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On the Polyclads from the Gulf of Mannar Biosphere Reserve with new records

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Abstract

The present paper deals with the study of 10 species of polyclad flatworms found in the coral reef and inter-tidal areas of Gulf of Mannar Biosphere Reserve based on collections from Thalayari Island made during February 2017 to April 2019. This study reports five species, viz. *Phirkocerous katoi, Pseudobiceros hymanae, Pseudoceros bicolor, Pseudoceros galatheensis* and *Thysanozoon brocchii,* as new distributional records from Gulf of Mannar Biosphere Reserve.

Keywords: First Report, Flatworms, Polycladida, Range Extension, Thalayari Island

Introduction

The order Polycladida represents a highly diverse clade of free living, almost exclusively marine, turbellarian flatworms. The order is divided into two suborders Cotylea and Acotylea based on the character of presence or absence of sucker. Polyclads are prominent among the fauna of coral reefs from tropical and sub-tropical waters (Bolaños *et al*., 2007). Other than coral reefs, polyclads often inhabit rocky intertidal crevices, in association with other invertebrates (Quiroga *et al*., 2004). Polyclads are found from the littoral to the sublittoral zone and are common on coral reefs where they may act as indicator for the health of these ecosystems. They are major predators of sessile, marine invertebrates, including ascidians and commercial bivalves. Furthermore, they reveal fascinating new insights into the reproductive behavior of hermaphrodites, and are important in studies of regeneration.

Polyclad flatworms have been recorded from tropical, temperate and even arctic waters (Prudhoe, 1989). A few species also occurs in mangroves and deep-sea environments (Quiroga *et al*., 2006). Though several taxonomic studies on polyclads have been published elsewhere, in Indian waters their study remains meager. Little is known about their diversity on the east and west coasts of India. Laidlaw (1902) pioneered the study of polyclads in India with the description of 7 species from Minicoy Is. (Lakshadweep). Shrinivaasu *et al.* (2018) collected four species from reef areas of Gulf of Mannar Islands and provided a checklist of polyclads known from India comprising 55 species in 7 families. However, four species included in that list, viz. *Pseudobiceros gardinieri* (Laidlaw 1902), *Planocera armata* Laidlaw, 1902, *Prosthiostomum cooperi* Laidlaw, 1902 and *Prosthiostomum elegans* Laidlaw, 1902, were not collected by Laidlaw (1902) from Indian (Minocoy Is.) waters, but only from Maldives, and those are also never recorded from India in later years. Further, two new species were described from Andaman & Nicobar Islands (Dixit *et al*. 2018) and two more new species and one new record from Lakshadweep (Dixit *et al*. 2019). Pitale and Apte (2019) contributed to study of intertidal polyclads from Maharashtra coast reporting 4 new records to India and one new species. Therefore, a total of 62 species of polyclads currently known from India (Shrinivaasu e*t al*., 2018; Dixit e*t al*., 2018, 2019; Pitale & Apte, 2017, 2019), out of which only 25 species are known from Lakshadweep Islands (Dixit *et al*., 2019) and 40 species from Andaman & Nicobar Islands (Dixit *et al*., 2018). The present paper reports 10 species belonging to two family and six genera, in which three species are new record to Gulf of Mannar Biosphere Reserve and two species identified up to genus level (Table 1).

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Table 1. List species from the Gulf of Mannar Biosphere Reserve

Sl. No.	Species	Reference (locality)
1.	*Phirkocerous katoi* Newman & Cannon, 1996	Present study (Keelakarai)
2.	*Pseudobiceros hymanae* Newman & Cannon, 1997	Present study (Thalayari Is.)
3.	*Pseudobiceros uniarborensis* Newman & Cannon, 1994	Shrinivaasu *et al.,* 2018 (Valimunai Is.) Present study (Thalayari Is.)
4.	*Pseudoceros bicolor* Verrill, 1901	Present study (Keelakarai)
5.	*Pseudoceros galatheensis* Dixit, Raghunathan & Chandra, 2017	Present study (Thalayari Is.)
6.	*Pseudoceros indicus* Newman & Schupp, 2002	Shrinivaasu *et al.,* 2018 (Shingle Is.) Present study (Thalayari Is.)
7.	*Pseudoceros prudhoei* Newman & Cannon, 1994	Shrinivaasu *et al.,* 2018 (Manouliputti Is.) Present study (Thalayari Is.)
8.	*Thysanozoon brocchii* (Risso, 1818)	Present study (Thalayari Is.)
9.	*Tytthosoceros lizardensis* Newman & Cannon, 1996	Shrinivaasu *et al.,* 2018 (Vaan Is.)
10.	*Notoplana* sp.	Present study (Shingle Is.)
11.	*Prosthiostomum* sp.	Present study (Mullai Is.)

