

In situ observations increase the diversity records of Rocky-reef inhabiting Echinoderms along the South West Coast of India

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Diversity of Echinoderms was studied *in situ* in rocky reefs areas of the south west coast of India from Goa (Lat. N 15°21.071'; Long. E 073°47.069') to Kanyakumari (Lat. N 08°06.570'; Long. E 077°18.120') via Karnataka and Kerala. The underwater visual census to assess the biodiversity was carried out by SCUBA diving. This study reveals 11 new records to Goa, 7 to Karnataka, 5 to Kerala and 7 to the west coast of Tamil Nadu. A total of 15 species representing 12 genera, 10 families, 8 orders and 5 Classes were recorded namely *Holothuria atra*, *H. difficilis*, *H. leucospilota*, *Actinopyga mauritiana*, *Linckia laevigata*, *Temnopleurus toreamaticus*, *Salmacis bicolor*, *Echinothrix diadema*, *Stomopneustes variolaris*, *Macrophiothrix nereidina*, *Tropiometra carinata*, *Linckia multifora*, *Fromia milleporella* and *Ophiocoma scolopendrina*. Among these, the last three are new records to the west coast of India. Present work also stresses the importance novel techniques to data collection on echinoderm diversity in rocky shores of west coast of India.

[**Keywords:** Rocky reefs, Echinoderms, West Coast of India].

Introduction

Rocky reefs refer to all areas of rocky outcrops or boulders occurring within marine and estuarine waters below the highest high tide level. Rocky reefs are distributed along the tropical, sub-tropical and temperate regions. They are the main supporters for the growth of seaweeds. Rocky reefs are similar to coral reefs in terms of providing habitats and harboring biodiversity¹.

The Mainland of India has a vast coastline with diverse marine ecosystems and marine biodiversity. The South East Coast of India and their biodiversity have been studied exhaustively². Apart from a few places in coast of Gujrat and Goa which contain fringing coral reef, the west coast of India is mainly characterized by the presence of rocky reefs and rocky outcrops^{3, 4} which also includes chains of submerged and exposed rocky islands such as Netrani of the coast of Karnataka. Among the marine ecosystems of India, rocky reefs habitats are distinctive and least studied⁵. Most *in situ* studies on the west coast of India were on Scleractinian coral diversity^{6, 7} and fish ecological studies^{8, 9, 10}. There is a

huge knowledge gap on the status of other lesser known organisms like Echinoderms, which inhabit these rocky areas.

Echinoderms are highly diverse, exclusively marine creatures. They are distributed from intertidal region to abyssal depth in all seas and all latitudes¹¹. Around 7000 species of echinoderms are reported worldwide of which 741 species have so far been found in India¹². Some echinoderms are important as they are keystone species among different marine ecosystems. High diversity of echinoderms is associated with coral and rocky reefs of shallow water areas¹³. Plancus and Gualitire (1743) started the first exploration of echinoderms in Goa¹⁴. Reports on the occurrence of various species of echinoderms in South West Coast of India are scattered in different works¹³, because no major targeted exploration has been conducted for echinoderms in this region.

James (2007)¹⁵ termed the echinoderm diversity of the west cost of India as "*Terra incognita*" because of the lack of exploration in these regions. He listed only 59 species from the Gulf of Kutch to Tamil Nadu along the west cost of India of which 25 were from

Kerala coast alone. In 2016 Raghunathan *et al.* reviewed available literature and presented 123 species of echinoderms out of a total of 777 (revised to 741, see Samuel *et al.*, 2017) in the East coast of India, excluding the Gulf of Kutch region, whereas 343 species are so far reported along the east coast of peninsular India¹⁶. This relatively low diversity was due to the lack of intensive exploration with diverse sampling methods and this list was prepared based on fisheries bycatch data alone in the west coast of India. Other recent contributions are by Sastry (2007 & 2012)^{13, 17}, Rajkumar and Ebanasara (2008)¹⁸, Hegde and Rivonker (2013)¹⁹ Hedge *et al.* (2013)²⁰, Velip and Rivonker (2015)²¹, Ravinesh and Bijukumar (2013)²² who gave qualitative distribution records of echinoderms in the west cost of India. None of the above mentioned works were based on SCUBA diving observation, as all sampling were done by analyzing bycatches at landing centers. Sastry (2007)¹³ recommended the exploration of echinoderms by diving and so this study focuses on *in situ* sampling by

SCUBA diving in unexplored rocky reefs of the west cost of India to improve our understanding of the diversity of echinoderms in the west coast of India.

