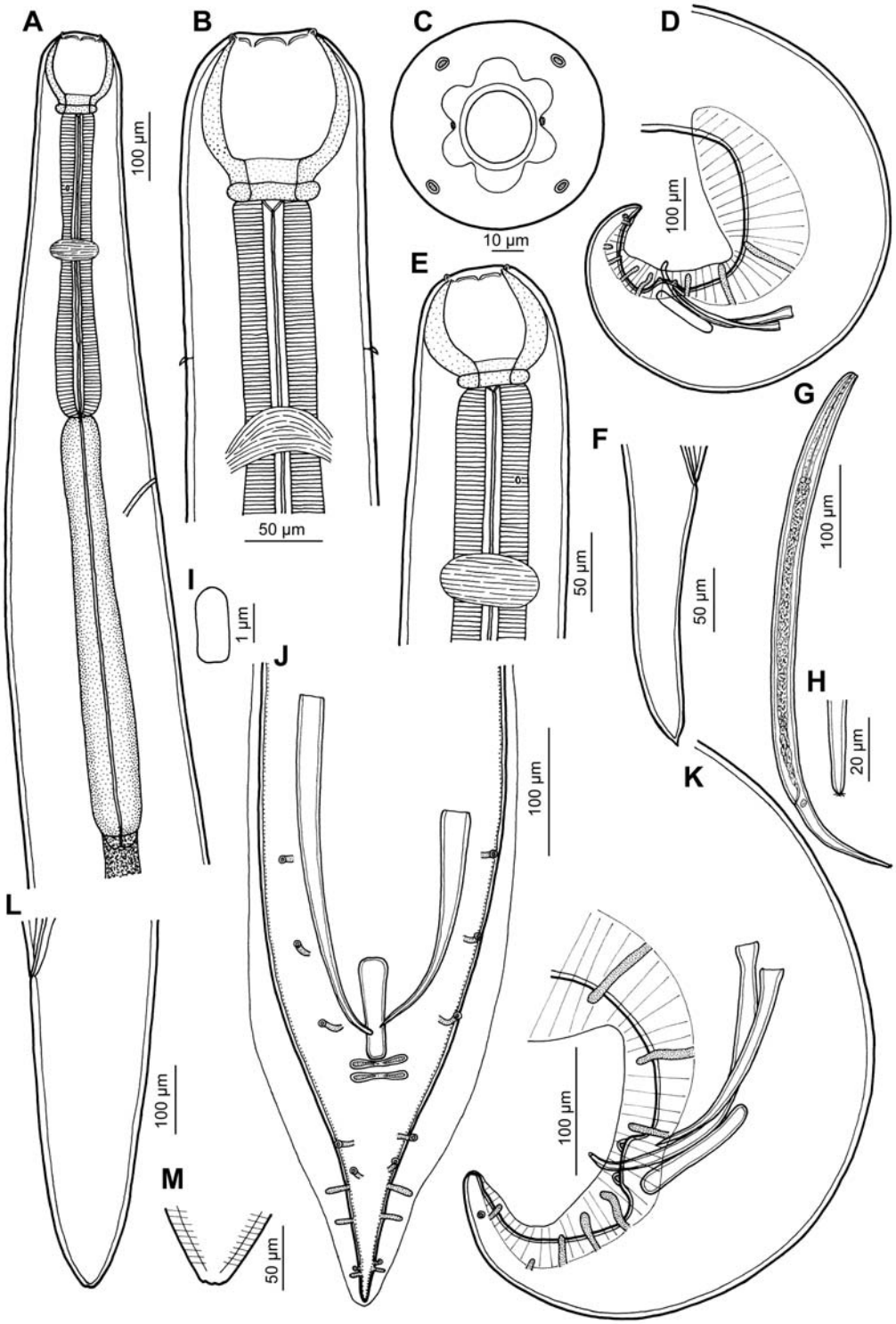

Fig. 1. *Procamallanus* (*Procamallanus*) *annulatus* Yamaguti 1955. A, B, C) Anterior end of male, lateral, dorsoventral and apical views, respectively; D) Posterior end of male, lateral view; E) Anterior end of fourth-stage larva, lateral view; F) Tail of fourth-stage larva, lateral view; G) First-stage larva from uterus; H) Tail tip of first-stage larva; I) Shape of deirid, lateral view; J, K) Tail of male, ventral and lateral views; L) Tail of gravid female, lateral view; M) Tail tip of gravid female.

tubular, empty. Tail conical, 204 long, sharply pointed at tip (Fig. 1F).
Host: Golden-lined spinefoot, *Siganus lineatus* (Siganidae, Perciformes).
Site of infection: Intestine and pyloric caeca.
Locality: New Caledonia (off Nouméa; Nouméa fish market).
Prevalence and intensity: 4 fish infected/6 fish examined; 1 – 61 (mean 18) specimens per fish.
Deposition of voucher specimens: Muséum National d'Histoire Naturelle, Paris (JNC 1992, 2860, 2873, 2998); Institute of Parasitology, BC ASCR, České Budějovice (N-953).

