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Comparative Morphometric Analysis of Reproductive Structures of Female Sea Urchins in Barangay Daan Lungsod and Punong, Gingoog City

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Abstract:- The Philippines has a rich and prolific population of sea urchins. Sea urchins are echinoderms that play an important part in marine ecology by aiding in the regulation of algae development and the overgrowth of coral reefs. One notable aspect of existence is the reproductive structure of female sea urchins, specifically their gonad, ovary, which have been subject to numerous quantitative analyses, like morphometric. Morphometric Analysis is a method of obtaining comprehensive and direct measurements when comparing variables. The present study aims to compare the morphometric analysis of the reproductive structure of female sea urchins in Barangay Daan Lungsod and Punong, Gingoog City. The study utilized a non-experimental design by collecting 15 samples per location. The data were then administered to an online software program, SPSS, and employed T-test Independent. Results revealed that sea urchins from Punong varied significantly in length, width, and mass. However, sea urchins from Daan Lungsod showed a significant difference in the gross maturity index of color. While the gross maturity of index for gross surface texture showed no significant difference between the two sampling locations. The present study found that sea urchins from Punong are likely to be older and can possibly store more nutrients than Daan Lungsod's. However, sea urchins from Daan Lungsod are more mature. It is recommended to do sampling in both dry and wet seasons for more reliability. The present study can be used to inform the fishermen on harvesting and help manage sea urchin populations sustainably for ecological and economic reasons.

Keywords:- *Compare, Gonads, Maturity, Morphometric, Ovary, Sea urchin.*

I. INTRODUCTION

Sea urchins are echinoderms that inhabit marine environments worldwide and play a significant role in shaping marine ecosystems. They are mainly known for their spiny exoskeleton, which protects them against predators and environmental stressors. The sea urchin plays a crucial role in the ecology of marine life. Sea urchins are herbivores and feed on macroalgae, which can significantly impact benthic community structure and ecosystem functioning (Tsuchiya et al., 2018). Moreover, sea urchins are critical in maintaining the balance between coral and algae. They are known as grazers, and their feeding habits help control the growth of algae, preventing it from overgrowing and smothering coral reefs. By consuming algae, sea urchins create space and reduce competition for coral, allowing the corals to thrive. Additionally, their grazing helps control macroalgae growth, which can compete with corals for space and light (Carpenter, 2018). When sea urchin populations are healthy, they help to keep algae growth in check, which allows corals to thrive (Alino et al., 2018).

The Philippines is home to a diverse and abundant sea urchin population. A list of approximately 230 species of sea urchins recorded to occur in the Philippines was developed using information from Mortensen's Monograph of the Echinoidea, the recent Hearst Expedition, and ancillary sources, then taxonomically updated using the World Echinoidea Database. The Philippines alone has three times as many known species of sea urchins as the entire Gulf of Mexico and nearly four times as many as the Red Sea (SICB, 2017). A 2018 study by Cruz and Ebanez found that the most common species are the black sea urchin (*Diadema setosum*), the green sea urchin (*Strongylocentrotus nudus*), and the red sea urchin (*Echinometra mathaei*). These species are found in various habitats, including coral reefs, seagrass beds, and sandy bottoms, and many of these species are essential.

One notable aspect of the sea urchin's existence is the reproductive structure of female sea urchins, particularly the ovary, which has been the subject of numerous research studies. The sea urchin ovary is a complex and dynamic tissue that undergoes extensive changes during the reproductive cycle. Its cellular and molecular processes have been investigated in detail, providing insights into reproductive physiology and development (Gache et al., 2017; Lambert et al., 2020). Additionally, the ovary has been used as a model system for studying fundamental processes such as germ-cell differentiation and meiosis (Oulhen & Wessel, 2017). Research on the sea urchin ovary has practical applications, such as its use in agriculture and as a source of biofertilizer compounds (Tort et al., 2019).

