

ECHINODERMATA ASSOCIATED WITH CORAL REEFS OF ANDAMAN AND NICOBAR ISLANDS

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INTRODUCTION

Coral reefs are an important ecosystem of the coastal environment. The reef ecosystem is highly productive and provides substratum, shelter, food *etc.* to a variety of biota. Consequently a number of faunal and floral elements are attracted towards the reef ecosystem and are closely associated with each other to form a community. Thus the reefs are also rich in biodiversity. Among the coral reef associates echinoderms are a conspicuous element on account of their size, abundance and effect on the reef ecosystem including the corals. In spite of their importance in the coral reef ecosystem and its conservation, very few studies were made on the echinoderm associates of the coral reefs. Though there were some studies elsewhere, the information on reef-associated echinoderms of Indian coast is meager and scattered (see Anon, 1995). Hence an attempt is made here to collate the scattered accounts and unpublished information available with Zoological Survey of India. Since the information is from several originals and quoted references and many are to be cited often, these are avoided in the text and a comprehensive bibliography is appended which served as source material and also provides additional references of details and further information.

ECHINODERMS OF CORAL REEFS

More than 200 species of echinoderms occur in the reef ecosystem of Andaman and Nicobar Islands. These belong to five extant classes with 30 to 60 species of each class. The ecology of many echinoderms with particular reference to coral reef habitats is not extensively studied. Most of the available information is from scattered literature and casual observations. Comprehensive studies of only a few reef-associated species elsewhere are available because of their economic importance or threat to coral reefs. Jones and Endean (1973, 1976) compiled the information available till then. The following account is based on the scattered literature, information available with Zoological Survey of India and author's observations. In the list of species, species reported in the literature or present in the National Zoological Collections whose current status is not known are also included with the same identity. Also species that are likely to have been collected or occurring in the coral reefs are included. The distribution of each species in different islands

is given from the published literature and the unpublished information available with Zoological Survey of India. Most of the earlier literature does not contain the exact locality details and some are observed only in the field but not collected. These are given as Andamans and Nicobars without localities. Other localities are classified into North, South and Middle Andamans, Ritchie's Archipelago and Nicobars. Some localities or islands are administratively under North Andamans but geographically fall under Middle Andamans. These are listed under Middle Andamans. The position of some islands is such that they are to be arbitrarily taken under North, Middle or South Andamans.

Class CRINOIDEA

The Crinoidea have arms in multiples of five at the base, which later branch though regularly, but resulting in odd number of arms. The arms are beset with side branches called pinnules, which help in swimming, feeding and reproduction. Of the two groups of Crinoidea, members of one group namely the stalked crinoids commonly known, as 'sea lilies' are inhabitants of soft substrata in the deep sea. They lead a sedentary life with the stalk attached to a hard object or buried in the substratum and do not occur in coral reefs. Members of the other group called 'feather stars' lead a free life in shallow waters mostly on hard substrata. They generally appear dark green or black though quite a few exhibit attractive red, white or yellow patterns on their pinnules. They are rarely of a single colour.

Order COMMATULIDA

Family COMASTERIDAE

1. *Capillaster mariaae* (A. H. Clark) : Andamans – 0 to 108 m.
2. *C. multiradiatus* (Linnaeus) : Andamans – 110 m; North Andamans-eight miles west of Interview Island, 82 m; Oliver Island; South Andamans – Pongibalu; Rutland Island, 64 m; West of South Andaman Island, 11° 49' 30" N, 92° 55' 00" E, 100 m; Nicobars.
3. *Comanthus nobilis* (P.H. Carpenter) : South Andamans – Pongibalu; Invisible Bank; littoral to 77 m.
4. *C. parvicirrus* (Mueller) : North Andamans – Table Island; South Andamans – Port Blair; Ritchie's Archipelago – Havelock Island; Nicobars-Kamorta Island; Nancowry Island; littoral to 77 m.
5. *C. samoanus* A. H. Clark/*C. wahlbergi* (Mueller) : North Andamans – Orchid Island; Interview Island; Egg Island; Swamp and Dotrel Islands; Curlew (BP) Island; South Andamans – Off Port Blair; Invisible Bank; Ritchie's Archipelago-Havelock Island; Sir William Peel Island; Nicobars – Kamorta Island; Trinket Island.
6. *Comaster gracilis* (Hartlaub) : South Andamans – Port Blair; littoral to 55 m.
7. *C. multibrachiatus* (P. H. Carpenter) : Andamans – 31 to 55 m.

8. *C. multifidus* (J. Mueller) : North Andamans-Curlew (BP) Island; Ritchie's Archipelago-Sir William Peel Island.
9. *Comatella maculata* (P. H. Carpenter) : North Andamans – Swamp and Dotrel Islands; South Andamans – Pongibalu; Nicobars – Trinket Island.
10. *C. nigra* (P. H. Carpenter) : North Andamans – Oyster-1 Island; South Andamans – Alexandra Island; Pongibalu; Ritchie's Archipelago – Havelock Island.
11. *C. stelligera* (P. H. Carpenter) : North Andamans – Interview Island; Ritchie's Archipelago – Havelock Island; Sir William Peel Island.
12. *Comatula brevicirra* (Bell) : Nicobars – Kamorta Island; Nancowry Island.
13. *C. pectinata* (Linnaeus) : Nicobars – Nancowry Island.
14. *Oxycomanthus bennetti* (Mueller) : North Andamans – Table Island; 27 to 64 m; Ritchie's Archipelago-Sir William Peel Island.

Family HIMEROMETRIDAE

15. *Amphimetra mollerii* A. H. Clark : Andamans.
16. *A. mortenseni* Clark : Andamans.
17. *A. philiberti* (Mueller) : South Andamans – Port Blair.
18. *Craspedometra acuticirra* (P. H. Carpenter) : Andamans.
19. *C. anceps* (P. H. Carpenter) : Andamans, 18–80 m.
20. *Heterometra bengalensis* (Hartlaub) : Andamans, 0–44 m.
21. *Himerometra magnipinna* (A. H. Clark) : South Andamans – Pongibalu.
22. *H. robustipinna* (P. H. Carpenter) : South Andamans – Pongibalu; Boat Island; Little Andaman Island.

Family MARIAMETRIDAE

23. *Dichrometra protectus* (P. H. Carpenter) : South Andamans – Port Blair; Cinque Island.
24. *Lamprometra palmata* (J. Mueller) : North Andamans – Oliver Island; Egg Island Ritchie's Archipelago – Havelock Island.
25. *Stephanometra indica* (Smith) : Ritchie's Archipelago – Havelock Island.
26. *S. monacantha* (Hartlaub) : South Andamans – Port Blair; Nicobars. 0–38 m.

Family COLOBOMETRIDAE

27. *Colobometra discolor* (A. H. Clark) : North Andamans – Table Island; South Andamans Port Blair, 27–64 m.

28. *Cotylometra gracilicirra* (A. H. Clark) : Andamans.
29. *Oligometra serripinna* (P. H. Carpenter) : Andamans.
30. *Iconometra intermedia* (A. H. Clark) : Andamans.
31. *Pontiometra andersoni* (P. H. Carpenter) : Andamans, 0–44.

Family ANTEDONIDAE

32. *Dorometra nana* (Hartlaub) : Andamans; Nicobars; 0–75 m.

Class ASTEROIDEA

Members of Asteroidea commonly known as 'sea stars' have a central disc gradually drawn into five arms along the five radii represented by the five ambulacra. A few however have more than five arms regularly or as an exception. Most species are of uniform dull colours while a few exhibit variegations or bright colours. They live hidden under hard substrata or burrow into the soft substratum.

Order PAXILLOSIDA

Family LUIDIIDAE

1. *Luidia maculata* Mueller and Troschel : South Andamans–Cinque Island, 20–46 m.
2. *L. savignyi* (Audouin) : Andamans.
3. *L. hardwicki* (Gray) : Andamans.

Family ASTROPECTINIDAE

4. *Astropecten monacanthus* Sladen : North Andamans – Centre of West Coral Bank, 27 m; South Andamans – Off Port Monatt, 37 m; Little Andaman Island.
5. *A. polyacanthus* Mueller and Troschel : North Andamans – Table Island, 27 to 55 m; Middle Andamans – Mayabunder; South Andamans – Port Blair.
6. *Astropecten zebra* Sladen : South Andamans – Cinque Island, 20 m.

Order VALVATIDA

Family ARCHASTERIDAE

7. *Archaster typicus* Mueller and Troschel : North Andamans – Ross Island; Diglipur; Aerial Bay; Middle Andamans – Mayabunder; South Andamans – Ross Island; Port Blair; Chidyatapu; Little Andaman Island; Ritchie's Archipelago – Havelock Island; Nicobars – Car Nicobar Island; Kamorta Island; Nancowry Harbour.