Comments: The general morphology of specimens of the present material, in particular the presence of the buccal capsule without spiral ridges or other ornamentations on inner surface, shows clearly that they belong to the nominotypical subgenus of *Procamallanus* Baylis, 1923. Of

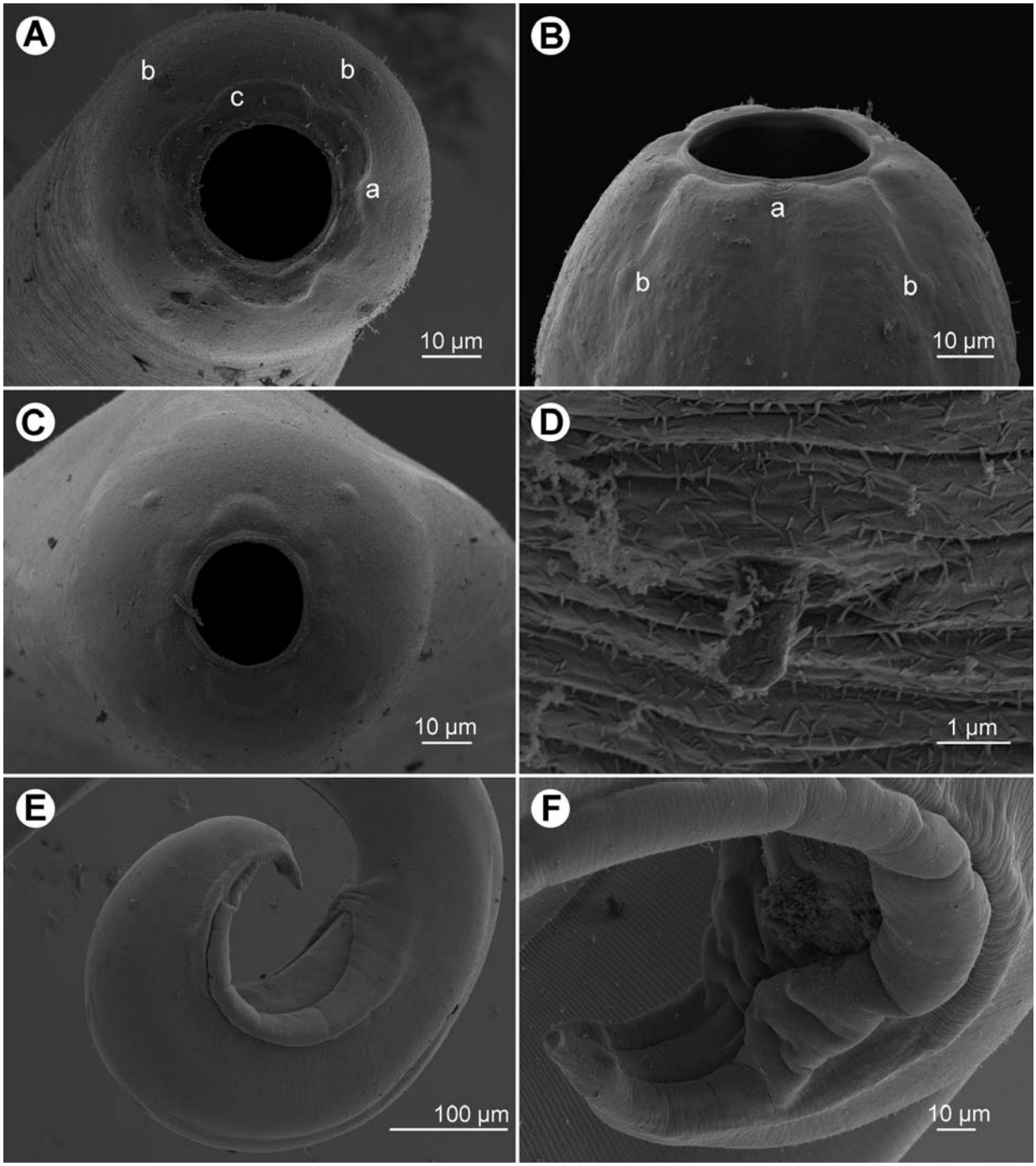

Fig. 2. *Procamallanus* (*Procamallanus*) *annulatus* Yamaguti 1955, SEM micrographs. A, B) Cephalic end of female, apical and lateral views; C) Cephalic end of male, apical view; D) Deirid; E) Posterior end of male showing sucker-like formation formed by caudal alae, sublateral view; F) Posterior end of male tail, ventrolateral view. a - amphid, b - cephalic papilla, c - circumoral sclerotized elevation.

