Distribution of Sea Urchins in Punta Dumalag, Matina Aplaya, Davao City

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Abstract

This study investigated the distribution and diversity of sea urchins along the intertidal zone of Punta Dumalag, Matina Aplaya, Davao City. A total of 100 quadrats (1m x 1 m) spaced 5 m apart, in 3 transects laid perpendicular to the shoreline, recorded a total of 347 individuals, resolved into 5 species, namely, *Echinometra mathaei* (rock- boring or common sea urchin), *Echinothrix calamaris* (Hatpin urchin), *Diadema setosum* (long-spine or "tuyom"), *Prionocidaris verticillata* (rough spine urchin), and *Diadema savignyi*. Among the 347 individuals recorded, *Echinometra mathaei* was the most abundant in the site with a total of 286 individuals. Shannon-Weiner Diversity Analysis (0.602) suggests low species diversity. Physico-chemical measurements such as water temperature, pH, dissolved oxygen, and salinity revealed that the study site is suitable for the culture of sea urchins.

Keywords: sea urchin, Punta Dumalag, distribution, diversity

Sea urchins, also known as sea hedgehogs, are small, spiny, and globular animals that comprises the class Echinoidea of Phylum Echinoderm with their close relatives, such as the sand dollars (Animal Diversity Web, 2012). Their colors are black and dull shades of red, green, brown, purple, and olive. It plays an important role in marine food chains, consuming various algae, and invertebrates, and being consumed by fishes, sea stars, crabs, birds as well as mammals. They can be found in ocean floors worldwide and also inhabit coral reefs (Hibberd, 2009).

The biodiversity of sea urchins is ecologically important. Echinoids, specifically the sea urchins have been found to retain levels of metals in their bodies. Recent studies demonstrated that Echinoids are valuable biological indicator of heavy metal contamination (Freeman, 2004). Even public aquariums used sea urchins as an indicator for water quality. Sea urchins are among the first organisms to show signs of stress that leads to death. Thus, it makes them excellent organisms to use for studies on pollution. Sea urchins act as important keystone species within an ecosystem. By feeding on algae, sea urchins control the algal growth that if allowed to proliferate, would cover coral surfaces, smothering, and killing the corals. Through their burrowing and feeding behaviors, they moderate the balance between coral erosion, algal growth, and are considered sensitive bio-indicators of various contaminants (Zizka, 2012).

Sea urchins also have economic importance. They serve as source of livelihood for the residents in the area. Their gonad is a high valued fishery commodity sold as fresh roe in central wholesale market in Tokyo, Japan. *Tripteneustes gratilla* is an economically important fishery resource generating multi-million peso earning per annum. They are widely collected for food in many Pacific countries. Their shells, like seashells, serve as decorations (Prado et al., 2012). Tomsic et al. (2101) also stated that the gonads of sea urchins as well as their roe can be eaten boiled, baked, or raw. They are also used as tools in laboratory in embryology. Their gametes are the same size with human gametes (Freeman, 2004).

Researchers nowadays are use sea urchins to diseases such as Alzheimer's, cancer, Parkinson's diseases, and muscular dystrophy. Sea urchins, though invertebrates, share common ancestry with humans and have more than 7,000 of the same genes. With a complete map of DNA of sea urchins, scientist can learn how to treat and prevent diseases in humans better (Freeman, 2004).

Punta Dumalag is known for its high diversity of marine species and beautiful spot that makes

it one of the frequently visited places in Davao City. It is located in Barangay Matina Aplaya 75–A, in the eastern part of Davao City, with seashores and natural resources, such as mangroves, sea grasses, sea urchins, corals and nesting areas for turtles. It is bounded on the north by Barangay 76-A, to the east by Davao Gulf, to the south by Barangay Talomo and to the west by Barangay Matina (LGU-Dumalag, 2008). Punta Dumalag is a Marine Protected Area (MPA). Marine Protected Area (MPA) sustains fisheries utilization in the fishing areas, and also protects and conserves ecosystems. It provides habitat and protection to large and reproductive mature members of various marine species. MPA also protects and conserves the nesting sites for the endangered marine turtles and birds. Thus, the study was conducted to gather ecological information as well as identification and distribution of sea urchins in the Southside of Marine Protected Area (MPA) in Punta Dumalag, Matina Aplaya, Davao City.

