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Clathria (Thalysias)reinwardtii(Porifera, Demospongiae)– An active space competitor on the coral communities of Gulf of Mannar Marine Biosphere Reserve - Southeast India

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Abstract

The complex interactions between sponges and corals are likely to increase and remain more successful for sponges in physically stressed habitats. Recovery of these corals is dubious when sponges take over and end up dominating them. The present paper deals with theobservation of a new report on coral-overgrowing growth form of *Clathriareinwardtii* from GoM, southeast India. A total of 624 coral colonies were surveyed along the transects. Of them 57.21% were branching corals dominated by *A. muricata* and the coral massive category were dominated by 38.14% of *P. solida* (N=238). The sponge overgrows the live coral colonies of *A. muricata* (N=357) with an average infestation rate of 29.13%. *P. solida* (N=238) showed an infestation rate of 14.71% (N=35). Directed long-term monitoring is a fundamental requirement for deciding the major factors benefiting the sponge progress over the coral and to further investigate the impact of sponge-coral cooperation on reef ecology.

Key words: Coral-Sponge interactions, overgrowth, *Clathria*, space competition, reef ecology, Gulf of Mannar

Introduction

The marine sponges are the most primitive metazoans found in ocean waters (Müller, 1995). They form an integral part in any marine ecosystem (Aerts, 1998; Díaz& Rützler, 2001; Rossi *et al.*, 2015). Coral reefs support a diverse variety of benthic fauna and flora including sponges (Connell, 1976; Jackson, 1977). They are generally spoken into various territories by ecologically adjusting towards various environmental conditions in both marine (Worheide et al.,

2012) and freshwater ecosystems (Cocchiglia et al., 2013). Some sponges can invade expansive reef regions by over-heading different coral networks (Vincente, 1978; Rützler&Muzik, 1993). They are not always benefiting the various reef ecosystems. However, sometimes they are said to harm different coral networks even in non-contact vicinity (Porter &Targett, 1988). While the sponge is really sparing the coral's life, the reef might have all the earmarks of being occupied with a forceful abundance.

Ecology of the sponges varies in different environments. Fast growing, competitive sponges can cause serious damage to various ecosystems by creating widespread outbreak or even when being introduced into new environments (Rützler&Muzik, 1993; Ávila&Carballo, 2009). They have previously been observed to increase in abundance with eutrophication in various environments (Rose & Risk, 1980; Holmes, 1997; Holmes *et al.*, 2000; Holmes, 2001) especially after coral mortality (Rützler, 2002; Schönberg and Ortiz, 2009; Carballo*et al.*, 2013). Identifying the sponges with the different biological attributes they possess, authors depict them as moderately tolerant to environmental changes that can be distressing to other benthic life forms (Schönberg&Suwa 2007). Some sponge species can grow laterally or congest live corals and eventually displace them (Aerts, 1998; Rossi *et al.*, 2015). The mediocre health of Indian coral reefs is considered an ideal condition for sponge encrustations (Schönberg*et al.*, 2017). The increased abundance of fast-growing sponges has been reported as a result of their unsettling influence on the reefs and coral mortality (Rützler, 2002; Schönberg&Ortiz, 2009, González-Rivero*et al.*,2016)

The taxonomical and ecological aspects of Indian sponges remain under-investigated till date. The local corals and sponges of Gulf of Mannar have been studied individually by various researchers until 1990 (Dendy,1887,1889;Burton & Rao,1932;Pillai,1972,1977,1986,1994;Thomas,1968,1968a,1968b,1968c,1968d,1968e,1985,1989; Pattanayak,1999), yet the various *in situ* encounters underlying the corals and sponges remain untouched. Relatively inadequate attention has been paid to the ecological context and taxonomical aspects of Indian sponges (Peyrot-Clausade*et al.,* 1999; Zahir, 2002; Carreiro-Silva&McClanahan, 2012). The earlier reports of Annandale, 1915; Burton&Rao 1932 , Thomas 1985, Pattanayak 1999) suggest the existence of a rich biodiversity of marine sponges in India. Marine sponges of the family Microcionidae are much varied with life form categories such as