several species of this subgenus described from marine fishes (see Ivashkin *et al*., 1971; Petter, 1979; Arya, 1984), the most similar are the following four species, all described from *Siganus* spp. of the Indo-Pacific region: *P. sigani* Yamaguti, 1935 from *S. fuscescens* (Houttuyn) from Japan (Inland Sea of Japan and Pacific coast of Mie and Wakayama Prefectures) (Yamaguti, 1935) and later reported from *S. guttatus* (Bloch) and *S. oramin* (Bloch et Schneider) from North Borneo, Malaysia (Myer & Kuntz, 1969); *P. lonis* Yamaguti, 1941 from *S. unimaculatus* (Evermann et Seale) from Okinawa, Japan (Yamaguti, 1941) and later reported from Australia from *S. lineatus* (Valenciennes) and *S. punctatus* (Schneider et Forster) from the Great Barrier Reef (Lester and Sewell, 1989) and from *Platax batavianus* Cuvier (Ephippidae, Perciformes) off the coast of Queensland (Smales, 2000); *P. annulatus* Yamaguti, 1955 from *Siganus* sp. from Celebes (Macassar), Indonesia, later also reported from *S. stellatus* (Forsskål) from Sri Lanka (Colombo) (Parukhin, 1971, 1976); and *P. elatensis* Fusco et Overstreet, 1979 from *S. luridus* (Rüppel) and *S. rivulatus* (Forsskål) from the Red Sea (Fusco & Overstreet, 1979).

However, the original descriptions of all these four species are very incomplete, their measurements often overlap, their type specimens (except for *P. elatensis*) are in poor condition preventing their re-examination, so that it cannot be excluded that in fact they represent only one species. However, until their redescriptions based on newly collected topotypic materials are available, they should be considered valid. Of them, *P. sigani*, *P. lonis* and *P. elatensis* differ from New Caledonian specimens by distinctly shorter body not exceeding 16 mm in males and 28 mm in gravid females (vs. 17 – 20 and 38 – 47 mm); moreover, no gubernaculum and ring-like internal thickening (ledge) of the buccal capsule are mentioned to be present in *P. sigani* and *P. lonis* (but the latter is illustrated in *P. lonis*). Both the gubernaculum and the circular ledge are reported for *P. elatensis*, but the length ratio of spicules in this species is different (1:2.4 – 3.3 vs. 1:1.1 – 1.5) and the gubernaculum is V-shaped, weakly sclerotized, only 41 – 63 long (vs. non-bifurcated, strongly sclerotized, 135 – 165 long); data on the location of the excretory pore anterior to the level of nerve ring and the absence of deirids in *P. elatensis* are evidently erroneous.

Body lengths (male 10 – 20 mm, female 28 – 43) and other measurements of *P. annulatus* are similar to those in the present specimens, both forms possess the buccal capsule with a distinct circular ledge and the gubernaculum of a similar shape and length, the number and distribution of male genital papillae are identical, and the lengths of larvae from uterus are also similar. Therefore, the New Caledonian specimens are considered to belong to *P.* (*P.*) *annulatus*, even though it was originally described from a different geographical region (Indonesia).

In the original description of *P. annulatus*, Yamaguti (1955) did not report some taxonomically important features, such as the presence of deirids, six crescent-shaped elevations surrounding the mouth, three poorly developed protuberances on the female tail tip, and circumcloacal papillae and phasmids on the male tail. It is necessary to remark, however, that some of these features are difficult to observe by LM and can be properly studied only by SEM.

The fourth-stage larva of *P. annulatus* is described here for the first time; its buccal capsule resembles that in adults, including the presence of a weakly sclerotized circular ledge, but the deirids are pointed, as also the tail tip. It is remarkable that the tail tip of first-stage larvae of *P. annulatus* from uterus is provided with several digit-like processes. Similar caudal processes in first-stage larvae have hitherto been reported only for two species of the camallanid genus *Camallanus* Railliet et Henry 1915 (see Moravec and Justine, 2006) and recently also for the African species *P. laeviconchus* (Wedl, 1862) (Mašová *et al*., 2010).

