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Acanthocolpidae (Digenea) of marine fishes off New Caledonia, with the descriptions of two new species

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Abstract: The following acanthocolpid species are reported from New Caledonia. *Acaenodera nautili* sp. n. from *Conger cinereus* Rüppel differs from other *Acaenodera* species in details of the body-spination, the sucker-ratio and the bipartite seminal vesicle; *Stephanostomum murielae* sp. n. from *Carangoides hedlandensis* (Whitley) differs from most species of *Stephanostomum* in the average of 36 circum-oral spines, the circum-oral spine rows with a ventral hiatus and the anterior extent of the vitellarium being >10% of the hindbody length from ventral sucker. The species is distinguished from the three other species with these characters in a detailed review. The other species reported are: *Stephanostomum aaravi* Bray et Cribb, 2003 from *Lethrinus miniatus* and *L. rubrioperculatus*; *Stephanostomum ditrematis* (Yamaguti, 1939) from *Gnathanodon speciosus*; *Stephanostomum japonocasum* Durio et Manter, 1969 from *Cephalopholis urodeta*, *Epinephelus areolatus*, *E. chlorostigma*, *E. maculatus, E. retouti*, *Lethrinus miniatus* and *Variola louti*; *Stephanostomum uku* Yamaguti, 1970 and *Pleorchis uku* Yamaguti, 1970 from *Aprion virescens*.

Keywords: Digenea, Acanthocolpidae, *Acaenodera*, *Pleorchis*, *Stephanostomum*, New Caledonia

In this paper we are adding to the sparse knowledge of the acanthocolpids of fishes from the coast of New Caledonia. Durio and Manter (1969) reported two *Stephanostomum* species, *S. japonocasum* Durio et Manter, 1969 and *S. casum* (Linton, 1910) and Justine et al. (2010) recorded the former again. Bray and Justine (2007) mentioned an immature *Stephanostomum* in a balistid. We have identified members of three acanthocolpid genera and report on one new species of *Acaenodera* Manter et Pritchard, 1960, one species of *Pleorchis* Railliet, 1896 and five species of *Stephanostomum* Looss, 1899, including one new species.

MATERIALS AND METHODS

Most fish were caught by hook and line, a few were bought at the fish market or spear-fished and the conger was taken in a baited cage for the collection of *Nautilus* at a depth of 400 m. Digeneans were collected live, immediately fixed in nearly boiling saline and then transferred to 80% ethanol (Cribb and Bray 2010). Whole-mounts were stained with Mayer's paracarmine, cleared in beechwood creosote and mounted in Canada balsam. Measurements were made through a drawing tube on an Olympus BH-2 microscope, using a Digicad Plus digitising tablet and Carl Zeiss KS100 software adapted by Imaging Associates, and are quoted in micrometres. The following abbreviations are used: BMNH, British Museum (Natural History) Collection at the Natural History Museum, London, UK; MNHN JNC, Muséum National d'Histoire Naturelle, Paris, France; IPCAS, Institute of Parasitology, Biology Centre of the Academy of Sciences of the Czech Republic, České Budějovice, Czech Republic.

RESULTS

Acanthocolpidae Lühe, 1906

Acaenodera Manter et Pritchard, 1960

Acaenodera nautili sp. n. Figs. 1–4

Description. Based on 7 whole-mounts, 4 measured, measurements and ratios in Table 1. Specimens difficult to mount exactly dorso-ventrally. Body elongate, narrow, cylindrical, narrower forebody (Fig. 1). No eyespots seen. Forebody spination complicated (Figs. 2–3). About 19 rows of three (usually) or four large spines in mid-ventral region. These spines are irregular, fairly blunt, and gradually reduce in size to merge with usual body-spines at about level of pharynx; anteriormost spines 60–76 long, spines in 19th row 32–43 long. Each lateral region with about 19 rows of 5 to 6 spines, similar in structure to those of mid-ventral region; anteriormost spines 50–74 long. Large spines apparently overlain by layer of tegument. Between mid-ventral and lateral large spine fields, and dorsally between lateral large spine fields are rows of

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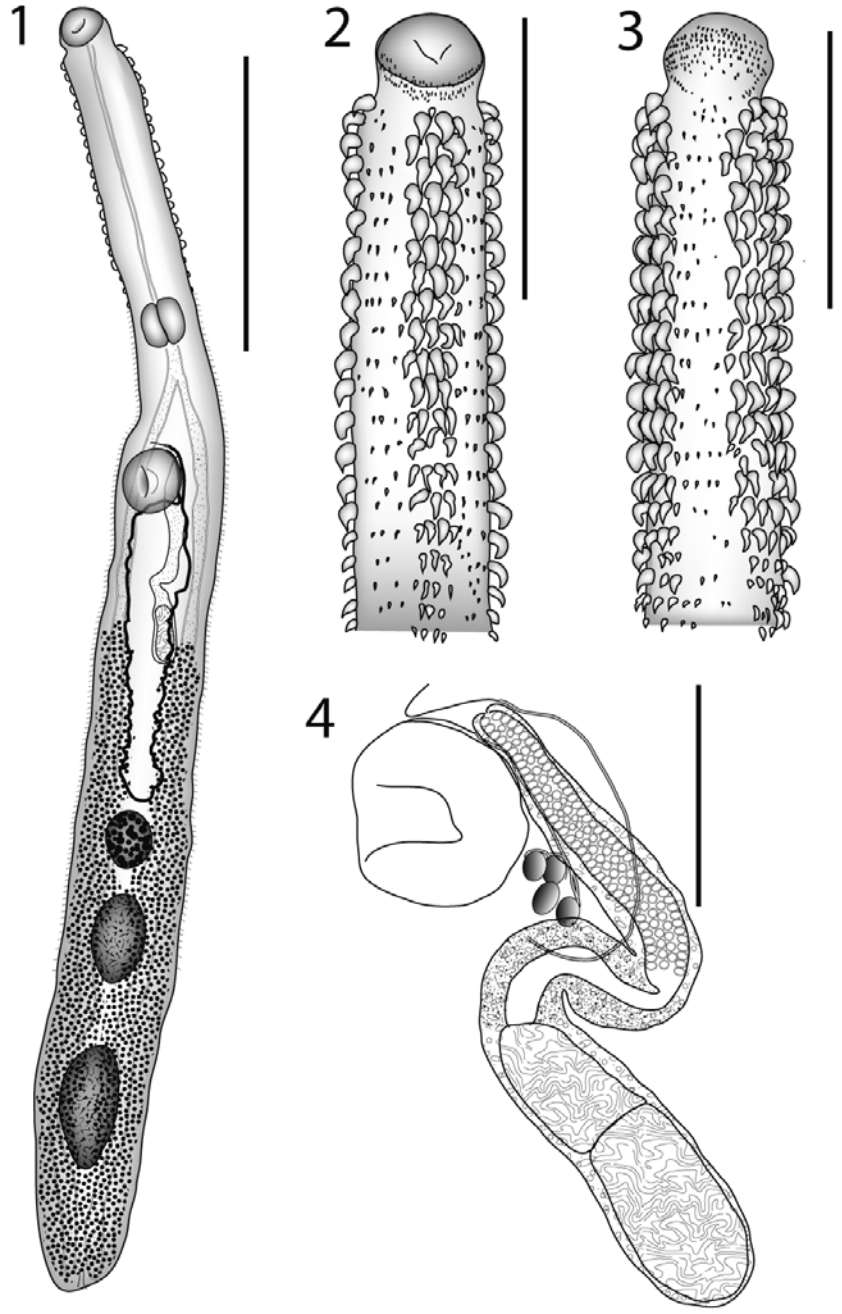