ISSN:0971-1260
Vol-22- Issue-14-December-2019

encrusting, massive to erect sponges (Hooper, 1996;VanSoest*et al*.,2017). Sponges of the order Poecilosclerida are profoundly studied for the possession of various secondary metabolites (Melawaty and Pasau 2015) but their ecological aspects have not drawn enough attention in the Indian Ocean. Till date 26 Poecilosclerids have been described and documented from the Indian Ocean. Many of the reported species from the Indian Ocean are currently subjected to taxonomic revisions on account of poor description, lack of stock specimens or want of confirmation for some of the identifications (Schönberg*et al.,* 2017). This apparent lack of updated faunal information along with the less reliable knowledge on marine sponges is likely to reflect the poor management of Indian coral reef communities. A better understanding of the up-to-date situation and of the changes in the abundance and diversity of various sponges in Gulf of Mannar is not just beneficial but vital to manage the entire reef biome. Here, we present observations on a new report on coral-overgrowing growth form of *C. reinwardtii*, which is expected to develop as a strong space competitor to the local reefs of Gulf of Mannar. Our primary aim is to trigger further investigations that will prompt healthier monitoring and management practice.

Materials and Methods

Gulf of Mannar is located at the southeast coast of India. It extends from Rameswaram Island in the north to Kanyakumari in the south along a coastal distance of 160 km comprising a chain of 21 uninhabited islands. Gulf of Mannar and Palk Bay in Tamil Nadu are among the major marine national parks in India, which came into existence in 1986. They occur mainly around the 21 uninhabited coral islands and the surrounding shallow waters, and cover an area of 560 km^2. The entire Marine National Park strictly maintains a 'no entry' and 'no take' status (Raj,*et al.,* 2006; Ashok *et al.*, 2018). The Tuticorin group of islands forms the southernmost tip of Gulf of Mannar with 4 islands namely Vaan, Koswari, Kariyachalli and Vilanguchalli. The islands occur at an average distance of 6-15 km away from the mainland and are surrounded by fringing and patch reefs. The present study was conducted in Vaan, Koswari, Kariyachalli and Vilanguchalli Islands of Tuticorin coast, Gulf of Mannar Marine National Park (Fig 1). The coral communities of Tuticorin region are exposed to various natural and human interferences (Edward *eta.l*, 2012). The Tuticorinsea has been severely exploited by coral mining and pearl fisheries (Edward *et al.,* 2012). There is a constant inflow of sewage from outlets in Tuticorin causing high sedimentation and turbidity in seawater all along the coast of Gulf of Mannar. Influx of untreated sewage is likely to disturb the natural ecosystems with a constant and high loads of nutrients input. In addition, the local reefs of the Tuticorin group continue to be victims of various human activities such as destructive fishing methods, seaweed harvesting, ornamental fish collection, etc. (Raj *et al.,* 2006; Edward *et a.l,* 2014; Ashok *et al.,* 2018).

After noticing the unusual occurrence of the sponge overgrowth on various coral communities, an underwater assessment was carried out using SCUBA to identify the sponge and to estimate the ecological context of the sponge colonies. Three 20 x 2 belt transects were haphazardly laid on each island reef, parallel to the coast and to each other, separated by a distance of 5 meters, resulting in an area of 120 m^2. The depth ranged between 3 and 10 m along all transects. Data were collected on the total number of coral colonies, listed by genus, and number of corals invaded by the sponge within the belt transects. The area covers of corals and sponges along with the description of other benthic communities within these belts were quantified via line intercept method, following the central line of the transects (English *et al.,* 1997). The protected status of the area very much limited the sampling opportunities (Ashok *et al.*, 2018) to the researchers. Small volumes of sponge-encrustations were hand-picked for the identification of the sponge species. The tissues were immediately stored in 80% ethanol, and subsequent laboratory analyses were made following Old (1941).

