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VERSITA

Diplectanum parvus sp. nov. (Monogenea, Diplectanidae) from *Cephalopholis urodeta* (Perciformes, Serranidae) off New Caledonia

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Abstract

Diplectanum parvus sp. nov. is described from the coral reef fish *Cephalopholis urodeta* collected off New Caledonia, South Pacific, and is the first diplectanid described from this fish. The new species has a very small male copulatory organ (24 µm in length) and a minute body (246 µm in length) and is close to *D. nanus* Justine, 2007 from which it can be distinguished by the shape of dorsal bars and various measurements. These species belong to a group of diplectanids found in groupers (Serranidae, Epinephelinae), characterised by small funnel-shaped male copulatory organs and no sclerotized female organs. The attribution of these parasites to *Diplectanum* Diesing is provisional. Other parasites are briefly listed.

Résumé

Diplectanum parvus sp. nov. est décrit du poisson de récif corallien *Cephalopholis urodeta* pêché en Nouvelle-Calédonie, et est le premier Diplectanidae décrit de ce poisson. La nouvelle espèce a une organe copulateur mâle (long de 24 µm) et un corps (long de 246 µm) très petits et est proche de *D. nanus* Justine, 2007 dont elle peut être différenciée par la forme des barres dorsales et diverses mesures. Ces espèces appartiennent à un groupe de Diplectanidae parasites de mérous (Serranidae, Epinephelinae), caractérisés par des organes copulateurs mâles petits en forme d'entonnoir et l'absence d'organes sclérifiés femelles, qui sont attribués provisoirement à *Diplectanum* Diesing. Les autres parasites sont brièvement mentionnés.

Keywords

Monogenea, Diplectanidae, *Diplectanum parvus* sp. nov., Serranidae, *Cephalopholis urodeta*, New Caledonia

Introduction

Diplectanids of groupers (Serranidae, Epinephelinae) belong to four genera. Most species belong to *Pseudorhabdosynochus* Yamaguti, 1958 (list in Justine 2007a); species of *Echinoplectanum* Justine et Euzet, 2006, are restricted to members of *Plectropomus* (see Justine and Euzet 2006); two species of *Laticola* Yang *et al*., 2006 have been described (Journo and Justine 2006, Sigura and Justine 2008); and four species of uncertain generic status have been attributed to *Diplectanum* Diesing, 1858 (Bu *et al*. 1999; Justine 2007a, b; Justine and Sigura 2007). The present paper describes an additional species of '*Diplectanum*' from the darkfin hind, *Cephalopholis urodeta*, which is the first diplectanid described from this fish.

Cephalopholis urodeta has a wide geographic distribution in the Indian and Pacific Oceans, from the coast of Africa to French Polynesia and the Pitcairn Islands, and from Southern Japan to New Caledonia (Randall 2005); in New Caledonia, it is common in the outer slope of the barrier reef (Laboute and Grandperrin 2000). The fish is of limited interest as a food fish because of its small size but has a market as an aquarium fish (Heemstra and Randall 1993).

Materials and methods

Darkfin hinds, *Cephalopholis urodeta* (Forster, 1801), were line-fished around the barrier reef off Nouméa, New Caledonia. Twenty-five specimens, ranging from 155 to 221 mm in fork length and from 61 to 175 g in weight, were collected from May 2003 to October 2006 near Récif Le Sournois (14 specimens; 22°31′30″S, 166°26′30″E), Récif To (7; 22°29′30″S, 166°26′E), Récif Toombo (3; 22°26′10″S, 166°33′00″E) and Passe de Mato (1; 22°39′30″S, 166°37′E).

