



Faculty of Resource Science and Technology

**SPECIES COMPOSITION AND EXTERNAL MORPHOLOGY OF
ECHINODERMS IN BINTULU WATERS OF EXCLUSIVE
ECONOMIC ZONE (EEZ) SARAWAK,
SOUTH CHINA SEA**

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**Species Composition and External Morphology of Echinoderms at Bintulu waters
of Exclusive Economic Zone (EEZ) Sarawak, South China Sea**

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The Final Year Project is submitted in partial fulfilment of requirement for degree
of Bachelor of Science with Honours
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DECLARATION OF AUTHORSHIP

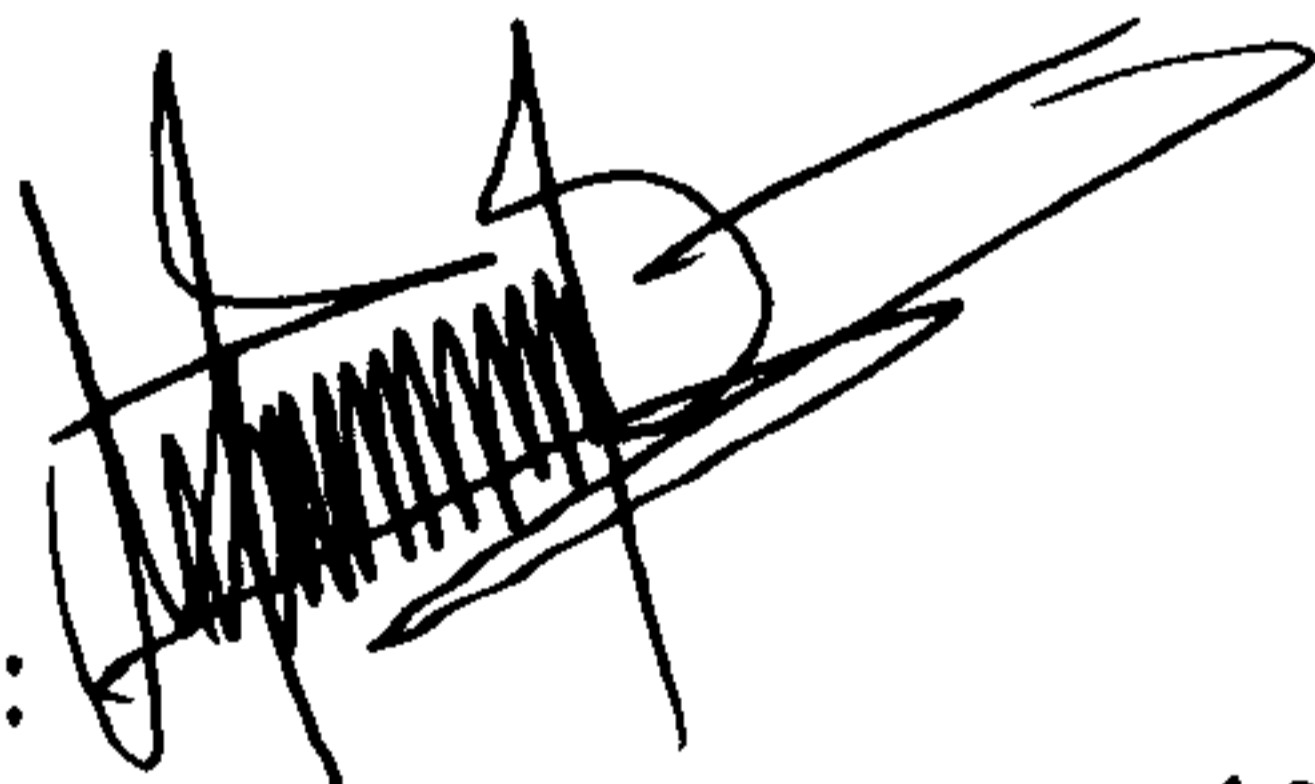
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ABSTRACT

