CLASSIFICATION OF ECHINODERMS

The members of the phylum Echinodermata are known to mankind since ancient times. Echinoderms were first given the status of a distinct group by Bruguiere in 1791. Echinoderms are bilaterally symmetrical (in larval stage) or pentamerous radially symmetrical (in adults) having mesodermal calcareous ossicles as exoskeleton, enterocoelom, water-vascular system and without distinct head.

But H. B. Fell (1948, 1965), the authority on echinoderm taxonomy of Harvard University, USA, rejected the older classification as it was an artificial one because it was on the basis of mode of existence. The scheme of classification presented in this book (4th ed.), largely based on the classification plan outlined by Edward E. Ruppert and Robert D. Barnes (1994, 6th ed.).

Classification with Characters:

A. Subphylum Homalozoa (Mid- Cambrian —Devonian):

Features:

1. Extinct, irregular, palaeozoic.

2. Carpoids (resembling crinoids but laterally compressed giving the evidence of a bilateral symmetry).

Example:

Enoploura.

B. Subphylum Crinozoa:

Features:

1. Radially symmetrical echinoderms with a globoid or cup-shaped theca and brachioles or arms.

2. Mostly attached, with oral surface directed upward.

This subphylum includes the fossil eocrinoids, cystoids and the fossil and living crinoids.

1. Class Eocrinoidea (Early Cambrian to Ordovician):

Features:

1. The oldest extinct crinoids.

2. They were stalked or stalk-less, with an enclosed theca.

3. The upper or oral end contained five ambulacra and five to many brachioles.

Example:

Mimocystites.

2. Class Cystidea (Ordovician—Silurian):

Features:

1. The well-known group of extinct echinoderms.

2. They have vase-like bodies which remain fixed with the substratum directly or through a stalk.

3. The theca is composed of many rigid polygonal plates.

4. The plates constituting the theca are mostly porous and are perforated by canals.

5. The food-grooves extend over the surface of the theca.

6. The branchioles are devoid of pinnules.

(i) Order Rhombifera:

Features:

1. The theca canals produce various types of pores in a few or in all plates of the theca.

Examples:

Caryocystites, Echinosphaerites, Glyptocystites, Lovenicystis, Cystoblastus.

(ii) Order Diploporita:

Features:

1. The theca canals are usually in the form of diplopores in all or in some of the thecal plates.

Examples:

Proteroblastus, Aristocystites, Sphaeronites, Mesocystis, Asteroblastus.

(iii) Order Blastoidea (Ordovician—Permian):

Features:

1. The members of this extinct class had pentamerous radially symmetrical thecae consisting of thirteen plates in three rows.

2. They were mostly fixed forms and remained attached with the substratum directly or through a short stalk.

3. The ambulacra are petaloid and are five in number.

4. They possess the characteristic respiratory structures, called hydrospires.

Examples:

Codaster, Pentremites, Phaenoschisma, Orophocrinus, Troostocrinus, Zygocrinus.

3. Class Crinoidea (Cambrian—Recent):

[Gk. crinon = lily; eidos = form], Approx. 700 species.

Features:

1. Stalked and free-living echinoderms.

2. Body exhibits stong pentamerous symmetry.

3. Well-developed movable arms which are typically branched and bearing pinnules.

4. Oral surface is directed upwards.

5. Mouth is centrally placed and anus is generally excentrically placed on the oral surface of the body.

6. The theca (protective covering or case) on the aboral side is differentiated into a non-porous cup-like calyx.

7. Madreporite, spines and pedicellariae are wanting.

8. Barrel-shaped, free-swimming larva, called doliolaria larva, with 5 ciliated bands.

It includes sea lilies and feather stars.

1. Subclass Inadunata (Up. Cambrian— Permian):

Features:

1. Extinct, stalked crinoids with or without cirri.

2. The calyx is rigid and the ambulacra are mostly open.

3. The pinnules may or may not be present.

4. The lower arm ossicles are separated from the calyx.

Examples:

Anartiocrinus, Ottawacrinus, Botryocrinus , Hybocystitus.

