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# *Pseudorhabdosynochus argus* n. sp. (Monogenea: Diplectanidae) from *Cephalopholis argus*, *P. minutus* n. sp. and *Diplectanum nanus* n. sp. from *C. sonnerati* and other monogeneans from *Cephalopholis* spp. (Perciformes: Serranidae) off Australia and New Caledonia

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**Abstract** Monogeneans from three species of *Cephalopholis*, namely *C. argus, C. sonnerati* and *C. boenak*, are described from fish caught off New Caledonia, South Pacific, with comparisons with material from off Queensland, Australia. *Pseudorhabdosynochus argus* n. sp. from *C. argus* is present off New Caledonia and Australia; it is characterised by its male quadriloculate organ with very elongate cone, and its sclerotised vagina with anterior trumpet, coiled primary canal and distal part with two chambers and an accessory part. *C. boenak* has no monogeneans off New Caledonia, but off Australia it harbours *Pseudorhabdosynochus* sp., a new species which is morphologically related to *P. argus. P. minutus* n. sp. from *C. sonnerati* is characterised by its minute body and a sclerotised vagina with two spherical chambers. *Diplectanum nanus* n. sp. from *C. sonnerati* is characterised by its very small funnel-shaped male copulatory organ and minute body. A new species, *Haliotrema* sp. from *C. sonnerati* is characterised by a very elongate tubular penis; it is distinct from *H. cromileptis* Young, 1968 (redescribed herein from specimens collected from *Cromileptes altivelis* off New Caledonia). The species described here include the first members of *Pseudorhabdosynochus* and the first diplectanids described from species of *Cephalopholis*. There is no evidence for a clade of *Pseudorhabdosynochus* species specific to members of *Cephalopholis*, since the species described here share similarities with other species from *Epinephelus*. However, it is suggested that the gill structure of *Cephalopholis* spp. imposes selection toward small body sizes for monogeneans.

**Résumé** Des monogènes de trois espèces de *Cephalopholis, C. argus, C. sonnerati* et *C. boenak*, sont décrits de poissons de Nouvelle-Calédonie, Pacifique sud, et comparés avec du matériel du Queensland, Australie. *Pseudorhabdosynochus argus* n. sp. de *C. argus* est présent en Nouvelle-Calédonie et en Australie, et est caractérisé par son organe copulateur mâle à cône très allongé et son vagin sclérifié avec trompette antérieure, canal primaire enroulé et partie distale avec deux chambres et une partie accessoire. *C. boenak* n'a pas de monogènes en Nouvelle-Calédonie, mais héberge en Australie *Pseudorhabdosynochus* sp., une nouvelle espèce qui est morphologiquement proche de *P. argus. P. minutus* n. sp. de *C. sonnerati* est caractérisé par son corps très petit et un vagin sclérifié à deux chambres sphériques. *Diplectanum nanus* n. sp. de *C. sonnerati* est caractérisé par son organe copulateur mâle très petit, en forme d'entonnoir, et son corps très petit. Une

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nouvelle espèce, *Haliotrema* sp. de *C. sonnerati* est caractérisée par son pénis tubulaire très allongé; elle est distincte de *H. cromileptis* Young, 1968 (redécrit ici à partir de spécimens récoltés chez *Cromileptes altivelis* en Nouvelle-Calédonie). Les espèces décrites ici sont les premiers *Pseudorhabdosynochus* et les premiers Diplectanidae décrits de *Cephalopholis*. Aucun argument en faveur d'un clade d'espèces de *Pseudorhabdosynochus* spécifique de *Cephalopholis* n'a été trouvé, parce que les espèces décrites ici ressemblent à d'autres espèces qui sont parasites d'*Epinephelus*. Toutefois, on suggère que la structure de la branchie de *Cephalopholis* spp. impose une sélection vers une petite taille du corps pour les monogènes.

## Introduction

The Epinephelinae, or groupers, comprise 15 genera (Heemstra & Randall, 1993). Species of *Pseudorhabdosynochus* Yamaguti, 1958 have been described from members of only three genera: *Epinephelus* (the most speciose genus, whose members harbour the majority of *Pseudorhabdosynochus* species), *Mycteroperca* and *Variola* (lists in Justine, 2007). In contrast, diplectanids from members of *Plectropomus* belong to *Echinoplectanum* Justine & Euzet, 2006. The present paper describes several new species of *Pseudorhabdosynochus* from members of *Cephalopholis* caught off New Caledonia, South Pacific, with some additional information about material from off eastern Australia (Table 1), and thus extends the host range of *Pseudorhabdosynochus* to members of a fourth epinepheline genus. In addition, diplectanid species of uncertain generic status, herein attributed to *Diplectanum* Diesing, 1858, and a species of *Haliotrema* Johnson & Tiegs, 1922, are also described.

## Materials and methods

Specimens of three species of *Cephalopholis*, namely *C. argus* Bloch & Schneider, *C. boenak* (Bloch) and *C. sonnerati* (Valenciennes) (local names, respectively, "loche paon", "loche à bandes marrons" and "loche tomate", Laboute & Grandperrin, 2000) were caught with hand-lines on board the R/V 'Coris', or sometimes spear-fished, off New Caledonia (see list of specimens examined). *C. boenak* was collected mainly from shallow waters with muddy bottoms, but the two other species were collected from the barrier reef, about 20 km off the shore, especially on the external slope; this corresponds to the recorded habitats for these species (Laboute & Grandperrin, 2000; Randall, 2005). Live fish were kept in a container with seawater and immediately brought back to the laboratory. All fish were measured, weighed and photographed. A unique number (JNC) was assigned to each fish; for certain hosts, only the right gills were collected and the fish specimens were deposited in the ichthyological collection of the Muséum National d'Histoire Naturelle, Paris. The parasitological material was then assigned a corresponding JNC linked to the respective fish host. Measurements of hosts are indicated (generally as fork length, FL, and weight, W) for possible future comparison of parasite prevalence and host age in other localities, and because the monogenean fauna of serranids has been shown to change according to

**Table 1** Monogenes found in three species of *Cephalopholis* from off New Caledonia and Australia

| Species | New Caledonia | | Australia | |
|---|---|---|---|---|
| | Hosts examined | Results | Material | Results |
| *C. argus* | 3 fish | *Pseudorhabdosynochus argus* n. sp.<br>Capsalidae | 3 slides | *Pseudorhabdosynochus argus* n. sp. |
| *C. boenak* | 43 fish | No monogeneans | 3 slides | *Pseudorhabdosynochus* sp. |
| *C. sonnerati* | 3 fish | *Pseudorhabdosynochus minutus* n. sp.<br>*Diplectanum nanus* n. sp.<br>*Haliotrema* sp.<br>Capsalidae | None | No information |

fish size (Hinsinger & Justine, 2006a, b). In addition, slides made by Delane Kritsky from material collected off Heron Island, Queensland, Australia were examined.

*Fish examined*

*C. boenak*. 43 fish, all from Grande Rade (GR), 22°13′S, 166°24′ E, or Anse Vata (AV), 22°18′13″ S, 166°26′44″ E; for all specimens, size range was 110–230 mm and weight range was 22–164 g. JNC137–140, GR, 30 January, 2003, FL 150–190, W 50–100; JNC199, AV, 21 February, 2003, FL 110, W 22; JNC226–230, GR, 4 March, 2003, FL 190–230, W 102–152; JNC271–275, GR, 13 March, 2003, FL155–190, W 57–97; JNC291–295, GR, 19 March, 2003, FL 175–205, W 73–115; JNC337–339, GR, 27 March, 2003, FL 130–205, W 31–122; JNC713–721, GR, 16 July, 2003, FL 142–200, W 45–124; JNC1072–1074, GR, 1 April, 2004, FL 160–180, W 74–92; JNC1697–1702, GR, 9 January, 2006, FL 140–195, W 38–101; JNC1745, GR, 15 February, 2006, FL 160, W 51; JNC1846, AV, 12 May, 2006, FL155, W 57.

*C. argus*. 3 fish. JNC1425, Récif Toombo, 22°32′48S, 166°26′36E, 25 January, 2005, FL 300, W 380, fish specimen deposited in MNHN ichthyological collection; JNC1828, Fausse Passe de Dumbéa, 22°21′30″S, 166°15′20″E, 14 May, 2005, total length 401, W 348; JNC1836, Passe de Boulari, external slope, 22°29′30″S, 166°25′45″E, 18 May, 2006, total length 345, W 765.

*C. sonnerati*. 3 fish. JNC1614–15, off Île Amédée, 13–20 m depth, 22°28′30″S, 166°28′00″E, 19 September, 2005 (JNC 1614, FL 410, W 1400; JNC1615, FL280, W 1250), both fish specimens deposited in MNHN ichthyological collection; JNC1634, Passe de Boulari, 22°30′S, 166°28′E, 9 November, 2005, FL 305, W 550.

Gills were extracted and examined in seawater with a dissecting microscope. Live monogeneans were individually picked off the gills with fine needles and immediately prepared. Specimens were routinely processed for carmine staining, including initial flattening between a slide and a coverslip in ethanol (referred to as 'carmine' – see Justine, 2005a), according to Justine (2005a), or with ammonium picrate-glycerine, according to Malmberg (1957), but slightly modified (referred to as 'picrate' – see Justine, 2005a). 'Picrate' slides were made with a single or several worms; carmine slides were made with a single worm per slide for the preparation of the different monogenean species. A few specimens were also examined alive in seawater.

Monogeneans were drawn using a BH2 microscope equipped with a camera lucida and DIC optics. Measurements were taken on the pencil drawings with the help of a custom-made transparent rule, previously calibrated with a stage micrometer. Drawings were scanned and redrawn on a computer with Adobe Illustrator. Method of measurement of haptoral hard-parts (Fig. 1) is as in Justine (2005a); measurements of the right-hand haptoral hard-parts and left-hand equivalents were pooled. All measurements are given in micrometres as: the holotype and mean (except for the number of rodlets) followed by the range and number of measurements in parentheses. Measurements of ammonium picrate preparations and of specimens flattened in ethanol may vary significantly (Justine, 2005a) and are separated when indicated.

*Abbreviations*: MNHN, Muséum national d'Histoire Naturelle, Paris; BMNH, Natural History Museum, London; USNPC, United States National Parasite Collection, Beltsville; ZRC, Zoological Collection of the Raffles Museum, Singapore; c, carmine; p, picrate.

## *Pseudorhabdosynochus argus* n. sp.

*Type-host*: *Cephalopholis argus* Bloch & Schneider (Serranidae).

*Type-locality*: Barrier reef off Nouméa, New Caledonia.

*Site*: Between secondary gill lamellae.

*Type-specimens*: Holotype, JNC1425A10, Récif Toombo, 22°32′48S, 166°26′36E, 25 January, 2005.

