SEAWEED PRODUCTION DEVELOPMENT PROJECT
PHI/89/004

Field Document 09

March 1993

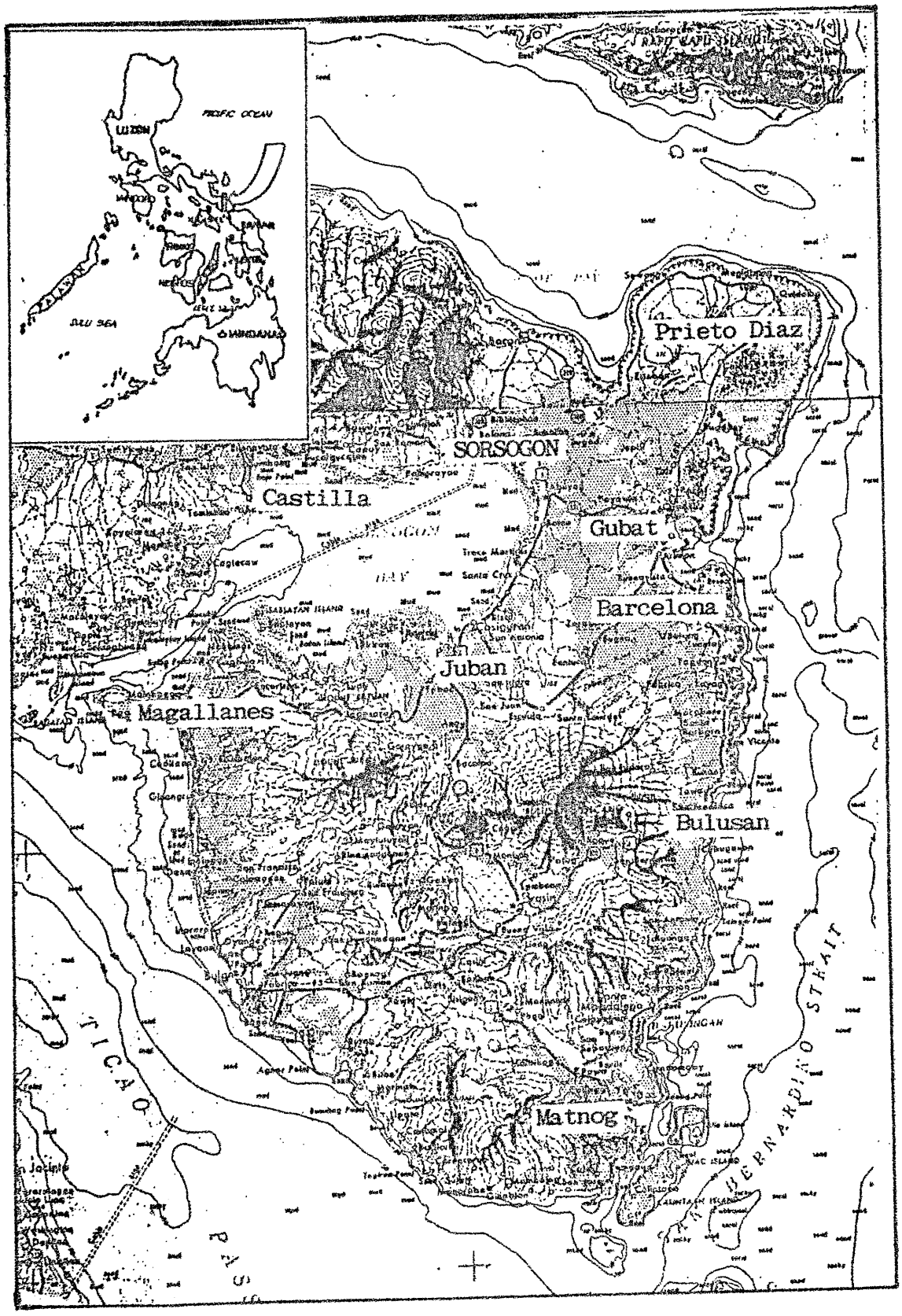
SEAWEED (*GRACILARIA*) FARMING TRIALS IN SORSOGON, THE PHILIPPINES.

by

Nyan Taw
Chief Technical Adviser

BUREAU OF FISHERIES AND AQUATIC RESOURCES
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
UNITED NATIONS DEVELOPMENT PROGRAMME
Manila, Philippines

This field document is one of a series of documents prepared during the course of the project identified on the title page. The conclusions and recommendations given in the document are those considered appropriate at the time of its preparation. They may be modified in the light of further knowledge gained at subsequent stages of the project.



The Project Area: Eastern Sorsogon and Sorsogon Bay

Abstract

The paper is on experimental farming trials carried out in Sorsogon Bay and the eastern coastal areas of Sorsogon, the Philippines, using *Gracilaria* species found in the area. Four major *Gracilaria* species - *G. firma (=G. fisheri)*, *G. fastigiata*, *G. cylindrica (=G. changii)* and *G. tenuistipitata* - were recognised and used in the trials. Fixed bottom monoline (10 x 10 meter plot), floating raft monoline (5 x 5 meter) and pond (in brackish water fish pond) farming trials at 18 localities in the area were conducted. Three environmental conditions were identified : high salinity/ clear water/ firm substrate; high salinity/ semi-clear water/ sandy-mud substrate; and low salinity/ semi-clear water/ muddy substrate. Under optimum environmental condition during early part of year, an average daily percentage growth rate for *G. fastigiata*, *G. firma*, *G. cylindrica* and *G. tenuistipitata* was observed to be 9.0%, 8.7%, 9.1% and 11.2% respectively from monoline farming trials. For *G. fastigiata* and *G. firma*, an average weight attained after 54 days of growing period with initial average individual seed plant of 35.3 grams and 51.0 grams were recorded as 505.2 grams and 1,005.8 grams respectively from fixed bottom monoline farming trials.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

1. INTRODUCTION

Commercial production of seaweeds through farming is at present limited to a few countries in east Asia. The countries noted for the culture of several species of seaweeds with the bulk of production are: *Porphyra*, *Undaria* and *Laminaria* in Japan; *Porphyra*, *Laminaria* and *Gracilaria* in China; *Porphyra*, *Laminaria* and *Undaria* in Korea; *Gracilaria* in Taiwan (Province of China); and *Eucheuma* and *Caulerpa* in the Philippines (Trono, 1987). Of these seaweeds the species feasible for farming in warm waters are that of the genera *Eucheuma*, *Caulerpa*, *Porphyra* and *Gracilaria*.

In the Philippines farming of *Eucheuma* was initiated in 1967 with the first commercial trial at Caluyas, south of Mindoro based on studies of Dr. Doty of Marine Colloids. The trial funded by Marine Colloids was carried out by Mr. V. Alvarez (Delmendo, et.at.,1992). In 1989 production of red seaweeds was recorded at 269,701 MT. (Anonymous, 1992). The bulk of the production are that of red seaweed *Eucheuma* through farming. *Caulerpa* has been successfully cultured in ponds at Mactan, Cebu but as yet to be transfered to the other areas in the Philippines (Trono & Fortes, 1988). Although the technology for the farming of *Gracilaria* is available, apart from a few experimental cultures, it has not been commercially applied in the Philippines (Largo et.al,1989; Uy, et.al.,1990; Hurtado-Ponce, et.al.,1992). Farming trials of *Gracilaria* were initiated at Bagacay, Gubat and Mapapac, Barcelona at the eastern coast of Sorsogon by the project (Delmendo, 1992).

Statistical data on the production of *Gracilaria* in the Philippines is not available. However, according to McHugh (1987) 1,470 MT of agarophyte seaweeds classified as 'other seaweeds ' were exported to Japan from the Philippines in 1984. This could be presumed as *Gracilaria* which was seasonally abundant in Manila Bay and other parts of the country naturally.

The main source of *Gracilaria* is still Manila Bay, although commercial gathering of this species has been reported from other sites as in Panay and Negros in the Visayas and Davao area in Mindanao. Approximatelly 2,400 MT of dried *Gracilaria* were bought by a Chinese trader during the height of *Gracilaria* harvesting from 1970 to 1972 (Trono & Fortes,1988).

Recently, assessment of seaweeds and associated invertebrates in Eastern Sorsogon reveal that there are at least 97 species of seaweeds (Llana,1992). Seven species of *Gracilaria* - *G. Changii* (= *G. cylindrica*), *G. fastigiata*, *G. firma*, *G. salicornia*, *G. tenuistipitata* , *G. eucheumoides* and *G. coronopifolia* are recognized from Sorsogon area after preliminary taxonomic examination (Trono, 1992). Estimated volume of *Gracilaria* being gathered from the wild and traded within Sorsogon amounts to 57.5

MT per year, about 68 % from eastern Sorsogon and the remaining from Sorsogon Bay area (Guanio,1993). The Philippines with over 7,000 islands and having diversified seaweed resources has great potential in seaweed farming. Seaweeds and seaweed products now comprise the Philippines' third biggest export in the fisheries sector, behind shrimps and tuna (Llana,1990).

