The Spiny Skin Animals—Enchinodermata

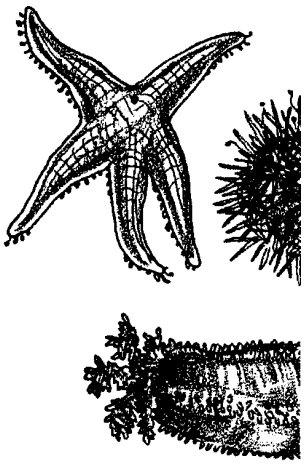
Lesson by Holly Anne Foley
Marine Science Center, Poulsbo, Washington

Key Concepts

1. Scientists classify sea stars, sea urchins, sand dollars, sea lilies, and brittle stars in the phylum Echinodermata.

2. Echinoderms have an internal skeleton composed of ossicles (bone-like pieces of calcium carbonate), their symmetry is penta-radial, they move using suction-cup like tube feet operated by a water vascular system, and they often have spines.

3. Scientists divide echinoderms into five classes: Asteroidea, Schinoidea, Ophiuroidea, Holothuroidea, and Crinoidea.



Background

Echinoderms are exclusively marine animals, and they resemble no other phyla. Some 6,000 modern species and over 20,000 fossil species have been described. Members of the phylum Echinodermata have been recorded from the start of the Cambrian Period - some 60,000,000 years ago. The inability of echinoderms to control the water movement into their bodies may be a principal reason that they have never occupied a freshwater niche.

Some of the most beautiful and eye catching organisms of the coastal region belong to the phylum Echinodermata, which includes the seastars, the brittle stars, the sea cucumbers, the sand dollars, the sea urchins and the sea lilies. The following characteristics are common to nearly all echinoderms (see Figures 1, 2, 3 and 4 for anatomy):

1. The symmetry is radial; i.e., the organism can be cut in a number of planes to yield similar halves.
2. The skeleton is of mesodermal origin and is covered by an epidermal layer. The gut is usually complete. (A few forms lack an anal opening.)
3. There is a spacious true coelom (body cavity lined on both sides by mesodermal tissue).

4. The circulatory system is almost functionless. Circulation is carried out by the coelom and water-vascular system.
5. A water-vascular system complete with tubed feet is present in most groups.
6. Respiration and excretion take place by diffusion through the body wall via papillae leading from the coelom, through the tube feet, or through a respiratory tree (present only in the cucumbers).
7. Movement in most cases is accomplished by tube feet and occasionally by body contraction.
8. The nervous system is poorly developed and movement is almost always a very slow process. (Some of the brittle stars can swim by thrashing the radii.)
9. Sexes are separate and, in most cases, fertilization is external, and motile, ciliated larvae are produced.

Scientists have subdivided echinoderms into these five classes:

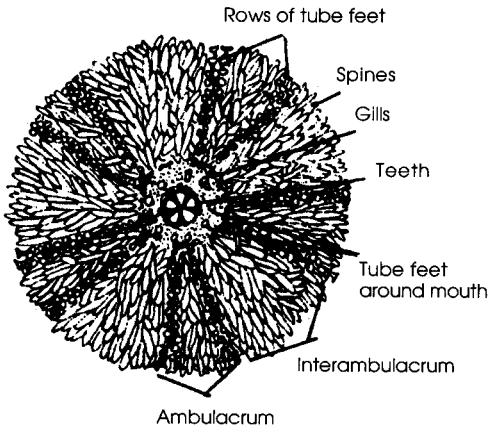
Class 1. Asteroidea - Sea stars - five or more solid radii (rays) which blend with the central disc.

Class 2. Ophiuroidea - Brittle stars - five jointed radii clearly demarcated from the central disc.

