

A preliminary checklist and photographic catalogue of polyclad flatworms recorded from Singapore

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Abstract. A preliminary checklist of Singapore polyclad flatworms is presented together with photographs to serve as a quick reference for the identification of the Cotylea species and as an introductory guide to the Acotylea species found in Singapore. It shows that there is a rich polyclad diversity in Singapore, with an estimated 81 Cotylea species from the families Euryleptidae, Pericelidae, Pseudocerotidae, and Prosthiostomidae; and an estimated 38 Acotylea species (from families such as Callioplanidae, Limnostylochidae, Gnesiocerotidae, Planoceridae, and Stylochidae, to name a few).

Key words. Polycladida, Cotylea, Acotylea, Euryleptidae, Pseudocerotidae, diversity

INTRODUCTION

Singapore may be a small country in the heart of Southeast Asia, but it has a relatively rich marine biodiversity that has been well-documented over the years. The remarkable diversity can be attributed to Singapore's location being situated at the crossroads of the Indian and Pacific Oceans. It is without surprise that the polyclad diversity in the country is high. However, only until recently, this group of almost exclusively marine, free-living flatworms belonging to the phylum Platyhelminthes, clade Rhabditophora Ehlers (1986), has received some attention (Chim et al., 2015; Bolaños et al., 2016; Ong et al., 2018). Previously, the only polyclad records for Singapore were by Collingwood (1876) and Laidlaw (1903), in which eight species were described. To date there is no functional polyclad list or reliable estimates on the number of species found in Singapore. Taxonomic work regarding polyclads was mostly lacking and almost non-existent. We aim to address these issues with this preliminary checklist and photographic catalogue.

We believe the present checklist will help to facilitate future research. It can be used as a first source of information, as an aid for checking identifications, and as a handy reference of the species that have been recorded in the country so far. In addition, the checklist serves as an introduction to the study and understanding of Singapore's polyclad diversity. A photographic documentation of the listed species is also provided as a quick visual guide. Localities of where the specimens were collected and/or sighted are listed for each species. Whenever possible, all flatworms were preserved for future histology works and photographed to record their live colours and features before these were lost to preservation. The photographs of live specimens are expected to enhance any future studies.

Currently, the overall taxonomic classification approach for polyclads is based on the presence or absence of the sucker—a ventral, circular adhesive organ, posterior to the female gonopore. It is present on members of the suborder Cotylea, and absent on members of the suborder Acotylea. As the internal reproductive anatomy of pseudocerotids is generally very similar (Newman & Cannon, 1994), external morphological characters, such as the number of male and female gonopores, type of pharynx, shape of pseudotentacles, arrangement of cerebral eyespot and pseudotentacular eyes, and particularly the colour and pattern, are used for identification. On the other hand, the identification of acotyleans (polyclads without a sucker) require histology to study the internal reproductive structures. No histology, however, was conducted for this work.

The present checklist is intended to serve as an introductory guide to the possible different species and morphotypes of Actoylea flatworms found within Singapore. It is essential to include the morphotypes of acotyleans as there is almost no information on this group of flatworms. The only popularly known acotylean is the mangrove flatworm, possibly *Limnostylochus* sp. (Ng & Sivasothi, 1999, 2001; Ng et al., 2007, 2011; Chou & Tan, 2008; Chua, 2010; Yeo, 2012; Tan, 2008–2016a) that had been recorded and sighted at numerous mudflat areas. The other species that was mentioned in some publications is *Meixneria furva* (Ng & Wee, 1994; Wee & Ng, 1994; Ng et al., 2011; Davison et al., 2008). Beyond that, there were no other acotylea records or sightings, and there were also no proper taxonomic studies on the mentioned species despite them being identified as such. This checklist presents the first attempt at doing so. It is therefore important to include all the polyclads, including the acotyleans, so that their presence and diversity can be known despite our current inability to identify them to species. This checklist and photographic catalogue show that Singapore has a high diversity of colourful cotylea flatworms, as well as a diverse group of plain-looking acotyleans. It is hoped that this compilation will generate interest in these duller-looking and elusive flatworms.

MATERIAL AND METHODS

The present checklist is largely derived from the specimens collected during the Comprehensive Marine Biodiversity Survey (CMBS) between 2010–2015. Records found in locally published literature that was made available to us during this study are also included and identified/complemented with latest taxonomic information where possible. A few of the records were compiled from reported sightings by nature volunteers (Tan, 2008–2016a, b; Loh, 2005–2016) who regularly surveyed Singapore waters via photographic records. The presentation of this checklist is straightforward - species name and author, followed by the sources of information (in chronological order), materials examined and remarks if any. The identification of the specimens is based primarily on a combination of the classification systems proposed by Faubel (1984), Prudhoe (1985), and Newman & Cannon (1994, 1997, 1998, 2000, 2002). The lowest possible classification was assigned as far as possible. Families, genera and species, are listed in alphabetical order for ease of reference.

Only materials collected during the course of CMBS were examined for this study. The polyclads were hand collected using a soft paintbrush, from different intertidal and subtidal habitats. Specimens were placed in individual containers for transportation. The animals were measured and photographed on glass petri dishes, using DSLR cameras, Nikon D800 with 60mm macro lens and speedlight SU-800 flash system, and Canon EOS 5D with MP-E65 macro lens and speedlite 430EX II flash system. The specimens were fixed on a block of frozen 10% buffered formalin, and transferred to 70% ethanol after 24–48 hours (Newman & Cannon, 1995). Where available, physical specimens examined are deposited in the Zoological Reference Collection (ZRC.PLA) of the Lee Kong Chian Natural History Museum at the National University of Singapore. Numbers listed with the prefixes ARM (Autonomous Reef Monitoring Structure), JS (Johore Strait Expedition), SS (Southern Strait Expedition), SUB (subtidal), INT (intertidal), and OTC (outside of the regular CMBS survey sites) refer to specimens which had been examined by the authors but which were subsequently damaged or disintegrated. Photographic images of these specimens are, however, available for reference. A few species are represented in the checklist only by photographs of live animals taken in the field. These images are included in this catalogue.

Place names: Pulau = island, Terumbu = submerged reef, Beting = sandbar, Besar = big, Sungei = river or stream, Tengah = middle, Laut = sea ward.

POLYCLADS RECORDED FROM SINGAPORE

Clade Rhabditophora Ehlers, 1986

Order Polycladida Lang, 1884

Suborder Cotylea Lang, 1884

Superfamily Euryleptoidea Faubel, 1984

Family Euryleptidae Lang, 1884

cf. Acerotisa sp. 1

(Fig. 1A)

Materials examined. INT-1299.

Localities. Pulau Salu.

Remarks. This species was obtained once from Pulau Salu, which is within a military restricted zone.

Cycloporus venetus Newman & Cannon, 2002

(Fig. 1B)

Cycloporus venetus Newman & Cannon, 2002: 293 (type locality: North Exmouth, West Australia).

Cycloporus venetus Newman & Cannon, 2003: 66; Sreeraj & Raghunathan, 2015: 85; Ong et al., 2018: 54, Fig. 1.

Materials examined. ZRC.PLA.0145, ZRC.PLA.0146, SUB-0547.

Localities. Little Sister's Island, Pulau Hantu, Pulau Senang, Pulau Sudong, Pulau Tekukor, and St John's Island.

Remarks. This species is usually found at subtidal areas.

Cycloporus sp. 1
(Fig. 1C)

Materials examined. ZRC.PLA.0147.

Localities. Terumbu Berkas.

Remarks. This extremely small (about 5 mm) species can be easily missed.

Eurylepta aurantiaca Heath & Mc Gregor, 1912
(Fig. 1D)

Eurylepta aurantiaca Heath & Mc Gregor, 1912: 481 (type locality: Monterey Bay, California, USA).

Eurylepta aurantiaca - Hyman, 1953: 370; Hyman, 1955a: 10; Faubel, 1984: 220; Bolaños et al., 2003; Bahia et al., 2014: 520.

Materials examined. ZRC.PLA.0148, ZRC.PLA.0149, ZRC.PLA.0307.

Localities. Beting Bemban Besar, Pulau Semakau and Raffles Lighthouse.

Eurylepta sp. 1
(Fig. 1E)

Materials examined. ZRC.PLA.0150, ZRC.PLA.0151, ZRC.PLA.0152.

Localities. Labrador Park and Lazarus Island.

Remarks. The worms were found under rocks, at rocky shore intertidal zone. The authors have observed their egg cases to be roundish and transparent, and the larvae hatching sometime after a week's development.

Eurylepta sp. 2
(Fig. 1F)

Materials examined. ZRC.PLA.0153.

Localities. St John's Island.

Remarks. Only a single specimen was collected so far.

Eurylepta sp. 3
(Fig. 1G)

Materials examined. ZRC.PLA.0154, ZRC.PLA.0155.

Localities. Kusu Island, Pulau Hantu, Pulau Semakau, Pulau Sudong and Pulau Tekukor.

Remarks. This species has only been recorded at subtidal areas.

Eurylepta sp. 4
(Fig. 1H)

Materials examined. ZRC.PLA.0156.

Localities. Pulau Hantu, Terumbu Berkas and Pulau Berkas.

Remarks. This species has only been recorded at subtidal areas.

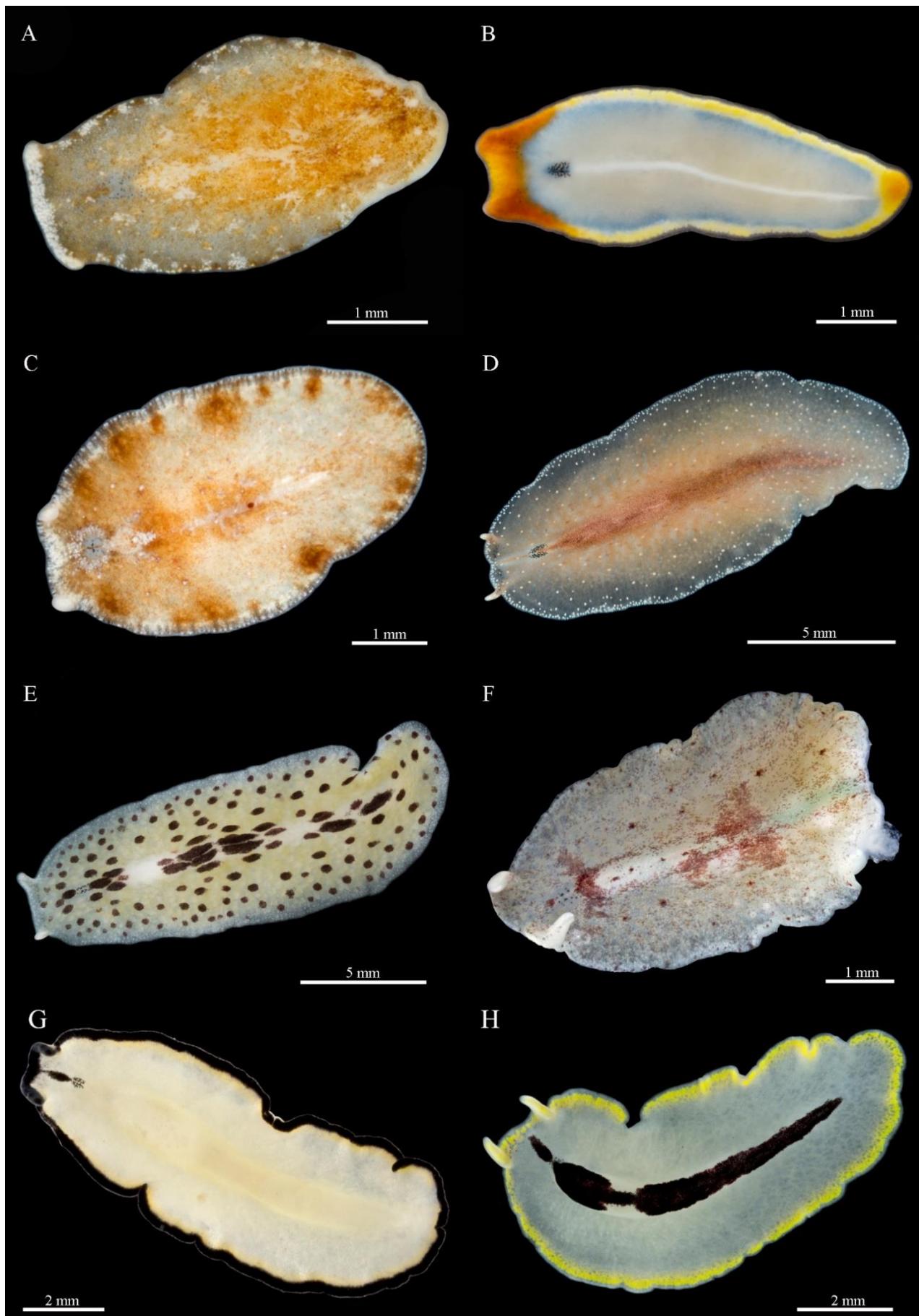


Fig. 1. Dorsal view of live flatworms. A, cf. *Acerotisa* sp. 1 (INT-1299); B, *Cycloporous venetus* (SUB-0547); C, *Cycloporous* sp. 1 (ZRC.PLA.0147); D, *Eurylepta aurantiaca* (ZRC.PLA.0149); E, *Eurylepta* sp. 1 (ZRC.PLA.0151); F, *Eurylepta* sp. 2 (ZRC.PLA.0153); G, *Eurylepta* sp. 3 (ZRC.PLA.0155); H, *Eurylepta* sp. 4 (ZRC.PLA.0156).

***Eurylepta* sp. 5**
(Fig. 2A)

Materials examined. ZRC.PLA.0157.

Localities. Pulau Biola and Pulau Hantu.

Remarks. This brightly coloured species has only been recorded at subtidal areas.

***Eurylepta* sp. 6**
(Fig. 2B)

Materials examined. ZRC.PLA.0158.

Localities. Pulau Hantu and Pulau Sudong.

Remarks. Apart from the specimen recorded by CMBS at Pulau Sudong, another example was sighted by An Ng during a leisure dive at Pulau Hantu in February 2017.

***Eurylepta* sp. 7**
(Fig. 2C)

Materials examined. None. See Fig. 2C.

Localities. Pulau Hantu.

Remarks. The only example known from Singapore was photographed by Toh Chay Hoon at Pulau Hantu on 20 September 2015. The distinctive erected pseudotentacles place this flatworm in the genus *Eurylepta*.

Maritigrella fuscopunctata (Prudhoe, 1978)
(Fig. 2D)

Pseudoceros fuscopunctatus Prudhoe, 1978: 594 (type locality: Donsborough, Western Australia).

Eurylepta fuscopunctatus - Gosliner et al, 1996: 95.

Maritigrella fuscopunctata - Newman & Cannon, 2000: 195; Velasquez et al., 2018: 252.

Materials examined. ZRC.PLA.0159, ZRC.PLA.0222, SUB-1687, SUB-1764.

Localities. Chek Jawa, Cyrene Reef, Pulau Hantu, Pulau Jong, Pulau Semakau, Pulau Senang, Pulau Sudong, and Raffles Lighthouse.

Remarks. Many of the specimens examined were immature.

Maritigrella virgulata Newman & Cannon, 2000
(Fig. 2E)

Maritigrella virgulata Newman & Cannon, 2000: 201 (type locality: Heron Island, southern Great Barrier Reef, Australia).

Maritigrella virgulata - Ng et al., 2011: 274; Ng, 2012: 105.

Materials examined. ZRC.PLA.0160.

Localities. Big Sister's Island, Pulau Hantu, Pulau Jong, Pulau Tekukor and Pulau Semakau.

Remarks. Besides the material from the CMBS collection, this species was also recorded in Ng et al. (2011) and Ng (2012).

FAMILY PERICELIDAE Laidlaw, 1902

Pericelis byerleyana (Collingwood, 1876)
(Fig. 2F)

Typhlolepta byerleyana Collingwood, 1876: 92 (type locality: Borneo).

Pericelis byerleyana - Laidlaw, 1902: 291; Laidlaw, 1903: 9; Meixner, 1907: 473; Kato, 1943: 84; Kato, 1944: 294; Newman et al., 2003: 189; Velasquez et al., 2018: 250.

Pericelis cf. hymanae - Newman & Cannon, 2003: 70.

Pericelis sp. 3 - Newman & Cannon, 2003: 70.

Materials examined. ZRC.PLA.0309.

Localities. Pulau Jong.

Remarks. Apparently rare in Singapore.

FAMILY PSEUDOCEROTIDAE Lang, 1884

***Acanthozoon* sp. 1**
(Fig. 2G)

Acanthozoon sp. - Lim et al., 1994:71; Chua, 2007: 129; Ng et al., 2007: 89; Ng et al., 2011: 374; Ng, 2012: 105.

Materials examined. ZRC.PLA.0161, ZRC.PLA.0162, ZRC.PLA.0163, ZRC.PLA.0164, ZRC.PLA.0165, ZRC.PLA.0166, ZRC.PLA.0167, ZRC.PLA.0168, ZRC.PLA.0169, ZRC.PLA.0170, ZRC.PLA.0171, ZRC.PLA.0172, ZRC.PLA.0173, INT-1104, SS-1028, OTC-0183.

Localities. Beting Bronok, Cyrene Reef, East Coast shore, Kusu Island, Labrador beach, Lazarus Island, Pulau Hantu, Pulau Pawai, Pulau Tekukor, Pulau Semakau, Raffles Lighthouse, Sentosa, Sisters' Islands, St John's Island, Terumbu Bemban, Terumbu Pempang Tengah, Terumbu Raya and Terumbu Semakau.

Remarks. This species is listed merely as 'polyclad' in Lim et al. (1994: 71) and Ng et al. (2007: 89), but based on photographs, the flatworms can be identified as a species of *Acanthozoon*. This is one of the most common and biggest flatworms found in Singapore. It has been observed to prefer semi-muddy areas where examples can easily be found.

***Acanthozoon* sp. 2**
(Fig. 2H)

Materials examined. None. See Fig. 2H.

Localities. Unknown.

Remarks. A small mature specimen that unfortunately disintegrated before it was preserved.

