Photo 29 Zostrea zone

2) Result of Experiment

(1) Research survey

The study was based on samples of rabbit fish, S. canaliculatus, collected weekly (June-December 1981) from the South-east Coast of Panjang Island, Banten Bay, Indonesia. Spawning season, gonad maturity, and fecundity were monitored.

Four hundred and two fishes were collected, which consisted of 233 individuals female, 130 individuals male and 39 individuals were unknown. The highest average gonad index of 5.3 and 3.5 for female and male were obtained, respectively. The spawning season was occurred from September and the major spawning was on October. The minimum size of matured fish was 20.0 and 18.6 cm in total length for female and male, respectively. The fish of 22 and 27 cm in total length have 200,000 to 1,300,000 eggs. (Table 3 and 4, Fig. 28 - 33).

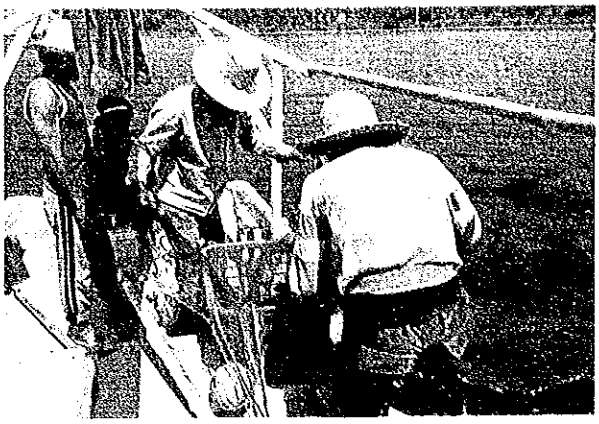


Photo 30 Throwing in seine net

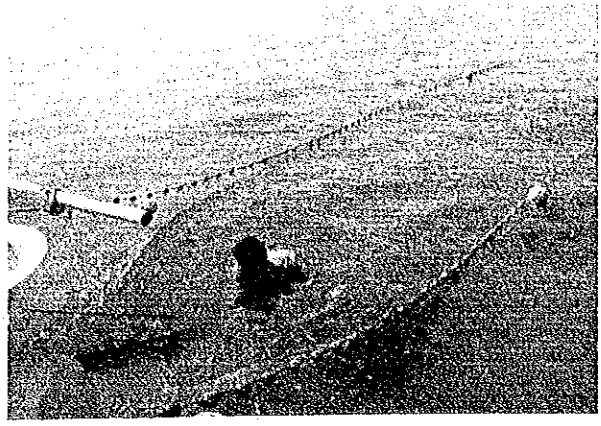


Photo 33 Hauling seine net

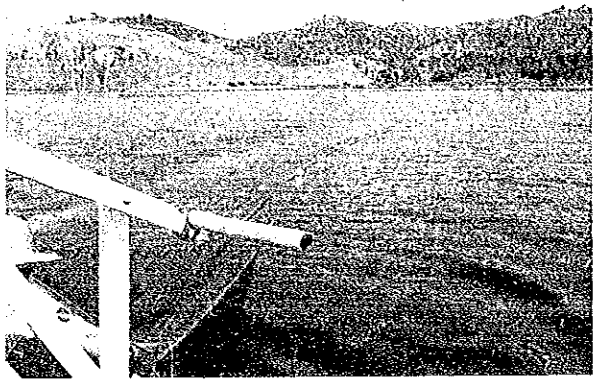


Photo 31 Finished throwing

Photo 34 Fry caught

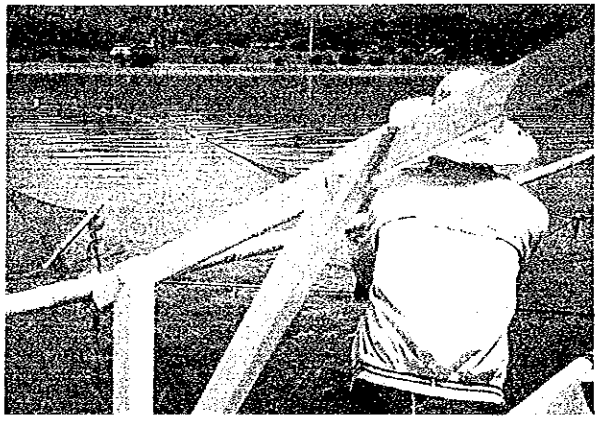


Photo 32 Hauling seine net

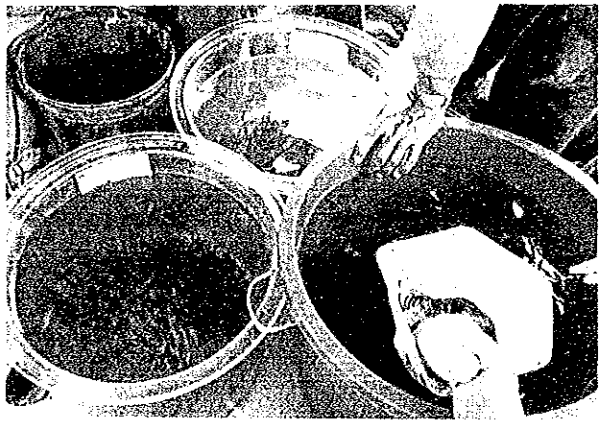


Photo 35 Fry selection

Table 3 Biodata of females (233 individuals) and males (130 individuals) of S. canaliculatus, which were collected from South-East Coast of Panjang Island, Banten Bay