Seaweed Production Development Project is one of the action programmes recommended by the National Conference on Fisheries Policy and Planning sponsored by UNDP-FAO in March 1987. The Development objective is to contribute to the improvement of the socio-economic conditions of fishing communities dependent on coastal fisheries for livelihood by developing alternative employment and income opportunities through an expanded and diversified seaweed farming industry. The project is to develop farming and processing techniques of other species of seaweeds (such as *Gracilaria*) other than *Eucheuma*. The project started the operation from 21 August 1991. Eastern Coastal area of Sorsogon was initially considered as the project area. In June 1992, Sorsogon bay was included as project site due to its natural *Gracilaria* resource potential.

The present study is on the farming trials of *Gracilaria* species at various parts of Eastern Sorsogon and Sorsogon Bay areas, which is one of the major components of the project.

2. STUDY AREA

2.1. PROJECT AREA IN GENERAL.

The project area is shown in figure 1. Sorsogon is the southern most part of Luzon Island, approximately 650 km south of Metro-Manila. The area is situated within Bicol Region (Region IV). The study area in the region is divided into two - east coast of Sorsogon and Sorsogon Bay. The municipalities are - Preto Diaz, Gubat, Barcelona, Bulusan, Sta. Magdalena and Matnog at the east coast; and Castilla, Sorsogon, Juban and Magallanes at Sorsogon Bay.

Initially, as required by the project guideline, the whole east coast of Sorsogon was studied for selection of demonstration farms. However, based on the results from the test plants and trial plots, environmental conditions the northern coastal areas, such as Preto Diaz, Gubat, Barcelona and Bulusan were selected for development. In Sorsogon Bay area, trials were done at Castilla, Juban and Magallanes. As of now there appears to be many areas suitable for further development in Sorsogon bay areas. However, more studies on biology and ecology are needed to select sites for seaweed farming and resource management.

Figure 1. Eastern Sorsogon and Sorsogon Bay, project area.

2.2. SOCIO-ECONOMICS.

The east coast has six coastal municipalities namely - Prieto Diaz, Gubat, Barcelona, Bulusan, Santa Magdalena and Matnog. At the east coast, 89 barangays out of 169 in the municipalities, can be considered as coastal barangays. The Sorsogon bay has five municipalities which comprises of Castilla, Sorsogon, Casiguran, Juban and Magallanus. There are 52 barangays, which are situated around the bay area, out of the 157 barangays in the municipalities (Tagarino, 1992). Of the eastern coastal communities, there are 13.905 households with an average size of 5.2 person per household. In the area there are at least 4,528 fishermen of which 2,908 are full-time fishermen equiped with a total of 3,352 fishing boats. Only seven per cent of the boats are motorised. Gillnets, pushnets and hook & line are the most commonly used fishing gear. Only about 30% of the coastal population are engaged in fishing as their source of income. The estimated average income level of the coastal households in the area ranges from P 2,006 to 3,556 per month. About 70% of their income is derived from primary sources indicating that households have limited alternative incomes.

2.3. COOPERATIVE DEVELOPMENT.

Cooperative development activities has been initiated incorporation with technical activities. The CDA, Sorsogon Office and Co-operative Entrepreneurship for Rural Development Project (PHI/89/MOI/DAN) have been assisting the project in identification/ selection of viable cooperatives for proposed project cooperators. Nine cooperators have been screened/selected for their participation in the development of seaweed farming and processing activities.

2.4 QUALITY OF THE *GRACILARIA* SPECIES.

Quality of the *Gracilaria* species from Sorsogon was studied by Santos (1993). Commercially, the quality of *Gracilaria* depends upon agar yield and gel strength. The results from the analysis indicated that some of the *Gracilaria* from the project area are of very high quality. The following are the results: *G. firma* - agar yield= 11.13 - 23.00% / G.S = 485-1,062 g/cm2 ; *G. fastigiata* - agar yield= 13.38 - 22.40% / G.S.= 832 - 947 g/cm2 ; *G. cylindrica* - agar yield = 11.45- 22.00% / G.S. = 745 - 1051 g/cm2; and *G. tenuistipitata* - agar yield= 6.23- 8.25% / G.S.= 189 - 704 g/cm2.

2.5. MARKETING.

Estimated volume of *Gracilaria* being gathered from the wild and traded within Sorsogon amounts to 57.5 MT per year, about 68 % from eastern Sorsogon and the remaining from Sorsogon Bay area (Guanio,1993). It appears that there is a readied market for both *Gracilaria* and *Eucheuma*. The going price in Sorsogon for dried *Gracilaria* are: buying(from gatherers)= P 3.00/kg; Selling(buyers to agents)= P 5.50 - 6.50/kg. According to a buyer from Bulusan, he was having difficulty in trying to meet his target of 60.0 tons. The problem appears to be the price rather than demand for the seaweed.

3. MATERIALS AND METHODS

3.1. *GRACILARIA* SPECIES.

Preliminary identification and classification of wild and farmed seaweeds in the project area are being carried out by Dr. Trono, National Biologist Consultant and Ms. Llana, National Project Coordinator. At present over 12 common species of *Gracilaria* species have been tentatively identified. However, four species namely, *G. firma(=G. fisheri), G. fastigiata, G. changii(= G. cylindrica), and G. tenuistipitata*, are being used for farming trials (Trono,1992). Four forms of *G. tenuistipitata* are recognised in the area. Recently another species, *G. salicornia* which appears to have good potential is now being under consideration. Field identification of the *Gracilaria* species used in the trials are shown in plate I (Nyan Taw, 1993).

3.2. FARMING AREA

Major farming trials were carried out along the eastern coastal areas of Prieto Diaz and Gubat in Eastern Sorsogon. In Sorsogon Bay , Juban was the area where farming trials were done. Test plots were setup to determine the feasibility in a number of places both in the east coast and in Sorsogon bay. At the east coast, test plots were set at the municipalities of Barcelona and Bulusan. In Sorsogon Bay a number of test plots were set around the munilicipaties of Magallanes and Castilla. Basically the methods used were either fixed bottom or floating raft system. Pond culture trials were also implemented in Tagdon, Barcelona and in Juban with the cooperation of fishpond operators. The four *Gracilaria* species were used in accordance with their specific environmental preference.

3.3. FARMING METHODS

3.3.1. Fixed bottom monoline (Figures 2,3 & 4)

The fixed bottom monoline method has been used extensively in the farming of *Eucheuma* in the Philippines. The method was described by Trono and Fortes (1988) and Trono (1988). The monoline method used in farming trials of the *Gracilaria* species is basically the same to that described by the Authors. The main differences are the type of line used and the way the seed stock are attached to the line. The line used was bi-filament polyethylene twine No.5 (2.5 mm). A simple 10x10 meter fixed bottom monoline plot is shown in figures 3 and 4. The stakes which were driven deep into the substrata were spaced either 5 or 10 meters apart and at 32 cm interval. A plot was considered as having 32 lines with a length of 5 meters x 2 or 10 meters. In a plot 1,024 seed plants (32x32 plants) were planted. The seed stock cuttings (approximatelly 25 to 50 grams/ plant) were inserted between the twines. In practice the lines stretched 5 meters apart can withstand the weight of farmed seaweed better than line 10 meter apart especially during the final period of farming. The lines were suspended between 30 and 50 cm from the substratum. The lines were positioned parallel to the water current.

3.3.2. Floating raft monoline (Figures 5 & 6)

The method is also being used in farming of *Eucheuma* in the Philippines. Comparatively, this type of farming is more expensive than the fixed bottom monoline method. The method was described for farming of *Eucheuma* by Trono & Fortes (1988) and Trono (1988). Apart from the line used and the method of attaching the the seed stock the floating raft monoline method is basically the same as given by Authors. The type of line and the method of attaching the seed plant were as explained in the fixed bottom monoline method. The size of raft was 2.5x 2.5 Meter (figures 5 and 6). The seaweeds were approximately 30 cm submerged in the water from the surface.

3.3.3. Pond

Pond culture method of farming of *Gracilaria*, specially *G. teniustipitata* has been extensively used along the southern coast of mainland China and the western coast of Taiwan (Anonymous, 1990). In the Philippines, although Trono & Fortes(1988) and Trono (1988) described the method, apart from some experimental studies, very little is being done. In the present study, attempts are being made in cooperation with fish pond owners to initiate the trials. No special treatment nor management on pond water had been done during the trials.