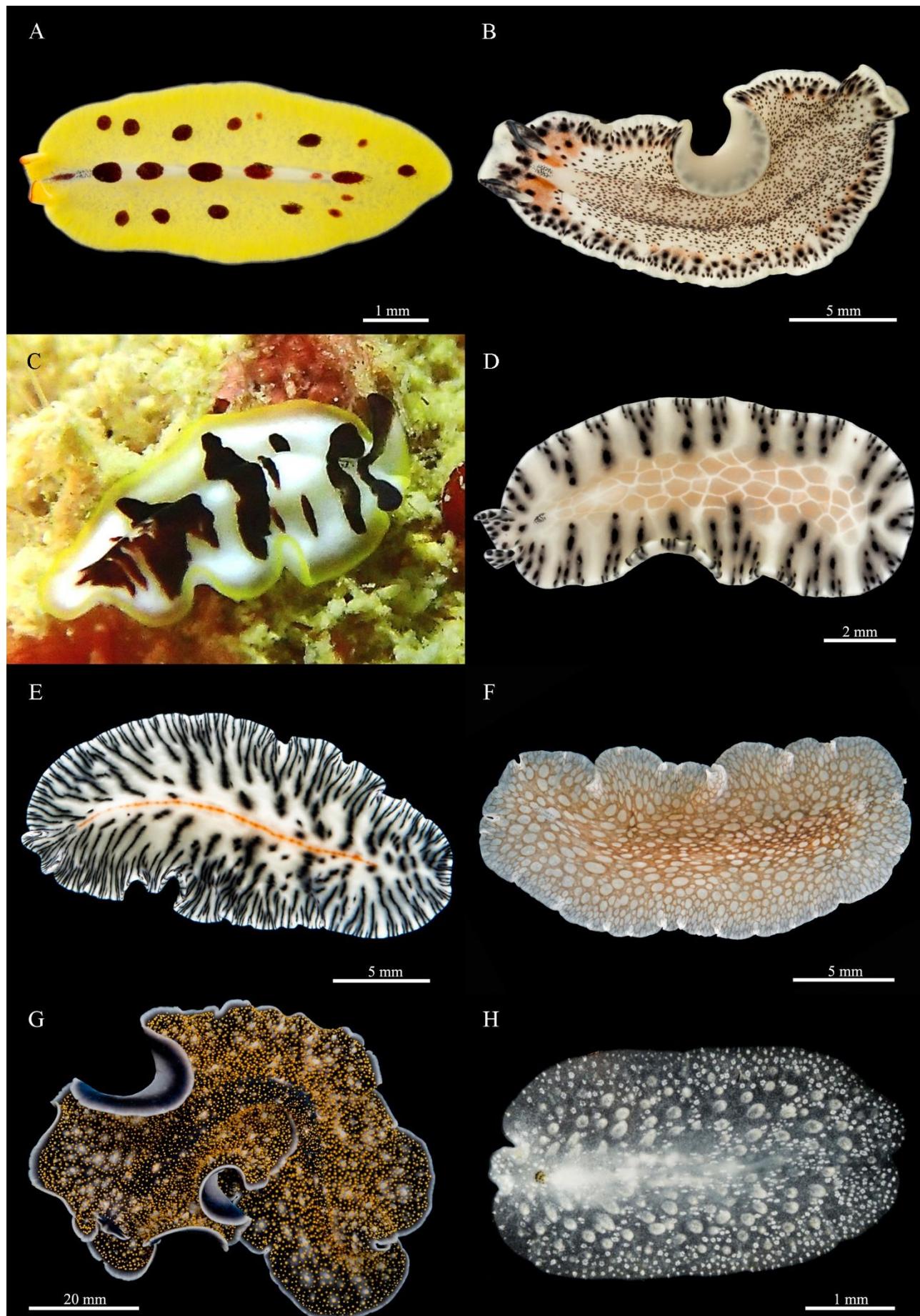


Fig. 2. Dorsal view of live flatworms. A, *Eurylepta* sp. 5 (ZRC.PLA.0157); B, *Eurylepta* sp. 6 (ZRC.PLA.0158); C, *Eurylepta* sp. 7; D, *Maritigrella fuscopunctata* (SUB-1764); E, *Maritigrella virgulata* (ZRC.PLA.0160); F, *Pericelis byerleyana* (ZRC.PLA.0309); G, *Acanthozoon* sp. 1 (SS-1028); H, *Acanthozoon* sp. 2. (Photograph by: Toh Chay Hoon [C].)

Thysanozoon lagidium Marcus, 1949
(Fig. 3A)

Thysanozoon lagidium Marcus, 1949: 81 (type locality: Brazil).

Materials examined. ARM-0739.

Localities. Raffles Lighthouse.

Remarks. There is much controversy surrounding this species that will require extensive DNA analysis and a comprehensive literature review to resolve. The single specimen that was obtained in this study is assigned as this species as it best fits the original description and illustration in Marcus (1949).

Thysanozoon nigropapillosum (Hyman, 1959)
(Fig. 3B)

Acanthozoon nigropapillosum Hyman, 1959: 581 (type locality: Ifaluk Atoll, Micronesia).

Thysanozoon nigropapillosum - Faubel, 1984: 213; Gosliner et al., 1996: 111; Newman et al., 2003: 198; Dixit & Raghunathan, 2013: 168; Jie et al., 2014: 764; Ong et al., 2018: 54, fig. 2.
Flatworm - Leong et al., 2003: 110.

Materials examined. ZRC.PLA.0174, OTC-0254.

Localities. Beting Bemban Besar, Big Sister's Island, Lazarus Island, Pulau Hantu, Pulau Jong, Pulau Pawai, Pulau Tekukor and Terumbu Pempang Tengah.

Remarks. The flatworm illustrated in Leong et al. (2003: 110) is herein identified as *Thysanozoon nigropapillosum*.

Thysanozoon nigrum Girard, 1851
(Fig. 3C)

Thysanozoon nigrum Girard, 1851: 137 (type locality: Coast of Florida, USA).

Thysanozoon nigrum - Hyman, 1939: 15; Hyman, 1940: 484; Hyman, 1952: 196; Hyman, 1955b: 263; Hyman, 1955c: 137; Verrill, 1901: 41; Marcus & Marcus, 1968: 69; Ong et al., 2018: 56, fig. 3.
Thysanozoon brochii var. *nigrum* - Lang, 1884: 535.

Material examined. ZRC.PLA.0175, ZRC.PLA.0176, ZRC.PLA.0177.

Localities. Pulau Salu, Pulau Semakau and Pulau Senang.

Remarks. This appears to be the only completely blackish papillated flatworm found in Singapore. It has so far been sighted only at remote areas.

***Thysanozoon* sp. 1**
(Fig. 3D)

Materials examined. ZRC.PLA.0304, INT-009, INT-010.

Localities. Beting Bemban Besar, Big Sister's Island and Lazarus Island.

Remarks. Colour change was observed in two of the examples when the flatworms were kept alive for more than a week for observation. From reddish-brown, the dorsal colour slowly faded to light pale brown, with no changes in the pattern or marginal band.

Acanthozoon/Thysanozoon sp. 1
(Fig. 3E)

Materials examined. OTC-0142.

Localities. Big Sister's Island.

Remarks. As the specimen was immature, it is not possible to determine the number of gonopores to assign it to the correct genus.

Acanthozoon/Thysanozoon sp. 2
(Fig. 3F)

Materials examined. None. See Fig. 3F.

Localities. Pulau Hantu.

Remarks. One example was photographed at Pulau Hantu on 9 August 2014 by Loh Kok Sheng. Although no actual specimen was available for examination, the image clearly shows some of the key features that classify it as either an *Acanthozoon* or *Thysanozoon* species.

Nymphozoon bayeri Hyman, 1959
(Fig. 3G)

Nymphozoon bayeri Hyman, 1959: 578 (type locality: Iwayama Bay, Palau, Micronesia).

Nymphozoon bayeri - Prudhoe, 1985: 30; Newman et al., 2003: 198; Bolaños et al., 2016: 135.

Pseudobiceros sp. - Chua, 2007: 129.

Materials examined. ZRC.PLA.0002, ZRC.PLA.0003, ZRC.PLA.0004, ZRC.PLA.0104, SUB-1686.

Localities. Chek Jawa, Kusu Island, Little Sister's Island, Pulau Hantu, Pulau Pawai, Pulau Sekudu, Pulau Semakau, Pulau Senang, Raffles Lighthouse, Tanah Merah beach and Terumbu Salu.

Remarks. One of the biggest polyclad species found in Singapore, which, was misidentified as *Pseudobiceros gratus* (see Bolaños et al., 2016) in the past. Labelled as *Pseudobiceros* sp. in Chua (2007), the photograph clearly shows the flatworm to be *Nymphozoon bayeri*. On a well-preserved specimen (ZRC.PLA.0104) collected in 1998, the distinct black pigmentation still remains, along with the presence of two male gonopores and at least 18 female gonopores, confirming its identity as *Nymphozoon bayeri*.

Nymphozoon orsaki (Newman & Cannon, 1996)
(Fig. 3H)

Maiazoon orsaki Newman & Cannon, 1996a: 1427 (type locality: Dam awan, Madang, Papua New Guinea).

Maiazoon orsaki - Newman & Cannon, 2003: 71.

Flatworm - Leong et al., 2003:110.

Nymphozoon orsaki - Bolaños et al., 2016: 136.

Materials examined. ZRC.PLA.0124, ZRC.PLA.0125, ZRC.PLA.0126, ZRC.PLA.0127, ZRC.PLA.0005, ZRC.PLA.0195.

Localities. Lazarus Island and Pulau Hantu.

Remarks. Four specimens at the ZRC collected almost two decades ago were labelled as *Maiazoon orsaki* (ZRC.PLA.0124, ZRC.PLA.0125, ZRC.PLA.0126, ZRC.PLA.0127). Unfortunately no notes or photographs can be located for these specimens. Based on the examination of the physical specimens, we can only confidently conclude that ZRC.PLA.0125 and ZRC.PLA.0127 are indeed *Nymphozoon orsaki*, as they possess four and three female gonopores, respectively.

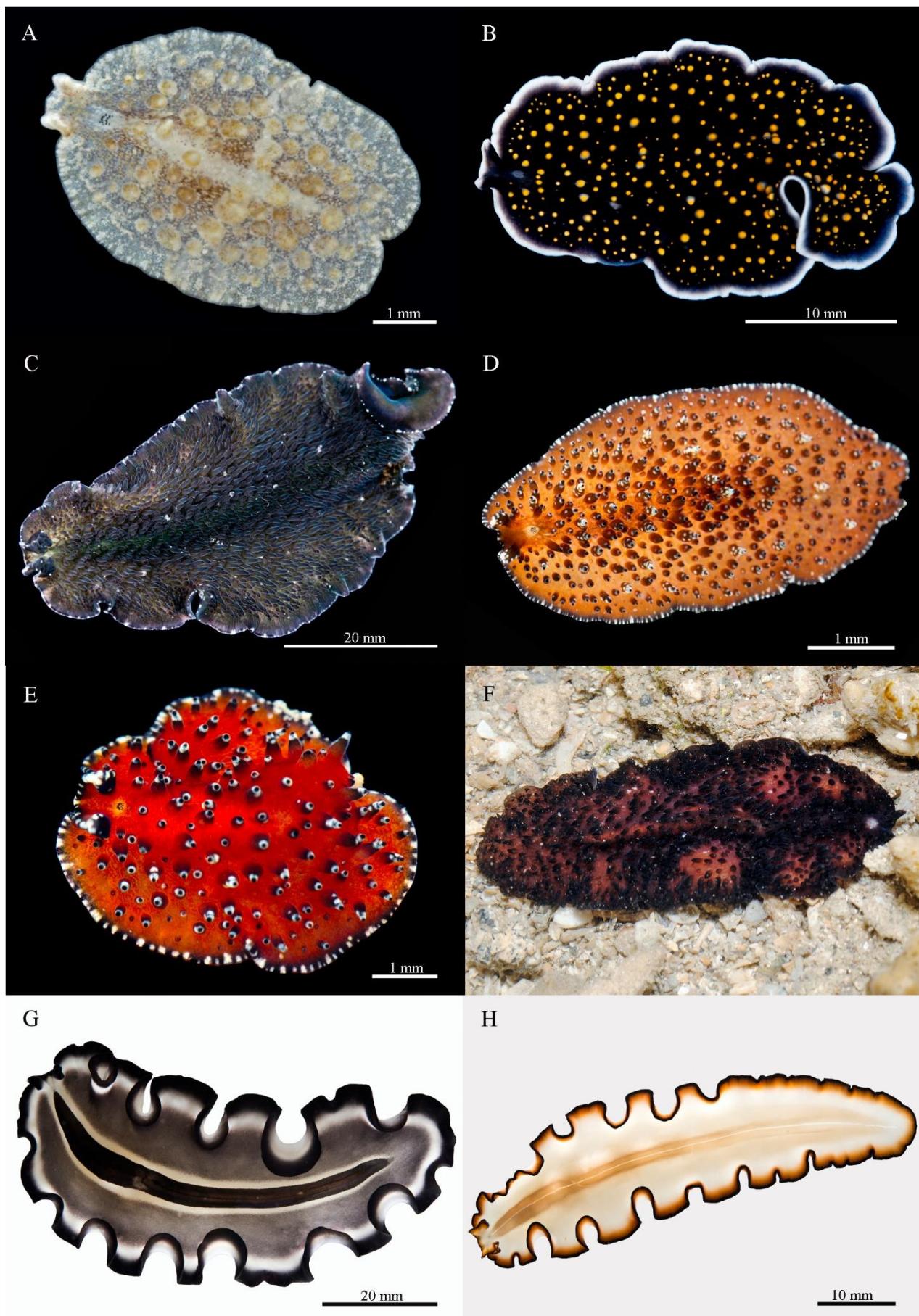


Fig. 3. Dorsal view of live flatworms. A, *Thysanozoon lagidium* (ARM-0739); B, *Thysanozoon nigropapillosum* (OTC-0254); C, *Thysanozoon nigrum* (ZRC.PLA.0177); D, *Thysanozoon* sp. 1 (ZRC.PLA.0304); E, *Acanthozoon/Thysanozoon* sp. 1 (OTC-0142); F, *Acanthozoon/Thysanozoon* sp. 2; G, *Nymphozoon bayeri* (ZRC.PLA.0004); H, *Nymphozoon orsaki* (ZRC.PLA.0005). (Photograph by: Loh Kok Sheng [F]).

Phrikoceros baibaiye Newman & Cannon, 1996
(Fig. 4A)

Phrikoceros baibaiye Newman & Cannon, 1996a: 1430 (type locality: Hastings Point, New South Wales, Australia).
Phrikoceros baibaiye - Newman & Cannon, 2003: 71; Ng et al., 2011: 314; Ng, 2012: 104; Bolaños et al., 2016: 138. Marine Flatworm - Chua, 2002: 67.

Pseudobiceros sp. - Tan & Yeo, 2003: 171.
cf. *Phrikoceros baibaiye* - Chua, 2007: 129.
Phrikoceros sp. - Ong et al, 2015: 182, fig. 7.

Materials examined. ZRC.PLA.0006, OTC-0399.

Localities. Chek Jawa, Cyrene Reef, Pulau Sekudu, Pulau Semakau and Seringat Kias.

Remarks. Commonly called ‘ruby flatworm’, due to its bright orange-red colour, this species seems to be seasonally abundant and sightings during intertidal surveys were often reported by nature volunteers (pers. comm.). A photograph of an unidentified marine flatworm in Chua (2002) is *Phrikoceros baibaiye*. Tan & Yeo (2003) incorrectly labelled the flatworm in their photograph as *Pseudobiceros* sp. The subject of the photograph in Chua (2007) is herein confirmed to be *Phrikoceros baibaiye*. In Ong et al. (2015), three flatworms closely resembling *Phrikoceros baibaiye* was reported as *Phrikoceros* sp. as their body colour appeared to be pale yellow instead of bright orange. After close examination, they herein confirmed as *Phrikoceros baibaiye*.

***Phrikoceros* sp. 1**
(Fig. 4B)

Materials examined. ZRC.PLA.0196.

Localities. Big Sister’s Island, Pulau Hantu.

Remarks. This rarely sighted flatworm has laterally ruffled, square-like pseudotentacles and a simple pharynx that easily identify it as a species of *Phrikoceros*. A few more sightings were reported in the month of September and October 2017 during leisure diving at Pulau Hantu by Toh Chay Hoon.

***Phrikoceros* sp. 2**
(Fig. 4C)

Materials examined. None. See Fig. 4C.

Localities. Pulau Hantu.

Remarks. This flatworm has been recorded only once at Pulau Hantu, based on a photograph (Fig. 4C) taken by Toh Chay Hoon on 27 April 2014.

Pseudobiceros bajae (Hyman, 1953)
(Fig. 4D)

Pseudoceros bajae Hyman, 1953: 365 (type locality: Gulf of California, Mexico).
Cryptobiceros bajae - Faubel, 1984: 215.

Pseudobiceros bajae - Newman & Cannon, 1994: 240; Marquina et al., 2015: 373; Bahia & Schrodl, 2016: 109; Ong et al., 2018: 57, fig.4.

Material examined. ZRC.PLA.0197, OTC-0423.

Localities. Seringat Kias, Terumbu Berkas and Terumbu Semakau.

***Pseudobiceros bedfordi* (Laidlaw, 1903)**
(Fig. 4E)

Pseudoceros bedfordi Laidlaw, 1903: 314 (type locality: Singapore).

Pseudoceros bedfordi - Bock, 1913: 254; Kato, 1943: 87; Kato, 1944: 299; Marcus, 1950: 84; Dawyodoff, 1952: 82; Hyman, 1954: 220; Hyman, 1959: 566; Prudhoe, 1978: 586; Prudhoe, 1989: 77; George & George, 1979: 43.

Pseudoceros micronesianus - Hyman, 1955d: 78.

Pseudobiceros bedfordi - Faubel, 1984: 216; Newman & Cannon, 1994: 241; Newman & Cannon, 1997: 343; Newman & Cannon, 2003: 81; Newman et al., 2003: 197; Chua, 2007: 129; Ng et al., 2011: 374; Ng, 2012: 105; Sreeraj & Raghunathan, 2013: 39; Dixit & Raghunathan, 2013: 167; Bolaños et al., 2016: 138.

Flatworm - Ng et al., 2007: 89.

Materials examined. ZRC.PLA.0007, ZRC.PLA.0008, OTC-0255.

Localities. Lazarus Island, Little Sister's Island, Pulau Semakau, Raffles Lighthouse, St John's Island, Tanah Merah beach and Terumbu Hantu.

Remarks. Commonly known as the 'Persian carpet flatworm', this polyclad is one of the few flatworms that was described from Singapore.

***Pseudobiceros damawan* Newman & Cannon, 1994**
(Fig. 4G)

Pseudobiceros damawan Newman & Cannon, 1994: 243 (type locality: Laing Island, Madang, Papua New Guinea)

Pseudobiceros damawan - Newman & Cannon, 1997: 347; Sreeraj & Raghunathan, 2011: 2; Dixit & Raghunathan, 2013: 168; Bolaños et al., 2016: 141; Velasquez et al., 2018: 244.

Materials examined. OTC-0035.

Localities. Kusu Island, Little Sister's Island, Pulau Hantu and Pulau Tekukor.

