ABUNDANCE AND BIODIVERSITY OF ECHINODERMS IN TANJUNG ARU AND PULAU GAYA

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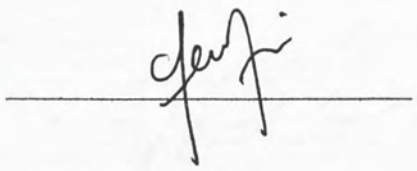

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ABSTRAK

Sebanyak 29 spesies ekinodermata dari 11 famili dikumpulkan semasa kajian dilakukan. Sebelas spesies dari enam famili direkodkan di Tanjung Aru dan 26 spesies dari 11 famili direkodkan di Pulau Gaya. Stesen persampelan terdiri daripada PG4, PG8, TA4 dan TA8. Crinoidea mempunyai jumlah yang paling banyak daripada semua kelas (16 spesies) dan mendominasi kedua-dua tempat kajian. Ophiuroidea adalah salah satu kelas yang hanya ditemui di Pulau Gaya (3 spesies, 3 famili). *Ophiarachna affinis* mempunyai kelimpahan yang paling kurang (1.50 ind/m^2) dan ia hanya direkodkan di PG8. Untuk struktur habitat, kedua-dua tempat kajian diliputi dengan terumbu karang, pasir dan kerikil tetapi terumbu karang mendominasi tempat kajian. Pulau Gaya mempunyai kelimpahan ekinodermata yang lebih tinggi, PG8 (329.50 ind/m^2) and PG4 (140 ind/m^2) diikuti oleh TA8 (18.75 ind/m^2) and TA4 (17.25 ind/m^2). Pulau Gaya mempunyai kepadatan spesies yang lebih tinggi iaitu di antara 20 hingga 22 spesies. Sementara itu, di Tanjung Aru pula hanya mempunyai separuh daripada jumlah spesies daripada Pulau Gaya (5-10 spesies). Walau bagaimanapun, TA4 yang mempunyai jumlah spesies yang paling kurang (5 spesies) tetapi ia mempunyai keseragaman spesies yang paling tinggi, J' = 0.92. Nilai yang lebih tinggi menunjukkan spesies tersebut tersebar dengan seragam di tempat tersebut. Kajian ini menunjukkan ekinodermata memberi keputusan diversiti yang lebih baik di persekitaran yang yang lebih baik seperti tahap sedimentasi.

ABSTRACT

A total of 29 species of echinoderms from 11 families were collected during the study. 11 species from six families were found in Tanjung Aru and 26 species from 11 families were recorded in Pulau Gaya. Crinoidea has the highest total of species among the classes (16 species) and dominated both study area. Ophiuroidea was the only class that was found only in Pulau Gaya (3 species, 3 families). *Ophiarachna affinis* had the lowest abundance (2 ind/m^2) and it was only recorded in PG8. For habitat structure, both areas were cover with coral, sand and rubble but coral dominated the study area. Pulau Gaya is significantly higher abundance of echinoderms, PG8 (330 ind/m^2) and PG4 (140 ind/m^2) followed by TA8 (19 ind/m^2) and TA4 (17 ind/m^2). Pulau Gaya had the higher species richness (20-22 species). While, in Tanjung Aru only had almost half of the species richness from Pulau Gaya (5-10 species). TA4 however had the lowest number of species (5 species) but it has the highest evenness, J' = 0.92. Higher value of J' shows that a species is evenly distributed in an area. This study showed that echinoderms were found to show better diversity in a better environmental parameters such as sediment level.

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CHAPTER 1

INTRODUCTION

1.1 Phylum Echinodermata

Echinoderms are multi-cellular marine invertebrates. Members of the phylum, Echinoderms are exclusively marine and are largely bottom dwellers. The most striking characteristic of this phylum is their pentamerous radial symmetry. For example the body can usually be divided into five parts arranged around a central axis. Echinoderms have approximately 7000 described living species and about 13,000 extinct species are known from the fossil record (Brusca and Brusca, 2003). They occur in various habitats from the intertidal zone down to bottom of the deep sea trenches and from sand to rubble to coral reefs and in cold and tropical seas.

