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First report of *Phyllodesmium acanthorhinum* Moore & Gosliner, 2014 from the west coast of India

(Heterobranchia, Nudibranchia)

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The present communication records the occurrence of *Phyllodesmium acanthorhinum* Moore & Gosliner, 2014, belonging to the nudibranch gastropod family Myrrhinidae from the West coast of India. A literature review on distribution of the family Myrrhinidae revealed that only four species of this family – *Phyllodesmium poindimiei*, *P. serratum*, *P. briareum* and *P. macphersonai* were so far reported from India. Therefore, this is the first record of *P. acanthorhinum* from the Indian marine waters. A note on morphological features and about the biology such as natural history, egg mass, defensive strategy of *P. acanthorhinum* is explained in detail.

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Introduction

Heterobranchia are a shelled as well as non-shelled colourful marine group belonging to Mollusca, Gastropoda. The Heterobranchia include diverse groups of exclusively marine sea slugs among the group Tectipleura which includes the major subgroups Nudipleura, Cephalaspidea, Anaspidea, Sacoglossa etc. (Wägele et al. 2014). The Nudibranchia, an order of the subclass Heterobranchia, have an evolutionary adaptation towards the loss of shell in the adult state (Anderson 1995). Approximately 6000 species of Nudibranchia were reported worldwide (Gosliner et al. 2015). The Myrrhinid genus *Phyllodesmium*, previously classified under family Facelinidae, includes 30 species (WoRMS, 2022) among which only four species, *Phyllodesmium poindimiei* (Risbec, 1928) from the Ratnagiri, Maharashtra (Bhave 2009), *P. briareum* (Bergh, 1896), *P. macphersonae* (Burn, 1962) from Andaman and Nicobar Islands (Apte et al. 2015) and *P. serratum* (Baba, 1949) from the Gulf of Kuchchh, Gujarat (Apte & Desai 2017) were reported from the Indian coastline (https://www.medslugs.de). Nudibranchs are carnivorous and feed on sponges, tunicates, soft corals, sea anemones, zoanthids or other molluscs and may derive toxic compounds from the diet for their defense (Fontana et al. 2001, Ramakrishna et al. 2010, Poriya et al. 2015). The species of this genus predominantly feed on octocorals through particular shaped radular teeth (Rudman 1981, 1991, Wägele 2004). The first evolutionary scenario for the aeolid nudibranchs in the genus *Phyllodesmium* came from the work of Rudman (1991), based on their adaptation of cerata to form a symbiosis with zooxanthellae. The present study adds a new distribution record of *Phyllodesmium acanthorhinum* to the Indian peninsula along with information on systematics and biology of this species.