***Pseudobiceros flowersi* Newman & Cannon, 1997**
(Fig. 4H)

Pseudobiceros sp. 1 - Gosliner et al., 1996: 102.

Pseudobiceros flowersi Newman & Cannon, 1997: 347 (type locality: Lizard Island, Great Barrier Reef, Australia).

Pseudobiceros flowersi - Newman & Cannon, 2003: 81; Newman et al., 2003: 197; Ong et al., 2015: 182, fig. 4; Bolaños et al., 2016: 143.

Materials examined. ZRC.PLA.0009, ZRC.PLA.0010.

Localities. Pulau Semakau.

***Pseudobiceros fulgor* Newman & Cannon, 1994**
(Fig. 5A)

Pseudobiceros fulgor Newman & Cannon, 1994: 245 (type locality: Heron Islands, Great Barrier Reef, Australia).

Pseudobiceros fulgor - Gosliner et al., 1996: 101; Newman & Cannon, 1997: 348; Newman & Cannon, 2003: 81; Tan & Yeo, 2003: 172; Chua, 2007: 129; Bolaños et al., 2016: 144.

Materials examined. ZRC.PLA.0012, ZRC.PLA.0013, ZRC.PLA.0014, ZRC.PLA.0011, ZRC.PLA.0015, ZRC.PLA.0016, SUB-1124, OTC-0200.

Localities. Chek Jawa, Kusu Island, Pulau Hantu, Pulau Jong, Pulau Sekudu, Pulau Semakau, Pulau Senang, Raffles Lighthouse, Sisters' Islands, St John's Island, Terumbu Bemban, Terumbu Pempang Tengah, Terumbu Salu and Terumbu Semakau.

Remarks. Commonly known as 'fine-lined flatworm', this polyclad is one of the more common *Pseudobiceros* encountered at Singapore shores.

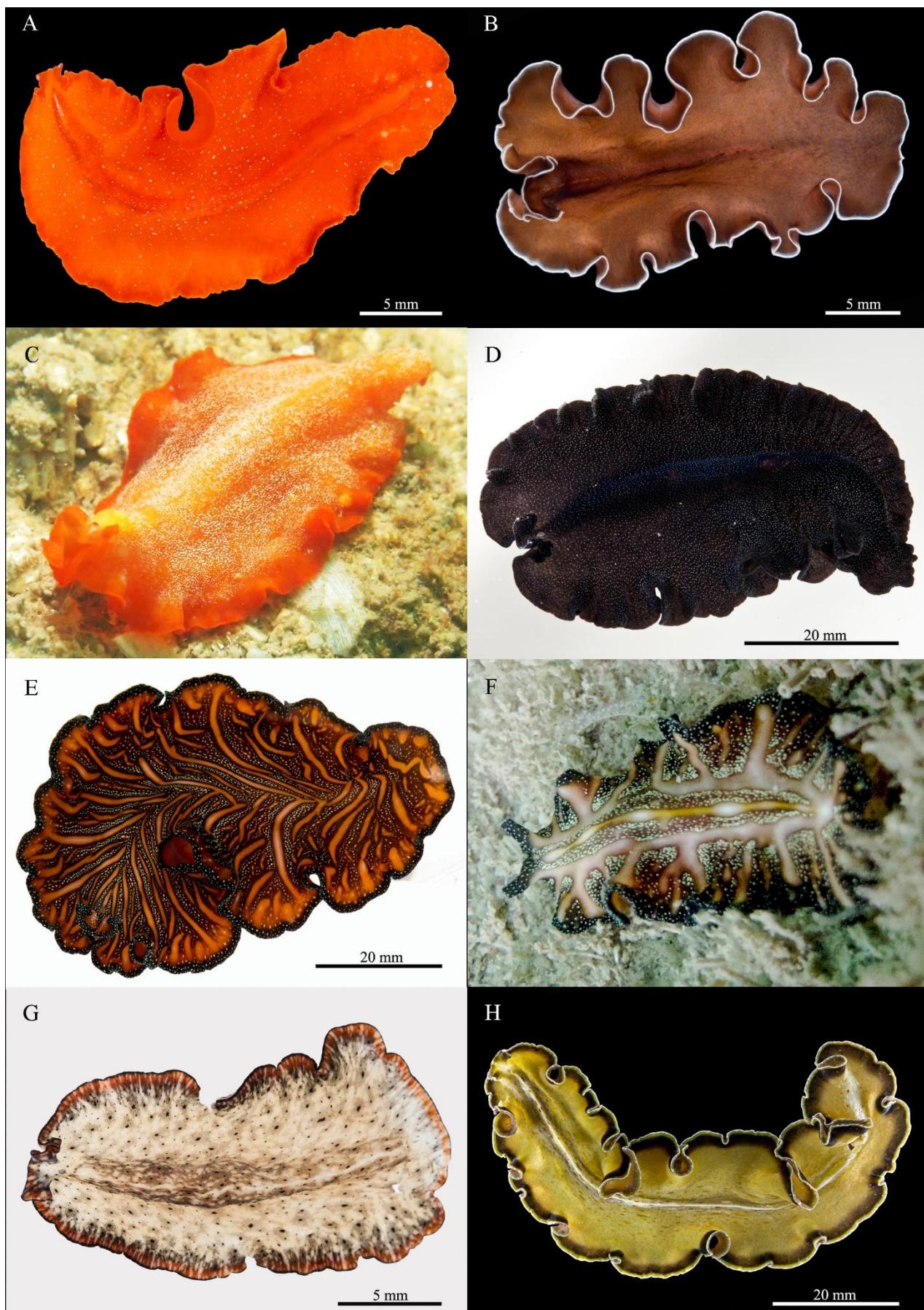


Fig. 4. Dorsal view of live flatworms. A, *Phrikoceros baibaiye* (ZRC.PLA.0006); B, *Phrikoceros* sp. 1 (ZRC.PLA.0196); C, *Phrikoceros* sp. 2.; D, *Pseudobiceros bajae* (ZRC.PLA.0197); E, *Pseudobiceros bedfordi* (OTC-0255); F, *Pseudobiceros* sp. 7; G, *Pseudobiceros damawan* (OTC-0035); H, *Pseudobiceros flowersi* (ZRC.PLA.0009). (Photographs by: Toh Chay Hoon [C]; Stephen Beng [F]).

Pseudobiceros hancockanus (Collingwood, 1876)
(Fig. 5B)

Proceros hancockanus Collingwood, 1876: 91 (type locality: Singapore).
Stylochopsis malayensis Collingwood, 1876: 94 (type locality: Pulo Barundum, Borneo).
Prostheceraeus hancockanus - Lang, 1884: 567.
Pseudoceros malayensis - Bock, 1913: 258, 259.
Pseudoceros hancockanus - Kaburaki, 1923: 639.
Flatworm - Ng et al., 2007: 89.
Pseudobiceros uniarborensis Newman & Cannon, 1994: 252 (type locality: Heron Islands, Great Barrier Reef, Australia).
Pseudobiceros uniarborensis - Newman & Cannon, 1997: 360; Newman et al., 2003: 197; Gosliner et al., 1996: 103;
Apte & Pitale, 2011: 110; Ng, 2012: 142; Maghsoudlou & Rahimian, 2014: 332
Pseudobiceros hancockanus - Bolaños et al., 2016: 146.

Materials examined. ZRC.PLA.0018, ZRC.PLA.0019, ZRC.PLA.0020, ZRC.PLA.0021, ZRC.PLA.0023, ZRC.PLA.0024, ZRC.PLA.0025, ZRC.PLA.0026, ZRC.PLA.0027, ZRC.PLA.0310, ZRC.PLA.0311, SS-1894, SUB-1123, OTC-0186, OTC-0631.

Localities. Beting Bemban Besar, Sisters' Islands, Cyrene Reef, Kusu Island, Lazarus Island, Pulau Biola, Pulau Hantu, Pulau Tekukor, Pulau Senang, Pulau Sudong, Raffles Lighthouse, St John's Island, Tanah Merah beach, Terumbu Bemban, Terumbu Pempang Tengah and Sentosa.

Remarks. This is one of the more common *Pseudobiceros* flatworms found in Singapore waters. The example illustrated in Ng et al. (2007) is herein identified as *Pseudobiceros hancockanus*.

Pseudobiceros hymanae Newman & Cannon, 1997
(Fig. 5C)

Pseudoceros affinis - Hyman, 1960: 309 [Not *Pseudoceros affinis* (Collingwood, 1876)].
Pseudobiceros hymanae Newman & Cannon, 1997: 350 (type locality: Madang Papua New Guinea).
Pseudobiceros hymanae - Sreeraj & Raghunathan, 2013: 39; Dixit & Raghunathan, 2013: 167; Bolaños et al., 2016: 149.

Materials examined. ZRC.PLA.0017, SUB-1552, SUB-1688, OTC-0425.

Localities. Lazarus Island, Pulau Hantu, Pulau Jong, Pulau Salu, Pulau Senang, Raffles Lighthouse and Seringat Kias.

Remarks. Easily mistaken as *Pseudobiceros hancockanus*, this flatworm is not sighted as often as that species.

Pseudobiceros stellae Newman & Cannon, 1994
(Fig. 5D)

Pseudobiceros sp. - Poulter, 1987: pl. 2.I.2e.
Pseudobiceros stellae Newman & Cannon, 1994: 252 (type locality: Great Barrier Reef, Australia).
Pseudobiceros stellae - Newman & Cannon, 1997: 360; Newman & Cannon, 2003: 83; Apte & Pitale, 2011: 110; Ng, 2012: 142; Marquina et al., 2015: 373; Sreeraj & Raghunathan, 2015: 87; Bahia & Schrodl, 2016: 114; Ong et al., 2015: 182, figs. 1 - 3; Ong et al., 2018: 58, fig. 5; Velasquez et al., 2018: 247.

Material examined. ZRC.PLA.0198, ZRC.PLA.0199, ZRC.PLA.0200, INT-0005.

Localities. Cyrene Reef, Kusu Island, Pulau Semakau, Tanah Merah beach and Seringat Kias.

Remarks. Aggregation of this species at Seringat Kias has been reported by Ong et al. (2015). This is one of the *Pseudobiceros* species that can be found in the intertidal zones.

***Pseudobiceros* sp. 1**
(Fig. 5E)

Materials examined. ZRC.PLA.0201, ZRC.PLA.0240, ZRC.PLA.0241, ZRC.PLA.0242.

Localities. Beting Bemban Besar, Kusu Island, Lazarus Island, Pulau Hantu, Pulau Tekukor and Raffles Lighthouse.

Remarks. This species is similar to *Pseudobiceros* sp. 2 in being brownish in colour, but can be distinguished by the absence of the brown median stripe and presence of broad black marginal band.

***Pseudobiceros* sp. 2**
(Fig. 5F)

Marine flatworm - Chua, 2002: 67.

Pseudobiceros gratus - Tan & Yeo, 2003: 172; Chua, 2007: 128; Ng, 2012: 142. [Not *Pseudobiceros gratus* (Kato, 1937)]

Materials examined. ZRC.PLA.0202, ZRC.PLA.0203, JS-0531.

Localities. Beting Bronok, Changi beach, Kusu Island, Labrador Park, Pulau Hantu, Pulau Ubin, Seringat Kias, Sisters' Islands and Tanah Merah beach.

Remarks. Commonly known as the 'brown-striped flatworm', it has been misidentified as *Pseudobiceros gratus* by Tan & Yeo (2003), Chua (2007) and Ng (2012). It can be easily distinguished from *Pseudobiceros gratus* in having only one single brown median stripe on its dorsal side, not three.

***Pseudobiceros* sp. 3**
(Fig. 5G)

Pseudobiceros sp. - Ong et al., 2015: 182, fig. 5.

Materials examined. ZRC.PLA.0204, ZRC.PLA.0249, OTC-0599.

Localities. Seringat Kias, St John's Island and Raffles Lighthouse.

Remarks. The colour and pattern of this flatworm can be mistaken for *Pseudobiceros damawan* or *Pseudobiceros murinus*. The presence of an orange submarginal band and black rim in *Pseudobiceros damawan* easily distinguishes it from *Pseudobiceros* sp. 3. While *Pseudobiceros murinus* has mottled grey-green dorsal body and narrow yellow-orange marginal band and clear rim, *Pseudobiceros* sp. 3 is black to greyish with white outermost margin followed by interrupted yellow and black margins.

***Pseudobiceros* sp. 4**
(Fig. 5H)

Materials examined. ZRC.PLA.0205, ZRC.PLA.0238, ZRC.PLA.0239, INT-1477.

Localities. Terumbu Salu.

Remarks. This polyclad has a completely plain black dorsal body and can easily be mistaken for a blackish ascidian when it is immobile. It can be differentiated from *Pseudobiceros bajae* from the absence of numerous white dots on its dorsal surface.

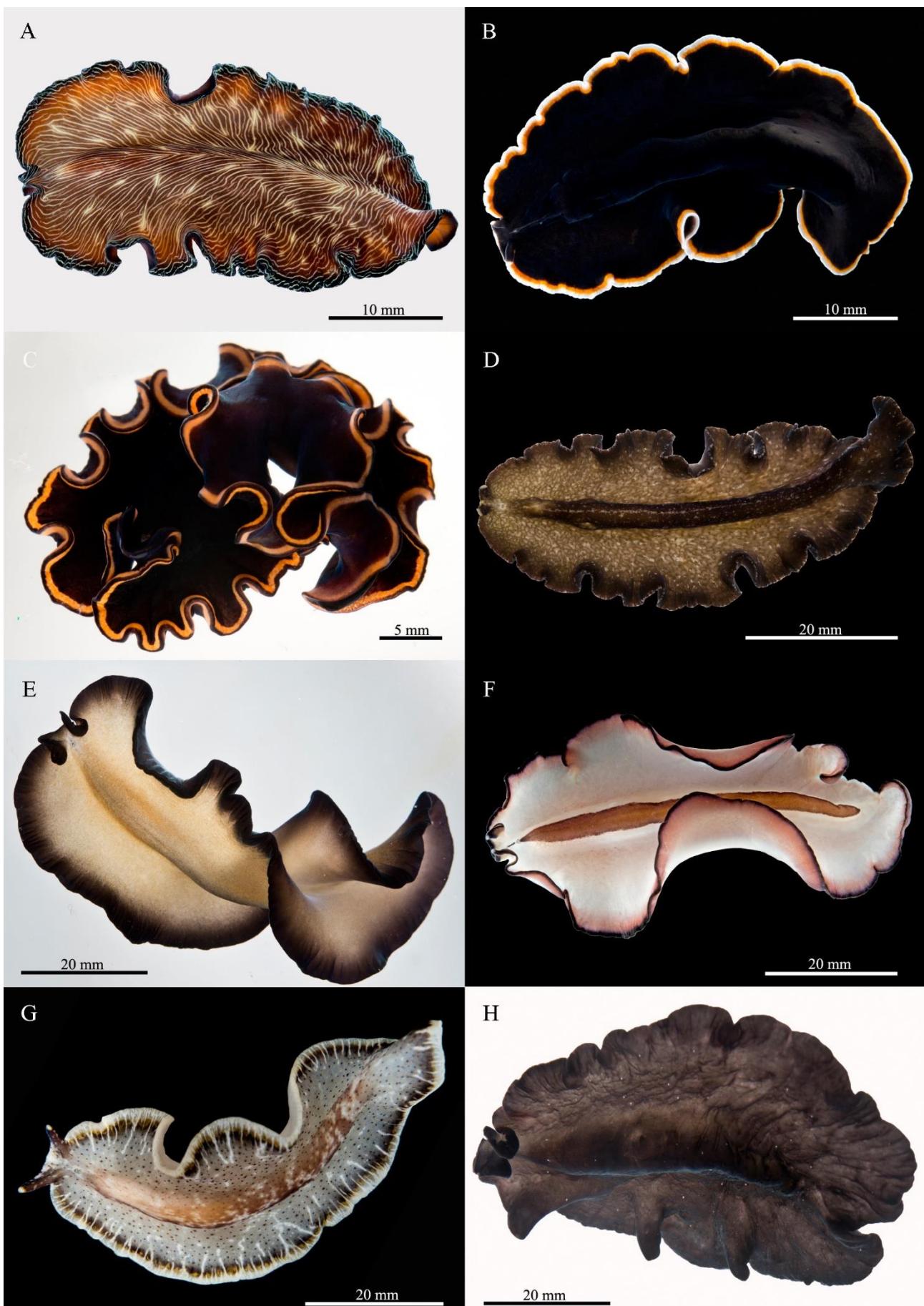


Fig. 5. Dorsal view of live flatworms. A, *Pseudobiceros fulgor* (ZRC.PLA.0013); B, *Pseudobiceros hancockanus* (ZRC.PLA.0023); C, *Pseudobiceros hymaniae* (OTC-0425); D, *Pseudobiceros stellae* (INT-0005); E, *Pseudobiceros* sp. 1 (ZRC.PLA.0242); F, *Pseudobiceros* sp. 2 (ZRC.PLA.0202); G, *Pseudobiceros* sp. 3 (ZRC.PLA.0249); H, *Pseudobiceros* sp. 4 (INT-1477).

***Pseudobiceros* sp. 5**
(Fig. 6A)

Materials examined. ZRC.PLA.0206.

Localities. Pulau Jong, Pulau Hantu, St John's Island, Terumbu Bemban, Terumbu Salu and Terumbu Semakau.

Remarks. This is one of the bigger species of flatworms found in Singapore waters.

***Pseudoceros bifurcus* Prudhoe, 1989**
(Fig. 6B)

Pseudoceros dimidiatus - George & George, 1979: 43, pl. 49 fig 7 [Not *Pseudoceros dimidiatus* Graff, 1893].

Pseudoceros bifurcus Prudhoe, 1989: 78 (type locality: M'Sanga Tsohole Reef, Benthedi, Mayotte, Comoro Island, Madagascar).

Pseudoceros bifurcus - Newman & Cannon, 1994: 216; Gosliner et al., 1996: 104; Newman & Cannon, 1998: 299; Newman & Cannon, 2003: 72; Sreeraj & Raghunathan, 2011: 3; Ng, 2012: 105; Dixit & Raghunathan, 2013: 166; Bolaños et al., 2016: 151.

Materials examined. ZRC.PLA.0028, ZRC.PLA.0029.

Localities. Chek Jawa, Lazarus Island, Sentosa and Tuas.

Remarks. Commonly known as the 'racing-stripe flatworm', this bluish polyclad can easily be identified by its single median stripe of two colours: bright orange anteriorly and white posteriorly. The longitudinal line is also bordered by a dark purple hue.