Results and Discussion

We observed the occurrence of the sprawling, pale orange overgrowth of the sponge *Clathria (Thalysias)reinwardtii*on massive and branching coral communities in all the four Island regions. The sponge grows horizontally, extending like a branching tree root (Fig. 2A and 2C). The sponge could be separated with moderate ease from the underlying substrate. The oscules were abundant and were more or less oval, with bright orange, slightly raised, delicate rims. They were contractile and closed when samples were taken out. A prominent and profound star shaped canal pattern was radiating all over the body. There was no traces of sponge penetration into the hard substrates. A growth form change was noticed in all the sampling sites depending on the substrate and morphology of the coral, the sponge attached .In branching

ISSN:0971-1260
Vol-22- Issue-14-December-2019

corals, the sponge exhibited a more or less slender morphology but the in the massive corals sponges were thicker. Samples turned orange brown upon alcohol preservation. Microscopic observations of the tissue confirmed the characteristic reticulate pattern of the genus (Fig 2D)

We observed sponge over dead portions of corals (Fig 2A) and subsequently growing horizontally on various living coral colonies (Fig 2A, 2B, 2C). In most cases, the sponge grows on parts of coral colonies already dead, covered by algae or sediment (Fig 2 A). An evident thin pink boundary was visible between the growing sponge and the living coral (Fig 2 C)

The microscopic observation of the spicule dimensions established with a spicule compliment consisting of, echinatingacanthostyles (Fig 3A, 3B) chelae (Fig 3C) and toxas(Fig 3D) styles (Fig 3E, 3F). Most commonly the auxiliary styles distributed in the choanosomal and ectosomal regions were slightly longer than wide.The microsclere representations of *Clathriareinwardtii* consisted of palmate isochelae, which occurred in two size classes that mainly differed by length (Table 1).The abundantly distributed toxas were small and delicate.

Table 1. Spicule dimensions of *Clathria (Thalysias) reinwardtii*from Tuticorin group,Gulf of Mannar Marine National Park, with N=25 Min. – minimum, max. – maximum, S.E. – standard error

Spiculation	Min., **mean**± S.E., max.	Remarks
Choanosomal styles	146,192.6 ± 1.2,266	Long, Slender
Sub ectosomal Styles	141, 219.7±1,301	Long
Ectosomal styles	82,104.1±1.5,157	Slightly curved, tapering pointed ends

ISSN:0971-1260
Vol-22- Issue-14-December-2019

Acanthostyles	46,60.1±1,72	Short and stout
Chelae 1	10,14.0±1.2,19	Abundant
Chelae 2	2,54±1,9	Abundant
Toxas	12,119.3±1,186	Long, Wing shaped

The proportional contribution of individual category was quantified using the Line intercept method to understand the community structure (Fig. 4). Along the studied transects, in all the four islands, the dead corals varied between 20.31% and 30.35%. Macroalgae were the most dominant category in all the study sites which varied between 14.87% and 53.4%. Average live coral cover in the 4 islands ranged between 9.8% and 23.68%. The sponge cover contributed between 3.6 and 4.51% . Of all categories, soft corals were the least counted along the intercept line in all the study sites, the range of their live cover being 0.38 to 0.79%. The otherSconsidered here include sea anemones, gastropods, molluscs, sea urchins, star fish, etc and varied between 2.32% and 8.1%. The end to end assessment of Belt transects were carried out to find the most preferred substrate by the sponge. The sponge was found utmost overgrowing in the order of *Acropora*branching >coral massive>Sand (Fig.5). Among the coral morphologies, branching coral of the genera *Acropora*and massive corals of the genera *Porites* were the dominant categories. Our observations were unusual in that the sponge was never found on other coral morphologies such as *Acropora*Submassive(ACS), *Acropora* encrusting (AE) and Coral Foliose (CF). The sponge progressed horizontally to the adjacent colonies that were in physical contact. In terms of coral species, *Acroporamuricata*was the common substrate chosen by the sponge in all the study sites. Of the total of 624 colonies counted along the surveyed transects, 57.21% were *Acroporamuricata* (N=357), and of the 357 *Acroporamuricata*colonies, 29.13% were infested by the sponge (N=104). The coral massive category was dominated by 38.14% of *Poritessolida* (N=238) with an infestation rate of 14.71% (N=35).The other common coral

