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Productivity of the Seagrass *Enhalus acoroides* (L.f.) Royle in the Littoral Zone of Guang-Guang, Mati, Davao Oriental

Ann Cherry C. CERENO[1], Ariel C. EBALLE[2], and Lea AngSinco-JIMENEZ[2]
[1]Part-time Instructor, [2]Instructor, Natural Sciences Department,
Davao Oriental State College of Science and Technology,
Mati, Davao Oriental

Abstract

The productivity, growth rate, population density and some physico-chemical parameters affecting *Enhalus acoroides* in the littoral zone of Guang-guang, Mati, Davao Oriental was conducted from November 1996 to January 1997. Productivity of *E. acoroides* was detennined using the stabbing technique. Estimated mean shoot density ranged from 16.15 to 28.9 shoot/m^2. Growth rate ranged from 1.34 to 1.49 cm/d while shoot biomass ranged from 0.876 to 1.874 g/shoot. Standing crop of the species averaged at around 155,052.00 to 531,760.00 g/m. Results obtained from areal shoot biomass ranged from 84.465 to 192.416 g/m$^{2.}$ Production rate values averaged from 193.82 to 607 g/m^2/y. Correlation tests between growth and different physicochemical parameters were also' obtained.

Keywords: *Enhalus acoroides* (L.f.) Royle, seagrass community, blade biomass, growth rate, stabbing technique

Introduction

Seagrasses are green flowering monocots adapted to submarine reproduction, existence and periodic areal exposure. Seagrasses are also known for their importance in the marine ecosystem as a structural framework for plant and animal interrelations and in the nutrient cycle (Fortes, 1992; Menez and Phillips, 1998).

One important ecological function of seagrasses is their high production of dry matter which ranges from 300 to 600 g/m^2/y (not including the root production) (Thayer et al., 1975 as cited by Rollon and Fortes, 1990). Seagrasses have high productivity r-ate compared to some terrestrial crops such as com, rice, wheat, hay and sugar beets. In the Philippine* production rate of some species of seagrasses is from 500 to 1000 g/m^2/y.

Seagrasses are also important in the economy of certain places since these can be used for weaving as source of salts, fertilizers, animal foodstuffs and even as raw material for making papers (Fortes, 1992; 1993; and 1995).

Enhalus acoroides, one of the most Common seagrasses in the world is popularly known as the “tropical eelgrass” (Fig. 1). It belongs to the family *Hydrocharitaceae* (Fortes, 1993). E. acoroides differs from other seagrasses morphologically. It is known as the largest seagrass species. It is a thick-leafed plant with thick rhizomes that consist of long fibrous bristles with a coarse extensive root system. Flowers and fruits are also present in this species.

E. acoroides provides shelter to micro and macro algae such as Laurencia sp. and *Acanthopora sp*. through its large leaf blade (Jayasuriya and Pathirma, 1993). Aside from that, its roots and rhizomes hold and bind sediments so as to prevent erosion since their roots are embedded deep in the substratum.

Results of this study could serve as baseline information and guide in making plans or measures for the proper management of this resource as part of the rich marine resource in the area. This study could also aid in ecological studies.

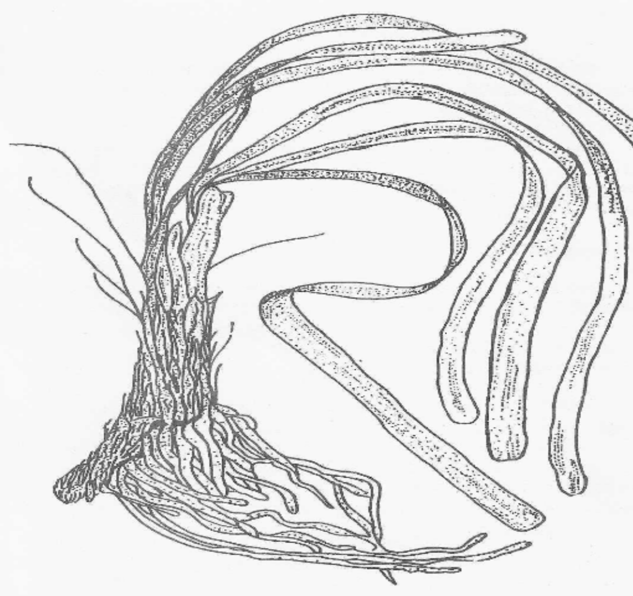

Figure 1. *Enhalus acoroides* (L.f.) Royle

This study aimed to determine the productivity rate of the seagrass, *E. acoroides*, in the littoral zone of Guang-guang, Mali, Davao Oriental. Population density, growth rate and physico-chemical factors in the sampling stations were also conducted.