FEMALE:	No. (ind.)	A.T.L. (cm)	A.B.W. (g)	G.I. max.	G.I. min.
Jun.	3	18.93 ± 0.11	106.00 ± 9.52	0.68	0.22
Jul.	26	23.32 ± 2.31	197.19 ± 62.73	2.00	0.03
Aug.	2	25.20 ± 1.55	241.00 ± 21.21	4.87	3.67
Sep.	62	22.38 ± 2.72	184.95 ± 62.89	10.91	0.03
Oct.	20	23.68 ± 2.45	213.50 ± 61.79	17.43	0.23
Nov.	41	22.31 ± 1.94	184.00 ± 45.81	11.30	0.19
Dec.	79	21.98 ± 2.11	162.82 ± 53.05	6.27	0.08
Total	233				

MALE:	No. (ind.)	A.T.L. (cm)	A.B.W. (g)	G.I. max.	G.I. min.
Jun.	1	20.50	100.00		
Jul.	10	21.61 ± 1.01	152.70 ± 18.76	1.49	0.03
Aug.	2	19.85 ± 2.90	110.00 ± 45.25	0.13	
Sep.	24	19.84 ± 1.78	119.03 ± 35.08	7.12	0.06
Oct.	7	20.67 ± 0.76	122.57 ± 18.82	5.21	0.66
Nov.	34	20.70 ± 1.71	139.88 ± 37.95	8.24	0.13
Dec.	52	20.45 ± 1.58	125.42 ± 26.50	3.63	0.03
Total	130				

Table 4 Length frequency distribution for Siganus canaliculatus, which were collected monthly at South-East Panjang Island, Banten Bay

TOTAL LENGTH (cm)	TOTAL NUMBER (ind.)	MONTH Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
12 - 13	2				2			
13 - 14	2	2						
14 - 15	2				2			
15 - 16	7				7			
16 - 17	11				11			
17 - 18	11			1	7			3
18 - 19	31	3		1	6		7	14
19 - 20	59		3	2	13	2	19	20
20 - 21	56	1	6	1	6	5	10	27
21 - 22	66		6	2	12	4	12	30
22 - 23	61		11	1	12	6	14	17
23 - 24	37		3		12	1	9	12
24 - 25	23		3	1	6	2	6	5
25 - 26	14		1		6	3	1	3
26 - 27	11		1	2	4	1	2	1
27 - 28	6		1		1	2		2
28 - 29	3		1			1		1
Total	402	6	36	11	108	27	79	135

