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New records of polycladida flatworms (Platyhelminthes: Cotylea) from Gujarat coast, India

Piyush Vadher[1], Hitesh Kardani[1]*, Rajkumar Dabhi[1] and Imtiyaz Beleem[2]
[1]Fisheries Research Station, Kamdhenu University, Sikka-361 140, Gujarat, India.
[2]Estonian Marine Institute, University of Tartu, Mäealuse 14, Tallinn 12618, Estonia.

*Correspondence email: hiteshkardani@gmail.com
ORCiD: https://orcid.org/0000-0002-8112-5061

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Short Communication

Abstract

The present study reports two new records of flatworm species, *Pseudobiceros fulgor* Newman and Cannon, 1994 and *Pseudobiceros hancockanus* (Collingwood, 1876), from the Gulf of Kachchh, Gujarat. *Pseudobiceros fulgor* is recorded for the first time from the West coast of India, while *Pseudobiceros hancockanus* is a new record for Gujarat, India. This study provides detailed information on the morphology, distribution, and habitat of these species. The discovery of these species raises the number of flatworm species recorded in Gujarat from eight to ten. A comprehensive checklist of the flatworm fauna is prepared based on previous records from Gujarat waters. The study includes a comprehensive review of previously recorded flatworms from the region and presents new distribution data, particularly for Gujarat, where flatworm fauna had not been extensively explored before. The study emphasizes the importance of further exploration and documentation to understand the diversity and distribution of marine flatworms in India.

Keywords: *Flatworms, new records, distribution, checklist*

Introduction

Flatworms of the suborder Cotylea Lang, 1884, are cosmopolitan in distribution, inhabiting tropical and subtropical waters near coral reefs, deep waters, shallow reefs, and water surfaces. The most biodiverse regions for these groups are the Indo-Pacific and Caribbean regions (Khalili *et al.*, 2009; Dixit *et al.*, 2018b; Dixit *et al.*, 2021b). They feed on ascidians, sponges, and small invertebrates (Newman and Cannon, 1994; Ryanskiy, 2021). Globally, around 482 species from 57 genera within 18 families are reported in the Suborder Cotylea (WoRMS, 2024). In Indian waters, 66 species from 13 genera within four families are mostly found in the Andaman and Nicobar Islands and the Lakshadweep Islands (Dixit *et al.*, 2021b; Pitale and Apte, 2021).

Research on the flatworm fauna of Indian waters has been limited. Laidlaw (1902) was the pioneering biologist to report on marine flatworms from Indian waters, describing seven species from the Lakshadweep Islands (Laccadive group), five of which were new to science. After nearly a century, several studies have recently explored the flatworm fauna of Indian waters, including those by Apte and Pitale (2011), Sreeraj and Raghunathan (2011, 2013, 2015), Pitale *et al.* (2014), Dixit *et al.* (2015, 2017a, 2017b, 2018a, 2018b, 2019, 2021a, 2021b), Sreeraj *et al.* (2015), Dixit (2018), Shrinivaasu *et al.* (2018), Pitale and Apte (2019, 2021), and Padmanaban *et al.* (2020). The first comprehensive work on the flatworm fauna of Indian waters was conducted by Dixit *et al.* (2015, 2017a, 2017b, 2018a, 2018b, 2019, 2021a, 2021b) in the Lakshadweep Islands and Andaman and Nicobar Islands. They reported 12 species new to science, six species new to Indian waters, and three species new to the Lakshadweep Islands. Other notable contributions include studies by Pitale and Apte (2017, 2019, 2021) in Maharashtra, who identified three species new to science and six species new to Indian waters.