It has been mentioned above that *P. annulatus* was previously reported from off Indonesia and Sri Lanka (Yamaguti, 1955; Parukhin, 1971, 1976). Its occurrence in New Caledonia, representing new host and geographical records, is not surprising, because many *Siganus* spp. have broad Indo-Pacific distributions. By sucking the host's blood, camallanids may be rather pathogenic and their heavy infections may be even a cause of death in cultured fish, as was documented, for example, for *P.* (*S.*) *guttatusi* (Andrade-Salas, Pineda-López et García-Magaña, 1994) in the reared orange-spotted spinefoot, *Siganus guttatus*, in a fish farm in the Philippines (Machida & Taki, 1985; Moravec *et al*., 2004). Therefore, *P. annulatus* may also be a potential pathogen for cultured *Siganus* spp. This is of possible economic importance for rabbitfish aquaculture, which is presently under development in the Pacific and especially in New Caledonia (Teitelbaum *et al*., 2008).

Procamallanus (*Spirocamallanus*) *monotaxis* (Olsen, 1952) (Figs. 3, 4)

Description

General (based on specimens from *L. genivittatus*): Medium-sized nematodes with finely transversely striated cuticle. Mouth aperture oval to square (Figs. 3D, 4A, B), provided with narrow circumoral flange (Fig. 4A – D) and surrounded by six flat, crescent-shaped elevations and 12 submedian cephalic papillae arranged in three circles, each formed by four papillae; papillae of external circle distinctly larger. Pair of small lateral amphids present (Figs. 3D, 4A – D). Buccal capsule orange-brown, thick-walled, barrel-shaped, slightly longer than wide, with simple, well developed basal ring. Maximum width/length ratio of buccal capsule 1.1.10 – 1.41. Inner surface of capsule provided with 14 – 17 spiral ridges in lateral view, 1 – 3 of them being incomplete (Fig. 3A – C). Muscular oesophagus somewhat shorter than glandular oesophagus; both parts of oesophagus slightly expanded near their posterior ends (Fig. 3A). Intestine brown, narrow. Deirids small, simple, with rounded end situated at about mid-way between posterior end of buccal capsule and nerve ring (Figs. 3B, E, F, 4G). Excretory pore somewhat anterior to junction of both

parts of oesophagus (Fig. 3A). Tail of both sexes with two (dorsal and ventral) terminal cuticular spikes.
Male (7 specimens): Length of body 10.54 – 17.699 mm, maximum width 218 – 354. Buccal capsule including basal ring 87 – 93 long, its width 66 – 69; basal ring 9 – 12 long and 42 – 54 wide. Maximum width/length ratio of buccal capsule 1:1.26 – 1.41. Spiral ridges 14 – 17, of which 1 – 3 incomplete. Length of muscular oesophagus 367 – 490, maximum width 66 – 109; length of glandular oesophagus 517 – 721, maximum width 78 – 122; length ratio of muscular and glandular oesophagus 1:1.2 – 1.4. Length of entire oesophagus and buccal capsule representing 7 – 9 %