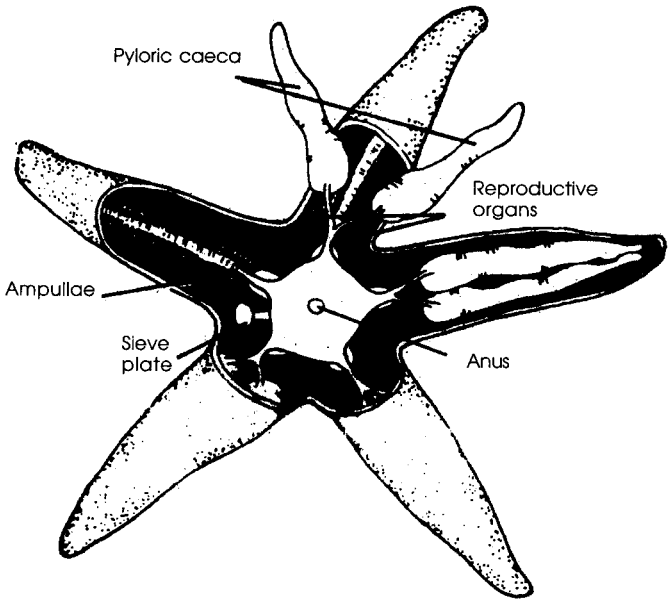
Class 3. Holothurioidea - Sea cucumbers - soft bodied, elongate animals without spines and without radii.

Class 4. Echinoidea - Sea urchins and sand dollars - spiny, spherical or disc-shaped animals without radii.

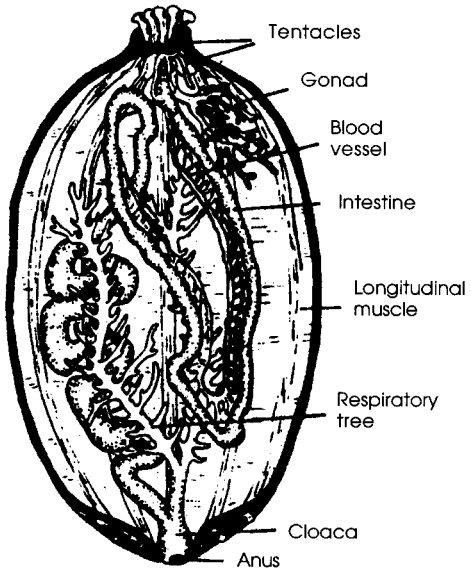
Class 5. Crinoidea - Sea lilies and feather stars - The mouth opens upwards and is surrounded by branching radii. Crinoid are not commonly represented in the intertidal region.



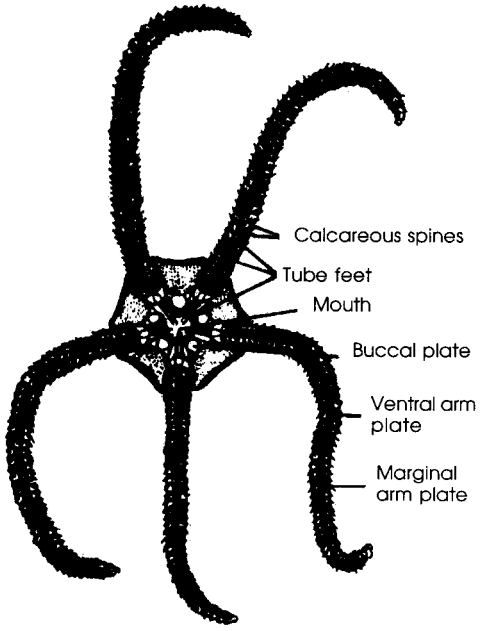
External Anatomy of a Sea Urchin



Internal Anatomy of a Sea Star



Internal Anatomy of a Sea Cucumber



External Anatomy of a Brittle Star

From: Flora, Charles J. and Eugene Fairbanks. 1977. *The Sound and the Sea*. The Washington State Department of Printing.

Materials

For each student:

- one copy of "The Spiny Skin Animals - Echinodermata" student pages

Teaching Hints

"The Spiny Skin Animals" includes a reading and a word puzzle which introduce the phylum Echinodermata. Two additional activities in this unit look in more detail at selected echinoderms. You may consider having your students observe the fertilization and development of sea urchin or sand dollar eggs in the following lesson, "Urchin Spawning". The next lesson includes a journal article, "Starfish Threaten Pacific Reefs", which describes the tremendous impact the voracious crown-of-thorns sea star has on coral populations in tropical reefs.