Material and Methods

The surveys were made during December 2017 to March 2019, on the reefs surrounding the Shingle, Krusadai, Pullivasal, Poomarichan, Manoli and Hare Island of Mandapam group; Mulli, Valai, Thalayari, Appa, Valimunai and Anaipar Islands of Keelakarai group; Vaan, Kasuwar and Karaichalli of Tuticorin group and Nallathanni, Upputhanni and Vilanguchalli of Vembar group in Gulf of Mannar Marine Biosphere Reserve (GoMBR) (Figure 1). The present work is restricted to the collections from Thalayari Island in Kilakarai group. All Polyclads encountered were collected during low tides in the intertidal region by overturning rocks, coral skeletal rubbles, sea grasses and coral reef with soft brushes and transferred into sample containers. Specimens were photographed live with digital underwater camera and *in situ* to record for true colour identification. As they usually secrete mucus, they were isolated from other samples to avoid stress. The separated polyclads were then preserved in 10% formaldehyde buffered with seawater after relaxing them using 5% ethanol for morphological studies. Preserved specimens were identified following Newman & Cannon (1996, 1997, 1998, 2003, 2005), Newman & Schupp (2002), Dixit *et al.* (2017, 2019) and Pilate & Apte (2017). The identification was based on morphological characteristics and coloration pattern. All data so gathered were compared with original description and previous literature. Identified specimens were deposited and registered in National Zoological Collections (NZC) at Zoological Survey of India (ZSI), Marine Biology Regional Centre (MBRC), Chennai. Abbreviations used: GoM – Gulf of Mannar; GBR – Great Barrier Reef; Is. – Islands.

Results

Systematic Account

Phylum PLATYHELMINTHES Minot, 1876

Sub Phylum RHABDITOPHORA Ehlers, 1985

Order POLYCLADIDA Lang, 1884

Family PSEUDOCEROTIDAE Lang, 1884

1. *Phirkocerous katoi* Newman & Cannon, 1996 (Figure 2)

Material examined: ZSI/MBRC/PL-346, 1 ex, Keelakarai (9°20–59.79”N78°74’28.38”E), 25.xii.2018, at 2 m depth among dead coral rubble.

Diagnosis: Body bright orange colour, two clusters of white microdots behind cerebral eyespot and posteriorly, white raised microdots covering the entire dorsal surface in irregular clusters, also concentrated medially in two distinct clusters behind the cerebral eyespot and posteriorly. Ventral surface orange, darker at the margin, Size: 30 mm (mature).

Distribution: India: Keelakarai, GoM; Andaman & Nicobar Islands. *Elsewhere*: Heron Is., southern GBR, Australia.

Remarks: This species is recorded for the first time from the Gulf of Mannar and forms second locality in India after it was reported from Andaman and Nicobar Islands (Sreeraj *et al.,* 2015).

