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Occurrence of Abnormal Starfish from Olaikuda in Rameswaram Islands, South East Coast of India

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Abstract

Starfish *Linckia multifora*, *Anthenea pentagonula*, *Goniodiscaster vallei* was collected from Olaikuda in Rameswaram island of Southeast coast of India, Tamil Nadu (India) in December 2014. Samples are collected by using skin diving. Totally, 27 specimens collected among three species have abnormally developed. Normally, *L. multifora*, *A. pentagonula*, *G. valley* has five arms and the deviation from pentamerism is a rare phenomenon in starfishes. The present observations suggest that deviations from pentamerism are not a heritable character but are a consequence of environmental perturbations on the metamorphosis of larvae and/or abnormal regeneration of arms.

Keywords: Starfish; *Linckia multifora*; *Anthenea pentagonula*; *Goniodiscaster valley*; Abnormal regeneration; Pentamerism;

Introduction

Echinodermata are most familiar invertebrates exclusively marine and are largely bottom dwellers. The phylum contains some 6600 known species and constitutes the only major group of deuterostome invertebrates by [1]. Starfishes are the class Asterozoa of phylum Echinodermata consisting of 1890 species with 36 families and approximately 370 genera by [2]. Five extant universally recognized families are Asterozoa, Ophiurozoa, Echinozoa, Holothurozoa and Crinozoa. Echinoderm from the voyage were described by [3] (Asterozoa), [4] (Ophiurozoa), [5, 6] (Holothurozoa), [7, 8] (Crinozoa) and [9] (Echinozoa). Members are characterized by the combination of basic pentamerous adult, a calcite skeleton and hydraulic tube feet or water vascular system. The skeletal arrangement allows for the extension of a comparatively large coelomic cavity from the central disc into the arms, which serves to hold gonads and pyloric caecae [10]. Other functions and a more or less conspicuous, it possesses five-part radial symmetry. A closer look at some extant echinoderms will show that some taxa of sea cucumbers lack calcite in their body walls, some taxa of sea stars have "outgrown" five-part symmetry and may have 50 or more arms, and many echinoderms (*Acanthaster planci*) show a more or less conspicuous bilateral symmetry superimposed upon a radial pattern. Five species of Asterozoa like *Goniodiscaster vallei*, *Anthenea pentagonula*, *Ludia magulata*, *Linckia lavigata* and *Linckia multifora* are the number of arms less than five or more than five due to freak formation at the time of development [11, 12]. Fossil echinoderms can be even more puzzling, for some are decidedly asymmetrical and others may lack evidence of a water-vascular system. The arms are break either due to injury or by autotomy, especially when they are disturbed [13]. Echinoderms are pentamerous and therefore most of the asterozoa have only five arms. However, some of the asterozoa like *Luidia magulata*, *Acanthaster planci* have more than five arms. In some starfishes *Pentaceraster regulus* and *Protoreaster linckii* are have less than five or more than five arms due to freak formation at the time of development. The abnormalities of starfish *Astropecten indicus* along the southeast coast of India was observed in Mudasalodai [14]. Normally, *A. indicus* has five arms and the deviation from pentamerism is a rare phenomenon in starfishes. According to Hotchkiss, these abnormalities appear to be generally the consequence of regeneration of predator injury [11]. Although Echinoderms are highly evolved among invertebrates, they show primitive characters like autotomy, regeneration, radial symmetry and asexual reproduction. During regeneration more number of arms is formed. Sometimes a single arm develops into a complete starfish.

Study Area

The samples were collected from Rameswaram, Olaikuda (Lat 9° 17' N, Long 79° 19' E), southeast coast of India.



Fig 1: Study area Map showing the Sample collection site

Materials and Methods

The samples were collected from Rameswaram, Olaikuda (Lat 9° 17 N, Long 79° 19 E), southeast coast of India. Olaikuda is a stretch of shallow mud flat region along the same shore as the significant bathing Ghat of Rameswaram. It stretches across 15 to 20 kms and extends over an approximate of 12 nautical miles into the sea from the shore. Olaikuda shelters a grassy meadow that supports a wide variety of crustaceans, mollusk and echinoderms apart from many other invertebrates. The present study was carried out in

Rameswaram Islands that comprises of some of the most productive fishing water of the country. Abnormal starfishes are collected by skin diving at Rameswaram. The collected samples were preserved in 5% buffered formalin – seawater mixture. Specimens were identified as *Goniodiscaster vallei*, *Anthenea pentagonula*, *Ludia magulata*, *Linckialavigata*, *Linckia multifora* using the monograph of shallow water Indo-West Pacific echinoderms [15]

Results



Fig 2: Normal occurrence of Star fish in usual forms (1, 2, 3)



Fig 3: Normal occurrence of Star fish in unusual forms (abnormal ones (1a, 2a, 3a))

1. *Linckia multifora*, 2. *Anthenea pentagonula*, 3. *Goniodiscaster vallei*

Taxonomic characteristics features

Linckia multifora (Lamarck, 1816)

Diagnostic Characters:

The colour in live samples is observed to be variegated, with purple or red spots on ray. The tip of ray is blue. The sub ambulacral spines are thick and hardly project out from the coat of coarse granules [15]

Description

1. The length of the arms varied due to most of the specimens being comet forms and hence R/r value could not be calculated.
2. The arms a cylindrical and slender in nature and have a very small central region in ratio to the length of the arms.
3. It occurs sub tidally on coral rubble. Comet forms were

common suggesting asexual reproduction through fissiparity.

