Trypanorhynch cestodes (Platyhelminthes) parasitic in elasmobranchs and crustaceans in Moreton Bay, Queensland

Ian BEVERIDGE [1] & Bjoern C. SCHAEFFNER [2]

[1]Faculty of Veterinary and Agricultural Science, University of Melbourne, Veterinary Clinical Centre, Werribee, Victoria 3030, Australia. Email: ibeve@unimelb.edu.au.

[2]Institute of Parasitology, Biology Centre, Czech Academy of Sciences, České Budějovice, Czech Republic

Citation: Beveridge, I. & Schaeffner, B.C. 2018. Trypanorhynch cestodes (Platyhelminthes) parasitic in elasmobranchs and crustaceans in Moreton Bay, Queensland. *Memoirs of the Queensland Museum – Nature* 61:109-142. Brisbane. ISSN 2204-1478 (Online). ISSN 0079-8835 (Print). Accepted: 5 June 2018. First published online: 22 November 2018.

https://doi.org/10.17082/j.2204-1478.61.2018.2017-13

LSID urn:lsid:zoobank.org:pub:AFF9A603-D9F2-4BF9-BB2A-8F9443D786E8

ABSTRACT

Examination of 64 elasmobranchs comprising 13 species from Moreton Bay yielded 13 identifiable species of cestodes of the order Trypanorhyncha Diesling, 1863. Two new species, *Dollfusiella armata* sp. nov. from *Maculabatis toshi* (Whitley, 1939) and *M. cf. astra* Last, Manjaji-Matsumoto and Pogonoski, 2008, and *Dollfusiella pilosa* sp. nov. from *Aetobatus ocellatus* (Kuhl, 1823) are described. *Prochristianella odonoghuei* Beveridge, 1990 becomes a junior synonym of *Prochristianella butlerae* Beveridge, 1990 based on identical strobilar and tentacular morphologies. *Prochristianella omunae* Beveridge and Justine, 2010 is reported from Australia for the first time, where it was recovered from the type host *Neotrygon trigonoides* (Castelnau, 1873). Additional new host records are included as well as extensions of known geographical distributions to now include south-eastern Queensland. Metacestodes were recovered from the digestive glands of yabbies, *Trypaea australis* (Dana, 1852), representing an undescribed species of *Dollfusiella*. Adults of this species were found in the spiral valves of *N. trigonoides* and *Ae. ocellatus*. Six species of metacestodes of trypanorhynch cestodes were recovered from the digestive glands of pistol shrimps, *Alpheus* spp. (*A. richardsoni* Yaldwyn, 1971 and *A. papillosus* Banner & Banner, 1982). Of these, three were identified as *Parachristianella monomegacantha* Kruse, 1959, *Prochristianella aciculata* Beveridge and Justine, 2010 and *Zygorhynchus robertsoni* Beveridge and Campbell, 1988, the adults of all three species being originally reported from batoids. Two undescribed species of *Dollfusiella* and undescribed species of *Parachristianella* and *Zygorhynchus* were also recovered from alpheid shrimps; definitive hosts were identified for each species, but the material available was insufficient to allow formal descriptions. ❒ *Cestoda, Trypanorhyncha, elasmobranchs, Callianassidae, Alpheidae, life cycles, new species.*

Although the trypanorynch cestode fauna of the Australian region is better known than in many other regions of the world (Beveridge *et al.* 2017b), much of the collecting upon which current reports are based has been opportunistic. The only defined region of the continent which has been relatively intensively studied is that of the South Australian Gulfs, with the elasmobranch species examined summarised in Beveridge (1987). However, the results from this region are contained in various publications (e.g. Beveridge 1990; Beveridge & Campbell 1987, 1988a, 1996; Beveridge & Sakanari 1987; Campbell & Beveridge 1996; Palm & Beveridge 2002) with no current synthesis of the data available from these studies. Studies on the trypanorhynch fauna of Moreton Bay have been extremely limited to date. Beveridge (1990) reported a number of species of eutetrarhynchids from batoids in Moreton Bay, while Beveridge and Campbell (1988a) described *Shirleyrhynchus butlerae* Beveridge and Campbell, 1988 from *Hemitrygon fluviorum* (Ogilby, 1908) and recorded *Callitetrarhynchus gracilis* (Rudolphi, 1819) from the same host species (Beveridge & Campbell 1996). Palm and Beveridge (2002) also reported tentaculariid trypanorhynchs from elasmobranchs and teleosts both within Moreton Bay and from the oceanic coast of North Stradbroke Island. However, there has been no systematic collecting of trypanorhynch cestodes in this region to date.

The current report is part of an examination of the trypanorhynch fauna of Moreton Bay, Queensland. In an earlier publication, the larval trypanorhynch species in teleost fishes were reported (Beveridge *et al.* 2017a). In this paper, we report the adult species of trypanorhynchs encountered in elasmobranchs from Moreton Bay together with limited observations on intermediate stages present in crustaceans.

MATERIALS AND METHODS

Elasmobranchs, mainly batoid rays, were collected from a commercial fishery in Moreton Bay in November 2011, and January and June 2016. Photographs and/or tissue samples were collected from each fish to confirm identifications if necessary. Host specimens were identified primarily using the keys and descriptions in Last and Stephens (2009). In the case of any elasmobranchs whose identity was uncertain, entire specimens were deposited in the Queensland Museum (QM). Elasmobranch host nomenclature follows Last *et al.* (2016). In instances where host names have changed since the original publication, the original name is also cited in the text. Authorities for elasmobranch species listed in Table 1 are not repeated in the text. Collection localities within Moreton Bay are shown in Fig. 1. To avoid repetition, localities mentioned in the text are assumed to be within Moreton Bay.

Spiral valves were opened along the dorsal midline. Representative cestodes visible were removed and placed on microscope slides in saline. A cover slip was placed over them and pressure was applied to the coverslip with fine forceps to force the eversion of tentacles. The specimens were flooded with 70% ethanol while maintaining pressure to keep the tentacles everted. Once fixed, the cestodes were stored in ethanol. The remaining spiral valve and its contents were flooded with hot saline, followed immediately with either 70% ethanol or 10% formalin. Spiral valves fixed in formalin were subsequently transferred to 70% ethanol for storage. Cestodes were removed from spiral valves and stored in 70% ethanol. Some scoleces with everted tentacles were mounted in Hoyer's medium. Entire cestodes were stained in Celestine Blue, destained in 70% acid alcohol, dehydrated in an ethanol series, cleared in methyl salicylate and mounted in Canada balsam.

Specimens selected for scanning electron microscopy were dehydrated in ethanol, transferred to hexamethyldisilazane and allowed to dry. They were mounted on stubs with carbon tape, coated with gold and examined using a FEI Nova NanoSEM 450 FEG field emission gun scanning electron microscope using an accelerating voltage of 3-10 Kv. Microthrix terminology follows Chervy (2009).

Crustaceans (*Trypaea australiensis* Dana, 1852, *Alpheus richardsoni* Yaldwyn, 1971 and *Al. papillosus* Banner & Banner, 1982) were collected at low tide on mud flats at Wynnum (November 2011) and Dunwich (May 2010, January and June 2016) in areas where batoids feed at high tide. Localities are shown in Fig. 1. Each crustacean was dissected individually, any metacestodes present in the digestive glands were placed on a microscope slide in saline, pressure was applied to a coverslip to evert tentacles and then the slide was flooded with 70% ethanol. Subsequently, metacestodes were stored in 70% ethanol and were mounted in a similar fashion to the adult cestodes. Several heavily infected digestive glands were fixed in 10% neutral buffered formalin. They were then embedded in paraffin and sectioned at a thickness of 5 µm. Sections were stained with haematoxylin and eosin.

Several species of crabs collected at Wynnum were also examined for metacestodes. These comprised 11 *Metopograpsus frontalis* Miers, 1880, 3 *Ancylocheles gravelei* (Sankolli, 1963), 1 *Leptodius exeratus* (H. Milne Edwards, 1834) and 1 *Macromedaeus crassimanus* (H. Milne Edwards, 1867).

All cestode specimens collected have been deposited either in the QM or in the South Australian Museum, Adelaide (SAM).

Terminology for the anatomical features of the cestodes follows Pintner (1913) and Dollfus (1942). The names of the genera *Parachristianella* Dollfus, 1946 and *Prochristianella* Dollfus, 1946 are abbreviated as '*Para.*' and '*Pro.*' respectively to avoid confusion. Measurements are included for species in which they provide novel information. Measurements were made with an ocular micrometer and are presented in millimetres unless otherwise indicated. In instances where only one or two specimens were available, individual measurements are provided. In cases where additional specimens were available, the measurements are presented as the range followed, in parentheses, by the mean and the number of specimens measured.

In the case of the tentacular armature of very small species, at the limits of resolution of the light microscope and without specimens suitably cleaned for scanning electron microscopy, photographs of the tentacles were taken and measurements were made from the photographs. In these instances, measurements are presented in micrometers, to one decimal point of accuracy.

Identifications of known species are supported by confirmatory illustrations and measurements wherever possible. Instances in which this has not been possible are indicated. The extent of morphological information included in current descriptions depended upon the completeness of information already published. Essentially, additional morphological information has been provided only in instances where it contradicts or adds to data already published.

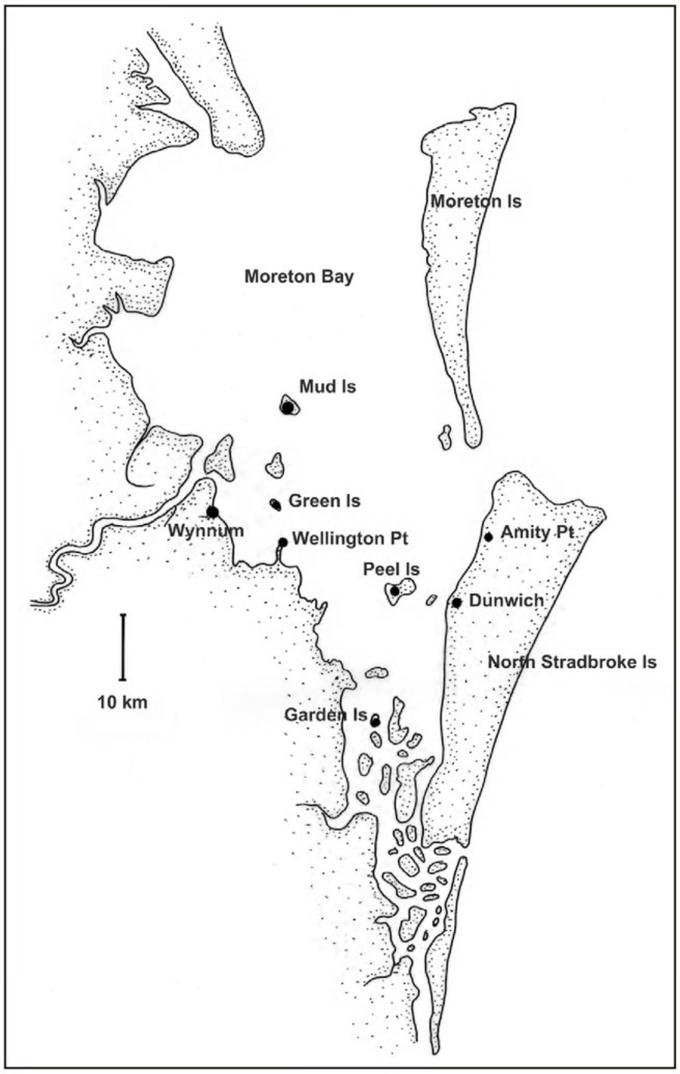


FIG. 1. Moreton Bay region of south-eastern Queensland showing principal collecting localities. Scale bar = 10 km.

Trypanorhynch taxonomy at the superfamily level follows Palm (2004). Family level nomenclature is either unstable or under question (Beveridge *et al.* 2017b) and therefore only superfamily and generic allocations are utilised here.

Within the Eutetrarhynchoidea, genera and species are presented in alphabetical order.

Terminology for prevalence and intensity follows Bush *et al.* (1997).

TABLE 1. Elasmobranchs from Moreton Bay, Queensland, examined for trypanorhynch cestodes.

Host order		Family	Species	N
Selachoidea				
	Carcharhiniformes	Carcharhinidae	*Carcharhinus cf. limbatus* (Valenciennes, 1839)	3
	Orectolobiformes	Orectolobidae	*Orectolobus maculatus* (Bonnaterre, 1788)	1
			Orectolobus ornatus (de Vis, 1883)	1
		Hemiscylliidae	*Chiloscyllium punctatum* Müller & Henle, 1838	3
Batoidea				
	Myliobatiformes	Aetobatidae	*Aetobatus ocellatus* (Kuhl, 1823)	8
		Dasyatidae	*Hemitrygon fluviorum* Ogilby, 1908 (formerly *Dasyatis fluviorum*)	4
			Maculabatis cf. astra (formerly *Himantura astra*)	3
			Maculabatis toshi Whitley, 1939 (formerly *Himantura toshi*)	5
			Himantura australis Last, Whyte & Naylor, 2016 (formerly *Himantura uarnak* Forsskål, 1775)	1
			Neotrygon trigonoides (Castelnau, 1873)	19
			Pastinachus ater (MacLeay, 1883)	1
	Rhinopristiformes	Glaucostegidae	*Glaucostegus typus* (Bennett, 1830)	9
		Trygonorrhinidae	*Aptychotrema rostrata* (Shaw, 1794)	6
Total				64

TABLE 2. Prevalence and intensity of trypanorhynch plerocerci found in the digestive glands of crustaceans collected in Moreton Bay, Queensland.

Intermediate host	Locality	Date	N	Prevalence (%)	Intensity	Mean Intensity
Typaea australiensis	Dunwich	May 2010	17	82	1–17	5.9
		July 2016	20	65	1–5	2.1
	Wynnum	Nov 2011	54	56	1–3	1.6
Alpheus spp.	Dunwich	Jan 2016	25	52	1–8	3.4
		July 2016	20	85	1–57	16.8
	Wynnum	Nov 2011	70	54	1–17	2.2

RESULTS

A total of 64 elasmobranchs was examined for parasites (Table 1). The collection included three specimens of a ray which was provisionally identified as *M. astra* using the keys in Last and Stevens (2009) (therein as *Himantura astra*) but which had mainly white rather than black spots on its disk. Two of the specimens collected were deposited in QM (1.38898, 1.40746). Tissues from one of these rays was included in a molecular analysis by Naylor *et al.* (2012) and proved to be genetically distinct from the remaining specimens of *H. astra* included in the study. Naylor *et al.* (2012, p. 69) suggested that the morphologically different specimens warranted further investigation. For this reason they have been identified here as *M. cf. astra*.

Crustaceans (*T. australiensis* and *Alpheus* spp.) collected opportunistically at mudflats at both Dunwich and Wynnum yielded numerous larval eutetrarhynchids in their digestive glands (Table 2). The highest prevalences and intensities of infection found were at Dunwich in July (Table 2). The metacestodes encountered are dealt with in the following taxonomic section.

The alpheid shrimps were identified specifically from a relatively small sample retained from dissections following Banner and Banner (1982). Three voucher specimens retained from Wynnum were *Al. richardsoni* Yaldwyn, 1971 while at Dunwich, a sample of 15 shrimps consisted of 5 *Al. richardsoni* and 10 *Al. papillosus* Banner

TABLE 3. Records of trypanorhych cestodes from elasmobranchs of Moreton Bay, Queensland. Host authorities are provided in Table 1.

Trypanorhynch cestode(s)	Host(s)
Tentacularioidea Poche, 1926	
Kotorella pronosoma (Stossich, 1901)	*Maculabatis toshi**
Otobothrioidea Dollfus, 1942	
Proemotobothrium southwelli Beveridge & Campbell, 2001	*Glaucostegus typus**
Eutetrarhynchoidea Guiart, 1927	
Dollfusiella owensi (Beveridge, 1990)	*Hemitrygon fluviorum**
	*Maculabatis toshi**
	Maculabatis cf. *astra**
	*Neotrygon trigonoides**
Dollfusiella armata sp. nov.	*Maculabatis cf. astra*
	Maculabatis toshi
Dollfusiella pilosa sp. nov.	*Aetobatus ocellatus*
Dollfusiella spinulifera (Beveridge & Jones, 2000)	*Hemitrygon fluviorum**
	Glaucostegus typus
	*Maculabatis toshi**
Dollfusiella sp. 1	*Aetobatus ocellatus*
	Neotrygon trigonoides
Dollfusiella sp. 2	*Aptychotrema rostrata*
	Hemitrygon fluviorum
	Glaucostegus typus
Dollfusiella sp. 3	*Aptychotrema rostrata*
Hispidorhynchus australiensis (Toth, Campbell & Schmidt, 1992)	*Aetobatus ocellatus*
Parachristianella monomegacantha Kruse, 1959	*Hemitrygon fluviorum*

Trypanorhynch cestode(s)	Host(s)
	*Glaucostegus typus**
Eutetrarhynchoidea Guiart, 1927 cont…	*Neotrygon trigonoides**
Parachristianella sp. (undescribed)	*Hemitrygon fluviorum*
Poecilorhynchus perplexus Schaeffner & Beveridge, 2013	*Chiloscyllium punctatum*
Prochristianella aciculata Beveridge & Justine, 2010	*Hemitrygon fluviorum**
	Maculabatis cf. *astra**
	Neotrygon trigonoides
Prochristianella butlerae Beveridge, 1990	*Pastinachus ater*
	*Glaucostegus typus**
Prochristianella clarkeae Beveridge, 1990	*Hemitrygon fluviorum**
	*Glaucostegus typus**
	Maculabatis toshi
	Maculabatis cf. *astra**
	Neotrygon trigonoides
Prochristianella omunae Beveridge & Justine, 2010	*Neotrygon trigonoides*
Zygorhynchus elongatus Beveridge & Campbell, 1988	*Hemitrygon fluviorum**
	Maculabatis cf. *astra**
Zygorhynchus robertsoni Beveridge & Campbell, 1988	*Aetobatus ocellatus**
	*Maculabatis toshi**
Zygorhynchus sp. (undescribed)	*Neotrygon trigonoides*
* indicates new host record.	

and Banner, 1982. None of the crabs examined was found to be infected with trypanorhynch metacestodes.

SYSTEMATICS

Superfamily TENTACULARIOIDEA Poche, 1926

Genus *Kotorella* Euzet & Radujkovic, 1989

Kotorella pronosoma (Stossich, 1901) (Figs 2-3)

Material examined. 2 specimens, stomach, *Maculabatis toshi*, Green Island (QM G235986-7).

