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## New records of *Cotylea* (Polycladida, Platyhelminthes) from Lizard Island, Great Barrier Reef, Australia, with remarks on the distribution of the *Pseudoceros* Lang, 1884 and *Pseudobiceros* Faubel, 1984 species of the Indo-Pacific Marine Region

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### Abstract

In the present work eleven polyclad species of Lizard Island are studied. Seven of them are new records for this locality of the Australian coral reef and one is new to science, *Lurymare clavocapitata* n. sp. (Family Prosthiostomidae). The remaining recorded species belong to the genera *Pseudoceros* (*P. bimarginatus*, *P. jebborum*, *P. stimpsoni*, *P. zebra*, *P. parataliclavus* and *P. prudhoei*) and *Pseudobiceros* (*Pb. hancockanus*, *Pb. hymanae*, *Pb. flowersi* and *Pb. uniARBorensis*). Regardless of the different distribution patterns, all pseudocerotid species show brilliant colours, but similar internal morphology. Furthermore, differences in the form and size of the stylet are characteristic, because it is a sclerotic structure that is not affected during fixation. In *Pseudoceros*, the distance between the sucker and the female pore also differs among species. These features do not vary enough to be considered as diagnostic, but they provide information that can help to disentangle similarly coloured species complexes. A key of the genera *Pseudoceros* and *Pseudobiceros* of the Indo-Pacific region is provided, in order to facilitate the identification of species from this area.

**Key words:** *Pseudoceros*, *Pseudobiceros*, key, *Lurymare*

### Introduction

In the present study eleven species belonging to the suborder *Cotylea* (Polycladida, Platyhelminthes) from Lizard Island are studied. These species belong mainly to *Pseudoceros* and *Pseudobiceros*, both genera with a high biodiversity in the Indo-Pacific. Additionally, a new species belonging to the genus *Lurymare* (Family Prosthiostomidae) is described. The distribution of *Lurymare* (actually four species) is characteristic for the Indo-Pacific region, with the exception of *L. drygalskii* (Bock, 1931), Marcus & Marcus 1968 and *L. utarum* Marcus, 1952. *Lurymare drygalskii* was described from Simon's Bay (or Simon's Town, South Africa) (Bock 1931) near the Indo-Pacific region. *Lurymare utarum* has been found in Brazil, Florida and Colombia (Marcus 1952; Quiroga *et al.* 2004a; Bahia *et al.* 2014). *Pseudoceros* Lang, 1884 (87 species) and *Pseudobiceros* Faubel, 1984 (37 species) are characteristic for tropical and subtropical waters (Tyler *et al.* 2006–2015). The geographic distribution of most species of *Pseudoceros* and *Pseudobiceros* is restricted to the Indo-Pacific region. Most of the species have been reported from Japan, with more than 20 records (Yeri & Kaburaki 1918; Kaburaki 1923; Kato 1944), and from the Indo-West Pacific region, with 57 records for *Pseudoceros* (Newman & Cannon 1994a, 1998; Tyler *et al.* 2006–2015) and 26 for *Pseudobiceros* (Newman & Cannon 1997, Tyler *et al.* 2006–2015). However, some species have been found in the Mediterranean (Lang 1884), Brazil (Marcus 1950), California (Hyman 1953), Galapagos Islands (Plehn 1896), Bermudas (Verrill 1905; Quiroga 2008), and Puget Sound, British Columbia (Hyman 1953). The latter report is unexpected due to the distribution of these genera seems to be limited to warm waters.

Throughout the nineties and early 2000s, Leslie Newman, Lester Cannon and collaborators made a series of

comprehensive studies on the polyclad fauna of Eastern Australia and Papua New Guinea (Newman & Cannon 1994a, 1994b, 1995, 1996a, 1996b, 1997, 1998, 2000, 2002; Newman *et al.* 1994; Jennings & Newman 1996a, 1996b; Merory & Newman 2005). Although they found representatives of several families from both suborders (Cotylea and Acotylea), the family Pseudocerotidae was undoubtedly the most abundant and diverse in the Great Barrier Reef (Newman & Cannon 1994a). Later studies (Doignon *et al.* 2003, Lee *et al.* 2006) also found a similar diversity pattern. In contrast, another well-known family within Cotylea, Prosthiostomidae, is under-represented in taxonomic surveys, the only record at the species level from the Great Barrier Reef is the corallivorous *Amakusaplana acroporae* Rawlinson, Gillis, Billings & Borneman, 2011 (Rawlinson & Stella 2012), which was found in Lizard Island on its host *Acropora valida*.

The genera *Pseudoceros* and *Pseudobiceros* are characterised by the combination of a ruffled pharynx, marginal pseudotentacles of the anterior body-edge, an anastomosed intestine and a beautiful variety of colour patterns. Though both genera are easy to distinguish, species limits are difficult to discern (Newman & Cannon 1994b); the colour pattern, which is often very conspicuous, has been used as practically the only feature to differentiate them (Hyman 1954, 1959; Prudhoe 1985, 1989). For this reason, preserved specimens are almost impossible to identify. Previous authors (Faubel 1984) have claimed that other possible identifying characters can be used. The copulatory apparatus is widely used in Polycladida as a diagnostic feature and, although it seems to be quite uniform within *Pseudoceros* and *Pseudobiceros*, there are details that may have taxonomic importance. In the present work we provide comprehensive descriptions of species from Lizard Island and discuss the taxonomical relevance of some features found in these taxa. Additionally, a key for the valid species of the genera *Pseudoceros* and *Pseudobiceros* known for the Indo-Pacific is provided.

## **Material and methods**

All specimens were manually collected from different areas in Lizard Island (Queensland, Australia), and surroundings (Table 1 in Ribas & Hutchings, 2015, *Zootaxa* 4019). The collecting was done in the intertidal zone, and using SCUBA diving in the subtidal zone. Specimens were removed from the substrate using a brush and stored in containers. In the laboratory they were photographed and a small piece of tissue was removed and stored in 100% alcohol for future DNA analysis, while the rest of the animal was fixed in Bouin's fluid and stored in 70% alcohol. Later, they were dehydrated, cleared with Benzil-Benzoate, embedded in paraplast, serially sectioned at 7–10 µm, and stained with Azan's trichromic stain. Reconstructions of internal anatomy were derived from serial sections; in the case of *Pseudobiceros* species, only one of the male reproductive complexes is represented. Measurements were determined from fixed material. Live specimens were photographed by Alexander Semenov with the camera equipment Canon 5d Mark II with Canon MP-E 1-5x Macro f2.8 lens + 2x Inon Z-240 Strobes; shots were made with ISO100, 1/200sec shutter speed, aperture—f13. The material is deposited in the Marine Invertebrate Collection of the Australian Museum, Sydney (AM). Number of specimens listed under each registration number is one unless otherwise specified.

## **Results**

### **Rhabditophora Ehlers, 1985**

#### **Order Polycladida Lang, 1881**

##### **Suborder Cotylea Lang, 1884**

##### **Superfamily Pseudocerotoidea Faubel, 1984**

##### **Family Pseudocerotidae Lang, 1884**

## Genus *Pseudoceros* Lang, 1884

*Pseudoceros* Lang, 1884: 430, 538, Taf. 5 fig. 4, Taf. 9, figs 1–3.

*Pseudoceros*.—Faubel 1984: 208; Prudhoe 1985: 131, fig. 116; *Pseudoceros* Newman & Cannon 1996: 214, figs 1A, 2A, 3A, B, E, 4A, 5A, 6A, 7A, B.

**Type-species.** *Pseudoceros velutinus* (Blanchard, 1847) Lang 1884, by monotypy.

**Diagnosis.** *Pseudoceros* is characterized by colourful and aposematic pigmentation. Body consistency soft; body shape oval, with wavy margin and posteriorly slightly tapered. Sucker conspicuous and located in middle of body. Anterior margin folds form pseudotentacles. Pseudotentacles simple folds in two forms: tubular folds or pointed broad flaps. Cerebral eyes horseshoe shaped or a round cluster by immature animals. Dorsal pseudotentacular eyes paired or impaired spread lines; ventral pseudotentacular eyes two loose clusters. Pharynx anteriorly located with seven (one anterior, four lateral and two posterior) ruffled, deep folds. Intestine narrow, with numerous lateral branches, usually anastomosed.

One posterior male pore located close to pharynx and inserted between last pair of pharyngeal folds. Female and male pores well separated. Sucker behind female pore. Single male copulatory organ with an elongated muscular seminal vesicle and a free, rounded prostatic vesicle with extraepithelial glands. Ejaculatory and prostatic duct joins at base of penis papilla. Penis papilla armed with a conical stylet with specific length and width. Testes very abundant and ventrally located. *Vasa deferentia* as spermiducal vesicles, but not spermiducal bulbs. Ovaries dorsally and widely distributed. Female system short and posteriorly oriented. Uteri paired with numerous uterine vesicles. Vagina descends straight to cement pouch, sack-like shaped. Cement glands well developed.

In the following descriptions, only morphological features that characterised the different species, or outstanding differences respect to the generic diagnosis are added or described.

### *Pseudoceros bimarginatus* Meixner, 1907

(Fig. 1)

*Pseudoceros bimarginatum* Meixner, 1907: 168–170.—Marcus 1950: 84.

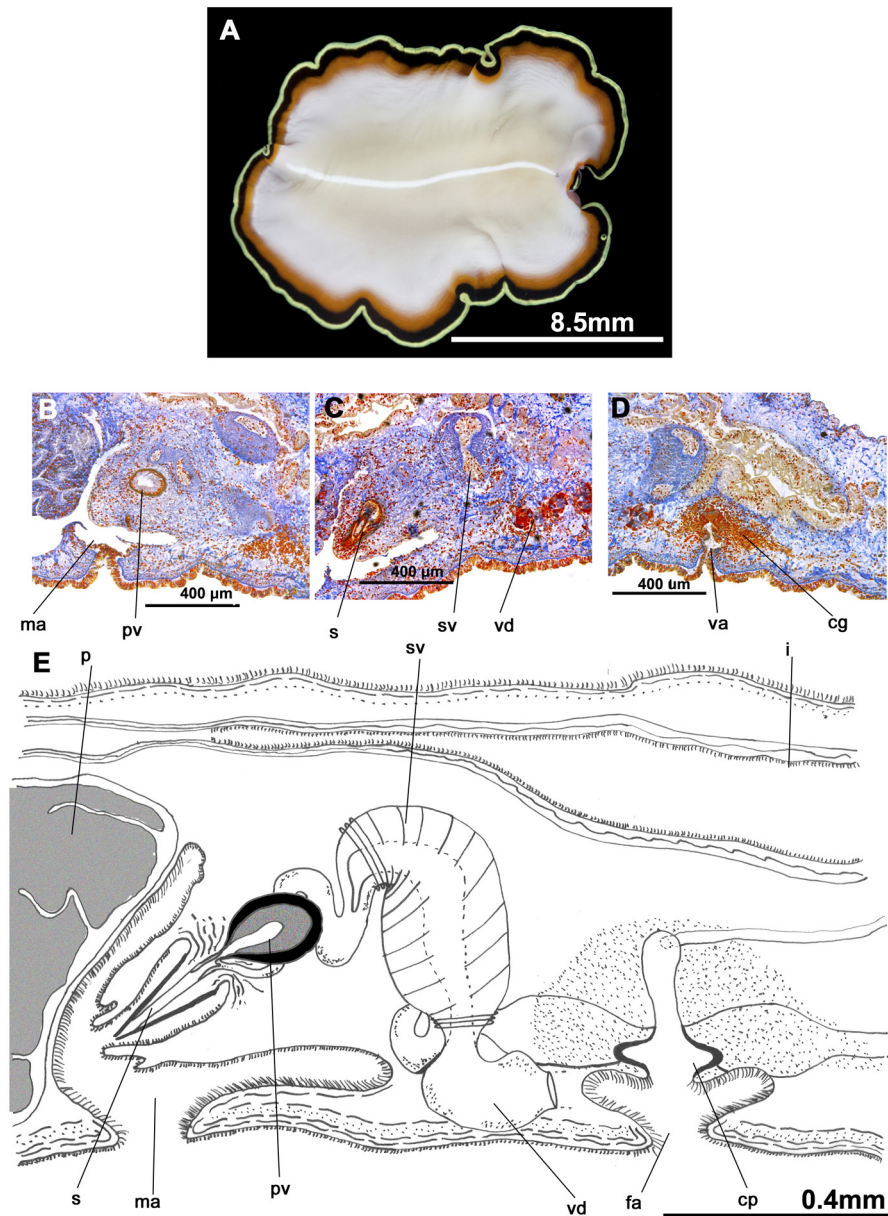
*Pseudoceros corallophilus* Hyman, 1954: 223–224, fig. 2.—Coleman 1990: 31; Cannon & Newman 1994b: 83, fig. 4.

