IRREGULAR ECHINOIDS

MORPHOLOGY: ORAL VIEW

Irregular echinoids are characterised by having their **anus outside the apical system**. The anus has moved towards **the posterior** of the test (skeleton) of the echinoid). This gives irregular echinoids a **heart-shape** and rather than showing five-fold radial symmetry, they show **bilateral symmetry**.

The mouth is still on the underside of the test but it has often moved away from the centre. The **mouth lacks jaws** and **the perignathic girdle** found in regular echinoids. Instead, the animal takes in **particles from seawater and filters these.**

There is a large lip called the **labrum,** projecting on the **lower side of the mouth**. This has two functions: to **direct currents** into the mouth and to **prevent unwanted sediment entering the mouth**.

Behind the labrum is the **plastron:** an area made up of **modified interambulcaral plates** with tub**ercles for spine attachment**. Small spines attach to these small tubercles and are used to help dig a burrow or for movement within it.

There are no ambulacral plates on the oral side (underside)

MORPHOLOGY: ABORAL VIEW

The **ambulacra did not extend all the way** down from the top of the mouth but **form a flower-shaped structure** called the **Petaloid ambulacra**. These have **many small pore pairs** for **tube feet** on the top of the echinoid. We tend to say that the ambulacral plates are **porous**.

The **petaloid ambulacra at the anterior** of the animal **are larger than others** and form the **anterior groove**. This is **lined by cilia**, which beat to generate currents that pass food particles towards the mouth and is called the **fasciole.**

Very long tube feet extend from **the anterior ambulacra**, which are used to **help dig the burrow** and **keep it stable.**

There is another modified area close to the anus, the **sub-anal fasciole**, which has many **beating cilia** to take **waster particles and direct** them **into the sanitary tube.** The **tube feet** on the **two posterior ambulacra** are modified to keep the **burrow clean** and **maintain the sanitary tube**.

The interambulacral plates lack tubercles on the aboral side (topside).

MODE OF LIFE

- Irregular echinoids live in soft sediment and in low-energy environments (infaunal).
- They filter feed rather than grazing the seabed and so they have a reduced sized mouth area (peristome) because they filter feed.
- Instead, they dig burrows, using the spines on the plastron (on the oral, underside). Irregular echinoids will usually be wedge-shaped so that they move easily through the sediment.
- Cilia along the anterior groove (the fasciole) beat to generate currents that direct food particles towards the mouth.
- Cilia in the sub-anal fasciole also beat to generate currents to remove waste and direct it into the anal/sanitary tube.
- The echinoid extends its long tube feet from its petaloid ambulacra up and out of the burrow. These tube feet provide a surface for gas exchange for respiration to occur. As irregular echinoids evolved, the petaloid ambulacra became larger and longer for more efficient gas exchange (more/larger tube feet).

EVOLUTIONARY HISTORY OF ECHINOIDS (COMPLIES WITH OCR BOOK & FOSSILS AT A GLANCE)

Crinoids are **fixed (mainly**) **suspension-feeders** whilst in the other echinoderm groups, the tube feet are used **primarily for locomotion.**

Regular echinoids appeared first in the **lower Cambrian** (marking the beginning of **the Palaeozoic**). However, they did not become common until the Carboniferous.

Maximum **echinoderm diversity** occurred in the **mid-Palaeozoic.**

Crinoids appeared in the **Ordovician** and are still present today (extant). Crinoids were most diverse in the **Palaeozoic era**.

Lower Palaeozoic (**regular echinoids)** tended to be **smaller and size generally increased** through the era. Echinoids became **more common in the Carboniferous** but their numbers **reduced significantly in the late Carboniferous** became almost extinct at the **end-Permian mass extinction event**

Echinoid **abundance greatly increased** in the **early Mesozoic** times. The group underwent **major radiation** in the **early Jurassic** and so **irregular echinoids** first appeared in the lower Jurassic. Irregular echinoids did not do well in the Jurassic or the Cretaceous.

Flattened sand dollars first appeared in the Palaeocene and became **widely distributed**.

CASE STUDY OF IRREGULAR ECHINOID: SAND DOLLARS

Sand dollars are **extant (alive today**) but there are also **similar fossils**, Clypeaster, found in **Jurassic aged rocks**. the test is covered with **short, movable, fur-like spines** that aid movement through **the burrow/sand** while **feeding (infaunal).**

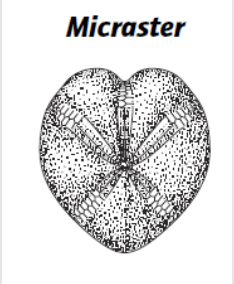
The aboral surface has five Petaloid ambulacral plates. The petaloid ambulacra plates also have **tube feet** that **extend to provide a gas exchange surface** and system.

Sand dollars feed on the **organic materi**al, including diatoms, found in the **coarse biogenic sands** which they were buried.

The anus is situated in a **pronounced groove** on the aboral surface. Mouth is almost at the centre of the oral surface.

CASE STUDY OF IRREGULAR ECHINOID: MICRASTER (EXTINCT CRETACEOUS TO PALEOCENE

Micraster was an **infaunal echinoid** living in a **burrow below the sediment surface**. It is from the **Cretaceous period.**



The test is clearly **bilateral** and heart-shaped.

There is a **deep anterior groove** for taking water laden with **organic particles** to the mouth.