Figs. 1–4. *Acaenodera nautili* sp. n. from *Conger cinereus*. **Fig. 1.** Ventral view of holotype, uterus in outline, detail of forebody spination omitted. **Fig. 2.** Ventral view of forebody spination. **Fig. 3.** Dorsal view of forebody spination. **Fig. 4.** Lateral view of terminal genitalia, lining of metraterm omitted for clarity. Scale bars: Fig. 1 = 1000 μm; Figs. 2, 3 = 500 μm; Fig. 4 = 200 μm.

small acicular intercalary spines about 11–20 long, more or less in line with the large spine rows, apparently easily lost, particularly dorsally. Hindbody spination reaches to about anterior testis. Oral sucker oval, terminal. Oral spination formed of irregular rows of small acicular spines, about three ventrally and up to about six dorsally. Ventral sucker rounded, slightly protuberant. Prepharynx long, straight. Pharynx oval. Oesophagus short. Intestinal bifurcation in posterior forebody. Caeca reach to posterior extremity: uroproct not apparent.

Testes two, oval, entire, tandem, separated, in posterior half of hindbody. Cirrus-sac long, claviform, sinuous, reaches to about mid-distance between ventral sucker and ovary (Fig. 4). Seminal vesicle large, bipartite. Pars prostatica short, not highly glandular. Ejaculatory duct lined throughout with pavement of thin-walled irregular cupolas. Genital atrium short. Genital pore median, immediately anterior to ventral sucker.

Ovary oval, entire, pre-testicular, separated from anterior testis. Uterine seminal receptacle in proximal uterus.

Mehlis' gland antero-dextral to ovary. Laurer's canal opens dorsally to ovary. Uterus mostly intercaecal between ovary and ventral sucker. Eggs numerous, tanned, operculate. Metraterm about half length of cirrus-sac, lined in similar fashion to ejaculatory duct. Vitellarium follicular, reaching from about mid-way between ventral sucker and ovary anteriorly and posterior extremity; in lateral fields, ventral, lateral and dorsal to caeca, overlaps gonads, almost confluent or confluent between testes, confluent in post testicular region.

Excretory pore terminal. Excretory vesicle not traced.

Type-host: *Conger cinereus* Rüppell, Congridae, longfin African conger.

Site: Digestive tract.

Type-locality: Deep Sea 400 m, near Passe de Dumbéa, off Nouméa, New Caledonia (03/07/2009).

Prevalence: 1 of 1.

Specimens: Holotype MNHN JNC2993B-1, paratypes MNHN JNC2993B-2-4; BMNH 2010.9.29.1-3; IPCAS D-689.

Etymology: Named after *Nautilus*. The host was captured in a *Nautilus* trap.

Discussion. The type-species of this genus, *Acaenodera placophora* Manter et Pritchard, 1960, is known from the longfin African conger *Conger cinereus* Rüppell (syn. *Conger marginatus* Valenciennes) from off Hawaii (Manter and Pritchard 1960, Yamaguti 1970). The only other confirmed report of this genus is that of *A. spinosior* Etchegoin, Lanfranchi, Cremonte et Timi, 2006 from the Argentine conger *Conger orbignianus* Valenciennes, off Mar del Plata, Argentina (Etchegoin et al. 2006). Manter and Pritchard (1960) thought that the species *Stephanostomum robustum* (MacCallum, 1917) from the European conger eel *Conger conger* (Linnaeus) from New York Aquarium (MacCallum 1917) probably belonged in *Acaenodera*, but the material was too poor to be certain. The spination of the forebody is unusual in this genus and confusingly described, but well illustrated, for *A. placophora*. Manter and Pritchard (1960) stated 'Three distinct sets of spines present: (1) small, sharp body spines decreasing in both size and number from a level anterior to pharynx to level of ovary; (2) 2 lateral groups of 12 to 18 conspicuously enlarged, recurved spines extending from just posterior to oral sucker to level of eyespots, decreasing in size to merge with body spines … ; (3) 17 flat plates in 7 midventral rows (2-3-2-3-2-3-2) beginning just posterior to oral sucker and decreasing in size to level of eyespots … . No peribuccal spines. Spines, particularly the large ones, may be lost in macerated specimens; lateral spines may leave basal stumps only'. Yamaguti (1970) said 'Although Manter & Pritchard (1960) stated in their original description that there are no peribuccal spines, I have clearly observed five alternating, circumoral rows of sharp spines; the spines are more distinct (up to 13–18 μ long) on the dorsal side than on the ventral side where the anterior spines may be missing or rudimentary. Body spines sharply pointed, 9–12 μ long, decreasing in size and number posteriorly. Of the five lateral cervical spines the anterior two are larger than the posterior three, up to 60–160 μ long; ventrolateral spines are arranged in five transverse rows of two or three each, beginning just posterior to oral sucker, up to 80–170 μ long; they are followed by several transverse rows of distinctly smaller spines.' We have illustrated and described the situation in our material and as far as we can tell the basic pattern is similar to that described by Manter and Pritchard (1960) and Yamaguti (1970). As the spines in the mid-ventral rows decrease in size gradually until they are indistinguishable from the regular body-spines, it is not easy to accurately assess how many rows there are. We reckon that in our specimens there are about 19. Manter and Pritchard (1960) described and illustrated 7 rows, and Yamaguti (1970) illustrated about 14 rows, the posterior 7 of which are distinctly smaller than the anterior seven. We are confused by Yamaguti's (1970) description and cannot ascertain how many mid-ventral rows he is describing. We reckon that, in our specimens, the spines in the anterior 12 rows are of similar size and the diminution in size occurs between about rows 13 and 19. Etchegoin et al. (2006) described 18–20 rows of enlarged mid-ventral spines and illustrated about 12 rows of large hooks and reduced size posterior to that. This arrangement is similar to that in our specimens. Thus in this feature *A. nautili* differs from *A. placophora*, but not *A. spinosior*. In the illustrations in Yamaguti (1970) and Etchegoin et al. (2006) the hooks appear acicular, rather than blunt and curved as in our specimens.

Acaenodera nautili is similar to the described species but is distinctly narrower, with a relatively longer forebody (see width ratios in Table 1) (it should be noted, however, that our specimens are not flattened). The ventral sucker is relatively smaller (see sucker ratios in Table 1) and the testes are distinctly separated. In addition *A. nautili* differs from *A. spinosior* in the relatively shorter cirrus-sac (see ratios in Table 1). The seminal vesicle in *A. nautili* appears bipartite, a condition not described in the other species.

Pleorchis Railliet, 1896

Pleorchis uku Yamaguti, 1970

Host: *Aprion virescens* Valenciennes, Lutjanidae, green jobfish.

Site: Digestive tract.

Locality: Récif Snark off Nouméa, New Caledonia (22°26′S, 166°25′E, 05/06/2008).

Prevalence: 1 of 2.

Vouchers: MNHN JNC2568.

Discussion. All specimens are immature. This species has been reported in *Aprion virescens* from Hawaii (Yamaguti 1970), off Xisha Islands, China (Gu and Shen 1983) and from Lizard Island on the Great Barrier Reef (Bray et al. 2005). The host is unusual for a member of this genus, in that most species are parasites of sciaenids

Table 1. Measurements and ratios of *Acaenodera* spp.