This study was conducted to gather important ecological information of sea urchins in Punta Dumalag, Matina Aplaya, Davao City. Specifically, this study sought to (i) identify the different species of sea urchins found in the study area based on morphological characteristics, (ii) determine species frequency, species density, species richness, species evenness, abundance, diversity, and (iii) determine the physico-chemical characteristics of the study site such as water temperature, pH, dissolved oxygen, and salinity.

Materials and Method

Study Area

This study was conducted in Punta Dumalag, Matina Aplaya, Davao City. The place is recognized as one of the Marine Protected Areas (MPA) in the Gulf of Davao. The site was declared as a protected area due to the presence of mangroves, seagrasses and coral reef resources within the 37-hectare MPA, which boundaries start from the shoreline and extend to a distance of about 300 meters seaward (Barangay Punta Dumalag 5-Year Marine Protected Area Management Plan, 2008-2012). The study covered an overall total sampling area of 1,360 m^2.

Geographic coordinates were determined using Garmin GPs receiver to geotag the location of the area, namely, Transect 1 (7° 1'28.30"N, 125° 34'35.10"E); Transect 2 (7° 1'28. 16"N, 125° 34'34.81"E), and Transect 3 (7° 1'28.00"N, 125° 34'34. 43"E).

Sampling Design

Three (3) transect lines were established perpendicular to the shoreline in the southern part of Punta Dumalag Marine Protected Area (MPA). Each transect consisted of 100 quadrats measuring 1m x 1m, spaced 5 m apart. The total area covered 1,360 $m^{2,}$ while the total area of the three (3) transects measured 300 m^2. Specimens were collected in shallow water through snorkeling and by and picking along the sampling area. All sea urchins found in the quadrat were photographed and counted. Species length and weight measurements were taken using a ruler and digital balance.

Collection of Data

Field data were gathered during the lowest low tide, in July, September and October, 2014, where species were visible. Collected sea urchins were soaked in 70 % isopropyl alcohol. All morphometric measurements were taken in millimeter (mm).

Physico-chemical parameters such as pH, water temperature, dissolved oxygen, and salinity were measured *in situ* using a thermometer and portable water quality meters, respectively.

Species Identification

Sea urchins were identified using morphological markers (spines and colors) using field guides, books, journals and previous theses, and taxonomic verification was carried out by local and international experts (Rach Mooi, Ph.D., Center of Echinoderm, Dept. of Invertebrate Zoology and Geology, California Academy of Science, San Francisco, USA).

Spicule Determination

Spicules of sea urchins found in the study area were obtained by scrapping the inner test or shell using a scalpel or blade. The scrapped part was mounted on the slide, added with a small amount of *zonrox* (clorine) solution. The slide was viewed through a microscope under high power magnification. Identification of spicules was determined using a field guide. Verification of the initial species ID was done by sending the data to Dr. Rach Mooi.

Results and Discussion

Five (5) species of sea urchins were found in Punta Dumalag Marine Protected Area - *Echinometra mathae* (rock-boring or common sea urchin), *Diadema setosum* (long-spine or "tuyom"), *Echinothrix calamris* (Hatpin urchin), *Diadema savignyi* (long-spine urchin), and *Prionocidaris verticillata* (rough spine urchin), resolved in three (3) Families. Three (3) species were found under Diadematidae, one (1) species under Echinometridae, and one (1) species under Cidaridae. *Echinometra mathaei* from Echinometridae recorded the highest number of individuals among the five (5) species, while *Prionocidaris verticillata* showed the least number. As observed, representative Diadema are bigger and heavier compared to the other two families.

Table 1 shows that there were 347 individuals found in the sampling area, dominated by *Echinometra mathaei* with a total count of 296 individuals.

As shown in Table 2, *Echinometra mathaei* has the highest frequency and density observed in seventy six (76) quadrats. Followed by *Diadema setosum*, then *Echinothrix calamaris*, then *Diadema savignyi,* while *Prionocidaris verticillata* has the lowest frequency and density.

Table 3 shows species diversity analysis of sea urchins in the study area. Results show that Shannon-Weiner Diversity Index in Punta Dumalag is 0.602, suggesting low diversity because an area is considered diverse if the value of the Shannon-Weiner Diversity Index is greater than 1.5.