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Materials and Methods

Study area. The study was conducted at the littoral zone of Guangguang, Mati, Davao Oriental (Fig.2). Said site is located 2 kilometers away from the national highway and has a total area of 30 hectares.

Study duration and sampling frequency. Sampling covered a period of three (3) months from November 1996 to January 1997. Productivity measurements and population count of *E. acoroides* were conducted once in every station during low tide.

Field Sampling

Population density. Population density of *E. acoroides* was determined through random sampling. Twenty (20) 0.25 m2 quadrats were laid during the sampling period. *E acoroides* was randomly sampled by throwing the quadrat in various locations in the station twenty (20) times. All *E. acoroides* that were found were counted and recorded.

Growth rate determination. Stabbing technique was used to get the average growth rate of the *E. acoroides* (Tomasko and Lapointe, 1991). Shoots were stabbed at the blade sheath junction of the species using a syringe needle. Seven days after the Stabbing period, *E. acoroides* plants were dug and harvested. Whole plants were placed in plastic bags and treated with 5% formalin-seawater solution. Plastic bags were labeled, sealed and taken to the laboratory for analysis.

Physico-chemical parameters. Physico-chemical parameters such as temperature, transparency and water depth were noted in situ through the use of an alcohol thermometer, sechi disk and meter stick, respectively.

Aside from those taken in the field, salinity and dissolved oxygen were analyzed in the laboratory using a hand refractometer and dissolved oxygen meter, respectively. Three (3) replicates of water samples were collected from each station for the said analysis.

