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Photographic evidence on association of sponge dwelling brittle star *Ophiactis savignyi* with Chocolate sponge *Spheciospongia* sp. in Gulf of Mannar

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Abstract
During an intensive coral reef monitoring survey at Hare Island and Manoli Island under Mandapam group of Islands, and Valimunai Island of Keezhakarai group, in the month of February 2019, the common brittle star *Ophiactis savignyi* was found inside the tissue of chocolate sponge *Spheciospongia* sp. Adult, young and juveniles of *O. savignyi* were encountered during the survey. Disc diameter of the specimens ranged between 0.8mm to 9.3mm. A total of 34 specimens of *O. savignyi* were observed inside the 5 sponges. Photographic evidence of this mutualistic associations have been highlighted in the present study with short taxonomic note on *Ophiactis savignyi*.

Keywords: *Ophiactis savignyi*, *Spheciospongia* sp., association, Gulf of Mannar

1. Introduction
Ophiuroids belonging the phylum echinodermata are the most common benthic dwellers in marine ecosystem. They are found from the littoral zone to the abyssal zone of the ocean depth. The coastal habitats and offshore benthic zone of Gulf of Mannar Biosphere Reserve (GoMBR) consists of variety of habitats such as rocks, mud, sand, coral reefs and mangroves which supports a rich diversity of echinoderms here [1]. In Palk Bay and Gulf of Mannar (GoM), a total of 103 species of echinoderms were reported of which 25 species of Ophiuroids were reported from till date [2, 3]. Though several taxonomical research on echinoderms have been attempted earlier in India, habitat and ecological research on echinoderms are very scare, especially on ophiuroids. Ophirouid species *Amphioplus depressus* was studied based on habitat and ecology from Cochin in early 1970s [4]. Several studies on biological associations of ophiuroids were also described in world habitats [5-7], but such reports and photographic evidences are sadly missing from Gulf of Mannar as well as from India.
Ophiactis savignyi, commonly called as savigny's brittle star or the tiny brittle star belonging to the phylum Echinodermata and class Ophiuroidea, usually inhabits in a variety of habitat such as coral reef zones, under the rocks and tissue of different sponge species, bryozoans and coralline algae [8]. During intensive coral reef monitoring survey in Gulf of Mannar, plenty numbers of brittle star *Ophiactis savignyi* were observed and photographed while this tiny brittle star gets firmly attached to the sponge *Spheciospongia* sp. colonies recorded in Hare Island, Manoli Island and Valimunai Island. Detailed observation on the association of *O. savignyi* with *Spheciospongia* sp are emphasized in the present paper.

2. Materials and Methods
2.1. Study Area
Observation was recorded during the intensive marine faunal survey conducted at different islands of Gulf of Mannar during the month of January, 2019 to April, 2019 to assess the benthic faunal communities of the region. Locations (Hare Island (Site1): 09°12.679'N 79°05.088'E, Manoli Island (Site2): N09°13.186' E79°08.044', Valimunai island (Site3): N09°09.318' E78°44.040') were marked with GARMIN e-Trex handled GPS device (Fig.1).

Fig 1: Map showing collection sites of sponge associated brittle stars *O. savignyi*

2.2. Sampling and Observation

Sampling was done during survey on coral reef monitoring in Gulf of Mannar by SCUBA diving and Snorkeling techniques. Specimens were collected and preserved in 70% alcohol for microscopic studies. Field photographs were taken by using NIKON W300 digital underwater camera and microscopic images were performed by using OLYMPUS BX53M stereo microscope connected with software system.

3. Results and Discussion

During the survey, *O. savignyi* was recorded deeply encrusted on the outer layer of the chocolate sponge with spreading of their arms outside and the disc inside the sponge tissue. Single *Spheciospongia* sp. harbors plenty of brittle star within it and the fragile arms of brittle star remains out of the sponge tissue which gives a furry looks to the sponge. Four specimens were collected by tearing the sponge tissue carefully with a knife for referene collection of *O. savignyi* (Fig.1). *In situ* observation also revealed that this association is specific at the species level in all the islands. Other sponge species *Clathria gorgonoides* and *Bubaris vermiculata* were also reported from the same habitat but there is no such association have been observed during the study. Adult, young and juvenile of *O. savignyi* were sighted during the survey (Fig.3a, c-e). Body colour is slight green with black stripes present on the slender arms (Fig.3a). Aboral surface are covered by intersecting scales and bears scattering spines (Fig.3f). Some specimens were observed with newly regenerating arms (Fig.3b).