Table 4 shows the results of the physico-chemical parameter in the sampling area. Mean value of pH in Punta Dumalag is 8.07. This falls within the normal pH range of 6.5 to 8.5 pH (Tehranifard, 2011). This pH helps sperm motility and respiration rate. *Diadema savignyi* can tolerate the pH 7.5 to 8.2. Their optimal pH is 7.8. *Diadema setosum* and *Echinometra mathei* preferred 8.1 to 8.4 pH. Below pH 6, sea urchin larval motility weakens and growth stops. pH must be maintained between 6.0 to 9.0 pH. Result shows that the mean water temperature in Punta Dumalag is 25.1ºC. According to Tehranifard (2011), sea urchin can maintain high growth rate between 24ºC to 25ºC.

Table 1. Sea urchins identified in Punta Dumalag, Matina Aplaya, Davao City.

Family	Scientific Name	Common Name	Counts	Length (mm)	Weights (g)
Echinometridae	*Echinometra mathaei*	Common Urchin	296	70	50.2
Diadematidae	*Diadema setosum*	Long spine urchin	21	89	90.1
Diadematidae	*Echinothrix calamris*	Hatpin urchin	15	124	170.4
Diadematidae	*Diadema savignyi*	Long spine urchin	11	158	150.5
Cidaridae	*Prionocidaris verticillata*	Rough spine urchin	4	48	30.9

Table 2. Ecological distribution of sea urchins in Punta Dumalag, Matina Aplaya, Davao City.

Species Name	Total number of individuals	Species Frequency	Relative Frequency (%)	Population Density	Relative Density (%)
Echinometra mathaei	296	0.8530	85.3	0.99	85.30
Diadema setosum	21	0.0605	6.05	0.07	6.05
Echinothrix calamaris	15	0.0432	4.32	0.05	4.32
Diadema savignyi	11	0.0317	3.17	0.04	3.17
Prionocidaris verticillata	4	0.0115	1.52	0.01	1.15

Table 3. Species diversity of sea urchin in Punta Dumalag.

Family	Species	Total number of individuals
Echinometridae	*Echinometra mathaei*	296
Diadematidae	*Diadema setosum*	21
Diadematidae	*Echinothrix calamaris*	15
Diadematidae	*Diadema savignyi*	11
Cidaridae	*Prionocidaris verticillata*	4
	Total	347
	Shannon-Weiner Diversity Index	0.602
	H max	1.609
	Species Evenness	0.374
	Species Richness	5

Table 4. Physico-chemical parameters in Punta Dumalag.

Transect	pH	Water Temperature	Dissolved Oxygen	Salinity
1	8.05	25.1	17.95	25
2	8.09	25.3	18.35	27
3	8.07	24.9	17.64	26
Mean	8.07	25.1	17.98	26

Dissolved oxygen has a mean value of 17.98 mg/L which is suitable for the survival of sea urchin. Rivero et al. (1996) stated that Oxygen concentrations of 1- 2 mg/L reduce fertilization success to below 50% and can cause mass mortality (Riveros et al., 1996). The mean salinity in Punta Dumalag is 26 ppt. Hendler (2013) attested that Sea urchin cannot tolerate less than 21 ppt salinity because, if reduced it can cause mortality. Result revealed that the physico-chemical parameters in Punta Dumalag is suitable for the survival of sea urchin.

Family Echinometridae - *Echinometra mathaei*

Collected *Echinometra mathaei* (Figure 1A) measures 70 mm and weighs 50.2 g. Their color varies but the test is usually of dark color. During the lowest low tide, they are found along the shoreline in varieties of color.

The test is small, strong, and oval shaped. Primary spines are half of the test diameter, usually stout, tapering, and colors are getting lighter at tips. Secondary spines are short, flat tips that are like rolling pins. It has a pale ring at the base of the