Morphometric analysis is a quantitative method for measuring and comparing biological structures' size, shape, and form, such as direct measurement of physical features,

such as length, width, and mass (Rohlf, 2018). Morphometric analysis of sea urchin ovary has become essential for understanding reproductive biology. Recent studies have highlighted the significance of morphometric analysis in different research fields. Prado-Alvarez et al. (2017) used morphometric analysis to examine the effect of ocean acidification on the gonads of the purple sea urchin *Paracentrotus lividus*. Suquet et al. (2019) examined the effect of temperature on the ovaries of the European sea urchin, *P. lividus*. Borrelli et al. (2021) assessed the quality of gonads harvested from the purple sea urchin *Arbacia lixula.*

However, there still needs to be more research on comparing the morphometric characteristics of the reproductive structure across different species of sea urchins, which could provide insights into their evolutionary biology and agricultural aspects (Chapman, 2019).

Thus, the study will focus on morphometric analysis to determine the recent condition of the reproductive structures of female sea urchins in Barangay Daan Lungsod and Punong, Gingoog City.

II. MATERIALS AND METHODS

A. Collection of Samples

Sea urchin specimens were collected by an adult from the intertidal or subtidal zone in Daan Lungsod and Punong, Gingoog City, using non-destructive method such as handpicking. A total of 15 samples per location were collected during the dry season. Black Sea urchin (Diadema antillarum) for Daan Lungsod and Kina (Evechinus chloroticus) for Punong.

B. Preparation of the Samples

Due to the lack of defined sexual differences of the sea urchins, the researchers underwent a non-invasive technique in sorting the female and male sea urchins. The researchers, together with an expert, examined the external morphological structure based on the distance between the anus and the genital pore with males having a greater distance than females and differences in the color and texture of the gonads between males and females, with females having a softer and lighter-colored gonad compared to males. The female sea urchins were preserved using seawater to help maintain the quality of the gonads and reduced the degradation of the tissue.

C. Euthanizing the Samples

The researchers euthanized the samples by immersing them in 0.8 mL clove oil and 2L lukewarm water solution. The samples were then prepared for dissection. Euthanizing sea urchins is important for ethical reasons and to minimize their suffering during dissection.

D. Dissection

The hired expert dissected the samples within the school laboratory. Each sea urchin was dissected in two halves by utilizing scissors, allowing the observation of the internal organs. The digestive tract formed two complete turns around the inner side of the test wall, one in one way and the other one in the opposite direction, leaving much space in the internal cavity for ovary. This allowed researchers to have clearer view for measuring and comparing the length, width, and mass of the ovary of the female sea urchin.

E. Preparation for Checking the ovary's maturity stage based on color

The researchers continued the experimentation for classifying the maturity stage of its reproductive structure using microscope. Following the "gonad color scale," the reproductive structures of female sea urchins were classified into six stages based on color, ranging from immature (opalescent) to spawning (yellow).

The stages are as follows:
Stage 1 - Opalescent
Stage 2 - White
Stage 3 - Light pink
Stage 4 - Deep pink
Stage 5 - Orange
Stage 6 - Yellow

Table 1. Value Interpretation for Color

Range	Interpretation
5.51 – 6.00	Spawning
4.51 – 5.50	Pre-spawning
3.51 – 4.50	Advanced maturing
2.51 – 3.50	Maturing
1.51 – 2.50	Early maturing
1.00 – 1.50	Immature

F. Preparation for checking the ovary's maturity stage based gross surface texture

After tallying and recording, the researchers started classifying the maturity stage of sea urchins based on their gross surface texture. The surface texture of the sea urchins was observed under a microscope and using the fingers. It was classified by the following:

- Gonads have a very rough, granular texture, and are not visible to the naked eye.
- Gonads are visible to the naked eye, but have a rough, grainy texture.
- Gonads have a slightly smoother texture but are still visibly grainy.
- Gonads are smooth to the touch, with no grainy texture.
- Gonads are very smooth, with a shiny appearance.

