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A Guide to Common Echinoderms of Andaman and Nicobar Islands

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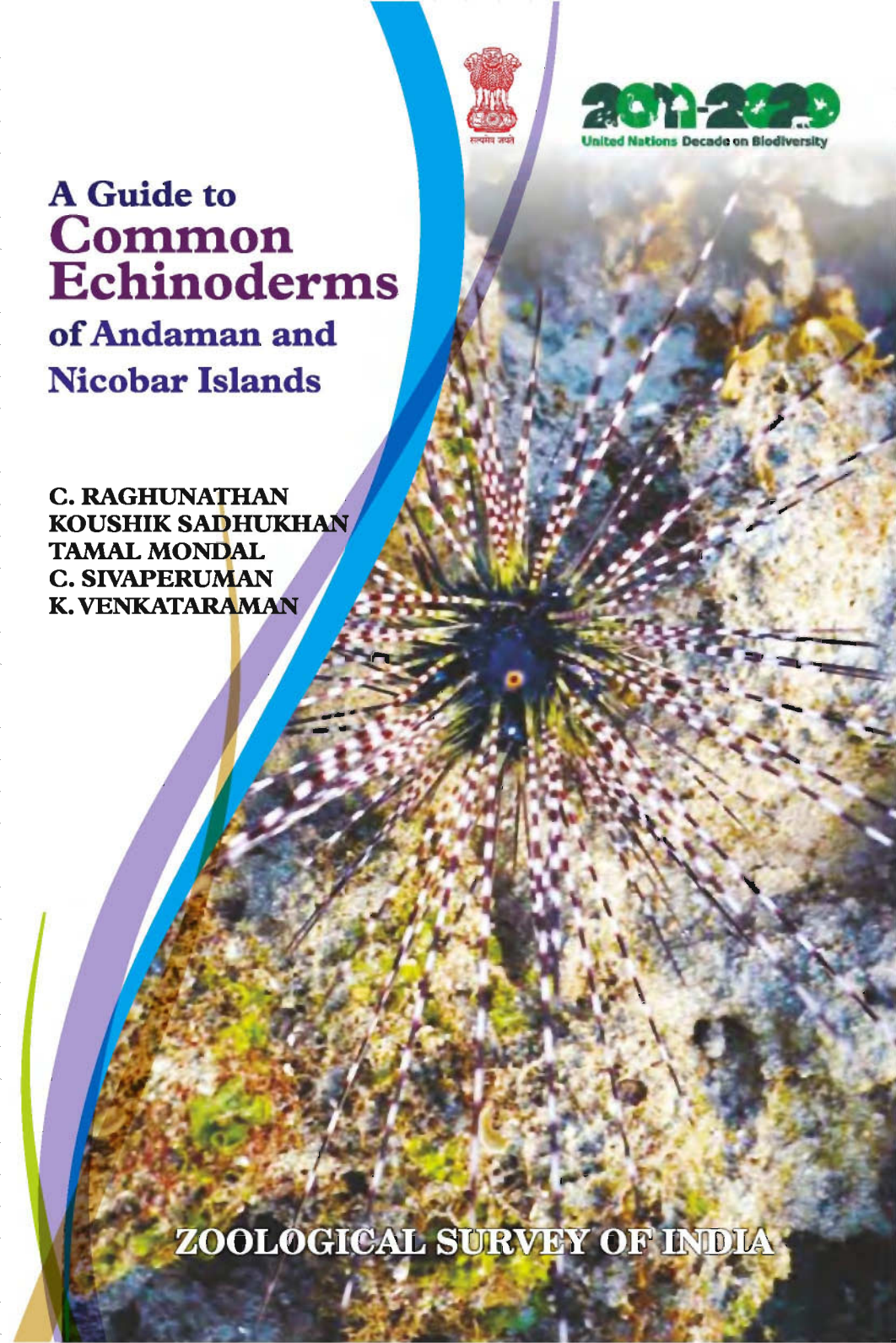

ZOOLOGICAL SURVEY OF INDIA

A Guide to
Common Echinoderms
of Andaman and Nicobar Islands

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1. GENERAL INTRODUCTION

Preamble

The Ehinodermata is one of the best characterized and most distinct phyla of animal kingdom (Bather, 1900). The echinoderms being common and conspicuous marine animals have been known since ancient times. They are found at every ocean depth, from the intertidal zone to the abyssal zone. The first definitive members of the phylum appeared near the start of the Cambrian period. The echinoderms are important both biologically and geologically: biologically because few other groupings are so abundant in the biotic desert of the deep sea, as well as the shallower oceans, and geologically as their ossified skeletons are major contributors to many limestone formations, and can provide valuable clues as to the geological environment. Further, it is held by some that the radiation of echinoderms was responsible for the Mesozoic revolution of marine life.

The word "echinoderm" is derived from the Greek word *ἐχινοδέρματα* (*Echinodermata*), plural of *ἐχινόδερμα* (*Echinoderma*), "spiny skin" from *ἐχινός* (*echinos*), "hedgehog," and *δέρμα* (*derma*), "skin". The name Echinodermata appears to have originated with Jacob Klein (1734), who however applied it only to echinoids. Linnaeus in the 10th edition (1758) of his *Systema naturae* relegated all invertebrates except insects to one class, Vermes. The Echinodermata, (from the Greek meaning spiny skin), is a phylum containing some 13,000 extinct and 7,000 extant species. Living representatives are only found in marine environment, making the echinodermata the largest phylum lacking in terrestrial and freshwater forms. Echinoderms evolved from bilaterally symmetric animals exhibiting five fold radial symmetry in portions of their body at some stage of life. Echinoderms can reversibly

vary the rigidity of their dermis and general connective tissue. They are pentamerous symmetrical animals where the body can be divided into five similar parts arranged around the central axis. The radial symmetry, however, evolves within the echinoderms and does not indicate a close evolutionary relationship with others.

Definition

The Echinodermata or echinoderms are enterocoelous coelomates, having a pentaradiate construction derived from an original bilaterality, without definite head or brain, with a calcareous endoskeleton of separate plates or pieces, often bearing external spines or protuberances, and with a water-vascular system of coelomic nature that sends numerous small projections (podia) to the exterior and communicates with the external medium by a pore or cluster of pores, at least in juvenile stages (Hymen,1955).

Body wall

The body wall of echinoderms consists of three layers. The outer layer, called the epidermis, is only a single layer of cells which covers the entire animal including its various spines. The third layer is also a single layer of cells the main difference being that these cells are ciliated. This layer encloses the animal's coelom separating the animal's guts from its skin. It is called the 'coelomic lining'. The middle layer is much thicker and is called the dermis. It is composed of connective tissue and contains the endoskeleton. This endoskeleton takes three different forms: a set of closely joint plates with little individual movement that exist as a test or shell (Sea urchins), a set of separately articulating (more freely moving) small plates called ossicles (Seastar, Brittle Stars and the arms of Crinoids), and a collection of widely

separated microscopic ossicles lying in the lethery dermis (Sea cucumbers). Whatever form they take these plates or ossicles are always made from calcite, the ingredients for which are found in sea water. The endoskeleton of echinoderms grows continuously throughout the animals life, thus older animals are always larger than younger ones. The endoskeleton supports the spines, warts and tubercles that are often found on the echinoderm surface. These various protuberances are also generally made from calcite.

Endoskeleton

Echinoderms have a mesodermal skeleton composed of calcareous plates or ossicles. Despite the robustness of the individual skeletal modules, complete echinoderm skeletons are rare in the fossil record. This is because they quickly disarticulate once the encompassing skin rots away, and in the absence of tissue there is nothing to hold the plates together. The modular construction is a result of the growth system employed by echinoderms, which adds new segments at the centre of the radial limbs, pushing the existing plates outwards in the fashion of a conveyor belt. The spines of sea urchins are most readily lost, as each spine can be moved individually and is only loosely attached in life. A walk above a rocky shore will often reveal a large number of spineless but otherwise complete sea urchin skeletons. Echinoderm skeletons are made up of interlocking calcium carbonate plates and spines. This skeleton is enclosed by the epidermis and is thus an endoskeleton. In some, such as sea urchins, the plates fit together tightly. In others, such as starfish, the plates are more loosely bound, and in sea cucumbers the plates are usually microscopic. But whatever their shape, the plates of echinoderms have a very typical microstructure: electron

microscopy reveals them to be, not solid blocks, but fine networks of calcium carbonate forming a structure known as stereom. Each skeletal element of an echinoderm is actually a single crystal of calcium carbonate, very finely branched and structured. Between the skeletal plates, a number of special structures protrude, with which the echinoderm breathes, moves, and defends itself. Typically, these are tube feet, pedicellaria, and gills.

Water-vascular System

Echinoderms possess a unique water vascular or "ambulacral" system. The water vascular system of the echinoderms is unique in the living world and easily distinguishes them from all other phyla. This is a network of fluid-filled canals that function in gas exchange, feeding, and secondarily in locomotion. This system is derived from both the hydrocoel and axocoel. This system may have allowed echinoderms to function without the gills found in other deuterostomes. The system comprises a central ring, the hydrocoel, and radial ambulacra stretching along the body or arms. There are extensions (tube feet, papulae etc.) of the water vascular system which project out through holes in the skeleton and can be extended or contracted by the redistribution of fluid between the foot and internal sac.

The system takes slightly different forms in the different classes. In the Crinoidea, which are believed to be the most ancient of the echinoderms, the tube feet are branched and secrete mucous. In the Ophiuroidea the tube feet are simple and slender. In Asteroidea, Echinoidea and Holothuroidea they are thicker and end in suckers. The water vascular system starts with an opening to the external environment called a madreporite. From this a short straight canal called the 'stone canal' leads to the

'ring canal'. The ring canal is a ring as might be expected and it has five longitudinal canals branching off from it into each of the arms, or their morphological equivalents in Echinoidea and Holothuroidea. In species with more than 5 arms these canals branch out into each arm. On each side of each canal there arises a series of short lateral canals that lead, via a valve, into the descending tube feet and the ampulla that operate them. The tube feet pass through small holes in the animal's endoskeleton and muscles around the ampulla (which remains inside the endoskeleton) squeeze water into them causing them to extend or relax.

Reproduction

Sexual reproduction: Echinoderms become sexually mature after approximately two to three years, depending on the species and the environmental conditions. The eggs and sperm cells are released into open water, where fertilization takes place. The release of sperm and eggs is coordinated temporally at same location and spatially at different regions. Internal fertilization has currently been observed in three species of sea star, three brittle stars and a deep water sea cucumber. In some species of feather star, the embryos develop in special breeding bags, where the eggs are held until sperm released by a male happen to find them and fertilize the contents. This can also be found among sea urchins and sea cucumbers, where exhibit care for their young can occur, for instance in a few species of sand dollars who carry their young between the pricks of their oral side, and heart urchins possess breeding chambers. With brittle stars, special chambers can be developed near the stomach bags, in which the development of the young takes place. Species of sea cucumbers with specialized care for their offspring may

also nurse the young in body cavities or on their surfaces. In rare cases, direct development without passing through a bilateral larval stage can occur in some sea stars and brittle stars. Another strategy that has evolved in some sea stars and brittle stars is the ability to reproduce asexually by dividing in two halves while they are small juveniles, while turning to sexual reproduction when they have reached sexual maturity.

Asexual reproduction: Many echinoderms have remarkable powers of regeneration. Some sea stars are capable of regenerating lost arms. In some cases, lost arms have been observed to regenerate a second complete sea star. Sea cucumbers often discharge parts of their internal organs if they perceive danger. The discharged organs and tissues are quickly regenerated. Seaurchins are constantly losing their spines through damage all parts are replaceable. Some seastar populations can reproduce entirely asexually purely by the shedding of arms for long periods of time.

Larval development: The development of an echinoderm begins with a bilaterally symmetrical embryo, with a coeloblastula developing first. Gastrulation marks the opening of the "second mouth" that places them within the deuterostomes, and the mesoderm, which will host the skeleton, migrates inwards. The secondary body cavity, the coelom, forms by the partitioning of three body cavities. Upon metamorphosis, each taxon produces a distinct larva, the left hand side of which develops into the adult organism, the right hand side eventually being absorbed; the left hand side typically becomes the oral plate. The different larval types such as *Bipinnaria & Brachiolaria, Auricularia, Ophiopluteus, Echinopluteus* and *Vitellaria* for Asteriods, Holothuroids, Ophiuroids, Echinoids and Crinoids respectivley are classified.

Feeding

Echinoderms are filter feeders, su.bstrate eaters or carnivores. The gut is U-shaped in the Crinoidea with the mouth and anus being on the same surface. In the other groups such as Echinoidea and Holothuroidea, it is straight-through gut with the mouth and anus on approximately opposite sides of the body. Echinoderms also have a spacious coelom (an open, fluid-filled body cavity lined with tissue), large gonads, and (usually) a complete gut. Many seastar have the peculiar ability to feed by turning the stomach inside out through the mouth; sea urchins scrape algae from rocks with five large teeth arranged in a structure known as "Aristotle's lantern."

The modes of feeding vary greatly between the constituent taxa. Crinoids and some brittle stars tend to be passive filter-feeders, absorbing suspended particles from passing water; sea urchins are grazers, sea cucumbers deposit feeders, and most seastars are carnivores. Crinoids employ a large net-like structure to sieve water as it is swept by currents, and to absorb any particles of matter sinking from the ocean overhead. Once a particle touches the arms of the creature, the tube feet act to swish it to the central mouth of the crinoid, where it is ingested, nutrients removed, and the remains egested through its anus to the water column. Many sea urchins graze on the surfaces of rocks, scraping off the thin layer of algae covering the surfaces. Sand dollars may perform suspension or sediment feeding. Sea cucumbers may be suspension feeders, sucking vast quantities of sea water through their guts and absorbing any useful matter. Others use their feeding apparatus to actively capture food from the sea floor. Yet others deploy their feeding apparatus as a net, in which smaller organisms become ensnared. While some sea stars are detrivores, extracting the organic material from mud, and others mimic the crinoids' filter

feeding, attacking other sea stars or shellfish. The latter are seized and held by the tube feet; sea stars then stiffen their legs, expanding the shell. The sea stars can use connective tissue to lock their arms in place and maintain a force on the prey whilst exerting minimal effort; the unfortunate victim must expend energy resisting the force with its adductor muscle. When the adductor tires, the sea star can insert its stomach through the opening and release gastric juices, digesting the prey alive.

Despite their low nutrition value and the abundance of indigestible calcite, many organisms, such as crabs, sharks, sea birds and larger starfish, make a living by feeding on echinoderms. Defensive strategies employed include the presence of spines, toxins, which can be inherent or delivered through the tube feet, and the discharge of sticky entangling threads by sea cucumbers. Being stabbed by a sea urchin may result in painful injury.

Distribution and habitat

Echinoderms are globally distributed in almost all depths, latitudes and environments in the ocean. They reach highest diversity in reef environments but are also widespread on shallow shores, around the poles refugia where crinoids are at their most abundant, and throughout the deep ocean, where bottom-dwelling and burrowing sea cucumbers are common, sometimes accounting for up to 90% of organisms. Whilst almost all echinoderms are benthic, that is, they live on the sea floor and some sea-lilies can swim at great velocity for brief periods of time, and a few deep-sea sea cucumbers are fully floating. Some crinoids are pseudo-planktonic, attaching themselves to floating logs and debris, although this behaviour was exercised most extensively in the Paleozoic, before competition from such organisms as barnacles restricted the extent of the behaviour. Some sea cucumbers employ

a similar strategy, hitching lifts by attaching to the sides of fish.The larvæ of many echinoderms, especially starfish and sea urchins, are pelagic, and with the aid of ocean currents can swim great distances, reinforcing the global distribution of the phylum.

Ecology

Echinoderms provide a key ecological role in ecosystems. The grazing of sea urchins reduces the rate of colonization of bare rock; the burrowing of sand dollars and sea cucumbers depleted the sea floor of nutrients and encouraged deeper penetration of the sea floor, increasing the depth to which oxygenation occurs and allowing a more complex ecological tiering to develop. Seastar and brittle stars prevent the growth of algal mats on coral reefs, which would obstruct the filter-feeding constituent organisms. Some sea urchins can bore into solid rock; this bioerosion can destabilise rock faces and release nutrients into the ocean. The echinoderms are also the staple diet of many organisms, most notably the otter; conversely, many sea cucumbers provide a habitat for associates, including crabs, worms and snails. The extinction of large quantities of echinoderms appears to have caused a subsequent overrunning of ecosystems by seaweed, or the destruction of an entire reef.

Evolution

The first universally accepted echinoderms appear in the Lower Cambrian period (Paul and Smith 1984). Echinoderms left behind an extensive fossil record. Despite this, there are numerous conflicting hypotheses on their phylogeny. Based on their bilateral larvae, many zoologists argue that echinoderm ancestors were bilateral and that their coelom had three pairs of spaces (trimeric).

Some have proposed that radial symmetry arose in a free-moving echinoderm ancestor and that sessile groups were derived several times independently from free-moving ancestors. Unfortunately, this view does not address the significance of radial symmetry as an adaptation for a sessile existence.

The more traditional view is that the first echinoderms were sessile, became radial as an adaptation to that existence, and then gave rise to free-moving groups. This view perceives the evolution of endoskeletal plates with stereom structure and of external ciliary grooves for feeding as early echinoderm developments.

The extinct members of Class Homalozoa, commonly referred to as carpoids, had stereom ossicles but were not radially symmetrical, and the status of their water-vascular system is not known. Further, extinct members of the Class Helicoplacoidea possessed three, true ambulacral grooves, and their mouth was on the side of their body.

Attachment to a substratum would have selected for radial symmetry and may have marked the origin of the Class Crinoidea. Members of Crinoidea, along with the extinct members of Class Cystoidea, were primitively attached to a substratum by an aboral stalk. An ancestor that became free-moving might have given rise to Asteroidea, Ophiuroidia, Holothuroidea, and Echinoidea.

Economic importance

Echinoderms are also elements of many cuisines. Around 50,000 tons of sea urchins are captured each year, the gonads of which are consumed particularly in Japan, Peru and in France. The taste is described as soft and melting, like a mix of seafood and fruit. The quality

depends on the colour, which can range from light yellow to bright orange.

Economically, sea cucumbers are important in two main ways. First, some species produce toxins that are of interest to pharmaceutical firms seeking to learn their medical value. Some compounds isolated to date exhibit antimicrobial activity or act as anti-inflammatory agents and anticoagulants. Second, as a gourmet food item in the orient, they form the basis of a multimillion-dollar industry that processes the body wall for sale as beche-de-mer or trepang. However, the high value of some species, the ease with which such shallow-water forms can be collected and their top-heavy age structures all contribute to over-exploitation and collapse of the fisheries in some regions. Sea cucumbers are also considered a delicacy in some countries of southeast Asia; particularly popular are the pineapple roller *Thelenota ananas* and the red *Halodeima edulis*. They are well known as *bêche de mer* or *Trepang* in China and Indonesia. The sea cucumbers are dried, and the potentially poisonous entrails removed. The strong poisons of the sea cucumbers are often psychoactive, but their effects are not well studied. It does appear that some sea cucumber toxins restrain the growth rate of tumour cells, which has sparked interest from cancer researchers.

The calcareous tests or shells of echinoderms are used as a source of lime by farmers in areas where limestone is unavailable; indeed 4,000 tons of the animals are used annually for this purpose. This trade is often carried out in conjunction with shellfish farmers, for whom the starfish pose a major irritation by eating their stocks

2. LITERATURE REVIEW

The Phylum Echinodermata, comprising approximately 7,000 living species, and 13,000 fossil

species, is epitomized by the familiar sea star, a universal symbol of the marine realm. The history of the phylum is fraught with misconceptions. Linnaeus (1758) did not recognize the echinoderms as a separate group, and placed the echinoderms that were known to him in his "Mollusca", a subdivision of "Vermes". Bruguière (1791) revived Klein's (1734) name Echinodermata—a short-lived independence for the group, for Lamarck (1801) referred the echinoderms to his "Radiata", where they stayed for several decades until finally Leuckart (1854) successfully established the Echinodermata as a distinct phylum. Over the past 160 years, progress on the higher classification of the extant and fossil echinoderms has been fairly steady, with such authors as Ludwig (1889–1907), Bather (1900), Cuénot (1948), and Hyman (1955) providing authoritative summaries of classification history. The numerous authors contributed to the Echinodermata volumes of the Treatise on Invertebrate Paleontology (Moore, 1966–1978) to revise the groups for which they were responsible, so that the 1960's became an era of great change in our knowledge of the phylum. Publication of the Treatise volumes stimulated much research work, particularly on fossil groups. New and exciting approaches to taxonomy have resulted in a reassessment of most major groups of fossil and living echinoderms. Cladistic analyses of extant and fossil groups helped to reshape some major classifications, and Mooi and David's (2000 *et. al.)* extraxial-axial theory (EAT) provided a new framework for study of interrelationships. Within the past couple of decades, molecular analyses are offering powerful tools, especially in combination with morphology, with which to address long-standing problems. Thus, the past 40 years have witnessed upheavals in classification at the family, order, and even class level. In the past decade numerous important volumes have been published on the echinoderms, living and fossil. Some of the most

comprehensive include: Candia Carnevali & Bonasoro (1999), Mooi & Telford (1998), Barker (2001), Jangoux & Lawrence (2001), Féral & David (2001), Kasyanov (2001), Heinzeller & Nebelsick (2004), Matranga (2005). Despite the increasing attention received by to this phylum, there remain many major uncertainties and unresolved problems.

The extant Deuterostomia ("second mouth") are usually defined as animals in which the mouth develops from a second opening in the embryo, opposite to the initial opening, the blastopore, of the rudimentary gut. In addition the coelom develops by enterocoely, or pouching from the primitive gut. Smith (2004b) noted that there was fossil evidence to show that the major deuterostome groups were established by about 520 million years ago. Composition of the extant Deuterostomia has changed in recent years. At present, it is usually regarded as comprising the phyla Chordata, Hemichordata, and Echinodermata (Cameron *et al.*, 2000), as well as the recently-defined phylum Xenoturbella (Bourlat *et al.*, 2006). In echinoderms with planktotrophic larval stages, the deuterostome affinities of the group are evident. Fell (1948) and others have pointed out that in a significant percentage of echinoderms the coelom develops from a splitting in mesoderm and not from pouching, and the larval mouth becomes the adult mouth. Pawson and Kerr (2001) reported presence of chitin in one species of sea cucumber. Chitin is usually unknown in deuterostomes, but it has been reported from a blenniid fish (Wagner *et al.*, 1993). These various exceptions to the deuterostome "norm" are believed to be relatively minor, and the echinoderms are regarded as fully qualified members of the Deuterostomia.

Five extant classes of echinoderms are universally recognized: Asteroidea, Ophiuroidea, Echinoidea,

Holothuroidea, and Crinoidea. A sixth class, Concentricycloidea, was described 21 years ago (Baker *et al.*, 1986). Smith (1988a), in a phylogenetic analysis of fossil evidence, suggested times of divergence of the five (then) modern classes at 450–590 million years ago. Smith noted that the long subsequent history for each class allowed for introduction of a great deal of "noise" via mutations. The surge in molecular taxonomy occurred at around this time. Wada & Satoh (1994) analyzed one species from each class, and concluded that phylogenetic relationships among extant classes matched those deduced from the fossil record. Littlewood (1995) discussed molecular and morphological data sets, noting that poor phylogenetic resolution arose from inconsistent morphological data sets, and inadequate molecular data, based upon a small representation of taxa. Soon thereafter, Littlewood *et al.* (1997) combined more comprehensive morphological, molecular, and stratigraphic data, and arrived at three competing phylogenetic solutions, of which two appeared to be the most plausible. Their study demonstrated that frustrating pitfalls can appear even when data sets are fairly detailed. Smith (1997) reaffirmed what many previous authors had noted, that larval morphology of echinoderms has evolved independently of adult morphology, and that larval morphology, when taken alone, cannot inform the phylogeny of adult echinoderms. Janies (2001), providing additional sequence data, especially for the refractory ophiuroids and asteroids, concluded that echinoids and holothuroids "are related", and crinoids are the sister taxon to the remaining extant echinoderm classes. The relationship between asteroids and ophiuroids was more difficult to address, but Janies found strong support for monophyly of each of these two classes. McEdward & Miner (2001) comprehensively summarize what is known about larval development in echinoderms, and construct phylogenies for the extant classes based upon patterns of

development. As more molecular data become available, and more comprehensive and refined morphological databases are produced. The various supra-class names that have been applied to groupings of echinoderms – Echinozoa, Asterozoa, Crinozoa, Pelmatozoa, Eleutherozoa – are occasionally used in the formal sense, but for the most part they are used as informal and convenient adjectives in describing life habits, body form, feeding propensities, and the like.

Since the first concentricycloid was described (Baker *et al.*, 1986) numerous authors have investigated and discussed the status of these small (usually <1 cm diameter), discoidal echinoderms with the mouth frame in the form of a ring, and a ring of tube feet. The only known habitat is deep-sea wood, either naturally occurring waterlogged wood, or wood that has been placed at depth by submersibles for extended periods of time. Baker *et al.* (1986) referred these extraordinary animals to a new class Concentricycloidea. Three species are now known: *Xyloplax medusiformis* Baker, Rowe and Clark, 1986; *X. turnerae* Rowe, Baker and Clark, 1988; *X. janetae* Mah, 2006. In the 21 years since description of the first species, numerous authors have voiced their opinions about the status of these strange echinoderms. Smith (1988a), Belyaev (1990), Janies & Mooi (1999), Janies (2001), argued for placement of the concentricycloids within the Class Asteroidea, perhaps near the caymanostellids. Rowe *et al.* (1988), Pearse & Pearse (1994), Mooi *et al.* (1998), Baker (2003) and others have been a little more cautious in their assignment of the group. In a detailed recent summary, Mah (2006), having examined the morphological, cladistic, and molecular evidence, placed the concentricycloids within the Asteroidea (Figure 2), where they comprise the monotypic Infraclass Concentricycloidea of the Subclass Ambuloasteroidea (*sensu* Blake & Hagdorn, 2003).

Crinoidea

The 650 species of extant crinoids (Class Crinoidea, *Extant crinoids*), represented by 100 stalked crinoids and 550 feather stars, have received considerable attention from specialists, partly because of their intrinsic interest, and partly because these extant animals can throw some light on the living habits of the fossil crinoids. The living crinoids are all referred to the Subclass Articulata Zittel, 1879. Most authors regard the feather stars as comprising a single order, Comatulida A.H. Clark, 1908. Messing (1997) notes that Simms (1988) reduced the comatulids to an infraorder, Comatulidia. Rasmussen & Sieverts-Doreck (1978) recognized seven superfamilies in the order Comatulida. Further details are provided by Messing (1997). The extant stalked crinoids are assigned to four orders: Millericrinida Sieverts-Doreck, 1952; Cyrtocrinida Sieverts-Doreck, 1952; Bourgueticrinida Sieverts- Doreck, 1952; Isocrinida Sieverts-Doreck, 1952. In a recent review of the comatulids, Messing (1997) covers classification, ecology, and taphonomy, among other topics. For the stalked crinoids Roux (2002) provide keys and checklists to the genera. Comprehensive and detailed revisions, such as David (2006) of the stalked crinoid genus *Endoxocrinus* are regrettably rare, as are regional studies such as Messing (2007). The emphasis on morphology is gradually being complemented by molecular approaches, some producing astonishing results. Cohen *et al.* (2004) found that a clade containing the genera *Caledonecrinus, Gymnocrinus, Holopus,* and *Proisocrinus,* and also possibly *Cyathidium* raises many intriguing questions about the taxonomic placement of these entities. More than 6,000 species of fossil crinoids are known as extict, and revisionary work, usually below the order level, is proceeding apace. The current classification of the class

Crinoidea, in the opinion of Ausich (1998) recognizes six subclasses: Aethocrinea Ausich 1998; Cladida Moore & Laudon, 1943; Camerata Wachsmuth & Springer, 1885; Flexibilia Zittel, 1895; Articulata Zittel, 1879; Disparida Moore & Laudon, 1943. Hess (2003) describe assemblages of crinoids from the Ordovician to the Tertiary, and they study form and function, evolutionary history, classification, among other topics. Ausich (1999) discussed the origin of crinoids in light of the re-interpretation of the Cambrian *Echmatocrinus* as an octocoral. Ausich suggests an early Ordovician origin for the crinoids from primitive rhombiferans via paedomorphosis. Ausich & Kammer (2001), emphasizing mostly fossils, comment on the status of research on crinoids, and identify areas for future research.

A useful and comprehensive classification of fossil echinoderm groups is provided by Simms (1993). Mooi (2001) discussed and critically assessed publications on fossil echinoderms for the period 1980-2000. Loven's law and ray homologies are described in echinoids, ophiuroids, edrioasteroids, and an ophiocistioid by Hotchkiss (1995). In a related study with broad implications, Sumrall & Wray (2007) discuss pentamerous symmetry and its origin in the 30 Cambrian-Ordovician clades of echinoderms. Shu *et al.* (2004) describe, and Smith (2004b) comments on, what are believed to be ancestral echinoderms ("velulocystids") from the Lower Cambrian of China. The vetulocystids have a globosetheca and a tail. Smith (2004a) studied phylogeny of deuterostomes, and anatomy of carpoids, and concluded that early deuterostomes with a stereom skeleton and gill slits may have existed, but it is not likely that sterom and a notochord co-occurred. These conclusions support in part (gill slits), and disagree in part (notochord) with the ideas of Jefferies (1996). David (1999), applying the extraxial/ axial theory, regard the four non-pentamerous classes

comprising the homalozoans as early echinoderms, but not indicative of the plesiomorphic morphology of the phylum. Further, the Homalozoa is not a monophyletic assemblage. Lefebvre (2007) studied in detail the palaeobiogeography and palaeoecology of cornutes and mitrates. Parsley (1999), using a cladistic approach, determined that the Cincta (Homostelea) are blastozoans. Ophiocistioids have been reviewed by Haude (2004), and Reich & Haude (2004). Dominguez-Alonso (1999) presented new data on the structure of ctenocystoids and proposed a new approach to the early evolution of echinoderms. Molecular analyses are transforming our view of the echinoderms at all taxonomic levels. Wilson (2007) found that the Antarctic comatulid previously known as the single widely distributed species *Promachocrinus kerguelensis* may in fact embrace at least five species-level clades.

Plancus and Gaultire (1743) first reported the presence of echinoderms from Goa, coastal area of India (James, 1987). Bell (1887) compiled the list of echinoderms from Bay of Bengal. Nagabhushanam and Rao reported the echinoderms of Orissa and Lakshadweep in 1969 and 1972. Soota (1983) gave distribution of some holothurians in Andaman and Nicobar Islands without mentioning the species wise distribution. Venkataraman (2002) also compiled a report on echinoderms. Sastry (2005, 2007) reported an annotated checklist on echinodermata of Andaman and Nicobar Islands with 424 species and in India with 649 species. The present study dealt with pictorial description of 89 species of most commonly found echinoderms belonging to 53 genera, 31 families and 15 orders recorded from Andaman and Nicobar Islands.

Asterioidea

Today's oceans are graced by 2100 species of sea stars. In their magisterial monograph of Atlantic sea stars

(Class Asteroidea, *Extant asteroids*), Clark and Downey (1992) noted that the status of the entire group—whether it should be referred to a Class or a Subclass—was 'controversial" and they declined to discuss the topic. At the ordinal level, they elected to follow the classification proposed by Blake (1987, 1989), and recognized seven orders: Paxillosida Perrier, 1884; Notomyotida Ludwig, 1910; Valvatida Perrier, 1884; Velatida Perrier, 1893; Spinulosida Perrier, 1893; Forcipulatida Perrier, 1893; Brisingida Fisher, 1928. Clark and Downey chose to ignore, or did not accept, the three Superorders proposed by Blake (1987). Gale (1987) proposed a new Subclass, Neoasteroidea for the post-Paleozoic crow group asteroids, and he differed from Blake in naming just four orders: Paxillosida, Notomyotida, Valvatida (including the velatids and spinulosids), and Forcipulatida (including the brisingids).