***Pseudoceros caeruleocinctus* Hyman, 1959**
(Fig. 6C)

Pseudoceros caeruleocinctus Hyman, 1959: 569 (type locality: Palau Islands, Micronesia).

Pseudoceros caeruleocinctus - Bolaños et al., 2016: 153.

Pseudoceros sapphirinus Newman & Cannon, 1994: 236 (type locality: Heron Island, Australia).

Pseudoceros sapphirinus - Newman & Cannon, 1998: 313; Gosliner et al., 1996: 108; Newman & Cannon, 2003: 76; Newman et al., 2003: 198.

Materials examined. ZRC.PLA.0044, ZRC.PLA.0045, ZRC.PLA.0046.

Localities. Beting Bemban Besar, Big Sister's Island, Cyrene Reef, Lazarus Island, Pulau Hantu, Pulau Semakau, Pulau Sudong and Tuas.

Remarks. This contrasting coloured flatworm is more commonly encountered at the subtidal region.

***Pseudoceros concinnus* (Collingwood, 1876)**
(Fig. 6D)

Proceros concinnus Collingwood, 1876: 90 (type locality: Labuan, Pulo Daak, Borneo).

Proceros concinnus - Lang, 1884: 593.

Pseudoceros concinnus - Kaburaki, 1923:64; Newman & Cannon, 1994: 208; Newman & Cannon, 2003: 73; Dixit & Raghunathan, 2013: 166; Sreeraj & Raghunathan, 2011: 4; Bolaños et al., 2016: 155.

Pseudoceros sp. - Chou, 1988: 84; Chua, 2007: 15 & 129; Ng, 2012: 104.

Polyclad - Tan & Ng, 1988: 34; Lim et al., 1994: 71; Leong et al., 2003: 76; Ng et al., 2007: 90.

Materials examined. ZRC.PLA.0030, ZRC.PLA.0031, ZRC.PLA.0032, ZRC.PLA.0033, ZRC.PLA.0034, ZRC.PLA.0035, ZRC.PLA.0036, ZRC.PLA.0037, ZRC.PLA.0038, ZRC.PLA.0039, ZRC.PLA.0049, SS-4165, INT-0257, INT-0305, INT-0548, INT-1127.

Localities. Beting Bemban Besar, Chek Jawa, Labrador Park, Lazarus Island, Pulau Hantu, Pulau Jong, Pulau Pawai, Pulau Salu, Pulau Sekudu, Pulau Semakau, Pulau Tekukor, Sentosa, Sisters' Islands, St John's Island, Seringat Kias,

Raffles Lighthouse, Terumbu Bemban, Terumbu Pempang Laut, Terumbu Pempang Tengah, Terumbu Raya and Terumbu Semakau.

Remarks. This is one of the most common *Pseudoceros* species observed in Singapore.

***Pseudoceros cf. cruentus* Newman & Cannon, 1998**
(Fig. 6E)

Pseudoceros cruentus Newman & Cannon, 1998: 290 (type locality: One Tree Island, Great Barrier Reef, Australia).

Materials examined. None. See Fig. 6E.

Localities. Big Sister's Island and Pulau Ubin.

Remarks. The example illustrated in fig. 6E was photographed at Big Sister's Island on 15 December 2012 by Loh Kok Sheng.

***Pseudoceros duplicinctus* Prudhoe, 1989**
(Fig. 6F)

Pseudoceros duplicinctus Prudhoe, 1989: 81 (type locality: Inhaca Island, Mozambique).

Pseudoceros duplicinctus - Velasquez et al., 2018: 240.

Marine flatworm - Leong et al., 2003: 110; Ng et al., 2011: 374.

Materials examined. ZRC.PLA.0178.

Localities. Pulau Berkas, Pulau Hantu and Terumbu Berkas.

Remarks. Our specimens closely match the original description of *Pseudoceros duplicinctus* by Prudhoe (1989), except for the outer margin. Instead of a narrow orange rim, our specimens have a yellow rim. The difference could be due to the fact that Prudhoe had described the colour of the flatworm from a watercolour painting. In Velasquez et al. (2018), *Pseudoceros prudhoei* (see remarks in *Pseudoceros cf. prudhoei*) was assigned as a junior synonym of *Pseudoceros duplicinctus*. However, it should be noted that none of the flatworms examined in Velasquez et al. (2018) resembles the original description, but resembles closer to the *Pseudoceros prudhoei* illustrated in Newman & Cannon (1994), (2003) and (2005).

***Pseudoceros indicus* Newman & Schupp, 2002**
(Fig. 6G)

Pseudoceros unidentified sp. - Stummer-Traunfels, 1933: 3565, fig. 16.

Pseudoceros concinnus - Hyman, 1954: 220; Prudhoe, 1989: 79. [Not *Pseudoceros concinnus* (Collingwood, 1876)]

Pseudoceros indicus Newman & Schupp, 2002: 178 (type locality: Dunwich, Stradbroke Island, Moreton Bay, Queensland, Australia).

Pseudoceros indicus - Newman & Cannon, 2003: 74; Newman et al., 2003: 197; Apte & Pitale, 2011: 109; Ng, 2012: 105; Dixit & Raghunathan, 2013: 166; Sreeraj & Raghunathan, 2013: 39; Bolaños et al., 2016: 157. Flatworm - Tan & Yeo, 2003: 63.

Materials examined. ZRC.PLA.0050, ZRC.PLA.0051, ZRC.PLA.0053, ZRC.PLA.0052, ZRC.PLA.0061, ZRC.PLA.0062, ZRC.PLA.0063, ZRC.PLA.0064, ZRC.PLA.0066.

Localities. Beting Bemban Besar, Beting Bronok, Changi beach, Little Sister's Island, Pulau Hantu, Pulau Pawai, Pulau Sekudu, Pulau Semakau, Pulau Senang, Pulau Tekukor, Pulau Ubin, Raffles Lighthouse, St John's Island and Terumbu Selegi.

Remarks. A common species in Singapore. Its reproduction and egg development are reported by Chim et al. (2015).

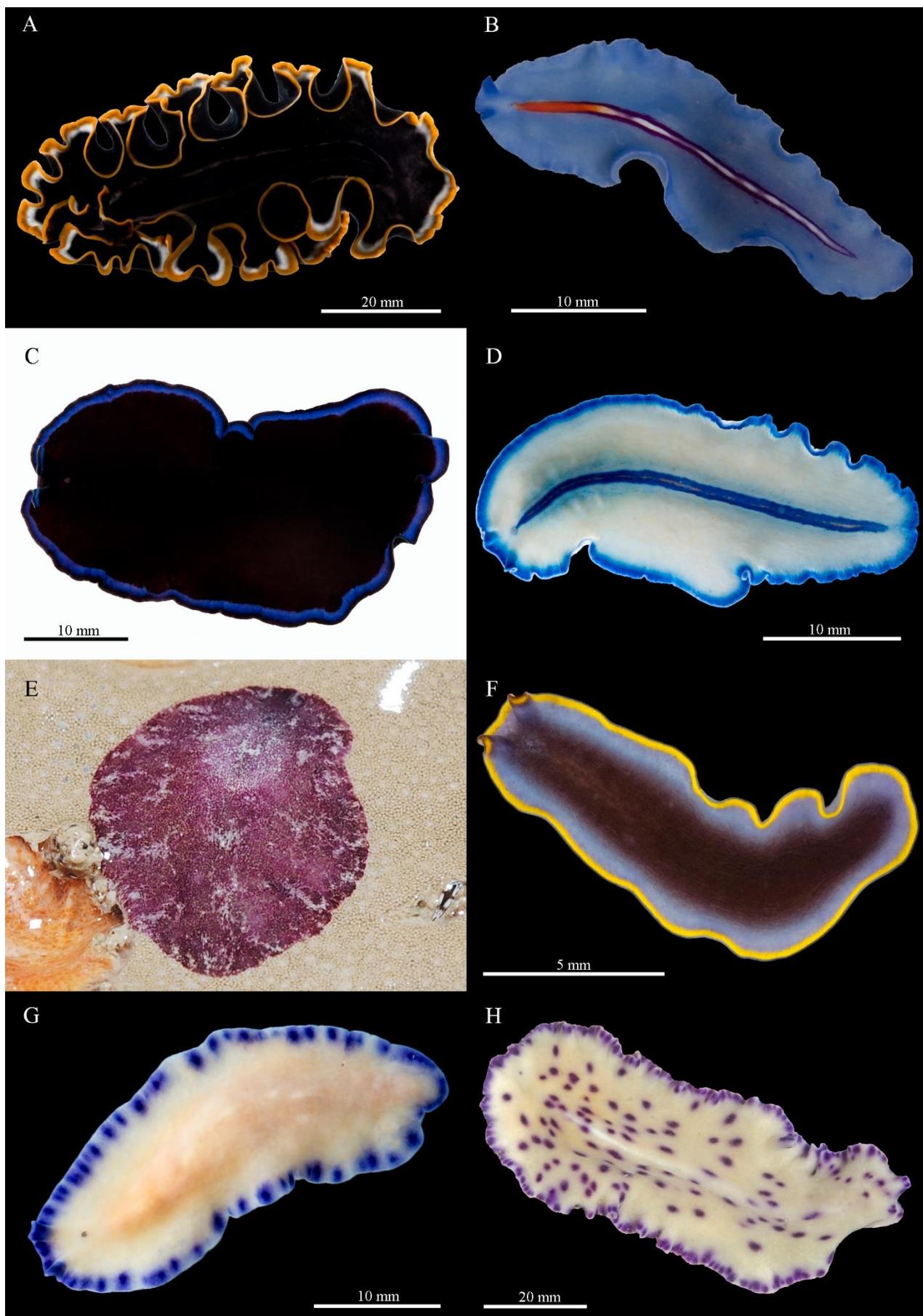


Fig. 6. Dorsal view of live flatworms. A, *Pseudobiceros* sp. 5 (ZRC.PLA.0206); B, *Pseudoceros bifurcus* (ZRC.PLA.0028); C, *Pseudoceros caeruleocinctus* (ZRC.PLA.0046); D, *Pseudoceros concinnus* (ZRC.PLA.0038); E, *Pseudoceros* cf. *cruentus*; F, *Pseudoceros duplicinatus* (ZRC.PLA.0178); G, *Pseudoceros indicus* (ZRC.PLA.0063); H, *Pseudoceros laingensis* (JS-0498). (Photograph by: Loh Kok Sheng [E]).

***Pseudoceros laingensis* Newman & Cannon, 1998**
(Fig. 6H)

Pseudoceros laingensis Newman & Cannon, 1998: 309 (type locality: Laing Island, Madang, Papua New Guinea).
Pseudoceros laingensis - Newman & Cannon, 2003: 75; Ng, 2012: 142; Bolaños et al., 2016: 159.

Materials examined. ZRC.PLA.0040, JS-0498.

Localities. Beting Bronok, Changi beach, Chek Jawa, Pulau Sekudu, Pulau Semakau, Terumbu Raya and Sentosa.

Remarks. Popularly known as ‘purple-spotted flatworm’, *Pseudoceros laingensis* is often found at intertidal zones.

***Pseudoceros meenae* Dixit & Raghunathan, 2018**
(Fig. 8F)

Pseudoceros meenae Dixit & Raghunathan, 2018: 365 (type locality: Kalapathhar, Hut Bay, Little Andaman, India).

Materials examined. ZRC.PLA.0189, ZRC.PLA.0190.

Localities. Cyrene Reef and Pulau Jong.

***Pseudoceros microcelis* Prudhoe, 1989**
(Fig. 7A)

Pseudoceros microcelis Prudhoe, 1989: 85 (type locality: Inhaca Island, Mozambique).
Pseudoceros microcelis - Ong et al., 2018: 59, fig. 6.

Material examined. ZRC.PLA.0179.

Localities. Big Sister’s Island, Pulau Biola, Pulau Hantu and Pulau Tekukor.

Remarks. This species can easily be mistaken for *Thysanozoon nigropapillosum*.

***Pseudoceros paralaticlavus* Newman & Cannon, 1994**
(Fig. 7B)

Pseudoceros paralaticlavus Newman & Cannon, 1994: 232 (type locality: Heron Island, Australia).
Pseudoceros paralaticlavus - Newman & Cannon, 1998: 311; Gosliner et al., 1996: 107.

Materials examined. ZRC.PLA.0181.

Localities. Big Sister’s Island and Terumbu Pempang Tengah.

Remarks. In Singapore, this flatworm has only been sighted at the subtidal zone.

***Pseudoceros cf. prudhoei* Newman & Cannon, 1994**
(Fig. 7C)

Pseudoceros prudhoei Newman & Cannon, 1994: 235 (type locality: Heron Island, Australia).
Pseudoceros prudhoei - Newman & Cannon, 1998: 312; Newman & Cannon, 2003: 36 & 76; Newman & Cannon, 2005; Apte & Pitale, 2011: 110; Dixit & Raghunathan, 2013: 167; Marquina et al., 2015: 360.
Pseudoceros cf. prudhoei - Maghsoudlou & Rahimian, 2014: 333.

Materials examined. ZRC.PLA.0184, ZRC.PLA.0252, ZRC.PLA.0253, ZRC.PLA.0254, ZRC.PLA.0255, SUB-0274, SUB-1136.

Localities. Cyrene Reef, Labrador Park, Pulau Hantu, Pulau Senang, Pulau Sudong, Sisters’ Islands and St John’s Island.

Remarks. In Newman & Cannon (1994), *Pseudoceros prudhoei* was described as having an inner margin of sky blue or mauve with yellow or cream rim. The description closely resembled that of Prudhoe (1989)'s *Pseudoceros duplincinus*. The only difference is that Prudhoe (1989) described the outer margin as orange not yellow. Nevertheless, the examples in the photographs available in Newman & Cannon (1994, 2003, 2005) all show a white inner margin instead of a blue one. This discrepancy adds confusion to the identification of *Pseudoceros prudhoei*. Velasquez et al. (2018) synonymised *Pseudoceros prudhoei* as a junior synonym of *Pseudoceros duplincinus* based on their examination of three morphotypes of *Pseudoceros prudhoei*. However, no specimen resembling *Pseudoceros duplincinus* was examined. Neither was the discrepancy in Newman & Cannon (1994)'s description and illustrations discussed. Velasquez et al. (2018) went on to propose that the colour variation is possibly due to intestinal contents in the flatworm. To support this theory, they cited that Marquina et al. (2015) noticed the bluish marginal band can fade to white. This, however, is not what Marquina et al. (2015) meant. They were describing the marginal band as it is - bluish fading to white, followed by yellow rim. This can be easily seen in the specimen illustrated in their Fig. 4. In our observation of live flatworm specimens, only the overall dorsal colour may change, while the pattern and/or marginal bands remain the same. As such, it is unclear if *Pseudoceros duplincinus* and *Pseudoceros prudhoei* are the same species. We are hereby treating them as two separate species until further examination and actual molecular analysis of both are compared.

***Pseudoceros cf. rubronanus* Newman & Cannon, 1998**
(Fig. 7D)

Pseudoceros rubronanus Newman & Cannon, 1998: 312.

Materials examined. ZRC.PLA.0182.

Localities. Chek Jawa.

Remarks. This flatworm has only been recorded at Chek Jawa. We have reservations regarding the colour description given in Newman & Cannon (1998) that in our opinion requires further examination and literature reviews. Newman & Cannon (1998) named *Pseudoceros rubronanus* without considering a few described species that also have red/purplish bodies.

***Pseudoceros rubrotentaculatus* Kaburaki, 1923**
(Fig. 7E)

Pseudoceros rubrotentaculatus Kaburaki, 1923: 643 (type locality: Dumurug Point, Cataingan Bay, Masbate, The Philippines).

Pseudoceros rubrotentaculatus - Marcus, 1950: 88; Bolaños et al., 2016: 161.

Pseudoceros sp. - Chua, 2007: 129; Auger, 2013: 165.

Pseudoceros tristriatus - Ng et al., 2011: 374; Ng, 2012: 105. [Not *Pseudoceros tristriatus* Hyman, 1959]

Materials examined. ZRC.PLA.0041, ZRC.PLA.0042, ZRC.PLA.0043, SS-1034.

Localities. Big Sister's Island, Pulau Hantu, Pulau Jong, Pulau Tekukor, Raffles Lighthouse and St John's Island.

Remarks. In Singapore, this species is popularly referred to as 'triple-stripes flatworm'. It had been mistaken as *Pseudoceros tristriatus* Hyman (1959) as it has a similar pattern of triple-stripes on its dorsal surface. The two species can be distinguished by their colouration - *Pseudoceros tristriatus* has blue dorsal body with three orange stripes, each bordered by black or dark purple, while *Pseudoceros rubrotentaculatus* has creamy-white body with three non-connecting ochre stripes bordered dark brown or purplish brown. So far, there has been no actual record of *Pseudoceros tristriatus* in Singapore. The examples identified in Ng et al. (2011) and Ng (2012) as *Pseudoceros tristriatus* are actually *Pseudoceros rubrotentaculatus*. The flatworms illustrated as *Pseudoceros* sp. in Chua (2007) and Auger (2013) are clearly *Pseudoceros rubrotentaculatus*.

***Pseudoceros scintillatus* Newman & Cannon, 1994**
(Fig. 7F)

Pseudoceros scintillatus Newman & Cannon, 1994: 237 (type locality: Heron Island, Australia).

Materials examined. ZRC.PLA.0183.

Localities. Chek Jawa, Pulau Hantu, Pulau Jong and Pulau Sekudu.

Pseudoceros cf. stimpsoni Newman & Cannon, 1998
(Fig. 7G)

Pseudoceros stimpsoni Newman & Cannon, 1998: 315 (type locality: Madang, Papua New Guinea).

Materials examined. ZRC.PLA.0308, ARM-0004, ARM-0753.

Localities. Raffles Lighthouse and St John's Island.

Remarks. This flatworm does not fully meet the original description by Newman & Cannon (1998). The orange submarginal band is not bordered with black on both sides, and the pseudotentacles are not small as originally described. Furthermore, the pseudotentacles have a distinct orange submarginal band bordered with black that is absent in the original description.

Pseudoceros sp. 1
(Fig. 7H)

Materials examined. 41115.

Localities. Pulau Ubin.

Remarks. This flatworm is similar in appearance to *Pseudoceros stimpsoni* but can be easily differentiated by the presence of random blotches of white and transverse white streak that are absent in *Pseudoceros stimpsoni*.

Pseudoceros sp. 2
(Fig. 8A)

Materials examined. ZRC.PLA.0185.

Localities. Lazarus Island.

Remarks. This brightly coloured flatworm seems to be mimicking the nudibranch *Gymnodoris rubropapulosa* (Bergh, 1905) in having similar orange spots on its body (Tan, 2015).