Species	*Acaenodera nautili* sp. n.	*Acaenodera placophora*	*Acaenodera placophora*	*Acaenodera spinosior*
Host	*Conger cinereus*	*Conger cinereus*	*Conger cinereus*	*Conger orbignyanus*
Source	Original	Manter and Pritchard (1960)	Yamaguti (1970)	Etchegoin et al. (2006)
Locality	New Caledonia	Hawaii	Hawaii	Argentina
n	4	5	31	12
Length	4,546–4,608 (4,575)	2,370–3,351	2,300–5,650	5,140–7,140 (6,170)
Width	393–453 (430)	438–533	300–770	560–1,000 (714)
Forebody	1,615–1,761 (1,662)			1,160–2,330 (1,742)
Ventral spine row number	18–19 (19)	7	[about 14]	18–20
Ventral spine	46–63 (55)		'ventrolateral' up to 80–170	90–130 (110), reducing to 46–65 (58)
Intercalary small spines	15–21 (19)			
Oral sucker	121–132 × 161–178 (128 × 171)	94–119 × 60–73	50–130 × 80–130	120–168 × 160–184 (147 × 167)
Prepharynx	840–987 (907)	400–550	180–750	740–1,240 (956)
Pharynx	154–179 × 122–152 (167 × 132)	95–146 × 88–121	80–150 × 80–130	168–240 × 136–200 (207 × 160)
Oesophagus	138–202 (173)		50–300	60–136 (107)
IB to VS	246–296 (269)			
Ventral sucker	221–235 × 210–254 (226 × 223)	190–241 × 180–238		360–512 × 328–500 (412 × 395)
Cirrus-sac	784–913 × 90–111 (849 × 102)		400–720 × 70–110	1,660–1,900 × 85–300 (1,838 × 207)
Cirrus-overlap into hindbody	464–510 (486)			
VS to vitellarium	226–357 (285)			130–650 (299)
VS to ovary	969–1,001 (988)			1,330–2,300 (1,717)
Ovary	212–244 × 161–183 (227 × 174)	133–161 × 124–175	100–250 × 100–250	176–340 × 248–400 (267 × 305)
Ovary to anterior testis	28–88 (65)			
Anterior testis	257–331 × 162–227 (306 × 195)	289–380 × 162–241	250–900 × 170–350 (both testes)	488–900 × 240–600 (711 × 416)
Distance between testes	156–214 (181)			0–230 (73)
Posterior testis	455–471 × 201–268 (461 × 228)	316–496 × 170–212	250–900 × 170–350 (both testes)	504–1,300 × 272–580 (891 × 435)
Post-testicular distance	387–419 (398)			260–780 (472)
Post-caecal distance	31–91 (60)			75–460 (181)
Eggs	77–92 × 38–44 (85 × 42)	60–74 × 46–61	67–81 × 46–58	65–95 × 48–59 (75 × 53)
Width%*	8.61–9.87 (9.40)	{15.9–18.5}	{13.0–13.6}	{10.9–14.0}
Forebody%*	35.4–38.2 (36.3)	[27]	[25]	{22.6–32.6}
Sucker-length ratio	1:1.67–1.87 (1:1.76)	{1:2.0}	[1:3]	1:2.4–3.4 (1:2.7)
Sucker-width ratio	1:1.20–1.50 (1:1.31)	1:2.0–2.4 {1:3.0–3.3}	[1:2.1]	1:2.0–2.8 (1:2.4)
Cirrus-sac length%*	17.2–19.9 (18.5)		{12.7–17.4}	29.8
VS-CS%VS-Ov	46.3–50.9 (49.2)		[33]	[42]
VS to vitellarium%*	4.91–7.83 (6.24)	[7.5]	[0]	{2.5–9.1}
VS-Ov%*	21.0–22.0 (21.6)	[31]	[21]	{26–32}
Ov-AT%*	0.62–1.92 (1.41)	0	[0.9]	[2.3]
Distance between testes%*	3.38–4.69 (3.96)	[1.5]	0–? [0]	{0–3.2}
Post-testicular region%*	8.41–9.15 (8.71)	[6]	[8]	{5.1–10.9}
Oral sucker length%*	2.66–2.91 (2.80)	{3.6–4.0}	{2.2–2.3}	{2.3–2.4}
Ventral sucker length%*	4.85–5.11 (4.93)	{7.2–8.0}	[8]	{7.0–7.2}
Prepharynx%*	18.3–21.4 (19.8)	{16.4–16.9}	{7.8–13.3}	{14.4–17.4}
Pharynx length%*	3.37–3.94 (3.64)	{4.0–4.4}	{2.7–3.5}	{3.3–3.4}
Anterior testis length%*	5.61–7.28 (6.69)	{11.3–12.2}	[13.6]	{9.5–12.6}
Posterior testis length%*	9.92–10.2 (10.1)	{13.3–14.8}	[17.4]	{9.8–18.2}
Ovary length%*	4.66–5.36 (4.96)	{4.8–5.6}	{4.3–4.4}	{3.4–4.8}
Hindbody (HB)	2,612–2,734 (2,687)			3,932–4,900 (3,932)
Hindbody%*	56.7–59.7 (58.7)	[67]	[67]	{69–76}
VS-Vit % HB	8.66–13.1 (10.6)	[11]	[0]	{3.3–13.3}

* percentage of body-length; {within curly brackets are estimates derived from published ranges}, [within square brackets are estimates derived from published illustrations]

(Bray 2005). *Pleorchis uku* has also been reported from the crimson jobfish *Pristipomoides filamentosus* (Valenciennes) (Lutjanidae) and the redbelly yellowtail fusilier *Caesio cuning* (Bloch) (Caesionidae) off Xisha Islands, China (Gu and Shen 1983). Molecular phylogenies presented by Miller et al. (2007) indicated that the Caesionidae is embedded within the Lutjanidae, so these findings suggest that *P. uku* is a specific parasite of lutjanids. The record of *P. uku* from the camouflage grouper *Epinephelus polyphekadion* (Bleeker) (Serranidae) from off the

Maldives Island in the Indian Ocean needs confirmation (Lorber et al. 2006).

Stephanostomum Looss, 1899

Bray and Cribb (2003) listed the then known species of *Stephanostomum* Looss, 1899. Since then several species have been erected (the circum-oral spine number (COS) and information on the presence (VH) or absence (VC, i.e. ventral continuum) of a ventral hiatus in the COS rows are indicated in parentheses, LHH signifies two lateral hiatuses): *S. qatarense* Saoud, Nahhas, Al Kuwari et Ramadan, 2002 (COS 35–35, VC), *S. beukelaardori* Bray et Reimer, 2004 (COS 33–38, VC), *S. euzeti* Bartoli et Bray, 2004 (COS 49–51, VC), *S. tantabiddii* Bray et Cribb, 2004 (COS 38–45, VH), *S. fijiensis* Nahhas, Nasser et Tam, 2004 (COS 44–48, VC), *S. talakitok* Bray et Cribb, 2006 (COS 34–40, VC), *S. adlardi* Bray, Cribb, Waeschenbach et Littlewood, 2007 (COS 30–31, LHH), *S. gibsoni* Shaukat et Bilqees, 2007 (COS 38–41, VC), *S. lamothei* Bray et Cribb, 2008 (COS 50–55, VC) and *S. tupatupa* Bray et Cribb, 2008 (COS 34–36, VC) (Saoud et al. 2002, Bartoli and Bray 2004, Bray and Cribb 2004, 2006, 2008, Bray and Reimer 2004, Nahhas et al. 2004, Bray et al. 2007, Shaukat and Bilqees 2007).