They are enterocoeluos coelomates. They have a pentaradiate construction derived from an original bilatrality, without definite head or brain. In adult condition, it is radial symmetrical and bilaterally symmetrical in the larvae. They have a calcareous endoskeleton of separate plates or pieces, often bearing external spines or protuberances.

They have an extensive body cavity or coelom, surrounding the internal organs. Echinoderms have an unique water vascular system of coelomic nature that sends numerous small projections to the exterior and communicate with external medium by a pore or cluster of pores, at least in juvenile stages (Brusca and Brusca, 2003). This system is responsible for respiration and locomotion in animal. It is due to the characteristic spiny endoskeleton that echinodermata earned in Latin its name which means 'spiny-skinned'. Circulatory system is typically present in echinodermata. Their sense organs are poorly developed. They usually reproduce sexually; few reproduce asexually or by regeneration. In echinoderms although the sexes are separate but there is no sexual dimorphism. The gametes are released directly in the sea water where fertilization occurs. The development may be direct or indirect. In the direct development there is no larval stage but in the indirect development different kinds of free swimming larval forms are found. In each class, a few members, deep sea species are viviparous (Bhamrah and Juneja, 2001). They rear the young in the brood pouch-like structure found in their body. The most striking feature of the larva is bilateral symmetry, which is in marked contrast to the radial symmetry of the adult. After a free swimming life, the bilateral larva undergoes metamorphosis, in which symmetry of adult is developed. Sexes are usually separate with few exceptions and their gonads are simple, with or without simple ducts (Bhamrah and Juneja, 2001).

Echinoderms are divided to 5 classes. They are Asteroidea (sea stars), Crinoidea (feather stars), Ophiuroidea (brittle stars), Echinoidea (sea urchin) and Holothuroidea (sea cucumber).

2.1 Significance of Study

Echinoderms have not been studied in great detail in this region. As echinoderms play an important role in the ecological community and some species are economically important, it is vital to assess the current status of echinoderms in our water.

A famous experiment was conducted in Pacific-coast tide pools in which *Pisaster,* a species of sea star was removed. By removing the sea stars, an increase in mussel population occurred as the sea stars preys on mussels. This demonstrated the disturbance to the ecological balance of that entire community. Sea stars are so important to tide pool communities where they are considered a "keystone species" (Campbell, 1990).

Echinoderms are also host to various symbiotic animals. For examples, there are some small shrimp (*Periclimenes colemani*) that can be found living on the poisonous spines of the fire urchins (*Asthenosome varium*) to protect themselves from predator. Some cardinal fishes and juvenile shrimp fishes also like to take shelter in between these spines. The mandarin dragonet lives close to congregations of sea urchins and hide among them if threatened. Holothurians are also a host or a variety of symbiotic organisms such as crabs, shrimps, worms and even a very unusual fish called the pearl fish *Encheliophis homei.* Pearl fish has a long slender, transparent body and lives in the gut cavity of sea cucumber. They also inhabit some starfish as well as pearl oyster shells. The fish leaves and enters through the holothurian's anus. They probably feed on the gonads and other tissues of its host. It is said to leave at night to feed on small fishes and shrimps.

Echinoderms too are important economically. Humans consume sea cucumber and sea urchins. Sea urchin eggs are edible and served in sushi bars (Brusca and Brusca, 2003) and dried sea cucumbers are a highly priced delicacy. This demand will destroy a certain species of echinoderms if the echinoderms are not protected and will result in an ecological imbalance in the marine ecosystem. Echinoderms can be a pest in the aquaculture industry. Certain species feed on clams and pearl oyster. This will reduce the economic output in aquaculture.

This study will allow us to have an idea about the current numbers of echinoderms and their species that exist today in the study area. By having the data, we could conserve them from being overexploited. The data could be helpful for further studies of echinoderms in future and could become references for comparison. This information will be valuable to government agencies to protect rare and valuable species of echinoderms.

1.3 Objectives of Study

The main objectives of this study are:

1. To survey the diversity and abundance of echinoderms in the study area.
2. To assess and compare the status of echinoderms in the two study areas.