Morphology. Total length 17, 22; Scolex length 0.62, 0.64; pars bothrialis 0.34, 0.35; pars vaginalis 0.39, 0.42; bulb length 0.08; bulb width 0.035, 0.045; velum 0.065, 0.070.

Remarks. Although the tentacles of the two specimens were only partially everted, the characteristic scolex (Fig. 2) and proglottis morphology (Fig. 3) permitted identification of the species. The features of the tentacular armature visible were consistent with previous descriptions. Palm (2004, p. 162) remarked on the different sizes and shapes of the scolex in various descriptions of the species. For this reason, an illustration and measurements of the scolex (Fig. 2) are included here. This cosmopolitan species (Palm 2004) has previously been reported from *H. fluviorum* in Moreton Bay (Palm & Beveridge 2002) (as *Dasyatis fluviorum*). Its occurrence in *M. toshi* represents a new host record.

Superfamily OTOBOTHRIOIDEA Dollfus, 1942

Genus *Proemotobothrium* Beveridge & Campbell, 2001

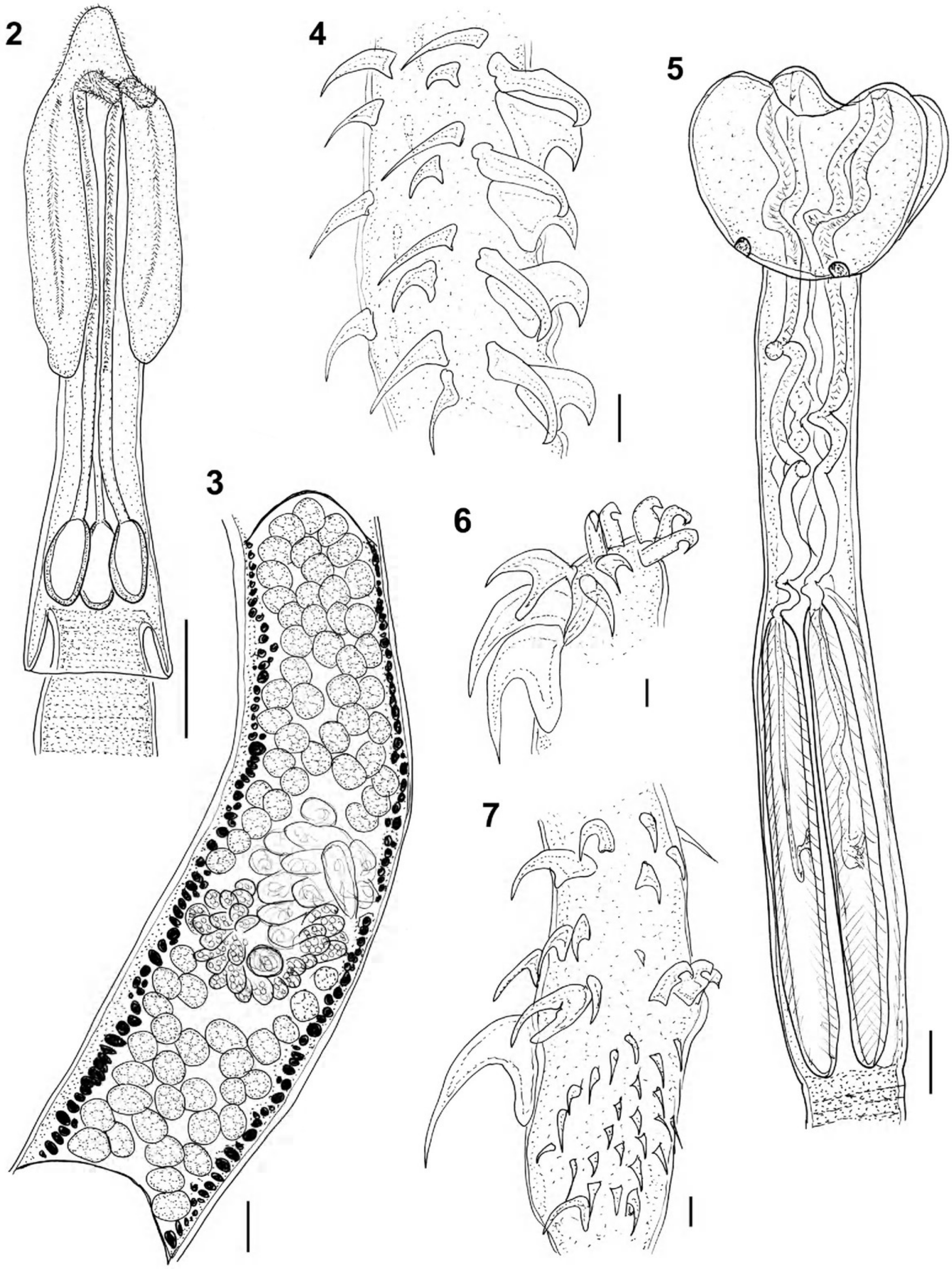
Proemotobothrium southwelli Beveridge & Campbell, 2001 (Figs 4-7)

Material examined. 1 specimen, spiral valve, *Pastinachus atrer*, Peel Island (QM 236206); 7 specimens, spiral valve, *Glaucostegus typus*, Garden Island (QM G236208-9), Wynnum North (QM 236210-14); 1 specimen, spiral valve, *Carcharhinus cf. limbatus*, Green Island (QM G236207).

Morphology. Scolex length 1.58-1.70 (1.69, n=8), scolex width 0.23-0.30 (0.27, n=8), pars bothrialis 0.32-0.38 (0.35, n=8), pars vaginalis 0.79-0.89 (0.85, n=8), bulb length 0.75-0.84 (0.79, n=8), bulb width 0.08-0.12 (0.11, n=8), pars postbulbosa absent (Fig. 5); large basal hooks (Figs 6, 7) 80, 45 µm long, base 50, 35 µm long; metabasal armature (Fig. 4): hook 1, 30 µm long, base 25 µm long; hook 2, 28 µm long, base 10 µm long, hook 3, 25 µm long, base 10 µm long, hook 4, 22 µm long, base 10 µm long; hook 5, 22 µm long, base 8 µm long; intercalary hook 25 µm long, base 15 µm long; hook from band on external surface 13 µm long, base 5 µm long.

Remarks. A full description of this species was provided by Beveridge and Campbell (2001) and additional host records were added by Schaeffner and Beveridge (2013a). The only set of measurements for the species are those of the type specimens from *C. limbatus* (see Beveridge & Campbell 2001). The measurements presented here from *G. typus* are generally smaller than those of the original description apart from bulb lengths. However the scolex ratios (Pbo:Pvag:Pbulb) are similar (1: 3.1: 2.3 in the original description; 1: 2.8: 2.3 in the current material) and all other morphological features accord well with the original description.

Glaucostegus typus is a new host for this species and the collections from Moreton Bay extend the previously known Australian distribution from the north west of Western Australia, the Northern Territory, and the Whitsunday Islands and Heron Island in Queensland (Beveridge & Campbell 2001; Beveridge *et al.* 2014) to the south-eastern region of Queensland. Beveridge *et al.* (2017a) reported the plerocercus of this species from the teleosts *Ostorhinchus limenus* (Randall & Hoese, 1984) and *Monacanthus chinensis* (Osbeck, 1765) in Moreton Bay.



FIGS. 2-7. *Kotorella pronosoma* (Stossich, 1901) (2-3) and *Proemotobothrium southwelli* Beveridge & Campbell, 2001 (4-7). **2**, scolex, lateral view; **3**, mature segment, dorso-ventral view; **4**, metabasal armature, antibothrial view, internal surface on right side; **5**, scolex, dorso-ventral view; **6**, enlarged hooks on basal swelling; **7**, basal swelling. Scale bars: Figs. 2,3,5 = 0.1 mm; 4,6,7 = 0.01mm.

Superfamily EUTETRARHYNCHOIDEA Guiart, 1927

Genus *Dollfusiella* Campbell & Beveridge, 1994

***Dollfusiella armata* sp. nov.**
(Figs 8-14, 32)

Material examined. Types: holotype, spiral valve, *Maculabatis cf. astra*, Garden Island (QM G235827); 23 paratypes, same data (QM G23528-50). Vouchers: 2 specimens, Wynnum (QM G235851-2); 2 specimens, from spiral valve, *Maculabatis toshi*, Wynnum (QM G235853-4); 2 specimens, Peel Island (QM G235861-2); 3 specimens, Green Island (QM G235855-7); Wellington Point (QM G235864-5) (2 specimens used for SEM).

Morphology (based on type series). Small cestodes, largest immature specimen (holotype), 0.88 long with 3 segments; scolex length 0.56-0.65 (0.61, n=10), scolex narrower in pars vaginalis (Figs 8, 9), 0.05-0.08 (0.06, n=10) wide, broader in pars bulbosa, 0.08-0.14 (0.11, n=10); pars bothrialis 0.10-0.12 (0.11, n=10); pars vaginalis 0.30-0.35 (0.32, n=10); tentacle sheaths sinuous to convoluted; no pigment in scolex anterior to bulbs; bulb length 0.25-0.30 (0.27, n=10), bulb width 0.03-0.05 (0.04, n=10); bulb length: width ratio 5-9 (6.6, n=10); pars postbulbosa very short. Enlarged gladiate microtriches (Fig. 32) cover entire scolex to posterior extremity of pars bulbosa as well as antibothrial surface of bothria; microtriches on scolex peduncle largest in pars vaginalis, diminishing in size posteriorly; largest microtriches 11.4 µm long, with rounded base in dorso-ventral view, 6.5 µm in diameter, in lateral view with bifurcate base (Fig. 14); enlarged microtriches arranged in quincunxial pattern; microtriches on bothria generally smaller, 8.1mm long, but with similar structure.

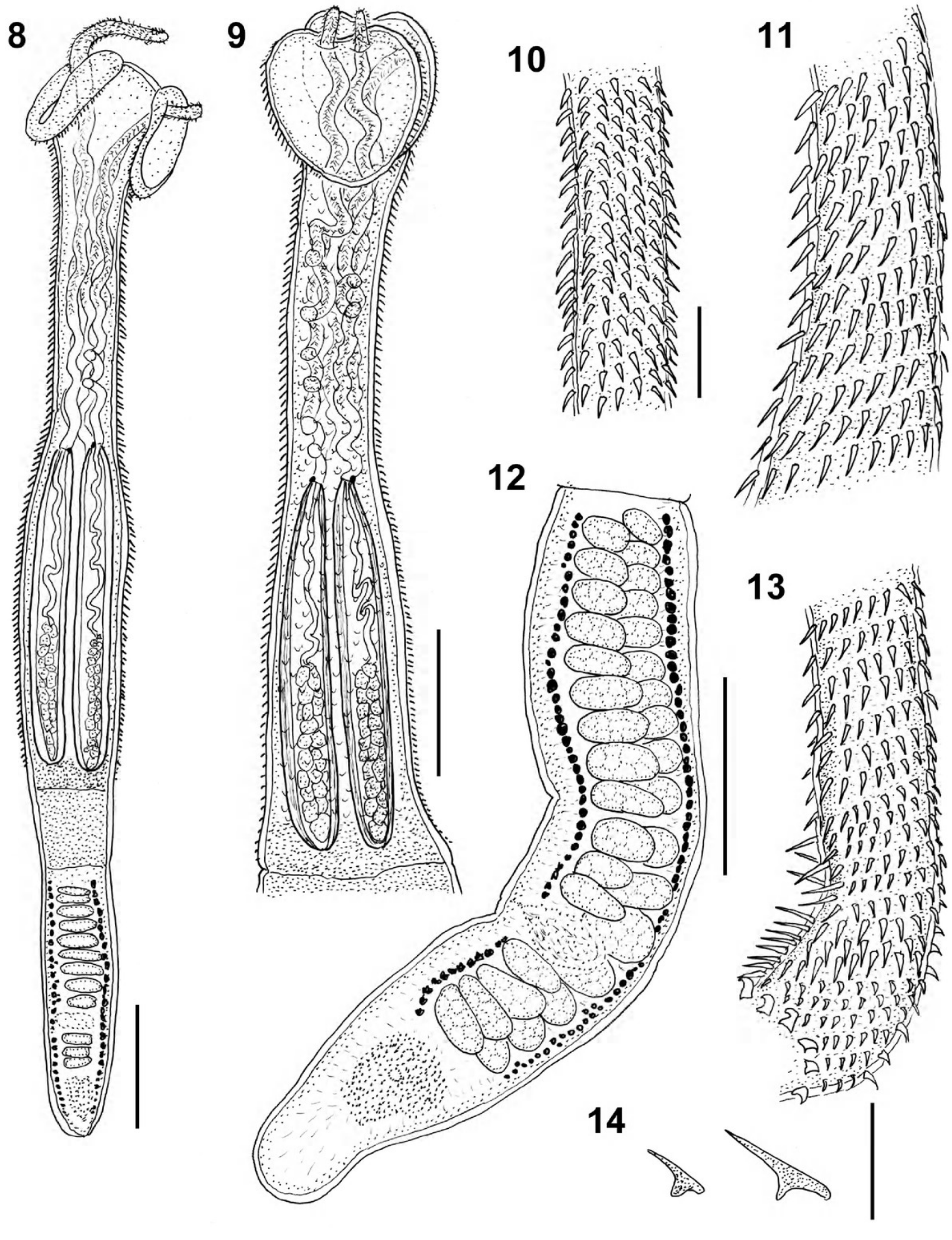
Tentacular armature. Basal swelling present (Fig. 13), 15-20 µm (17, n=5) in diameter; diameter of tentacle in metabasal region 17mm, in distal region 10 -11mm (10.2, n=5). Armature heteroacanthous, heteromorphous, orientation of armature from antibothrial to bothrial surface. Basal armature (Fig. 13): initial row of hooks enlarged, uncinate, 3.4-5.0 µm (4.2, n=5) long, base 1.6-2.5 µm (2.2, n=5) long; anterior to basal row, hooks initially small, spiniform, 2.0 µm long, base 0.8 µm long; becoming larger anteriorly, 3.4 µm long, base 1.3 µm long; internal surface of basal swelling with elongate spiniform hooks 4.2-6.7 µm (5.3, n=5) long, base 1.3-1.7 µm (1.3, n=5) long; on external surface, hooks uncinate, 3.4-4.2 µm (3.9, n=5) long, base 1.3-1.7 µm (1.6, n=5) long. Metabasal armature: 8-9 hooks per half-spiral in metabasal region (Fig. 11), decreasing to 7-8 in distal region of tentacle (Fig. 10); hooks homeomorphous, spiniform, no apparent change in size on different surfaces of tentacle; in metabasal region hooks 3.8-5.0 µm (4.3, n=5) long, base 0.8-1.3 µm (1.1, n=5) long.

Segments. All specimens immature; single specimen with 4 segments; pre-mature segments 0.15-0.46 (0.25, n=5) long, 0.06-0.13 (0.08, n=5) wide with genital pore in posterior region of segment; testes arranged in 2 columns (Fig. 12); total number of testes 25-33 (28, n=4), with 13-17 (15, n=4) antiporal, 10-12 (11, n=4) pre-vaginal and 2-4 (3, n=4) postvaginal; remaining male and female genitalia not developed; vitelline follicles circum-cortical.

Diagnosis. The description of this species is incomplete due in part to the tiny dimensions of the tentacular armature and the lack of availability of specimens suitable for scanning electron microscopy, as well as the lack of fully mature or gravid specimens. However, the species is unique and clearly identifiable based on the size of the enlarged microtriches arming the scolex and extending to the very base of the scolex. This feature immediately distinguishes it from all congeners apart from *D. imparispinis* Schaeffner and Beveridge, 2013.

Its scolex size (maximum 0.65) distinguishes it from all congeners with enlarged microtriches extending to the base of the scolex, apart from *D. spinulifera* (Beveridge & Jones, 2000), while its bulb length (maximum 0.30) distinguishes it from all comparable congeners apart from *D. spinulifera* and *D. imparispinis.*

In addition, the tiny tentacular armature distinguishes it from all currently known species apart from *D. imparispinis.* It differs from *D. imparispinis* in the basal armature as in *D.*



FIGS. 8-14. *Dollfusiella armata* sp. nov. **8**, entire cestode, holotype, lateral view; **9**, scolex, dorso-ventral view; **10**, tentacular armature, distal region; **11**, tentacular armature, metabasal region; **12**, mature proglottis; **13**, basal armature, external surface, antibothrial surface on left side; **14**, profile of enlarged mictrotriches from pars vaginalis and bothrium. Scale bars: Figs 8, 9, 12 = 0.1 mm; 10, 11, 13, 14 = 0.01 mm.

imparispinis, there is an extensive area with few hooks between the enlarged hooks at the very base and the rows of erect spiniform hooks and in the metabasal region, the hooks of the current species are relatively homeomorphous in contrast to those in *D. imparispinis* which are highly heteromorphous. In addition, *D. imparispinis* has 35-48 testes (Schaeffner & Beveridge 2013c) compared with 25-33 in the current species. *Dollfusiella imparispinis* has been found only in the orectolobiform shark *Chiloscyllium punctatum* off Borneo (Schaeffner & Beveridge 2014), while the present species was found primarily in dasyatid rays. The three *Ch. punctatum* examined in Moreton Bay (Table 1) were not infected with the species.

In spite of the obvious limitations in the description, the species has been named in the expectation that future collecting will enable more complete description based on features observable using scanning electron microscopy.