Family GONIASTERIDAE

8. *Anthenea pentagonula* (Lamarck) : South Andamans – Port Blair; Middle Andamans – Long Island.
9. *Anthenea* sp. : Andamans.

Family OREASTERIDAE

10. *Choriaster granulatus* Luetken : North Andaman – Sound Island.
11. *Culcita novaeguineae* Mueller and Troschel[#] : North Andamans – Brown Point, Ray Hill; Ritchie's Archipelago-Havelock Island; South Andamans – Port Blair; Ross Island; Chidyatapu; Nicobars – Kamorta Island; Katchal Island.
12. *C. schmideliana* (Retzius) : North Andamans – East Island; South Andamans – Port Blair; Chester Island; Ritchie's Archipelago – Inglis Island; Nicobars – Katchal Island.
13. *Poraster superbis* (Möbius) : South Andamans – Port Blair.
14. *Protoreaster lincki* (de Blainville) : Middle Andamans – Rangat; Nicobars – Kamorta Island; Great Nicobar Island.
15. *P. nodosus* (Linnaeus) : Nicobars – Great Nicobar Island.

Family OPHIDIASTERIDAE

16. *Dactylosaster cylindricus* (Lamarck) : North Andamans – Channel Island; Ritchie's Archipelago – Outram Island; Nicobars – Great Nicobar Island.
17. *Fromia armata* Koehler : South Andamans – Port Blair; Chidyatapu; Nicobars – Trinket Island.
18. *F. indica* (Perrier) : South Andamans – Port Blair; Pongibalu; Macpherson Strait, north side of eastern end near Chidyatapu; Ritchie's Archipelago – Henry Lawrence Island.
19. *F. milleporella* (Lamarck) : Andamans.
20. *F. monilis* Perrier : North Andamans – Curlew (BP) Island; South Andamans – Pongibalu.
21. *Gomophia egyptiaca* Gray : South Andamans – Off Port Monatt, 37 m.
22. *Heteronardoa carinata* (Koehler) : Andamans.
23. *Leiaster glaber* Peters : Andamans.
24. *Linckia guildingi* Gray : North Andamans – Table (Excelsior) Island; West Island; South Andamans – Port Blair; Pongibalu; Rutland Island; Nicobars.

[#] Though some specimens can be identified with *C. novaeguineae* or with *C. schmideliana*, it is not always possible particularly in the case of young specimens. According to some the former might be a junior synonym of the latter.

25. *L. laevigata* (Linnaeus) : North Andamans – Table (Delgarno) Island; Table (Excelsior) Island; Trilby Island; Tree Island; Landfall Island; Point Island; East Island; West Island; Orchid Island; Oliver Island; Oyster-1 Island; Brown Point, Ray Hill; Curlew (BP) Island; Middle Andamans – Mayabunder; South Andamans – Port Blair; Pongibalu; Malay Island; Twin Islands; Ritchie's Archipelago – Outram Island; Havelock Island; Nicobars – Kamorta Island; Nancowry Island; Katchal Island.
26. *L. multifora* (Lamarck) : South Andamans – Port Blair; Chidyatapu; Pongibalu; Nicobars-Car Nicobar Island; Kamorta Island.
27. *Nardoa frianti* (Koehler) : Andamans.
28. *Nardoa galathea* (Luetken) : South Andamans – Little Andaman Island.
29. *Neoferdina offreti* (Koehler) : South Andamans – Little Andaman Island, 18 m.
30. *Ophidiaster armatus* Koehler : North Andamans – Off Passage Island, 31 m.
31. *O. hemprichi* Mueller and Troschel : Nicobars – Car Nicobar Island.
32. *Paraferdina sohariae* Marsh and Price : Andamans.
33. *Tamaria dubiosa* (Koehler) : Andamans.
34. *T. megaloplax* (Bell) : Andamans; Nicobars – Trinket Island.
35. *Chaetaster vestitus* Koehler : Andamans.

Family ASTEROPSEIDAE

36. *Asteropsis carinifera* (Lamarck) : North Andamans – Channel Island.

Family ASTERINIDAE

37. *Asterina burtoni* Gray : North Andamans – Tree Island; Channel Island; South Andamans – Port Blair; Rutland Island; Little Andaman Island; Ritchie's Archipelago – Inglis Island; Nicobars – Nicobars.
38. *A. sarasini* (de Loriol) : Middle Andamans – Mayabunder; South Andamans – Port Blair; Pongibalu; Rutland Island; Ritchie's Archipelago – Outram Island; Inglis Island; Neil Island; Nicobars – Car Nicobar Island.
39. *Disasterina spinosa* Koehler : South Andamans – Port Blair.
40. *D. spinulifera* H.L. Clark : South Andamans – Northern side of eastern end of Macpherson Strait near Chidyatapu.
41. *Patiriella pseudoexigua* Dartnall : North Andamans-Smith Island; Middle Andamans–Mayabunder; Strait Island; Rangat; South Andamans – Port Blair; Ross Island; Rangachang; Chidyatapu; Rutland Island; Little Andaman Island; Nicobars.
42. *Tegulaster emburyi* Livingstone : Nicobars – Katchal Island.

Family ACANTHASTERIDAE

43. *Acanthaster planci* (Linnaeus) : Middle Andamans – Mayabunder. South Andamans – Pongibalu; Alexandra Island; Chester Island; Grub Island; Redskin Island; Twin Islands; Ritchie's Archipelago – Inglis Island; Neil Island; Nicobars – Nancowry Island; Katchal Island.

Family VALVASTERIDAE

44. *Valvaster striatus* (Lamarck) : North Andamans-Brown Point, Ray Hill.

Order VELATIDA

Family PTERASTERIDAE

45. *Euretaster cribrosus* (von Martens) : Nicobars – Kamorta Island.

Order SPINULOSIDA

Family ECHINASTERIDAE

46. *Echinaster callosus* Marenzeller : South Andamans – Rutland Island.
47. *E. luzonicus* (Gray) : Andaman Sea; Nicobars – Kamorta Island.

Family METRODIRIDAE

48. *Metrodira subulata* Gray : Andamans; Nicobars – Kamorta Island.

Class OPHIUROIDEA

The ophiuroids, commonly known as 'brittle stars' have a central disc and distinct arms. The arm segments are box-like and articulate like vertebrae. In most species belonging to suborder Euryalina the arms are branched. All others have only five arms excepting the fissiparous ones, which possess more than five arms.

Order PHRYNOPHIURIDA

Family GORGONOCEPHALIDAE

1. *Astrocladus exiguus* (Lamarck) : Andamans.

Family EURYALIDAE

2. *Trichaster acanthifer* Doederlein : Andamans Sea – Stn 554. 12° 47' 30'' N 98° 15' 30'' E, 44 m.
3. *Asteromorpha flosculus* (Alcock) : Andamans.

Family ASTEROSCHEMATIDAE

4. *Asteroschema fastosum* Doederlein : Nicobars.
5. *Asteroschema subfastosum* Doederlein : Nicobars.
6. *Ophiocreas sibogae* (Doederlein) : Nicobars.
7. *Ophiocreas* sp. : Andamans.

Family OPHIOMYXIDAE

8. *Ophiomyxa australis* Luetken : Andamans, 24 – 62 m; Andaman Sea, 316 m.

Order OPHIURIDA

Family AMPHIURIDAE

9. *Amphioplus (Amphioplus) personatus* (Koehler) : Andamans; Nicobars – Nancowry Harbour.
10. *A. (Lymanella) depressus* (Ljungman) : Andamans – Andamans, 13 – 18 m; West coast of Andamans, 27 m; South Andamans – Off Little Andaman Island, 13 – 18 m.
11. *A. (L.) hastatus* (Ljungman) : Andamans.
12. *A. (L.) laevis* (Lyman) : Andamans.
13. *Amphipholis misera* (Koehler) : Andamans.
14. *A. squamata* (Delle Chiaje) : North Andamans – Port Cornwallis; Nicobars – Car Nicobar Island.
15. *Amphiura septemspinosa* H. L. Clark Andamans.
16. *Ophiocentrus dilatatus* (Koehler) : Andamans.

Family OPHIACTIDAE

17. *Ophiactis modesta* Brock : Andamans – Andamans; South Andamans-Port Blair; Ritchie's Archipelago – Sir William Peel Island.
18. *O. picteti* (de Loriol) : Andamans, 13 – 18 m.
19. *O. savignyi* (Mueller and Troschel) : Andamans, 0 – 66 m; South Andamans – Port Blair; Pongibalu; Alexandra Island; Little Andaman Island; Ritchie's Archipelago – Havelock Island; Neil Island; Nicobars – Kamorta Island; Nancowry Harbour; Nancowry Island; Great Nicobar Island.