Key Words

calcareous - containing calcium carbonate

gonads - reproductive organs

rays - arms of an animal that radiates from a central disk or point

trepang - Malaysian word for sea cucumber or dried smoked sea cucumber used as food in China

tube feet - the suction-like extensions of a water vascular system present in most echinoderms and used for movement and grasping

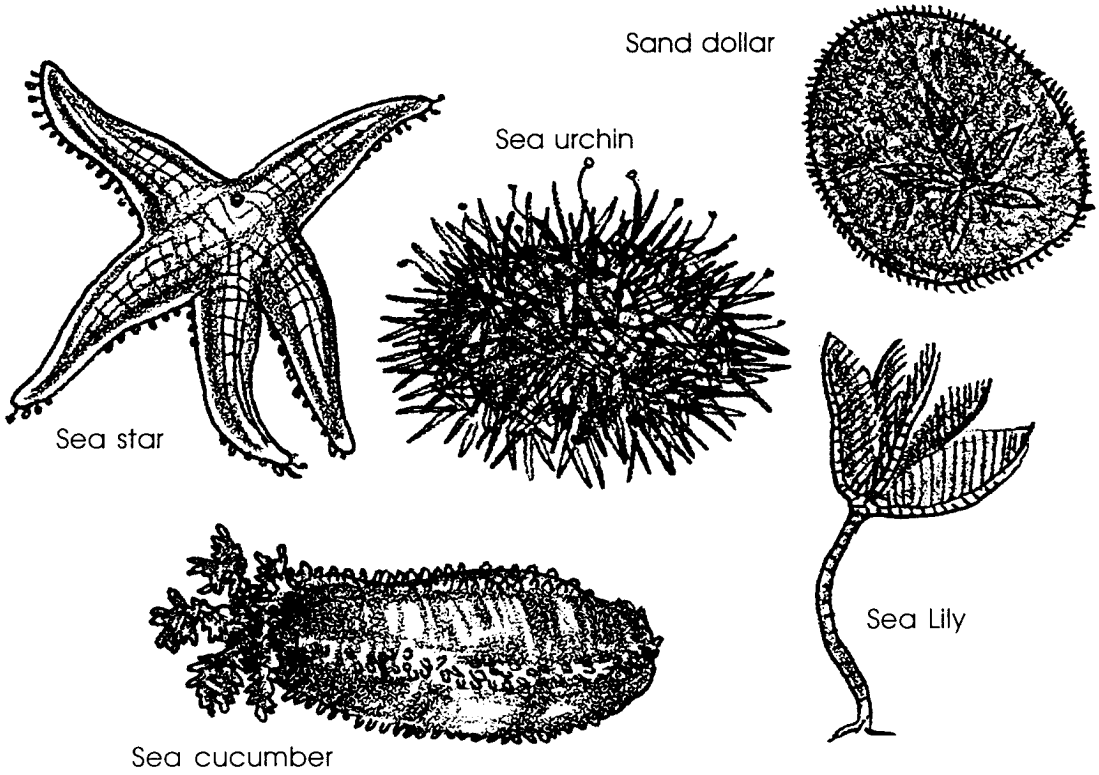
Answer Key

1. radial **S** ymmetry
2. o **P** hiuroidea
3. ench **I** nodermata
4. ce **N** tral disc
5. s **Y** stem

6. te **S** t
7. endos **K** eleton
8. sess **I** le
9. rege **N** erate
10. exter **N** al
11. tube f **E** et
12. gona **D** s

13. r **A** ys
14. cri **N** oidea
15. paral **L** tic
16. sea cucu **M** bers
17. sea st **A** rs
18. zoop **L** ankton
19. os **S** icles