**Material examined.** AM W.44682, MI QLD 2400, sagittally sectioned.

**Description.** Elongated body 17 mm long, 9 mm wide. Cerebral eyes horseshoe-shaped. Dorsal colouration: ivory white background, a mid-dorsal bright white line; three marginal bands (inner to outer): orange, black and a yellow rim (Fig. 1A). Sucker and genital pores, all at the same distance. Seminal vesicle large and rounded, ventrodorsally oriented. Spherical prostatic vesicle with a narrow and short duct. Penis papilla, forwards oriented, with a conic stylet. Stylet wide, housed in a very deep male atrium (Fig. 1B, C, E). Female genital complex (Fig. 1D, E) with the characteristic configuration of the genus.

**Remarks.** *Pseudoceros bimarginatus*, *P. contrarius* Newman & Cannon 1995, *P. intermittus* Newman & Cannon, 1995, and *P. confusus* Newman & Cannon, 1995 share a similar colour pattern (Newman & Cannon 1995) and coexist on the reefs of Eastern Australia. The characteristic order of the marginal bands (orange-black-yellow) distinguish *P. bimarginatus* from the other three species mentioned. Newman & Cannon (1994b) noticed that most specimens possess a bright white mid-dorsal line and an extra marginal band inner to the orange one of the same colour, though these lines may be occasionally faint or absent; in the examined specimen the mid-dorsal line is present, but the marginal one is absent.

**Distribution.** Previously found in the Gulf of Tadjourah, Somalia (Meixner 1907), Djibouti (Gosliner *et al.* 1996), Heron Island, Australia, and Anilao, Philippines (Newman & Cannon 1994b), Kwajalein, Marshall Islands (Newman & Cannon 1998). First report for Lizard Island.



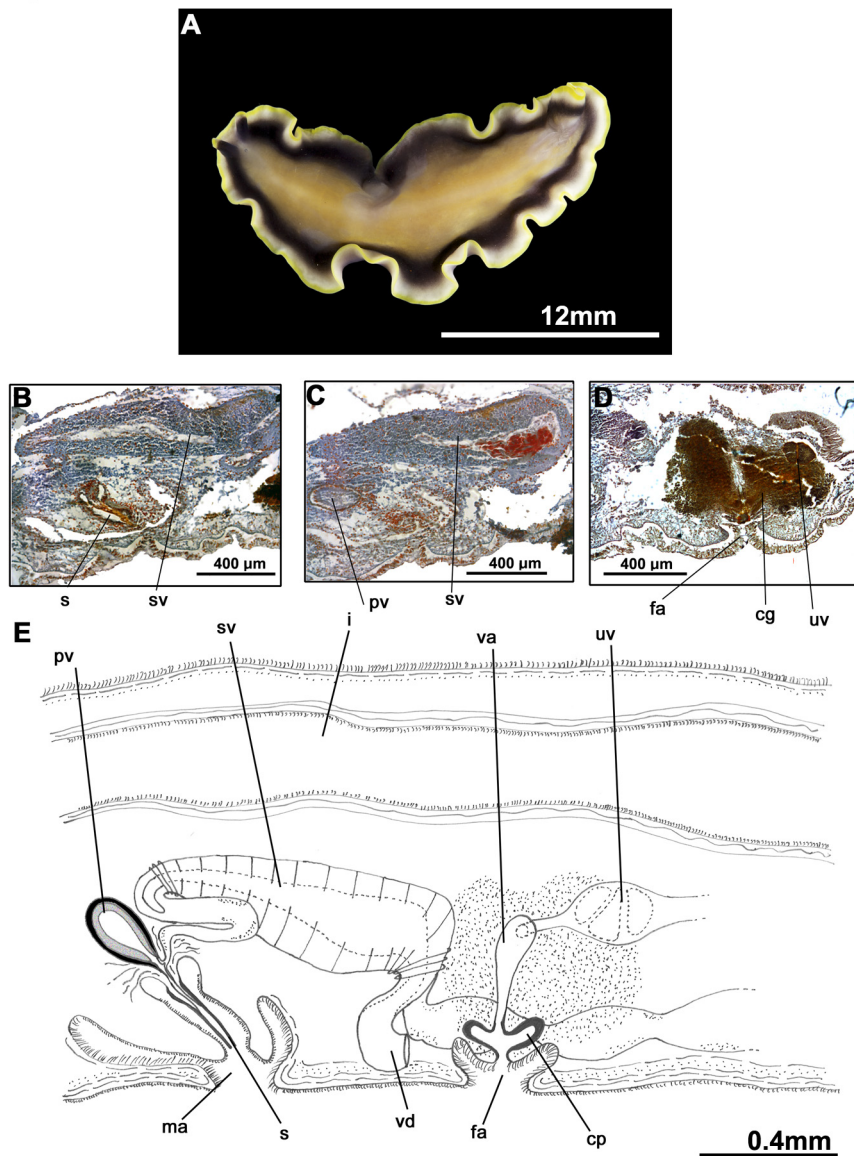
**FIGURE 1.** *Pseudoceros bimarginatus* Meixner, 1907, AM W.44682, MI QLD 2400. A. Live specimen; B–D. Histological sections of the reproductive system; E. Sagittal reconstruction of the reproductive system, anterior to the left in B–E. Abbreviations: cg = cement glands, cp = cement pouch, fa = female atrium, i = intestine, ma = male atrium, p = pharynx, pv = prostatic vesicle, s = stylet, sv = seminal vesicle, va = vagina, vd = vas deferens.

***Pseudoceros jebborum* Newman & Cannon, 1994**

(Fig. 2)

**Material examined.** AM W.45203, MI QLD 2448, sagittally sectioned.

**Description.** Elongated body is 23 mm long and 6 mm wide. Dorsal colour pattern is yellowish-white, with three marginal bands: inner black, white in the middle, and a yellow outer rim (Fig. 2A). Sucker is at middle of the body, far from female pore. Seminal vesicle elongated, slightly flattened, oriented antero-posteriorly. Prostatic vesicle is elongated. Ejaculatory duct is directed backwards. Prostatic duct is narrow. Penis papilla, backwards, armed with a thin and long stylet, is housed in a shallow male atrium (Fig. 2B, C, E). The female genital complex (Fig. 2D, E) represents the configuration characteristic of the genus.



**FIGURE 2.** *Pseudoceros jebborum* Newman & Cannon, 1994, AM W.45203, MI QLD 2448. A. Live specimen; B–D. Histological sections of the reproductive system; E. Sagittal reconstruction of the reproductive system, anterior to the left in B–E. Abbreviations: cg = cement glands, cp = cement pouch, fa = female atrium, i = intestine, ma = male atrium, pv = prostatic vesicle, s = stylet, sv = seminal vesicle, uv = uterine vesicles, va = vagina, vd = vas deferens.

**Remarks.** The stylet in the examined specimen is thin and similar to that of *P. astrorum* (Bulnes & Torres 2014), but with a less pronounced curvature.

**Distribution.** Previously found in Heron Island and Coral Bay, Australia (Newman & Cannon 1994b, 1998), Hawaii (Gosliner *et al.* 1996), and Mandang, Papua New Guinea (Newman & Cannon 1994b). First report for Lizard Island.

***Pseudoceros paralaticlavus* Newman & Cannon, 1994**  
(Fig. 3)

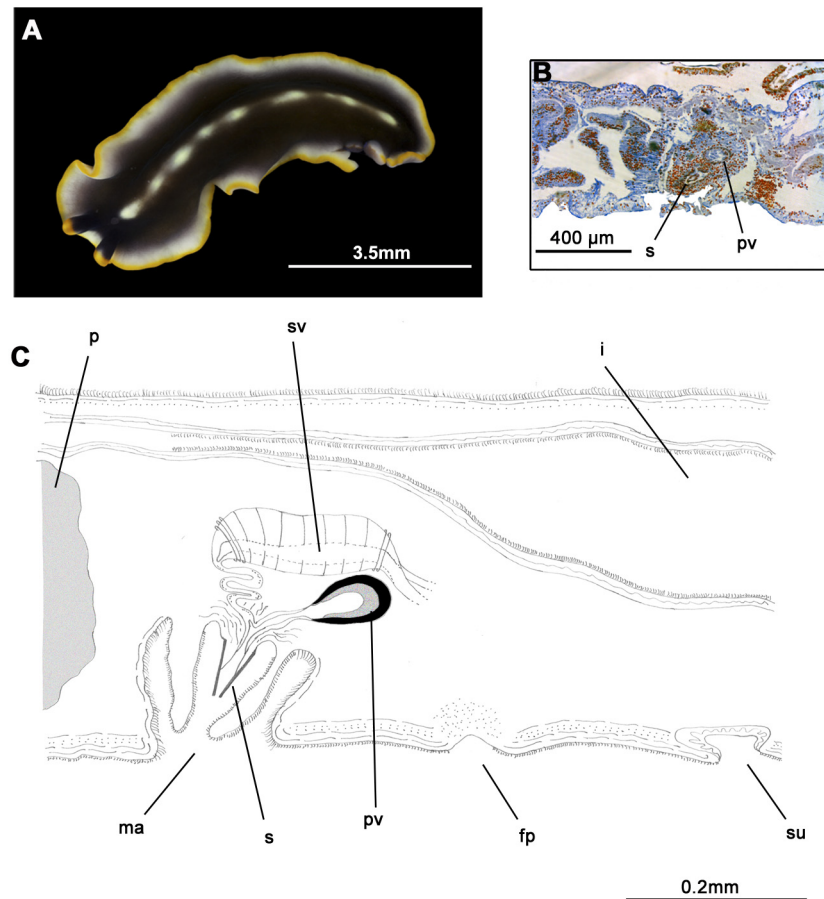
*Pseudoceros paralaticlavus* Newman & Cannon, 1994: 232–233, figs 25A–C, 48F.

**Material examined.** AM W.44678, MI QLD 2400, sagittally sectioned.

**Description.** Elongated body is 7 mm long and 3 mm wide. Dorsal colour pattern is black background, with a



whitish longitudinal medial band that is discontinuous and thin. It begins behind the eyespot and continues through almost the posterior end of the body; there are two additional marginal bands (inner to outer): wide white and yellow (Fig. 3A). Sucker is near female pore. Seminal vesicle is small, elongated and flattened, oriented antero-posteriorly. Prostatic vesicle is spherical. Ejaculatory duct is narrow, sinuous. Prostatic duct is long and wide. Penis papilla is armed with a short conical stylet inside a shallow male atrium (Fig. 3B, C). Female genital complex (Fig. 3C) is immature.



**FIGURE 3.** *Pseudoceros paralaticlavus* Newman & Cannon, 1994, AM W.44678, MI QLD 2400. A. Live specimen; B. Histological sections of the reproductive system; C. Sagittal reconstruction of the reproductive system, anterior to the left in B, C. Abbreviations: fp = female pore, i = intestine, ma = male atrium, p = pharynx, pv = prostatic vesicle, s = stylet, su = sucker, sv = seminal vesicle.

**Remarks.** The description of *P. paralaticlavus* (Newman & Cannon 1994b) refers to a cream-white longitudinal band with an inner white line. The examined specimen lacks the white line, and the cream-white band is narrow. However, the small size of the specimen, together with the immaturity of the female reproductive system, suggests that the colour pattern may vary during the life cycle, and may not be completely developed.