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For specimen JNC1212, only the right gills were collected and the fish was deposited in the ichthyological collection of the MNHN, as MNHN 2004-2170. Measurements of the hosts are indicated 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 fish size (Hinsinger and Justine, 2006; Sigura and Justine 2008). The fishes were kept in a container with seawater and immediately brought back to the laboratory. 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') or with ammonium picrate-glycerine (referred to as 'picrate') (Justine 2005). 'Picrate' slides were made with a single or several worms; carmine slides were made with a single worm per slide. Monogeneans were drawn with a microscope equipped with a camera lucida and differential interference contrast 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. Methods of measurement of haptoral hard-parts are as in Justine (2005, 2007a, b); measurements of the right-hand haptoral hard-parts and left-hand equivalents were pooled. All measurements are given in micrometres. Measurements are indicated as the mean of the whole sample of specimens and standard deviation, then in parentheses the range and the number of measurements. Measurements of ammonium picrate preparations and of specimens flattened in ethanol may vary significantly (Justine 2005) and are separated when indicated.

Description of squamodiscs: A new method for the description of squamodiscs is proposed here (also used by Sigura and Justine 2008). Squamodiscs are made up of numerous rows of rodlets; a detailed drawing provides information on a single specimen but does not account for intraspecific variation. Squamodiscs, observed with a differential interference microscope under oil immersion, were either drawn in detail or schematically drawn (a short line for each rodlet); counts of rodlets in each row were tabulated, in a series of numbers. In Tables, each number of a line shows the total number of rodlets in each row, the first number representing the anteriormost (innermost) row and the last number the posteriormost (outermost) row. Incomplete rows are indicated by 'i'. The total number of rows (excluding incomplete rows) and the total number of rodlets are also shown for each squamodisc. This tabulation method provides, in a compact format, detailed information on the structure of squamodiscs including intraspecific variations, and is useful for comparing species. Only squamodiscs in excellent conditions are used, but specimens with a single good squamodisc can be used. The method is best explained by comparing a line in a Table and the actual drawing of the same squamodisc: see Table I and Figure 1G, H.

Abbreviations: MNHN – Muséum National d'Histoire Naturelle, Paris; BMNH – Natural History Museum, London; USNPC – United States National Parasite Collection, Belts-

Table I. *Diplectanum parvus* sp. nov., rodlets in squamodiscs

Specimen		Number of rodlets in each row (from innermost to outermost row)	Total number of complete rows	Total number of rodlets
**a	vs	i2-7-7-8-10-7-7-7-7-4	9	66
d	vs	i2-8-10-9-8-11-10-8-9-7	9	82
h	vs	5-i3-10-10-8-9-8-7-5-4	9	69
i	vs	8-8-7-8-i3-10-8-8-9-8	9	77
j	vs	i2-6-9-8-9-8-12-8-i2-9-6-4	10	83
k	vs	i3-6-8-7-6-8-8-5-7-4	9	62
l	vs	i3-6-8-7-10-11-8-i3-7-5	8	68
*m	vs	i3-6-10-8-9-9-8-9-9-4	9	75
n	vs	i2-7-7-9-9-8-8-9-8-4	9	71
q	vs	7-i3-8-7-9-7-8-7-6-2	9	64
b	ds	i3-4-5-6-5-5-5-7-7-5	9	52
c	ds	i3-4-5-6-6-6-7-7-5	8	49
e	ds	4-7-7-6-7-7-6-5-5-3	10	57
f	ds	2-5-7-8-8-9-9-10-6-6	10	70
g	ds	4-i4-5-6-6-8-9-7-4	8	53
i	ds	4-6-8-6-7-9-8-8-6	9	62
j	ds	i2-4-6-8-7-7-8-8-7-7	9	64
k	ds	i2-4-7-7-6-6-6-7-7-4	9	56
*m	ds	i2-5-5-7-7-7-7-8-7-5-2	10	62
n	ds	i1-4-5-8-8-9-9-8-6-4	9	62
o	ds	i1-5-6-6-8-8-9-8-9-5-3	10	68
	vs	ventral squamodisc, mean 72 rodlets (62–83, n = 10)		
	ds	dorsal squamodisc, mean 60 rodlets (49–70, n = 11)		

*Drawn in Figure 1; **holotype. For certain specimens, only one squamodisc could be examined.