CHAPTER 2

LITERATURE REVIEW

2.1 Class Asteroidea (Sea Stars)

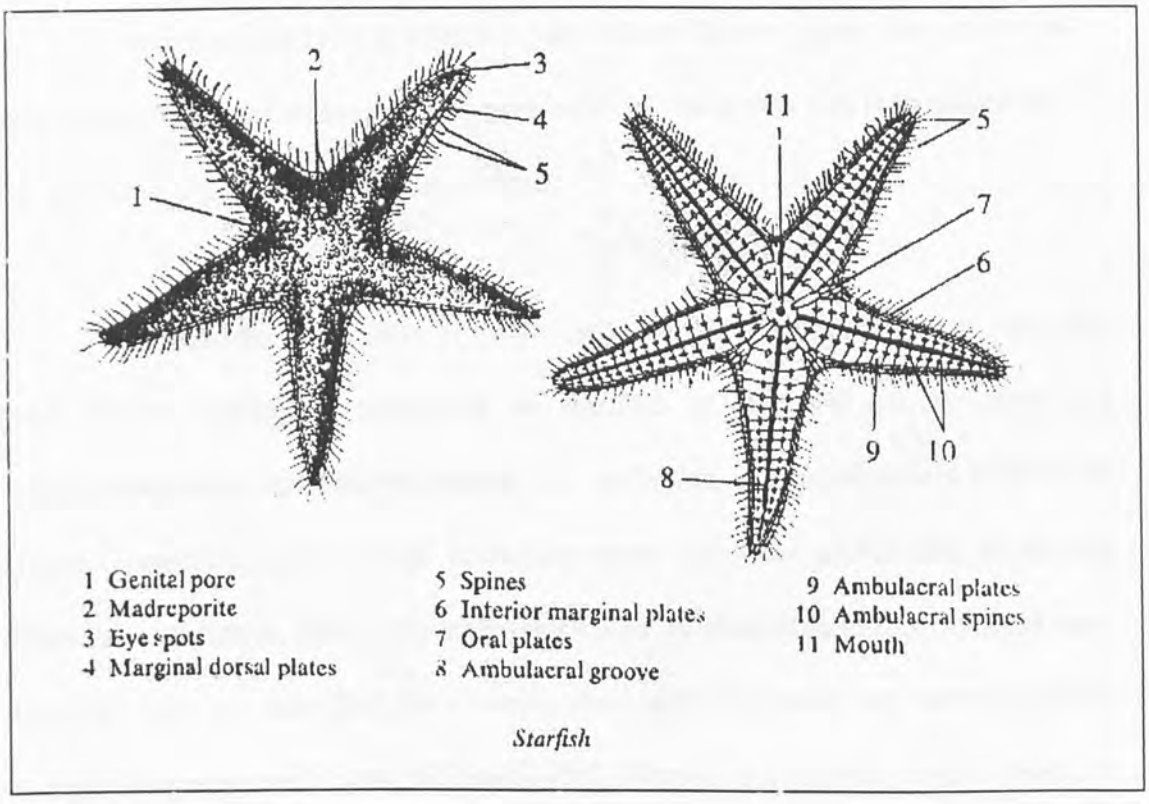

Figure 2.1 Diagram of Asteroidea

(http://www.beachgolff.com/images/Starfish_diagram).

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 multi-species group. There are approximately 1600 extant species (Clark 1977; Clark and Downey 1992) which are found throughout the world's oceans. Sea stars live everywhere in coral reef, on sands and on rocks. Sea stars are characterised by flattened, mostly pentagonal, radial symmetry, several arms; five or in multiplies of five radiating from a central body. The oral surface is held downwards. It has flexible endoskeleton. Its mouth and anus are close together on the underside, with the anus at the center of the disc together with the water intake. The upper surface is often very colourful while the underside is often a lighter colour. Minute pincer-like structures called pedicellaria are present on the upper surface. These structure is to ensure that the surface of the arms stay free from algae.