The colour pattern of *Pseudoceros paralaticlavus* resembles the pigmentation pattern of *P. jebborum*. However, the background colour in *P. jebborum* is white with black and white marginal bands, while in *P. paralaticlavus* the background colour is black with white (or cream-white) bands. The white coloured area in *P. jebborum* is much extensive than in *P. paralaticlavus*. Additionally, a narrow white line is present in mature specimens of *P. paralaticlavus*, which is absent in *P. jebborum* (Newman & Cannon 1994b). Moreover, the stylet in *P. paralaticlavus* is short and conical, while in *P. jebborum* it is long and very narrow; the prostatic vesicle is spherical in *P. paralaticlavus*, but clearly oval in *P. jebborum*. Finally, the sucker is near the female pore in *P. paralaticlavus*, but in the middle of the body, far from the female pore, in *P. jebborum*.

**Distribution.** Previously found at Heron Island, One Tree Island, Lizard Island and Moreton Bay, Australia

(Newman & Cannon 1994b, 1998), Laing Island and Mandang, Papua New Guinea (Newman & Cannon 1994b, 1998), and Lakshadweep Island, India (Apte & Pitale 2011).

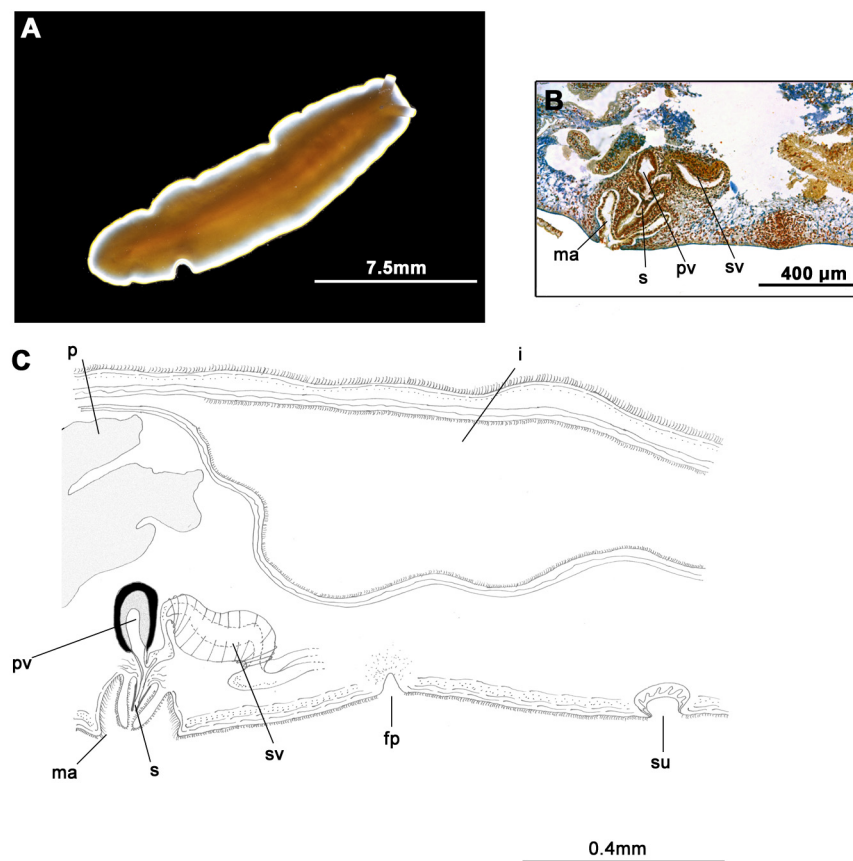
***Pseudoceros prudhoei* Newman & Cannon, 1994**

(Fig. 4)

*Pseudoceros prudhoei* Newman & Cannon, 1994: 235–236, figs 28A–C, 49C.

**Material examined.** AM W.45204, MI QLD 2448, sagittally sectioned.

**Description.** Elongated body is 15 mm long and 5 mm wide. Dorsal colour pattern is uniform orange-brown background with two marginal bands (inner to outer): one is bluish grey to whitish towards the margin, another is yellow, narrow. Male and female pores are well separated (Fig. 4A). Sucker is at the same distance from the female pore as the female pore from the male pore. Seminal vesicle is small, elongated and flattened, slightly curved ventrally in the middle. Prostatic vesicle is large and elongated. Ejaculatory duct descends up to base of penis papilla. Prostatic duct is wide and short. Stylet is broad and small, housed in a shallow male atrium (Fig. 4B, C). Female genital complex (Fig. 4C) is immature.



**FIGURE 4.** *Pseudoceros prudhoei* Newman & Cannon, 1994, AM W.45204, MI QLD 2448. A. Live specimen; B. Histological sections of the reproductive system; C. Sagittal reconstruction of the reproductive system, anterior to the left in B, C. Abbreviations: fp = female pore, i = intestine, ma = male atrium, p = pharynx, pv = prostatic vesicle, s = stylet, su = sucker, sv = seminal vesicle.

**Remarks.** Newman & Cannon (1994b) mentioned that the dorsal surface is covered with numerous small granules of dark brown colour, over the orange background, which confers it a darker appearance, almost black. In the examined specimen, those granules do not appear, and thus, the dorsal colouration is lighter. Such variation in the colour tone, while maintaining the basic pattern, has been already described by other authors (Ang & Newman 1998; Litvaitis *et al.* 2010). Although in the original description the inner marginal band is described as sky blue or

mauve, in the attached picture it can be seen that, as happens in our specimen, the band fades to white (Newman & Cannon 1994b, 2003). A similar morphotype was reported by Apte & Pitale (2011) from India, while Dixit and Raghunathan (2013) reported from India a specimen of *P. prudhoei* that matched the original description. This could be another case of colour variation.

**Distribution.** Previously found at Heron Island and Lizard Island, Australia (Newman & Cannon 1994b, 1998), Mandang, Papua New Guinea (Newman & Cannon 1994b, 1998), Shimoni, Kenya (Newman & Cannon 1998), Persian Gulf, Iran (Maghsoudlou & Rahimian 2014), and India (Apte & Pitale 2011; Dixit & Raghunathan 2013).

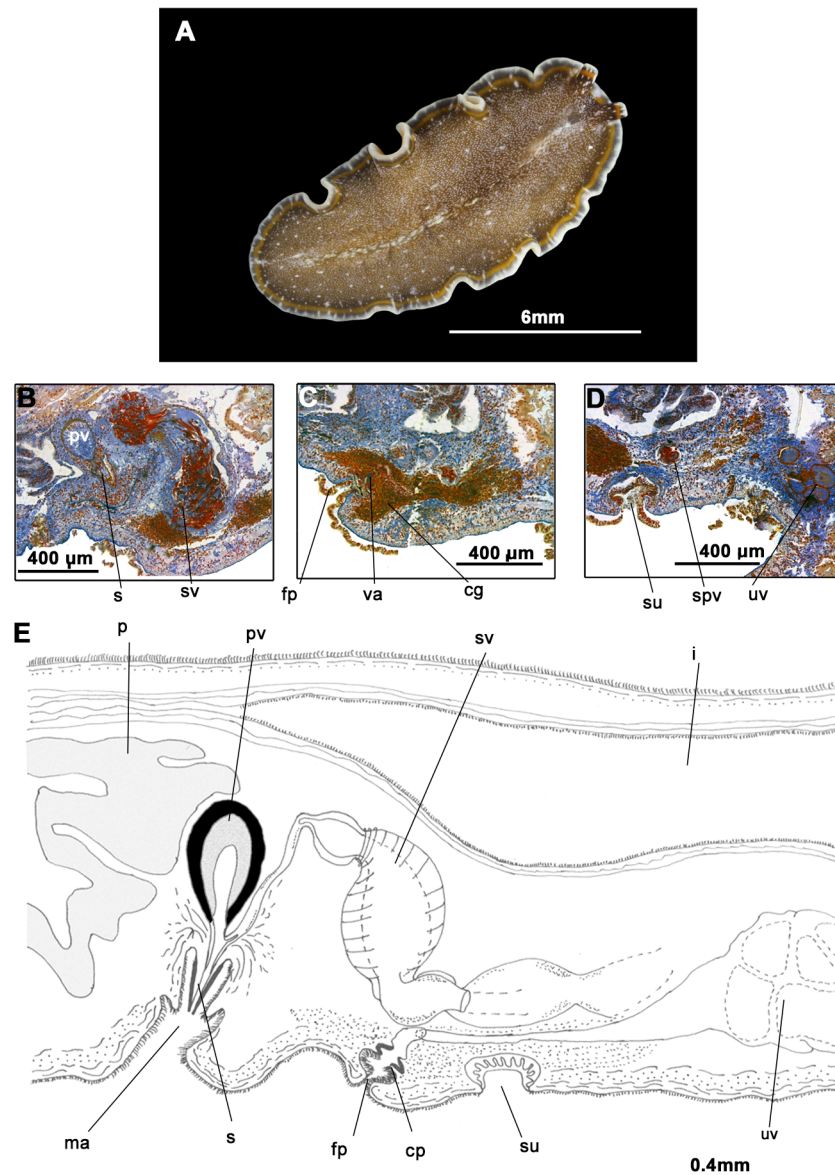
***Pseudoceros stimpsoni* (Stimpson, 1855)**

(Fig. 5)

*Eurylepta interrupta* Stimpson, 1855: 380.

*Pseudoceros stimpsoni* Newman & Cannon, 1998: 315–316, figs 12A–C, 16D.

*Pseudoceros interruptus* Kato, 1944: 298.—Prudhoe 1989: 84, fig. 31.



**FIGURE 5.** *Pseudoceros stimpsoni* Newman & Cannon, 1998, AM W.45205, MI QLD 2448. A. Live specimen; B–D. Histological sections of the reproductive system; E. Sagittal reconstruction of the reproductive system. Anterior to the left in B–E. Abbreviations: cg = cement glands, cp = cement pouch, fp = female pore, i = intestine, ma = male atrium, p = pharynx, pv = prostatic vesicle, s = sucker, spv = spermiducal vesicles, su = sucker, sv = seminal vesicle, uv = uterine vesicles, va = vagina.



**Material examined.** AM W.45205, MI QLD 2448, sagittally sectioned.

**Description.** Body is oval, 12 mm long, 6 mm wide. Dorsal colour pattern is light brown background, with numerous white speckles of irregular outline and size. In the median line the speckles are bigger, forming a false line; two marginal bands (inner to outer), are orange and white. Orange band is surrounded at both sides by fainter bands of grey or black (Fig. 5A). Sucker very close to female pore (Fig. 5D, E). Seminal vesicle is small, with strong muscular walls and ventro-dorsally oriented. Prostatic vesicle is big and oval. Prostatic duct is narrow and short. Penis papilla is armed with a conic stylet, inside a very shallow male atrium (Fig. 5B, E). Female system (Fig. 5C, E) has the configuration characteristic for the genus.

**Remarks.** *Pseudoceros stimpsoni* shows the colour pattern comparable with the light brown morphotype of *Pseudoceros bicolor* Verrill, 1901 (Litvaitis *et al.* 2010; Bahia *et al.* 2014). However, some differences are noticeable between the examined specimen and the light brown morphotype of *P. bicolor*: first, the orange marginal band is narrow in *P. stimpsoni*, but wider and diffuse in *P. bicolor*; although faint, in *P. stimpsoni* it appears as a black/grey band at both sides of the orange marginal band, while in *P. bicolor* a discontinuous black band appears only external to the orange one; lastly, the interruptive white speckles of the orange band are quite small in *P. stimpsoni* in comparison to those in *P. bicolor*. Furthermore, *P. stimpsoni* occurs in the Indo-Pacific region, while *P. bicolor* is only known from West Atlantic (Bermuda (Verrill 1901), Curaçao (Marcus & Marcus 1968; Litvaitis *et al.* 2010), Caribbean coast of Colombia (Quiroga *et al.* 2004b), Belize, Florida, Honduras, Jamaica, Panamá (Litvaitis *et al.* 2010), and Brazil (Bahia *et al.* 2014)). However, future DNA analysis should be conducted in order to confirm or reject the synonymisation of these two species.

**Distribution.** Previously found in Ryukyu Islands, Japan (Kato 1944), Nagada Harbour, Papua New Guinea (Newman & Cannon 1998) and Mozambique (Prudhoe 1989). First report for Lizard Island and Australia.

### ***Pseudoceros zebra* (Leuckhart, 1828)**

(Fig. 6)

*Planaria zebra* Leuckart, 1828: 11.