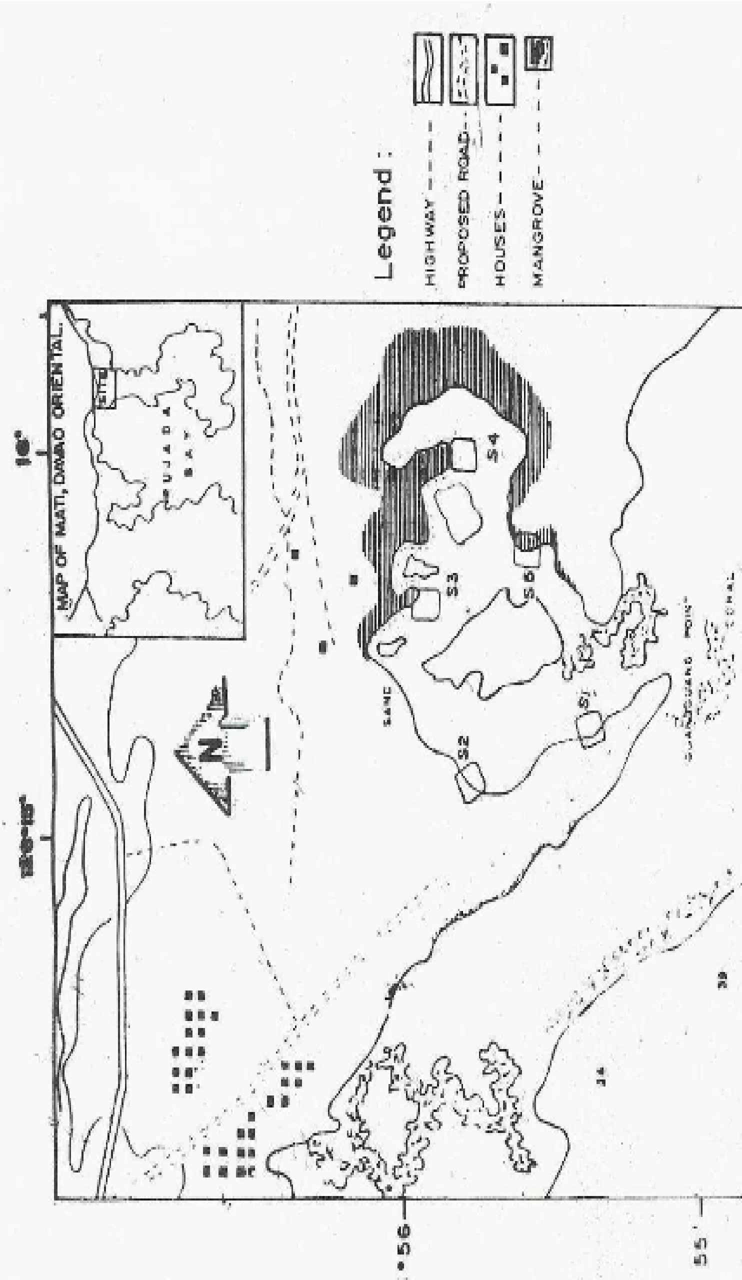

Fig. 3 Location Map of the study site.

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Sediment grain-size analysis. Grain-size of the substrates were also subjected to analysis. Sediment samples were obtained through the application of the Coring Method, where a plastic borer was bored into the ground for about 20 cm. Sediments taken inside the plastic borer were placed in plastic bags, labeled and sealed. Before analysis, sediment samples were air-dried for several days. After drying, about 100 Grams of sediments were analyzed at the Regional Soils Laboratory, Department of Agriculture, Davao City

Laboratory Analysis

Growth measurements and biomass determination. The harvested shoots of *E. acoroides* were separated into roots, rhizomes and Leaves. Rhizomes and roots were regarded as below-ground parts while leaves or blades as aboveground parts.

Measurement of the blades of *E. acoroides* for the growth analyses were made using a plastic ruler. Measurement of the old blade was made from the stabbed portion to the tip of the blade while measurement of the new blade was made from the leaf junction to the stabbed portion. Blades found with no markings were designated as virgin blades. After the measurements, the new blades were separated from the old blade by cutting at the stabbed portion and the leaf junction.

Fractions of the seagrass were. weighed for wet weights (WW) and oven dried at 650C for 48 h to get the constant dry weight (DW) (Tomasko and Lapointe, 1991). The epiphytes were scraped off from the blades using a razor blade then weighed for wet weight and dried to get the constant dry weight.

Data Analysis

The following formulas of Tomasko and Lapointe (1991) were used in the calculation of *E. acoroides* productivity:

$$\text{Daily Shoot Production (g/shoot/d)} = \frac{\text{new blade biomass}}{\text{(DW)no. of days}}$$

Annual Shoot Production (g/shoot/y) = daily shoot production (DW) x 365 days

$$\text{Shoot Biomass (g/shoot)} \ \frac{\text{total dry weight of shoots}}{\text{no. of shoots}}$$

Areal Shoot biomass shoot biomass (including roots and rhizomes) x shoot density

Areal Blade Biomass (g/m^2) — mean blade biomass x shoot density

Leaf Area Per Shoot (cm^2) = blade length x blade width

$$\text{Growth Rate (cm/d)} = \frac{\text{new blade length}}{\text{no. of days}}$$

Production Rate (g/m^2/d or g/m^2/y) shoot production x shoot density

Turn-over Rate (blade-DW): Based on Blade Length

$$\text{TOR (\%/d)} — \frac{\frac{\text{new blade length}}{\text{total blade length}} \times 100}{\text{no. of days}}$$

Turn-over Rate: Based on Blade Biomass

$$\text{TOR(\%/d)} = \frac{\frac{\text{new blade dry weight (DW)}}{\text{total blade biomass dry weight (DW)}} \times 100}{\text{no. Of days}}$$

Turn-over Time:

$$\text{TOT (d)} = \frac{100\%}{\text{Tum-over rate}}$$

Standing Crop (g/m^2) — shoot biomass (including roots and rhizomes) x shoot density x total area

Correlation test was also employed to determine the relationship between growth and some physico-chemical parameters using the Statistic 3.1 Software.