Echinodermata is a phylum that belongs to benthic invertebrates which has spiny skin. Presence of echinoderms community is important part in aquatic ecosystem in biological assessment as primary and secondary consumers. However, the information of this phylum is still poor in Malaysia especially in EEZ Sarawak waters. Hence, this study wanted to determine the variety of echinoderms specimens that had been obtained as part of bycatch from the M. V. SEAFDEC 2 survey using bottom otter trawl from 19 August until 2 September 2015. The aim of this study were (1) to document the species composition of echinoderms of South China Sea at the Exclusive Economic Zone Bintulu Sarawak waters according to depth strata strata (0-50 m, 51 – 100m and 100-200 m) and seabed type and (2) to describe the external morphology of the echinoderms. Samples were available at twenty stations out of 30 stations. Only four classes, ten orders and 13 families found in this study. Total of 21 species of echinoderms had been found. Most dominant class was Asteroidea and most dominant species was *Stellaster childreni*. Abnormality had been found on starfishes, *S. childreni* and *Goniodiscaster scaber*. There were eight species with new record in Malaysia waters. The most abundance at strata 0 – 50 m and seabed mud, sand and shell. Total of 11 species at mud and sand seabed.

Key words: Echinodermata, South China Sea, morphology, abnormality, *Stellaster childreni*

ABSTRAK

Echinodermata adalah filum yang merangkumi invertebrata dasar laut yang mempunyai kulit yang tajam. Kewujudan komuniti echinodermata memainkan peranan dalam ekosistem akuatik dalam kegiatan biologi sebagai pengguna primer dan sekunder. Walaubagaimanapun, informasi mengenai filum ini masih kurang di Malaysia terutamanya di perairan ZEE Sarawak. Oleh yang demikian, kajian ini memastikan kepelbagaian organisma Echinodermata yang diperoleh daripada hasil tangkapan secara tidak langsung daripada operasi pukat tarik kapal M.V SEAFDEC 2 dari 19 Ogos sehingga 2 September 2015. Tujuan kajian ini (1) mendokumentasi taburan spesies Echinodermata di perairan Bintulu Sarawak berdasarkan strata kedalaman (0 – 50 m, 51 – 100 m dan 101 – 200 m) dan jenis dasar dan (2) menerangkan morfologi luaran haiwan Echinodermata. Sampel diperoleh dari 20 stesen daripada 30 stesen. Hanya empat kelas, sepuluh order dan 13 famili dijumpai dalam kajian ini. Sebanyak 21 spesies Echinodermata telah dikenalpasti. Kelas Asteroidea mendominasi hasil tangkapan dan spesies *Stellaster childreni* merupakan spesies dominan. Keabnormalan morfologi didapati pada *S. childreni* dan *Goniodiscaster scaber*. Terdapat lapan spesies yang baru direkod di dalam perairan Malaysia dalam kajian ini. Banyak individu di strata 0 – 50 m dan dasar berlumpur, berpasir dan bercangkerang. Sebanyak 11 spesies ditemui di dasar berlumpur dan berpasir.

Kata Kunci : Echinodermata, Laut China Selatan, morfologi, keabnormalan, *Stellaster childreni*

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List of Abbreviations

R	Radius of longest arm of asteroids
r	Radius of shortest arm of asteroids
th	Test height of Echinoids
tl	Test length of Echinoids
td	Test diameter of Echinoids
tw	Test width of Echinoids
SCS	South China Sea
EEZ	Exclusive Economic zone
mm	millimeter
m	meter
ID	Identification
km	kilometer
ST	stations
SEAFDEC	Southeast Asian Fisheries Development Center

1.0 Introduction

Southeast Asian Fisheries Development Center (SEAFDEC) were working on the M.V. SEAFDEC 2 vessel that had been conducting to assess the utilization of fishery resources for the development of the trawl fishery in order to control the fishing efforts in Malaysian waters.

The sampling operation of demersal fish had been completed with collaboration with Universiti Malaysia Sarawak at 32 stations. The sampling operations had been done by bottom otter trawl operation. Bottom otter trawl operation had resulted to huge catchment of fish (Mazuki *et al.*, 2012). However, bottom trawl operation contributes to the loss of erect epifauna by entraps moveable in its path and other non-target species. Trawling operation will be altered the species population due of modification of the substrate and become disturbance to other benthic communities. Sea stars, feather stars, sea lilies, brittle stars, sea urchins, heart urchins, sand dollars and sea cucumbers which are belong to phylum Echinodermata are the non-target species that had been collected in this study as one of the bycatch from the trawl operation.