*Pseudoceros zebra* Lang, 1884: 544.

*Eurylepta zebra* Diesing, 1850: 211.

*Proceros zebra* Diesing, 1862: 554.

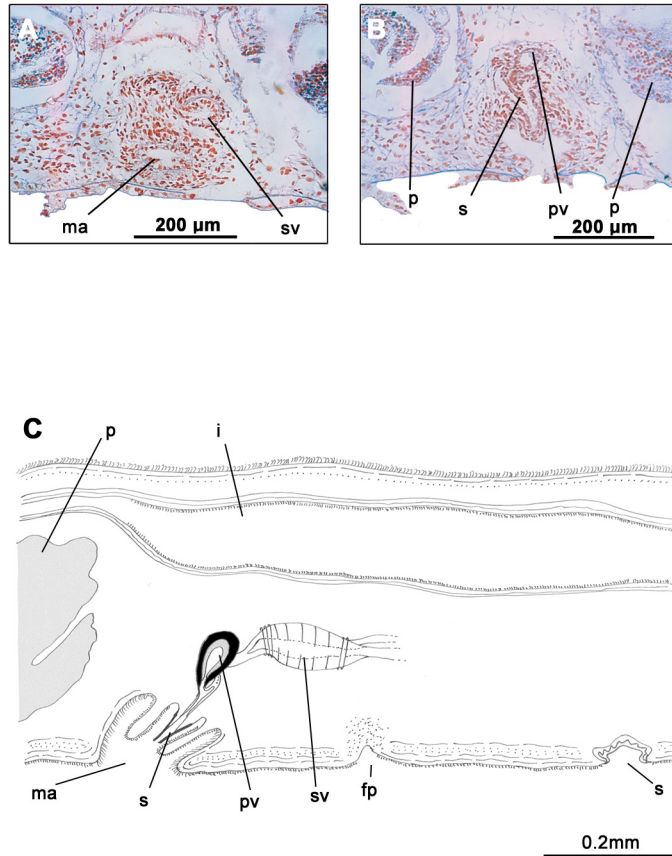
*Pseudoceros pleurostrictus*, Bock, 1913: 257–258.

**Material examined.** AM W.43982, MI QLD 2348, in transverse sections.

**Description.** Body is oval, 13 mm long and 6 mm wide. Dorsal colour pattern is black background with a mid-dorsal white stripe, from which transversal white stripes emerge to the body margin; with one orange marginal band. Sucker is at same distance from female pore as female to male pore. *Vasa deferentia* is empty, entering into the seminal vesicle from behind. Seminal vesicle is small, ovate. Prostatic vesicle is oval, small. Ejaculatory duct is long. Prostatic duct is very short. Penis papilla is armed with a small, conic stylet, housed in a shallow atrium (Fig. 6A–C). Female genital complex (Fig. 6C) is immature.

**Remarks.** The original description of *Pseudoceros zebra* (Leuckhart, 1828) mentions a violaceous-black background, with a mid-dorsal white stripe, transversal white stripes towards the margin, and white transversal stripes that do not reach the mid-dorsal one; additionally one marginal band orange/yellow is present. Given this description, the specimens described by Bock (as *Pseudoceros pleurostrictus* Bock, 1913), those described by Prudhoe (1989), as well as two specimens designated as *Pseudoceros zebra* and *Pseudoceros* sp. 4 by Newman & Cannon (2003), together with our specimen can be considered *Pseudoceros zebra*, although they exhibit differences in the number and width of the white stripes. This disparity within a basic colour pattern is not unique for this species, similar variation has been observed also in *Pseudoceros dimidiatus* von Graff, 1893 (Newman & Cannon 2003).

**Distribution.** Previously found in the Gulf of Naples (Lang 1884), the Gulf of Suez (Leuckhart 1828), Mauritius (Newman & Cannon 2003), Mozambique (Prudhoe 1989), Madagascar (Bock 1913), and Heron Island, Australia (as *Pseudoceros* sp.4, Newman & Cannon 2003). First report for Lizard Island.



**FIGURE 6.** *Pseudoceros zebra* (Leuckhart, 1828), AM W.43982, MI QLD 2348. A–B. Histological sections of the reproductive system; C. Sagittal reconstruction of the reproductive system, anterior to the left. Abbreviations: fp = female pore, ma = male atrium, p = pharynx, pv = prostatic vesicle, s = stylet, su = sucker, sv = seminal vesicle.

### Genus *Pseudobiceros* Faubel, 1984

*Pseudobiceros* Faubel, 1984: 215.

*Pseudoceros* Lang, 1884: 430, 538, Taf. 5 fig. 5.—Prudhoe 1985: 131, fig. 116.

*Pseudobiceros* Newman & Cannon, 1996: 239, figs 1B, 2B, 3C, D, F, 4B, 5B, 6A.

**Type-species.** *Pseudobiceros strigosus* (Marcus, 1950), by monotypy.

**Diagnosis.** *Pseudobiceros* shows, as *Pseudoceros*, a flamboyantly aposematic and conspicuous colouration. Body consistency squasy and extremely delicate, elongate oval shape. Anterior end flattened and posterior end tapering, margin highly ruffled. Characteristic pseudotentacles well developed, mainly ear-like, but sometimes square. Cerebral eyespot rounded, elongated (with pointed ends). Dorsal pseudotentacular eyes in four star-like elongate clusters, ventral pseudotentacular eyes in four dense clusters. Sucker medial and located far from gonopores. Pharynx within anterior end; oval, with shallow simple pharyngeal folds. Intestine wider with numerous extremely narrow intestinal branches. Two symmetrical male pores emerge posteriorly to pharynx. Male apparatus duplicate and identical. Muscular seminal vesicle elongated. Rounded prostatic vesicle free, antero-dorsally oriented with extraepithelial glands. Ejaculatory and prostatic ducts join at base of penis papilla. Penis papilla armed with a conical stylet with specific length and width. Testes usually very abundant and ventrally located. *Vasa deferentia* as spermiducal vesicles, but not spermiducal bulbs.

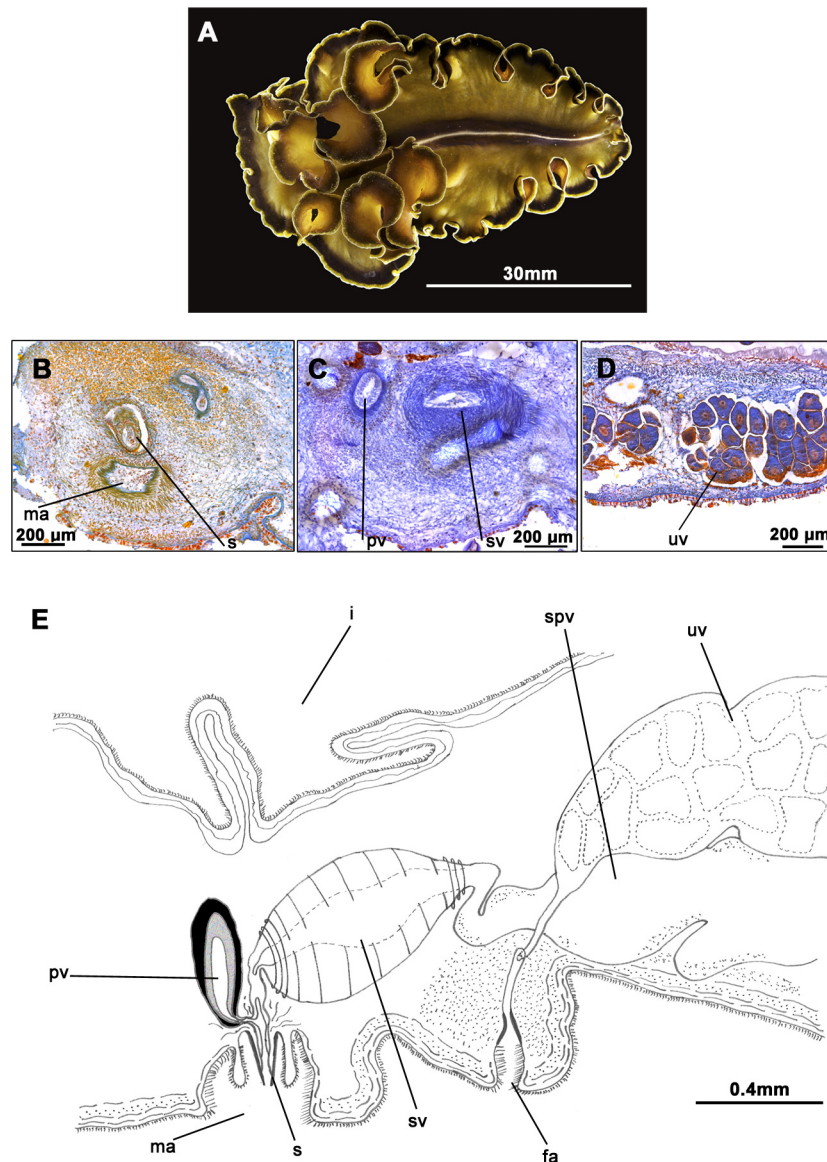
Female pore between male pores. Female complex without conspicuous difference with *Pseudoceros*. Ovaries situated dorsally and widely distributed; vagina short and posteriorly oriented; uteri paired, usually with numerous vesicles; cement pouch sack-like shaped; cement glands conspicuous.

*Pseudobiceros flowersi* Newman & Cannon, 1997

(Fig. 7)

**Material examined.** AM W.44685, MI QLD 2410, sagittally sectioned.

**Description.** Elongated body is 60 mm long and 25 mm wide. Dorsal colour pattern is golden yellow background with two mid-dorsal lines, one is wider, dark, another is thinner, white, formed by very small dots; three marginal bands are an inner black, olive green in the middle, and narrow white outer rim (Fig. 7A). Seminal vesicle is oval, heavily muscularized, ventrally inclined to distal end. Prostatic vesicle is long, narrow. Ejaculatory duct is short, descends straight to penis papilla base. Prostatic duct is small, narrow. Penis papilla is armed with a long conic stylet, inside a shallow atrium (Fig. 7B, C, E). Female system (Fig. 7D, E) has the configuration characteristic of the genus.



**FIGURE 7.** *Pseudobiceros flowersi* Newman & Cannon, 1997, AM W.44685, MI QLD 2410. A. Live specimen; B–D. Histological sections of the reproductive system; E. Sagittal reconstruction of the reproductive system. Anterior to the left in B–E. Abbreviations: fa = female atrium, i = intestine, ma = male atrium, pv = prostatic vesicle, s = stylet, spv = spermiducal vesicles, sv = seminal vesicle, uv = uterine vesicles.

**Remarks.** The colour of this species in the original description and diagnosis (Newman & Cannon 1997) is olive green to brown, with black-green-white marginal bands, and white narrow and black wide mid-dorsal line. The examined specimen presents a yellow background instead of olive green.

**Distribution.** Previously found under rubble in Lizard Island Lagoon (Lizard Island, Australia) (Newman & Cannon 1997) and also in Luzon, Philippines (Luzon, Philippines (Gosliner *et al.* 1996)).

***Pseudobiceros hancockanus* (Collingwood, 1876)**

(Fig. 8)

*Proceros hancockanus* Collingwood, 1876: 87, 91.

*Pseudobiceros hancockanus* Faubel 1984: 207.

*Stylochopsis malayensis* Collingwood, 1876: 88, 94.

