# THE EFFECT OF *GRACILARIA VERRUCOSA* ON THE GROWTH RATE OF PACIFIC OYSTER(*CRASSOSTREA GIGAS*)

BY

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# ABSTRACT

In natural aquatic systems, there are ecological balances between different species of organisms and individuals. However in culture conditions the systems are usually meant to favour the preferred organisms, but still other organisms might invade and share in the utilization of resources. ***Gracilaria verrueosa*** is an unwanted plant that grows in marine cultured beds along the Namibian coast and this experiment showed that it adversely affects the growth performance of the Pacific oyster (***Crassostrea gigas).*** The decrease in growth of the oyster in rafts was directly linked to the presence of ***Gracilaria verrucosa.*** This experiment quantitatively showed that invasion quantities of ***Gracilaria verrucosa*** influences the percentage growth reduction rates of oyster. The various seeding rates (O, 400, 800 g) of ***Gracilaria verrucosa*** resulted in significantly (P>0.05) reduced growth rates of oysters by 21% and 37% in medium and high seeding rates of the seaweed, respectively. This was shown to be significant using the *t-test* and *Wilcoxon Sum Rank Test (P>0.05).* Although conducted over a short growing period of 6 weeks, the experiment demonstrated detrimental invasion of ***Gracilaria verrucosa*** in oyster rafts.

# LITERATURE REVIEW

Most fisheries of the world have experienced fluctuations in production. Among marine populations of oysters which occur in shallow coastal waters, reduction of production have occurred and sometimes over a long term basis (Alderman, 1974).

Identification of the causes has proved to be very difficult as only a few mortalities have been associated with specific pathogens, predators or other environmental factors (Kat-Kansky 1975). Inhibition of growth of oysters by organisms like pathogens, predators and seaweeds like ***Gracilaria verrucosa*** has severely been ignored ( Alderman and Gras, 1969).

Although mortalities and disturbances in growth are natural phenomena, man has contributed to increase the likelihood of occurrence by crowding individuals into dense populations often under marginal environmental conditions (Alderman , 1974). Crowding effects have mainly been in the presence of *Gracilaria verrucosa* (Alderman and Gras,1969).

Experimental infections were achieved with cultured ***Crassosrea gigas*** (Kat-Kansky, 1975). The effects of ***Gracilaria verrucosa*** have been seen in the slow growing oysters (Alderman , 1974). Studies of three harbours in the North Island New Zealand provided some answers . For instance, there was depletion of nutrients in areas where red seaweed (***Glaricaria verrucosa*** ) occur . It is also known that the red seaweed (***Glaricaria verrucosa*** ) , can be used to reduce the effect of eutrophication of coastal waters because of its ability to absorb nutrients resulting from waste water discharge at a higher rate .The presence of the red seaweed in oyster beds also affects water flow, stressing the animals and reducing

the efficiency of the filtering process (Pyke, 1998 ) . The cause of slow growth was unknown and probably related to metabolic disturbances by (Matate S, and Imai 1966).

# INTRODUCTION

The pacific oyster ***Crassostrea gigas*** is an exotic species that was introduced into the West Coast estuaries from Japan. Spawning depends on a rise in water temperature of above (18 degrees celcius) and only breeds erratically in West Coast estuaries. When spawning does occur it occurs primarily in July and August. Eggs and larvae are planktonic and distributed throughout the water column later, they crawl on the bottom searching for a suitable habitat before settlement (Alderman, 1974).

Introduced in the early 1900's from Japan to America , ***Crassostrea gigas*** has contributed to a growing mariculture industry.

***Gracilaria verrucosa*** grows naturally in Namibian waters and is harvested in Luderitz for agar production. Quest International was established in 1992 at Ludertiz, to exploit this resource and supplied by Taurus Atlantic seaweed with wild stock of ***Gracilaria verrucosa***. This stock was supplemented by cultured ***Gracilaria verrucosa ,*** in which exercise there was close collaboration between researchers of the Ministry of Fisheries and Marine Resources and the company.

Quests International processes its seaweed to the agar stage (Namibia Brief, No. 20. October 1998)

The seaweed contains 23% gel when cultured and 16% from natural stock making the cultured stock superior (Maurihingirire and Griffin ,1998).