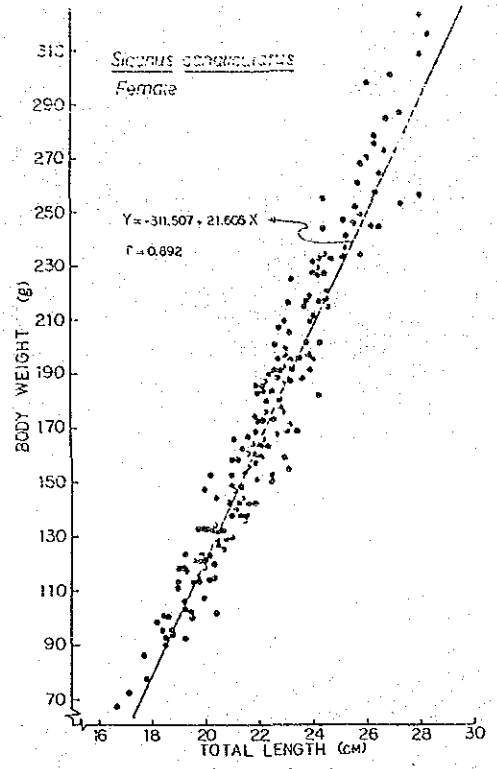


Fig. 28 Relationship between total length and body weight

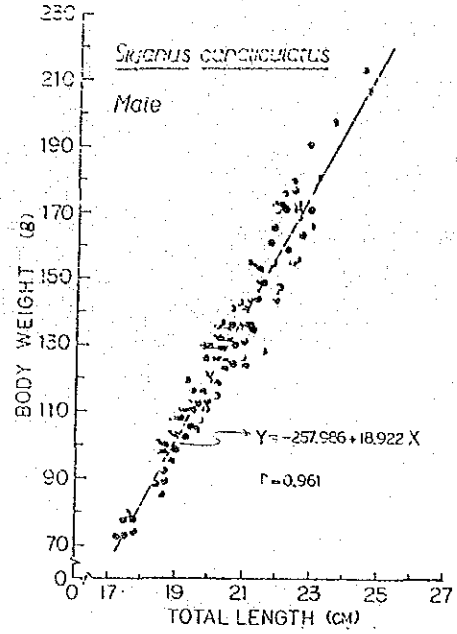


Fig. 29 Relationship between total length and body weight

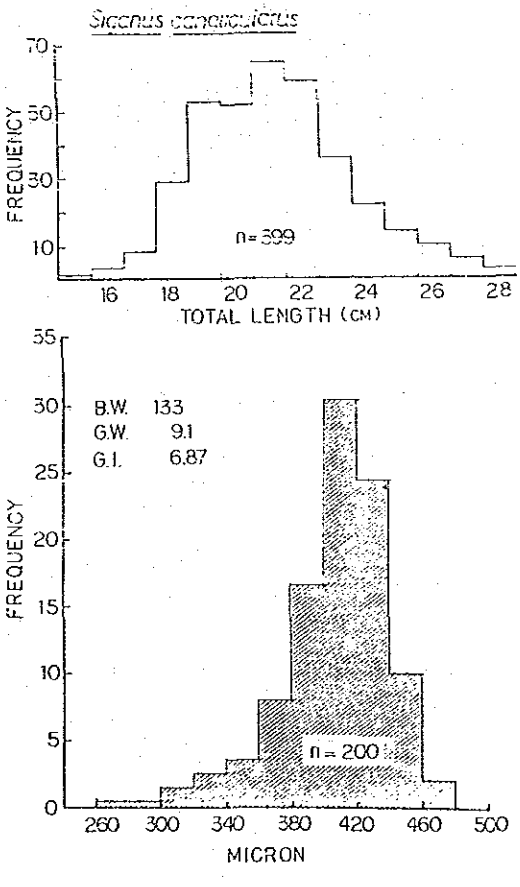


Fig. 30 Total length and egg diameter

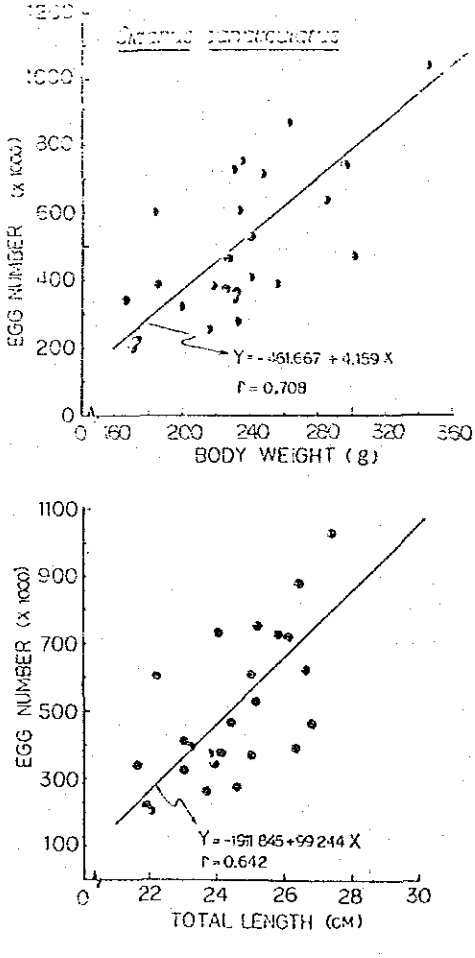


Fig. 31 Ralationship between body weight and total length and

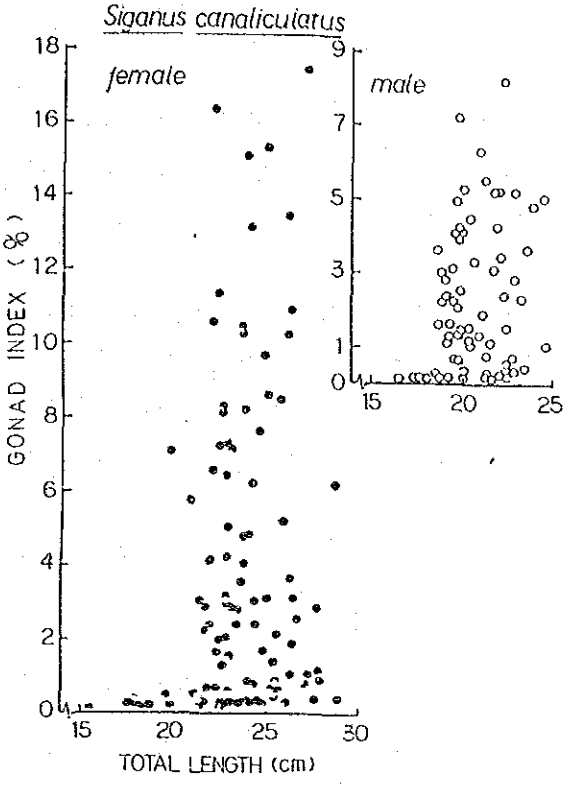


Fig. 32 Relationship between total length and gonad index

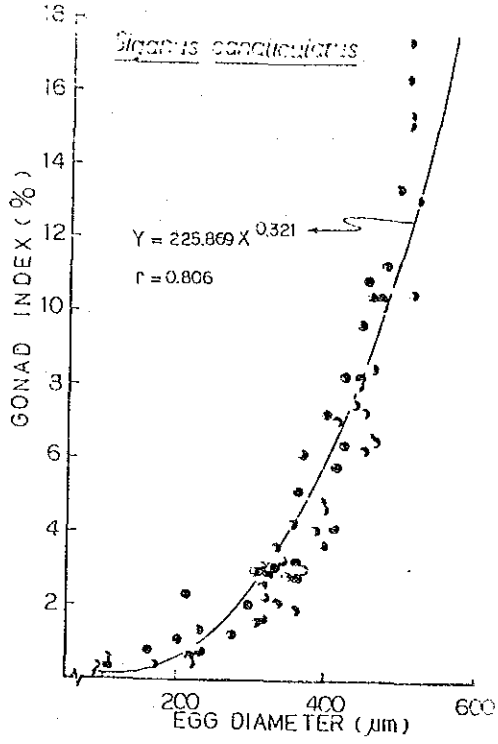


Fig. 33 Relationship between egg diameter and gonad index

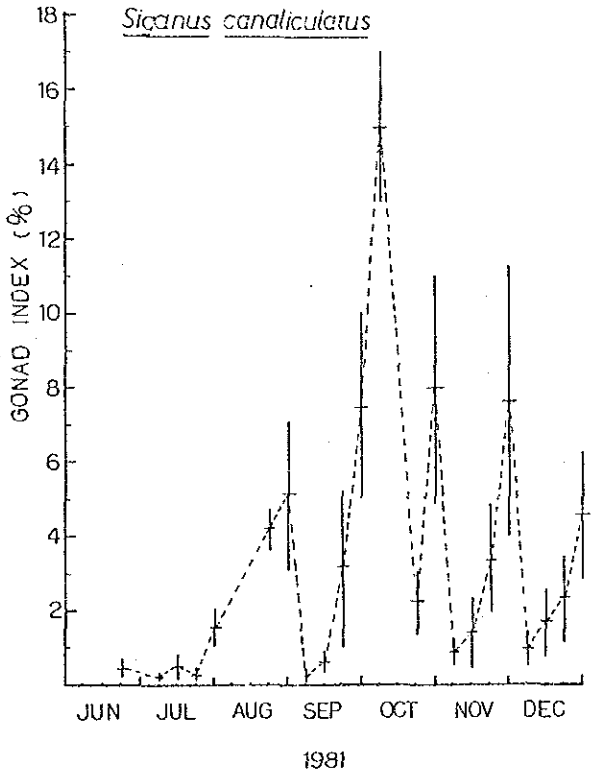


Fig. 34 Change of gonad index in the season

(2) Culture experiment

Observation on the growth some species of rabbit fish cultured in floating net-cages were carried out at Bojonegara Experimental Station from May 1983 to January 1984.

Four species of rabbit fish, S. virgatus, S. canaliculatus, S. javus and S. guttatus were used in this experiment. Experimental fish were fed with a mixing of artificial diet of carp and chopped trash fish at a ratio of 1:1.

The result showed that daily growth rate of S. virgatus, S. canaliculatus, S. javus and S. guttatus are 0.55%, o,59%, 0.66%, and 0.68% of body weight, respectively. THe food conversion rate are 5.6, 4.1, 3.6, and 3.3, respectively. (Table 5 and 6, Fig. 35).