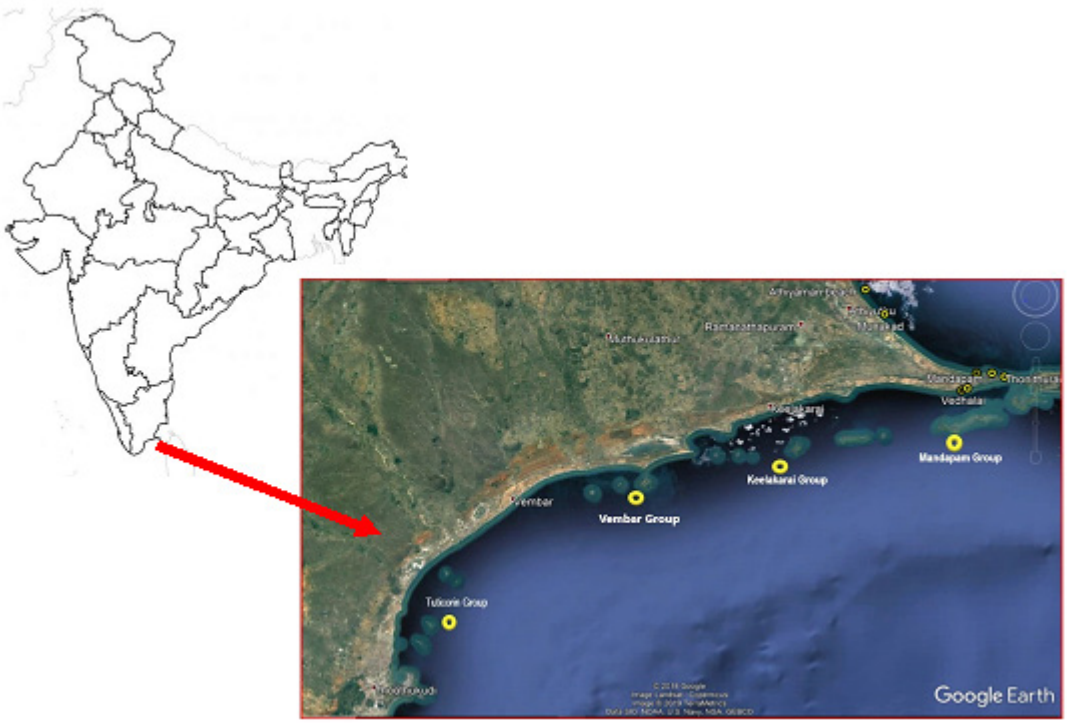


Figure 1. Map showing Gulf of Mannar Island groups studied.

Figure 2. *Phirkocerous katoi* Newman & Cannon, 1966.

2. *Pseudobiceros uniarborensis* Newman & Cannon, 1994 (Figure 3)

Material examined: ZSI/MBRC/PL-347, 2 ex, Thalayari Is., Keelakarai (9°17'93.29"N 78°89'89.41"E), 25.xii.2018; ZSI/MBRC/PL-352, 1 ex, Devipattinam (9°29'85.10"N 78°56'56.41"E), 17.ii.2019, from dead coral patches in the intertidal zone.

Diagnosis: Body is delicate and elongated. Pseudotentacles are black with pointed white tips and have grey-white triangle between them. Dorsal surface is dark brown with margins having three distinct bands; inner bright orange band, middle wide grey band and outer by a white rim.

Distribution: India: Thalayari Island, GoM; Vallimunai Island, Andaman & Nicobar Islands; Gujarat; Lakshadweep. *Elsewhere*: Indian Ocean, from South Africa, Maldives to Indonesia and Australia.

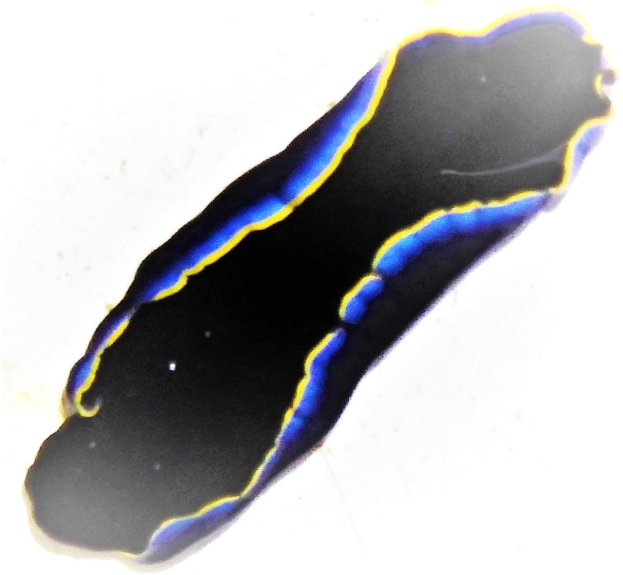


Figure 3. *Pseudobiceros uniarborensis* Newman & Cannon, 1994.

3. *Pseudobiceros hymanae* Newman & Cannon, 1997 (Figure 4&5)

Material examined: ZSI/MBRC/PL-355, 2 ex, Thalayari Is., Keelakarai, (9°17–93.29"N 78°89'89.41"E), 25.xii.2018, from branching colonies of dead corals.