The Namibia mariculture industry is focused on the cultivation of shellfish, especially oysters, and unpolluted nutrient rich Benguella current waters greatly enhance the suitability for culture .

The oyster producer at Walvis Bay uses a land-based system in which water is pumped from the sea into man-made ponds and the oysters are put in bags that hang from ropes or wooden structures. This allows wild ***Gracilaria verrucosa*** to grow within the oysters. Both organisms utilize the rich marine water pumped into the ponds, thus the production rates of oysters are affected by various environmental conditions including toxic sulfur compounds, unfavorable temperature gradients and salinity .

***Gracilaria verrucosa*** has not yet been identified with certainty as a culprit that might partly cause a reduction in production rates. Oyster rafters from Walvis Bay have frequently been observed to be intergrown with ***Gracilaria verrucosa.***

## HYPOTHESIS

***Gracilaria verrucosa*** growing within oyster rafts at the Walvis Bay oyster farm will not affect growth rates and adversely affects oyster productivity.

## GENERAL OBJECTIVE

To find out the effects of ***Gracilaria verrucosa*** on the growth rates of the Pacific oyster (***Crassostrea gigas).***

# METHODS AND MATERIALS

Three months old oyster spats were used for research. They average weight of 0.45 grams per spat.

**The oysters were divided among 3 treatments as follows.**

1. Control (no ***Gracilaria verrucosa***)
2. Medium cover (400 grams of ***Gracilaria verrucosa***)
3. Full cover (800 grams of ***Gracilaria verrucosa*** )

***Gracilaria verrucosa*** was weighed to the nearest decimal point using , a Analytical laboratory balance scale. Each treatment was replicated 4 times and weight measurements were taken every two weeks.

While the weight of oysters was obtained every two weeks, ***Gracilaria verrucosa*** content was also monitored during the same period. All replications were weighted using a balance scale. The average weight was taken for each treatment by dividing by four. The t- test and Wilcoxon sum rank test were done for comparative analysis (controls vs full, full vs medium and medium vs control). A graph of weight over time was constructed to depict changes in growth. The overall growth percentage for each treatment was computed by using initial weight and the final weight. In addition, the percentage growth per day for each treatment was calculated. A graph was constructed to show the percentage growth of three different treatments over a period of six weeks growing period.

# RESULTS

**Table 1 . The percentage growth of oysters for each treatment.**

| Treatments | Initial weight (grams) | Final weight (grams) | Overall % growth | % growth per day |
|---|---|---|---|---|
| 1. control (0 g) | 0.44 | 1.00 | 56 | 1.3 |
| 2.Medium cover (400 g) | 0.50 | 0.85 | 35 | 0.8 |
| 3.Full cover (800 g) | 0.47 | 0.66 | 19 | 0.5 |

**ble 2. The growth of oysters in grams in the control treatment over 6 weeks**

| | Repli 1 | Repli 2 | Repli 3 | Repli 4 | Average |
|---|---|---|---|---|---|
| al weight | 0.43 | 0.43 | 0.44 | 0.46 | |
| k 2 | 0.68 | 0.68 | 0.66 | 0.67 | |
| k 4 | 0.81 | 0.83 | 0.78 | 0.82 | |
| k 6 | 1.04 | 1.1 | 0.94 | 0.89 | |
| | | | | | **Mean 0.73** |
| | | | | | **Std 0.24** |

**ble 3. The growth of oysters in grams under medium cover of Gracilaria over 6 weeks**

| | Repli 1 | Repli 2 | Repli 3 | Repli 4 | Average |
|---|---|---|---|---|---|
| al weight | 0.5 | 0.5 | 0.49 | 0.5 | |
| ek 2 | 0.64 | 0.62 | 0.6 | 0.62 | |
| ek 4 | 0.78 | 0.75 | 0.74 | 0.72 | |
| ek 6 | 0.89 | 0.84 | 0.8 | 0.88 | |
| | | | | | **Mean 0.68** |
| | | | | | **Std 0.15** |