Dollfusiella owensi (Beveridge, 1990)
(Figs 15-18, 33-34)

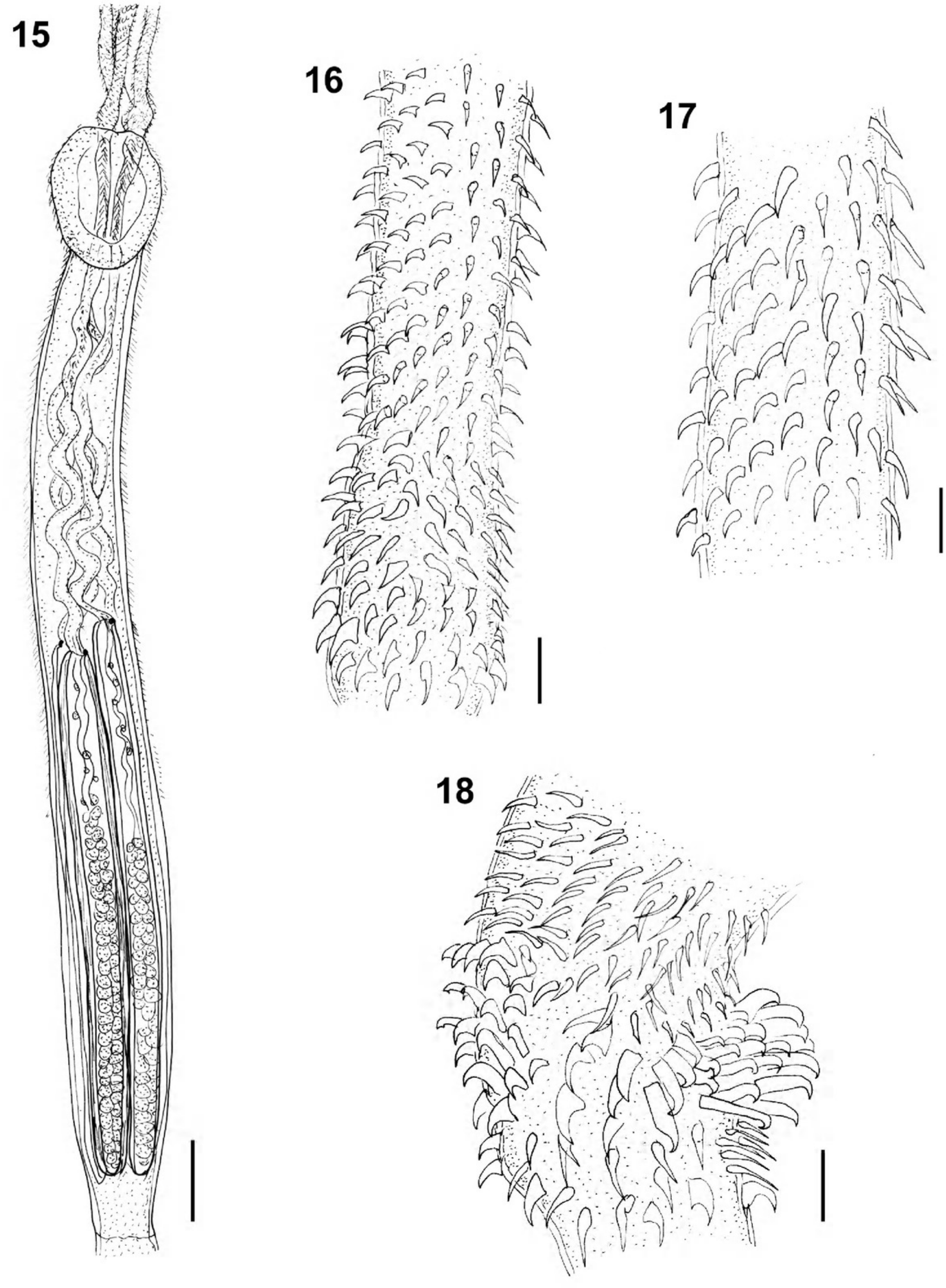
Material examined. 16 specimens, spiral valve, *Maculabatis toshi*, Peel Island (QM G235866-75), Green Island (QM G235876-9); 9 specimens, spiral valve, *Maculabatis cf.. astra*, Garden Island (QM G235882-4), Wynnum North (QM G235888-93); 6 specimens, spiral valve, *Hemitrygon fluviorum*, Wynnum North (QM G235880 -1); 3 specimens, spiral valve, *Neotrygon trigonoides*, Wynnum North (QM G235885-7).

Morphological features. Scolex measurements of specimens from *M. toshi*: scolex length 1.22-1.45 (1.30, n=6) (Fig. 15), scolex width 0.06-0.15 (0.11, n=6) in pars vaginalis, 0.15-0.21 (0.17, n=6) in pars bulbosa; pars bothrialis 0.16-0.24 (0.19, n=6); pars vaginalis 0.54-0.70 (0.63, n=6); bulb length 0.59-0.71 (0.65, n=6); bulb width 0.05-0.08 (0.06, n=6), pars postbulbosa absent. Enlarged gladiate microtriches present on scolex (Fig. 34) to level of pars bulbosa and on internal aspects of bothria (Fig. 33). Armature: metabasal armature begins on antibothrial surface, terminates on bothrial surface. Hooks in metabasal region hollow, arranged in ascending half circles (Figs 16, 17), spiniform, varying in size from 0.026-0.032 (0.029, n=10) long with base 0.007-0.014 (0.010, n=10) long on antibothrial surface to 0.016-0.021 (0.018, n=10) long, with base 0.003-0.007 (0.005, n=10) long on bothrial surface; in basal region, cluster of enlarged bill-hooks on antibothrial surface (Fig. 18).

Remarks. *Dollfusiella owensi* was described by Beveridge (1990) from *H. australis* (as *H. uarnak)* and *N. leylandi* (Last, 1987) (as *Dasyatis leylandi*) from the Northern Territory. The original report of the species from *N. leylandi* is now questionable as the distribution of this species has been reduced. Formerly reported as occurring across northern Australia from Townsville in Queensland to the Monte Bello Islands in Western Australia (Last & Stevens 1994, p. 394) it is now considered to be restricted to an area off the northern Western Australian coast (Last & Stevens 2009, p. 454). The correct host may be the more recently described species *Neotrygon picta* Last and White, 2008, which was formerly included within *N. leylandi.*

This cestode species is readily recognisable as the enlarged microtriches of the scolex extend to the anterior region of the pars bulbosa and the bill-hooks on the antibothrial surface of the basal swelling are extremely prominent (Fig. 18). In the original description (Beveridge 1990), the enlarged microtriches were described as covering the anterior two thirds of the pedunculus scolecis. The electron micrographs presented here provide novel information on the morphology of the enlarged gladiate microtriches in this species (Fig. 34). It would have been clearer to have described them as extending into the anterior region of the pars bulbosa (Fig. 15). Using the key of Schaeffner and Beveridge (2013c), *D. owensi* is most similar to *D. angustiformis* Schaeffner and Beveridge, 2013 but the latter species differs in lacking the very large bill-hooks on the basal swelling. The current specimens are slightly larger than those of the original description, requiring some alteration to couplet 25 in the key of Schaeffner and Beveridge (2013c).

The metabasal armature originates on the antibothrial surface of the tentacle and terminates on the bothrial surface, as in other congeners in which this feature has been examined closely



FIGS. 15-18. *Dollfusiella owensi* (Beveridge, 1990). **15**, scolex, dorso-ventral view; **16**, basal armature, bothrial surface, external surface on left; **17**, metabasal armature, bothrial surface on left; **18**, basal armature, bothrial surface on left. Scale bars: Fig.15 = 0.1 mm; 16-18 = 0.01 mm.

(Schaeffner & Beveridge 2013c). In the original description (Beveridge 1990), the armature was described under the assumption that hook rows ran invariably from the internal to the external surface.

Apart from extending the host range to include *M. toshi*, *M. cf. astra* and *H. fluviorum* (all new host records), the current collection also extends the geographical range of the species from the Northern Territory (Beveridge 1990) to south-eastern Queensland.

Dollfusiella pilosa sp. nov.
(Figs 19-23)

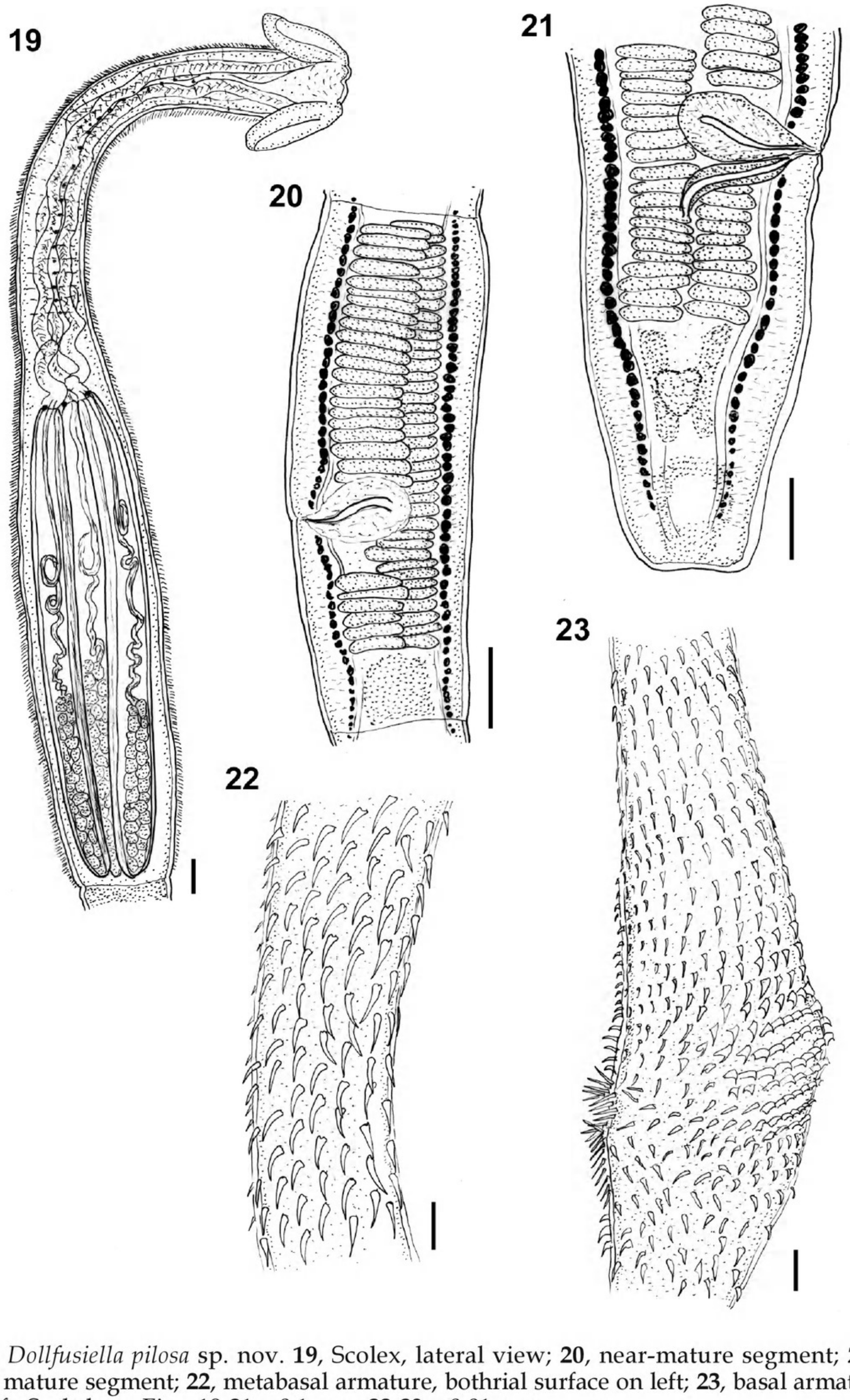
Material examined. Holotype, spiral valve, *Aetobatus ocellatus*, Wynnum North (QM G235894); 5 paratypes, same data (QM G235895-9).

Description. Scolex acraspedote (Fig. 19), 2.40-3.52 (3.00, n=5) long, 0.18-0.30 (0.23, n=5) wide in pars vaginalis, 0.38-0.44 (0.41, n=5) wide in pars bulbosa; scolex covered with enlarged microtriches to distal end (Fig. 19); enlarged microtriches readily lost in poorly fixed specimens; 2 patelliform bothria, pars bothrialis 0.23-0.40 (0.30, n=5); pars vaginalis 1.49-2.08 (1.63, n=5), sheaths sinuous, Pintner's cells prominent; bulbs 1.10-1.57 (1.34, n=5) long, 0.13-0.15 (0.13, n=5) wide, bulb length: width ratio 8.5-12.0 (10.0, n=5); prebulbar organ present; retractor muscle originates at base of bulb; gland cells present within bulb; pars post-bulbosa absent. Tentacles up to 0.97 long; 30-33 µm (33, n=4) in diameter in distal region of tentacle; basal swelling present, 35-50 µm (45, n=4) in diameter (Fig. 23).

Tentacular armature. Distinctive basal armature present. Metabasal armature heteroacanthous, relatively homeomorphous (Fig. 22); hooks hollow; hook rows begin on antibothrial surface, terminate on bothrial surface; 9-10 hooks per half spiral. Hooks slender, spiniform with slight size gradient; hooks on bothrial surface 72-88 µm (79, n=5) long, base 10-20 µm (16, n=5) long; on external surface, slightly longer, 92-104 µm (98, n=5) long, base 20-28 µm (22, n=5) long, diminishing in size on antibothrial surface, 52-64 µm (59, n=5) long, base 12-16 µm (14, n=5) long. On basal swelling, initial 10 rows of hooks uncinate to spiniform, not enlarged, 44-64 µm (53, n=5) long, base 20-28 µm (n=5) long; following 8-9 rows commence as erect, elongate, spiniform hooks on antibothrial surface, 52- 56 µm (53, n=5) long, base 8-12 µm (9, n=5) long, becoming short and spiniform on external surface, 36-56 µm (45, n=5) long, base 12-16 µm (13, n=5) long and terminating on bothrial surface as bill-hooks 40-60 µm (48, n=5) long, base 12-24 µm (19, n=5) long; in anterior basal region, hooks spiniform with only slight size difference around tentacle, 40-48 µm (45, n=5) long with base 12-20 µm (14, n=5) long on bothrial surface and 36-40 µm (38, n=5) long with base 8-12 µm (10, n=5) long on antibothrial surface.

Segments. Single portion of strobila 14 segments long, immature; largest intact segment 0.67 long, 0.23 wide; genital pore 0.28 from posterior extremity; testes arranged in 2 columns (Fig. 20), 74 in number, with 21 pre-poral, 7 post-poral and 46 antiporal; cirrus sac large, ellipsoidal, 0.15 long, 0.07 wide, no seminal vesicles visible (Fig. 21); vagina opens to genital atrium posterior to cirrus sac; distal vaginal wall greatly thickened; ovary and Mehlis' gland not developed; vitelline follicles circum-cortical.

Diagnosis. The specimens studied represent a new species. The possession of enlarged microtriches extending to the posterior end of the scolex distinguishes the species from all congeners apart from *D. aculeata* (Beveridge, Neifar & Euzet, 2004), *D. acuta* (Menoret & Ivanov, 2015), *D. imparispinis*, *D. litocephala* (Heinz & Dailey, 1974), *D. micracantha* (Carvajal, Campbell & Cornford, 1976), *D. ocallaghani* (Beveridge, 1990), *D. owensi*, *D. spinifer* (Dollfus, 1969), *D. spinosa* (Schaeffner & Beveridge, 2013), *D. taminii* (Menoret & Ivanov, 2014) and *D. tenuispinis* (Linton, 1890). All of these species except *D. litocephala* have bulb lengths shorter than 0.88 µm (compared with 1.10-1.60 µm in the current species and (apart from *D. litocephala* and *D. spinifer*), scolex lengths shorter than 1.68 µm (2.4-3.5 µm in the current species). *Dollfusiella litocephala* has filiform microtriches on the scolex which are much less robust than those encountered in the current species and has much larger bulbs (ie. 2.4-3.4 µm) (Beveridge *et al.* 2004). *Dollfusiella spinifer*,



FIGS. 19-23. *Dollfusiella pilosa* sp. nov. **19**, Scolex, lateral view; **20**, near-mature segment; **21**, posterior extremity of mature segment; **22**, metabasal armature, bothrial surface on left; **23**, basal armature, bothrial surface on left. Scale bars: Figs. 19-21 = 0.1 mm; 22-23 = 0.01 mm.

apart from having shorter bulbs, possesses enlarged hooks at the base of the tentacle (Beveridge *et al.* 2004) which are lacking in the current species. The strobilar material of this species is both limited and fragmentary, but key features such as the testis number and the basic features of the cirrus sac and vagina are discernible.

The species described here has been named in spite of the material available being insufficient to provide a full description of the tentacular armature and the only specimen with pre-mature segments (Figs 20, 21) lacks the pars bothrialis and tentacles although in every other respect it resembles the specimen from the same host individual as well as the specimens from the other two individual rays infected. Nevertheless, the distinctiveness of the species is clear and additional morphological details can be added with the collection of additional specimens.

This species has been found only in *Ae. ocellatus* in Moreton Bay thus far. A congener, *D. aetobati* (Beveridge, 1990) has similarly been found only in *Ae. ocellatus* in northern Australia. The two species are immediately distinguishable as *D. aetobati* lacks enlarged microtriches on the scolex and differs in scolex measurements.

Dollfusiella spinulifera (Beveridge & Jones, 2000)

Material examined. 22 specimens, spiral valve, *Glaucostegus typus*, Peel Island (QM G235902-10), Garden Island (QM G235911-2), Wynnum North (QM G235900 -1); 2 specimens, spiral valve, *Hemitrygon fluviorum*, Wynnum North (QM G235913-5); 1 specimen, spiral valve, *Maculabatis toshi*, Wellington Point (QM G235916).