Pseudoceros sp. 3
(Fig. 8B)

Materials examined. ZRC.PLA.0186, ZRC.PLA.0248, ZRC.PLA.0250, ZRC.PLA.0251.

Localities. Chek Jawa, St John's Island, Lazarus Island, Pulau Pawai and Pulau Semakau.

Remarks. This flatworm can be confused with either *Pseudoceros concinnus* or *Pseudoceros bifurcus*, but can be told apart by the yellow median line bordered with dark blue.

Pseudoceros sp. 4
(Fig. 8C)

Materials examined. ZRC.PLA.0187, ZRC.PLA.0245, ZRC.PLA.0246, ZRC.PLA.0247, INT-0547.

Localities. Big Sister's Island, Cyrene Reef, Pulau Tekukor and St John's Island.

Remarks. This flatworm resembles *Pseudoceros* sp. 3 in appearance. Instead of having a plain yellow median stripe that ends behind the cerebral eyespots, *Pseudoceros* sp. 4 has a golden-speckled yellow line that looks intermittent by some dull orange and ends in front of the cerebral eyespots.

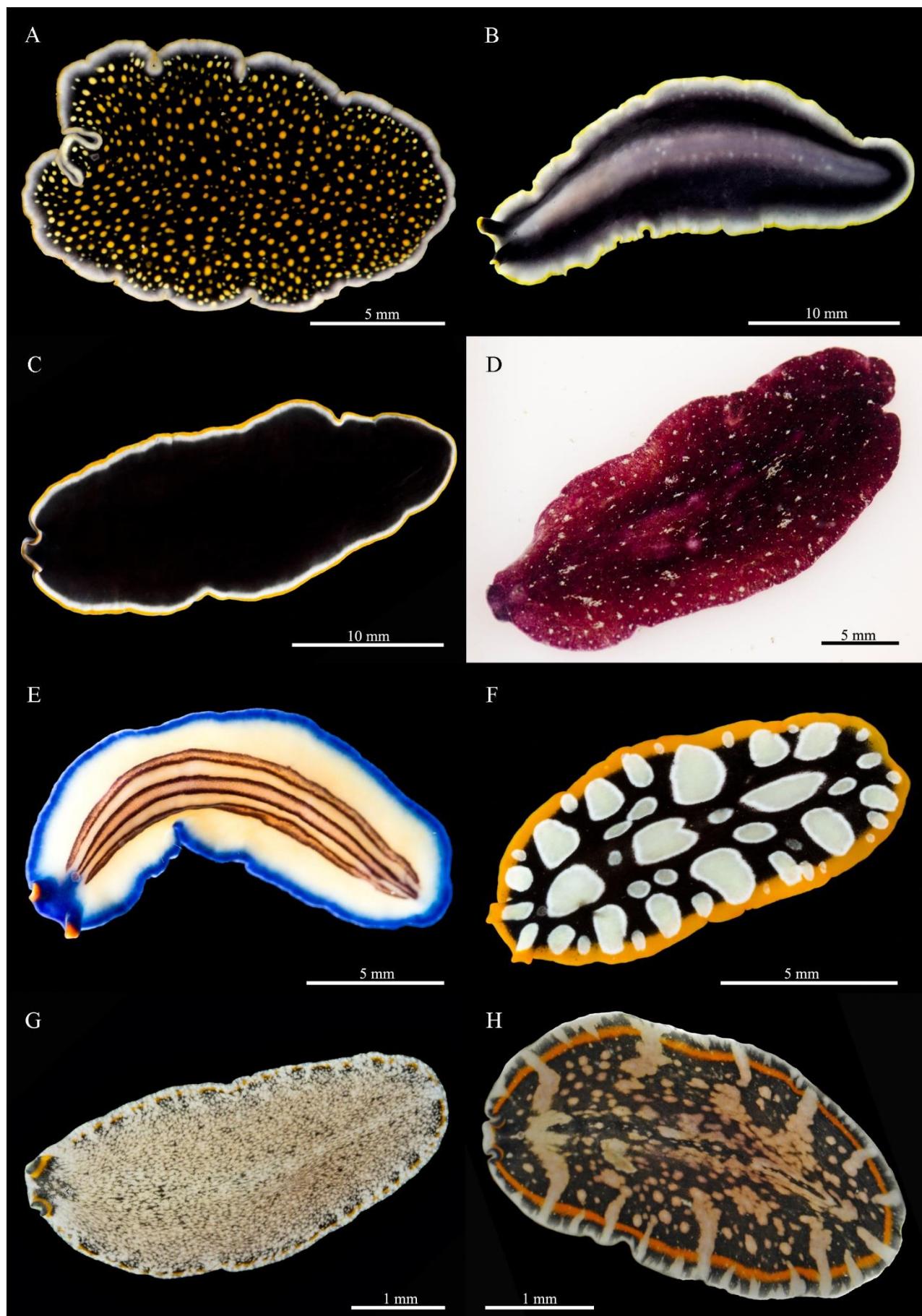


Fig. 7. Dorsal view of live flatworms. A, *Pseudoceros microcelis* (ZRC.PLA.0179); B, *Pseudoceros paralaticlavis* (ZRC.PLA.0181); C, *Pseudoceros* cf. *prudhoei* (ZRC.PLA.0255); D, *Pseudoceros* cf. *rubronanus* (ZRC.PLA.0182); E, *Pseudoceros rubrotentaculatus* (ZRC.PLA.0043); F, *Pseudoceros scintillatus* (ZRC.PLA.0183); G, *Pseudoceros* cf. *stimpsoni* (ZRC.PLA.0308); H, *Pseudoceros* sp. 1 (41115).

***Pseudoceros* sp. 5**
(Fig. 8D)

Materials examined. INT-0848, SS-1953b.

Localities. Sisters' Islands, Pulau Hantu, Pulau Jong, Pulau Senang and Raffles Lighthouse.

Remarks. This species appears similar to *Pseudoceros rubrotentaculatus* but the lateral bands are shorter than the middle band, and is orange instead of ocher in colour.

***Pseudoceros* sp. 6**
(Fig. 8E)

Materials examined. ZRC.PLA.0188, ZRC.PLA.0243, ZRC.PLA.0244.

Localities. Little Sister's Island, Pulau Biola, Pulau Hantu and Pulau Jong.

Remarks. This flatworm resembles *Pseudoceros vishnui* Dixit et al. (2017), but is distinguished by its light orange dorsal body with purple spots, each surrounded with a halo of white, and intermittent bluish margin. *Pseudoceros vishnui* has creamy dorsal body with purple or violet spots and a margin made up of blue dots of varying sizes. As we are unable to ascertain if they are conspecific, this polyclad is not assigned a species name.

***Pseudoceros* sp. 7**
(Fig. 4F)

Materials examined. None. See Fig. 4F.

Localities. Big Sister's Island.

Remarks. Locally, this flatworm has only been photographed once during a reef survey at Big Sister's Island in February 2015 by Stephen Beng. It closely resembles *Pseudobiceros bedfordi* (Laidlaw, 1903) but the colour and pattern show distinct differences. While *Pseudobiceros bedfordi* has orange-brown transverse lines with no median line, this specimen has three distinct median lines and random light pinkish radial lines encompassing around these median lines. A recent specimen was collected in Lakshdweep, India, by Sudhanshu Dixit, in June 2018 clearly showed this flatworm to be a *Pseudoceros* with only one male gonopore and complex, branching pharynx (Sudhanshu Dixit, pers. comm.).

***Pseudoceros* sp. 8**
(Fig. 8G)

Materials examined. ZRC.PLA.0191.

Localities. Big Sister's Island, Kusu Island and Pulau Hantu.

Remarks. This is one of the few large *Pseudoceros* species found in Singapore waters.

***Pseudoceros* sp. 9**
(Fig. 8H)

Materials examined. ZRC.PLA.0192.

Localities. Pulau Pawai.

Remarks. This flatworm, an immature specimen, was an accidental find. It was so well-camouflaged among ascidians that it was not noticed until the piece of ascidian was closely examined. It is possible that *Pseudoceros* sp. 9 is associated with that particular colonial ascidian which has yet to be identified.

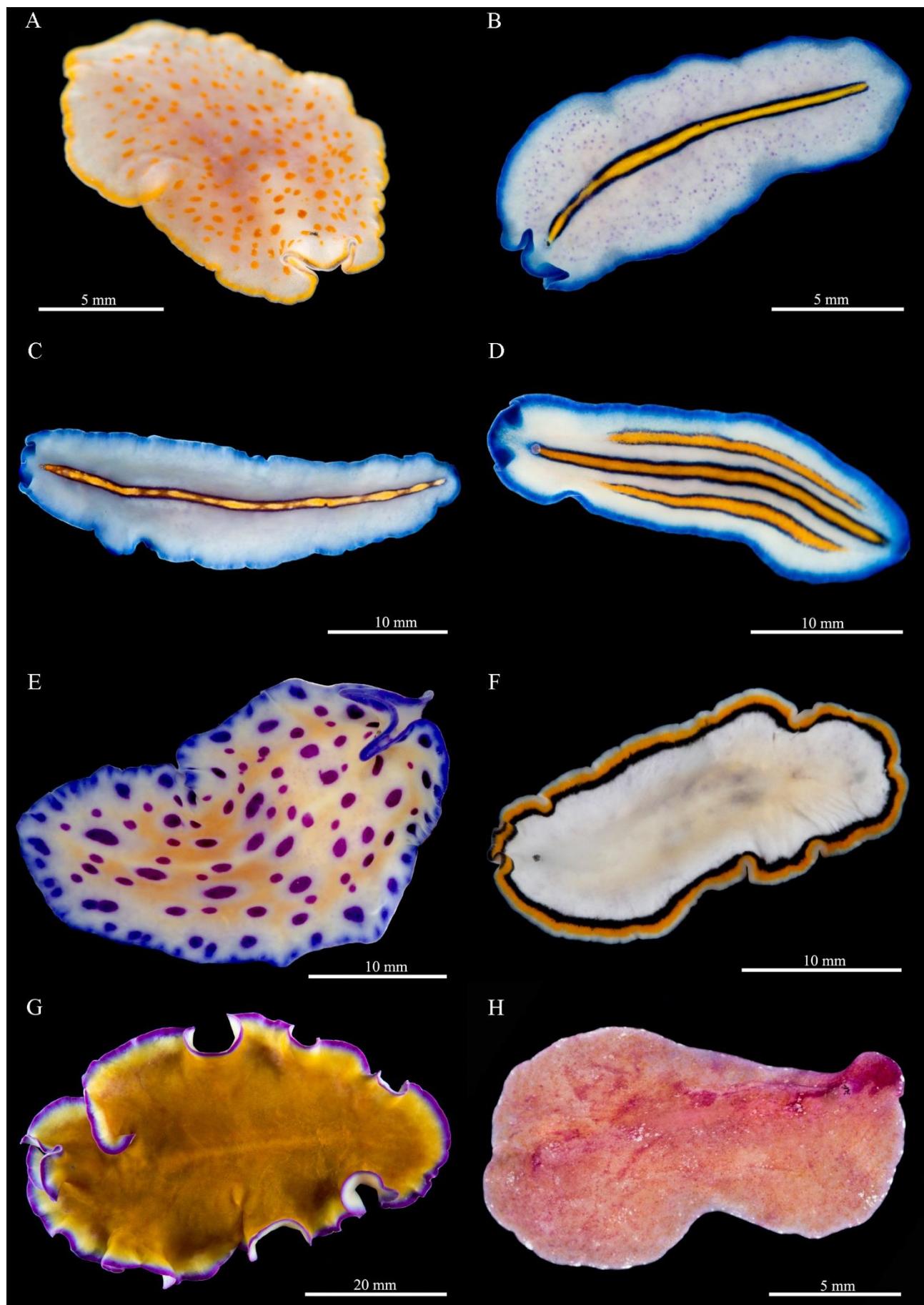


Fig. 8. Dorsal view of live flatworms. A, *Pseudoceros* sp. 2 (ZRC.PLA.0185); B, *Pseudoceros* sp. 3 (ZRC.PLA.0248); C, *Pseudoceros* sp. 4 (ZRC.PLA.0245); D, *Pseudoceros* sp. 5 (SS-1953b); E, *Pseudoceros* sp. 6 (ZRC.PLA.0243); F, *Pseudoceros meenae* (ZRC.PLA.0190); G, *Pseudoceros* sp. 8 (ZRC.PLA.0191); H, *Pseudoceros* sp. 9 (ZRC.PLA.0192).

***Pseudoceros* sp. 10**
(Fig. 9A)

Materials examined. ZRC.PLA.0306.

Localities. Pulau Biola.

Remarks. Only the pseudotentacles of this species match those of *Pseudoceros verecundus* Newman & Cannon (1994). As the specimen lacks the distinct marginal band of *Pseudoceros verecundus*, we are unable to confirm if it is that species.

***Pseudoceros* sp. 11**
(Fig. 9B)

Materials examined. None. See Fig. 9B.

Localities. Pulau Jong.

Remarks. This flatworm has been sighted only once in Singapore. One was photographed at Pulau Jong on 15 September 2012 by Toh Chay Hoon. Its relatively small size could have made it hard to find.

***Pseudoceros* sp. 12**
(Fig. 9C)

Materials examined. None. See Fig. 9C.

Localities. Pulau Hantu and Pulau Semakau.

Remarks. This flatworm has only been sighted a couple of times in Singapore at subtidal areas. One of them was photographed at Pulau Hantu on 17 February 2013 by Toh Chay Hoon.

***Tytthosoceros lizardensis* Newman & Cannon, 1996**
(Fig. 9D)

Tytthosoceros lizardensis Newman & Cannon, 1996b: 485 (type locality: Heron Island, Australia)

Tytthosoceros lizardensis - Newman & Cannon, 2003: 86; Khalili et al., 2009: 41; Maghsoudlou & Rahimian, 2014: 336; Dixit et al., 2015: 3; Ong et al., 2015: 182, fig. 6; Bolaños et al., 2016: 163; Ong, 2016: 108.

Materials examined. ZRC.PLA.0048, OTC-0421, OTC-0422, OTC-0455.

Localities. Beting Bronok, Lazarus Island, St John's Island, Seringat Kias and Tanah Merah.

Remarks. Aggregations of this species have been reported by Ong et al. (2015) at Seringat Kias and by Ong (2016) at Beting Bronok. This flatworm seems to be seasonally abundant and is observed to be found where patches of seaweed and seagrass are present.

***Tytthosoceros* sp. 1**
(Fig. 9E)

Materials examined. ZRC.PLA.0303.

Localities. St John's Island.

Remarks. Interestingly, this flatworm was found on the autonomous reef monitoring structures that were deployed at St. John's Island. This could suggest that it is associated with the microhabitats that had established on the structures during the six-month deployment period. At about 1 cm, it appears to be a rather small species.

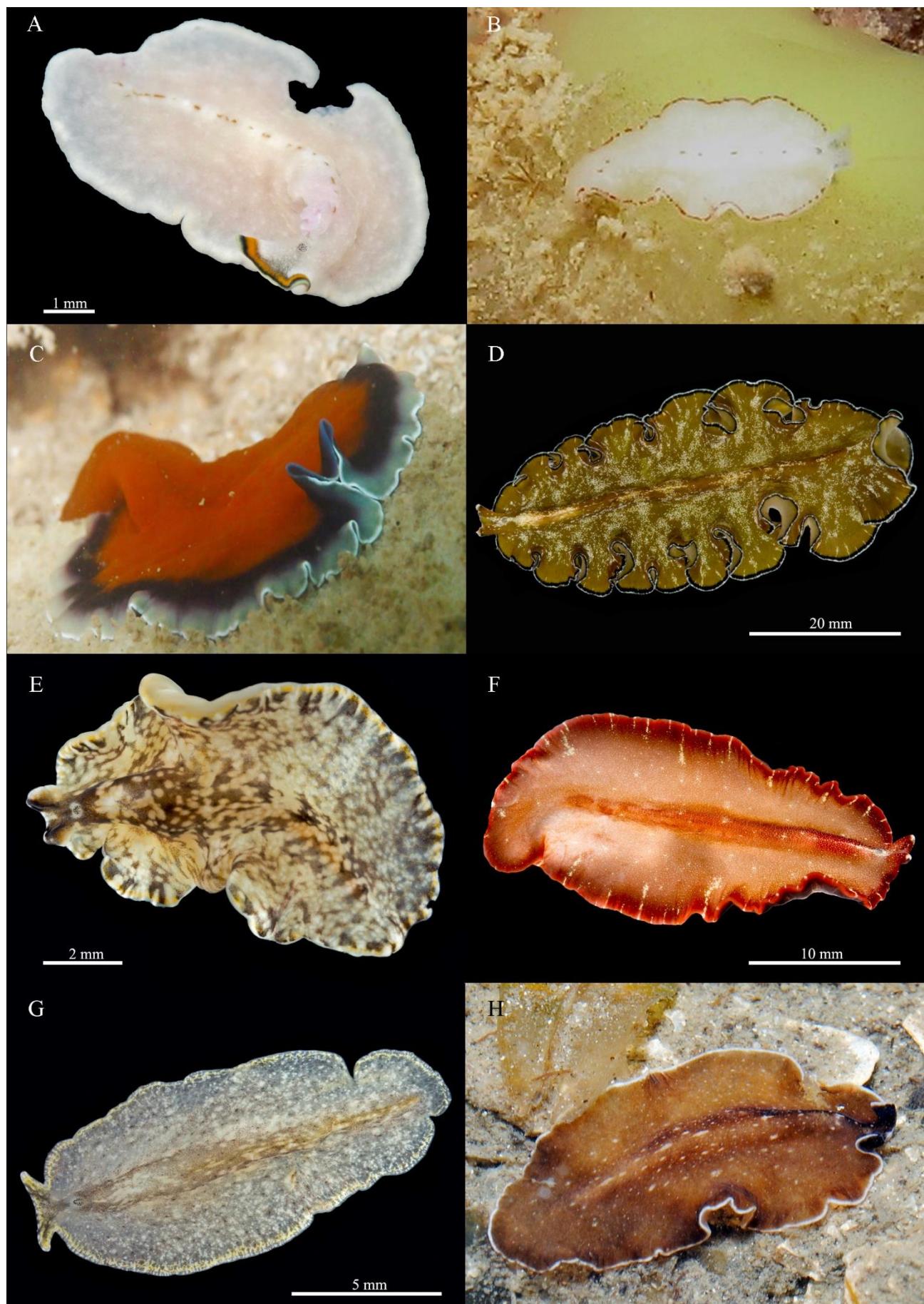


Fig. 9. Dorsal view of live flatworms. A, *Pseudoceros* sp. 10 (ZRC.PLA.0306); B, *Pseudoceros* sp. 11; C, *Pseudoceros* sp. 12; D, *Tythesoceros lizardensis* (OTC-0455); E, *Tythesoceros* sp. 1 (ZRC.PLA.0303); F, *Tythesoceros* sp. 2 (ZRC.PLA.0194); G, *Pseudocerotid* 1 (ZRC.PLA.0300); H, *Pseudocerotid* 2. (Photographs by: Toh Chay Hoon [B, C]; Loh Kok Sheng [H]).

