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Some camallanid nematodes from marine perciform fishes off New Caledonia

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Abstract. Two new, one known and three unidentified species of the nematode family Camallanidae are reported and described from the intestines of marine perciform fishes off the southwestern coast of New Caledonia, South Pacific: *Camallanus carangis* Olsen, 1952 from the forked-tailed threadfin bream *Nemipterus furcosus* (Nemipteridae), the yellowstriped goatfish *Upeneus vittatus* and the whitesaddle goatfish *Parupeneus ciliatus* (both Mullidae) (new host records); *Procamallanus* (*Spirocamallanus*) *variolae* sp. n. from the white-edged lyretail *Variola albimarginata* (type host) and the blacktip grouper *Epinephelus fasciatus* (both Serranidae); *Procamallanus* (*Spirocamallanus*) *longus* sp. n. from the twotone tang *Zebrasoma scopas* (Acanthuridae); *Procamallanus* (*Spirocamallanus*) sp. 1 (female tail with 2 terminal spikes on a digit-like projection) from the speckled sandperch *Parapercis hexophtalma* (Pinguipedidae); *Procamallanus* (*Spirocamallanus*) sp. 2 (female tail with 1 spike on a digit-like projection) from the drab emperor *Lethrinus ravus* (Lethrinidae) and *Procamallanus* (*Spirocamallanus*) sp. 3 (female tail with a smooth digit-like protrusion) from the two-lined monocle bream *Scolopsis bilineata* (Nemipteridae). *Camallanus paracarangis* Velasquez, 1980 is synonymized with *C. carangis*. Several additional species of *Camallanus* from marine fish of the Indo-Pacific region may be synonymous with *C. carangis* as it has a poorly sclerotized left spicule and 3 small caudal projections on the tail of young (i.e., non-gravid) females. The fourth-stage larva of *C. carangis* is described for the first time. *P.* (*S.*) *variolae* differs from most similar species of this region mainly in the position (i.e., at level or posterior to the nerve ring) and shape of deirids. *P.* (*S.*) *longus* differs from the similar *P.* (*S.*) *chaimha* mainly in a different arrangement of postanal papillae, shape of the female tail, much longer right spicule (429 μm) and longer body of gravid females (38–55 mm). All *Camallanus* and *Procamallanus* (*Spirocamallanus*) spp. reported here represent the first records of camallanids from marine fishes in New Caledonian waters.

The nematode fauna of New Caledonian fishes remains little known. Although members of the family Camallanidae are frequent parasites of Indo-Pacific fishes, where many species have been reported, the only representative recorded from New Caledonia is the recently described *Procamallanus* (*Procamallanus*) *pacificus* Moravec, Justine, Würtz, Taraschewski et Sasal, 2006, a freshwater parasite of eels (*Anguilla* spp.) (Moravec et al. 2006).

Parasitological examinations of marine fishes off the southwestern coast of New Caledonia carried out by J.-L. Justine in 2003 and 2004 revealed, among other helminths, camallanid nematodes in several species of perciform fishes. This material was supplemented by camallanid specimens collected earlier (1997) in New Caledonia by M.C. Rigby. An examination of all these camallanids showed that they included one already known species of *Camallanus* Railliet et Henry, 1915, two new species of *Procamallanus* Baylis, 1923 (subgenus *Spirocamallanus* Olsen, 1952) and three forms of *Procamallanus* (*Spirocamallanus*) unidentifiable to species (i.e., only females were available), which may represent additional species. The results of detailed studies of these parasites are presented herein.

MATERIALS AND METHODS

The following fishes were collected and examined for nematodes in 1997: Acanthuridae: twotone tang, *Zebrasoma scopas* (Cuvier) (7 specimens examined); Chaetodontidae: melon butterflyfish, *Chaetodon trifasciatus* Park (n=29); Mullidae: whitesaddle goatfish, *Parupeneus ciliatus* (Lacépède) (n = 1); Nemipteridae: two-lined monocle bream, *Scolopsis bilineata* (Bloch) (n = 5); and Pinguipedidae: speckled sandperch, *Parapercis hexophtalma* (Cuvier) (n = 1). Fishes were caught by spear gun. Nematodes were fixed in Berland's fluid (9 parts of glacial acetic acid: 1 part 40% formaldehyde solution) and stored in 70% ethanol and 5% glycerine.

In 2003 and 2004, the following fishes were collected and examined for nematodes: Lethrinidae: drab emperor, *Lethrinus ravus* Carpenter et Randall (n = 1); Mullidae: yellowstriped

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goatfish *Upeneus vittatus* (Forsskål) (n = 2); Nemipteridae: forked-tailed threadfin bream, *Nemipterus furcosus* (Valenciennes) (n = 80); Serranidae: blacktip grouper, *Epinephelus fasciatus* (Forsskål) (n = 20) and white-edged lyretail, *Variola albimarginata* Baissac (n = 1). Fishes were caught by line, at distances less than 30 km from Nouméa, New Caledonia. A few fish specimens were bought at the fishmarket in Nouméa. All fish were measured, weighted and photographed. For specimens caught in 2003–2004, a unique number (JNC) was assigned to each fish. The parasitological material was then assigned a corresponding JNC linked to the respective fish host. In the lists of material examined, dates of collection of hosts are given, and measurements of hosts are abbreviated as FL (fork length) in millimetres and W (weight) in grams, for possible future comparison of parasite prevalence, host age and seasonality in other localities. The nematodes for morphological studies were fixed in hot 70% ethanol or 4% formaldehyde solution.

For light microscopical examination, nematodes were cleared with glycerine. Drawings were made with the aid of a Zeiss microscope drawing attachment. Specimens used for scanning electron microscopy (SEM) were transferred to 4% formaldehyde solution and then postfixed in 1% osmium tetroxide, dehydrated through a graded ethanol series, critical point dried and sputter-coated with gold; they were examined using a JEOL JSM-6300 scanning electron microscope at an accelerating voltage of 15 kV. All measurements are in micrometres unless otherwise stated. Fish names follow FishBase (Froese and Pauly 2006).

The following specimens were examined for comparative purposes: *Procamallanus* (*Spirocamallanus*) *chaimha*: 1 subgravid female from *Acanthurus olivaceus* and 2 body fragments from *Ctenochaetus striatus*, both from Moorea, Society Islands, French Polynesia; *P*. (*S*.) *colei*: 1 subgravid female from *Acanthurus achilles* from Rangiroa, Tuamotu Islands, French Polynesia, 4 subgravid females from *Acanthurus triostegus*, and 1 subgravid female from *Zebrasoma scopas*, both from Moorea, Society Islands. All were collected by M.C. Rigby and are now deposited in Muséum National d'Histoire Naturelle, Paris (Cat. Nos. MNHN 314–318 HG).

Type specimens of *C. carangis*, *C. marinus*, *P*. (*S*.) *guttatusi* (syn. *Spirocamallanus philippinensis* Machida et Taki, 1985), *P*. (*S*.) *istiblenni*, and *P*. (*S*.) *monotaxis* were re-examined by M.C. Rigby within previous studies (Rigby and Adamson 1997, Rigby and Font 1997, Rigby et al. 1998).

DESCRIPTIONS

Camallanus carangis Olsen, 1954 Figs. 1–3

Syns.: *Camallanus marinus* Schmidt et Kuntz, 1969; *C. paracarangis* Velasquez, 1980.

Description (see also Table 1): Medium-sized nematodes with thick, finely transversely striated cuticle and large, orange-brown capsule typical of genus. Body of larger females reddish (brownish after fixation), with distinct dark-brown intestine; body of small specimens whitish. Mouth aperture slit-shaped, dorsoventrally elongated, surrounded by 4 large submedian cephalic papillae, pair of small lateral amphids, and 4 large sublateral sclerotized plates extending posteriorly to about third of length of buccal capsule. Valves of buccal capsule roughly pentagonal in lateral view, internally bearing 24–40 smooth longitudinal ridges (some incomplete); some incomplete ridges followed by several small round thickenings (dots) arranged in longitudinal rows or irregularly scattered. Bottom of capsule formed by well-developed, sclerotized basal ring. Basal ring joined to oesophagus by colourless sclerotized cup. Tridents large, surpassing posterior border of buccal capsule. Excretory pore situated at level of about middle of muscular oesophagus or somewhat more anteriorly. Deirids small, simple, situated some distance posterior to level of nerve ring.

Male (10 specimens): Length of body 4.87–12.68 mm, maximum width 177–326. Buccal capsule (including basal ring) 99–156 long, maximum width 90–126; basal ring 15–27 long, 60–84 wide; length of tridents 93–186. Each valve of capsule strengthened internally by 24–36 longitudinal ridges, 6–29 incomplete; in addition, 6–18 very small dots forming discontinuous portions of longitudinal ridges. Muscular oesophagus 558–830 long, 75–111 wide; glandular oesophagus 571–816 long, 69–123 wide; length ratio 1:0.90–1.19. Length of buccal capsule and oesophagus forms 14–35% of total body length. Nerve ring, excretory pore and deirids 186–299, 348–594 and 449–503, respectively, from anterior extremity. Posterior end of body with vesiculate caudal alae supported by pedunculate papillae. Caudal papillae: 7 pairs of preanal and 6 pairs of postanal pedunculate papillae present. Preanal papillae: 7 pairs of subventral, equally spaced papillae. Postanal papillae: 6 pairs of subventral papillae; first 3 pairs close to each other, following 2 pairs equally spaced; last pair near to tail tip. Cloacal opening surrounded by 2 transverse mounds, forming laterally 2 pairs of additional, sessile papillae. Spicules unequal, simple, with sharply pointed distal ends. Large (right) spicule well sclerotized, 216–330 long; small (left) spicule poorly sclerotized, 96–210 long. Tail conical, 90–141 long, with rounded tip.

