SPECIFIC GROWTH RATE AND SURVIVAL RATE OF *Kappaphycus alvarezii* AND *Kappaphycus striatum* IN SAN LORENZO, GUIMARAS

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of the Requirements in
SCIENCE RESEARCH 2

by

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THE SPECIFIC GROWTH RATE AND SURVIVAL RATE OF *Kappaphycus alvarezii* AND *Kappaphycus striatum* IN SAN LORENZO, GUIMARAS

prepared and submitted by Marynel G. dela Riarte, Twilitte Ae Q. Medalle, Gianne Gilbert P. Nismal in partial fulfilment of the requirements in Science Research 2, has been examined and recommended for acceptance and approval.

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The Specific Growth Rate and Survival Rate of *Kappaphycus alvarezii* and *Kappapycus striatum* in San Lorenzo, Guimaras

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ABSTRACT

Seaweeds are important components in marine ecosystem and an important commodity in the Philippines, which export it in either raw or processed form. The carrageenan from seaweeds is used as gelling agent in medicines, cosmetics, and food. Seaweed farming and culture can be done in different sites depending on the type of seaweed that will be cultured. The study aims to determine the Specific Growth Rate and Survival Rate of *Kappaphycus alvarezii* and *Kappaphyus striatum* in Suclaran, San Lorenzo, Guimaras. The seaweeds were weighed approximately 150-200 grams for initial data and then tied to the line. Each line is composed of 20 individuals each. There are three lines of *K. striatum* and a line of *K. alvarezii.* After 16 days of culture, three randomly chosen seaweeds were then harvested and weighed. The number of surviving individuals was also checked. The method repeated after days 28, 42, 56, 70, 91. It was then used to calculate the SGR and the Survival Rate. The mean of SGRs of *K. striatum* after 16, 28, 42, 56, 70, and 91 days were 0.69508%, 0.75303%, 0.12873%, -0.319%, and -0.15595%, respectively while *K. alvarezii* grew 1.33579%, 0.68215%, -0.9419%, -0.9742%, -1.38637%, -1.4065% respectively. The average survival rate for *K. striatum* after day 16, 28, 56, 70 and 91 were 90%, 85%, 68.33%, 50%, 45%, and 33.33%, respectively while for the K. *alvarezii* were 100%, 95%, 85%, 70%, 70%, 30% after days 16, 28, 42, 56, 70 and 91 respectively.

Keywords: *Kappaphycus species, Specific Growth Rate, Survival Rate, seaweed culture*

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

A. Background of the study

Seaweed, as one of the most important components in this marine ecosystem, is an important aqua commodity in the Philippines. The Philippines is the top producers of seaweeds, which is exported for raw forms or even processed forms. *Kappaphycus* species of seaweed is one of the major commercial seaweeds in the Philippines. These species of seaweed introduced in different parts of the world and is a source of kappa carrageenan, an ingredient used in industrial gums and as smoothening agent in ice cream, toothpaste, jellies, medicines and paint.

Seaweed farming, or better known as seaweed culture, is promoted as a livelihood option here in the Philippines. It is one of the most productive alternative sources of livelihood and employment (DA BFAR 1988 as cited in Orbita 2013). Seaweed farmers usually enjoy a good harvest from January to June, which are considered peak months for seaweed farming. During summer period, March to June, seaweed may have ice-ice disease because of too much heat and sunlight received by it. There are about 800 species of seaweeds in the Philippines. There are 114 species in Panay and 37 species as new record for Panay (Hurtado-Ponce 1994).

Seaweeds can be cultured in different sites depending on the species of seaweed needed to be cultured. It can be in different areas of water and in different depth. The best site to grow seaweed is where it is protected from sea waves and strong winds. The culture period of seaweeds could be as short as 45 days under ideal conditions (SEAFDEC updated 2011). During the period, there are aspects- physical, biological, and chemical- that affect the growth of seaweeds (Phillips 1990).

The Bureau of Fisheries and Aquatic Resources Region 6 (BFAR 6) had recommended that this research as be pursued to determine what strain of seaweed is to be planted depending on the sites. Different sites should also be assessed to be able to have scientific data which is not just only based on observations. New sites will be used for culture to expand culture areas and increase production, in this way, there will be alternative site to be used for culture in the future and the existing sites will be uncultured. In a review by Ask and others, carrageenan industry still face raw material problem relating to quality, volume and supply (2002).

This study found out the suitability of the different species of *Kappaphycus* seaweed in different sites in Western Visayas. There are possible conditions that can affect seaweed whether environmental or not, depending on the location where the site is situated. New sites are needed to have scientific data. These sites will also be used for farming in the future.

B. Objectives of the study

B.1 General Objective

This study aimed to determine the Specific growth rate (SGR) and survival rate of *Kappaphycus alvarezii* and *Kappaphycus striatum* in Brgy. Suclaran, San Lorenzo, Guimaras after 16, 28, 42, 56, 70 and 91 days of culture.

B.2 Specific Objectives

(1) To determine the Specific Growth Rate of *Kappaphycus* seaweed species: *K. alvarezii* and *K. striatum* in Brgy. Suclaran, San Lorenzo, Guimaras

(2) To determine the survival rate of *K. alvarezii* and *K. striatum* in the Brgy. Suclaran, San Lorenzo, Guimaras.

C. Scopes and delimitation of the study

Researches and studies should be conducted to know the suitability of different seaweed species in different sites. There are also studies about the seasonality of different seaweed species. Future studies should be made on the effect on growth depending on the sites. Also, checking the aspects that would affect the growth of seaweed, it was proposed to compare the growth of *Kappaphycus* seaweed species in different sites.

The scope of our study is limited only to a site in San Lorenzo, Guimaras. The study included the suitability of the sites and had focused only in two *Kappaphycus* seaweed species namely: *K. alvarezii* and *K. striatum. K. alvarezii,* one popular variety of *Kappaphycus*, is an important source of kappa carrageenan that has been used as thickening agent and gelling (Hurtado and others 2008 as cited in Orbita 2013). The study only covered one set of farming. This study determined the Specific Growth rate and survival rate of the two said species. For this study, off bottom method of farming was used. The study did not cover the water quality parameter of the sites.