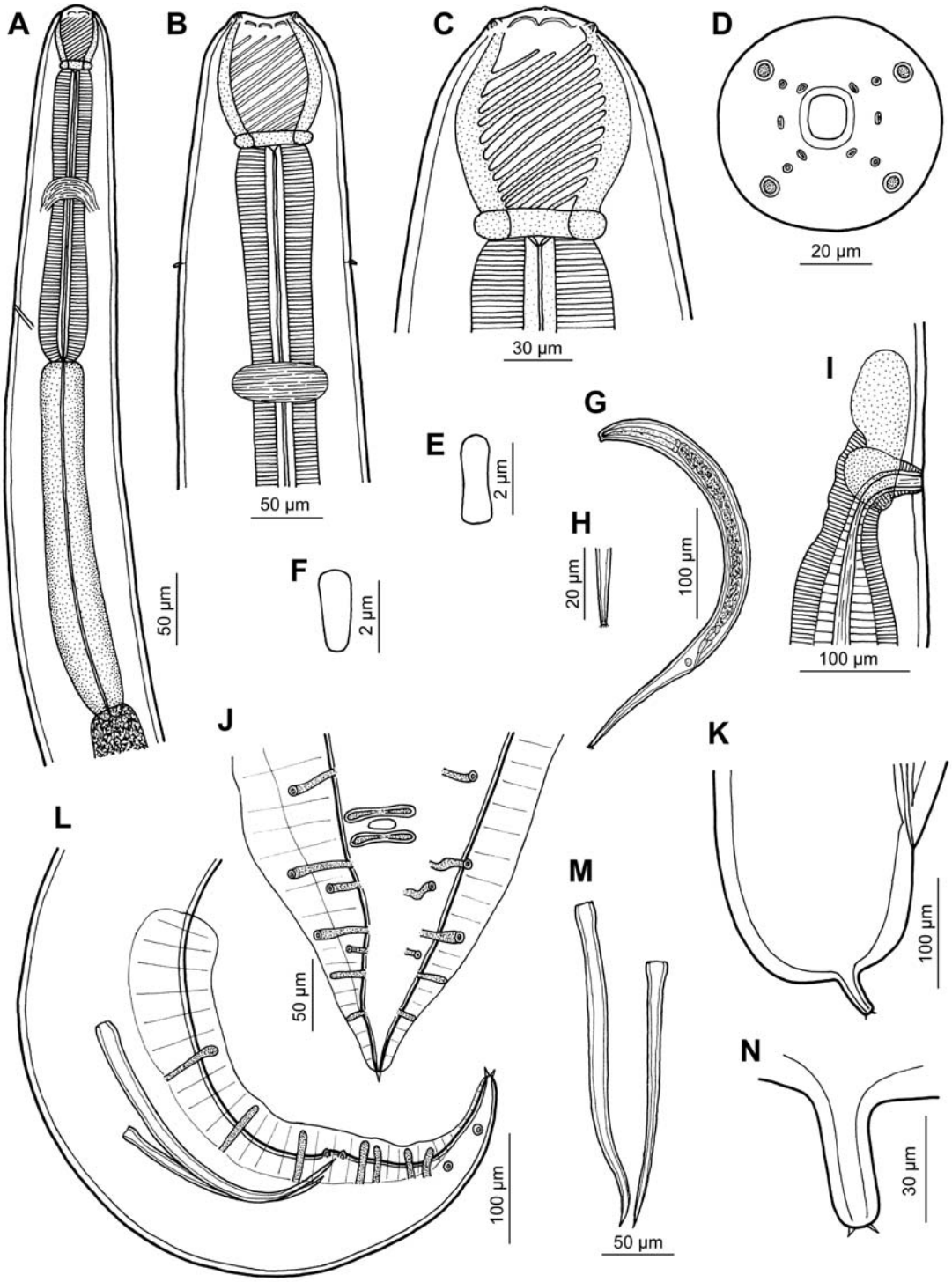

Fig. 3. *Procamallanus* (*Spirocamallanus*) *monotaxis* (Olsen 1952). A, B) Anterior end of male, lateral and dorsoventral views; C, D) Cephalic end of male, lateral and apical views; E, F) Shapes of deirids in two different specimens, lateral views; G) First-stage larva from uterus; H) Tail tip of first-stage larva; I) Vulva, lateral view; J) Tail of male, ventral view; K) Tail of gravid female, lateral view; L) Posterior end of male, lateral view; M) Right and left spicules, ventral view; N) Female caudal projection, lateral view.

of body length. Nerve ring, deirids and excretory pore 286 – 313, 168 – 186 and 471 – 571, respectively, from anterior extremity. Posterior end of body ventrally bent, provided with wide, vesiculated caudal alae supported by pedunculate papillae; alae anteriorly interconnected by mound, forming thus a kind of pseudosucker, and posteriorly reaching to base of caudal terminal spikes (Figs. 3J, L, 4E). Preanal papillae: 3 pairs of equally spaced subventral pedunculate papillae; postanal papillae: 4 pairs of anterior subventral and 2 pairs of posterior lateral pedunculate papillae (last pair probably representing phasmids); additional 2 pairs of small transversely elongate sessile ventral papillae surrounding cloacal opening (Fig. 3J, L). Spicules similar in shape, unequal, with sharply pointed distal ends (Fig. 3L, M); large (right) spicule 279 – 315 long; small (left) spicule less sclerotized, 171 – 213 long. Length ratio of spicules 1:1.48 – 1.67. Gubernaculum not observed. Tail conical, 162 – 210 long (Figs. 3J, L); length of terminal spikes 4 – 6.