***Tytthosoceros* sp. 2**
(Fig. 9F)

Materials examined. ZRC.PLA.0194.

Localities. Pulau Hantu and Pulau Senang.

Remarks. Examples of this species were found at subtidal regions.

Pseudocerotid 1
(Fig. 9G)

Materials examined. ZRC.PLA.0300, ZRC.PLA.0301, ZRC.PLA.0302.

Localities. Punggol, Raffles Lighthouse and St John's Island.

Remarks. The identification of this flatworm is uncertain as it bears a mixture of key characteristics of the known genera. Without a thorough investigation, we are unable to assign it to any particular genus.

Pseudocerotid 2
(Fig. 9H)

Materials examined. None. See Fig. 9H.

Localities. Chek Jawa.

Remarks. Only one example was photographed on 4 January 2014 at Chek Jawa by Loh Kok Sheng.

Pseudocerotid 3
(Fig. 10A)

Materials examined. None. See Fig. 10A.

Localities. Pulau Jong.

Remarks. This polyclad, is included based on a photograph taken at Pulau Jong, on November 2012, by Toh Chay Hoon during a dive survey.

Pseudocerotid 4
(Fig. 10B)

Materials examined. None. See Fig. 10B.

Localities. Terumbu Raya.

Remarks. An injured greenish flatworm was photographed at Terumbu Raya in March 2009 during an intertidal survey by Loh Kok Sheng.

Pseudocerotid 5
(Fig. 10C)

Materials examined. None. See Fig. 10C.

Localities. Little Sister's Island.

Remarks. This flatworm appears similar to *Nymphozoon orsaki*, but has a different body colour and lacks the orange-brown inner marginal band present in *Nymphozoon orsaki*. It is included based on a photograph taken at Little Sister's Island on 22 December 2012 by Toh Chay Hoon.

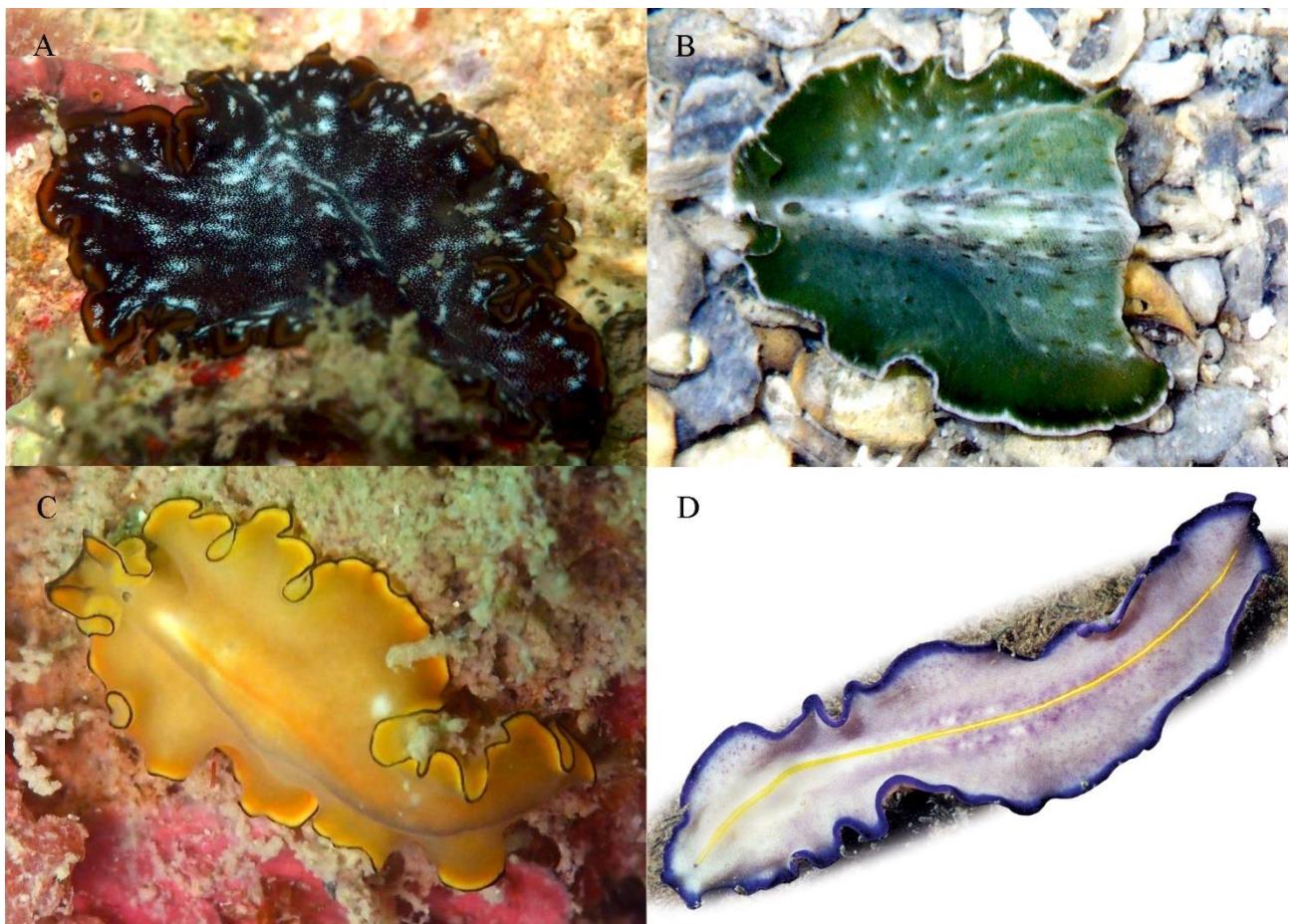


Fig. 10. Dorsal view of live flatworms. A, Pseudocerotid 3; B, Pseudocerotid 4; C, Pseudocerotid 5; D, Pseudocerotid 6. (Photographs by: Loh Kok Sheng [B]; Toh Chay Hoon [A, C]; Alan Yeo [D]).

Pseudocerotid 6
(Fig. 10D)

Pseudobiceros sp. - Tan & Yeo, 2003: 171.

Materials examined. None. See Fig. 10D (also published in Tan & Yeo, 2003: 171).

Localities. Chek Jawa.

Remarks. This polyclad looks very similar to *Pseudoceros* sp. 3 and sp. 4. However, it is not assigned the same genus for there are no images or notes to illustrate the number of male gonopores to confirm its genus. As such, it is herein assigned only to family level.

FAMILY PROSTHIOSTOMIDAE Lang, 1884

cf. *Enchiridium* sp.
(Fig. 11A)

Materials examined. ZRC.PLA.0207.

Localities. Pulau Tekukor.

Prosthiostomid 1
(Fig. 11B)

Materials examined. ZRC.PLA.0208, ZRC.PLA.0236, ZRC.PLA.0237, SS-1929.

Localities. Cyrene Reef, Lazarus Island, Pulau Semakau and St John's Island.

Prosthiostomid 2
(Fig. 11C)

Materials examined. ZRC.PLA.0209, ZRC.PLA.0210, ZRC.PLA.0223, SS-1028,.

Localities. Lazarus Island, Terumbu Bemban and Raffles Lighthouse.

Remarks. We have observed one specimen ejecting its pharynx, and its eggs undergoing indirect development.

Prosthiostomid 3
(Fig. 11D)

Materials examined. ZRC.PLA.0211, SS-1022.

Localities. St John's Island.

Prosthiostomid 4
(Fig. 11E)

Materials examined. ZRC.PLA.0212, SS-4225.

Localities. Kusu Island and St John's Island.

SUBORDER ACOTYLEA Lang, 1884

FAMILY CALLIOPLANIDAE Hyman, 1953

Meixneria* cf. *furva Bock, 1913
(Fig. 11F)

Meixneria furva Bock, 1913: 112 (type locality: Gulf of Siam).

Meixneria furva - Wee & Ng, 1994: 73 (?); Ng & Wee, 1994 (?): 56; Davison et al., 2008 (?): 42; Ng et al., 2011: 374 (?).

Meixneria sp. - Ng & Sivasothi, 1999: 6 (?).

Materials examined. ZRC.PLA.0221.

Localities. Pasir Ris beach and Changi beach.

Remarks. Information regarding this species is extremely lacking. There is no other taxonomic report on this species since it was described by Bock in 1913. The external morphology of the only specimen examined closely resembles Bock's (1913) description of *Meixneria furva*. Histology will be needed to confirm the identity as well as thorough literature research to ensure this species had not been wrongly identified and described as other species. The specimen was observed to be able to stay out of water for hours. It also excreted lots of mucus. In Wee & Ng (1994) and Ng et al. (2011), this species was listed with no comment, description or photograph. In the Singapore Red Data Book (Ng & Wee, 1994; Davison et al., 2008), the species is indicated as data deficient and the photographs shown are not *Meixneria furva* but most possibly a species of *Limnostylochus*.

FAMILY LIMNOSTYLOCHIDAE Faubel, 1983

Limnostylochus borneensis Stummer-Traufels, 1902

Limnostylochus borneensis Stummer-Traufels, 1902: 160 (type locality: Borneo).

Limnostylochus borneensis - Chuang, 1973: 133 (?).

Materials examined. None.

Localities. Unknown.

Remarks. This species was mentioned by Chuang (1973) but without description, comment, illustration, or reference specimen. Therefore, the presence of this species in Singapore remains unclear.

***Limnostylochus* sp.**

Limnostylochus sp. - Ng & Sivasothi, 1999: 6; Ng et al., 2008: 97; Chua, 2010: 94; Ng et al., 2011: 374.

Materials examined. None.

Localities. Sungei Buloh Wetland Reserve (Chua, 2010: 94).

Remarks. Commonly known as 'mangrove flatworm', and reported to be seasonally abundant at intertidal mangrove area. However, it seems that there was no proper examination of specimens to confirm that they were indeed a species of *Limnostylochus*. Neither are we able to find any documentation that led to the identification. It does not help that there is scant literature on this genus. This group of flatworms is in dire need of a major taxonomic review.

Limnostylochid 1

(Fig. 11G)

Materials examined. ZRC.PLA.0214, ZRC.PLA.0215, ZRC.PLA.0216, JS-2466.

Localities. Admiralty Park, Lim Chu Kang, Kranji mudflat, Pulau Ubin, and Sungei Buloh.

Remarks. Seasonally abundant at intertidal mangrove area, this Limnostylochid closely resembles the *Limnostylochus* sp. mentioned above. As this group of flatworms is poorly known and in need of a major taxonomic review, we are only comfortable to assign it to family level. We are keeping this species separate from the afore-mentioned *Limnostylochus* sp. as we are unable to verify if they are conspecific.

Limnostylochid 2

(Fig. 11H)

Materials examined. ZRC.PLA.0217, ZRC.PLA.0218, ZRC.PLA.0233, ZRC.PLA.0234, ZRC.PLA.0235, JS-0630.

Localities. Kranji mudflat, Pulau Ubin, Sungei Buloh, and Sungei Mandai.

Remarks. Seasonally abundant at intertidal mangrove areas. Although this flatworm closely resembles Limnostylochid 1, it can be distinguished by its dorsal colour, being brownish instead of reddish and does not have any yellow median line. This polyclad can also be mistaken for *Meixneria* cf. *furva*. The key difference between the two is the tentacle eyespots and marginal band. *Meixneria* cf. *furva* has a pair of distinct round-shaped tentacle eyespots and broad, white marginal band, while the tentacle eyespots of Limnostylochid 2 do not have a distinct shape and there is a narrow, white marginal band.

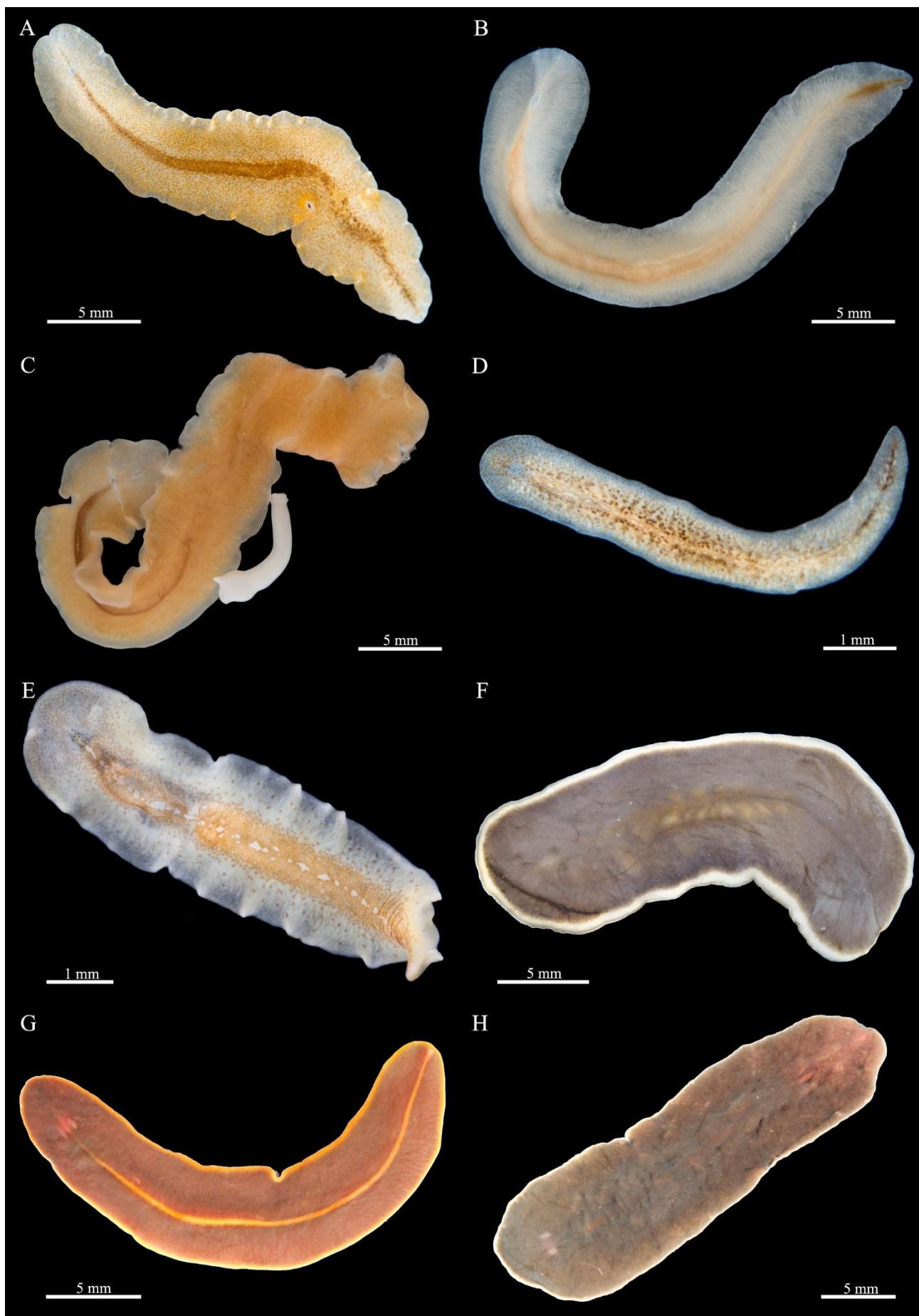


Fig. 11. Dorsal view of live flatworms. A, cf. *Enchiridium* sp. (ZRC.PLA.0207); B, Prosthiostomid 1 (ZRC.PLA.0237); C, Prosthiostomid 2 (ZRC.PLA.0223); D, Prosthiostomid 3 (SS-1022); E, Prosthiostomid 4 (SS-4225); F, *Meixneria* cf. *furva* (ZRC.PLA.0221); G, Limnstylochid 1 (ZRC.PLA.0216); H, Limnstylochid 2 (ZRC.PLA.0234).

FAMILY GNESIOCEROTIDAE Marcus & Marcus, 1968

Gnesioceros* cf. *sargassicola Mertens, 1833
(Fig. 12A)

Gnesioceros sargassicola Mertens, 1833: 13X; (type locality: Atlantic Ocean).
Gnesioceros sargassicola - Prudhoe, 1989: 69.

Materials examined. ZRC.PLA.0295, ZRC.PLA.0312, ZRC.PLA.0321, INT-0926, INT-1303, INT-1304, INT-1306.

Localities. Pulau Berkas, Pulau Biola, Pulau Sudong and Terumbu Berkas Besar.

Remarks. Information regarding this species is extremely lacking, and histology is needed to positively identify this species. This species is commonly found on *Sargassum* seaweed, and seasonally abundant when *Sargassum* is in bloom. The flatworms were observed to lay their eggs on *Sargassum*.

FAMILY PLANOCERIDAE Lang, 1884

Planocerid 1
(Fig. 12B)

Materials examined. ZRC.PLA.0313, ZRC.PLA.0314.

Localities. St John's Island.

Planocerid 2
(Fig. 12C)

Materials examined. INT-0925.

Localities. Pulau Biola.

Planocerid 3
(Fig. 12D)

Materials examined. INT-1305.

Localities. Terumbu Berkas Besar.

Planocerid 4
(Fig. 12E)

Materials examined. ZRC.PLA.0294, ZRC.PLA.0322, ZRC.PLA.0323.

Localities. Pulau Berkas.

Planocerid 5
(Fig. 12F)

Materials examined. ZRC.PLA.0213.

Localities. Tuas.