Results and Discussion

Population density. *E. acoroides* was observed to grow in patches. It was sparsely distributed in the different study sites in Guang-guang, Mati, Davao Oriental. Figure 3 shows the mean shoot density Of *E. acoroides*. Stations l, 2 and 4 showed shoot densities ranging from 27.75 to 30.5 shoots/m2. Stations 3 and 5 gave densities of 16.15 and 17.7 shoots/m2, respectively. The low densities found in stations 3 and 5 suggest poor conditions for *E. acoroides* compared to other stations. This is because station 3 was probably affected by the waste water discharged by local residents. According to Fortes (1995), pollution from waste water discharge results in disease, causing seagrass population to diminish. Furthermore, along with the waste water discharge, detergents could also be a factor affecting population of seagrasses. since detergents are found to be lethal to seagrass tissues. Detergents accumulate in the sediments causing damage to tissues of roots and rhizomes and leaves (Picard and

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Peres, 1975 as cited by Fortes, 1995). Mean shoot density of station 5 was also found to be low compared to other stations. This might be due to the physical disturbance by fishermen and shell gatherers. Destruction of seagrass species particularly *E acoroides* is brought about by fishermen themselves or the poles which are used to maneuver their boats during low tide. This activity

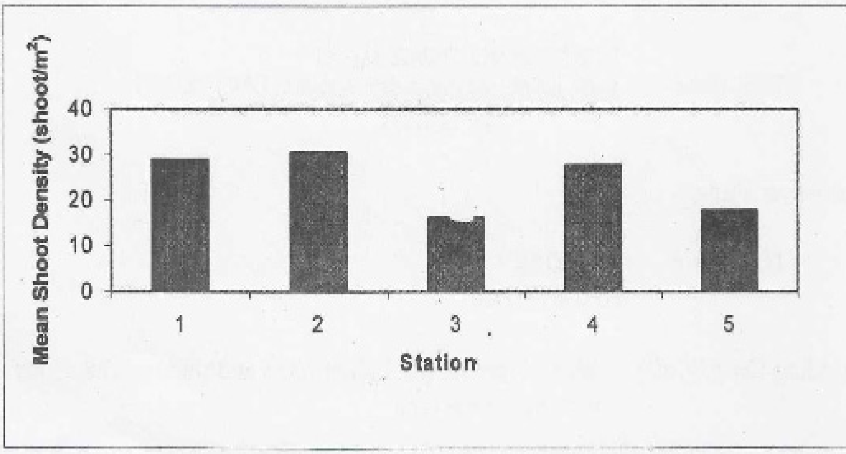

Figure 3. Mean shoot density of *Enhalus acoroides* in the five study sites of Guang-guang, Mati, Davao Oriental.

scours the seagrass and results in suspension of sediments (Fortes, 1995). On the Other hand, uprooting of the seagrasses by the shell gatherers could be another contributing factor.

Total blade biomass in all stations is reflected in Table I. Station 5 was found to have less leaf development compared 10 Other stations since nutrients in the area are low due to the medium sand characteristic of the substratum. However, these values are much higher compared to the study done by Kiswara (1990) in Java, Indonesia in which *E. acoroides* had a density of 10 shoots/m^2.

High density values in stations l, 2 and 4 seems to be influenced by substrate, degree of physical disturbance and pollution. Other factors include water depth and nutrient availability (Rollon and Fortes, 1990 as cited by Maghuyop, 1995).

Biomass estimates. Seagrass biomass varied widely, depending on the species, local conditions, densities and their morphology.

Results revealed that below-ground biomass were higher compared to the above-ground biomass in all stations (Fig. 4). This is due to the thick mass of the underground system of rhizomes and roots which are found to be extensive and coarse.

Total blade biomass in all stations is reflected in Table 1. There was lesser leaf development in Station 5 compared to other stations since nutrients in the area are low due to the medium sand characteristic of the substratum.

Stations l, 2 and 4, Showed higher estimated values of areal blade biomass due to their higher shoot densities per. square meter. Moreover, blades in these stations were thicker and wider. Aside from having a low-density value, stations 3 and 5 were subjected to man-induced changes such as water pollution. EMB (1990) as cited by Fortes (1995) reported that increase in pollution results in a, concomitant decrease in seagrass biomass and reduction of species biodiversity.