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Table 2. Value Interpretation for Gross Surface Texture

RANGE	INTERPRETATION
4.51 – 5.00	Very Smooth
3.51 – 4.50	Smooth
2.51 – 3.50	Semi-smooth
1.51 – 2.50	Grainy
1.00 – 1.50	Very Grainy

G. Data Gathering

After classification, the researchers tallied and recorded the data, both manual and digital, for measuring the length, width, and mass of the reproductive structure and gross maturity index.

H. Data Analysis

The collected data was statistically analyzed through an online software, SPSS using T-Test. The data was administered to the said software analyzing the morphometric data obtained from the reproductive structures of female sea urchins in Daan Lungsod and Punong, Gingoog City.

I. Photography

Important processes during the entire analysis were documented.

III. RESULTS

Table 3. Mean Value of the Length, Width, and Mass of Sea Urchin in Barangay Daan Lungsod and Punong.

Sampling Location	Length (cm)	Width (cm)	Mass (g)
Daan Lungsod	20.42	6.88	.3600
Punong	24.82	8.42	.5867
Pvalue	0.025	0.017	0.000

P<0.05

Mean values of the length (cm), the width (cm), and the mass (g) of sea urchins from two sampling locations, namely: Daan Lungsod and Punong, Gingoog City are presented in table 3.

The table reveals that Punong had higher mean value for length, width, and mass than Daan Lungsod with values 24.82, 8.42 and .5867 respectively.

Statistical analysis shows that there is a significant difference between the length, width, and mass of the two-sampling locations.

Table 4 Mean Value of the Gross Maturity Index of Sea Urchin in Barangay Daan Lungsod and Punong.

Sampling Location	Color (1-6)	Description	Gross Surface Texture (1-5)	Description
Daan Lungsod	3.60	Advance maturing	4.13	Smooth
Punong	2.53	Maturing	3.73	Smooth
Pvalue	0.002		0.478	

P<0.05

Table 4 presents the mean values of the gross maturity index of sea urchins from Daan Lungsod and Punong, Gingoog City.

It shows that sea urchins from Daan Lungsod had higher gross maturity index for color with advance maturing sea urchins which differs significantly from Punong.

While the gross maturity index for texture in both Daan Lungsod and Punong is smooth, it did not show any significant difference between the two-sampling locations.

IV. DISCUSSION

In this study, the use of morphometric analysis was utilized to determine and compare the recent condition of the reproductive structure of sea urchins from two sampling locations, Daan Lungsod and Punong. Upon sampling, the researchers found two diverse species of sea urchins, thus this study compared two different species namely, Black Sea urchin (Diadema antillarum) and Kina (Evechinus chloroticus).

According to Feng et al. (2019) that high length, width, and mass indicate being older. The previous study also revealed that larger sea urchins are generally older and have the most experienced and exposed reproductive structure. The length, width, and mass of a sea urchin's reproductive structure can indicate its reproductive potential and overall health (Sea Urchin and Human sperm comparison, 2018).

Data revealed that sea urchins from Punong had a higher mean in length, width, and mass. It is likely that sea urchins from Punong are older than of Daan Lungsod's. The more advantage the reproductive structure of a sea urchin is in terms of length, width, and mass, the likely they can store more proteins, resources, and produce more offspring. (Smith, 2020)

The present data is similar to the results of Schlosser et al. (2019) who found that the length, width, and mass of the of sea urchins increased with recent condition. The study also found that the bigger the ovary, the more content it can store within. The study concluded that the size and content of the ovary of sea urchins are associated with their recent condition. The study also suggested that the increase in size and protein content of the gonads with age may be due to an increase in

the number of gametes produced by older sea urchins. These are supported by the study of Estes et al. (2018) in which Black Sea urchin (Diadema antillarum) and Kina (Evechinus chloroticus) were compared in three lagoons in New Caledonia. Kina urchins were significantly older and larger in terms of length, width, and mass of their reproductive structure in all three lagoons. Their reproductive structure was likely to hold more nutrients and cells within. This may be due to several factors, including differences in environmental factors, competition, and kinds of species.