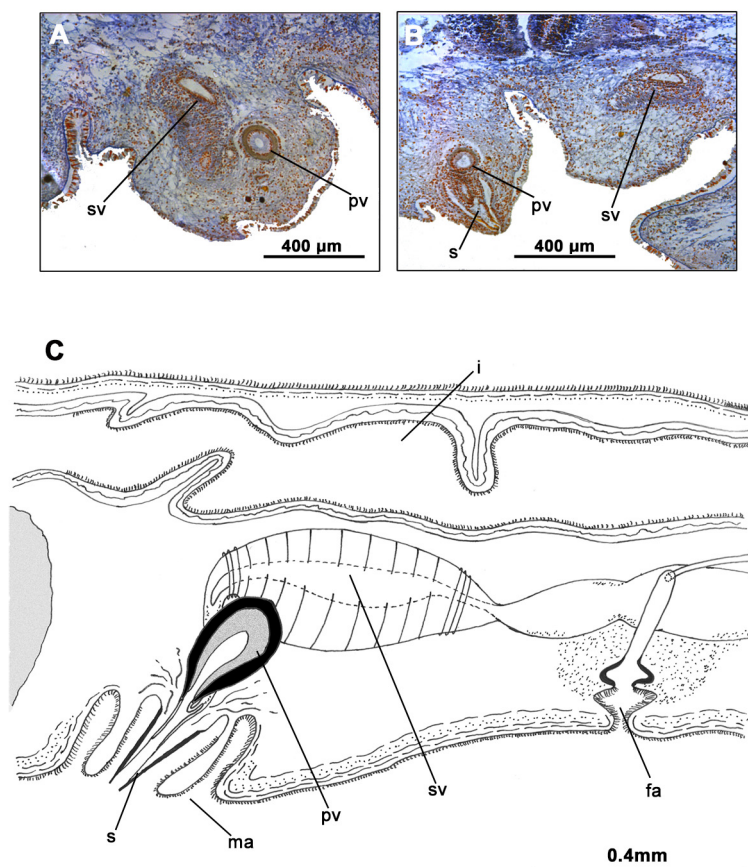
*Prostheceraeus hancockanus* Lang, 1884: 567.

*Pseudoceros malayensis* Bock, 1913: 258.

*Pseudoceros hancockianus* Laidlaw 1903: 301, 302, 315.

**Material examined.** AM W.44684, MI QLD 2390, transversally sectioned; AM W.44683, MI QLD 2390, in 70% ethanol.

**Description.** Elongated body is 38 mm long and 9 mm wide. Dorsal colouration: black background, with two marginal bands (inner to outer), wide orange and white. Seminal vesicle is ovoid and large. Prostatic vesicle is ovoid, oriented forward. Ejaculatory duct is narrow, descends behind seminal vesicle until base of penis papilla. Prostatic duct is short. Stylet is conic, large, housed in a shallow atrium (Fig. 8A–C). Female genital complex (Fig. 8C) has the configuration characteristic for the genus and a small atrium.



**FIGURE 8.** *Pseudobiceros hancockanus* (Collingwood, 1876), AM W.44684, MI QLD 2390. A–B. Histological sections of the reproductive system; C. Sagittal reconstruction of the reproductive system. Anterior to the left. Abbreviations: fa = female atrium, i = intestine, ma = male atrium, pv = prostatic vesicle, s = stylet, sv = seminal vesicle.



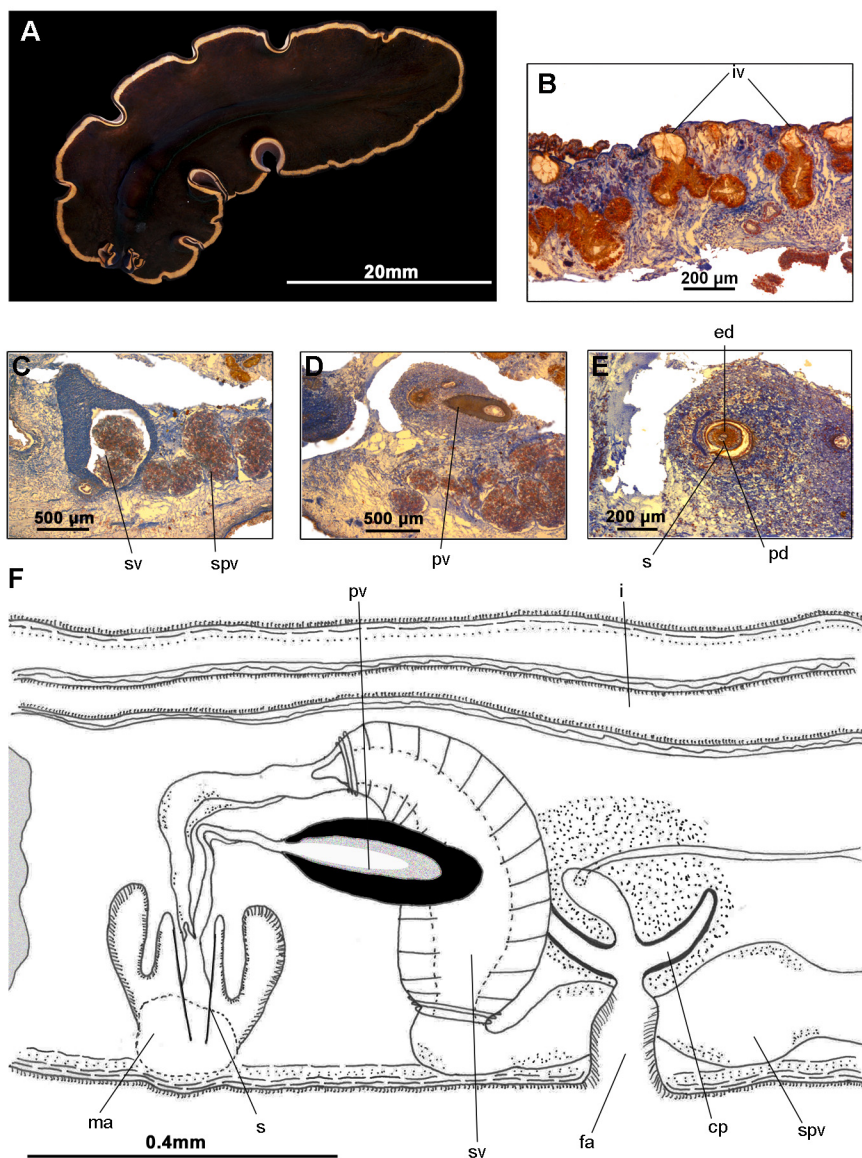
**Remarks.** *Pseudobiceros hancockanus* shows similar colouration as *Pseudobiceros gloriosus*, but the latter presents a black rim at the margin, external to the white band.

**Distribution.** Previously found at Heron Island and One Tree Island (Australia), Laccadives (India), Japan, Singapore, and Philippines (Newman & Cannon 1994b). First report from Lizard Island.

***Pseudobiceros hymanae* Newman & Cannon, 1997**

(Fig. 9)

*Pseudobiceros hymanae* Newman & Cannon, 1997: 350–352, figs 5A–C, 12D.



**FIGURE 9.** *Pseudobiceros hymanae* Newman & Cannon, 1997, AM W.45014, MI QLD 2434. A. Live specimen; B. Histological section of the dorsal surface; C–E. Histological sections of the reproductive system; F. Sagittal reconstruction of the reproductive system. Anterior to the left in B–F. Abbreviations: cp = cement pouch, ed = ejaculatory duct, fa = female atrium, i = intestine, iv = intestine vesicles, ma = male atrium, pd = prostatic duct, pv = prostatic vesicle, s = stylet, spv = spermiducal vesicles, sv = seminal vesicle.

**Material examined.** AM W.45014, MI QLD 2434, sagittally sectioned.

**Description.** Elongated body is 45 mm long and 10 mm wide. Pseudotentacles are square. Dorsal colouration: purple-black background, with two marginal bands (inner to outer), wide orange and black (Fig. 9A). The intestinal



branches dorsally project small round vesicles, of trabecular section, that open to the exterior through a pore (Fig. 9B) and form so-called intromittent intestinal vesicles (Faubel 1983), or “anal” pores (Lang 1884). These vesicles are scattered all over the dorsal surface, although they are much less abundant in the anterior region, on the median line over the pharynx and copulatory apparatus. Seminal vesicle is large, pyriform, heavily muscularised and ventrodorsally oriented. Prostatic vesicle is oval, long and flattened. Ejaculatory duct is wide at proximal end, narrows near penis papilla. Prostatic duct is narrow and long. Ejaculatory and prostatic duct join inside the stylet (Fig. 9E). Stylet is long and conical, housed in a deep atrium. Male pores are laterally oriented; female pore are at short distance from the male apertures (Fig. 9C–F). The female system (Fig. 9F) shows the characteristic configuration of the genus.

**Remarks.** This is the first time that intromittent intestinal vesicles (vesicles with gastrovascular external pores) are described for *Pseudobiceros*. These gastrovascular external pores are similar to those present in the genus *Cycloporus* and *Yungia aurantiaca* (Delle Chiaje, 1822) (see Lang 1884). The location of the vesicles is different in each genus; in *Yungia* and *Pseudobiceros* (family Pseudocerotidae) they are present in the dorsal surface (Lang 1884), while in *Cycloporus* (family Euryleptidae) they are restricted to the body margin (Lang 1884; Newman & Cannon 2002; Bahia *et al.* 2014). Lang (1884) stated that these intestinal vesicles are used for water capture or for excretion. In *P. hymanae* clots of excreted material have been found near the pores of the vesicles, therefore, the function of the vesicles in *P. hymanae* (and in *Y. aurantiaca*) may be the excretion.

In regard to the internal reproductive anatomy, *P. hymanae* displays significant differences with the rest of *Pseudobiceros* spp. examined: the ejaculatory and prostatic ducts join inside the penis papilla at a point where the stylet is present, instead of the base of the penis papilla.

On the other hand, *P. hymanae* presents a colour pattern similar to that of *P. hancockanus*, though both species can be distinguished by the external marginal bands, which is black in *P. hymanae* and white in *P. hancockanus*. The prostatic vesicle of *P. hymanae* is oval and flattened, in contrasts to round prostatic vesicle of *P. hancockanus*.

**Distribution.** Previously found in Heron Island and Rottneest Island, Australia, Mandang, Papua New Guinea (Newman & Cannon 1997) and Button Island, India (Sreeraj & Raghunathan 2013). First report from Lizard Island, Australia.

#### ***Pseudobiceros uniarborensis* Newman & Cannon, 1994**

(Fig. 10)

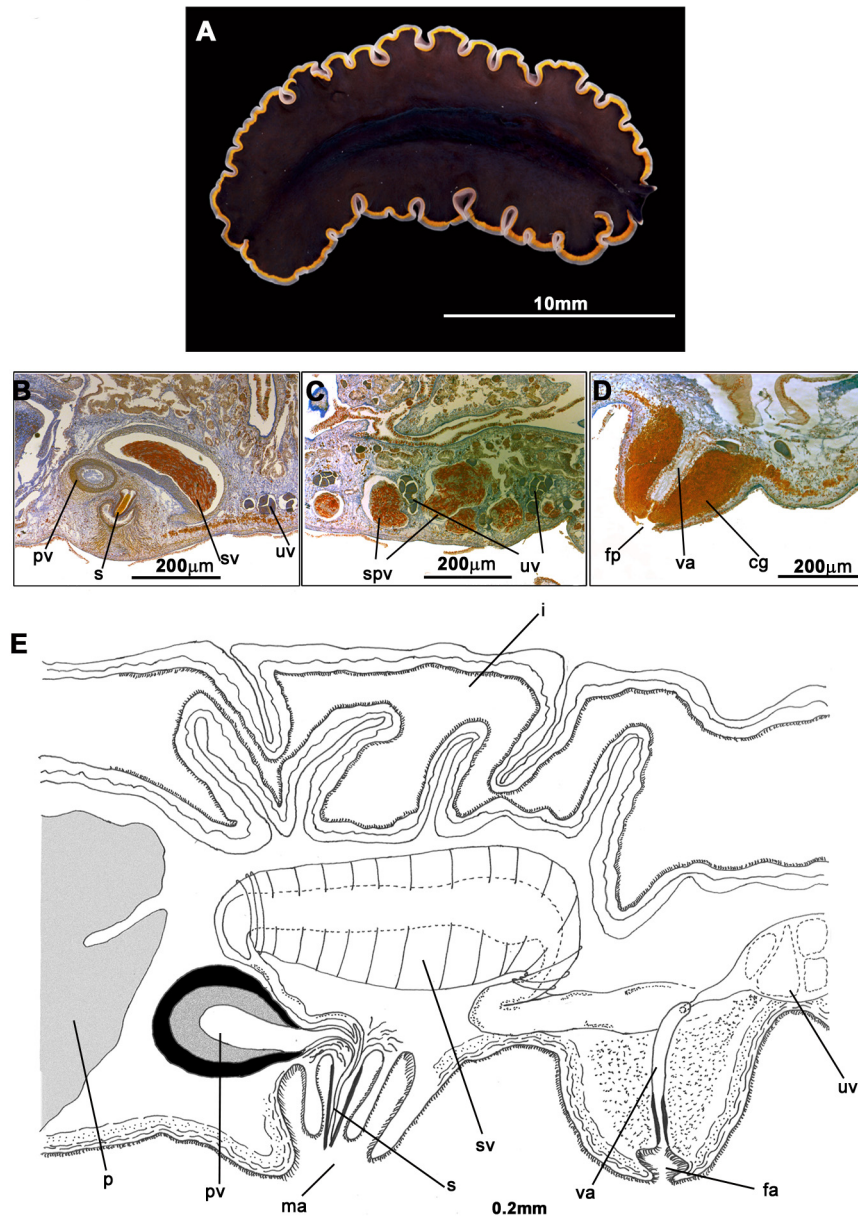
*Pseudobiceros uniarborensis* Newman & Cannon, 1994: 252–254, figs 42a–d, 51f.