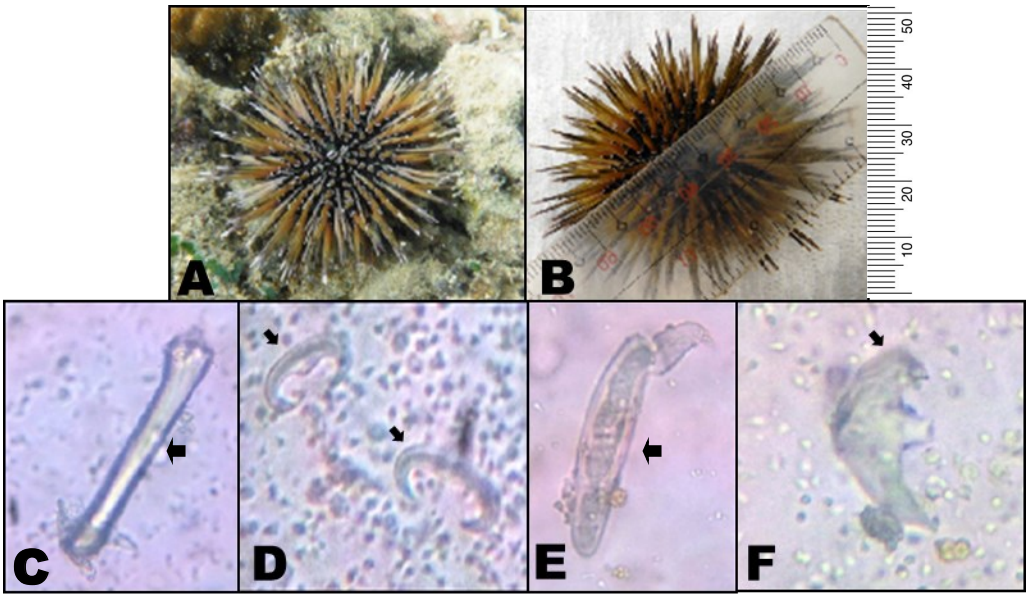

Figure 1. A. *Echinometra methai*, common sea urchin collected in Punta Dumalag, Matina Aplaya, Davao City. B. Measurement of specimen. C-F. Different spicules of the species: C. tylote, D. sigma, E. chela, F. isochela micrographs taken at 100X using bright field microscope (Amscope).

spine (Jeng, 1998). The spicules found in the inner test are tylote, sigma, chela, and isochela (Figure 1C-F). It thrives in shallow waters.

Family Diadematidae - *Diadema setosum*

The collected specimen measure 89 mm and weighs 90.1g (Figure 2). They are herbivores and can therefore play a vital role as an interesting member of the clean-up crew (Coppard & Cambell, 2006).

This urchin is well known for having long, sharp, brittle spines capable of painful sting when stepped upon, but slightly venomous. It can be distinguished from other *Diadema* species by the presence of five white spots on the test located between the ambulacral grooves. It also includes the presence of a bright orange ring around the ur-

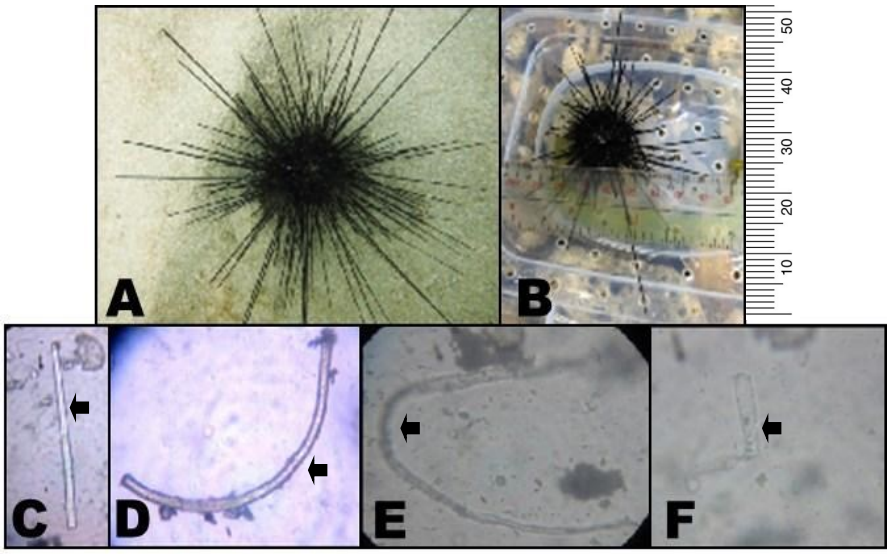

Figure 2. A. *Diadema setosum*, long spine urchin collected in Punta Dumalag, Matina Aplaya, Davao City. B. Measurement of specimen. C-F. Spicules of the species: strongyles micrographs taken at 110X using bright field microscope (Amscope).

chin's periproctal cone, a structure called "anus" (Jeng, 1998). The only spicule found is called strongyle (Figure 2C-F) that was found in the inner test of these species (Lee & Shin, 2013).

Family Diadematidae - *Echinothrix calamris*

The collected specimen measures 124 mm and weighs 170.4 g. *E. calamris* (Figure 3) occurs from surface to 70 cm depth and can be found in lagoons and channels (Kroh & Mooi, 2014). They are active during the night and hide in crevices or under rocks during the day (LeBris & Maran, 2010). The spicules (Figure 3C-E) found in the inner test of this species are chela, style , and strongyle (Lee & Shin, 2013).