Stephanostomum murielae sp. n. Figs. 5–7

Description. Based on 9 whole-mount preparations, 6 measured. Measurements and ratios in Table 2. Body elongate, narrow, widest in region of gonads (Fig. 5). Tegument spinous, unarmed patch immediately posterior to oral sucker, spines large, acuminate in forebody, smaller in hindbody, becoming sparse in hindbody, detectable to varying levels in hindbody, in some cases to posterior testis. Oral sucker terminal, distinctly wider than long. Circum-oral spines in double ring, with distinct ventral hiatus (Fig. 6). Ventral sucker rounded, in anterior fifth of body. Prepharynx long. Pharynx pyriform. Oesophagus short. Intestinal bifurcation in posterior forebody. Caeca long, narrow, terminations often obscured by vitellarium, but uroproct sometimes detected.

Testes 2, rounded to oval, entire, tandem, separated by vitelline follicles. Post-testicular region short. Cirrus-sac elongate (Figs. 5, 7), reaches well into hindbody; anterior extremity dorsal to about mid-ventral sucker. Seminal vesicle claviform, undivided, narrows anteriorly. Pars prostatica relatively short, lined with anuclear cell-like bodies, surrounded by gland-cells. Ejaculatory duct long, wide, lined with closely packed small cupolas, with round bases seen as circles on wall of duct, with distinct, but short, naked region distally. Genital atrium reaching to mid-ventral sucker. Genital pore median, slit-like, immediately anterior to ventral sucker.

Ovary oval, entire, widely separated from anterior testis. Mehlis' gland antero-dorsal to ovary. Laurer's canal opens dorsally to ovary. Uterine seminal receptacle not seen. Uterus narrow, intercaecal, pre-ovarian. Eggs large, tanned, operculate, in one specimen only. Metraterm slightly shorter than cirrus-sac, lining lacking cupolas or with weakly developed cupolas. Vitellarium follicular, just overlaps posterior end of cirrus-sac; fields confluent ventrally and dorsally to uterus, gaps lateral to gonads, confluent dorsally and ventrally between gonads and in post-testicular region.

Excretory pore terminal. Vesicle I-shaped, anterior extent not detected.

Type-host: *Carangoides hedlandensis* (Whitley), Carangidae, bumpnose trevally.

Site: Digestive tract.

Type-locality: Nouméa Fish Market, New Caledonia (13/03/2009).

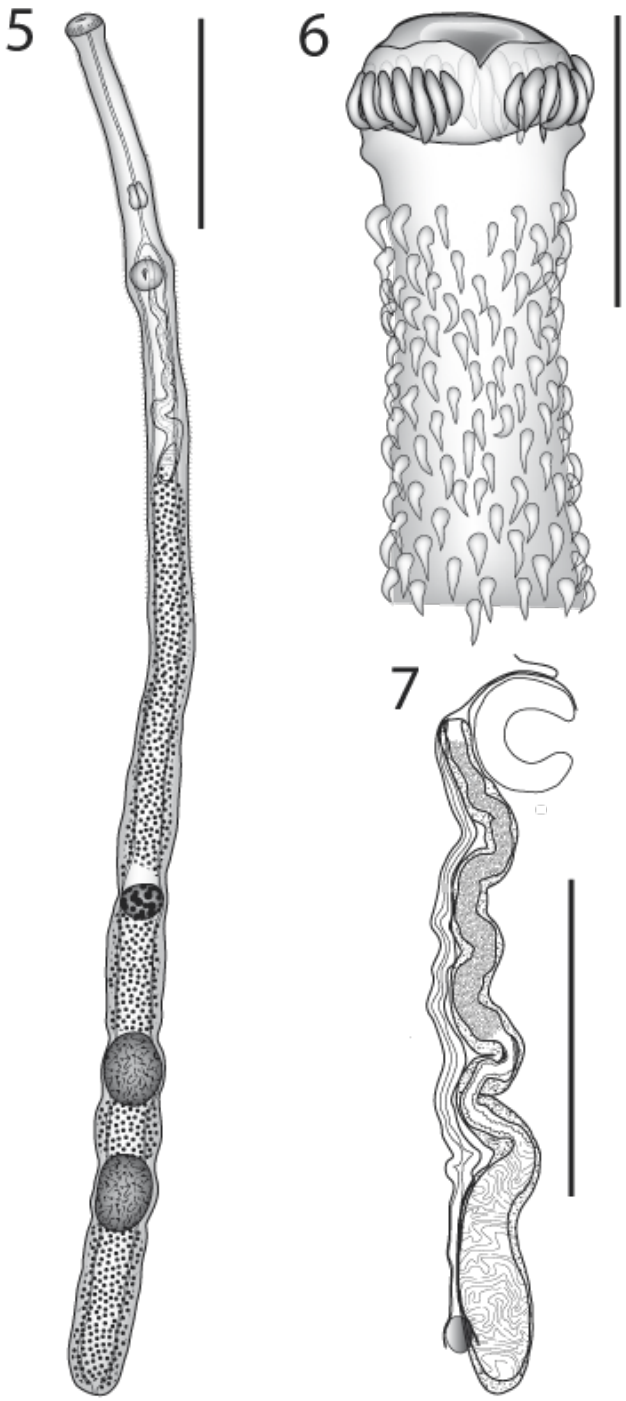
Prevalence: 1 of 1.

Specimens: Holotype: MNHN JNC2883-1, paratypes JNC2883-2-5, JNC2883C, BMNH 2010.9.29.8-9.

Etymology: This species is named after the mother of the senior author, who died during the preparation of this paper.

Discussion. According to Bray and Cribb (2003) there are three species of *Stephanostomum* with 10% or more of the hindbody devoid of vitelline follicles, the circum-oral spine count around 30 and with a ventral hiatus, namely *S. megacephalum* Manter, 1940, *S. bicoronatum* (Stossich, 1883), and *S. madhaviae* Bray et Cribb, 2003. None of the species described since Bray and Cribb (2003) show these features.