2. Subclass Flexibilia (Ordovician— Permian):

Features:

1. Extinct crinoids.

2. The calyx is flexible and the ambulacra are covered.

3. The pinnules are totally absent.

4. The lower arm ossicles are united with the calyx.

Examples:

Forbesiocrinus.

3. Subclass Camerata (Ordovician— Permian):

Features:

1. Extinct crinoids.

2. The calyx is rigid with branched pinnulated arms.

3. The arm ossicles on the lower side are united with calyx.

4. The tegmen is armoured with plates and covers the mouth and ambulacra.

5. Usually an anal tube is present.

Examples:

Xenocrinus, Reteocrinus, Archaeocrinus, Platycrinus, Technocrinus.

4. Subclass Articulata:

Features:

1. The subclass contains both living and fossil crinoids with flexible pentamerous calyx.

2. The arm ossicles on the lower side are united with the calyx.

3. The arms are generally branched.

4. The tegmen is leathery with small plates.

5. The ambulacra and the mouth remain open.

It includes 5 orders:

(i) Order Millericrinida:

Stalked sea lilies without cirri.

Examples:

Hyocrinus, Ptilocrinus.

(ii) Order Cyrtocrinida:

The sea lilies of this order are attached to the substrate with a very short stalk.

Examples:

Holopus.

(iii) Order Bourgueticrinida (Sea lilies):

These are stalked small sea lilies and lack cirri. These lilies possess 5 or 10 very short arms.

Examples:

Rhizocrinus, Bathycrinus (Bathycrinus recorded in about 10,000 m in depth and is known in deepest depth).

(iv) Order Isocrinida (Sea lilies):

These sea lilies have long stalks with cirri. Many species are attached to the hard substrates.

Examples:

Cenocrinus, Metacrinus, Neocrinus, Isocrinus

(v) Order Comatulida (Feather stars):

These are stalkless, unattached crinoids and called feather stars. Most of crinoid species are included with in this order.

1. Calyx upward.

2. A series of jointed, flexible appendages, called cirri, occur at the base of the body and help to grasp the solid substrates.

Examples:

Antedon , Comantheria, Florometra, Heliometra, Nemaster, Commisia.

C. Subphylum Asterozoa:

Features:

1. Radially symmetrical, free living echinoderms.

2. Body composed of a flattened central disc and radially arranged arms or rays.

3. Oral surface directed downward.

4. Anus, when present, is placed aborally.

The subphylum includes 3 classes:

1. Class Asteroidea (Cambrian—Present):

Features:

1. Body star-shaped.

2. Arms not sharply set off from the central disc.

3. Number of the arms usually 5 which may increase in some forms.

4. Ambulacral grooves open and contain rows of tube-feet.

5. Ambulacra (sing ambulacrum) restricted to the oral surface of the body.

6. Arms are hollow and each arm bears continuation of the coelom.

7. Madreporite situated on the aboral surface.

8. Pedicellariae is present.

9. The larval forms are bipinnaria and/or brachiolaria.

10. Generally called sea star.

The class is divided into 5 orders:

(i) Order Platyasterida:

Features:

1. Primitive, mostly extinct asterioids.

2. Aboral surface bears large upright spines beset with two or three circlets of spinelets.

3. Margin of the arm is formed by the infra-marginal plates.

4. No anus.

5. Tube-feet without suckers.

The two living genera are platyasterias and Luidia.