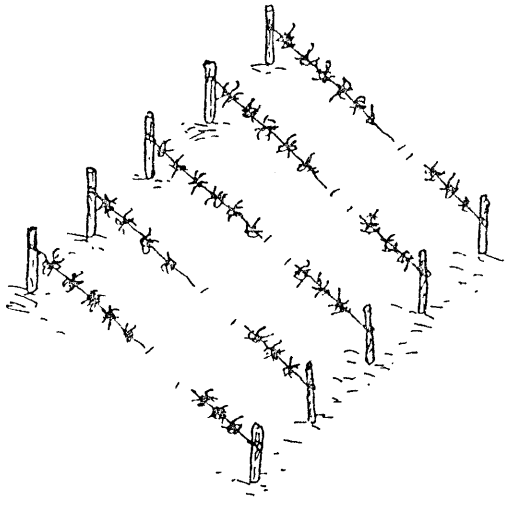


Fig.2. Monolines with seed plants

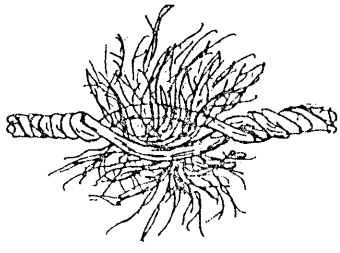


Fig. 3. Seed plants in bi-filament

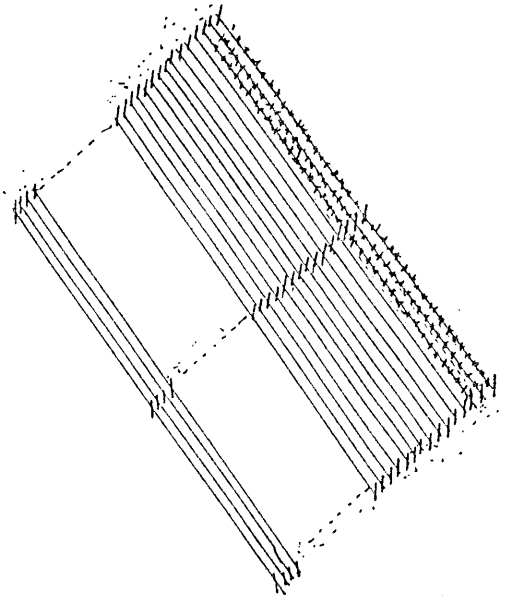


Fig. 4. A fixed bottom monoline plot

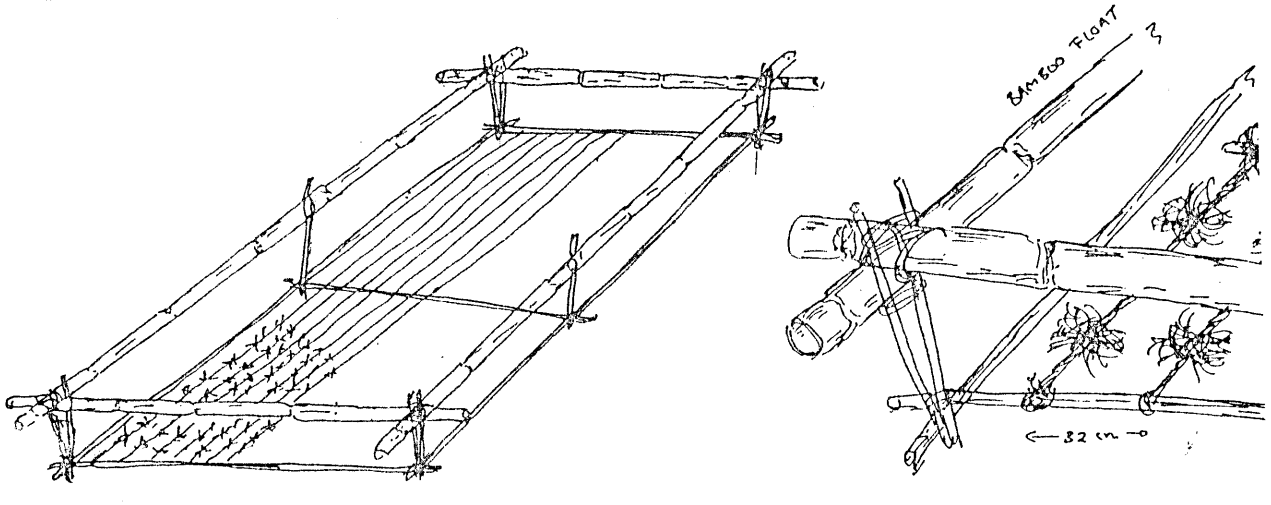


Fig. 5. A floating monoline raft

4. RESULTS AND DISCUSSION

4.1 ENVIRONMENT

From the studies, the most feasible area on the eastern coast are at the northern part namely, extended coastal areas off Preito Diaz and Gubat. Barcelona and Bulusan have environmental conditions feasible for farming but for about 6 to 7 months of a year and in confined areas only. The environmental conditions of southern part of eastern Sorsogon such as at Santa Magdalena and Matnog were found to be not feasible due to its narrow seashore line. From the on-going studies in Sorsogon Bay, Juban with its protected bays appears to have an environmental condition most suitable for *Gracilaria* farming.

4.1.1 Eastern Coastal area of Sorsogon.

Geographically, the coastal area is located between 13° 02.5' lat.,124° 12'E long. from the north to 12°34.4' lat., 124°05.8' E long. south (figure 6). The northern area off Prieto Diaz has a very extended rocky reef flat flanked by coral reef parallel to the coast line. There are also a network of bays and channels within the area. This extended reef area extends down south to Barcelona through Gubat, gradually narrowing upon reaching Bulusan. From Bulusan down south to Matnog the coast line has a narrow strip parallel to either a rocky cliff or sandy beach. There are a number rivers and creeks flowing into the coastal areas. Most of the river systems are along the northern part of the coast, off Prieto Diaz and Gubat. The runoff from these rivers and creeks into the area would have either positive or negative effect on the hydrological condition. The substrate soil nature at the extended area off Prieto Diaz to Gubat and part of Barcelona can be generally considered as sandy/ muddy/ coralline with semi-clear water (visibility to approximately 3 meters during fine weather). Salinity recorded within the trial/test plots ranged between 29.0 and 36.0 ppt with the temperature from 29.0 to 32.0° C. The pH was recorded at between 6.0 and 8.0. From off Barcelona to Bulusan the substrata is flat rocky/coralline with clear water (visibility - more than 5 meter). High salinity of between 30.0 and 35.5 ppt was recorded in the area. The temperature ranged between 29.0 and 33.0 with a pH of approximately 8.0. South of Bulusan to Matnog along narrow strip the substratum is usually sandy/rocky or sandy or muddy with clear water.

Hydrological conditions of the east coast was studied by Llana(1992). Seasonal variations in temperature and salinity of the east coast is shown in figure 7. Generally, the water temperature was high in the northern area particularly from May to July (up to 40°C). Low temperatures were recorded during the months from

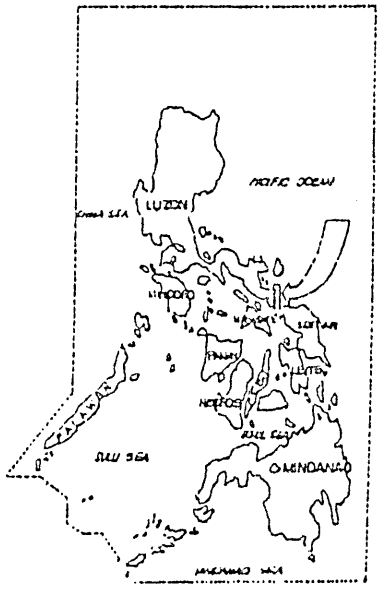
Novmber to February (from 27°C). The salinities ranged from 24.00 to 36.00 ppt along the coast. Generally the salinities off the northern coast were lower than the southern area.