Stephanostomum megacephalum was described from the crevalle jack *Caranx hippos* (Linnaeus) (Carangidae), off Bahia Honda, on the Pacific coast of Panama, off San Francisco on the coast of Ecuador and off White Friars on the Pacific coast of Mexico (Manter 1940), as having 30–32 circum-oral spines, almost always 32 (based on 11 specimens). Manter (1940) also reported a macerated specimen of this species from the horse-eye jack *Caranx latus* Agassiz (Carangidae) with 30 oral spines. The species has been reported several times since mainly from the Gulf of Mexico or Caribbean Sea in a variety of carangids (Manter 1947, Sparks 1958, Nahhas and Cable 1964, Nahhas and Short 1965, Overstreet 1969, Nahhas and Powell 1971, Fischthal 1977). It has also been reported from carangids in the Red Sea (Parukhin 1970) and off Cochin and Krusadai, India (Zhukov 1977) and in *C. hippos* and the dwarf mullet *Mugil curvidens* (Valenciennes) (Mugilidae) off Ghana in the eastern Atlantic Ocean (Fischthal and Thomas 1968). Manter's original description of *S. megacephalum* indicates that it differs from *S. murielae* in being much smaller (1,431–2,212 × 375–465 vs. 5,107–6,645 × 184–283), much broader (width 21–26% of body-length vs. 3–4%) and with a relatively longer forebody (25–33% of body-length vs. 17–21%). The cirrus-sac is not illustrated in detail, but the cirrus (?ejaculatory duct) is 'spined, extending only slightly posterior to' the ventral sucker, whereas in *S. murielae* the



Figs. 5–7. *Stephanostomum murielae* sp. n. from *Carangoides hedlandensis*. **Fig. 5.** Ventral view of holotype, uterus in outline. **Fig. 6.** Ventral view of oral-sucker and forebody spination. **Fig. 7.** Lateral view of terminal genitalia. Scale bars: Fig. 5 = 1000 µm; Fig. 6 = 200 µm; Fig. 7 = 500 µm.

ejaculatory duct is long and reaches well into the hindbody. The gonads in *S. megacephalum* are close together or contiguous, with no intervening vitelline follicles and continuous lateral bands of follicles at the level of the gonads; in *S. murielae* the gonads are well separated, with intervening vitelline follicles and with the vitelline fields interrupted at the level of the gonads.

Stephanostomum bicoronatum is a reasonably well-studied widespread parasite, mainly infecting members of the Sciaenidae. The type-host is the shi drum *Umbrina cirrosa* (Linnaeus) (Sciaenidae), from off Trieste (Stossich 1883). Our comparison of this species is based mainly on its redescription from the brown meagre *Sciaena umbra* Linnaeus (Sciaenidae) off Corsica, France by Bartoli and Bray (2001), where they list many of the previous records. Later records are by Lozano et al. (2001) who reported *S. bicoronatum* from off the southern Iberian coast in the meagre *Argyrosomus regius* (Asso) (Sciaenidae) giving some dimensions, and by Bray and Cribb (2003) who described the worm from off the southern Queensland coast, Australia in the Madagascar meagre *Argyrosomus hololepidotus* (Lacepède) (Sciaenidae). Over 80% of all records are from sciaenids. Bartoli and Bray's (2001) study indicates that *S. bicoronatum* differs from *S. murielae* in being relatively wider (width about 9% of body length vs. 3–4%) with a longer forebody (20–30% of body-length vs. 17–21%). The genital atrium is longer, reaching to about the posterior margin of the ventral sucker (vs. about mid-ventral sucker). The cirrus-sac reaches 55–57% of the ventral sucker to ovary distance (vs. 32–38%). The gonads are only slightly separated or contiguous (vs. distinctly separated). The post-testicular region is shorter (4–5% of body length vs. 10–11%). Judging by the description in Bray and Cribb (2003) *S. bicoronatum* is relatively wider (width 6–10% of body-length), with a similar forebody length (15–19% of body-length), a longer genital atrium, a longer reach of the cirrus-sac into the hindbody (43–54% of ventral sucker to ovary distance), contiguous testes and with the ovary contiguous or very close to the anterior testis, and a short post-testicular region (3–4% of body-length). The vitelline fields are not interrupted laterally at the level of the gonads in *S. bicoronatum*.

Stephanostomum madhaviae was described from three specimens from the giant trevally *Caranx ignobilis* (Forsskål) (Carangidae) by Bray and Cribb (2003) from off Hope Island, southern Queensland, Australia. They considered this to be the same form as described as *'Stephanostomum orientalis* (Srivastava, 1939)' by Madhavi (1976) from the Malabar trevally *Carangoides malabaricus* (Bloch et Schneider) (Carangidae) and the longnose trevally *Carangoides chrysophrys* (Cuvier) (Carangidae) off the Waltair coast, Bay of Bengal. It differs from *S. murielae*, judging by Bray and Cribb (2003), in being shorter (2,606–3,936 long vs. 5,107–5,645), wider (width 8–9% of body length vs. 3–4%), with a longer forebody (28–30% of body-length vs. 17–21%), contiguous gonads (the testes may occasionally be very slightly separated), and a shorter post-testicular region (5–6% of body length vs.

Table 2. Measurements and ratios of *Stephanostomum* spp.

Species	*Stephanostomum murielae* sp. n.	*Stephanostomum aaravi*	*Stephanostomum ditrematis*
Host	*Carangoides hedlandensis*	*Lethrinus miniatus*	*Gnathanodon speciosus*
n	6	1	1
Length	5,107–5,645 (5,977)	3,901	7,660
Width	184–283 (215)	636	325
Forebody	884–1,1270 (1,133)	1,141	1,222
Oral spine count	28–31 (30)	36	36
Anterior ventral spine	23–40 (30)	61	41
Posterior ventral spine	30–50 (39)	64	36
Anterior dorsal spine	38–61 (50)	55	63
Posterior dorsal spine	46–65 (57)	53	53
Oral sucker	70–86 × 122–147 (77 × 131)	194 × 201	105 × 164
Prepharynx	512–785 (712)	429	735
Pharynx	105–123 × 73–83 (115)	267 × 227	255 × 212
Oesophagus	33–147 (114)	128	87
IB to VS	63–250 (116)	121	0
Ventral sucker	118–146 × 122–138 (136 × 133)	374 × 377	253 × 249
Cirrus-sac	967–1,205 × 78–105 (1,029 × 90)	876 × 102	1,058 × 88
Cirrus-overlap into hindbody	812–1,067 (923)	410	1,981
VS to vitellarium	756–934 (845)	0	2,040
VS to ovary	2,293–2,919 (2,599)	752	4,160
Ovary	131–165 × 103–157 (152 × 133)	216 × 232	173 × 136
Ovary to anterior testis	336–461 (386)	13	378
Anterior testis	284–403 × 150–200 (348 × 169)	362 × 219	401 × 209
Distance between testes	72–221 (167)	33	248
Posterior testis	308–424 × 154–227 (361 × 178)	400 × 248	459 × 238
Post-testicular region	506–708 (631)	578	312
Eggs	72 × 36	88 × 31	63 × 28
Width%*	3.19–4.45 (3.59)	16.3	4.24
Forebody%*	17.3–20.6 (18.9)	29.3	16.0
Sucker-length ratio	1:1.69–1.98 (1:1.77)	1:1.93	1:2.42
Sucker-width ratio	1:0.94–1.12 (1:1.02)	1:1.88	1:1.52
Cirrus-sac length%*	15.9–18.9 (17.3)	22.4	13.8
VS-CS%VS-Ov	31.8–37.9 (35.5)	54.6	47.6
VS to vitellarium%*	12.4–14.9 (14.2)	0	26.6
VS-Ov%*	42.0–44.9 (43.5)	19.3	54.3
Ov-AT%*	5.29–7.58 (6.47)	0.32	4.94
Distance between testes%*	1.27–3.71 (2.79)	0.83	3.24
Post-testicular region%*	9.91–11.2 (10.5)	14.8	4.08
Oral sucker length%*	1.08–1.54 (1.30)	4.97	1.36
Ventral sucker length%*	2.08–2.61 (2.28)	9.58	3.30
Prepharynx%*	10.0–13.5 (11.9)	11.0	9.59
Pharynx length%*	1.84–2.25 (1.93)	6.68	3.33
Anterior testis length%*	5.16–6.92 (5.83)	9.29	5.23
Posterior testis length%*	5.53–6.68 (6.04)	10.3	5.99
Ovary length%*	2.44–2.69 (2.55)	5.53	2.25
Hindbody (HB)	4,090–5,233 (4,708)	2,386	6,185
Hindbody%*	77.3–80.1 (78.8)	61.2	80.7
VS-Vit%HB	15.6–18.7 (18.0)	0	33.0
Genital atrium	90–125 (103)	114	1,212
Ejaculatory duct	367–583 (474)	181	317
Pars prostatica	172–248 (212)	320	366
Seminal vesicle length	218–478 (371)	431	347
Male duct	981–1,188 (1,056)	931	1029
Ejaculatory duct%male duct	36.8–59.5 (45.1)	19.4	30.8
Pars prostatica%male duct	16.5–24.8 (20.1)	34.3	35.6
SV length%male duct	22.2–40.2 (34.8)	46.3	33.7