ISSN:0971-1260
Vol-22- Issue-14-December-2019

genera such as *Platygyra, Montipora,Acanthastrea,* and*Cyphastrea*are very rare, with few, scattered colonies only.

Clathriareinwardtii species has been commonly reported to exhibit branching growth form (Hooper, 1996). The Indian sample was peculiar and exhibited varying growth morphologies. A coral-overgrowing morphology of *Clathriareinwardtii*was predominant in all the study area. *Acropora* branching was the substrate more preferred by the sponge than sand in the entire study site. The upward growth form of coral could have favored the horizontalovergrowth by the sponge.

We interpret the widespread occurrence of overgrowth of the sponge as a consequence of the most recent bleaching event (Edward *et al*., 2018). Despite this situation, the early reports on the occurrence of other coral killing sponges such as clionaids (Thomas, 1972; Ashok *et al.*, 2018) and suberitids (Raj *et al.*, 2018) also suggest that sponge outbreak is becoming increasingly evident in GoM or sponges may often be the dominant space occupiers of the reefs in near future (Rützler, 1970; Suchanek& Green, 1982). The present study provides a preliminary account on the common occurrence of a new report of coral overgrowing sponge in Tuticorin region in Gulf of Mannar. We regard the sponge prevalence in Tuticorin as increasing over time and the studied sponge may contribute to more overgrowth interactions which are deleterious to coral communities. Sewage influx would also have a significant impact on tendencyon corals overgrown by this particular sponge species. These further upset the ecosystem balance in favor of the sponges where it outcompetes the corals and damage the reefs for long term (Gonzalo *et al.*,2016). The recently observed coral mortality is expected to further enhance the sponge abundances in near future. Coral reefs of Gulf of Mannar act as a hub for reef dependant fishery. The Island resources provide livelihood to thousands of local fishermen and their dependents. In view of the global concern for declining reef quality, the sponge assemblages on various coral communities of the ecologically sensitive coral reef system such as GoM should be periodically monitored to determine the potential of sponges to become more abundant in response to changing environmental conditions. The present study also aims to draw the attention of the reef managers to the need for focusing more research on the important space-occupying species such as sponges.

ISSN:0971-1260
Vol-22- Issue-14-December-2019

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Vol-22- Issue-14-December-2019

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ISSN:0971-1260
Vol-22- Issue-14-December-2019

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Vol-22- Issue-14-December-2019

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ISSN:0971-1260
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Figure legends

ISSN:0971-1260
Vol-22- Issue-14-December-2019

Figure 1. Map of the study area at the southern coast of India,showing Tuticorin group of Islands Gulf of Mannar.

Figure 2. Growth adaptations of *Clathriareinwardti* at the study sites,Tuticorin group of Islands, Gulf of Mannar and its skeletal arrangement. A,Sponge in habitat (100µm); B, Sponge-infested *Porites* colonies (50µm); C, sponge infestation on Acropora colonies (50 µm); D,Skeletal architecture of Clathriareinwardti (100µm).