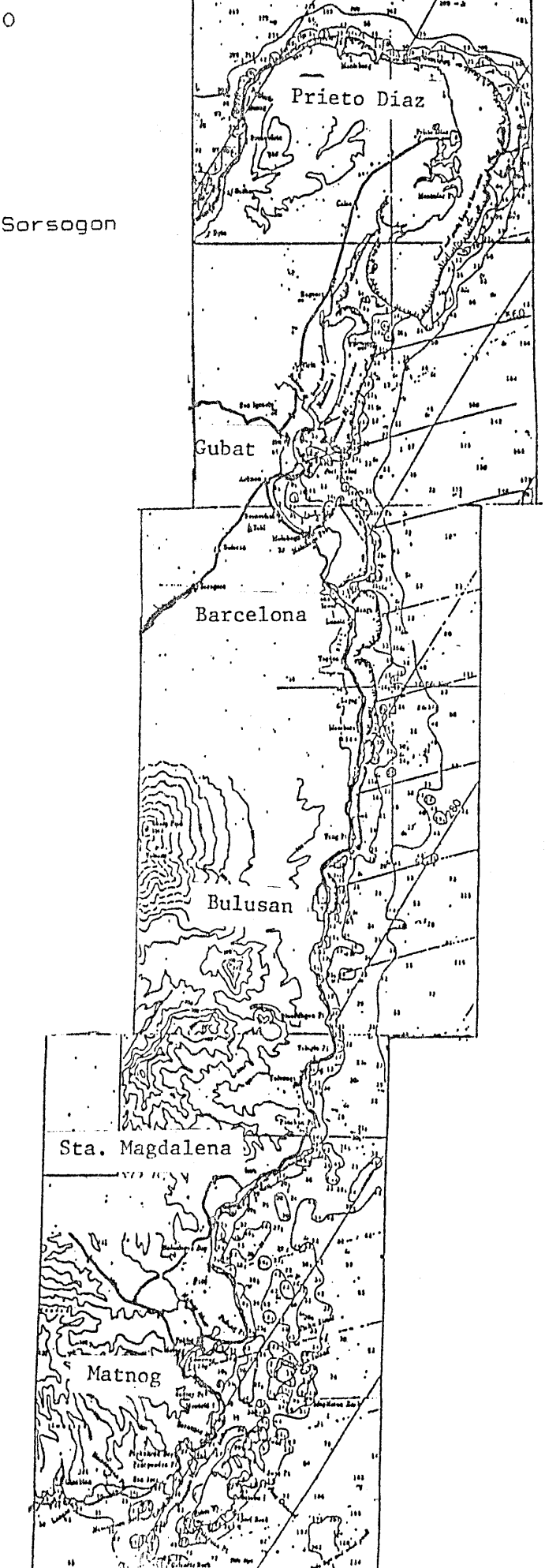
The tidal amplitude at Legaspi ranged between 0.166 M (Mean Low Water) and 1.392 M (Mean High Water). Generally at the farming site locations, minimum depth during the minimum tidal cycle was observed to be approximately 0.25 M from the substrata. During the spring tide the depth observed was approximately 2.0 M. At the site localities, the currents from the open sea are of tidal in nature only. However, localized currents created by the river runoff and due to geographic nature of the bays and channels were also encountered.

4.1.2. Sorsogon Bay

Sorsogon Bay is located due west of the municipality of Gubat on the east coast of Sorsogon. It opens to the west into the Ticao Pass. Apart from the narrow channel and areas off Castilla in the north and Sablayan Island to the south, the water depth is less than 5.0 meters. Along the narrow channel near the opening the water is deeper (more than 10.0 M) (figure 8). According to the locals, the water surface area is estimated as approximatelly 20,000 ha. Generally the substrata of the bay is either muddy,sandy or muddy/sand in nature. The water was observed to be clear near the channel opening and semi-clear (muddy- visibility in certain condition to 30-100 cm only) within the bay area. The condition of the water depends upon the tidal current and the location. The water salinity also depends on the locality of rivers and creeks with freshwater runoff. The salinity varies between 18.0 and 31.0 ppt with temperature of between 27.0 and 33.0°C within the bay at most of the trial sites. The pH observed was from 6.0 to 8.0. Higher salinities were encountered near the mouth and in the mid region of the bay. Low salinities were found in small bays near rivers and creeks outlets. During raining season some areas became totally fresh (0.0 ppt). Temperature ranged between 25 and 30 °C.

Fig. 6. East Coast of Sorsogon





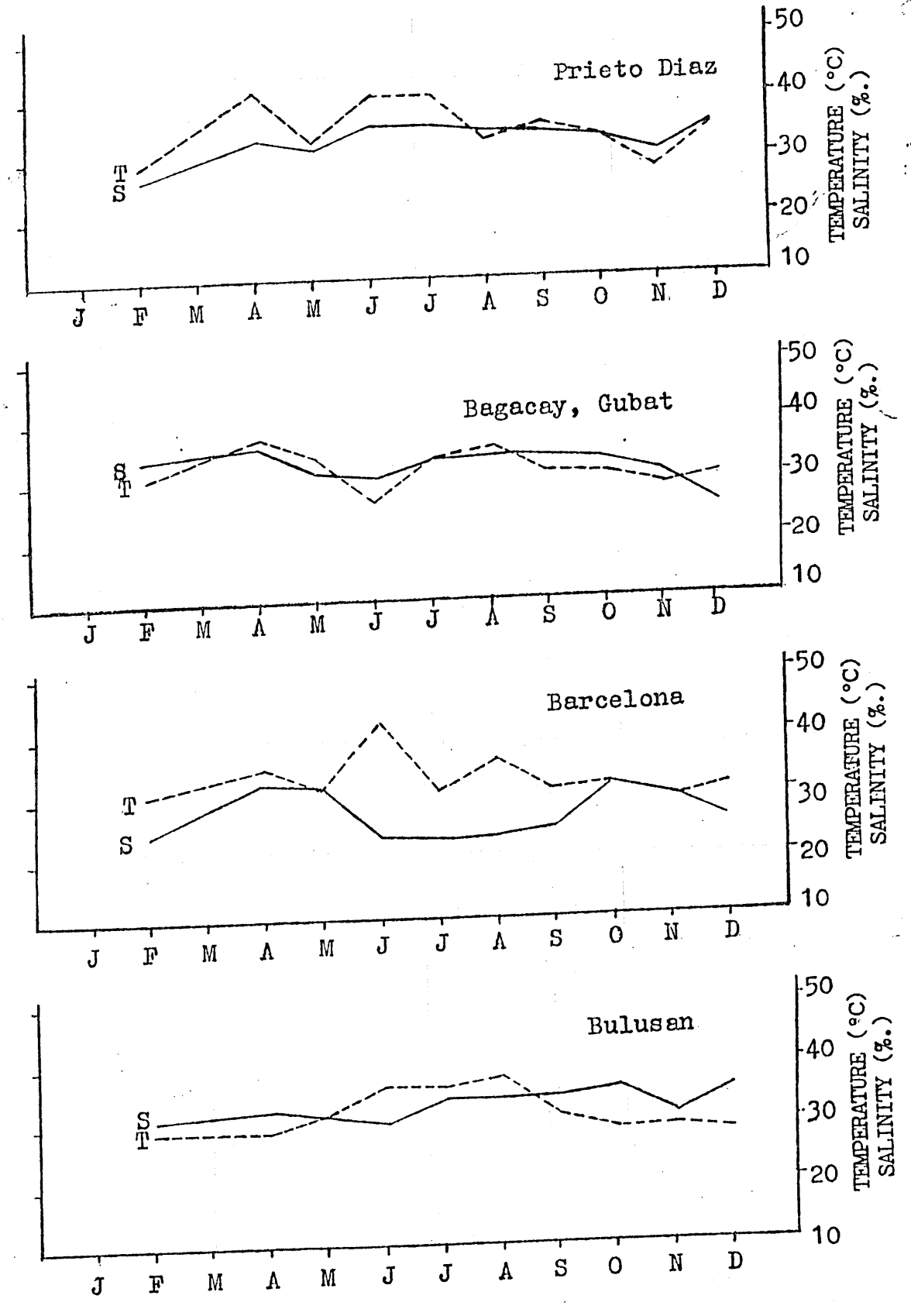


Figure 7. Seasonal salinity and temperature variation of eastern coastal shelf waters in 1990. (Llana, 1993)