**Material examined.** AM W.45437, MI QLD 2445, sagittally sectioned.

**Description.** Elongated body is 20 mm long and 6 mm wide. Dorsal colour pattern is black background, with three narrow marginal bands: (to outer), inner orange, pale or transparent grey in the middle and a white outer rim. Female pore close to the male pores (Fig. 10A). Sucker is at the middle of the body. *Vas deferens* is with very dilated spermiducal vesicles (Fig. 10C). Seminal vesicle is pyriform, large, heavily muscularized and anteriorly oriented. Prostatic vesicle is round, large. Ejaculatory duct is long and narrow, runs backwards. Prostatic duct is long and narrow. Penis papilla is armed with a long stylet housed in a shallow atrium (Fig. 10B, E). The female system (Fig. 10D, E) shows the characteristic configuration of the genus.

**Remarks.** *Pseudobiceros uniarborensis* belongs, along with *P. hymanae*, *P. gloriosus*, *P. hancockanus*, and *P. periculosus*, to a group of species with very similar colour pattern, can be distinguished based on morphological characters. *P. uniarborensis* presents ear-like pointed pseudotentacles, while the rest of the species show square pseudotentacles. Moreover, the transparent grey marginal band with the white rim is exclusive for *P. uniarborensis*. Furthermore, the junction of the prostatic and ejaculatory ducts at the base of the penis papilla distinguishes *P. hymanae* from *P. uniarborensis*.

**Distribution.** Previously found at Heron Island, One Tree Island, Lizard Island, Ningaloo Reef and Coral Bay, Australia (Newman & Cannon 1994b, 1997), Mandang, Papua New Guinea (Newman & Cannon 1994b, 1997), Oman Gulf, Iran (Maghsoudlou & Rahimian 2014) and Kavaratti Island, India (Apte & Pitale 2011).



**FIGURE 10.** *Pseudobiceros uniarborensis* Newman & Cannon, 1994, AM W.45437, MI QLD 2445. A. Live specimen; B–D. Histological sections of the reproductive system; E. Sagittal reconstruction of the reproductive system. Anterior to the left in B–E. Abbreviations: cg = cement glands, fa = female atrium, fp = female pore, i = intestine, ma = male atrium, p = pharynx, pv = prostatic vesicle, s = stylet, spv = spermiducal vesicles, sv = seminal vesicle, uv = uterine vesicles, va = vagina.

### Superfamily Euryleptoidea Faubel, 1984

#### Family Prosthiostomidae Lang, 1884

#### Genus *Lurymare* Marcus & Marcus, 1968

*Lurymare* Marcus & Marcus, 1968: 88, fig. 88.

*Lurymare*.—Faubel 1984: 234; Prudhoe 1985: 147, fig. 137.

*Prosthiostomum* (*Lurymare*) Poulter, 1975: 317, 323, figs 7, 9–11.

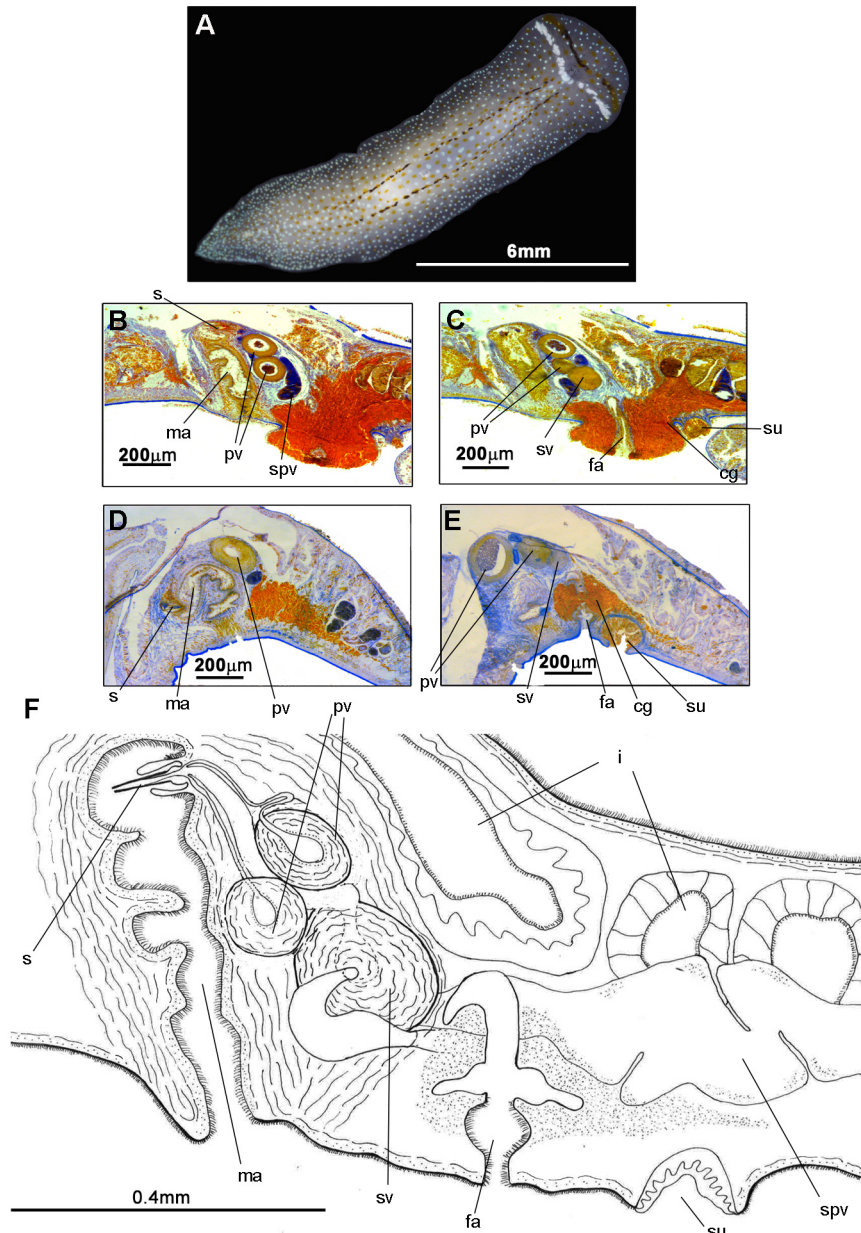
**Type-species.** *Lurymare drygalskii* (Bock, 1931) Marcus & Marcus 1968, by monotypy.

**Diagnosis.** Prosthiostomidae are with marginal eyes limited to varying lengths of the anterior margin; accessory vesicles of adult worms are bound in a common muscle sheath which may include the seminal vesicle; sucker is not far behind the female gonopore.

***Lurymare clavocapitata* n. sp.**

(Fig. 11)

**Material examined.** Holotype: AM W.44692, MI QLD 2395. Paratype: AM W.44065, MI QLD 2351.



**FIGURE 11.** *Lurymare clavocapitata* n. sp., AM W.44065, MI QLD 2351, AM W.44692, MI QLD 2395. A. Live specimen; B–E. Histological sections of the reproductive system; F. Sagittal reconstruction of the reproductive system, anterior to the left in B–F. Abbreviations: cg = cement glands, fa = female atrium, i = intestine, ma = male atrium, pv = prostatic vesicle, s = stylet, spv = spermiducal vesicles, su = sucker, sv = seminal vesicle.

**Diagnosis.** The *Lurymare* species that has orange and blue-white dots on the dorsal surface. There are three dark brown stripes, one transversal in front of the cerebral eyes, two interrupted longitudinal at both sides of the

pharynx; sometimes a white transversal stripe runs behind the cerebral eyes. The whole male copulatory apparatus is enclosed in a muscle bulb. Sucker is very close to the female pore.

**Description.** Elongated body is anteriorly rounded and pointed posteriorly, 9–12 mm long and 2–3 mm wide. Tentacles are absent. Cerebral eyes are in two close clusters of 10–12 eyespots each, with an anterior row of four eyes (two in front of each cerebral cluster), marginal eyes are in the anterior margin; there is a pair of ventral eyes in front of the brain. Dorsal surface is smooth. Dorsal colour pattern is transparent white with orange and blue-white dots; a dark brown transversal stripe appears at the front of the cerebral eyes, and a white one behind them. There are two intermittent dark brown stripes at both sides of the median line (Fig. 11A) that do not reach the posterior end. Pharynx is plicate tubular, occupies one third of body length. Oral pore is behind brain. Male and female pores are close to each other at the middle of the body. Sucker is very close to female pore. Male reproductive system consists of a large, spherical and heavily muscularised seminal vesicle, two spherical prostatic vesicles, and an armed penis papilla, all enclosed together with the male atrium in a muscular bulb. Spermiducal vesicles are present. Ejaculatory duct is wide with a thick muscular layer. Prostatic vesicles are spherical. Prostatic ducts are narrow, with a muscular layer. Prostatic ducts run attached to the ejaculatory duct, but without any tissue bounding them. Penis papilla is armed with a slender stylet. Atrium is deep ciliated (Fig. 11B–F). Female system lies immediately posterior to male muscular bulb. Proximal end of vagina is bended forward, descends straight to cement pouch and opens in a heart-shaped female atrium. Cement glands are well developed (Fig. 11C, E, F).

**Remarks.** The enclosing of the three vesicles (two prostatic vesicles and the seminal vesicle) into a common muscle bulb places the examined specimens into the genus *Lurymare* Marcus & Marcus, 1968, together with *L. drygalskii* (Bock, 1931), *L. katoi* (Poulter, 1975), *L. monosorum* (Schmarda, 1859), *L. singulare* (Laidlaw, 1904), and *L. utarum* (Marcus, 1952) (Faubel 1984; Bahia *et al.* 2014). Among them, *L. utarum* and *L. drygalskii* are found in the Atlantic Ocean (Bock 1931; Marcus 1952; Quiroga *et al.* 2004a; Bahia *et al.* 2014), while *L. katoi*, *L. monosorum* and *L. singulare* present an Indo-Pacific distribution. *Lurymare clavocapitata* n. sp. can be easily distinguished from *L. singulare*, *L. utarum* and *L. monosorum* by their dorsal colouration, which is white cream to ivory, with a brown median line, and dark-reddish brown central line. Bock (1931) did not mention the colouration of *L. drygalskii*, but this species can be distinguished from *L. clavocapitata* n. sp. in the reproductive anatomy: both the penis papilla and the sucker are much larger in *L. drygalskii* than in *L. clavocapitata* n. sp., while the male atrium is narrower and deeper in *L. clavocapitata* n. sp. Furthermore, the characteristic three brown stripes present in *L. clavocapitata* n. sp. did not disappear after fixation and they are not present in Bock's drawings (Bock 1931, Taf. 45, Fig. 18).

*L. clavocapitata* n. sp. shows some similarities in the dorsal colouration with *L. katoi*, as the white colour with orange-gold spherules. However, *L. katoi* lacks the blue-white dots and the three (one transversal, two longitudinal) brown stripes characteristic of *L. clavocapitata* n. sp. In respect of the internal anatomy, the male atrium is deeper in *L. clavocapitata* n. sp., and is included in the common muscular bulb, the feature that does not appear in *L. katoi*. Also, the sucker is much closer to the female pore in *L. clavocapitata* n. sp. than in *L. katoi*.