(ii) Order Paxillosida:

Features:

1. The tube-feet lack suckers.

2. The ampullae are bifurcated.

3. Sea stars with marginal plates and usually with paxillae (i.e., upright movable spines) on the ambulacral surface.

4. Pedicallariae either sesssile or pectinate types.

Examples:

Ctenodiscus, Goniopecten, Astropecten

(iii) Order Valvatida:

Features:

1. Tube-feet with terminal suckers.

2. Aboral plates usually flattened and have mosaic arrangement.

Examples:

Archaster, Asterina, Odontaster, Acodontaster, Notioceramus, Chitonaster, Oreaster , Porcellanaster, Morelha

(iv) Order Spinulosida:

Features:

1. Marginal plates are sometimes conspicuous, but in general, plates are absent or small.

2. Spines are present on the aboral surface either singly or in groups.

3. Tube-feet are provided with suckers and occur in two rows in each ambulacral groove.

4. Pedicellariae rarely present.

5. Ampullae may be simple or bifurcated.

Examples:

Echinaster, Henricia, Ganerio, Cycethra, Patiria, Solaster , Acanthaster, Crossaster, Pteraster.

(v) Order Forcipulata:

Features:

1. Marginal plates are not prominet.

2. Spines occur singly.

3. Tube-feet are arranged in two or four rows and are provided with suckers.

4. Pedicellariae is stalked.

Examples:

Asterias , Odinia, Ordinella, Asterostephane, Heliaster, Leptasterias, Pisaster, Brisinga, Zoroaster

2. Class Ophiuroidea (Carboniferous— Recent):

Features:

1. They are commonly termed the brittle stars or serpent stars.

2. Body pentamerous and star-shaped.

3. It has a distinct central disc with 5 elongated flexible arms.

4. The arms are sharply marked off from the central disc.

5. Ambulacral grooves absent excepting some fossils.

6. Body flattened with distinct oral and aboral surfaces.

7. There are no spacious prolongations of the coelom into the arms.

8. Anus is lacking.

9. Mouth and madreporite are situated on the oral surface of the body.

10. Gonads are pentamerous and the genital bursae usually act as the gonoducts.

11. Larva is Ophiopluteus.

It includes 3 orders –

(i) Order Oegophiurida:

Features:

1. It consists most of the fossil species except single living species.

2. No dorsal or ventral shields or bursae.

3. Madreporites at edge of disc.

Example:

Ophiocanops.

(ii) Order Phrynophiurida:

1. Dorsal arm shields are absent.

2. Arms are usually branched and can move vestically.

3. They can coil themselves around any object.

4. Spines are directed downward.

5. One madreporite at each inter-radius and the number corresponds with that of the stone canal.

6. Spines are often modified into hooks.

Examples:

Ophiomyxa, Asteronyx, Gorgonocephalus, Astrophyton, Astrogymnotes, Euryale, Astrothorax

(iii) Order Ophiurida:

Features:

1. Mostly small ophiuroids, usually with 5 arms.

2. Arms are simple and un-branched.

3. Arms can move along the transverse plane of the body.

4. Dorsal arm shields are present.

5. Madreporite single.

6. Spines are directed outward.

The order includes most of the brittle stars.

Examples:

Amphiura, Ophiopholis, Ophiothrix, Ophioderma, Ophiocoma, Ophiolepis, Ophiostigma, Ophiactis, Ophiura, Ophiacantha, Sigsbeia.

3. Class Concentricycloidea:

They are called sea daisies and are known by single genus and two species that were discovered in 1986 from a submerged wood.

Features:

1. Minute (maximum 1 cm diameter), deep-water medusa-like bodies.

2. Two concentric water rings on the outer edge of the disc.

3. Coelom spacious.

4. Ambulacral system is absent.

5. No larval stage.

Example:

Xyloplax.

D. Subphylum Echinozoa:

Features:

1. Globoid or discoid echinoderms without radiating arms or brachioles (small arm-like processes).

2. Mouth and anus lie at opposite poles in earliest members.

3. Mostly unattached.

4. Hydrocoel forms a ring about the mouth.

The subphylum comprises 2 classes.

4. Class Echinoidea (Ordovician—Recent):

The sea urchins, heart urchins, cake urchins are included under this class.

Features:

1. Body may be globular, heart-shaped, oval or disc-shaped.

2. Body orally and aborally flattend and without arms.

3. Body enclosed by a skeleton in the form of a continuous test, shell (= corona) of closely set of calcareous plates.

4. Spines movable.

5. Ambulacral grooves absent but surface is divided into alternate ambulacral and inter-ambulacral areas.

6. Ambulacral plates have pores for the passage of tube-feet.

7. Tube-feet highly extesible, provided with suckers and locomotory in function.

8. Mouth and anus surrounded by membranous peristome and periproct respectively.

9. Larva is Echinopluteus.

Echinoids may be divided into regular or irregular urchins.