Table 5 Stocking Density and Size of Rabbitfish, Siganus Spp. Used in the Experiment

Species	No. of fish (ind.)	ATL (cm)	ABW** (g)	Stocking density (ind/m^3)	Size of net cage (m)
S. virgatus	340	10,3	17,4	43	2x2x2
S. canaliculatus	454	11,2	20,0	57	2x2x2
S. javus	378	9,8	14,1	47	2x2x2
S. guttatus	3200	9,6	10.9	128	3x3x3

* ATL = Average total length.
** ABW = Average body weight.

Table 6 Growth Rate, Food Conversion Ratio and Mortality of Rabbitfish, Siganus spp. Cultured in Floating Net-cages

Item	species			
	S. virgatus	S. canaliculatus	S. javus	S. guttatus
Period of observation(ind.)	270	270	270	270
Initial number of fish (ind.)	340	454	378	3200
Final number of fish (%)	245	368	301	2500
Mortality (g)	27.9	18.9	20.4	21.8
Initial ABW (g)	17.4	20.4	14.1	10.9
Initial TBW (g)	5916	9080	5294	34880
Final TBW (g)	121.1	177.8	237.6	268.7
Final TBW (g)	29670	65430	71518	671750
Total gained of BW(g)	23754	56350	66225	636870
Daily gained of BW(g)	0.38	0.58	0.83	0.96
Daily growth ratio(%)	0.55	0.59	0.66	0.68
Total food consumed (g)	133020	231035	238410	2101670
Food conversion rate	5.6	4.1	3.6	3.3

TBW = Total body weight
ABW = Average body weight

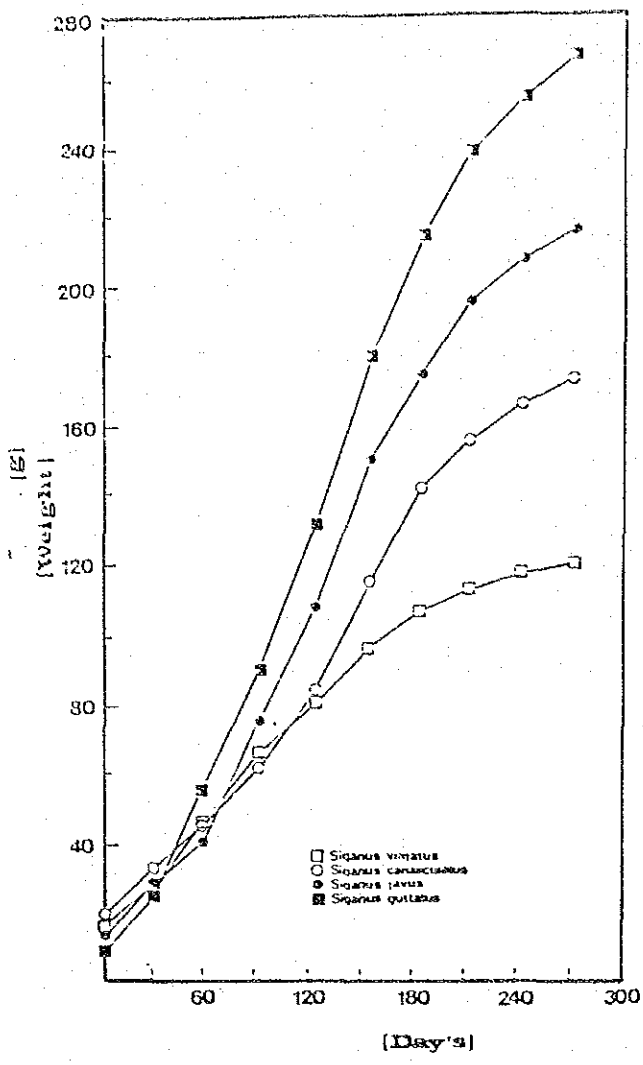


Fig. 35 Growth of rabbitfish, Siganus spp. cultured in floating net-cages.

The mixed culture experiment of S. javus and S. canaliculatus was conducted from September 1982 to May 1983 at Bojonegara Experimental Station.

Two species were cultured together in 5 m x 5 m net cage. The comparison study on growth and survival rate between species was conducted. The substance of diet was the moist pellet made of commercial formulated diet for carps and minced fish meat, which was provided twice a day with satiating quantity. The initial number and body weight of S. javus and S. canaliculatus were 204 and 634 fish, and 75 g and 23.9 g in average body weight, respectively. And the average body weight at the end of experiment of S. javus and S. canaliculatus were 263 g and 118 g, respectively. Those two species grew up to marketable size for eight months. However, the survival rate was very low because of disease and parasite.