Studies on the flatworm fauna of the Gujarat coast are limited to a few publications by Bhadja (2010), Pitale and Apte (2017), Thakkar *et al.* (2017), Patel *et al.* (2022), and Nanda *et al.* (2024). To date, eight species belonging to five genera in two families of flatworms have been recorded from the Gujarat coast (Bhadja, 2010; Pitale and Apte, 2017; Thakkar *et al.*, 2017; Patel *et al.*, 2022; Nanda *et al.*, 2024). No previous work has focused on the flatworm fauna in the Gulf

Table 1. Distribution of flatworms along Gujarat coast, India

No.	Family	Genus	Species	Distribution	References
1	Pseudocerotidae	*Pseudobiceros*	*Pseudobiceros fulgor* Newman & Cannon, 1994	Sikka reef	Present Study
2			*Pseudobiceros hancockanus* (Collingwood, 1876)	Sikka reef	Present Study
3			*Pseudobiceros stellae* Newman & Cannon, 1994	Veraval coast, Dwarka coast	Bhadja (2010)
4		*Pseudoceros*	*Pseudoceros bolool* Newman & Cannon, 1994	Shivrajpur coast	Thakkar *et al.* (2017)
5			*Pseudoceros indicus* Newman & Schupp, 2002	Dwarka coast	Bhadja (2010)
6			*Pseudoceros susanae* Newman & Anderson, 1997	Kodinar coast, Veraval coast, Mangrol coast, Dwarka coast	Bhadja (2010)
7		*Thysanozoon*	*Thysanozoon brocchii* (Risso, 1818)	Dwarka coast	Pitale and Apte (2017)
8			*Thysanozoon nigrum* Girard, 1851	Paga reef, Okha coast	Nanda *et al.* (2024)
9		*Tytthosoceros*	*Tytthosoceros nocturnus* Newman & Cannon, 1996	Mithapur coast, Okha coast	Nanda *et al.* (2024)
10	Euryleptidae	*Maritigrella*	*Maritigrella fuscopunctata* (Prudhoe, 1978)	Shivrajpur coast	Patel *et al.* (2022)

of Kachchh. In the present study, we report the occurrence of two flatworm species from the Gujarat coast for the first time. Consequently, a total of ten species from five genera have now been recorded from Gujarat waters (Table 1).

Material and methods

The specimens were collected from the Sikka reef in the lower intertidal zone, specifically the rocky-sandy zone. Samples were collected and placed in an aquarium for observation and maintenance. Stainless steel scale was used for precise measurements, which were submerged in the aquarium to measure the body width (BW) and body length (BL) of the specimens. The specimens were identified using the keys provided by Newman and Cannon (1994), Maghsoudlou and Rahimian (2014) and Bolaños *et al.* (2016). Detailed morphological characteristics were examined under a LABOMED LX-500 LED binocular microscope. They were preserved in 10% formalin buffered with seawater and subsequently deposited in the Museum of Fisheries Research Station, Kamdhenu University, Sikka, Gujarat, India, with accession numbers (FRSPRP).

Result and discussion

Systematics

Phylum : Platyhelminthes Minot, 1876
Subphylum : Rhabditophora Ehlers, 1985
Order : Polycladida Lang, 1884
Suborder : Cotylea Lang, 1884
Family : Pseudocerotidae Lang, 1884
Genus : *Pseudobiceros* Faubel, 1984

Pseudobiceros fulgor Newman and Cannon, 1994 (Fig. 1-2)

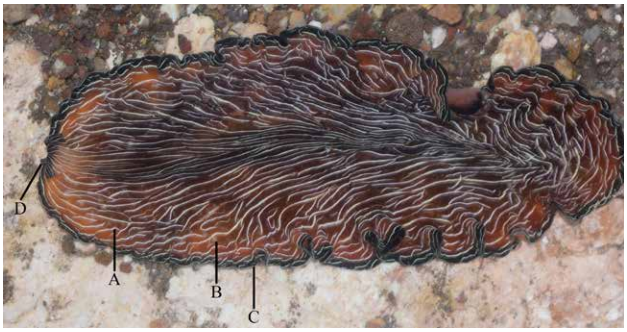

Fig. 1. Dorsal view of *Pseudobiceros fulgor* (FRSPRP-02): A) thin white broken stripes, B) yellow patches, C) thick black margin, D) Pseudotentacles