Subsequent to the Blake and Gale papers, Lafay *et al.* (1995) made a combined morphological and molecular study of nine sea star species, in an attempt to provide a broader framework for discussion of the differing classifications. Papers published following a symposium on evolution of starfishes (Blake, 2000; Blake *et al.*, 2000; Mooi & David, 2000; Hotchkiss, 2000; Vickery & McClintock, 2000; Hrincevich *et al.*, 2000; Mah, 2000; Knott & Wray, 2000) offered possibilities for resolution of some differences in morphology-based phylogenies by the addition of more comprehensive molecular data. The consensus of opinion seemed to be that molecular/morphological studies are very necessary and desirable, especially for resolving problems at the family-level and below (Hrincevich *et al.*, 2000; Knott & Wray, 2000; O'Loughlin & Waters, 2004; Mah, 2007). Matsubara *et al.* (2005) found that comparisons of genome structure were "uninformative for the purposes of asteroid phylogeny, but that phylogenetic

analyses based upon nucleotide and amino acid sequences indicated that paxillosidan characters are secondarily derived, and perhaps the paxillosids are specialized rather than primitive asteroids". In a comprehensive paper describing the Ordovician to recent history of the Asteroidea, Blake & Hagdorn (2003) diagnosed a new Subclass Ambuloasteroidea, to reflect their findings and those of Mooi & David (2000) on their extraxial/axial theory; in regard to the axial skeleton of Paleozoic and post- Paleozoic asteroids. Blake & Elliott (2003) found that axial skeletal characters could be compared across stem and crown-groups of asteroids. The Ambuloasteroidea embrace two infraclasses, one "Unknown" which includes the late Paleozoic Families Calliasterellidae Schöndorf 1910, and Compsasteridae Schuchert 1914, the other Gale's (1987) Infraclass (formerly Subclass) Neoasteroidea. The Neoasteroidea embraces the remaining post-Paleozoic asteroids. Shackleton (2005) comprehensively reviewed Ordovician stem-group asterozoans (asteroids plus ophiuroids) and proposed a revised classification. A new Plesion (Order) Eopentaroida was proposed to accommodate three distinctive Silurian genera. It was noted that the asteroid and ophiuroid body plans, already established in the Ordovician, indicated that these groups had a considerable, but unknown, pre-Ordovician history. In this context, Herringshaw *et al.* (2007) established that the Silurian *Lepidaster grayi* was the earliest-known multiradiate sea star, so that the multiradiate body plan was also established early. Blake & Hotchkiss (2004) characterized the post-Paleozoic asteroid crown group, identifying apomorphies of crown-group diversification.

Ophiuroidea

The 2,000 species of ophiuroids (Class Ophiuroidea, *Extant ophiuroids)* are traditionally assigned to two

orders such as Order Euryalida Lamarck, 1816 and Order Ophiurida Müller & Troschel, 1840. Smith, Paterson & Lafay (1995) summarized the state of knowledge of ophiuroid classification after a cladistic analysis based upon morphological characters. Their molecular data were equivocal, and did not help to resolve some problems arising from the morphological analyses. Smith & Paterson assigned the mysterious *Ophiocanops fugiens* to Subclass Oegophiuridea Matsumoto, 1915, and referred all other ophiuroids to Subclass Ophiuridea Gray, 1840. However, Pearse *et al.* (1998), with access to new material of *Ophiocanops*, demonstrated that this genus belonged in the Family Ophiomyxidae. These findings, coupled with those of Hotchkiss (1977) have resulted in the disappearance of the Oegophiuridea as a subclass of ophiuroids. Cisternas *et al.* (2004) studied development patterns in 23 species, suggested some evolutionary pathways, and noted that good molecular phylogenies would help to refine their hypotheses. The puzzling Ordovician stelleroid *Stenaster* was studied in detail by Dean (1999), who concluded, after a cladistic analysis of early asteroids, somasteroids, and ophiuroids, that this asteroid-like animal was in fact an ophiuroid, converging secondarily with asteroids. Kroh (2004) reported on the first fossil record of a euryalid ophiuroid from the Miocene of the Mediterranean. Jagt (1999) found a rich fauna of ophiuroids in the Cretaceous of the Maastrichtian Stage. Hotchkiss (1993) has described several Ordovician and Devonian ophiuroids from North America, and commented extensively on origins and relationships of skeletal features.

Echinoidea

The 800 species of echinoids (Class Echinoidea, *Extant and fossil echinoids)* alive today, coupled with the wonderful

fossil record, make the echinoids excellent candidates for a great variety of studies, from reproductive biology to evolution. Echinoids are also of commercial importance; Yokota *et al.* (2002) cover biology and aquaculture of sea urchins, and Lawrence (2001, 2006) deals with biology, ecology, and aquaculture of edible sea urchins worldwide. Extant echinoids are informally divided into "regular" forms with obvious radial symmetry, spherical bodies and uniformly long spines, and "irregular" forms – bilaterally symmetrical urchins, including sand dollars and heart urchins. Echinoids are typically classified into two subclasses and 12 orders, as listed by Smith (1984), and modified slightly by Littlewood & Smith (1995). Subclass Cidaroidea Claus, 1880 comprises the Order Cidaroida Claus, 1880. Subclass Euechinoidea Bronn, 1860 includes all other echinoids: Order Echinothurioida Claus, 1880; Order Diadematoida Duncan, 1889; Order Pedinoida Mortensen, 1939; Order Calycina Gregory, 1900; Order Arbacioida Gregory, 1900; Order Phymosomatoida Mortensen, 1904; Order Temnopleuroida Mortensen, 1941; Order Echinoida Claus, 1876; Order Cassiduloida Claus, 1880; Order Clypeasteroida Agassiz, 1872; Order Spatangoida Claus, 1876. All of the above orders except the last three are regular echinoids; the last three comprise the irregular echinoids. Phylogenetic relationships of the echinoid higher taxa have been studied by several authors, using morphological data (test and spine morphology, structure of teeth, pedicellariae, and structure of larvae) and molecular sequences. Some of the more comprehensive studies include Smith (1988b), Smith *et al.* (1992), Littlewood & Smith (1995), Lee (2003), Stockley *et al.* (2005), Smith *et al.* (2006) and Smith (2007). Most of the regular echinoids seem to have diverged relatively recently, between 65 and 35 million years ago. Solovjev

& Markov (2004) studied earliest divergence of irregular echinoids, and selected 15 binary characters for cladistic analysis. They agreed in general with the conclusions of Smith (1984) and Rose & Olver (1988) but differed in some details.

Holothuroidea

The approximately 1400 species of holothurians (Class Holothuroidea, *Extant holothuroids)*, in particular the tropical shallow-water forms, are receiving increasing attention from specialists, and substantial changes in classification below the family level are expected to occur over the next decade. Above the family level, the classification has been fairly stable for many years. The orders Aspidochirotida Grube, 1840; Elasipodida Théel, 1882; Molpadiida Haeckel, 1896; and Apodida Brandt, 1835 remain well-characterized. The distinction between the Dendrochirotida Grube, 1840 and Dactylochirotida Pawson & Fell, 1965 is less well-defined. At some points the alleged morphological differences between these two groups are less well defined, but at the molecular level, the distinctions are more robust (Kerr & Kim, 2001). The three subclasses introduced by Pawson & Fell (1965)- Apodacea, Aspidochirotacea, and Dendrochirotacea—as a convenient grouping of the orders have essentially been abandoned over the years, and Kerr & Kim (2001) convincingly demonstrate their impracticality. The interrelationships between extant holothurians at the family level and above were rather neglected until the 1990's, when a few authors used morphological and molecular approaches to investigate relationships. The publications by Kerr & Kim (1999, 2001) and Kerr (2001) were pioneering efforts, and they surely stimulated the surge in popularity of holothurians as research subjects

at all levels of classification. Lacey (2005) found cause to disagree in some areas with Kerr & Kim's conclusions, but all of these authors agreed with several earlier authors in suggesting a basal position for the Apodida. Smirnov (1998) revised the classification of the Order Apodida, using morphological characters. Phylogenetic studies of family-level and lower groups are burgeoning (Kerr, 2005). The fossil record of extinct holothurians has long been regarded as poor, an opinion disputed by Kerr & Kim (1999). Since the attempts by Pawson (1966, 1980) to integrate the higher-level classifications of fossil and recent holothuroids, the study of fossil groups has burgeoned, largely under the leadership of Gilliland (1992, 1993) and Reich (2002, 2004). Gilliland (1993) provides a comprehensive summary of the state of knowledge of fossil holothurians, and identifies areas where more research is required. In several publications, Reich reviews European and other fossil holothurians. Gilliland and Reich, and Smirnov (1999), suggest divergence times for the major holothurian taxa, and their conclusions are discussed by Kerr & Kim (1999, 2001), and others.

3. CHARACTERISTICS OF EXTANT CLASSES

Crinoidea

Crinoids are the least understood of living echinoderms, their skeletal remains are among the most abundant and important of fossils. They appeared during the Lower Ordovician and underwent several major radiations during the Paleozoic Era. Crinoids were major carbonate producing organisms during the Paleozoic and Mesozoic. In many Paleozoic and Mesozoic settings entire carbonate shelves were composed predominantly of crinoidal remains

(Ausich 1997). A persistent, traditional view treats living crinoids as chiefly deep-sea organisms, relicts of their opulent Paleozoic past, holding off final extinction in remote abyssal habitats. This view is generally applied to stalked crinoids, or sea lilies, as typical of the entire group, because they most closely resemble their fossil forebears. It is true that the approximately 80 extant species of stalked crinoids are chiefly restricted to depths greater than 200m (the shallowest occurs in 100m). However, 85% of extant crinoids (approximately 540 named species) are unstalked feather stars, or comatulids, the products of a continuing post-Paleozoic radiation (Meyer & Macurda 1977). About 65% of living comatulids occur at shelf depths (<200 m). All crinoids are passive suspension feeders. They produce no feeding/respiratory current but, rather, rely on extrinsic, ambient water movement. In extant crinoids, the food-gathering apparatus functions as follows: each featherlike arm that radiates from the central body bears an open ambulacral groove bordered by triads of fingerlike podia, or tube feet, which are terminal extensions of the water vascular system. The longest tube foot in each triad, 0.43-0.85 mm in length, is held out at a right angle and flicks passing food particles into the groove. After a food particle is captured by a crinoid, the shortest tube foot wraps it in mucous secretions; ciliary tracts on the groove floor then transport it toward the mouth. In living crinoids, food particle size ranges from about 50 to 400 μm. Diets include a variety of protists (e.g., diatoms and other unicellular algae, foraminiferans, actinopods), invertebrate larvae, small crustaceans, and detrital particles.

Crinoids are pentamerous, stalked echinoderms with a cuplike body bearing five usually branched and commonly featherlike arms. Most of a crinoid's body

consists of an endoskeleton composed of numerous calcareous pieces, called plates or ossicles. The visceral mass of the crinoid animal is encased in the aboral cup that is typically composed of 2-3 circlets of plates. The mouth and anus are on the upper or oral surface of the animal. Additional circlets of fixed arm plates and fixed interradial plates may occur above the aboral cup, making a larger calyx. Five radial plates (the uppermost circlet of aboral cup plates) are aligned with the radial water vascular canals and give rise to five arms on the oral side of the body. Each arm is an articulated series of ossicles extending outward from the body. Arms contain extensions of coelomic, nervous, water vascular, and reproductive systems and bear an ambulacral groove bordered by fingerlike tube feet, or podia. Arms may be non-branching or branch in many different ways. All living crinoids are pinnulate, that is, they bear a small side branch (pinnule) on alternating sides of successive ossicles along the arm. In living crinoids, the pinnules bear the food-gathering tube feet. The crinoid stalk typically consists of numerous discoidal skeletal pieces called columnals, held together by ligaments and penetrated by a central canal containing coelomic and neural tissue. In most species, the stalk serves to anchor the animal permanently to the substrate via one of a variety of terminal structures, e.g., a discoidal or encrusting holdfast, rootlike radix, or grapnel. In others, such as the living isocrinids, whorls of hooklike cirri along the stalk allow the crinoid to release its hold and crawl with its arms. Several crinoid groups, notably the comatulids, which include the only living shallow-water crinoids, have lost the stalk. Comatulids anchor via numerous cirri that arise from the retained topmost columnal (the centrodorsal).

Asteroidea

The Asteroidea is one of the largest and most familiar classes within the Phylum Echinodermata. These animals, commonly known as sea stars or starfishes, form a diverse and speciose group. There are approximately 1600 extant species (Hyman 1955; Clark 1977; Clark and Downey 1992) which are found throughout the world's oceans. Like other echinoderms, asteroids are important members of many marine benthic communities. They can be voracious predators, having significant impacts on community structure. Paine (1966) used *Pisaster ochraceus* to illustrate his concept of the role keystone species play in community ecology. The crown-of-thorns starfish, *Acanthaster planci*, is particularly well-known because it can cause extreme detrimental effects to coral reefs, particularly during population outbreaks (Moran 1988).

The controversial Concentricycloidea (a proposed sixth class of the Echinodermata; Baker *et al.* 1986, Rowe *et al.* 1988, Pearse and Pearse 1994) have been diagnosed as unusual asteroids (Smith 1988, Belyaev 1990, Janies and Mooi 1999). Their relationship to other asteroid taxa is not well resolved, but alliances with species from the Velatida and the Forcipulatida have been proposed. The unique morphology of the concentricycloids makes it difficult to assign this group to the recognized asteroid orders and is cited as sufficient distinction for class recognition.

Like other asterozoans, asteroids have a characteristic star-shaped body plan consisting of a central disc and multiple (typically 5) radiating arms. Asteroids are most easily distinguished from other asterozoans (the Ophiuroidea) by the structure of the arms. In asteroids, skeletal support for the arms is provided by the ossicles

of the body wall, which merge with those of the central disc, giving the arm a very broad based attachment to the disc. This skeletal arrangement allows for the extension of a comparatively large coelomic cavity from the central disc into the arms, which serves to hold some of the animal's organ systems, namely the gonads and pyloric caeca. Additionally, this skeletal arrangement also limits lateral flexion of the arms. Locomotion by asteroids is accomplished almost exclusively by means of the podia of the water vascular system. Taxonomy of asteroids usually is based on externally observable characteristics of the skeleton, particularly the primary ossicular series which define the body wall (ambulacrals, adambulacrals, marginals, terminals, actinals, abactinals), as well as secondary ossicles such as spines, spinelets and pedicellariae. Perhaps the most important ossicular series defining the Asteroidea is the ambulacral column, found along the oral surface of the disk and radiating arms and associated with two or four rows of podia. The asteroid ambulacrum is distinguished by erect ambulacral ossicles arranged in series along the length of the ambulacral column. According to the EAT, the ambulacral and terminal ossicles of asteroids are axial elements. These ossicles are formed according to the Ocular Plate Rule (OPR) and are associated with the developing water vascular system during ontogeny as are the axial ossicles of other echinoderms. The remaining asteroid ossicle series are extraxial elements, which can be added during ontogeny without any particular ordering system (although secondarily ordered serial homologous elements are common in the asteroids, e.g. adambulacrals and marginals). In comparison to axial elements, extraxial ossicles are prone to much more evolutionary lability (Mooi and David 1997).

Ophiuroidea

Ophiuroids are a large group (over 1600 species) of echinoderms that includes the brittle stars (Ophiurida) and basket stars (Euryalida). The more familiar Ophiurida, or brittle stars, usually have five arms and superficially resemble true starfish (Asteroidea). However, brittle stars have long, flexible arms (hence the other common name for ophiuroids, "snake stars" and a central, armored, disk-shaped body that is clearly demarcated from the arms. Instead of crawling on hundreds of tube feet like starfish, brittle stars move fairly rapidly by wriggling their arms. These fragile arms are supported by an internal skeleton of calcium carbonate plates that superficially look like vertebrae, and that are in fact called vertebral ossicles. These are moved by a system of muscles and linked together by ball-and-socket joints. The body and arms are also protected by calcium carbonate plates, and the arms generally bear delicate spines. Basket stars (Euryalida) have a similar structure to brittle stars, although they are usually larger. However, their arms are very highly forked and branched, and even more flexible than those of brittle stars.

Ophiuroids can be found in most parts of the world, from the Arctic and Antarctic to the tropics. Ophiuroids are common in many shallow-water marine habitats, and include a few species which can adapt to brackish water, which is quite unusual for echinoderms. Ophiuroids are dominant in many parts of the deep sea, where in certain regions the bottom may swarm with brittle starts. Basket stars also tend to live in deeper water. Most ophiuroids are scavengers and detritus feeders, although they also prey on small live animals such as small crustaceans and worms. Some, in particular the basket stars, filter-feed on plankton with their arms.

Echinoidea

Echinoids are one of the more diverse and successful echinoderm groups today, including familiar echinoderms such as the sea urchins and sand dollars. The roe (egg mass) of some species, notably certain sea urchins, is eaten in some cultures, notably in Japanese sushi; as a result, certain echinoid species are commercially fished. The larval development of echinoids has also been studied extensively, and many discoveries in developmental biology have been made using echinoids. In echinoids, the skeleton is almost always made up of tightly interlocking plates that form a rigid structure or test in contrast with the more flexible skeletal arrangements of starfish, brittle stars, and sea cucumbers. Test shapes range from nearly globular, as in some sea urchins, to highly flattened, as in sand dollars. Living echinoids are covered with spines, which are movable and anchored in sockets in the test. These spines may be long and prominent, as in typical sea urchins. In sand dollars and heart urchins, however, the spines are very short and form an almost belt-like covering. The mouth of most echinoids is provided with five hard teeth arranged in a circlet, forming an apparatus known as Aristotle's lantern.

Echinoids are classified by the symmetry of the test, the number and arrangement of plate rows making up the test, and the number and arrangement of respiratory pore rows called petals Traditionally, echinoids have been divided into two subgroups: regular echinoids, with nearly perfect pentameral (five-part) symmetry; and irregular echinoids with altered symmetry. Regular echinoids include the Cidaroida (pencil urchins) and Echinoida (sea urchins, including the long-spined sea urchin). The Clypeasteroida (sand dollars and sea biscuits,

above center), the Spatangoida (heart urchins), and the Cassiduloida, a somewhat sand-dollar-like group whose members are rare today, make up the irregular echinoids.

Holothuroidea

The Holothuroidea, or sea cucumbers, are an abundant and diverse group of worm-like and usually soft-bodied echinoderms. They are found in nearly every marine environment, but are most diverse on tropical shallow-water coral reefs. They range from the intertidal, where they may be exposed briefly at low tide, to the floor of the deepest oceanic trenches. Considerable diversification has occurred since then with about 1400 living species in a variety of forms. Some of these are about 20 cm in length, though adults of some diminutive species may not exceed a centimeter, while one large species can reach lengths of 5 m (*Synapta maculata*). Several species can swim and there are even forms that live their entire lives as plankton, floating with the ocean currents.

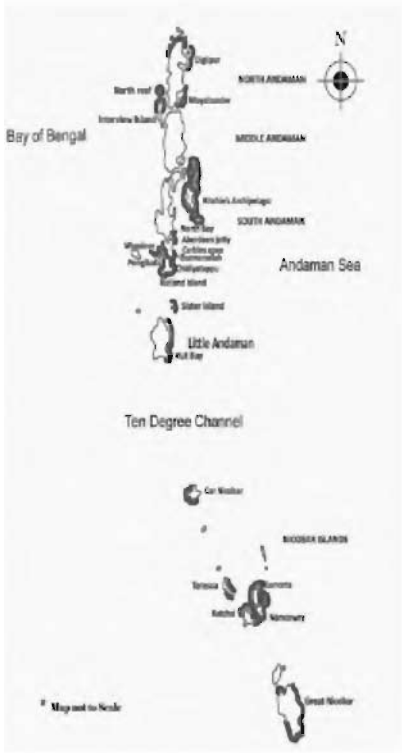
The most important feature distinguishing the sea cucumbers is a calcareous ring that encircles the pharynx or throat. This ring serves as an attachment point for muscles operating the oral tentacles and for the anterior ends of other muscles that contract the body longitudinally. Sea cucumbers are also distinct as echinoderms in having a circlet of oral tentacles. These may be simple, digitate (with finger-like projections), pinnate (feather-like), or peltate (flattened and shield-like). A third key feature, found in 90% of living species, is the reduction of the skeleton to microscopic ossicles. In some species, the ossicles may be enlarged and plate-like. As in other echinoderms, the holothurian water vascular system consists of an anterior ring canal from which arise long canals running posterior.

Despite their similarity to the radial canals of other echinoderms, these latter structures arise embryologically in a quite different Mannar. For this reason these canals in holothurians have been recently renamed longitudinal canals (Mooi and David 1997). In holothurians, the larval structures that would form the radial canals in other echinoderms instead become the five primary tentacles. Also, holothurians with the exception of members in Elasipodida have a madrepore that opens into the coelom (body cavity). In contrast, elasipodans and nearly all other echinoderms have a madrepore that opens externally. Some sea cucumbers possess organs not found in other invertebrates. In some Aspidochirotida, the respiratory trees display Cuvierian tubules. In most species, these are apparently defensive structures. They can be expelled through the anus, whereupon they dramatically expand in length and become sticky, entangling or deterring would-be predators, such as crabs and gastropods. Many forms, with the exception of members of Elasipodida and Apodida, possess respiratory trees used in gas exchange. These are paired, heavily branched tubes attached to the intestine near the anus. This type of breathing ("cloacal breathing") is also present in an unrelated group, the echiuran worms.

4. STUDY AREAS

The Andaman and Nicobar group of Islands is located in the southeast of Bay of Bengal, between 6°-14° N Latitude and 91°-94° E Longitude. They are the part of the mountain chain and lie on a ridge that extends southward from Irrawaddy delta of Burma, containing the trend of the Arakan Yoma range (Venkataraman *et al.*, 2003). There are 572 islands in the chain, some of which are volcanic.

The islands occupy an area of 8293 km^2 with a coastline of 1962 km and account for 30% of the Indian Exclusive Zone. There are 106 protected areas in these islands, 96 designated as wildlife sanctuaries, 9 national parks and one biosphere reserve. Among 9 national parks, 2 are marine national parks which have not yet inventoried thoroughly. The coral reefs of Andaman and Nicobar Islands are the biodiversity hot spot of India (Jeyabaskaran, 1999).



The names of the study areas are cited below with Global Positioning System (GPS) coordinates.

Sl. No.	Area surveyed	GPS Coordinates	
		Latitude	Longitude
South Andaman			
1.	Off Burmanella	11° 33.468'N	92° 43.873'E
2.	Off Rangachang	11° 34.350'N	92° 44.133'E
3.	Chidyatapu	11° 29.460'N	92° 42.530'E
4.	Pongibalu	11° 31.030'N	92° 39.159'E

Sl. No.	Area surveyed	GPS Coordinates	
		Latitude	Longitude
5.	North Bay	11° 42.068'N	92° 45.116'E
6.	Off Collinpur	11° 41.598'N	92° 37.035'E
7.	Off Kurmadera	11° 39.933'N	92° 35.903'E
Rutland Island			
8.	Chain Nalah	12° 08.522'N	93° 06.551'E
9.	Padauk Dikri	12° 29.288'N	92° 40.141'E
10.	Surumai Dikri	11° 25.504'N	92° 40.301'E
11.	Komeo	11° 24.314'N	92° 39.780'E
12.	Mitta Nalah	11° 28.541'N	92° 40.371'E
13.	Arom Point	11° 30.541'N	92° 38.769'E
14.	Aam Dera	11° 24.664'N	92° 37.456'E
Mahatma Gandhi Marine National Park			
15.	North Wandoor	11° 37.270'N	92° 37.035'E
16.	Grub Island	11° 35.391'N	92° 35.637'E
17.	Jolly Buoy Island	11° 30.251'N	92° 32.591'E
18.	Tarmugli Island	11° 33.261'N	92° 36.809'E
Ritchie's Archipelago			
19.	Havelock Island	12° 00.005'N	92° 56.808'E
20.	Inglis Island	12° 08.639'N	93° 06.786'E
21.	Henry Lawrence Island	12° 05.000'N	93° 06.312'E

Sl. No.	Area surveyed	GPS Coordinates	
		Latitude	Longitude
22.	John Lawrence Island	12° 04.075'N	93° 00.398'E
23.	Outram Island	12° 00.574'N	92° 56.808'E
24.	Sir William Peel Island	12° 03.315'N	92° 59.929'E
25.	Nicolson Island	12 ° 06.739'N	92 ° 57.235'E
26.	South Button Island	12° 13.467'N	92° 01.334'E
27.	North Button Island	12° 18.974'N	92° 03.826'E
28.	Middle Button Island	12° 16.473'N	93° 01.334'E
29.	Wilson Island	12° 13.061'N	93° 15.207'E
Neill Island			
30.	Lakshmanpur	11° 50.826'N	93° 00.554'E
31.	Hawrah Bridge	11° 49.727'N	93° 00.818'E
32.	Middle Point	11° 50.857'N	93° 00.554'E
33.	Ramangar	11° 48.400'N	93° 01.440'E
34.	Sunset point	11° 51.941'N	93° 00.667'E
35.	Little Neil Island	11° 47.063'N	93° 04.616'E
36.	Pearl Park Beach	11° 50.766'N	93° 00.795'E
Little Andaman Island			
37.	Butler Bay	10° 40.232'N	92° 56.808'E

Sl. No.	Area surveyed	GPS Coordinates	
		Latitude	Longitude
38.	Kala Pathar	10° 39.558'N	92° 34.109'E
39.	Haminder Bay	10° 32.975'N	92° 32.651'E
40.	Off Ramkrishnapur	10° 42.630'N	92° 33.066'E
41.	Sister Island	10° 55.830'N	92° 07.023'E
42.	Hut Bay	10° 35.419'N	92° 33.066'E
43.	Dugong Creek	10° 48.385'N	92° 64.000'E
44.	Off Light House	10° 30.734'N	92° 30.264'E
Middle Andaman			
45.	North Reef Island	12° 56.084'N	92° 57.345'E
46.	Interview Island	12° 59.125'N	92° 42.981'E
47.	Avis Island	12° 56.210'N	92° 33.066'E
48.	Sound Island	12° 56.084'N	92° 57.345'E
49.	Rail Island	12° 56.860'N	92° 54.620'E
50.	Karlo Island	12° 56.084'N	92° 53.378'E
51.	Karmatang	12° 51.322'N	92° 56.050'E
North Andaman			
52.	Ross Island	13° 18. 167'N	93° 04.261'E
53.	Smith Island	13° 18. 406'N	93° 04.207'E
54.	Ariel Bay	13° 16. 093'N	93° 02.433'E

Sl. No.	Area surveyed	GPS Coordinates	
		Latitude	Longitude
55.	Lamia Bay	13° 24. 879'N	93° 05.516'E
Nicobar Islands Car Nicobar Island			
56.	Malacca	09° 10.490'N	92° 49.714'E
57.	Kakaana	09° 07.750'N	92° 48.678'E
58.	Tamoloo	09° 11.350'N	92° 49.498'E
59.	Kimos	09° 07.587'N	92° 46.316'E
60.	Perka	09° 11.203'N	92° 49.877'E
61.	Lapati	09° 13.978'N	92° 48.002'E
Nancowry Islands			
62.	Kamorta Island - Bada Enaka	12° 51.322'N	92° 56.050'E
63.	Champin Island	08° 01.670'N	93° 33.123'E
64.	Trinket Island	08° 02.806'N	93° 34.556'E
65.	Kamorta Island – Kardip	08° 02.151'N	93° 33.182'E
66.	Kamorta Island – Kakkana	08° 07.170'N	93° 31.606'E
67.	Munak Island	07° 59.813'N	93° 30.534'E
68.	Katchal Island	07° 58.952'N	93° 24.351'E
69.	Teressa Island	08° 13.686'N	93° 10.913'E
70.	Kundol Island	07° 10.023'N	93° 42.949'E

Sl. No.	Area surveyed	GPS Coordinates	
		Latitude	Longitude
Great Nicobar Island			
71.	Campbell Bay	06° 59.749'N	93° 56.718'E
72.	Off Laxman Beach	07° 01.482'N	92° 37.456'E
73.	Off Gandhi Nagar	06° 50.496'N	93° 53.680'E
74.	Joginder Nagar	06° 57.226'N	93° 55.495'E
75.	Singam Basti	06° 58.307'N	93° 55.748'E
76.	Navy Dera	07° 07.571'N	93° 53.133'E
77.	Indira Point	06° 45.428'N	93° 49.541'E
78.	Kopen Heat	06° 50.923'N	93° 47.983'E

5. MATERIAL AND METHODS

Several surveys were conducted during the period of April, 2009 to July, 2010 at different sites of Andaman and Nicobar Islands to assess the diversity of echinoderms in coral reef enviornments by employing Self Contained Underwater Breathing Apparatus (SCUBA) diving and snorkeling. Line intercept transect (Bradbury and Reichelt *et.al.,* 1986), Quadrate methods (Endean and Stablum, 1973), Photoquadrate and underwater video transect method were applied to investigate the diversity and distribution of the Echinoderms. Underwater video sampling provides highly precise quantitative estimate of echinoderms and abundance of common benthic taxa. During SCUBA diving, species recording was made by

underwater digital photography (Sony - Cyber shot, Model-T900, marine pack, 12.1 megapixels) for detailed identification.