**ble 4 The growth of oysters in grams under full cover of Gracilaria over 6 weeks**

| | Repli 1 | Repli2 | Repli 3 | Repli4 | Average |
|---|---|---|---|---|---|
| al weight | 0.5 | 0.45 | 0.44 | 0.47 | |
| ek 2 | 0.51 | 0.47 | 0.48 | 0.5 | |
| ek 4 | 0.63 | 0.53 | 0.56 | 0.53 | |
| ek 6 | 0.7 | 0.66 | 0.6 | 0.67 | |
| | | | | | **Mean 0.55** |
| | | | | | **Std 0.09** |

**Table 4. Comparison of control and medium treatment.**

| | |
|---|---|
| **T-test value** | 0.39 |
| **Probability** | 0.05 |
| **Degrees of freedom** | 4 |

**Table 5. Comparison of control and high treatment.**

| | |
|---|---|
| **T-test value** | 0.05 |
| **Probability** | 0.05 |
| **Degrees of freedom** | 4 |

**Table 6. Comparison of medium and high treatment.**

| | |
|---|---|
| **T-test value** | 0.02 |
| **Probability** | 0.05 |
| **Degrees of freedom** | 4 |

**Table 7. Wilcoxon Signed Ranked Test for medium and Control.**

| Data # | Table 2(control) | Table 3 (medium) | | Ranks |
|---|---|---|---|---|
| 1 | 0.44 | 0.5 | -0.6 | 1 |
| 2 | 0.67 | 0.62 | 0.05 | 2 |
| 3 | 0.81 | 0.75 | 0.06 | 3 |
| 4 | 1 | 0.85 | 0.15 | 4 |

| | |
|---|---|
| **Sum of + ranks** | 9 |
| **Sum of - ranks** | -1 |
| **Probability** | 0.05 |
| **Degrees of Freedon** | 4 |

**Table 8. Wilcoxon Signed Ranked Test for control and Full cover.**

| Data # | Table 2 (control) | Table 4( high) | | Ranks |
|---|---|---|---|---|
| 1 | 0.44 | 0.47 | -0.3 | 1 |
| 2 | 0.67 | 0.49 | 0.18 | 2 |
| 3 | 0.81 | 0.56 | 0.25 | 3 |
| 4 | 1 | 0.66 | 0.34 | 4 |

| | |
|---|---|
| **Sum of + Ranks** | 9 |
| **Sum of - Ranks** | -1 |
| **Probability** | 0.05 |
| **Degrees of freedom** | 4 |

**Table 9. Wilcoxon Signed Ranked Test for medium and High cover**

| Data # | Table 3 (medium) | Table 4 (High) | | Ranks |
|---|---|---|---|---|
| 1 | 0.5 | 0.47 | 0.3 | 1 |
| 2 | 0.62 | 0.49 | 0.13 | 2 |
| 3 | 0.75 | 0.56 | 0.19 | 3.5 |
| 4 | 0.85 | 0.66 | 0.19 | 3.5 |

| | |
|---|---|
| **Sum of + Ranks** | 10 |
| **Sum of - Ranks** | 0 |
| **Probability** | 0.05 |
| **Degrees of freedom** | 4 |

