Status, Prospects and Potentials of Echinoid Sea Urchins in Malaysia

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***Abstract*—**Among the bottom-dwelling invertebrates, sea urchins have been considered as the high-valued new marine bioresource in Asia. They inhabit the depths of coral reefs and rocky shores that are covered with coralline algae and seaweeds. They are usually spherical in shape, and their whole body is covered by numerous thorns or spines that act as defense mechanism against predators. The sea urchin gonad has been used as luxury food and folk medicine by the peoples of certain countries. For this reason, sea urchin became an important product and fetches high price in international markets. It also plays an important role towards providing employment opportunity and income source to the coastal communities in many Pacific island countries including Malaysia. Sea urchin gonad is very rich in essential proteins, lipids and bioactive compounds having profound nutraceutical and pharmaceutical importance. Nowadays, sea urchins have been harvested for trade with Asia and are perhaps one of the worthy exports from the Indo-Pacific islands. Unluckily, owing to increasing demand and prices, combined with the development of cash economies and growing coastal populations, it has led to extensive overfishing of the resource across much of this region, especially in Pulau Bum Bum near Semporna between Philippines and Eastern Malaysia. Nevertheless, some Pacific island countries have completed research trials on breeding, nursing and culture techniques, but such types of research works are yet to be completely explored and determined in Malaysia. In the recent years, undiscriminating catching and over-exploitation of sea urchin turns out to be excessive and disrupts its sustainability. Because of this prevalent situation, aquaculture of sea urchins through the appropriate breeding, seed production and culture techniques in captivity should be the best alternative to solve these problems in a worthwhile and sustainable manner.

***Keywords*—**Sea urchin, status, prospects, potential, roe, food, medicine, benefits

I. Introduction

SEA urchin (Echinodermata: Echinoidea) is an important bioresource for research in different fields of biology, ecology, biodiversity, culture conservation and evolution. It is a member of a large group of marine invertebrates (including starfish, sea cucumber, sea lily and brittle star). It's body is usually spherical, having five equal segments and is covered with long movable spines located on its hard, calcareous shell. The spines are used for locomotion, passive defense against predators and trapping food particles. Numerous tube feet are located between the spines and are used for movement, capturing food as well as attaching to substrates. A stinging jaw (or small pinchers), called the pedicellariae, is also used for protection and to clutch the food items. The mouth of sea urchin is located on the underside of the organism and consists of a 5-pointed jaw called "Aristotle's Lantern" [1, 2]. The internal organs are enclosed in a hard shell or "test" composed of fused plates of calcium carbonate covered by a thin dermis and epidermis. The test is rigid, and divides into five ambulacral grooves separated by five interambulacral areas. Each of these areas consists of two rows of plates, so the sea urchin test includes 20 rows of plates in total. The plates are covered in rounded tubercles, to which the spines are attached. The inner surface of the test is lined by peritoneum.

Sea urchins are dioecious, having separate male and female sexes, although distinguishing the two is not easy, except for their locations on the sea bottom. Males generally choose elevated and exposed locations, so their milt can be broadcast by sea currents. Females generally choose low-lying locations in sea bottom crevices, presumably so the tiny larvae can have better protection from predators. Indeed, very small sea urchins are found hiding beneath rocks. Regular sea urchins have five gonads, lying underneath the interambulacral regions of the test, while the irregular forms have only four, with the hindmost gonad being absent. Each gonad has a single duct rising from the upper pole to open at a gonopore lying in one of the genital plates surrounding the anus. The gonads are lined with muscles underneath the peritoneum, and these allow the animal to squeeze its gametes through the duct and into the surrounding sea water where fertilization takes place.