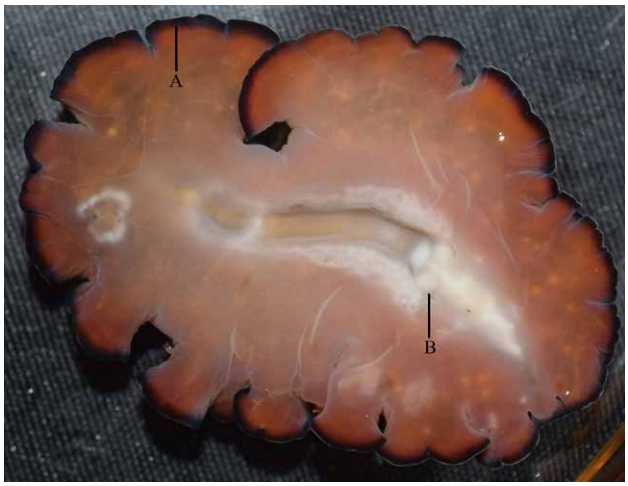

Fig. 2. Ventral view of *Pseudobiceros fulgor* (FRSPRP-02): A) wide black border, B) simple pharynx

Synonymised names

Pseudobiceros fulgor Newman and Cannon, 1994: 245, figs. 36a-d, 50e.
Pseudobiceros fulgor Newman and Cannon, 1997: 348.
Pseudobiceros fulgor Bolaños *et al.*, 2016: 144, fig. 9.

Materials examined

04 specimens, unsexed, FRSPRP-02 (i) BL 52 x BD 33.50 mm; (ii) BL 59 x BD 35 mm; (iii) BL 62.50 x BD 38 mm; (iv) BL 58 x BD 34.50 mm, (22° 26′ 46.2″ N; 69° 48′ 15.4″ E), lower intertidal zone, Sikka reef, coll. by Sidik Mepani, 10 February 2023.

Description

Dorsal surface of body ranges from light brown to dark brown, covered in stacks of thin white broken stripes (Fig. 1A). Random white or faint yellow patches near a few of these lines (Fig. 1B). Thick black edge/margin around the body, including the pseudotentacles, with white streaks running parallel to rim (Fig. 1C). Ventral surface light brown with a wide black border (Fig. 2A). Entire body delicate. Pseudotentacles look like ears, pointed, made from a simple fold at the front margin (Fig. 1D). Cerebral eyes horseshoe shaped with simple pharynx (Fig. 2B).

Habitat

Previously, this specimen was documented beneath a boulder at the reef crest in Queensland, Australia (Newman and Cannon, 1994) and in the intertidal zone of Singapore (Bolaños *et al*., 2016). In the present study, the specimens were observed attached to boulders and dead corals, occasionally appearing in tide pools within the lower intertidal zone of Sikka reef.

Distribution

The species has been recorded from various regions, including Australia (Newman and Cannon, 1994; Ryanskiy, 2021), East Africa (Ryanskiy, 2021), Indonesia (Newman and Cannon, 1997; Ryanskiy, 2021), Micronesia (Newman and Cannon, 1997; Ryanskiy, 2021), Philippines (Newman and Cannon, 1994; Ryanskiy, 2021), Red Sea (Ryanskiy, 2021), Singapore (Bolaños *et al*., 2016), and Taiwan (Jie, 2017). This species was previously recorded from the Andaman and Nicobar Islands (Sreeraj *et al*., 2015; Dixit, 2018) and is now reported from Gujarat, India.