Microscopic observations revealed that disc diameter ranges from 0.8mm-9.3mm, six arms and arm length varied from 0.6cm – 3.7cm (Fig.3a). Disc have irregular, numerous overlapped scales. Few spines are also present on the scales situated near the disc margin (Fig.3a). Dorsal arm plate: 0.632mm ± 0.63; Ventral arm plate: 0.611mm ±0.25; Oral shield: 0.852mm ± 0.65 (Fig.3c, 2d, 2e). On the ventral side, oral shields are oval shaped and adoral shields are laterally wide. Dorsal arm plates are wider than long (Fig.3d). First two dorsal arm plates are small and round shaped, a prominent black colour marking at middle of these two arm plates form a distinct black spot on the arm plate. Arm spines are six in numbers, small and slender. Genital silt is shingle at each side of the plate (Fig.2e).

Brittle stars have significant ecological role in marine ecosystem by reshaping the seafloor sediment surface which in turn allow many other benthic organism to inhabit. They are also an important food source for many marine fishes, crabs and sea stars and inversely, many ophiuroids feed on detritus substances, tiny invertebrates and filter feed organism from ocean water. *O. savignyi* are widely distributed in tropical and subtropical countries [9]. This species commonly occurs in variety of habitats such as reef substrates, mud, rocks, sandy bottoms, mangroves and association with different biological organisms like bryozoans, sponges, algae and seagrasses. *O. savignyi* is frequently found with the association of different species of sponges [10, 11]. Earlier research on the association of sponge and *O. savignyi* revealed that brittle star may reside within sponges to avail the function of water canals which provide currents for circulation and feeding for the brittle stars [12]. Similar sponge dwelling brittle star *Ophiothrix lineata* were exclusively found to be associated with tube sponge *Callyspongia* sp. at 99.0% of rate of occurrence of [13]. *O. lineata* potentially depend on the sponge larvae for their food and 60.9% of association of *O. lineata* was observed with brooding *Callyspongia* sp. [13]. But there is a lack of information on the feeding method of *O. savignyi* living inside a sponge. Though the occurrence of *O. savignyi* within sponge tissue is common throughout the marine habitat, no reports on the photographic evidence available from Gulf of Mannar reef. In India, abundant occurrence of *O. savignyi* with sponge species *Ircinia fusca* were documented from Ratnagiri coast which also revealed that mass recruitment of *O. savigny* reported during March to May in Ratnagiri coast [14]. Present study also recorded similar observations of *O. savignyi* association with sponge species during February to April in Gulf of Mannar coast. To our knowledge, our findings represent the first photographic proof of this beautiful association in between *O. savignyi* and *Spheciospongia* sp. from Gulf of Mannar. This ophiuroids also have association with other sponge species like *Haliclona* sp. [11], *Geodia corticostylifera* [15] and *Ircinia fusca* [14]. Interestingly, it has also been hypothesized that chemical cues extracted by some sponges attracts *O. savignyi* to avail the shelter from predators and epibionts [16]. Therefore, our observation on the association of brittle star with sponges is a preliminary assessment of available marine resources in Gulf of Mannar. Further experimental and thorough studies are required to understand more ecological significance of this association in terms of feeding, reproduction, shelter from predators and the attraction due to natural products from the host organism.