Sea urchin, among the bottom-dwelling marine invertebrates, has been considered as the most important echinoderm fishery in the world, especially Asian, Mediterranean and Caribbean Island countries [1-5]. In Asia, the Indo-Malaysian Archipelago is the hotspots region of marine biodiversity, especially endemic with a huge number of sea urchin species. Until now, twelve tropical species (Fig. 1) have been documented in Malaysia's coral reef communities, such as: *Diadema setosum, D. savignyi, Echinometra mathaei, Astropyga radiata, Toxopneustes pileolus, Echinothrix calamaris, Echinothrix diadema, Parasalenia gratiosa, Salmacis sphaeroides, Pseudoboletia maculata, Tripneustes gratilla and Salmaciella dussumieri* [1, 6]. Among them, the high-valued tropical urchin, *Tripneustes gratilla* (Linnaeus, 1758) (Echinodermata: Echinoidea: Tripneustidae) or collector sea urchin is considered as one of the most commercially important regular echinoid in Malaysia, and also has a

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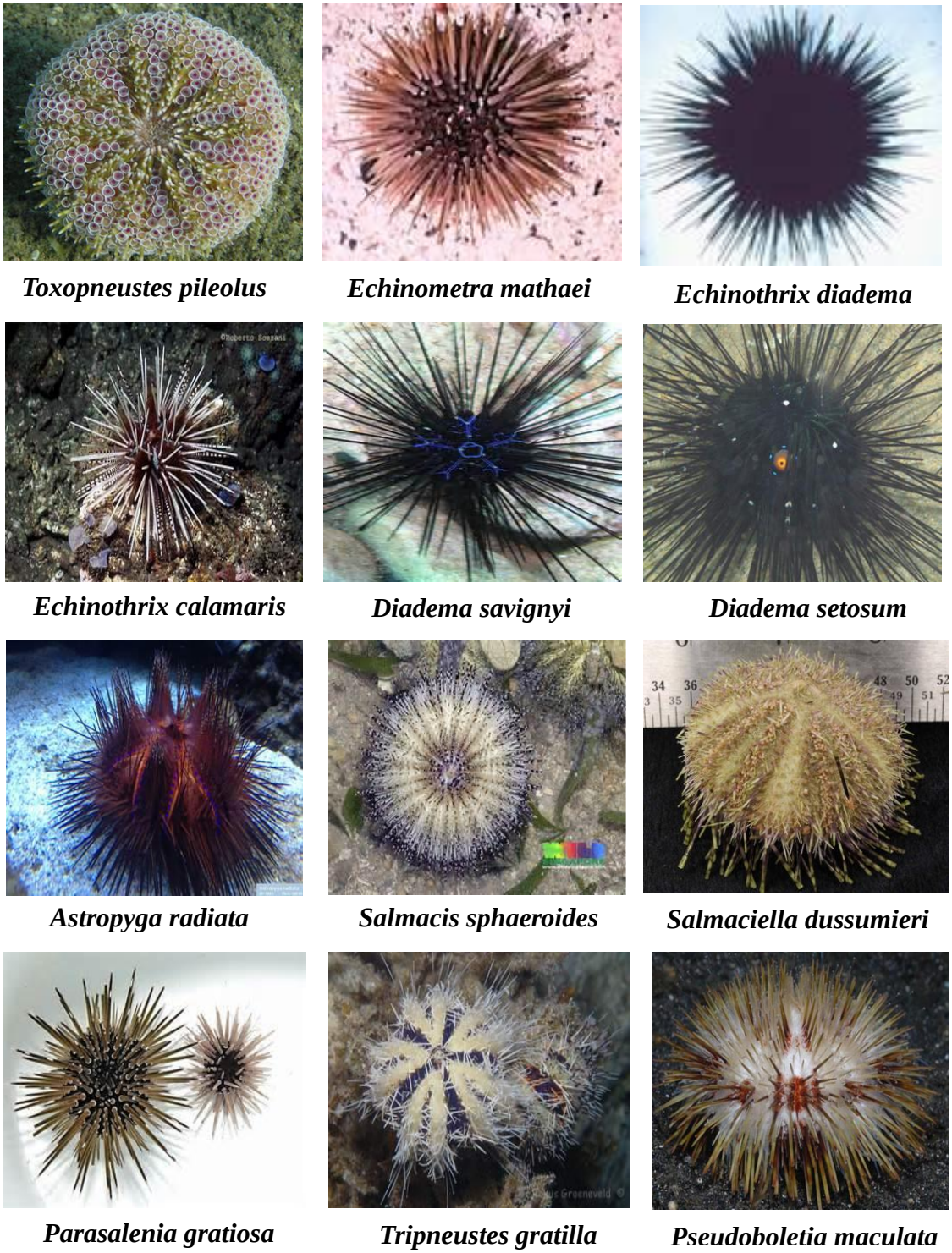

Fig. 1. Twelve species of tropical sea urchins endemic to the coral reef habitats in Malaysia.

circumtropical distribution extending into the subtropics [7]. It has profound biological, aquacultural, nutritional and medicinal significance in Asian and Mediterranean countries.