6. KEY CHARACTERS

Class : CRINOIDEA

Proximal pinnules very flexible and with some of the terminal segments modified to form a comb; mouth near the edge of the disc and anal tube approximately central ..... Family: **Comasteridae**

The two ossicles of the IBr series and the first two after most, if not all the axillaries united by syzygy, Division series often alternating with arms .... Genus: ***Comaster***

No dorsal process on the basal segments of the proximal pinnules; if cirri are present at all then their distal segments are smooth dorsally ..... ***Comaster schlgeli***

Arms well over 100 in number (when fully grown) .... ***Comaster multibrachiatus***

The most external IIIbr series of each ray usually two, the internal ones four; arms upto 200 .... Genus: ***Comanthina***

Whole body black in color, central disc and proximal portions of arms with black spots; some distal parts of arms also with black spots but fewer; tips of pinnules yellow ..... ***Comanthina nobilis***

III Br series, when present, either all four or else four and two irregularly; upto 120 arms but in most species less than 60 ..... Genus: ***Comanthus***

Cirri very reduced in size, often discontinuously arranged around the edge of the centrodorsal, their distal segments only slightly shorter than the proximal ones ....***Comanthus parvicirrus***

More than 60 arms; no dorsal processes on the distal cirrus segments..... ***Oxycomanthus bennetti***

Middle and distal cirrus segments with a pair of dorsal spines or tubercles, one each side of the mid-line, rarely a transverse rigid ..... Family: **Colobometridae**

Arms fewer <40, rarely >45 cirrus segments, 53-120 arms; division series all two; cirri with 41-80 segments; all the pinnule present..... ***Pontiometra andersoni***

Outer pinnules (2) very stout, stiff and erect or even recurved over the disc, its segments with conscipicously flared and spinose distal ends, Arms: more than 10 .... Genus: ***Cenometra***

Basal segments of none of the proximal pinnules carinates, A simple keel on the bases of the proximal pinnules or else the edge rounded .....***Cenometra bella***

Basal segments of the proximal pinnules with knob-like rounded process forming a crest along the edge facing the tip of the arm.....***Cenometra emendatrix***

Outer pinnules (2) markedly prismatic, often with the angles conscipicously produced at the distal ends of the segments..... ***Oligometra serrapinna***

All the pinnules prismatic; the distal pinnules, if not all of them, flexible and not conscipicously stiffened..... ..... Family: **Himerometridae**

The first three external brachial pinnules (P_1, P_2, P_3), progressively diminishing in size, if any pinnules are present on the division series they are largest of all..... .....Genus: ***Himerometra***

Proximal pinnule upto 25, usually 20, segments, tapering fairly abruptly near the tip, not flagellate, Enlarged proximal pinnules with smooth segments although their distal ends may be flared; proximal brachials with smooth but hardly at all flared distal edges ..... ***Himerometra robustipinna***

Rarely more than 10 arms but should this number be exceeded than the IIBr series are two; the proximal pinnules little different from the following ones..... ..... Genus: ***Amphimetra***

Cirri with 30-35 segments and outer pinnules with 18-21 ..... ***Amphimetra molleri***

Usually more than 10 arms with the IIBr series mostly four but if only 10 arms are present then the proximal pinnules are distinctly modified with a strong crest or the segments have flared or spinose distal ends .....Genus: ***Heterometra***

Distal cirrus segments with distinct dorsal spines or tubercles, Proximal pinnules appearing serrated in profile, due to projections from the distal ends of the segments... ..... ***Heterometra crenulata***

Arms often exceeding 20 in number than the IIIBr series usually with four ossicles..... ***Heterometra philiberti***

Always more than 10 arms... .... Family: **Mariametridae**

Second interradial arm is the largest proximal pinnule..... .....Genus: ***Lamprometra***

Second inter radial arm either very stout or distinctly carinate basally..... ***Lamprometra palmata***

Class : ASTEROIDEA

Skeleton of dorsal surface paxilliform or otherwise tube feet with suckers ..... Order: **Valvatida**

The quadrangular or crescentic abactinal plates more or less obviously imbricating in the proximal direction usually armed with fine spineletsor granules, rarely naked except around the anus and madreporite, arms flattened or rounded above, occasionally somewhat carinate but then with no mid-radial series of conspicuous spines .... Family: **Asterinidae**

Body usually stellate but if nearly pentagonal then the margin is thin and pliable, often curling upwards in preserved specimens. Radius from centre to arm exceeding 20mm, Abactinal armament usually distinctly spiniform and sometimes fine ..... Genus: ***Asterina***

Abactinal armament very delicate, consisting of fine minute hyaline spinelets, easily rubbed off, the petaloid radial popular areas linked only to the area in the centre of the disc, body markedly flattened .....***Asterina sarasini***

Marginal plates large, forming a conscipicous side-wall to the body, the upper surface almostflat, rarely somewhat convex; no papillae on the lower side; interradial arcs rounded.....Family: **Goniasteridae**

Radial areas, if not the whole upper side, distinctly convex; supero-marginals narrower; arms slender; granules around the papulae usually similar to the rest.. ..... Genus: ***Stellaster***

Not more than one infero-marginal spine, sometimes none..... ***Stellaster equestris***

Three series of spines on the ambulacral plates; arms usually triangular or tapering to a blunt tip; carinal rows of tubercles not conscipicously enlarged.....Genus: ***Anthenea***

Armament of the distal plates not dissimilar to that of the other abactinalm plates, though the tubercles may be somewhat enlarged and more numerous than proximally; primary aboral tubercle stout, flat-topped and widely spaced with more than one tubercle..... ***Anthenea tuberculosa***

Form massive, adults with major radius often well in excess of 100mm, interradial areas extensive, the arms tapering and stellate or short, body almost flat below but usually markedly convex above, often highest at the five primary radial plates which may each be crowned by a high conical prominence, marginal plates well developed but not very conscipicous in aboral view.....Family: **Oreasteridae**

Marginal plates concealed by thickened skin, some enlarge tubercles present on the upper side, pore areas usually rather irregular and sometimes indistinct or more or less continuous .....Genus: ***Culcita***

A distinct pore free area at least towards the lower side at the margins as well as more or less extensive reticular areas on the upper side, though some of the pore areas may be somewhat confluent, some larger, usually spaced tubercles often also present, No spines or spinelets on the pore areas ..... ***Culcita schemideliana***

Actinal granulation including more or less numerous coarse, often polygonal granules, often in groups but generally with some fine granules among the coarse ones, pores area somewhat irregular and often only narrowly or incompletely separated..... ***Culcita noveguineae***

At least the distal marginal plates and the convex part of the larger abactinal plates covered with asmooth plastering of unequal polygonal flattened granules, dorso lateral areas of the arms rarely with any convexities..... .....Genus: ***Protoreaster***

A few of the distal supero-marginal plates bearing laterally projecting, usually conscipicous, tapering spines or at least knobs .....***Protoreaster lincki***

Disc markedly elevated, some of the carinal plates with very conscipicous, more or less high, rounded or conical elevations, particularly huge on the five primary radial plates, the consecutive carinal tubercles usually

spaced from each other and not broadened; pore areas confluent ..... ***Protoreaster nodosus***

Only the primary plates of the upper side with elevations and these tending to form regular longitudinal series; pore-areas usually well defined..... Genus: ***Pentaceraster***

No spines on the first two or four supero-marginal plates in each interradial angle; some of the interradial supero-marginals with spines; dorso-lateral elevations or spines developed along the arms..... ***Pentaceraster regulus***

The distalmost supero marginals not conscipicously different from the other marginal plates, arms usually well developed but some genera stellate or even pentagonal or circular in outline ..... Genus: ***Choriaster***

Entire surface covered by opaque smooth skin, interrupted only by the relatively small adambulacral spines and the popular areas, arms well-developed but short and broadly rounded at the tip ..... ***Chorister granulatus***

Edge of the body defined by the two series of marginal plates, the supero-marginals sometimes smaller than the infero-marginals but always conscipicously different from the paxillae..... Family: **Astropectinidae**

Periphery fringed with conscipicous large spines ....Genus: ***Astropecten***

Arms more or less blunt at the tip, the paxillar areas ending abruptly; ventral sides of the infero-marginal plates usually with few spines among the small rounded scales, sometimes only on the interradial plates .... ***Astropecten indicus***

Supero-marginal plates relatively narrow, the paxillar area at the base of the arm distinctly more than half the total arm breadth, usually abut two-thirds; ventral side od the infero-marginal superficially appearing very smooth,

being covered with short, rounded more or less apressed squamules.....***Astropecten monacanthus***

Body with cylindrical arms or sometimes cushion like rounded ventro- laterally; aboral skeleton usually reticular with relatively large space between the plates often small.....Family: **Asteropsidae**

Body covered with smooth skin obscuring the non-imbricating oval or circular abactinal plates which are nearly all quite naked, though bearing crystal-bodies embedded in their surface; the edge of the body formed by supero marginal plates with prominent conical single spines.....***Asteropsis carinifera***

Armament predominantly granuliform, usually continuous, though sometimes increasing in size or modified into tubercles, basal as well as distal marginals bearing granules, intermarginal plates present and then only basally.....Family: **Ophidiasteridae**

Plates rounded and completely granule-covered, not markedly swollen, pores in groups, rarely occurring on the lower side.....Genus: ***Linckia***

Subambulacral spines are in two series, those of each plate contiguous with each other and with the furrow spines but aligned slightly obliquely so as to give a herring bone pattern to the underside of each arm .....
.....***Linckia guildingi***

Subambulacral spines or tubercles very low and surrounded by the granulation, usually only a single series present, granules extending down between the furrow spines, especially numerous in large specimens, arms normally five in number and madreporite single. Arms fairly stout and blunt at the tips, body colour blue.
.....***Linckia laevigata***

Arms often irregular in length and number, normally two madreporites; Arms more slender and attenuated

towards the tips; colour in life often variegated, purpulish, reddish, brownish or khaki coloured with yellowish, sometimes more nearly uniform..... ***Lincki multifora***

Papular pores present on the oral side, no pores in the infero-marginals, pores single, form more or less flattened, the marginals usually defining the edge of the body..... .....Genus: ***Fromia***

Carinal plates not conspicuously enlarged and widely separated from the supero-marginals. Denuded plates with bumpy surface due to embedded crystal bodies, actinal pores few or absent on the disc, abactinal granulation is very fine..... ***Fromia monilis***

Abactinal plates markedly unequal in size, usually two longitudinal series of distinctly enlarged plates on each arm..... ***Fromia indica***

Tube feet tapering to a rounded or conical knob, no terminal disc; tube feet cylindrical and with a terminal disc; edge of the body defined by the large infero-marginal plates alone, the supero-marginals indistinguishable from the paxillae..... Family: **Ludiidae**

No large bivalve pedicillarie at the apics of the jaws close to the mouth; most of the arm breath taken up by the larger, quadrangular lateral paxillae, upto five longitudinal rows of which each side also tend to form transverse rows, often many of these bearing single enlarged spines .....Genus: ***Luidia***

No conscipicous single paxillar spines, though the smaller proximal paxillae may have alarge blunt central spinelet about twice as high as the peripheral spinelets; some or many of the lateral paxillae armed with large sharp single spines; seven to nine arms..... ***Luidia maculata***

Ten to twenty arms and numerous madreporites, aboral armament consisting of large conical isolated

spines mounted singly on stalklike pedicle .....
..... Family: **Acanthasteridae**

Usually five to six arms and only one madreporite, sometimes two. Armament variable but if conical spines are present then these are mounted only von low eminences ..... **Genus: *Acanthaster***

Aboral spines are long and conscipicous, commonly 15-30mm, long when major radius exceeds 100mm, Pedicellariae slender ..... ***Acanthaster planci***

Conscipicous marginal plates forming a broad vertical edge to the arm usually wanting, Aboral skeleton reticulate or imbricate, tubefeet in two rows with suckers, Pedicellariae rarely present..... Order: **Spinulosida**

No enveloping aboral granulation, Spines sometimes conscipicous but more often diminutive, adambulacral spines few, usually about 3 in number.....
.....Family: **Echinasteridae**

Skeletal reticulum irregular aborally, no well defined longitudinal and transverse series of plates.....
..... Genus: ***Echinaster***

Five or six rays, occasionally seven, autonomous with single separated arms regenerating to produce comet forms but apparently not fissparous, arms slender and cylindrical, often relatively long..... ***Echinaster luzonicus***

Class : OPHIUROIDEA

No dorsal process of the arm bases, both tooth papillae and oral papillae present, the former usually numerous but occasionally few..... Family: **Ophiocomidae**

Disc covered, at least dorsally, with a dense coat of rounded granules, the marginal ones either similarly spherical or else very slightly elongated.....
..... Genus: ***Ophiocoma***

Colour uniformly dark, above and below, Two tentacles scales, Colour paler on the underside, variegated or sometime uniformly dark above.....***Ophiocoma erinaceus***

Colour of the disc either uniformly dark or variegated, reticulated or spotted with dark markings.....
.....O***phiocoma dentata***

Disc granulation coarse, 3-6 granules/mm. length; uppermost arm spines usually thickened and cigar shaped or cylindrical, rarely tapering.....***Ophiocoma scolopendrina***

Disc completely naked, uppermost spines similar to each other, none abruptly and markedly clavate though some spines may be slightly so..... Genus: ***Ophiarthrum***

Disc beautifully patterned with grey, yellow and white, at least in life, Arms with a dusky longitudinal stripe dorsally .....***Ophiarthrum pictum***

No oral papillae, each jaw crowded with a more or less compact cluster of apical tooth papillae .....
.....Family: **Ophiotrichidae**

Radial shields with some or many thorny granules or short stumps similar to, but shorter than, the stumps on the rest of the rather puffy disc, which completely obscure the countless underlying scales, Arm spines usually transparent..... Genus: ***Macrophiothrix***

Longer arm spines with the sides parallel or only slightly diversgent distally and finely thorny for most of their length, not at al clavate, Radial shields granules covered; colouration spotted .....***Macrophiothrix longipeda***

Ventral arm plates hexagonal, narrower at the proximal end, the distal edge slightly concave.....
.....***Macrophiothrix propinqua***

Disc densely granulated, also the oral plates, sometimes even the oral and adoral shields .....
..... Family: **Ophidermatidae**

Arms spines long and flaring, all of them easily exceeding the segment in length; apical oral papillae sometimes rather irregular, stimulating the tooth papillae of ophiocomids, though much numerous..... Genus: ***Ophiarachna***

Arms spines four, rarely five basally; size very large, colour in life including extensive areas of uniform green, becoming yellow or buff in preservation and running along the arms above and below, contrasting with interradial areas of black-ringed light sports forming a reticulation and with the annulated arm spines..... ***Ophiarachna incrassata***

Class : ECHINOIDEA

Primary spines large, widely separated, contrasting markedly with numerous, small secondary spines .... Order: **Cidaroida**

Interambulacral plates high, each with a single massive primary spine, usually ringed by much smaller, often spatulate secondary spine, ambulacral plates simple so that the pore-pairs form single vertical series, sometimes sinuous.....Family: **Cidaridae**

In the apical system the ocular plates usually nearly all insert, large globiferous Pedicellariae usually with a limb or frill of rods on the stalk close to the head..... .....Genus: ***Prionocidaris***

Primary spines distinctly verticillate, with three or four spaced complete thorny whorls along their lengths .. .. ***Prionocidaris verticillata***

Test very flexible, in life more or less hemispherical in shape but usually collapsing into a flat pancake on preservation.....Family: **Arbaciidae**

The ambulacral and interambulacral tubercles developed throughout the adapical and adoral sides..... ..... Genus: ***Arbacia***

Plates of abactinal system and upper interambulacral plates coarsely granular, not marked with deep red in contrast with the ground colour ..... ***Arbacia punctulata***

Epiphysis of the Aristotle's lantern not fused across the top of each pyramid, Spines lack a cortex and are solid or provided with a narrow lumen .....Order: **Diadematoida**

Primary tubercles perforate and often also crenulate, Spines usually hollow, long, cylindrical and very slender and breakable..... Family: **Diadematidae**

Ambulacral spines of the aboral side very fine and needle like with backwardly-directed barbs near the tip, contrasting with the other spines..... Genus: ***Echinothrix***

Ambulacra distinctly bulging aborally, with naked interambulacral areas between them apically, Naked test usually greenish in colour..... ***Echinothrix calamaris***

Ambulacra not distinctly bulging and no naked interambulacral areas aborally, Cavity of primary spines very small, their surface with fine longitudinal ridges only, No green colour on the naked test .... ***Echinothrix diadema***

No spines on the buccal plates, no globiferous pedicellariae ..... Genus: ***Diadema***

Large tridentate pedicellariae mostly with narrow blades only meeting at the tip, A red ring around the anus ..... ***Diadema setosum***

Tridentate pedicellariae leaf or spoon shaped, tapering slightly to the rounded distal end ..... ***Diadema savignyi***

Spines are solid with or without cortex teeth unkeeled .....Order: **Phymosomatoida**

Stirodonts with: apical disc hemicyclic; pore-pairs in strongly offset arcs at ambitus and adapically; Primary tubercles imperforate and non-crenulate..... ..... Family: **Stomechinidae**

No complete bridges across the V-shaped space at the upper end of each of the five pyramids forming frame of the Aristotle's lantern, Ambulacral plates doubly compound so that at the ambitus one very large tubercle correspondence to three to six arcs each of three pore pairs ..... ***Stomopneustus variolaris***

Epiphysis of the Aristotle's lantern not fused across the top of each pyramid ..... Order: **Temnopleuroida**

Tubercles usually crenulate; test usually with distinct pits, troughs or pores at the angles of the sutures, or the plates more extensively sculpture ..... Family: **Temnopleuridae**

Crenulations conscipicous, Pore pairs more or less distinctly in arcs of three ..... Genus: ***Temnopleurus***

Spines not banded but often greenish basally becoming purple distantly, or else uniform in colour- green, purple or white ..... ***Temnopleurus alexendri***

Tubercles distinctly crenulate, pores distinct; no extensive bare areas on the test ..... Genus: ***Salmacis***

Base of spines green ..... ***Salmacis belli***

Ten conspicuous abruptly spineless vertical areas on the test covered with extremely numerous globiferous pedicellariae, forming a dense carpet, their valves with the blades bearing two or three lateral teeth each side .... ***Mespila globulus***

Globiferous pedicellariae less conscipicously developed the blade fairly narrow and bearing not more than one lateral tooth each side, tubercles indistinctly crenulate; sutural pores very small and inconscipicous; naked areas conspicuous aborally ..... Genus: ***Macrocyphus***

Test patterned with olive-green; spines banded with reddish brown and white ..... ***Microcyphus ceylanicus***

Gill slits sharps and deep, test circular or pentagonal, as viewed from above ..... Family: **Toxopneustidae**

Globiferous pedicillarie not enlarged but inconscipicous; only one in three or four ambulacral plates with a primary tubercle; test high almost globular; pore-pairsin horizontal arcs and spaced to form three distinct vertical series in larger specimens; preserved material often with a conscipicous dark vertical stripe down each inter ambulacrum contrasting with the light ambulacral areas and white spines.....***Tripneustes gratilla***

Lantern and teeth present throughout life; test usually more or less flattened with a low sometimes acute margine, rarely the test ovate ..... Order: **Clypeasteroda**

Plates of the petals all alike and running across half the width of the petal; aboral miliary spines ending in a crown or a glandular bag; five genital pores; periproct below the margin ..... Family: **Clypeasteridae**

No interradial projections around the peristome ....Genus: ***Clypeaster***

Generally smaller; test flat orally; frontal petals closed ..... ***Clypeaster humilis***

Test always very flat and perforated by two or more lunules; a pair of interambulacral plates heading the double series apically, miliary spines ending in a glandular bag..... Family: **Astriclypeidae**

Only two lunules, situates in the posterior paired ambulacra.....Genus: ***Echinodiscus***

Lunules open distally .....***Echinodiscus auritus***

Primary and secondary spines not markedly contrasting in size..... Order**: Echinoida**

Shape either circular or more or less ovate, Periproct with multiple plates; globiferous pedicellariae with an unpaired lateral tooth ..... Family: **Echinometridae**

Test usually oval..... Genus: ***Echinometra***

Long axis of the test through ambulacrum I and interambulacrum 3, Spines slender and acute, Usually only pore-pairs per arc aborally.....***Echinometra mathaei***

Long axis; primary spine often massive and either very long or truncated and very short, but even if they are slender then the lower ones are more or less flattened and some are angular, Eight or more pore-pairs per arc aborally.....***Echinometra oblonga***

Primary spines massive, all either rounded and are very thick but somewhat flattened towards the tip, or triangular in cross section and slightly tapering.....
.....Genus: ***Heterocentrotus***

Usually 15-16 pore-pairs in each arc at the ambital region, primary ambulacral tubercles gradually decreasing in size aborally and their spines correspondingly only gradually shorter and not truncated.....
.....***Heterocentrotus trigonarius***

Class : HOLOTHUROIDEA

Podia (Pedicels and papillae) present, body usually stout, body wall more or less thick and muscular, usually 1-15mm thick, dominant spicules in the form of tables, perforated plates, buttons, cups, rods or rosettes present in the body wall .....Order: **Aspidochirotida**

Gonads in a single tuft to the left of the dorsal mesentery, Spicules diverse in form and combination, 'S' or 'C' shaped rods not present .....Family: **Holothuriidae**

Spicules: tables nearly always present buttons, rods, perforated plates and rosettes present or absent, minute dichotomously branched or lobed rods rarely present and if so then only in combination with tables,Anus guarded by five calcified papillae, 20-30 tentacles..... Genus: ***Actinopyga***

Colour completely black .....***Actinopyga miliaris***

Colours brown or brown and white, Colour brown on upper side and white on lower side; often found near low water mark..... ***Actinopyga mauritiana***

Colour completely brown with often sand deposits on upper side of the body, mostly found din deeper waters... .....***Actinopyga echinites***

Body colour: light grey or brown; Spicules composed of small rods ..... ***Actinopyga lacanora***

No calcified anal teeth present though five groups of papillae may be evident, presence of 20 tentacles .... Genus: ***Bohadschia***

Colour black or brown with distinct eye like spots all over the body..... ***Bohadschia argus***

Colour variable, usually light brown with black spots .....***Bohadschia marmorata***

Body colour: pale cream with brown speckling and low papillae, spicules resemble a somewhat tack-like bundle of spinose rods described as racquet-like..... .....***Bohadschia graeffei***

Spicules: variously developed and in various combinations,Calcareous ring never ribbon-like, radial plates either as long as broad or longer, intertidal plates usually half as long as broad but never curved, Body wall variously developed often rather thick. Body form showing a wide range but pedicles usually irregularly arranged on a more or less flattened ventral 'sole' and papillae irregularly arranged on the arched dorsal surface ....Genus: ***Holothuria***

Body tubular, body wall not very thick. No lateral projections in the living condition, Body completely black in colour, red colour comes off when live specimens are handled ..... ***Holothuria atra***

Yellow transverse band on the upper side of the body, lower side white with a number of black dots ....***Holothuria scabra***

Body like a loaf with very thick body wall. In the living condition about six pairs of lateral teat-like projections are seen, Body with black or white patches ....***Holothuria nobilis***

Buttons of the spicules have large holes, In the spicules tables stout with a cluster of short spines at the top fugitive form skin sandy to touch.....***Holothuria impatiens***

Spicules: tables not stout and with a few spines at the top skin smooth and soft, fugitive form ..... ***Holothuria hilla***

Spicules: buttons with small holes burrowing form with often red spots..... ***Holothuria arenicola***

Body large and snake like, Spicules: tables with complete or incomplete discs often reduced to four holes, buttons may sometimes be asymmetrical, tentacles- 20 ... .***Holothuria leucospilota***

Tentacles large, sub-globose when fully expanded. Pedicles arranged in three rows. Papillae irregular, Spicules: tables and rods present, Rods simple and granulated .....***Holothuria cinerascens***

Body colour pink with varying degrees of black pigment, numerous pedicles on the ventral side, Spicules: Tables and buttons present, discs of tables is narrower than the top of the spire .....***Holothuria edulis***

Body colour brownish pink with some of the tubercles blackish brown, Spicules consist of only tables in the body wall .....***Holothuria pyxis***

Papillae scattered on the dorsal side, Cuvierian tubules are thick, Body colour brown with 5-7 honey coloured transverse bands of different widths. Spicules:

incomplete and oblong rods with lateral projections resembling narrow rosettes, tables subcircular .... ***Holothuria pervicax***

Body colour brownish black with grey ventral side, Cuvierian tubules large. Button has two narrow slit-like holes and one or two pairs of minute holes at each end .. ..***Holothuria fuscocinerea***

Body colour black with white papillae, Spicules include spinose 'cup and saucer' tables and rosettes ..... ***Holothuria coluber***

Spicules: rods only, usually dichotomously branched or lobed, tables and buttons never present, Calcareous ring very stout, both radial and interradial plates with their anterior margin scalloped and sometimes with their suture indistinct, radial plates usually about twice as large as the interradials and possessing median anterior ampullary notch, Tentacles: 20-30, Body wall very thick and muscular, usually about 5mm. thick, pedicels and papillae small and numerous, indistinguishable from each other, scattered ventrally and dorsally ..... Family : **Labidodematidae**

Spicules: tables scattered, variously developed, either with disc reduced and spire low and ending in a row of spines or else disc well developed and spinose, with spire of moderate height and usually very spinose, Buttons when present very smooth and irregular, often incomplete or deformed and suggesting clumsy 'C' shaped body, Body cylindrical or vermiform with pedicels and papillae confined to the five ambulacral areas, size moderate, Cancerous ring ribbon like, radial plates usually shorter than broad, intertidal plates also shorter than broad tending to be curved ..... Genus: ***Labidodemas***

White, almost translucent sea cucumber, with yellow tube feet and a dark posterior end, Spicules are spinose tables and sometimes buttons and rods ....***Labidodemas semperianum***

Gonads in two tufts, one each side of the dorsal mesentery, Spicules: primarily tables, branched rods and 'S' or 'C' shaped rods , the latter very rarely absent, or slender dichotomously branched rods, buttons rarely, if ever, present ..... Family: **Stichopodidae**

Spicules reduced: grains and dichotomously- branched rods, pedicles crowded ventrally, papillae resembling large leaf shaped structures dorsally.....Genus: ***Thelenota***

Very massive form with numerous large pointed teats in groups of two or three all over the upper surface .... ***Thelenota ananas***

Spicules: tables, branched rods and S and C shaped rods (the latter absent only in some growth stages of *Stichopus horrens*, H.L.Clark, 1922) buttons rare..... .....Genus: ***Stichopus***

Body quadrangular with four rows of large finger like processes, Body colour dark green, appearing almost black in some shades of light..... ***Stichopus chloronatus***

Body massive and loaf-like with irregular brown patches on yellow grey background.....***Stichopus variegatus***

Body colour grey to green-black with dark patches, smooth tegument but large and irregular papillae, Spicules are tables and large "C" bodies..... ***Stichopus horrens***

The body wider in the middle, tapering at both ends, covered with a bright smooth skin, upper surface uniformly brown, zigzag bands at all over the body, spicules consists of tables, branched rods and 'S' and 'C' shaped rods..... .....***Stichopus vastus***

Tentacles bush or tree shaped, dendritic. Anterior end in the form of a thin walled introvert capable of retraction by special muscles.....Order: **Dendrochirotida**

Body cylindrical or fusiform, without a well defined ventral 'sole', no conscipicous dorsal plates, Mouth and anus terminal in position, Tentacles 10 ....Family: **Cucumariidae**

Spicules: small nodular buttons with few holes, usually four, sometimes larger perforated plates present. .....Genus: ***Stolus***

Body colour dark, purple-black and brown or grey colour, Spicules: small nodular buttons ..... ***Stolus buccalis***

Podia absent, though warty prominences may be present, Body either vermiform, body wall thin, thick or less often translucent, with smooth, rough or warty surface, or body stout and sausage-shaped with a caudal appendage ..... Order: **Apodida**

Spicules: anchors and anchor-plates, rods and granules, never wheels or sigmoid particles, rarely spicules wanting, Tentacles pinnate or digitate..... Family: **Synaptidae**

Anchor-plates not abruptly contracted at the posterior end but with a large hole on each side, Calcareous ring without conscipicous anterior projections, Stone canals always few in number (one to three) .....Genus: ***Euapta***

Body colour: mottled cream-white with grey, spicules are anchors with tiny knobs on the vertex and plates with large posterior holes .....***Euapta godeffroyi***

Spicules: characteristically large, Anchor plates sub rectangular or irregular broad posterior with numerous smooth holes..... Genus: ***Synapta***

Tentacles- 15; Body colour: (brown-yellow) with broad longitu dinal stripes and large dark patches ....***Synapta maculata***

7. DESCRIPTIONS

Class CRINOIDEA Miller, 1821

Order : COMATULIDA A. H. Clark, 1908
Family : COMASTERIDAE Clark, 1908
Genus : ***Comanthus***

1. ***Comanthus parvicirrus*** (Muller, 1841)

Description: Cirri are very short in size. It is discontinuously arranged around the edge of the centrodorsal and their distal segments only slightly shorter than the proximal ones. Arms are 10-63 in number. Cirri are formed with 11-16 segments. Distal segments bear a sharp aboral transverse bar or tubercle. Centrodorsal are small in size discoidal in shape. Radials are easily visible.

Colour: Brownish black.

Habitat: Benthic, inshore in habitat and this species is suspension feeder.

Distribution: ***India***: Andaman and Nicobar Islands, Gulf of Mannar; ***Elsewhere***: Aldabra, Eastern Africa, Madagascar, Fiji, Great Barrier Reef, Indonesia, Marion Reef, Mascarene Basin, Mozambique, New Caledonia, Palau, Philippines, Seychelles, South China Sea, South Japan, Thailand Exclusive Economic Zone, Tongan Exclusive Economic Zone and West Indian Ocean.

Comanthus parvicirrus (Muller, 1841)

Genus : ***Comanthina***

2. ***Comanthina nobilis*** (P.H. Carpanter, 1884)

Description: Central disc and proximal portion of arms have black spots. Tips of pinnules are yellow in colour. Cirri are 0-5 in number. Proximal aboral surface is heavily plated and smooth. Arms are 50-140 in number. Combs of pinnules arising from brachials often with one tooth per segment.

Colour: Body is uniformly black in colour.

Habitat: It is found over 8m depth ranging upto 92m.

Distribution: ***India***: Andaman Islands; ***Elsewhere***: Coral Sea, Great Barrier Reef, Indonesia, Malaysia, New Caledonia, Philippines and Sri Lanka.

Comanthina nobilis (P.H.Carpanter, 1884)

Genus : ***Comaster***

3. ***Comaster schlegeli*** (P.H. Carpanter, 1881)

Description: This species bears 9-33 cirri which consist of 11-17 segments. Proximal aboral area is relatively smooth. Radial plates are narrowly visible. Arms are 10-90 in number. Brachial pinnules (except possibly P_1) with a pair of more or less equally sized teeth.

Colour: Body colour- Grey.

Habitat: Found over 5 m depth.

Distribution: ***India***: Andaman and Nicobar Islands, Gulf of Mannar; ***Elsewhere***: Fiji, Indonesia, Japan and Kerama Group.

Comaster schlegeli (P.H.Carpanter, 1881)

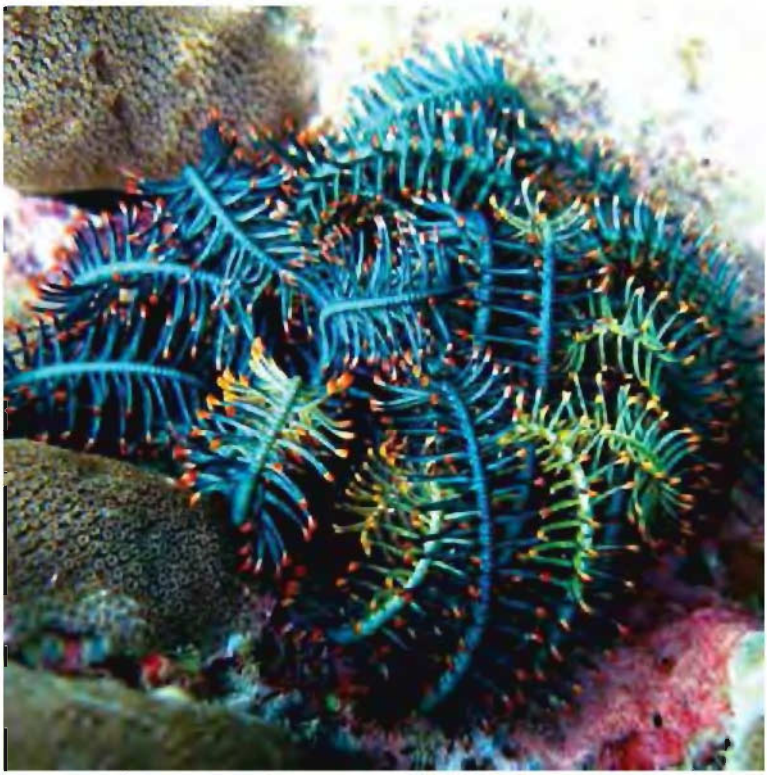
4. ***Comaster multibrachiata***
(P.H. Carpanter, 1888)

Description: Cirri are 21-50 in number. Each cirrus is of 12-15 segments. Arms are more than 100 in number with a maxiumum of 170.

Colour: Body colour is blue with orange colour tips of the pinnules.

Habitat: It is found on reefs at variable depth.

Distribution: ***India***: Andaman Islands; ***Elsewhere***: East Indies, China, South Japan and Philippines.



Comaster multibrachiata (P.H. Carpanter, 1888)

Genus : ***Oxycomanthus***

5. ***Oxycomanthus bennetti*** (Muller, 1841)

Description: Arms are 31-120 in number. Anterior arms not markedly longer than posterior arms. Cirri consist of 23-35 segments (usually 25-29) and these segments usually as broad as long and without aboral processes. Centrodorsal is large and thick, covering radials.

Colour: Uniformly yellow in colour.

Habitat: This species is commonly found below 5m depth. It mainly occurs on live coral specimen.

Distribution: ***India***: Andaman Islands; ***Elsewhere***: East Indies, North Australia, Philippine, China, south Japan and South Pacific Islands.

Oxycomanthus bennetti (Muller, 1841)

Family : HIMEROMETRIDAE
Genus : ***Himerometra***

6. ***Himerometra robustipinna*** (P.H. Carpanter, 1912)

Description: This species have stout, enlarged proximal pinnules that taper rapidly or gradually to the tip. Almost all segments are broader than long with 20-42 in numbers. The distal end of the segments is unmodified or swollen, but never spinous. Distal edges of proximal brachial smooth or slightly produced. Arms 33-52 upto 200 mm long.

Colour: Grey to white in colour.

Habitat: Found with the reefs.

Distribution: ***India***: Andaman Islands; ***Elsewhere***: Ashmore Reef, China, China Sea, East Indies, Great Barrier Reef, Indonesia, Japan, Lady Musgrave Island,North Australia, Northern Territory, Okinawa, Philippines, South China Sea, South Japan, South Pacific and Sri Lanka.

Himerometra robustipinna (P.H. Carpanter, 1912)

Family : MARIAMETRIDAE
Genus : ***Heterometra***

7. ***Heterometra philiberti*** (Muller, 1849)

Description: Arms are more than 20 in number. The proximal pinnules are distinctly modified with a strong crest or the segments have flared or spinose distal ends.

Colour: It is usually brown in colour. Sometimes it can be seen in the form of brown-black specimen.

Habitat: Found in the rocky areas of reef slopes.