*Material examined*: 51 specimens from New Caledonia: 26 'carmine' (c) mainly from JNC1425, 25 'picrate' (p) mainly from JNC1828. 3 specimens from Heron Island, Australia, collected 22 July, 2001, and mounted on slides by Delane Kritsky (Idaho University, Pocatello, USA).

*Material deposited*: Holotype (c) and 48 paratypes (23 c, 25 p), MNHN; 1 paratype (c), BMNH 2007.3.1.1; 1 paratype (c), USNPC 99680; 1 paratype (c), G227642 and 3 vouchers from Heron Island, G227643–227645, Queensland Museum, Brisbane.

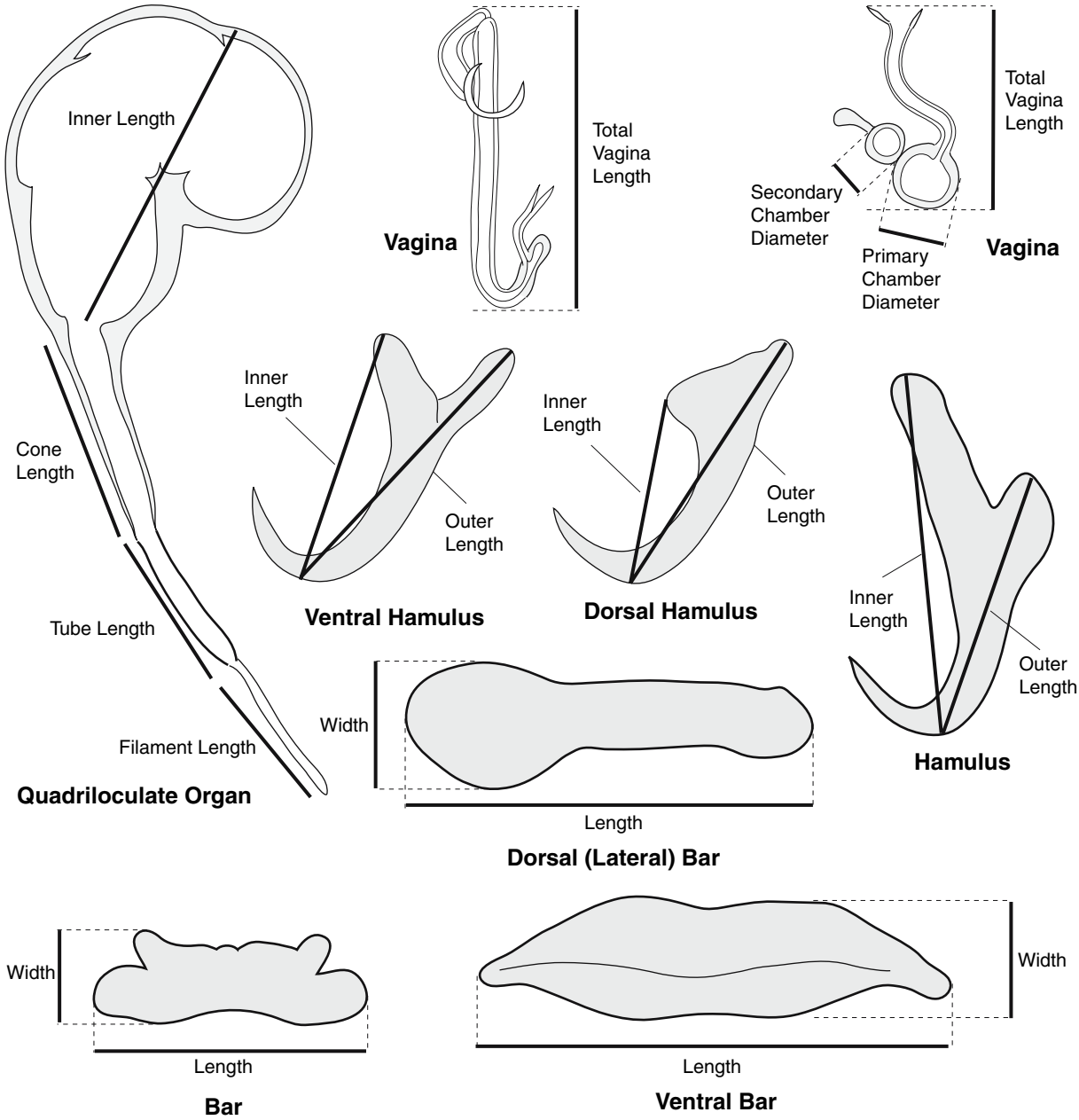


**Fig. 1** Methods of measurements used for sclerotised organs of *Pseudorhabdosynochus* spp. and *Haliotrema* spp

*Prevalence:* 100% (3/3).
*Intensity*: See Table 2. Maximum intensity for both gill sides evaluated to 58.
*Etymology*: From '*Argus*' (Latin), the name of a mythological monster; chosen after the name of the fish host.

Description (Figs. 2–4)

*Material from New Caledonia* (Figs. 2–3)
[Measurements are given separately for 'carmine' (c) and 'picrate' (p) specimens.] Body length 430, c 468 (330–630, n = 13), p 888 (750–1200, n = 16), width

**Table 2** Monogeneans found on *Cephalopholis sonnerati* and *C. argus* off New Caledonia

| *C. sonnerati* | Method | *P. minutus* n. sp. | *D. nanus* n. sp. | *Haliotrema* sp. | Capsalidae |
|---|---|---|---|---|---|
| JNC1614 | RGNE | 11 | 1 | 17 | 11 |
| JNC1615 | RGNE | 10 | 2 | 2 | 0 |
| Total (54) | | 21 (39%) | 3 (6%) | 19 (35%) | 11 (20%) |
| *C. argus* | Method | *P. argus* n. sp. | | | Capsalidae |
| JNC1425 | RGNE | 29 | | | 0 |
| JNC1828 | RGE | 23 | | | 1 |
| Total | | 52 | | | 1 |

RGNE: Right gill only, not exhaustive search; RGE: Right gill only, exhaustive search

*P.*: *Pseudorhabdosynochus*; *D.*: *Diplectanum*

200, c 203 (160–230, n = 15), p 260 (200–320, n = 16). Tegument scaly; posterior region with scales on ventral and dorsal faces from squamodiscs to level of ovary and testis. Anterior region with 3 pairs of head organs and 2 pairs of eye-spots; distance between outer margins of anterior eye-spot pair 42, c 41 (32–52, n = 11), of posterior eye-spot pair 41, c 40 (32–51, n = 11).

Haptor differentiated from rest of body, width 190, c 169 (140–190, n = 13), provided with 2 similar squamodiscs, 2 pairs of lateral hamuli, 3 bars and 14 marginal hooklets. Squamodiscs made up of rows of rodlets; rodlets similar in width in all rows except last row with very thin rodlets; ventral and dorsal squamodiscs similar, but ventral slightly larger; central rows form closed ovals; ventral squamodisc round in shape, length 58, 53 (48–58, n = 10), width 55, c 51 (47–55, n = 10), with 10 rows of rodlets and 1–2 closed ovals; dorsal squamodisc round in shape, length 50, c 49 (44–53, n = 7), width 50, c 47 (43–50, n = 7), with 11, 9–11 (n = 7) rows of rodlets. Ventral hamulus with thick handle and distinct guard, outer length 45, c 46 ± 1.4 (42–49, n = 27), p 53 ± 2.2 (47–56, n = 48), inner length 45, c 43 ± 1.9 (40–47, n = 30), p 44 ± 1.6 (38–46, n = 48). Dorsal hamulus with indistinct guard, outer length 42, c 42 ± 1.2 (39–44, n = 30), p 44 ± 1.2 (42–47, n = 48), inner length 26, c 25 ± 1.5 (23–29, n = 26), p 27 ± 1.2 (24–28, n = 48). Dorsal (lateral) bars straight, with flattened medial extremity and thick cylindrical lateral extremity, length 62, c 59 ± 2.3 (56–63, n = 30), p 68 ± 3.4 (57–73, n = 48), maximum width 21, c 18 ± 1.7 (15–23, n = 29), p 20 ± 1.6 (16–23, n = 48). Ventral bar flat, massive, with slightly constricted median portion and blunt extremities, length 77, c 73 (65–81, n = 15), p 79 (71–84), maximum width 19, c 18 (15–20, n = 15), p 20 (17–23, n = 24); groove visible on its ventral side.

Pharynx subspherical, length 43, c 41 (33–50, n = 14), width 40, c 40 (35–50, n = 14). Oesophagus apparently absent, such that intestinal bifurcation immediately follows pharynx. Caeca simple, terminate blindly at level of posterior margin of vitelline field.

Testis subspherical, intercaecal, length 65, c 63 (50–75, n = 9), width 65, 71 (60–90, n = 11). Vas deferens emerges from antero-sinistral part of testis, enlarges into seminal vesicle; seminal vesicle inconspicuous, in middle region of body, transforms into duct; duct forms bend then connects with quadriloculate organ. Prostatic reservoir conspicuous, connects with quadriloculate organ. Quadriloculate organ with fourth (posterior) chamber slightly more sclerotised than 3 anterior chambers; fourth chamber ends in elongate sclerotised cone, prolonged by sclerotised tube; end of tube prolonged by thin unsclerotised filament of variable length. Inner length of quadriloculate organ 39, c 39 (37–41, n = 11), p 58 (55–63, n = 24); cone length 22, c 20 (18–22, n = 15), p 22 (12–26, n = 24); tube length 18, c 18 (16–20, n = 15), p 20 (15–25, n = 24); tube diameter 2.5, c 3 (2–3, n = 7), p 3 (3–4, n = 24); filament length 28, c 0–30 (n = 15), p 0–45 (n = 24).