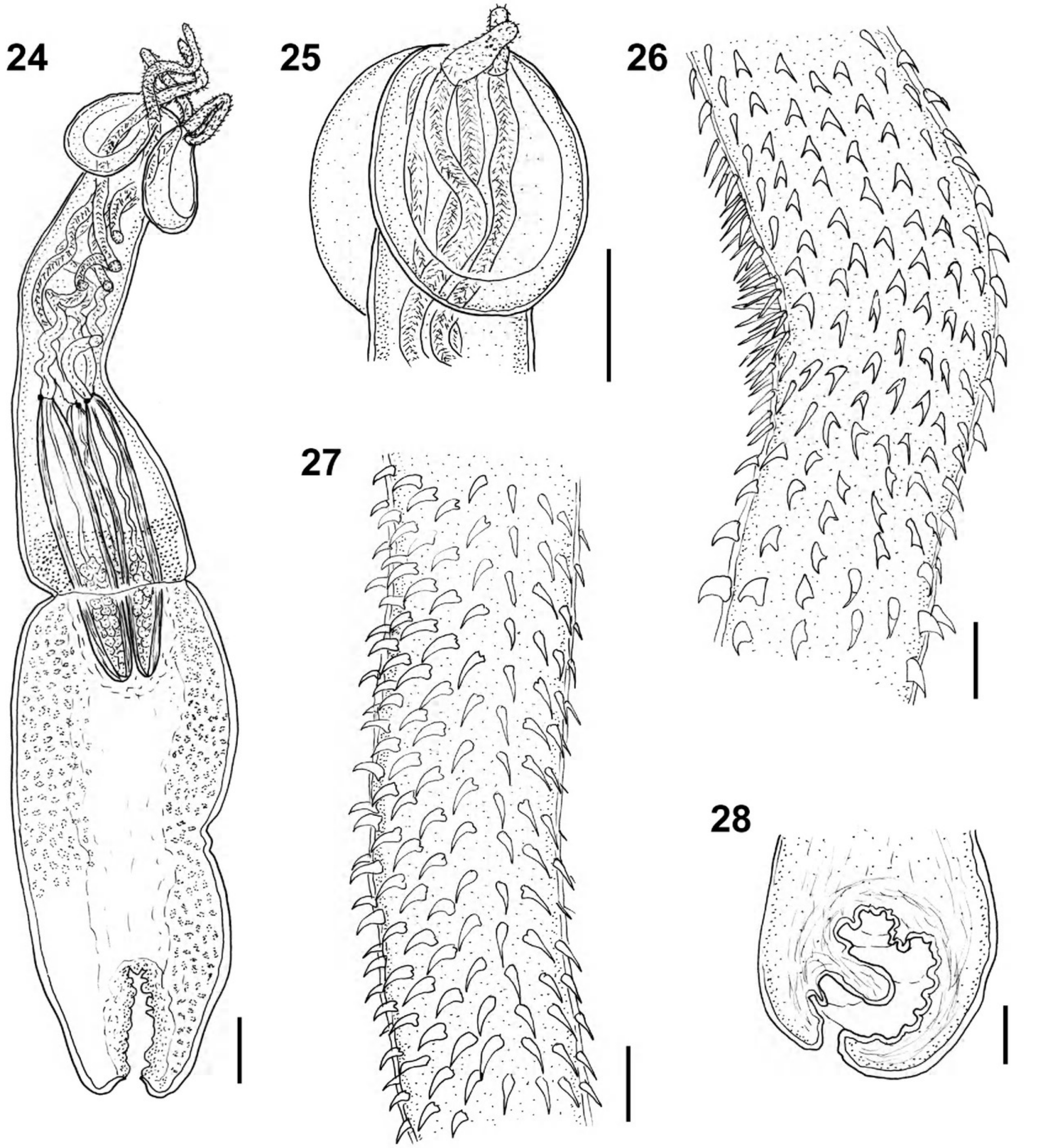
Morphological features. Scolex measurements of specimens from *G. typus*: scolex length 0.41-0.55 (0.50, n=10), scolex width 0.08-0.14 (0.11, n=10), pars bothrialis 0.08-0.11 (0.10, n=10), pars vaginalis 0.22-0.29 (0.27, n=10), bulb length 0.16-0.25 (0.22, n=10), bulb width 0.03-0.05 (0.05, n=10); pars postbulbosa absent.

Remarks. *Dollfusiella spinulifera* was initially described from *Glaucostegus typus* (as *Rhynchobatus typus*) (type host) and *Pateobatis fai* (Jordan & Seale, 1906) (as *Himantura fai*) from Heron Island, Queensland (Beveridge & Jones 2000). This species is readily recognisable by its small size, the extension of the enlarged microtriches to the posterior region of the scolex and the tiny hooks. The range of measurements provided here is similar to that of the original description (Beveridge & Jones 2000). Schaeffner and Beveridge (2013c) extended the geographical range of the species to Borneo as well as adding eight new host species. They recognised the species as being quite variable with two populations based on scolex and bulb lengths. The current species falls at the lower end of the measurement ranges reported by Schaeffner and Beveridge (2013c). The species is readily recognisable by its small size and the extension of the enlarged microtriches to the posterior region of the scolex. The current report expands the geographical range of the species further south from Heron Island (Beveridge & Jones 2000) to Moreton Bay and further expands the host range to include *H. fluviorum* and *M. toshi*. However, the current specimens provide no additional morphological data beyond that described by Beveridge and Jones (2000) and consequently no additional illustrations have been provided.

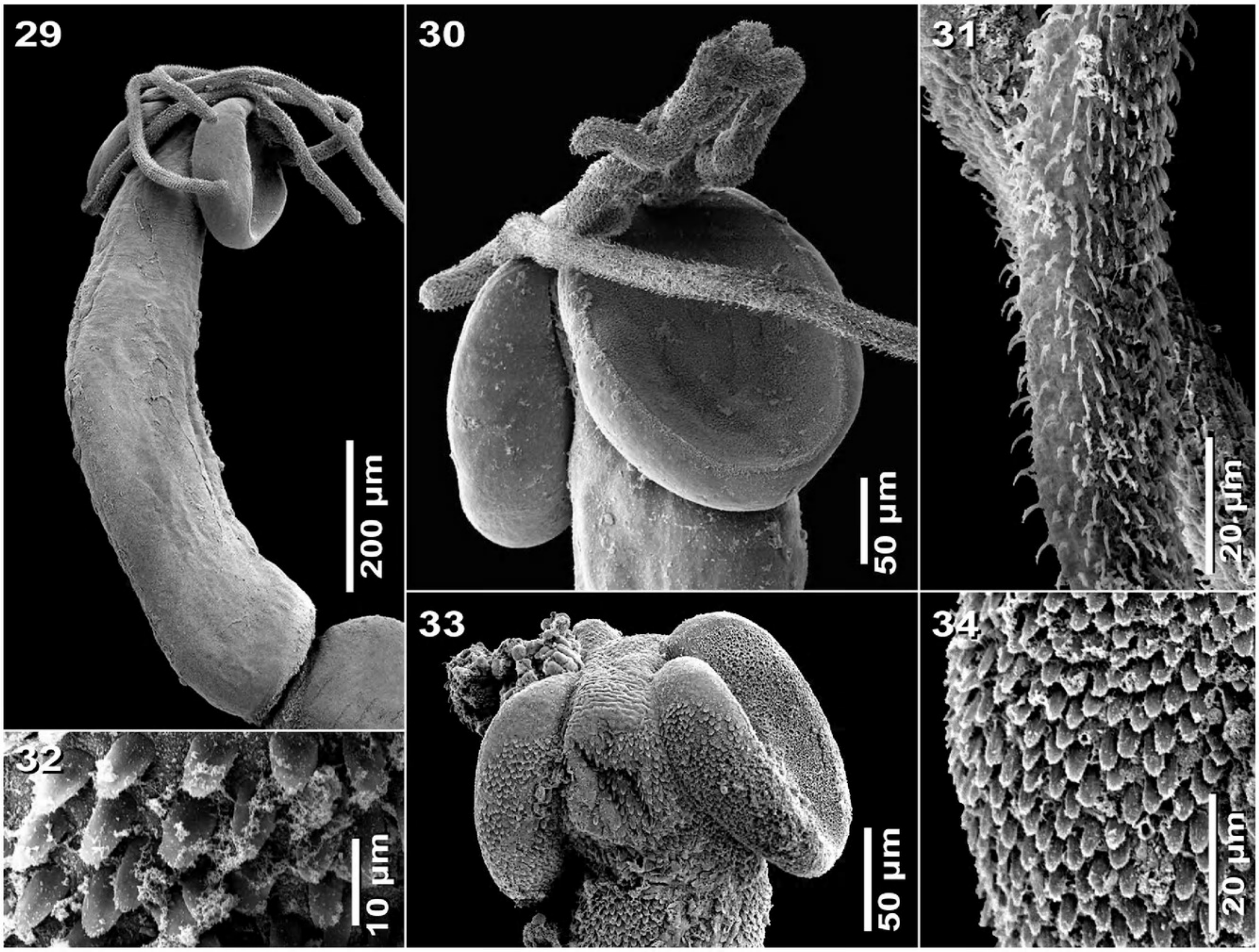
Dollfusiella sp. nov. 1 (Figs 24-31)

Material examined. 34 plerocerci, digestive gland, *Trypaea australiensis*, Wynnum (SAM 36324, QM G 235938-46); 9 plerocerci, Dunwich (QM G235930-7); 1 specimen, digestive gland, *Alpheus richardsoni*, Wynnum (QM G235947); 2 specimens (1 plerocercus, 1 adult scolex), spiral valve, *Neotrygon trigonoides*, Amity Point (QM G235917-8); 1 immature adult, spiral valve, *Neotrygon trigonoides*, Wynnum North (QM G235919); 1 scolex, spiral valve, *Aetobatus ocellatus*, Wynnum (QM G 235920).

Description. (From plerocerci in digestive gland of *T. australiensis*): Scolex length 0.80-1.10 (0.97, n=10) (Figs 24, 29); maximum scolex width in posterior region of bulbs, 0.19-0.27 (0.23, n=10); 2 bothria, semicircular in lateral view (Figs 25, 30), pars bothrialis 0.17-0.24 (0.21, n=10), pars vaginalis 0.48-0.60 (0.54, n=10), tentacular sheaths sinuous; bulbs elongate, length, 0.37-0.55 (0.47, n=10) width 0.05-0.06 (0.05, n=10), bulb length: width ratio 6.2-13.8 (9.1, n=10);



FIGS. 24-28. *Dollfusiella* sp. 1, metacestodes from *Typaea australiensis*. **24**, entire plerocercus; **25**, bothria of plerocercus, dorsal view; **26**, basal armature, bothrial surface on right; **27**, metabasal armature, bothrial surface on right; **28**, pygidium, dorso-ventral view. Scale bars: Figs. 24, 25, 28 = 0.1 mm; 26-27 = 0.01 mm.



FIGS. 29-34. Scanning electron micrographs. **29 – 31**, *Dollfusiella* sp. 1, metacestode from *Typaea australiensis*. **29**, scolex; **30**, bothrium; **31**, metabasal region of tentacle. **32**, *Dollfusiella armata* sp. nov., gladiate spinitriches on scolex peduncle; **33 - 34**, *Dollfusiella owensi* (Beveridge, 1990); **33**, pars bothrialis, dorso-ventral view; **34**. gladiate spinitriches on scolex peduncle.

no pigment in anterior region of bulbs; pars post-bulbosa absent; blastocyst 0.78-1.35 (0.98, n=10) long, 0.28-0.49 (0.37, n=10) wide, without prominent transverse striations (Fig. 24); pygidium prominent with corrugated walls, laterally elongated (Fig. 28), 0.12-0.21 (0.16, n=7) long; blastocyst with numerous prominent calcareous corpuscles (Fig. 24).

Tentacular armature. Tentacles with prominent basal swelling and distinctive basal armature (Fig. 26); basal swelling 20-25 µm (21, n=10) in diameter; diameter of tentacle in metabasal region 13-18 µm (15, n=10). Armature heteroacanthous, heteromorphous, commencing on antibothrial surface, terminating on bothrial surface; metabasal armature with c. 8 hooks per half circle (Fig. 27); hooks erect, spiniform with short base (Figs 27, 31), 4.0-6.4 µm (5.3, n=5) long, base 1.2-2.8 µm (1.8, n=5) long; slight decrease in hook size from antibothrial to bothrial surface; initial rows of hooks at base uncinate (Fig. 26), enlarged, 5.2-8.0 µm (6.2, n=5) long, base 2.8-4.0 µm (3.5, n=5) long; subsequent rows of hooks spiniform with elongated base, 4.0-4.8 µm (4.4, n=5) long, base 2.8-4.4 µm (3.4, n=5) long; rows commence on antibothrial surface with cluster of erect spiniform hooks with very narrow base, 6.0-6.8 µm (6.4, n=5) long, base 0.8-1.2 µm (0.9, n=5) long; rows terminate on bothrial surface with uncinate hooks 4.8-5.2

µm (5.0, n=5) long, base 2.0-3.6 µm (2.6, n=5) long (Fig. 26).

Remarks. This species of *Dollfusiella* is readily recognisable in the larval stage by its non-striated blastocyst, prominent pygidium (Figs 24, 28) and the lack of any pigment in the scolex at the junction of the tentacle sheaths and the bulbs. It is also distinguishable from the other species of *Dollfusiella* encountered in crustaceans in the length of the tentacular bulbs. It appears to represent an undescribed species within the genus. Currently known congeners lacking enlarged tegumental microtriches on their scolex are: *D. aetobati*, *D. australis* (Prudhoe, 1969), *D. bareldsi* (Beveridge, 1990), *D. caryoni* (Dollfus, 1942), *D. geraschmidti* (Dollfus, 1974), *D. lineata* (Linton, 1909), *D. macrotrachela* (Heinz & Dailey, 1974), *D. martini* (Beveridge, 1990), *D. musteli* (Carvajal, 1974), *D. vooremi* (São Clemente & Gomes, 1989) and *D. qeshmiensis* Haseli and Palm, 2015. Mean scolex lengths and bulb lengths (Beveridge *et al.* 2004; Schaeffner & Beveridge 2013c; Haseli & Palm 2015) of these species eliminate all congeners other than the Australian species *D. aetobati*, *D. bareldsi* and *D. martini*. *Dolfusiella aetobati* and *D. bareldsi* have 14 hooks per half spiral in the metabasal region compared with eight in the current species. While *D. martini* has five to six hooks per half spiral, it lacks enlarged hooks at the base. Consequently, the current species appears to be undescribed.

The material of this species obtained from elasmobranchs was extremely limited. One specimen from *N. trigonoides* is a newly evaginated plerocercus, with the characteristic pygidium as well as the tentacular armature and the scolex measurements clearly identifying it as this species. The second specimen from the same locality was a scolex, but clearly belongs to the same species. The specimen from Wynnum North from the same host, *N. trigonoides* (QM G235919), was very poorly preserved, but appears to belong to the same species. In this specimen, pre-mature segments are present with c. 40 testes but development of the female genitalia and other internal features are not discernable. A single scolex probably attributable to this species was also found in one *Ae. ocellatus* examined.

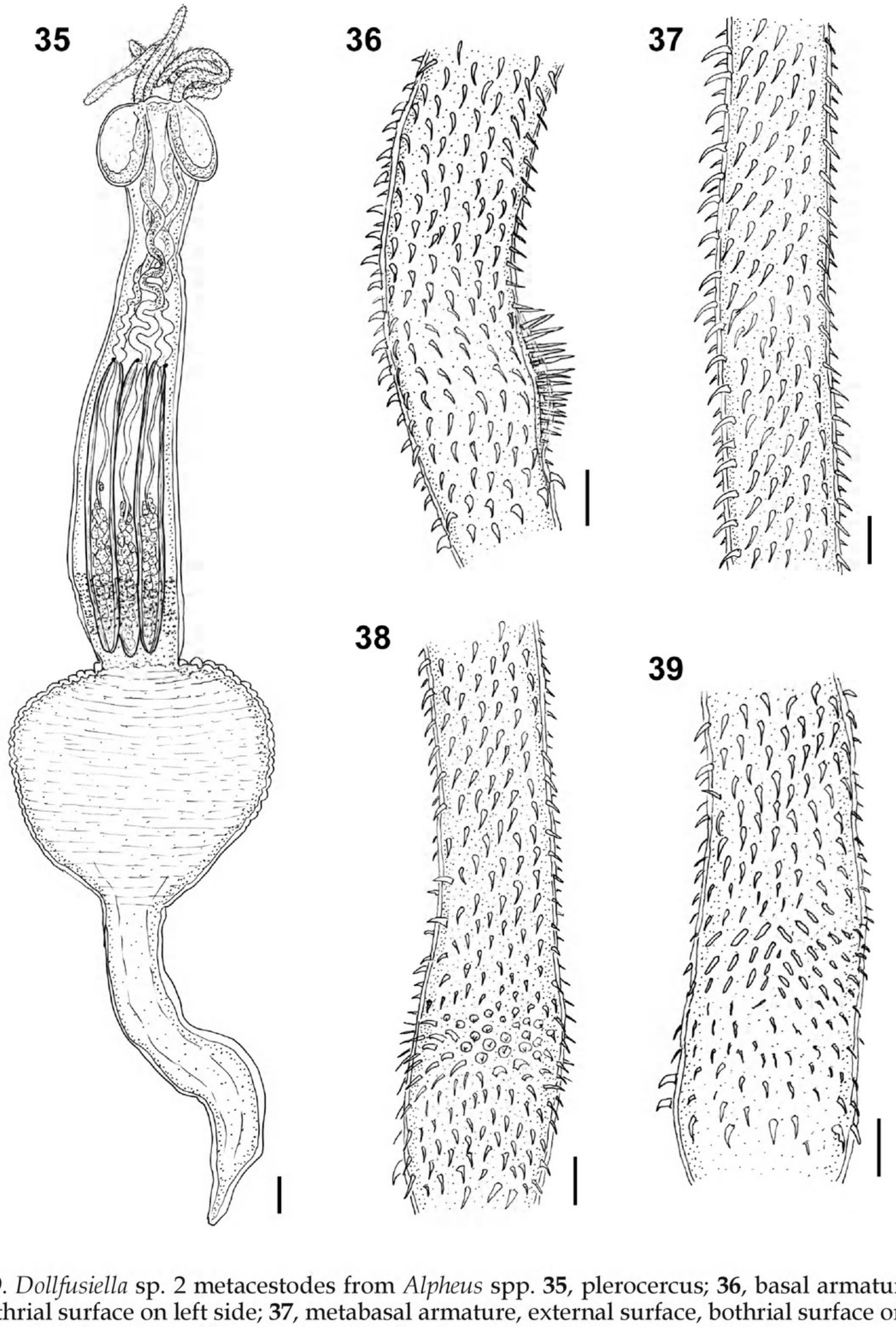
Although a reasonably complete description of the plerocercus can be given, and the probable definitive hosts identified, the inability to provide a more detailed description of the adult precludes naming this evidently new species.

Dollfusiella sp. nov. 2
(Figs 35-39)

Material examined. 7 plerocerci, digestive gland, *Al. richardsoni*, Wynnum (SAM 36325); 19 plerocerci, digestive gland, *Al. papillosus*, Dunwich (QM G236948- 65); 1 scolex, spiral valve, *Aptychotrema rostrata*, Wynnum (QM G235921); 3 scoleces, spiral valve, *Glaucostegus typus*, Wynnum North (QM G235922-3), Peel Island, (QM G235924); 3 scoleces, spiral valve, *Hemitrygon fluviorum*, Wynnum North (QM G235925-7).