They have no head, brain or mouth parts to help them capture prey. They use their sensory perception consisting of eyespots at the end of the arms and neurosensory cells scattered throughout the epidermis. A ring of nerves around the mouth connects to nerve cords extending down the arms coordinates movement (Bhamrah and Juneja, 2001). Sea stars which feed on bivalve mollusks pry them open with their arms and tube feet, then turning their stomachs inside out into the opening to digest the prey while it is still in its shell (Brusca and Brusca, 2003). Digestive juices are secreted and the tissue of the prey liquefied. The digested food mass, together with the stomach is then sucked back in. The majority of sea stars is carnivorous (Brusca and Brusca, 2003) and feed on sponges, bryozoans, ascidians and mollusks. Other starfishes are detritus feeders or scavengers. Some starfish are specialized feeders, for example the crown of thorns that feeds on live coral polyps.

Starfishes are well known for their powers of regeneration. A complete new animal can grow from a small fragment such as an arm. In some species (*Linckia multifora* and *Echinaster luzonicus*), one of the arms will virtually pull itself away, regenerates and forms a new animal. Self amputation is usually a protective function, losing the body part to escape a predator rather than being eaten. But here, it acts as a form of asexual reproduction. In other species of sea stars (*Allostichaster polyplax* and *Coscinasterias calamaria*) the body broken into unequal parts can regenerate the missing parts (Brusca and Brusca, 2003).

The crown-of-thorns (*Acanthaster planci*) is one of the largest and the most venomous starfish. It can reach 50 cm diameter and has numerous (10 to 20) spiny arms with formidable thorn like toxic spines. They feed on live coral polyps. They "graze" the corals which are left behind white and dead. Their predators are the giant triton shell (*Charonia tritonis*) and some puffer fish (Bhamrah and Juneja, 2001).

The cushion star (*Culcita nouvaeguineae*) does not look like a starfish at all, more like a large sea urchin without spines. Its pentagonal appearance gives only the slightest indication that this organism is related to other starfish.