Female (4 gravid and 5 subgravid specimens; measurements of latter in parentheses): Body length 21.49–28.81 (7.25–14.46) mm, maximum width 544–639 (204–394). Buccal capsule (including basal ring) 195–198 (105–177) long, maximum width 150–165 (129–153); basal ring 30 (21–30) long, 105–129 (24–96) wide; length of tridents 174–186 (105–180). Each valve of capsule with 28–40 (21–35) longitudinal ridges, 23–35 incomplete; in addition, about 18–30 (18–30) very small dots forming discontinuous portions of longitudinal ridges. Muscular oesophagus 1,020–1,047 (639–925) long, 129–165 (90–123) wide; glandular oesophagus 952–1,034 (625–952) long, 105–165 (81–122) wide; length ratio of both parts of oesophagus 1:0.91–1.03 (1:0.90–1.14). Length of buccal capsule and oesophagus forms 8–10 (14–35) % of total body length. Nerve ring, excretory pore and deirids 299–303

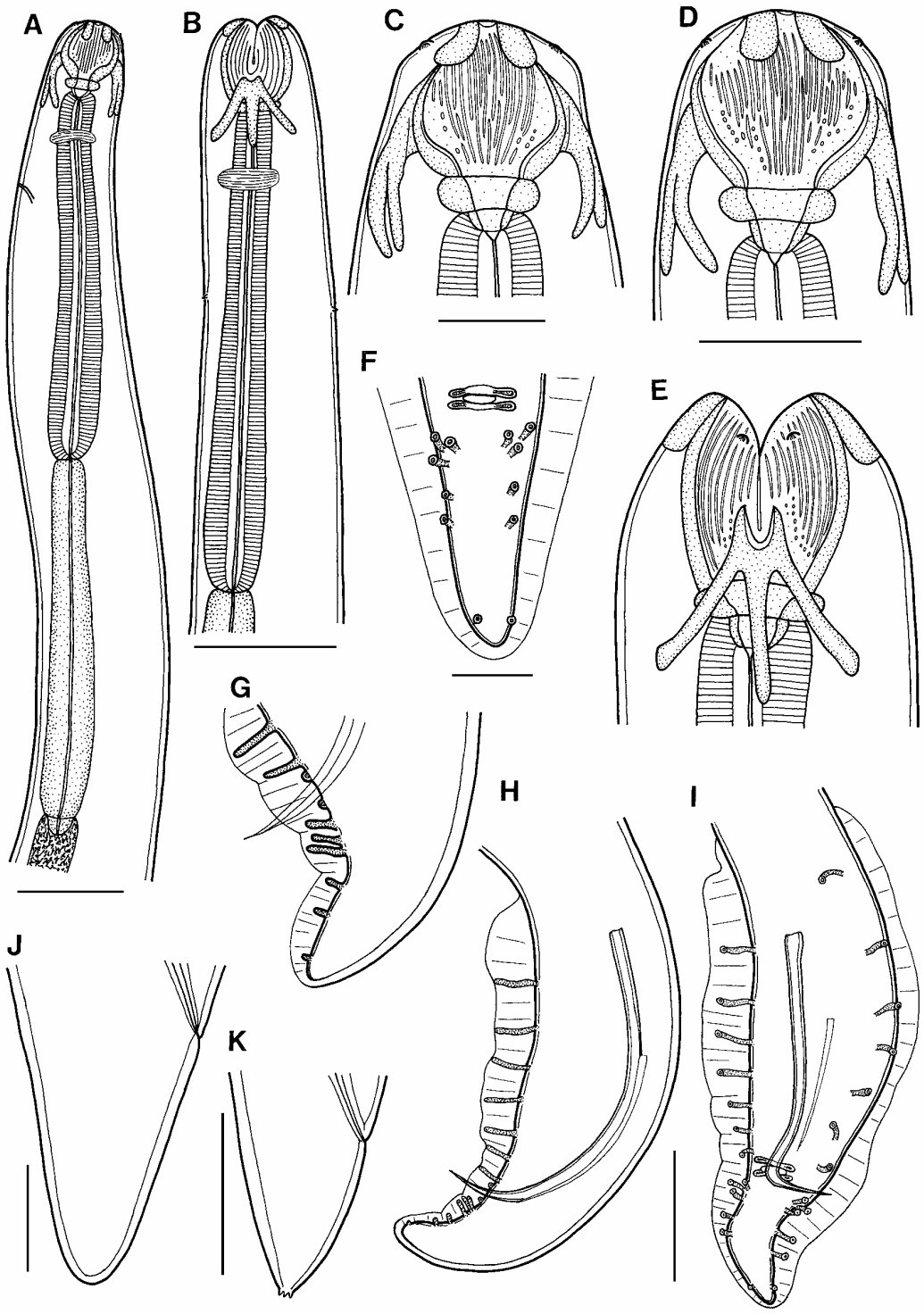

Fig. 1. *Camallanus carangis* Olsen, 1954. **A**, **B** – anterior end of male, lateral and dorsoventral views; **C**, **D** – buccal capsule of gravid female and male, respectively, lateral views; **E** – buccal capsule of male, dorsoventral view; **F**, **G** – tail of male, ventral and lateral views; **H**, **I** – posterior end of male, lateral and ventral views; **J** – tail of gravid female, lateral view; **K** – tail of small female, lateral view. Scale bars: A, B = 200 µm; C–E, H–K = 100 µm; F, G = 30 µm. (A–F, J – from *Upeneus vittatus*; G–I, K – from *Nemipterus furcosus*.)

(204–285), 450–555 (420) and 585–707 (240–421), respectively, from anterior extremity. Vulva pre-equatorial, 10.06–13.40 (3.28–7.14) mm from anterior extremity, at 47 (44–52) % of body length, with elevated anterior vulvar lip. Vagina muscular, directed anteriorly from vulva. Uterus filled with numerous larvae (444–513 long, maximum width 18–21) or/and eggs. Tail conical, 201–249 (96–153) long, representing 0.9 (1.1–1.6) % of body length, with smooth, rounded tail tip (tail tip of smaller subgravid specimens with 3 minute caudal projections).

Fourth-stage larva (female) (1 specimen from *N. furcosus*): Body 2.57 mm long, maximum width 132. Buccal capsule (including basal ring) 105 long, maximum width 84; basal ring long, 21 in length, 51 wide. Buccal capsule provided with sclerotized longitudinal rod-like formation 120 long on dorsal and ventral side instead of tridents. Anterior sclerotized plates on valves of capsule small, transverse oval. Each valve internally supported by 22 thin longitudinal ridges, 18 incomplete. Muscular oesophagus 462 long, 57 wide; glandular oesophagus 517 long, 66 wide; length ratio 1:0.9. Nerve ring 177 from anterior extremity. Excretory pore and deirids not located. Tail conical, 60 long, with 3 small conical caudal projections at tip.

H o s t s : *Nemipterus furcosus* (Nemipteridae) (infected fish: JNC253, 10.03.2003, FL 195, W 115; JNC276, 13.03.2003, FL 185, W 110; JNC280, FL 195, W 124; JNC465, 21.05.2003, FL 190, W 129; JNC467, FL 195, W 124), *Upeneus vittatus* (Mullidae) (JNC1261, 16.09.2004, FL 225, W 179; JNC1265, FL 235, W 195) and *Parupeneus ciliatus* (Mullidae) (all Perciformes). Gravid (larvigerous) females recorded only from *U. vittatus*.

S i t e o f i n f e c t i o n : Intestine.

L o c a l i t y : Off Nouméa, New Caledonia.

P r e v a l e n c e a n d i n t e n s i t y : *N. furcosus*: 6% (5 fish infected/80 fish examined); 1–2 specimens per fish. *U. vittatus*: 2/2; 4–19. *P. ciliatus*: 1/1; 5.

V o u c h e r s p e c i m e n s : Muséum National d'Histoire Naturelle, Paris (JNC276A, JNC276B, JNC280A, JNC465, JNC467, JNC1261A, MNHN 309 HG) and Biology Centre, Institute of Parasitology, ASCR, České Budějovice (Cat. No. N-859).

Comments. The genus *Camallanus* Railliet et Henry, 1915 comprises a large number of species parasitizing fishes and amphibians (Ivashkin et al. 1971, Moravec 1973, Petter 1979, Sood 1990, 1999). Of them, the following 31 nominal species were described from marine fishes (listed chronologically): *C. carangis* Olsen, 1954, *C. marinus* Schmidt et Kuntz, 1969, *C. chorinemi* Rasheed, 1970, *C. surmai* Rasheed, 1970, *C. indicus* Kalyankar, 1971, *C. karachiensis* Khan et Begum, 1971, *C. cinereusis* Bilqees, Khanum et Jehan, 1971, *C. magnivaginatus* Bilqees, Zakia et Qamar, 1971, *C. trichiuris* Bashirullah et Rahman, 1972, *C. atropusi* Bashirullah et Khan, 1973, *C. dollfusi* Bashirullah et Khan, 1973, *C. aotea* Slankis et Korotaeva, 1974, *C. gnuluyumbu* Slankis et Korotaeva, 1974, *C. kububudgeri* Slankis et Korotaeva, 1974, *C. chauhani* Srivastava et Gupta, 1975, *C. priacanthi* Kataytseva, 1975, *C. puriensis* Srivastava et Gupta, 1975, *C. therapsi* Srivastava et Gupta, 1975, *C. penkotai* Srivastava et Gupta, 1976, *C. trichiurusi* Srivastava et Gupta, 1976, *C. guttatusi* Khan et Begum, 1977, *C. qadrii* Ashraf, Farooq et Khanum, 1977, *C. longimonospiculata* Parukhin, 1978, *C. musteli* Wang, Zhao, Wang et Zhang, 1979, *C. ophichthysi* Gupta et Gupta, 1980, *C. paracarangis* Velasquez, 1980, *C. goaensis* Soota, 1981, *C. psettodi* Parukhin, 1982, *C. trichiae* Arya, 1987, *C. nigeri* Arya, 1987, and *C. bispiculus* Rajyalakshmi, Rao et Shyamasundari, 1988. In addition, *C. kirandensis* Baylis, 1928, a parasite of freshwater cyprinids in Africa (see Khalil and Polling 1997), was reported from a "saw-fish" [probably an elasmobranch *Anoxypristis cuspidata* (Lathan)] from Bangladesh by Khan and Yaseen (1969); this was evidently an incorrect identification.

All these species were reported only from fishes (mostly perciforms) in the warmer Indo-Pacific regions (mainly off the Indian subcontinent) and the descriptions of the great majority of them are inadequate or, sometimes, erroneous. With a few exceptions, their type specimens are missing. None have previously been studied using SEM. Moreover, the situation is further complicated by a high degree of intraspecific variability in the number, arrangement and character of the longitudinal ridges (ribs) on the inner surface of the buccal capsule in *Camallanus* spp. (e.g., Moravec 1994, Rigby et al. 1998), a considerable growth of the body and organs in adults (after the fourth moult) (Levsen and Berland 2002a), a weak sclerotization of the left spicule, and by the fact that some taxonomically important features (e.g., postanal papillae, deirids, and the excretory pore), are sometimes difficult to observe under the light microscope.