CHAPTER 2

REVIEW OF LITERATURE

A. Seaweeds

A.1 Commercial cultivation of seaweed and extraction of carrageenan

Seaweeds are macroalgaes found in seawaters. It is harvested anywhere around the world for food and export for the production of agar and carrageenan. It is cultured traditionally in Southeast Asian countries like Korea, Japan, and even Philippines. *Kappaphycus, Eucheuma, Glacilaria* and many other genera are harvested. *Kappaphycus* and *Eucheuma*are named as carrageenocytes

There are 114 species of seaweeds in Panay and 37 species as new record for Panay (Hurtado-Ponce 1994) and there are 3 commercially farmed seaweed species grown in different seasons of the year: *K. alvarezii* (tambalang), *K. striatum* (sacol) and *E. denticulatum*(spinosum). *K. alvarezii*, a red algae, and *K. striatum*, a green morphophyte, are good sources of carrageenan, a polysaccharide, causing these to be economically important. *K. alvarezii* and *K. striatum* grow fast that it can double in size in 15-30 days. The commercial cultivation of *K. alvarezii* started in the Philippines. After it, many other countries started to cultivate a large scale of seaweeds. There are a lot of experiments done in growing seaweed in some parts of the country. Today, Philippines is leading the production of *Eucheuma* and *Kappaphycus* seaweeds (Arevalo and others).

A.2 The uses of carrageenan

Carrageenan is used in food, pharmaceuticals and even cosmetics (De San 2012). It is processed into gels and the gels are used in food industry: such as processed meat, ice cream, deserts, concentrated milk and many more, and in pharmaceuticals, such as pills, and cosmetics.

A.3 Classification of Seaweeds

Start from Kingdom: *Kappaphycus* and *Eucheuma* genera are under the family of*S olieriaceae* which is under the Order Gigartinales. In the Philippines there are 4 *Kappaphycus* species and 3 Eucheuma species namely: *K. alvarezii, K. striatum, K. cotonii, K. procrusteanum, E. denticulatum, E. arnoldii, E. gelatinae* respectively.

B. Specific Growth Rate and Survival Rate

B.1 Monitoring of Specific Growth Rate (SGR) and Survival Rate

The growth rate and the survival is one of the most commercially important characteristics together with the yield and quality and usually used to determine and compare the weight gain of a certain organism. This is also to check the performance of an organism (Izzati 2011).

Specific Growth Rate, simply called SGR, is usually used to determine the improvement of a certain plant which can tell if it suits the area or not.it is defined as the speed of growth of a certain species of seaweeds (Soon Yong and others 2013).

In the study of Thirumaran, they got the daily growth rate in different seasons and compared if it is suitable to those seasons (2009).

In a study by Thirumaran and others, they investigated the adaptation of using horizontal rope floating raft culture to suit the conditions and study the Daily growth rate of the seeds (2009). Using five different seedling densities were analyzed for daily growth rate every 15 days until the 75th day of culture in each season. During the postmonsoon season, the maximum daily growth rate was 6.11 ± 0.04%, where 6.11 is the mean and 0.04 is the SD. During summer, 5.69 ± 0.05% and during premonsoon is 6.03 ± 0.04%.

In the study by Sahoo and others in 2002, they collected *Eucheuma serra* by SCUBA diving from Pacific Ocean, Mugi Bay, Tokushima Prefacture, Shikoku, Southern Japan. Five grams of plants were transferred into tanks and kept in the shade under the natural day: night condition at 18°C. Daily Growth Rate for both field and deep sea water were calculated using a formula:

$$DGR = \frac{\ln(W_f - W_i)100}{d}$$

Where:
W_f = final weight
W_o = original weight
d = number of culture days
ln = normal log of the quotient of final over initial weight

The temperature is constant at 18 °C, but light intensity varied as the depth goes deeper. At 1 meter, the DGR is 2.14 ± 0.04, at 2, 1.14 ± 0.02 and at 3rd meter, 0.87 ± 0.06. It means that the best growth is at 1 meter.

In 2012, a study by Oliveira and others studied the effect of depth to the growth rate of

$$DGR\% = \frac{\ln(w_f - w_o)}{t} * 100$$

Gracilaria birdiae in the shrimp pond. The study site was at carried out at a shrimp pong in Northern Brasil. Every week, they remove the seaweeds from the line to determine its weight and growth rate using the formula:

It was found out that the growth of the seaweeds is affected by the abiotic parameters essential in the variation of depths. it was found out that the temperature, salinity, pH, and the nutrients affects the growth of seaweeds. Small variation in depth will change the growth of the algaes. During the first 21 days, the *Gracilaria* seaweeds have positive SGR values but at 2nd to 3rd week, it was found at 10-20 cm.

The average SGR of the seaweeds in the surface, 10 cm and 20 cm in depth during the making of the project were 0.36 ± 0.57% d^{-1}, 0.38 ± 0.96% d^{-1}, 0.38 ± 0.54% respectively.

In the study by Moñuz and others in 2004, they studied about the seasonality of *K. alvarezii* using three colored strains and culture days over a 6-month period as factors of assessing growth rate and feasibility of producing seaweeds in waters of Yucatán peninsula. Carrageenan content was also evaluated as a measure of quality. These was done April to September 2002 to present the best environmental conditions that might be favorable for K. alvarezii farming. These months covers dry season (April to June) and wet seasons (July to October). Cold seasons, occurs from November to February, was not considered because of northern winds, high turbidity, low temperature and stormy weather which is not a good time to plant or culture seaweeds. The highest average growth rate obtained was 6.5±1% day^{-1-} for red strain, 7.1±1.8% day^{-1} for brown and 8.1±1.6% day^{-1}. The lowest obtained was 2.0±0.6% day^{-1}

$$SGR = \frac{\ln(w_f - w_o)}{t} * 100$$

during August to September. There was no significant difference for green during the months of April, May and July and in red strain during first part of May and June to September. As a whole, there is no significant difference between strains, showed by ANOVA. The formula used was:

In 2014, Atithan studied about growth performance of seaweeds in ponds in India. The study was conducted at a farm unit of Department of Agriculture, Tharuvaikulam, India. Using a floating raft with a size of 10x10 feet, seaweeds with a weight of 150 grams (average) was tied into it. The average growth of seaweeds in grams is 25.71 grams day^{-1} and specific growth rate of 4.11% day^{-1}. DGR was calculated using the formula:

$$DGR\% = \frac{\ln(w_f - w_o)}{t} * 100$$

Average growth rate was calculated by Athitan using the formula:

$$ADG = \frac{weight\ gain}{time}$$

B.2 Formulating the formula for seaweed growth rate

In 2013, a study by Soon Yong and others investigated about the formulae of seaweed growth rate. Using four equations, they tested each and checked its degree of error. First, they got the Growth Rate using those formulas. Afterwhich, using the calculated Growth rate and the given initial weight, they predicted the final weight, by means of the geometric progression theory. After predicting, the degree of error was calculated by this formula.

$$Degree\ of\ error = \left|\frac{W_{predict} - W_o}{W_o}\right| * 100\%$$

Based on the data gathered, the formula $DGR_3 = \left|\left(\frac{w_t}{w_o}\right)^{\frac{1}{t}} - 1\right| * 100\%$ has the least degree of error. Although the degree of error of $DGR_2 = \left[\left(\frac{w_t}{w_o}\right)^{\frac{1}{t}} - 1\right] * 100\%$ (Mtolera and others 1995; Gerung and others 1997; Aguirre-von-Wubesser and others 2001; Bulboa and others 2007; Hayashi and others 2007, 2011; Hung and others 2009 as all cited by Soon Yong and others 2013) is low, matched percentage is also low but still the highest among the equations. Therefore, they conclude that this formula is more reliable to be used in growth determination.