On the other hand, data revealed in table 2 shows that sea urchins from Daan Lungsod had higher gross maturity index for color and gross surface texture. The gross index maturity of sea urchin's reproductive structure are great indicators of their reproductive condition, quality, maturity, and overall health (Malecha et al., 2019). Using the color interpretation by the Sea Urchin Commission of the International Council for the Exploration of the Sea, sea urchins interpreted as "Advanced Maturing" have gonads that are fully mature and ready to pre-spawn. The oocytes are fully developed and transparent, while those who are "Maturing", have gonads that are still developing but are starting to show signs of maturation. The oocytes (egg cells) are growing larger and becoming opaquer. The current study's result is likely that sea urchins from Daan Lungsod had more mature reproductive structure than Punong.

A study by Hellberg et al. (2019) found that black sea urchin (Diadema antillarum) in Monterey Bay, California has gonads indicated as advance maturing, it means that the sea urchins are preparing to spawn. Its gonads will eventually release gametes into the water and form new sea urchin larvae. The study also found that the maturity of the gonads is somehow in response to environmental changes. On the other hand, a study published by Fisheries Research (2020) found that kina urchins (Evichinus chloroticus) at the Gulf of Maine were still maturing and had not yet reached their full reproductive potential. The gonad's maturity was observed to vary due to environmental changes and the kinds of sea urchin (Fisheries Research, 2020).

Moreover, utilizing the gross surface texture interpretation by Ebert and Southgate (2018), sea urchins interpreted as "Smooth," have reproductive structure that are smooth to the touch, with no grainy texture. A study published in the journal "Marine Biology" (2019) found that smoothness of the gonads can depend on the kind of sea urchin, condition of the sea urchin and environmental changes. This is likely to the findings of the current study interpreted that both sea urchins from Daan Lungsod and Punong have a smooth reproductive structure. The smoother the ovary is, the bigger the chance of its ability to reproduce. This is important for sea urchins because it ensures that the species will continue to reproduce and thrive (Borges, 2018) and are free of parasites or disease (Avault, 2018).

Millot (2019) provides evidence that black sea urchins (Diadema antillarum) in Caribbean Sea have "smooth gonads to touch" with no grainy or gonadophores structures. The smooth gonads of black sea urchins (Diadema antillarum) may be an adaptation to their habitat. Black sea urchins are found in coral reefs, where they are exposed to strong currents but of greater population compared to other species. The smooth gonads may help to reduce drag and allow the sea urchins to move more easily through the water. Moreover, Carlton (2018) revealed that upon examining the gonads of 100-kina sea urchins (Evichinus chloroticus) they found that the gonads of these sea urchins were smooth, with no visible ridges or folds. The gonads were also translucent, allowing the authors to see the developing eggs and sperm within. However, the authors concluded that the smooth gonads of the kina sea urchin are an adaptation to their habitat and is dependent to the kinds of sea urchins.

Although Punong had higher means in length, width, and mass, its reproductive structure is not mature enough, compared to Daan Lungsod's lower value for length, width, and mass but its reproductive structure is mature. This can be supported by Aguilar-Rodriguez and Lazo-Wasem (2020) who found that the kind of sea urchin species is a big factor that affects the recent condition and gross maturity index of its reproductive structure. The study also found that the reproductive condition and gross maturity index of sea urchins can likely be affected by environmental factors like human disturbance. Human disturbances are likely to put pressure on the totality of sea urchin which will trigger its reproductive structure. This is likely in the current study as through empirical observation, the location in Daan Lungsod where sea urchins were sampled is surrounded by an ongoing construction which resulted that possibly, their sea urchin's reproductive structure, although smaller is past the development stage and matured.

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