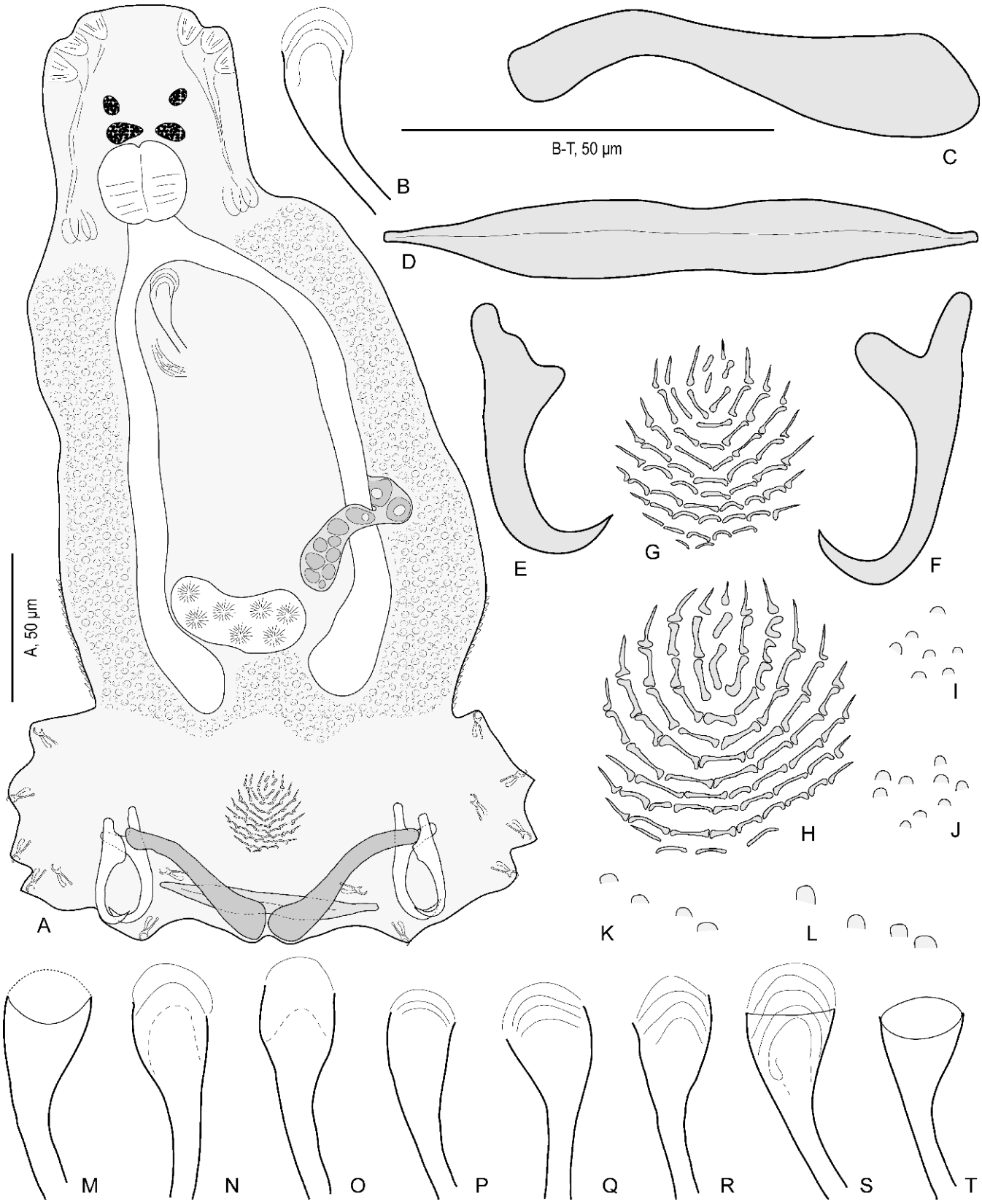

Fig. 1. *Diplectanum parvus* sp. nov. from *Cephalopholis urodeta*: **A.** Composite view of body, mainly from holotype, dorsal view; tegumental scales drawn only on edges. **B.** Male copulatory organ, holotype. **C.** Dorsal (lateral) bar. **D.** Ventral bar. **E.** Dorsal hamulus. **F.** Ventral hamulus. **G.** Dorsal squamodisc. **H.** Ventral squamodisc, same individual, dorsal view. **I, K.** Dorsal tegumental scales. **J, L.** Ventral tegumental scales. **M-T.** Male copulatory organs, from 8 specimens. A, G-J, M-P, carmine; C-F, K, L, Q-T, picrate; B, holotype, C-T, paratypes

ville; SAMA AHC – South Australian Museum Adelaide, Australian Helminthological Collection; c – carmine; p – picrate.

