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Report on the occurrence of abnormal four-armed red-knobbed starfish *Protoreaster linckii* (Echinodermata: Astroidea), Tuticorin coast, south-east coast of India

G. CHELLADURAI[1], S. BALAKRISHNAN[2], G. JAYANTHI[3], K.K. AJEESH KUMAR[4] AND J. MOHANRAJ[1]

[1]Department of Zoology, Marine Gastropod Hatchery and Research Laboratory, Kamaraj College, Manonmaniam Sundaranar University, Tuticorin 628 003, Tamil Nadu, India, [2]Department of Marine Science, School of Marine Sciences, Bharathidasan University, Tiruchirappalli 620 024, Tamil Nadu, India, [3]Department of Marine and Coastal Studies, Madurai Kamaraj University, Madurai, Tamil Nadu, India, [4]Department of Biochemistry, Central institute of Fisheries Technology, Kochi, India

*Starfish are echinoderms that live among corals and occur from the supra-littoral to the hadal zone. Deviation from pentamerism is a rare phenomenon in starfish and was observed in the red-knobbed starfish (*Protoreaster linckii*) collected from the Tuticorin coast, India. Eighty-five specimens were collected and, among these, one was found to be abnormal and had only four arms. The reasons for this abnormality may be due to the changes that occur during larval metamorphosis or caused by an abnormal regeneration of the arm.*

Keywords: abnormal star fish, Pentamarism, *Protoreaster linckii*, Gulf of Mannar

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INTRODUCTION

Sea stars are a group of invertebrates that exist in ecosystems with sea grass, coral, rocky substratum, etc., from shallow areas to the deepest regions in the ocean, at depths of approximately 6000 m. There are about 1890 species of sea star belonging to 370 genera and 36 families of the class Asteroidea, under the phylum Echinodermata (Cintra-Buenrostro *et al.*, 2005; Mah & Blake, 2012). They are star-shaped, oral-aborally flattened, free-living marine deuteron, and some are found to be distributed ubiquitously throughout the world's oceans. Sea stars have a centrally located disc from which an arm arises and they have the power to regenerate damaged organs. Normally, most sea stars have five arms; and having either more than five arms or less than five arms is considered as abnormal. The reason for such abnormalities might be due to environmental conditions or they may be caused during predation, when the sea star is wounded. The wound can be healed by a regeneration of the arms or by just covering the wound by the growth of a body wall (Hotchkiss, 1979). At the time of the regeneration of the arms, the sea star may regenerate two arms instead of one or it may just close the wound without growing an additional arm (Shanker & Vijayanand, 2014). They are considered as an indicator of fishing intensity and biomarkers for pollution because of their important role in ecology. Sea stars play a vital role in maintaining the benthic community due to their predatory activities and some of them act as key species (Menge, 1982). Hence, they are used as a model organism in areas of community structure and feeding ecology (Menge *et al.*, 1999; Ortiz *et al.*, 2003). Studies on the biology, or other related aspects, of sea stars are scarce from Indian waters. Sea stars have evolved with rich sources of bioactive metabolites such as steroidal glycosides, steroids, anthraquinones, alkaloids, glycolipids and phospholipids (Pathirana & Andersen, 1986; Palagiano *et al.*, 1995; de Marino *et al.*, 1997).

The sea star *Protoreaster lincki* (Blainville, 1830) has a gorgeous appearance, is relatively larger in size and can grow up to 30 cm in total length, with five short triangular arms that have bright red or orange reticulate patterns on their dorsal sides. Distributed throughout the Indo-Pacific region as sand or sea grass bed dwellers, this species is never encountered in inter-tidal areas. It is considered as a voracious scavenger, mainly feeding on sponges, sea anemones, soft corals, etc. It is considered as an enemy of pearl oysters along the coast of the Gulf of Mannar. This species generally follows the rule of pentamerism. Therefore, the number of arms is usually five. Above or below the normal arm count is considered as an abnormality. The present study concerns the occurrence of abnormality in *P. linckii* from the bycatch of Tharuvaikulam, Tuticorin coast, Gulf of Mannar, India.