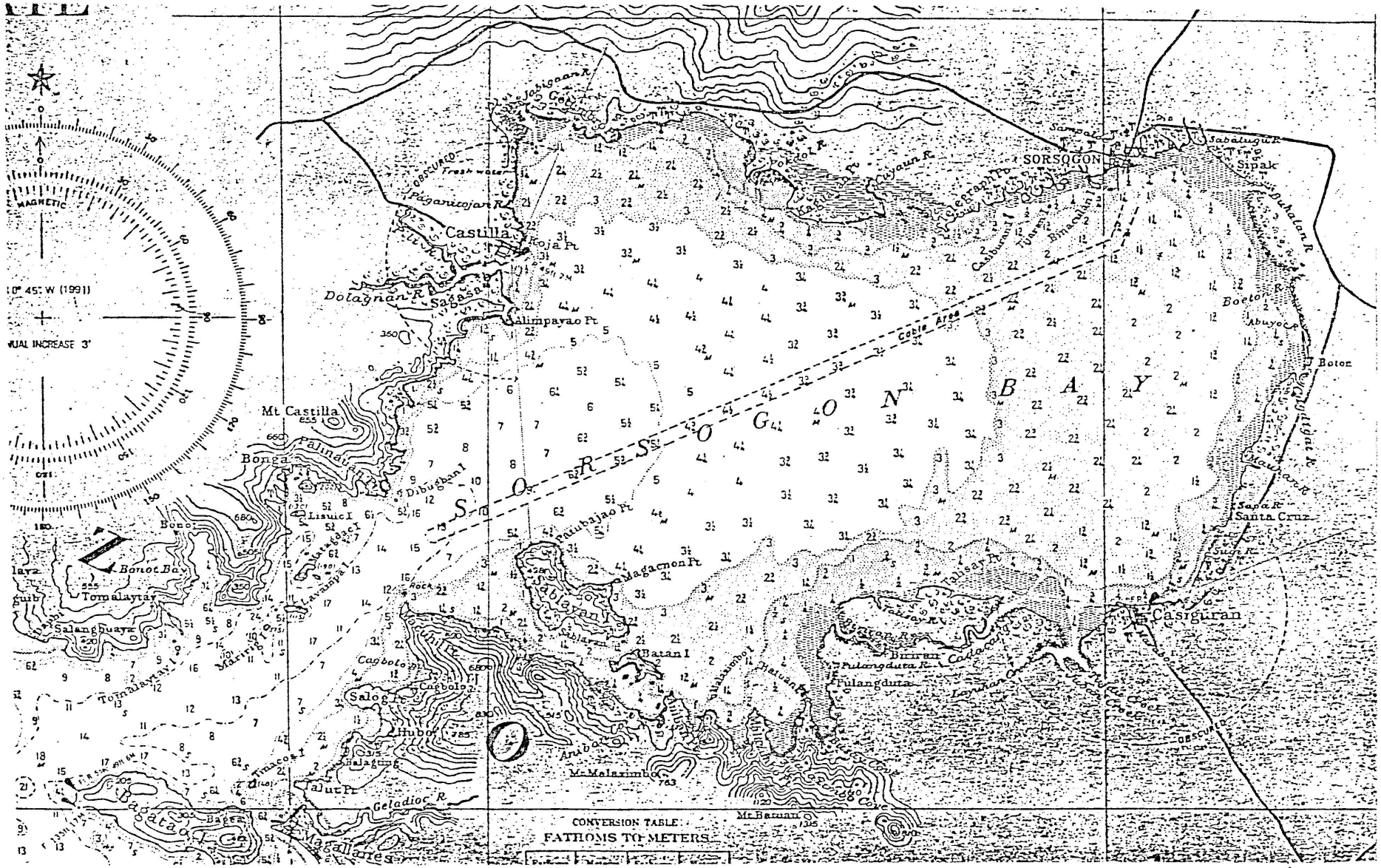


Figure 8. Sorsogon Bay chart.

4.2. GROWTH AND PRODUCTION

The results from the farming trials are given in Figures 9 & 10 and table 1. Generally, the daily growth rate ranged from as low as 1.2 to a maximum of 16.7/day for the four species studied from monoline farming trials. Trial in fish pond had to be discontinued due to water management problem. The pond water was drained to harvest the cultured fish without prior notice for the project technicians to determine planned data. High growth (above 10 % /day) had been observed during the first two weeks using seed plants weighing less than 50 grams under favorable environmental conditions during early part (March/April) of the year. The daily growth rate then declined to less than 5.0 % /day (Figures.9 & 10). For *G. firma* and *G. fastigiata*, the weight attained after 54 days growing period with initial seed plant of 51.0 and 35.3 grams were recorded as 1,005.8 and 505.2 grams respectively. Average daily growth rate was recorded as 8.1 % for *G. fastigiata* and 8.7 % for *G. firma*. Daily growth rate of *G. cylindrica* was found to ranged between 4.0 and 9.1 % under favorable environmental conditions. Growth of *G. tenuispititata* was between 3.3 and 11.2 % within the range found with the other *Gracilaria* species. Slow growth of *G. cylindrica* observed on the test plants in Tughan, Juban (Sorsogon Bay) was probably due to environmental conditions not suitable to the species. The *G. cylindrica* seed plants were from Bulusan, Sorsogon which is the natural habitat of the species. The slow growth and daily % growth of *G. fastigiata* and *G. firma* observed during later part of the year (September to December) could be attributed to strong currents caused by typhoons in the area (Figure 10). Lost of seaweed plants and planted lines were common during the period. An average daily growth rate of the four species studied is given in table 1. Under optimum environmental condition a maximum daily growth rate for *G. fastigiata*, *G. firma*, *G. cylindrica* and *G. tenuistipitata* was observed to be 9.0 %, 8.7 %, 9.1 % and 11.2 % respectively.

Problems encountered, in the monoline farming trials using vegetative thalli, include grazing by fish, sediment accumulation and epiphytism. Strong wind and currents were the major cause of losses of seaweed from the lines in some open areas, especially during the typhoon period. The major non-environmental problem faced during the trials was theft of planted seaweeds.

Field culture of *Gracilaria* in Danajon Reef, the central Visayas by Largo, et.al.(1989) indicated that a biomass production may reach 100 times the initial stock after two months time or a daily growth rate of not more than 5.0 % depending on the species and planting method. However, according to Largo, et.al.(1989) a mean daily growth rate during field experiments of *Gracilaria verrucosa* was recorded as 10.02% in the intertidal areas and 4.29% in ponds in Visayas. Comparatively, an average daily growth rate of *Eucheuma* has been recorded as 5.0%/day (Trono & Ganzon-Fortes.

1988). For *Eucheuma*, at 5% average daily growth rate with 40,000 seedlings (300 gm each) could produce 48,000 kg within two months.

Experiments in growing of *Gracilaria* sporelings in petri dishes and dextrose bottles using different culture media under controlled environmental conditions were conducted for 30 days by Uy, et.al.(1990). Highest growth rate and early development of newly shed carpospores grown in petri dishes were recorded in Waines' Conway medium (104%/day) followed by VonStosch medium (59%/day). For the 30 day sporelings grown in dextrose bottles with continuous aeration, highest growth rate was recorded in VoSthsch (33.8%/day) followed by TMRL (11.05%/day). The present findings of faster growth at the early stage agreed with the findings of Uy, et.al. (1990) experimental results.

Recently *Gracilaria* species are being farmed in natural drainage canals and ponds in Panay, Western Visayas (Hurtado-Ponce, et.al.,1992). According to them, initial harvest are made 15 to 60 days after planting. High production of 7- 14 tons (dried)/ha/year are obtained from canals than in ponds (3-4 t/ha/year).It appeared that the estimated production of *Gracilaria* from the present trials are approximately the same as the production recorded by Hurtado-Ponce et.at (1992) on *Gracilaria* planted in the canal in western Visayas. In the present case *G. fastigiata* and *G. firma* attained an average plant weight of 505.2 and 1,005.5 grams in 54 days from an initial seed plant weighing 35.3 and 51.5 grams respectively. Growth and daily growth rate of the two species are shown in figures 9 and 10.

Hypothetically, based on results of the daily growth rate of between 6.0 and 11.2% for the *Gracilaria* species studied, with initial individual seed plant weight of approximately 100 grams a final individual weight of 400 grams can be attained, after losses due to seedling mortality and other environmental factors, after 45 to 50 days of farming period, under favorable environmental condition. From a hectare (100 plots with 102,400 seed plants- see 3.3.1) a production of 40 tons (wet) (wet to dry weight ration varies between 9:1 and 10:1) can be expected per cycle. Depending of the location of farm and environmental conditions 3 to 5 farming cycles can be managed in a year.