Some species of *Camallanus* were described to possess only one (right) spicule, which is usually well sclerotized and easily visible. However, Yeh (1960) states that the degree of sclerotization of copulatory organs (i.e., spicules and gubernaculum) in camallanids may vary considerably. Generally, the left spicule in camallanids (e.g., *Camallanus*, *Procamallanus*) is only weakly sclerotized. In some species it is so poorly sclerotized that it is hardly visible and, in such cases, it may appear to be completely absent. Re-examinations of some species reported to possess only one spicule showed that also the left spicule was present (De and Moravec 1980, Moravec et al. 2003). In our opinion, the presence of two spicules is a generic feature in *Camallanus*; however, because of the variability in the degree of sclerotization of the left spicule, not much attention should be paid to this feature.

This unsatisfactory situation in the taxonomy of these parasites makes their species identification highly problematic. Specimens of the present material originating from all three named host species are morphologically

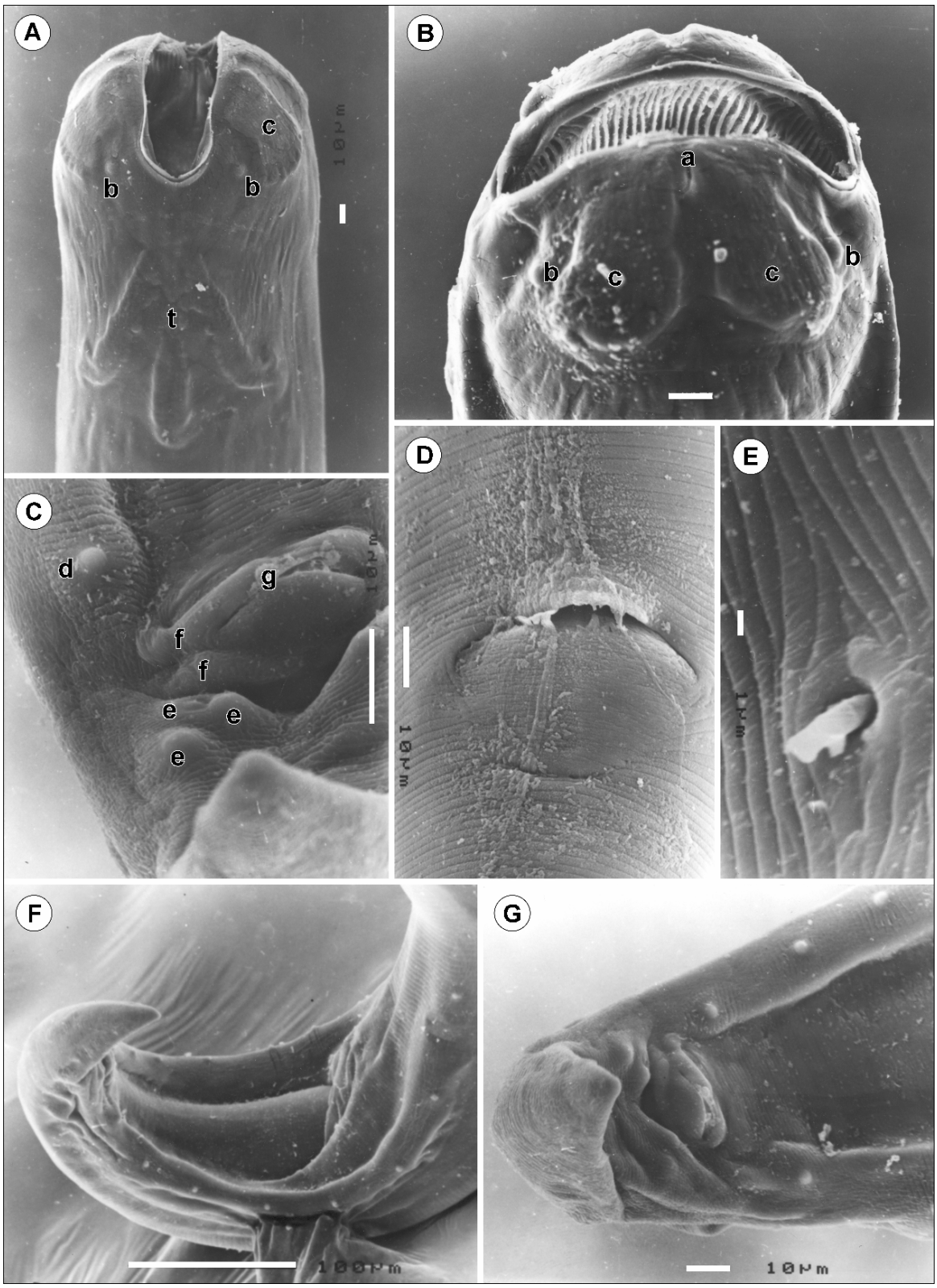

Fig. 2. *Camallanus carangis* Olsen, 1954 from *Upeneus vittatus*, scanning electron micrographs of adults. **A**, **B** – cephalic end, dorsoventral and lateral views; **C** – region of cloaca, ventral view; **D** – anal opening of female; **E** – deirid; **F** – posterior end of male, sublateral view; **G** – caudal end of male, ventral view. Abbreviations: a – amphid; b – cephalic papilla; c – sclerotized plate on buccal capsule; d – preanal subventral papilla; e – postanal subventral papilla; f – preanal/postanal ventral flat papilla; g – cloacal aperture; t – trident of buccal capsule. Scale bar: B = 10 µm.

and biometrically (Table 1) very similar to *C. carangis*, a species originally described by Olsen (1954) from *Caranx* sp. (Carangidae) in Fiji and redescribed by Rigby et al. (1998) based on the male type specimen and those newly collected from *Epinephelus merra* Bloch (Serranidae) from French Polynesia and *Heteropriacanthus cruentatus* (Lacépède) (Priacanthidae) from Hawaii. The latter authors also synonymised it with *C. marinus*, a species described by Schmidt and Kuntz (1969) from the perciform fishes *Atule mate* (Cuvier) (as *Caranx affinis*) (Carangidae), *Gazza minuta* (Bloch) (Leiognathidae) and *Trichiurus lepturus* Linnaeus (as *T. haumela*) (Trichiuridae) and a scorpaeniform fish *Thysanophrys nematophthalmus* (Günther) (Platycephalidae) from the Philippines. We consider this synonymisation fully justified. *C. carangis* was also reported by Velasquez (1966) from *Caranx* sp. in the Philippines and by Parukhin (1971) and Kataytseva (1975) from the Philippine, Arafura, South China and Red Seas and from the Monar Bay.

Although Olsen (1954) reported two spicules and deirids in *C. carangis*, Schmidt and Kuntz (1969) and Rigby et al. (1998) found only one (right) spicule and no deirids in this species. However, as found in our specimens, the left spicule is only slightly sclerotized (Fig. 1 H, I) and may easily be overlooked (i.e., it may appear to be absent); small deirids are present (Fig. 1 B), as also confirmed by SEM (Fig. 2 E). In contrast to the redescription and illustrations of *C. carangis* given by Rigby et al. (1998), the tridents of the buccal capsule of New Caledonian specimens do not reach the nerve ring, the excretory pore is situated more anteriorly, the muscular oesophagus is somewhat shorter, and the male caudal alae are not combined anteriorly (Fig. 2 F) as illustrated. However, these differences may be due to intraspecific morphological variability or/and inaccuracies in observations (e.g., *C. carangis* was not previously studied by SEM). The New Caledonian specimens are considered to belong to *C. carangis*.

As compared with other *Camallanus* spp., *C. carangis* is characterized by the presence of a markedly large, orange-coloured basal ring of the buccal capsule and an unusually large, thick-walled, colourless sclerotized oesophageal cup (frequently almost cylindrical; termed cylinder by Rigby et al. 1998) connecting the buccal capsule with the oesophagus. Such a cup was also reported for *C. paracarangis* described by Velasquez (1980) from the perciforms [*Caranx* sp., *Gazza minuta* (Bloch), *Leiognathus* (as *Leigonathus*) sp., *Terapon* (as *Therapon*) *puta* (Cuvier)] and a siluriform (*Arius* sp.) in the Philippines, who had used it as one of the features distinguishing allegedly *C. paracarangis* from *C. carangis*. Rigby et al. (1998) found that the description of the former is almost identical with that of *C. carangis*, but they did not formally synonymize it with the latter because type specimens of *C. paracarangis* were not deposited. Therefore, Rigby et al. (1998) designated *C. paracarangis* a *species inquirenda*. In our opinion, even if types were not deposited, *C. paracarangis* should be taken for a junior synonym of *C. carangis*; in addition to morphological similarity, both species have some common hosts (*Caranx*, *Gazza*) and occur in the same region (Philippines).

In having a buccal capsule with a markedly large basal ring with a spacious cavity and an unusually large oesophageal cup, *C. carangis* somewhat resembles members of *Paracamallanus* Yorke et Maplestone, 1926, parasites of some freshwater fishes in the tropics. However, the anterior and the posterior portions of the buccal capsule of *Paracamallanus* adults are of almost the equal size, whereas the posterior portion of the capsule in *Camallanus* species is reduced to a short basal ring (Moravec 1998).

The presence/absence of small caudal projections on the tail tip of females is generally considered a taxonomically important feature in *Camallanus* spp. However, the present study shows that three small caudal projections, sometimes poorly developed, are present in young non-gravid and small subgravid (containing eggs only) females of *C. carangis*, whereas they are totally absent from gravid females. It shows that the presence/absence of female caudal projections may be an important inter-specific feature in *Camallanus* spp., but only if gravid (larvigerous) females are compared. Unfortunately, only young females are known for many *Camallanus* spp. from marine fish.

Fourth-stage larvae of *Camallanus* species from marine fish have not previously been reported. This also applies to the fourth-stage larva of *C. carangis*, which is described here for the first time. In contrast to species of *Camallanus* parasitic in freshwater fish, where the buccal capsule of fourth-stage larvae does not have dorsal and ventral sclerotized structures analogous to tridents (e.g., Campana-Rouget 1961, Moravec 1969, 1971, Stromberg and Crites 1974, Levsen and Berland 2002a,b), the buccal capsule of the fourth-stage larva of *C. carangis* is remarkable in that its anterior portion bears two (one dorsal and one ventral) long rod-like sclerotized structures. Similar, but much shorter "knob-like" or "rod-like" structures were described on the buccal capsules of the fourth-stage larvae of *Paracamallanus* spp. (see Moravec 1974, Moravec et al. 1993). This confirms the affinity of *C. carangis* to *Paracamallanus* (see above).