Ovary subequatorial, intercaecal, pre-testicular, encircles right caecum. Ovary width 50, c 67 (50–80, n = 11). Oviduct passes medially to form oötype, surrounded by Mehlis' gland; oötype short, opens into uterus. Uterus dextral. Unsclerotised vagina often inconspicuous, elongate (Fig. 3B,D). Duct from sclerotised vagina to oötype inconspicuous. Vitelline

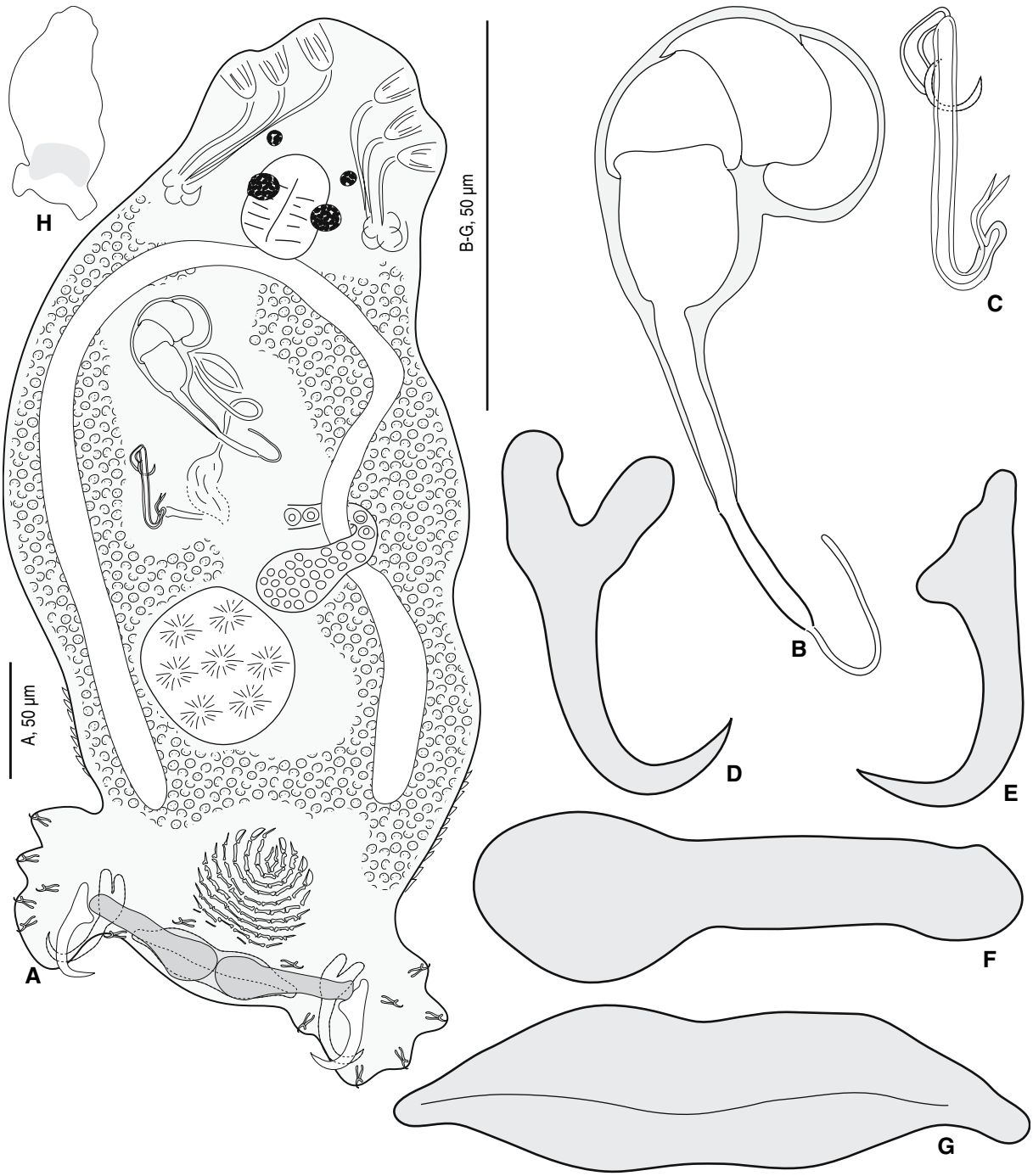


**Fig. 2** *Pseudorhabdosynochus argus* n. sp. from *Cephalopholis argus* off New Caledonia: A. Composite view of body, mainly from holotype, dorsal view; B. Male quadriloculate organ, holotype; C. Sclerotised vagina, holotype; D–G. Haptoral hard parts, picrate, paratype; D. Ventral hamulus; E. Dorsal hamulus; F. Dorsal bar; G. Ventral bar; H. Extent of tegumental scales, diagrammatic

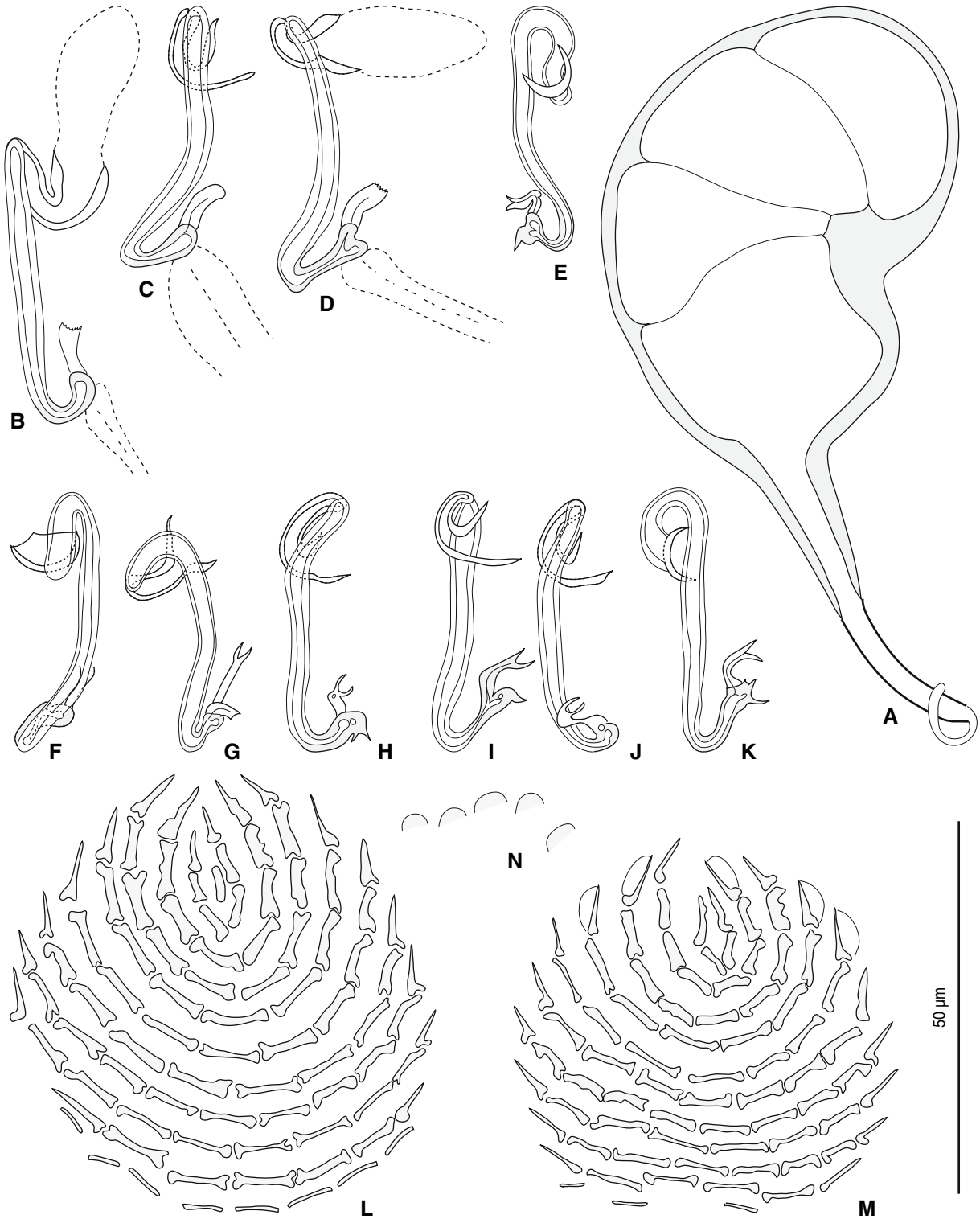


**Fig. 3** *Pseudorhabdosynochus argus* n. sp. from *Cephalopholis argus* off New Caledonia: A. Male quadriloculate organ, picrate, paratype; B–K. Sclerotised vagina, paratypes, all dorsal view except E,K, ventral; B–D. Picrate; E–K. Carmine; L. Ventral squamodisc, holotype, ventral view; M. Dorsal squamodisc, holotype, ventral view; N. Tegumental scales

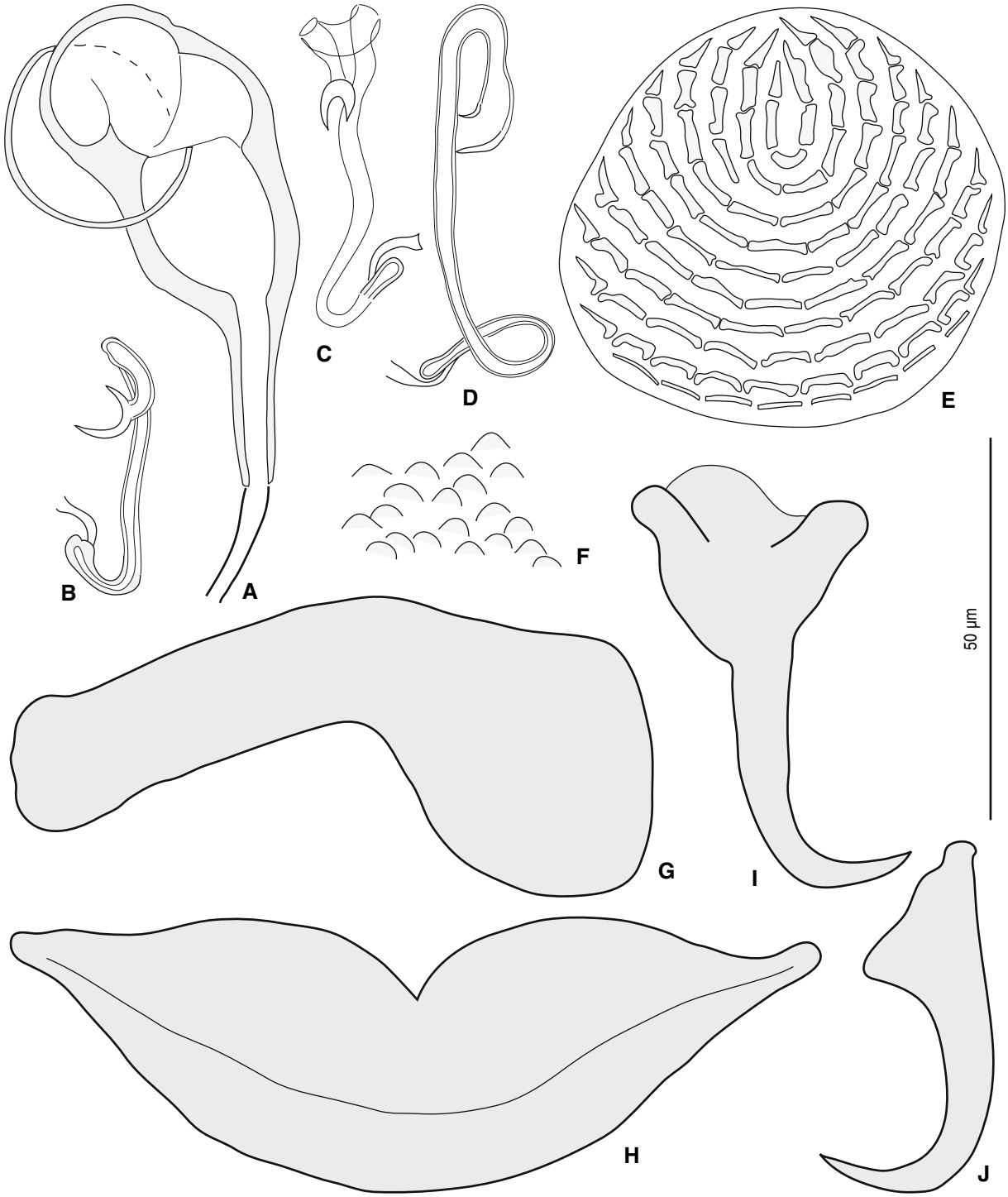


**Fig. 4** *Pseudorhabdosynochus argus* n. sp. from *Cephalopholis argus* off Heron Island, Australia: A. Male quadriloculate organ; B-D. Sclerotised vagina. A,D. Picrate. B,C. Gomori staining; E. Ventral squamodisc; F. Tegumental scales; G–J. Haptoral hard parts, picrate; G. Dorsal bar; H. Ventral bar; I. Ventral hamulus; J. Dorsal hamulus

fields extend posteriorly from posterior to pharyngeal level in 2 lateral bands, confluent in post-testicular region and terminate anterior to peduncle. Bilateral connections from vitelline fields to oötype inconspicuous. Egg not seen.