Diagnosis: Background velvety black, opaque; margin with two distinct bands, rusty orange with narrow black rim. Pseudotentacles black with the same marginal bands laterally only. Combination of smooth dorsal surface, tentacles as upfolds of the anterior margin, ruffled pharynx present, Size 65 mm.

Distribution: India: Thalayari Is., GoM; Lakshadweep Islands; Andaman & Nicobar Islands. *Elsewhere*: Australia; Indonesia; Maldives; Papua New Guinea; Solomon Islands and South Africa.

Remarks: This forms its first report from the Gulf of Mannar.

Figures 4&5. *Pseudobiceros hymanae* Newman & Cannon, 1997.

4. *Pseudoceros indicus* Newman & Schupp, 2002 (Figure 6&7)

Material examined: ZSI/MBRC/PL-340, 1 ex, 16.xii.2017; MBRC/ZSI/PL-348, 2 ex, 25.xii.2018, Thalayari Is., Keelarakai, (9°17'93.29"N 78°89' 89.41"E), from coral rubble.

Diagnosis: Body soft, elongate oval and leaf-like with few marginal ruffles. Pseudotentacles well developed, simple

and erected. Dorsal surface opaque, mottled cream with well-defined irregular purple spots found along the margin and also extending over the pseudotentacles. The species shows a wide range of colour variation.

Distribution: India: Thalayari Is., GoM; Andaman & Nicobar; Gujarat; Lakshadweep Islands. *Elsewhere*: Indian Ocean, from South Africa, Maldives to Indonesia and Australia.

Figure 6&7. *Pseudoceros indicus* Newman & Schupp, 2002.

5. *Pseudoceros prudhoei* Newman & Cannon, 1994 (Figure 8)

Materials examined: ZSI,/MBRC/PL-341, 1 ex, 17.xii.2017; ZSI/MBRC/PL-349, 2 ex, Thalayari Is., Keelakarai, (9°17'93.29"N 78°89'89.41"E), 25.xii.2018; from dead coral patches from intertidal zone.

Diagnosis: Body is elongated with shallow marginal ruffling and simple pseudotentacles. Dorsal surface is deep brown to black with two marginal bands; the inner band is blue and outer yellow. Size: 30 mm.

Distribution: India: Thalayari Is., Manoliputtii Is., GoM; Andaman & Nicobar Islands; Lakshadweep. *Elsewhere:* Indo-west Pacific region from Australia, Papua New Guinea, Micronesia and Kenya.

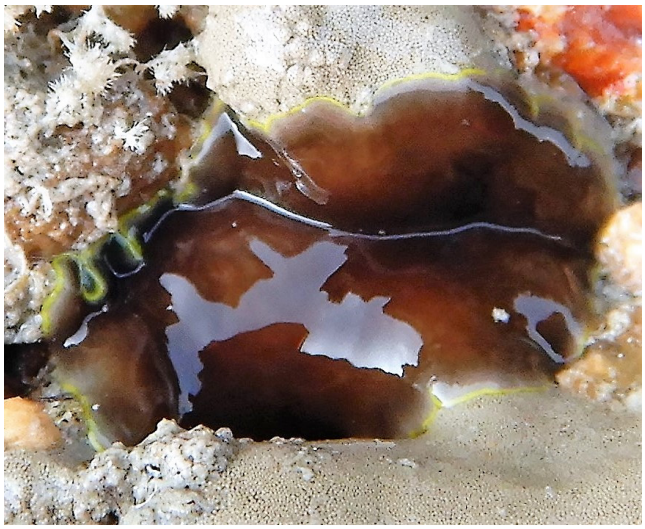


Figure 8. *Pseudoceros prudhoei* Newman & Cannon, 1994.

6. *Pseudoceros bicolor* Verrill,1901 (Figure 9)

Material examined: ZSI/MBRC/PL-354, 1ex, Keelakarai, (9°20'59.79"N78°74' 28.38"E), 17.xii.2019, at 2 m depth sandy bottom coral reef habitat.

Diagnosis: Body with broad dorsal surface yellow to orange in colour, white spots present throughout the body, white margin bands with greenish black transverse strips present pseudodetacles well marked.

Distribution: India: Keelakarai (new record to GoM). *Elsewhere*: Described from Birds Island Bermuda, reported from Curacao Caribbean coast of Colombia Florida Virgin Islands, Jamica, Belize Honduras and Caribbean coast of Panama Brazil Cabo Frio, South eastern Brazil.