Petter and Sey (1997) described a juvenile *Camallanides* sp. from the digestive tract of the marine perciform fish *Trichiurus lepturus* Linnaeus from the Persian Gulf near Kuwait. However, its morphology is very similar to that of the fourth-stage larva of *C. carangis* and it is apparent that, in fact, it belonged to a *Camallanus* species. By the presence of rod-like structures, the buccal capsule of this larval stage somewhat resembles that of adults of *Camallanides* Baylis et Daubney, 1922, but all members of this genus are parasites of snakes in

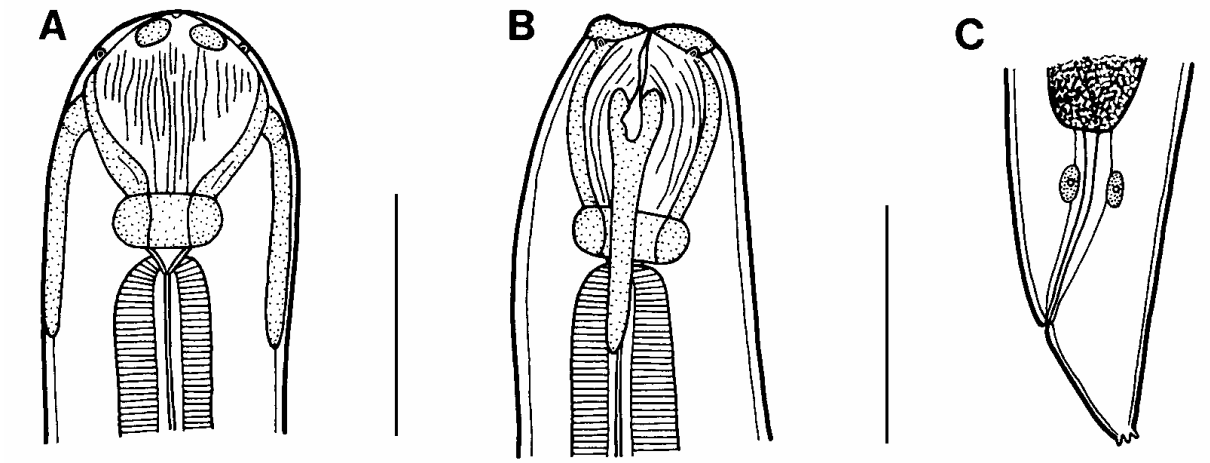

Fig. 3. *Camallanus carangis* Olsen, 1954, female fourth-stage larva from *Nemipterus furcosus*. **A**, **B** – buccal capsule, lateral and dorsoventral views; **C** – tail, lateral view. Scale bars: 100 μm.

Table 1. Comparison of measurements of *Camallanus carangis* from three hosts in New Caledonia.

Host	*Nemipterus furcosus*		*Upeneus vittatus*		*Parupeneus ciliatus*	
	Males	Females – subgr.	Males	Females – gr. (subgr.)	Males	Females – subgr. (nongr.)
No. of specimens	2	2	5	5	3	2
Body length (in mm)	4.87–5.03	7.25–8.30	8.49–12.68	21.49–28.81 (14.5)	6.56–8.12	9.79 (8.28)
Body width	177–204	218–231	231–326	544–639 (394)	204–218	218 (204)
Buccal capsule – l.	135–147	153–159	144–156	195–198 (177)	99–102	105 (120)
Buccal capsule – w.	105–126	144–153	120–123	150–165 (150)	90–93	129 (120)
No. of ridges	31–36	32–35	28–32	28–40 (30)	24–29	27 (21)
Basal ring – length	27	21–27	21–27	33 (30)	15–18	78 (66)
Basal ring – width	75–84	81–90	75–81	105–129 (96)	60–69	24 (27)
Oesoph. cup – l.	not measured	not measured	21–27	27 (24)	not measured	not measured
Oesoph. cup – w.	–	–	33–36	39–42 (42)	–	–
Length of tridents	141–150	174–186	150–180	174–186 (180)	93–105	120 (105)
Musc. oesoph. – l.	775–830	775–816	707–816	1.02–1.05 (0.93)	558–585	639 (694)
Musc. oesoph.– w.	82–90	105–122	90–111	129–165 (123)	75–81	105 (90)
Gland. oesoph.– l.	653–721	680–748	680–816	0.95–1.03 (0.95)	571–585	653 (625)
Gland. oesoph.– w.	82–84	99–122	75–123	105–165 (117)	69–75	90 (81)
Musc./gland. oesoph. length ratio	1:1.15–1.19	1:1.09–1.14	1:0.96–1.00	1:0.91–1.03;1:1.03	1:0.90–1.02	1:1.02 (1:0.90)
% of buc. c. and oesoph. of body	31–35	19–24	14–20	8–10 (14)	14–19	14 (17)
Nerve ring	231–299	240–258	216–258	299–303 (285)	186–201	204 (216)
Excretory pore	517	?	348–594	450–555 (420)	?	?
Deirids	not measured	421	449–503	585–707 (327)	?	240 (–)
Right spicule	288–309	–	306–330	–	216–231	–
Left spicule	96–114	–	99–210	–	105–111	–
Dist. of vulva in mm; %	–	3.28–3.69; 44–45	–	10–13 (7); 47 (49)	–	4.95(4.31); 51 (52)
Tail	90–108	111–117	102–141	201–249 (153)	93–114	147 (96)

India and Indonesia (Ivashkin et al. 1971). The structure of the buccal capsule in camallanids undergoes substantial morphological changes during their ontogenetic development, which may reflect phylogenetic relationships; e.g., the third-stage larvae of *Camallanus* spp. are of a *Paracamallanus*-type (e.g., Campana-Rouget 1961).

Findings of *C. carangis* in *Nemipterus furcosus*, *Parupeneus ciliatus* and *Upeneus vittatus* in New Caledonia represent new host and geographical records. In New Caledonia, two nematodes were already collected from *N. furcosus*: *Huffmanela branchialis* Justine, 2004, and *Raphidascaris* (*Ichthyascaris*) *nemipteri* Moravec et Justine, 2005 (see Justine 2004, Moravec and Justine 2005a).

Procamallanus* (*Spirocamallanus*) *variolae sp. n.
Figs. 4, 5

Description: Medium-sized nematodes with finely transversely striated cuticle. Mouth aperture oval, surrounded by six flat, crescent-shaped elevations and eight submedian cephalic papillae arranged in two circles, each formed by four papillae; papillae of external circle distinctly larger. Pair of small amphids present. Buccal capsule orange-brown, thick-walled, barrel-shaped, slightly longer than wide, with simple, well-developed basal ring. Inner surface of capsule provided with 11–12 spiral ridges in lateral view, 3–4 incomplete. Muscular oesophagus slightly shorter than glandular oesophagus; both parts of oesophagus somewhat expanded near their posterior ends. Intestine brown, narrow. Deirids small, simple, with rounded end, situated slightly posterior to level of nerve ring. Excretory pore somewhat posterior to junction of both parts of oesophagus. Tail of both sexes with two (dorsal and ventral) terminal cuticular spikes (mucrons); dorsal spike smaller than ventral spike.

Male (3 specimens from *V. albimarginata*; measurements of holotype in parentheses): Length of body 10.47–12.66 (11.37) mm, maximum width 272–313 (313). Buccal capsule (including basal ring) 84–87 (84) long, 60–66 (60) wide; basal ring 9 (9) long and 42–48 (42) wide. Spiral ridges 11–12 (11) in number, of which 3–4 (4) incomplete. Length of muscular oesophagus 394–435 (422), maximum width 75–87 (75); length of glandular oesophagus 449–558 (449), maximum width 81–90 (81); length ratio 1:1.1–1.3 (1:1.1). Length of entire oesophagus and buccal capsule representing 8–10 (8) % of body length. Nerve ring, deirids and excretory pore 183–195 (183), 273–285 (273) and 503–598 (517), respectively, from anterior extremity. Posterior end of body ventrally bent, provided with wide, vesiculated caudal alae supported by pedunculate papillae; anterior margin of alae joined by mound, forming a kind of pseudosucker, posteriorly alae reach base of caudal terminal spikes. Preanal papillae: 3 pairs of equally spaced subventral pedunculate papillae; postanal papillae: 4 pairs of subventral and 2 pairs of lateral pedunculate papillae present; additional 2 pairs of small transversely elongate sessile ventral papillae surrounding cloacal opening. Spicules similar in shape, unequal, with sharply pointed distal ends; large (right) spicule 327–357 (327) long; small (left) spicule less sclerotized, 216–243 (216) long. Length ratio 1:1.4–1.5 (1:1.5). Gubernaculum not observed. Tail conical, 162–195 (195) long; length of terminal spikes 4–6 (4.6).

Female (1 gravid specimen [allotype] from *V. albimarginata*): Length of body 24.49 mm, maximum width 598. Buccal capsule including basal ring 99 long and 78 wide; basal ring 12 long and 54 wide. Number of spiral ridges 12, 3 incomplete. Length of muscular oesophagus 462, maximum width 102; length of glandular oesophagus 612, maximum width 99; length ratio 1:1.3. Length of entire oesophagus and buccal capsule representing 5% of body length. Nerve ring, deirids and excretory pore 216, 270 and 694, respectively, from anterior extremity. Vulva pre-equatorial, 10.30 mm from anterior extremity (at 42% of body length). Vagina muscular, directed posteriorly from vulva. Uterus filled with larvae 438–468 long and 24–27 wide. Tail rounded, with digit-like projection bearing two small terminal spikes. Length of entire tail 165; digit-like projection with terminal spikes 39 long and 15 wide; spikes 5 and 6 long.

Hosts: *Variola albimarginata* (JNC1247, 15.09.2004, FL 992, W 400) (type host) and *Epinephelus fasciatus* (JNC1253, 15.09.2004, FL 180, W 88) (both Serranidae, Perciformes).

Site of infection: Intestine.

Type locality: Off Nouméa, New Caledonia.

Prevalence and intensity: *V. albimarginata*: 1 fish infected / 1 fish examined; 4 specimens. *E. fasciatus*: 5% (1/20); 1.

