Preliminary Study on the Polyculture of Sea Urchin *(Tripneustes gratilla)* and Sea Cucumber *(Actinopyga* spp.) in Concrete Tank

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Abstract

This experimental study was undertaken to assess the growth performance and monitor the survivorship of sea urchin (Tripneustes gratilla) and sea cucumber (Actinopyga spp.) polycultured in tank. It was conducted at the UNP-Marine Resources Development Center in Nalvo, Sta. Maria, Ilocos Sur from October 2005 to February 2006.

Two hundred (200) juvenile sea urchins and two hundred (200) juvenile sea cucumbers collected from the wild were stocked in a 10-ton capacity concrete tank filled with 4-ton sea water and provided with enough aeration. These were fed with Sargassum spp (aragan) twice a week. Cleaning of the tank as well as regular water change was also done.

The initial average body weight (g), test diameter (cm), and test height (cm) of sea urchins as well as the initial average body weight (g) of sea cucumbers were recorded. To monitor the growth performance of the experimental organisms, the monthly increases in the aforementioned parameters were monitored and recorded. In addition, the final number of stocks left after the four-month culture periods were also recorded and the percentage (%) survivorship were computed.

Results on the growth performance of sea urchins showed that the highest increase in weight of 29.02g (74.83% growth increment) was observed on the second month of culture period while the lowest increase of 8.73g (02.88%) was observed during the third month. In terms of mean monthly increase in test diameter, the highest mean increase of 1.22cm (38.73%) was observed during the first month; while the lowest mean was observed during the last month with 0.10cm (1.69%).

Data on the mean monthly increase in test height showed that the highest mean monthly increase of 0.82 cm (43.62%) was recorded during the first month, while the lowest mean was noted during the fourth month with 0.09cm (2.49%).

On the other hand, data on the growth performance of sea cucumber revealed that the mean monthly increase in body weight (g) and growth increment (%) of sea cucumbers was highest (12.02g or 39.18%) during the first month while the lowest (3.17g or 6.09%) was recorded during the fourth month of culture period. Results further showed that the percentage survivorship of sea urchin and sea cucumber after four-month culture period were 98% and 100%, respectively.

From the above findings, it was concluded that there is a high growth performance and survivorship of sea urchin and sea cucumber polycultured in tank. Considering the high performance and survivorship of these organisms, this activity is recommended as a management tool for these echinoderms. It is further recommended that similar study using higher stocking density for sea urchin and sea cucumber should be undertaken to fully maximize the culture area. A comparative study on the monoculture and polyculture of these echinoderms both in grow-out and in tanks should be undertaken so as to have a more comprehensive analysis of data. Furthermore, since sea cucumbers are known as substrate feeders, the tank should be overlaid with sand as its substrate. Production technologies such as sea urchin and sea cucumber hatchery should be developed in the province to have an access for juveniles needed for culture.

Introduction

Background of the Study

Echinoderms, including sea urchins and sea cucumbers, are among the marine species that greatly help in sustaining the Filipino's livelihood; as these resources are considered promising export products. In Ilocos Sur, grow-out culture of sea urchin has become a popular aquaculture venture in some coastal communities. Juvenile sea urchins are being collected from the wild; and these are being stocked in cages and fed with the seaweed *Sargassum* spp. (aragan). These are sold in the market after 4-6 months of culture period or until they reach the marketable size of 5-7 cm test diameter.

The marketing of sea cucumber is also a promising venture in some coastal communities in the province. Based on the result of an undergraduate thesis conducted by Badiola, et. al. (2005) entitled *Preliminary Studies on the Distribution and Marketing of Sea Cucumber in Ilocos Sur,* different species of sea cucumbers collected from the wild,

either through band-picking or diving, are used either for local consumption or being delivered and sold in Metro Manila for the popular soup no. 5 in Japanese and Chinese restaurants.

Although the production of sea cucumber in the province is mainly through open-access fishery, there are some fisher folks of Brgy. Nalvo, Sta. Maria, Ilocos Sur, who are already engaged in its cage culture, particularly the greenish brown species locally known as balat. Similar to that of sea urchin cage culture, juvenile sea cucumbers collected from the wild are being stocked in cages and these are fed with *Sargassum* (aragan) and other seaweed species.