In the paratype, which is smaller than the holotype, although is a mature specimen, the white transversal stripe behind the cerebral eyes is absent. However, a similar colour variation has been reported for *Prosthiosomum trilineatum* Yeri & Kaburaki, 1920 by Newman & Cannon (2003) and Pitale *et al.* (2014).

**Etymology.** The specific name derives from the Latin *clavo* (=line) + *capita* (=head), for the distinctive transversal brown stripe before the eyes.

**Habitat.** Holotype found on rocks over fine sand, while the paratype was found on coral rubble and flat algae.

**Type locality.** Coconut Beach, Lizard Island (Queensland, Australia), 14°40'53"S, 145°28'12"E.

### Key to Indo-Pacific species of *Pseudoceros*

1.	Marginal bands absent . . . . .	2
-	Marginal bands: a rim . . . . .	11
-	Marginal bands: one . . . . .	9
-	Marginal bands: two . . . . .	27
-	Marginal bands: three . . . . .	29
-	Marginal bands: four . . . . .	33
-	Marginal bands formed by transverse streaks or stripes . . . . .	34
-	Marginal bands interrupted (completely or partially) . . . . .	35

-	Marginal bands formed by transverse triangular patches, additionally two longitudinal black bands at the middle line, pink spots on patches and bands, and white spots on the triangular bands. Background colour: orange-pink . . . . .	<i>Pseudoceros tigrinus</i> Laidlaw, 1902
2. (1)	Cerebral eyes absent, ventral eyes at the anterior end, central. Colour (fixed individuals) beige-whitish. . . . .	<i>Pseudoceros langamaakensis</i> Faubel, 1983
-	Cerebral eyes in one cluster (round). . . . .	3
-	Cerebral eyes in two clusters; background colour dusky greyish brown, middle line pale. . . . .	<i>Pseudoceros fuscogriseus</i> Hyman, 1959
-	Cerebral eyes horseshoe shaped . . . . .	7
-	Cerebral eyes inverted "v" shaped . . . . .	9
3. (2)	Not mottled (plain) . . . . .	4
-	Mottled . . . . .	6
-	Mottled with cream background; medial line pale; marginal band yellow. . . . .	<i>Pseudoceros microceraeus</i> (Schmarda, 1859)
4. (3)	Longitudinal median line absent. . . . .	5
-	Longitudinal median line wide; background light red, with a purple marginal band. . . . .	<i>Pseudoceros liparus</i> Marcus, 1950
5. (4)	Background evenly purple-red; longitudinal bands absent . . . . .	<i>Pseudoceros vinosus</i> Meixner, 1907
-	Background dark violet with lateral wide yellow band (circle like) . . . . .	<i>Pseudoceros clavicornis</i> (Schmarda, 1859)
6. (3)	Pseudotentacles simple folds; background colour deep red; raised cream microdots scattered over the dorsal surface and the margin. . . . .	<i>Pseudoceros cruentus</i> Newman & Cannon, 1998
-	Pseudotentacles ear-shaped; background colour pearly white, with transverse black streaks . . . . .	<i>Pseudoceros punctatus</i> Laidlaw, 1903
7. (2)	Pseudotentacles simple folds . . . . .	8
-	Pseudotentacles deep folds; background colour black . . . . .	<i>Pseudoceros ater</i> Hyman, 1959
-	Pseudotentacles distal buttons; background colour red-yellowish . . . . .	<i>Pseudoceros cardinalis</i> Haswell, 1907
-	Pseudotentacles major lateral folds; background colour dark violet . . . . .	<i>Pseudoceros perviolaceus</i> (Schmarda 1859)
8. (7)	Background colour cream with scattered purple spots; transverse streaks and stripes with reticulate (star-shaped) pattern; vas deferens unbranched. . . . .	<i>Pseudoceros irretitus</i> Newman & Cannon, 1998
-	Background cream with scattered purple spots; transverse streaks and stripes absent; vas deferens branched. . . . .	<i>Pseudoceros laingensis</i> Newman & Cannon, 1998
9. (2)	Without spots, dots or maculae. . . . .	10
-	With orange, pink and brick-red dots; margin a pink irregular band and cream background . . . . .	<i>Pseudoceros goslineri</i> Newman & Cannon, 1994
-	With large golden yellow maculae medially, blue maculae marginally and burgundy background . . . . .	<i>Pseudoceros lindae</i> Newman & Cannon, 1994
10. (9)	Body shape oval; background colour magenta red. . . . .	<i>Pseudoceros rubellus</i> Laidlaw, 1903
-	Body shape elongated-oval; background black . . . . .	<i>Pseudoceros bolool</i> Newman & Cannon, 1994
11. (1)	Pseudotentacles simple folds . . . . .	12
-	Pseudotentacles deep folds; background pale red with violet/brown patches; margin with a black rim . . . . .	<i>Pseudoceros nigrocintus</i> (Schmarda, 1859)
-	Pseudotentacles distal buttons; background colour velvety bright red-orange or fuchsia-pink; irregular white dots over the surface; margin with a white rim or white spots; sometimes with irregular clusters longitudinally and medially . . . . .	<i>Pseudoceros rubronanus</i> Newman & Cannon, 1998
-	Pseudotentacles major lateral folds . . . . .	17
12. (11)	Cerebral eyes in one cluster (round). . . . .	13
-	Cerebral eyes horseshoe shaped . . . . .	15
-	Cerebral eyes inverted "v" shaped . . . . .	16
13. (12)	Without dots, spots or maculae. . . . .	14
-	Covered with numerous small yellow spots; margin with small white spots; background transparent black . . . . .	<i>Pseudoceros josei</i> Newman & Cannon, 1998
14. (13)	Longitudinal bands absent; background colour brick red, margin with black rim. . . . .	<i>Pseudoceros regalus</i> Laidlaw, 1902
-	Longitudinal bands wide, incomplete or irregular; background cream-yellow, white with black; margin narrow orange . . . . .	<i>Pseudoceros scriptus</i> Newman & Cannon, 1998
15. (12)	Longitudinal median line absent; black background with a white margin band . . . . .	<i>Pseudoceros albomarginatus</i> Hyman, 1959
-	Longitudinal median line white, fine or interrupted; background cream-white with 5 marginal bands from inside to outside: narrow white, black, orange, black and a yellow rim. . . . .	<i>Pseudoceros confusus</i> Newman & Cannon, 1995
-	Longitudinal median line present, wide, brick red; background yellow-brownish . . . . .	<i>Pseudoceros cardiosorus</i> (Schmarda, 1859)
16. (12)	Not mottled; background black; green, cream and yellow margin. . . . .	<i>Pseudoceros depilkatabub</i> Newman & Cannon, 1994
-	Mottled; black-grey background with small black and white spots; margin with black rim . . . . .	<i>Pseudoceros colemani</i> Prudhoe, 1977



17. (11)	Cerebral eyes in one cluster (round); background red-blue; margin with a blue-black rim . . . . .	<i>Pseudoceros periphaeus</i> Bock, 1913	
-	Cerebral eyes inverted "v" shaped . . . . .		18
18. (17)	Longitudinal bands absent; background black; margin violet and purple . . . . .	<i>Pseudoceros peripurpureus</i> Newman & Cannon, 1994	
-	Longitudinal lateral wide, royal-blue band (circle-like), present; background velvety black; margin with a white (yellow or turquoise) rim . . . . .	<i>Pseudoceros sapphirinus</i> Newman & Cannon, 1994	
19. (1)	Pseudotentacles simple folds . . . . .		20
-	Pseudotentacles deep folds; background cream colour; narrow marginal band cobalt blue; three longitudinal orange bands with a brown border. . . . .	<i>Pseudoceros rubrotentaculatus</i> Kaburaki, 1923	
-	Pseudotentacles ear-shaped. . . . .		25
-	Pseudotentacles major lateral folds . . . . .		26
20. (19)	Cerebral eyes in one cluster (round). . . . .		21
-	Cerebral eyes horseshoe shaped; background blue; orange longitudinal wide band with a medial white stripe, red margin . . . . .	<i>Pseudoceros susanae</i> Newman & Anderson, 1997	
-	Cerebral eyes inverted "v" shaped . . . . .		24
21. (20)	Vas deferens unbranched . . . . .		22
-	Vas deferens branched; background black, white margin. . . . .	<i>Pseudoceros lactolimbus</i> Newman & Cannon, 1998	
22. (21)	Longitudinal median line and transverse streaks and stripes absent . . . . .		23
-	Longitudinal median prominent line yellow-green with white borders and transverse streaks and stripes with the same colour; background dark brown; margin wide and orange. . . . .	<i>Pseudoceros imperatus</i> Newman & Cannon, 1998	
23. (22)	Dorsal surface dark brown, with irregular cream dots and spots; margin with a thin bright orange band, and a brown interrupted rim . . . . .	<i>Pseudoceros kylie</i> Newman & Cannon, 1998	
-	Dorsal surface cream-whitish with a blue or purple margin. . . . .	<i>Pseudoceros gamblei</i> Laidlaw, 1902	
24. (20)	Longitudinal median line absent; background black with yellow-green maculae encircled by white rim; marginal band wide orange. . . . .	<i>Pseudoceros scintillatus</i> Newman & Cannon, 1994	
-	Longitudinal median line fine or interrupted; background black; 2 yellow medial bands; orange margin . . . . .	<i>Pseudoceros dimidiatus</i> Graff, 1893	
-	Longitudinal median line as white wide stripe; black background; wide white margin . . . . .	<i>Pseudoceros laticlavus</i> Newman & Cannon, 1994	
25. (19)	Cerebral eyes one cluster (round); longitudinal median line blue, fine or interrupted; background cream; margin with blue spots . . . . .	<i>Pseudoceros concinnus</i> (Collingwood, 1876)	
-	Cerebral eyes horseshoe shaped; longitudinal median line absent; background black with large cream-yellow dots; margin with small spots; tips of marginal tentacles black . . . . .	<i>Pseudoceros imitatus</i> Newman & Cannon, 1994	
26. (19)	Cerebral eyes one cluster (round); background black with orange margin . . . . .	<i>Pseudoceros periaurantius</i> Newman & Cannon, 1994	
-	Cerebral eyes inverted "v" shaped; background black with violet and purple margin. . . . .	<i>Pseudoceros peripurpureus</i> Newman & Cannon, 1994	
27. (1)	Cerebral eyes one round cluster; background dark brown; two marginal bands: inner chrome yellow and wide, outer black and narrow . . . . .	<i>Pseudoceros litoralis</i> Bock, 1913	
-	Cerebral eyes horseshoe shaped; background blue with many yellow stripes . . . . .	<i>Pseudoceros gravieri</i> Meixner, 1907	
-	Cerebral eyes inverted "v" shaped . . . . .		28
28. (27)	Longitudinal median line absent; background black with green, cream & yellow margin . . . . .	<i>Pseudoceros depiliktabus</i> Newman & Cannon, 1994	
-	Longitudinal median line absent; background brown with blue and yellow margin . . . . .	<i>Pseudoceros prudhoei</i> Newman & Cannon, 1994	
-	Longitudinal median line white and broad and a narrow stripe; background black; margin with two bands: inner wide, white; outer narrow, yellow-orange . . . . .	<i>Pseudoceros paralaticlavus</i> Newman & Cannon, 1994	
29. (1)	Cerebral eyes one round cluster; background cream mottled with brown-grey, dark spots and dots. Margin with an interrupted narrow orange band, bordered by black. . . . .	<i>Pseudoceros stimpsoni</i> Newman & Cannon, 1998	
-	Cerebral eyes horseshoe shaped . . . . .		30
-	Cerebral eyes inverted "v" shaped . . . . .		31
30. (29)	Longitudinal median line absent; background colour white or white-cream with three (interrupted), marginal bands: inner wide, orange-brown; middle narrow, black and outer bright yellow-green. Black triangle and white spot between the marginal tentacles. . . . .	<i>Pseudoceros intermittus</i> Newman & Cannon, 1995	
-	Longitudinal median line fine, yellow; maculae in the background; background colour cream with three distinct marginal bands: inner yellow, middle black, and orange at rim; black triangle between pseudotentacles . . . . .	<i>Pseudoceros contrarius</i> Newman & Cannon, 1995	
31. (29)	Longitudinal median line absent. . . . .		32
-	Longitudinal median line fine or interrupted; white background; margin with an orange inner band, black medial and yellow outer band . . . . .	<i>Pseudoceros bimarginatus</i> Meixner, 1907	
32. (31)	Background not mottled; cream-orange medially; two distinct marginal bands; inner wide black, outer cream orange . . . . .	<i>Pseudoceros jebborum</i> Newman & Cannon, 1994	
-	Background mottled cream-yellow, with small chocolate brown dots; marginal bands orange, black and a yellow-green rim . . . . .		