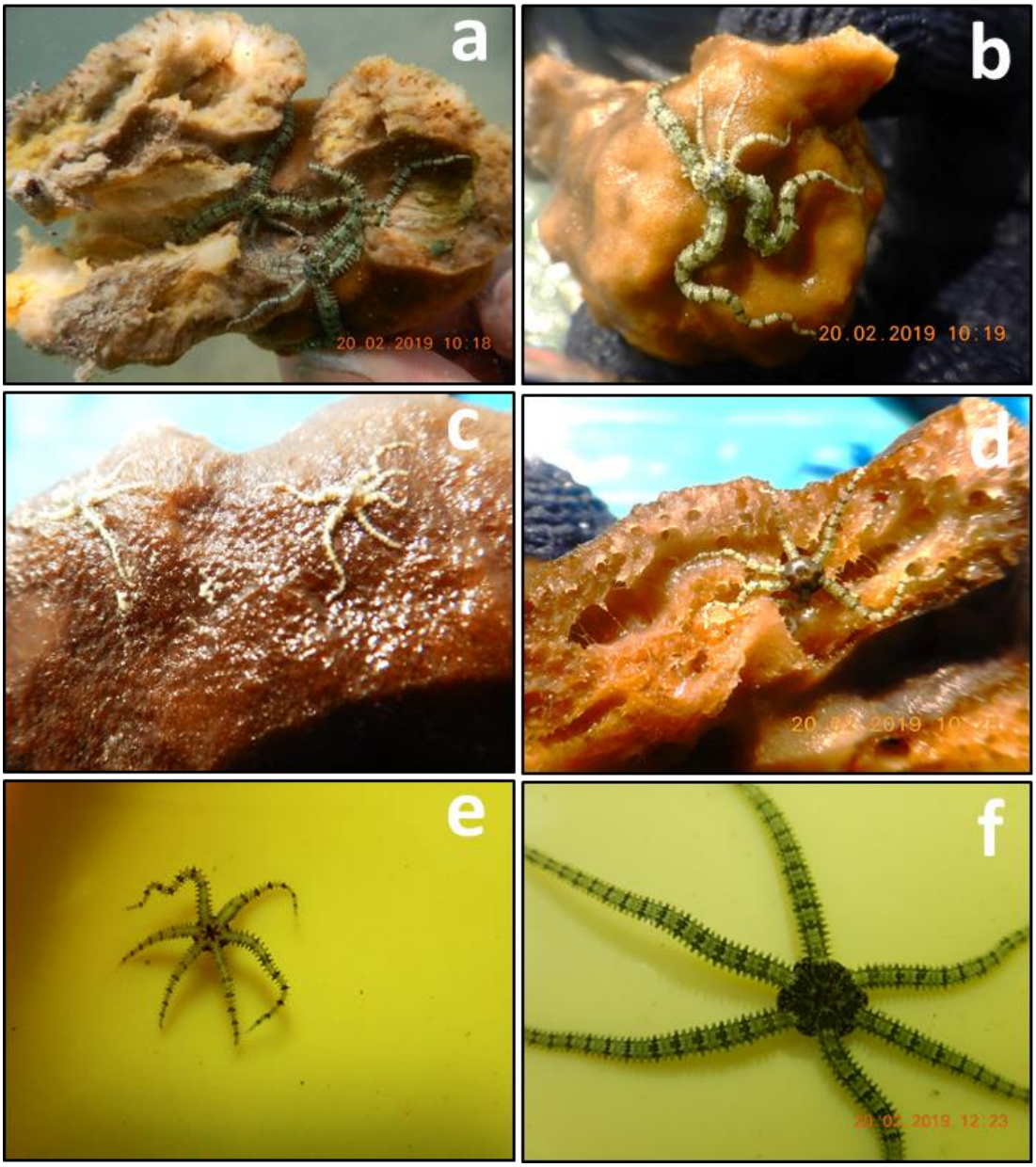

Fig 2: Field observation of *O. savignyi in* association with sponge *Spheciospongia* sp.; a. Adult Specimen found within sponge tissue; b. yellow arrow showing newly regenerating arms of adult *O. savignyi*; c-d. Young specimen of *O. savignyi* within sponge tissue; e. Ventral view of *O. savignyi*; f. Close view of the dorsal side of *O. savignyi*

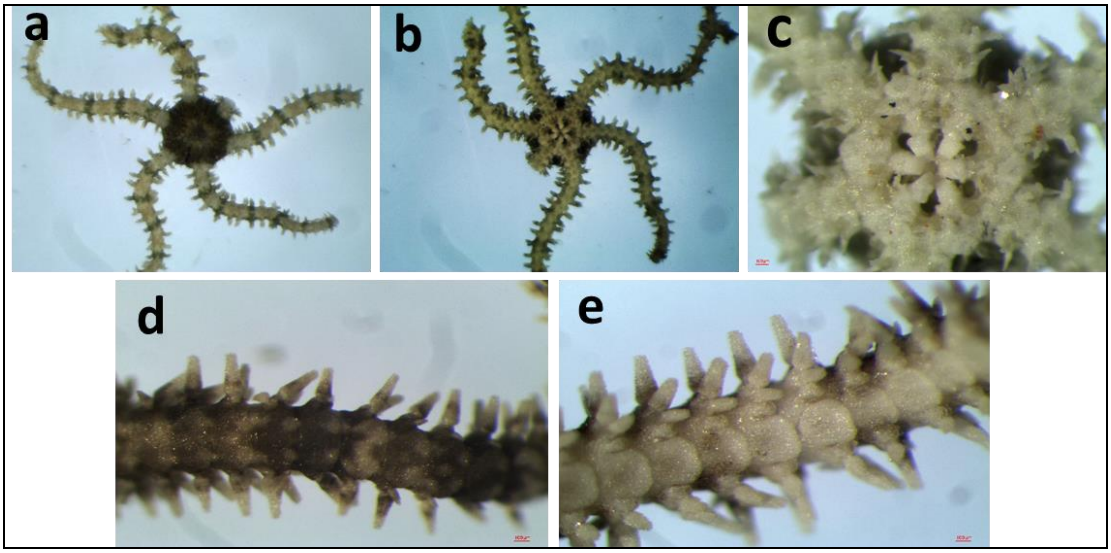

Fig 3: Microscopic illustrations of *O. savignyi*: a. Dorsal view (0.5x); b. Ventral view (0.5x); c. Details of oral view (2.5x, Scale bar 100µm); d. Dorsal arm plate (2.5x, Scale bar 100µm); e. Ventral arm plate (2.5x, Scale bar 100µm)

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