At present, the Marine Resources Development Center (MRDC) under the Center for Environmental Education and Sustainable Development (CEESDev) of the University of Northern Philippines, houses various aquaculture projects such as culture of milkfish (bangus), siganid (malaga), prawn (sugpo), oyster (talaba), and sea urchin. However, its sea urchin culture is only being undertaken in grow-out as being practiced by the local fisher folks.

With the available concrete tanks at MRDC, the researchers wanted to look into the feasibility of growing sea urchins specifically *Tripneustes gratilla* in polyculture with sea cucumbers, *Actinopyga* spp. in tank which could eventually be added as a component of the production endeavors of the university. This activity could also be a good means of sustaining sea urchins and sea cucumbers especially during rainy seasons when the salinity of seawater fluctuates; thus, affecting the growth of these organisms.

Objectives

This study aimed to conduct an assessment of the growth performance and survivorship of sea urchins and sea cucumbers polycultured in concrete tank. In particular, it sought to:

1. assess the growth performance of sea urchins in polyculture with sea cucumbers in tank in tenns of mean monthly increase in body weight (g), test diameter (cm), and test height (cm);
2. assess the growth performance of sea cucumbers in polyculture with sea urchins in tank in terms of mean monthly increase in body weight (g);
3. monitor the survivorship of sea urchins and sea cucumbers in tank.

Scope and Delimitation

This study was delimited to the assessment of the growth perfonnance and survivorship of sea urchins *(Tripneustes gratilla)* and sea cucumber *(Actinopyga* spp.) polycultured in tank. The growth perfonnance of sea urchin was assessed in tenns of mean monthly increase in test diameter (cm), test height (cm), and body weight(g) whereas sea cucumber's growth perfonnance was assessed in tenns of monthly increase in weight (g).

The seed stocks used in this study were collected from the wild, along the sea urchin farm in Nalvo, Sta. Maria, Ilocos Sur. Juvenile sea cucwnbers used were those locally known as balat, the greenish brown species *(Actinopyga* spp.) usually consumed by the local fisher folks as kilawin or pickled.

This preliminary study was conducted utilizing only one concrete tank to check the feasibility of growth of these two species in tank. *Sargassum* spp. was used as feeding materials.

Review of Related Literature

Members of the phylum Echinodermata, commonly called echinoderms, or spiny-skinned animals, are so named because of their spiny outer body coverings. The echinoderms include marine groups such as the sea stars, sea cucwnbers, brittle or serpent stars, sand dollars , sea lilies , sea urchins, basket stars, heart urchins, and feather stars.

Sea urchin *(Tripneustes gratilla)* and sea cucumber *(Actinopyga* spp.) belong to the phylum Echinodermata– from the Greek word "echinos" and "derma", meaning spiny and skin, respectively.

Sea urchins feed on various types of organic matter, including plants, small animals, and waste material. Some species, called heart urchins, lack jaws and burrow into sand or mud for their food. A number of species are venomous to humans, and some species are used as food in East Asia and South America.

Tripneuses gratilla, locally known as swaki, santol-santolan, maritangtnag, and kuden-kuden, is the most commercially exploited sea urchin species in the Philippines. Its fishery is a major source of livelihood in many coastal villages, particularly in the Ilocos and Bicol regions (Juinio-Meffes, et.al., 2001).

As cited by Juinio-Meftes, et.al. (2001), Namisato (1974) mentioned that fishery for sea urchin is rapidly expanding in many countries because of the high demand for sea

urchin gonads or roe, which is rich in glycogen, carotenoids, alanine, valine, glycine, methionine, and glutamic acid.

In a study conducted by Juinio-Mefies which was presented to the North Pacific Symposium on Invertebrate Stock Assessment and Management in 1998, a comparison of the utilization of sea urchin in Nalvo, Sta. Maria, Ilocos Sur and Bolinao, Pangasinan was undertaken. Results of their surveys and interviews revealed that in Nalvo, sea urchins are a regular part of the local diet or sold whole at the local market; while in Bolinao, sea urchins are harvested primarily for export in which gonads are shucked from whole urchins and marketed fresh or in brine to local buyers for Manila-based exports.

Several studies and projects on sea urchin grow-out culture have already been conducted wherein juvenile urchins are stocked in bamboo pens or net cages and being fed with seaweeds. In these studies, growth performance, growth rate and survivorship of urchins were being monitored.

Domingo and Florendo conducted a study on the use of two types of feeds – pure *Sargassum* spp. and mixed seaweeds – for sea urchin in cages in 1997. Based on their findings, the growth performance in terms of increase in test diameter and test height of those fed with pure *Sargassum* was significantly higher than those fed with mixed seaweeds.