The Spiny–Skin Animals

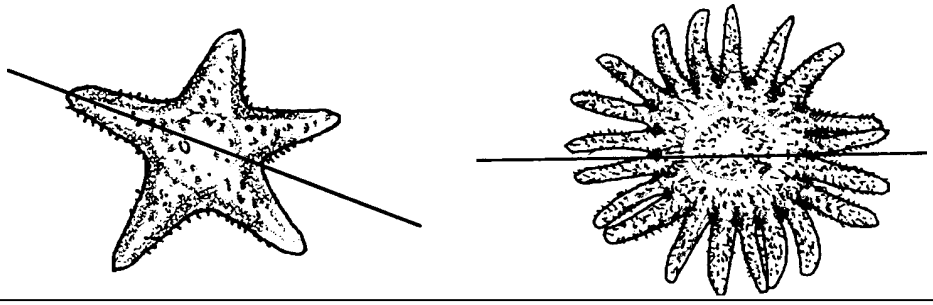


Enchinodermata

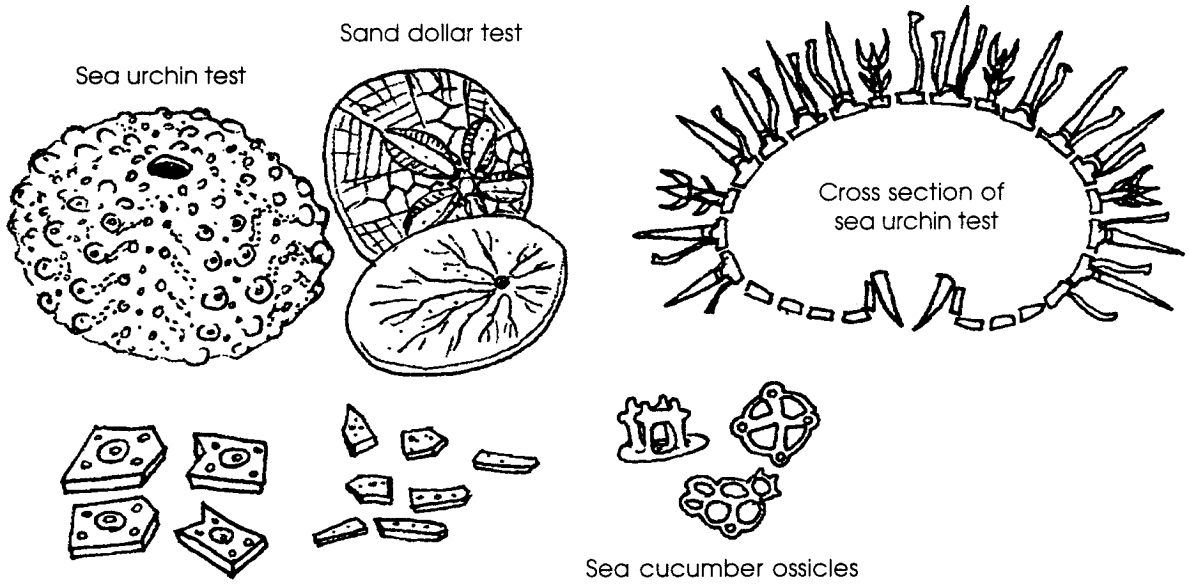
Spiny-skinned animals have been around for a long time, about 60,000,000 years. Who are these “spiny skinned animals”? They are the sea stars (starfish), sea urchins, sand dollars, sea cucumbers, and sea lilies. They all live in marine waters. And scientists have classified them all in the phylum Echinodermata. “Echino” means “spiny animal”, and “derm” means “skin”. Hence, these are the spiny-skin animals.

The members of the phylum Echinodermata share several common features:

1. The adult animal is radially symmetrical; the animal can be cut in a number of planes that will yield similar halves.



2. They possess a supporting endoskeleton located just below the skin. It is called a test when it is fused as in the sand dollar.