Figure 3.Spicule overview of *Clathriareinwardti.*A,B Echinatingacanthostyles;C, Palmate Isochelae; D,Toxa E,F; Styles

Figure 4.Composite Benthic community structure of the study area

Figure 5.Average Percentage Composition of the available substratum choosen by the sponge at the study site

Fig 1,

ISSN:0971-1260
Vol-22- Issue-14-December-2019

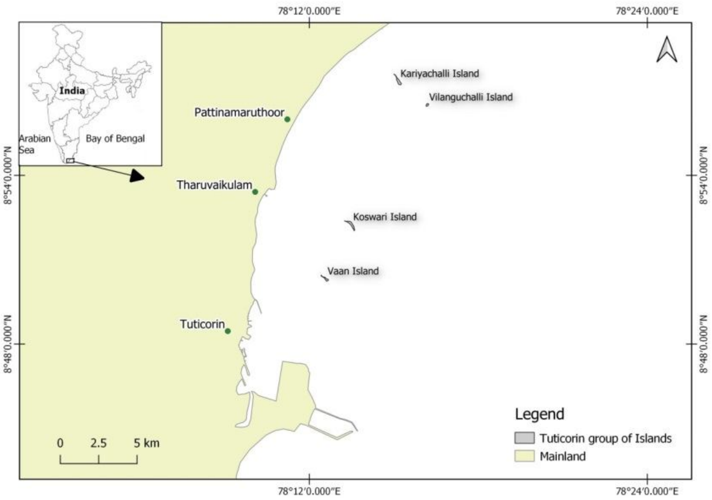
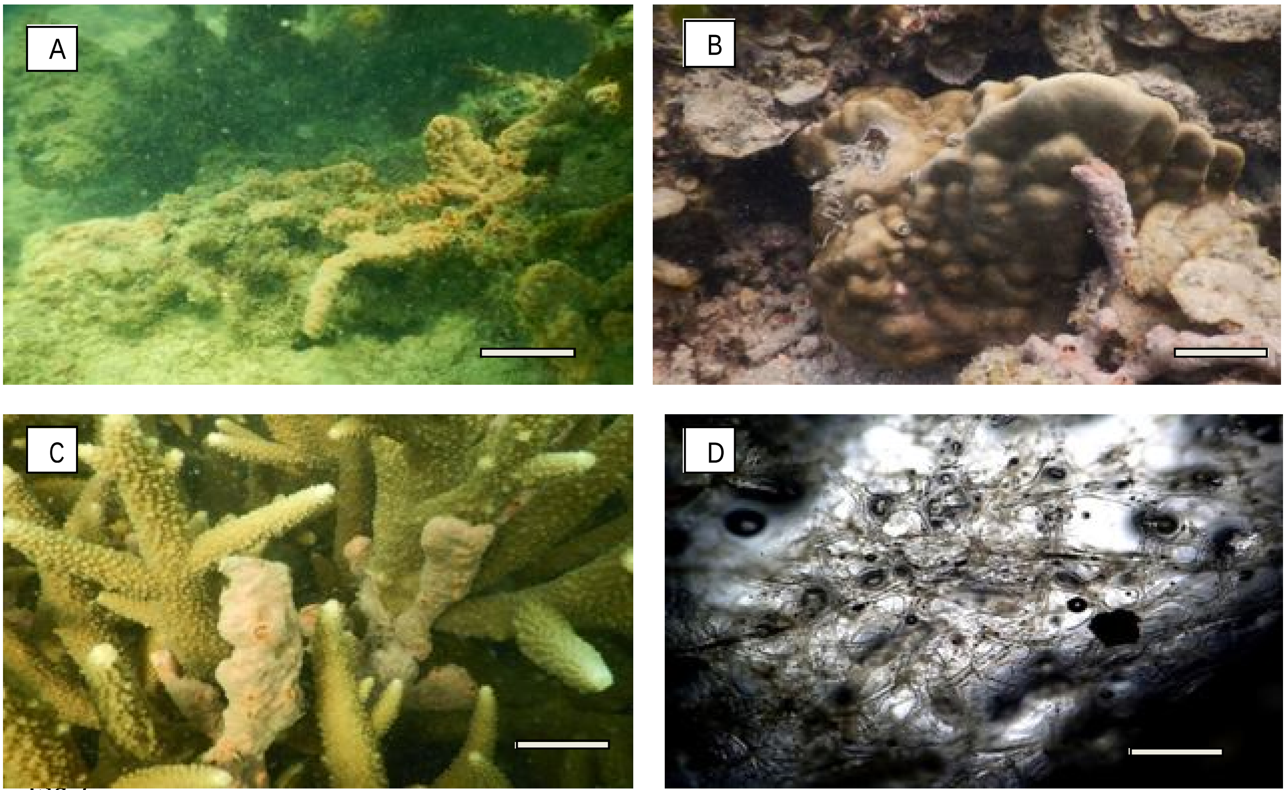