Echinoderms are benthic macro-invertebrates that have calcium-rich skeleton, five-part body plan with arms that available from the intertidal to deep zone of waters (Sakthivel and Fernando, 2014). Many echinoderms are suspension feeders, while others are predators, scavengers and herbivores. A few are deposit feeders. Importance of echinoderms are highly impact on ecology, scientific, medicinal and even aesthetical value. Present of echinoderms community shows significant part in aquatic ecosystem in biological assessment as primary and secondary consumers (Sakthivel and Fernando, 2014). Even, there are certain species from this phylum contribute significantly to the biomass of the benthos (Pavlova and Zuyev, 2010). In case of sea cucumbers, these are scavengers that feed on debris at benthic layer (Purcel *et al.*, 2012). However, some echinoderms population need to be well monitored or destroys. As the

case of population of crown of thorns in benthic area had been destroyed in order to prevent the corals population being damage. In scientific field, sea urchins are useful in long term of standard study of embryology meanwhile sea cucumbers are properties in healing purposes (Purcel *et al.*, 2012). In Malaysia, sea cucumbers are well known as gamat and highly extracted in producing oil, cream or cosmetics. Besides, the diversity of echinoderms and theirs colouring appearances become attraction to human while observing them as long as made the echinoderms are important in aesthical value.

Nevertheless, there are few publish reports about the echinoderms. In Malaysia, there were limited study on echinoderms. There are only three accounts of Asteroidea that previously reported in 1987 and yet until 2008 the exact numbers of this class are unknown (Kwang *et al.*, 2008). There were only 113 species of crinoids, 272 species of ophiuroids, 167 species of echinoids and 203 species of holothuroids that reported in South China Sea (Lane *et al.*, 2000). Therefore, the information of echinoderms are little especially in EEZ Sarawak.

Thus, this study was to ensure the variety of echinoderms specimens that had been obtained as part of bycatch from the M. V. SEAFDEC 2 survey bottom trawl operation. Therefore, the main objectives of this study were (1) to document the species composition of echinoderms of South China Sea at the Exclusive Economic Zone Bintulu Sarawak according to depth strata and seabed type and (2) to describe the external morphology of the echinoderms.

2.0 Literature Review

2.1 Exclusive Economic Zone (EEZ), Malaysian waters

The South China Sea represents a western marginal sea of the Pacific Ocean, surrounded by the Southeast Asian mainland in the north and west and the islands of Borneo, Palawan, Luzon, and Taiwan to the south and the east (Wetzel, 2008). South China Sea (SCS) extends 2800 km north from the Equator and averages 1000 km in width with an area exceeding 2.8 million km². Malaysia claims an Exclusive Economic Zone (EEZ) with a total area of 548,800 km² which represent about 69% of Malaysia's coastal waters (Mazuki *et al.*, 2012). Exclusive Economic Zone (EEZ) Sarawak covers an area of about 160,000 km² of the South China Sea (Lane *et al.*, 2000). Meanwhile its continental shelf covers about 125,000 km² and slopes to 200 m in depth (Teh and Teh, 2014). Seabed of the South China Sea basin are covered with muddy, sandy, benthic shell, and clayey mud (Wetzel, 2008).

2.2 Phylum Echinodermata

Phylum Echinodermata were represented almost 7000 living and 13,000 fossil species in the world's ocean and has five classes, namely class Crinoidea that includes the feather stars and lilies stars, class Asteroidea that belongs to sea stars, class Ophiuroidea that belongs to brittle stars, class Echinoidea that includes sea urchins, heart urchins and sand dollars and class Holothuroidea that belongs to sea cucumbers (Oztoprak *et al.*, 2014). Echinoderms as a term means "spiny skin" although not all of them have obvious spines. The basic body plan of echinoderms was made up of the five-fold radial symmetry (Oztoprak *et al.*, 2014). The body is organized into five ambulacra with intervening regions called interambulacra (Bryne, 2001). The structure of the skeleton differs greatly between species and that is a key character in echinoderm taxonomy. Although the phylum is quite diverse, echinoderm physiology and their body plan display a surprising uniformity. They are characterized by an internal skeleton

composed of calcite plates called ossicles and a water vascular system. The ossicles have a porous microstructure that is distinctive. A major feature of the skeleton is that the ossicles may increase in size during the growth of the animal. The main portion of the body skeleton, known as the theca or calyx in most echinoderms, may have accessory appendages arms, rays, stem or brachioles (Sakthivel & Fernando, 2014). The further special characteristics of echinoderms between five classes was described in Table 1.0