Corresponding author:
G. Chelladurai
Email: chellam.zoo@gmail.com

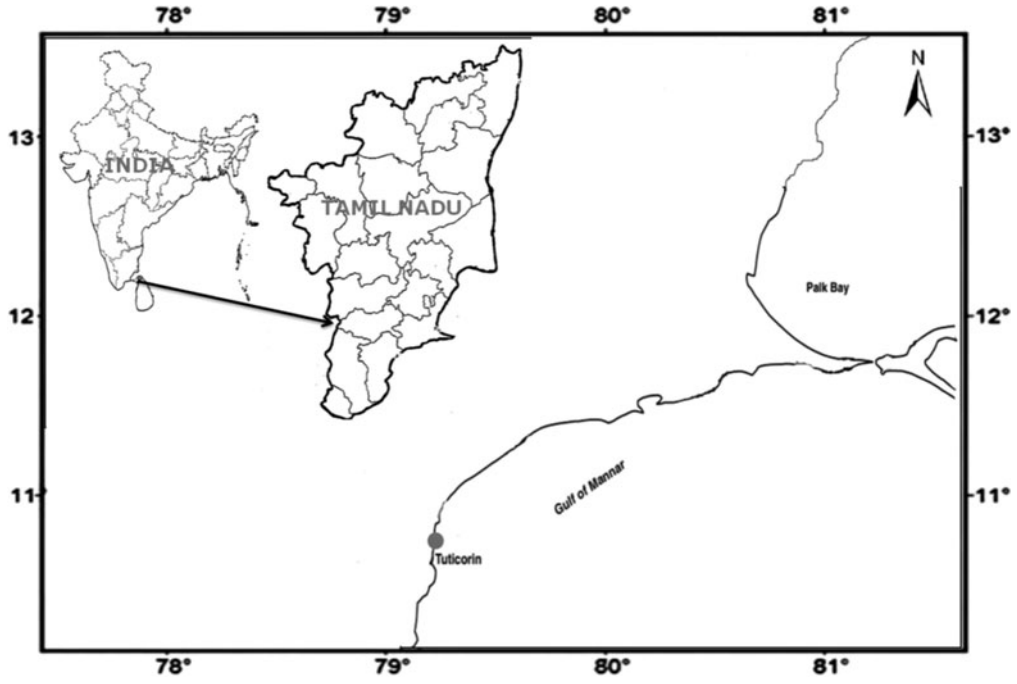

Fig. 1. Study area.

Fig. 2. Normal *Protoreaster linckii*.

MATERIALS AND METHODS

Sample collection

Starfishes were collected from trawl bycatch landing at Tharuvaikualm fishing harbour (Latitude 8°89′N Longitude 78°16′E), Gulf of Mannar, in December 2014 (Figure 1). Among the 85 specimens of *Protoreaster linckii* (Blainville, 1830) (Figure 2) collected, 84 specimens were found to be normal and only one was abnormal. The collected specimens were immediately brought to the laboratory and washed with tap water to remove the adhered mud and other particles. Then they was measured, weighed and the readings were noted and specimens were identified using the monograph of shallow-water Western Indo-Pacific echinoderms (Clark and Rowe, 1971) and later, the specimens were preserved in 5% buffered formalin for further analysis.

SYSTEMATICS
Class ASTEROIDEA
Order VALVATIDA
Family OREASTERIDAE
Genus *Protoreaster*
Protoreaster linckii (Blainville, 1830)

DESCRIPTION
This species is more distinct from other species by having unique polygonal plates on oral and aboral sides. The number of arms is five and arms are elongated and more triangular than the disc. R/r: 120–114/35–39; and br: 38–42 mm (where, R = arm length; r = measurement from centre of mouth to the end of inter radius; bd = arm breadth). Disc raised upwardly, plates reticulated, angular inter radius, single central spine near anus, single spine on each primary plate and three on secondary plates. Spines are stout with pointed tips. Carinal spines are stout and shorter than primary one. Either lateral side towards arm tip of adult specimen has three lateral spines. Bivalve pedicellariae are more scattered on oral side.

RESULTS AND DISCUSSION

Among the 85 collected specimens, one exhibited abnormality in the arms (having only four arms) (Figures 2 and 3). The length of the normal and abnormal specimen was 120.4 ± 1.05 and 130.1 mm and the weight was 173.12 ± 0.89 and 143.55 g, respectively. This species is quite common along the coast of the Gulf of Mannar, especially in sea grass beds and coral reef ecosystems and it attracts aquarium keepers because of its ornamental nature. It has been used for ornamental purposes – live sea stars range in price from Rs 50 to 80 per piece and the dried ones range from Rs 8 to 10 per piece. Dried sea stars are also used as decorations. Per day, an