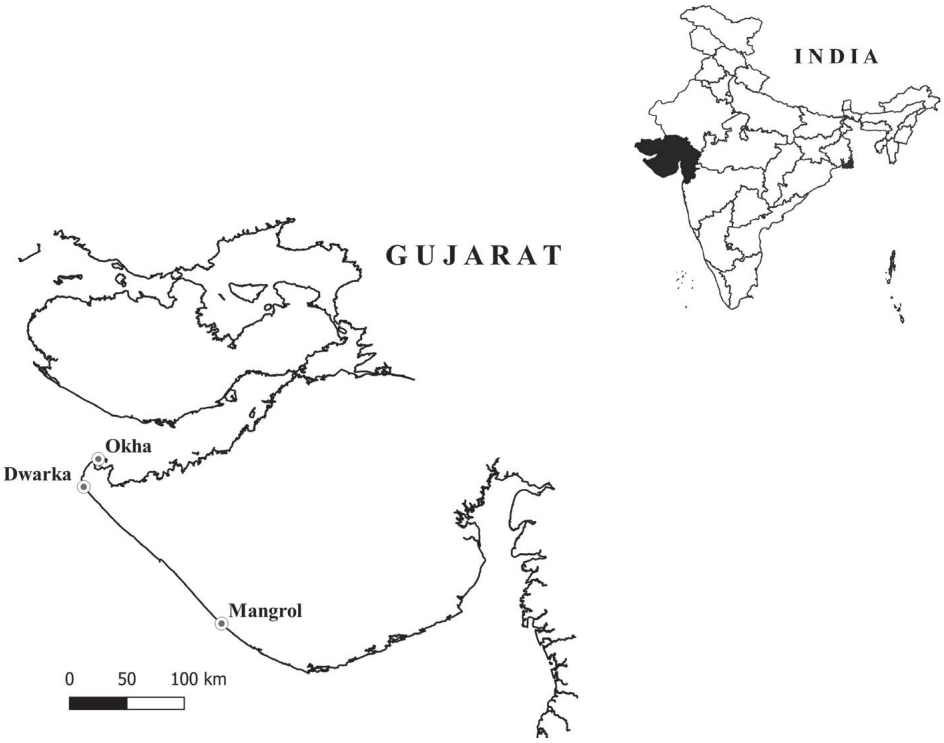

Fig. 1. Map of the study sites where *Phyllodesmium acanthorhinum* were recorded.

Materials and methods

The specimens were collected from the intertidal area of three different locations: Okha (22.28° N 69·40° E), Dwarka (22.24° N 68.95° E) and Mangrol (21.12° N 70.12° E) of Saurashtra Peninsula of Gujarat, western India (Table 1). Photographs of live specimens as well as egg masses were captured. Live specimens were observed under a ZEISS stereo microscope at the laboratory to examine the external morphological features and then the specimens were narcotized with 7 % $MgCl_2$ followed by preservation in 4 % Formalin. The voucher specimen was submitted to Museum of Department of Biosciences, Saurashtra University. The buccal mass was extracted for the radular preparation. It was soaked in 10 % NaOCl to dissolve connective and muscle tissue, afterwards the radula was rinsed with the distilled water and transferred to 70 % alcohol for the dehydration. Dehydrated radula was prepared with a sputter coater machine prior to final microscopic observation. Photographs of the radula were taken by using a Zeiss EVO 18 scanning electron microscope. Identification of the *Phyllodesmium* was done on the bases of comparing morphological features provided in previous descriptions (Moore & Gosliner 2014). For the current taxonomic status of this species, we followed WoRMS database (2022).

Table 1. Observational data of *P. acanthorhinum* along the survey sites during Jan-2020 to Jan-2022.

No.	Date of field survey	Survey site	No. of individuals	No. of egg masses
1.	16/02/2020	Mangrol	1	–
2.	22/12/2020	Okha	7	10
3.	19/03/2021	Mangrol	1	1
4.	04/11/2021	Okha	6	3
5.	18/12/2021	Okha	1	1
6.	19/12/2021	Dwarka	5	8
7.	01/01/2022	Okha	3	4
8.	02/01/2022	Dwarka	2	–