C. Methods

C.1 Parameters

C.1.1 Surrounding Floras and Faunas

The unwanted seaweeds might compete for nutrients or cover the farm-raised *Kappaphycus* resulting in quick deposition of silt on the stems and branches. Silt or mud covers the plants reducing their growth that is why a muddy sea bottom is not advisable. Murky waters will also limit the amount of sunlight that reaches the plants.

C.1.2 Water Temperature

A water temperature ranging from 25-30 degrees Celsius is best for growing *Kappaphycus*. The ideal area is one between the spring low tide limit and the reef edge or the area which does not dry up during these extreme low tides occurring during full or new moon.

C.1.3 Water Salinity

Areas that are near the mouth of rivers or where there is a heavy freshwater runoff should be avoided. The salinity of seawater to a level that is detrimental to the growth of the seaweed might be decreased by the freshwater from the rivers.

C.1.4 Amount of Sunlight

For the synthesis of organic products necessary for their normal growth and development, seaweeds require light as a source of energy. Potential sites should have water with good transparency because clear seawater allows sunlight to penetrate more easily to the plants. This is why seaweeds planted closer to the sea surface grow faster and healthier compared to those planted close to the sea bottom or in deep water.

C.1.5 Water Movement and Speed

Water movement plays an important role in preventing an increase in pH, caused by consumption of carbon dioxide, and in supplying nutrient. In an ordinary site, you can consider a site suitable for seaweed culture if its current is about 20 cm/s. If the site is already rich in nutrients, the current could be as slow as 10cm/s. But, when the site is deficient in nutrients, a faster current is required but should not exceed 30cm/s.

C.1.6 Climate

In the minireview made by Harley and others, predicting the individual response due to climate change is challenging (2012). Its life history stages and transition, which the environmental change can act, gives difficulty to do so.

C.2 Seaweed Culture Methods

C.2.1 Off – bottom culture method

This technique is best suited for lagoons, where at low tide, there is relatively shallow water. The general approach is to suspend a series of lines 10m in length between two posts which are usually made of wood (San 2012). In this method, head ropes are tightened between poles at a distance of around 40-50cm above the seafloor. The average planting distance on these ropes is 20-25 cm (Blankenhorn 2007).

C.2.2 Fixed Monoline

Bottom monoline is the cheapest to establish, easy to maintain and not prone to surface conditions. This consists of a module having 28 monolines (single line) with a length of 30 ft. Thirty-six plants can be planted in a monoline and a hectare will have 35 modules (Juanich 1988).

C.2.3 Floating Raft

In floating raft, seaweeds are tied to a device to keep them float with the tidal change. The floating device is made of bamboo, mangrove wood or bush timber wood frame. For a 2.5 by 2.5 m frame, 3-millimeter rope or line are stretched. 225 seaweed saplings can be tied in this kind of frame. Seaweeds are tied to the shore by placing the raft on a support: oil drums or wooden poles (FAO).

C.2.4 Longline Method

The same as floating raft, longline also have floaters to keep the seaweeds float together with the tidal change. But this time it is hung in a rope which is thicker, about 10–15 mm in diameter. This rope then tied to floaters with 4–5 meters interval. Raffias are then tied to the main rope (FAO).

C.2.5 Pond Culture

In the study of Zonghe and others in 2013, the culture was done in a shrimp pond with muddy bottom with an area of 0.1 ha and depth of 1.2 m. It was found that *Sargassum hemiphyllum* grow well with some tips floating in water surface.

C.2.6 Laboratory Culture

In 2002, Sahoo and others investigated the growth of *Eucheumaserra*at different temperature and light condition in a laboratory. Also they cultivate seaweeds at deep sea in different levels. The thalli were brought to the laboratory from SCUBA. With the light density and temperature combination of 30 μmol and 25°C, as well as 50 μmol and 18°C, the seaweed's color was bleached and had negative growth rate. In 40 μmol and 25°C, the seaweed's color was completely bleached and had negative growth rate.

C.2.7 Transportation of Seaweeds

Seaweeds are sensitive. During the transportation of seaweeds, it needs to be kept moist and well-aerated, cool, and protected (FAO).

In a study by Thirumaran and others in 2009, the live material was shipped in plastic bags or jute sacks wet enough to prevent dryness.

CHAPTER 3

METHODOLOGY

A. Research Design

The study had a site in San Lorenzo, Guimaras that was tested for seaweed culture. The site had *Kappaphycus alvarezii* and *Kappaphycus striatum* tested. Three replicates for *Kappaphcus striatum* and only one for *Kappaphycus alvarezii* was used in the site and each replicate consists of an off-bottom line with 20 individuals.

B. Materials

In this experiment, since off-bottom method was used, bamboo poles, polyethylene ropes numbers 4 and 8, and Styrofoam block or sack (for transporting) was used in order to culture the seaweeds. In measuring the weight of the seaweeds, a weighing scale (1kg) was used.

C. Preparation

In this experiment, the controlled variable was the species of the seaweed. This is to see how different parameters in different sites affect their growth. Through this, identifying the site which has positively affected the growth of the seaweeds will be recognized without difficulty.

C.1 Assessing of sites

In assessing which species of seaweed is suitable for the different sites, test planting was done using *Kappaphycus* seaweed species. The site was planted with different *Kappaphycus* species and the growth of each species was checked.