Remarks

The external morphological characters of these specimens align closely with the earlier descriptions (Newman and Cannon, 1994 and Bolaños *et al*., 2016). The colour and stripes observed on present live specimens closely matched the distinctive features outlined for *P. fulgor* as described by Newman and Cannon (1994). All the specimens examined in this study exhibited continuous white longitudinal lines running to the posterior end, forming an acute angle as described by Bolaños *et al.* (2016). Newman and Cannon (1994) categorized *P. fulgor* in Group 6 (colour pattern group) together with *P. dendriticus* (Prudhoe, 1989) and *P. flavolineatus* (Prudhoe, 1989) based on their striped patterns. *Pseudobiceros dendriticus* differentiated from *P. fulgor* by its yellow central stripe, branching into several lines towards the edge, and the absence of white streaks on its black border. On the contrary, *P. flavolineatus* resembles *P. fulgor* with its reddish-brown surface and numerous yellow lines angled towards the back and sides, along with a dark border encircling the body (Prudhoe, 1989). Newman and Cannon (1994) noted that *P. flavolineatus* has concentric stripes instead of the broken white lines found in *P. fulgor*.

Later, Bolaños *et al.* (2016) highlighted the similarities and uncertainties between *P. fulgor* and *Pseudoceros dubius* Prudhoe, 1989. They highlight that while there are resemblances between the two, specific details regarding key characteristics such as pseudo tentacle shape, cerebral eyespot, pharynx type, and male gonopores are missing for *P. dubius*. This absence of crucial information makes it challenging to definitively assign *P. dubius* to either the *Pseudoceros* or *Pseudobiceros* genus, leading to its classification as incertae sedis. Bolaños *et al.* (2016) also discussed colour pattern variations within *P. fulgor* from the Marshall Islands, suggesting discrepancies between the colour photographed morphotypes and the holotype described by Newman and Cannon (1994). Bolaños *et al.* (2016) studied and observed six morphotypes in Singapore; They speculate that *P. fulgor*, *P. flavolineatus* and *P. dubius* might be the same species. They encouraged for further molecular analyses using additional material from different variants of *P. fulgor* and newly collected specimens of *P. flavolineatus* and *P. dubius* to confirm their relationships and explore possible intraspecific variations in *P. fulgor*.

Pseudobiceros hancockanus (Collingwood, 1876) (Fig. 3-4)

Synonymised names

Proceros hancockanus Collingwood (1876): 91, Figs. 5a-b.
Prostheceraeus hancockanus Lang (1884): 567.
Pseudoceros hancockanus Kaburaki (1923): 639, pl. 1, Fig. 3.
Pseudobiceros uniarborensis Newman and Cannon (1994): 252, Figs. 42a-d, 51f.
Pseudobiceros uniarborensis Newman and Cannon (1997): 360, Figs. 13c-d.
Pseudobiceros uniarborensis Maghsoudlou and Rahimian (2014): 332, Fig. 4.
Pseudobiceros hancockanus Marquina *et al.* (2015): 365, Figs. 8a-c.
Pseudobiceros hancockanus Bolaños *et al.* (2016): 146, Figs. 10-11.

Materials examined

03 specimens, unsexed, FRSPRP-03 (i) BL 45.50 x BD 25 mm; (ii) BL 49 x BD 26 mm; (iii) BL 52 x BD 26.50 mm, (22° 27′ 37.0″ N; 69° 48′ 21.9″ E) lower intertidal zone, Sikka reef, coll. by Sidik Mepani, 15 February 2023.

Description

Dorsal pattern dark brown or velvety background with three edge bands, inner bright orange, middle clear grey, and solid white rim (Fig. 3A). Ventral surface brown with brown marginal bands. Black, ear-shaped, sharp pseudotentacles, outlined with solid white rim and noticeable white tips (Fig. 4A). Cerebral eyespot appears in a distinct oval space with a short forward projection and a thin line at back (Fig. 4B). A white-greyish triangle amid the pseudotentacles, linking to clear area surrounding the eyespot (Fig. 3B).

Habitat

Previously, this species was reported under rocks associated with didemnid ascidians along the coast of the Gulf of Oman, Iran (Maghsoudlou and Rahimian, 2014), and in the intertidal zone of Australia (Bolaños *et al.*, 2016). In the present study, specimens were observed in tide pools of the lower intertidal zone at Sikka reef.