Echinothrix calamris are found in an intertidal zone along the horizontal coral rocky area during night time. They have a number of color patterns in the spines which move smoothly, white

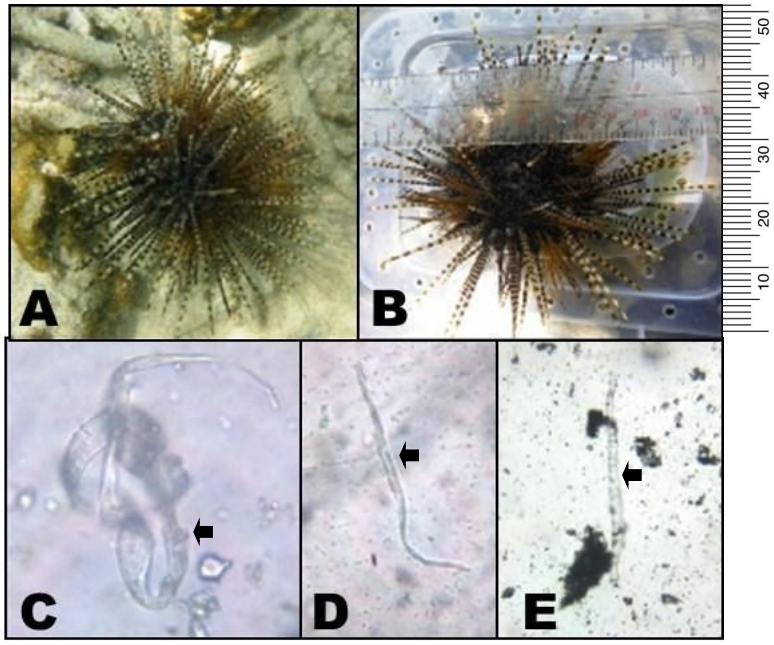

Figure 3. A. *Echinothrix calamris*, hatpin urchin collected in Punta Dumalag, Matina, Aplaya, Davao City. B. Measurement of specimen. C-E. Different spicules of the species: C. chela, D. style, E. strongyle micrographs taken at 100X using bright field microscope (Amscope).

for the primary and yellow for the shorter spines that can deliver a nasty sting, while the longer open ended spines are banded with light and dark color.

Family Diadematidae - *Diadema savignyi*

It was observed that the long spines of *Diadema savignyi* (Figure 4) and other species of Echinoidea oftentimes can cause injury when people accidentally step on them. Alender & Russel (1966) stated that the once the spine detaches and penetrate the body tissue, an infection can occur. Collected specimen measures 158 mm and weighs 150.5 g. It has solid iridescent blue or sometimes green lines that run along its black test and periproct, area surrounding anus (Coppard & Cambell, 2006).

This species lives in shallow waters (Muthiga, 2003). It is an urchin that displays pentamerism, a quality of the class Echinodermata. It has many long spines, tube feet and a round body. Its anal sac is dark. According to Muthiga et al. (2007), given suitable condition, the test can grow as long as 90 mm in diameter. They live in sand flats and coral reef areas, which are warm shallow areas near the coasts (Hoey, 2008). Species of *Diadema* are prey of 15 species of finfish, the spiny lobster, and 2 species of gastropods (Shafir & McClanahan, 1990). Spicules (Figure 4C-D) found in the inner test of *Diadema savignyi* are tylote and toxaspire.