First, in selecting the sites, these things must be considered. These are the requirements that the selected sites needs to be considered as a suitable sites:

Water movement	Rapid water turnover but not heavy enough to damage the farm.	20 to 40 meters per minute
Water Temperature	High temperature will kill the plants.	25–30°C

Water Depth	At least knee deep at spring low tide. Shallower waters can still grow but it is exposed to direct sunlight and wind.	0.5 meters – 1 meter
Water salinity	Planting seaweed in brackish water or fresh water could kill the seedlings.	Minimum of 28 ppt (parts per thousandths)
Bottom type	Bottom filled with seagrasses and hard coral formations is not a good site to establish farms	White, sandy bottom with limited amount of natural seaweeds
Sunlight	Seaweeds planted in shallow water near the surface receive a plenty of sunlight.	30 to 50 centimeters from the surface

The area must be sheltered from very strong wave action, current and winds. The area needs to be away from pollution. Other marine plants and animals located in the area will also be acknowledged (Juanich 1988). In measuring physical-chemical parameters, water temperature, pH and salinity, a multiparameter probe will be used. After this, temperature was measured in the field using a mercury thermometer (Shibata and others 2004).

C.2 Seaweed Preparation

Seedlings should be taken from healthy and fast growing plant. In cutting its branches, the usage of clean, sharp knife is advisable to leave a smooth surface. Do not cut in a slant position and do not reproduce the branches with cuts at its edges or branches. Before planting, the specimen was weighed individually. For identification purpose, tags were put.

It is advisable to get the seaweed seedlings at the area. In transporting the seaweeds, there are things to be followed. Water should be drained first before the transport. To keep its moisture, you can cover the seedlings with a tarpaulin or coconut leaves. If the traveling will take several hours, you can place the seedlings in an onion bag or jute. It is very important to keep its moisture at all times. If the moisture will not be kept, the seedlings will spoil. For it to maintain, you can pour some saltwater (in regular intervals) or if have chance deep it to the sea. Except of using a bag, you can also use a Styrofoam box. In using the box, several holes will be placed at the edges to facilitate aeration. Never fill the box with saltwater. It will rot. The seedlings are covered to avoid its direct exposure to sunlight, wind, rain, change in temperature, and humidity. Seaweeds need to be kept moist cool and protected to survive while it is out of water. During the transferring of seaweeds, pour some seawater from the area for the seaweeds to adjust. In the study by Muñoz and others, seedlings were transported by Styrofoam boxes to the farm sites (2004). Stress causes the seedlings to die.

Commercial eucheumatoids can stay for at least 2 days if packed properly (Ask 2001).

D. Experimental set-up

During this experiment, off-bottom method was used and the general approach was to suspend a series of lines of approximately 10m in length between two posts. The wooden stakes was sharpened at one end so it will be easily driven to the sand, 20 to 25 centimeters apart from other straight rows. The stakes needs to be 5 to 10 centimeters in diameter and 1 to 1.5 meter long. 0.5 meter of the stake was driven to the sand to secure. A 3-millimeter thick rope PE rope was firmly stretched between the stakes with a distance of 4 meters. Attached to the line are the raffia (PE strings) where the seaweeds (bought from seaweed farmers), 100-150 grams in weight, was tied. While tying the seaweeds, proper handling is important. Then the rope was suspended 40 – 50 centimeters above the seafloor to prevent the growing seaweeds from being tossed in the sand and 20 to 30 centimeters from the water surface to prevent from exposed sunlight. While on land, seaweeds seedlings were tied 15-20 cm apart, using the slip knot, to the cultivation. The seaweeds were tied not too loose and not too tight. This string needs to be knotted in both ends, preventing fraying.

If the preparation will be on land, make sure that the seaweeds are covered and, when possible, prepare it at night or in shade during the day. It needs to be kept moist. Prepare the seaweeds and lines as quickly as possible and place them in the sea water. The seaweeds will grow better if the seaweeds are kept away from the water in limited time. The string needs to be tied first before the seaweeds are tied to them. The preparation can be done either on shore, shallow water, on land or in the punt near the farm. Carry the ropes to the site at the lowest tide and tie both ends to stakes already placed 4-meter apart on the seabed.

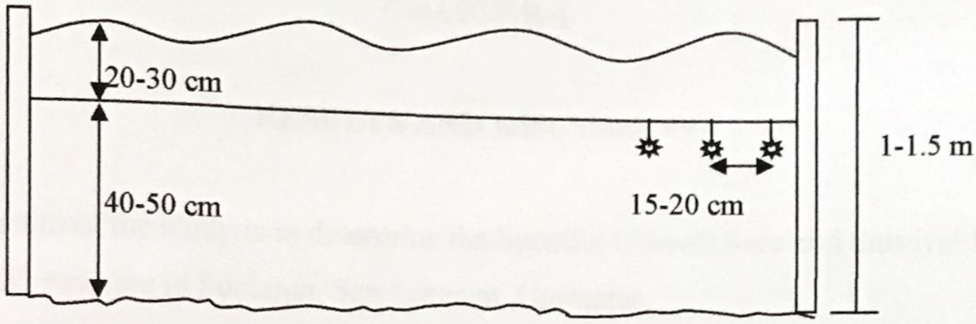


Figure 1. Experimental Set-up with measurements.

E. Collection of Data

Seaweeds are ready for harvest in 45 to 60 days.

In checking the growth of the seaweeds, the data gathering was done every 14±7 days. For a reliable data, it is advisable to conduct the gathering not less than 6 weeks. *Kappaphycus alvarezii* and *Kappaphycus striatum* are the strains that were used which had 20 individuals in a replicate. The lines were brought near the shore. Three seaweed seedlings were harvested randomly and measured using a weighing scale.

F. Data Processing

In measuring the growth of each of the seaweed, weight was considered (Kotiya and others 2011). To calculate its growth rate, it was calculated from the change of the fresh weight of the organism after t days (Soon Yong 2013).

$$DGR_3\% = \left[\left(\frac{W_t}{W_o}\right)^{\frac{1}{t}} - 1\right] * 100\%$$

The growth of seaweeds from each site was differentiated and compared. Through this, the area best suitable for seaweed was identified. Survivability rate was measured through getting the percentage of the seedlings left after a period of time and the seedlings originally planted.

$$Survival\ rate = \frac{n_t - n_o}{t}$$

CHAPTER 4

RESULTS AND DISCUSSION

The main aim of the study is to determine the Specific Growth Rate and Survival Rate of *K. alvarezii* and *K. striatum* in Suclaran, San Lorenzo, Guimaras.

The set-up was composed of three lines of *K. striatum* and a line of *K. alvarezii* with 20 individuals in each line. Off bottom method technique was used to grow the seaweeds. The data were gathered six times for every 14±7 days until the 91st day of culture. The weights of three randomly selected seaweeds on Day 16, Day 28, Day 42, Day 56, Day 70 and Day 91 were recorded. The number of seaweeds survived for the said days was also noted.