Fig 2,



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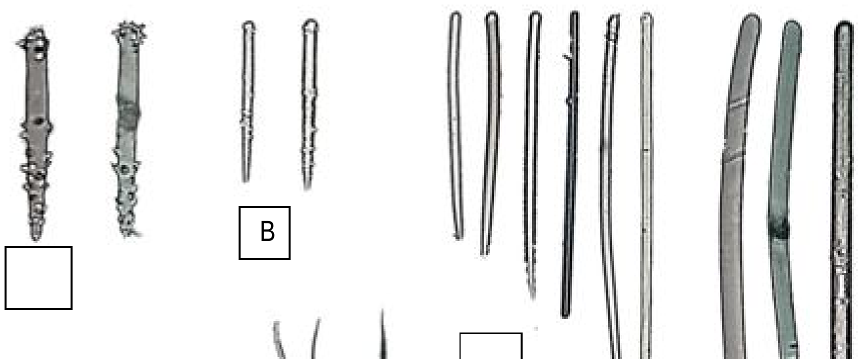

ISSN:0971-1260
Vol-22- Issue-14-December-2019

Fig 4,

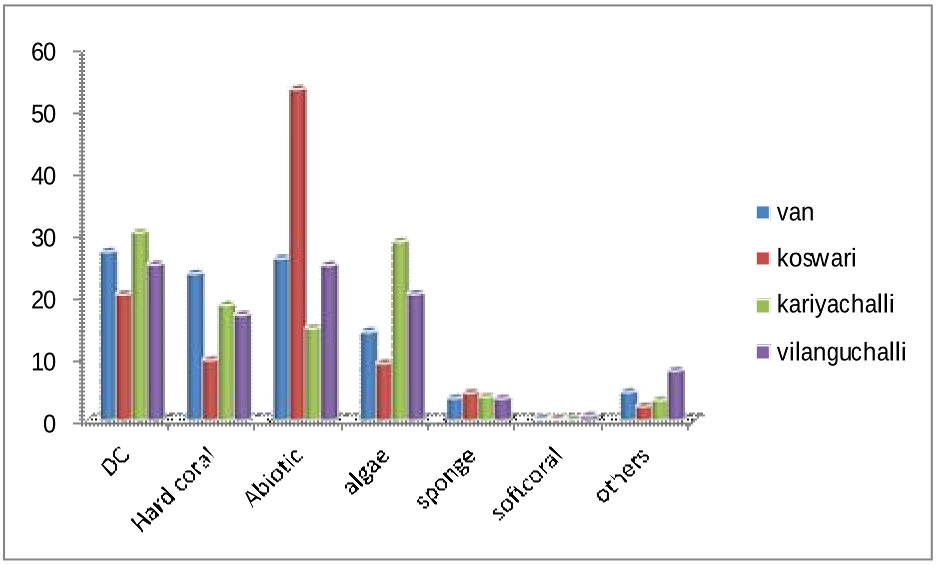

Fig 5,

ISSN:0971-1260
Vol-22- Issue-14-December-2019