II. Present Status, Potentials And utilizations

a. Status, prospects and potentials

World sea urchin fisheries have expanded so greatly in recent years, that the natural population in Japan, France, Chile, the northeastern United States, the Canadian Maritime Provinces and the west cost of the north America from the California to British Colombia have been overfished to meet the great demand [4, 7-10]. World landings of sea urchins peaked at 120,000 mt in 1995 and were reported at 82,000 mt in 2012 [11]. However, over half of this catch comes from the recently expanded Chilean fishery for *Loxechinus albus*. The other major sea urchin fisheries, in terms of tonnage landed, are in Japan, Maine (USA), British Colombia (Canada) and California (USA) [12]. The major sea urchin producing countries are Chile, Japan, the U.S., Canada, Russia and China. Chile is by far the largest producer, contributing about 45 percent of the global production by volume [13]. In Europe, the sea urchin (*Paracentrotus lividus*) stocks in France and followed by Ireland were overfished in the 1980s to supply the French market and those have never recovered [14]. These decreasing patterns clearly reflect the overexploitation of most fishery grounds and highlight the need for conservation policies, fishery management and aquaculture development [15].

In Sabah, the Eastern Malaysia, sea urchin fishery especially *T. gratilla* was once available. It has been used as local delicacy and also the sources of income, especially by the Bajau and Philipino people in Sabah [6, 13]. In the recent decades, the natural population and abundance of some sea urchin species have been declining from the Malaysian intertidal and subtidal reefs due to the environmental and man-made interventions effecting spawning and feeding grounds to a severe state. Hence, it is urgently needed to protect this species from extinction as well as conserve it's biodiversity along with other commercially important sea urchins, which have great potentials not only for aquaculture industry but also towards the development of nutraceutical and pharmaceutical products for the therapeutic and human health benefits.

b. Food and nutritional usage

Sea urchins are found in oceans all over the world. They play an important role in marine food chains, consuming algae and various invertebrates, and being consumed by crabs, sea stars, fishes, mammals, and birds. For humans, sea urchins are harvested and served as a delicacy food and nutrition. They are used as raw materials to produce foodstuff, in particular, the product of processing gonads known as "Sea urchin Roe" and is considered a prized delicacy in Asian, Mediterranean and Western Hemisphere countries [1-5, 16]. Either fresh or in the form of processed food, the gonads of sea urchins have long been used as a luxury food in Japan [2, 5, 17, 18]. Although, sea urchin gonad has not yet been used as food and medicine in Malaysia, it is reported in Sabah that an indigenous tribe known as "Bajau Laut" eats sea urchin roe with rice. The body of sea urchin known as test, is cleaned and the roes removed. The clean test is then filled with rice and roe and the concoctions are steamed after adding spices, and then serve to guests [1, 6].

On the basis of nutritional facts, a 100 g of sea urchin gonad, which is equal to about 3.5 ounces, contains 172 calories and very little fat. The fat that a serving sea urchin does contain is almost all unsaturated fat. For example, there is 1.75 g of polyunsaturated fat content in a serving sea urchin. Consumption of polyunsaturated fats instead of saturated fats, such as those found in a burger, can help in reducing the overall cholesterol level. Sea urchins also contain omega-3 fatty acids, which can help in lowering blood pressure and reducing the risk of an abnormal heart beat [19]. In addition, they serve as frequent model organism for developmental and immunological studies.

c. Economic importance

Echinoderms offer important benefits to human beings due to their use in scientific research and education and also for food. In the economic point of view, sea urchin gonad either in the form of fresh or processed food, is considered as one of the most expensive and luxury seafood in the world [21]. In Japan, for example, sea urchin (known as "uni") and its processed roe can retail for as much as AU$ 450 per kg. In addition, scientists and researchers can learn much about animal reproduction, fertilization, development and evolution by studying sea urchins, sea stars and other echinoderms [20].