Distribution: ***India***: Andaman Islands; ***Elsewhere***: East Indies.

Heterometra philiberti (Muller, 1849),

8. ***Heterometra crenulata*** (P.H. Carpenter, 1882)

Description: Proximal pinnules are large and strongly triangular in cross section, strongly serrate in profile. Outer portion of prismatic ridge on each segment raised into conspicuous broad rounded triangular processes. Distal cirrus segments occur with distinct dorsal spines or tubercles.

Colour: Body colour Red with white ridges in arms.

Habitat: Found in the reef slopes.

Distribution: ***India***: Andaman Islands; ***Elsewhere***: Cambodia, China, Double Island Point, East Indies, Indonesia, Maldives, Monte Bello Islands, North Australia, Philippines, Queensland, Singapore, South Japan, Vietnam and West Australia.

Remark: New record to Andaman and Nicobar Islands reported from Pongibalu, South Andaman.

Heterometra crenulata (P.H. Carpanter, 1882)

Genus : ***Amphimetra***

9. ***Amphimetra molleri*** (A.H. Clark, 1908)

Description: Usually 10 arms are present and rarely more than 10 arms are found. Cirri are stout, curved and formed of 24-50 short sub equal segments. First aboral spine appears proximal to 8th cirrus. Arms are 150mm in size. Outer pinnules are 18-21 in number.

Colour: Black in colour.

Habitat: Mainly found on shoreline to 50m depth range.

Distribution: ***India***: Andaman and Nicobar Islands and Gulf of Mannar; ***Elsewhere***: China, East Indies, Greater Sunda Islands, Gulf of Thailand, Maldives, Philippines, South Japan and Sri Lanka.

Remark: New record to Andaman and Nicobar Islands

Amphimetra molleri (A.H.Clark, 1908)

Genus : ***Lamprometra***

10. ***Lamprometra palmata*** (Muller, 1841)

Description: Second interradial arm is stout or distinctly carinate basally and has the largest proximal pinnule. Arms more than 140 in number. This species is commonly distributed in tropical Indo-Pacific Ocean.

Colour: Arms greenish black in colour with white patches

Habitat: Benthic, inshore, continental shelf, suspension feeder. Depth range: 0-51m

Distribution: ***India***: Gulf of Mannar, Andaman and Nicobar Islands and Karwar Coast; ***Elsewhere***: Aldabra, Eastern Africa, Madagascar, Red Sea and Tanzania.

Lamprometra palmata (Muller, 1841)

Family : COLOBOMETRIDAE
Genus : ***Cenometra***

11. ***Cenometra bella*** (Hartlaub, 1890)

Description: Outer pinnules (2) are very stout, stiff and erect or even recurved over the disc. Arms are more than 10 in number. Basal segments of none of the proximal pinnules carinates. A simple keel on the bases of the proximal pinnules forms rounded edge.

Colour: Central ridge of the arm is white and pinnules are dark red in colour.

Habitat: Commonly found below 5m depths and it lives with the association of encrusting and massive coral species.

Distribution: ***India***: Andaman Islands; ***Elsewhere***: East Indies, Philippines, China, South Japan and South Pacific Islands.

Remark: New report from India.

Cenometra bella (Hartlaub, 1890)

12. ***Cenometra emendatrix*** (Bell, 1892)

Description: The Basal segments of the proximal pinnules have knob-like rounded process that forms a crest along the edge. Arms are 10 in number.

Colour: Dark red in colour

Habitat: It occurs in Littoral to 55m depths.

Distribution: ***India***: Andaman Islands; ***Elsewhere***: Aldabra, Madagascar, Mascarene Basin, Mauritius, Seychelles and West Indian Ocean.

Remark: New record to India reported from Rutland Island, South Andaman.

Cenometra emendatrix (Bell, 1892)

Genus : ***Oligometra***

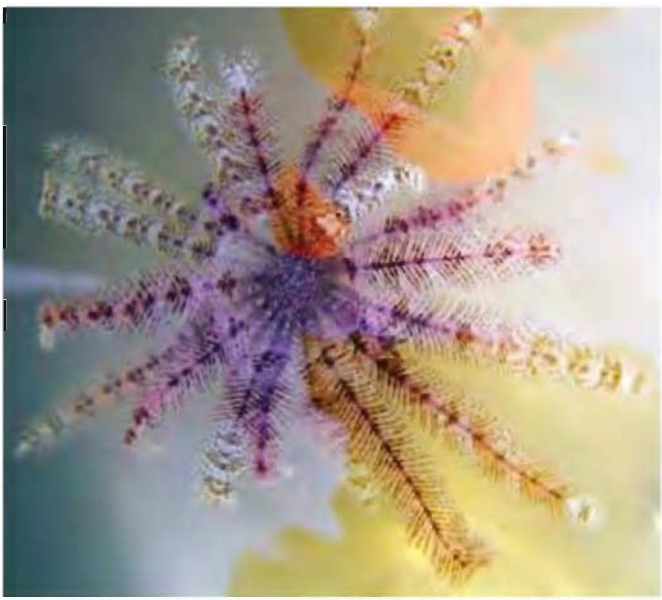
13. ***Oligometra serripinna*** (P.H. Carpanter, 1881)

Description: Pinnules are variable in form with most segments as long as, or longer than, broad, either simply prismatic with only the dorsal keel well developed or the segments more or less flared at the distal ends on the angels of the longitudinal ridges, with spinose process, so that the profile of the pinnule is more or less serrated.

Colour: Uniformly white in colour with reddish patches throughout the body.

Habitat: Depth range 0-91m.

Distribution: ***India***: Andaman and Nicobar Islands, Gulf of Mannar, Lakshadweep and Andhra Pradesh coast; ***Elsewhere***: Aldabra, Eastern Africa, Madagascar, Mascarene Basin, Mauritius, Red Sea, Seychelles, West Indian Ocean.



Oligometra serripinna (P.H. Carpanter, 1881)

Family : PONTIOMETRIDAE
Genus : ***Pontiometra***

14. ***Pontiometra andersoni*** (P.H. Carpanter, 1889)

Description: Middle and distal cirrus segments are attached with a pair of dorsal spines or tubercles that situated one each side of the mid-line. Arms are 53-120 in number. Cirri are composed of 41-80 segments.

Colour: Uniformly red in colour.

Habitat: Depth range 0-91m.

Distribution: ***India:*** Andaman and Nicobar Islands; ***Elsewhere:*** East Indies, Philippines, China, South Japan, South Pacific Island.

Pontiometra andersoni (P.H. Carpanter, 1889)

Class : ASTEROIDEA de Bklainville, 1830

Order : VALVATIDA Perrier, 1884
Family : ASTERINIDAE
Genus : ***Asterina***

15. ***Asterina sarasini*** (de Loriol, 1897)

Description: Body is usually stellate and pentagonal. The margin of the periphery is thin and pliable. Abactinal armament is composed of fine minute hyaline spinelets. Body is markedly flattened and the petaloid radial popular areas are linked only to the area in the centre of the disc.

Colour: After preservation the specimen becomes white in colour. Live specimens are uniformly grey or variegated colour.

Habitat: This species is commonly found in intertidal rocky areas and shallow reef areas.

Distribution: ***India***: Andaman and Nicobar Islands and Gulf of Mannar; ***Elsewhere***: Ceylon.

Asterina sarasini (de Loriol, 1897)
from left to right ventral and dorsal

Family : GONIASTERIDAE Forbes, 1841
Genus : ***Stellaster***

16. ***Stellaster equestris*** (Retzius, 1805)

Description: Arms are slender and long. Granules around the papulae are usually similar to the rest. Radial areas on the upper side are distinctly convex. Only single infer-marginal spine is present.

Body Colour: Live specimens are white or grey in colour.

Habitat: Rocky shore areas, benthic, sometimes found in shallow reef environments.

Distribution: ***India***: Gulf of Mannar, Andaman Islands and West Bengal: Digha; ***Elsewhere***: East Africa, Madagascar, Red Sea, S.E Arabia, Persian Gulf, Ceylon, East Indies, North Australia, Philippines, China and South Japan.

Stellaster equestris (Retzius, 1805)

Family : OREASTERIDAE
Genus : ***Culcita***

17. ***Culcita noveguineae*** (Muller and Troschel, 1842)

Common name: Pin Cushion Sea Star

Description: Actinal plates have polygonal granules and granulation forms more or less numerous coarse. Pores area is somewhat irregular and often only narrowly or in completely separated. It is common in reef flats at low tide and also inhabits in deeper waters to 30m.

Colour: Body colour is light greenish black.

Habitat: It feed on a variety of organism including algae, bottom detritus and the polyps and some flesh of corals.

Distribution: ***India***: Andaman and Nicobar Islands and Lakshadweep; ***Elsewhere***: Persian Gulf, East Indies, Philippines, Northern Australia, China, South Japan and South Pacific Island.

Culcita noveguineae (Muller and Troschel, 1842)
from left to right dorsal and ventral

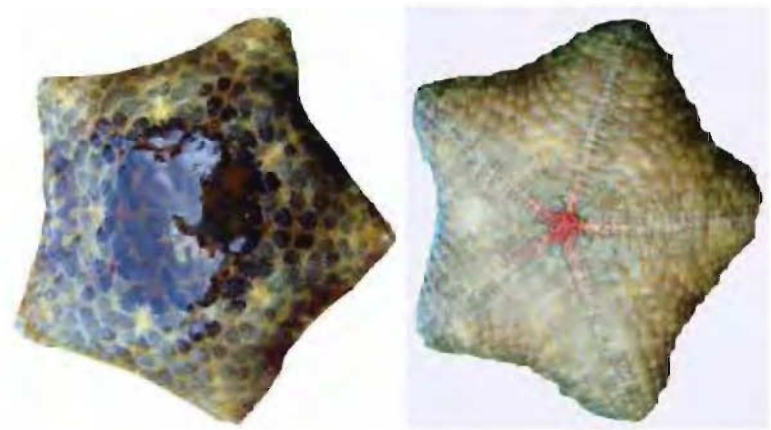
18. ***Culcita schmideliana*** (Retzius, 1805)

Description: Presence of a distinct pore free area at least towards the lower side at the margins as well as more or less extensive reticular areas on the upper side. Some of the pore areas may be somewhat confluent. Some pores are larger in size. Spaced tubercles often also present. There are no spines or spinelets on the pore areas.

Colour: Body colour is dark grey with small irregular pink patches mostly adjacent to black tubercles. Madreporite is some shade of orange being the same colour as the intertubercular areas at the arm tips.

Habitat: It is commonly found in the Indo-Pacific region. No spines or spinelets are present on the pore areas. It mainly occurs in benthic, inshore and continental shelf area. Depth range: 0-92m.

Distribution: ***India***: Andaman and Nicobar Islands, Lakshadweep; ***Elsewhere***: Western Indian Ocean, Mascarene Islands, East Africa, Madagascar, Maldives and Ceylon.



Culcita schmideliana (Retzius, 1805)
from left to right dorsal and ventral

Genus : ***Choriaster***

19. ***Choriaster granulatus*** (Lutken, 1869)

Description: Body surface is entirely covered by opaque smooth skin. The skin is often formed with relatively small ambulacral spines. The pore areas and arms are well-developed but short and broadly rounded at the tip.

Colour: Body is uniformly red in colour.

Habitat: It is usually found at the reef slopes.

Distribution: ***India***: Andaman and Nicobar Islands; ***Elsewhere***: East Africa, New Caledonia ,Palau Islands, Red Sea, Seychelles, Sulawesi and West Indian Ocean.

Choriaster granulatus (Lutken, 1869)
from left to right dorsal and ventral

Genus : ***Anthenea***

20. ***Anthenea tuberculosa*** (Gray, 1847)

Description: Ambulacral plates consist of three series of spines. Armament of the distal plates is more or less similar to the abactinal plates. Primary aboral tubercle is stout, flat-topped and widely spaced with more than one tubercle.

Colour: Body colour is white.

Habitat: It is found in the sandy area.

Distribution: ***India***: Andaman Islands and Orissa coast; ***Elsewhere***: South Japan

Anthenea tuberculosa (Gray, 1847)

Genus : ***Protoreaster***

21. ***Protoreaster lincki*** (Blainville, 1830)

Description: Furrow spines are white with pink tube feet. The distal marginal plates and the convex part of the larger abactinal plates are covered with a smooth plastering of unequal polygonal flattened granules. Dorso lateral areas of the arms are rarely with any convexities. A few of the distal supero-marginal plates laterally projected. Those are usually conscipicous. The tapering spines look like knobs.

Colour: Body Colour is red on pink or grey background.

Habitat: It is found almost all over the sandy-muddy areas of reef slopes. The deapth ranges from 1-10 m.

Distribution: ***India***: Andaman and Nicobar Islands and Gulf of Mannar; ***Elsewhere***: Aldabra, Cargados Carajos, Eastern Africa, Kenya, Madagascar, Mascarene Basin, Mauritius, Mozambique, Red Sea, Seychelles, Somalia, Tanzania and West Indian Ocean.

Protoreaster lincki (Blainville, 1830)

Genus : ***Protoreaster***

22. ***Protoreaster nodosus*** (Linneaus, 1758)

Description: Disc is markedly elevated. Carinal plates are very conscipicous, more or less high, rounded or conical elevations. Ambulacral spines are white, tube feet pink with purple centre, particularly huge on the five primary radial plates, the consecutive carinal tubercles usually spaced from each other and not broadened; pore areas confluent.

Colour: Tubercles are yellow with orange tips and papular areas blue-grey with paulae green. Remainder of aboral surface is deep green; marginals are pale yellow in colour.

Distribution: ***India***: Andaman and Nicobar Islands; ***Elsewhere***: Cargados Carajos, Eastern Africa, Madagascar, Kenya, New Caledonia, Palau Islands, Seychelles, Tanzania and West Indian Ocean.

Protoreaster nodosus (Linneaus, 1758)

Genus : *Pentaceraster*

23. ***Pentaceraster regulus*** (Muller and Troschel, 1842)

Description: Primary plates of the upper side are elevated that tend to form regular longitudinal series. Pore-areas are usually well defined. Spines are absent on the first two or four supero-marginal plates in each interradial angle. Dorso-lateral elevations or spines are developed along with the arms.

Colour: Body colour is yellow with reddish spine on the upper side.

Habitat: Usually found in sandy slopes of the marine water. Depth ranges 2-115.

Distribution: ***India***: Gulf of Mannar, Lakshadweep and Andman and Nicobar Islands; ***Elsewhere***: New Caledonia, Red Sea and West Indian Ocean.

Pentaceraster regulus (Muller & Troschel, 1842)

Family : ASTEROPSIDAE Müller and Troschel, 1840
Genus : ***Asteropsis***

24. ***Asteropsis carinifera*** (Lamarck, 1816)

Description: Body covered with smooth skin obscuring the non-imbricating oval or circular abactinal plates which oval or circular in shapes which are nearly all quite naked. Crystal-bodies embedded in their surface, the edge of the body formed by supero marginal plates with prominent conical single spines. The carinal plates formed a mid radial ridge emphasized by a series of spines.

Colour: Body colour pale grey with irregular greenish marking or sometimes uniformly grey in colour.

Habitat: It is commonly found in sandy and rocky areas. Some times it can be seen under the coral reefs. Depth range: 0-15m.

Distribution: ***India***: Andaman and Nicobar Islands and Lakshadweep; ***Elsewhere***: Aldabra, Chagos, Eastern Africa and Madagascar, Kenya, Mascarene Basin, Mozambique, New Caledonia, Red Sea, Seychelles and West Indian Ocean.

Asteropsis carinifera -ventral *Asteropsis carinifera* -dorsal

Family : ACANTHASTERIDAE
Genus : ***Acanthaster***

25. ***Acanthaster planci*** (Linneaus, 1758)

Description: This species usually bears 15 to 18 arms and usually more madreporite. Armament is variable but if conical spines are present then these are mounted only on low eminences. Aboral spines are long and conscipicous, commonly 15-30mm in size. Pedicellariae are slender.

Colour: Body colour is blue with black large spines on the upper side.

Habitat: It lives mainly with the association of coral beds and sometimes taking shelter under stones close to the live colonies.

Distribution:

India: Andaman and Nicobar Island, Lakshadweep;

Elesewhere :

Western Indian Ocean, Mascarene Islands, East Africa, Madagascar, Red Sea, South East Arabia, Maldive area, Bay of Bengal, East Indies, Philippines, Northern Australia, China, South Japan, South Pacific Island and Hawaii.

Acanthaster planci (Linneaus, 1758)
from left to right ventral and dorsal

Family : OPHIDIASTERIDAE Verrill, 1870
Genus : ***Fromia***

26. ***Fromia monilis*** (Perrier, 1869)

Description: Carinal plates are not large in size. It is widely separated from supero marginal. Actinal pores are few or absent. Abactinal granulation is very fine. This star is quite hard to the touch and its rigid skeleton does not allow it to be bent without breaking.

Colour: The specimen is uniformly red in colour although some specimens may have solid red patches on the disc.

Habitat: It occurs in shallow water lagoon areas among living coral reefs, and on channel slopes between reefs and on drop offs in moderately deep water.

Distribution: ***India***: Andaman and Nicobar Islands and Lakshadweep; ***Elsewhere***: East Indies, Philippines, China, South Japan and South Pacific Islands.

Fromia monilis (Perrier, 1869) -ventral

Fromia monilis (Perrier, 1869) -dorsal

27. ***Fromia indica*** (Perrier, 1869)

Description: Abactinal plates are unequal in size. Each arm bears two longitudinal series of two distinctly enlarged plates. Papular pores are present on the oral side. Single pore forms more or less flattened marginals that usually define the edge of the body.

Colour: It is reddish-brown in colour.

Habitat: It is usually found on the rocky shores of reef areas.

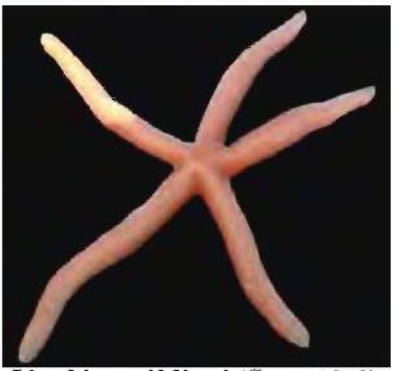
Distribution: ***India***: Andaman and Nicobar Island, Lakshadweep and Gulf of Mannar; ***Elsewhere***: Maldives, East Indies, Philippines, China, South Japan, South Pacific Island and Ceylon.

Fromia indica (Perrier, 1869)

Genus : ***Linckia***

28. ***Linckia guildingi*** (Gray, 1840)

Description: Plates are covered with granules and round in shape. Pores are present in groups. Subambulacral spines are in two series. Those of each ambulacral plate contiguous with each other and with the furrow spines but aligned slightly obliquely so as to give a herring-bone pattern to the underside of each arm.



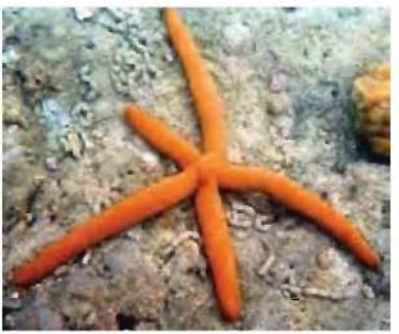
Linckia guildingi (Gray, 1840)

Colour: Body colour is uniformly brown.

Habitat: This species is commonly found in shallow water depths and inhabits in rocky reefs and rocky shore areas.

Linckia guildingi (Gray, 1840)

Distribution: ***India***: Andaman and Nicobar Islands and Lakshadweep Islands; ***Elswhere***: Mascarene Islands, East Africa, Red Sea, Madagascar, Maldives, South East Arabia, Ceylon, Persian Gulf, East Indies, Philippines, Northern Australia, China, South Japan, South Pacific Island and Hawaii.



Linckia guildingi (Gray, 1840)

29. ***Linckia laevigata*** (Linneaus, 1758)

Description: Subambulacral spines are distinctly placed from furrow spines. Usually only a single series present, granules are extending down between the furrow spines, especially numerous in large specimens. Arms are normally five in number. Single madreporite is present. Arms fairly stout and blunt at the tips.

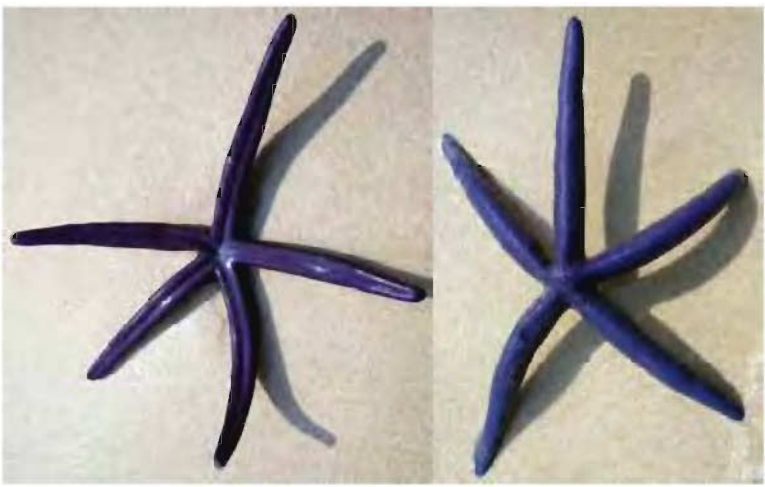
Colour: Body colour is blue.

Habitat: This species is commonly found in shallow water depths and inhabits in rocky reefs and rocky shore areas.

Distribution:

India: Andaman and Nicobar Islands, Lakshadweep and Gulf of Mannar.

Elsewhere: Northern Australian reefs, Western Indian Ocean, Mascarene Basin, East Africa and Madagascar, Maldives area, Ceylon, East Indies, Philippines, China, South Japan, South Pacific Island and Hawaii.



Linckia laevigata (Linneaus, 1758)
from left to right ventral and dorsal

30. ***Linckia multifora*** (Lamarck, 1816)

Description: Arms are variable in length and number. Normally two madreporites are present. Arms are more slender and attenuated towards the tips.

Colour: Body colour purplish, reddish, brownish coloured with yellow.

Habitat: This sea star is much smaller and rarely occurs in the open on intertidal reef flat. It is a very common species and is abundant at depths of 5-30m and is generally observed on bommies and underhangs.

Distribution: ***India***: Andaman and Nicobar Islands, Lakshadweep and Gulf of Mannar; ***Elsewhere***: Maldives, Aldabra, Comores, Eastern Africa, Kenya, Madagascar, Mascarene Basin, Mauritius, Mozambique, Red Sea Seychelles, Somalia, South Africa, Tanzaniaan and West Indian Ocean.

Linckia multifora (Lamarck, 1816)

Order : SPINULOSIDA Perrier, 1884
Family : ECHINASTERIDAE
Genus : ***Echinaster***

31. ***Echinaster luzonicus*** (Gray, 1840)

Description: Arms are five or six in number, sometimes 7 in number. Arms are slender, cylindrical and stellatae. Skeletal reticulum is placed aborally, longitudinal and transverse series of plates are not well defined. This species is commonly distributed in Indian Ocean region.

Colour: Body colour is reddish brown, sometimes may be uniformly brown in colour.

Habitat: It is found in shallow reef environments, usually below 3m depth.

Distribution: ***India***: Andaman and Nicobar Islands, Gulf of Mannar and Gulf of Kachchh; ***Elsewhere***: East Indies, Philippines, China, South Japan, South Pacific Island and Northern Australia.

Echinaster luzonicus (Gray, 1840)
from left to right dorsal and ventral

Order : PAXILLOSIDA Perrier, 1884
Family : ASTROPECTINIDAE Gray, 1840
Genus : ***Astropecten***

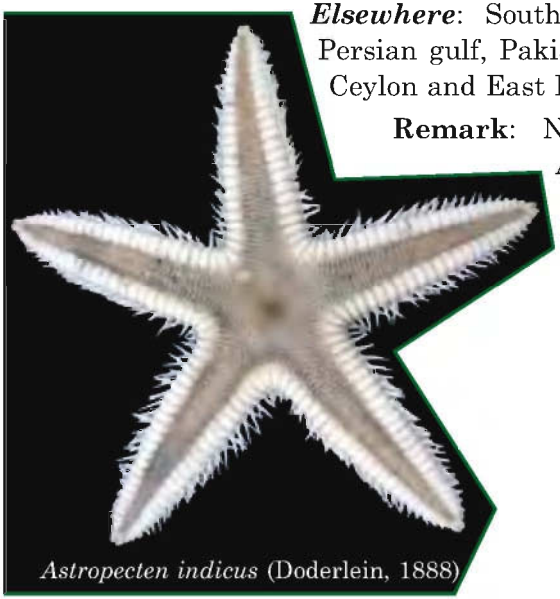
32. ***Astropecten indicus*** (Doderlein, 1888)

Description: It has pointed legs and with that many legs, the paxillar areas are ended abruptly. Ventral sides of the infero-marginal plates are usually with few spines among the small rounded scales. Sometimes spines are also present on the interradial plates.

Colour: Live specimens are white or grey in colour, sometimes with black patches on the upper side.

Habitat: It lives in the sandy shore areas, or on dead corals. This species is a very good burrower and it is in this domain that it hunts for its preys.

Distribution: ***India***: Gujarat, Orissa, West Bengal, Tamil Nadu and Andaman and Nicobar islands; ***Elsewhere***: South East Arabia, Persian gulf, Pakistan, Maldives, Ceylon and East Indies.


Astropecten indicus (Doderlein, 1888)

Remark: New record to Andaman and Nicobar Islands

33. ***Astropecten monacanthus***(Sladen, 1883)

Description: Peripheral margins of the body are fringed with conscipicous large spines. Supero-marginal plates are relatively narrow. The paxillar area at the base of the arm is more than half the total arm breadth. Actinal surface of the infero-marginal plates is very smooth and covered with short, rounded more or less apressed squamules.

Colour: Body is purple or reddish yellow or light grey in colour.

Habitat: This species are lying on the sand and feeds on sea shells.

Distribution: ***India***: Tamil Nadu, Orissa coast and Andaman and Nicobar Islands; ***Elsewhere***: East Africa, Eastern Africa, Madagascar, Mozambique and Red Sea.

Astropecten monacanthus (Sladen, 1883)

Family : LUIDIIDAE Verrill, 1899
Genus : ***Luidia***

34. ***Luidia maculata*** (Muller and Troschel, 1842)

Description: Large bivalve Pedicellariae are absent at the apics of the jaws close to the mouth. Single paxillar spines are absent though the smaller proximal paxillae may have a large blunt central spinelet about twice as high as the peripheral spinelets. Arms are seven to nine in number. Some or many of the lateral paxillae armed with large sharp single spines.

Colour: Usually brown in colour, some times yellowish with black patches.

Habitat: It is found in the depth of 1-10 m.

Distribution: ***India***: Gulf of Mannar, Gulf of Kachchh and Andaman Islands; ***Elsewhere***: Western Indian Ocean, East Africa, Madagascar, Persian Gulf, Maldives, Ceylon, East Indies, North Australia, Philippines, China and South Japan.

Luidia maculata (Muller & Troschel, 1842)

Class OPHIUROIDEA Gray, 1840

Order : OPHIURIDA Muller and Troschel, 1840
Family : OPHIOCOMIDAE Lyman, 1865
Genus : ***Ophiocoma***

35. ***Ophiocoma erinaceus*** (Muller and Troschel, 1842)

Description: Arm length upto 12 cm, disc diameter upto 20 mm. Spines on the arms is long, thick and shorter towards the tips. Disc scales are covered by rounded granules, extending into a V-shaped interradial area on the ventral side of the disc. Dorsal arm plates broader than long, narrower on one side. Arm spines alternating three and four for greater part of the arm length.

Colour: Uniformly black in colour.

Habitat: Sand and rubble in shallow areas and shallow sublittoral among coral; coral reef, beacon reef.

Distribution: ***India***: Andaman and Nicobar Islands, Lakshadweep and Gulf of Mannar; ***Elsewhere***: Aldabra, Chagos, Comores, Eastern Africa, Madagascar, Kenya, Mascarene Basin, Mauritius, Mozambique, Red Sea, Seychelles, Somalia, South Africa, Tanzania and West Indian Ocean.

Ophiocoma erinaceus (Muller & Troschel, 1842)

36. ***Ophiocoma dentata*** (Muller and Troschel, 1842)

Description: Dorsal arm plates with a light border along the edges and sometimes form a light central region. Disc scales are with rounded granules, covering the radial shields. Dorsal arm plates broader than long, lateral angles rounded. Five arm spines, flat, second from above longer than the breadth of the segment.

Colour: Colour of the disc uniformly dark or variegated, reticulated or spotted with dark markings.

Habitat: Benthic, inshore.

Distribution: ***India***: Andaman and Nicobar Islands and Lakshadweep Islands; ***Elsewhere***: Eastern Africa, Madagascar, Mascarene Basin, Mozambique, Red Sea and West Indian Ocean.

Ophiocoma dentata (Muller & Troschel, 1842) -dorsal

Ophiocoma dentata (Muller & Troschel, 1842) -ventral

37. ***Ophiocoma scolopendrina*** (Lamarck, 1816)

Description: Arm length up to 10 cm, disc diameter up to 20 mm. Disc scales are covered by granules, becoming spiky towards the edges, higher than thick. Arms with spines as long as the arm width. Disc mottled green, arms distinctly banded. Only one tentacle scale at least beyond the fifth segment.

Colour: Arms commonly black or green brown and banded by darker areas but banding may be deep brown or cream. Disc uniformly dull green to dark brown.

Habitat: It inhabits in shallow substrates; rocks, coral reef, under weed.

Distribution: ***India***: Lakshadweep; Andaman Islands;

Ophiocoma scolopendrina (Lamarck, 1816)

Elsewhere: Aldabra, Chagos, Eastern Africa, Kenya, Madagascar, Mascarene Basin, Mozambique, Red Sea, Seychelles, Somalia, South Africa, Tanzania and West Indian Ocean.

Remark: New record to Andaman and Niocbar Islands

Genus : ***Ophiarthrum***

38. ***Ophiarthrum pictum*** (Muller and Troschel, 1842)

Description: Disc diameter 25 mm. Arms 6 times the disc diameter in length. Disc is covered with thick skin. Arm spines are blunt, twice as long as the segment with dark rings or bands.

Colour: Disc patterned with grey, yellow and white. Arms with dark longitudinal lines.

Habitat: Benthic, inshore.

Distribution: ***India***: Andaman and Nicobar Islands; ***Elsewhere***: Red Sea, West Indian Ocean, East Indies, North Australia and Philippines.

Ophiarthrum pictum (Muller & Troschel, 1842)

Genus : ***Ophiomastix***

39. ***Ophiomastix annulosa*** (Lamarck, 1816)

Description: Disc scales with scattered blunt spines. Ventral shields have concentric dark and light colouration. Arm spines are claviform. Dorsal arm plates with light coloured edges.

Ophiocoma scolopendrina (Lamarck, 1816)

Colour: Disc light red in colour. Arms are red in colour with white spines.

Habitat: Benthic, Inshore.

Distribution: ***India***: Andaman and Nicobar Islands and Lakshadweep. ***Elsewhere***: Maldives, Ceylon, East Indies, North Australia, Philippine, China, South Japan and South Pacific Island.

Family : OPHIOTRICHIDAE
Genus : ***Macrophiothrix***

40. ***Macrophiothrix propinqua*** (Lyman, 1861)

Description: Arm length upto 14 cm, disc diameter upto 1 cm. Disc surface with or without scattered stumps. Dorsal arm plates broader than long, distal side convex or straight, laterodistal angles bent backwards, broadest at about the middle of the plate. Distal edge of oral arm plates straight. Arm spines as long as or slightly longer than breadth of the segment. Colour variable, from evenly dark bluish to banded orange and cream. Arms variegated or uniformly blue with darker bands of 3-4 segments.

Colour: Disc black in colour. Arms are black with white patches.

Habitat: It is found in rock crevices and among coral.

Distribution: ***India***: Andaman and Nicobar Islands and Lakshadweep; ***Elsewhere***: West Indian Ocean, Mascarene Island, East Africa, Madagascar, Red Sea, South East Arabia, Maldives, East Indies, North Australia, Philippines, China, south Japan and South Pacific Islands.