Fig. 3. Dorsal view of *Pseudobiceros hancockanus* (FRSPRP-03): A) three rims: inner bright orange, middle clear grey, and outer solid white rim, B) sharp pseudotentacles

Fig. 4. Ventral view of *Pseudobiceros hancockanus* (FRSPRP-03): A) two rims: inner rim light yellowish and outer rim white, B) cerebral eyespot

Distribution

This species has been previously recorded from various locations, including Australia (Newman and Cannon, 1994; Newman and Cannon, 1997; Marquina *et al.*, 2015; Ryanskiy, 2021), Borneo (Collingwood, 1876; Lang, 1884), Indonesia (Ryanskiy, 2021), Iran (Maghsoudlou and Rahimian, 2014), Mauritius (Ryanskiy, 2021), Micronesia (Newman *et al.*, 2003; Ryanskiy, 2021), Papua New Guinea (Newman and Cannon, 1997; Ryanskiy, 2021), Philippines (Kaburaki, 1923; Ryanskiy, 2021), Red Sea (Ryanskiy, 2021), and Singapore (Collingwood, 1876; Lang, 1884; Bolaños *et al.*, 2016). This species has been recorded from the Gulf of Mannar (Shrinivaasu *et al.*, 2018), Lakshadweep Islands (Apte and Pitale, 2011), and Andaman and Nicobar Islands (Dixit, 2018), with the present study reporting it from Gujarat, India.

Remarks

The external morphological characters of these specimens align closely with the earlier descriptions (Maghsoudlou and Rahimian, 2014; Bolaños *et al.*, 2016). The colour and stripes observed on the live specimens closely matched the distinctive features outlined for *P. hancockanus* as described by Bolaños *et al.* (2016). Bolaños *et al.* (2016) thoroughly examined 15 living *P. hancockanus* and proposed that *Pseudobiceros uniarborensis* Newman and Cannon, 1994 is a synonym for *P. hancockanus*. Our specimen exhibits the same characteristics as those analysed by Bolaños *et al.* (2016), which include white tips and margin, but the absence of an orange band.

Newman and Cannon (1994) categorized *P. hancockanus* in group 1 together with *Pseudobiceros gloriosus* Newman and Cannon, 1994 and *Pseudobiceros evelinae* (Marcus, 1950) based on the presence of three marginal bands. *Pseudobiceros gloriosus* and *P. evelinae* are differentiated from *P. hancockanus* by possessing a distinct black rim, whereas *P. hancockanus* comprises an opaque white rim. The dorsal colouring of *P. hancockanus* varies from opaque black to semi-transparent brown, with or without white spots while other species, translucent specimens might display empty intestinal branches and consequently appear lighter in colour. Variations in background colour are not uncommon in polyclads, as noted in previous reports for other species (Newman and Cannon, 1994; Bahia *et al.*, 2012, 2014; Bolaños *et al.*, 2016).

Conclusion

The present work, which reports on two species of flatworm fauna collected from the Gulf of Kachchh, provides the first documentation of these species on the Gujarat coast. In Indian waters, *Pseudobiceros fulgor* has previously been recorded from the Andaman and Nicobar Islands, while *Pseudobiceros hancockanus* has been documented from the Gulf of Mannar, the Lakshadweep Islands, and the Andaman and Nicobar Islands. The records of these species in the Gulf of Kachchh extend their known distribution range within the northern Indian Ocean. This finding highlights the importance of further biodiversity assessments in the region, as it suggests that the marine ecosystems of Gujarat may harbour a more diverse and previously undocumented flatworm fauna.

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Author contributions

Conceptualisation: PV, HK, IB; Methodology: PV, HK, IB; Data Collection: PV, HK; Data Analysis: PV, HK, RD, IB; Writing Original Draft: PV, HK, RD; Writing Review and Editing: HK, IB; Supervision: HK

Data availability

The data are available and can be requested from the corresponding author.

Conflict of interests

The authors declare that they have no conflict of financial or non-financial interests that could have influenced the outcome or interpretation of the results.

Ethical Statement

No ethical approval is required as the study does not include activities that require ethical approval or involve protected organisms/ human subjects/ collection of samples/ protected environments.

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