- ..... *Pseudoceros heronensis* Newman & Cannon, 1994
33. (1) Pseudotentacles simple folds; cerebral eyes horseshoe shaped; longitudinal median line fine and white; background colour cream-white with 5 marginal bands, from inside to outside: narrow white, black, orange, black and a yellow rim . . . . .  
 - ..... *Pseudoceros confusus* Newman & Cannon, 1995
- Pseudotentacles major lateral folds; cerebral eyes inverted "v" shaped; background colour cream with a narrow dorsal black-brown median stripe and a wide brown dorsal median stripe; marginal rim blue or brown; unusual dimpled texture of the dorsal surface. . . . . *Pseudoceros monostichos* Newman & Cannon, 1994
34. (1) Cerebral eyes one cluster (round); background colour pearly white, with transverse black streaks . . . . .  
 - ..... *Pseudoceros fuscopunctatus* Prudhoe, 1977
- Cerebral eyes inverted "v" shaped; marginal eyes only in the anterior margin; background grey with cream, pale yellow, dark brown blotches medially and black blotches laterally. Margin orange with narrow black bifurcating stripes and a thin black rim. . . . . *Pseudoceros felis* Newman & Cannon, 1994
35. (1) Cerebral eyes in two cluster; background colour creamy yellow; marginal band wide, blue with indigo blue dots . . . . .  
 - ..... *Pseudoceros caerulopunctatus* Palombi, 1928
- Cerebral eyes horseshoe shaped; background cream with white spots; margin discontinuous with blue or dark purple dots and maculae . . . . . *Pseudoceros indicus* Newman & Cannon, 2002
- Cerebral eyes inverted "v" shaped . . . . . 36
36. (35) Pseudotentacles simple folds; background colour cream with white maculae; margin interrupted orange/black band; tentacles orange-brownish . . . . . *Pseudoceros verecundus* Newman & Cannon, 1994
- Pseudotentacles major lateral folds; background colour opaque cream-white with orange dots medially and laterally; margin with bright pink spots concentrated across the pseudotentacles. . . . . *Pseudoceros ouini* Newman & Cannon, 1994

### Key to Indo-Pacific species of *Pseudobiceros*

1. Marginal bands absent . . . . . 2
- Marginal bands as a rim . . . . . 5
- Marginal bands: one band. . . . . 9
- Marginal bands: two bands. . . . . 14
- Marginal bands: three bands. . . . . 17
- Marginal dark bands (green or brown) interrupted by white dots; background colour green or beige . . . . .  
 - ..... *Pseudobiceros kryptos* Newman & Cannon, 1997
2. (1) Pseudotentacles square shaped . . . . . 3
- Pseudotentacles ear-shaped. . . . . 4
3. (2) Cerebral eyes: one round cluster; background colour black with white irregular dots (small stars) . . . . .  
 - ..... *Pseudobiceros stellae* Newman & Cannon, 1994
- Cerebral eyes horseshoe shaped; background grey with black irregular scattered dots and spots. . . . .  
 - ..... *Pseudobiceros gardineri* (Laidlaw, 1902)
4. (2) Background colour black with 3 purple-grey stripes, margin orange. . . . . *Pseudobiceros philippensis* (Kaburaki, 1923)
- Background colour black; sometimes white irregular maculae . . . . . *Pseudobiceros bajae* (Hyman 1953)
5. (1) Pseudotentacles simple folds . . . . . 6
- Pseudotentacles square shaped; background orange with dots and a black margin. . . . .  
 - ..... *Pseudobiceros apricus* Newman & Cannon, 1994
- Pseudotentacles ear-shaped. . . . . 7
6. (5) Cerebral eyes: one round cluster; background grey to yellowish brown; longitudinal median line fine flanked by yellowish brown bands; light, fine margin-rim; tentacles brown edged with a glow rim. . . . .  
 - ..... *Pseudobiceros fulvogriseus* (Hyman, 1959)
- Cerebral eyes: inverted "v" shaped; background pink-reddish with white dots and a marginal dark blue rim . . . . .  
 - ..... *Pseudobiceros miniatus* (Schmarda, 1859)
7. (5) Cerebral eyes: one round cluster; background colour whitish translucent with 3 or 4 black longitudinal wide bands . . . . .  
 - ..... *Pseudobiceros gratus* (Kato, 1937)
- Cerebral eyes: horseshoe shaped; dorsal surface opaque; longitudinal bands absent . . . . . 8
8. (7) Background colour black with yellow dots and pink streaks transversal or diagonal oriented; vas deferens unbranched . . . . .  
 - ..... *Pseudobiceros bedfordi* (Laidlaw, 1903)
- Background grey-green; orange margin; vas deferens branched . . . . . *Pseudobiceros sharroni* Newman & Cannon, 1997
9. (1) Not mottled. . . . . 10
- Mottled pattern: dots. . . . . 12
- Mottled pattern: spots. . . . . 13
- Mottled pattern: maculae; background colour orange-brown; yellow and white stripes, dark margin . . . . .  
 - ..... *Pseudobiceros fulgor* Newman & Cannon, 1994
- Mottled pattern: black wide margin with white dots; background colour pinkish-orange; mid-dorsal wide dark, band branched to the margins. . . . . *Pseudobiceros micronesianus* (Hyman, 1958)

10. (9) Pseudotentacles square shaped . . . . . 11  
 - Pseudotentacles ear-shaped; background velvety black with a broad whitish marginal band, slightly tinged with orange . . . . . *Pseudobiceros flavomarginatus* (Laidlaw, 1902)
11. (10) Cerebral eyes: one round cluster; background colour black; 2 grey longitudinal bands, grey margin . . . . . *Pseudobiceros cinereus* (Palombi, 1931)  
 - Cerebral eyes horseshoe shaped; background colour black; margin orange. . . . . *Pseudobiceros periculosus* Newman & Cannon, 1994
12. (9) Pseudotentacles simple folds; cerebral eyes: one round cluster; dorsal surface opaque, background pale yellow, purplish brown undulating longitudinal lines and spots. . . . . *Pseudobiceros undulatus* (Kelaart, 1858)  
 - Pseudotentacles ear-shaped; cerebral eyes: horseshoe shaped; dorsal surface translucent; background grey-bluish with white small patches and spots, some black dots. . . . . *Pseudobiceros murinus* Newman & Cannon, 1997
13. (9) Pseudotentacles simple folds; background dark blue or black: margins with a wide, red band. . . . . *Pseudobiceros rubrocinctus* (Schmarda, 1859)  
 - Pseudotentacles ear-shaped; background green spotted brown; margins dark grizzly brown; ventral paler . . . . . *Pseudobiceros viridis* (Kelaart, 1858)
14. (1) No mottling . . . . . 15  
 - Mottled: brown spots with a background colour green or brown and cream . . . . . *Pseudobiceros brogani* Newman & Cannon, 1997  
 - Mottled: white dots and spots in a brown background; white margins. . . . . *Pseudobiceros mikros* Newman & Cannon, 1997  
 - Mottled: black spots and dots; background grey and white; orange mottled marginal band . . . . . *Pseudobiceros damawan* Newman & Cannon, 1994
15. (14) Cerebral eyes: in one cluster (round); vas deferens branched . . . . . 16  
 - Cerebral eyes: horseshoe shaped; background colour black; orange and white marginal band; vas deferens unbranched. . . . . *Pseudobiceros hancockanus* (Collingwood, 1876)
16. (15) Background colour black with white and yellow margins. Gastrovascular external pores (anal pores) absent. . . . . *Pseudobiceros flavocanthus* Newman & Cannon, 1994  
 - Background velvety black; margins with an orange band and narrow black rim; gastrovascular external pores (anal pores) present. . . . . *Pseudobiceros hymanae* Newman & Cannon, 1997
17. (1) Longitudinal median line absent; background colour black; margins with inner orange band, grey medial and white outer band. . . . . *Pseudobiceros uniarborensis* Newman & Cannon, 1994  
 - Longitudinal median line fine or interrupted . . . . . ; background colour black; margins with inner orange band, pink/purple medial and black outer band. . . . . *Pseudobiceros gloriosus* Newman & Cannon, 1994  
 - Longitudinal median line fine and white; background green or brown-yellowish; margins with an inner black band and an outer fine white rim . . . . . *Pseudobiceros flowersi* Newman & Cannon, 1997

## Discussion

Until now, 22 species were known from Lizard Island (Tyler *et al.* 2006–2015) and most of them (18) belong to the genus *Pseudoceros* and *Pseudobiceros* (F. Pseudocerotidae). The remaining four belong to the family Pseudocerotidae (*Bulaceros porcellanus* Newman & Cannon, 1996 and *Tythosoceros lizardiensis* Newman & Cannon, 1996) and to the family Euryleptidea (*Asciodiophilla alba* Newman, 2002 and *Cycloporus variegatus* Kato, 1938). Surprisingly, all known species belong to the suborder Cotylea, whereas no records for the suborder Acotylea are identified to date.

The genera *Pseudoceros* (87 valid species) and *Pseudobiceros* (37 valid species) show their great diversity mainly in the marine region of the Indo-Pacific with over 75% of the species described for this region, and more specifically for the Great Barrier Reef (Newman & Cannon 1994, 1995, 1997, 1998). Among the species examined in this study, *Pseudoceros paralaticlavus*, *Pseudoceros prudhoei*, *Pseudobiceros flowersi*, and *Pseudoceros uniarborensis* have been previously found around Lizard Island, while the rest are new records for Lizard Island.

Depending on their distribution, the examined species can be placed in the following groups:

- 1) From all species recorded to date from Lizard Island, *Pseudobiceros flowersi* and *Lurymae clavocapitata* n. sp. have been only found at Lizard Island.
- 2) *Pseudoceros jebborum*, *Pseudoceros paralaticlavus*, *Pseudobiceros hancockanus* and *Pseudobiceros hymanae* are widely distributed and well known for all the Indo-Pacific region.
- 3) *Pseudoceros stimpsoni* was originally described from Japan by Stimpson (1855) as *Eurylepta interruptus* and was also collected in Papua New Guinea (Newman & Cannon 1998). The present record from Lizard Island is the southernmost within the region.
- 4) *Pseudoceros bimarginatus*, *Pseudoceros prudhoei*, *Pseudoceros zebra*, and *Pseudobiceros uniarborensis* also identified in this

study from Lizard Island and known for areas widely separated from each other, such as India and New Zealand or Iran and Australia. They show an interesting Western- Eastern distribution within the Indo-Pacific region.

Regardless of the distribution patterns of the studied species, all of them show brilliant colours, but similar internal morphology, which hinders reliable identification at the species level. Newman & Cannon (1994b) described the general characteristics of the genera *Pseudoceros* and *Pseudobiceros* mainly for species of the Great Barrier Reef making especial emphasis in the colouration pattern. This approach was followed in further studies (Newman *et al.* 1994; Newman & Cannon 1994b, 1995, 1997, 1998; Newman & Schupp 2002), while the internal anatomy was described without much detail. In this and in other recent studies (Bolaños *et al.* 2007, Bahia *et al.* 2014), the descriptions are more detailed. Features such as the orientation of the seminal vesicle, shape of the prostatic vesicle, and the depth of the male atrium differ among species. Furthermore, differences in the form and size of the stylet are of special importance because this sclerotic structure is not affected during the fixation process in the same way as the soft structures. Within the genus *Pseudoceros*, the distance between the sucker and the female pore also differs among species. These features do not vary enough to be considered as diagnostically useful, but they provide information that can help to disentangle similarly coloured species complexes.

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