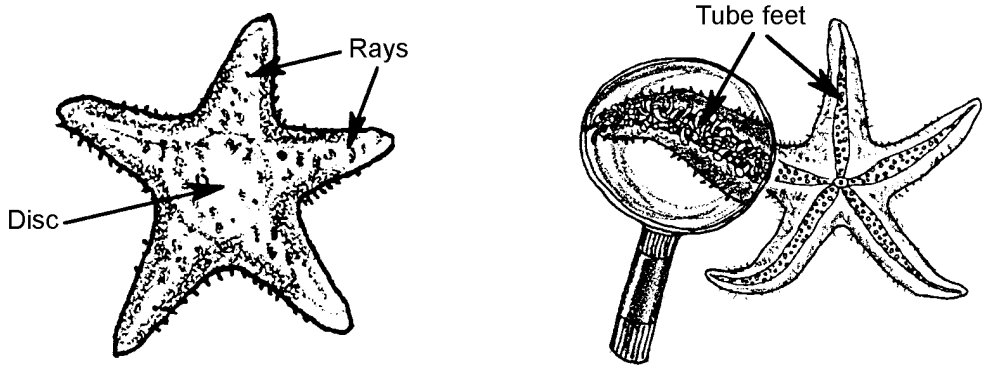
3. Most have a complete digestive system which includes two openings (a mouth and anus).

4. They have a water-vascular system with tube feet which aids in locomotion and circulation.

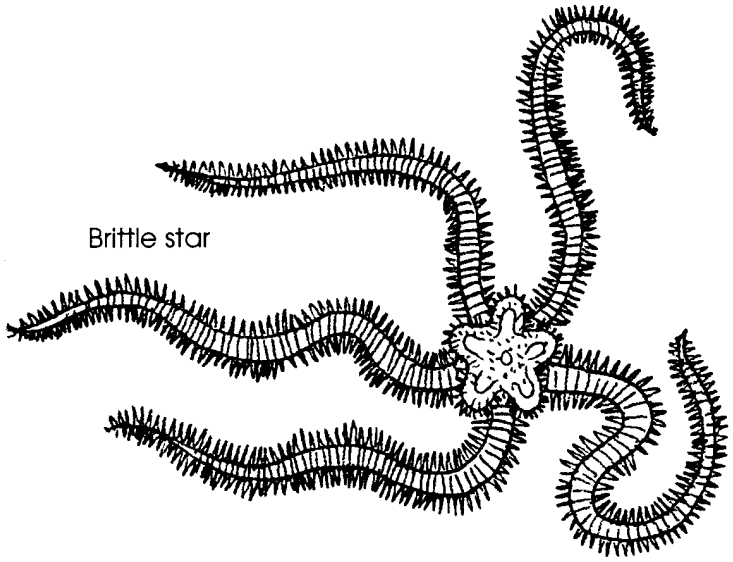
5. Males and females are separate organisms and shed or "broadcast" either sperm or eggs into the water (external fertilization) to produce ciliated larvae.

Taxonomists usually divide the echinoderms into five classes:

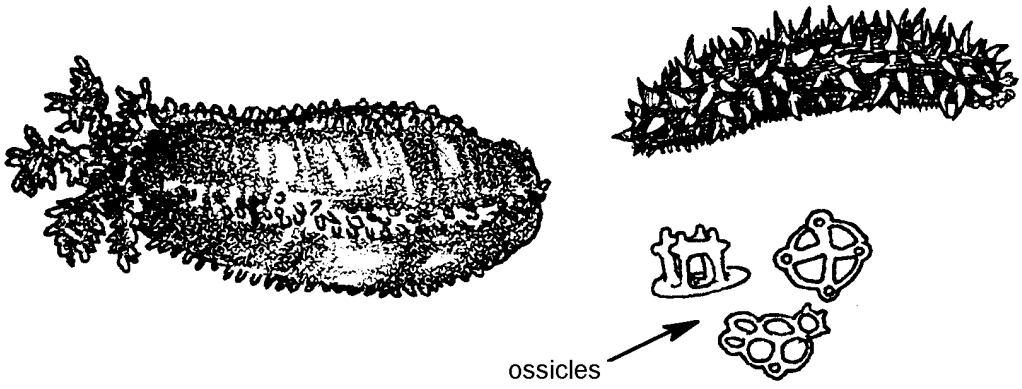
Class 1. Asteroidea - the sea stars. They have five or more solid rays (arms) which blend with a central disc. In this group, the tube feet are found on the lower surface, while spines cover both the upper and lower surfaces.