The rearing experiment of S. guttatus was conducted from June 1983 to February 1984. 44,000 fries with 0.5 g B.W. and 3.3 cm T.L. collected in May 1983 were raised in 3 m x 3 m net cage, fed with minced fish meat. They were transferred into 5 m x 5 m net cage in June 1983, then the culture experiment was conducted, feeding formulated diet. As of September 1983, the average body weight was 56.5 g, average total length 14.4 cm, survived fish 3880, and survival rate 8.6%. Big mortality happened during July to September 1983. In February 1984, the number 2,464 fish with average body weight of 269 g were harvested, and the survival rate 5.6% after the culture period of 264 days. The daily growth rate were 2.4 to 3.5% from June to September 1983, 1.2% from September to December 1983 and 0.7% to 1% from December 1983 to February 1984. On the other hand, from the observation of gonad of natural and cultured adults, the biological minimum size were seemed to be 300 to 350 g and 200 to 250 g in body weight respectively. (Fig. 36 and 37).

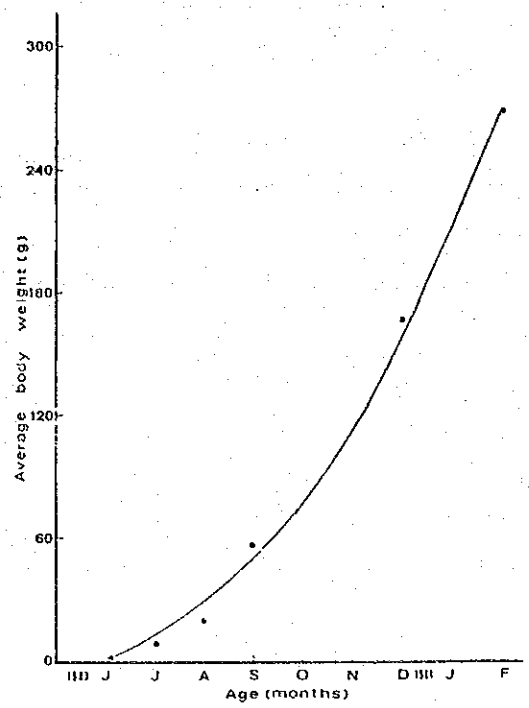


Fig. 36 Growth curve of Siganus guttatus cultured in floating net cage.

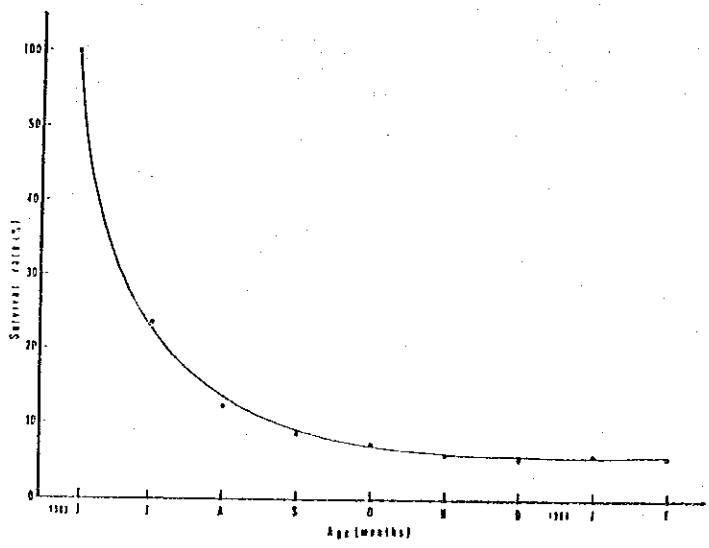


Fig. 37 Survival rate of Siganus guttatus during the experiment.

The comparison study of growth on different formulated diet between Siganus canaliculatus and S. javus was started in September 1985 and still being continued. The experiment is still being conducted 4,000 fish of S. canaliculatus with average body weight 20 g, put each 1000 fish into each one of four 3 m x 3 m net cage, and then began the culture experiment with four different feed compositions. The four compositions were, I. commercial formulated diet for carp (protein 2%), II. commercial formulated diet for carp (protein 40%), III. commercial formulated diet for carp (protein 27%) vegetables = 1 : 1, IV. commercial formulated diet for carp (protein 27%) vegetables: raw fish = 2 : 1 : 1. (Photo 36).