Macrophiothrix propinqua (Lyman, 1861)

41. ***Macrophiothrix longipeda*** (Lamarck, 1816)

Description: Arm length 80 cm (about 20 times disc diameter), disc diameter 1-4 cm. Disc scales are covered by thorny stumps. Radial shields with rugose granule-like stumps. Dorsal arm plates more than twice as broad as long, distal edge with a straight median region, marked laterodistal angles, broadest distally. Ventral arm plates octogonal, distal edge straight. Up to ten thorny arm spines, lowest one comb-like.

Colour: Disc colour blackish blue with dark blue spots.

Macrophiothrix longipeda -ventral

Macrophiothrix longipeda -dorsal

Habitat: Lower eulittoral, sublittoral, under coral boulders or in burrow or a crevice.

Distribution: ***India***: Andaman and Nicobar Islands, Lakshadweep Islands, Gulf of Mannar and West Bengal coast; ***Elsewhere***: Aldabra, Chagos, Eastern Africa, Madagascar, Mascarene Basin, Mauritius, Mozambique, Red Sea, Seychelles, South Africa, Tanzania and West Indian Ocean.

Family : OPHIODERMATIDAE Ljungman, 1867
Genus : ***Ophiarachna***

42. ***Ophiarachna incrassata*** (Lamarck, 1816)

Description: Arms spines are 4-4 basally and are long and flaring. Body colour is uniformly green, but it appears yellow or buff in preservation and running along the arms above and below. Interradial areas have black ringed light spots forming a reticulation and with the annulated arm spines.

Ophiarachna incrassata (Lamarck, 1816)

Colour: Green in colour.

Habitat: Large ophiuroid inhabits in coral reefs. During the day time they hide below the coral slabs or in crevices.

Distribution: ***India***: Andaman Islands; ***Elsewhere***: Eastern Africa, Madagascar, Red Sea, Seychelles, Tanzania and West Indian Ocean.

Class ECHINOIDEA Leske, 1778

Order : CIDAROIDA
Family : CIDAROIDAE
Genus : ***Prionocidaris***

43. ***Prionocidaris verticillata*** (Lamarck, 1816)

Description: In the apical system the ocular plates usually nearly all insert. Large globiferous Pedicellariae usually with limb or frill of rods on the stalk close to the head. Verticillate primary spines bear 3 or 4 thorny whorls.

Colour: Uniformly greenish brown in colour.

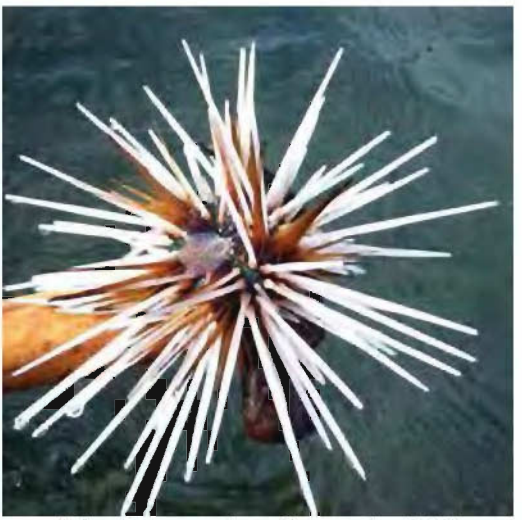
Habitat: Benthic, inshore, continental shelf.

Distribution: ***India***: Andaman and Nicobar Islands and Lakshadweep; ***Elsewhere***: West Indian Ocean, Mascarene Island, East Africa, Madagascar, Bay of Bengal, East Indies, North Australia, Philippine, China, South Japan and South Pacific Island and Australia.

Prionocidaris verticillata (Lamarck, 1816)

Family : ARBACIIDAE
Genus : ***Prionocidaris***

44. ***Arbacia punctulata*** (Lamarck, 1816)



Arbacia punctulata (Lamarck, 1816)

Description: Test diameter of 2 inches, with total diameter reaching 4 inches. Long and sharp spines generally white in colour. Tube feet are inconscipicous and are generally an olive colour.

Colour: Body colour ranges from black to reddish brown and spines are white in colour, sometimes it may brown.

Habitat: The species inhabits in nearshore areas including coral reefs, sea grasses beds, hard bottoms, sand and shell areas. They are typically found from the intertidal zone to depths of 250m but almost common at 53m.

Distribution: ***India*** : Andaman Islands; ***Elsewhere***: Capecod, Masachusetts, South to Cuba including Florida and the Gulf of Mexico, Panamas, Barbados and French Guiana.

Remark: New record to Indian waters reported from Rutland Island, South Andaman.

Order : DIADEMATOIDA
Family : DIADEMATIDAE
Genus : ***Diadema***

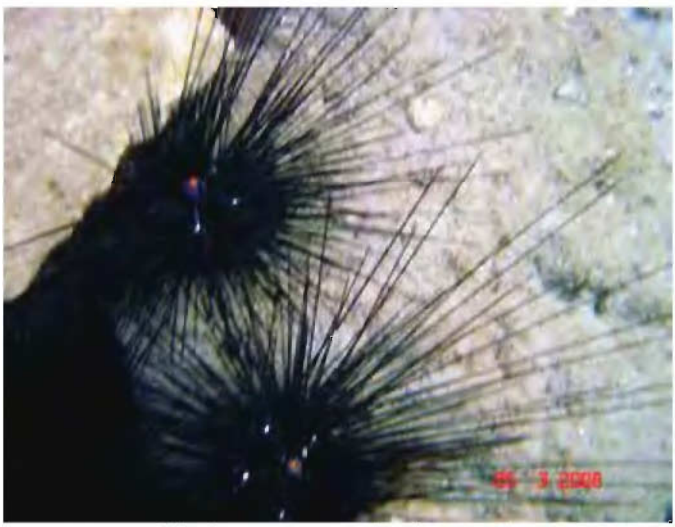
45. ***Diadema setosum*** (Leske, 1778)

Description: Globiferous pedicellariae and spines on the buccal plates are absent. A red ring is present around anus and white spot over each genital pore. This species is commonly distributed in tropical Indo-Pacific region and Indo-West Pacific Ocean. Tridentate pedicellariae are Large in size and mostly form narrow blades meeting at the tip.

Colour: Uniformly black in colour.

Habitat: Benthic, inshore, continental shelf.

Distribution: ***India*:** Andaman and Nicobar Islands and Lakshadweep; ***Elsewhere***: Aldabra, Eastern Africa, Madagascar, Kenya, Mascarene Basin, Mauritius, Mozambique, Red Sea, Seychelles, Tanzania and West Indian Ocean.



Diadema setosum (Leske, 1778)

46. ***Diadema savignyi*** (Michelin, 1845)

Description: This sea urchin has a black anal cone and no white on the body. Buccal plates do not bear any spines. Pedicellariae which are leaf or spoon shaped and is tapering to the rounded distal end. It is found in small pockets in reefs or around rocks. It has a wide range throughout Indo-west Pacific region.

Colour: Black in colour.

Habitat: It is found in the rocky shores.

Distribution: ***India***: Andaman and Nicobar Islands and Lakshadweep; ***Elsewhere***: Aldabra, Eastern Africa, Madagascar, Kenya, Mascarene Basin, Mauritius, Mozambique, Red Sea, Seychelles, South Africa and West Indian Ocean.

Diadema savignyi (Michelin, 1845)

Genus : ***Echinothrix***

47. ***Echinothrix calamaris*** (Pallas, 1774)

Description: Naked test is green in colour. Ambulacra distinctly bulged aborally. Inter ambulacral spines occur with fine to broad transverse white bands. The banded sea urchin should be avoided and certainly not touched as its secondary spines are extremely fine and sharp and capable of penetrating over the gloves. These spines are highly venomous and cause painful wounds.

Colour: Body colour is purplish brown with white strips like band.

Habitat: It is usually found in the slopes of coral reef with rocky substances.

Distribution: ***India***: Andaman and Nicobar Islands, Lakshadweep Islands and Gulf of Mannar; ***Elsewhere***: Aldabra, Chagos, Eastern Africa, Kenya, Madagascar, Mascarene Basin, Mozambique, Red Sea, Seychelles, Somalia, South Africa, Tanzania and West Indian Ocean.

Echinothrix calamaris (Pallas, 1774)

48. ***Echinothrix diadema*** (Linneaus, 1758)

Description: Spines are large and about 9 inch long. Naked test is black in colour. Cavity of the primary spines is very small. This species is commonly found in Indian Ocean rather than Pacific reefs. The surface of the primary spines has longitudinal ridges.

Colour: The body colour of the live specimens is velvet-black or crimson red.

Habitat: The animal hides under ledges, and in caves along the reef edges.

Distribution: ***India***: Andaman and Nicobar Islands and Lakshadweep Islands; ***Elsewhere***: Maldives, Aldabra, Chagos, Eastern Africa, Madagascar, Kenya, Mascarene Basin, Red Sea, Seychelles, Somalia and West Indian Ocean.

Echinothrix diadema (Linneaus, 1758) - dorsal

Order : ECHINOIDA
Family : ECHINOMETRIDAE
Genus : ***Echinometra***

49. ***Echinometra oblonga*** (de Blainville, 1969)

Description: Test is oval in shape. Primary spine is often massive and either very long or truncated and very short. If they are slender than the lower ones are more or less flattened and some are angular. Eight or more pore-pairs per arc are present aborally.

Colour: Uniformly black in colour.

Habitat: Found on rocks, or on dead corals.

Distribution: ***India***: Andaman and Nicobar Islands; ***Elsewhere***: Seychelles and Tanzania.

Echinometra oblonga (de Blainville, 1969)

50. ***Echinometra mathaei*** (de Blainville, 1825)

Description: Mathae's sea urchin is a cosmopolitan rock boaring species that thrives in the rugged condition of exposed intertidal situations. Spines of the sea urchin are slender and acute. Long axis presents on the oval test through ambulacra I and interambulacrum 3. This urchin is herbivore, scraping algae from boulders and rubbles close to its hollow at night and catching drifting algae.

Colour: Body colour may be brown, pink, green or purple but the spines have usually white circle around the base.

Habitat: It is common at the rocky shores

Distribution: ***India***: Andaman and Nicobar Islands, Lakshadweep Islands and Gulf of Mannar; ***Elsewhere***: Western Indian Ocean, Mascarene Islands, East Africa and Madagascar, Red Sea, South-East Arabia, Maldives, Ceylon, East Indies, Philippines, China, South Japan, South Pacific Island, Hawaiian, Persian Gulf and North Australia.

Echinometra mathaei (de Blainville, 1825)

Genus : *Heterocentrotus*

51. ***Heterocentrotus trigonarius*** (Lamarck, 1816)

Description: Primary spines are massive which either rounded or are very thick but somewhat flattened towards the tip. Ambital region contains 15-16 pore-pairs in each arc. Primary ambulacral tubercles are gradually decreasing in size aborally and their spines are short and not truncated

Colour: Uniformly mid brown.

Habitat: Rocky shore areas.

Distribution: ***India***: Nicobar Islands; ***Elsewhere***: Aldabra, Eastern Africa, Kenya, Madagascar, Mascarene Basin, Mauritius, Red Sea, Seychelles, Somalia and Tanzania.

Heterocentrotus trigonarius (Lamarck, 1816)

Family : ASTRICLYPEIDAE
Genus : ***Echinodiscus***

52. ***Echinodiscus auritus*** (Leske, 1778)

Description: Test is highly developed and oval in shape. Lunules are two in number. Lunules open at the distal end. This species has a bite marks at the posterior margins of the test.

Colour: Uniformly brown in colour

Habitat: Sandy sea shore.

Distribution: ***India***: Andaman and Nicobar Islands, Gulf of Mannar and Mouth of Hugly River; ***Elsewhere***: Mascarene Island, East Africa, Maagascar, Red Sea, South East Arabia, Persian Gulf, Ceylon, East Indies, North Australia, Philippines, China and South Japan.

Echinodiscus auritus (Leske, 1778)

Order : TEMNOPLEUROIDA
Family : TEMNOPLEUROIDAE
Genus : ***Temnopleurus***

53. ***Temnopleurus alexendri*** (Bell, 1884)

Description: Crenulations are conscipicous and Pore pairs more or less distinctly in arcs of three. Spines not banded but often greenish basally becoming purple distantly. Globiferous pedicillaria does not bear lateral teeth. The pores reach to the edge of the ambulacral areas. Tubercles are absent at the outside of the pores.

Colour: Uniform in colour- green, purple or white

Habitat: This species inhabits in rocky substances and found in shallow water depths.

Distribution: ***India***: Tamil Nadu coast, Andaman Islands; ***Elsewhere***: East Indies and North Australia.

Temnopleurus alexendri (Bell, 1884)

Genus : ***Mespilia***

54. ***Mespilia globulus*** (Linneaus, 1758)

Description: Ten conspicuous abruptly spineless vertical areas on the test are covered with extremely numerous globiferous pedicellariae. These pedicellariae forms a dense carpet, their valves with the blades bearing two or three lateral teeth each side.

Colour: Uniformly blue colour with reddish-brown spines.

Habitat: In warmer currents of shallow waters, on hard bottom.

Distribution: ***India***: Andaman and Nicobar Islands; ***Elsewhere***: Red Sea, West Indian Ocean, Red Sea, West Indian Ocean, North Australia, Philippine, China, south Japan, South Pacific Island and Australia.

Mespilia globulus (Linneaus, 1758)

Genus : *Microcyphus*

55. ***Microcyphus ceylanicus*** (Mortensen, 1925)

Description: Globiferous pedicellariae are less conscipicously developed. The blade fairly narrow and bearing not more than one lateral tooth each side. Tubercles are indistinctly crenulate. Sutural pores are very small and inconscipicous. Naked areas are conspicuous aborally. Test patterned with olive-green.

Colour: Test is black in colour. Spines banded with reddish brown and white.

Habitat: Inhabits in rocky substances and found in shallow water depths.

Distribution: ***India***: Andaman Islands; ***Elsewhere***: Ceylon.

Microcyphus ceylanicus (Mortensen, 1925)

Genus : ***Salmacis***

56. ***Salmacis belli*** (Doderlein, 1902)

Description: Test is moderate in size that inflated in profile with rounded ambitus. Apical disc is small, dicyclic, with marginally positioned gonopores. Genital plates with tubercles are developed around their inner edge forming a perianal ring. Periproct is subcircular and central in position. Spines are small, simple, without cortex.

Colour: Test black in colour, spines are whitish brown in colour.

Habitat: Found in algal beds. It is a grazer and algae eater.

Distribution: ***India***: Nicobar Islands; ***Elsewhere***: East Indies and North Australia.

Remark: New record to Indian waters found in Great Nicobar Islands.

Salmacis belli (Doderlein, 1902)

Family : TOXOPNEUSTIDAE
Genus : ***Tripneustus***

57. ***Tripneustes gratilla*** (Linneaus, 1758)

Description: The pattern of the body spaces between the spines is a reliable visual feature. The tube feet of the large, tube-shaped, five body spaces and the five smaller ones. Pore pairs are present horizontally on the arcs and spaced to form three distinct vertical series in larger specimens.

Colour: It may be purple, black, brown or red and even green.

Habitat: It is a grazer and algae eater and found in the sandy reef slopes with muddy coverage.

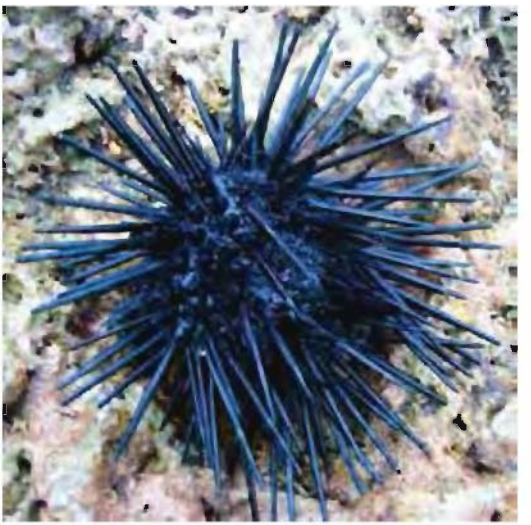
Distribution: ***India***: Andaman and Nicobar Islands, Lakshadweep and Gulf of Mannar; ***Elsewhere***: Aldabra, Chagos, Eastern Africa, Madagascar, Kenya, Mascarene Basin, Mauritius, Mozambique, Red Sea, Seychelles, Somalia, South Africa, Tanzania and West Indian Ocean.

Tripneustes gratilla (Linneaus, 1758)

Order : PHYMOSOMATOIDA
Family : STOMECHINIDAE (Clark and Rowe)
Genus : ***Stomopneustus***

58. ***Stomopneustus variolaris*** (Lamarck, 1816)

Description: Complete bridges are absent across the V-shaped space at the upper end of each of the five pyramids forming frame of the Aristotle's lantern. Ambulacral plates are doubly compound so that large tubercle correspondence to three to six arcs each of three pore pairs are placed at the ambitus.



Stomopneustus variolaris (Lamarck, 1816)

Colour: Uniformly black in colour.

Habitat: It is commonly found in rocky shore or sometimes below the rubbles and dead coral patches.

Distribution: ***India***: Andaman and Nicobar Island, Lakshadweep, Gulf of Mannar and Andhra Pradesh Coast; ***Elsewhere***: Mascarene Island, East Africa, Madagascar, South East Arabia, East Indies, Maldives, Ceylon, North Australia, China, South Japan, South Pacific Island and Australia.

Order : CLYPEASTEROIDA
Family : CLYPEASTERIDAE
Genus : ***Clypeaster***

59. ***Clypeaster humilis*** (Leske, 1778)

Description: Interradial projections are not formed around the peristome. Petals are generally smaller and test flat orally. Frontal petals are closed.

Colour: Uniformly white in colour sometimes may be light yellowish in colour.

Habitat: Benthic, inshore, continental shelf.

Distribution: ***India***: Gulf of Mannar, Kochi coast, Lakshadweep and Andaman Islands; ***Elsewhere***: Eastern Africa, Madagascar, Red Sea, South East Arabia, Persian Gulf, Ceylon area, East Indies, North Australia and Philippines.

Remark: Newly recorded in Andaman Islands.

Clypeaster humilis (Leske, 1778)

Class HOLOTHUROIDEA de Blainville, 1834

Order : ASPIDOCHIROTIDA Grube, 1840
Family : HOLOTHUROIDAE Ludwig, 1894
Genus : ***Actinopyga***

60. ***Actinopyga mauritiana*** (Quoy and Gaimard, 1833)

Description: The shape is cylindrical with a flat underside; length upto 300 mm and live weight varies from 0.5 to 1.0 kg. The tube feet are firmly attached to rocks to prevent the animal from being washed away by the waves.

Colour: Colour in living condition is brick red above and white below.

Habitat: Usually found where the surf breaks on the outside of the reef.

Distribution: ***India***: Gulf of Mannar, Andaman and Nicobar Islands and Lakshadweep; ***Elsewhere***: Aldabra, Chagos, Comores, Eastern Africa, Kenya, Madagascar, Mascarene Basin, Mauritius, Mozambique, Red Sea, Seychelles, Somalia, Tanzania and West Indian Ocean.

Actninopyga mauritiana (Quoy and Gaimard, 1833)

61. ***Actinopyga miliaris***
(Quoy and Gaimard, 1833)

Description: Length of the specimens ranged from 120 to 300 mm and the weight varied from 0.5 to 2 kg. Massive cylindrical forms with rough surface. Anal teeth very distinct.

Colour: Green and Black.

Habitat: Found mainly in waters less than 10 m depth on pure sand. They also live on the reef flats among live corals and on algal beds.

Distribution: ***India***: Gulf of Mannar, Andaman and Nicobar Islands and Lakshadweep; ***Elsewhere :*** Aldabra, Comores, Eastern Africa, Kenya, Madagascar, Mascarene Basin, Mauritius, Mozambique Red Sea, Seychelles, Tanzania and West Indian Ocean.

Actinopyga miliaris (Quoy and Gaimard, 1833)

62. ***Actinopyga lecanora*** (Jaeger, 1833)

Description: The size of the specimens can be > 300 mm in length. The spicules are composed of small rods.

Colour: It is a light grey or brown sea cucumber, with light speckled patches particularly around the somewhat attenuated posterior end.

Habitat: It is often concealed amongst coral or rubble of reefs.

Distribution: ***India***: Andaman and Nicobar Islands; ***Elsewhere***: Djibouti (from synonym), East Africa, Eastern Africa, Kenya, Madagascar, Mascarene Basin, Mauritius, Mozambique, Somalia and Tanzania.

Actinopyga lecanora (Jaeger, 1833)

63. ***Actinopyga echinities*** (Jaeger, 1833)

Description: The body is wider in the middle and tapers at both ends. The upper surface is wrinkled, often with fine sand setteled over it. It attaches itself to rocks with its tube feet.

Colour: Uniformly brown.

Habitat: It occurs at a depth of between 3-7m and inhabits both hard (rocky area) and soft substratum (sand).

Distribution: ***India***: Andaman and Nicobar Islands, Gulf of Mannar and Lakshadweep. ***Elsewhere***: Northern Australian reefs, Western Indian Ocean, East Africa and Madagascar, South-East Arabia, Ceylon, East Indies, Philippines, China, South Japan and South Pacific Island.

Actinopyga echinities (Jaeger, 1833)

Order : ASPIDOCHIROTIDA Grube, 1840
Family : HOLOTHUROIDAE Ludwig, 1894
Genus : ***Holothuria***

64. ***Holothuria cinerascens*** (Brandt 1835)

Description: Ranges in length from 30 to 200 mm. robust, sub-cylindrical with dorsal and ventral sides sharply differentiated. Dorsal surface covered with uniformly distributed numerous papillae. Ventrally beset with crowded robust pedicels. Tentacles 20 in number, large and sub-globose when fully expanded. Mouth ventral, posterior end of the body blunt. Anus surrounded by papillae. Body wall thick and fairly smooth to touch. Pedicels more or less arranged in three rows. Papillae of dissimilar sizes. In the living condition the tentacles, though peltate, appear to be slightly arborescent. The collar surrounding the tentacles is inconspicuous. The calcareous ring is of the usual type. There were four polian vesicles of dissimilar size. On the right side of the mesentery there is a single stone canal. Cuvierian tubules are well developed. Longitudinal muscle bands are thin. Spicules are of two types, namely tables and rods.

Holothuria cinerascens (Brandt 1835)

Simple and finely granulated rdos are the characteristics of the species. They are either straight of curved with the extremetes often branched or coarser tubercles. Occasionally, triradiate and tetraradiate rods occur with three or four ends considerably branched. The length of the rods varies from 0.10 mm to 0.30 mm. Table simple with the annual disc varying in size from 0.042 mm to 0.060mm. Four large holes at the centre and four large holes at the margin in each disc of the table. The crown of the tables are subquadrate, being 0.045 mm in diameter.

Colour: Colour in living condition is reddish-brown with some of the papillae and pedicels yellowish in colour.

Habitat: This species is found in rocky shores. Individuals were often found attached firmly at the rock edges by the three rows of pedicels on the ventral side.

Distribution: ***India***: Gulf of Mannar, Andaman and Nicobar Islands and Lakshadweep; ***Elsewhere***: Western Indian Ocean, Mascarene Islands, East Africa and Madagascar, Red Sea, South-East Arabia, Maldive area, Ceylon area, East Indies, Philippines, China, South Japan, South Pacific Island and Hawaii.

65. ***Holothuria (Thymiosycia) hilla*** (Lesson, 1830)

Description: Length from 50 mm to 200 mm. body long and cylindrical with blunt ends, body wall soft. Dorsal and ventral sides demarcated in the living condition. Papillae sparsely arranged and have expanded bases. Ventral side has numerous pedicels arranged in three rows. A small space at the anterior end near the collar

Holothuria (Thymiosycia) hilla (Lesson, 1830)

is free from pedicels. Each band of pedicels with five or six tube feet arranged side by side. Mouth surrounded by 20 inconspicuous papillae. Tentacles are small. There are ten anal papillae. The calcareous ring is of the usual type with the radials longer than the interradials. The right respiratory tree is long, extending up to the anterior end, while the left end one is shorter and joins the viscera. Two polian vesicles and a stone canal are present. Spicules consist of a table and buttons. Tables possess smooth rounded discs. Four large holes corresponding to the four spires in addition to about fifteen peripheral holes. Spire of the tables consists of four pillars and one cross beam which terminates in twelve or more teeth. Buttons oval, smooth and symmetrical with three or four pairs of holes. Holes at either end generally elongate. Length of the button varies from 0.017 to 0.028 mm. diameter of the table varies from 0.031 mm to 0.038 mm.

Holothuria (Thymiosycia) hilla (Lesson, 1830)

Colour: In living condition, the colour of the specimen is chocolate brown and the large specimen is golden brown with a circular pale area around the appendages.

Habitat: It is a fungitive species always found under coral stones.

Distribution: ***India***: Palk Bay, Gulf of Mannar, Andaman and Nicobar Islands and Lakshadweep; ***Elsewhere***: Western Indian Ocean, Mascarene Islands, East Africa, Red Sea, South-East Arabia, Maldives, Sri Lanka, Bay of Bengal, Persian Gulf, East Indies, Philippines, Northern Australia, China, South Japan, South Pacific Island and Hawaii.

66. ***Holothuria (Thymiosycia) impatiens***
(Forskal, 1775)

Description: Length from 60 to 240 mm. Body bottle shaped with a long neck. Superficially the body can not be differentiated dorsally and ventrally. Mouth and anus is terminal. Tentacles about 20 crowded around the small mouth. Body surface covered by well developed papillae placed on low, round warts which are conspicuous by their lighter column than the rest of the body. Papillae scattered fairly evenly over the surface and not in series. Skin usually sandy to touch. Radial piece of the calcareous ring much longer than interradials and projects forward. The rounded margins have a deep cancavity. Interradial pieces with short teeth. A single stone canal and one or two olian vesicles. Cuvierian tubules occur in relatively large branches. Respiratory trees slender with few branches. Longitudinal muscle bands very thick. Spicules consist of tables, buttons and supporting plates. Tables arranged in a crowded Mannar with the edges of the disc touching

Holothuria (Thymiosycia) impatiens (Forskal, 1775)

or overlapping each other on the outer layer. Each table consists of four upright rods and two cross beams. Spire robust and top of the spire with a number of teeth which are level with the upper cross beam. Disc subquadrate usually provided with nine holes forming three rows, central hole is larger than the other two holes. Diameter of the table disc is 0.10 mm. Spire 0.09 mm high and 0.05 mm in diameter. Buttons oval in shape with mostly three pairs of holes, smooth and with slightly undulating margins and obtuse ends. Very rarely, with more than three holes on each side. Length of the button varies from 0.084mm to 0.10 mm and breadth from 0.040 mm to 0.049 mm. supporting rods slightly curved. Central portion dilated like a ring and has invariably two holes. Tips slightly expanded with one to four holes which are generally smaller than those found at the middle. Sometimes the tip of the rods in the papillae is not perforated.

Colour: In living condition the general body colour is light brown with 4 to 5 dark brown transverse bands on the dorsal side at the anterior end. A few dark brown blotches are also found on the dorsal side on the rest of the body. The ventral side is uniformly light brown with three dark bands of the dorsal side extending to the ventral side near the anterior end.

Habitat: It is often found under the dead coral stones.

Distribution: ***India***: Andaman and Nicobar Islands, Gulf of Mannar and Lakshadweep; ***Elsewhere***: Western Indian Ocean, Mascarene Islands, East Africa, Red Sea, Arabia, Maldives, Sri Lanka, Persian Gulf, East Indies, Philippines, Northern Australia, China, South Japan, South Pacific Island and Hawaii.

67. ***Holothuria atra*** (Jaeger, 1833)

Description: Length from 90-500 mm but known to grow up to 600 mm. body elongate, sub-cylindrical and capable of considerable extension. Posterior end is blunt. Mouth is in the form of a transverse slit and surrounded by a conspicuous papillose collar. There are 20 tentacles

Holothuria atra (Jaeger, 1833)

in double row. Pedicels numerous and crowded on the ventral side. Papillae rather thicker than the pedicels and sparsely arranged. Peristome rather thick, tough and lethery in consistency. Anus terminal. The calcareous ring is not large. The radial pieces extend rather forward than interradials. Radials square shaped, the anterior edge of each radial has a round incision while each interradial piece has an anterior tooth. Posterior margin of the interradial arched. There are four polian vesicle and 18 stone canals. The right respiratory tree extends forward to the calcareous ring and is firmly attached to the body wall and the left one which is shorter and connected with

Holothuria atra (Jaeger, 1833)

Holothuria atra (Jaeger, 1833)

the extensive rete mirabilis of the intestine. Curvierian tubules absent. The spicules consist of tables and rosettes. Tables numerous but not crowded. Each table posses a smaller annular disc and a robust spire composed of four rods and one cross beam. Disc diameter 0.055 mm and commonly consist s of a simple ring with perforation at the base of each rod. Cross beam nearer to the disc than to the crown. Spire surround by the eight robust horizontal and four equally strong, sharp large vertical teeth. Central hole of the spire varies from 0.06 mm to 0.08 mm and the breadth of the crown is about 0.06 mm. rosettes small and vary in size from 0.019 to 0.045 mm. pedicels have well developed terminal plates. A few bilaterally symmetrical fenestrated plates are present close to the terminal plates of the pedicels. The papillae contain slightly curved smooth or spinose rods, mostly with enlarged fenestrated ends.

Colour: In living condition the colour is black or vey dark brown or reddish-brown. The tentacles and the peristomes are dark brown.

Habitat: It is always found fully exposed in shallow water on sandy bottom.

Distribution: ***India***: Andaman and Nicobar Islands, Palk Bay, Gulf of Mannar and Lakshadweep; ***Elsewhere***: Western Indian Ocean, Mascarene Islands, East Africa, Red Sea, Arabia, Maldives, Sri Lanka, Persian Gulf, East Indies, Philippines, Northern Australia, South Japan, South Pacific Island and Hawaii.

68. ***Holothuria (Acanthotrapeza) pyxis***
(Selenka, 1867)

Description: The length of the specimens varied from 270-450 mm. The body is tubular. The posterior region is bulged and blunt with the anterior end narrow. A number of projections are found on the dorsal side. Some of them are 20 mm in length. They are not arranged in order. On the ventral side, there are four bands of pedicels. In each band there are five or six pedicels arranged side by side. Radials large with a deep notch at the anterior end, the posterior end straight. Interradials half the height of the radials and have a concavity at the posterior margin. A single stone canal and a single polian vesicles is present. The spicules consist of only tables in the body wall. Margins of the tables spiny with four large holes at the centre and a number of small holes around the margin. Table short and end in about 10 short spines. Height of the tables is 0.04 mm and the diameter of the disc of the tables is 0.05mm.

Colour: Dorsal side is brownish-pink with some papillae blackish brown. The ventral side is light brown, with spaces between the bands of the pedicels yellow.

Habitat: The species is always found under the large stones which are well fixed to the ground.

Distribution: ***India***: Andaman Islands; ***Elsewhere***: East Indies

Holothuria (Acanthotrapeza) pyxis
(Selenka, 1867)

69. ***Holothuria leucospilota*** (Brandt, 1835)

Description: Large and snake –like like forms with leathery skin. The pedicels are large with well developed sucking discs. The tentacles are 20 in number and are ventrally placed. There is a well developed tentacles collar with a fimbriated margin. In the calcareous ring each radial is large and has a deep groove white the interradial is a short, stump like projection. There is a single polian vesicle and a single stone canal. The respiratory trees are well developed. Cuvierian tubules are also well developed. The spicules consist of an external layer of tables with a complete or incomplete discs often reduced to four holes, one at the base of each pillar. Spire is low and often partly reduced, but when complete. It ends in a flattened crown of eight or twelve teeth. Inner layer consist of regular six holed buttons. The button may some times to asymmetrical. Pedicels are with large end plates and a few broad perforated plates with more or less slit like holes. The length of buttons varies from 0.050mm to 0.063

Holothuria leucospilota (Brandt, 1835)

mm, and the breadth varies from 0.025 mm to 0.033 mm. the height of the table is 0.042 mm and the diameter of the disc varied from 0.037 mm to 0.054 mm.

Colour: The colour is reddish-brown in live condition about looks black on contraction.

Habitat: The species has the peculiar habit of tucking its posterior end under a stone. Some times can be seen under coral stones.