- Arms are often irregular in length and number
- Presence of 5 arms or more than 5 arms due to fissiparous asexual reproduction.
- Both actinal and abactinal plates are covered with dense granules.
- Two madrepodites are usually observed ^[16]

***Anthenea pentagonula* (Lamarck, 1816)**

Diagnostic Characters:

In the genus *Anthenea* the pollen grain like bivalve pedicellariae are observed on the oral side of the species, an increase in size from the peripheral region towards the mouth. The pedicellariae is 3 to 4 times longer than broad. The aboral skeleton is stout, the spaces between the secondary plates being relatively small at least on the distal parts of the arm the flat rounded plates are more or less conspicuously bare ^[15]

Description

- The size of specimens found ranged between R=41mm r= 22 mm R/r=18.6 mm to R= 75mm r= 50mm R/r= 15 mm.
- All specimens showed 5 arms present.
- The Arms were broad, being half the length of body width. Arms are broad and rounded at the tips ^[16]
- The range of size R/r = 30 mm / 16mm – 85mm / 55mm ^[16]
- A very large, two- lipped pore is present on the ventral surface of each plate.
- The ambulacral spines are disposed in three rows. In the innermost row, there are five spines on each plate of which the one in the middle is the longest. On the outside of the row is another third incomplete row ^[15]
- Marginal plates are not tuberculated. The number of the marginal plates on each arm is about 10-11 ^[16]
- Spaces between the secondary plates are relatively small; at least on the distal parts of arms the flat rounded primary plates more or less conspicuously bare ^[15].
- The superio-marginal plates extended onto the aboral surface and prominently border that surface ^[15]

***Goniodiscaster vallei* (Koehler, 1910)**

Diagnostic Characters:

In the genus *Anthenea* the pollen grain like bivalve pedicellariae are observed on the oral side of the species, an increase in size from the peripheral region towards the mouth. The pedicellariae is 3 to 4 times longer than broad. The aboral skeleton is stout, the spaces between the secondary plates being relatively small at least on the distal parts of the arm the flat rounded plates are more or less conspicuously bare ^[15]

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Discussion

Echinoderms are efficient in scavengers within their respective marine ecosystems and it plays an important role in maintaining the marine ecological functions in the sea. Since the last major review of echinoderm autotomy explained ^[17], there has been a significant expansion in knowledge of the functional morphology of echinoderm autotomy planes in all five echinoderm classes. Each arm of asteroids was coded according to the Carpenter system. The large number of strictly pentamerous families of starfish supports the interpretation that there is “rigid control” of pentamerism, so such families can generate only five arms, sometimes the irregular arm number also can be observed. The control of ray number is very precise in 5-rayed species and this author experimentally observed the selective breeding in aberrant ray number and produced only 5- rayed offspring and not four rayed ones ^[18]. It was summarised that this may apply to loss of the whole crown by stalked crinoids, dropping of the spines by asteroids, ophiuroids and echinoids and shedding of the arms by asteroids at levels distal to the basal autotomy plane. It may also be the basis of certain ontogenetic and reproductive detachment phenomena, particularly fission in asteroids, ophiuroids and holothurians which like the cases of opportunistic self-detachment described above, is characterised by its slowness (taking many minutes to days) and the absence of preformed breakage planes (resulting in irregular wounds and prolonged wound healing), as well as by the presence of MCT (Mutable Collagenous Tissue) at the rupture site ^[19]. It has to be stressed, however, that the involvement of MCT destiffening in all these phenomena is at present speculative and needs to be verified by microscopical and physiological methods. Large number of strictly pentamerous families of starfish supports the interpretation of “rigid control” of pentamerous. As noted by Lawrence and Komatsu, the control of ray number is very precise in five rayed species ^[18].

James has reported six and four armed starfish *A. indicus*, *P. mamailatus*, *L. multifora*, *P. Lincki* and *N. galathea* some other abnormal seastars from Gulf of Mannar region ^[12]. The present reports are similar to that, the abnormality was observed in *G. vallei*, *A. pentagonula*, and *L. multifora* from Olaikuda in Rameswaram Islands of Southeast Coast of India. Hotchkiss has reported the unusually wide and two ambulacral groove that extended in single tip ^[20]. Samuel and Jerome have recorded four abnormal forms presenting deviation from the classical pentamerism of echinoderms observed within the brittle-star *A. squamata* ^[21]. Four or three arms formed during the metamorphosis is the result of teratological incomplete development, which is generally consistent with the observations of ^[22], *Asterina gibbosa* ^[23], on *Echinaster spinulosus* ^[24], on *Patiria miniata* ^[25]. However, the present evidence that ray number abnormalities in asteroids it may be caused by high salinity during early stages. The starfish are not included in the list of threatened fauna and still now there is no attempts were made for stock assessment to study the abundance of the species along the Southeast coast of India. There is no proper literature for asteroids abnormality

but few literatures supports the abnormal ambulacral grooves and rays. Hyman stated that if an arm is split vertically, a double outgrowth usually results producing a distally forked arm [13]. The present report describes abnormality in three species that may be observed for the first time report in India.

Conclusion

In the future, further more research is needed in the particular aspect for the regeneration of arms in the echinoderm species to maintain the diversity in ecological niche through molecular approach. In addition to that the locomotion and physiological functions are needed to study with special reference to echinoderms. Hence, further studies are needed to understand for the reasons of causing abnormality in sea stars, the mechanisms behind it and to understand their genetic differences among them.

Conflict of interest statement: We declare that we have no conflict of interest.

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