*Sclerotised vagina* (nomenclature of parts according to Justine, 2007). Sinistral, a complex sclerotised structure; aspect changes according to specimen and orientation (Fig. 3). Sclerotised vagina comprises anterior trumpet, followed by long primary canal, and distal sclerotised part; trumpet in continuity with unsclerotised vagina; canal coiled in its anterior part, just after trumpet, and curved in its posterior part, just before distal sclerotised part; canal continues into primary chamber; primary chamber in continuity with primary canal, more sclerotised than it but of similar external diameter; secondary chamber small, very close to primary chamber; both primary and secondary chambers embedded in same distal sclerotised part, thus secondary canal (between primary and secondary chamber) absent; small accessory structure, hollow, sclerotised, probably in continuity with secondary chamber, connects to distal sclerotised part. External and internal surface of sclerotised vagina smooth, but 2 'spines' sometimes visible on distal sclerotised part (Fig. 3H,K). Duct from sclerotised vagina to oötype connects to distal sclerotised part. Total length of sclerotised vagina (measured from extremity of trumpet to extremity of distal sclerotised part, i.e. not taking in account curved length along bend and coil of canal) 36, c 34 (31–37, n = 15), p 38 (35–41, n = 24). Orientation of sclerotised vagina: first bend with trumpet always anterior.

*Material from Heron Island, Australia* (Fig. 4)
[Description based on 2 slides stained with Gomori (g) and 1 picrate slide.] Body length 500–520, width 100–180. Ventral hooks, with morphology similar to New Caledonian specimens but guard and handle apparently linked in picrate specimen (probably effect of excessive flattening or maceration), outer length g 58 (n = 4), p 58 (n = 2), inner length g 53 (n = 1), p 44–50 (n = 2); dorsal hooks, outer length g 41–49 (n = 4), p 46–47 (n = 2), inner length g 32 (n = 1), p 29–30 (n = 2). Dorsal (lateral) bars, length g 66–74 (n = 3), p 83 (n = 2), width g 23–31 (n = 3), p 34 (n = 2). Ventral bar, length g 83 (n = 1), p108 (n = 1), width g 19 (n = 1), p 35 (n = 1). Squamodiscs observed in single specimen; ventral squamodisc length 52, width 54, with 10 rows of rodlets, no closed row; dorsal squamodisc length 41, width 45, with 10 rows of rodlets, no closed row. Last row of rodlets very thin as in New Caledonian material. Male quadriloculate organ very flattened in 2 specimens, but well preserved in single 'Gomori' specimen; morphology similar to New Caledonian specimens, particularly in long cone; inner length 43, cone length 20, tube length 18, tube diameter 3, no filament. Sclerotised vagina with morphology similar to New Caledonian specimens, total length g 33–41, p 51.

## Remarks

In the Australian material, measurements are generally greater than for the New Caledonian material for all organs, and especially the lateral (dorsal) bars are longer (83 *vs* 57–73 µm in 'picrate' material) and wider (34 *vs* 17–23 µm). However, the specimens are similar in the general morphology of the sclerotised parts, including the haptoral parts, number of rows in squamodiscs, characteristic long cone of the male quadriloculate organ and morphology of the sclerotised vagina. The material from Australia is thus considered conspecific with the New Caledonian material, and differences in measurements are attributed to intraspecific differences and different methods of preparation. Off Moorea, French Polynesia, no diplectanid was found infesting *C. argus* (see Lo & Morand, 2001).

## Differential diagnosis

Several species of *Pseudorhabdosynochus* have a sclerotised vagina similar to that of *P. argus* n. sp. in general structure, with an anterior trumpet, a primary canal with a bend in its anterior part, and posterior chambers connected to the distal extremity of the primary canal. In all these species, the male quadriloculate organ has a similar general structure, but differences can be detected in cone length.

*P. cupatus* (Young, 1969) from *Epinephelus fasciatus* (Forsskål), *P. calathus* Hinsinger & Justine, 2006 from *E. rivulatus* (Valenciennes), *P. cyathus* Hinsinger & Justine, 2006 from *E. howlandi* (Valenciennes) and *P. melanesiensis* (Laird, 1958) from *E. merra* Bloch, all members of, or close to, the 'cupatus group' (Hinsinger & Justine, 2006b) have a

grossly similar vagina, but the connection between the chambers and the canal is by antero-posterior lateral insertion, versus via a distal bend in *P. argus*. In addition, these species have very different squamodiscs, a shorter cone of quadriloculate organ (respectively 8, 9, 17 and 9 *vs* 20 µm in *P. argus*) and smaller haptoral parts (Justine, 2005a; Hinsinger & Justine, 2006b).

*P. lantauensis* (Beverley-Burton & Suriano, 1981) from *E. bruneus* Bloch and *E. longispinis* (Kner) has a vagina (see redescription in Justine, 2005a) that resembles *P. argus*, and the quadriloculate organ has also an elongate cone; however, the anterior part of the vagina is different, the squamodiscs have smaller numbers of rodlets and the cone is longer (25–30 *vs* 20 µm).

*P. hirundineus* Justine, 2005 from *Variola louti* (Forsskål) has a vagina with a dilate distal primary chamber and a lateral insertion of the secondary chamber; the quadriloculate organ is different with a short cone (Justine, 2005b).

*P. epinepheli* (Yamaguti, 1938) from *E. akaara* (Temminck & Schlegel) has a vagina of similar general morphology (see Kritsky & Beverley-Burton, 1986), but the chambers are larger and differ in shape.

*P. euitoe* Justine, 2007 from *E. maculatus* (Bloch) has a vagina with a sclerotised ring just behind the anterior trumpet and the shape of the chambers is different, with a very distinct, heavily sclerotised secondary chamber; the quadriloculate organ has a short cone (5 *vs* 20 µm in *P. argus*).

*P. huitoe* Justine, 2007 from *E. maculatus* has a vagina of similar general morphology, but the wall of the primary canal is thinner than in *P. argus* and the chambers are different, with a small but very distinct secondary chamber; the cone of the quadriloculate organ is shorter (10–15 *vs* 20 µm).

Finally, none of these species has a morphology of the sclerotised vagina exactly similar to that of *P. argus*, and each can be differentiated by additional features.

However, similarity in vaginal structures suggests relatively close phylogenetic relationships between *P. hirundineus, P. epinepheli, P. euitoe* and *P. argus*. The first of these species is from a species of *Variola*, and the latter three are from species of *Epinephelus*. This provides no argument in favour of a clade of *Pseudorhabdosynochus* species specific to members of *Cephalopholis*.

### *Pseudorhabdosynochus minutus* n. sp.

*Type-host*: *Cephalopholis sonnerati* (Valenciennes) (Serranidae).
*Type-locality*: Barrier reef off Nouméa, New Caledonia.
*Site*: Between secondary gill lamellae, deeply hidden between the lamellae (no part of the monogenean protruding).
*Type-specimens*: Holotype, JNC1615A2, off Île Amédée, 22°28′30″S, 166°28′00″E, 19 September, 2005.
*Material examined*: 21 specimens: 11 ‘carmine’ (c), 10 ‘picrate’ (p).
*Material deposited*: Holotype (c) and 18 paratypes (8 c, 10 p), MNHN; 1 paratype (c), BMNH 2007.3.1.2; 1 paratype (c), USNPC 99681.
*Prevalence*: 100% (3/3).
*Intensity*: See Table 2. Maximum calculated intensity on both gill sides: 22.
*Etymology*: The appellation *minutus* (Latin for small) refers to the small body size.

Description (Figs. 5–6)

[Measurements are given separately for ‘carmine’ (c) and ‘picrate’ (p) specimens.] Body length 230, c 278 (230–345, n = 11), p 363 (270–550, n = 4), width 92, c 111 (77–165, n = 11), p 131 (90–170, n = 4). Tegument scaly; posterior region with scales on ventral and dorsal faces from squamodiscs to level of ovary and testis. Anterior region with 3 pairs of head organs and 2 pairs of eye-spots; distance between outer margins of anterior eye-spot pair 18, c 22 (17–33, n = 9), of posterior eye-spot pair 18, c 18 (13–26, n = 9).