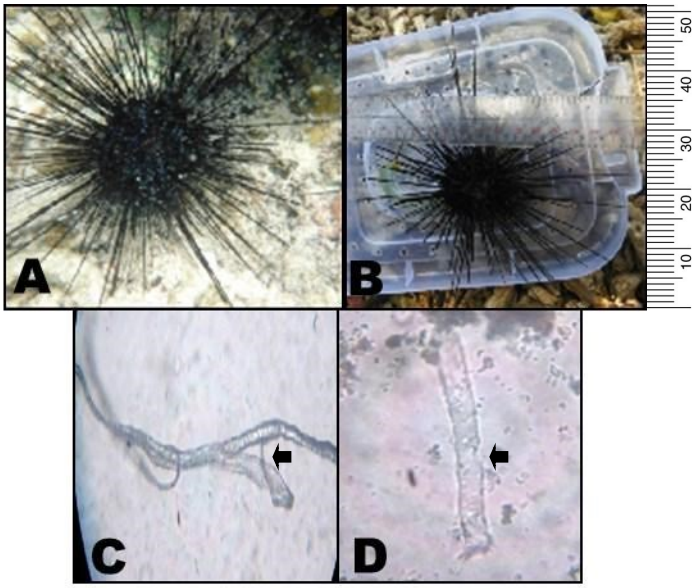

Figure 4. A. *Diadema savignyi*, long spine urchin collected in Punta Dumalag, Matina Aplaya, Davao City. B. Measure -ment of specimen. C-D. Different spicules of the species: C. tylote, D. toxaspire micrographs taken at 100X using bright field microscope (Amscope).

Family Cidaridae - *Prionocidaris verticillate*

Prionocidaris verticillata (Figure 5) is found in shallow waters in rocks and patch reefs. It varies in color from place to place. In Punta Dumalag, Matina Aplaya, *Prionocidaris verticilla- ta* blends with the color of the rock. The specimen found measures 48 mm and weighs 30.9 g. Spic- ules found in the inner test in *P. verticillata* is only rod (Figure 5C-F). It feeds on invertebrates, spong- es and even dead fish. To move, it uses its tube feet. But there were times when it hitched a lift on the back of crabs. Kroh & Mooi (2014) observed that the anus of this species is located on top, its jaws, so strong, are used for grinding its prey and is also sensitive to light. At a short distance, it has the capacity to shoot venom loaded spines.

It has a small globular test with an arma- ture of disproportionately long thorn-like spines. Rough long spines are used as walking stilts and

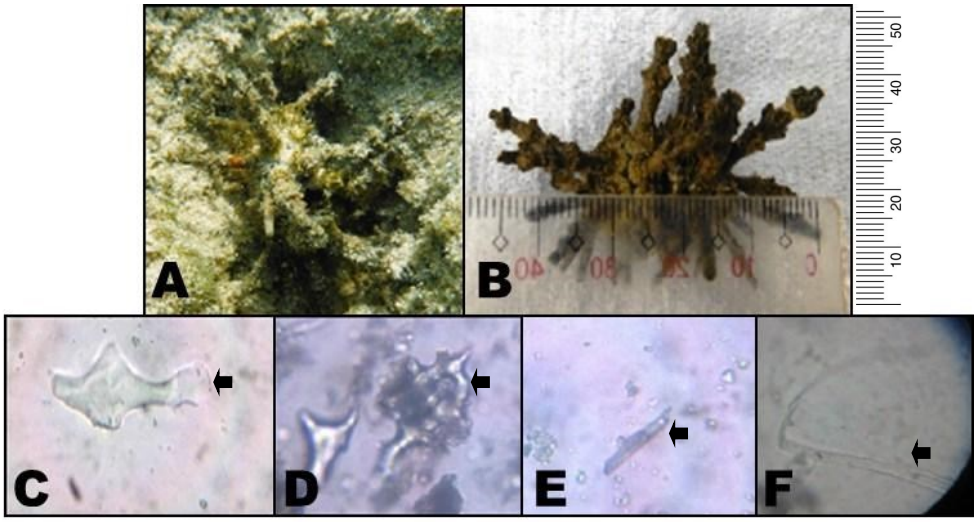

Figure 5. A. *Prionocidaris verticillata*, rough spine urchin collected in Punta Dumalag, Matina Aplaya, Davao City. B. Measurement of specimen. C-F. Different spicules of the species: C. sanidaster, D. buttons, E. tylote, F. toxaspire micro -graphs taken at 100X using bright field microscope (Amscope).

the points of the thorns are often worn (Taylor, 1996). Spicules (Figure 5C-F) found in the inner test are sanidaster, buttons, tylote, and toxaspire (Lee & Shin, 2013).

Conclusion

There were five (5) species of sea urchin observed in the study area.

The species diversity is low; therefore Punta Dumalag, being a marine protected area (MPA), does not provide an assurance for the increase of diversity of species in the area. Nevertheless, the physico-chemical parameters such as water temperature, pH, dissolved oxygen and salinity are suitable for the survival of sea urchin species.

It is recommended that annual assessment be conducted in the area to further evaluate the status of sea urchin. It is also recommended that a study of the variations in environmental factors such as temperature, salinity, pH, and dissolved oxygen that have important effects on the physiological and biochemical rates of an organism to survive and reproduce be conducted.

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