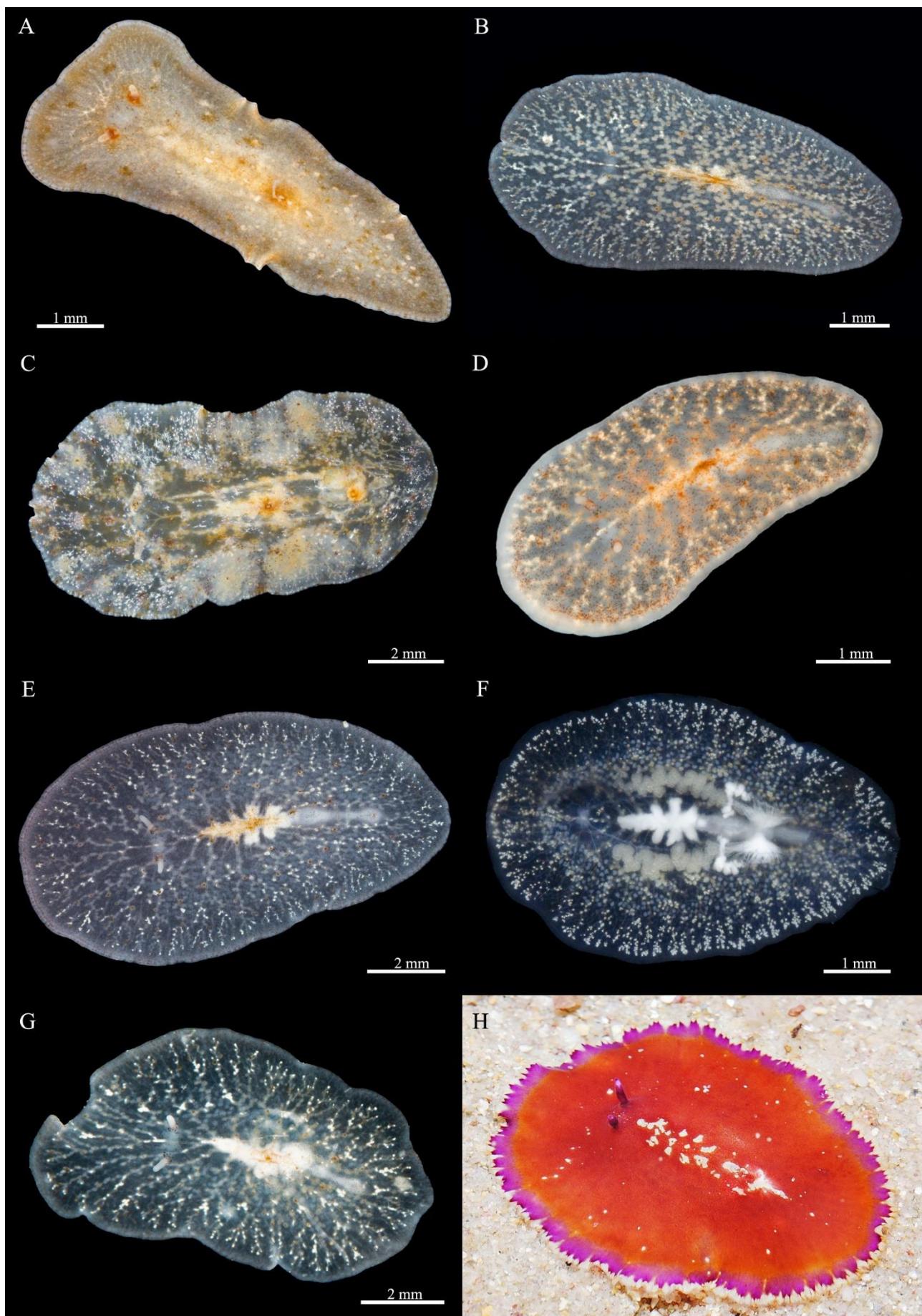


Fig. 12. Dorsal view of live flatworms. A, *Gnesioceros* cf. *sargassicola* (ZRC.PLA.0295); B, Planocerid 1 (ZRC.PLA.0313); C, Planocerid 2 (INT-0925); D, Planocerid 3 (INT-1305); E, Planocerid 4 (ZRC.PLA.0322); F, Planocerid 5 (ZRC.PLA.0213); G, Planocerid 6 (SS-1037); H, Planocerid 7. (Photograph by: Loh Kok Sheng [H]).

Planocerid 6
(Fig. 12G)

Materials examined. SS-1037.

Localities. Pulau Semakau.

Planocerid 7
(Fig. 12H)

Materials examined. None. See Fig. 12H.

Localities. Cyrene Reef.

Remarks. One example was photographed on Cyrene Reef in June 2011 by Loh Kok Sheng. Its striking colour sets it apart from the other planocerids recorded so far in Singapore.

FAMILY STYLOCHIDAE Stimpson, 1857

Stylochid 1
(Fig. 13A)

Materials examined. ZRC.PLA.0298, ZRC.PLA.0305, SA11-001.

Localities. Pulau Salu and St John's Island.

Remarks. This flatworm was found on seawall and rocky shore areas.

Stylochid 2
(Fig. 13B)

Materials examined. ZRC.PLA.0219, ZRC.PLA.0315.

Localities. Punggol Shore and Pulau Ubin.

Remarks. This species was found around intertidal mudflats, and its eggs were observed to be of direct development.

Stylochid 3
(Fig. 13C)

Materials examined. ZRC.PLA.0220, ZRC.PLA.0260.

Localities. Changi and Punggol Shore.

Remarks. One specimen was found under a rock at a rocky shore, while other specimens were associated with mussels (*Xenostrobus* sp.).

Stylochid 4
(Fig. 13D)

Materials examined. ZRC.PLA.0316, JS-0584a.

Localities. Pulau Ubin.

Remarks. This stylochid looks identical to *Pericelis cata*, which is a Cotylea.

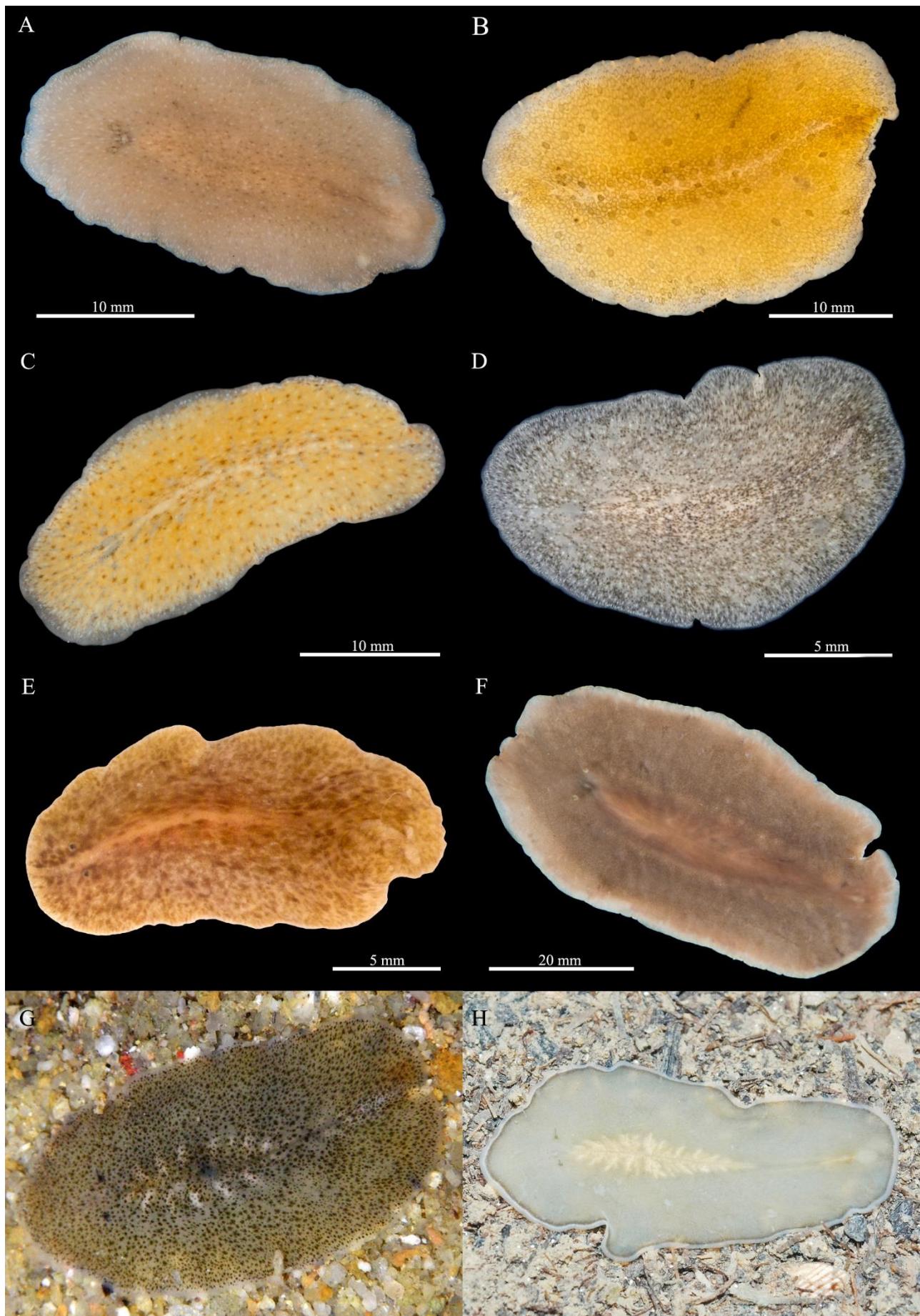


Fig. 13. Dorsal view of Stylochid flatworms. A, Stylochid 1 (SA11-001); B, Stylochid 2 (ZRC.PLA.0219); C, Stylochid 3 (ZRC.PLA.0220); D, Stylochid 4 (JS-0584a); E, Stylochid 5 (ZRC.PLA.0317); F, Stylochid 6 (ZRC.PLA.0297); G, Stylochid 7; H, Stylochid 8. (Photographs by: Loh Kok Sheng [G, H]).

Stylochid 5
(Fig. 13E)

Materials examined. ZRC.PLA.0293, ZRC.PLA.0317, ZRC.PLA.0318.

Localities. Changi beach, Pulau Tekong and Pulau Ubin.

Remarks. This species was found around intertidal mudflats.

Stylochid 6
(Fig. 13F)

Materials examined. ZRC.PLA.0296, ZRC.PLA.0297, ZRC.PLA.0299.

Localities. St John's Island.

Remarks. Examples of this flatworm were discovered under rocks.

Stylochid 7
(Fig. 13G)

Materials examined. None. See Fig. 13G.

Localities. Pasir Ris.

Remarks. This flatworm was photographed in January 2009 at Pasir Ris, by Loh Kok Sheng.

Stylochid 8
(Fig. 13H)

Materials examined. None. See Fig. 13H.

Localities. Seletar.

Remarks. This stylochid was photographed in January 2011 at Seletar, by Loh Kok Sheng.

NOT ASSIGNED TO FAMILY

Acotylea 1
(Fig. 14A, B)

Materials examined. ZRC.PLA.0224.

Localities. St John's Island.

Remarks. This flatworm has eyespots almost at mid-way of its body length, and has a tapering tail end.

Acotylea 2
(Fig. 14C, D)

Materials examined. ZRC.PLA.0225, ZRC.PLA.0226, ZRC.PLA.0227, ZRC.PLA.0228, ZRC.PLA.0229, ZRC.PLA.0230, ZRC.PLA.0231, ZRC.PLA.0232, INT-1298, JS-1457, SS-1996.

Localities. Big Sister's Island, Changi, besides Eastern Boarding Ground A, Pasir Ris River, Pulau Salu, Pulau Sekudu, Pulau Ubin and Terumbu Semakau.

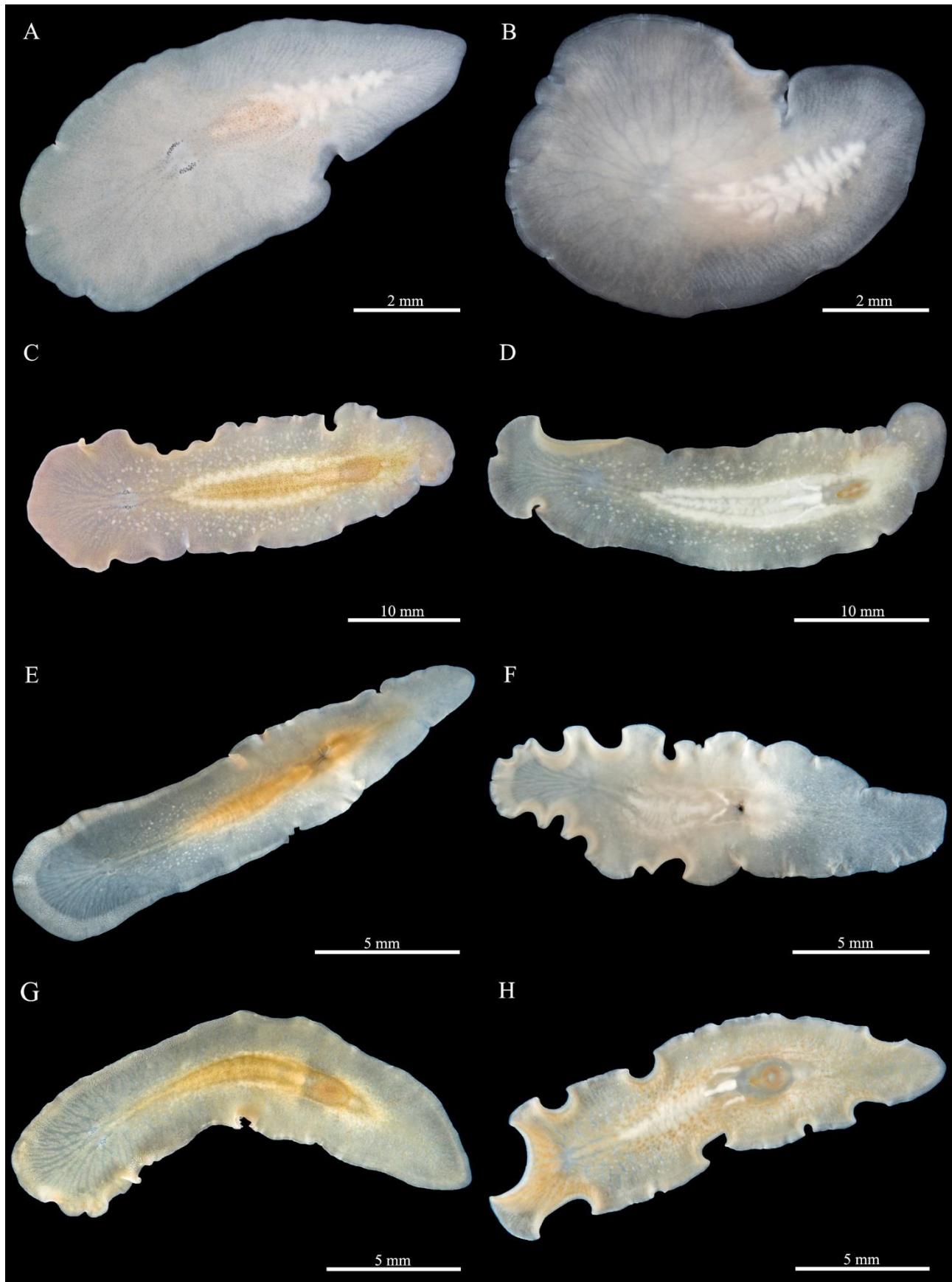


Fig 14. On left column, dorsal view of live animal and on the right column, the ventral view. A, B, Acotylea 1 (ZRC.PLA.0224); C, D, Acotylea 2 (ZRC.PLA.0231); E, F, Acotylea 3 (ZRC.PLA.0258); G, H, Acotylea 4 (ZRC.PLA.0262).

Acotylea 3
(Fig. 14E, F)

Materials examined. ZRC.PLA.0256, ZRC.PLA.0257, ZRC.PLA.0258, ZRC.PLA.0259.

Localities. Changi, Labrador Park, Lazarus Island and St John's Island.

Remarks. The eggs of this species were observed to be of direct development.

Acotylea 4
(Fig. 14G, H)

Materials examined. ZRC.PLA.0261, ZRC.PLA.0262, ZRC.PLA.0263.

Localities. Pulau Hantu, Pulau Tekukor and St John's Island.

Acotylea 5
(Fig. 15A, B)

Materials examined. ZRC.PLA.0264, ZRC.PLA.0265.

Localities. Terumbu Pempang Laut.

Acotylea 6
(Fig. 15C, D)

Materials examined. SS-1035.

Localities. Pulau Semakau.

Acotylea 7
(Fig. 15E, F)

Materials examined. SS-1947, DR2-163.

Localities. Eastern Bunkering A and off Lazarus Island.

Remarks. Specimens of this flatworm were collected from dredging surveys among rubble and sediments.

Acotylea 8
(Fig. 15G, H)

Materials examined. ZRC.PLA.0266, ZRC.PLA.0267, ZRC.PLA.0319, MF61.

Localities. Pulau Salu, Pulau Senang and Raffles Lighthouse.

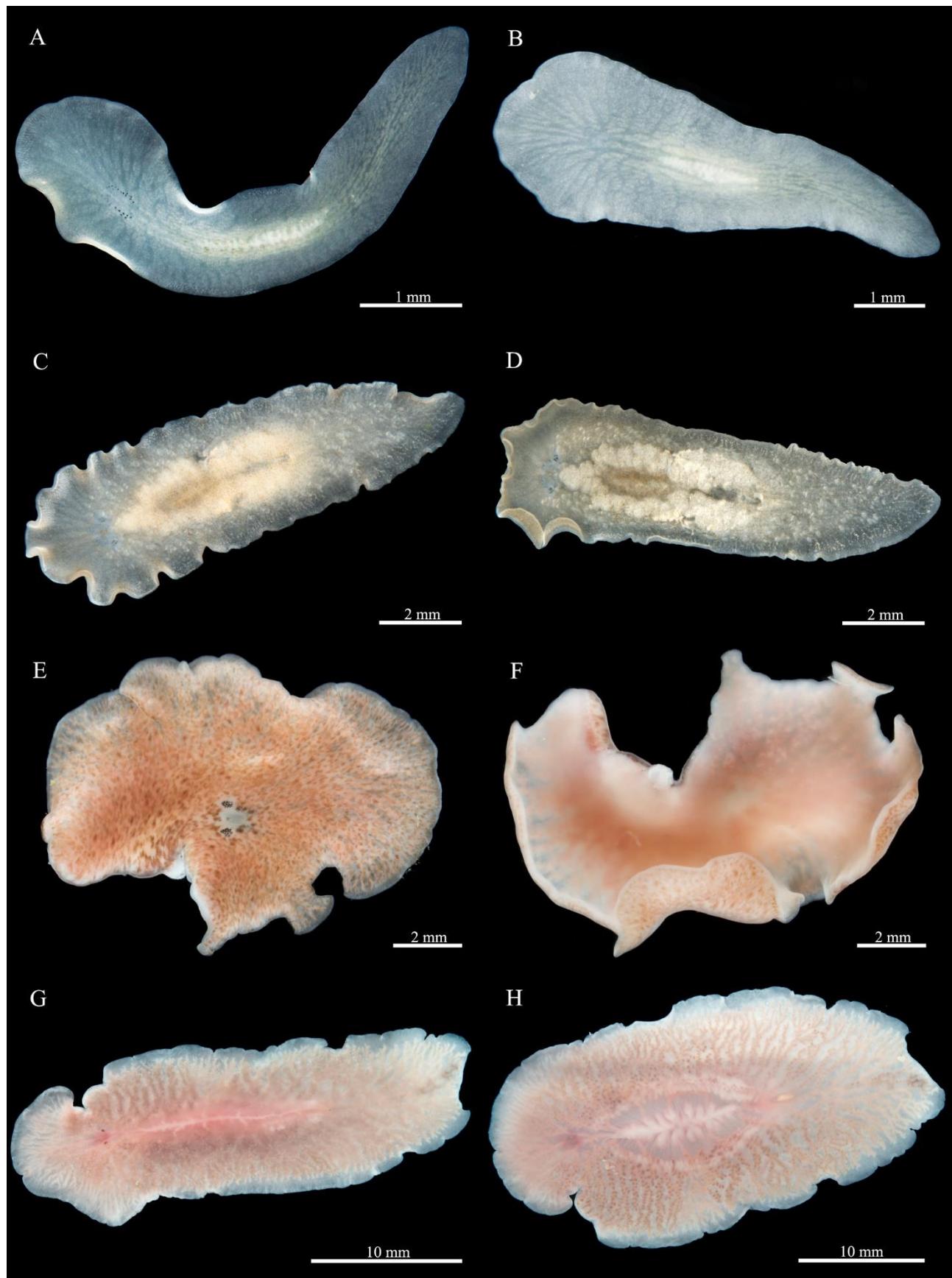


Fig 15. On left column, dorsal view of live animal and on the right column, the ventral view. A, B, Acotylea 5 (ZRC.PLA.0264); C, D, Acotylea 6 (SS-1035); E, F, Acotylea 7 (SS-1947); G, H, Acotylea 8 (ZRC.PLA.0319).