Family OPHIOTHRICIDAE

20. *Macrophiothrix aspidota* (Mueller and Troschel) : North Andamans – Ray Hill; South Andamans – Port Blair.
21. *M. demessa* (Lyman) : Ritchie's Archipelago-Neil Island.
22. *M. galatea* (Koehler) : South Andamans – Port Blair.
23. *M. koehleri* A. M. Clark : North Andamans – Tentul Tikri; Aerial Bay; Middle Andamans –Mayabunder; Long Island; South Andamans – Port Blair; Nicobars – Car Nicobar Island.
24. *M. longipeda* (Lamarck) : North Andamans – Interview Island; South Andamans – Port Blair, Rangachang; Pongibalu; Rutland Island; Alexandra Island; Jolly Buoy Island; Malay Island; Ritchie's Archipelago – Havelock Island; Nicholson Island; Nicobars.
25. *M. propinqua* (Lyman) : Andamans – Port Monatt; North Andamans – Diglipur; South Andamans – Chidyatapu; Pongibalu; Ritchie's Archipelago – Havelock Island; Sir William Peel Island; Neil Island; Nicobars – Nancowry Island; Kamorta Island.
26. *M. speciosa* (Koehler) : South Andamans – Port Blair.
27. *Ophiocnemis marmorata* (Lamarck) : Andamans.
28. *Ophiolophus novarae* Marktanner-Turneretscher : Nicobars.
29. *Ophiomaza cacaotica* Lyman : Andamans and Nicobars (on various crinoid hosts).
30. *Ophiopterion elegans* Ludwig : South Andamans-South Sentinel Island.
31. *Ophiothela danae* Verrill : South Andamans – Jolly Buoy Island; Ritchie's Archipelago– Havelock Island.
32. *Ophiothrix (Acanthophiothrix) proteus* Koehler : Nicobars – Nancowry Harbour.
33. *O. (A.) purpurea* von Martens : Andamans, 62 – 75 m; South Andamans – Pongibalu.
34. *O. (A.) vigelandi* A. M. Clark : South Andamans –North of Rutland Island.
35. *O. (Keystonea) nereidina* (Lamarck) : Andamans, 0 – 37 m; North Andamans – Curlew (BP) Island; South Andamans – Pongibalu; South Sentinel Island; Nicobars – Nancowry Harbour; Nancowry Island; Kamorta Island.
36. *O. (Ophiothrix) ciliaris* (Lamarck) : Andamans, 64 m; North Andamans – Aerial Bay; South Andamans-South Sentinel Island.
37. *O. (O.) exigua* Lyman : North Andamans – Aerial Bay; Port Cornwallis; Diglipur; Ritchie's Archipelago – Havelock Island; Nicobars – Kamorta Island; Nancowry Island.
38. *O. (O.) foveolata* Marktanner – Turneretscher : Andamans, 37 m; South Andamans – Chidyatapu.
39. *O. (O.) trilineata* Luetken : Andamans, 0 – 24 m; North Andamans – Aerial Bay; South Andamans – Port Blair; Chidyatapu; Ritchie's Archipelago – Havelock Island; Sir William Peel Island; Neil Island; Nicobars – Kamorta Island.

Family OPHIOCOMIDAE

40. *Ophiarthrum elegans* Peters : Andamans, 27 – 64 m; North Andamans – Interview Island; Brown Point, Ray Hill; Middle Andamans – Mayabunder; South Andamans – Port Blair; Alexandra Island; Jolly Buoy Island; Nicobars – Kamorta Island; Trinket Island.
41. *O. pictum* Mueller and Troschel : South Andamans – Port Blair; New Wandoor; Pongibalu; Ritchie's Archipelago – Havelock Island; Inglis Island; Nicobars – Kamorta Island; Nancowry Island.
42. *Ophiocoma brevipes* Peters : North Andamans – Brown Point, Ray Hill; Middle Andamans – Rangat; South Andamans – Port Blair; Rutland Island; Off South Sentinel Island, 24 m; Little Andaman Island; Ritchie's Archipelago – Inglis Island.
43. *O. dentata* Mueller and Troschel : Middle Andamans – Mayabunder; South Andamans – Port Blair; Kaudiaghat; Jolly Buoy Island; Little Andaman Island; Ritchie's Archipelago – Inglis Island; Nicobars – Nicobars; Car Nicobar Island; Kamorta Island; Nancowry Harbour; Katchal Island; Trinket Island; Great Nicobar Island.
44. *O. doderleini* Loriol : South Andamans – Port Blair
45. *O. erinaceus* Mueller and Troschel : North Andamans – Table Island; Aerial Bay, Port Cornwallis; Diglipur; Avis Island; Interview Island; Ray Hill; Egg Island; Swamp and Dotrel Islands; Curlew (BP) Island; Middle Andamans – Mayabunder; Rangat Bay; South Andamans – Port Blair; Pongibalu; South Sentinel Island; Ritchie's Archipelago – Havelock Island; Inglis Island; Neil Island; Nicobars – Car Nicobar Island; Kamorta Island; Nancowry Island; Trinket Island; Great Nicobar Island.
46. *O. pica* Mueller and Troschel : Nicobars – Nancowry Island; Trinket Island.
47. *O. pusilla* (Brock) : North Andamans – Tentul Tikri, near Aerial Bay; Ritchie's Archipelago – Havelock Island; Inglis Island; Neil Island; Nicobars – Kamorta Island; Nancowry Island.
48. *O. scolopendrina* (Lamarck) : North Andamans – Sound Island; Ross Island; Middle Andamans – Mayabunder; Bakri Tikri; Long Island; Rangat; South Andamans – Port Blair; Ross Island; Rangachang; Wandoor; New Wandoor; Pongibalu; Chidyatapu; Macpherson Strait; Rutland Island; Alexandra Island; Jolly Buoy Island; Ritchie's Archipelago – Nicholson Island; Havelock Island; Inglis Island; Neil Island; Nicobars – Car Nicobar Island; Kamorta Island; Nancowry Island; Trinket Island; Katchal Island; Great Nicobar Island.
49. *Ophiocomella sexradia* (Duncan) : South Andamans – Port Blair.
50. *Ophiomastix annulosa* (Lamarck) : North Andamans-Ray Hill; South Reef Island; Middle Andamans – Mayabunder; Long Island; South Andamans – Port Blair; Chidyatapu;

Pongibalu; Rutland Island; Jolly Buoy Island; Ritchie's Archipelago – Inglis Island; Neil Island; Nicobars – Car Nicobar Island; Kamorta Island; Nancowry Island; Trinket Island; Katchal Island; Great Nicobar Island.

51. *Ophiopsila pantherina* Koehler : North Andamans – Table Island, 27 – 64 m.

Family OPHIONEREIDAE

52. *Ophionereis andamanensis* James : South Andamans – Port Blair.
 53. *O. dubia* (Mueller and Troschel) : South Andamans – North of Rutland Island.
 54. *O. porrecta* Lyman : North Andamans – Off Passage Island, 31 m; South Andamans – South Sentinel Island.

Family OPHIODERMATIDAE

55. *Gymnopelta indica* (Koehler) : Andamans.
 56. *Ophiarachna incrassata* (Lamarck) : South Andamans – Port Blair.
 57. *Ophiarachnella gorgonia* (Mueller and Troschel) : South Andamans – Port Blair; Cinque Island, 20 m; Nicobars – Kamorta Island.
 58. *O. infernalis* (Mueller and Troschel) : North Andamans – Interview Island; Egg Island; Nicobars – Kamorta Island.
 59. *O. sphenesci* (Bell) : Andamans.
 60. *Ophiopeza custos* Koehler : Andamans.
 61. *Ophiopsammus yoldii* (Luetken) : Andamans.

Family OPHIURIDAE

62. *Ophioelegans cincta* (Mueller and Troschel) : North Andamans – Port Cornwallis; Ross Island; Egg Island; Middle Andamans – Mayabunder; Strait Island; Long Island; Bakri Tikri; South Andamans – Port Blair; Rangachang; Kaudiaghat; Pongibalu; Alexandra Island; Ritchie's Archipelago – Neil Island; Nicobars – Car Nicobar Island.
 63. *Ophiolepis superba* H.L. Clark : Middle Andamans – Mayabunder; South Andamans – Port Blair; Ritchie's Archipelago – Henry Lawrence Island.
 64. *Ophioplocus imbricatus* (Mueller and Troschel) : Middle Andamans-Rangat; South Andamans – Little Andaman Island; Nicobars – Kamorta Island; Nancowry Island; Trinket Island.