Description. Plerocerci: scolex length 1.10- 1.45 (1.32, n=10); maximum scolex width in posterior region of bulbs, 0.24-0.38 (0.30, n=10); 2 bothria, semicircular in lateral view (Fig. 35), pars bothrialis 0.20-0.28 (0.24, n=10), pars vaginalis 0.63-0.72 (0.67, n=10), tentacular sheaths sinuous; bulbs elongate, length, 0.65-0.82 (0.72, n=10) width 0.07-0.11 (0.09, n=10), bulb length: width ratio 6.3-10.6 (8.2, n=10); pale pink pigment in anterior region of bulbs; pars post-bulbosa absent; blastocyst with distinct anterior and posterior portions (Fig. 35); posterior portion lost in most mounted specimens; anterior portion oval to sub-circular when mounted, 0.45-0.75 (0.63, n=10) long, 0.55-0.72 (0.62, n=10) wide, with prominent transverse striations (Fig. 35); posterior portion elongate tapering distally, up to 0.99 long; pygidium inconspicuous c. 0.14 long (Fig. 35); blastocyst without numerous prominent calcareous corpuscles.

Tentacular armature. Tentacles with slight basal swelling and distinctive basal armature (Figs 38-39); basal swelling 23-38 µm (30, n=10) in diameter; diameter of tentacle in metabasal region 20-28 µm (24, n=10). Armature heteroacanthous, heteromorphous, commencing on antibothrial surface, terminating on bothrial surface; metabasal armature with c. 8 hooks per half circle (Fig. 37), hooks erect, spiniform with



FIGS. 35-39. *Dollfusiella* sp. 2 metacestodes from *Alpheus* spp. **35**, plerocercus; **36**, basal armature, external surface, bothrial surface on left side; **37**, metabasal armature, external surface, bothrial surface on right side **38**, basal armature, antibothrial surface; **38**, basal armature bothrial surface. Scale bars: Fig. 35 = 0.1 mm; 36-39 = 0.01 mm.

short base, 5.6-8.0 µm (6.5, n=5) long, base 1.6-2.4 µm (1.8, n=5) long; no obvious change in hook size from antibothrial to bothrial surface; basal armature: initial rows of hooks at base uncinate, enlarged, 4.0-4.8 µm (4.5, n=5) long, base 2.4-3.2 µm (2.6, n=5) long; subsequent rows of hooks spiniform with narrow base, 4.0-5.6 µm (4.6, n=5) long, base 0.8 µm (0.8, n=5) long; rows commence on antibothrial surface with cluster of erect spiniform hooks with very narrow base, 6.4-8.8 µm (7.8, n=5) long, base 0.8-1.6 µm (1.4, n=5) long: rows terminate on bothrial surface with uncinate hooks 4.8-5.6 µm (5.1, n=5) long, base 2.4-3.2 µm (2.7, =5) long.

Remarks. This species of *Dollfusiella* is readily recognizable in the larval stage with its bipartite blastocyst, the prominent transverse striations on the anterior part of the blastocyst and the vermiform posterior part of the blastocyst (Fig. 35). It differs from *Dollfusiella* sp. nov. 1 in having larger scolex measurements, particularly the lengths of the bulbs which do not overlap. This species appears to be undescribed as the scolex and bulb lengths lie outside the ranges of any of the known species of *Dollfusiella* lacking enlarged microtriches on the scolex (see above). Consequently, it appears that this species is also novel. Adults of this species, represented by scoleces only were recovered from the spiral valves of *Ap. rostrata*, *G. typus* and *H. fluviorum*, but the lack of mature segments and details of the anatomy of the adult prevent the naming of this evidently new species.

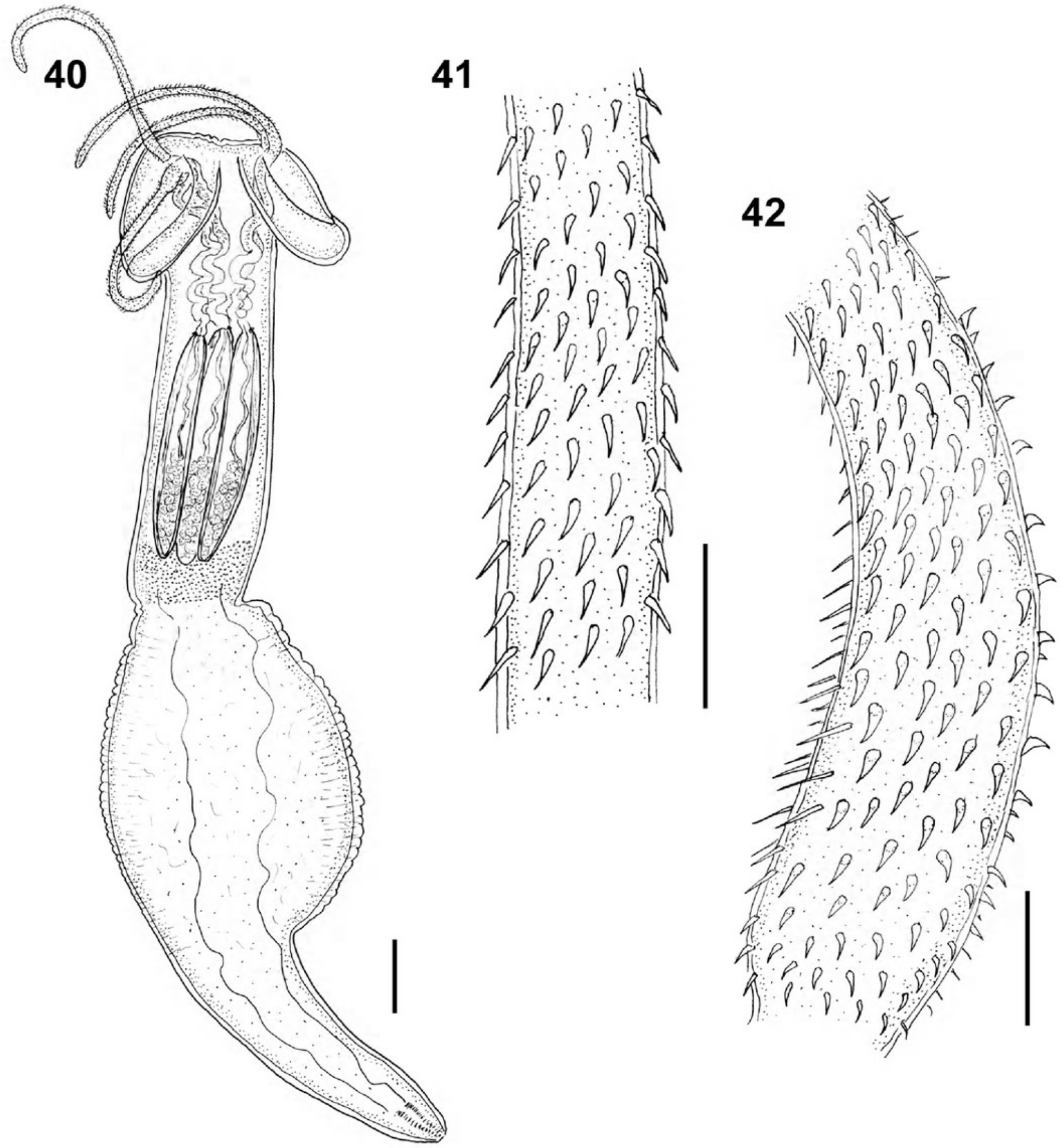
Dollfusiella sp. nov. 3
(Figs 40-42)

Material examined. 9 plerocerci, digestive gland, *Alpheus* sp., Wynnum (SAM 36326; QM G235976-9); 2 scoleces, spiral valve, *Aptychotrema rostrata*, Amity Point (QM G235928-9).

Description. Plerocerci: scolex length 0.60- 0.73 (0.67, n=9) (Fig. 40); maximum scolex width in posterior region of bulbs, 0.14-0.20 (0.17, n=9); 2 bothria, semicircular in lateral view, pars bothrialis 0.19-0.23 (0.21, n=9), pars vaginalis 0.30-0.43 (0.35, n=9), tentacular sheaths sinuous; bulbs elongate, length, 0.26-0.32 (0.30, n=9), width 0.04-0.06 (0.05, n=9), bulb length: width ratio 5.2-6.4 (5.9, n=9); no pigment noted in anterior region of bulbs; pars post-bulbosa up to 0.08 (0.02, n=9) long; blastocyst elongate, tapering posteriorly (Fig. 40), 0.45-0.95 (0.73, n=8) long, 0.20-0.37 (0.32, n=8) wide; pygidium inconspicuous; blastocyst without numerous prominent calcareous corpuscles.

Tentacular armature. Tentacles with slight basal swelling and distinctive basal armature (Fig. 42); basal swelling 13-18 µm (15, n=9) in diameter; diameter of tentacle in metabasal region 10-15 µm (10, n=9). Armature heteroacanthous, heteromorphous, commencing on antibothrial surface, termination on bothrial surface; metabasal armature with c. 6 hooks per half circle (Fig. 41), hooks erect, spiniform with short base, 2.0-2.8 µm (2.4, n=5) long, base 0.4-0.8 µm (0.6, n=5) long; no obvious change in hook size from antibothrial to bothrial surface; basal armature: initial rows of hooks at base uncinate, not enlarged (Fig. 42); subsequent rows of hooks spiniform with narrow base, 2.0-2.8 µm (2.2, n=5) long, base 0.4-0.8 µm (0.6, n=5) long; rows commence on antibothrial surface with cluster of erect spiniform hooks with very narrow base, 3.6-4.8 µm (4.1, n=5) long, base 0.4 µm (0.4, n=5) long: rows terminate on bothrial surface with uncinate hooks 1.6-2.4 µm (2.0, n=5) long, base 0.8-1.6 µm (1.2, =5) long.

Remarks. This species of *Dollfusiella* is much smaller than any of the metacestodes described above, differing in scolex measurements and particularly in the dimensions of the bulbs and the bulb ratio. The tentacular armature is also much smaller although it has the same general pattern as the previously described larval species. As with the previous species, this species is apparently undescribed as scolex and bulb measurements are smaller than any of the known species of this genus. Scoleces of the adults were found in the spiral valve of *Ap. rostrata*, but since mature segments were not present, the new species is not named here.



FIGS. 40-42. *Dollfusiella* sp. 3, plerocercus from *Alpheus* spp. **40**, plerocercus, lateral view; **41**, metabasal armature **42**, basal armature, external surface, bothrial surface on right side. Scale bars: Fig. 40 = 0.1 mm; 41-42 = 0.01 mm.

Genus *Hispidorhynchus* Schaeffner & Beveridge, 2012

Hispidorhynchus australiensis (Toth, Campbell & Schmidt, 1992)

Material examined. 3 specimens, spiral valve, *Aetobatus ocellatus*, Wynnum North (QM G235983-5).

Remarks. This species has been described previously from *Ae. ocellatus* under its former name, *Ae. narinari*, from the Northern Territory (Toth *et al.* 1992; Campbell & Beveridge 2009). As there is a recent redescription of the species (Campbell & Beveridge 2009), no additional morphological data are provided here. The current record extends the geographical distribution of the species from the Northern Territory (Campbell & Beveridge 2009) to south-eastern Queensland.

Genus *Parachristianella* Dollfus, 1946

Parachristianella monomegacantha Kruse, 1959 (Figs 43-45)

Material examined. Adult: 17 specimens, spiral valve, *Hemitrygon fluviorum*, Wynnum North (QM G235988-236004); 2 specimens, spiral valve, *Glaucostegus typus*, Wynnum North (QM G236016); 11 specimens, spiral valve, *Neotrygon trigonoides*, Wynnum North (QM G236008-15), Garden Island (QM G236005-7); Larval stage: 38 plerocerci, digestive gland, *Alpheus* spp. (*Al. richardsoni* and *Al. papillosus*), Dunwich (QM G236018-55).

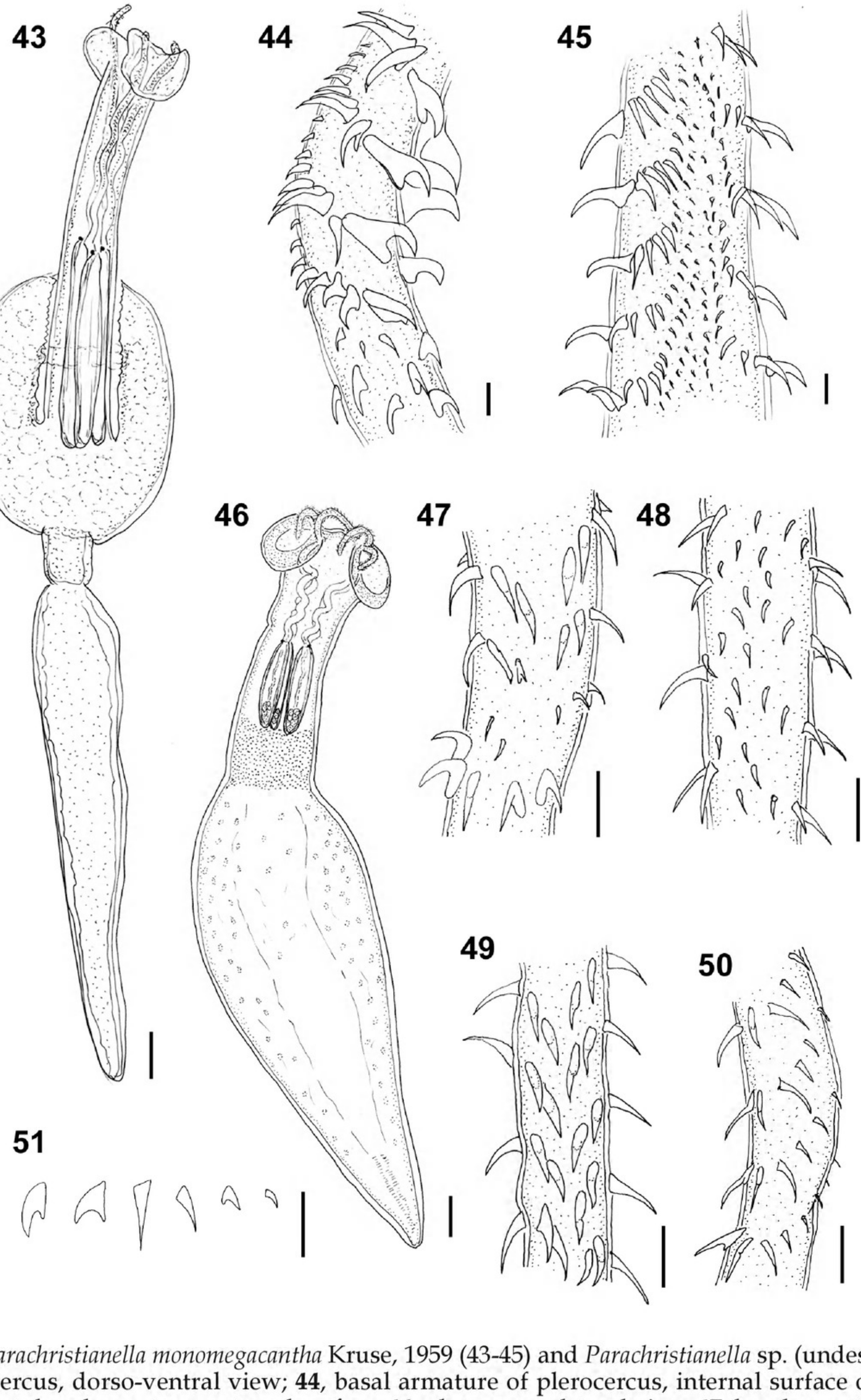
Morphological features. Plerocerci: blastocyst divided into anterior and posterior parts; posterior section variable in shape, usually elongate, tapering, maximum length 0.80-1.20 (0.99, n=7), width 0.12-0.26 (0.18, n=7) (Fig. 43), osmoregulatory canals extend to posterior end; anterior part of blastocyst hemi-spherical, 0.43-0.81 (0.59, n=10) long, 0.23-0.47 (0.40, n=10) wide, without ridges, with numerous white circular plaques (Fig. 43); scolex length 0.93-1.11 (1.02, n=10), scolex width 0.13-0.16 (0.15, n=10), pars bothrialis 0.14-0.21 (0.16, n=10) , pars vaginalis 0.49-0.61 (0.54, n=10), bulb length 0.41-0.55 (0.49, n=10), bulb width 0.04-0.05 (0.05, n=10). Four areas of dense red pigmentation at posterior end of pars vaginalis; pigment disappears when fixed.

Tentacular armature. Basal tentacular swelling absent; basal armature consisting of 2 rows of uncinate hooks, not enlarged (Fig. 44); principal hook rows begin on internal surface, terminate on external surface (Fig. 45); hooks arranged in ascending rows; c. 16 hooks per row, decreasing in size along rows (Fig. 45); hooks 1(1′) large, uncinate (Fig. 44); hooks 2(2′) – 6(6′) spiniform, gradually decreasing in size; remaining hooks tiny, spiniform; hooks solid.

Remarks. *Parachristianella monomegacantha* is a cosmopolitan species having been reported from a wide range of host species in the Gulf of Mexico (Kruse 1959), off the Atlantic coast of the USA (Whittaker *et al.* 1985), Hawaii (Carvajal *et al.* 1976), off the west coast of France and the Mediterranean (Beveridge *et al.* 2004) and Borneo (Schaeffner & Beveridge 2014) as well as from Australia (Beveridge 1990). The plerocercus has previously been reported from the digestive glands of the penaeid shrimps *Farfantepenaeus aztecus* (Ives, 1891) (formely *Penaeus aztecus*) and *Fa. duorarum* (Burkenroad, 1939) (formerly *Penaeus duorarum*) from the Gulf of Mexico (Kruse 1959), in *Fa. brasiliensis* (Latreille, 1817) (formerly *Penaeus brasiliensis*) from Mexico (Mudry & Dailey 1971; Feigenbaum 1975) and Florida (Feigenbaum & Cornuccio 1976) as well as from *Fenneropenaeus merguiensis* (de Man, 1888) (formerly *Penaeus merguiensis*) on Cape York Peninsula, Australia (Owens 1981). Mudry and Dailey (1971) experimentally infected the copepod *Tigriopus californicus* (Baker, 1912) and studied the development of the procercoid. The species is adequately described (see Beveridge 1990) and therefore morphological data presented here are confined to the plerocercus. This is the first report of the plerocercus of *Para. monomegacantha* from alpheid shrimps. In some of the shrimps examined with large numbers of plerocerci in their digestive glands, *Para. monomegacantha* was the predominant species present, but the number of *Para. monomegacantha* was determined only in 20 shrimps from Dunwich collected in July 2016. *Parachristianella monomegacantha* was found in 12 shrimps with between 1 and 61 (mean 23, n=12) individuals in each shrimp.