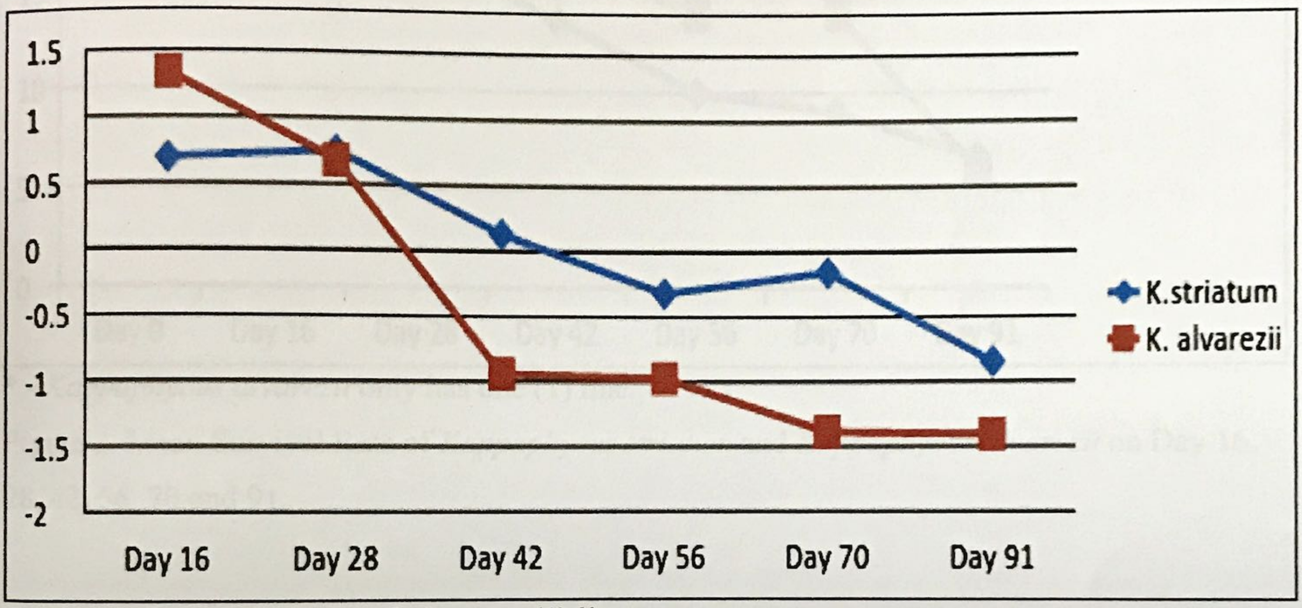
The mean weight of the seaweeds on the said dates was calculated. The mean weights were then used to calculate the specific growth rate using a formula by Soon Yong (2013). The number of surviving individuals was then used to calculate the survival rate.

The mean SGR and Survival Rate were then plotted in a graph to show the relationships.

A. Results

A.1 Mean Specific Growth Rate

After 91 days, each line of the seaweeds grown showed different specific growth rate. *Kappaphycus striatum* showed the higher growth rate. The seaweeds *Kappaphycus alvarezii* showed a lower specific growth rate. The seaweeds growth was not consistent as can be seen in the graph. Day 16 showed the highest specific growth rates of the seaweeds. On day 42, *K. alvarezii* already experienced negative growth rate and continue to decrease sooner while *K. striatum* started a negative data during the 56th day of culture. Day 91 showed the lowest growth rate to both species.

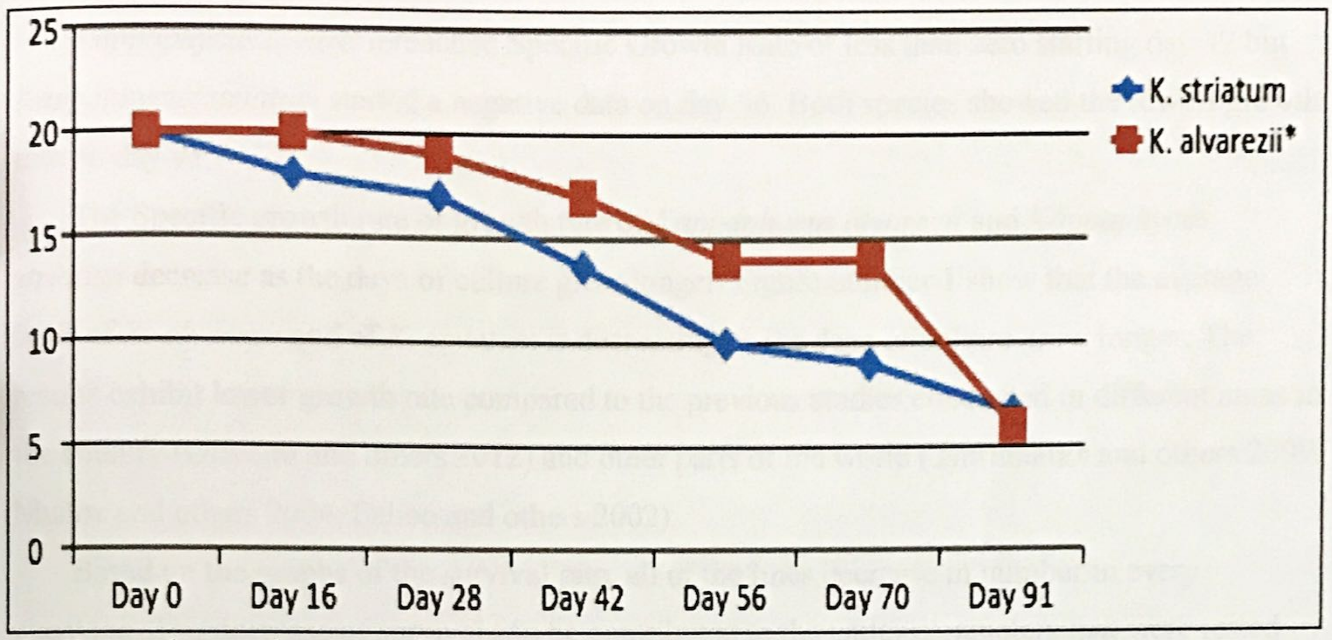


* - *Kappaphycus alvarezii* only has one (1) line.