Class ECHINOIDEA

These are variously known as sea urchins, sand dollars, cake urchins and heart urchins depending on the shape. The endoskeleton of the echinoids usually called as test, is a rigid box of calcareous plates arranged in ambulacral and interambulacral series. The regular echinoids, which have the anus opening in the apical system, are hemispherical in shape with a flat oral side and arched aboral side. In irregular echinoids, which have the anus opening outside the apical system, generally on the oral side, the test is flat or heart shaped. The spines on the test are well developed among which are different types of special structures called pedicellariae. The tube feet in regular echinoids are arranged in vertical series while they form petals in irregular echinoids. The roe of some echinoids is highly valuable though this resource is not exploited at present from India.

Order CIDAROIDA

Family CIDARIIDAE

1. *Eucidaris metularia* (Lamarck) : Middle Andamans – Long Island; South Andamans – Port Blair; Rutland Island; Off Port Monatt, 37 m; South Sentinel Island; Invisible bank.
2. *Phyllacanthus imperialis* (Lamarck) : Ritchie's Archipelago-Henry Lawrence Island.
3. *Prionocidaris verticillata* (Lamarck) Andamans – Andamans; Middle Andamans – Long Island; South Andamans – Pongibalu; Ritchie's Archipelago-Henry Lawrence Island.

Order DIADEMATOIDA

Family DIADEMATIDAE

4. *Astropyga radiata* (Leske) : North Andamans – Table Island.
5. *Diadema savignyi* Michelin : Distribution is given under the next species, *D. setosum* since the specimens might belong to either of the two species.
6. *D. setosum* (Leske) : North Andamans – Aerial Bay; Diglipur; Middle Andamans – Mayabunder; South Andamans – Ross Island; Port Blair; Chidyatapu; Pongibalu; Alexandra Island; Redskin Island; Malay Island; Jolly Buoy Island; Ritchie's Archipelago-Outram Island; Havelock Island; Neil Island; Nicobars – Car Nicobar Island; Kamorta Island; Nancowry Island; Katchal Island; Great Nicobar Island.
7. *Echinothrix calamaris* (Pallas) : North Andamans – Table Island; Aerial Bay; Diglipur; Ross Island; Middle Andamans – Rangat; South Andamans – Port Blair; Ross Island; Chidyatapu; Pongibalu; Alexandra Island; Grub Island; Little Andaman Island; Ritchie's Archipelago – Havelock Island; Henry Lawrence Island; Inglis Island.
8. *E. diadema* (Linnaeus) : North Andamans – Table Island; Nicobars – Car Nicobar Island.

Order PHYMOSOMATOIDA

Family STOMECHINIDAE

9. *Stomopneustes variolaris* (Lamarck) : South Andamans – Port Blair; Little Andaman Island; Ritchie's Archipelago – Havelock Island; Nicobars – Nancowry Island; Kamorta Island.

Order TEMNOPLEUROIDA

Family TEMNOPLEURIDAE

10. *Mespilia globulus* (Linnaeus) : South Andamans – Port Blair; Pongibalu; Ritchie's Archipelago – Henry Lawrence Island; Nicobars – Kamorta Island.
11. *Microcyphus ceylanicus* Mortensen : Andamans.
12. *Paratrema doederleini* (Mortensen) : Andamans.
13. *Salmaciella dussmieri* (L. Agassiz) : South Andamans – Cinque Island, 20 m.
14. *Salmacis bicolor* L. Agassiz : Nicobars-Nancowry Island.
15. *Temnopleurus toreumaticus* (Leske) : South Andamans-Port Blair.
16. *Temnotrema scillae* (Mazetti) : South Andamans – Port Blair.

Family TOXOPNEUSTIDAE

17. *Gymnechinus robillardi* (de Loriol) : Andamans.
18. *Toxopneustes pilelous* (Lamarck) : South Andamans – Chidyatapu; Ritchie's Archipelago – Neil Island; Nicobars – Car Nicobar Island; Kamorta Island; Great Nicobar Island.
19. *Tripneustes gratilla* (Linnaeus) : North Andamans – Table Island; South Andamans – Port Blair; Ross Island; Chidyatapu; Ritchie's Archipelago – Sir William Peel Island; Nicobars – Car Nicobar Island; Kamorta Island; Nancowry Island; Katchal Island.

Order ECHINOIDA

Family ECHINOMETRIDAE

20. *Colobocentrotus atratus* (Linnaeus) : South Andamans – Port Blair; Nicobars – Katchal Island; Great Nicobar Island.
21. *Echinometra mathaei* (de Blainville) : North Andamans – South Reef Island; Ray Hill; Curlew (BP) Island; Middle Andamans – Between Avis Island and Mayabunder; Long Island; South Andamans – Port Blair; Ross Island; Chidyatapu; Pongibalu; Jolly Buoy Island; Alexandra Island; East entrance to Macpherson Strait; North of Rutland Island;

Little Andaman Island; Ritchie's Archipelago – Outram Island; Havelock Island; Henry Lawrence Island; Inglis Island; Neil Island; Nicobars – Car Nicobar Island; Kamorta Island; Nancowry Island; Katchal Island; Great Nicobar Island.

22. *Echinostrephus molaris* (de Blainville) : Middle Andamans – Rangat; South Andamans – Port Blair; Ross Island; Kaudiaghat; Pongibalu; Chidyatapu; Macpherson Strait; Nicobars – Kamorta Island; Nancowry Island; Trinket Island.
23. *Heterocentrotus trigonarius* (Lamarck) : Nicobars – Nancowry Island.

Order HOLECTYPOIDA

Family ECHINONEIDAE

24. *Echinoneus cyclostomus* Leske : South Andamans – Wandoor; Ritchie's Archipelago-Havelock Island; Nicobars – Car Nicobar Island; Kamorta Island; Great Nicobar Island.

Order CLYPEASTEROIDA

Family ARACHNOIDIDAE

25. *Arachnoides placenta* (Linnaeus) : North Andamans – North Andaman Island; Off Smith Island; Middle Andamans – Rangat; South Andamans – Port Blair; Chidyatapu; Ritchie's Archipelago – Havelock Island.

Family LAGANIDAE

26. *Laganum depressum* Lesson : North Andamans – Smith Island; Stewart Island; Middle Andamans – Rangat; South Andamans – Port Blair; Wandoor; Pongibalu; Chidyatapu; Ritchie's Archipelago – Havelock Island.
27. *L. laganum* Klein : Andamans – Andaman Sea; South Andamans – Port Blair; Wandoor; New Wandoor; Alexandra Island; Ritchie's Archipelago – Havelock Island; Nicobars – Katchal Island.
28. *Peronella lessueuri* (Valenciennes) Nicobars – Katchal Island.
29. *P. macroproctes* Koehler : Andamans.
30. *P. rubra* Doederlein : South Andamans – Port Blair.

Family ASTRICLYPEIDAE

31. *Echinodiscus auritus* Leske : South Andamans – Off Port Monatt 37 m.
32. *E. bisperforatus* Leske : South Andamans – Port Blair; Little Andaman Island.

Order SPATANGOIDA

Family SCHIZASTERIDAE

33. *Moira stygia* Luetken : South Andamans – Port Blair.

Family BRISSIDAE

34. *Metalia spatagus* (Linnaeus) : Andamans – Andamans; North Andamans – West Coral Bank, 27 m; South Andamans – Port Blair.
35. *M. sternalis* (Lamarck) : Andamans – Andamans; South Andamans – Port Blair.

Family SPATANGIDAE

36. *Maretia planulata* Gray : Andamans.

Family LOVENIIDAE

37. *Breynia vredenburgi* Anderson : South Andamans – Port Blair.
38. *Lovenia elongata* (Gray) : Andamans-Andamans; South Andamans – Port Blair; Ritchie's Archipelago – Havelock Island.
39. *Lovenia subcarinata* (Gray) : Andamans.

Class HOLOTHUROIDEA

Members of Holothuroidea commonly known as 'sea cucumbers' have the body elongated along the oro-anal axis with a thick leathery body wall. The tube feet are well developed particularly on the ventral side, reduced into pedicels or altogether absent in some. The tube feet around the mouth are modified into tentacles performing specialised functions such as burrowing and feeding. The endoskeleton consists of microscopic spicules of various shapes that help in taxonomic identification. Some of the species are of commercial value and find export market.