The description presented here agrees with earlier descriptions of the species (Kruse 1959; Beveridge 1990), but the observation of live material enabled the additional description of the red pigment at the posterior end of the pars vaginalis in both plerocerci and adults. Such pigment has been reported in a number of other eutetrarhynchoid species (Dollfus 1942, pp. 56-57). The plerocerci of this species were readily recognisable in the live state relative to other co-occurring species by the white circular plaques on the anterior region of the blastocyst (Fig. 43).

Parachristianella monomegacantha has been reported previously from Moreton Bay (Beveridge 1990) in *H. fluviorum*. However, both *G. typus* and *N. trigonoides* represent new host records.



FIGS. 43-51. *Parachristianella monomegacantha* Kruse, 1959 (43-45) and *Parachristianella* sp. (undescribed) (46-51). **43**, plerocercus, dorso-ventral view; **44**, basal armature of plerocercus, internal surface on right; **45**, plerocercus, metabasal armature, external surface. **46**, plerocercus, lateral view; **47**, basal armature, internal surface; **48**, metabasal armature, external surface; **49**, metabasal armature, internal surface; **50**, metabasal armature, bothrial surface; **51**, profiles of hooks 1-6. Scale bars: Figs 43, 46 = 0.1 mm; 44-45, 47-51 = 0.01 mm.

Parachristianella sp. nov.
(Figs 46-51)

Material examined. 16 plerocerci, digestive gland, *Alpheus* sp., Wynnum (SAM 36328); 1 immature adult, spiral valve, *Hemitrygon fluviorum*, Wynnum North (QM G236056).

Description. Plerocerci: scolex length 0.56-0.76 (0.69, n=10) (Fig. 46), scolex width 0.20-0.30 (0.24, n=10), pars bothrialis 0.16-0.20 (0.19, n=10), pars vaginalis 0.21-0.38 (0.30, n=10), tentacle sheaths sinuous; bulb length 0.22-0.27 (0.25, n=10), bulb width 0.04-0.06 (0.05, n=10), bulb ratio 4.3-6.5 (5.3, n=10); prebulbar organ present; retractor muscle originates at base of bulb; gland cells present within bulb; pars post bulbosa 0.10-0.18 (0.13, n=10); blastocyst vermiform, tapering posteriorly (Fig. 46), 0.65 - 1.12 (0.92, n=10) long, 0.40-0.54 (0.46, n=10) wide; pygidium inapparent.

Tentacular armature. Tentacles without basal swelling and distinctive basal armature, 10-25 µm (17, n=10) in diameter. Armature heteroacanthous, heteromorphous; hooks solid; armature begins on internal surface (Figs 47, 49), ends on external surface (Fig. 48); hooks arranged in ascending half circles with 6 hooks per principal row (Fig. 50). Base with ring of uncinate hooks (Fig. 47), 7.0-9.0 µm (8.4, n=5) long, base 4.0-6.0 µm (5.0, n=5) long; ascending rows begin immediately after basal ring on internal surface; hooks 1(1′) large, uncinate, 8.0-11.0 µm (9.8, n=5) long, base 4.0-6.0 µm (4.8, n=5) long; hooks 2(2′) uncinate, 8.0-9.0 µm (8.2, n=5) long, base 4.0-6.0 µm (4.6, n=5) long; hooks 3(3′) erect, spiniform, with short base, 10.0-11.0 µm (10.2, n=5) long, base 2.0-3.0 µm (2.2, n=5) long, hooks 4(4′) short, spiniform, 4.0-7.0 µm (6.0, n=5) long, base 1.0-3.0 µm (1.8, n=5) long; hooks 5 (5′) short, spiniform, 4.0-6.0 µm (5.0, n=5) long, base 1.0-2.0 µm (1.2, n=5) long; hooks 6 (6′) short, spiniform, 3.0-5.0 µm (3.8, n=5), base 1.0 µm (1.0, n=5) long.

Remarks. Based on scolex lengths and bulb lengths, the species described above is closest to *Para. caribbensis* (Kovacs & Schmidt, 1980) (scolex length 0.64-0.75, bulb length 0.27-0.28) and *Para. parva* Campbell and Beveridge, 2007 (scolex length 0.33-0.42, bulb length 0.19-0.23) (Kovacs & Schmidt 1980; Campbell & Beveridge 2007). However, the measurements of the species described here (scolex length 0.56-0.76, bulb length 0.22-0.27), do not match either of these species. The scolex tegument of *Para. caribbensis* is covered with enlarged microtriches (Kovacs & Schmidt 1980) which are lacking in the current species. *Parachristianella caribbensis* has 10 hooks in each principal row and *Para. parva* 11 hooks (Kovacs & Schmidt 1980; Campbell & Beveridge 2007), compared with only six hooks in the current species. Only a single adult specimen was found in a single *H. fluviorum*, but this specimen lacked segments. For these reasons, the current species is considered to be new but has not been named in the absence of mature adult specimens.

Genus *Poecilorhynchus* Schaeffner & Beveridge, 2013

Poecilorhynchus perplexus Schaeffner & Beveridge, 2013

Material examined. 26 specimens, spiral valve, *Chiloscyllium punctatum*, Mud Island (QM G235304-29).

Remarks. This species was described recently from *Chiloscyllium punctatum* by Schaeffner and Beveridge (2013b) from the north west of Western Australia. The current record extends the distribution of this species to south-eastern Queensland. No additional morphological information was observable in the new specimens apart from the fact that in fresh specimens, there was a dense area of red pigmentation in the anterior extremity of the pars bulbosa.

Genus *Prochristianella* Dollfus, 1946

Prochristianella aciculata Beveridge & Justine, 2010
(Figs 52-53)

Material examined. 1 specimen, spiral valve, *Neotrygon trigonoides*, Garden Island (QM G236061); 4 specimens, spiral valve, *Hemitrygon fluviorum*, Wynnum North (QM G236509-60); 2 specimens, spiral valve, *Maculabatis cf. astra*, Garden Island (QM G236057-8); 47 plerocerci, digestive gland, *Alpheus* sp., Wynnum (SAM 36327, QM G236062-83); 1 plerocercus, digestive gland, *Trypaea australiensis*, Wynnum (QM G236084).

Morphological features. Plerocercus: blastocyst simple, variable in size, elongate (Fig. 52), 0.54 – 1.20 (0.79, n=10) long, 0.35-0.56 (0.41, n=10) wide, without ridges or white plaques; scolex without obvious pigments; scolex length 0.62-0.85 (0.75, n=10), scolex width 0.19-0.31 (0.27, n=10), pars bothrialis 0.16-0.26 (0.23, n=10), pars vaginalis 0.36-0.55 (0.43, n=10), bulb length 0.29-0.35 (0.32, n=10), bulb width 0.04-0.06 (0.05, n=10).

Remarks. This species was first described from *N. trigonoides* (as *N. kuhlii*) from New Caledonia (Beveridge & Justine 2010) and was subsequently reported from northern Australia (Nickol Bay, Western Australia and Weipa, Queensland) in *H. uarnak*, *M. toshi* and *Rhynchobatus* sp. (Schaeffner & Beveridge 2012). It is also common in elasmobranchs off Borneo (Schaeffner & Beveridge 2012, 2014). The records from *H. fluviorum* and *M. cf. astra* presented here represent new host records.

The intermediate stage of this parasite has not previously been reported. *Prochristianella aciculata* was common in *Alpheus* spp. collected at Wynnum, but was absent at Dunwich, even though the two localities are only 4 km apart. A single specimen was recovered from the digestive glands of *T. australiensis* at Wynnum but not from the same host species at Dunwich.

The measurements of the scolex of the plerocerci agree well with those from the adults reported by Beveridge and Justine (2010) and the characteristic aciculate hooks of the metabasal armature are unique within the genus (Fig. 53).

Prochristianella butlerae Beveridge, 1990

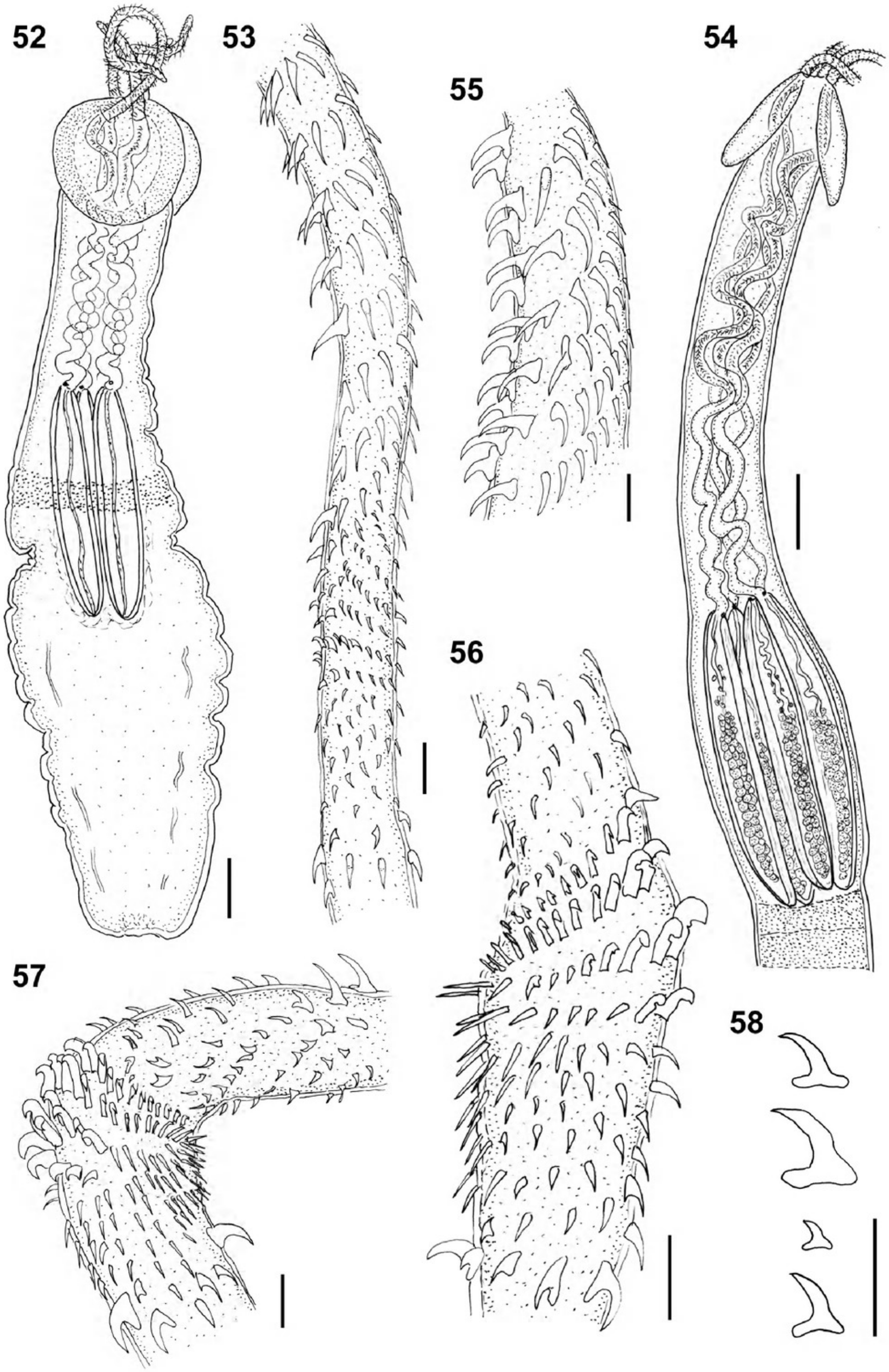
Syn: *Prochristianella odonoghuei* Beveridge, 1990 (new synonymy). (Figs 54-58)

Material examined. 130 specimens, spiral valve, *Pastinachus ater*, Peel Island (QM G236085-119); 1 specimen, spiral valve, *Glaucostegus typus*, Wynnum North (QM 236120).

Morphological features. (Specimens from *P. ater*): scolex length 0.96-1.26 (1.09, n=10) (Fig. 54), scolex width in pars vaginalis 0.10-0.16 (0.14, n=10), in pars bulbosa 0.15-0.22 (0.19, n=10), pars bothrialis 0.16-0.19 (0.17, n=10), pars vaginalis 0.56-0.75 (0.63, n=10), bulb length 0.39-0.49 (0.44, n=10), bulb width 0.06-0.07 (0.07, n=10), pars postbulbosa absent.

Remarks. *Prochristianella butlerae* was first described from *H. fluviorum* from Moreton Bay, as well as from *P. ater* (as *Dasyatis sephen* Forsskål, 1775) from the Northern Territory and Western Australia (Beveridge 1990). Palm (2004) described the same species under the name *Prochristianella macracantha* Palm, 2004 from "*Pastinachus sephen*" (probably *P. ater* based on distributions in Last *et al.* (2010)) from Indonesia, and Haseli *et al.* (2010) reported the same species from *P. cf. sephen* from the Persian Gulf. Schaeffner and Beveridge (2012) reduced *Pro. macracantha* to synonymy with *Pro. butlerae*, while also noting variation within the species. Schaeffner and Beveridge (2012) reported the species from Borneo as well as from additional localities in Australia (Heron Island, Lizard Island and Weipa in Queensland) and expanded the host range to include species of *Aetomyleus* Garman, 1908, *Neotrygon* Castelnau, 1873, *Taeniura* Müller and Henle, 1837 and *Urogymnus* Müller and Henle, 1837 belonging to the Myliobatidae and Dasyatidae. *Prochristianella butlerae* appears to be one of the more widely distributed members of the genus. *Glaucostegus typus* is reported here as a new host for the species.

Prochristianella butlerae is very similar to *Pro. odonoghuei* Beveridge, 1990 and the two species have been reported from the same host, *P. ater* by Beveridge (1990). Beveridge (1990) did not discuss the separation of these two species, but relied on the differences in the sizes of the bill-hooks on the basal swelling of the tentacle. However, not only are the cardinal measurements of these two species very similar, but the hooks of the metabasal armature are also very similar. Hooks 1(1′) are uncinate with an enlarged base as are hooks 2(2′) (Fig. 55). Subsequent hooks are uncinate or spiniform, but the morphology of hooks 1(1′) and 2(2′) is quite characteristic and is similar in both species. Although the bill hooks on the basal armature of *Pro. odonoghuei* were reported to be larger than those of *Pro. butlerae* (0.016-0.018 versus 0.005-0.010) (Figs 56, 57), re-examination of the paratype specimens suggests that this may have been due to viewing the hooks in different



FIGS. 52-58. *Prochristianella aciculata* Beveridge and Justine, 2010 (52 – 53) and *Prochristianella butlerae* Beveridge, 1990 (54 – 58). **52**, plerocercus, dorso-ventral view; **53**, basal and metabasal armature, external surface; **54**, scolex, lateral view; **55**, metabasal armature, internal surface, antibothrial surface on left; **56**, basal armature, oblique view of external surface, antibothrial surface on left; **57**, basal armature, internal surface, antibothrial surface on right, showing prominence of bill hooks on bothrial surface; **58**, profiles of hooks 1(1′) and 2(2′). Scale bars: Figs 52, 54 = 0.1 mm; 53, 55-58 = 0.01 mm.

orientations. When the enlarged bill- hooks of the paratype specimens of *Pro. odonoghuei* (SAM 218313) and *Pro. butlerae* (SAM 218315) were drawn at the same orientation, they proved to be indistinguishable. Current data therefore suggest that the two species are synonyms.

Prochristianella clarkeae Beveridge, 1990
(Figs 59-62)

Material examined. 4 specimens, spiral valve, *Hemitrygon fluviorum*, Wynnum North (QM G236180-2, G236188); 7 specimens, spiral valve, *Neotrygon trigonoides*, Garden Island (QM G236173-9); 1 specimen, Wynnum North (QM 236187); 3 specimens, spiral valve, *Maculabatis toshi*, Peel Island (QM G236171), Green Island (QM G236172), 2 specimens, Wellington Point (QM 236189-90); 49 specimens, spiral valve, *Maculabatis cf. astra* Garden Island (QM G236121-70); 7 specimens, spiral valve, *Glaucostegus typus*, Wynnum North (QM G236183-6, 236191-3); 1 specimen, Garden Island (QM G236194).

Morphological features. Measurements of specimens from *M. cf. astra*: Scolex length 0.58-0.75 (0.67, n=10) (Fig. 59), scolex width 0.10-0.14 (0.13), pars bothrialis 0.10-0.15 (0.13, n=10), pars vaginalis 0.26-0.41 (0.32), bulb length 0.30-0.37 (0.33), bulb width 0.03-0.05 (0.04, n=10), pars postbulbosa 0-0.02 (0.01, n=10).