Results

Family Diplectanidae Bychowsky, 1957
Genus *Diplectanum* Diesing, 1858

***Diplectanum parvus* sp. nov.** (Fig 1)

Description: Measurements are separated for holotype (h), 'carmine' (c) and 'picrate' (p) specimens. Body elongate: length h 320, c 245 ± 42 (178–330, n = 28), p 350 ± 43 (260–450, n = 25), width at level of ovary h 85, c 104 ± 19 (65–145, n = 28), p 167 ± 37 (100–230, n = 22). Tegument scaly, tegumental scales on ventral and dorsal surfaces from level of squamodiscs to level of ovary; tegumental scales small, c 2 in width (carmine), slightly larger in picrate. Anterior region with 3 pairs of head organs and 2 pairs of eyespots; distance between outer margins of anterior eye-spot pair h 28, c 25 ± 5.6 (16–40, n = 23), of posterior eye-spot pair h 26, c 23 ± 5.6 (14–35, n = 24); inner margins of posterior pair often in contact.

Haptor differentiated from rest of body, wider than body, width h 170, c 156 ± 17 (120–190, n = 28), p 208 ± 29 (165–260, n = 26), provided with 2 dissimilar squamodiscs, 2 pairs of lateral hamuli, 3 bars and 14 marginal hooklets. Squamodiscs small, with small rodlets; central rodlets often disturbed, not forming regular row; other rodlets forming regular rows; central rows never forming closed circles; ventral squamodisc round in shape, length h 36, c 36 (32–43, n = 17), width h 34, c 36 (31–40, n = 17), with 8–10 (generally 9) rows of rodlets (n = 17), total number of rodlets h 66, 72 (62–83, n = 10, see Table I); dorsal squamodisc round in shape, length c 26 (20–31, n = 15), width c 25 (21–30, n = 15), with 8–10 (generally 9) rows of rodlets (n = 10), total number of rodlets 60 (49–70, n = 11, see Table I). Ventral hamulus with distinct guard and handle, outer length h 40, c 40 ± 1.4 (36–43, n = 49), p 42 ± 1.3 (39–45, n = 59), inner length h 32, c 33 ± 1.3 (30–38, n = 42), p 33 ± 1.2 (30–36, n = 58). Dorsal hamulus with indistinct guard and handle, outer length h 35, c 35 ± 1.6 (30–38, n = 51), p 36 ± 1.0 (34–38, n = 60), inner length h 22, c 23 ± 1.6 (19–26, n = 33), p 23 ± 1.3 (20–25, n = 58). Dorsal (lateral) bars curved, with flattened medial extremity and cylindrical lateral extremity, length h 58, c 61 ± 3.3 (55–68, n = 56), p 66 ± 2.6 (60–72, n = 59), maximum width h 12, c 12 ± 1.5 (9–15, n = 55), p 13 ± 1.6 (10–16, n = 58). Ventral bar flat, elongate with thin extremities, length h 73, c 82 ± 6.6 (72–99, n = 25), p 85 ± 4.6 (77–93, n = 29), maximum width h 8, c 10 ± 1.4 (7–12, n = 25), p 11 ± 1.1 (9–14, n = 29); groove visible on ventral side.

Pharynx subspherical, length h 27, c 24 (16–35, n = 22), width h 29, c 24 (16–35, n = 22). Oesophagus apparently absent, such that intestinal bifurcation immediately follows pharynx. Caeca simple, terminate blindly at level of posterior margin of vitelline field.