Order ASPIDOCHIROTIDA

Family HOLOTHURIIDAE

1. *Actinopyga echinites* (Jaeger) : South Andamans – Port Blair; Wandoor.
2. *A. lacanora* (Jaeger) : Andamans and Nicobars.
3. *A. mauritiana* (Quoy and Gaimard) : Middle Andamans – Rangat; South Andamans – Port Blair; Ross Island; Kaudiaghat; Chidyatapu; Jolly Buoy Island; Tarmugli Island; Little Andaman Island; Ritchie's Archipelago – Havelock Island; Neil Island; Nicobars – Car Nicobar Island; Nancowry Island; Trinket Island; Great Nicobar Island.

4. *A. miliaris* (Quoy and Gaimard) : South Andamans – Jolly Buoy Island; Malay Island; Ritchie's Archipelago – Neil Island.
5. *Bohadschia argus* Jaeger : South Andamans – Redskin Island; Twin Islands.
6. *B. marmorata* Jaeger : South Andamans – Port Blair; Little Andaman Island; Nicobars – Trinket Island.
7. *B. vitiensis* (Semper) : South Andamans – Chester Island; Malay Island.
8. *Holothuria (Acanthotrabeza) pyxis* Selenka : Andamans – Port Monatt, Surf line; South Andamans – Wandoor; Jolly Buoy Island; Rutland Island; Ritchie's Archipelago – Havelock Island; Nicobars – Kamorta Island.
9. *H. (Cystipus) rigida* (Selenka) : North Andamans – Sound Island; Middle Andamans – Mayabunder; Long Island; South Andamans – Port Blair; Rutland Island; Little Andaman Island; Ritchie's Archipelago – Neil Island; Nicobars – Nancowry Island.
10. *H. (Halodeima) atra* Jaeger : North Andamans – Interview Island; Middle Andamans – Mayabunder; Bakri Tikri; Long Island; South Andamans – Port Blair; Ross Island; Rangachang; Chester Island; Malay Island; Jolly Buoy Island; Little Andaman Island; Ritchie's Archipelago – Havelock Island; Inglis Island; Neil Island; Nicobars – Car Nicobar Island; Kamorta Island; Nancowry Island; Trinket Island; Great Nicobar Island.
11. *H. (H.) edulis* Lesson : South Andamans – Port Blair; Jolly Buoy Island; Rutland Island.
12. *H. (Lessonothuria) pardalis* Selenka : North Andamans – Sound Island; Middle Andamans – Mayabunder; Long Island; Rangat; South Andamans – Port Blair; Chidyatapu; Wandoor; Little Andaman Island; Ritchie's Archipelago – Inglis Island; Havelock; Nicobars – Car Nicobar Island; Nancowry Harbour; Katchal Island; Great Nicobar Island.
13. *H. (Mertensiothuria) fuscocinerea* Jaeger : South Andamans – Port Blair.
14. *H. (M.) leucospilota* Brandt : North Andamans – Sound Island; South Island; Middle Andamans – Rangat; Bakri Tikri; South Andamans – Port Blair; Macpherson Strait; Jolly Buoy Island; Little Andaman Island; Ritchie's Archipelago – Havelock Island; Neil Island; Nicobars – Nancowry Island; Trinket Island.
15. *H. (M.) pervicax* Selenka : South Andamans – Port Blair.
16. *H. (Metriatyla) scabra* Jaeger : North Andamans – Diglipur; Middle Andamans – Rangat; South Andamans – Port Blair; North Bay; Chidyatapu; Tarmugli Island; Ritchie's Archipelago – Inglis Island.
17. *H. (Microthele) nobilis* (Selenka) : South Andamans – Port Blair.
18. *H. (Platyperona) difficilis* Semper : Nicobars – Kamorta Island.
19. *H. (Selenkothuria) erinaceus* Semper : North Andamans – Interview Island; Middle Andamans – Mayabunder; South Andamans – Port Blair; Nicobars – Nancowry Island.

20. *H. (Semperothuria) cinerescens* (Brandt) : Middle Andamans – Rangat; South Andamans – Port Blair; Rutland Island; Ritchie's Archipelago – Neil Island; Nicobars – Car Nicobar Island; Kamorta Island.
21. *H. (Thymiosycia) arenicola* Semper : North Andamans; South Andamans – Port Blair; Ritchie's Archipelago – Neil Island; Nicobars – Car Nicobar Island; Kamorta Island.
22. *H. (T.) gracilis* Semper : Andamans – Andamans; South Andamans-Port Blair.
23. *H. (T.) hilla* Lesson : Middle Andamans – Rangat; South Andamans – Port Blair; Chidyatapu; Jolly Buoy Island; Little Andaman Island; Nicobars – Trinket Island.
24. *H. (T.) impatiens* Forskal : North Andamans – Curlew Island; Sound Island; Middle Andamans – Long Island; South Andamans – Port Blair; Malay Island; Ritchie's Archipelago – Inglis Island; Havelock Island; Henry Lawrence Island; Neil Island; Nicobars – Kamorta Island; Trinket Island; Katchal Island.

Family LABIDODEMATIDAE

25. *Labidodemas rugosum* (Ludwig) : South Andamans – Port Blair; North Andamans – South Reef Island, Surf line; Nicobars – Great Nicobar Island.

Family STICHOPODIDAE

26. *Stichopus chloronotus* Brandt : North Andamans – Sound Island; South Andamans – Port Blair; Ross Island; Wandoor; Alexandra Island; Redskin Island; Jolly Buoy Island; Port Monatt, surf line; Rutland Island; Ritchie's Archipelago – Havelock Island; Neil Island; Nicobars – Car Nicobar Island; Nancowry Island; Great Nicobar Island.
27. *S. horrens* Selenka : South Andamans – Ross Island; Nicobars – Nancowry Harbour.
28. *S. variegatus* Semper : South Andamans – Port Blair; Ritchie's Archipelago – Inglis Island; Nicobars – Trinket Island.
29. *S. vastus* Sluiter : South Andamans – Wandoor; Nicobars.

Order DENDROCHIROTIDA

Family CUCUMARIIDAE

30. *Aslia forbesi* (Bell) : Ritchie's Archipelago – Havelock Island.

Family PHYLLOPHORIDAE

31. *Afrocucumis africana* (Semper) : Andamans – Andamans; North Andamans – Sound Island; South Andamans – Port Blair; Rangachang; Little Andaman Island; Ritchie's Archipelago – Havelock Island; Neil Island; Nicobars – Trinket Island.

32. *Phyllophorus celer* Nicobars – Katchal Island.
 33. *Phyrella fragilis* (Ohshima) : South Andamans – Port Blair

Order APODIDA

Family SYNAPTIDAE

34. *Opheodesoma grisea* (Semper) : Middle Andamans – Rangat; South Andamans – Port Blair; Nicobars – Car Nicobar Island; Nancowry Island.
 35. *Patinapta ooplax* (von Marenzeller) : Andamans.
 36. *Synapta maculata* (Chamisso and Esenhardt) : North Andamans – Sound Island; South Andamans – Port Blair; Chidyatapu; Jolly Buoy Island; Alexandra Island; Ritchie's Archipelago – Inglis Island; Nicobars – Car Nicobar Island; Kamorta Island.
 37. *Synaptula recta* (Semper) : South Andamans – Port Blair; Nicobars – Kamorta Island.
 38. *S. striata* Sluiter : Nicobars – Kamorta Island.

Family CHIRIDOTIDAE

39. *Polycheira rufescens* (Brandt) : North Andamans – Sound Island; Port Cornwallis; Middle Andamans – Rangat; Long Island; South Andamans – Port Blair; Ross Island; Wandoor; Chidyatapu; Macpherson Strait; Nicobars – Kamorta Island; Nancowry Island; Trinket Island; Great Nicobar Island.
 40. *Trochodota havelockensis* Rao : Ritchie's Archipelago – Havelock Island.

Family MOLAPADIIDAE

41. *Acaudina molpadioides* (Semper) : Andamans.

DISCUSSION

Coral reefs are a highly productive and stable ecosystem providing a variety of habitats to different groups of animals with varied modes of life and catering to their needs. Hence several groups of animals with diverse habits of life make the coral reef their habitat. Of the several groups of biota inhabiting the reef ecosystem, echinoderms are important because of their size, numbers, living habits and effect on coral cover. Echinoderms inhabit both hard and soft substrata and a variety of suitable habitats are provided by the coral reef ecosystem. They interact through dwelling, feeding and reproductive activities, both with corals and other denizens of the ecosystem. In the process the corals experience both advantages and disadvantages. The association of echinoderms with corals is mostly facultative, the echinoderm taking advantage of the facilities available in the reef habitats.