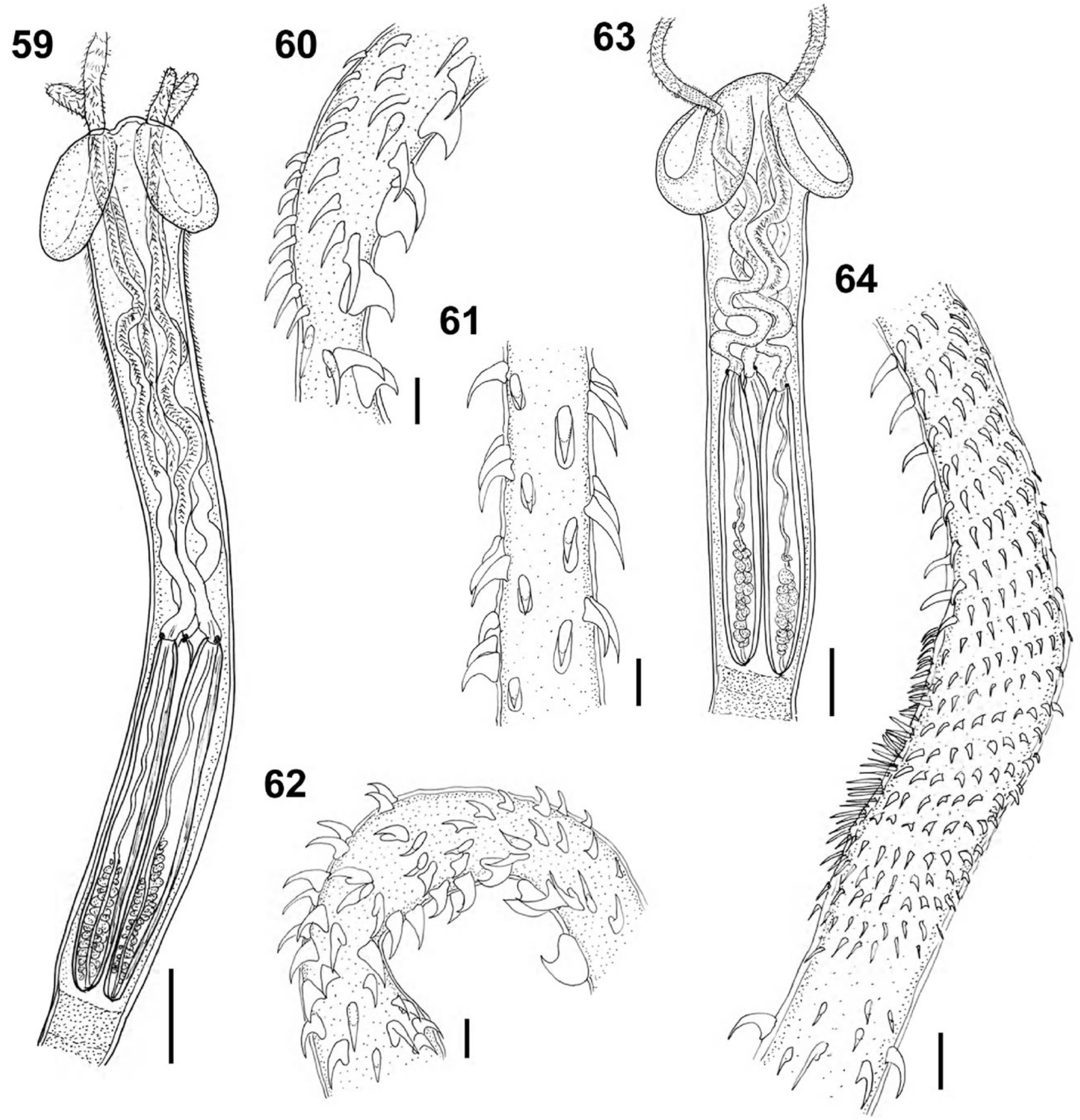
Remarks. This species was described from a wide range of Australian elasmobranchs, including specimens from *N. trigonoides* (as *Amphotistius kuhlii*) from Moreton Bay (Beveridge 1990). Schaeffner and Beveridge (2012) reported extensive collections from Borneo as well as new collections from northern Australia, thereby expanding the host range to 43 elasmobranch species. Salmani and Haseli (2017) have reported the species from *P. sephen* from the Persian Gulf, together with molecular evidence for its identification. The current report potentially includes three new host species, *M. cf. astra*, *H. fluviorum* and *G. typus*. However, *M. cf. astra* was formerly confused with *M. toshi* (Last & Stevens 2009) and therefore it is possible that the original record of *Pro. clarkeae* from *M. toshi* in Beveridge (1990) could be from *M. astra*.

Schaeffner and Beveridge (2012) noted variation in the distribution of microtriches on the scolex, with some well-preserved specimens entirely lacking enlarged microtriches and noting that in specimens from the South Australian Gulfs, enlarged microtriches were also entirely absent. Salmani and Haseli (2017) studied this variation in specimens from the Persian Gulf using scanning electron microscopy together with molecular identification of their specimens. They concluded that there was indeed intraspecific variation in the distribution of enlarged microtriches on the scolex, but that normally, the microtriches extended to the anterior region of the pars bulbosa. In the current series of specimens, microtriches generally extended to the level of the anterior region of the pars bulbosa, but three specimens in the series from *M. cf. astra* and one specimen in the series from *M. toshi* had microtriches extending as far as the mid pars vaginalis. In a single specimen from *M. toshi*, the microtriches extended to the posterior end of the scolex. However, the current study relied entirely on light microscopy and it is possible that microtriches were overlooked. Salmani and Haseli (2017) found in their study that microtriches not evident using light microscopy were seen using SEM. In this study, several specimens were mounted in Hoyer's medium which greatly facilitated the determination of enlarged microthrix distribution. However, too few specimens were mounted to allow broad conclusions to be drawn. The measurements of specimens presented here are much smaller, often 50% smaller than those of the original description (Beveridge 1990). Given the wide host and geographical distribution of this species, a more careful examination is warranted lest the current concept of the species be too broad and additional species are present under this current name.

In fresh specimens of this species, there was an area of red pigmentation at the anterior extremity of the pars bulbosa.

Prochristianella omunae Beveridge & Justine, 2010
(Figs 63-64)

Material examined. 2 specimens, spiral valve, *Neotrygon trigonoides*, Wynnum North (QM G236195-6); 1 specimen, Wynnum (QM G236197); 1 specimen, Amity Point, Qld (QM G236198).



FIGS. 59-64. *Prochristianella clarkeae* Beveridge, 1990 (59 - 62) and *Prochristianella omunae* Beveridge and Justine, 2010 (63 – 64). **59**, scolex, lateral view; **60**, metabasal armature, external surface; **61**, metabasal armature, antibothrial surface ; **62**, basal armature, external surface; **63**, scolex, lateral view; **64**, basal and metabasal armature, external surface. Scale bars: Figs 59, 63 = 0.1 mm; 60-62, 64 = 0.01 mm.

Morphological features. Scolex length 0.96, 1.01 (Fig. 63), scolex width 0.17, 0.17, pars bothrialis 0.20, 0.21, pars vaginalis 0.46, 0.46, bulb length 0.48, 0.50, bulb width 0.06, 0.06.

Remarks. *Prochristianella omunae* was described from *N. trigonoides* (as *N. kuhlii*) from New Caledonia (Beveridge & Justine 2010). The current record is the first from Australian waters. The measurements presented here accord reasonably well with the original description and the species is immediately identifiable by the characteristically elongate region of basal armature (Fig. 64).

Genus *Zygorhynchus* Beveridge & Campbell, 1988

Zygorhynchus elongatus Beveridge & Campbell, 1988
(Figs 65-66)

Material examined. 1 specimen, spiral valve, *Hemitrygon fluviorum*, Wynnum North (QM G236217); 1 specimen, spiral valve, *Maculabatis cf astra*, Garden Island, (QM G236215-6).

Morphological features. Immature specimen from *H. fluviorum*: scolex length 6.8 (Fig. 66), pars bothrialis 0.73, pars vaginalis 3.5, bulb length 2.9, bulb width 0.15, pars postbulbosa 0.05, tentacular diameter 0.10, hook length 0.025 (internal and external surfaces), hook base 0.025 (internal and external surfaces), 0.018 (bothrial and antibothrial surfaces); immature specimen from *M. cf. astra*: scolex length 6.3, pars bothrialis 0.89, pars vaginalis 3.65, bulb length 3.25, bulb width 0.18, pars postbulbosa 0.09, tentacle diameter 0.10, hook length 0.025 (internal and external surfaces), 0.020 long (bothrial and antibothrial surfaces), hook base 0.020-0.025 long (internal and external surfaces), 0.018 (bothrial and antibothrial surfaces).

Remarks. Although both specimens were immature, their general features were consistent with those of *Z. elongatus*. Measurements were slightly larger than in the case of the original description of Beveridge and Campbell (1988b) but as the original and only description was based on six specimens, these differences are likely to be due to intraspecific variation. This species was originally described from *H. australis* (as *H. uarnak*), *M. toshi* and *Rhynchobatus djiddensis* (Forsskål, 1775) from the Northern Territory and the north-west of Western Australia (Beveridge & Campbell 1988b). The current hosts represent new records as well as indicating an expanded geographical distribution to include south-eastern Queensland. However, *M. astra* was not described until 2008 and this species had previously been included within *M. toshi* (Last & Stevens 2009, p. 441). Consequently, a fish identified as *M. toshi* in 1988 from Nickol Bay, Western Australia, could have been *M. astra*.

Zygorhynchus robertsoni Beveridge & Campbell, 1988
(Figs 67-69)

Material examined. 1 adult specimen, spiral valve, *Maculabatis toshi*, Peel Island (QM G236220); 1 adult specimen, spiral valve, *Aetobatus ocellatus*, Peel Island (QM G236218-9); 1 plerocercus, digestive gland, *Alpheus papillosus*, Dunwich (QM G236221).

Morphological features. Immature specimen from *M. toshi*: scolex length 4.2, pars bothrialis 0.81, pars vaginalis 2.4, bulb length 1.6, bulb width 0.21, pars postbulbosa 0.05; gravid specimen from *Ae. ocellatus*: scolex length 4.2, pars bothrialis 0.79, pars vaginalis 2.7, bulb length 1.5, bulb width 0.29, pars postbulbosa absent; cirrus sac with internal seminal vesicle; distal vagina enlarged, with 2 diverticula; plerocercus: scolex length 4.7 (Fig. 67), pars vaginalis 2.8, bulb length 1.6, bulb width 0.24, pars postbulbosa 0.30. Hooks in basal region arranged in quincunxes (Fig. 69), slender, slightly sinuous, hook length 0.013-0.018 (0.015, n=10) with very short base, hook base 0.005-0.008 (0.006, n=10) long; metabasal hooks arranged in ascending rows, broad uncinated (Fig. 68), length 0.020-0.025 (0.022, n=10), with long base, 0.018-0.023 (0.021, n=10) long. Hooks hollow.

Remarks. The material examined consisted of an immature specimen (no strobila) from *M. toshi*, a gravid specimen from *Ae. ocellatus* and a plerocercus from *Al. papillatus*. The armature of the tentacles of the plerocercus (Figs 68-69) was identical to that already described for *Z. robertsoni* although the measurements of the scoleces were slightly different to those of the original description (Beveridge & Campbell 1988b), with a longer scolex, shorter pars bothrialis, longer pars vaginalis and longer bulbs. However, the original description was based on only four specimens and the differences are considered to be due to intra-specific variation. The morphology of the mature and gravid segments conformed with the description of Beveridge and Campbell (1988b). One difference noted relative to the original description was found in the metabasal armature. There, hooks are arranged in a heteroacanthous fashion (Fig. 68), whereas in the basal armature they are arranged in quincunxes (Fig. 69), therefore representing an homeoacanthous armature. This difference is not obvious in the illustration of Beveridge and Campbell (1988b, fig. 42), but is clear in the new material (Figs 68, 69). The original and only description of this species was from *H. australis* (as *H. uarnak)* and *N. leylandi* (as *Dasyatis leylandi*) from the Northern Territory (Beveridge & Campbell 1988b). As indicated above, the latter record is more likely to have been from *N. picta*. The current records are therefore from new host species and from a new geographic locality.

The plerocercus of this species has not been reported previously and provides novel information on the possible life cycle of the species. Only a single specimen was found in the 115 alpheid shrimps examined, although there may be additional crustacean intermediate hosts.

Zygorhynchus sp. nov.
(Figs 70-71)

Material examined. 1 plerocercus, digestive gland, *Alpheus* sp., Dunwich (QM G236223); 1 immature cestode, spiral valve, *Neotrygon trigonoides*, Wynnum (QM G236222).

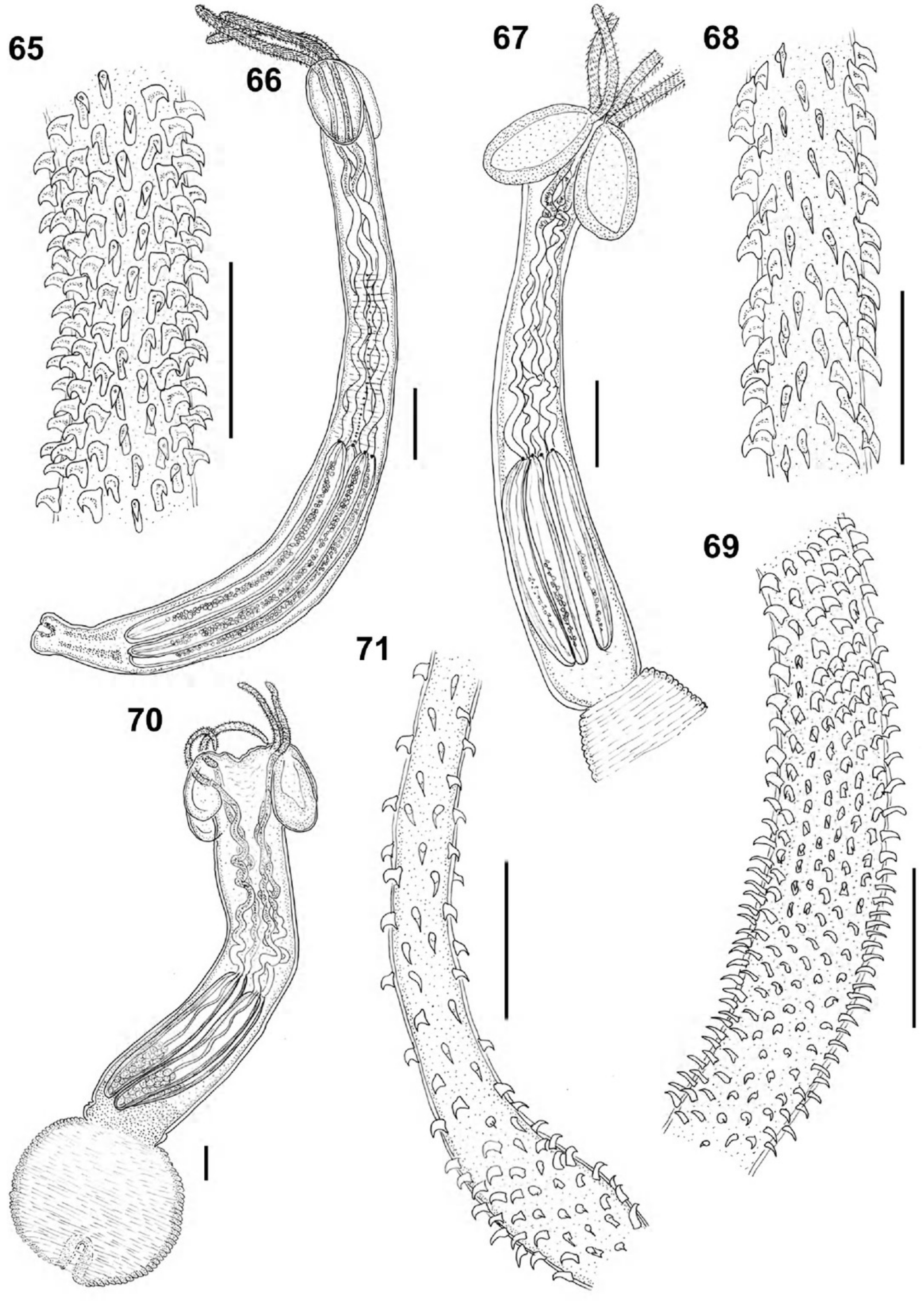
Description. Measurements of adult: scolex length 1.53; scolex width 0.30; pars bothrialis 0.31; pars vaginalis 0.85; bulb length 0.65; bulb width 0.09; bulb ratio 7.2; measurements of plerocercus: scolex length 1.50 (Fig. 70); scolex width 0.25; pars bothrialis 0.30; pars vaginalis 0.95; bulb length 0.67; bulb width 0.08; bulb ratio 8.4; blastocyst 0.56 long, 0.69 wide (Fig. 70). Two bothria, pars vaginalis longer than pars bothrialis; sheaths sinuous; bulbs elongate; prebulbar organ visible in adult, not in plerocercus; retractor muscle originates at base of bulb; gland cells present within posterior region of bulbs; bulbs project into pars postbulbosa. Tentacular armature: armature heteroacanthous, homeomorphous in metabasal region; hooks hollow; tentacle with basal swelling and distinctive basal armature (Fig. 71); basal swelling c. 30 µm in diameter; hooks of basal armature erect, spiniform, 5-8 µm (6.8, n=5) long, base 2-3 µm (2.8, n=5) long; tentacle diameter in metabasal region c. 18 µm; hooks of uniform size, arranged in ascending half circles of 5 hooks; hooks uncinate with elongate base, 6-7 µm (6.2, n=5) long, base 5-8 µm (6.0, n=5) long. Adult unsegmented; plerocercus with ovoid blastocyst; blastocyst with prominent transverse folds; pygidium not prominent (Fig. 70).

Remarks. This species, which is represented only by a single plerocercus and a single immature adult is tentatively allocated to the genus *Zygorhynchus* based on its tentacular armature. Beveridge and Campbell (1988b) separated *Zygorhynchus* from *Tetrarhynchobothrium* Diesing, 1854 primarily on the morphology of the cirrus and distal vagina, features which are unknown in the current species. However, the tentacular armature is remarkably similar to that of *Z. robertsoni*, although all the measurements are much smaller. Consequently, these specimens appear to belong to an undescribed species of *Zygorhynchus*, but the material available is too limited to permit a formal description.

DISCUSSION

The two principal findings emerging from this study of the trypanorhynch fauna of Moreton Bay, along with a companion study of the species present as plerocerci and plerocercoids in teleosts (Beveridge *et al*. 2017a), are that the fauna is quite diverse and that the decapod families Callianassidae and Alpheidae are intermediate hosts for some of the cestode species using rays as definitive hosts.

The diversity of trypanorhynch cestodes reported here is not surprising given that collecting of these cestodes in the past has been entirely opportunistic. Two new species of *Dollfusiella*, *D. armata* sp. nov. and *D. pilosa* sp. nov, were encountered. One species (*Pro. omunae*) is reported for the first time in Australia and a number of findings represent new host records (Table 3), new records for south-eastern Queensland and also significant extensions of the known geographical ranges of these species. The examination of a relatively wide range of species of rays has resulted in numerous new host records (Table 3), a



FIGS. 65-71. *Zygorhynchus elongatus* Beveridge and Campbell, 1988 (65-66), *Zygorhynchus robertsoni* Beveridge and Campbell, 1988 (67-69) (plerocercus) and *Zygorhynchus* sp. undescribed (70-71). **65**, metabasal tentacular armature; **66**, scolex, dorsoventral view; **67**, scolex, lateral view; **68**, metabasal tentacular armature; **69**, basal tentacular armature; **70**, plerocercus, lateral view; **71**, basal and metabasal armature. Scale bars: Figs 65 - 70 = 0.1 mm; 71 = 0.01 mm.

result expected given the relatively low host specificity of many adult trypanorhynchs (Palm & Caira 2008). Schaeffner and Beveridge (2014) calculated specificity indices for *Para. monomegacantha*, *Pro. aciculata*, *Pro. butlerae* and *Pro. clarkeae* using the index developed by Caira *et al.* (2003), showing that each of these species was euryxenous. *Prochristianella clarkeae* had the highest index and widest host range of all the species they examined, with 41 known host species. By contrast, one of the new species described above, *D. pilosa*, was found in a single species of ray only, *Ae. ocellatus*, illustrating the range of host specificity seen in adult trypanorhynchs.