Female (5 gravid specimens; measurements of 1 subgravid

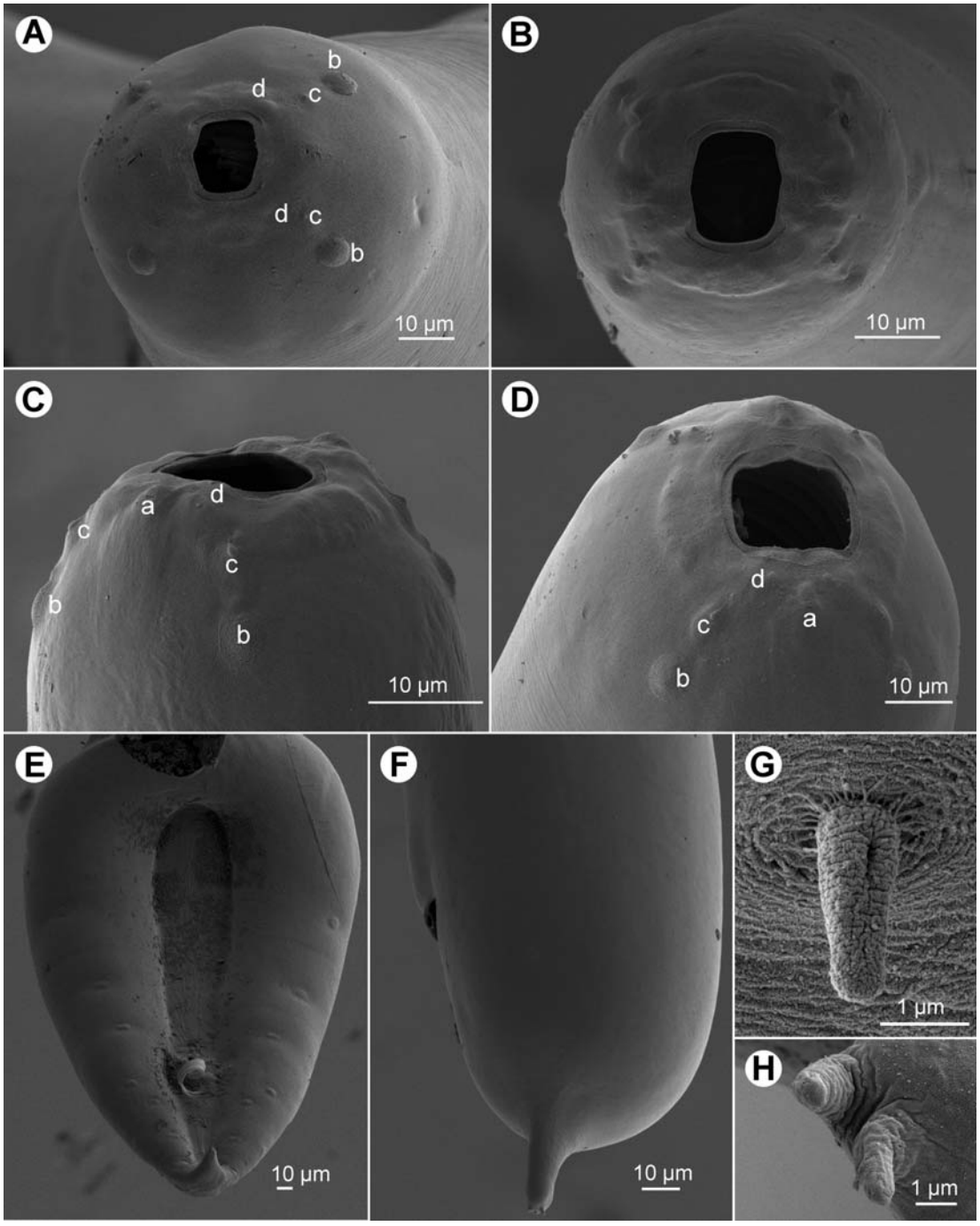

Fig. 4. *Procamallanus* (*Spirocamallanus*) *monotaxis* (Olsen, 1952), SEM micrographs. A) Cephalic end of male, apical view; B) Cephalic end of female, apical view; C, D) Cephalic end of female, sublateral and lateral views; E) Caudal end of male illustrating structure and shape of caudal alae, ventral view; F) Tail of female, lateral view; G) Deirid; H) Two spikes on distal tip of digit-like projection of female tail, sublateral view. a - amphid, b - cephalic papilla of most external circle, c - cephalic papilla of middle circle, d - cephalic papilla of most interior circle.