Among the crinoids, species such as *Capillaster multiradiatus*, *Comanthina nobilis*, *Comaster gracilis*, *Comatella maculata* and *Himerometra magnipinna* are common even in knee-deep water. They are most common among the dead branches and bases of corals. They firmly hold the substratum with the help of the cirri. A few species with small and nonfunctional cirri or lacking cirri inhabit hollows in the massive colonies or the intricate branches of acroporans. During daytime they are cryptic. At night they lay perched on vertical surfaces to feed on the floating microorganisms filtered by pinnules of the spread out arms. Thus they compete with corals and other animals with a similar mode of feeding. Along with the microorganisms they also trap the suspended particles in their mucus and reduce silt settlement on the corals. The feeding on microorganisms does not affect the corals in view of their abundance but it helps corals by trapping the silt in mucus secreted for feeding.

A few asteroids such as *Luidia*, *Astropecten* and *Archaster* inhabit patches of soft substratum among the coral colonies or in their neighborhood. During low-tide periods they lie buried. The inhabitants of hard substratum take shelter under dead coral bases and massive corals or in the crevices of conglomerates. Forms of small to moderate size such as *Fromia*, *Linckia multifora*, *Dactylosaster*, and *Asteropsis* hide in crevices or under massive corals. Even the large sized *Acanthaster planci*, the crown-of-thorns sea star (CoT) lies hidden under boulders and massive colonies in the vicinity of live corals. However the large sized *Linckia guildingi*, *L. laevigata*, *Culcita*, *Pentaceraster*, and *Protoreaster* lie exposed in open places mostly on hard substrata. Though no specific preference can be attributed, *Dactylosaster* was reported from *Favites*, *Tamaria* from *Synarea* and *Asterina* from several species of *Acropora*, *Pocillopora damicornis* and equally from *Millepora*.

The feeding habits of asteroids are varied. Forms such as *Pentaceraster regulus*, *Dactylosaster cylindricus*, *Linckia guildingi*, *L. multifora*, and *Echinaster purpureus* feed on surface film. Some exhibit a combination of different feeding habits. Some oreasterids such as *Protoreaster lincki* feed on oysters while other ophiasterids and asterinids feed on sponges, ascidians, small crustaceans, molluscs, algae and encrusting organisms. *Protoreaster nodosus* is known to feed on algae, meiobenthos as well as substrate film. *Linckia laevigata*, feeds on coralline algae, detritus and microscopic organisms. Goniasterids are omnivorous feeding on encrusting organisms, detritus, decaying organisms *etc.* The surface film feeders and epifaunal carnivores prevent destructive organisms settling on dead bases and their environs. Among the carnivores, astropectinids feed on infaunal elements such as crabs, bivalves and gastropods. Only a few sea stars are known to feed on coral polyps. Notables among these are *Culcita* and CoT. The former is known to feed on a variety of coral species belonging to *Acropora*, *Galaxea*, *Porites*, *Goniopora* *etc.* It also feeds on substrate film, sponges, and algae and sometimes on soft corals. The juveniles and young specimens up to 8mm diameter of CoT inhabit and feed exclusively on coralline algae. Only larger specimens exclusively feed on live polyps of a variety of hermatypic corals particularly branching species. They also feed on *Millepora*, *Tubipora*, sea anemones and soft corals.

The greatest destruction to corals is from CoT. Generally the population density of the sea star is low and their feeding activity restricted to nights. In addition, part of the colony is spared before moving to another. The herbivores such as *Trochus*, *Turbo*, sea urchins *etc.* feeding on algae particularly coralline algae, control the CoT populations at normal densities by destroying the larvae and juveniles taking shelter in them. Coral polyps also engulf the larvae in the plankton though not selectively. Several organisms taking shelter among the live corals such as crabs and shrimps nibble the tube feet of the sea star restricting their feeding intensity. The deadly predator of *Acanthaster* is the giant triton, *Charonia tritonis* that engulfs whole young specimens. However the adults are partly eaten and the sea star also escapes by severing the attacked arm. At high densities called infestation resulting from population explosion or mass scale invasion the sea star feeds continuously even during daytime leaving no part of the colony untouched. However the windward reef slopes with currents and wave action are spared.

Of the ophiuroids, forms with branched arms filter the floating microorganisms in the network of branched arms. Some amphiuroids, particularly *Amphipholis squamata* and the ophiactids *Ophiactis* species are associated with algae and sponges of coral reefs and also take shelter in narrow crevices. Among the Ophiothricidae several species of *Ophiothrix* and *Macrophiothrix* are common in reef habitats taking shelter in the crevices of dead bases. Some are associated with alcyonarians of the reef. Species with very long arms like *Macrophiothrix longipeda* bury the disk and one or two arms under the rubble or anchor in deep crevices, projecting the remaining arms out into the waters for feeding. The other common species belong to Ophiocomidae. *Ophiomastix annulosa* is common on undersurfaces and in crevices during low tide periods. The spines are long and the arms have characteristic coloration. Among the species of *Ophiocoma*, species such as *O. erinaceus* and *O. brevipes* extend up to about 40 m depth on reef slope while *O. pica*, *O. pusilla*, *O. scolopendrina*, *etc.* occur in shallow waters. *O. brevipes* is most common on *Acropora digitifera* and exceptionally found also on *Pocillopora*. Others are found on a number of species of *Acropora*, *Pocillopora*, *Stylophora*, *Pavona*, *Porites*, *Favia*, *Galaxea*, *etc.* *O. erinaceus* is very commonly associated with *Millepora* also. The fissiparous ophiocomid *Ophiocomella sexradia* also occurs on a number of corals. The ophiurids *Ophioplocus imbricatus* and *Ophioelegans cincta* occur on dead coral base and on *Pocillopora*. *Ophiolepis superba* with an attractive brilliant star shaped dark marking on disc is common on branching corals. Of the ophiodermatids, *Ophiarachnella gorgonia* and *Ophiarachna incrassata* are common among reef habitats. Most ophiuroids are substrate or filter feeders. Species with branching arms filter the microorganisms of the water currents. Others trap microorganisms and organic detritus in mucous secretions. The food trapped also includes the silt that would otherwise settle on corals and mucus as well as microorganisms released by the polyps. Only a few ophiuroids with branching arms along with feather stars are competitors of corals for food consisting of floating microorganisms. Considering the richness of microorganisms in the waters, they do not pose any threat to corals. On the other hand, the mucus and microorganisms from corals and silt in the waters are trapped by many ophiuroids, thus cleaning the waters and reducing silt load on corals.

Most regular echinoids are inhabitants of hard substrata and are common in the reef environments. The common cidariid on most reefs is *Prionocidaris verticillata*. It generally hides under rocks. The diadematids, *Diadema setosum* and *D. savignyi* hide under coral bases or in hollows of massive corals extending out their long needle like spines. The ambulacral primary spines of *Echinohrix calamaris* and *E. diadema* are fine needles with backwardly pointed barbs near the tip. The temnopleurids *Salmacis bicolor* and *Temnopleurus toreumaticus* are not so common in Andaman and Nicobar reefs and the later prefers sandy sea grass beds. The small sized *Mespilia globulus* has bare areas carpeted with pedicellariae and alternating with regions of short spines. The family Toxopneustidae is represented by two common species. *Toxopneustes pileolus* has short white spines and a thick forest of large globiferous pedicellariae with gaping jaws. The jaws are provided with large poisonous sacs. The other species, *Tripneustes gratilla* inhabits shallow lagoons with algae and sea grass beds. The spines are white and short while the black bare areas of test have a mat of minute globiferous pedicellariae.

Stomopneustes variolaris, the sole extant representative of the family Stomechinidae, inhabits undersurfaces frequently boring into rocks, shale and dead coral bases for protection from wave action. The other boring species are members of the family Echinometridae namely *Echinometra mathaei*, *Echinostrephus molaris* and *Colobocentrotus atratus*. Of these *E. molaris* makes vertical cylindrical burrows in calcareous rocks and sometimes in hard shale and stays at the opening of the burrow. At the slightest disturbance the animal quickly drops to the bottom of the burrow. *C. atratus* inhabits shallow depressions on rocks exposed to battering waves. As an adaptation to heavy wave action, the short and flat aboral spines form a mosaic to dissipate the wave energy and the marginal spines are broad like chisel to apply firmly on to the rock. The oral surface bears crowded tube feet for a firm grip of the substratum. The animal virtually looks like a limpet. The boring activity of sea urchins in the dead coral bases severs the attachment of the live portions to be detached and ultimately lost. *Heterocentrotus trigonarius* has long spines, which are triangular in cross section with flattened tip. The irregular echinoids are inhabitants of soft substrata and thus are not common in the reef proper. The frequently encountered members are the holectypoid *Echinoneus cyclostomus*, the sand dollars *Laganum depressum* and *L. laganum* and the heart urchin *Lovenia elongata*.