10–11%). Usually the ejaculatory duct is relatively shorter (36% of male-duct vs. 37–59 (45)). The vitelline fields are not interrupted laterally at the level of the gonads in *S. madhaviae*.

Stephanostomum aaravi Bray et Cribb, 2003

Hosts: *Lethrinus miniatus* Forster, Lethrinidae, trumpet emperor; *Lethrinus rubrioperculatus* Sato, Lethrinidae, spotcheek emperor.

Sites: Digestive tract, stomach.

Localities: *L. miniatus*, Récif Toombo (22°33′S, 166°27′E, 20/11/2007), *L. rubrioperculatus*, Récif Toombo (22°26′S, 166°33′E, 27/06/2006), Shallow, Interior Lagoon near Récif Toombo (22°33′S, 166°29′E, 25/11/2008), all off Nouméa, New Caledonia.

Prevalence: *L. miniatus* 3.7% (1 of 27); *L. rubrioperculatus*, 12% (2 of 17).

Vouchers: *L. miniatus* MNHN JNC2402; *L. rubrioperculatus*, MNHN JNC1885, JNC2773.

Discussion. These specimens fit comfortably into the original and only description of this species from *Lethrinus miniatus* off Heron Island, Queensland (Bray and Cribb 2003), although those from *L. rubrioperculatus* are distorted and not measured (see Table 2 for measurements of specimen from *L. miniatus*).

Stephanostomum ditrematis (Yamaguti, 1939) Manter, 1947

Host: *Gnathanodon speciosus* (Forsskål), Carangidae, golden trevally.

Site: Digestive tract.

Locality: Nouméa Fish Market (05/12/2008).

Prevalence: 25% (1 of 4).

Vouchers: MNHN JNC2819C, BMNH 2010.9.29.4.

Discussion. These worms (see Table 2) are indistinguishable from those described as this species from the same species of host off Heron and Lizard Islands on the Great Barrier Reef by Bray and Cribb (2008). The type host was reported as *Ditrema temmincki* Bleeker (Embiotocidae) from the Inland Sea of Japan (Yamaguti 1939), but most subsequent reports have been from carangids.

Stephanostomum japonocasum Durio et Manter, 1969 Figs. 8–13

Hosts: *Cephalopholis urodeta* (Forster), Serranidae, darkfin hind; *Epinephelus areolatus* (Forsskål), Serranidae, areolate grouper; *Epinephelus chlorostigma* (Valenciennes), Serranidae, brownspotted grouper; *Epinephelus maculatus* (Bloch), Serranidae, highfin grouper; *Epinephelus retouti* Bleeker, Serranidae, red-tipped grouper; *Lethrinus miniatus* (Forster), Lethrinidae, trumpet emperor; *Variola louti* (Forsskål), Serranidae, yellow-edged lyretail.

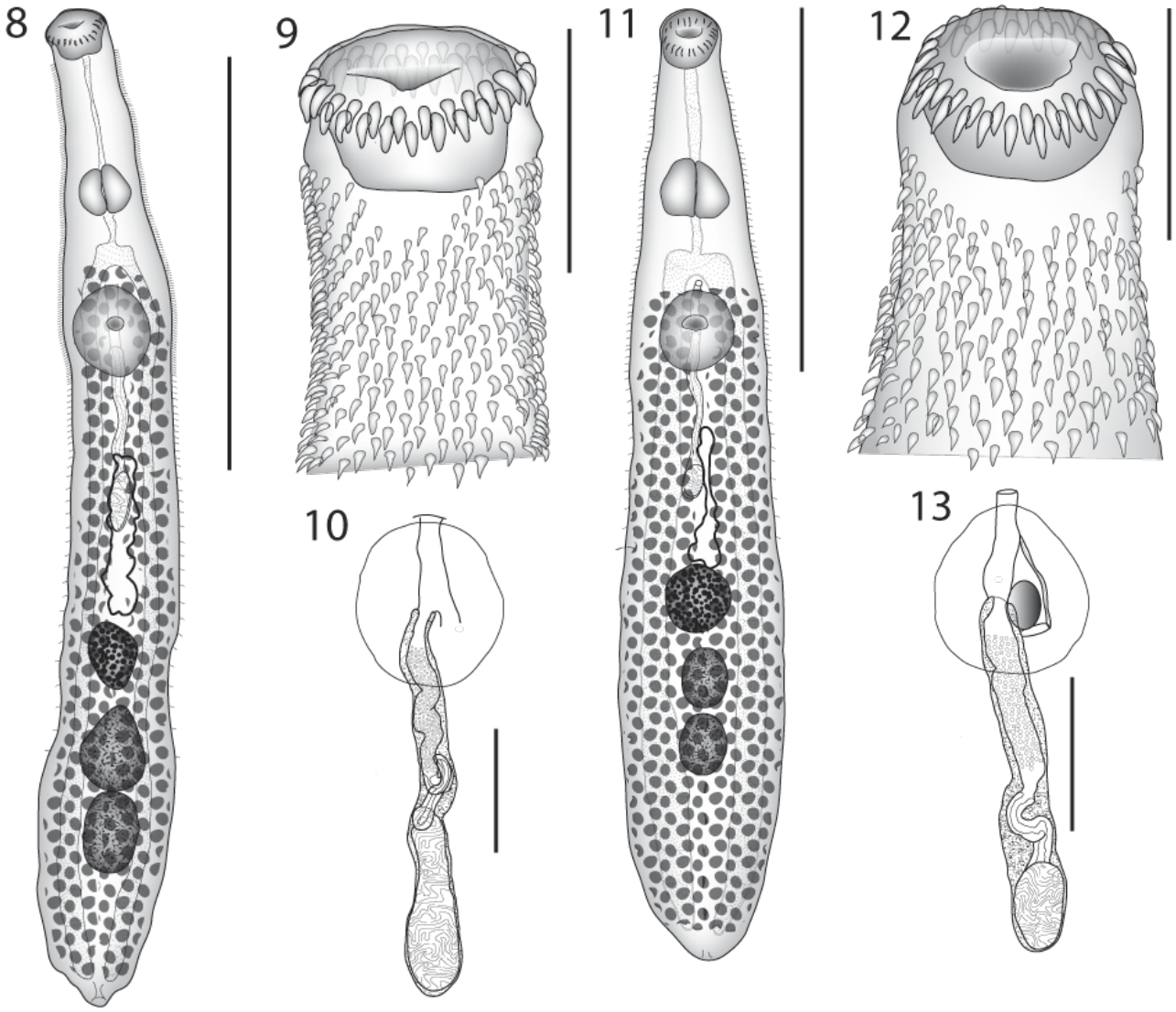
Site: Intestine, digestive tract.