specimen in parentheses): Length of body 24.64 (19.20) mm, maximum width 653 – 707 (476). Buccal capsule including basal ring 96 – 105 (105) long and 81 – 87 (78) wide; basal ring 12 (12) long and 51 – 57 (51) wide. Number of spiral ridges 14 – 15 (15), of which 2 (2) incomplete. Length of muscular oesophagus 571 – 612 (544), maximum width 120 – 123 (105); length of glandular oesophagus 775 – 925 (762), maximum width 129 – 162 (105); length ratio of muscular and glandular oesophagus 1:1.3 – 1.6 (1:1.4). Length of entire oesophagus and buccal capsule representing 6 (7) % of body length. Nerve ring, deirids and excretory pore 340 – 381 (381), 198 – 210 (192) and 585 – 680 (653), respectively, from anterior extremity. Vulva pre-equatorial, 11.36 – 12.83 (9.11) mm from anterior extremity, at 45 – 47 (47) % of body length. Vulval lips not elevating (Fig. 3I). Vagina muscular, directed posteriorly from vulva. Uterus filled with larvae 447 – 456 (-) long and 24 (24) wide; oesophagus 90 – 93 long (20 – 21 % of body length), tail 117 – 125 long (226 – 28 % of body length); tail tip of larva bearing several digital projections (Fig. 3G, H). Tail of female rounded, with digit-like projection bearing two small terminal spikes (Figs. 3K, N, 4F, H). Length of entire tail 180 – 243 (201); digit-like projection with terminal spikes 45 – 75 (57) long and 18 – 21 (21) wide; spikes 3 – 6 (5) long.

Hosts: Longspine emperor, *Lethrinus genivittatus*, and slender emperor, *Lethrinus variegatus* (Lethrinidae, Perciformes).

Site of infection: Intestine.

Locality: New Caledonia (off Nouméa).

Prevalence and intensity: *L. genivittatus*: 52 fish infected/118 fish examined; 1-5 (mean 3) specimens per fish. *L. variegatus*: 1 specimen found in 1 fish of 5 examined.

Deposition of voucher specimens: Muséum National d'Histoire Naturelle, Paris (JNC 643-648, 653, 658, 659, 1959, 1960, 2022, 2030-2033, 2077, 2228, 2229, 2231, 2234, 2236, 2237, 2239-2247, 2250, 2312, 2317, 2321, 2327, 2507); Institute of Parasitology, BC ASCR, České Budějovice (N-952).

Comments: Nematodes of the present material belong to the morphological group of *Procamallanus* (*Spirocamallanus*) species characterized by the presence of wide caudal alae, three pairs of pedunculate preanal papillae and two unequal spicules, that are mostly parasites of marine fishes (Petter, 1979). As pointed out by Petter *et al*. (1977) and Rigby and Adamson (1997), the shape and structure of the female tail appears to be constant within a species of *Procamallanus* (*Spirocamallanus*). To date, six morphologically very similar species of this subgenus possessing two caudal spikes on a digit-like projection in females have been described from marine perciform and atheriniform fishes in the Pacific: *P.* (*S.*) *pereirai* Annereaux, 1946, *P.* (*S.*) *monotaxis* (Olsen, 1952), *P.* (*S.*) *istiblenni* (Noble, 1966), *P.* (*S.*) *philippinensis* (Velasquez, 1980), *P.* (*S.*) *guttatusi* (Andrade-Salas, Pineda-López et García-Magaña, 1994) and *P.* (*S.*) *variolae* Moravec, Justine et Rigby, 2006 (see Olsen, 1952; Noble, 1966; Velasquez, 1980; Machida & Taki, 1985; Andrade-Salas *et al*., 1994; Moravec *et al*., 2004, 2006a); of them, *P. philippinensis* is considered a *species inquirenda* (see Rigby & Font, 1997).

Of the above-named valid species, *P.* (*S.*) *pereirai*, originally described from the atheriniform fish *Atherinopsis californiensis* Girard (Atherinopsidae) off California, differs from New Caledonian specimens mainly in having a longer right spicule (about 430 vs. 279 – 315), postequatorial (vs. preequatorial) vulva and somewhat different shape (more slender) of the female tail (Annereaux, 1946). *Procamallanus* (*S.*) *guttatusi* from *Siganus guttatus* (Siganidae) from the Philippines differs by longer gravid females (30 – 37 vs. 25 – 28 mm) with a distinctly smaller buccal capsule (75 – 78 vs. 96 – 105 long), more posterior location of the excretory pore (at level of the glandular oesophagus) and a more slender female tail (Moravec *et al*., 2004); *P.* (*S.*) *variolae* from *Variola albimarginata* and *Epinephelus fasciatus* (both Serranidae) from New Caledonia mainly by the location of deirids at the level of nerve ring, more posterior location of the excretory pore (at level of the glandular oesophagus) and a somewhat longer right spicule (327 – 357).