Haptor differentiated from rest of body, width 190, c 197 (107–225, n = 10), p 211 (185–240, n = 4), provided with 2 similar squamodiscs, 2 pairs of lateral hamuli, 3 bars and 14 marginal hooklets. Squamodiscs made up of rows of rodlets; rodlets similar in width in all rows except last row with very thin rodlets; central row sometimes forming closed ovals; ventral squamodisc round in shape, length 50,

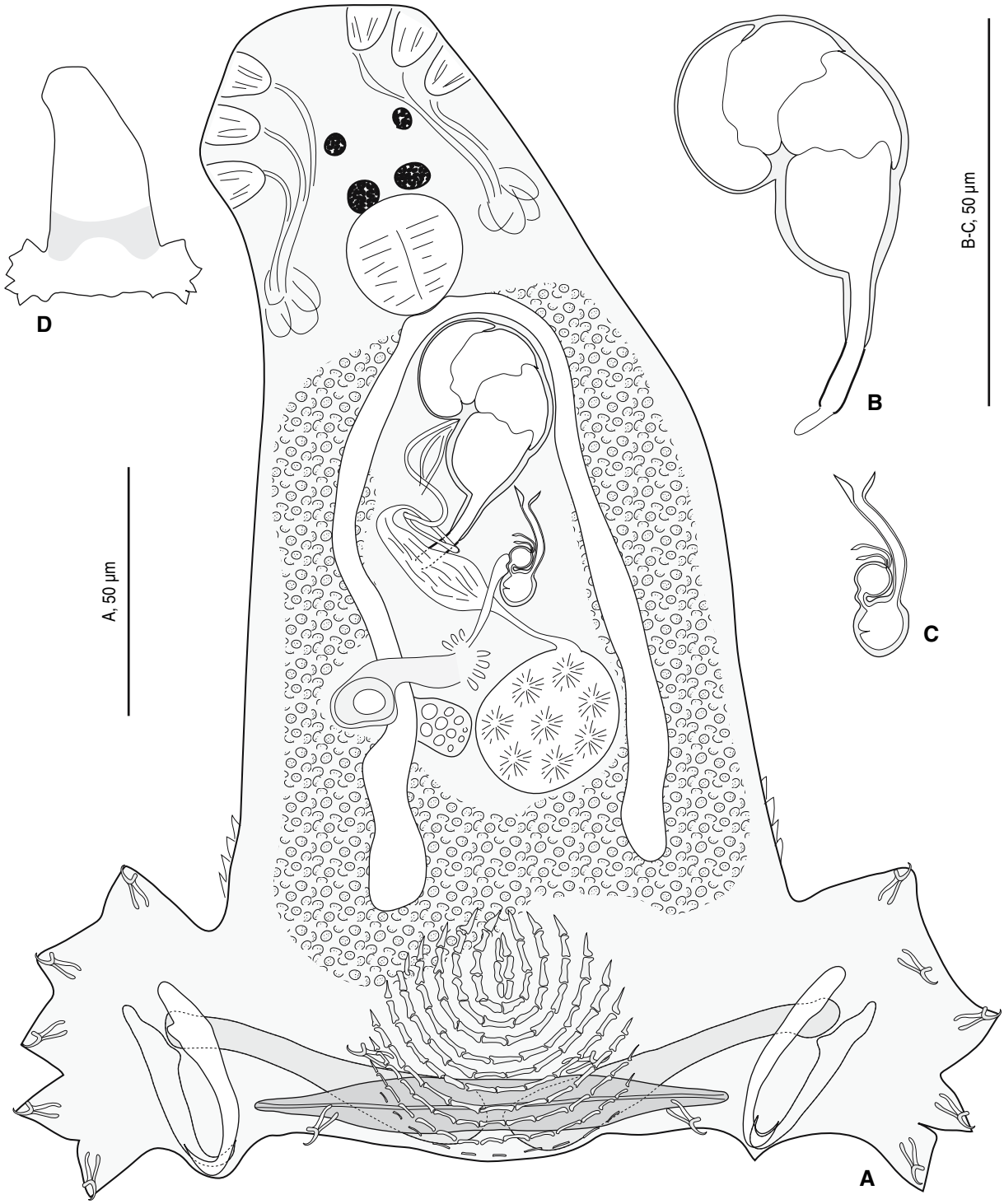


**Fig. 5** *Pseudorhabdosynochus minutus* n. sp. from *Cephalopholis sonnerati* off New Caledonia: A. Composite view of body, mainly from holotype, ventral view; B. Male quadriloculate organ, holotype; C. Sclerotised vagina, holotype; D. Extent of tegumental scales, diagrammatic

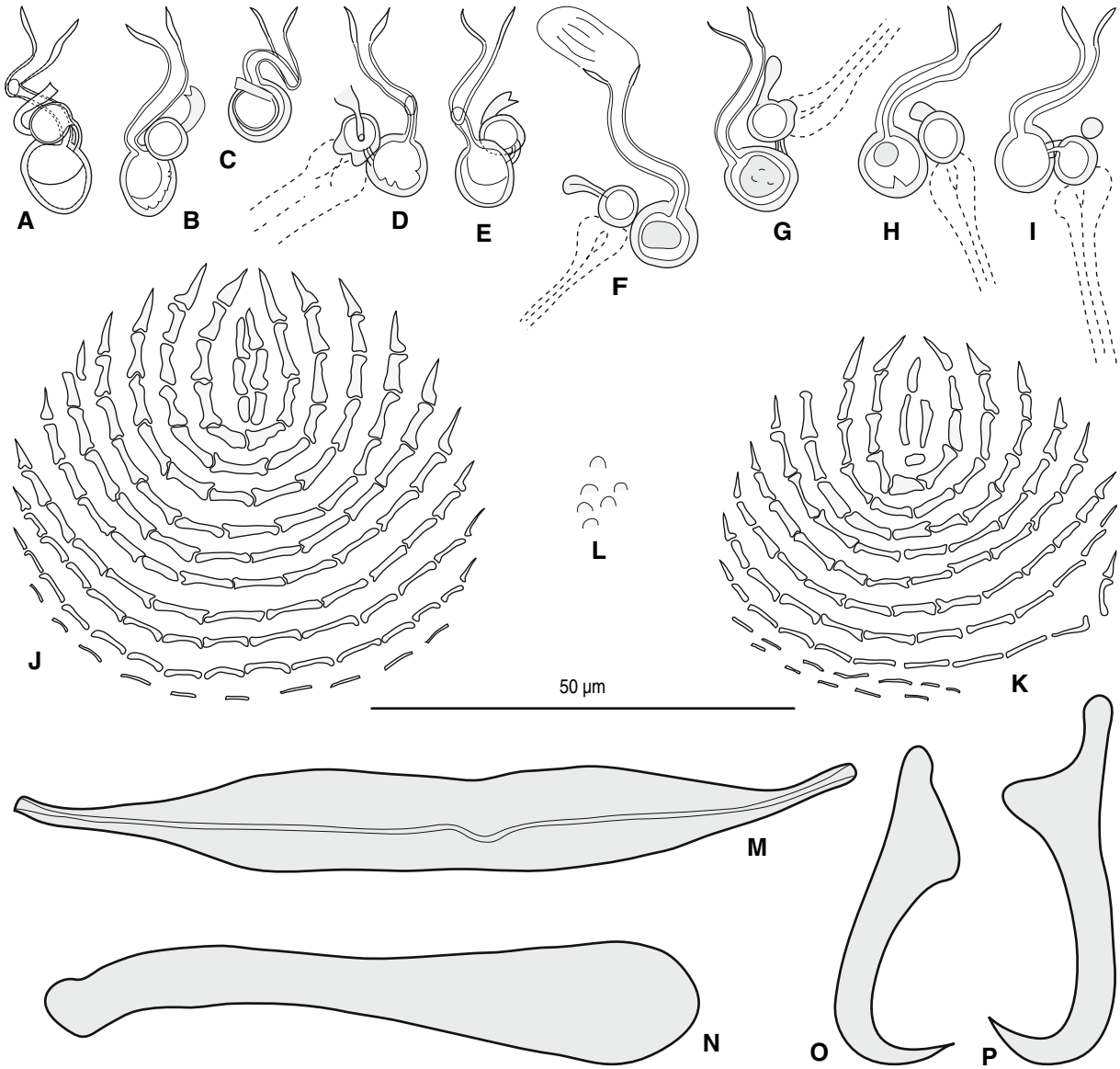


**Fig. 6** *Pseudorhabdosynochus minutus* n. sp. from *Cephalopholis sonnerati* off New Caledonia: A–I. Sclerotised vagina; A–E. Carmine; F–I. Picrate; E,H,I, dorsal view, others, ventral; J. Ventral squamodisc, holotype, ventral view; K. Dorsal squamodisc, holotype, ventral view; L. Tegumental scales; M–P. Haptoral hard parts, paratype, picrate; M. Ventral bar; N. Dorsal bar; O. Dorsal hamulus; P. Ventral hamulus

c 50 (43–58, n = 10), width 52, c 51 (48–55, n = 10), with 11, 10–11 (n = 10) rows of rodlets and 0–1 closed ovals; dorsal squamodisc round in shape, length 42, c 44 (40–52, n = 8), width 45, c 44 (38–48, n = 8), with 11, 10–11 (n = 8) rows of rodlets and 0–1 closed row. Ventral hamulus with distinct handle and guard, outer length 39, c 40 ± 1.9 (37–43, n = 21), p 44 (41–45, n = 18), inner length?, c 32 (30–33, n = 7), p 33 (30–38, n = 18). Dorsal hamulus with indistinct guard, outer length 37, c 37 ± 0.9 (35–39, n = 22), p 37, (35–39, n = 18), inner length 25, c 25 (23–27, n = 19), p 25 (23–26, n = 18). Dorsal (lateral) bars straight, elongate, with flattened medial extremity and cylindrical lateral extremity, length 68, c 67 ± 3.3 (57–73, n = 22), p 69 (63–76, n = 18), maximum width 12, c 12 ± 1.7 (8–13, n = 21), p 12

(9–15, n = 17). Ventral bar flat, thin, elongate, with slightly constricted median portion and pointed extremities, length 96, c 98 (93–105, n = 11), p 99 (93–104, n = 9), maximum width 11, c 10 (8–12, n = 11), p 10 (9–11, n = 9); groove visible on its ventral side and extending to both thin extremities.

Pharynx subspherical, length 23, c 23 (18–27, n = 10), width 24, c 23 (18–27, n = 10). Oesophagus apparently absent, such that intestinal bifurcation immediately follows pharynx. Caeca simple, terminate blindly at level of posterior margin of vitelline field.

Testis subspherical, intercaecal, length 25, c 35 (25–55, n = 10), width 27, c 43 (27–80, n = 10). Vas deferens emerges from antero-sinistral part of testis, enlarges into seminal vesicle; seminal vesicle in mid-region of body, forms bend, then transforms into duct; duct directed posteriorly, then reflexes to run anteriorly parallel to itself, then bends again and connects with quadriloculate organ. Prostatic reservoir conspicuous, connects with quadriloculate organ.

Quadriloculate organ with fourth (posterior) chamber more sclerotised than 3 anterior chambers; fourth chamber ends in sclerotised cone, prolonged by sclerotised tube; end of tube prolonged by thin unsclerotised filament of variable length. Inner length of quadriloculate organ 32, c 34 (29–36, n = 11), p 49 (45–53, n = 9); cone length 7, c 6 (5–8, n = 11), p 6 (4–7, n = 9); tube length 10, c 10 (8–10, n = 11), p 10 (6–14, n = 9); tube diameter 2.5, c 2 (2–2.5, n = 11), p 2 (2–2.5, n = 9); filament length 3, c 0–10 (n = 11), p 0–14, (n = 5).