Testis generally inconspicuous, subspherical, intercaecal, length h 30, c 36 (30–42, n = 4), width h 40, c 27 (12–40, n = 4). Small seminal vesicle sometimes visible, posterior to sclerotized male copulatory organ (MCO). Sclerotized 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 or slightly oblique. Within penis anterior cone, 4 very thin transverse walls limit 4 chambers. Penis length h 25, c 24 ± 2.8 (17–29, n = 20), p 25 ± 1.2 (21–28, n = 29); tube diameter h 3, c 3 (3–3, n = 15), p 3 ± 0.6 (3–5, n = 29).

Ovary often inconspicuous, subequatorial, intercaecal, pre-testicular, encircles right caecum. Ovary width h 55, c 47 (24–75, n = 5). Oviduct passes medially to form ootype; ootype short, opens into uterus. Uterus dextral. 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

Table II. Measurements of species resembling *Diplectanum parvus* sp. nov.

	D. grouperi	***D. uitoe***	***D. maa***	***D. nanus***	***D. parvus***
Host	*Epinephelus coioides*	*Epinephelus maculatus*	*Epinephelus malabaricus*	*Cephalopholis sonnerati*	*Cephalopholis urodeta*
Body length	641	405	475	240	246
MCO length	26	35	36	24	24
Ventral hamulus outer length	44*	37	46	35	40
Dorsal hamulus outer length	37*	33	41	31	35
Dorsal bar length	50*	58	57	50	61
Ventral bar length	70*	75	72	67	82
Ventral squamodisc length × width	44 × 38**	61× 58	33 × 30	30 × 30	36 × 36
Dorsal squamodisc length × width	44 × 38**	57 × 53	33 × 34	21 × 20	26 × 25
Ventral squamodisc rodlet number	?	124	65	84	72
Dorsal squamodisc rodlet number	?	111	64	41	60

Measurements are generally means from carmine specimens; *from redescription by Justine (2007a); **dorsal and ventral squamodiscs measurements not separated in original description.

fields to ootype inconspicuous. Egg *in utero*, elongate, 110 (98–132) × 59 (52–67), n = 4.

Type-host: *Cephalopholis urodeta* (Forster, 1801) (Serranidae).

Type-locality: Lagoon of New Caledonia.

Site: Between secondary gill lamellae.

Type-specimens: Holotype, carmine, JNC1856A5, 6 June 2006, Récif Le Sournois, 22°31´30˝S, 166°26´30˝E, New Caledonia.

Material examined: 59 specimens: 29 'carmine' (c), 30 'picrate' (p).

Material deposited: Holotype (c) and 25 paratypes (25 c in 25 slides, 30 p in 12 slides), MNHN; 1 paratype (c), BMNH 2008.1.4.1; 1 paratype (c), USNPC 100490; 1 paratype (c), SAMA AHC 29463.

Comparative material examined: *Diplectanum nanus* Justine, 2007, holotype and 1 paratype (MNHN), with additional observations on squamodiscs (Table III).

Prevalence: 68% (17/25).

Intensity: up to 40 monogeneans per fish (3 cases), but often only 1–3 monogeneans per fish (14 cases).

Etymology: Latin for little refers to body size.

Generic status: This species belongs to a group of diplectanids from groupers (Epinephelinae), which already includes four species: *D. grouperi* Bu, Leong, Wong, Woo et Foo, 1999 from *Epinephelus coioides* off Malaysia and South China, *D. uitoe* Justine, 2007 from *Epinephelus maculatus*, *D. nanus* Justine, 2007 from *Cephalopholis sonnerati*, and *D. maa* Justine et Sigura, 2007 from *Epinephelus malabaricus* (the three latter from New Caledonia) (Bu *et al*. 1999; Justine 2007a, b; Justine and Sigura 2007).

In this group, no sclerotized female organs are present and the sclerotized male copulatory organ (MCO) is a spoon-shaped or funnel-shaped penis. In the shape of MCO, species of this group are similar to members of *Laticola* Yang, Kritsky, Sun, Zhang, Shi et Agrawal, 2006, but the described species of *Laticola* have much larger male copulatory organs (Yang *et al*. 2006; Journo and Justine 2006) and a characteristic vaginal structure, not seen in this group. Some members of *Laticola* have sclerotized vaginal structures (Journo and Justine 2006, Sigura and Justine 2008). The species of this group (see Table II) are provisionally attributed (Justine 2007a, b; Justine and Sigura 2007) to *Diplectanum* Diesing.