Figure 1. Mean Specific Growth Rate of *Kappaphycus striatum* and *Kappaphycus alvarezii* on Day 16, 28, 42, 56, 70 and 91.

A.2 Survival Rate

In every 14±7 days, the number of individuals left per line was recorded and the mean of the survival rate is plotted through a graph. *Kappaphycus alvarezii* showed higher Survival Rate but on day 91, the survival for both species is almost the same.



* - *Kappaphycus alvarezii* only has one (1) line.

Figure 2. Mean Survival Rate of *Kappaphycus striatum* and *Kappaphycus alvarezii* on Day 16, 28, 42, 56, 70 and 91.

B. DISCUSSION

The results of the study show that *Kappaphycus* seaweed species do not grow well at Suclaran, San Lorenzo, Guimaras after 91 days of culture. There are specific individuals that gained weight but in general, the weight and growth rate per line of relatively smaller in every 14±7 days.

Kappaphycus alvarezii reached Specific Growth Rate of less than zero starting day 42 but *Kappaphycus striatum* started a negative data on day 56. Both species showed the lowest growth rate on day 91.

The Specific growth rate or growth rate of *Kappaphycus alvarezii* and *Kappaphycus striatum* decrease as the days of culture grew longer. Figure number 1 show that the average SGR of *K. alvarezii* and of *K. striatum* is decreasing as the days of culture grew longer. The results exhibit lower growth rate compared to the previous studies conducted in different areas in the country (Oliveira and others 2012) and other parts of the world (Thirumaran and others 2009; Muñoz and others 2004; Sahoo and others 2002).

Based on the graphs of the survival rate, all of the lines decrease in number in every checking. The decrease of survival can be contributed to the water parameters that were tested during the duration of the culture. The survival rate is the same on the last day of checking. The highest survival is on day 16 of *K. alvarezii* and *K. striatum* with 20 individuals left and the least is on day 91 of *K. Striatum* with 5 individuals left.

The decrease can be contributed to the water parameters such as Turbidity, Dissolved Oxygen, DSS, Phosphate and Nitrate Levels, Flora and Fauna, and water height that were tested during the duration of culture and also to the storms happened in the period of the study.

The result of the study show that Suclaran, San Lorenzo, Guimaras is not a good substitute or culture area for *Kappaphycus* seaweed species in months September until November. However, the suitability of seaweeds for the whole year cannot be fully concluded since there is no data during the months of January until August.

CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMENDATION

The study aimed to determine the Specific growth Rate and Survival Rate of *K. alvarezii* and *K. striatum* through getting the weight and survival of the seaweeds in Suclaran, San Lorenzo, Guimaras, respectively.

Three randomly chosen seaweeds were weighed every 14±7 days until the 91st day of culture. Each checking, the number of remaining individuals were also counted and recorded. The mean weight was then calculated and was used to determine the mean SGR of the seaweeds per day. The formula from the study of Soon Yong and others was used to calculate for the Specific Growth Rate of the seaweeds per day (2013).

Summary of Findings

1. The mean Specific Growth Rate of *K. striatum* calculated using the formula by Soon Yong, 0.695084232, 0.75302687, 0.128728372, -0.318955273, -0.155952577 and -0.847440297 in days 16, 28, 42, 56, 70 and 91 respectively while the Specific Growth Rate of *K. alvarezii* in days 16, 28, 42, 56, 70 and 91 are 1.336, 0.682, -0.942, -0.974, -1.386 and -1.407, respectively. *K. alvarezii* only has one (1) line.
2. The survival rate was also calculated. The mean Survival Rate of *K. striatum* is 90, 85, 73.33, 53.33, 65, and 45 in days 16, 28, 42, 56, 70 and 91 respectively and in days 16, 28, 42, 56, 70 and 91, the Survival Rate of *K. alvarezii* is 100, 95, 85, 70, 70, and 30.
3. This implies that the SGR and Survival Rate of the species decreases as the days of culture went longer.

Conclusion

From the data gathered, it can be concluded that Suclaran, San Lorenzo, Guimaras is not a suitable site for seaweed culture during the months of October until December because of the SouthWest Monsoon or Habagat that happens in the area. During the culture period, storms, strong winds high winds and many other parameters affected the growth and survival of the said seaweed species.

Recommendation

The suitability of the site for seaweed culture for the whole year cannot be concluded since the study was only done in short period of time due to shortage of time and supply of the species.

Suclaran, San Lorenzo, Guimaras was recommended by the Municipal Agriculturist of San Lorenzo in months April until October which is not covered in the duration of the study. It is recommended for the future research to conduct the same study in months January until September since this are the months recommended by the Municipal Agriculturist of San Lorenzo. It is also recommended to use other strand of seaweeds and different site for the conduct of upcoming studies.

It is encourage completing the replicates of each species of seaweeds during the conduct of the study to compare the SGR of both species.

And it is recommended to have a professional to identify the seaweed species since the seaweeds' physical appearance differ from one place to the other.

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APPENDIX A

RAW DATA

Table 1.Weight of three (3) randomly chosen *Kappaphycus striatum* per line in days 16, 28, 42, 56, 70, 91 in grams.

	Number of Culture Days																	
	Day 16			Day 28			Day 42			Day 56			Day 70			Day 91		
Line Number	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Line 1	135	130	135	150	150	200	50	165	87.5	30	250	75	220	55	115	30	75	165
Line 2	165	155	170	150	100	100	250	100	80	130	100	110	60	160	125	30	70	130
Line 3	145	180	130	200	150	150	145	130	120	25	135	67.5	120	100	50	20	40	85

Table 2. Weight of three (3) randomly chosen *Kappaphycus alvarezii* after 16, 28, 42, 56, 70, and 91 days of culture in grams.

	Number of Culture Days																	
	Day 16			Day 28			Day 42			Day 56			Day 70			Day 91		
Line Number	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Line 1	135	130	135	125	175	150	90	70	90	10	135	52.5	50	50	40	20	27.5	80

Table 3. Survival of *Kappaphycus* species after days 16, 28, 42, 56, 70, and 91.

	Number of Culture Days						
Kappaphycus species Line Number	Day 0	Day 16	Day 28	Day 42	Day 56	Day 70	Day 91
Kappaphycus striatum Line 1	20	15	15	15	15	12	10
Kappahycus striatum Line 2	20	19	18	14	6	6	5
Kappaphycus striatum Line 3	20	20	18	12	9	9	5
Kappaphycus alvarezii Line 1	20	20	19	17	14	14	6

APPENDIX B

PROCESSED DATA

Table 4. Mean weight of *Kappaphycus* seaweeds per line after days 16, 28, 42, 56, 70, 91 in grams.