The results presented here suggest that more extensive collecting of elasmobranchs in Moreton Bay will reveal significant numbers of additional species. Unfortunately, there was inadequate material of several species available to permit a full description and hence these obviously new species have not been named. Recent keys to the genus *Dollfusiella* by Schaeffner and Beveridge (2013d) and Haseli and Palm (2015) utilise features of the mature segment, particularly testis number, as important differentiating features. Consequently, species have been named only in instances where some description of the premature segments was possible. Naming of the remaining species encountered is dependent upon the collection of mature adult specimens.

Very few larval trypanorhynchs have been reported from callianassid and alpheid crustaceans (Dollfus 1929; Bates 1990; Palm 2004). Young (1954) reported a plerocercus identified as *Christianella trigonis-buccalis* (Wagener, 1854) from *Callianassa* sp. from southern California, with adults in *Urobatis halleri* (Cooper, 1863). Also cited as *Christianella trygonbrucco* (see Dollfus 1942, p. 219), this Mediterranean species was considered unrecognisable from its available descriptions by Beveridge *et al.* (2004) who suggested that it probably belonged within *Dollfusiella*. In addition, the only species of *Dollfusiella* reported to date from *U. halleri* is *Dollfusiella cortezensis* (Friggens & Duszynski 2005), redescribed by Menoret and Ivanov (2015). Consequently, the precise identity of Young's specimens remains uncertain. They do however suggest the presence of a species of *Dollfusiella* in a callianassid.

Pearce (1934) reported the larval stage of a *Rhynchobothrius* sp. from "*Crangon armillatus* (Milne-Edwards, 1837)" collected in the Dry Tortugas, Florida. As *Rhynchobothrius* was used as a generic name for a wide variety of trypanorhynchs, its current generic allocation is uncertain. The current name of the shrimp host is *Alpheus armillatus* Milne-Edwards, 1837, as cited by Palm (2004). However, this species is currently considered to be a complex, with several species occurring in Florida (Anker 2012). The precise identity of the host and the parasite therefore remain to be determined. Dollfus (1942) cited the reference to this report as 'Pearce, 1932, p.107' but did not include the reference in his bibliography. The correct reference is Pearce (1934, p. 107). The title page indicates that the paper was issued in December 1932, but the volume was not published until September 1934. The publication date of the volume has been adopted here as no record of the 1932 issue could be found and it is cited in the Index Catalogue of Medical and Veterinary Zoology as having been published in 1934.

The present study therefore suggests that callianassids and alpheids may be significant intermediate hosts of eutrarhynchid cestodes. To date, most reports of crustacean hosts for eutetrarhynchids are from crabs and prawns, particularly commercial species (see records summarised in Dollfus 1942; Bates 1990; Palm 2004) with a very small number of additional records from holothurians and molluscs (Palm, 1994). In Australian waters, the plerocercus of *Para. monomegacantha* has been reported from prawns from the Gulf of Carpentaria (0wens 1981) and the plerocerci of *Dollfusiella martini* and *Trimacracanthus aetobatidis* (Robinson, 1959) have been reported from *Cancer maenas* Linnaeus, 1785 in Victoria (Gurney *et al.* 2004). Consequently, more detailed examination of callianassids and alpheids could prove to be fruitful. In this study only a limited number of crabs was examined for larval cestodes with no infections found, but more extensive sampling may reveal larval cestodes. In attempting to understand the life cycles of trypanorhynch cestodes in Moreton Bay, a more extensive study of both crabs as well as prawns would be advisable.

ACKNOWLEDGEMENTS

This project was supported financially by the Australian Biological Resources Study National Taxonomy Research Grant RF215-40. We thank Tom Cribb and Scott Cutmore for providing the opportunities to collect all of the material included in this study, John Page and David Thompson for assistance with the collection of the elasmobranch hosts and Rod Bray, Storm Martin, Daniel Huston, Russell Yong, Xena Brooks, Nicholas Wee and Hoi Yan Iao for assistance with dissections. We thank Jeff Johnson of the Queensland Museum for assistance with fish identifications.

All applicable institutional, national and international guidelines for the care and use of animals were followed. Fish examined during this study were obtained from a commercial fishery.

We wish to thank Joan Clarke, Monash University, for taking the scanning eletron micrographs.

LITERATURE CITED

Anker, A. 2012. Revision of the western Atlantic members of the *Alpheus armillatus* H. Milne Edwards, 1837 species complex (Decapoda, Alpheidae), with description of seven new species. *Zootaxa* **3386**: 1-109.

Banner, D.M. & Banner, A.H. 1982. The alpheid shrimps of Australia. Part III: The remaining alpheids, principally the genus *Alpheus*, and the family Ogyrididae. *Records of the Australian Museum* **34**: 1-357. https://doi.org/10.3853/j.0067-1975.34.1982.434

Bates, R.M. 1990. A checklist of the Trypanorhyncha (Platyhelminthes: Cestoda) of the world (1935-1985). *National Museum of Wales, Zoological Series* **1**: 1-218.

Beveridge, I. 1987. *Echinocephalus overstreeti* Deardorff & Ko, 1983 (Nematoda: Gnathostomatoidea) from elasmobranchs and molluscs in South Australia. *Transactions of the Royal Society of South Australia* **111**: 79-92.

Beveridge, I. 1990. Taxonomic revision of Australian Eutetrarhynchidae Guiart (Cestoda: Trypanorhyncha). *Invertebrate Taxonomy* **4**: 785-845. https://doi.org/10.1071/IT9900785.

Beveridge, I., Bray, R.A., Cribb, T.C. & Justine, J.-L. 2014. Diversity of Trypanorhynch metacestodes in teleost fishes from coral reefs off eastern Australia and New Caledonia. *Parasite* **21**: 60 (pp. 19).

Beveridge, I. & Campbell, R.A. 1987. *Trimacracanthus* gen. nov. (Cestoda: Trypanorhyncha: Eutetrarhynchidae), with redescriptions of *T. aetobatidis* (Robinson, 1959) comb. nov. and *T. binuncus* (Linton, 1909) comb. nov. *Transactions of the Royal Society of South Australia* **111**: 163-171.

Beveridge, I. & Campbell, R.A. 1988a. *Cetorhinicola* n. g., *Shirleyrhynchus* n. g. and *Stragulorhynchus* n. g., three new genera of trypanorhynch cestodes from elasmobranchs in Australian waters. *Systematic Parasitology* **12**: 47-60 https://doi.org/10.1007/BF00182028.

Beveridge, I. & Campbell, R.A. 1988b. A review of the Tetrarhynchobothriidae Dollfus, 1969 (Cestoda: Trypanorhyncha) with descriptions of two new genera, *Didymorhynchus* and *Zygorhynchus*. *Systematic Parasitology* **12**: 3-29 https://doi.org/10.1007/BF00182025.

Beveridge, I. & Campbell, R.A. 1996. New records and descriptions of trypanorhynch cestodes from Australian fishes. *Records of the South Australian Museum* **29**: 1-22.

Beveridge, I. & Campbell, R.A. 2001. *Proemotobothrium* n. g. (Cestoda: Trypanorhyncha), with the redescription of *P. linstowi* (Southwell, 1912) n. comb. and description of *P. southwelli* n. sp. *Systematic Parasitology* **48**: 223-233.

Beveridge, I., Cribb, T.H. & Cutmore, S.C. 2017a. Larval trypanorhynch cestodes in fishes from Moreton Bay, Queensland. *Marine and Freshwater Research* 68: 2123-21. https://doi.org/10.1071/MF17010.

Beveridge, I., Haseli, M., Ivanov, V.A., Menoret, A. & Schaeffner, B.C. 2017b. Trypanorhyncha Diesling, 1863. *University of Kansas, Natural History Museum, Special Publication No.* **25**: 401-429.

Beveridge, I. & Jones, M.K. 2000. *Prochristianella spinulifera* n. sp. (Cestoda: Trypanorhyncha) from Australian dasyatid and rhynchobatid rays. *Systematic Parasitology* **47**: 1-8.

Beveridge, I. & Justine, J.-L. 2010. Two new species of *Prochristianella* Dollfus, 1946 (Platyhelminthes, Cestoda) from the blue-spotted stingray *Neotrygon kuhlii* (Müller & Henle, 1841) off New Caledonia. *Zoosystema* **32**: 643-652.

Beveridge, I., Neifar, L. & Euzet, L. 2004. Eutetrarhynchid cestodes from Atlantic and Mediterranean elasmobranchs, with the description of two new species of *Dollfusiella* Campbell & Beveridge, 1994 and redescriptions of *Prochristianella papillifer* (Poyarkoff, 1909) Dollfus, 1957 and *Parachristianella trygonis* Dollfus, 1946. *Systematic Parasitology* **59**: 81- 102.

Beveridge, I. & Sakanari, J.A. 1987. *Lacistorhynchus dollfusi* sp. nov. (Cestoda: Trypanorhyncha) in elasmobranch fishes from Australian and North American coastal waters. *Transactions of the Royal Society of South Australia* **111**: 147-154.

Bush, A.O., Lafferty, K.D., Lotz, J.M. & Shostak, A. W. 1997. Parasitology meets ecology on its own terms: Margolis et al. revisited. *Journal of Parasitology* **83**: 575-583.

Caira, J.N., Jensen, K. & Holsinger, K.E. 2003. On a new index of host specificity. *In*, (eds. C. Combes, J. Jourdane) *Taxonomy, ecology and evolution of metazoan parasites. Livre homage à Louis Euzet*. (Presses Universitaires de Perpignan: Perpignan). Pp. 161-201.

Campbell, R.A. & Beveridge, I. 1996. Revision of the family Pterobothriidae Pintner, 1931 (Cestoda: Trypanorhyncha). *Invertebrate Taxonomy* **10**: 617-662.

Campbell, R.A. & Beveridge, I. 2007. A new species and new records of *Parachristianella* Dollfus, 1946 (Cestoda: Trypanorhyncha) from the Gulf of California, Mexico. *Comparative Parasitology* **74**: 218-228. https://doi.org/10.1654/4261.1

Campbell, R.A. & Beveridge, I. 2009. *Oncomegas aetobatidis* sp. nov. (Cestoda: Trypanorhyncha), a re-description of *O. australiensis* Toth, Campbell & Schmidt, 1992 and new records of trypanorhynch cestodes from Australian hosts. *Transactions of the Royal Society of South Australia* **133**: 18-29.

Carvajal, J., Campbell, R.A. & Cornford, I. 1976. Some trypanorhynch cestodes from Hawaiian fishes, with descriptions of four new species. *Journal of Parasitology* **62**: 70-77.

Chervy, L. 2009. Unified terminology for cestode microtriches: a proposal from the International Workshop on Cestode Systematics in 2002-2008. *Folia Parasitologica* **56**: 199-230.

Dollfus, R.P. 1929. Sur les Tétrarhynques. I. Définition des genres. *Bulletin de la Société Zoologique de France* **45**: 308-342.

Dollfus, R.P. 1942. Etudes critiques sur les Tétrarhynques du Muséum de Paris. *Archives du Muséum national d'Histoire naturelle, Paris*, **19**: 1-466.

Feigenbaum, D.L. 1975. Parasites of the commercial shrimps *Penaeus vannamei* Boone and *Penaeus brasiliensis* Latreille. *Bulletin of Marine Science* **25**: 491-514.

Feigenbaum, D.L. & Cornuccio, J. 1976. Comparison between the trypanorhynch cestode infections of *Penaeus duorarum* and *Penaeus brasiliensis* in Biscayne Bay, Florida. *Journal of Invertebrate Pathology* **29**: 127-130.

Friggens, M.M. & Duszynski, D.W. 2005. Four new cestode species from the spiral intestine of the round stingray, *Urobatis halleri*, in the northern Gulf of California, Mexico. *Comparative Parasitology* **72**: 136-149. https://doi.org/10.1654/4121

Gurney, R.H., Nowak, B.F., Dykova, I. & Kuris, A.M. 2004. Histopathological effects of trypanorhynch metacestodes in the digestive gland of a novel host, *Carcina maenas* (Decapoda). *Diseases of Aquatic Organisms* **58**: 63-69.

Haseli, M., Malek, M. &Palm, H.W. 2010. Trypanorhynch cestodes of elasmobranchs from the Persian Gulf. *Zootaxa* **2492**: 28-48.

Haseli, M. & H. W. Palm. 2015. *Dollfusiella qeshmiensis* n. sp. (Cestoda: Trypanorhyncha) from the cowtail stingray *Pastinachus sephen* (Forsskål) in the Persian Gulf, with a key to the species of *Dollfusiella* Campbell & Beveridge, 1994. *Systematic Parasitology* **92**: 161-169.

Kovacs, K.J. & Schmidt, G.D. 1980. Two new species of cestode (Trypanorhyncha: Eutetrarhynchidae) from the yellow-spotted stingray *Urolophus jamaicensis*. *Proceedings of the Helminthological Society of Washington* **47**:10-14.

Kruse, D.N. 1959. Parasites of the commercial shrimps, *Penaeus aztecus* Ives, *P. duorarum* Burkenroad and *P. setiferus* (Linnaeus). *Tulane Studies in Zoology* **7**: 123-144.

Last, P.R. & Stevens, J.D. 1994. *Sharks and Rays of Australia. First edition*. (CSIRO Publishing: Melbourne). 513 pp.

Last, P.R. & Stevens, J.D. 2009. *Sharks and Rays of Australia. Second edition*. (CSIRO Publishing: Melbourne). 644 pp.

Last, P.R., White, W.T., Caira, J.N., Dharmadi, Fahmi, Jensen, K., Lim, A.P.K., Manjaji-Matsumoto, B.M., Naylor, G.J.P., Pogonoski, J.J., Stevens, J.D. & Yearsley, G.K. 2010. *Sharks and Rays of Borneo*. (CSIRO Publishing: Melbourne). 298 pp.

Last, P.R., White, W.T., de Carvalho, M.R., Séret, B., Stehmann, M.F.W., & Naylor, G.J.P. 2016. *Rays of the World* (CSIRO Publishing: Melbourne). 790pp.

Menoret, A. & Ivanov, V.A. 2015. Trypanorhynch cestodes (Eutetrarhynchidae) from batoids along the coast of Argentina, including the description of new species in *Dollfusiella* Campbell et Beveridge, 1994 and *Mecistobothrium* Heinz et Dailey, 1974. *Folia Parasitologica* **62**: 058.

Mudry, D.R. & Dailey, M.D. 1971. Postembryonic development of certain tetraphyllidean and trypanorhynchan cestodes with a possible alternative life cycle for the order Trypanorhyncha. *Canadian Journal of Zoology* **49**: 1249-1253.

Naylor, G.J.P., Caira, J.N., Jensen, K., Rosana, K.A.M., White, W.T. & Last, P.R. 2012. A DNA sequence-based approach to the identification of shark and ray species and its implications for global elasmobranch diversity and parasitology. *Bulletin of the American Museum of Natural History* **367**: 1-262.

Owens, L. 1981. Relationships between some environmental parameters and trypanorhynch cestode loads in banana prawns (*Penaeus merguiensis* de Mann). *Australian Journal of Marine and Freshwater Research* **32**: 469-474.

Palm, H.W. 2004. *The Trypanorhyncha Diesing, 1863*. (PKSPL-IPB Press: Bogor). 710 pp.

Palm, H.W. & Beveridge, I. 2002. Tentaculariid cestodes of the order Trypanorhyncha (Platyhelminthes) from the Australian region. *Records of the South Australian Museum* **35**: 49-78.

Palm, H.W. & Caira, J.N. 2008. Host specificity of adult versus larval cestodes of the elasmobranch tapeworm order Trypanorhyncha. *International Journal for Parasitology* **38**: 381-388.

Pearce, A.S. 1934. Observations on the parasites and commensals found associated with crustaceans and fishes at Dry Tortugas, Florida. *Papers from the Tortugas Laboratory of the Carnegie Institute of Washington* **28**: 107-115 (publication number 435).

Pintner, T. 1913. Vorarbeiten zu einer Monographie der Tetrarhynchoideen. *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften in Wien. Mathematik-Naturwissenschaftliche Classe* **122**: 171-253.

Salmani, S. & Haseli, M. 2017. *Prochristianella clarkeae* Beveridge, 1990 (Eutetrarhynchidae): a species complex or a species with intraspecific variation in the distribution of its tegumental microtriches? *Acta Parasitologica* **62**: 69-75.

Schaeffner, B.C. & Beveridge, I. 2012. *Prochristianella* Dollfus, 1946 (Trypanorhyncha: Eutetrarhynchidae) from elasmobranchs off Borneo and Australia, including new records and four new species. *Zootaxa* **3505**: 1-25.

Schaeffner, B.C. & Beveridge, I. 2013a. *Pristiorhynchus palmi* n. g., n. sp. (Cestoda: Trypanorhyncha) from sawfishes (Pristidae) off Australia, with redescriptions and new records of six species of the Otobothrioidea Dollfus, 1942. *Systematic Parasitology* **84**: 97-121.

Schaeffner, B.C. & Beveridge, I. 2013b. *Poecilorhynchus perplexus* n. g., n. sp. (Cestoda:Trypanorhyncha) from the brownbanded bamboo shark *Chiloscyllium punctatum* Müller & Henle, from Australia. *Systematic Parasitology* **85**: 1-9.

Schaeffner, B.C. & Beveridge, I. 2013c. *Dollfusiella* Campbell & Beveridge, 1994 (Trypanorhyncha: Eutetrarhynchidae) from elasmobranchs off Borneo, including descriptions of five new species. *Systematic Parasitology* **86**: 1-31.

Schaeffner, B.C. & Beveridge, I. 2014. The trypanorhynch fauna of BorN. *Zootaxa* **3900**: 21-49.

Toth, L.M., Campbell, R.A. & Schmidt, G.D. 1992. A revision of *Oncomegas* Dollfus, 1929 (Cestoda: Trypanorhyncha: Eutetrarhynchidae), the description of two new species and comments on its classification. *Systematic Parasitology* **22**: 167-187.

Whittaker, F.H., Apkarian, A.P., Curless, B. & Carvajal, J. 1985. Scanning electron microscopy of the scolices (sic) of *Parachristianella monomegacantha* Kruse, 1959 (Trypanorhyncha) and *Phyllobothrium* sp. Beneden, 1849 (Tetraphyllidea). *Journal of Parasitology* **71**: 376-381.

Young, R.T. 1954. Cestodes of sharks and rays in southern California. *Proceedings of the Helminthological Society of Washington* **21**: 106-112.