Table 1. Summary on the productivity measurements of *Enhalus acoroides* in the five study sites of Guang-guang, Mati, Davao Oriental

	Unit	S1	S2	S3	S4	S5	Mean	SD
Number of sample	Shoot	30.000	30.000	30.000	30.000	30.000	30.000	0.000
New blade length	cm/shoot	10.412	9.860	10.636	11.612	9.480	10.400	0.816
Old blade length	cm/shoot	30.930	27.944	34.925	39.776	26.912	32.090	5.302
Total blade length	cm/shoot	41.350	37.854	45.561	51.388	36.342	42.490	6.107
Blade width	cm/shoot	1.710	1.410	1.530	1.560	1.330	1.510	0.146
Leaf area/shoot	cm^2	71.190	52.580	71.410	82.220	45.920	64.660	14.947
Virgin blade biomass	g/shoot	0.022	0.027	0.025	0.012	0.021	0.021	0.006
New blade biomass	g/shoot	0.389	0.226	0.301	0.416	0.200	0.306	0.096
Old blade biomass	g/shoot	1.423	0.817	1.154	1.410	0.636	1.090	0.353
Total blade biomass	g/shoot	1.832	1.070	1.480	1.859	0.857	1.420	0.449
Epiphyte biomass	g/shoot	0.006	0.005	0.008	0.015	0.019	0.011	0.006
Areal shoot biomass	g/m^2	192.416	110.837	84.465	170.024	102.961	132.140	46.493
Areal blade biomass	g/m^2	52.940	32.635	23.902	51.590	15.169	35.250	19.309
Shoot biomass	g/shoot	1.840	1.075	1.488	1.874	0.876	1.431	0.448
Standing crop	g/m^2	531760	327875	240312	20035	155052	355006	167593
Shoot production	gDW/ shoot/d	0.050	0.030	0.040	0.060	0.030	0.040	0.013
	gDW/ shoot/y	18.250	10.950	14.600	21.900	10.950	15.330	4.760
Growth rate	cm/d	1.490	1.410	1.450	1.650	1.350	1.470	0.113
Production rate	$g/m^2/d$	1.450	0.920	0.650	1.670	0.530	1.040	0.499
	$g/m^2/y$	527.430	333.980	235.790	607.730	193.820	379.750	181.089
Turn-over rate*	%/d	(3.590)	(3.720)	(3.330)	(3.220)	(3.730)	(3.520)	0.232
		3.03	3.02	2.91	3.19	3.26	3.08	0.141
Turn-over time*	d	(27.850)	(26.880)	(30.000)	(31.050)	(26.810)	(28.510)	1.914
		33.00	33.11	34.36	31.34	30.67	32.49	1.481

* Values in parenthesis are based on blade length

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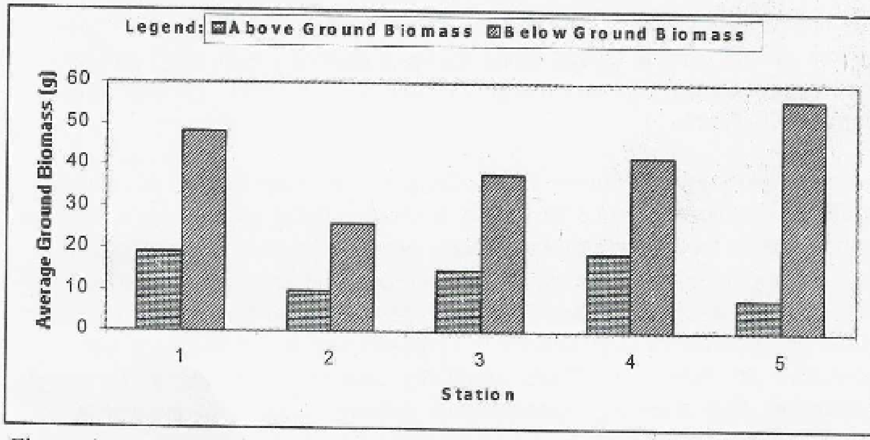

Figure 4. Average ground biomass estimates of *E. acoroides* in the study stations

Low biomass values result depending on the nature of the seagrass bed sampled, the completeness of the plant parts as well as the substrates which are predominantly sandy. Species found in this substratum were usually thin and incapable of supporting thick and lush beds, particularly of the bulkier species.

Seagrass productivity. Present findings of the *E. acoroides* production rate in the study area particularly stations l, 2 and 4 lie within the range of 300 to 600 g/ m^2/y for the tropical seagrasses as reported by Thayer e/ al., (1975) as cited by Rollon and Fortes (1990) (Table l). Standing crops of the species were also measured within total area of 10,000 m^2. The same results were exhibited by the stations having high production rate values. Standing crop these stations are high due to their high shoot densities. Shoot density is an element of the community structure which is used to estimate standing crop (Azkab, 1991 as cited by Maghuyop, 1995).