The regular sea urchins are mainly herbivores feeding on a variety of algae and occasionally omnivores feeding on encrusting organisms along with their vegetative diet. The excessive algal growth covers live corals depriving them of the light necessary for photosynthesis by zooxanthellae associated with them. The algae are also competitors of zooxanthellae for nutrients. Occasionally live basal portions are buried in the sediments trapped by the algae. The coralline algae are the habitat for settlement and growth of juveniles of CoT that may later pose a threat to coral polyps. The herbivorous regular echinoids control the excessive growth of algae and destroy the larvae and juveniles of CoT taking shelter in them. Species such as *Toxopneustes pileolus* and

Tripneustes gratilla with poisonous globiferous pedicellariae and species of *Diadema* and *Echinothrix* with long and brittle spines drive away many potential predators. Very few irregular echinoids occur in reef habitats and are not common. They burrow into the soft substratum and subsist on the organic content of the sediment. Their fecal pellets bring the nutrients to the surface.

Though most sea urchins take shelter under the stones and in depressions already available, these may be widened to suitable size through abrasion. Some actually bore into the dead bases and conglomerates. Notables among them are *Stomopneustes*, *Echinometra* and *Echinostrephus*. Thus they destroy the substratum for settlement. However this helps in the formation of beach sand and soft substratum for other benthic organisms as well as in early dissolution of calcium required by the corals.

Holothurians inhabit the protected places of hard substrata provided by the coral reefs and the soft substrata among them and adjoining vicinities. They take shelter under the coral bases and conglomerates as well as burrow into the soft substrata. However quite a few lie open on the soft bottom. Some species are abundant in the algae and sea grass beds. The most common are species of *Actinopyga*, *Bohadschia*, *Holothuria*, *Stichopus*, *Synapta*, *Polycheira*, etc. Of these *Actinopyga mauritiana*, *Bohadschia marmorata*, *Holothuria* species, *Stichopus chloronotus*, *Synapta maculata*, and *Polycheira rufescens* are common with a wide distribution in Andaman and Nicobar Islands. Many species lie openly on soft substrata with sea grasses or hide under rocks. Smaller specimens can also be found in the algae. Most holothurians are substrate feeders ingesting sediments rich in organic matter either from surface or by burrowing. Some however filter microorganisms from the water with a network of highly branched tentacles. They do not feed on live corals or degrade the dead pieces entering the gut. Through burrowing and feeding on the substratum they disturb the natural stratification of the sediment and thus act as substrata re-workers. In the marine environment holothurians are the counterparts of earthworms of terrestrial ecosystems. By ingesting organic matter of the substrate and trapping the suspended particles they help in reducing organic load of the environment and silt settlement on the polyps.

The echinoderms not only take advantage of the habitat but also contribute to the community. All the echinoderms produce millions of eggs and larvae, which are a source of food for many organisms of plankton, nekton as well as benthos. Many arrow worms, fishes, benthic invertebrates including the coral polyps feed on floating eggs and larvae of echinoderms. Echinoderms are habitat for several symbionts that usually take shelter and share the food of the host or feed on the food associated with the host. The symbionts mostly exhibit concealing coloration and are hard to notice. Crinoids are hosts for a number of symbionts belonging to several varied groups of animals. The alpheid and pontoninid shrimps, galatheid crabs, copepods, polychaetes, young ones of several molluscs and the ophiuroid *Ophiomaza cacaotica* are some important associates of crinoids. All these exhibit cryptic coloration of the host crinoid and mostly share its food. Some asteroids such as *Culcita* and *Acanthaster* are known to shelter alpheid and pontoninid shrimps.

Polychaetes are known to take shelter on the arms of ophiuroids such as *Ophiocoma scolopendrina* and *Macrophiothrix longipeda*. Species belonging to echinoid genera such as *Diadema*, *Echinothrix*, *Stomopneustes* and *Echinometra* are associated with several symbionts such as shrimps, crabs, copepods and fish. The polychaete *Polydora antennata* was reported to bore into the test and form internal galls in *Stomopneustes variolaris*. A good number of parasitic gastropods of the families Stiliferidae and Pyramidellidae are known from echinoids and holothurians. Several species of polychaetes, crabs and fish are also known associated with many holothurians. These generally crawl on the surface or take shelter in the oral region or cloaca of the host. Thus the echinoderms provide shelter and food to many species and thus enrich the biodiversity of the reef ecosystem.

Among the different relationships between corals and echinoderm inhabitants presented above, most are neutral in the sense they do not directly or adversely affect the corals. The advantages to corals in general are few but are of significant nature. The mucus feeding crinoids, ophiuroids and holothurians clean the water free of silt, which may otherwise settle on coral polyps. The surface film feeders clean the surface free of harmful organisms settling in the environment. The feeding habit of holothurians prevents reducing effect of organic load in the sediments and brings up the nutrients and minerals locked up in the subsurface sediment, for use by the zooxanthellae of the corals.

Among the echinoderms that are beneficial to corals, the sea urchins deserve a special mention. Algae are threats to coral reefs in so much as they compete with the zooxanthellae of the reef-building corals for light and nutrients. In addition they promote accumulation of sand that may bury live coral bases. The coralline red algae are also the habitat and food for the settling larvae and juveniles of CoT, the adults of which are voracious feeders on live coral polyps. Most of the regular sea urchins are herbivores feeding on a variety of algae. The larger species of *Diadema*, *Echinothrix*, *Stomopneustes* and *Tripneustes* feed extensively on algae controlling the algae as well as the larvae and juveniles of the menacing crown-of-thorns sea star. In fully mature and spawning individuals of *Stomopneustes variolaris* the gut contents constituted 1.5 to 2.3% of the total weight while in spent and maturing stages they showed a maximum of 8.5% of total weight. These coincided respectively with the maximum and minimum standing crops of algae in the habitat. This inverse relationship between the algae and sea urchin populations is evident at places like Wandoor, Pongibalu, Ritchie's Archipelago, Kamorta *etc.* Similarly, other species were also reported to have been responsible for the status of algae at various other places in the world. Samarao *et al.* (1974) found that elimination of *Diadema antillarum* resulted in a great increase in macro-algal biomass shifts in dominance *etc.* Habitats occupied by *Paracentrotus lividus* in densities of five to 12 urchins per square meter were devoid of algae and an area cleared of the sea urchin developed algal covering to the extent of 50% in about two months (Kitching and Ebling, 1961). Similarly, a population of 2-15 adults of *Lytechinus variegatus* per square meter

was estimated to consume the annual production of *Thalassia* in a square meter. It was estimated that a population of *Lytechinus* in a square meter consumes about 45 kg of algae per year and that of *Stomopneustes variolaris* consumes about 43.6 kg per year. Similar effects were noticed in the case of other species of sea urchins also. This is a clear indication of the role of sea urchins in controlling algae and their harmful denizens helping the corals. The long and fragile spines of *Diadema* and *Echinothrix* projecting out from the hollows in conglomerates and dead coral bases and the large globiferous pedicellariae with poisonous sacs of *Toxopneustes* and millions of small globiferous pedicellariae of *Mespilia*, *Tripneustes* etc. drive away several predatory and destructive organisms and protect the corals. Even the fragmentation of dead coral through abrasion and boring contributes beach sand and helps in early recycling of calcium and formation of fine substratum for other organisms of the reef. Threats to corals arising from the association with echinoderms appear to be mainly competition for food, destruction of substratum and predation on live polyps.

Crinoids, ophiuroids and to some extent holothurians feed on the floating microorganisms which are also a source of food for the corals. But this competition does not seem to be detrimental in view of the abundance of the planktonic organisms in the ambient waters and supplementary nature of the resource since the corals depend also on the photosynthetic activity of their zooxanthellae. However this feeding habit of echinoderms is advantageous to the corals since the suspended silt as well as mucus and microorganisms released by the corals are also trapped thus helping in cleaning the waters.

A few species of echinoids destroy the dead coral rocks through abrasion to make, widen or deepen the depressions. However this helps in the formation of beach sand protecting the shoreline and providing substratum for organisms increasing the biodiversity and biomass of the community. It also helps in easy dissolution of calcium in water facilitating sufficient supply for building coral skeleton.