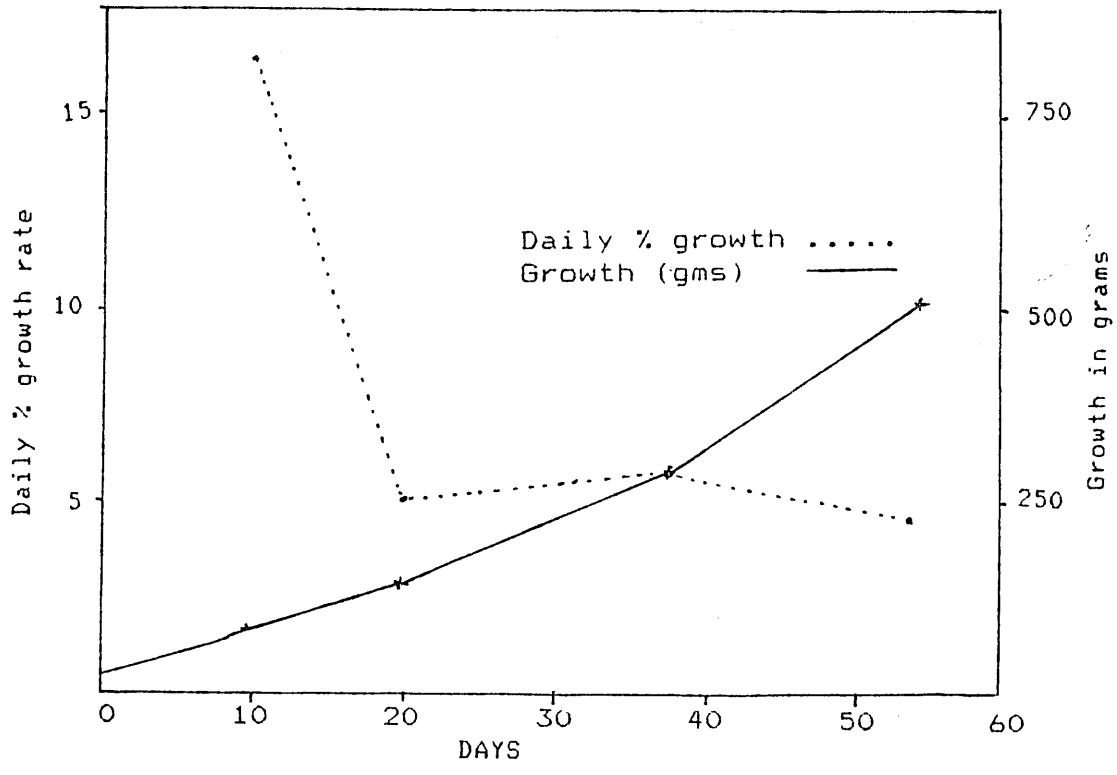


Figure 9. Growth and daily growth rate of *G. fastigiata* during March/April 1992 at Bacagay, Gubat.

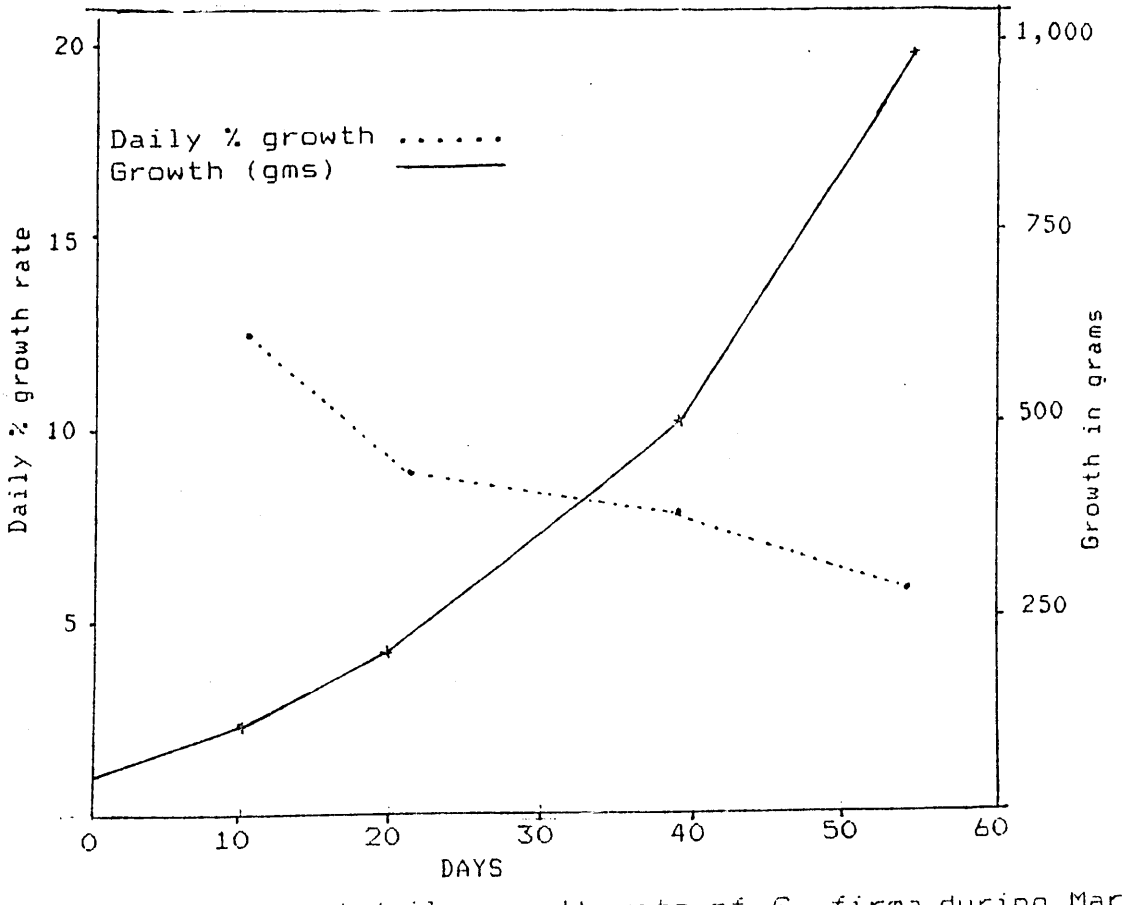


Figure 10. Growth and daily prowth rate of *G. firma* during March/ April 1992 at Bacagay, Gubat.

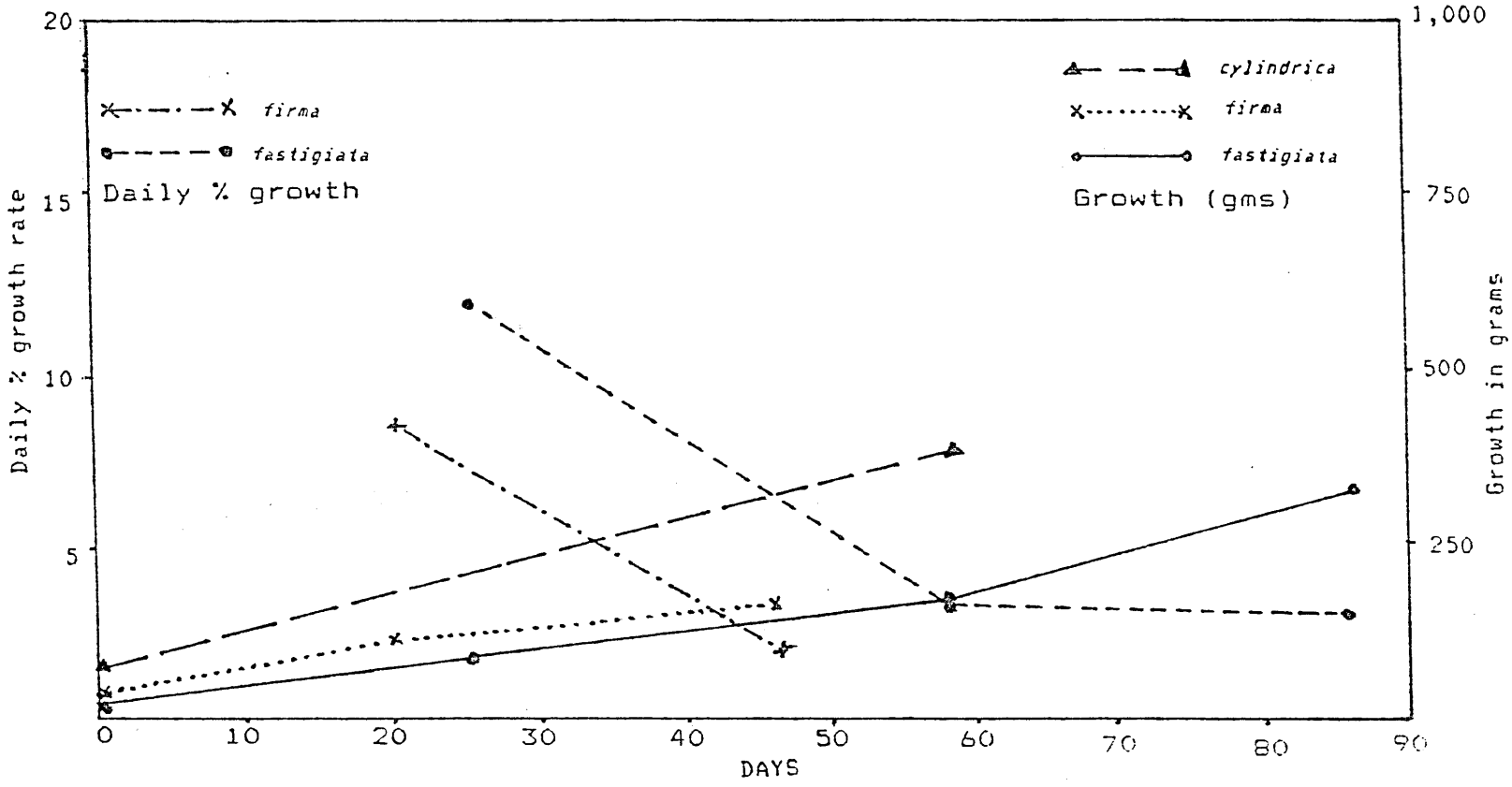


Figure 11. Growth and growth rate of (i) *G. fastigiata* and *G. firma* during September-December 1992 at Bacagay, Gubat; and (ii) *G. cylindrica* during December 1992/January 1993 at Barcelona.