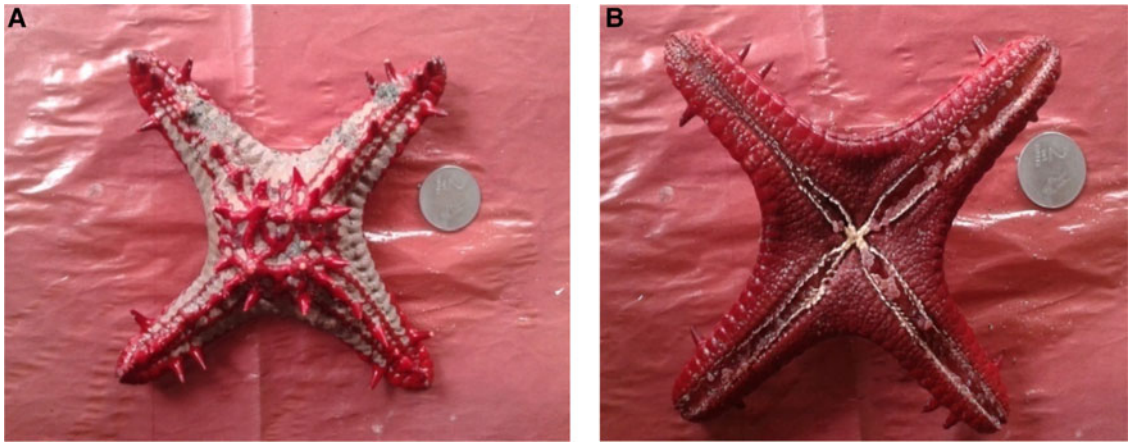

Fig. 3. Dorsal (A) and oral (B) view of four-armed *Protoreaster linckii*.

Table 1. The measurements of normal and abnormal star fish *Protoreaster linckii* specimens.

Serial no.	*Protoreaster linckii*	Total length (mm)	Total weight (g)	R (mm)					r (mm)	Br (mm)				
				A	B	C	D	E		A	B	C	D	E
1	Normal	120.4	173.12	100.6	100.2	100.7	110.1	100.8	30.5	30.1	30.4	30.2	30.1	20
2	Abnormal	130.1	143.55	90.1	90.2	80.7	90.1	–	30.1	30.8	30.7	30.5	30.4	–

Note: R, arm length; r, measures from mouth centre to the end of inter radius; br, arm breadth (at the base of arm).

average of 200–300 pieces are being collected during peak season and the business is considered as cheap but profitable. James (1999) reported that the number of arms may be less than five or more than five due to freak formation at the time of development in *Protoreaster linckii* on the Mandapam coast, Gulf of Mannar. Hotchkiss (2000) reported that changes in salinity are also responsible for sea stars having arm rays and the failure to develop a fifth arm after metamorphosis is consistent with the 'synchronic hypothesis' that the pathway to form the rudiments of the five primary rays operates for only a short time, switches off and does not recur. There are possibilities for the growth of two arms in place of the loss of a single arm. Hyman (1955) stated that if an arm of a star fish is split vertically, a double outgrowth usually results, producing a distally forked arm. Lawrence & Komatsu (1990) pointed out that the control of ray numbers is very precise in five-rayed species and they experimentally produced only five-rayed offspring by selective breeding from aberrant ones and not those that are four-rayed. It is evident that there has been a recurrent independent evolution of the multiradiate condition. Still there is no published information on abnormality in asteroids and only a few reports are available on the occurrence of abnormal ambulacra grooves and rays. From the literature, we can deduced that, normally, the sea star *P. linckii* has five rays and many factors such as environmental parameters, predation, escape, wound healing, metamorphosis, regeneration, etc. may cause abnormality (Tartarin, 1953).

CONCLUSION

The possibility of the over exploitation of this species, along with its habitat destruction by coral mining, warrants the initiation of conservation and also the necessity to study its impacts on the ecosystem. At present, starfish are not included in the list of threatened fauna and, so far, no stock assessment has been carried out to study the abundance of the species along the Gulf of Mannar. The present report describes abnormality in this species that was observed for the first time in India. Hence, further studies are needed to understand the reason for the abnormality in sea stars, the mechanisms behind it and to comprehend their genetic differences.

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Correspondence should be addressed to:
G. Chelladurai
Department of Zoology
Marine Gastropod Hatchery and Research Laboratory
Kamaraj College, Manonmaniam Sundaranar University
Tuticorin 628 003, Tamil Nadu, India
email: chellam.zoo@gmail.com