The regular urchins are characterised by:

1. The test or corona is globular and shows pentamerous symmetry.

2. Spines are long and unusually thick and cylindrical (e.g., Eucidaris, Echinus, Strongylocentrotus, etc.).

3. Each inter-ambulacrum has two rows of plates.

4. The lantern of Aristotle is well developed.

5. Centric anus.

All sea urchins are included to this group and also sometimes classified as regularia (regular urchins) or endocyclica (centric anus), as a subclass.

Examples:

Sea urchins (Cidaris, Diadema, Arbacia, Salmacis, Echinus, Echinometra, etc.).

The irregular urchins or irregularia (e.g., heart urchins, sand dollars, and sea biscuits) are characterised by:

1. The test or corona is mostly flattened and the shape is either oval or round and they exhibit varying degrees of bilateral symmetry.

2. The spines are relatively shorter.

3. The ambulacral areas on the aboral surface form a five-pointed petaloid condition like the petals of a flower.

4. The tube-feet are mostly non-locomotory.

5. Anus eccentric (exocyclic).

The irregular echinoids are sometimes classified as irrgularia or exocyclica (anus ecentric) as a subclass.

Examples:

Sea biscuits (Clypeaster); Sand dollar (Encope, Mellita, Dendraster, etc.); Heart urchins (Echinocardium, Lovenia, Spatangus, etc.)

The class Echinoidea is divided into two subclasses:

Subclass A. Perischoechinoidea:

Features:

1. They are largely primitive fossil sea urchins of the palaeozoic seas. The earlist representatives are found in the Ordovician period. Bothriocidaris has been reported from Russia. The test is rigid and round in shape. Each ambulacrum has two rows of plates and interambulacrum has single row of plates. The typical lantern of Aristotle is absent. The madreporite is radially disposed.

(i) Order Cidaroida:

The order includes both extinct and existing echinoids.

Features:

1. Test round.

2. There are two rows of plates for each ambulacrum and interambulacrum.

3. Each interambulacral plate bears one large spine which is surrounded by small spines at the basal end.

4. Gills, sphaeridia are absent.

Examples:

Cidaris, Eucidaris , Phyllacanthus, Stylocidaris, Goniocidaris.

Subclass B. Euechinoidea:

This subclass contains the most living species of echinoids.

Superorder Diadematacea:

1. Sea urchins with perforated tubercles.

2. Spines are extremely long and pointed.

3. Gills usually present.

(i) Order Pedinoida:

Rigid test with solid spines

Example:

Caenopedina.

(ii) Order Diadematoida:

Rigid or flexible test with hollow spines

Example:

Diadema

(iii) Order Echinothuroida:

1. Deep sea species with a delicate, flexible test.

2. Gills inconspicuous or lost.

Example:

Asthenosoma.

Superorder Echinacea:

1. Rigid test with solid spines.

2. Gills present.

(iv) Order Arbacioida:

1. Test globular.

2. Spines solid

3. Periproct with four or five plates.

Example:

Arbacia

(v) Order Temnopleuroida:

1. Test sculptured in some species.

2. Camarodont lantern (Epiphysis of the lantern are greatly enlarged and meet the pyramids to form bar).

Examples:

Temnopleurus, Salmacis, Toxopneustes, Lytechinus, Tripneustes.

(vi) Order Echinoida:

1. Test non-sculptured and rarely oval with imperforate tubercles.

2. Camarodont lantern.

Examples:

Echinus, Paracentrotus, Echinometra, Echinostrephus, Strongylocentrotus.