	Number of Culture Days						
Kappaphycus species Line Number	Day 0	Day 16	Day 28	Day 42	Day 56	Day 70	Day 91
Kappaphycus striatum Line 1	120.75	133.33	166.67	110	98.33	135	63.33
Kappahycus striatum Line 2	124.75	122.5	116.67	143.33	135	102	55
Kappaphycus striatum Line 3	119.25	151.67	166.67	131.67	71.67	90	49.8
Kappaphycus alvarezii Line 1	124	153.33	150	83.33	71.67	46.67	34.167

Table 5. Mean weight of *Kappaphycus* seaweeds per day after days 16, 28, 42, 56, 70, 91 in grams.

	Number of Culture Days						
Kappaphycus species Line Number	Day 0	Day 16	Day 28	Day 42	Day 56	Day 70	Day 91
Kappaphycus striatum Line 1	121.583	135.833	150.003	128.333	101.667	109	56.0443
*Kappaphycus alvarezii**	124	153.33	150	83.33	71.67	46.6667	34.1667

**Kappaphycus alvarezii* has one (1) line only.

Table 6. Mean survival of *Kappaphycus* seaweeds per day after days 16, 28, 42, 56, 70, 91 in grams.

	Number of Culture Days						
Kappaphycus species Line Number	Day 0	Day 16	Day 28	Day 42	Day 56	Day 70	Day 91
Kappaphycus striatum Line 1	20	18	17	13.6667	10	9	6.66667
*Kappaphycus alvarezii**	20	20	19	17	14	14	6

**Kappaphycus alvarezii* has one (1) line only.

Table 7. Mean specific growth rate of *Kappaphycus* seaweeds per day after days 16, 28, 42, 56, 70, 91 in grams.

	Number of Culture Days					
Kappaphycus species Line Number	Day 16	Day 28	Day 42	Day 56	Day 70	Day 91
Kappaphycus striatum Line 1	0.69508	0.75303	0.12873	-0.319	-0.15595	-0.8474
*Kappaphycus alvarezii**	1.33579	0.68215	-0.9419	-0.9742	-1.38637	-1.4065

**Kappaphycus alvarezii* has one (1) line only.

Table 8. Mean survival rate of *Kappaphycus* seaweeds per day after days 16, 28, 42, 56, 70, 91 in grams.

	Number of Culture Days					
Kappaphycus species Line Number	Day 16	Day 28	Day 42	Day 56	Day 70	Day 91
Kappaphycus striatum Line 1	90	85	68.3333	50	45	33.3333
*Kappaphycus alvarezii**	100	95	85	70	70	30

**Kappaphycus alvarezii* has one (1) line only.

APPENDIX C

PERMITS, LETTERS, AND REQUESTS

Philipppine Science High School – Western Visayas Campus
Doña Lawa-an, Bito-on, Jaro, Iloilo City

MUNICIPALITY OF JORDAN
PROVINCE OF GUIMARAS
RECEIVED
MAR 26 2014
BY

February 26, 2014

Hon. Cresente Chavez
Municipal Mayor
Municipality of Jordan
Jordan, Guimaras

Sir:

Good day!

I am writing you this letter on behalf of my third year students, Marynel dela Riarte, Twilitte Ae Medalle and Gianne Gilbert Nismal, of Philippine Science High School Western Visayas Campus (PSHS-WVC), in Bitoon, Jaro, Iloilo City who are currently taking Research as a subject. As part of their research study "Assessing the Suitability of Different Sites for *Kappaphycus alvarezii* and *Kappaphycus striatum* farming", they are expected to find areas in Western Visayas to be used as study sites for seaweed culture.

If permitted, an ocular inspection and assessing of the sites will be done. The group is expected to check the following parameters in the sites for their data:

- Bottom type
- Sunlight
- Water movement
- Water Temperature
- Water Depth
- Water salinity
- Water Acidity
- Surrounding Floras and Faunas

With this, the group is asking permission from your office to allow them to check certain coastal areas in your community. The information that will be collected will be used for research and educational purposes only.

If you have any further questions or clarifications, you can contact my students through e-mail: mtg.research.981725@gmail.com or through their cellular phones (09159161729) (09479584041) (09213896962)

We are hoping that you will take positive action on this request. You would be a great help to them students of science.

Thank you very much and God bless.

Respectfully yours,

EDWARD C. ALBARACIN
Research Adviser

Noted:

SHENA FAITH M. GANELA, Ph. D.
Campus Director, PSHSWVC

Plate 1. Letter to the Municipal Mayor of Jordan, Guimaras to Conduct Ocular Inspection and to Assess Sites

OFFICE OF THE MAYOR
RECEIVED
BY: [signature]
DATE: 3/26/14
TIME: 9:05 am
NUEVA VALENCIA, GUIMARAS

Philipppine Science High School – Western Visayas Campus
Doña Lawa-an, Bito-on, Jaro, Iloilo City

February 26, 2014

Hon. Emmanuel Galila
Municipal Mayor
Municipality of Nueva Valencia
Nueva Valencia, Guimaras

Sir:

Good day!

I am writing you this letter on behalf of my third year students, Marynel dela Riarte, Twilitte Ae Medalle and Gianne Gilbert Nismal, of Philippine Science High School Western Visayas Campus (PSHS-WVC), in Bitoon, Jaro, Iloilo City who are currently taking Research as a subject. As part of their research study "Assessing the Suitability of Different Sites for *Kappaphycus alvarezii* and *Kappaphycus striatum* farming", they are expected to find areas in Western Visayas to be used as study sites for seaweed culture.

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We are hoping that you will take positive action on this request. You would be a great help to them students of science.

Thank you very much and God bless.

Respectfully yours,

EDWARD C. ALBARACIN
Research Adviser

Noted:

SHENA FAITH M. GANELA, Ph. D.
Campus Director, PSHS WVC

Plate 2. Letter to the Municipal Mayor of Nueva Valencia, Guimaras to Conduct Ocular Inspection and to Assess Sites

Philipppine Science High School – Western Visayas Campus
Doña Lawa-an, Bito-on, Jaro, Iloilo City

February 26, 2014

Hon. Rolando Distura
Municipal Mayor
Municipality of Dumangas
Dumangas, Iloilo

OK let them coordinate w/ Eugene [illegible] MAO - Dumangas

Sir:

Good day!