Ovary subequatorial, intercaecal, pre-testicular, encircles right caecum. Ovary width 28, c 67 (50–80, n = 11). Oviduct passes medially to form oötype, surrounded by Mehlis' gland; oötype short, opens into uterus. Uterus dextral. Unsclerotised vagina often inconspicuous, oval (Fig. 6F). Unsclerotised duct from sclerotised vagina to oötype; no seminal receptacle seen. Vitelline fields extend posteriorly from posterior to pharyngeal level in 2 lateral bands, confluent in post-testicular region and terminate anterior to peduncle. Bilateral connections from vitelline fields to oötype inconspicuous. Egg not seen.

*Sclerotised vagina* (nomenclature of parts according to Justine, 2007). Sinistral, a complex sclerotised structure; aspect changes according to specimen and orientation (Fig. 6A–I). Sclerotised vagina comprises anterior trumpet, followed by primary canal and posterior chambers; unsclerotised vagina in continuity with trumpet; canal curved or coiled at mid-length; canal continues into primary chamber; primary chamber spherical, heavily sclerotised, sometimes with transverse line (or wall?) visible (Fig. 6A, B, E); secondary chamber spherical, ventral and superposed to primary chamber, communicates with primary chamber by very short secondary canal; small accessory structure, hollow, sclerotised, connects to secondary chamber. External surface of sclerotised vagina smooth; internal surface of primary chamber often with transverse line or with denticles. Total length of sclerotised vagina (measured from extremity of trumpet to extremity of primary chamber, i.e. not taking in account curved length along bend and coil of canal) 24, c 21 (16–25, n = 11), p 25 (24–30, n = 9); diameter of primary chamber 6.5, c 7 (6–7.5, n = 11), p 8 (7–8.5, n = 9); diameter of secondary chamber 5, c 5 (4.5–5, n = 10), p 5 (4.5–5, n = 9). Orientation of sclerotised vagina: trumpet always anterior.

## Differential diagnosis

Several species of *Pseudorhabdosynochus* have a sclerotised vagina similar to that of *P. minutus* n. sp. in general structure, with an anterior trumpet, a distinct primary canal, a large primary chamber and a highly visible secondary chamber.

*P. venus* Hinsinger & Justine can be differentiated by its much bigger (55 *vs* 21 µm) and more sclerotised vagina with different morphology, and, in addition, by the shape of the quadriloculate organ with very thin anterior wall, and by its shorter ventral bar (66 *vs* 99 µm).

*P. auitoe* Justine, 2007 can be differentiated, for the vagina, by the absence of bend in the primary canal and very different proportions and sizes of the chambers (primary chamber 16 *vs* 7 µm, secondary chamber 12 *vs* 5 µm) and, in addition, by the shape of the quadriloculate organ with very thin anterior wall.

*P. duitoe* Justine, 2007 can be differentiated by two chambers of similar diameters (*vs* dissimilar in *P. minutus*); its vagina has no bend in the canal and is more heavily sclerotised.

**Table 3** Body length of diplectanids from various epinephelines. Species ordered according to body length

| Species | Host | Length (μm) |
|---|---|---|
| *Diplectanum nanus* n. sp. | *Cephalopholis sonnerati* | 240 |
| *Pseudorhabdosynochus minutus* n. sp. | *Cephalopholis sonnerati* | 278 |
| *Pseudorhabdosynochus buitoe* | *Epinephelus maculatus* | 374 |
| *Pseudorhabdosynochus fuitoe* | *Epinephelus maculatus* | 395 |
| *Diplectanum uitoe* | *Epinephelus maculatus* | 405 |
| *Pseudorhabdosynochus cuitoe* | *Epinephelus maculatus* | 411 |
| *Echinoplectanum pudicum* | *Pseudorhabdosynochus leopardus* | 417 |
| *Pseudorhabdosynochus duitoe* | *Epinephelus maculatus* | 417 |
| *Pseudorhabdosynochus auitoe* | *Epinephelus maculatus* | 418 |
| *Pseudorhabdosynochus guitoe* | *Epinephelus maculatus* | 425 |
| *Pseudorhabdosynochus euitoe* | *Epinephelus maculatus* | 433 |
| *Pseudorhabdosynochus hirundineus* | *Variola louti* | 439 |
| *Laticola dae* | *Epinephelus maculatus* | 466 |
| *Pseudorhabdosynochus argus* n. sp. | *Cephalopholis argus* | 468 |
| *Pseudorhabdosynochus cupatus* | *Epinephelus fasciatus* | 478 |
| *Pseudorhabdosynochus caledonicus* | *Epinephelus fasciatus* | 480 |
| *Pseudorhabdosynochus huitoe* | *Epinephelus maculatus* | 500 |
| *Pseudorhabdosynochus melanesiensis* | *Epinephelus merra* | 514 |
| *Pseudorhabdosynochus calathus* | *Epinephelus rivulatus* | 536 |
| *Echinoplectanum leopardi* | *Pseudorhabdosynochus leopardus* | 570 |
| *Echinoplectanum chauvetorum* | *Pseudorhabdosynochus laevis* | 719 |
| *Pseudorhabdosynochus cyathus* | *Epinephelus howlandi* | 720 |
| *Echinoplectanum laeve* | *Pseudorhabdosynochus laevis* | 740 |
| *Pseudorhabdosynochus venus* | *Epinephelus howlandi* | 774 |

Additionally, *P. minutus* is differentiated from all other species by its very short body length (Table 3) and its characteristic shape, with a small body and relatively wide haptor.

Finally, *P. minutus* has some similarities with several *Pseudorhabdosynochus* species, which are all from members of *Epinephelus*, but seems relatively distant from them in terms of the morphology of its vagina, which has no close equivalent in other species.

### *Pseudorhabdosynochus* sp.

*Host*: *Cephalopholis boenak* (Bloch) (Serranidae).
*Locality*: Heron Island, Queensland, Australia.
*Site*: Between secondary gill lamellae.
*Material examined:* 3 specimens, collected 17 July, 2001, and mounted on slides by Delane Kritsky (Idaho University, Pocatello, USA).
*Material deposited*: 3 slides, vouchers, G227646–227648, Queensland Museum, Brisbane.
*Prevalence and intensity*: Unknown.

Description (Fig. 7)

[This material is briefly described from 2 slides.] Body length 240–320, width 70, haptor width 110. Tegument scaly on posterior part of body. Ventral hooks with visible guard and handle, outer length 29–32; dorsal hook with indistinct guard and handle, outer length 26–33, inner length 21–22; dorsal (lateral) bars with cylindrical medial extremity and flat external extremity, length 41–43, width 13–14; ventral bar flat, with constricted median part and pointed extremities, length 47–53, width 11–14. Ventral and dorsal squamodiscs (described from single specimen) similar, with central rows forming circles; ventral squamodisc, length 24, width 25, with 7 rows of rodlets including 2 closed rows; dorsal squamodisc, length 22,

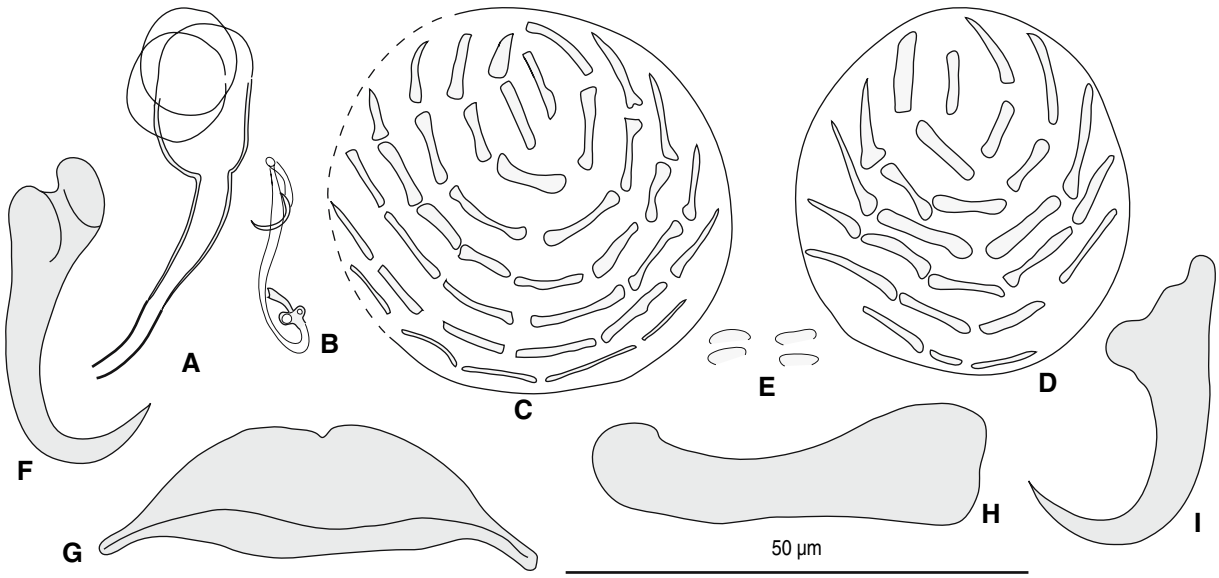


**Fig. 7** *Pseudorhabdosynochus* sp. from *Cephalopholis boenak* off Heron Island, Australia: A. Male quadriloculate organ; B. Sclerotised vagina; C. Ventral squamodisc, ventral view; D. Dorsal squamodisc, ventral view; E. Tegumental scales; F. Ventral hamulus; G. Ventral bar; H. Dorsal bar; I. Dorsal hamulus. A–D, gomori; E–I, picrate

width 21, with 7 rows of rodlets, no closed row. Quadriloculate organ not well flattened in available specimens, with elongate cone and tube; cone length 13, tube length 10, tube diameter 2. Sclerotised vagina in form of anterior trumpet, primary canal with anterior coil and posterior bend; distal part with 2 small chambers and accessory structure; total length 21.

Remarks

This material is briefly described to mention that a species of *Pseudorhabdosynochus* is present off Australia in *C. boenak*, in contrast with New Caledonia, where the examination of more than 40 fish specimens did not provide a single monogenean specimen (either diplectanid or otherwise).

The species resembles *P. argus* n. sp. in several aspects, including quadriloculate organ with an elongate cone and general aspects of haptoral parts, and is strikingly similar in general organisation of the sclerotised vagina. However, it differs from *P. argus* by smaller measurements of the body (length 240–320 *vs* 330–1,200 µm), haptoral parts (ventral hooks outer length 29–32 *vs* 42–57 µm), quadriloculate organ (cone length 13 *vs* 18–26 µm) and sclerotised vagina (length 21 *vs* 31–41 µm). The species generally resembles a dwarf *P. argus* and is probably closely phylogenetically related to this taxon, but it is evidently distinct and most probably corresponds to a new species.