Etymology: The specific name *variolae* relates to the generic name (*Variola*) of the type host.

Deposition of type specimens: Holotype and allotype (JNC1247) and 1 voucher specimen from *E. fasciatus* (JNC1253) in the Muséum National d'Histoire Naturelle, Paris; 1 paratype from *V. albimarginata* in the Institute of Parasitology, ASCR, České Budějovice (N-864).

Comments. To date, four morphologically very similar species of *Procamallanus* (i.e., characterized by the presence of two caudal spikes on a digit-like projection in females) are known from marine perciform fishes in the Pacific: *P.* (*S.*) *monotaxis* (Olsen, 1952), *P.* (*S.*) *istiblenni* (Noble, 1966), *P.* (*S.*) *philippinensis* (Velasquez, 1980), and *P.* (*S.*) *guttatusi* (Andrade-Salas, Pineda-López et García-Magaña, 1994) (Olsen 1952, Noble 1966, Velasquez 1980, Andrade-Salas et al. 1994, Rigby and Adamson 1997, Rigby and Font 1997, Moravec et al. 2004); of them, *P. philippinensis* is considered a *species inquirenda* (see Rigby and Font 1997). According to Rigby and Adamson (1997) and Rigby and Font (1997, 2001), *P. monotaxis* and *P. istiblenni* (both reported as *Spirocamallanus*) can be distinguished from each other only on the basis of the distance from the first to the second preanal papilla relative to the distance from the first to the third preanal papilla. Since the deirids of *P. istiblenni* have not yet been studied by SEM, at present there are no morphological features by which it can be separated from *P. guttatusi*, except for the usually more numerous spiral ridges in the buccal capsule (Moravec et al. 2004).

As indicated by González-Solís et al. (2002) and Moravec et al. (2004), one of the reliable specific features in this morphological group of *Procamallanus* (*Spirocamallanus*) spp. is the shape and the position of deirids. *Procamallanus variolae* differs distinctly from all three above-mentioned valid species in the position of the deirids relative to the nerve ring; i.e., whereas

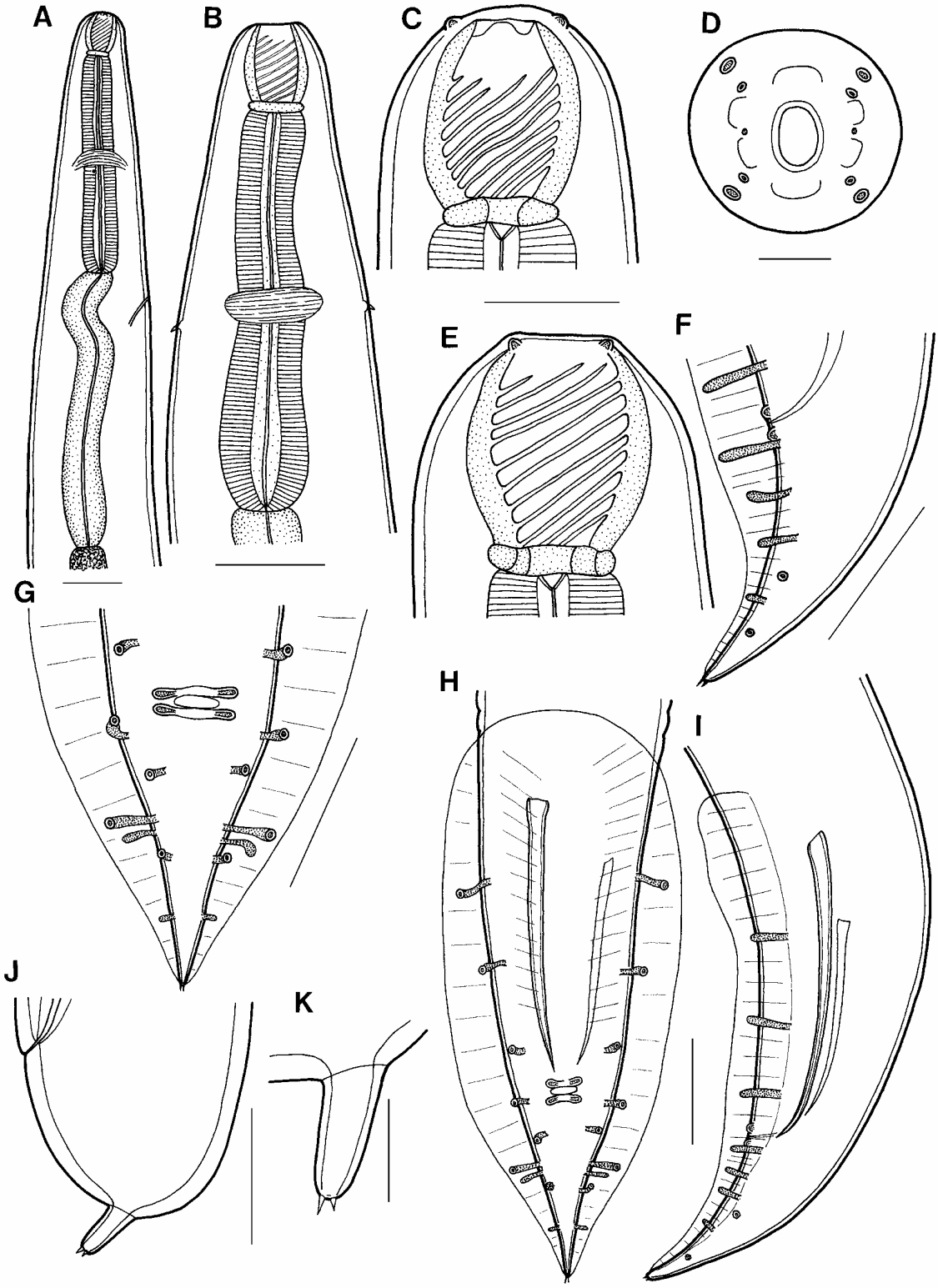

Fig. 4. *Procamallanus* (*Spirocamallanus*) *variolae* sp. n. **A**, **B** – anterior end of male, lateral and dorsoventral views; **C** – buccal capsule of male, lateral view; **D** – cephalic end, apical view; **E** – buccal capsule of gravid female, lateral view; **F**, **G** – tail of male, lateral and ventral views; **H**, **I** – posterior end of male, ventral and lateral views; **J** – tail of gravid female, lateral view; **K** – caudal digital protrusion of gravid female, lateral view. Scale bars: A, B, F–J = 100 μm; C, E = 50 μm; D = 20 μm; K = 30 μm.

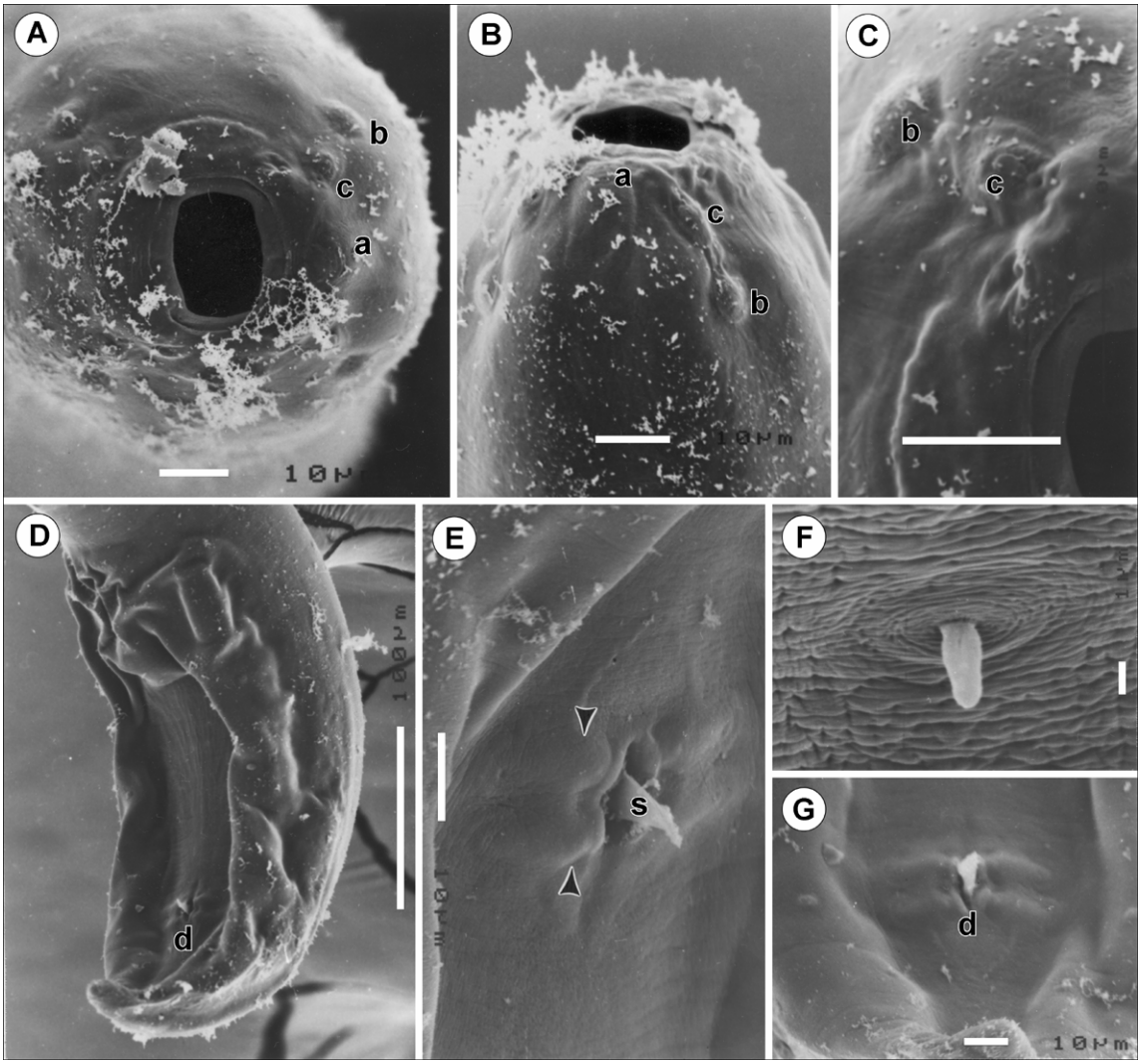

Fig. 5. *Procamallanus* (*Spirocamallanus*) *variolae* sp. n., scanning electron micrographs of male from *Variola albimarginata*. **A**, **B** – cephalic end, apical and sublateral views; **C** – detail of cephalic papillae; **D** – posterior end, ventrolateral view; **E** – preanal/postanal ventral flat papillae (arrowheads) around cloacal aperture; **F** – deirid; **G** – region of cloaca, ventral view. Abbreviations: a – amphid; b – external cephalic papilla; c – internal cephalic papilla; d – cloacal aperture; s – protruding spicule. Scale bars: C = 10 µm; F = 1 µm.

the deirids of *P. monotaxis* and *P. istiblenni* are situated about two-thirds of the distance from the buccal capsule to the nerve ring (Rigby and Adamson 1997, Rigby and Font 1997) and those of *P. guttatusi* are situated in about a midway between the buccal capsule and the nerve ring (Moravec et al. 2004), the deirids of *P. variolae* are located at the level of the nerve ring or posterior to it. Moreover, the deirids of *P. guttatusi* are chisel-shaped (i.e., with parallel sides and cut ends) (Moravec et al. 2004) in contrast to those of *P. variolae*, which have narrowed and rounded ends; the shape of the deirids in *P. monotaxis* and *P. istiblenni* is unknown.