Remarks: Although this species was known to have a distribution in western Atlantic, this is recently recorded

from Agatii Is., Lakshadweep (Dixit *et al*., 2019) and the present report forms its second report from India and first record from the Gulf of Mannar.

Figure 9. *Pseudoceros bicolor* Verrill, 1901.

7. *Pseudoceros galatheensis* Dixit, Raghunathan & Chandra, 2017 (Figure 10&11)

Material examined: ZSI/MBRC/PL-353, 1 ex, Thalayari Is., Keelakarai (9°17'93.29"N 78°89'89.41"E), 25.xii.2018, from the dead coral patches in the intertidal zone.

Diagnosis: Body colour light blue, darker at rim. One thin bright yellowish-orange median stripe with darker outline ends without touching posterior margin, Pseudotentacles small and dark blue in colour, in continuation with margins.

Distribution: India: Thalayari Is., GoM; Great Nicobar Island (type locality). *Elsewhere*: Additional photographic record from Micronesia and Indonesia.

Remarks: The present report of this species from the Gulf of Mannar extends its distributional range far westward from its type locality.

8. *Thysanozoon brocchii* (Risso, 1818) (Figure 12&13)

Material examined: ZSI/MBRC/PL-351, 1 ex, Thalayari Is., Keelarakai, (9°17'93.29"N 78°89'89.41"E), 25.xii.2018, from branching colonies of dead corals.

Diagnosis: Body brown to cream in colour, dorsal surface covered with yellowish brown to dark brown colored papillae, papillae are cylindrical, black median

Figure 10&11. *Pseudoceros galatheensis* Dixit, Raghunathan & Chandra, 2017.

longitudinal stripe mostly distinct. Pseudotentacles are erect, ear like, cream–brown with white tip.

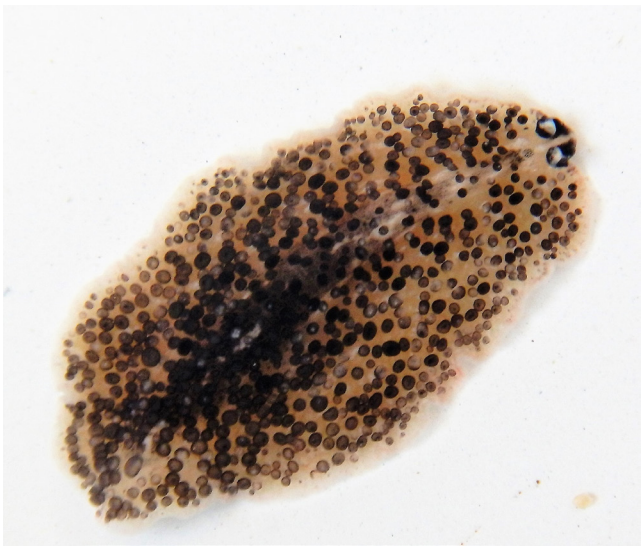
Distribution: Thalayari Is., GoM, Ratnagiri, Maharashtra; Dwarka, Gujarat. *Elsewhere*: Brazil, Japan and New Zealand. It was also reported from Canary Islands Argentina from northeastern and south-eastern Brazil.

Remarks: This species was recently reported from Ratnagiri and Dwarka, west coast of India (Pilate & Apte, 2017). The present report forms its second report from India and first record from the Gulf of Mannar.

9. *Notoplana* sp. (Figure 14)

Materialexamined: ZSI/MBRC/PL-344, 1 ex, Shingle Is., Mandapam (9°14'29.85"N79°13'59.87"E), 17.ii.2017, from dead coral patches in the intertidal zone.

Diagnosis: Body oval anteriorly slightly tapering posteriorly, transparent, brown in colour another specimen greyish-white, Tentacles absent, Eyes well distinct.