Material and methods

The present pilot study was carried out in rocky reefs areas of the south west coast of India along four maritime states - Goa, Karnataka, Kerala and the west coast Tamil Nadu. The survey was initiated from Goa (Lat. N 15°21.071'; Long. E 073°47.069') and completed at Tamil Nadu (Lat. N 08°06.570' ; Long. E 077°18.120') via Karnataka and Kerala. Totally 24 stations were studied along this four states (Fig. 1). The survey was done by a random swim across the rocky reefs using SCUBA and photographs were taken of all echinoderms that were encountered. Species were identified using field guides and monographs²³. Distribution list of echinoderms was prepared based on different previous reports from the study area along with data collected in present works.

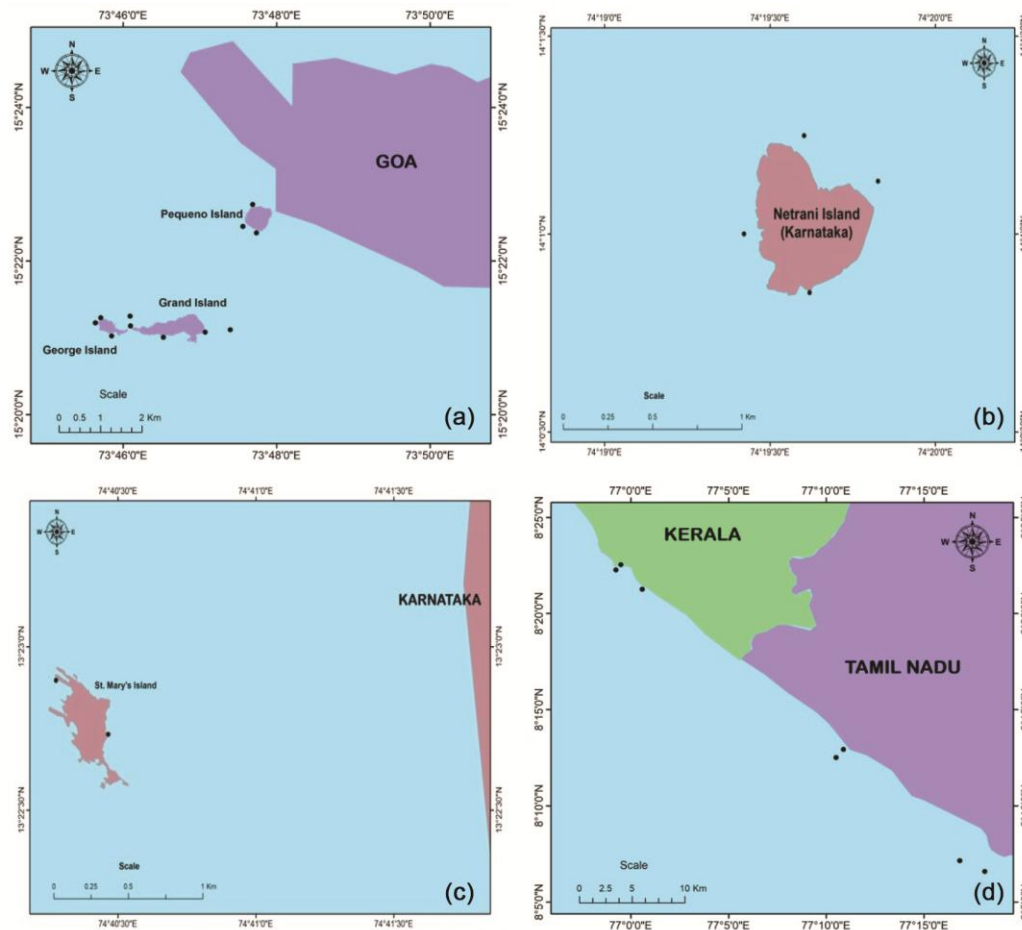


Fig. 1 — Study areas (A. Goa, B Karnataka, C Kerala and D Tamil Nadu)

While identifying through photographs, we omitted some of the echinoderms due to bad photography and lack of easily observable characters to maintain the reliability of the species identity. In that most of them were from the class Crinoidea, which could be under represented in this study.

Result and discussion

The study highlights 11 new records to Goa, 7 to Karnataka, 5 to Kerala and 7 to the west coast of

Tamil Nadu due to the survey conducted by using SCUBA. The distribution list of rocky-reef inhabiting echinoderms along the west coast is given in Table 1. Totally 15 species of echinoderms (Plate 1) were enlisted representing 12 genera, 10 families, 8 orders and 5 classes. The most diverse and abundant family was Holothuroidea in all four study areas.