### *Diplectanum nanus* n. sp.

*Type-host*: *Cephalopholis sonnerati* (Valenciennes) (Serranidae).
*Type-locality*: Barrier reef off Nouméa, New Caledonia.
*Site*: Between secondary gill lamellae, deeply hidden between the lamellae (no part of the monogenean protruding).
*Type-specimens*: Holotype, JNC1615A10, off Île Amédée, 220°28′30″S, 166°28′00″E, 19 September, 2005.
*Material examined:* 3 specimens in carmine.
*Comparative material examined*: *Diplectanum grouperi* Bu, Leong, Wong, Woo & Foo, 1999, paratype, 1 slide ZRC1998–960; *D. grouperi*, voucher, 1 individual, from *E. coioides*, Dapeng Bay, South China Sea, 18 April, 2004, collected by Bijian Zeng and Tingbao Yang, 1 slide MNHN JNA8A1; *D. uitoe* Justine, 2007, type-material.
*Material deposited*: Holotype (c) and 2 paratypes (c), MNHN.
*Prevalence*: 66% (2/3)

*Intensity*: See Table 2. Maximum calculated intensity on both gill sides: 4.
*Etymology*: The name *nanus*, a noun, Latin for dwarf, refers to the small body size.

Description (Fig. 8)

[Measurements are for holotype and 2 paratypes (in parentheses).] Body length 250 (230–240), width at level of ovary 85 (75–80). Tegument scaly, scales from posterior to level of ovary to squamodiscs. Anterior region with 3 pairs of head organs and 2 pairs of eye-spots; distance between outer margins of anterior eye-spot pair 20 (18), of posterior eye-spot pair 18 (22).

Haptor differentiated from rest of body, width 155 (130–155), provided with 2 dissimilar squamodiscs, 2 pairs of lateral hamuli, 3 bars and 14 marginal hooklets. Squamodiscs small, made up of rows of rodlets; central rows V-shaped, not forming closed rows; rows made up of minute rodlets, of similar width in all rows; ventral squamodisc distinctly larger than dorsal; ventral squamodisc round in shape, length 33 (27–28), width 32 (28–30), with 9 (9) rows of rodlets; dorsal squamodisc round in shape, length 21 (20–22), width 20 (19–20), with 7 (9) rows of rodlets. Ventral hamulus with distinct guard and handle (no specimen correctly oriented for drawing), outer length 34–36 (33–37). Dorsal hamulus with indistinct guard and handle, outer length 31–32 (28–32), inner length - (19). Dorsal (lateral) bars with flattened medial extremity and roughly cylindrical lateral extremity, length 47–53 (47–55), maximum width 8 (8–10). Ventral bar flat, with slightly pointed extremities, length 66 (67–69), maximum width 8 (7–10); groove visible on its ventral side.

Pharynx subspherical, length 23 (25), width 24 (25). Oesophagus and caeca inconspicuous in the material examined.

Testis indistinct. Sclerotised male copulatory organ (MCO) a small tubular penis; no accessory part. Penis 'spoon-shaped', a funnel, made up of anterior cone and straight posterior tube of regular diameter; tube oriented in same axis as cone. Within penis anterior cone, 4 very thin transverse walls limit 4 chambers. No posterior protruding cirrus seen. Penis length 24 (17); tube length 8 (6); tube diameter 2 (2).

Ovary subequatorial, visible as 2–3 large cells with large nuclei. Other canals and connection not seen. Vitelline fields on both sides of body, from posterior to level of pharynx to just anterior to squamodiscs.

Differential diagnosis and generic status

This species clearly belongs to a group of diplectanids which already includes *D. grouperi* Bu, Leong, Wong, Woo & Foo, 1999 and *D. uitoe* Justine, 2007. Justine (2007) commented that these species with a funnel-shaped penis are related, but that their generic status was uncertain. These species, by their spoon-shaped or funnel-shaped penis, are similar to *Laticola* Yang, Kritsky, Sun, Zhang, Shi & Agrawal, 2006, but the described species of *Laticola* have much larger male copulatory organs (Yang et al., 2006; Journo & Justine, 2006) and a characteristic vaginal structure. In *D. grouperi*, *D. uitoe* and *D. nanus* n. sp., the male copulatory organ is very small and the vagina is indistinct; these species are provisorily attributed to *Diplectanum* Diesing, 1858.

*D. nanus* n. sp. can be distinguished from *D. uitoe* by the smaller size of its MCO (24 *vs* 35 µm). Its MCO has a similar size to that of *D. grouperi* (21–26 µm). It can be distinguished from both other species by its very small body size (250 *vs* 405 in *D. uitoe* and 600–710 µm in *D. grouperi*), and very small squamodiscs with a small number of rows (7 *vs*13–14 in *D. uitoe* and 11–13 in *D. grouperi*). 'Spurs', as on the rodlets of *D. uitoe* (see Justine, 2007), were not seen in *D. nanus*.

The main characteristic of *D. nanus* is its very small body size, which is the smallest of all diplectanids from epinephelines examined and processed using the same method by the present author. See Table 3 and the discussion below on a possible trend toward dwarfism in monogeneans from *Cephalopholis* spp.

### *Haliotrema* sp.

*Type-host*: *Cephalopholis sonnerati* (Valenciennes) (Serranidae).
*Type-locality*: Barrier reef off Nouméa, New Caledonia.

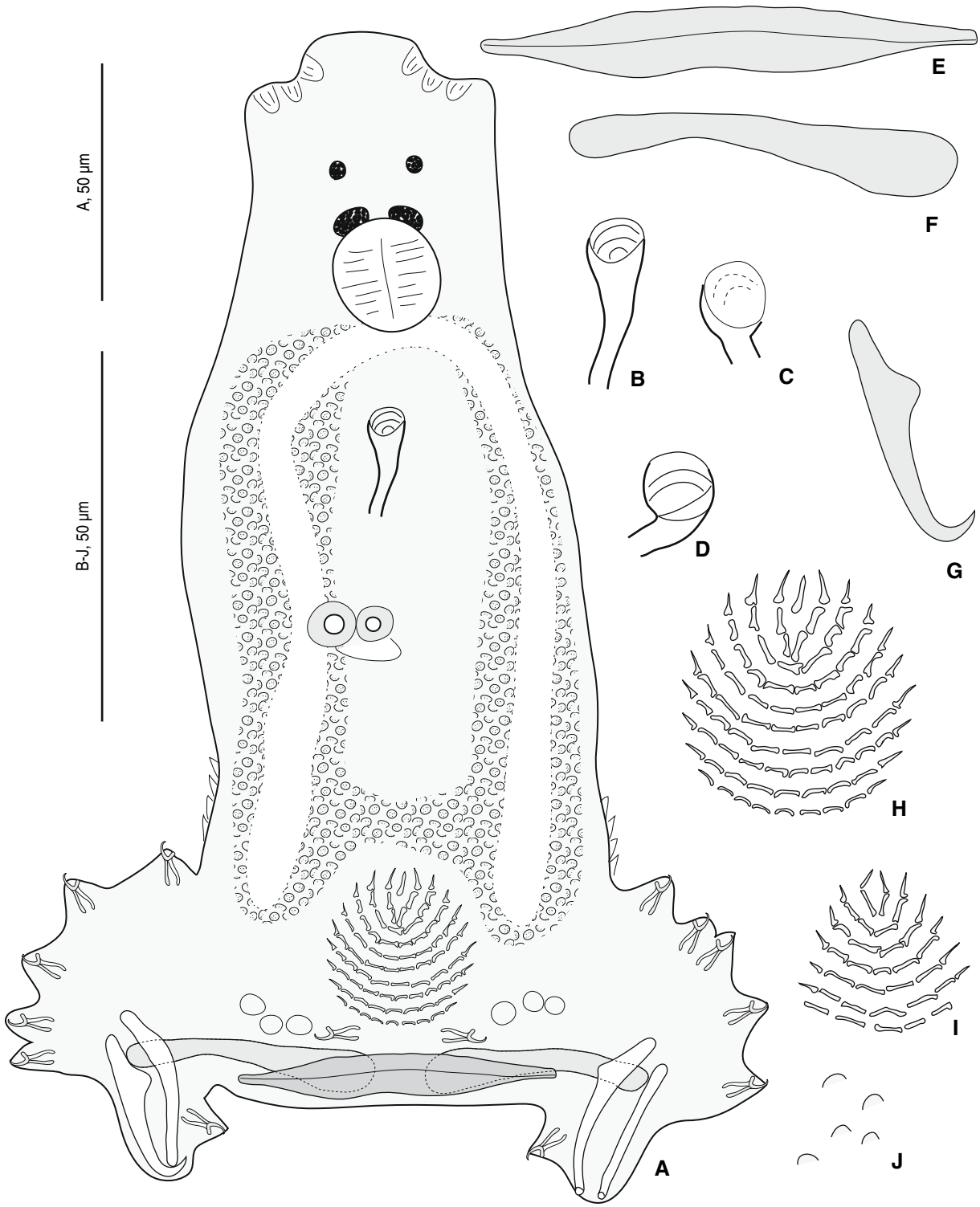


**Fig. 8** *Diplectanum nanus* n. sp. from *Cephalopholis sonnerati* off New Caledonia: A. Composite view of body, mainly from holotype, ventral view; B. Male copulatory organ, holotype; C–D. Male copulatory organ, paratypes; E–G. Haptoral hard parts, carmine; E. Ventral bar; F; Dorsal bar; G. Dorsal hamulus; H. Ventral squamodisc, holotype, ventral view; I. Dorsal squamodisc, holotype, ventral view; J. Tegumental scales

*Site*: Between secondary gill lamellae, deeply hidden between the lamellae (no part of the monogenean protruding).
*Material examined:* 4 specimens in picrate.
*Comparative material examined*: *Haliotrema cromileptis* Young, 1968, from *Cromileptes altivelis*, JNC1363, female, FL 580, W 3700, and JNC1364, male, FL 530, W 2900, both caught 28 September, 2004, Passe de Dumbéa, 22°21′30″S, 166°15′20″E, 6 specimens in picrate. New Caledonia is a new geographical record for this species. *Haliotrema* sp. of Justine (2007) from *Epinephelus maculatus*, MNHN material.
*Material deposited*: 9 specimens in picrate (from JNC1614, 1615, 1634) and 16 specimens in carmine (from JNC1614–1615).
*Prevalence*: 100% (3/3)
*Intensity*: See Table 2. Maximum calculated intensity for both gill sides: 34

Description (Fig. 9)

[Reduced to short description and measurements of sclerotised parts of penis and haptor from picrate specimens.] Body length 440–800 (n = 4). Sclerotised penis a long sclerotised cylinder with wider basal part, followed by long distal elongate part, apparently unsclerotised; length of sclerotised part 75–95 (n = 5), length of unsclerotised part 78–90 (n = 4), total length 163–185. Dorsal hamuli similar in shape to ventral hamuli but longer. Ventral hamuli, inner length 41 (38–42, n = 14), outer length 33 (31–36, n = 14). Dorsal hamuli, inner length 45 (42–46, n = 14), outer length 37 (35–38, n = 14). Ventral transverse bar straight with central notch, width 32 (28–36, n = 6). Dorsal bar straight, width 32 (32–33, n = 3).