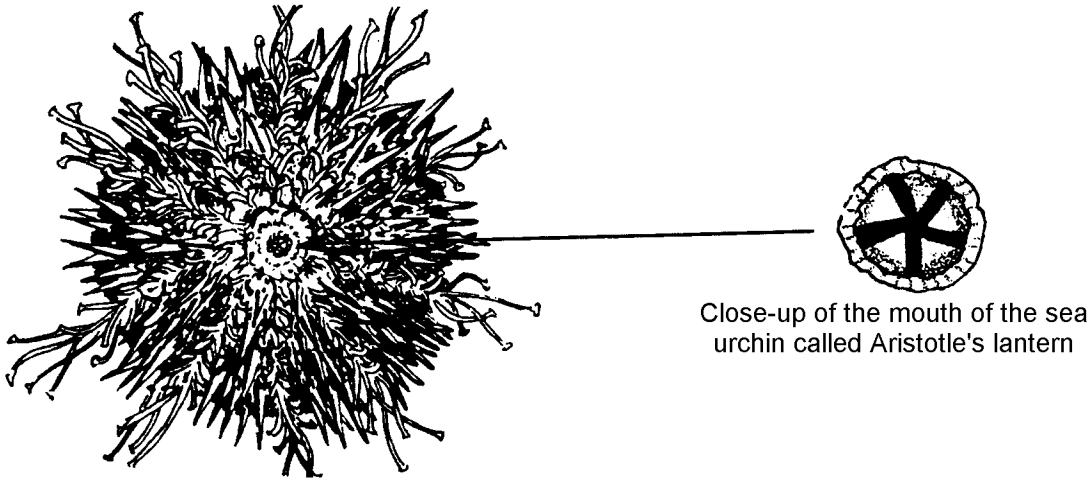
Class 2. Ophiuroidea - the brittle stars. They have five jointed rays (arms) clearly demarcated from the central disc. Brittle stars lack tube feet and move by wriggling their arms. The name, brittle star, refers to the tendency of the arms to fragment when the organism is disturbed.



Class 3. Holothuroidea - the sea cucumbers. They are soft bodied, elongated animals without visible spines and without rays. In the sea cucumbers, the calcareous skeleton takes the form of loose, disconnected spicules and plates called ossicles. Unlike the sea stars, the ossicles in the sea cucumbers are not paired to form a rigid skeleton.

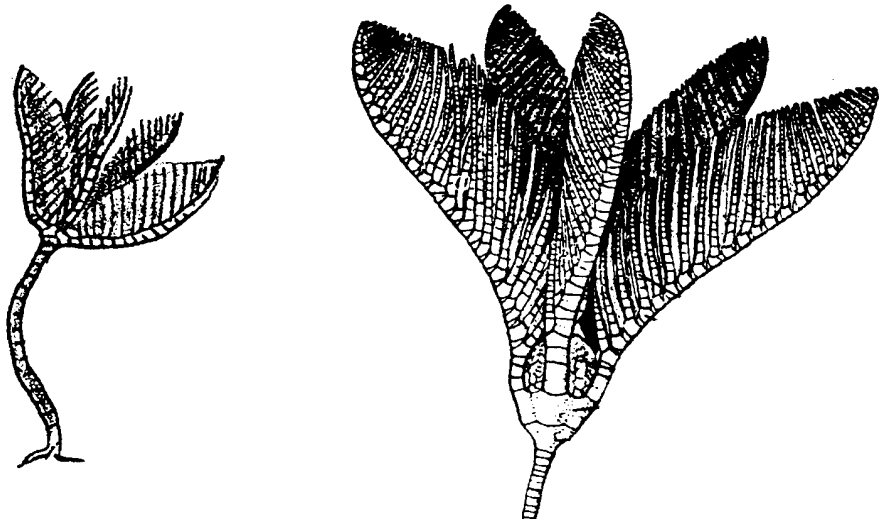


Class 4. Echinoidea - the sea urchins and sand dollars. They are spiny, spherical or disc shaped animals without rays. The body is enclosed in a calcareous box called the test. The test is a special type of endoskeleton. The mouth consists of an unusual five-toothed grinding device called Aristotle's Lantern.