While *P. guttatusi* is known only from *Siganus guttatus* (Bloch) (Siganidae, Perciformes) in the Philippines (Machida and Taki 1985, Moravec et al. 2004), *P. monotaxis* has been reported from 11 fish species belonging to Perciformes, Aulopiformes, and Beryciformes in Hawaii and French Polynesia (Olsen 1952, Rigby and Adamson 1997) and *P. istiblenni* from 17 fish species belonging to Perciformes and Pleuronectiformes in Hawaii, Okinawa, Fiji and French Polynesia (Noble 1966, Hasegawa et al. 1991, Rigby and Font 1997); the hosts of both *P. monotaxis* and *P. istiblenni* include members of the Serranidae (i.e., *Epinephelus merra* Bloch for *P. monotaxis* in French Polynesia and *Variola albimarginata* Baissac and *V. louti* (Forsskål) for *P. istiblenni* in Okinawa – see Hasegawa et al. 1991, Rigby and Adamson 1997). However, the records of *P. monotaxis* and *P. istiblenni* may well include each more than a single nematode species (Rigby and Font 1997, Moravec et al. 2004). The finding of *P. variolae* represents the first record of a *Procamallanus* species from New Caledonian marine fishes.

The genus *Variola* has only two species, *V. louti* and *V. albimarginata*. In New Caledonia, the latter is relatively rare but the former is abundant in the reef. Six *V. louti* were examined and none had camallanids. In New Caledonia, the helminths hitherto mentioned for *V. albimarginata* were monogeneans (Justine 2005b), and for *E. fasciatus*, monogeneans (Justine 2005a, Hinsinger and Justine 2006) and the philometrid *Philometra lateolabracis* (Yamaguti, 1935) (see Moravec and Justine 2005b).

Procamallanus (*Spirocamallanus*) *longus* sp. n.

Figs. 6, 7

Description: Large nematodes with finely transversely striated cuticle. Mouth aperture circular, surrounded by eight submedian cephalic papillae arranged in two circles, each formed by four papillae; papillae of outer circle distinctly larger. Pair of small lateral amphids present. Buccal capsule orange-brown, thick-walled, barrel-shaped, slightly longer than wide, with simple, well-developed basal ring. Inner surface of capsule provided with 22 spiral ridges in lateral view, 2–4 incomplete; ridges extending to anterior capsule margin. Capsule surrounded by six longitudinally elongate buccal sinuses. Muscular oesophagus slightly shorter than glandular oesophagus; middle part of glandular oesophagus broader than its posterior end. Intestine narrow, brown. Deirids small, claw-shaped, situated somewhat asymmetrically at level of nerve ring or slightly anterior to it. Excretory pore somewhat posterior to junction of both parts of oesophagus. Tail of both sexes without caudal spines.

Male (1 holotype specimen): Length of body 20.40 mm, maximum width 313. Buccal capsule (including basal ring) 123 long, maximum width 102; basal ring 12 long, 66 wide. Width/length ratio of buccal capsule 1:1.21. Spiral ridges 22 in number. Muscular oesophagus 517 long, maximum width 102; glandular oesophagus 585 long, maximum width 99; length ratio 1:1.1. Length of entire oesophagus and buccal capsule representing 6% of body length. Deirids, nerve ring and excretory pore 303, 340 and 707, respectively from anterior extremity. Posterior end of body ventrally bent, provided with wide, vesiculated caudal alae supported by pedunculate papillae; alae extending posteriorly to posterior extremity. Preanal papillae: 3 pairs of subventral pedunculate papillae, second pair nearer to third pair than to first; postanal papillae: 4 pairs of subventral and 2 pairs of lateral pedunculate papillae present; additional 2 pairs of small transversely elongate sessile ventral papillae surrounding cloacal opening. Spicules similar in shape, unequal, with sharply pointed ends; large (right) spicule 429 long; small (left) spicule less sclerotized, 258 long. Length ratio 1:1.66. Gubernaculum not observed. Tail conical, 180 long, with rounded tip.

Female (4 larvigerous specimens; measurements of allotype in parentheses): Body length 37.78–54.73 (48.85) mm, maximum width 517–707 (639). Buccal capsule (including basal ring) 117–129 (123) long and 111–117 (111) wide; basal ring 9–15 (12) long and 63–75 (66) wide. Number of spiral ridges 22 (22). Muscular oesophagus 544–585 (585) long, maximum width 114–132 (126); glandular oesophagus 558–695 (653) long, maximum width 108–126 (126); length ratio 1:1.1–1.2 (1:1.1). Length of entire oesophagus and buccal capsule representing 3 (3) % of body length. Deirids, nerve ring and excretory pore 299–378 (326/354), 326–381 (381) and 721–816 (816), respectively, from anterior extremity. Vulva pre-equatorial, 14.89–21.88 (20.33) mm from anterior extremity [at 40–43 (42) % of body length]. Vagina muscular, directed posteriorly from vulva. Uterus filled with numerous larvae. Tail broad, 286–367 (340) long, slightly narrowed near tip, with outlined small terminal protuberance.

T y p e h o s t : *Zebrasoma scopas* (Acanthuridae, Perciformes).

S i t e o f i n f e c t i o n : Intestine.

T y p e l o c a l i t y : Off Nouméa, New Caledonia (9 November 1997).

P r e v a l e n c e a n d i n t e n s i t y : 1 fish infected / 7 fish examined; 4 specimens.

E t y m o l o g y : The specific name *longus* (= long) relates to the unusually long body of this species.

D e p o s i t i o n o f t y p e s p e c i m e n s : Holotype and allotype (MNHN 310 HG) and one paratype (MNHN 311 HG) in Muséum National d'Histoire Naturelle, Paris; one paratype in the Institute of Parasitology, České Budějovice (Cat. No. N-863).

Comments. Of *Procamallanus* (*Spirocamallanus*) spp. characterized by the presence of broad caudal alae, three pairs of preanal papillae and unequally long spicules in the male, this species resembles only *P.* (*S.*) *colei* Rigby et Adamson, 1997 and *P.* (*S.*) *chaimha* Rigby et Adamson, 1997 by the shape of the female tail; both species were described from coral reef perciform fishes of the family Acanthuridae from French Polynesia (Rigby and Adamson 1997).

A recent re-examination of six subgravid females of *P. colei* from *Acanthurus achilles* (type host), *A. triostegus* and *Zebrasoma scopas* from French Polynesia (Moorea and Rangiroa) showed distinct morphological differences from New Caledonian specimens. Whereas all *P. colei* specimens had only 12 spiral ridges in the buccal capsule, all specimens of *P.* (*S.*) *longus* had 22 ridges. Both species distinctly differed also in the position of the deirids, which were more anterior in relation to the level of the nerve ring in the former, and in the shape of the female tail (i.e., tapered to a dull point in *P.* (*S.*) *colei* [Fig. 8 B] and blunt in *P.* (*S.*) *longus*). The spicules and the body length of gravid females are distinctly shorter in *P.* (*S.*) *colei* (see Rigby and Adamson 1997).