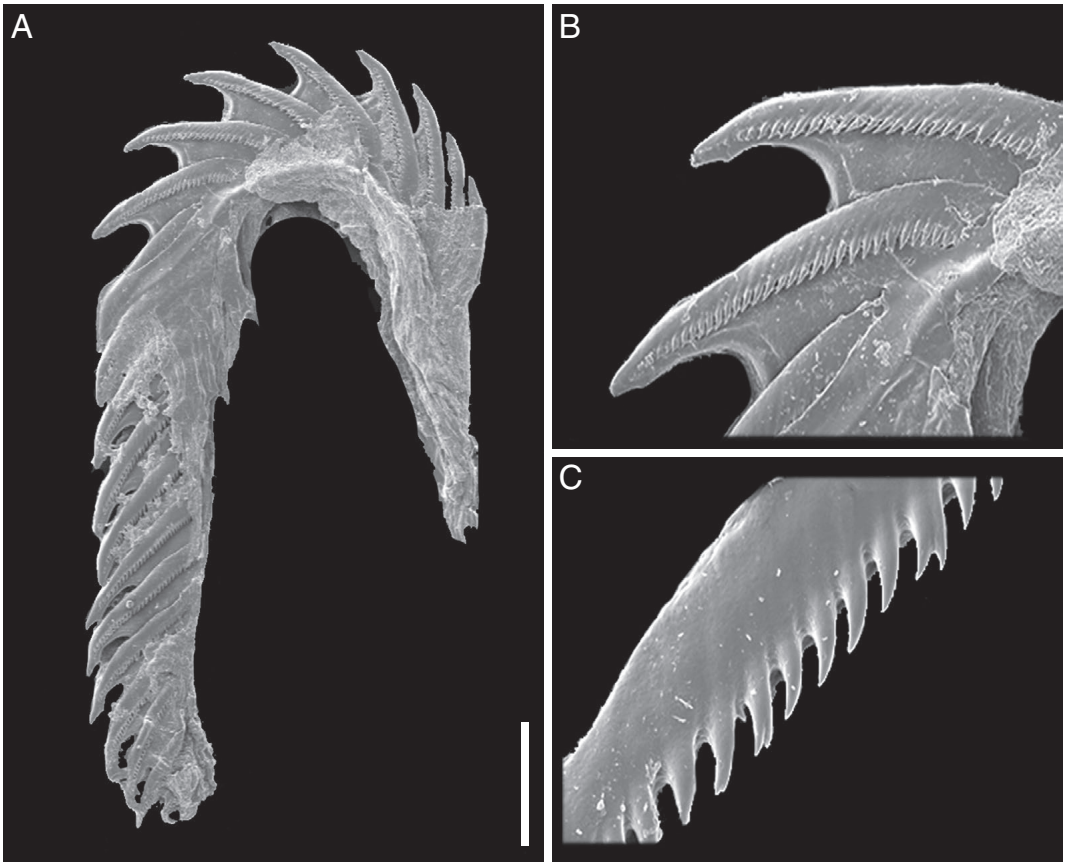

Fig. 2. A. Radular ribbon of *Phyllodesmium acanthorhinum* (scale bar 100 µm); **B.–C.** central rachidial teeth and denticles of rachidial teeth respectively, note few bifurcated denticles.

Results

Aeolidioidea Gray, 1827
Myrrhinidae Bergh, 1905
Phyllodesmium Ehrenberg, 1831

Phyllodesmium acanthorhinum Moore & Gosliner, 2014

Material examined. 1 specimen (ZM201312D1) and 1 egg mass collected from Okha; 1 specimen (ZM2143D6) collected from Mangrol. This *P. acanthorhinum* collected from Okha was deposited in the museum collection of the Department of Biosciences, Saurashtra University of Rajkot, Gujarat under the accession number ZM201312D3 (Fig. 1).

The body colour along with rhinophores and oral tentacles of the animal in living condition is translucent creamish orange with a clear white vertical line crossed by horizontal lines run centrally from in between rhinophores up to the tail. The foot is transparent white but becomes flap-like anteriorly. The cerata are transparent with a slight iridescent bluish colour, tips are yellowish and have a cnidosac without nematocyst. They are clustered into groups at each side of the body and arranged in arches and rows. The clearly visible red-coloured undivided digestive gland becomes yellow-coloured near the tip within each ceras. The rhinophores are creamish yellow in colour and conical in shape. In addition to these, the spiny appearance of the rhinophores is due to the presence of tubercles over the entire surface. The oral tentacles are smooth and transparent; slightly bluish leading to creamish white coloured tips. The length of the oral tentacle is twice that of the rhinophores.