Note on *H. cromileptis* Young, 1968

[Reduced to short description and measurements of sclerotised parts.] Body length 1,040. Sclerotised penis a long sclerotised cylinder with wider basal part, followed by short distal elongate part, apparently unsclerotised; length of sclerotised part 120–155 (n = 5), length of unsclerotised part 8 (n = 1), total length 131. Dorsal hamuli similar in shape to ventral hamuli but longer. Ventral hamuli, inner length 75–78, outer length 60. Dorsal hamuli, inner length 58–61, outer length 78–80. Ventral transverse bar straight with central notch, width 52. Dorsal bar straight with bifurcate extremities, width 58.

The morphology of the penis of the material from New Caledonia is very similar to the original description of the species from the same host off Heron Island, Australia (Young, 1968) and to the redescription of Zhang, Yang & Liu (2001) from the same host in South China Sea. The length of the sclerotised penis is 154–176 μm in the original description and *c*.96 μm for the Chinese material.

Remarks

This species is not formally described here because the material available did not permit the description of the soft parts of the anatomy.

Young (1968) proposed a classification, dividing *Haliotrema* spp. in six groups; the present species, together with *H. cromileptis* Young, 1968, *H. epinepheli* Young, 1968, *H. holocentri* Young, 1968 and *Haliotrema* sp. of Justine (2007), corresponds to Young's Group 5, characterised by the penis being a straight tube without an accessory piece; species of this group are parasites of serranids and holocentrids.

*Haliotrema* sp. can be easily differentiated from *H. epinepheli* because the morphology of the penis is different in the latter species, which has a characteristic distal flap, and from *Haliotrema* sp. of Justine (2007) by the size of the sclerotised part of penis (75–95 *vs* 37 μm) and its shape, which is much more elongate.

Both *Haliotrema* sp. from *C. sonnerati* and *H. cromileptis* have a penis in the form of a very long thin tube. Comparison with *H. cromileptis* from New Caledonia clearly show that the measurements are different for body length, the penis (75–95 *vs* 120–155 μm for the sclerotised part, 163–185 *vs* 131 μm for total length) and the haptoral parts (half as long as in *H. cromileptis*); additionally, the ventral bars exhibit very different morphologies.

The present report of a new species with an elongate, tubular penis confirms Young's (1968) interpretation and suggests that a distinct clade of *Haliotrema* species is specific to epinephelines.

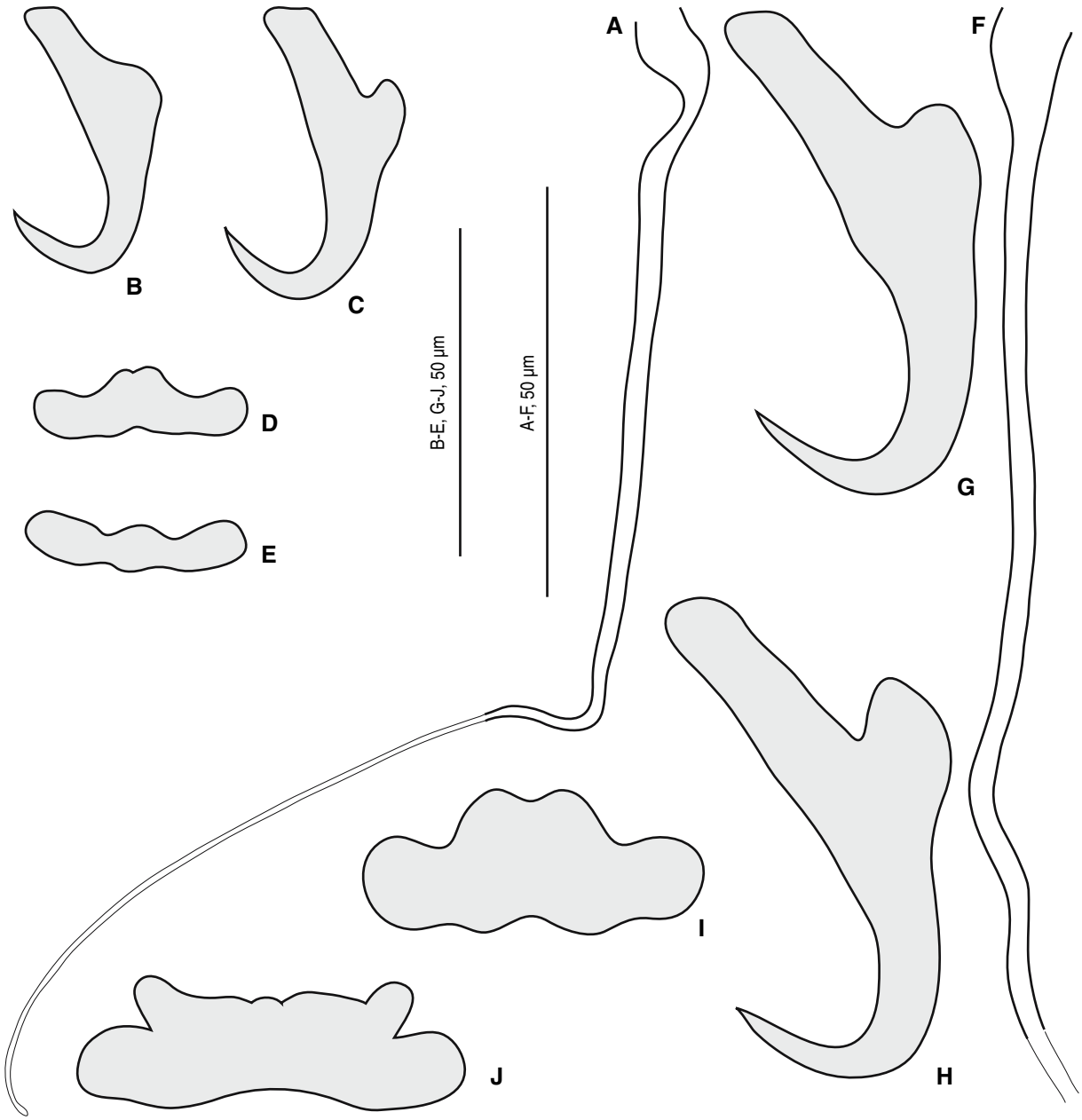


**Fig. 9** *Haliotrema* n. sp. from *Cephalopholis sonnerati* off New Caledonia (A–E) and *Haliotrema cromileptis* Young, 1968 from *Cromileptes altivelis*, New Caledonia (F–J). A, F. Male copulatory organ; B, G. Ventral hamulus; C, H. Dorsal hamulus; D, I. Ventral bar; E, J. Dorsal bar

## Remarks on species of diplectanids from *Cephalopholis* and other epinephelines

*Cephalopholis* is the second genus of the Epinephelinae after *Epinephelus* in the number of species. In a recent molecular phylogeny (Craig et al., 2001), the epinephelines were grouped in three clades: a basal clade with *Plectropomus*, *Rypticus* and *Pogonoperca*; a monophyletic clade of *Cephalopholis* spp. (with the inclusion of *Paranthias colonus*), which is the sister group to a large clade containing many *Epinephelus* spp. and species from several other genera. In a

recent work, Justine & Euzet (2006) demonstrated that the diplectanids from *Plectropomus* belong to *Echinoplectanum* Justine & Euzet, 2006 and suggested that *Echinoplectanum* is basal to all diplectanids from epinephelines. Thus, it would be tempting to distinguish a clade of *Pseudorhabdosynochus* specific to *Cephalopholis*, and to analyse its relationships with diplectanids from the other major epinepheline clade which includes *Epinephelus*.

The three species of *Pseudorhabdosynochus* from members of *Cephalopholis* described here can be allocated to two groups: a group with *P. argus* n. sp. and *P.* sp. from *C. boenak*, two species with a similar vaginal structure close to that found in several species from *Epinephelus*; and *P. minutus* n. sp., which has a more distinctive vaginal structure, but is, however, not very different from parasites of *Epinephelus* spp. However, the description of these new species gives no support in favour of a clade of species specific to *Cephalopholis*. Furthermore, *Diplectanum nanus* n. sp. is close to species described in *Epinephelus* spp. and thus also provides no support for this notion.

Therefore, for the diplectanids of epinephelines, it seems that only a distinction between a basal clade, *Echinoplectanum* (in *Plectropomus*) and a wide terminal clade, including *Pseudorhabdosynochus*, *Diplectanum* and *Laticola* (in *Epinephelus*, *Cephalopholis*, *Mycteroperca* and *Variola*) can be established. Only the basal node separating *Plectropomus* from the other epinephelines is reflected in the diplectanid host preferences. Even this limit is not strict, because a member of *Echinoplectanum* is found on a species of *Epinephelus* (see Justine & Euzet, 2006) and members of *Laticola* are found on centropomids and on a species of *Epinephelus* (see Journo & Justine, 2006).

Table 3 compares body length in a series of species collected and processed using the same method; it does not include measurements taken from the literature, since specimen processing can greatly alter body length (Justine, 2005a). Two of the species described here, *P. minutus* and *D. nanus*, both from *C. sonnerati*, are the smallest in Table 3. In addition, the *Haliotrema* species from *C. sonnerati* is also very small. During the collection of monogeneans, it was noted that all species from *C. sonnerati* were inserted deeply between the gill lamellae, i.e. with no part of the body protruding from the lamellae, as it is usually the case for diplectanids and ancyrocephalids of serranids. A general trend toward dwarfism seems to exist in the two unrelated diplectanid species and the ancyrocephalid from *C. sonnerati*. *P.* sp. from *C. boenak*, and an undescribed new species of *Diplectanum* from *C. urodeta* (unpublished results), are also very small. This suggests that something in the structure of the gill-filaments in several *Cephalopholis* spp. imposes selection toward small body sizes for monogeneans. However, this trend is not apparently pertinent to *P. argus* n. sp. from *C. argus*, which falls in the middle range of Table 3.

## Other gill parasites from *Cephalopholis* spp. off New Caledonia

In addition to the monogeneans described here, *C. argus* and *C. sonnerati* had unidentified capsalids, *C. argus*, *C. sonnerati* and *C. boenak* had gnathiid isopod larvae, and *C. sonnerati* had unidentified copepod larvae. *C. boenak* from New Caledonia is remarkable in the absence of both monogeneans and copepods on the gills, a situation rarely encountered among epinephelines.

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