Domingo and Corrales conducted another sea urchin grow-out culture study in 2002. In this research work, results showed that growth rates are faster and survivorship is higher while the sea urchins are smaller or younger, but gradually declines off as the animals become larger. It has been concluded that cage culture of sea urchin is a successful management tool to recover the depleted population of this resource.

Another group of echinoderms being used as subject for studies are the sea cucumbers. Also known as holothurians, sea cucumbers are marine animals that have flexible, cylindrical bodies moving sluggishly over the ocean floor.

Sea Cucumbers are soft-bodied, tubular invertebrates that live on coastal water sea beds around the world. A tough skin that contains tiny granules of calcium oxide covers their bodies. Tentacles surrounding the mouth collect microscopic plants from the sea bottom. Sea cucumbers are known as trepang in Asia, where they are considered a delicacy and are used to make soup. There are many species of sea cucumbers found all over the world. They Strictly live at the bottom of the sea, where they are found at all depths but some inhabit Practish water.

As cited by Badiola, et.al. (2005), Anderson (1988) mentioned that it has been revealed in Chinese studies that sea cucumbers contain saponin glycosides. These compounds have a structure similar to the active constituents of ginseng, ganoderma, and other famous tonic herbs. Additional Chinese studies also indicate anticancer properties of both the sea cucumber saponins and polysaccharides.

The popular Chinese name for sea cucumber is "haishen", which means roughly ginseng of the sea. It is often known medicinally as *fangcishen*, referring to the spiky protrusions that emanate from four sides. Sea cucumbers of about a dozen species that occur on coral reefs of the southwestern Pacific are known commercially as *beche-de-mer*, or trepang; they are dried and used to make soups. To prepare the sea cucumber after it was collected, the internal organs are removed; and the dirt and sand are washed out of cavity. It is, then, boiled in salty water and dried in the air to preserve it. When readied for use in making food, it is softened in warm water and then boiled (Encarta Encyclopedia Standard Edition, 2004).

In 2005, Badiola, et.al. conducted a preliminary study on the distribution and marketing of sea cucumber in Ilocos Sur considering four coastal municipalities namely Sinait, San Juan, Sta. Maria, and Santiago. Results of their surveys and interviews revealed that sea cucumber collectors from Sinait use diving as their mode of collection; and they claimed that their gain per fishing effort reaches up to Php3000 – 5000 since they have direct buyers from Metro Manila. On the other hand, the sea cucumber collectors from San Juan, Sta. Maria, and Santiago mainly collect sea cucumbers by handpicking wherein their average net is PhpS0.00 per fishing effort.

Moreover, common problems enumerated by the sea cucumber collectors include water temperature and pressure (for those who dive) and water level and low catch (for those who collect by handpicking). Collectors who have direct buyers claimed that they don't have any problem in marketing while the others identified low price and non-availability of buyers as their problems.

Raboy and Bagorio have conducted a preliminary study on the polyculture of sea urchin and sea cucumber in cages from October to December 2006. Results of this undergraduate thesis revealed that the growth performance of sea urchin and sea cucumber are affected by water level, salinity, and temperature.

Conceptual Framework

The following experimental paradigm was used in this research:

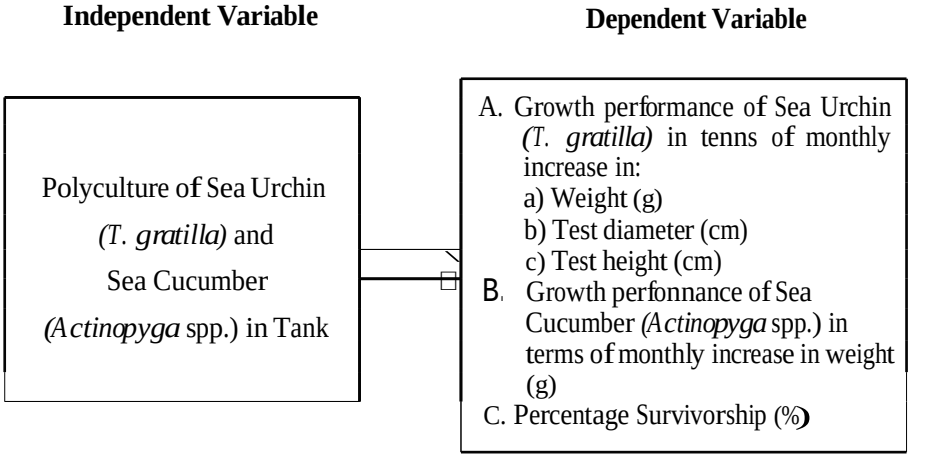

Figure 1

The Experimental Paradigm

As shown in the paradigm, the growth perfonnance of sea urchin was assessed in terms of monthly increase in weight (g), test diameter (cm) and test height (cm). Likewise, the growth perfonnance of sea cucumber was assessed in terms of monthly increase in weight (g).

Percentage survivorship (%) of sea urchin and sea cucumber after four months of polyculture was also recorded.

Operational Definition of Terms

The following terms that were used in this research are defined for a better understanding of the study.

Polyculture – it refers to the culture or growing of two or more organisms in a single area. In this study, it refers to the culture of sea urchin and sea cucumber contained in a concrete tank.

Growth Performance – it refers to the monthly increase in weight (g), test diameter (cm) and test height (cm) of sea urchins as well as of monthly increase in weight (g) sea cucumber.

Percentage Survivorship – it refers to the percentage of stocks of sea urchin and sea cucumbers that survived after the four-month culture period. It was computed using the following formula:

$$\% \text{ Survivorship} = \frac{\text{Final no. of stocks}}{\text{Initial no. of stocks}} \times 100\%$$

Methodology

The following were the materials used and the procedures employed in the conduct of this experimental research.

Materials

200 juvenile sea urchins
200 juvenile sea cucumbers
I0-ton capacity concrete tank
Sargassum spp. (aragan)
Vernier caliper
Weighing Balance
Aeration

Procedure

1. Place and Duration of Study. This study was conducted at the UNP-Marine Resources Development Center in Nalvo, Sta. Maria Ilocos Sur, utilizing one of the concrete tanks in the hatchery. It was a four-month experimental study, from October 2005 to February 2006.

2. Collection of Seedstocks and Stocking. A I0-ton capacity concrete tank was set up with aeration and filled with 4-ton seawater. Two hundred (200) juvenile sea urchins and two hundred (200) juvenile sea cucumbers collected from the wild were stocked in the tank.

3. Feeding and Maintenance. The sea urchins and sea cucumbers were fed with *Sargassum* spp. twice a week for the four-month culture period. Cleaning of the tank and regular changing of water were also done.

4. Monitoring Growth Performance and Survivorship. Prior to stocking, the initial average body weight (g), test diameter (cm), and test height (cm) of sea urchins as well as the initial average body weight of sea cucumbers were recorded. To monitor the growth performance, the monthly increases in the aforementioned parameters for the two experimental organisms were recorded using Vernier caliper and weighing balance. The monthly growth increment (%) was also recorded. After the four-month culture period, the final numbers of stock were counted and the percentage (%) survivorship was computed.

Results and Discussion

Growth Performance of Sea Urchin *(Tripneustes gratilla)*

The growth perfonnance of sea urchin in terms of mean monthly increase in body weight (g), test diameter (cm), and test height (g) as well as the monthly growth increment are presented in Tables 1a-1e.

Table 1a. Growth Performance of Sea Urchin *(Tripneustes gratilla)* in Terms of Mean Monthly Increase in Body Weight (g)

Culture Period	Mean Monthly Body Weight (g)	Mean Monthly Increase in Body Weight (g)	Growth Increment (%)
Initial	20.5		
1 Month	38.78	18.28	89.17
2'' Month	67.8	29.02	74.83
3'' Month	76.53	8.73	12.88
4 Month	91.58	15.05	19.66
		Overall 71.08	207.24

As revealed from the table, the highest increase in weight of 29.02g (74.83% growth increment) was observed on the second month of culture period; while the lowest increase of 8.73g (12.88%) was observed during the third month.

It can also be noted that there was an overall weight increase of 71.08 g or 207.24% growth increment for the four-month culture period.