Productivity of the seagrass could be influenced by the amount of the epiphytes (any macro or microorganisms) that adhere to the blades of the seagrass. Though they contribute significantly to the energy pool in the shallow reef flat (i.e., for food to fishes and invertebrates), epiphytes could reduce the amount of light available for seagrass photosynthesis by acting as a barrier It) carbon dioxide uptake. In this study, station 5 showed a high epiphyte biomass thus the production rate and the growth rate were affected resulting in lower productivity (Table l).

Growth and turnover rates. Growth rates ranged from 1.35 to 1.65 cm/d, where the population in station 4 showed raster growth while those in station 5 gave the slowest growth. This is because the grain size analysis of the area is very fine and silty clay. Silty substrates tend to retain large amount of nutrients than sandy substrates. This area is less disturbed from human activities. However, presence of large number of epiphytes tend to lower growth rate of *E. acoroides* in station 5. These epiphytes compete with the s61ar energy absorption, thus affecting photosynthetic activity which limit production and growth of seagrass.

Compared to the study done by Rollon and Fortes (1990) in Bolinao, Pangasinan, growth rates of *E. acoroides* ranged from 9 A to 13.5 mm/d, showed lower growth rates than the mean rate of *E. acoroides* which is 1.47 cm/d. These differences are due to latitudinal differences and climate.

Total blade length ranged from 36. 34 to 51.38 cm with mean turnover rates of 3.52%/d. Mean turnover lime is 28.51 days. These results suggest blades of *E. acoroides* in the study area could replenish in less than 4 weeks.

Physico-chemical parameters and their relation to growth. Physicochemical parameters that were determined in the study area are presented in Figure 5 and Table 2. It was observed that salinity fluctuated during the study. It ranged from 28.0 to 32.0 ppt. Fluctuations of salinity were due to climatic conditions during sampling period (November to January) which is rainy season. According to Sudara (1992), run-off reduces water salinity. Correlation between growth and salinity was slightly positive at $r^2 = 0.18$. Relationship was directly proportional.

This implies that decrease in salinity to 4.8 ppt resulted inhibition of cell division and photosynthetic activity. An increase ins salinity to 4.8 ppt activated photosynthesis and restored cell structure. However. increase in salinity beyond these tolerable limits would cause damage to cells. Temperature was at an average of 30.0 Temperature influenced seagrass growth since growth is a function of water temperature. Test between growth and temperature showed slight positive correlation with $r^2 = 0.05$ and direct proportional relationship. This implies that an increase of 1^{o}C in water temperature leads to a leaf growth increase of 1 mm/d. This is according to Brouns and Heijis (1986) as cited by Fortes (1990). But the trend was not observable in the area because *E. acoroides* is known to tolerate high temperatures.

Water depth was also monitored and it tended to influence growth. *E. acoroides* tended to grow faster in deeper than in shallow areas. Test between them showed these are directly proportional having $r^2 = 0.24$ which is slight positive correlation. Water transparency tended to affect the growth of Seagrasses since light is a main ingredient of the photosynthetic activity of the plant. In the study area, results Showed that compared to the rest of the station, station 3 has the lowest transparency value relative to water depth.

This could be due to eutrophication and siltation brought about by the local inhabitants. However, growth of *E. acoroides* in station 3 seemed to be similar with other stations. This would imply that transparency does not solely affect seagrass growth but some other factors too. Correlation test between them showed slight positive correlation and direct proportionality (Table 2).

Correlation test, however, between growth and dissolved oxygen showed a

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slight negative correlation, r = 0.09, and their relationship is inversely proportional. Result might suggest that some plant forms like phytoplankton and algae are present. However, if taunt to be abundant, these plant forms may affect growth of the seagrass since they will compete for the solar absorption.

Percentage of grain-size sediments showed negative correlation in (2.0• 1.0 mm) r = 0.40, while (325 mm) r = 0.35. showed positive correlation. Results implies that pebble substrates are not significant for *E. acoroides* growth while silty substrate is significant. Relationship between growth and grain-sized sediment is inversely proportional in 2.0-1.0 mm (grain-size l) and directly proportional to 325 mm (grain-size 6) (Table 2).