In Table II, two subgroups may be distinguished on the basis of body size: 'large' species (*D. grouperi*, *D. uitoe* and *D. maa*) and small species (*D. nanus* and *D. parvus*). Justine (2007b) remarked that species of diplectanids (*Pseudorhabdosynochus* spp. or *D. nanus*) from members of *Cephalopholis* were small in comparison to diplectanids from other genera of groupers, and hypothesized that something in the gill structure of *Cephalopholis* spp. imposed selection toward small body sizes for monogeneans. *D. parvus* is as small as *D. nanus* (body length 246 vs 240). Unfortunately, such small body sizes make observation of internal structure difficult; the testes and ovaries are particularly inconspicuous in these two species.

Differential diagnosis: *D. parvus* can be distinguished from the two 'large' species of Table II, *D. uitoe* and *D. maa*, by its smaller MCO (24 vs 35 and 36).

Diplectanum parvus has a MCO of similar length to *D. grouperi*, the third 'large' species; it can be distinguished from this species by its much smaller body size (246 vs 641); measurements of haptoral parts and squamodiscs are also different.

Diplectanum parvus shares with *D. nanus* similar body lengths (246 vs 240) and MCO lengths (24 vs 24). The two species are similar, but can however be distinguished by the shape of dorsal (lateral) bars (curved in *D. parvus*, straight in *D. nanus*), and measurements of ventral hamuli (outer length 40 vs 35), dorsal hamuli (outer length 35 vs 31), dorsal bars (length 61 vs 50) and ventral bar (length 82 vs 67). The squamodiscs were thoroughly compared, with additional observations on two specimens of *D. nanus* (Table III): the numbers of rodlets in the dorsal squamodiscs are distinctive (49–70 vs 41–44), but they overlap in the ventral squamodiscs (62–83 vs 67–84); however, squamodiscs are larger in *D. parvus* (36 × 36 and 26 × 25 vs 30 × 30 and 21 × 20).

Other parasites of *Cephalopholis urodeta*

This species is a small grouper of limited commercial importance and it is not surprising that reports on its parasites are very scarce. Dyer *et al*. (1989) recorded *Pseudohaliotrema sphincteroporus* Yamaguti, 1953 from *C. urodeta* (under its synonym *C. urodelus*, mistyped *udodellus*) in Okinawa, Japan, but this is a misidentification (Lim 2002, Kritsky and Galli 2007) and the specimens deposited in USNPC are unidentifiable (Kritsky and Galli 2007). No ancyrocephalid or capsalid monogeneans were found in our specimens of *C. urodeta* from New Caledonia, and *D. parvus* is the first diplectanid mentioned from this fish. In addition, we also collected isopod gnathiid larvae and unidentified copepods on the gills.

Table III. *Diplectanum nanus* Justine, 2007, rodlets in squamodiscs. Holotype, from figure 8 of Justine (2007b); paratype, new observations

Specimen		Number of rodlets in each row (from innermost to outermost row)	Total number of complete rows	Total number of rodlets
Holotype	vs	i1-6-8-10-10-10-10-11-9-9	9	84
Paratype	vs	5-8-8-9-8-9-8-7-5	9	67
Holotype	ds	4-6-6-7-6-7-5	7	41
Paratype	ds	4-5-5-6-6-5-6-5-2	9	44

Cribb *et al*. (2002) listed a single digenean species for *C. urodeta*, the opecoelid *Opoecoelus mexicanus* Manter, 1940, but considered this record as erroneous for a fish of the Indo-West Pacific. In New Caledonia, limited examinations of the intestine provided a single unidentified digenean, unidentified anisakid nematode larvae and tetraphyllid larvae. No philometrids were found in the eye (Moravec and Justine 2005). In the body cavity, cysts with larvae were identified by I. Beveridge as *Floriceps minacanthus* Campbell et Beveridge, 1993 (Trypanorhyncha, Lasiorhynchidae).

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