Table 1b. Growth Performance of Sea Urchin *(Tripneustes gratilla)* in Terms of Mean Monthly Increase in Test Diameter (cm)

Culture Period	**Mean Monthly Test Diameter (cm)**	**Mean Monthly Increase Test Diameter** (cm)	**Growth Increment %)**
Initial	3.15		
1 Month	4.37	1.22	38.73
2" Month	5.52	1.15	26.32
3 Month	5.82	0.30	5.43
4 Month	5.92	0.10	1.69
	Overall	**2.77**	**74.2**

In terms of monthly increase in test diameter, the above table shows that the highest mean increase of 1.22 cm (38.73%) was observed during the first month and the lowest was during the last month with 0.10cm (1.69%) increase.

For the whole four months of culture period, an overall increase in test diameter of 2.77 cm or 74.2% growth increment was recorded.

Table 1e. **Growth Performance of Sea Urchin *(Tripneustes gratilla)* in Terms of Mean Monthly** Increase **in Test Height (cm)**

Culture Period	**Mean Monthly Test Height** (cm)	**Mean Monthly Increase Test Height cm)**	**Growth Increment %)**
Initial	**1.88**		
1 Month	2.70	0.82	43.62
2 Month	3.50	0.80	29.63
3 Moth	3.61	0.11	3.14
4 Month	3.70	0.09	2.49
	Overall	**1.82**	**80.66**

As shown from the table, data on the mean monthly increase in test height showed that the highest mean monthly increase of 0.82 cm (43.62%) was during the first month, followed by 0.80 cm (29.63%) increase during the second month, then by the third month with 0.11cm (3.14%) and the lowest was during the fourth month with 0.09cm increase (2.49%),

For the whole four-month culture period, a total increase of 1.82 cm or 80.66% from the initial test height was recorded.

Growth Performance of Sea Cucumber *(Actinopyga* spp.)

The growth performance of sea cucumber in tank in polyculture with sea urchins in terms of mean monthly increase in body weight is presented in the following table.

Table 2. Growth Performance of Sea Cucumber *(Actinopyga* spp) in Terms of Mean Monthly Increase in Body Weight (g)

Culture Period	Mean Monthly Body Weight (g)	Mean Monthly Increase in Body weight g)	Growth Increment %)
Initial	30.68		
1"Month	42.7	12.02	39.18
2Month	48.27	5.57	13.04
3" Month	52.08	3.81	7.89
4 Month	55.25	3.17	6.09
		Overall 24.57	**75.84**

As shown in the table, the mean monthly increase in body weight (g) and growth increment (%) of sea cucumbers, polycultured in tank with sea urchin, was highest (12.02g or 39.18%) during the first month, followed by the second month (5.57g or 13.04%), then by the third month (3.81 g or 7.89%) and the lowest increase (3.17g or 6.09%) was recorded during the fourth month of culture period.

Likewise, it can be noted from the table that for the whole four months of culture period, an overall increase in body weight of sea cucumber was revealed to be 24.57g or 75.84%.

Survivorship

The percentage survivorship of sea urchins and sea cucumbers polycultured in tank are shown in the following table.

Table 3. Percentage (%) Survivorship of Sea Urchin *(Tripneustes gratilla)* and Sea Cucumber *(Actinopyga* sp.) Polycultured in Tank

Culture Organism	Initial no. of Stock	Final No. of Stock	%Survivorship
Sea Urchin	200	196	98
Sea Cucumber	200	200	100

It is shown from the above table that the sea urchin's and sea cucumber's survivorship after four months of culture period were 98% and 100%, respectively.

This result implies that sea urchins and sea cucumbers polycultured in tank have high survivorship. This high survival of the culture organisms could be attributed to the spacious culture area, thus competition is minimized. Other factors such as continuous 0aeration, regular water change and light regulation could have also contributed to the high survivorship of the culture organisms.

Conclusion

Based on the findings, the following conclusions were drawn:

1. There is a high growth performance as well as high survivorship of sea urchin and sea cucumber polycultured in tank.
2. Polyculture of sea urchin and sea cucumber in tank is a sustainable management tool for these two echinoderms.

Recommendations

Considering the high growth performance and survivorship of sea urchin and sea cucumber polycultured in tank, the following recommendations are hereby forwarded:

1. Similar study using higher stocking density for sea urchin and sea cucumber should be undertaken to fully maximize the culture area
2. A comparative study on the monoculture and polyculture of these echinoderms both in grow-out and in tanks should be undertaken so as to have a more comprehensive analysis of data.
3. Since sea cucumbers are known as substrate feeders, the tank should be overlaid with sand as its substrate.
4. Production technologies such as sea urchin and sea cucumber hatchery should be developed in the province to have an access for juveniles needed for culture.

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