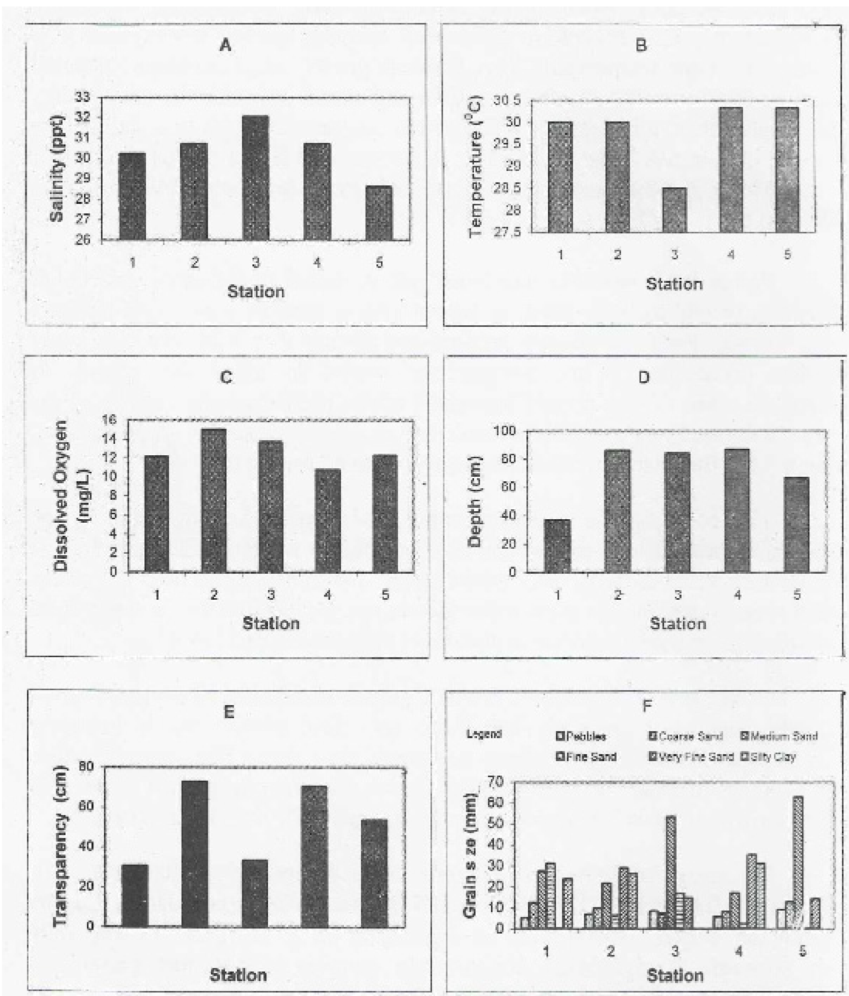

Figure 5. Physico-chemical parameters in Guang-guang, Mati, Davao Oriental

Table 2. Correlation between growth and some physico-chemical parameters

Physico-chemical parameters	r^2 value	Remarks
Salinity (ppt)	0.1833	Slight positive correlation
Temperature (^{0}C)	0.0516	Slight positive correlation
Depth (cm)	0.2420	Slight positive correlation
Dissolved oxygen (mg/L)	-0.0984	Slight negative correlation
Transparency (cm)	0.1076	Slight positive correlation
Percent grain size (%)		
2.0-1.0	-0.4000	Negative correlation
20-40	0.0168	Slight positive correlation
60-70	-0.1313	Slight negative correlation
80	0.0355	Slight positive correlation
170	-0.0648	Slight negative correlation
325	0.3521	Positive correlation

Conclusions

Population density of *E. acoroides* in the five sampling sites differed with station 2 registering the highest while stations 3 and 5 showing the lowest densities. *E. acoroides* in station 3 was found to grow in patches while it was sparsely distributed in station 5. High population density was influenced by the substrates grain-size they were embedded in while low density was due to the effect of man-induced factors.

Mean growth rate of *E. acoroides* is 1.47 cm/d and was found to the higher compared to growth of *E. acoroides* in Bolinao, Pangasinan. Difference in growth rates were probably due to some physical conditions of the study site and the degree of the effect of some physico-chemical factors in their microenvironment such as salinity, temperature, depth, dissolved transparency and percentage of grain size.

In terms of production rates, station 4 is found 10 be the most highly productive among the five study sites, as a whole, Guang-guang, Mati, Davao Oriental is considered too productive for it is significantly.

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