Localities: *C. urodeta*, Shallow, Interior Lagoon near Récif Toombo (22°33′S, 166°29′E, 04/11/2008); *E. areolatus*, Off Ilôt Brun et Baie des Citrons (22°17′S, 166°25′E, 29/04/2008); *E. chlorostigma*, Off Récif Toombo, deep-sea (22°34′S, 166°28′E, 04/01/2008); *E. maculatus*, Récif Toombo (22°26′S, 166°33′E, 14/12/2005), Interior Lagoon near Récif Toombo (22°33′S, 166°29′E, 30/04/2009), Near Récif Toombo (22°34′S, 166°29′E, 16/09/2009); *E. retouti*, Récif Kué, External slope (22°35′S, 166°30′E, 19/06/2007); *L. miniatus*, Récif Kué, External slope (22°35′S, 166°30′E, 21/06/2007, 22/06/2007), External slope of Récif Toombo (22°34′S, 166°27′E, 09/10/2007), Off Récif Kué, Middle of Reef (22°36′S, 166°32′E, 09/12/2008); *V. louti*, Récif Kué, External slope (22°35′S, 166°30′E, 21/06/2007), all off Nouméa, New Caledonia.

Prevalence: *C. urodeta*, 25% (1 of 4); *E. areolatus*, 20% (1 of 5); *E. chlorostigma*, 33% (1 of 3); *E. maculatus*, 12% (3 of 26); *E. retouti*, 33% (1 of 3); *L. miniatus*, 19% (5 of 27); *V. louti*, 8% (1 of 12).

Vouchers: *C. urodeta*, MNHN JNC2748; *E. areolatus*, MNHN JNC2494, JNC3053; *E. chlorostigma*, MNHN JNC2446; *E. maculatus*, MNHN JNC1684, JNC2930, BMNH 2010.9.29.5; *E. retouti*, MNHN JNC2181B; *L. miniatus*, MNHN JNC2205, JNC2207, JNC2300, JNC2822B, BMNH 2010.9.29.6-7; *V. louti*, JNC2198.

Discussion. This species is known only from the original record by Durio and Manter (1969) from *Epinephelus* sp. and an ‘unidentified serranid’ off New Caledonia and reports from six serranid species off New Caledonia by Justine et al. (2010). We here record the species in six serranid species and one lethrinid (Table 3). The latter is a surprising host as in the lethrinids of the Great Barrier Reef the similar species, *S. pagrosomi* (Yamaguti, 1939), is reported from *Lethrinus miniatus*, the spangled emperor *L. nebulosus* (Forsskål) and the Pacific yellowtail emperor *L. atkinsoni* Seale, off Heron Island (Bray and Cribb 2003). *Stephanostomum pagrosomi*, in lethrinids, is reported as having 49–59 uninterrupted circum-oral spines and vitelline fields that reach to about the posterior margin of the ventral sucker. According to our data *S. japonocasum* has 44–53 circum-oral spines and vitelline fields that reach to about the anterior margin of the ventral sucker or just into the forebody and the fields are confluent in the anterior region. The vitelline configuration is a convincing distinction between *S. japonocasum* and *S. pagrosomi*. Durio and Manter (1969) reported 40–44 circum-oral spines in *S. japonocasum*, distinguishing this species from *S. japonicum* (Yamaguti, 1934) by circum-oral spine number, i.e. 40–44 vs. 46. Our data cast doubt on this distinction. No spines were described in the ejaculatory duct or metraterm of *S. japonicum*. We observed cupolas with circular bases on the ejaculatory duct and metraterm walls, which we take to be the same as the spines with ‘spherical base’ as described by Durio and Manter (1969). The cirrus of *S. japonicum* is described by Yamaguti (1934) as joining ‘the metraterm near the conspicuous genital pore lying immediately’ anterior to



Figs. 8–13. *Stephanostomum japonocasum* Durio et Manter, 1969 ex *Lethrinus miniatus* (Figs. 8–10) and ex *Epinephelus areolatus* (Figs. 11–13). **Figs. 8, 11.** Ventral view, uterus in outline. **Figs. 9, 12.** Ventral view of oral-sucker and forebody spination. **Figs. 10, 13.** Lateral view of terminal genitalia. Scale bars: Fig. 8 = 500 µm; Figs. 9, 10, 12, 13 = 200 µm. Fig. 11 = 1000 µm.

the ventral sucker. In *S. japonocasum* the ejaculatory duct (= cirrus) joins the metraterm at about mid-ventral sucker level, and there is a distinct elongate genital atrium. These features associated with the terminal genitalia may serve to distinguish *S. japonicum* from *S. japonocasum*. There is also no evidence that the vitelline fields in *S. japonicum* are confluent in the anterior region or in the posterior forebody, as in *S. japonocasum*. *Stephanostomum japonicum* has been reported only in the spinyhead sculpin *Dasycottus setiger* Bean and *Cottunculus* sp. (Psychrolutidae) and the hookhorn sculpin *Artediellus pacificus* Gilbert (Cottidae) from Toyama Bay, Japan (Yamaguti 1934). We disagree with Machida (1984) who considered *S. japonicum* a synonym of *S. baccatum* (Nicoll, 1907), a widespread northern temperate species, originally described from the Atlantic halibut *Hippoglossus hippoglossus* (Linnaeus) (Pleuronectidae) off Scotland (Nicoll 1907). In *S. baccatum* the vitellarium does not reach into the forebody (Nicoll 1907, 1913, Manter 1926, Wolfgang 1955, Zhukov 1960, Machida 1984).

All specimens of *Lethrinus miniatus* and several of the serranids were taken outside the barrier reef in relatively deep water and, therefore, they share a common environment and probably common prey items which act as second intermediate hosts of *S. japonocasum*. *Lethrinus miniatus* is a relatively large predator as are most of the serranids (apart from *Cephalopholis urodeta*). The prevalence of *S. japonocasum* in *L. miniatus* was 19%, and in serranids the prevalence varied between 8% and 33%, suggesting that *L. miniatus* is not an accidental host. Other lethrinid species from within the lagoon apparently do not harbour this digenean, but they are smaller species.

Table 3. Measurements and ratios of *Stephanostomum japonocasum*.