Radular morphology. The radula possesses only single central rachidial triangular shaped teeth having slightly blunt ended apex runs downwards

towards the mantle (Fig. 2B). The arrangement of teeth is 21 x 0.1.0. The ivory shaped small denticles are arranged at the margin of each rachidial tooth. The denticles are curved towards apex of teeth and one or two bifurcated denticles are present over each rachidial teeth margin (Fig. 2C). The number of denticles varies from 21–38 (Fig. 2A).

Biology. The specimen from Okha and Dwarka were all found underneath of rocks scattered in the intertidal area (Fig. 3C). The specimen observed from Mangrol was found to be crawling over Rhodophyta in a 50–70 cm deep tide pool of the intertidal zone (Fig. 3A). Similarly, *P. acanthorhinum* from Japan were reported to be found from the shallow water on vertical walls with miscellaneous red algae (Moore & Gosliner 2014). The presumed egg mass was a creamish white coloured spiral coil found underneath of rock along the tide pools in the intertidal area (Fig. 3E, F). As many aeolids autotomize their cerata to acquire defense from the predators (Edmunds 1966, Burghardt et al. 2008), *P. acanthorhinum* also detach their cerata that exudes a mucus-like secretion during disturbances and stress (Fig. 3D).

Taxonomical status. *Phyllodesmium acanthorhinum* was reported as a *Phyllodesmium* sp. with only photographic representation from Bird Island of Australia, but lacks sufficient description about morphological and anatomical features (Wägele et al. 2006). The phylogenetic position of this species was initially defined by Moore and Gosliner (2014).

Geographical distribution. This species is reported from Horseshoe Cliffs, Okinawa, Ryukyu Islands, Japan (Moore & Gosliner 2014) and Lizard Island of Great Barrier Reef, La Balsa Park Sunshine Coast, Australia (Wägele et al. 2006, Cobb 2016), and now from the Saurashtra Peninsula, Gujarat, west coast of India (present study).

Remark. The anterior marking of foot extends up to angular foot corner which are white coloured in some specimens of Japan (Moore & Gosliner 2014) but no such marking is observed among the foot of specimens from Gujarat, India.

Discussion

The specimens of *Phyllodesmium acanthorhinum* were distinguished from the other members of its genus by the presence of the spiny rhinophores. However, the character shared by the members of this genus are symbiotic relations with dinoflagellates such as zooxanthellae (Rudman 1991, Moore & Gosliner 2014). The individuals of *P. acanthorhinum* were present underneath of scattered rocks as well as crawling over red algae present in the tide pool which may be the preferred habitat for this species to defend from the predators and to get protection from desiccation in the intertidal area. The specific diet of this species is still unknown (Moore & Gosliner 2014), but as the branches of digestive gland in the cerata are red-coloured there may be a symbiotic association of *P. acanthorhinum* with the Rhodophyta.

Until recently, *P. acanthorhinum* was known only from Japan and Australia, but there was a lack of information about the biology such as pattern of egg mass and the defensive strategy of this species. The presence of a higher number of individuals and egg mass of *P. acanthorhinum* in the intertidal zone during the month December suggests that winter is the suitable season for spawning of this species because winter seems a cooler season without rainfall. However, the egg mass was observed for five months from November to March. The spawning season of other species of nudibranchs varies among different localities (Nybakken 1978) and may depend on diverse environmental gradients. Such type of study on spawning events helps to understand about the population dynamics of the *P. acanthorhinum* which will be helpful in future impact assessment.

Declaration of competing interest

The authors declare no known competing financial interest or personal relationships that could have appeared to influence the work reported in present publication.