TABLE 1. The *Gracilaria* species daily growth rate and environmental conditions from the farming trials in Sorsogon.

Farm	Species	Period Month/yr	Days	Method	Growth Daily %	ENVIRONMENT(Range) Sal.	Temp.	pH
EAST COAST								
Ca/PD	*fastigiata*	09-12/92	87	FB	3.3 (L) 6.1 (C)	34/35	29/30	
Sa/PD	*fastigiata*	01- /93	8	FB	6.7 (L) 9.0 (C)	33/34	28	
Ba/GT	*fastigiata*	03-04/92	54	FB	8.1	29/36	29/32	
Ba/GT	*firma*	03-04/92	54	FB	8.7	29/36	29/32	
Ba/GT	*firma*	10-11/92	47	FB	2.7 (L) 5.0 (C)	33/34	30/32	
Ba/GT	*tenuistip.*	01- /93		FB		33	29	
Ba/GT	*tenuistip.*	01- /93		FB		36	28	
Mp/BAR	*cylindrica*	07-08/92	36	FR	3.2	30-34	29/33	6-8
Mp/BAR	*cylindrica*	10-11/92	21	FB	3.6	30	29/30	
Td/BAR	*tenuistip.*	11- /92		P		30	29/30	6
Bar/BAR	*cylindrica*	12/92-02/93	58	FB	9.1 (L) 8.5 (C)	34/35	27/30	8
Mb/BUL	*cylindrica*	09-10/92	28	FR	2.1 (L) 2.6 (C)	30/34	29/30	
SORSOGON BAY								
Da/CAS	*tenuistip.*	10- /92	26	FB	6.2	30/31	29	6.2
Tg/JB	*tenuistip.*	06-07/92	8	FR	5.2	?	?	?
Tg/JB	*tenuistip.*	06-07/92	8	FB	3.3	30	29	5.9
Tg/JB	*cylindrica*	01- /93	14	FB	1.2 (L) 0.3 (C)	18/25	28/29	6/8.5
Em/JB	*tenuistip.*	10-11/92		FR		0-10	25	6
Bd/MAG	*tenuistip.*	07-08/92	15	FR	11.2 (L) 7.3 (C)	29/30	29.4	6.4]

Ca/PD = Carayat, Preto Diaz
Sa/PD = Sabang, Preto Diez
Ba/GT = Bagacay, Gubat
Mp/BAR = MApapac, Barcelona
Td/BAR = Tagdon, Barcelona
Mb/BUL = Mabuhay, Bulusan
Da/BUL = Dancalan, Bulusan
Da/CAS = Dancalan, Castilla
Tg/JB = Tughan, Juban
Em/JB = Embarca, Juban
Bd/MAG = Banacud, Magallanes

(L) = Sample plant from line
(C) = Control plant

FB = Fixed bottom
FR = Floating raft
P = Pond

5. REFERENCES

Anonymous. 1990. Training on *Gracilaria* Culture and Processing in China. *Zhanjiang Fisheries College, People's Republic of China. Regional Seafarming Development and Demonstration Project RAS/90/002* Training Manual 6. 81 pp.

Delmendo, M.N.,1992. A report on Gracilaria farming development and management of natural seaweed grounds in eastern Sorsogon. *Seaweed Production Development Project. PHI/89/004 BFAR/UNDP/FAO Philippines.* Field Document 02.

Delmendo, M.N., V. Alvarez & H.R. Rabanal, 1992. The evolution of seaweed farming development and its relevance to rural agro-industrial development of coastal communities in the Philippines. *Seaweed Production Development Project. PHI/89/004 BFAR/UNDP/FAO Philippines.* Field Document 03.

Hurtado-Ponce,A.Q., G.PB.Samonte,Ma R.Luhan, & N.Guanzon Jr., 1992. *Gracilaria* (Rhodophyta)farming in Panay, Western Visayas, Philippines. *Aquaculture* 105: 233-240.

Largo, B.D., 1989. Stock assessment of the agarophyte *Gracilaria* (Gracilariales, Rhodophyta) and its potential in polyculture in central Visayas, Philippines. **In:** *22nd Annual Convention, Federation of Institutes of Marine and Freshwater Sciences, Aquatic Resources Development. Mindanao State University Tawi Tawi College of Technology and Oceanography, Sanga-Sanga, Bongao, Tawi Tawi.*

Largo,D.B., P.T.Bacolod, M.A.V.Cusi, C.A.Orosco & M.Ohno, 1989. Growth rate of *Gracilaria verrucosa* and *G. salicornia* (Gracilariales, Rhodophyta) in an intertidal and semi-enclosed pond systems in the Visayas, Philippines. *Bull. Mar. Sci. Fish., Univ. Kochidai Kaiyoseibutsu Kenpo,* No.11, 95-100.

Llana, Ma.E.G., 1992. Preliminary assessment of seaweeds and associated invertebrates in eastern Sorsogon, the Philippines. *Seaweed Production Development Project. PHI/89/004 BFAR/UNDP/FAO Philippines.* Field Document 01.

Nyan Taw, 1993. Manual on seaweed *Gracilaria* farming. *Seaweed Production Development Project. PHI/89/004 BFAR/UNDP/FAO Philippines.* Field Document 10 (Field Document 03/93).

Santos, G.A., 1993. The processing of *Gracilaria. Seaweed Production Development Project. PHI/89/004 BFAR/UNDP/FAO Philippines.* Field Document 08.

Tagarino R.N., 1992 Socio-economic profile of coastal communities in Eastern Sorsogon, the Philippines. *Seaweed Production Development Project. PHI/89/004 BFAR/UNDP/FAO Philippines.* Field Document 04.

Trono, Gavino C.Jr., 1988. Manual on seaweed culture. 2. Pond culture of *Caulerpa* and 3. Pond culture of *Gracilaria. ASEAN/UNDP/FAO Regional Small Scale Coastal Fisheries Development Project.* ASEAN/SF/88/Manual No.3 20pp.

Trono,G.C. Jr. and Edna T. Ganzon-Fortes, 1988. Philippines Seaweeds. *Technology and Livelihood Resource Center, National Book Store,Inc.* Metro Manila, Philippines.30pp.

Trono, G.C. Jr.,1992. Preliminary report on the site evaluation/ assessment and collection trip for seaweed farming at Sorsogon, the project area. *Seaweed Production Development Project. PHI/89/004 BFAR/UNDP/FAO Philippines.* Field Document 06.