Distribution: ***India***: Andaman and Nicobar Islands, Gulf of Mannar and Lakshadweep; ***Elsewhere***: Western Indian Ocean, Mascarene Islands, East Africa, Red Sea, Arabia, Maldives, Sri Lanka, Persian Gulf, East Indies, Philippines, Northern Australia, China, South Japan, South Pacific Island and Hawaii.

70. ***Holothuria (Mertensiothuria) fuscocinerea***
(Jaeger, 1833)

Description: The length of the specimen is 120 mm, the body is long and tubular with 20 large ventral tentacles. Tentacle on ventral side are arranged in three, though not distinct bands. The papillae on the dorsal side are scattered. There is a single polian vesicle and large stone canal. Cuvierian tubules are large. Usually button has two narrow slit like holes and one or two pairs of minute holes at each end. The length of the button varies from 0.01 mm to 0.04 mm.

Colour: Colour in living condition is brownish, more or less mottled, ventral side is pale gray.

Habitat: It is usually found sandy as well as rocky areas.

Distribution: ***India***: Andaman Islands; ***Elsewhere***: Sri Lanka, Philippines, Japan, Fiji, Samoa, Australia and Celebes.

Holothuria (Mertensiothuria) fuscocinerea (Jaeger, 1833)

71. ***Holothuria (Metriatyla) scabra*** (Jaeger, 1833)

Description: The length of the species is 300–400 mm the body is robust with both the ends blunt. The dorsal side is convex and the ventral side is flat. The skin is very thick and slimy to touch. On the dorsal side, there are many small papillae which are mainly scattered and often inconspicuous. On the ventral sides the pedicels are densly distributed without any arrangement. Each dark spot on the ventral side represents one pedicel. There are two polian vesicles and a single stone canal. The calcareous ring is of the usual type. The left respiratory tree is much larger than the right. The paired radial muscles are not in firm contact with the body wall. The spicules consist of tables and buttons. All the buttons are knobbed and with holes and with irregular perforated plates.the tables are short and the margins are not quite rounded. Each table has a few to many holes. The tables are short with a horizontal cross bar and a crown of spine at the top,

Holothuria (Metriatyla) scabra (Jaeger, 1833)

which are visible in lateral view. In the apical view, 8 outwardly pointed spines are seen. The spire consists of four vertical bars which terminate in a few spines. There is a tier of cross bars in the spire. Buttons are small and generally have three pairs of holes. The pedicels have small terminal plates.

Colour: Colour in the living condition is grey to black on the dorsal side, and white ventrally.

Habitat: It is found in muddy-sandy regions and prefer less saline waters.

Distribution: ***India***: Andaman and Nicobar Islands, Gulf of Mannar and Palk Bay; ***Elsewhere***: Mascarene Islands, East Africa, Red Sea, Arabia, Maldives, Sri Lanka, Persian Gulf, East Indies, Philippines, Northern Australia, China, South Japan, South Pacific Island and Hawaii.

72. ***Holothuria (Halodeima) edulis*** (Lesson, 1830)

Description: Length from 90 mm to 300 mm, body elongate, narrow at the anterior end and blunt at the posterior end. Minute papillae found on the dorsal side of the body. Numerous pedicels present on the ventral side. There are 20 medium-sized tentacles surrounded by a rim of black papillae. Skin is smooth and thin. The inner wall of the cloaca is black in colour. The calcareous ring is of moderate size. There are 37 stone canals and one polian vesicle. Both the right and left branches of the respiratory trees are large and of equal size. Spicules consisit of tables and buttons. Disc of the tables reduced to a ring which is narrower than the top of the spire. There is a horizontal beam in the middle of the spire. The top of the spire is expanded and bears four blunt spines on each side which can be seen only in the lateral view. Height of the tables varies from 0.052 mm to 0.066 mm and diameter of the spire varies from 0.037 mm to 0.043 mm. small button present in the inner layer. The number of the holes varies from 3 to 10 and most of them are incomplete. Length of the button varies from 0.026 mm to 0.058 mm and the

Holothuria (Halodeima) edulis (Lesson, 1830)

Holothuria (Halodeima) edulis (Lesson, 1830)

breadth from 0.017 to 0.031 mm. long supporting rods which have expanded ends and three to four holes are present in the pedicels.

Colour: Body colour is bright rose pink which may be obscured by varying degrees of black pigments. The black colour is well marked on the dorsal side where it varies from grey to intense black and at the side it is replaced by pink. On the ventral side there is no black colour.

Habitat: It is usually found in shallow deapth.

Distribution: ***India***: Andaman Islands and Gulf of Mannar; ***Elsewhere***: East Africa, Red Sea and South-East Arabia.

73. ***Holothuria (Microthele) nobilis*** (Selenka, 1867)

Description: The length varied from 250mm to 400 mm. the body is tubular and massive in shape. Live weight varies from 2 to 3 kg in fresh condition. Body wall is 10-15 mm in thickness. Pedicels and papillae are indistinguishable. Dorsal papillae are more thinly scattered than the ventral pedicles. Anus is surrounded by five calcified papillae. Calcareous ring is massive with distinctly scalloped anterior margin. The radial and interradials are squarish. Radial are twice the length of the interradials. Tentacular ampullae are very large. Spicules consist of tables and buttons. The tables are robust with smooth discs and the spires terminate in 15-20 small spines. The diameter of the table varies from 0.06 to 0.08 mm. the disc of the tables is either irregularly rounded or square shaped. The inner layer has closely packed hollow fenestrated ellipsoids which are 0.07 mm in length. They have four rows of holes. A few simple knobbed buttons are also present.

Colour: This species can be seen in two colour forms, white and black.

Habitat: The species lies freely in the lagoon in the adult stage and often covered with a coat of sand. Young white forms live among the algae. The white form is found in more than 3 m deapth.

Distribution: ***India***: Andaman and Nicobar Islands and Lakshadweep, ***Elsewhere***: Aldabra, Chagos, Comores, East Africa, Eastern Africa, Kenya, Madagascar, Mascarene Basin, Mauritius, Red Sea, Seychelles, Somalia, South Africa, Tanzania and West Indian Ocean.

Holothuria (Microthele) nobilis
(Selenka, 1867)

74. ***Holothuria coluber*** (Semper, 1868)

Description: It is a black sea cucumber with white papillae and 20 yellow tentacles. It is a long (500-600 mm) species with a firm, thick body wall, and a tough tegument. Spicules include spinose cup and saucer' tables and rosettes.

Colour: Uniformly black in colour.

Habitat: This species is found on reefs, usually with its posterior wedged below rocks on reef flats.

Distribution: ***India***: First time reported from Andaman Islands; ***Elsewhere:*** East Indies, North Australia, Philippines and South Pacific Islands.

Remark: New record to Indian waters reported from Andaman Islands

Holothuria coluber (Semper, 1868)

75. *Holothuria (Mertensiothuria) pervicax* (Selenka, 1867)

Description: The length of the specimens ranges from 70 mm to 120 mm. they are sub-cylindrical in shape. The dorsal and the ventral sides are well differentiated. O n the ventral side there are a number of pedicels arranged closely without any evidence of band formation. Tye papillae are scattered on the dorsal side. The tentacles are definitely ventral in position. Cuvierian tubules are thick. Calcareous ring is of the usual type. There are a large single polian vesicles and a single stone canal. Spicules consist of incomplete and oblong rods with lateral projections resembling narrow rosette. The disc of the table is usually sub-circular. Each disc has a fairly big hole at the base of each slender sire. Frequently supplientray holes are also present. The edge of the disc is smooth. The diameter of the discs varies from 0.03 mm to 0.05 mm. the spire has a cross beam and is frequently incomplete and ends in four simple teeth. In some cases, the spire is rudimentary and

Holothuria (Mertensiothuria) pervicax (Selenka, 1867)

the crowns have no transverse pieces. The rosette vary in size from 0.023 mm to 0.069 mm in length. They are irregular and smooth. The pedicels have well developed plates, but in the papillae they are rudimentary. The pedicels and papillae, in addition to long curved rods with short irregular processes, have bilateral fenestrated plates. These plates vary in length from 0.30 mm to 0.36 mm. Those plates which are neighborhood of the terminal plates of the pedicels are formed by the branching and joining of the lateral processes of the supporting rods.

Colour: In living condition the dorsal side is brown with 5 to 7 honey coloured transverse bands of differentiated width. The ventral side is lighter, mottled with white and light violet on a brown background. The cloacal opening is surrounded by a dark violet ring with some some portion of the inner cloacal wall of the same colour.

Habitat: It is usually found in sandy areas.

Distribution: ***India***: Andaman and Nicobar Islands and Lakshadweep; ***Elsewhere***: Western Indian Ocean, Mascarene Islands, East Africa, Red Sea, South East Arabia, Maldive area, Sri Lanka, Persian Gulf, East Indies, Philippines, Northern Australia, South Pacific Islands and Hawaii.

76. ***Holothuria arenicola*** (Semper, 1868)

Description: Body is slender and vermiform. Mouth is small and surrounded by tentacles ventrally. Pedicles small and not conscipicous and arranged in three bands ventrally. Anus is terminal in position and surrounded by five groups of four to six short papillae. The spicules consist of tables, buttons and supporting plates. Button smooth and regular with six holes with edges regularly indented between each pair of holes.

Colour: Body colour is white and on the dorsal side, three pairs of reddish-brown spots are present.

Habitat: It inhabits in the sand, under the stones and it is very difficult to take out the specimen completely.

Distribution: ***India***: Andaman and Nicobar Islands and Lakshadweep; ***Elsewhere***: West Indies, Zanzibar, Fiji, Tahiti, Galapagos and East Coast of Australia.

Holothuria arenicola (Semper, 1868)

Genus : ***Bohadschia***

77. ***Bohadschia marmorata*** (Jaeger, 1833)

Description: Body short and thick with the lower surface slightly flattened. It grows to a large size of 400mm.

Colour: Colour highly variable. Colour is golden brown with small brown dots. Sometimes the colour is yellowish brown with black spots.

Habitat: Occurs on coarse coarl sand at depths 2-6 m. it is also seen in the intertidal region covered by a coating of fine mud.

Distribution: ***India***: Gulf of Mannar, Andaman and Nicobar Islands and Lakshadweep; ***Elsewhere***: Aldabra, East Africa, Eastern Africa and Madagascar, Kenya, Madagascar, Mascarene Basin, Mozambique, Red Sea and Seychelles.

Bohadschia marmorata (Jaeger, 1833)

78. ***Bohadschia argus*** (Jaeger, 1833)

Description: Body is cylindrical with very smooth surface. At the slightest disturbance the sticky threads are thrown out. It grows to a large size of 600 mm in length. Live weight is 1-2 kg. Distinct eye like spots are found all over the body which are encircled with light yellow, white grey colours. The eye spots are situated at a particular angle.

Colour: Colour in living condition is brown or black.

Habitat: Occurs on coarse sand in 2-6 m depth. A few pieces of shell and coarse sand usually stick to body.

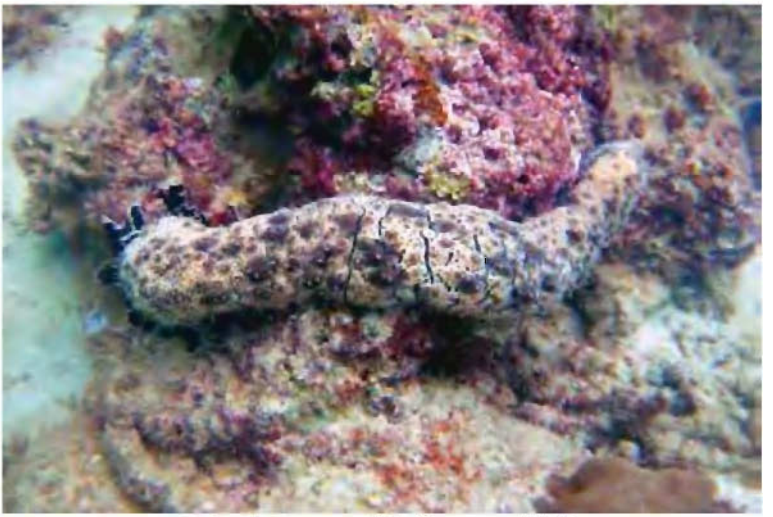
Distribution: ***India***: Andaman and Nicobar Islands and Lakshadweep; ***Elsewhere***: Western Indian Ocean, Ceylon, East Indies, Philippines, Northern Australia, South Pacific Islands, China and South Japan.

Bohadschia argus (Jaeger, 1833)

79. ***Bohadschia graeffei*** (Semper, 1868)

Description: The length of the species is variable from 15 cm to 18 cm. Underside is grainy. Upper side of the species is rough in structural conformation. Body thickness is 4mm. Papillae are low. Spicules resemble a somewhat tack-like bundle of spinose rods described as racquet-like.

Bohadschia graeffei (Semper, 1868)



Bohadschia graeffei (Semper, 1868)

Bohadschia graeffei (Semper, 1868)

Colour: Body colour: pale cream with brown speckling.

Habitat: Reef slopes, close to the coast. Abundant on bottom of mixed corals and calcareous red algae. Depth range- 0-25 m but it is mostly found in 0-10 m.

Distribution: ***India***: Andaman and Nicobar Islands and Lakshadweep. ***Elsewhere***: Red Sea.

Order : ASPIDOCHIROTIDA Grube, 1840
Family : LABIDODEMATIDAE
Genus : ***Labidodemas***

80. ***Labidodemas semperianum*** (Selenka, 1867)

Description: The length of the species ranges between 85-250 mm. Spicules are spinose tables and sometimes buttons and rods.

Colour: It is a white, almost translucent sea cucumber, with yellow tube feet and a dark posterior end.

Habitat: This species can be found buried in sand below rocks of the outer coral reef flat.

Distribution: ***India***: Andaman and Nicobar Islands; ***Elsewhere***: East Indies, Philippines, Northern Australia and South Pacific Island.

Labidodemas semperianum (Selenka, 1867)

Order : DENDROCHIROTIDA Grube, 1840
Family : CUCUMARIIDAE Ludwig, 1894
Genus : ***Stolus***

81. ***Stolus buccalis*** (Stimpson, 1856)

Description: It is small in size ranges from 70-110 mm, firm and cylindrical species, with a smooth tegument. Spicules are small nodular buttons. It is found in coastal habitats south to temperate regions, below stones on intertidal flats. It is mostly distributed in tropical, Indo-west Pacific Ocean.

Colour: Specimen is dark purple- black in colour with red colour tentacles.

Habitat: Usually found concealed under rock or in narrow crevices

Distribution: ***India***: Gulf of Mannar, Andhra Pradesh, Palk Bay, Gulf of Kachchh and Andaman and Nicobar Islands; ***Elsewhere***: East Africa and Madagascar, South East Arabia, Persian Gulf, West Indies, Ceylon, East Indies, North Australia, Philippines, China and South Japan.

Remark: New record to Andaman Islands reported from Burmanella, South Andaman.

Stolus buccalis (Stimpson, 1856)

Family : STICHOPODIDAE Haeckel, 1896
Genus : ***Thelenota***

82. ***Thelenota ananas*** (Jaeger, 1833)

Description: This species grows to a massive size 700 mm in length. The weight of a live specimen varies from 3 to 6 kg. It is seen in massive form with numerous large pointed teats in groups of two or three all over the upper surface.

Thelenota ananas (Jaeger, 1833)

Colour: Colour of the sample in live condition is reddish-orange on the upper side. Tube feet are bright orange colour on the lower surface.

Habitat: It is found on clean sandy bottom at a depth of 2-30 m.

Distribution: ***India***: Andaman and Nicobar Islands and Lakshadweep; ***Elsewhere***: Maldives, East Indies, North Australia, China, South Japan and South Pacific islands.

Thelenota ananas (Jaeger, 1833)

Genus : ***Stichopus***

83. ***Stichopus horrens*** (Selenka, 1867)

Description: It is a medium-sized species (to 300 mm) with a smooth tegument but large and irregular papillae. The big tubercles and irregular body form give an "irregular, soft and almost repulsive" appearance. Spicules are tables and large "C" bodies.

Colour: This species is a variable, grey to green/black sea cucumber. It is often variegated with dark patches.

Habitat: *S. horrens* may be found on reefs, below rocks on flats.

Distribution: ***India***: Andaman and Nicobar Islands; ***Elsewhere***: East Indies, North Australia, China, South Japan, South pacific Islands, Philippines and Hawaii.

Stichopus horrens (Selenka, 1867)

84. ***Stichopus chloronotus*** (Brandt, 1835)

Description: The maximum length of the body is 300 mm. Body quadrangular in shape with four rows of large finger like processes.

Colour: Green in colour. The tip of the finger like processes is orange in colour. The tentacles and the tube feet are ash-coloured and the stalks of tentacles are white.

Habitat: Usually found only beyond low water mark.

Distribution: ***India:*** Andaman and Nicobar Islands, Lakshadweep and Gulf of Mannar; ***Elsewhere:*** Western Indian Ocean, Mascarene Islands, East Africa, Madagascar, Red Sea, Maldives, Ceylon, Bay of Bengal, Persian Gulf, East Indies, Philippines, Northern Australia, China, South Japan, South Pacific Islands and Hawaii.

Stichopus chloronotus (Brandt, 1835)

85. ***Stichopus hermanni*** (Semper, 1868)

Description: The maximum length of the species is 900 mm. Body massive and loaf like in appearance. The tubercles are prominent.

Stichopus hermanni (Semper, 1868)

Colour: In living condition it is dark yellow with irregular brown patches and pink tube feet.

Habitat: Occurs on algal beds and clean sand bottoms between depths 3-30 m.

Distribution: ***India***: Gulf of Mannar, Andaman and Nicobar Islands, Lakshadweep and Palk Bay; ***Elsewhere***: Aldabra, East Africa, Eastern Africa, Kenya, Madagascar, Mascarene Basin, Mozambique, Red Sea, Seychelles, South Africa, Tanzania and West Indian Ocean.

Stichopus hermanni (Semper, 1868)

86. ***Stichopus vastus*** (Sluiter, 1887)

Description: This sea cucumber can grow upto a length of 500 mm and reach maximum weight of 2.5 kg. The body is wider in the middle, tapering at both ends and covered with a bright smooth skin. The upper surface is uniformly brown with zigzag bands at all over the body. Body spicules consists of tables, branched rods and 'S' and 'C' shaped rods.

Colour: Uniformly brown in colour with black patches.

Habitat: It is commonly found in the depth of 1-3m. It occurs in sand and rocky substrata.

Distribution: ***India***: Andaman Islands; ***Elsewhere***: North Australia and Maldives.

Stichopus vastus (Sluiter, 1887)

Order : APODIDA Brandt, 1835
Family : SYNAPTIDAE Östergren, 1898
Genus : ***Synapta***

87. ***Synapta maculata*** (Chamisso and Eysenhardt, 1821)

Description: The structure of the body is like a snake. It can reach more than 2 m in length. Presence of 15 tentacles.

Colour: It is tan to brown in colour with black margins. The whole body surface has small white rings which are closely arranged.

Habitat: It is usually found on the reef flat.

Distribution: ***India***: Gulf of Mannar, Andaman and Nicrobar Islands and Lakshadweep; ***Elsewhere***: Western Indian Ocean, Mascarene Islands, East Africa, Red Sea, Madagascar, Maldives, South East Arabia, Persian Gulf, East Indies, Philippines, Northern Australia, China, South Japan and South Pacific Island.

Synapta maculata (Chamisso and Eysenhardt, 1821)

Genus : ***Euapta***

88. ***Euapta godeffroyi*** (Semper, 1868)

Description: It is a medium to large species (to 400 mm in length), with 15 tentacles, each with numerous pairs of digits. Its spicules are anchors with tiny knobs on the vertex and plates with large posterior holes.

Colour: Body colour is creamy white with grey, with green or brown longitudinal stripes.

Habitat: It is found in intertidal pool, in sand, beneath stones. This species is found on reefs, concealed among rubble of reef flat or slope.

Distribution: ***India***: Andaman and Nicobar Islands and Lakshadweep; ***Elsewhere***: Mascarene Island, Red Sea, Maldives, East Indies, North Australia, Philippines and South Pacific Island.

Euapta godeffroyi (Semper, 1868)

Order : MOLPADIIDA Müller, 1850
Family : CAUDINIDAE Heding, 1931
Genus : ***Acaudina***

89. ***Acaudina molpadioides*** (Semper, 1868)

Descripition: This sea cucumber is loaf shaped and its maximum length is about 300mm. Body surface is thick and covered with a fine coat of sand and is brown coloured with black patches.

Colour: Uniformly brown in colour.

Habitat: This species is commonly found in shallow reef environments. Depth range 2-15m.

Distribution: ***India***: Andaman and Nicobar Islands, Gulf of Kachchh, Andhra Pradesh, West Bengal and Gulf of Mannar. ***Elsewhere***: Northern Australia.

Acaudina molpadioides (Semper, 1868)

8. CHECKLIST OF ECHINODERMS OF INDIA

Class : CRINOIDEA

Order : COMATULIDA

Family : Comasteridae

1. *Capillaster mariae* (A.H. Clark, 1907)
2. *Capillaster multiradiatus* (Linneaus, 1758)
3. *Comanthina nobilis* (P.H. Carpanter, 1884)
4. *Comanthina schlegeli* (P.H. Carpanter, 1881)
5. *Comanthus parviciirus* (Muller, 1841)
6. *Comanthus samoanus* (A.H. Clark, 1909)
7. *Comanthus wahlbergi* (Muller, 1843)
8. *Comaster gracilis* (Hartlub, 1890)
9. *Comaster multibrachiata* (P.H. Carpanter, 1888)
10. *Comaster multifidus* (J. Muller, 1841)
11. *Comaster parvus* (A.H. Clark, 1909)
12. *Comatella maculata* (P.H. Carpanter, 1888)
13. *Comatella nigra* (P.H. Carpanter, 1876)
14. *Comatella stelligera* (P.H. Carpanter, 1880)
15. *Comatula brevicirra* (Bell, 1834)
16. *Comatula micraster* (A.H. Clark, 1909)
17. *Comatula pectinia* (Linneaus, 1758)
18. *Oxycomanthus bennetti* (Muller, 1841)

Family : Himerometridae

19. *Amphimetra molleri* (A.H. Clark, 1908)
20. *Craspedometra acuticirra* (P.H. Carpanter, 1882)
21. *Craspedometra anceps* (P.H. Carpanter, 1888)
22. *Heterometra bengalensis* (Hartlaub, 1890)

23. *Heterometra compta* (A.H. Clark, 1909)
24. *Heterometra philiberti* (Muller, 1841)
25. *Heterometra reynaudi* (Muller, 1846)
26. *Heterometra crenulata* (P.H. Carpenter, 1882)
27. *Himerometra magnipinna* (A.H. Clark, 1908)
28. *Himerometra robustipinna* (P.H. Carpanter, 1912)

Family : Mariametridae

29. *Dichrometra ciliata* (A.H. Clark, 1912)
30. *Dichrometra protectus* (P.H. Carpanter, 1879)
31. *Lamprometra palmata* (Muller, 1841)
32. *Selenemetra aranea* (A.H. Clark,1909)

Family : Stephanometridae

33. *Stephanometra coronata* (A.H. Clark, 1909)
34. *Stephanometra indica* (Smith, 1876)
35. *Stephanometra monacantha* (Hartlaub, 1890)

Family : Colobometridae

36. *Cenometra herdmani* (A.H. Clark, 1909)
37. *Cenometra bella* (Hartlaub, 1890)
38. *Cenometra emendatrix* (Bell, 1892)
39. *Colobometra brevicirra* (A.H. Clark, 1912)
40. *Colobometra discolor* (A.H. Clark, 1909)
41. *Cotylometra gracilicirra* (A.H. Clark, 1908)
42. *Decametra brevicirra* (A.H. Clark, 1912)
43. *Decametra moebiusi* (A.H. Clark, 1911)
44. *Iconometra intermedia* (A.H. Clark, 1912)
45. *Oligometra imbricata* (A.H. Clark, 1909)
46. *Oligometra serripinna* (P.H. Carpanter, 1881)

Family : Pontiopmetridae

47. *Pontiometra andersoni* (P.H. Carpanter, 1889)

Family : Antedonidae

48. *Andrometra indica* (A.H. Clark, 1909)
49. *Euantedon* sp.
50. *Dorometra nana* (Hartlaub, 1890)
51. *Mastigometra micropoda* (A.H. Clark, 1909)
52. *Psathyrometra inusitata* (A.H. Clark, 1912)
53. *Psathyrometra mira* (A.H. Clark, 1909)
54. *Sarametra nicrobarica* (A.H. Clark, 1929)
55. *Trichometra plana* (A.H. Clark, 1912)
56. *Trichometra obscura* (A.H. Clark, 1909)

Family : Tropiometridae

57. *Tropiometra carinata* (Lamarck, 1816)

Family : Calometridae

58. *Neometra spinosissima* (A.H. Clark, 1909)

Family : Thalassometridae

59. *Crotalometra rustica* (A.H. Clark, 1909)
60. *Crotalometra sentifera* (A.H. Clark, 1909)
61. *Stiremetra carinifera* (A.H. Clark, 1912)
62. *Thalassometra peripolos* (A.H. Clark, 1929)
63. *Thalassometra* sp.

Family : Eudiometridae

64. *Eudiocrinus minor* (A.H. Clark, 1919)
65. *Eudiocirnus ornatus* (A.H. Clark, 1919)

Family : Zygometridae

66. *Zygometra andromeda* (A.H.Clark, 1912)

Family : Chartiometridae

67. *Glyptometra crassa* (A.H.Clark, 1912)
68. *Glyptometra invenusta* (A.H. Clark, 1909)
69. *Glyptometra macilenta* (A.H. Clark, 1909)
70. *Perissometra occidentalis* (A.H. Clark, 1929)

Family : Pentametrocrinidae

71. *Pentametrocrinus varians* (P.H. Carpanter, 1882)
72. *Decametrocrinus* sp.
73. *Thaumatocrinus investigatoris* (A.H. Clark, 1912)

Order : BOURGUETICRINIDA

Family : Bourgueticrinidae

74. *Bathycirrus woodmasoni* (A.H. Clark, 1909)

Family : Hintacrinitidae

75. *Comastrocinus ornatus* (A.H. Clark, 1909)
76. *Comastrocrinus springeri* (A.H. Clark, 1909)

Class : ASTEROIDEA

Order : PAXILLOSIDA

Family : Luidiidae

77. *Luidia denudata* (Koehler, 1910)
78. *Luidia hardwicki* (Gray, 1840)
79. *Luidia integra* (Koehler, 1910)
80. *Luidia limbata* (Sladen, 1889)
81. *Luidia maculata* (Muller and Troschel, 1842)
82. *Luidia savignyi* (Audouin, 1826)

Family : Astropectinidae

83. *Astropecten bengalensis* (Doderlein, 1917)
84. *Astropecten euryacanthus* (Lutken, 1805)
85. *Astropecten greigi* (Koehler, 1909)
86. *Astropecten hemipechi* (Muller and Troschel, 1841)
87. *Astropecten indicus* (Doderlein, 1888)
88. *Astropecten inutilis* (Koehler, 1910)
89. *Astropecten monacanthus* (Sladen, 1883)
90. *Astropecten polycanthus* (Muller and troschel, 1841)
91. *Astropecten tamilicus* (Doderlein, 1888)
92. *Astropecten vappa* (Muller and Troschel, 1841)
93. *Astropecten* sp.
94. *Craspidaster hesperus* (Muller and Troschel, 1840)
95. *Dipsacaster pentagonalis* (Alcock, 1894)
96. *Dipsacaster sladeni* (Alcock, 1893)
97. *Dytaster insignis* (Perrier, 1884)
98. *Persephonaster coelochiles* (Alcock, 1893)
99. *Persephonaster croceus* (Wood–Mason and Alcock, 1891)
100. *Persephonaster gracilis* (Sladen, 1889)
101. *Persephonaster rhodopeplus* (Wood–Mason and Alcock, 1891)
102. *Persephonaster roulei* (Koehler, 1909)
103. *Psilaster agassizi* (Koehler, 1909)

Family : Porcellanasteridae

104. *Abyssaster tara* (Wood–Mason and Alcock, 1891)
105. *Porcellanaster caulifer* (Sladen, 1883)
106. *Porcellanaster ceruleus* (Wyville Thomson, 1877)
107. *Sidonaster vaneyi* (Koehler, 1909)

108. *Stryracaster armatus* (Sladen, 1883)
109. *Styracaster caroli* (Ludwig, 1907)
110. *Styracaster clavipes* (Wood–Mason and Alcock, 1891)

Family : Goniopectinidae

111. *Goniopecten* sp.

Order : NOTOMYOTIDA

Family : Benthopectinidae

112. *Benthopecten huddlestoni* (Alcock, 1893)
113. *Benthopecten indicus* (Koehler, 1909)
114. *Benthopecten semisquamatus* (Sladen, 1889)
115. *Benthopecten violaceus* (Alcock, 1893)
116. *Cheriaster pilosus* (Alcock, 1893)
117. *Cheriaster synderi* (Fisher, 1906)
118. *Cheriaster cribellum* (Alcock, 1893)
119. *Pectinaster mimicus* (Sladen, 1889)

Order : VALVATIDA

Family : Chaetasteridae

120. *Chaetaster vestitus* (Koehler, 1910)
121. *Chaetaster* sp.