Superorder Gnathostomata:

1. Lantern present.

2. Ambulacral plates single.

3. Mouth in the centre of oral surface but anus situated to the apical centre.

4. Irregular urchins.

(vii) Order Holectypoida:

1. This order includes extenct forms.

2. The test is regular.

3. Ambulacra are simple and do not show petaloid development.

4. Lantern of Aristotle present.

Examples:

Pygaster, Plesiechinus, Holectypus, Echinoneus, Micropetalon.

(viii) Order Clypeasteroida:

1. Members are called sand dollars.

2. Body irregular with flattened test.

3. Lantern and petaloids present.

4. Gills lacking.

5. Mouth centrally placed but anus excentrically placed.

6. Ambulacra at the aboral side are petaloid.

Examples:

Clypeaster , Arachnoides, Echinocyamus, Fibularia, Mellita, Encope , Rotula, Laganum, Dendraster

Superorder Atelostomata:

Irregular urchins. Lantern absent.

(i) Order Spatangoida:

1. The members of this order are called heart urchins.

2. Body irregular with an oval test.

3. Lantern and the gills absent.

4. Mouth and anus excentrically placed.

5. Four of the five ambulacral areas have become petaloid at their aboral ends.

Examples:

Spatangus, Echinocardium, Plexechinus, Urechinus, Moira, Meoma, Lovenia, Brissopsis, Paraster, Hemiaster, Aeropsis, Palaeostoma.

(ix) Order Cassiduloida:

1. This order includes mostly the fossil forms.

2. Test round and oval in outline.

3. Lantern of Aristotle absent in living forms.

4. Ambulacra become petaloid at the aboral end.

5. Genital plates usually fused with, the madreporite.

Examples:

Echinolampus, Apatopygus, Cassidulus, Anochamus, Tropholampas.

5. Class Holothuroidea (Devonian—Recent):

[Gk. holothurion = a water polyp; eidos = form]; Approx. 1200 species.

Features:

1. The members of the class are known as sea cucumbers.

2. Body cylindrical and exhibits bilateral symmetry.

3. Mouth and anus located at the opposite extremities of the body.

4. Skin soft and thin and without spines and pedicellariae.

5. Oral podia modified as tentacles.

6. Skeleton reduced to microscopic ossicles.

7. Surface of the body may exhibit five ambulacral areas.

8. Stone canal without the external opening.

9. Tube-feet locomotory in function and restricted to the five ambulacral areas.

10. Larva is auricularia.

(i) Order Dactylochirotida:

1. Primitive sea cucumbers.

2. Tentacles simple.

3. Body U-shaped and enclosed within a flexible test.

Example:

Echinocucumis.

(ii) Order Dendrochirotida:

1. Oral tentacles are arborescent (tree like in appearance) and dendritic, i.e., with tree-like branches and number is usually 10 (upto 30). Tentacles are not provided with ampullae.

2. Tube-feet present and may spread all over the body or may be restricted to the ambulacral areas.

3. Respiratory trees present.

4. Respiratory trees lack Cuvierian tubules.

5. Usually shallow water forms.

Examples:

Cucumaria , Thyone, Trachythyone, Ypsilothuria, Psolus, Pentacta, Sphaerothuria, Leptopentacta.

(iii) Order Aspidochirotida:

1. Tube-feet numerous.

2. Oral tentacles shield-like or peltate, i.e., branched from central stalk and the number is usually 20 in most cases but varies 15 to 30 in some.

3. Pharyngeal retractor muscles absent.

4. Respiratory trees with Cuvierian tubules well-formed.

5. Usually shallow water forms.

Examples:

Holothuria, Actinopyga, Stichopus, Bathyplotes, Synallactes.

(iv) Order Elasipodida:

1. Tube-feet few.

2. Oral tentacles shield-shaped or peltate and their number varies from 10-20.

3. Body generally flat ventrally and mouth usually ventral.

4. Pharyngeal retractor muscles absent.

5. Tentacular ampullae absent.

6. Respiratory trees lacking.

7. Most of the deep sea species.

Examples:

Deima, Oneirophanta, Laetmogone, Benthodytes, Peniagone, Pelagothuria , Elpidia