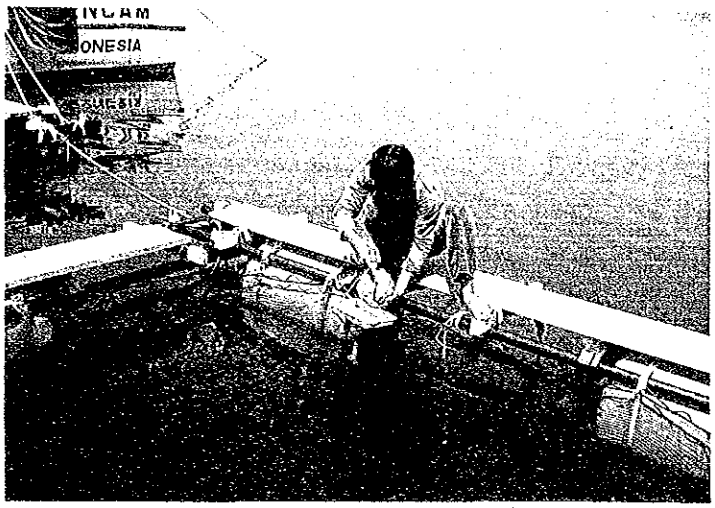


Photo 36 Feeding with rabbit fish

As for S. javus, 2000 fish were selected, put each 1,000 fish into each one of two 3 m x 3 m net cage, and then conducted the culture experiment, providing two groups with different feed compositions. Two feed compositions are; I. commercial formulated diet for carp (protein 27%) with 10% vegetables and II. commercial formulated diet for carp (protein 40%) with 10% vegetables.

Further, on S. guttatus and S. javus, the growth comparison experiment was conducted, providing the moist pellet composed of 60% of commercial formulated diet (protein 27%) and 40% of minced fish meat at the daily

feeding ratio of 20% total body weight. The experiment was started in October 1985, still being continued. 601 fish of S. guttatus and 2640 fish of S. javus were examined in this experiment. The body weight of S. guttatus was 48.0 ± 19.8 g at the start of experiment, and grew to 116,5 ± 26.4 g on January 23, 1986, after 3 months. The body weight of S. javus was 22.5 ± 9.0 g at the start of experiment, and grew to 36.5 ± 11.6 g on January 23 1986. Both species demonstrated good growth, particularly, the weight increase of S. guttatus was excellent.

Pen culture experiment of Siganus javus and S. canaliculatus was conducted from August to October 1985. The main purpose of the experiment was to search a measure to prevent big mortality of rabbitfish in a juvenile period and the rearing experiment by pen culture was attempted. This pen culture experiment aimed to compare with floating net cage method and try the supplemental feeding, 3 times a week.

The culture will be conducted in such close position to the sea bottom that juvenile will feed natural sea weed. The muddy bottom area near Bojonegara Experimental Station was selected as the place to install fish pen with size of 3 m x 3 m (Photo 37 and 38). The juvenile of S. javus and S. canaliculatus were selected, which were stocked in floating net cages at Bojonegara Experimental Station, and they were respectively transferred into fish pen in August 1985. The number of juvenile of S. javus and S. canaliculatus used for this experiment were 1,019 fish and 1,008 fish, respectively.

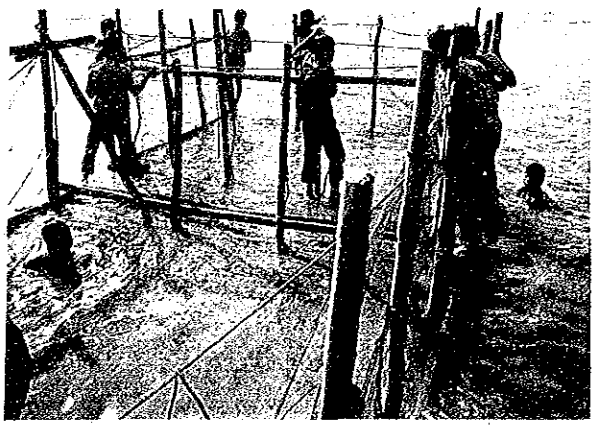


Photo 37 Construction of fish pen

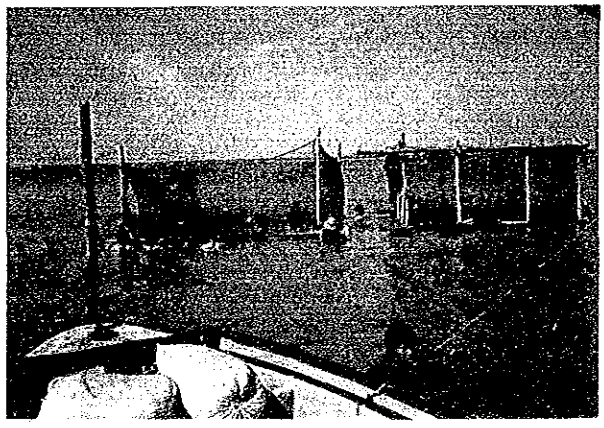


Photo 38 -Ditto-

The average total length and body weight of S. javus and S. canaliculatus at the start of experiment were 9.8 cm and 14.9 g, and 10.1 cm and 14.3 g, respectively. The average total length and body weight of S. javus and S. canaliculatus at the end of experiment were 10.4 cm and 16.1 g, and 10.7 cm and 15.7 g, respectively. And the survival rate during experiment of S. javus and S. canaliculatus were over 90% respectively.