Morphologically and biometrically very similar are the species *P.* (*S.*) *monotaxis* and *P.* (*S.*) *istiblenni*, both originally described from Hawaii from *Monotaxis grandoculis* Forsskål (Lethrinidae) and *Istiblennius zebra* (Vaillant et Sauvage) (Blenniidae), respectively. According to Rigby and Adamson (1997) and Rigby and Font (1997, 2001), both these species can be distinguished from each other only by the relative position of the male's second preanal papilla. However, considering the original description by Olsen (1952) and that by Noble (1966), the excretory pore is more posterior (at level of glandular oesophagus vs. at level of the posterior part of muscular oesophagus) and the female tail more slender in *P. istiblenni* than in *P. monotaxis*. Considering that the specimens of the present material are morphologically and biometrically most similar to *P. monotaxis*, so far the only *Procamallanus* species reported from a fish belonging to the family Lethrinidae in the Pacific (Rigby & Adamson, 1997), they are assigned to this species.

In the original description of *P.* (*S.*) *monotaxis* (as *Spirocamallanus monotaxis*), Olsen (1952) reported 16 spiral ridges in the buccal capsule of male and 10 in that of female. According to the redescription of this species by Rigby and Adamson (1997) based on specimens from French Polynesia, there are 10 – 14 ridges in the male and 8 – 10 in the female. In contrast, both males and females of the present material possess similar numbers of ridges (14 – 17 in males and 14 – 15 in females), this being apparently within the limits of intraspecific variability.

SEM examination, used for the first time in this species, revealed the presence of a previously unreported narrow circumoral flange. The presence or absence of such flange may be a good differentiating feature between some *Procamallanus* spp., as has recently been documented for some congeneric species in Africa (Mašová *et al*., 2011). Only 12 cephalic papillae arranged in three concentric

circles have now been confirmed by SEM, instead of 14 papillae reported by Rigby and Adamson (1997).

One of the reliable specific features in this morphological group of *Procamallanus* (*Spirocamallanus*) spp. is the shape (bifurcate or simple) of deirids, which, however, can be determined reliably only by SEM (González-Solís *et al*., 2002; Moravec *et al*., 2004). The first use of this method in *P. monotaxis* shows that deirids in this species are simple, chisel-shaped or with a somewhat narrowed distal end, resembling thus, e.g., those in *P. guttatusi* (see Moravec *et al*., 2004). As in the foregoing species, first-stage larvae of *P. monotaxis* have been, for the first time, found to be provided with numerous small digit-like processes at the tail tip, previously reported only for larvae of two species of *Camallanus* (see Moravec & Justine, 2006). The presence/absence and the character of caudal processes in first-stage larvae may be an important taxonomic feature in camallanids (Moravec & Justine, 2006). Apparently, caudal processes serve the larva to the better attachment by its tail to the bottom, after the larvae are released into the water; then the larvae attract by their movements the copepod intermediate hosts.

In addition to the type host *M. grandoculis* in Hawaii (Olsen 1952), *P. monotaxis* was reported by Rigby and Adamson (1997) from French Polynesia from the same host species and other ten species of anguilliform, aulopiform, beryciform and perciform fishes, including the lethrinid *L. olivaceus* Valenciennes. However, the records *P. monotaxis* and *P. istiblenni* may well include each more than a single nematode species (Rigby & Font, 1997; Moravec *et al*., 2004, 2006a). *Procamallanus monotaxis* has not previously been reported from New Caledonian waters and *L. genivittatus* and *L. variegatus* represent its first host records. This species seems to be relatively host-specific; in this study, no camallanid was found in 133 specimens of other species of *Lethrinus* examined, including *L. atkinsoni* Seale (14 specimens), *L. harak* (Forsskål) (2), *L. lentjan* (Lacépède) (7), *L. miniatus* (Forster) (27), *L. nebulosus* (Forsskål) (14), *L. obsoletus* (Forsskål) (3), and *L. rubrioperculatus* Sato (66).

From the intestine of the congeneric host (*L. ravus* Carpenter et Randall) off New Caledonia, Moravec *et al*. (2006a) reported a subgravid female of an unidentified species designated as *Procamallanus* (*Spirocamallanus*) sp. 2. Although the structure of its buccal capsule resembles that of *P. monotaxis*, this species distinctly differs from the latter in having a single conical spike on the digit-like caudal projection instead of two in *P. monotaxis*.

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