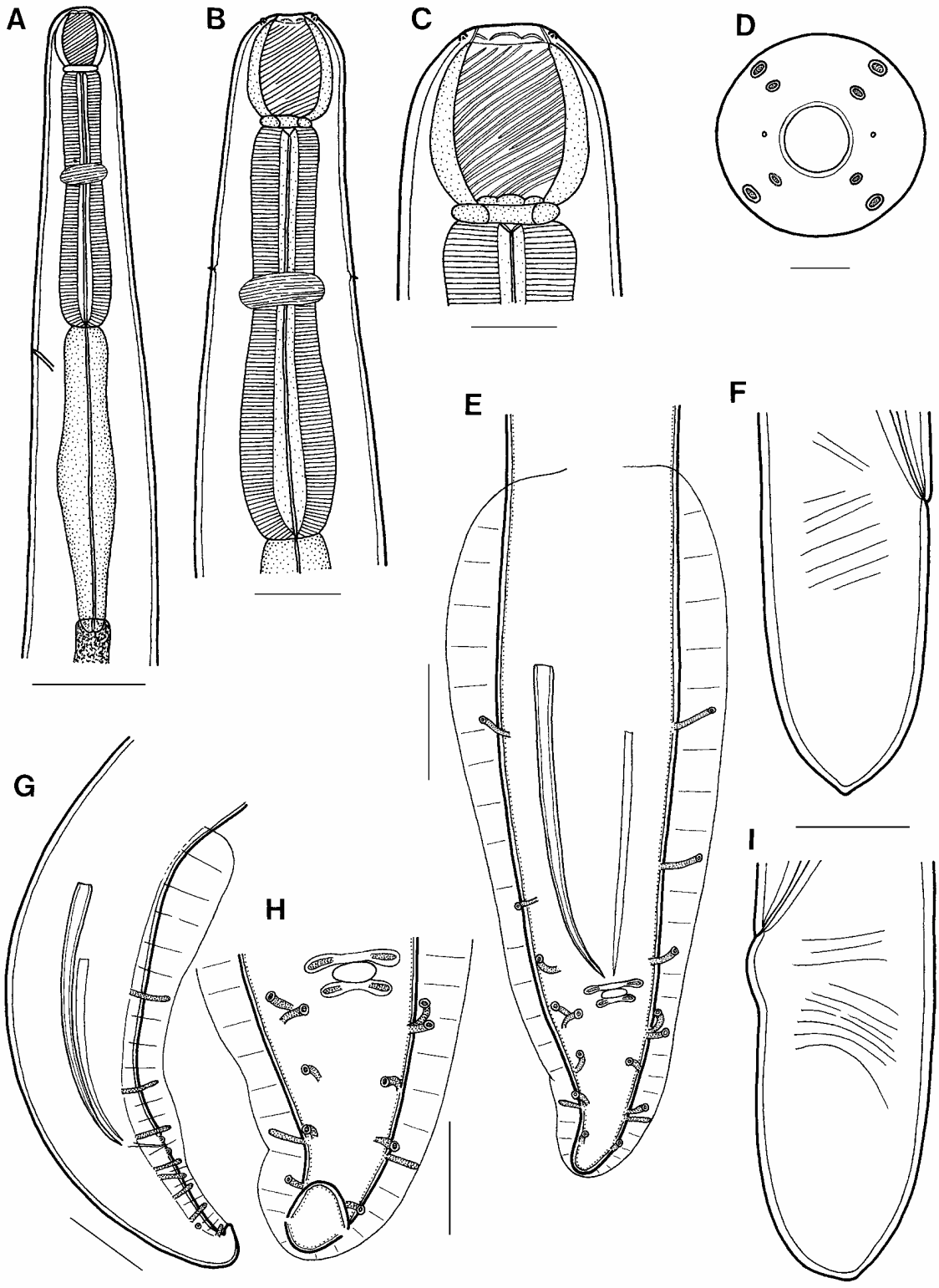

Fig. 6. *Procamallanus* (*Spirocamallanus*) *longus* sp. n. **A** – anterior end of male, lateral view; **B** – anterior end of gravid female, dorsoventral view; **C** – buccal capsule of male, lateral view; **D** – cephalic end of female, apical view; **E** – posterior end of male, ventral view; **F** – tail of gravid female, lateral view; **G** – posterior end of male, lateral view; **H** – tail of male, ventral view; **I** – tail of gravid female with almost rounded tip, lateral view. Scale bars: A = 200 μm; B, E–G, I = 100 μm; C = 50 μm; D, H = 30 μm.

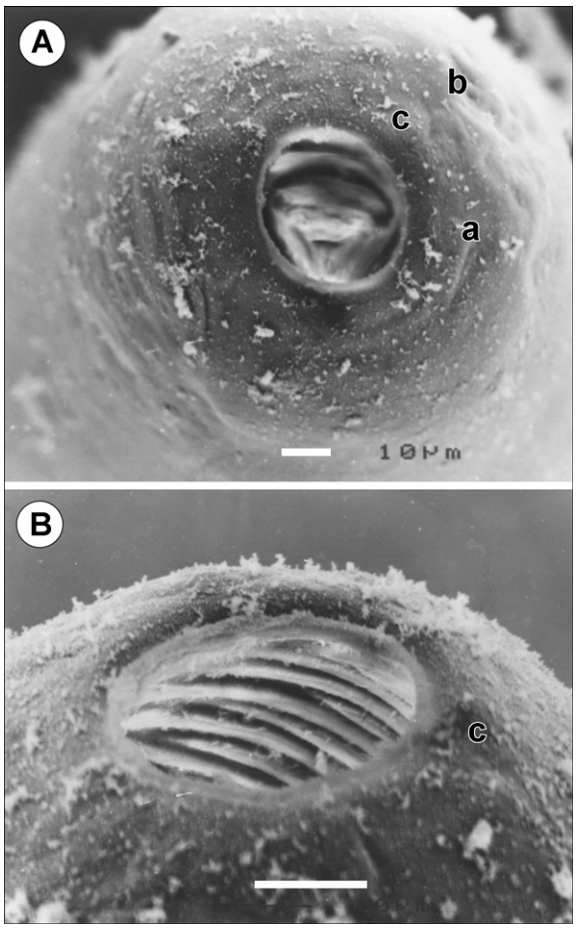

Fig. 7. *Procamallanus* (*Spirocamallanus*) *longus* sp. n., scanning electron micrographs of female. **A** – cephalic end, apical view; **B** – subdorsal view showing spiral ridges of buccal capsule reaching anterior end of capsule. Abbreviations: a – amphid; b – external cephalic papilla; c – internal cephalic papilla. Scale bar: B = 10 µm.

The most similar species to *P*. (*S*.) *longus* is *P*. (*S*.) *chaimha*. As found during a re-examination of one subgravid female of *P*. (*S*.) *chaimba* (body length 15.33 mm) from *Acanthurus olivaceus* from French Polynesia (Moorea), the buccal capsule of both species have 22 ridges (Fig. 8 D). In addition, the shape of the glandular oesophagus of *P*. (*S*.) *chaimha* resembled that of *P*. (*S*.) *longus*. Rigby and Adamson (1997) characterized *P*. (*S*.) *chaimha* by the absence of deirids, but these were present in the *P*. (*S*.) *chaimha* specimen examined and had practically the same position (Fig. 8 E) as those of *P*. (*S*.) *longus*. Apparently, the deirids were overlooked in the original description of *P*. (*S*.) *chaimha*.

However, *P*. (*S*.) *longus* differs from *P*. (*S*.) *chaimha* in the arrangement of postanal papillae in the male (first and second, and fourth and fifth pairs are close vs. distant to each other), in a somewhat different shape of the female tail (posterior end of tail slightly narrowed, with an outlined terminal protuberance vs. tail tip broadly rounded – see Fig. 8 C) and in a much greater body length of the gravid female (38–55 mm vs. 15–23 mm). The right spicule of *P*. (*S*.) *longus* is much longer than that of *P*. (*S*.) *chaimha* (429 µm vs. 244–289 µm). While *P*. (*S*.) *chaimha* occurs in French Polynesia, *P. longus* was found in New Caledonia.

Procamallanus (*Spirocamallanus*) sp. 1 Fig. 9

Description of female (1 subgravid specimen): Length of body 12.46 mm, maximum width 245. Orange-brown buccal capsule (including basal ring) 87 long and 72 wide (width/length ratio 1:1.21); basal ring 9 long and 42 wide. Number of spiral ridges 16, 5 incomplete. Muscular oesophagus 435 long, maximum width 78; glandular oesophagus 558 long, maximum width 78; length ratio 1:1.3. Length of entire oesophagus and buccal capsule representing 9% of body length.

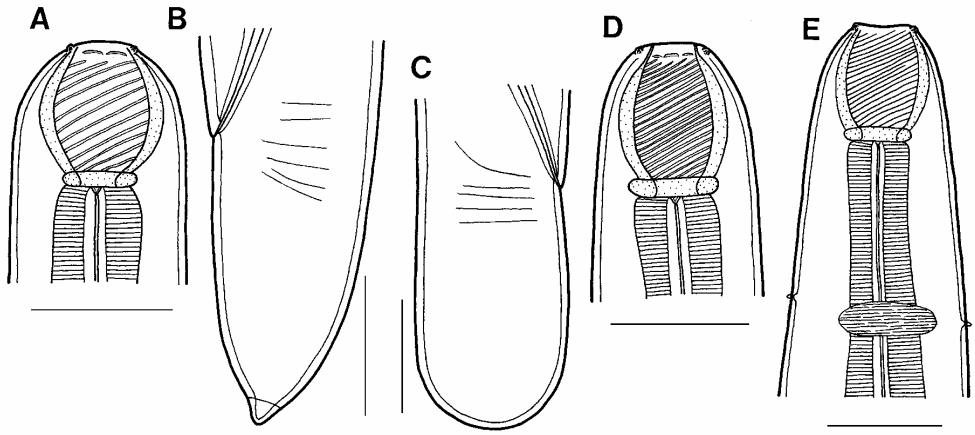

Fig. 8. *Procamallanus* (*Spirocamallanus*) *colei* and *P*. (*S*.) *chaimha* from French Polynesia, re-examined subgravid females. **A**, **B** – *P*. (*S*.) *colei* from *Acanthurus achilles* from Rangiroa, Tuamotu Islands (**A** – buccal capsule, lateral view; **B** – tail, lateral view). **C**–**E** – *P*. (*S*.) *chaimha* from *Acanthurus olivaceus* from Moorea, Society Islands (**C** – tail, lateral view; **D** – buccal capsule, lateral view; **E** – anterior end, dorsoventral view). Scale bars: A–E = 100 µm.

Nerve ring and excretory pore 279 and 625, respectively, from anterior extremity. Deirids situated somewhat asymmetrically, some distance anterior to level of nerve ring, at 204 and 198 from anterior end. Vulva pre-equatorial, 5.74 mm from anterior extremity (at 46% of body length). Vagina muscular, directed posteriorly from vulva. Uterus filled with numerous eggs. Tail rounded, with digit-like projection bearing 2 (1 shorter dorsal and 1 longer ventral) minute cuticular spikes; length of entire tail 165; digit-like projection with terminal spikes 51 long and 15 wide; spikes 6 and 3 long.

Host: *Parapercis hexophtalma* (Pinguipedidae, Perciformes).

Site of infection: Intestine.

Locality: Off Nouméa, New Caledonia (28 November 1997).

Prevalence and intensity: 1 fish infected / 1 fish examined; 2 specimens.

Voucher specimen: Muséum National d'Histoire Naturelle, Paris (Cat. No. MNHN 312 HG).

Comments. By having a buccal capsule with 16 spiral ridges, deirids situated well anterior to the nerve ring, and a female tail provided with a digit-like protrusion bearing two terminal spikes, this specimen resembles *P.* (*S.*) *monotaxis* Olsen, 1952, which was originally described from a lethrinid fish from Hawaii (Olsen 1952) and later reported from fishes belonging to eight families of four orders from French Polynesia (Rigby and Adamson 1997). *Parapercis millepunctata* (Günther) was one of the hosts of *P. monotaxis* in French Polynesia, a fish of the same genus as that harbouring the New Caledonian specimen. However, since only a single subgravid female has been available from New Caledonia, we refrain from assigning it to *P. monotaxis*.