Fourteen species of echinoderms were present in all four regions. This is different from previous studies because the present work concentrated on

Table 1 — Distribution list of echinoderms in the south west coast of India based on current *in situ* survey

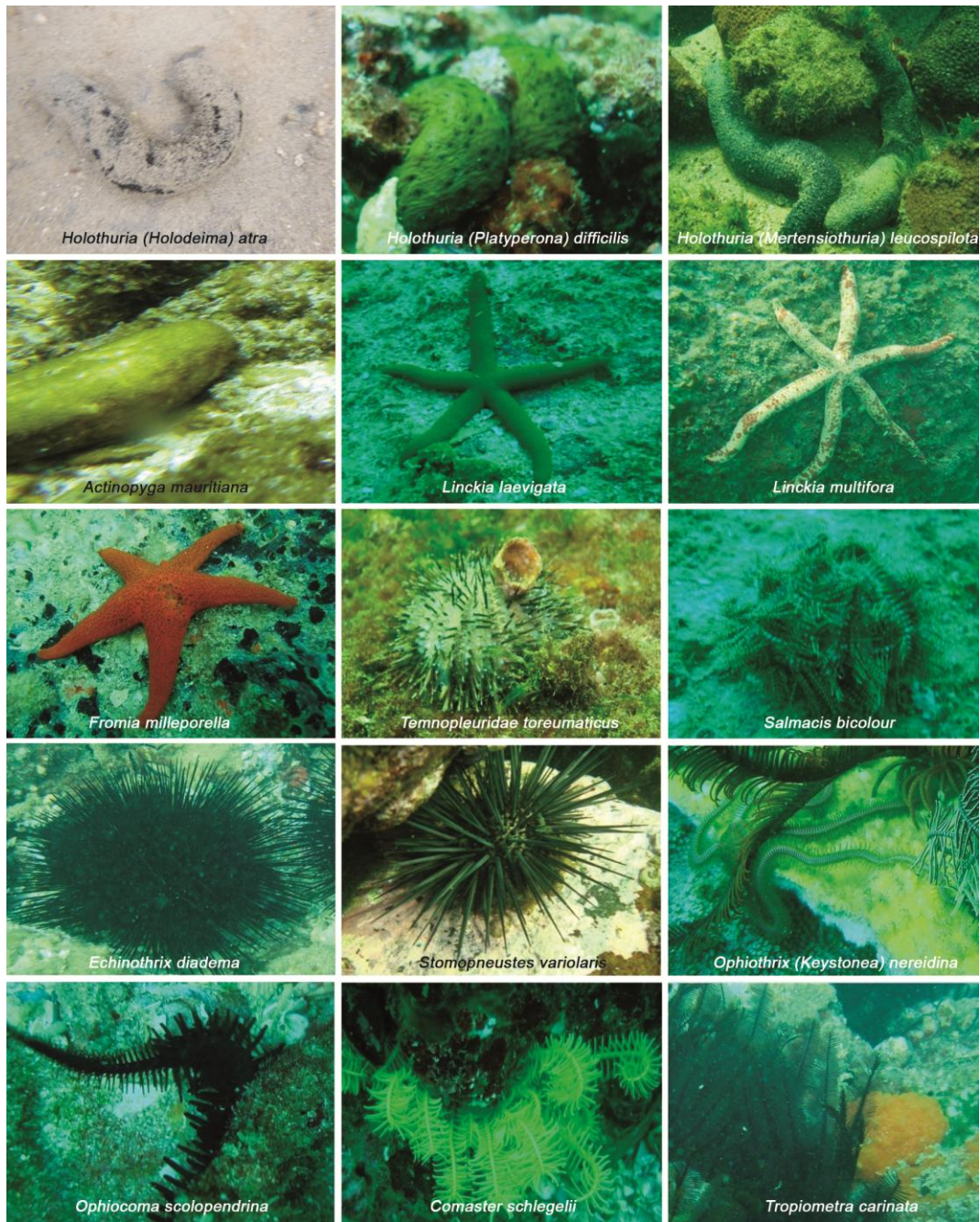
Taxa	Species	Goa	Karnataka	Kerala	Tamil Nadu
Class: Holothuroidea					
Order: Holothuriida					
Family: Hotothuriidae					
	1 <i>Holothuria atra</i>	*	**	**	**
	2 <i>H. difficilis</i>	*	*	**	*
	3 <i>H. leucospilota</i>	**	**	**	**
	4 <i>Actinopyga mauritiana</i>	*	**	*	*
Class: Asteroidea					
Order: Valvatida					
Family: Ophidiasteridae					
	5 <i>Linckia laevigata</i>	*	*	**	*
	6 <i>L. multifora</i>	*	*	*	*
Family: Goniasteridae					
	7 <i>Fromia milleporella</i>	*	*	*	*
Class: Echinoidea					
Order: Camarodonta					
Family: Temnopleuridae					
	8 <i>Temnopleurus toreumaticus</i>	**	**	**	**
	9 <i>Salmacis bicolor</i>	*	**	**	**
Order: Diadematoidea					
Family: Diadematidae					
	10 <i>Echinothrix diadema</i>	*	*	*	**
Order: Stomopneustoida					
Family: Stomopneustidae					
	11 <i>Stomopneustes variolaris</i>	**	**	**	**
Class: Ophiuroidea					
Order: Amphilepeidida					
Family: Ophiotrichidae					
	12 <i>Macrophiothrix nereidina</i>	*	*	**	**
Order: Ophiacanthida					
Family: Ophiocomidae					
	13 <i>Ophiocoma scolopendrina</i>	*	*	*	*
Class: Crinoidea					
Order: Comatulida					
Family: Comatulidae					
	14 <i>Comaster schlegelii</i>	-	-	†	*
Family: Tropiometridae					
	15 <i>Tropiometra carinata</i>	*	**	**	**