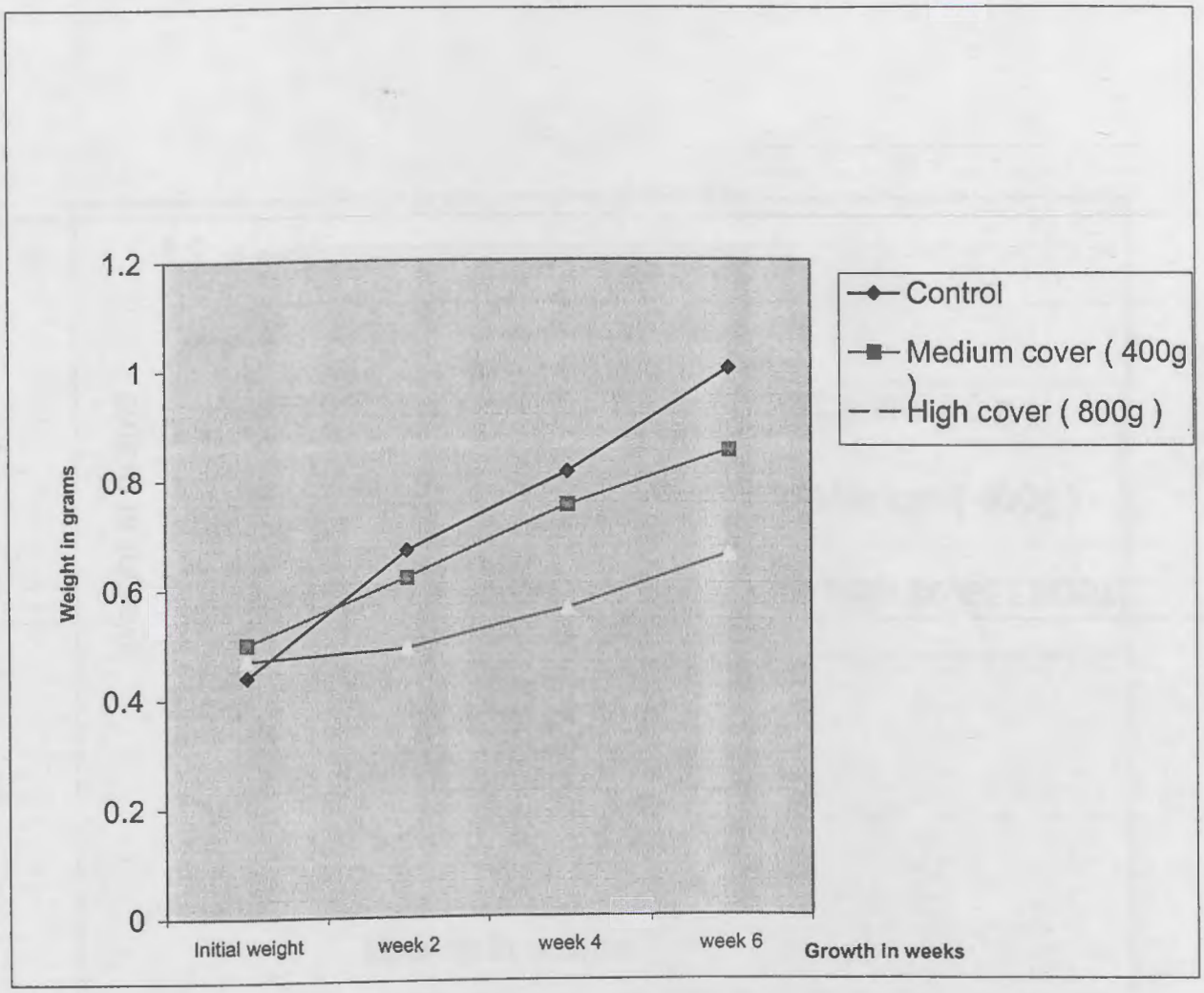


**Figure 1**. The growth rate of oysters at three different treatments of ***Gracilaria verrucosa***

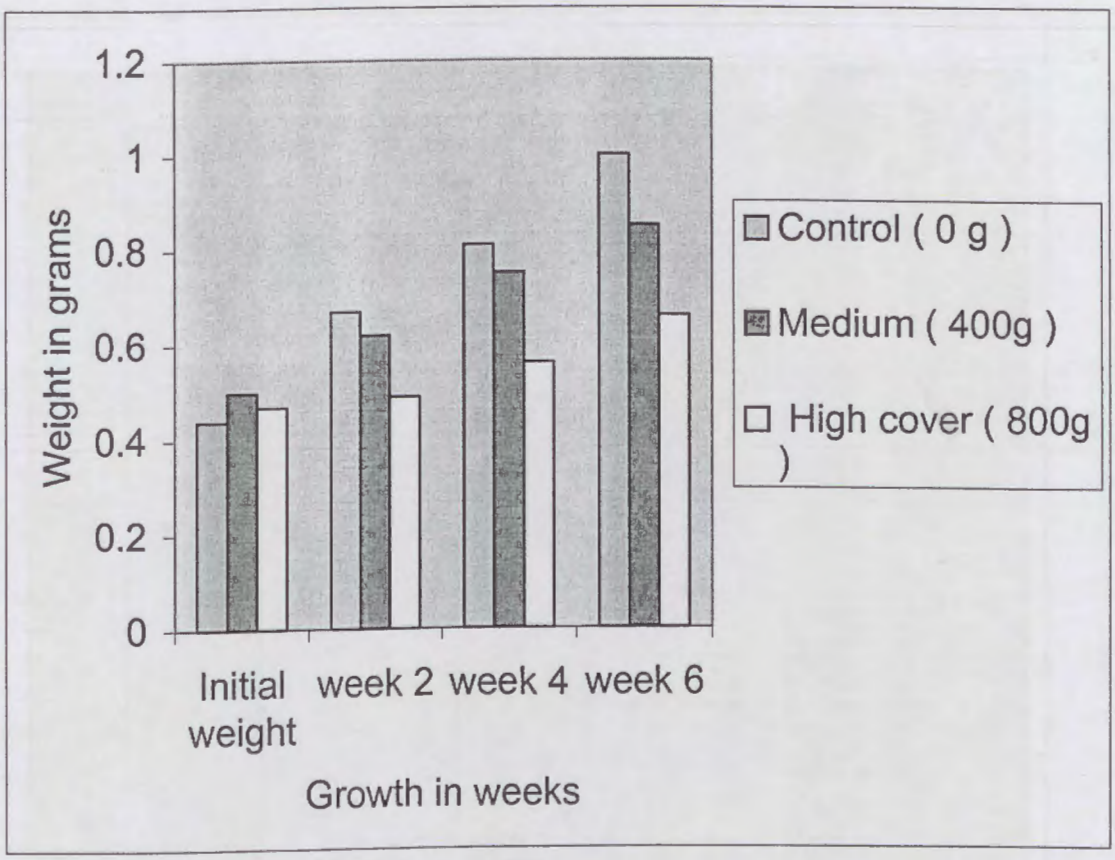


**Figure 2** .The growth of oysters at three different treatments of ***Gracilaria verrucosa***

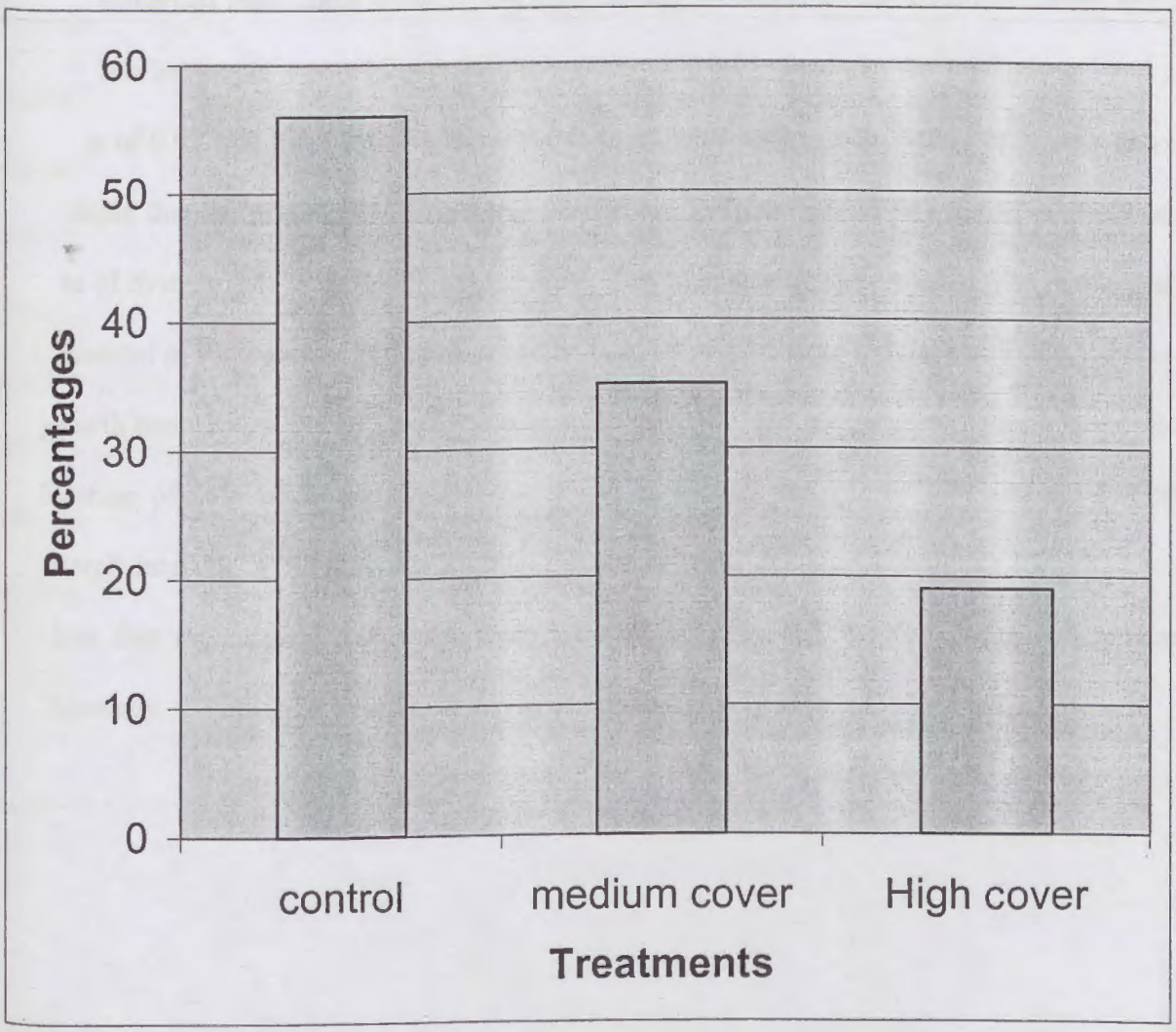


**Figure3.** Overall percentage growth rate of the three different treatments

# Analysis of Results

statistical tests show clear distinctions among treatments. The t-value between the control and .um treatment was 0.39 and the probability was 0.05. Between the medium and full content, a t-ıe of 0.02 was obtained. The control treatment gave high growth values of oysters and overall tests licate that the presence of ***Gracilaria verrrucosa*** in oyster beds has a negative effect on the growth te of oysters. The Wilcoxon's Signed Rank Test indicates similar results. The results are graphically esented in Figures 1-3. Differences can be seen among the three treatments. Table 1 shows the various growth percentages. It can clearly be seen that the control has a high growth rate