The only echinoderms, which feed on coral polyps, are a few carnivorous asteroids such as *Culcita*, *Dactylosaster*, *Linckia*, *CoT* etc. All the species excepting the *CoT*, feed on polyps only occasionally and not exclusively or voraciously. *CoT* is widely distributed in the coral reef environments of tropical Indo – West Pacific region from Red Sea and East Coast of Africa to Hawaiian Islands. It was Bell (1887) who first reported *Acanthaster planci* from Andamans. Subsequently it was recorded from several localities of Andaman and Nicobar Islands. It is an important inhabitant of any coral reef ecosystem. The juveniles are herbivores. The adults feed mainly on the hermatypic corals. It was noted that *Acropora* and *Pocillopora* of most exposed areas and *Goniastrea*, and *Goniopora* of less exposed areas are heavily predated. In the protected areas, *Porites* was attacked in greater proportion. The alcyonaceans, *Millepora* and *Heliopora* are rarely attacked. At low population densities, they feed only at night and only a portion of the colony is attacked either because of its habit or because of the menace from crustaceans and

mollusks inhabiting the colony. Then they move to another colony at some distance away. However at high densities, they feed continuously even during daytime and the whole colony is devoured leaving no live portion before moving to the next colony. Even then some portions of the windward slopes are spared for recovery.

Acanthaster planci occurs in many reefs of Andaman and Nicobar Islands but usually noticed in sparse numbers because of cryptic nature. High densities of the sea star were noticed once in 1989 at some islands. Some of these might be breeding aggregations. However, subsequent studies immediately afterwards did not reveal high densities at any locality. Even during the recent surveys at the selected reefs of North Reef Island, Ritchie's Archipelago, Cinque Island, Little Andaman and Great Nicobar, only a few feeding scars due to *Acanthaster* were noticed but not the sea star in large numbers.

Under natural conditions, many inhabitants of the reef ecosystem and pelagic elements control CoT and protect the coral reef. In the coral reef ecosystem the fish *Abudeduf* feeds on the eggs released by the sea star. Many benthic and pelagic organisms feed on planktonic larvae. The surface film feeders feed on the settling larvae. The herbivores such as gastropods and sea urchins feeding on algae destroy the settling larvae and juveniles taking shelter in the algae and feeding on them. Even coral polyps trap the eggs and larval stages floating in the waters and engulf whole juveniles when they try to feed on the polyps. Carnivorous mollusks such as giant tritons and probably also helmet shells and fishes such as wrasses attack adult sea stars and devour whole juvenile and smaller specimens. Many of the coral reef crustaceans such as xanthid crabs and members of several families of shrimps are a menace to the sea star since they nibble the tube feet and dislodge the climbing acanthasters. However, when these controlling organisms or their habitats are destroyed, there will be greater success in recruitment of juveniles and colonization of adults leading to high densities. High densities are also attained through mass invasion of large adults from reefs destroyed in the neighborhoods. The reasons for both are lack of controlling elements and prevalence of favorable conditions. These may be natural or anthropogenic.

Selective exploitation of predatory species reduces pressure on the *Acanthaster* resulting in population explosions. Wanton destruction of live corals, excessive silt and fresh water drainage through bad land usage are some of the causes for dead reefs. Deprived of food, the acanthasters of dead reefs are forced to invade healthy reefs where they culminate in infestations and further devastate live coral habitats. Effective land management practices, sustainable exploitation, and conservation of reef inhabitants protect the corals in a healthy condition. Exploitation of herbivorous organisms such as *Trochus*, *Turbo*, sea urchins *etc.* results in abundant algal habitats promoting settlement of larvae and growth of juveniles of *Acanthaster*.

Potential causes in the Andaman and Nicobar Islands for the destruction of reefs and reef inhabitants and increase in the *Acanthaster* populations to infestation densities are :

- Terrestrial run off
- Pollution from domestic, industrial and agricultural wastes
- Over fishing of reef fishes and
- Selective exploitation of predatory and herbivorous organisms for trade

Of these the first two destroy the corals forcing CoT to invade the healthy reefs. The other two factors help successful recruitment and colonization at high rates increasing the density of resident populations to infestation levels. Hence it is pertinent to keep the possible effects and their magnitude in mind before undertaking any activity that directly or indirectly affects the corals and their inhabitants. Effective land management practices preserve a healthy environment for the corals. Awareness programmes and alternate livelihood for the locals help in preventing wanton destruction of habitats and avoiding selective and overexploitation of reef resources which affect the natural balance in the reef community. Towards providing alternative livelihood and protection of corals in the islands there are prospects in the culture of some echinoderms. In addition to being a food resource for several pelagic and benthic inhabitants of the sea, the echinoderms are a rich source of food for human beings also. Two groups of echinoderms namely sea urchins and sea cucumbers serve as food for man.

The fleshy gonads of sea urchins in their mature stages are edible and considered a delicacy in several parts of America, Europe and Southeast Asia. The mature gonads of sea urchins comprise more than 20% of the wet weight. There is no local market for these, but the coral reef environments of Andaman and Nicobar Islands support populations of sea urchins of commercial value. These are *Stomopneustes variolaris*, *Tripneustes gratilla* and to some extent *Colobocentrotus atratus* and *Heterocentrotus trigonarius*. The sea urchins are occasionally collected and eaten by the Nicobarese. Other local communities also should be encouraged to adopt sea urchin food and provide facilities for their culture.

The processed body wall of sea cucumbers is commercially known as *Beche-de-Mer*. It is considered a great delicacy in several parts of the world particularly Southeast Asia. Among the holothurians that inhabit the reef areas of Andaman and Nicobar Islands, 12 to 15 species are useful for *beche-de-mer* and half a dozen species are abundant with fishery potential. These are species of *Holothuria*, *Actinopyga*, *Bohadschia* and *Stichopus*. It was reported that Diglipur and Mayabunder were rich in *Holothuria scabra* and *Bohadschia vitiensis*, Middle Andamans in *Actinopyga* spp. and *H. scabra*, South Andamans in *Holothuria* spp. , *Actinopyga* spp. and *B. vitiensis*, and Little Andaman in *H. leucospilota*. In the Nicobar group, though some species are common, their populations are not abundant since the local Nicobarese occasionally eat them. At Car Nicobar the Nicobarese collect indiscriminately all the intertidal organisms including the stray sea cucumbers, bivalves and even sipunculans for food. Hence they are not easily available. At other islands, the Nicobarese collect the sea cucumbers to supplement their main food consisting

of fish and pig or for a change. Hence *Stichopus* spp. at Nancowry and *Actinopyga* spp. at Great Nicobar occur in good numbers. *Holothuria atra* occurs abundantly in many reefs but it is of relatively less commercial value compared to other species available and not a preferred diet of Nicobarese.

In spite of the ban to collect sea cucumbers for commercial purposes, there is clandestine fishing and processing by poachers in uninhabited and inaccessible remote islands. This is leading to depletion of natural population, the cause for low densities of many common species at several localities. Hence there are prospects only for farming sea cucumbers for processing but not for exploitation of natural populations. James (1983,1993) gave details of sea cucumber breeding and farming for commercial exploitation and mentioned successful attempt to farm *H. scabra* at Aberdeen Bay. Similar farming of juveniles in enclosed pens at sheltered mangroves and creeks can be undertaken. These can be leased out to unemployed poor for farming sea cucumbers. However harvesting should be properly monitored to avoid collection of adults from natural populations to increase the income. Otherwise, the natural population cannot withstand the pressure of greedy exploitation.

Recent studies showed that several echinoderms produce bioactive compounds chiefly of saponin type. They are mainly toxic and hemolytic in nature. The extracts also showed anti-fungal and anti-bacterial effects. The toxic nature of the echinoderms, particularly of holothurians is supposed to be a chemical defense mechanism of organisms that are otherwise easily susceptible to predation. Holothurian extracts were also successfully used to eradicate unwanted organisms from fish farms. Some holothurians showed Central Nervous System stimulants and substances of diuretic and anti-viral properties.

SUMMARY

Among the various inhabitants of the coral reef ecosystem of Andaman and Nicobar Islands, echinoderms are conspicuous by their size, abundance and role in the ecosystem. Altogether 224 species of echinoderms belonging to Crinoidea (32 spp.), Asteroidea (48 spp.), Ophiuroidea (64 spp.), Echinoidea (39 spp.) and Holothuroidea (41 spp.) have been found to be occurring in the coral reefs of Andaman and Nicobar Islands. Their detailed distribution in the different islands is given. The general life styles and relationships with corals and other denizens of the coral reef ecosystem have been discussed. The effects of echinoderms are presented in neutral, beneficial and negative categories. The effect of the Crown-of-Thorns sea star, *Acanthaster planci* is discussed in detail with reasons for plague densities and measures to be taken for their control. The prospects for culture of sea urchins and holothurians for the benefit of the communities and reef health are presented. A note on the bioactive compounds of echinoderms is also added.

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