Table 1.0 Characteristic features of living echinoderm classes (Bhamrah *et al.*, 1992)

	Symmetry	Skeleton	Appendages	Habitat
Crinoids	Penta-radial central cup-like body	Flexible jointed arms	Pinnules, cirri, hooks	Rock and reef
Asteroids	Penta-radial central body	Flexible and skeletal elements embedded in leathery test	Spines, paxillae, pedicellariae	Rock, reef, sand and mud
Ophiuroids	Penta-radial central discoidal body	Flexible disc jointed arms	Spines and hooks	Benthic sites
Echinoids	Penta-radial or bilateral, heart shape, irregular shape	Rarely flexible and thin	Spines and pedicellariae	Rocks, reef and sand
Holothuroids	Bilateral cucumber	Flexible and tiny	Hooks, spicules	Benthic site

2.3 Ecology of echinoderms

Echinoderms are found everywhere and are adapted to live in many habitats along the intertidal zone down to the continental shelf, deep ocean trenches and abyssal plains (Mills *et al.*, 2014). Most of the echinoderms were bottom dwellers and being intertidal inhabitants chiefly on coral reefs, sandy beaches, muddy flats and rocky coasts. Although echinoderms occur at all depths from the intertidal to the abyssal zones and are present throughout all of the world's oceans, their distribution is limited by the composition and topography of the sea-bed, by temperature and pressure differences according to locality and depth, and by salinity and food supply. Plus, specific behavior of echinoderms influence their adaptation on certain habitats such as holothuroids were generally crawled along the bottom but were capable of burrowing and swimming (Anderson, 2001). Ophiuroids literally carpet the sea floor in many abyssal areas (Rupert *et al.*, 2004). Sea stars are the most in ecology because sea stars prey on molluscs, crustaceans, oysters, clams and other invertebrates.

2.4 Regeneration of echinoderms

Regeneration in echinoderms involved the process of repairing, regrowth and cloning. Regeneration is a physiological sensation in echinoderms (Hyman, 1955). Echinoderms have high abilities to redevelop body parts in replacement of tissues, repairing mechanism and cloning strategies. Asteroids are very mutual with regenerative phenomenon. New accomplished adults can be regenerated from individual autotomized arms. Ophiuroids and holothuroids undergo asexual propagation that involving the splitting of adults into two or three pieces with following regenerative expansion of new complete individuals from each isolated portion. Regeneration occurs in echinoderms but less remarkable in terms of extent and degree of capabilities (Wilkie, 2001).

2.5 Taxonomy of echinoderms of the South China Sea

Table 2.0 Taxonomy of Echinodermata (Lane *et al.*, 2000).

Phylum : Echinodermata
 Subphylum : Pelmatozoa
 Class : Crinoidea
 Subphylum : Eleutherozoa
 Class : Asteroidea
 Order : Paxillosida
 : Notomyotida
 : Valvatida
 : Velatida

 : Spinulosida
 : Forcipulatida
 Class : Ophiuroidea
 Order : Phrynophiurida
 : Ophiurida
 Subphylum : Echinozoa
 Class : Echinoidea
 Order : Cidaroida
 : Echinothuroidea
 : Diadematoida
 : Phymosomatoida
 : Micopygoida
 : Pedinoida
 : Echinoida
 : Cassiduloida
 : Clypeasteroida
 : Spatangoida
 : Hololectypoida
 Class : Holothuroidea
 Order : Aspidochirotida
 : Dendrochirotida
 : Dactylochirotida
 : Apodida

3.0 Materials and Methods

3.1 Study area

Specimens were collected from Bintulu waters of Exclusive Economic Zone (EEZ) Sarawak, South China Sea by participants of MV SEAFDEC 2 team on 19 August until 2 September 2015. The coordinates of study site as stated in Appendix 1.0 taken from the log sheet of the survey. The distance of the EEZ waters is 200 nautical miles from the mainland. However, specimens were only available at 20 stations out of 32 stations (Figure 1.0).