Uy, W.H., M.Balanay, D. Ologuin, & G. Tumanda, 1990. Growth and development of *Gracilaria sp.* sporelings in different culture media. **In:** *23rd Annual Conversion, Federation of Institutes for Marine and Freshwater Sciences, Development and Ecologic Crisis: In search of new directions and actions, Mindanao State University-Naawan, Naawan, Misamis Oriental.*

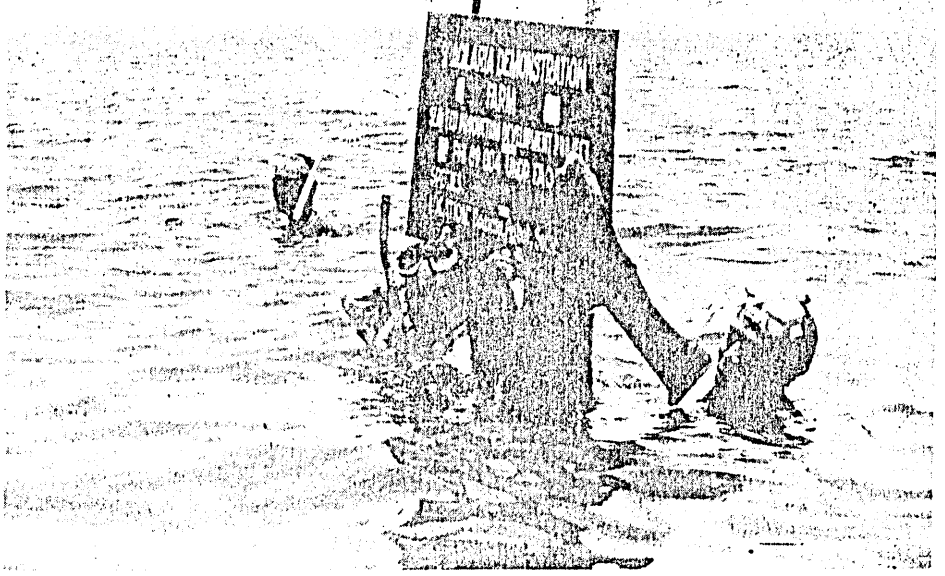
6. ACKNOWLEDGEMENT

I would sincerely like to thank the following: Mr. Renato E. Teruel, Mr. Ronilo G. Conde, Ms. Jenny A. Gabito and Ms. Juvy L. Estreja, project field technicians in Sorsogon in setting up trial lots/rafts and recording essential data: Mr. Jose Ordonez. National Project Director, Ms. Ma Ethel G. Llana, National Project Coordinator and Mr. F. Taclan. Project Leader for their support, without which this study could not have been possible. The wholehearted support of Mr. Guillermo L. Morales, Director and Mrs. Natividad M. Lagua, Assistant Director of BFAR is also highly appreciated.

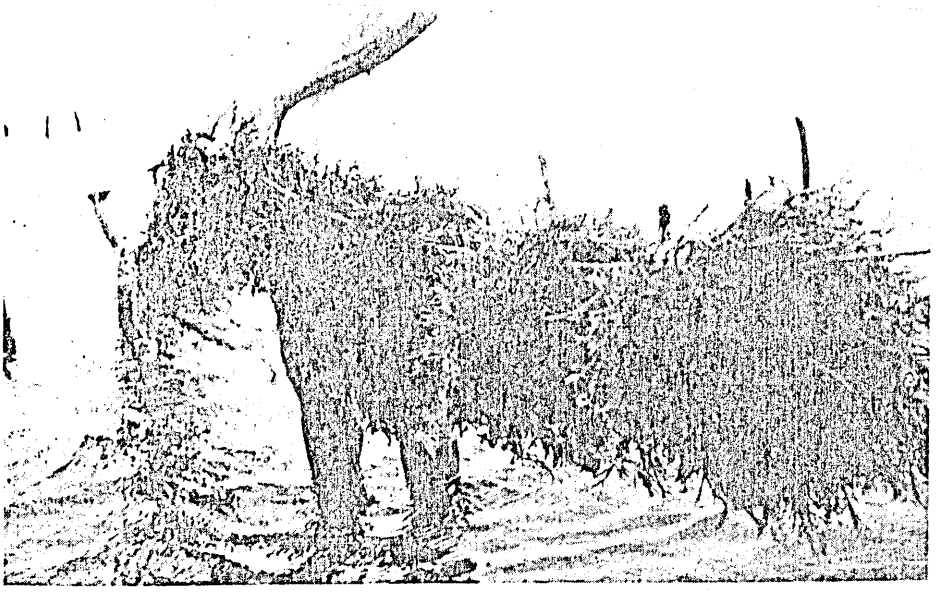
Note: Specific names of the Gracilaria species illustrated are subject to further confirmation.

PLATE I. *Gracilaria* species from Sorsogon area

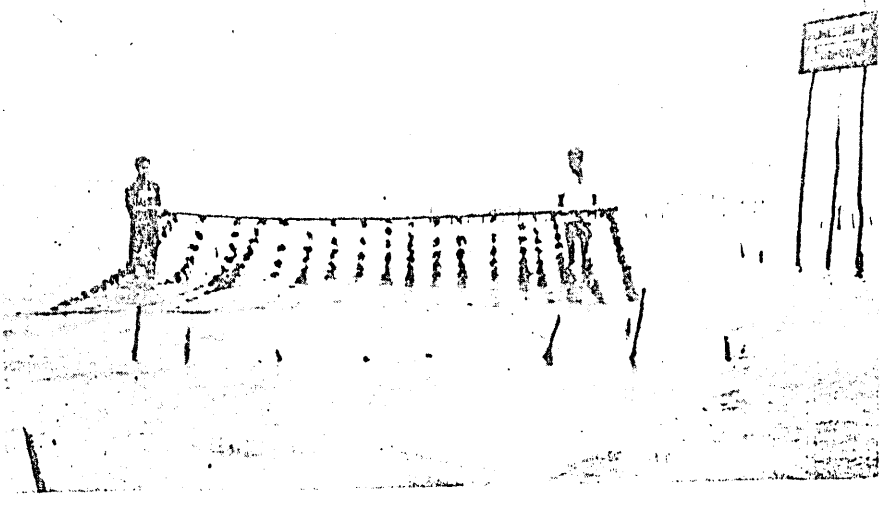
(a) *Gracilaria firma* (=*G. fisheri*)
(b) *G. fastigiata*
(c) *G. cylindrica* (=*G. changii*)
(d) *G. tenuistipitata? 'A'*
(e) *G. tenuistipitata? 'B'*
(f) *G. tenuistipitata? 'C'*
(g) *G. tenuistipitata? 'D'*



G. firma from fixed bottom monoline at high tide at Bagacay, Gubat



G. fastigiata on line ready for harvest at low tide at Bagacay, Gubat



Floating raft monoline of *G. fastigiata* at low tide at Bagacay, Gubat

Plate II. Farming trials of *Gracilaria*.

FIELD DOCUMENTS AND PAMPHLETS OF THE BFAR-DA/UNDP/FAO SEAWEED PRODUCTION DEVELOPMENT PROJECT PHI/89/004, PHILIPPINES

FIELD DOCUMENTS

Field Document 01 Llana, Ma.E.G. 1992 Preliminary Assessment of Seaweeds and Associated Invertebrates in Eastern Sorsogon, the Philippines. **BFAR-DA/UNDP/FAO** *Seaweed Production Development Project* PHI/89/004 January 1992. Philippines.

Field Document 02 Delmendo, M. N. 1992 A Report on *Gracilaria* Farming Development and Management of Natural Seaweed Grounds in Eastern Sorsogon. **BFAR-DA/UNDP/FAO** *Seaweed Production Development Project.* PHI/89/004 February 1992. Philippines.

Field Document 03 Delmendo,M.N., V. Alvarez & H.R. Rabanal 1992 The Evolution of Seaweed Farming Development and its Relevance to Rural Agro-Industrial Development of Coastal Communities in the Philippines. **BFAR-DA/UNDP/FAO** *Seaweed Production Development Project.* PHI/89/004 February 1992. Philippines.

Field Document 04 Tagarino, Rogelio N. 1992 Socio-economic Profile of Coastal Communities in Eastern Sorsogon, the Philippines. **BFAR-DA/UNDP/FAO** *Seaweed Production Development Project.* PHI/89/004 November 1992. Philippines.

Field Document 05 Nyan Taw 1992 Iodine in Seaweeds. **BFAR-DA/UNDP/FAO** *Seaweed Production Development Project.* PHI/89/004 November 1992 Philippines.

Field Document 06 Trono, Gavino C. 1992 Preliminary Report on the Site Evaluation/ Assessment and Collection Trip for Seaweed Farming at Sorsogon, the Project Area. **BFAR-DA/UNDP/FAO** *Seaweed Production Development Project.* PHI/89/004 November 1992. Philippines.

Field Document 07 Guanio, Luis V. 1993 Preliminary Assessment of the Existing Regional Market of *Gracilaria* in the Sorsogon- Bicol Area, the Philippines. **BFAR-DA/UNDP/FAO** *Seaweed Production Development Project* PHI/89/004 January 1993. Philippines.

Field Document 08 Santos, G.A. 1993 The Processing of *Gracilaria.* **BFAR-DA/UNDP/FAO** *Seaweed Production Development Project* PHI/89/004 March 1993 Philippines.

Field Document 09 Nyan Taw 1993 Seaweed *Gracilaria* Farming Trials in Sorsogon, the Philippines. **BFAR-DA/UNDP/FAO** *Seaweed Production Development Project* PHI/89/004 March 1993. Philippines.

PAMPHLETS

Pamphlet 1 Project Management 1993 BFAR-DA/UNDP/FAO *Seaweed Production Development Project* PHI/89/004, January 1993 the Philippines.