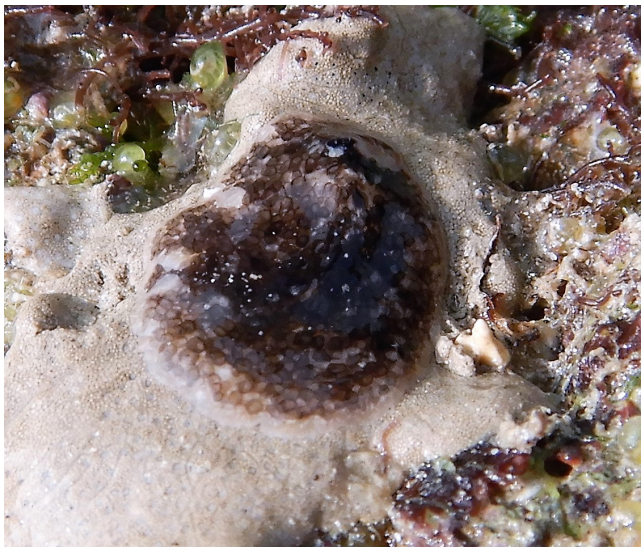


Figure 12&13. *Thysanozoon brocchii* (Risso, 1818).

Remarks: Efforts are being given for further collection and species level identification. The same species has been reported from Andaman and Nicobar Islands (Sreeraj *et al.,* 2015).

Family: PROSTHIOSTOMIDAE Lang, 1884.

10. *Prosthiostomum* sp. (Figure 15)

Material examined: ZSI/MBRC/PL-350, 1 ex, Mullai Is., (9°17'93.29"N78°89'E), Keelakarai, from branching colonies of dead coral.

Diagnosis: Body elongated, rounded anteriorly and tapering posteriorly, transparent smooth dorsal surface.

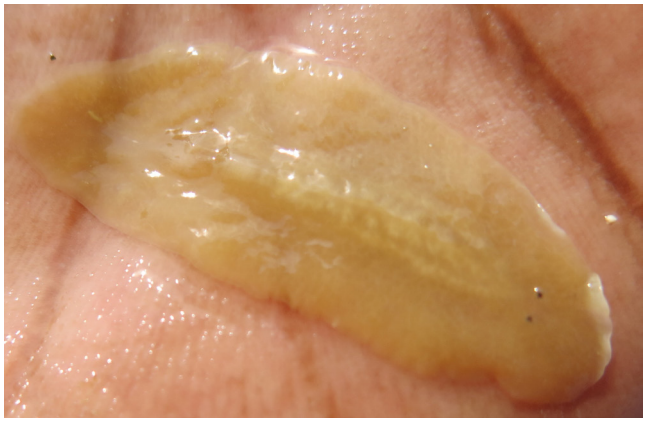


Figure 14. *Notoplana* sp.

Remarks: This is also another species reported from Andaman and Nicobar Islands (Sreeraj *et al.,* 2015). However, attempts are being made for species level identification.

Figure 15. *Prosthiostomum* sp.

Discussion

Among the ten species of polyclads recorded in Gulf of Mannar Biosphere Reserve reported in this work *Pseudoceros indicus*, *P. prudhoei* and *Pseudobiceros uniarborensis* were common in occurrence. The species *P.bicolor* has recently been recorded from Lakshadweep islands (Dixit *et al*., 2019), but not known from other parts of India including Andaman & Nicobar Islands.

The present report of this species from the Gulf of Mannar forms its second record from India. Similarly, in Indian waters *Phirkocerous katoi* was only known from Andaman Islands (Sreeraj *et al*., 2015) in India and the present report from Gulf of Mannar forms its second record from India. *Pseudobiceros hymanae,* earlier known from Andamans and Lakshadweep, is now recorded first time from the Gulf of Mannar. *Thysanozoon brocchii* was recently recorded from Ratnagiri (Maharashtra) and Dwarka (Gujarat) (Pitale & Apte, 2017) and its present report from Gulf of Mannar is new record to this region and second report from India as well. *Pseudoceros galatheensis* has been described from Great Nicobar Island recently (Dixit *et al*., 2017) and the present report forms its west ward distributional range extension to the Gulf of Mannar. However, the authors could not collect *Tytthosoceros lizardensis* specimens during the present period of survey though that was reported by Shrinivaasu *et al*. (2018) earlier collected from Vaan Island, situated in Tuticorin group of Islands of the Gulf of Mannar.

The Development of taxonomic expertise for this less studied group may facilitate group-specific faunal explorations leading to the better understanding of their diversity. There are 21 islands present in Gulf of Mannar Biosphere Reserve, while most of the specimens were collected only from Thalayari Island in Keelakarai group only during the present study. Intensive studies required in order to evaluate reef biodiversity and to assess status of polyclad fauna, their seasonal presence, and habitat and food preference.

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