In Sabah, the Bajau, Suluk, Kokos and Ubian tribes harvest the sea urchins, particularly their eggs, to be sold and eaten as a delicacy. The sea urchins having long spines are known as "tayum" in Sabah, while the shorter spined species are called "tehe-tehe". Sea urchins are usually sold in wet markets at different prices depending on their type and location. Tayum eggs are usually eaten raw and the selling price is from RM 2 to RM 5 per pack. Meanwhile, "tehe-tehe" is sold at RM 1 to RM 2 per plate i.e., containing three urchins with their skin intact to be cooked into oko-oko, a traditional Bajau delicacy. In comparison, price of sea urchin eggs is RM 36 to RM 60 for every 80 g in America, while in Japan, an urchin can cost as much as RM 18 [22]. Aesthetically, the diverse forms of the sea urchins, and their beautiful coloring, are often provide not only a source of joy and recreation but also increase the additional revenue to humans observing them.

d. Medical and human health welfares

The sea urchin roes improve blood circulation includes reproductive organs. Hence and therefore, it will improve on sexual arousal. The population of the Asian Pacific Region has also been using sea urchin gonad for long time as a remedy for improving general living tone, treatment for a number of diseases and strengthening of the sexual potency of men, especially the middle aged [23, 24]. Sea urchins gonads are also rich in valuable bioactive compounds, such as polyunsaturated fatty acids (PUFAs) and β-carotene [25]. PUFAs, especially eicosapentaenoic acid (EPA, C20:5n-3) and docosaphexaenoic acid (DHA C226n-3), have significant preventive effects on arrhythmia, cardiovascular diseases and

cancer [26]. On the other hand, the high levels of AA (arachidonic acid) and EPA recently detected in sea urchin gonads supported the development of aquaculture of this species [27], since PUFAs are important for human nutrition [28]. Sea urchin is also rich in high-quality proteins and thus a good substitute for protein rich foods such as meat, fish, beans and legumes.

e. Livelihood improvements

Alike other commercially important marine invertebrates, sea urchin plays a significant role on livelihood development in coastal communities. *Tripneustes gratilla* usually used to make traditional delicacy known as "Oku-Oku" or "Ketupat Tehe-Tehe", whereby glutinous rice is put into degutted urchin test and boiled with coconut milk or water, and after adding spices, the concoctions are steamed and then serve to the guests and customers [1-5, 19]. This is usually prepared for special events such as Lepa-Lepa festival, wedding ceremony and other cultural events and is being treated as valuable fishery resources, especially by Bajau people in the Sabah state of the Eastern Malaysia [28, 29]. However, the custom of consuming sea urchin gonad is thought to come from the influence of Philipino and Indonesian peoples that live in Sabah. Although sea urchins are always treated as the "enemy", especially by divers and snorkelers since their spines could cause serious injuries to them, Sabah citizens treat sea urchins as a traditional delicacy and source of subsistence income.

III. Conclusion

Based on the above findings and considerations in mind, it could be concluded that sea urchins play an important role in subsistence income generations, and health benefits to the coastal communities in Malaysia. However, this important marine bioresource is yet to be fully determined, explored and utilized in Malaysia. The present investigation has been made an attempt to document the current status, species identifications and benefits of sea urchin species in Malaysia. Until now, few systematic studies on the abundance, distribution and population growth patterns of *D. setosum* and *S. sphaeroides* have been conducted in Peninsular Malaysia [24, 25, 26], but no published information on their breeding, nursing, seed production and culture techniques are available [30]. Due to the higher nutritional and medicinal values of sea urchin gonads, it is very important to develop appropriate techniques for breeding, larval rearing and nursing. Bearing this in mind, aquaculture through the proper brood stock management, seed production and culture techniques in captivity should be considered as the best alternative to prevent this severe problem in a sustainable and worthwhile manner.

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