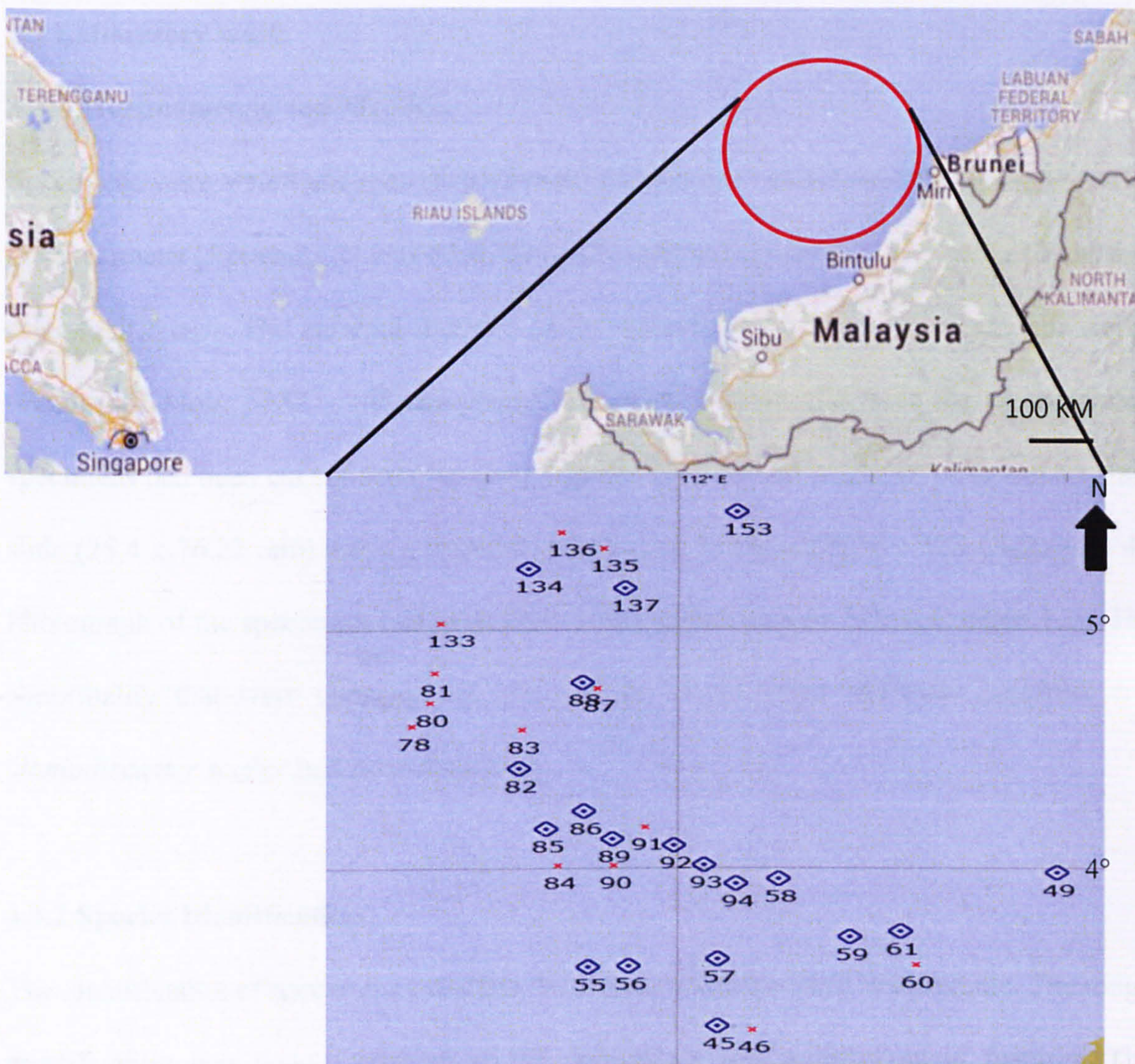


Figure 1.0 : Stations in Bintulu waters of EEZ Sarawak, South China Sea. (x) Stations with no samples.

3.2 Collection of specimens

Specimens were collected from the bycatch of the bottom otter trawl net. The mesh of trawl net ranged from 2 cm to 10 cm. Trawling period fixed to 60 minutes except for Station 55 and 78. Specimens were collected from three depth strata (20 -50 m, 51 – 100 m and 100 - 200 m). Depth strata, seabed type and seabed period had been taken from trawling logsheet of the operation. Representative of echinoderms (maximum 30 individuals per station) found in each haul were collected, packed, labelled and frozen in -20°C.