Close-up of the mouth of the sea urchin called Aristotle's lantern

Class 5. Crinoidea - sea lilies and feather stars. They are sessile (attached) plant-like forms in which the mouth opens upward and is surrounded by branching rays. They are filter feeders and are most abundant in tropical waters and the deep sea.



Interestingly, echinoderms are the only major phylum in the animal kingdom in which there are no parasitic species. In addition, symbiotic relationships (those in which two species interact to benefit one or both) are few. The spiny echinoderms are Nature's "loners".

A few echinoderms find their way to the table for use as human food. The ripe gonads (reproductive organs) of sea urchins are an expensive delicacy in Japan where they are eaten raw or cooked. The body wall of the sea cucumber is given the elegant name of "bêche-de-mer" (not so elegant if you translate it from the French as "worm of the sea") or trepang. One method of preparation involves dropping the cucumber in boiling water. The shock causes the animal to eviscerate ("throw up") its internal organs, leaving behind an intact body wall. The body wall is then dried and sold as a delicacy for use in soups. The muscle tissues of the sea cucumber are becoming popular as a food source in the United States. The five muscles are stripped from the body wall and then lightly cooked like scallops or shrimp.

Oyster growers continually wage war on the sea star. Sea stars are predators on oysters and can cause a considerable economic loss to the oyster industry. At one time a standard practice was to dredge up the sea stars, cut them up into pieces and throw them overboard. ("That'll show 'em.") Unfortunately, any piece of a sea star with a piece of the central disc still attached can regenerate an entire new organism. The poor oystermen were multiplying their problem.

PUZZLING WORDS

Using the clues on the next page, complete the spelling of each word.

1. _ _ _ _ _ _ S _ _ _ _ _ _ _
2. _ P _ _ _ _ _ _ _ _ _
3. _ _ _ I _ _ _ _ _ _ _ _
4. _ _ N _ _ _ _ _ _ _ _ _
5. _ Y _ _ _ _
6. _ _ S _
7. _ _ _ _ _ K _ _ _ _ _ _
8. _ _ _ _ I _ _
9. _ _ _ _ N _ _ _ _ _
10. _ _ _ _ _ N _ _
11. _ _ _ _ _ E _ _
12. _ _ _ _ D _
13. _ A _ _
14. _ _ _ N _ _ _ _ _
15. _ _ _ _ _ I _ _ _
16. _ _ _ _ _ _ _ M _ _ _ _
17. _ _ _ _ _ A _ _
18. _ _ _ _ L _ _ _ _ _ _
19. _ _ S _ _ _ _ _

CLUES:

1. Adult echinoderms can be cut in a number of planes and yield similar halves. They have_____ _____(two words).

2. This class contains the brittle stars.

3. This phylum name means “spiny skinned”.

4. The rays of the sea star are attached to this structure.

5. Echinoderms move fluid around the body by using a water vascular

6. The calcareous box which encloses the sea urchin.

7. A supporting structure located just below the skin. Number 6 is an example of this.

8. Attached.

9. Sea stars can _____ new body parts if a piece of the central disc is still attached.

10. Fertilization in the echinoderms is _____to the body.

11. These structures are part of the water-vascular system and aid in locomotion.

12. Reproductive organs are called.

13. Sea star arms are called.

14. This class contains sessile filter feeders.

15. The Echinodermata is the only major animal phylum without any _____ members.

16. These animals belong to the class Holothuroidea.

17. These animals belong to the class Asteroidea.

18. Ciliated echinoderm larvae are free floating as _____ .

19. In the sea cucumber, these spicules and plates are disconnected.