I am writing you this letter on behalf of my third year students, Marynel dela Riarte, Twilitte Ae Medalle and Gianne Gilbert Nismal, of Philippine Science High School Western Visayas Campus (PSHS-WVC), in Bitoon, Jaro, Iloilo City who are currently taking Research as a subject. As part of their research study "Assessing the Suitability of Different Sites for *Kappaphycus alvarezii* and *Kappaphycus striatum* farming", they are expected to find areas in Western Visayas to be used as study sites for seaweed culture.

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- Sunlight
- Water movement
- Water Temperature
- Water Depth
- Water salinity
- Water Acidity
- Surrounding Floras and Faunas

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We are hoping that you will take positive action on this request. You would be a great help to them students of science.

Thank you very much and God bless.

Respectfully yours,

EDWARD C. ALBARACIN
Research Adviser

Noted:

SHENA FAITH M. GANELA, Ph. D.
Campus Director, PSHSWVC

Plate 3. Letter to the Municipal Mayor of Dumangas,Iloilo to Conduct Ocular Inspection and to Assess Sites

APPENDIX D

PHOTOS

Plate 4: The seaweeds were initially weighed approximately 150-200 grams.

Plate 5: After weighing, the seaweeds were then tied to the lines under a shade of a tree.

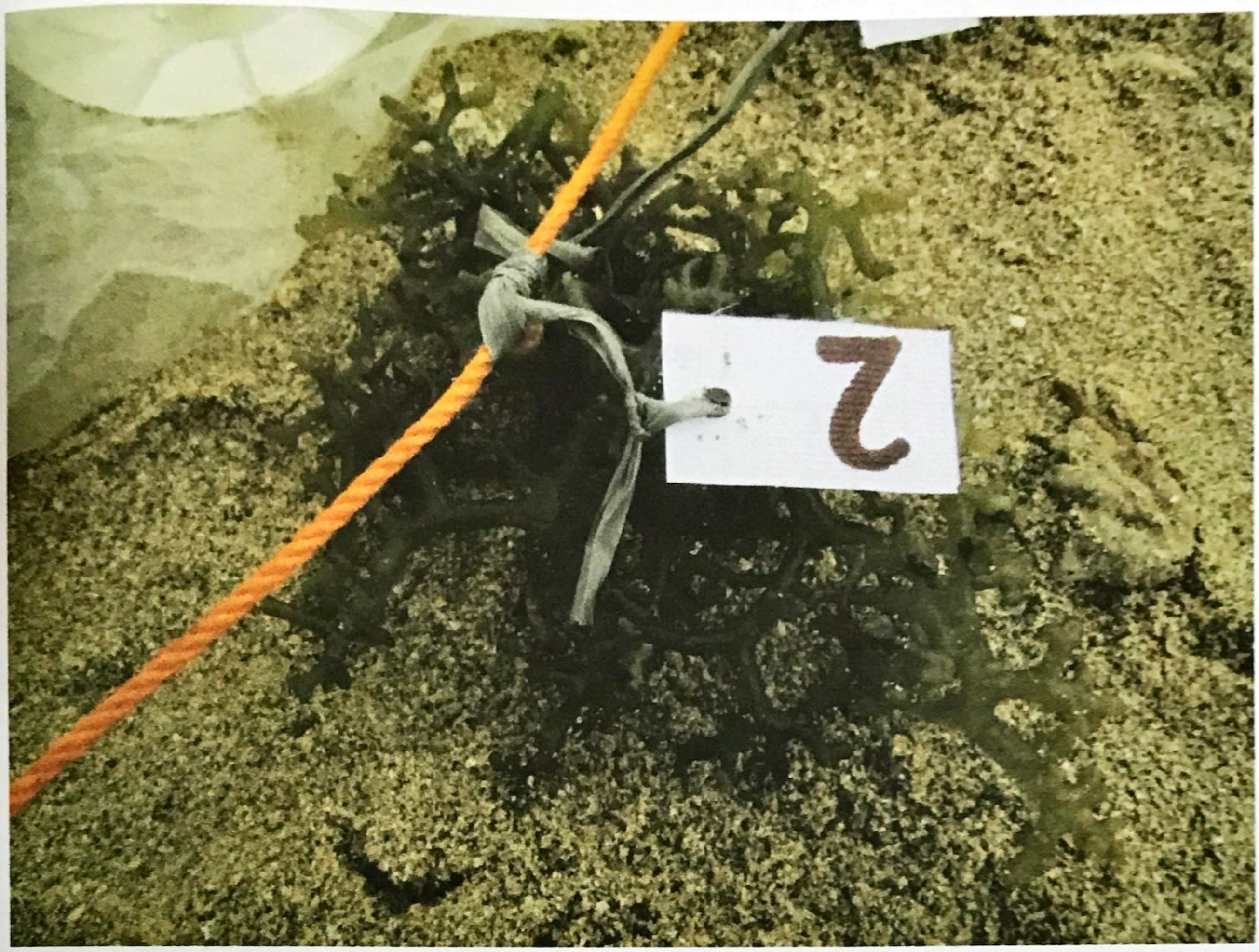

Plate 6: ID tags were placed for identification purposes.

APPENDIX E

LIQUIDATION

A. Transportation

Destination	Means of Transport	Price per Trip (Php/person/trip)	Number of Individuals	Frequency of Trip	Total Amount
Suclaran - Nadulao Island, San Lorenzo Guimaras	Boat	Php 400/person/trip	2	1	Php 800.00
Iloilo City - Suclaran, San Lorenzo, Guimaras	Jeep, Tricycle, Boat	Php 100/person/trip	3	12	Php3600.00
Total					Php4400.00

B. Other Materials

Quantity	Item	Source	Price per Unit	Total Amount
1 roll	Polyethylene Rope #8	Store	380.00/roll	Php
1 roll	Polyethylene Rope #4	Store	120.00/roll	Php
17 Kg	*Kappaphycus alvarezii* seaweeds	Nadulao Island, San Lorenzo	20.00/kilogram	Php 340.00
40 Kg	*Kappaphycus striatum* seaweeds	Nadulao Island, San Lorenzo	20.00/Kilogram	Php 800.00
Total				Php1640.00

LIST OF RECEIPTS

Received note from the boatman during the trip to Nadulao Island

RECEIPTS

An amount of **Php 800.00**
was received from **Twilitte Ae Q. Medalle**
as payment for the **transportation during their trip Nadulao Island - Suclaran, San Lorenzo, Guimaras and vise versa, for the collection of their seaweeds.**

for ROBERT TACANA
boatman

Note from the boatman during the trip to Nadulao Island