The **tube feet** also help keep a supply of **nutrient-laden water moving into the burrow.**

The anus has a **waste tube behind** it, the **two ambulacral plates of the posterior** have **tube feet** which **help clean and maintain the sanitary tube**.

Ambulacra are narrow and sub-petaloid

The anterior ambulacrum is situated in a deep groove leading to the mouth. The mouth is on the lower surface, positioned towards the anterior margin. It is partially covered by the labrum. Evolutionary changes in Micraster are well-documented and changes in morphology can be related to the depth of burrowing.

Table 7.3 Echinoid life habits and morphology.

	Epifaunal	Shallow infaunal	Deep infaunal
Mode of life	Echinoids living on the substrate surface as scavangers or grazers in intertidal or shallow subtidal environments	Echinoids that are able to burrow rapidly in high energy, shifting sands	Echinoids that construct structured, semipermanent burrows in low energy environments
Morphology	Regular echinoids with a rounded test and radial symmetry. The anus is on the upper surface and the mouth is directly opposite on the underside of the test	Irregular echinoids with very flattened, bilaterally symmetric tests. Ambulacra are petal shaped. The anus and mouth are on the lower surface	Irregular echinoids with heart-shaped, bilaterally symmetric tests. Ambulacra are petal shaped. The anus is on the posterior margin of the test

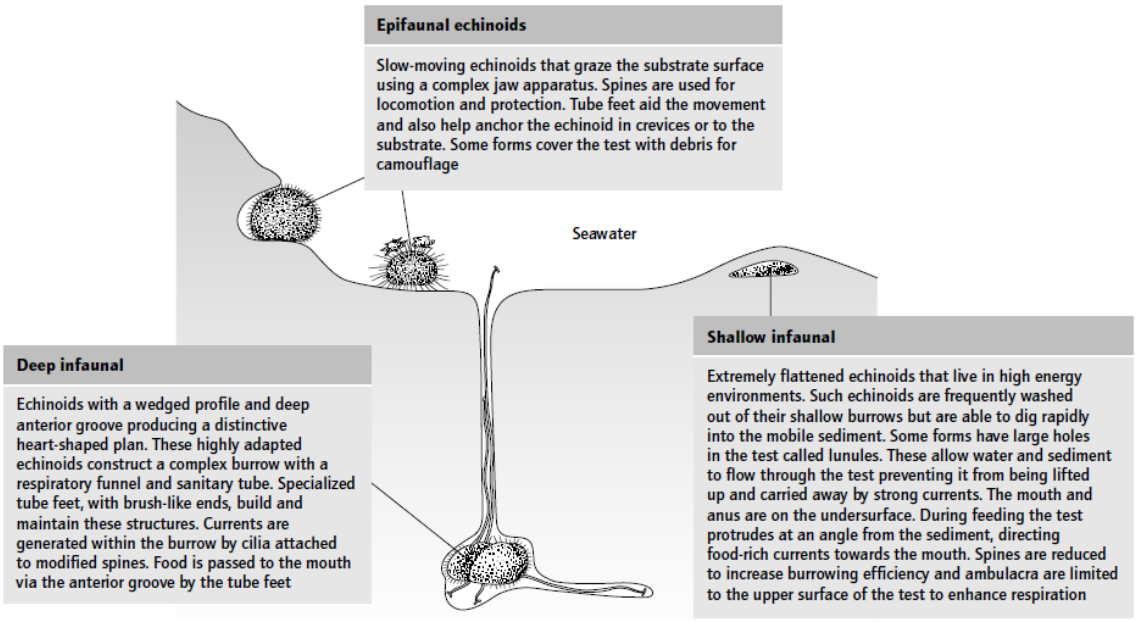


Fig. 7.9 Echinoid life habits.

COMPARING REGULAR AND IRREGULAR MORPHOLOGY

Feature	Regular echinoids	Irregular echinoids
Shape	Hemispherical/round/dome	Heart-shaped
Symmetry	Five-fold radial symmetry (pentamerous radial)	Bilateral symmetry
Position of mouth	Centre of the oral (underside) surface. This has Aristotle's lantern with a perignathic girdle and 5 jaws with a single tooth.	Lies in the centre of the oral surface or towards the anterior margin (increasing feeding efficiency).
Shape of the ambulacra and pore-pairs	Ambulacral areas extend from the apical system to the mouth (on opposite side). There is a pair of pores for every ambulacral plate. Pores are round and close-set.	Petaloid ambulacra plates on the top (aboral) surface only. One pair of pores per plate. Pores are round and close-set except when respiratory tube feet are present, then pores can be elongated.
Size of tubercles	Tubercles are large (locomotion is vital) Well spread out	Tubercles are smaller (limited movement in burrow) Tubercles are closer together
Anterior groove	Not present	Present (increases the efficiency of fasciole bringing in water currents into the burrow for water vascular system and feeding).
Apical system	A total of 10 plates arranged in 2 rings around the apical system. 5 ocular plates and 5 genital plates. One of which is large and perforated called the Madreporite.	Does not enclose the periproct (membrane around the anus). It is small and may be linear. Anus is sometimes in a well-defined posterior groove
Fasciole	Not present	Fasciole at the anterior groove with ciliated spines to beat currents of food-laden water towards the mouth. There is also a sub-anal fasciole which generates currents to clean the sanitary tube/direct waster into it.