Acotylea 9
(Fig. 16A, B)

Materials examined. ZRC.PLA.0268, ZRC.PLA.0269, ZRC.PLA.0270, ZRC.PLA.0273, ZRC.PLA.0274, ZRC.PLA.0275, 63260-61, MF63034-036.

Localities. Lazarus Island, Pulau Jong, Pulau Pawai, Pulau Senang, Pulau Semakau, St John's Island and Raffles Lighthouse.

Remarks. This flatworm may be seasonal. At times it is abundant under rocks or near seawalls.

Acotylea 10
(Fig. 16C, D)

Materials examined. ZRC.PLA.0276, ZRC.PLA.0277, SS-1036.

Localities. Pulau Salu, Pulau Semakau and Raffles Lighthouse.

Acotylea 11
(Fig. 16E, F)

Materials examined. ZRC.PLA.0278, INT-1295.

Localities. Pulau Salu and Punggol shore.

Remarks. The eggs of this species were observed to be of direct development.

Acotylea 12
(Fig. 16G, H)

Materials examined. INT-0553.

Localities. Kusu Island.

Remarks. This flatworm was found at intertidal areas.

Acotylea 13
(Fig. 17A, B)

Materials examined. ZRC.PLA.0279, ZRC.PLA.0280.

Localities. Pulau Pawai and St John's Island.

Remarks. This flatworm was found at intertidal areas.

Acotylea 14
(Fig. 17C, D)

Materials examined. ZRC.PLA.0281, ZRC.PLA.0282, ZRC.PLA.0283, ZRC.PLA.0284, ZRC.PLA.0285, ZRC.PLA.0286.

Localities. Kusu Island, Lazarus Island, Pulau Bukom and St. John's Island.

Remarks. This flatworm was found at intertidal areas.

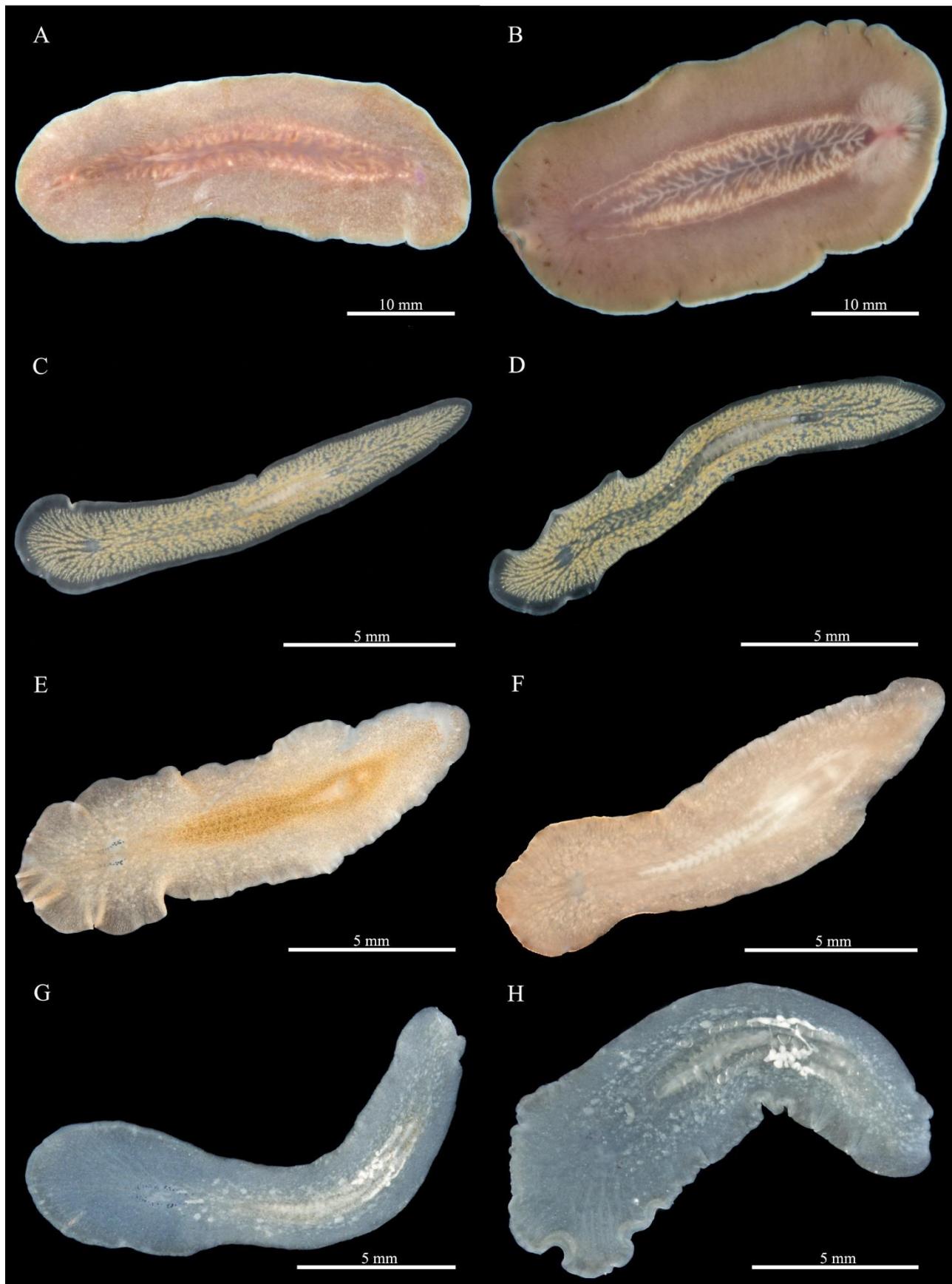


Fig 16. On left column, dorsal view of live animal and on the right column, the ventral view. A, B, *Acotylea* 9 (ZRC.PLA.0273); C, D, *Acotylea* 10 (ZRC.PLA.0277); E, F, *Acotylea* 11 (ZRC.PLA.0278); G, H, *Acotylea* 12 (INT-0553).

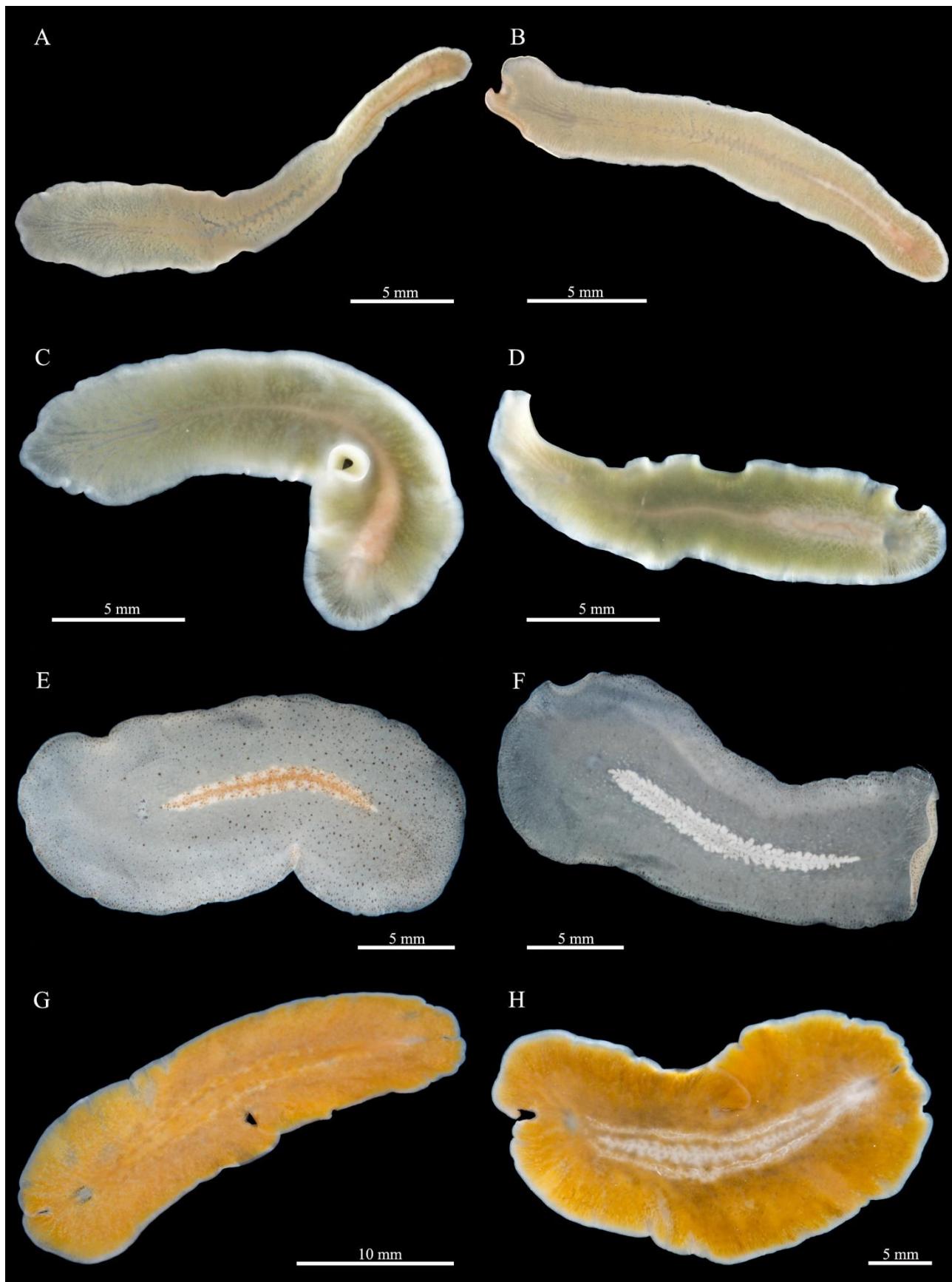


Fig 17. On left column, dorsal view of live animal and on the right column, the ventral view. A, B, Acotylea 13 (ZRC.PLA.0279); C, D, Acotylea 14 (ZRC.PLA.0282); E, F, Acotylea 15 (ZRC.PLA.0287); G, H, Acotylea 16 (ZRC.PLA.0290).

Acotylea 15
(Fig. 17E, F)

Materials examined. ZRC.PLA.0287.

Localities. Pulau Semakau.

Remarks. This species was found at intertidal areas.

Acotylea 16
(Fig. 17G, H)

Materials examined. ZRC.PLA.0288, ZRC.PLA.0289, ZRC.PLA.0290.

Localities. East Coast and Sisters' Islands.

Acotylea 17
(Fig. 18A, B)

Materials examined. ZRC.PLA.0291.

Localities. Sungei Buloh.

Acotylea 18
(Fig. 18C, D)

Materials examined. JS-2707.

Localities. Pulau Ubin.

Acotylea 19
(Fig. 18E, F)

Materials examined. BNC-089.

Localities. St. John's Island.

Remarks. An example was found among empty barnacle shells.

DISCUSSION AND CONCLUSION

Of the cotyleans recorded from Singapore, only 22 have previously been identified to species level (Bolaños et al., 2016, Ong et al., 2018). The present compilation lists 81 Cotylea species and approximately 38 Acotylea species. It is far more comprehensive and shows the great diversity of polyclads that can be found in Singapore. However, it should be noted that many species featured in this catalogue require further examination and literature reviews. Supported by current literature and latest taxonomic observations of live specimens and good photographic records, this catalogue is intended to serve as a source of information for future research and further documentation of local polyclad diversity. It is expected to facilitate any future biodiversity survey and/or impact studies, as well as enhancing the knowledge of Singapore's marine fauna. This is particularly important since Singapore shores are facing numerous challenges, from extensive coastal developments, high shipping traffic to coral bleaching (Guest et al., 2016; Tan et al., 2016).

It should be noted that apart from the 22 cotyleans that were recently described by Bolaños et al. (2016) and Ong et al. (2018), as well as the two acotylean, *Limnostylochus* sp. and *Meixneria furva* that had appeared in some publications, all other species mentioned in this checklist are new records for Singapore. The numbers consolidated in this study, however, are only a provisional representation of Singapore's polyclad diversity, particularly for the Acotylea flatworms whereby accurate identification can only be made after histological examination. The identification of the acotyleans is therefore tentative and only serves as a rough guide to the possible different species that have been found in Singapore. Although the acotylean identifications in this study may hardly be useful taxonomically speaking, it still serves as an introduction

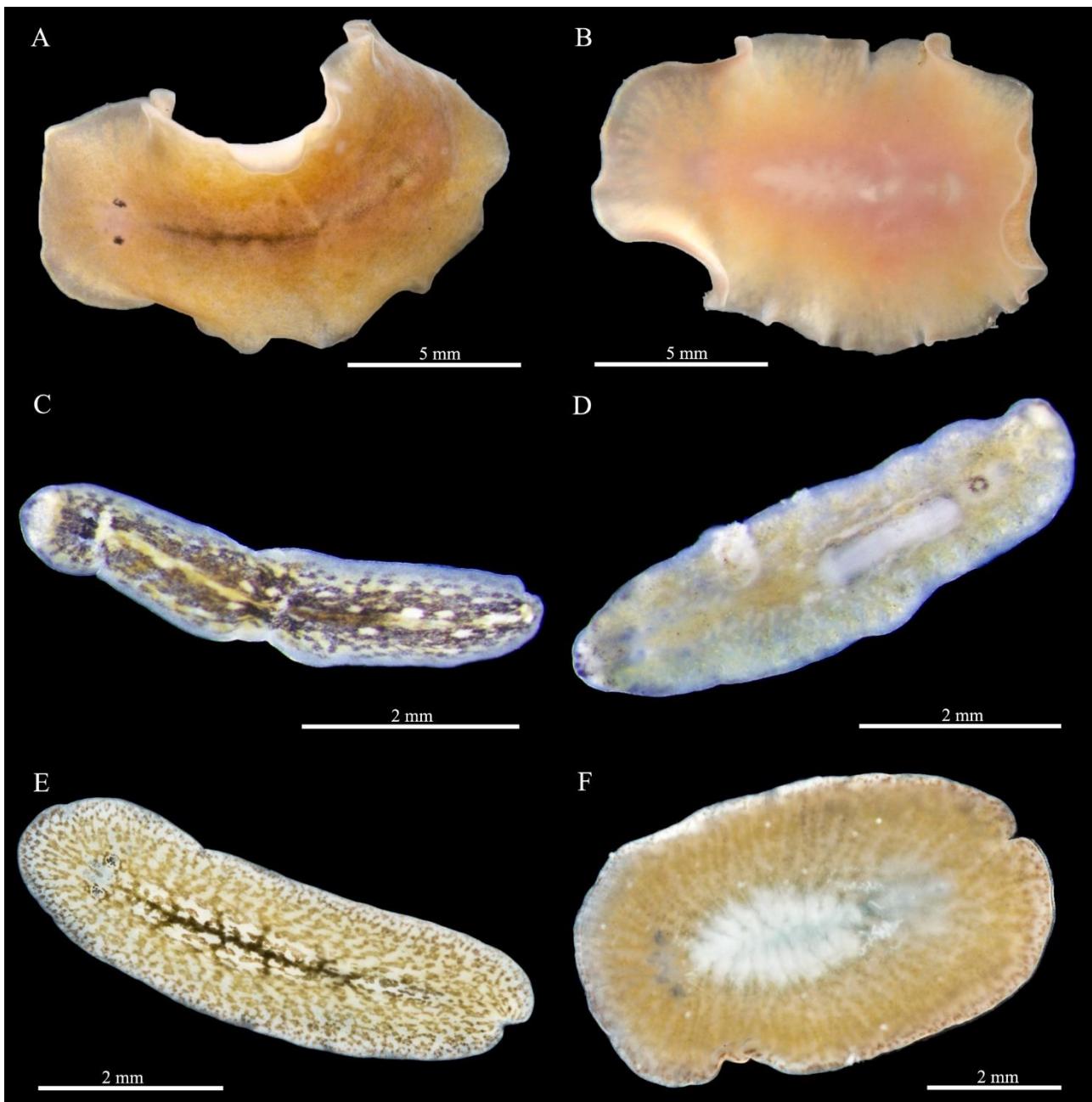


Fig 18. On left column, dorsal view of live animal and on the right column, the ventral view. A, B, *Acotylea* 17 (ZRC.PLA.0291); C, *Acotylea* 18 (JS-2707); E, F, *Acotylea* 19 (BNC-089).

to this group of flatworms. The diversity of *Acotylea* in Singapore is not restricted to the few species reported so far. Too little is known about these flatworms in Southeast Asia as compared to their colourful cotylean counterparts. We hope that with this catalogue, more awareness can be created and these polyclads will be given due attention as well.

This checklist is not expected to be exhaustive as flatworms are generally well-camouflaged and cryptic in nature, and many species are likely to have been missed. Nonetheless it is the first to consolidate all the records and sightings of Singapore's flatworms known to us for easy reference. We hope that this compilation will provide an inspiration for further studies to be conducted and published on the polyclad fauna of Singapore waters.

ACKNOWLEDGEMENTS

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for her enormous effort in making regular survey trips that have helped map the distribution of the polyclads in Singapore and Gan Bin Qi for assistance in preservation and cataloging.

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