Species	*Stephanostomum japonocasum*	*Stephanostomum japonocasum*	*Stephanostomum japonocasum*	*Stephanostomum japonocasum*
Host	*Cephalopholis urodeta*	*Epinephelus areolatus*	*Epinephelus chlorostigma*	*Epinephelus maculatus*
n	1	1	1	2
Length	2,247	2,741	3,786	2193–2,289
Width	293	466	492	367–396
Forebody	814	788	942	655–802
Oral spine count	48	44	45	46–51
Anterior ventral spine	32	31	36	36–40
Posterior ventral spine	39	35	43	36–37
Anterior dorsal spine	35	18	43	22–27
Posterior dorsal spine	49	25	59	36–37
Oral sucker	137 × 171	145 × 171	161 × 214	140–151 × 157–168
Prepharynx	359	262	320	220–290
Pharynx	150–138	177 × 198	185 × 195	164–170 × 161–175
Oesophagus	74	91	131	61–105
IB to VS	93	103	145	75–89
Ventral sucker	234 × 188	228 × 214	306 × 273	215–229 × 167–229
Cirrus-sac	504 × 54	494 × 97	670 × 79	467–492 × 57–88
Cirrus-overlap into hindbody	206	364	529	315–356
VS to vitellarium	0	0	0	0–51
VS to ovary	384	566	920	410–471
Ovary	140 × 108	192 × 179	239 × 208	92–147 × 92–118
Ovary to anterior testis	64	35	136	14–26
Anterior testis	171 × 122	179 × 132	291 × 192	150–152 × 112–154
Distance between testes	0	0.51	0	0
Posterior testis	173 × 119	176 × 119	310 × 179	138–144 × 107–144
Post-testicular region	264	523	616	390–444
Eggs	75 × 32	64 × 44	81 × 36	52–75 × 32–38
Width%*	13.1	17.0	13.0	16.8–17.3
Forebody%*	36.2	28.8	24.9	29.9–35.0
Sucker-length ratio	1:1.70	1:1.57	1:1.90	1:1.52–1.53
Sucker-width ratio	1:1.10	1:1.25	1:1.28	1:1.06–1.36
Cirrus-sac length%*	22.4	18.0	17.7	21.3–21.5
VS-CS%VS-Ov	53.8	64.3	57.5	75.6–76.8
VS to vitellarium%*	0	0	0	0–2.2
VS-Ov%*	17.1	20.7	24.3	18.7–20.6
Ov-AT%*	2.83	1.29	3.60	0.64–1.1
Distance between testes%*	0.00	0.51	0.00	0.00
Post-testicular region%*	11.7	19.1	16.3	17.0–20.3
Oral sucker length%*	6.12	5.29	4.25	6.4–6.6
Ventral sucker length%*	10.4	8.31	8.09	9.79–10.0
Prepharynx%*	16.0	9.56	8.47	10.0–12.7
Pharynx length%*	6.69	6.47	4.88	7.41–7.48
Anterior testis length%*	7.61	6.54	7.68	6.62–6.84
Posterior testis length%*	7.69	6.43	8.19	6.01–6.56
Ovary length%*	6.23	6.99	6.30	4.03–6.72
Hindbody (HB)	1,200	1,725	2,537	1,259–1,324
Hindbody%*	53.4	62.9	67.0	55.0–60.3
VS-Vit%HB	0	0	0	0–4.1
Genital atrium	72	141	199	126–136
Ejaculatory duct	273	266	376	219–316
Pars prostatica	132	227	99	139–172
Seminal vesicle length	143	110	199	72–127
Male duct	548	603	674	485–560
Ejaculatory duct%male duct	49.9	44.1	55.7	45.3–56.5
Pars prostatica%male duct	24.1	37.6	14.7	28.6–30.7
SV length%male duct	26.0	18.3	29.6	12.8–26.2

(continued)

Table 3. Continued.

Species	*Stephanostomum japonocasum*	*Stephanostomum japonocasum*	*Stephanostomum japonocasum*
Host	*Epinephelus retouti*	*Lethrinus miniatus*	*Variola louti*
n	1, poor specimen	3	1
Length	2,933	2,618–3,362 (3,007)	2558
Width	513	370–469 (422)	383
Forebody	776	730–941 (838)	783
Oral spine count	46	45–53 (48)	50
Anterior ventral spine	30	26–34 (30)	32
Posterior ventral spine	33	28–34 (31)	33
Anterior dorsal spine	41	24–33 (28)	32
Posterior dorsal spine	49	34–43 (39)	35
Oral sucker	147 × ?	107–160 × 148–198 (129 × 174)	129 × 187
Prepharynx	281	261–369 (321)	338.2
Pharynx	171 × 197	126–177 × 141–171 (150 × 161)	139 × 143
Oesophagus	36	68–107 (91)	88
IB to VS	142	136–168 (149)	0
Ventral sucker	295 × ?	206–298 × 203–253 (255 × 224)	221 × 216
Cirrus-sac	?	593–686 × 91–102 (639 × 96)	562 × 79
Cirrus-overlap into hindbody	?	373–525 (449)	368
VS to vitellarium	?	42–100 (76)	0
VS to ovary	625	587–809 (677)	514
Ovary	150 × 157	144–217 × 97–158 (175 × 132)	117 × 106
Ovary to anterior testis	85	44–92 (61)	100.3
Anterior testis	206 × 185	205–285 × 167–220 (235)	179 × 143
Distance between testes	24	0	93.9
Posterior testis	222 × 185	230–283 × 172–217 (259 × 192)	162 × 135
Post-testicular region	365	327–486 (409)	377.8
Eggs	80 × 35	75–79 × 34–35 (77 × 34)	74 × 29
Width%*	17.5	12.7–15.4 (14.1)	15.0
Forebody%*	26.5	27.7–28.0 (27.9)	30.6
Sucker-length ratio	1:2.00	1:1.86–2.15 (1:1.98)	1:1.71
Sucker-width ratio	??	1:1.23–1.37 (1:1.29)	1:1.16
Cirrus-sac length%*	?	19.5–20.4 (19.9)	22.0
VS-CS%VS-Ov	?	58.8–65.0 (61.9)	71.5
VS to vitellarium%*	0	1.40–3.23 (2.53)	0
VS-Ov%*	21.3	20.8–24.1 (22.4)	20.1
Ov-AT%*	2.89	1.31–3.50 (2.12)	3.92
Distance between testes%*	0.80	0	3.67
Post-testicular region%*	12.4	12.3–16.0 (13.6)	14.8
Oral sucker length%*	5.02	3.97–4.76 (4.27)	5.04
Ventral sucker length%*	10.1	7.88–8.86 (8.43)	8.63
Prepharynx%*	9.58	9.98–11.0 (10.6)	13.2
Pharynx length%*	5.82	4.80–5.28 (4.97)	5.43
Anterior testis length%*	7.01	7.11–8.48 (7.81)	7.01
Posterior testis length%*	7.55	8.43–8.79 (8.63)	6.35
Ovary length%*	5.11	5.41–6.47 (5.79)	4.56
Hindbody (HB)	1,861	1,682–2,123 (1,915)	1,554
Hindbody%*	63.5	63.1–64.2 (63.7)	60.8
VS-Vit % HB	?	2.19–5.02 (3.97)	0
Genital atrium	?	98–157 (136)	183
Ejaculatory duct	?	245–327 (284)	260
Pars prostatica	?	126–216 (162)	221
Seminal vesicle length	?	141–316 (251)	145
Male duct	?	530–858 (696)	626
Ejaculatory duct%male duct	?	38.1–46.3 (41.4)	41.6
Pars prostatica%male duct	?	18.0–27.0 (23.4)	35.3
SV length%male duct	?	26.7–42.1 (35.2)	23.2

Stephanostomum uku Yamaguti, 1970

Host: *Aprion virescens* Valenciennes, Lutjanidae, green jobfish.

Site: Posterior intestine.

Locality: Reef near Îlot La Regnière (22°19′S, 166°20′E, 05/07/2005), off Nouméa, New Caledonia.

Prevalence: 1 of 2.

Vouchers: MNHN JNC1557C.

Discussion. This species is known only from *A. virescens*, in Hawaii (Yamaguti 1970) and a report of immature specimens from Lizard Island, Great Barrier Reef (Bray et al. 2005).

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