2.1 Class Crinoidea (Feather Stars)

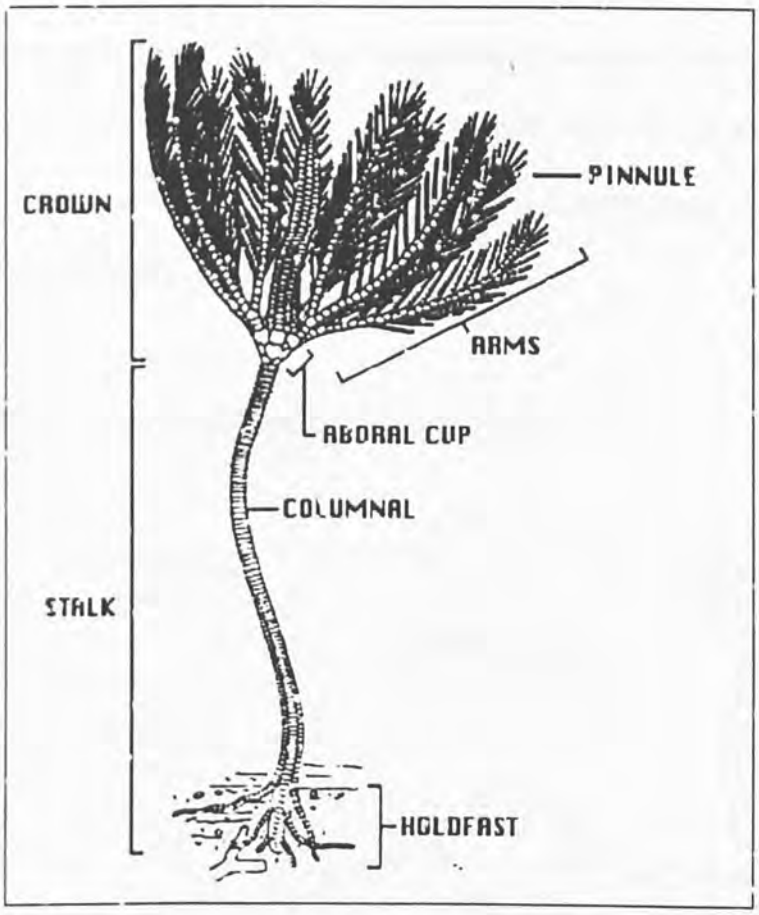

Figure 2.2 Diagram of Crinoidea *(http://www.tolweb.org/Crinoidea).*

Feather stars are also known as crinoids. They are characterized by radial symmetry. The body of a feather star is usually a cup-shape. They have numerous feathery arms coming out from a central disc. Some have five arms; others have as many as 200 arms. The arms are called pinnules. They are coated with a sticky substance that helps to catch food. These arms are supported by an internal skeleton of calcium carbonate plates that superficially look like vertebrae, which are in fact called vertebral ossicles (Bhamrah and Juneja, 2001). These are moved by a system of muscles and linked together by ball-andsocket joints. The body and arms are also protected by calcium carbonate plates, and the arms generally bear delicate spines.

There are appendages known as cirri attached to the underside of the body with which they cling to sponges or corals. Both their mouth and anus are situated on the upper side. Feather stars are primarily nocturnal but they are seen during day with their arms rolled up. They can crawl, roll, walk and even swim but usually they cling to sponges or corals. They can be found in most parts of the world, from the Arctic and Antarctic to the tropics.

2.2 Class Ophiuroidea (Brittle Stars)

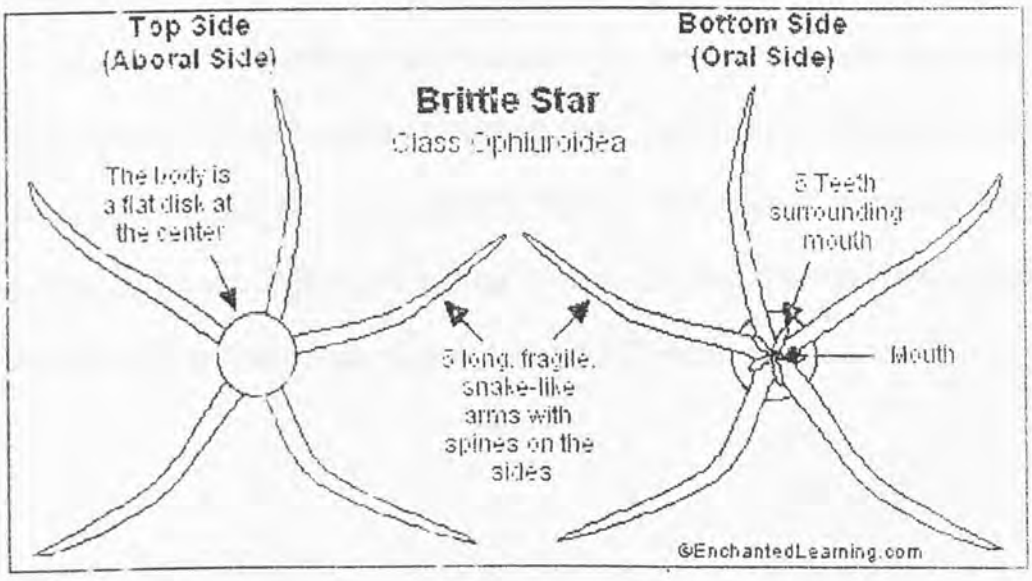

Figure 2.3 Diagram of Ophiuroidea

(http://www.enchantedlearning.com/cgi-in/paint/La/subjects/invertebrates.shtml.jpg).

Brittle stars are close relatives of sea stars. They are radially symmetrical. They have five snakelike arms which are flexible. There is no replication of internal organs, having just one set in the central disk. Compared to starfish, brittle stars have a much smaller central disc and no anus (Bhamrah and Juneja, 2001). Wastes are eliminated through the mouth that is situated on the underside of the central disk. On the

underside of the centre disk there is a split like opening at the base of each side of each arm. These openings are for breathing and shedding eggs or sperm into the sea.