with an overall growth increase of 56% while the medium cover has an overall increase of 35% and the full cover had an overall increase of 19%. Assuming that the control provides ideal conditions for growing oysters it is lear that the medium cover has been reduced by 21% and the full cover was reduced by 37%. Generally, the invasive ***Gracilaria verrucosa*** quantitatively affected the growth of oysters.

# DISCUSSION

Although the experiment was conducted over a short growing period of 6 weeks, certain observations were made that are useful to oyster farming. The results of the study support the alternative hypothesis that ***Gracilaria verrucosa*** has a deleterious effect on the growth of oyster. Many possible reasons might be advanced why growth rates of oysters are reduced, but it appears the major one might be due to space limitations. The exudates produced by the seaweed might also pose a problem to the oysters by emitting substances which are toxic, while the slimy substance from the seaweed may interfere with absorption or the filtering process of oysters ( Maurihingirire and Griffin 1998 ). The seaweed might also be interfering with water flow and thereby reduce the efficiency of the filtering process (Pyke, 1998) . ***Gracilaria verrucosa*** is also known for its high absorption capacity for nutrients thus nutrients might be taken up and thereby decreasing the general productivity of the affected area (Pyke ,1998). For optimum stocking densities cleaning the oyster beds regulary inorder to minimize the effect of ***Gracilaria verrucosa*** on the growth of oysters is recommended.

# CONCLUSION

The growth rate of oysters are affected by ***Gracilaria verrucosa*** which can be linked to many factors including extensive physical disturbances .The extent of ecological overlaps between the pacific oysters (***Crassostrea gigas*** ) and the seaweed ( ***Gracilaria verrucosa*** )should be understood in order to reduce the effect of ***Gracilaria verrucosa*** on oysters. The results obtained in this experiment indicates that the presence of ***Gracilaria verrucosa*** decreases growth rate and hence overall productivity of oysters.

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