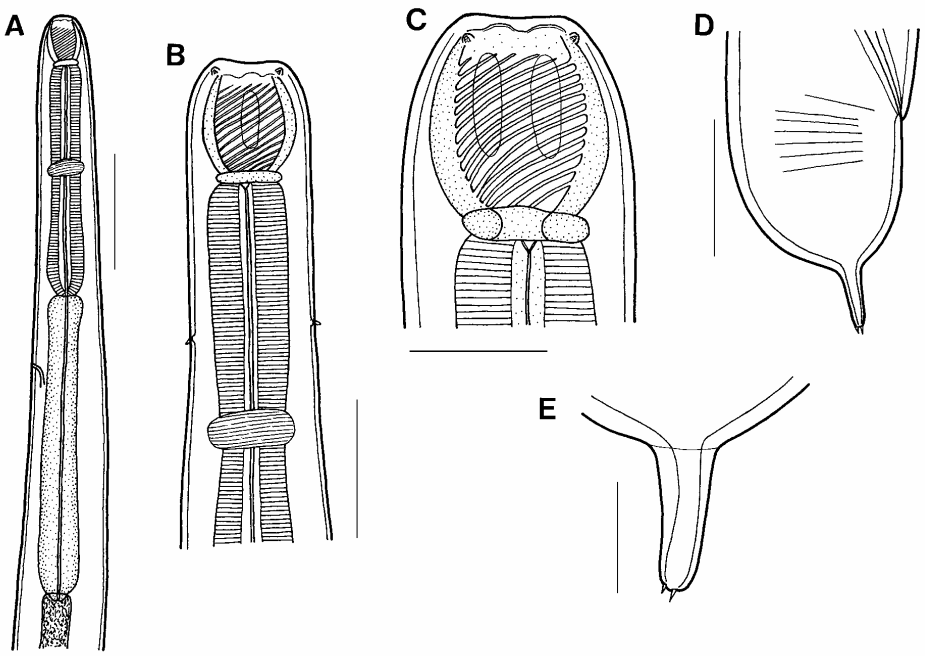

Fig. 9. *Procamallanus* (*Spirocamallanus*) sp. 1 from *Parapercis hexophtalma*, subgravid female. **A**, **B** – anterior end, lateral and dorsoventral views; **C** – buccal capsule, lateral view; **D** – tail, lateral view; **E** – caudal digital protrusion, lateral view. Scale bars: A = 200 µm; B, D = 100 µm; C = 50 µm; E = 30 µm.

Procamallanus (*Spirocamallanus*) sp. 2 Fig. 10

Description of female (1 subgravid specimen): Body length 14.14 mm, maximum width 449. Orange-brown buccal capsule (including basal ring) 99 long and 81 wide (width/length ratio 1:1.22); basal ring 9 long and 60 wide. Number of spiral ridges 13, 4 incomplete. Muscular oesophagus 422 long, maximum width 99; glandular oesophagus 707 long, maximum width 108; length ratio 1:1.7. Length of entire oesophagus and buccal capsule representing 9% of body length. Nerve ring and excretory pore 270 and 625, respectively, from anterior extremity. Deirids situated some distance anterior to level of nerve ring, at 396 from anterior end. Vulva pre-equatorial, 5.58 mm from anterior extremity (at 39% of body length). Vagina muscular, directed posteriorly from vulva. Several eggs present in uterus. Tail rounded, with digit-like projection bearing single small conical spike. Length of entire tail 159; digit-like projection (with terminal spike) 36 long and 15 wide; spike 4 long.

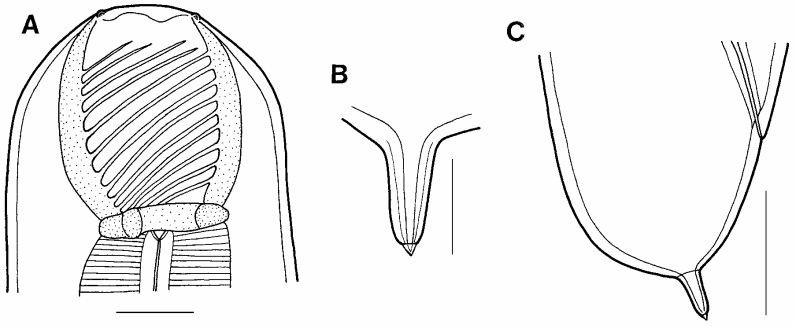

Fig. 10. *Procamallanus* (*Spirocamallanus*) sp. 2 from *Lethrinus ravus*, subgravid female. **A** – buccal capsule, lateral view; **B** – caudal digital protrusion, lateral view; **C** – tail, lateral view. Scale bars: A, B = 30 µm; C = 100 µm.

H o s t : *Lethrinus ravus* (JNC1286, 22.09.2004, FL 270, W 351) (Lethrinidae, Perciformes).

S i t e o f i n f e c t i o n : Intestine.

L o c a l i t y : Coral reef near Nouméa, New Caledonia.

P r e v a l e n c e a n d i n t e n s i t y : 1 fish infected / 1 fish examined; 1 specimen.

V o u c h e r s p e c i m e n : Muséum National d'Histoire Naturelle, Paris (JNC1286).

Comments. By the shape of the female tail (i.e., digit-like projection with one terminal spike) and the presence of 16 spiral ridges in the buccal capsule, this specimen resembles *P.* (*S.*) *jaliscensis* Moravec, Salgado-Maldonado et Caspeta-Mandujano, 2000 from a mugilid fish of the Pacific coast in Mexico. However, *P. jaliscensis* has deirids situated well anterior to the nerve ring (Moravec et al. 2000), whereas the deirids in this specimen are posterior to the nerve ring. Since only

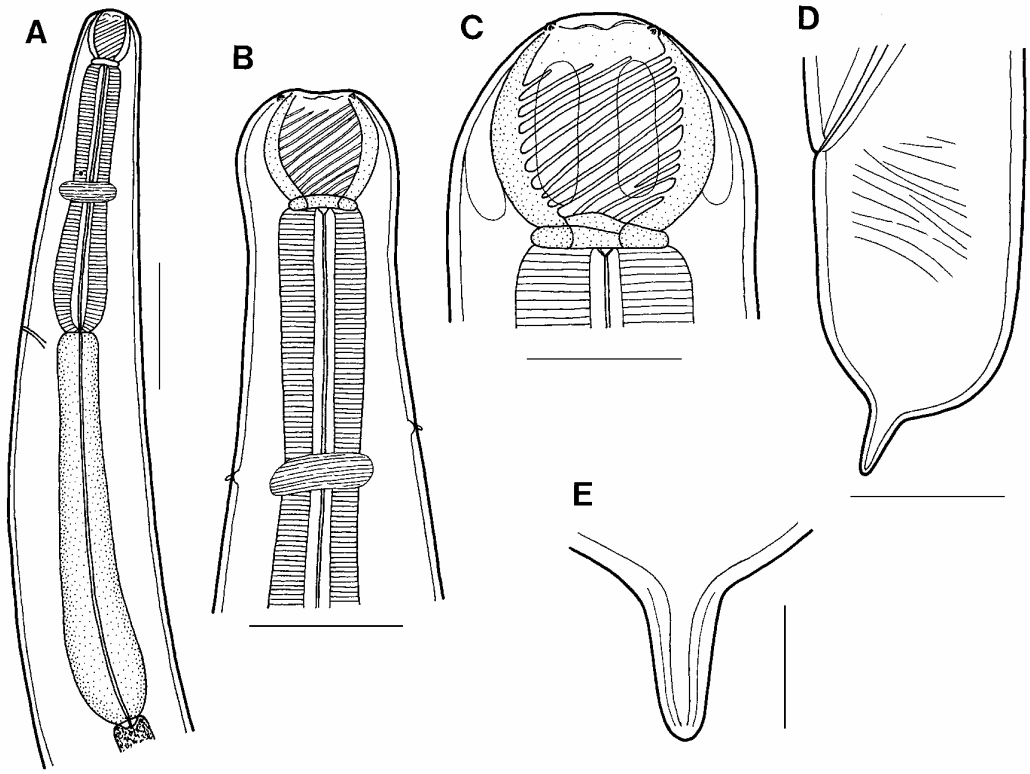

Fig. 11. *Procamallanus* (*Spirocamallanus*) sp. 3 from *Scolopsis bilineata*, subgravid female. **A**, **B** – anterior end, lateral and dorsoventral views; **C** – buccal capsule, lateral view; **D** – tail, lateral view; **E** – caudal digital protrusion, lateral view. Scale bars: A = 200 µm; B, D = 100 µm; C = 50 µm; E = 30 µm.

a single subgravid female has been recorded from New Caledonia, its species identification is impossible.

Procamallanus (*Spirocamallanus*) sp. 3 Fig. 11

Description of female (1 subgravid specimen): Length of body 14.95 mm, maximum width 299. Orange-brown buccal capsule (including basal ring) 87 long and 84 width (width/length ratio 1:1.04); basal ring 9 long and 51 wide. Number of spiral ridges 13, 4 incomplete. Muscular oesophagus 449 long, maximum width 96; glandular oesophagus 680 long, maximum width 135; length ratio 1:1.5. Length of entire oesophagus and buccal capsule representing 8% of body length. Nerve ring and excretory pore 303 and 544, respectively, from anterior extremity. Deirids situated asymmetrically at level and anterior to nerve ring, at 282 and 255 from anterior end. Vulva equatorial, 7.49 mm from anterior extremity (at 50% of body length). Vagina muscular, directed posteriorly from vulva. Uterus contains numerous eggs. Tail rounded, with terminal digit-like protrusion with smooth, rounded tip; length of entire tail 225; digit-like protrusion 48 long and 18 wide.

Host: *Scolopsis bilineata* (Nemipteridae, Perciformes).

Site of infection: Intestine.

Locality: Off Nouméa, New Caledonia (19 November 1997).

Prevalence and intensity: 1 fish infected / 5 fish examined; 1 specimen.

Voucher specimen: Muséum National d'Histoire Naturelle, Paris (Cat. No. MNHN 313 HG).

Comments. By the shape of the female tail (i.e., possessing a digit-like projection without terminal spikes), this specimen resembles *P.* (*S.*) *murrayensis* Johnston et Mawson, 1940, *P.* (*S.*) *macaensis* (Vicente et Santos, 1972) and *P.* (*S.*) *mexicanus* Moravec, Salgado-Maldonado et Caspeta-Mandujano, 2000 from marine and freshwater fishes of Australia, Brazil and Mexico, respectively. However, the deirids of *P.* (*S.*) *mexicanus* are situated more anteriorly (Moravec et al. 2000). Since only a single subgravid female was collected from New Caledonia, it cannot be identified to species.

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