The basket stars are a specialised type of brittle stars. They have a series of complex branched arms which are used to catch plankton. The arms of the brittle stars are rather liable to break. This is actually an escape mechanism. Those arms regenerate quickly forming an entire new organism. Brittle stars can reproduce asexually by self-division. Brittle stars are the most active and fastest moving echinoderms. They are best seen at night time. 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. They are very abundant in areas that are exposed to periodic strong currents because they feed on planktonic food. Most ophiuroids are scavengers and detritus feeders, although they also prey on small live animals such as small crustaceans and worms (Clark and Downey, 1992).

2.4 Class Echinoidea (Sea Urchin)

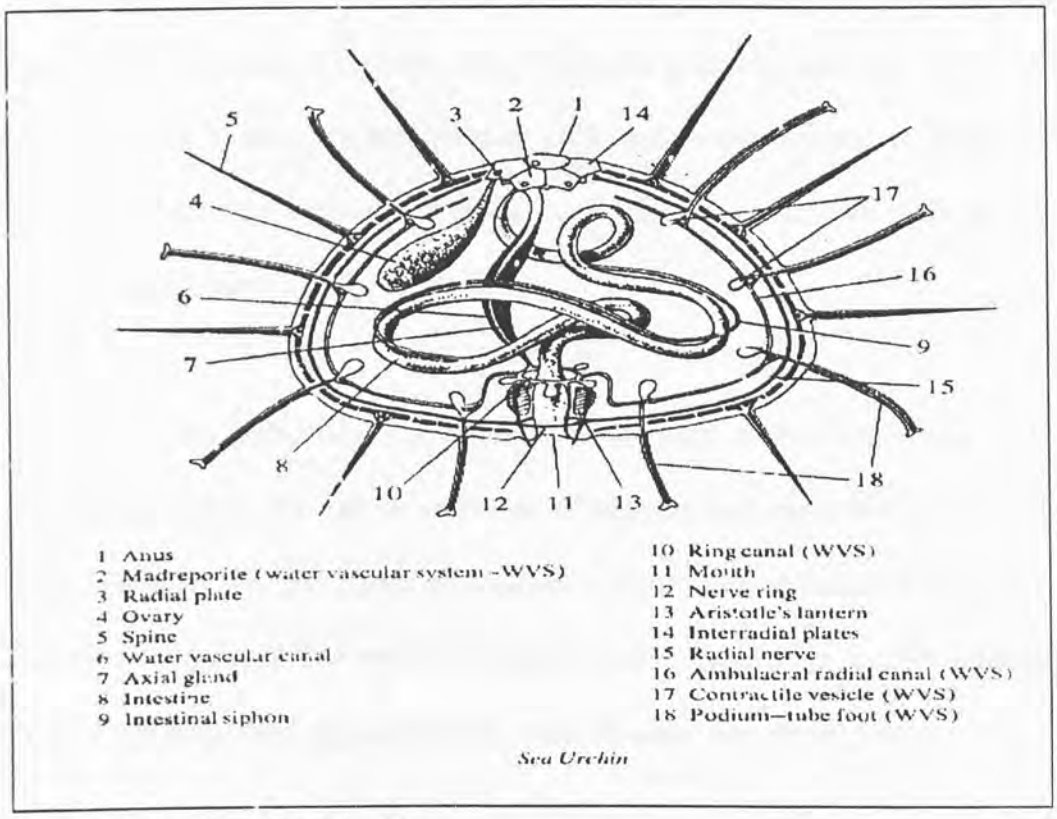

Figure 2.4 Diagram of Echinoidea

(http://www.beachgolff.com/images/Sea_urchin_diagram).

Sea urchin has radially symmetrical body with an external chitinous skeleton and a centrally located jaw with teeth. The mouth consists of a complex arrangement of muscles and plates surrounding the circular opening. The anus is located on the upper surface. Some sea urchins have a spherical, bulb like cloaca that protrudes from the anal opening (Brusca and Brusca, 2003). It can be withdrawn into the shell. Depending on the species, movable spines of various sizes and forms are attached to the body. These spines often are sharp, pointed and in some cases even venomous. Some spines such as the pediculiaria can be used as pincers for grabbing small prey. Other pedicellaria are poisonous. An abundance of sea urchins can be an indicator of

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