Family : Asterinidae

122. *Anserpoda ludovici* (Alcock, 1893)
123. *Anserpoda pellucida* (Alcock, 1893)
124. *Asterina burtoni* (Gray, 1840)
125. *Asterina cepheus* (Muller and troschel, 1842)
126. *Asterina coronata* (Von Martens, 1866)
127. *Asterina lorioli* (Koehler, 1897)
128. *Asterina sarasini* (de Loriol, 1897)

129. *Disasterina leptalacantha* (H.L.Clark, 1916)
130. *Disasterina spinosa* (Koehler, 1910)
131. *Disasterina spinulifera* (H.L. Clark, 1938)
132. *Paranepanthia brachiata* (Koehler, 1910)
133. *Patiriella pseudoexigua* (Dartnall, 1910)
134. *Tegulaster ceylanica* (Doderlein, 1888)
135. *Tegulaster emburyi* (Livingstone, 1933)

Family : Archasteridae

136. *Archaster angualtus* (Muller and Troschel, 1842)
137. *Archaster typicus* (Muller and Troschel, 1840)

Family : Goniasteridae

138. *Anthenoides sarissa* (Alcock, 1893)
139. *Astroceramus fisheri* (Koehler, 1909)
140. *Calliaster childreni* (Gray, 1840)
141. *Calliaster mamillifera* (Alcock, 1894)
142. *Ceramaster cueneti* (Koehler, 1909)
143. *Ceramaster mortenseni* (Koehler, 1909)
144. *Circeaster magdalenae* (koehler, 1909)
145. *Circeaster marcelii* (Koehler, 1909)
146. *Johannaster superbus* (Koehler, 1909)
147. *Lithosoma pentaphylla* (Alcock, 1893)
148. *Mediaster arcuatus* (Salden, 1889)
149. *Milteliphaster woodmasoni* (Alcock, 1893)
150. *Nymphaster moebii* (Studer, 1884)
151. *Nympahster nora* (Alcock, 1893)
152. *Ogmaster capella* (Muller and Troschel, 1842)
153. *Paragonaster tenuiradiis* (Alcock, 1893)
154. *Pentagonaster intermedius* (Alcock, 1893)

155. *Pentagonaster pulvinus* (Alcock, 1893)
156. *Pentagonaster ctenipes* (Sladen, 1891)
157. *Pentagonaster* sp.
158. *Plinthaster doderleini* (Koehler, 1909)
159. *Plinthaster investigators* (Alcock, 1893)
160. *Pseudarchaster jordani* (Fisher, 1906))
161. *Pseudarchaster mozaicus*(Wood Mason and Alcock, 1891)
162. *Pseudarchaster roseus* (Alcock, 1891)
163. *Rosaster confinis* (Koehler, 1910)
164. *Rosaster florifer* (Alcock, 1893)
165. *Stiraster tubercualtus* (H.L.Clark, 1915)
166. *Stellaster childreni* (Gray, 1805)

Family : Asterodiscididae

167. *Asterodiscides elegans* (Gray, 1847)

Family : Oreasteridae

168. *Anthenea pentagonalua* (Lamarck, 1816)
169. *Anthenea tuberculosa* (Gray, 1847)
170. *Choriaster granulatus* (Lutken, 1869)
171. *Culcita novaguineae* (Muller and Troschel, 1841)
172. *Culcita schmideliana* (Retzius, 1805)
173. *Goniodiscaster forficulatus* (Perrier, 1875)
174. *Goniodiscaster scaber* (Mobius, 1859)
175. *Goniodiscaster vallei* (Koehler, 1910)
176. *Halityle regularis* (Fisher, 1913)
177. *Pentaceraster affinis* (Muller and troschel, 1841)
178. *Pentaceraster gracilis* (Lutken, 1871)
179. *Pentaceraster multispinus* (Von Martens, 1866)

180. *Pentaceraster regulus* (Muller and Troschel, 1842)
181. *Pentaceraster westermanni* (Lutken, 1871)
182. *Poraster superbus* (Mobius, 1859)
183. *Protoreaster lincki* (de Blainvillae, 1830)
184. *Protoreaster nodosus* (Linneaus, 1758)

Family : Asteropsidae

185. *Asteropsis carinifera* (Lamarck, 1816)
186. *Valvaster striatus* (Lamarck, 1816)

Family : Acanthasteridae

187. Acanthaster planci (Linneaus, 1758)

Family : Ophidiasteridae

188. *Andora faouzii* (Macan, 1938)
189. *Certonardoa semiregularis* (Muller and Troschel, 1842)
190. *Cistina columbiae* (Gray, 1840)
191. *Dactylaster cylindricus* (Lamarck, 1816)
192. *Fromia armata* (Koehler, 1910)
193. *Fromia indica* (Perrier, 1869)
194. *Fromia milleporella* (Lamarck, 1816)
195. *Fromia monilis* (Perrier, 1869)
196. *Gomophia egyptiaca* (Gray, 1840)
197. *Heteronardoa carinata* (Koehler, 1910)
198. *Leiaster glaber* (Peters, 1852)
199. *Leiaster leachi* (Gray, 1840)
200. *Linckia guildingi* (Gray, 1840)
201. *Linckia laevigata* (Linneaus, 1758)
202. *Linckia multifora* (Lamarck, 1816)
203. *Nardoa frianti* (Koehler, 1910)

204. *Nardoa glatheae* (Lutkan, 1865)
205. *Nardoa lemonnieri* (Koehler, 1910)
206. *Nardoa novacaledoniae* (Perrier, 1875)
207. *Nardoa* sp.
208. *Neoferdina offreti* (Koehler, 1910)
209. *Ophidiaster armatus* (Koehler, 1910)
210. *Ophidiaster hemprichi* (Muller and Troschel, 1842)
211. *Paraferdina laccadivensis* (James, 1976)
212. *Paraferina sohariae* (Marsh and Price, 1991)
213. *Tamaria fusca* (Gray, 1840)
214. *Tamaria dubiosa* (Koehler, 1910)
215. *Tamaria hirsuta* (Koehler, 1910)
216. *Tamaria megaloplax* (Bell, 1884)

Order : VELATIDA

Family : Pterasteridae

217. *Eureaster cibrosus* (von Martens, 1867)
218. *Hymenaster alcocki* (Koehler, 1909)
219. *Hymenaster nobilis* (Wyville Thompson, 1876)
220. *Marsipaster hirsutus* (Wood Mason and Alcock, 1891)

Order : SPINULOSIDA

Family : Echinasteridae

221. *Dictyaster xenophilus* (Wood Mason and Alcock, 1891)
222. *Dictyaster woodmasoni* (Alcock, 1893)
223. *Echinaster callosus* (von Marenzeller, 1895)
224. *Echinaster luzonicus* (Gray, 1840)
225. *Echinaster purpureus* (Gray, 1840)
226. *Henricia mutans* (Koehler, 1893)

Family : Metrodiridae

227. *Metrodira subulata* (Gray, 1840)

Order : FORCIPULATIDA

Family : Zoroasteridae

228. *Cnemidaster squameus* (Alcock, 1893)
229. *Zoroaster adami* (Koehler, 1909)
230. *Zoroaster alfredi* (Alcock, 1893)
231. *Zoroaster angulatus* (Alcock, 1893)
232. *Zoroaster barathri* (Alcock, 1893)
233. *Zoroaster carinatus* (Alcock, 1893)
234. *Zoroaster gilesii*(Alcock, 1893)
235. *Zoroaster planus* (Alcock, 1893)
236. *Zoroaster zea* (Alcock, 1893)
237. *Zoroaster* sp.

Family : Pedicellaster

238. *Pedicellaster atratus* (Alcock, 1893)

Family : Asteriidae

239. *Scleraasterias mazophora* (Wood–Mason and Alcock, 1891)
240. *Sclerasterias nitida* (Koehler, 1910)

Order : BRISINGIDA

Family : Brisingidae

241. *Brisinga andamanica* (Wood-Mason and Alcock,1891)
242. *Brisinga bengalensis*(Wood-Masona and Alcock, 1891)
243. *Brisinga gunni* (Alcock, 1893)
244. *Brisinga insularum* (Wood-Masona and Alcock, 1891)

245. *Brisinga panopla* (Fisher, 1906)
246. *Brisinga parallela* (Koehler, 1909)
247. *Stegnobrisinga gracilis* (Koehler, 1909)

Family : Freyellidae

248. *Freyastera benthphila* (Sladen, 1889)
249. *Freyastera tuberculata* (Sladen, 1889)

Class : OPHIUROIDEA
Order : PHRYNOPHIURIDA
Family : Ophiomyxidae

250. *Ophiomyxa australis* (Lutken, 1869)
251. *Ophiophrixus confinis* (Koehler, 1922)

Family : Asteronychidae

252. *Asteronyx loveni* (Muller and Troschel, 1842)

Family : Euryalidae

253. *Asteromorpha fosculus* (Alcock, 1893)
254. *Trichaster acanthifer* (Doderlein, 1911)

Family : Gorgonocephalidae

255. *Astroboa clavata* (lyman, 1861)
256. *Astroba nuda* (Lyman, 1874)
257. *Astrocladus exiguus* (Lamarck, 1816)
258. *Astrothrombus vacors* (Koehler, 1904)

Family : Asteroschematidae

259. *Asterschema subfastosum* (Doderlein, 1930)
260. *Ophiocreas sibogae* (Koehler, 1904)
261. *Ophiocreas* sp.

Order : OPHIURIDA

Family : Ophiuridae

262. *Ophioelegans cincta* (Muller and Troschel, 1842)
263. *Ophiolepis superba* (H.L. Clark, 1842)
264. *Ophiolypus granulatus* (Koehler, 1897)
265. *Ophimusium elegans* (Koehler, 1897)
266. *Ophimusium familiare* (Koehler, 1897)
267. *Ophimusium fimbriatum* (Koehler, 1927)
268. *Ophimusium lymani* (Wyville Thompson, 1873)
269. *Ophimusium relictum* (Koehler, 1927)
270. *Ophimusium scalare* (Lyman, 1878)
271. *Ophimusium simplex* (Lyman, 1878)
272. *Ophimusium validum* (Ljungman, 1871)
273. *Ophioplocus imbricatus* (Muller and Troschel, 1841)
274. *Ophiosphalma elegans* (Koehler, 1897)
275. *Ophiosphalma planum* (Lyman, 1878)
276. *Ophioteichus nodosa* (Duncan, 1887)
277. *Ophiotrochus panniculus* (Lyman, 1878)
278. *Ophiozonella bispinosa* (Koehler, 1897)
279. *Ophiozonella molesta* (Koehler, 1904)
280. *Ophiernus adspersus adspersus* (Lyman, 1878)
281. *Ophioleuce seminudum* (Koehler, 1904)
282. *Ophiopallas paradoxa* (Koehler, 1904)
283. *Ophiostratus bispinosus* (Koehler, 1897)
284. *Amphiophiura ornata* (Lyman, 1878)
285. *Amphiophiura paupera*(Koehler, 1897)
286. *Amphiophiura radiata* (Lyman, 1878)
287. *Amphiophiura sculptilis* (Lyman, 1878)
288. *Amphiophiura sordida* (Koehler, 1897)
289. *Amphiophiura stellata* (Studer, 1882)

290. *Homalophiura inflata* (Koehler, 1897)
291. *Ophiomastus tumidus* (Koehler, 1897)
292. *Ophiopyrgus alcocki* (Koehler, 1897)
293. *Ophiotypa simplex* (Koehler, 1897)
294. *Ophiura aequalis* (Lyman, 1878)
295. *Ophiura flagellata* (Lyman, 1878)
296. *Ophiura forbesi* (Duncan, 1879)
297. *Ophiura irrorata* (Lyman, 1878)
298. *Ophiura kinbergi* (Ljungman, 1867)
299. *Ophiura undulata* (Lyman, 1878)

Family : Ophiocomidae

300. *Ophiarthrum elegans* (Peters, 1851)
301. *Ophiarthrum pictum* (Muller and Troschel, 1842)
302. *Ophiocoma anglyptica* (Ely, 1944)
303. *Ophiocoma brvipes* (Peters, 1851)
304. *Ophiocoam dentata* (Muller and Troschel, 1842)
305. *Ophiocoma doderleini* (de Loriol, 1890)
306. *Ophiocoma erinaceus* (Muller and Troschel, 1842)
307. *Ophiocoma lubrica* (Koehler, 1898)
308. *Ophiocoma pica* (Muller and troschel, 1842)
309. *Ophiocoma pusilla* (Brock, 1888)
310. *Ophiocoma scolopendrina* (Lamarck, 1816)
311. *Ophiocoma valenciae* (Muller and Troschel, 1842)
312. *Ophiocomella sexradia* (Duncan, 1887)
313. *Ophiomastix annulosa* (Lamarck, 1816)
314. *Ophiopsila pantherina* (Koehler, 1898)

Family : Ophionereidae

315. *Ophiochiton ambulator* (Koehler, 1897)

316. *Ophiochiton modestus* (Koehler, 1897)
317. *Ophionereis andmanensis* (James, 1987)
318. *Ophionereia dubia* (Muller and Troschel, 1842)
319. *Ophionereis porrecta* (Lyman, 1860)

Family : Ophiodermatidae

320. *Bathypectinura heros* (Lyman, 1879)
321. *Gymnopelta indica* (Koehler, 1897)
322. *Ophiarachna incrassata* (Lamarck, 1816)
323. *Ophiarachnella gorgonia* (Muller and Troschel, 1842)
324. *Ophiarachnella infernalis* (Muller and Troschel, 1842)
325. *Ophiarachnella intermedia* (Bell, 1888)
326. *Ophiarachnella megaloplax* (Bell, 1884)
327. *Ophiarachnella sphenesci* (Bell, 1894)
328. *Ophiocormus compsus* (A.M.Clark, 1968)
329. *Ophiopeza custos* (Koehler, 1897)
330. *Ophiopeza fallax arbacia* (A.M.Clark, 1968)
331. *Ophiosammus yoldii* (Lutken, 1856)

Family : Ophiacanthidae

332. *Ophiacantha abnormis* (Lyman, 1879)
333. *Ophiacantha composita* (Koehler, 1897)
334. *Ophiacantha indica* (Ljungman, 1899)
335. *Ophiacantha pentagona* (Koehler, 1897)
336. *Ophiacantha sociabilis* (Koehler, 1897)
337. *Ophiacantha vagans* (Koehler, 1899)
338. *Ophiacantha vestita* (Koehler, 1897)
339. *Ophiacantha vorax* (Koehler, 1897)
340. *Ophiocamax fasciculata* (Lyman, 1883)

341. *Ophiocamax rugosa* (Koehler, 1904)
342. *Ophiomitra integra* (Koehler, 1897)
343. *Ophioplinthaca rudis* (Koehler, 1897)
344. *Ophiotreta matura* (Koehler, 1904)

Family : Hemieuryalidae

345. *Ophiomoeris tenera* (Koehler, 1897)

Family : Ophaictidae

346. *Ophiactis acosmeta* (H.L. Clark, 1971)
347. *Ophiactis brachyura* (Doderlein, 1971)
348. *Ophiactis delagoa* (Balinsky, 1957)
349. *Ophiactis flexuosa* (Koehler, 1897)
350. *Ophiactis maculosa* (von Martens, 1870)
351. *Ophiactis modesta* (Brock, 1888)
352. *Ophiactis picteti* (de Loriol, 1893)
353. *Ophiactis savignyi* (Muller and Troschel, 1842)

Family : Amphiuridae

354. *Amphiodia caullery* (Koehler, 1897)
355. *Amphioplus intermedius* (Koehler, 1983)
356. *Amphioplus cyrtacanthus* (H.L. Clark, 1915)
357. *Amphioplus personatus* (Koehler, 1971)
358. *Amphioplus andreae* (Lutken, 1971)
359. *Amphioplus depressus* (Ljungman, 1867)
360. *Amphioplus gravelyi* (James, 1927)
361. *Amphioplus hastatus* (Ljungman, 1867)
362. *Amphioplus laevis* (Lyman, 1874)
363. *Amphioplus misera* (Koehler, 1899)
364. *Amphioplus squamata* (Delle Chiaje, 1828)

365. *Amphiura ambigua* (Koehler, 1905)
366. *Amphiura septemspinosa* (H.L. Clark, 1915)
367. *Amphiura tenius* (H.L. Clark, 1938)
368. *Amphiura dispar* (Koehler, 1897)
369. *Amphiura famula* (Koehler, 1910)
370. *Amphiura lorioli* (Koehler, 1897)
371. *Dougaloplus echinatus* (Ljungman, 1867)
372. *Histampica duplicata* (Lyman, 1874)
373. *Ophiocentrus dilatatus* (Koehler, 1905)
374. *Ophiocentrus verticillatus* (Doderlein, 1971)
375. *Ophiostigma formosa* (Lutken, 1899)

Family : Ophiotrichidae

376. *Gymnolophus obscura* (Ljungman, 1969)
377. *Macropohiothrix aspidota* (Muller and Troschel, 1842)
378. *Macropohiothrix demessa* (Lyman, 1869)
379. *Macropohiothrix galatheae* (Lutken, 1872)
380. *Macropohiothrix koehleri* (A.M. Clark, 1905)
381. *Macropohiothrix longipeda* (Lamarck, 1816)
382. *Macropohiothrix Propinqua* (Lyman, 1861)
383. *Macropohiothrix speciosa* (Koehler, 1898)
384. *Macropohiothrix variabilis* (Duncan, 1887)
385. *Macropohiothrix hirsuta* (Muller and Troschel, 1842)
386. *Ophiocnemis marmorata* (Lamarck, 1816)
387. *Ophiogymna elegans* (Ljungman, 1971)
388. *Ophiogymna lineata* (H.L.Clark, 1969)
389. *Ophiogymna pellicula* (Duncan, 1887)
390. *Ophiolophus novarae* (Marktanner-Turneretsher, 1887)
391. *Ophiomaza cacaotica* (Lyman, 1871)

392. *Ophiopteron elegans* (Ludwig, 1888)
393. *Ophiothela danae* (Verill, 1869)
394. *Ophiothrix diligens* (Koehler, 1898)
395. *Ophiothrix proteus* (Koehler, 1905)
396. *Ophiothrix purpurae* (von Martens, 1867)
397. *Ophiothrix vigelandi* (A.M. Clark, 1922)
398. *Ophiothrix nereidina* (Lamarck, 1816)
399. *Ophiothrix aristulata* (Lyman, 1879)
400. *Ophiothrix ciliaris* (Lamarck, 1816)
401. *Ophiothrix exigua* (Lyman, 1874)
402. *Ophiothrix foveolata* (Marktanner-Turneretscher, 1887)
403. *Ophiothrix savignyi* (Muller and Troschel, 1842)
404. *Ophiothrix trilineata* (Lutken, 1869)
405. *Ophiothrix variegata* (Duncan, 1887)
406. *Ophiothrix vitrea* (Doderlein, 1896)
407. *Ophiothrix fumaria* (Muller and Troschel, 1842)
408. *Ophiothrix striolata* (Grube, 1868)
409. *Ophiothrix accedens* (Koehler, 1966)
410. *Ophiothrix* sp.

Class : ECHINOIDEA

Order : CIDAROIDA

Family : Cidariidae

411. *Eucidaris metularia* (Lamarck, 1816)
412. *Histocidaris denticulata* (Koehler, 1907)
413. *Phyllacanthus forcipulatus* (Mortensen, 1936)
414. *Phyllacanthus imperialis* (lamarck, 1816)
415. *Prinocidaris purpurata* (Wyville- Thompson, 1869)
416. *Prinocidaris baculosa* (Lamarck, 1816)

417. *Prinocidaris bispinosa* (Lamarck, 1816)
418. *Prinocidaris verticillata* (Lamarck, 1816)
419. *Stereocidaris alcocki* (Anderson, 1894)
420. *Stereocidaris indica* (Doderlein, 1901)
421. *Stylocidris albidens* (H.L. Clark, 1925)
422. *Stylocidaris brevicollis* (de Meijere, 1904)
423. *Stylocidaris lorioli* (Koehler, 1927)
424. *Stylocidaris tiara* (Anderson, 1894)
425. *Acanthocidaris maculicollis* (Meijere, 1903)

Order : ECHINOTHURIOIDA

Family : Echinothuridae

426. *Hygrosoma luculentum* (Agassiz, 1879)
427. *Phormosoma bursarium* (Agassiz, 1881)
428. *Phormosoma verticillatum* (Mortensen, 1904)
429. *Phormosoma* sp.
430. *Sperosoma biseriatum* (Doderlein, 1901)

Order : DIADEMATOIDA

Family : Diadematidae

431. *Astropyga radiata* (Leske, 1778)
432. *Centrostephanus nitidus* (Koehler, 1927)
433. *Chaetodiadema granulatum* (Mortensen, 1903)
434. *Diadema savignyi* (Michelin, 1845)
435. *Diadema setosum* (Leske, 1758)
436. *Echinothrix calamaris* (Pallas, 1774)
437. *Echinothrix diadema* (Linneaus, 1758)

Family : Aspidodiadematidae

438. *Aspidodiadema nicobaricum* (Doderlein, 1901)

Order : PEDINOIDA

Family : Pedinidae

439. *Coenopedina depressa* (Koehler, 1927)

Order : SELENIOIDA

Family : Saleniidae

440. *Salenocidaris miliaris* (Mortensen, 1939)

441. *Salenia sculpta* (Koehler, 1927)

Order : PHYMOSOMATIDAE

Family : Stomechinidae

442. *Stomopneustes variolaris* (Lamarck, 1816)

Order : ARBACIOIDA

Family : Arbaciidae

443. *Arbacia punctulata* (Lamarck, 1861)

444. *Coelopleurus vittiatus* (Koehler, 1927)

445. *Pygmaeocidaris prionigera* (Agassiz, 1879)

Order : TEMNOPLEUROIDA

Family : Temnopleuridae

446. *Mespilia globulus* (Linneaus, 1758)

447. *Microcyphus ceylanicus* (Mortensen, 1925)

448. *Paratrema doderleini* (Mortensen, 1904)

449. *Printechinus impressus* (Koehler, 1927)

450. *Prionechinus agassizi* (Wood-Mason and Alcock,1891)

451. *Salmaciella dussumieri* (L. Agassiz and Desor, 1846)

452. *Salmacis belli* (Doderlein, 1902)

453. *Salmacis bicolor* (Agassiz, 1841)

454. *Salmacis virgulata* (Agassiz, 1846)

455. *Salmacis belli* (Doderlein, 1902)

456. *Temnopleurus apodus* (Agassiz and H.L. Clark, 1943)
457. *Temnopleurus proctalis* (Koehler, 1927)
458. *Temnopleurus toreumaticus* (Leske, 1778)
459. *Temnopleurus alexandri* (Bell, 1884)
460. *Temnometra scillae* (Mazetti, 1894)
461. *Trigonocidaris versicolor* (Koehler, 1927)

Family : Toxopneustidae

462. *Gymnechinus robillaridi* (de Loriol, 1883)
463. *Pseudoboletia maculata* (Troschel, 1869)
464. *Toxopneustes pileolus* (Lamarck, 1816)
465. *Tripneustes gratilla* (Linneaus, 1758)

Order : Echinoida

Family : Echinometridae

466. *Colobocentrotus atratus* (Linneaus, 1758)
467. *Echinometra mathai* (de Blainvillae, 1825)
468. *Echinometra oblonga* (de Blainvillae, 1969)
469. *Echinostrephus molaris* (de Blainvillae, 1825)
470. *Heterocentrotus mammilatus* (Linneaus, 1758)
471. *Heterocentrotus trigonarius* (Lamarck, 1816)

Order : HOLECTYPOIDA

Family : Echinoneidae

472. *Echinoneus cyclostomus* (Leske, 1778)

Order : CLYPEASTEROIDA

Family : Clypeasteridae

473. *Clypeaster annandalei* (Koehler, 1922)
474. *Clypeaster fervens* (Koehler, 1922)
475. *Clypeaster humilis* (Leske, 1778)

476. *Clypeaster rarispinus* (de Meijere, 1903)
477. *Clypeaster reticulatus* (Linneaus, 1758)

Family : Arachnoididae

478. *Arachnoides placenta* (Linneaus, 1758)

Family : Fibularidae

479. *Echinocyamus crispus* (Mazetti, 1893)
480. *Echinocyamus sollers* (Koehler, 1922)
481. *Fibularia cribellum* (de Meijere, 1904)
482. *Fibularia oblonga* (Gray, 1847)
483. *Fabularia volva* (Agassiz, 1847)

Family : Laganidae

484. *Laganum decagonale* (de Blainvillae, 1827)
485. *Laganum depressum* (Lesson, 1841)
486. *Laganum laganum* (Leske, 1778)
487. *Laganum retinens* (Koehler, 1922)
488. *Laganum retinense mortenseni* (Mortensen, 1948)
489. *Laganum versatile* (Koehler, 1922)
490. *Peronella lessueri* (Valenciennes, 1841)
491. *Peronella macroproctes* (Koehler, 1922)
492. *Pronella oblonga* (Mortensen, 1948)
493. *Pronella orbicularis* (leske, 1778)
494. *Pronella rubra* (Doderlein, 1885)
495. *Pronella rutlandi* (Koehler, 1922)

Family : Astriclypeidae

496. *Echinodiscus auritus* (Leske, 1778)
497. *Echinodiscus bisperforatus* (Leske, 1778)

Order : CASSIDULOIDA

Family : Echinolampadidae

498. *Echinolampas alexandri* (de Loriol, 1876)
499. *Echinolampas castanea* (Alcock, 1894)
500. *Echinolampas ovata* (Leske, 1778)

Order : SPATANGOIDA

Family : Hemiasteridae

501. *Hemiaster vanus* (Koehler, 1914)

Family : Palaeostomatidae

502. *Palaeostoma mirabile* (Gray, 1851)

Family : Pericosmidae

503. *Pericosmus micronesius* (Koehler, 1914)

Family : Schizasteridae

504. *Brisaster indicus* (Koehler, 1914)
505. *Faorina chinensis* (Gray, 1851)
506. *Moira stygia* (Lutken, 1872)
507. *Schizaster kempi* (Koehler, 1914)
508. *Schizaster angulatus* (Koehler, 1914)
509. *Schizaster gibberulus* (Agassiz, 1847)
510. *Schizaster investigatoris* (Koehler, 1914)
511. *Schizaster compactus* (Koehler, 1914)

Family : Brissidae

512. *Brissopsis luzonica* (Gray, 1851)
513. *Brissopsis oldhami* (Alcock, 1893)
514. *Brissopsis parallela* (Koehler, 1914)
515. *Brissus latecarinatus* (Leske, 1778)

516. *Gymnopatagus magnus* (Agassiz and Alcock, 1907)
517. *Gymnopatagus valdiviae* (Doderlain, 1901)
518. *Metalia latissima* (H.L. Clark, 1925)
519. *Metalia spatagus* (Linneaus, 1758)
520. *Rhynobrissus pyramidalis* (Agassiz, 1872)

Family : Spatangidae

521. *Maretia planulata* (Lamarck, 1914)
522. *Nacospatangus alta* (Agassiz, 1863)

Family : Loveniidae

523. *Breynia verdenburgi* (Anderson, 1907)
524. *Lovenia elongata* (Gray, 1845)
525. *Lovenia gregalis* (Alcock, 1834)
526. *Lovenia subcarinata* (Gray, 1845)

Family : Asterostomatidae

527. *Araeolampas glauca* (Wood-Masona and Alcock, 1891)
528. *Argopatagus vitreus* (Agassiz, 1881)
529. *Elipneustes denudatus* (Koehler, 1914)
530. *Elipneustes rubens* (Koehler, 1914)
531. *Heterobrissus hemingi* (Anderson, 1899)
532. *Linopneustes spectabilis* (de Meijere, 1904)
533. *Paleotrema ovatum* (Koehler, 1914)

Class : HOLOTHUROIDEA
Order : ASPIDOCHIROTIDA
Family : Holothuriidae

534. *Actinopyga mauritiana* (Quoy and Gaimard, 1833)
535. *Actinopyga lecanora* (Jaeger, 1833)
536. *Actinopyga echinities* (Jaeger, 1833)

537. *Actinopyga miliaris* (Quoy and Gaimard, 1833)
538. *Bohadsschia argus* (Jaeger, 1833)
539. *Bohadschia marmorata* (Jaeger, 1833)
540. *Bohadschia graeffei* (Semper, 1868)
541. *Bohadschia tenuissiama* (Semper, 1868)
542. *Holothuria pyxis* (Selenka, 1867)
543. *Holothuria inhabilis* (Selenka,1867)
544. *Holothuria rigida* (Selenka, 1867)
545. *Holothuria atra* (Jaeger, 1833)
546. *Holothuria edulis* (Lesson, 1830)
547. *Holothuria paradalis* (Selenka,1867)
548. *Holothuria exilis* (Koehler and Vaney, 1908)
549. *Holothuria fuscocinerea* (Jaeger, 1833)
550. *Holothuria leucospilota* (Brandt, 1835)
551. *Holothuria pervicax* (Selenka, 1867)
552. *Holothuria albiventer* (Semper, 1893)
553. *Holothuria ocellata* (Jaeger, 1833)
554. *Holothuria scabra* (Jager, 1833)
555. *Holothuria fuscogilva* (Cherbonnier, 1908)
556. *Holothuria nobilis* (Selenka, 1867)
557. *Holothuria difficilis* (Semper, 1868)
558. *Holothuria erinaceus* (Semper, 1868)
559. *Holothuria moebii* (Ludwig, 1883)
560. *Holothuria cinerascens* (Brandt, 1835)
561. *Holothuria prompta* (Koehler and Vaney, 1908)
562. *Holothuria kurti* (Ludwig, 1908)
563. *Holothuria spinifera* (Theel, 1886)
564. *Holothuria arenicola* (Semper, 1868)
565. *Holothuria gracillis* (Semper, 1868)
566. *Holothuria hilla* (Lesson, 1830)

567. *Holothuria impatiens* (Forskal, 1775)
568. *Holothuria remollescens* (Lampert, 1908)
569. *Holothuria integra* (Koehler and Vaney, 1908)
570. *Holothuria coluber* (Semper, 1869)

Family : Labidodematidae

571. *Labidodemas rugosum* (Ludwig, 1875)
572. *Labidodemas semperianum* (Selenka, 1867)

Family : Stichopodidae

573. *Aspostichopus japonicus* (Selenka, 1969)
574. *Stichopus chloronatus* (Brandt, 1835)
575. *Stichopus hermanni* (Semper, 1868)
576. *Stichopus horrens* (Selenka, 1867)
577. *Stichopus vastus* (Sluiter, 1888)
578. *Thelenota ananas* (Jaeger, 1833)

Family : Synallactidae

579. *Allopatides dendroides* (Koehler and Vaney, 1905)
580. *Bathyplotes assimilis* (Koehler and Vaney, 1905)
581. *Bathyplotes cinctus* (Koehler and Vaney, 1905)
582. *Bathyplotes crenulatus* (Koehler and Vaney, 1905)
583. *Bathyplotes pappillosus* (Koehler and Vaney, 1905)
584. *Bathyplotes profundus* (Koehler and Vaney, 1905)
585. *Bathyplotes variabilis* (Koehler and Vaney, 1905)
586. *Benthothuria cristatus* (Koehler and Vaney, 1905)
587. *Benthothuria distortus* (Koehler and Vaney, 1905)
588. *Mesothuria abbreviata* (Koehler and Vaney, 1905)
589. *Mesothuria incerta* (Koehler and Vaney, 1905)
590. *Mesothuria multipes* (Ludwig, 1894)

591. *Mesothuria squamosa* (Koehler and Vaney, 1905)
592. *Pleopatides gelatinosus* (Walsh, 1891)
593. *Pleopatides insignis* (Koehler and Vaney, 1905)
594. *Pleopatides modestus* (Koehler and Vaney, 1905)
595. *Pleopatides mollis* (Koehler and Vaney, 1905)
596. *Pleopatides ovalis* (Walsh, 1891)
597. *Pleopatides verrucosa* (Koehler and Vaney, 1905)
598. *Pseudistichopus occulatus* (Marenzeller, 1893)
599. *Synallactes horridus* (Koehler and Vaney, 1905)
600. *Synallactes pellucidus* (Koehler and Vaney, 1905)
601. *Synallactes rigidus* (Koehler and Vaney, 1905)
602. *Synallactes woodmasoni* (Walsh, 1891)

Order : DENDROCHIROTIDA

Family : Psolidae

603. *Psolidium rugosum* (Koehler and Vaney, 1905)
604. *Psolus mannarensis* (James, 1927)
605. *Psolus membranaceus* (Koehler and Vaney, 1905)
606. *Psolus* sp.