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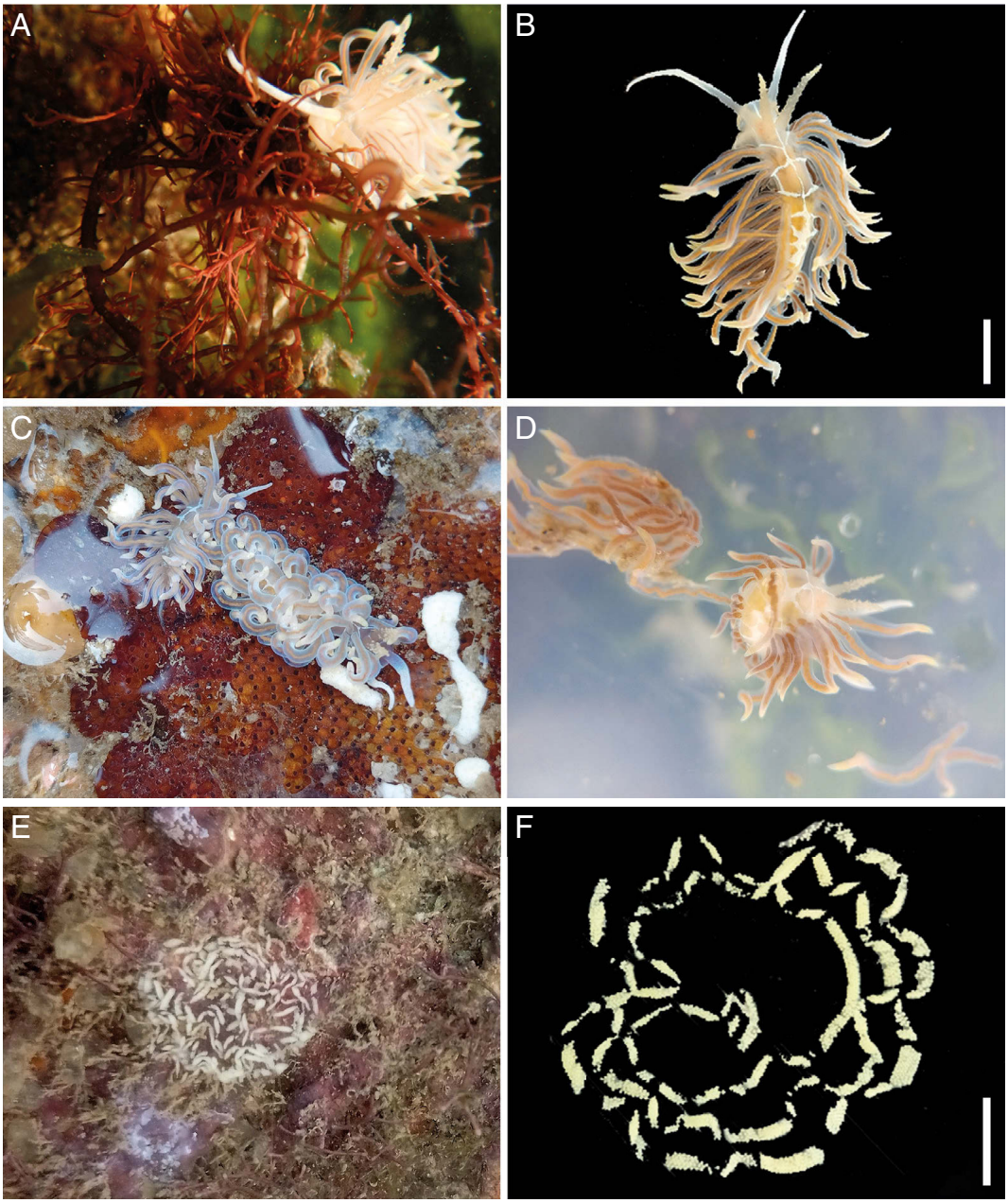

Fig. 3. A. *Phyllodesmium acanthorhinum* associated to Rhodophyta and found underneath of rock; **B.** *P. acanthorhinum* (scale bar 5 mm) and **C.** *P. acanthorhinum* with ascidian; **D.** autotomy of cerata; **E.–F.** egg mass of *P. acanthorhinum* from underneath of rock and egg mass of captivity respectively (scale bar 1 mm).

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