3.3 Laboratory work

3.3.1 Morphometric and Meristic

Specimens were sorted and thawed with room temperature. Morphometric measurement of the specimens (Appendix 2) was done using dial caliper (Mitutoyo \pm 0.01 mm), thread and ruler (\pm 0.1 cm). The external meristic of the specimens was observed using the stereo microscope Motic SMZ – 168 and magnifying glass. The ossicles from the sea cucumber specimens had been cut off from the inner layer of the skin and had been observed on glass slide (25.4 x 76.22 mm) using compound microscope Magnus MLXi – DX (Appendix 4). Photograph of the specimens had been taken using digital camera Nikon Coolpix L29. The abnormality that were observed on two species of starfishes *Stellaster childreni* and *Goniodiscaster scaber* had been discussed.

3.3.2 Species Identification

The identification of specimens was done two bases : morphometric and meristic. The rough identification was done according to the appearance and morphological features. The identification were based on taxonomic descriptions from published writing (Pawson *et al.*, 2010), (Mecho *et al.*, 2014), and (Mills *et al.*, 2014).

3.3.3 Preservation

Star fishes were preserved in 10% formalin for a day. After one day, specimens were air dried and preserved in 70 % ethanol for long term preservation (Kwang *et al.*, 2008). Sea urchins, sand dollars and heart urchins were preserved in 10% buffered formalin with sea water. Feather star were preserved in 10 % buffered formalin. Sea cucumber specimen were preserved in 10 % buffered formalin with sea water for 3 days and then the formalin were replaced with 70% buffered ethanol solution. After few days, the ethanol were refreshed with 70% buffered ethanol solution for the permanent storage. The ossicles of sea cucumber were preserved with drops of 70% buffered ethanol on glass slide and were covered with cover slip for permanent slide. All specimens were soak in preservatives in container and labelled (Station, date, location, depth, preservative solution and identification).

3.4 Data analysis

The morphometric and meristic data were used for identification process. After the identification process, specimens were analysed based on species composition according to the depth strata (0 – 50 m, 51 – 100 m and 101 – 200 m), species composition according to six categories of seabed type (1) mud only, (2) sand only, (3) mud and sand, (4) sand and coral, (5) mud sand and shell and (6) mud and clay). The sea bottom type at each stations were identified using openCPN 3.2.2 software. Furthermore, starfish *Stellaster childreni* were analysed on size of disc diameter based on depth strata.

4.0 Results

Only four classes, ten orders, thirteen families were been identified (Figure 2). Total of 120 individuals belong to twelve species twelve asteroids, seven species of echinoids, one species of holothuroid and one species of unidentified crinoid.

4.1 Species Composition of Echinoderms in Bintulu waters

A total of 120 individuals of echinoderms were recorded at 20 stations out of 30 stations in Bintulu waters (Figure 3). Only twenty-two species were found bycatch in this sampling. Twelve species of asteroids, seven species of echinoids, one species of crinoids and one species of holothuroid. Among the echinoderms, *Stellaster chidreni* were dominant species with 60.83% followed by *Maretia planulata* (5%), *Euretaster insignis* (4.17%), *Faorina chinensis* and *Peronella lesueuri* (3.33%), *Chaetaster longipes*, *Psilaster acuminatus*, *Anthenea aspera* and unknown species of crinoids with 2.5% respectively, *Asthenoma varium*, *Goniodiscaster scaber*, *Pentaceraster cumingi* and *Zoarester* sp. (1.67%) and lastly *Clypeaster humilis*, *Salmacis belli*, *Salmacis bicolor*, *Protoreaster* sp., *Anthenea pentagonula*, *Paracaudina australis* and Order Brisingida with 0.83% respectively. No ophiuroid was obtained. Checklist of echinoderms at Bintulu waters EEZ Sarawak, South China Sea (Table 2.0) showed of name of species at 20 stations that were available. Only ten stations in strata 0- 50 m, six stations of strata 51-100 m and four stations in strata 101 – 200 m. The most abundance were at strata 0 – 50 m, followed by 51 – 100 m and 100 – 200 m. *S. chidreni* and *E. insignis* only were available at all strata.