Family : Phyllophoridae

607. *Actinocucumis typicus* (Ludwig, 1875)
608. *Afrocucumis africana* (Semper, 1868)
609. *Oshimella ehrenbergi* (Selenka, 1868)
610. *Phyllophorus celer* (Koehler and Vaney, 1905)
611. *Phyllophorus intermedius* (Koehler and Vaney, 1905)
612. *Phyllophorus parvipedes* (H.L.Clark, 1938)
613. *Phyllophorus* sp.
614. *Phyllophorus cubuensis* (Semper, 1868)

615. *Phyllophorus brocki* (Ledwig, 1888)
616. *Phyrella fragilis* (Ohshima, 1912)
617. *Pseudocucumis acicula* (Semper, 1868)

Family : Cucumariidae

618. *Aslia forbesi* (Bell, 1884)
619. *Althyone* sp.
620. *Cladolabes acicula* (Semper, 1983)
621. *Cucumaria ardens* (Koehler and Vaney, 1905)
622. *Cucumaria ariana* (Koehler and Vaney, 1905)
623. *Cucumaria frauenfeldi* (Ludwig, 1971)
624. *Cucumaria inflexa* (Koehler and Vaney, 1905)
625. *Cucumaria turbinata* (Hutton, 1988)
626. *Havelockia versicolor* (Semper, 1868)
627. *Hemithyone semperi* (Bell, 1884)
628. *Leptopentacta bacilliformis* (Koehler and Vaney, 1905)
629. *Leptopentacta imbricata* (Semper, 1868)
630. *Leptopentacta japonicus* (Sluiter, 1880)
631. *Pentacta quadrangularis* (Troschel, 1846)
632. *Pseudocnus echinatus* (von Marenzeller, 1882)
633. *Pseudocolochirus tricolor* (Sluiter, 1971)
634. *Pseudocolochirus violaceus* (Theel, 1882)
635. *Stolus buccalis* (Stimpson, 1855)
636. *Stolus conjungens* (Semper, 1868)
637. *Stolus rapax* (Koehler and Vaney, 1905)
638. *Thorsonia investigatoris* (Koehler and Vaney, 1905)
639. *Thyone dura* (Koehler and Vaney, 1905)
640. *Thyone papuensis* (Theel, 1886)
641. *Trachythyone alcocki* (Koehler and Vaney, 1905)

Order : DACTYLOCHIROTIDA

Family : Yapsilothuridae

642. *Yapsilothuria bitentaculata* (Ludwig, 1894)

Order : ELASIPODODA

Family : Deimatidae

643. *Amphideima investigatoris* (Koehler and Vaney, 1905)
644. *Deima blakei* (Theel, 1886)
645. *Deima validum* (Theel, 1882)
646. *Oneiriphanta conservata* (Koehler and Vaney, 1905)
647. *Orphnurgus glaber* (Walsh, 1891)
648. *Orphnurgus invalidus* (Koehler and Vaney, 1905)

Family : Laetmogonidae

649. *Apodogaster alcocki* (Walsh, 1901)
650. *Laetmogone spongiosa* (Theel, 1882)
651. *Laetmogone violacea* (Theel, 1882)

Family : Psychropotidae

652. *Benthodytes glutinosa* (Perrier, 1902)
653. *Benthodytes typica* (Theel, 1882)
654. *Filithuria elegans* (Koehler and Vaney, 1905)

Family : Pelagothuriidae

655. *Euriplaster obscura* (Koehler and Vaney, 1905)

Order : APODIDA

Family : Synaptidae

656. *Anapta gracilis* (Semper, 1868)
657. *Chondrocolea baselii* (Jaeger, 1833)

658. *Euapta godeffroyi* (Semper, 1868)
659. *Labidoplax* sp.
660. *Leptosynapta* sp.
661. *Opheodesoma grisea* (Semper, 1868)
662. *Patinapta oollax* (von Marenzeller, 1882)
663. *Protankyra conferta* (Koehler and Vaney, 1905)
664. *Protankyra denticulata* (Koehler and Vaney, 1905)
665. *Protankyra errata* (Koehler and Vaney, 1905)
666. *Protankyra innominata* (Koehler and Vaney, 1905)
667. *Protankyra pseudodigitata* (Semper, 1868)
668. *Protankyra similes* (Semper, 1868)
669. *Protankyra timida* (Koehler and Vaney, 1905)
670. *Protankyra tristis* (Koehler and Vaney, 1905)
671. *Protankyra tuticorensis* (Jaeger, 1833)
672. *Protankyra* sp.
673. *Psamothuria ganapati* (Rao, G.C.1968)
674. *Synapta maculata* (Chamisso and Eysenhardt, 1821)
675. *Synapta* sp.
676. *Synaptulam recta* (Semper, 1868)
677. *Synaptula striata* (Sluiter, 1888)

Family : Chiridotidae

678. Polycheira rufescens (Brandt, 1835)
679. Trochodota havelockensis (Rao, G.C.1975)

Family : Myriotrochidae

680. *Ankyloderma brevicaudatum* (Koehler and Vaney, 1905)
681. *Ankyloderma contortum* (Koehler and Vaney, 1905)
682. *Ankyloderma intermedim* (Koehler and Vaney, 1905)
683. *Ankyloderma danielseni* (Theel, 1886)

684. *Ankyloderma musculus* (Risso, 1826)

685. *Ankyloderma polymorphium* (Koehler and Vaney, 1905)

686. *Trochostoma albicans* (Koehler and Vaney, 1905)

687. *Trochostoma andamanensis* (Walsh, 1891)

688. *Trochostoma ecalcareum* (Koehler and Vaney, 1905)

689. *Trochostoma elegatum* (Koehler and Vaney, 1905)

690. *Trochostoma pauperum* (Koehler and Vaney, 1905)

Order : MALPADIIDAE

Family : Caudiniidae

691. *Acaudina leucoprocta* (Clark, H.L.1938)

692. *Acaudina malpadiodes* (Semper, 1868)

693. *Paracaudina australis* (Semper, 1868)

Source: Sastry (2007)

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10. REFERENCES

Ausich, W.I. 1997. Calyx plate homologies and early evolutionary history of the Crinoidea. *Paleont. Soc. Papers,* **3**: 289-304.

Ausich, W. 1998. Early phylogeny and subclass division of the Crinoidea (Phylum Echinodermata). *Journal of Paleontology,* **72**(3): 499–510.

Ausich, W. 1999. Origin of crinoids. *In:* Candia Carnevali, M.D.C. and Bonasoro, F. (Eds.) *Echinoderm Research 1998.* Balkema, Rotterdam: 237–242.

Ausich, W. and Kammer, T.W. 2001. The study of crinoids during the 20th century and the challenges of the 21st century. *Journal of Paleontology,* **75**(6): 1161–1173.

Baker, A.N. 2003. Concentricycloidea (sea daisies). *In:* Hutchins, M., Thoney, D.A. and Schlager, D. (Eds.) *Grzimek's Animal Life Encyclopedia, 2nd edition. Volume 1.* Gale Group, Farmington Hills, Michigan: 381–386.

Baker, A.N., Rowe, F.W.E. and Clark, H.E.S. 1986. A new class of Echinodermata from New Zealand. *Nature,* **321**: 862–864.

Barker, M. 2001. *Echinoderms 2000.* Balkema, Lisse, 590 pp.

Bather, F.A. 1900. Part III The Echinoderma. *In:* Lankester, E.R. (Ed.) *A Treatise on Zoology.* Adam and Charles Black, London: 1–344.

Belyaev, G.M. 1990. Is it valid to isolate the genus *Xyloplax* as an independent class of echinoderms? *ZoologicheskiiZhurnal,* **69**: 83–96.

Blake, D.B. 1987. A classification and phylogeny of post-Paleozoic seastars (Asteroidea: Echinodermata). *Journal of Natural History,* **21**: 481–528.

Blake, D.B. 1989. Asteroidea: functional morphology, classification and phylogeny. *In:* Jangoux, M. and Lawrence, J.M. (Eds.) *Echinoderm Studies 3.* Balkema, Rotterdam: 179–233.

Blake, D.B. 2000. The Class Asteroidea (Echinodermata): fossils and the base crown group. *American Zoologist,* **40**: 316–325.

Blake, D.B. and Elliott, D.R. 2003. Ossicular homologies, systematics, and phylogenetic implications of certain North American Carboniferous asteroids (Echinodermata). *Journal of Paleontology,* **77**(3): 476–489.

Blake, D.B. and Hagdorn, H. 2003. The Asteroidea (Echinodermata) of the Muschelkalk (Middle Triassic) of Germany. *Paläontologische Zeitschrift,* **77**: 23–58.

Blake, D.B. and Hotchkiss, F.H.C. 2004. Recognition of the asteroid (Echinodermata) crown group: implications of the ventral skeleton. *Journal of Paleontology,* **78**(2): 359–370.

Blake, D.B., Janies, D.A. and Mooi, R. 2000. Evolution of starfishes: morphology, molecules, development, and paleobiology. Introduction to the symposium. *American Zoologist,* **40**: 311–315.

Bourlat, S.J., Juliusdottir, T., Lowe, C.J., Freeman, R., Aronowicz, J., Kirschner, M., Lander, E.S., Thorndyke, M., Nakano, H., Kohn, A.B., Heyland, A., Moroz, L.L., Copley, R.R and Telford, M.J. 2006. Deuterostome phylogenyreveals monophyletic chordates and the new phylum Xenoturbellida. *Nature,* **444**: 85–88.

Bruguière, J.G. 1791. *Tableau encyclopédique et méthodique de trois règnes de la nature, vol. 7. Contenant l'helminthologie, ou les vers infusoires, les vers intestins, les vers mollusques and c.* Panckoucke, Paris.

Cameron, C.B., Garey, J.R. and Swalla, B.J. 2000. Evolution of the chordate body plan: new insights from phylogenetic analyses of deuterostome phyla. *Proceedings of the National Academy of Sciences USA* **97**: 4469–4474.

Candia Carnevali, M.D. and Bonasoro F. 2001. *Echinoderm Research 1998: Proceedings of the Fifth European Conference on Echinoderms, Milan, Italy, 7–12 September 1998.* Balkema, Rotterdam: 550 pp.

Cisternas, P., Selvakumaraswamy, P. and Byrne, M. 2004. Evolution of development and the Ophiuroidea – revisited. *In:* Heinzeller, T. and Nebelsick, J.H. (Eds.) *Echinoderms: München.* Taylor and Francis, London: 521–526.

Clark, A.M. and Rowe, F.W.E. 1971. Monograph of sahallow-water Indo-West Pacific Echinoderms., Trustees of the British Museum (Natural History), London.

Clark, A.M. and Downey, M.E. 1992. *Starfishes of the Atlantic.* Chapman and Hall, London, 794 pages.

Cohen, B.L., Améziane, N., Eleaume, M. and Richer de Forges, B. 2004. Crinoid phylogeny: a preliminary analysis (Echinodermata: Crinoidea). *Marine Biology*, **44**(3): 605–617.

Cuénot, L. 1948. Anatomie, éthologie et systématiques des echinoderms. *In:* Grasse, P.P. (Ed.) *Traité de Zoologie, vol. XI.* Masson, Paris: 3–275.

David, B., Lefebvre, B., Mooi, R. and Parsley, R. 1999. Homalozoans in the light of the extraxial-axial theory of skeletal homologies. *In:* Candia Carnevali,

M.D.C. and Bonasoro, F. (Eds.) *Echinoderm research 1998.* Balkema, Rotterdam, p. 319.

David, J., Roux, M., Messing, C.G. and Ameziane, N. 2006. Revision of the pentacrinid stalked crinoids of the genus *Endoxocrinus* (Echinodermata, Crinoidea), with a study of environmental control of characters and its consequences for taxonomy. *Zootaxa,* **1156**: 1–50.

Dean, J. 1999. What makes an ophiuroid? A morphological study of the problematic Ordovician stelleroid *Stenaster* and the paleobiology of the earliest asteroids and ophiuroids. *Zoological Journal of the Linnean Society,* **126**: 225– 250.

Dominguez-Alonso, P. 1999. The early evolution of echinoderms: the class Ctenocystoidea and its closest relatives revisited. *In:* Candia Carnevali, M.D.C. and Bonasoro, F. (Eds.) *Echinoderm research 1998.* Balkema, Rotterdam: 263–268.

Fell, H.B. 1948. Echinoderm embryology and the origin of chordates. *Biological 'Reviews of the Cambridge Philosophical Society,* **23**: 81–107.

Fell, H.B. 1962. Evidence for the validity of Matsumoto's classification of the Ophiuroidea. *Publications of the Seto Marine Biological Laboratory,* **10**: 145–152.

Fell, H.B. 1963. The evolution of echinoderms. *Annual Report of the Smithsonian Institution for 1962*: 457–490.

Fell, H.B. and Pawson, D.L. 1966a. Order Diadematoida. *In:* R.C. Moore (Ed.) *Treatise on Invertebrate Paleontology. Part U, Echinodermsta 3(2).* University of Kansas Press, Lawrence: 350–365.

Fell, H.B. and Pawson, D.L. 1966b. Echinacea. *In:* R.C. Moore (Ed.) *Treatise on Invertebrate Paleontology. Part U, Echinodermsta 3(2).* University of Kansas Press, Lawrence: 367–440.

Féral, J.-P. and David, B. 2001. *Echinoderm Research 2001.* Balkema, Rotterdam, 337 pp.

Forey P.L., Fortey, R.A., Kenrick, P. and Smith, A.B. 2004. Taxonomy and fossils: a critical appraisal. *Philosophical Transactions of the Royal Society. Series B. Biological Sciences,* **359**: 639–653.

Gale, A.S. 1987. Phylogeny and classification of the Asteroidea (Echinodermata). *Zoological Journal of the Linnaean Society,* **89**: 107–132.

Gilliland, P. 1992. Holothurians in the Blue Lias of southern Britain. *Palaeontology,* **35**(1): 159–210.

Gilliland, P. 1993. The skeletal morphology, systematics and evolutionary history of holothurians. *Special Papers in Palaeontology,* **47**: 1–147.

Haude, R. 2004. Mode of life of ophiocistioids (Echinozoa) according to plated and "naked" forms in the Rhenish Devonian. *In:* Heinzeller, T. and Nebelsick, J.H. (Eds.) *Echinoderms: München.* Taylor and Francis, London: 417– 420.

Heinzeller, T. and Nebelsick, J.H. 2004. *Echinoderms: München.* Balkema, Leiden, 633 pp.

Herringshaw, L.G., Smith, M.P. and Thomas, A.T. 2007. Evolutionary and ecological significance of *Lepidaster grayi*, the earliest multiradiate starfish. *Zoological Journal of the Linnean Society,* **150**(4): 743–754.

Hess, H., Ausich, W., Brett, C.E. and Simms, M.J. 2003. *Fossil crinoids.* Cambridge University Press, Cambridge, UK, 292 pp.

Hotchkiss, F.H.C. 1977. Ophiuroid *Ophiocanops* (Echinodermata) not a living fossil. *Journal of Natural History,* **11**: 377–380.

Hotchkiss, F.H.C. 1993. A new Devonian ophiuroid (Echinodermata: Ophiuroidea) from New York State and its bearing on the origin of ophiuroid upper arm plates. *Proceedings of the Biological Society of Washington,* **106**(1): 63– 84.

Hotchkiss, F.H.C. 1995. Loven's law and adult ray homologies in echinoids, ophiuroid, edrioasteroids, and an ophiocistioid (Echinodermata: Eleutherozoa). *Proceedings of the Biological Society of Washington,* **108**(3): 401–435.

Hotchkiss, F.H.C. 2000. On the number of rays in a starfish. *American Zoologist,* **40**: 340–354.

Hrincevich, A.W., Axayácatl, R.-O. and Foltz, D.W. 2000. Phylogenetic analysis of molecular lineages in a species-rich subgenus of sea stars (*Leptasterias* subgenus *Hexasterias*). *American Zoologist,* **40**: 365–374.

Hyman, L.H. 1955. *The invertebrates: Echinodermata.* McGraw-Hill, New York, 763 pp.

Jagt, J.W.M. 1999. Ophiuroid diversity in the type area of the Maastrichtian Stage. *Geologie en Mijnbouw,* **78**(2): 197–206.

James, D.B. 1987. Research on Indian Echinoderms- A review. *J. Mar. Boil. Ass. India,* **25** (1983): 91-108.

Jangoux, M. and Lawrence, J.M. 2001. *Echinoderm Studies 6.* Taylor and Francis, London, 285 pp.

Janies, D. 2001. Phylogenetic relationships of extant echinoderm classes. *Canadian Journal of Zoology,* **79**: 1232–1250.

Janies, D. and Mooi, R. 1999. *Xyloplax* is an asteroid. *In*: Candia Carnevali C. and Bonasoro F. (Eds.), *Echinoderm Research 1998.* Balkema, Rotterdam: 311–316.

Jefferies, R.P.S., Brown, N.A. and Daley, P.E.J. 1996. The early phylogeny of chordates and echinoderms and the origins of chordate left-right asymmetry and bilateral symmetry. *Acta Zoologica,* **77**: 101–122.

Kasyanov, V.L. 2001. *Reproductive strategy of marine bivalves and echinoderms.* Science Publishers, Enfield, New Hampshire, 240 pp.

Kerr, A.M. 2001. Phylogeny of the apodan holothurians (Echinodermata) inferred from morphology. *Zoological Journal of the Linnean Society,* **133**: 53–62.

Kerr, A.M. and Kim, J. 1999. Bi-penta-bi-decaradial symmetry: a review of evolutionary and developmental trends in Holothuroidea (Echinodermata). *Journal of Experimental Zoology,* **285**: 93–103.

Kerr, A.M. and Kim, J. 2001. Phylogeny of Holothuroidea (Echinodermata) inferred from morphology. *Zoological Journal of the Linnean Society,* **133**: 63–81.

Kerr, A.M., Janies, D.A., Clouse, R.M., Samyn, Y., Kuszak, J., Kim, J. 2005. Molecular phylogeny of coral reef sea cucumbers (Holothuriidae: Aspidochirotida)

based on 16S mitochondrial ribosomal DNA sequence. *Marine Biotechnology,* **7**: 53–60.

Klein, J.T. 1734. *Naturalis disposition Echinodermstium. Accesseit Lucubratiuncula des aculeis echinorum marinorum, cun Spicilegio de belemnitis.* Liutteris Schreiberianis, Gedani, 78 pp.

Knott, K.E. and Wray, G.A. 2000. Controversy and consensus in asteroid systematics: new insights to ordinal and familial relationships. *American Zoologist,* **40**: 382–392.

Kroh, A. 2004. First fossil record of the family Euryalidae (Echinodermata: Ophiuroidea) from the Middle Miocene of the central Mediterranean. *In:* Heinzeller, T. and Nebelsick, J.H. (Eds.) *Echinoderms: München.* Taylor and Francis, London: 447–452.

Lacey, K.M.J., McCormack, G.P., Keegan, B.F. and Powell, R. 2005. Phylogenetic relationships within the class Holothuroidea, inferred from 18S rRNA gene data. *Marine Biology,* **147**: 1149–1154.

Lafay, B., Smith A.B. and Christen, R. 1995. A combined morphological and molecular approach to the phylogeny of asteroids (Asteroidea: Echinodermata). *Systematic Biology,* **44**(2): 190–208.

Lamarck, J.B.P. 1801. *Système des animaux sans vertèbrès.* Maillard, Paris, 432 pp.

Lawrence, J.M. 2001. *Edible sea urchins: biology and ecology.* Elsevier, Oxford, UK, 432 pp.

Lawrence, J.M. 2006. *Edible sea urchins: biology and ecology, 37.* Elsevier, Oxford, UK, 380 pp.

Lefebvre, B. 2007. Early Palaeozoic palaeobiogeography and palaeoecology of stylophoran echinoderms. *Palaeogeography, Palaeoclimatology, Palaeoecology,* **245**: 156–199.

Le Gac, M., Féral, J. P., Poulin, E., Veyret, M. and Chenuil, A. 2004. Identification of allopatric clades in the cosmopolitan ophiuroid species complex *Amphipholis squamata* (Echinodermata). The end of a paradox? *Marine Ecology Progress Series,* **278**: 171–178.

Lee, Youn-Ho. 2003. Molecular phylogenies and divergence times of sea urchin species of Strongylocentrotidae, Echinoida. *Molecular Biology and Evolution,* **20**(8): 1211–1221.

Leuckart, R. 1854. Bericht über die Leistungen in der naturgeschichte der niederen Thiere während der Jahre 1848- 1853. *Archiv für Naturgeschichte,* **20**(2): 289–473.

Linnaeus, C. 1758. *Systema naturae. 10th edition.* Lucae, Juntiniana: 3–376.

Littlewood, D.T.J. 1995. Echinoderm class relationships revisited. *In:* Emson, R., Smith, A.B. and Campbell, A. (Eds.) *Echinoderm Research 1995.* Balkema, Rotterdam: 19–28.

Littlewood, D.T.J. and Smith, A.B. 1995. A combined morphological and molecular phylogeny for sea urchins (Echinoidea: Echinodermata). *Philosophical Transactions of the Royal Society of London. Series B. Biological Sciences,* **347**: 213–234.

Littlewood, D.T.J., Smith, A.B., Clough, K.A. and Emson, R.H. 1997. The interrelationships of the echinoderm classes: morphological and molecular evidence. *Biological Journal of the Linnean Society,* **67**: 409–438.

Ludwig, H. 1889–1907. Echinodermen. *In:* Bronn, H.G. (Ed.) *Klassen und Ordnungen des Tierreichs,* **2**(3). Winter, Leipzig, 1602 pp.

Mah, C.L. 2000. Preliminary phylogeny of the forcipulatacean Asteroidea. *American Zoologist,* **40**: 375–381.

Mah, C.L. 2006. A new species of *Xyloplax* (Echinodermata: Asteroidea: Concentricycloidea) from the northeast Pacific: comparative morphology and a reassessment of phylogeny. *Invertebrate Biology,* **125**(2): 136–153.

Mah, C.L. 2007. Phylogeny of the Zoroasteridae (Zorocallina: Forcipulatida). *Zoological Journal of the Linnean Society,* **150**: 177–210.

Matranga, V. 2005. *Echinodermsta.* Springer-Verlag, Berlin, 277 pp.

Matsubara, M., Komatsu, M., Araki, T., Asakawa, S., Yokobori, S.-I., Watanabe, K. and Wada, H. 2005. The phylogenetic status of Paxillosida (Asteroidea) based on complete mitochondrial DNA sequences. *Molecular Genetics and Evolution,* **36**: 598–605.

McEdward, L.R. and Miner, B.G. 2001. Larval and life-cycle patterns in echinoderms. *Canadian Journal of Zoology,* **79**: 1125–1170.

Messing, C.G. 1997. Living comatulids. *In:* Waters, J.A. and Maples, C.G. (Eds.) *Geobiology of echinoderms.*

Paleontological Society papers 3. Paleontological Society, Pittsburgh: 3–30.

Messing, C.G. 2007. The crinoid fauna (Echinodermata: Crinoidea) of Palau. *Pacific Science,* **61**(1): 91–111.

Meyer, D.L. and Macurda, Jr., D.B. 1977. Adaptive radiation of the comatulid crinoids. *Paleobiology,* **3** : 74-82.

Mooi, R. 2001. Not all written in stone: interdisciplinary syntheses in echinoderm paleontology. *Canadian Journal of Zoology,* **79**: 1209–1231.

Mooi, R. and B. David. 1997. Skeletal homologies of echinoderms. The *Paleontological Society Papers,* **3**: 305–335.

Mooi, R. and David, B. 2000. What a new model of skeletal homologies tells us about asteroid evolution. *American Zoologist,* **40**: 326–339.

Mooi, R., Rowe, F.W.E., and David, B. 1998. Application of a theory of axial and extraxial skeletal homologies to concentricycloid morphology. *In:* Mooi, R. and Telford, M. (Eds.), *Echinoderms: San Francisco.* Balkema, Rotterdam: 61–62.

Mooi, R. and Telford, M. 1998. *Echinoderms: San Francisco.* Balkema, Rotterdam, 923 pp.

Moore, R.C. 1966–1978. (Ed.) *Treatise on Invertebrate Paleontology. Part S Echinodermata 1, Volumes 1, 2 1967; Part-T, Echinodermsta 2, Volumes 1,2,3 1978; Part-U, Echinodermsta 3 Volumes 1, 2 1966.* University of Kansas Press, Lawrence.

Moran, P. J. 1988. The *Acanthaster* phenomenon. *Australian Institute of Marine Science Monograph Series,* Vol. **7**, 78 p.

Nagabhushanam, R and Rao, G.C. 1969. Preliminary observation on a collection of shore fauna of Orissa coast, India. *Proc. Zool. Soc. Calcutta,* **22**: 67-82.

Nagabhushanam, R and Rao, G.C. 1972. An ecological survey of the marine fauna of Minicoy Atoll (Laccadive Archipelago, Arabian Sea). *Mitt. Zool. Mus. Berlin,* **48**(2): 265-324.

O'Loughlin, P.M. and Waters, J.M. 2004. A molecular and morphological revision of genera of Asterinidae (Echinodermata: Asteroidea). *Memoirs of the Museum of Victoria,* **61**(1): 1–40.

Parsley, R. 1999. The Cincta (Homostelea) as blastozoans. *In:* Candia Carnevali, M.D.C. and Bonasoro, F. (Eds.) *Echinoderm Research 1998.* Balkema, Rotterdam: 369–375.

Paul C.R.C and Smith, A.B. 1984. "The early radiation and phylogeny of echinoderms". *Biol. Rev.,* **59**: 443–481

Pawson, D.L. 1966. Phylogeny and evolution of holothuroids. *In:* R.C. Moore (Ed.) *Treatise on Invertebrate Paleontology. Part-U, Echinodermata 3(2).* University of Kansas Press, Lawrence: 641–646.

Pawson, D.L. 1980. Holothuroidea. *In:* Broadhead, T.W. and Waters, J.A. (Eds.) *Echinoderms: Notes for a short course.* University of Tennessee Studies in Geological Science 3. University of Tennessee, Knoxville: 175–189.

Pawson, D.L and Fell, H.B. 1965. A revised classification of the dendrochirote holothurians. *Breviora,* **214**: 1–7.

Pawson, D.L. and Kerr, A.M. 2001. Chitin in echinoderms? Tentacle sheaths in the deep-sea holothurian *Ceraplectanatrachyderma* (Holothuroidea: Molpadiida). *Gulf of Mexico Science,* **19**(2): 192.

Pearse, V.B. and Pearse, J.S. 1994. Echinoderm phylogeny and the place of concentricycloids. *In:* David, B., Guille, A., Féral, J.-P., Roux, M. (Eds.), *Echinoderms Through Time.* Balkema, Rotterdam: 121–126.

Pearse, V.B., Pearse, J.S., Hendler, G. and Byrne, M. 1998. An accessible population of *Ophiocanops* off NE Sulawesi, Indonesia. *In:* Mooi, R. and Telford, M. (Eds.) *Echinoderms: San Francisco.* Balkema, Rotterdam: 413–418.

Plancus, J and Gualtaire, N. 1743. *De Stella Marina Echinata Quindecim Radii insturcta Epistolae binae. (In: James, 1987).*

Rasmussen, H.W. and Sieverts Doreck, H. 1978. Articulata. *In:* Moore, R.C. and Teichert, C. (Eds.) *Treatise on Invertebrate Paleontology Part T Echinodermsta 2 (3).* University of Kansas Press, Lawrence: T814–T1027.

Reich, M. 2002. Holothurien (Echinodermata) aus der Oberkreide des Ostseeraumes: Teil 1. Myriotrochidae Théel, 1877. *Neues Jahrbuch für Geologie und Paläotologie Abhandlungen,* **224**(3): 373–409.

Reich, M. .2004. Fossil Holothuroidea (Echinodermata): an overview. *In:* Heinzeller, T. and Nebelsick, J.H. (Eds.) *Echinoderms: München.* Taylor and Francis, London, p.602.

Reich, M. and Haude, R. 2004. Ophiocistioidea (fossil Echinodermata): an overview. *In:* Heinzeller, T. and Nebelsick, J.H. (Eds.) *Echinoderms: München.* Taylor and Francis, London: 489–494.

Rose, E.P.F. and Olver, J.P.S. 1988. Jurassic echinoids of the family Menopygidae: implications for the evolutionary interpretation and classification of early Irregularia. *In:* Burke, R.D., Mladenov, P.V., Lambert, P. and Parsley, R.L. (Eds.) *Echinoderm biology.* Balkema, Rotterdam: 149–158.

Roux, M., Messing, C.G. and Améziane, N. 2002. Artificial keys to the genera of living stalked crinoids (Echinodermata). *Bulletin of Marine Science,* **70**(3): 799–830.

Rowe, F.W.E., Baker, A.N. and Clark, H.E.S. 1988. The morphology, development, and taxonomic status of *Xyloplax* Baker, Rowe, and Clark, 1986 (Echinodermata: Concentricycloidea) with the description of a new species. *Proceedings of the Royal Society of London. Series B. Biological Sciences,* **233**: 431–459.

Sastry, D.R.K. 2007. Echinodermata of India: An Annotated list. *Rec. Zool. Surv. India,* Occ. Paper No., **271**: 1-387.

Sastry, D.R.K. 2005. Echinodermata of Andaman and Nicobar Islands, Bay of Bengal: An Annotated list. *Rec. Zool. Surv. India,* Occ. Paper No., **233**: 1-207.

Shackleton, J.D. 2005. Skeletal homologies, phylogeny and classification of the earliest asterozoan echinoderms. *Journal of Systematic Palaeontology,* **3**(1): 29–114.

Shu, D.G., Conway Morris, S., Han, J., Zhang, Z.F. and Liu, J.N. 2002. Ancestral echinoderms from the Chengjiang deposits of China. *Nature,* **430**: 422–428.

Simms, M.J. 1988. The phylogeny of post-Paleozoic crinoids. *In:* Paul, C.R.C. and Smith, A.B. (Eds.) *Echinoderm phylogeny and evolutionary biology.* Clarendon Press, Oxford: 269–284.

Simms, M.J., Gale, A.S., Gilliland, P., Rose, E.P.F. and Sevastopulo, G.D. 1993. Echinodermata. *In:* Benton, M.J. (Ed.) *The fossil record 2.* Chapman and Hall, London: 492–528.

Smirnov, A.V. 1998. On the classification of the apodid holothurians. *In:* Mooi, R. and Telford, M. (Eds.) *Echinoderms: San Francisco.* Balkema, Rotterdam: 517–522.

Smirnov, A.V. 1999. The origin of the Order Apodida (Holothuroidea) and its families. *In:* Candia Carnevali, M.D.C. and Bonasoro, F. (Eds.) *Echinoderm research 1998.* Balkema, Rotterdam: 393–395.

Smith, A.B. 1984. *Echinoid palaeobiology.* George Allen and Unwin, London, 190 pp.

Smith, A.B. 1988a. Fossil evidence for the relationships of extant echinoderm classes and their times of divergence. *In:* Paul, C.R.C. and Smith, AZ.B. (Eds.) *Echinoderm phylogeny and evolutionary biology.* Clarendon Press, Oxford: 85–97.

Smith, A.B. 1988b. Phylogenetic relationship, divergence times, and rates of molecular evolution for camarodont sea urchins. *Molecular Biology and Evolution* **5**(4): 345–365.

Smith, A.B. 1997. Echinoderm larvae and phylogeny. *Annual Review of Ecology and Systematics,* **28**: 219–241.

Smith, A.B. 2004a. Deuterostome phylogeny and the interpretation of problematic fossil echinoderms. *In:* Heinzeller, T. and Nebelsick, J.H. (Eds.) *Echinoderms: München.* Taylor and Francis, London: 543–546.

Smith, A.B. 2004b. Echinoderm roots. *Nature,* **430**: 411–412.

Smith, A.B. 2007. Intrinsic versus extrinsic biases in the fossil record: contrasting the fossil record of echinoids in the Triassic and early Jurassic using sampling data, phylogenetic analysis, and molecular clocks. *Paleobiology,* **33**(2): 310–323.

Smith, A.B., Lafay, B. and Christen, R. 1992. Comparative variation of morphological and molecular evolution through geologic time: 28s ribosomal RNA versus morphology in echinoids. *Philosophical Transactions of the Royal Society of London. Series B. Biological Sciences,* **338**: 365–382.

Smith, A.B., Paterson, G.L.J. and Lafay, B. 1995. Ophiuroid phylogeny and higher taxonomy: morphological, molecular and palaeontological perspectives. *Zoological Journal of the Linnean Society,* **114**: 213–243.

Smith, A.B., Pisani, D., Mackenzie-Dodds, J.A., Stockley, B, Webster, B.L. and Littlewood, T.J. 2006. Testing the molecular clock: molecular and paleontological

estimates oif divergence times in the Echinoidea (Echinodermata). *Molecular Biology and Evolution,* **23**(10): 1832–1851.

Solovjev, A.N. and Markov, A.V. 2004. The early evolution of irregular echinoids. *In:* Heinzeller, T. and Nebelsick, J.H.(Eds.) *Echinoderms: München.* Taylor and Francis, London: 551–556.

Soota, T.D., Mukhopadhyay, S.K. and Samanta, T.K. 1983. On some holothurians from the Andaman and Nicobar Islands. *Rec. zool. Surv. India,* **80**: 507–524.

Stockley, B., Smith, A.B., Littlewood, T., Lessios, H.A. and Mackenzie-Dodds, J.A. 2005. Phylogenetic relationships of spatangoid sea urchins (Echinoidea): taxon sampling density and congruence between morphological and molecular estimates. *Zoological Scripta,* **34**(5): 447–468.

Sumrall, C.D. and Wray, G.A. 2007. Ontogeny in the fossil record: diversification of body plans and the evolution of "aberrant" symmetry in Paleozoic echinoderms. *Paleobiology,* **33**(1): 149–163.

Vickery, M. and McClintock, J.B. 2000. Comparative morphology of tube feet among the Asteroidea: phylogenetic implications. *American Zoologist,* **40**: 355–364.

Wada, H. and Satoh, N. 1994. Phylogenetic relationships among extant classes of echinoderms, as inferred from sequences of 18S rDNA, coincide with relationships deduced from the fossil record. *Journal of Molecular Evolution,* **38**: 41–49.

Wagner, G.P., Lo, J., Laine, R. and Almeder, M. 1993. Chitin in the epidermal cuticle of a vertebrate (*Paralipophrys trigloides*, Blenniidae, Teleostei). *Cellular and Molecular Life Sciences,* **49**(4):317–319.

Wilson, N.G., Hunter, R.L., Lockhart, S.J. and Halanych, K.M. 2007. Multiple lineages and absence of panmixia in the "circumpolar" crinoid *Promachocrinus kerguelensis* from the Atlantic sector of Antarctica. *Marine Biology,* **152**(4): 895–904.

Yokota, Y., Matranga, V. and Smolenicka, Z. 2002. *The sea urchin: from basic biology to aquaculture*. Balkema, Rotterdam, 293 pp.