Notes: (*) New report.

(**) Reported in this study & also in different previous studies.

(†) Not reported in this study but reported in different previous studies.

(-) Not reported in this study & also in different previous studies.

**Plate 1**

rocky reef ecosystem and sampled using SCUBA. *Comaster schlegelii* was the only species to have a limited range and found only in Kanyakumari, Tamil Nadu in this study and it was previously reported only in Kerala coast. This may be due to the high cryptic nature of *C. schlegelii* or limitation of sampling in those localities.

DB James (2007) reported a similarity in diversity of echinoderms between the Gulf of Mannar in Tamil

Nadu and Vizhinjam coast in Kerala due to both locations lying in the same latitude¹⁵. Sastry (2007) mentioned that the high echinoderm diversity of Kerala may be due to its proximity to Lakshadweep¹³. However Kerala being one of the main fishing states of India, the echinoderms diversity could have been high due to the high amount of bycatch produced which was one of the main sampling methods in previous studies of echinoderms, whereas the other

states along the west coast might have been comparatively less exploited and exploited with different fishing activities and gears.

The Faunal diversity of echinoderms from the west coast of India is poor when compared with the south coast of India because of lack of coral beds and salinity changes due to heavy rain during southwest monsoon¹⁵. In 2007 Sastry reported only 16 species from Goa and mentioned clearly that it was a very low diverse area and states low diversity of echinoderms in Karnataka and Goa may be due to greater amount of sandy habitat compared to rocky habitat¹³. This study adds 11 new reports to Goa and 7 to Karnataka showing that the current sampling method greatly adds to our knowledge of echinoderms distribution. Rajkumar and Ebanasar (2008) studied the monthly occurrence of echinoderms at Muttom and Colachel coast in the South west coast of Tamil Nadu from 1992 to 1994 and reported 29 species of echinoderms¹⁸. This study reported an extra 5 new distribution records to Tamil Nadu coast. Many new records to the respective study areas clearly indicate the lack of exploration and inadequate sampling methodology by which echinoderms have been collected in the past. So the collection methods especially shore collection and by catch methods are not enough to assess the biodiversity of this phylum. Hence, there is a necessity to intensively explore with newer technologies such as SCUBA diving as compared to analyzing just bycatch.

Conclusion

This pilot study, though limited in its scope in having surveyed only 24 locations on the approximate 2000 km coastline of western India, has increased the known bio-geographic range of 11 species of echinoderms for this region. 3 species of echinoderms were found for the first time in the whole of the west coast of India during this study. This was possible only through *insitu* observations using SCUBA as earlier survey methods of using trawlers and surveying fishery bycatch could not detect these species. The west coast of India is characterized by different coastal habitats such as vertical rocky walls, crevices, caves, tunnels and overhangs which have been poorly explored. In our study areas most of the rocky reefs and rocky out crops were also colonized by corals. These regions are prime habitat for many echinoderms species. Intensive exploration by SCUBA diving is therefore necessary to further obtain many new

records and possibly new species to science from the rocky reef regions of west coast of India.

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