(3) Experiment of seed production

During the period of 1982 to 1984, several spawners of S. virgatus had been spawning every month. The experiment of seed production on S. virgatus had been conducted. From the result of this experiments, a little number of larva survived after one month from hatching out. Big. mortality was observed 4 days and 10 days after hatching.

In August 1983, hormon injection was tried to adult of S. canaliculatus and about 800,000 eggs were obtained from two spawner. The hatching rate was over 90%. However, almost larvae died within a week.

The experiment of seed production on S. guttatus was conducted from April to October 1985. During this period, a spawners of S. guttatus had been spawning every month. The spawning was occurred after spawners were transferred. From 3 ton FRP tank to 10 ton concrete tank and the quality of feed was changed to high protein and low fat diet. Larval hearing experiment had been conducted by using hatched Larva obtained by those natural spawning. During the period of this experiment, about 350 juveniles were totally obtained. (Table 7, Fig. 38 - 39, and Photo 39 and 40). Feeding regime of larval rearing of this species was completed as follows;

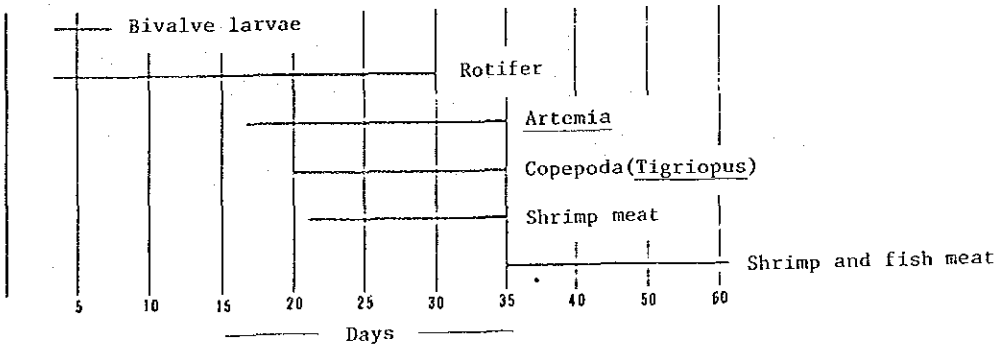


Table 7 Record on the spawning and number of Larvae survive of Signnus guttatus

Date of spawning	Survival Number
April 30th, 1985	4
May 29th, 1985	14
August 21st, 1985	86
September 23rd, 1985	95
October, 18th, 1985	139
Total	338

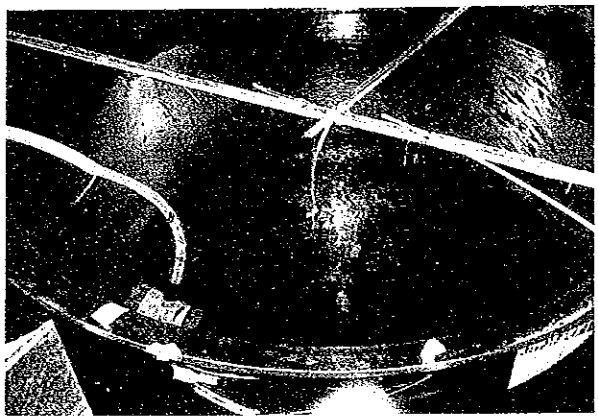


Photo 39 Fry of S. guttatus

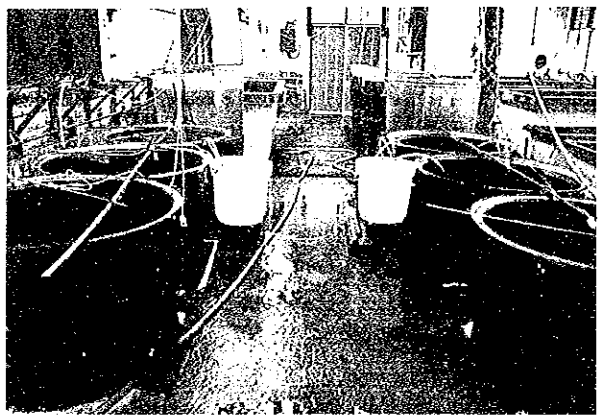


Photo 40 Laval Rearing Tank

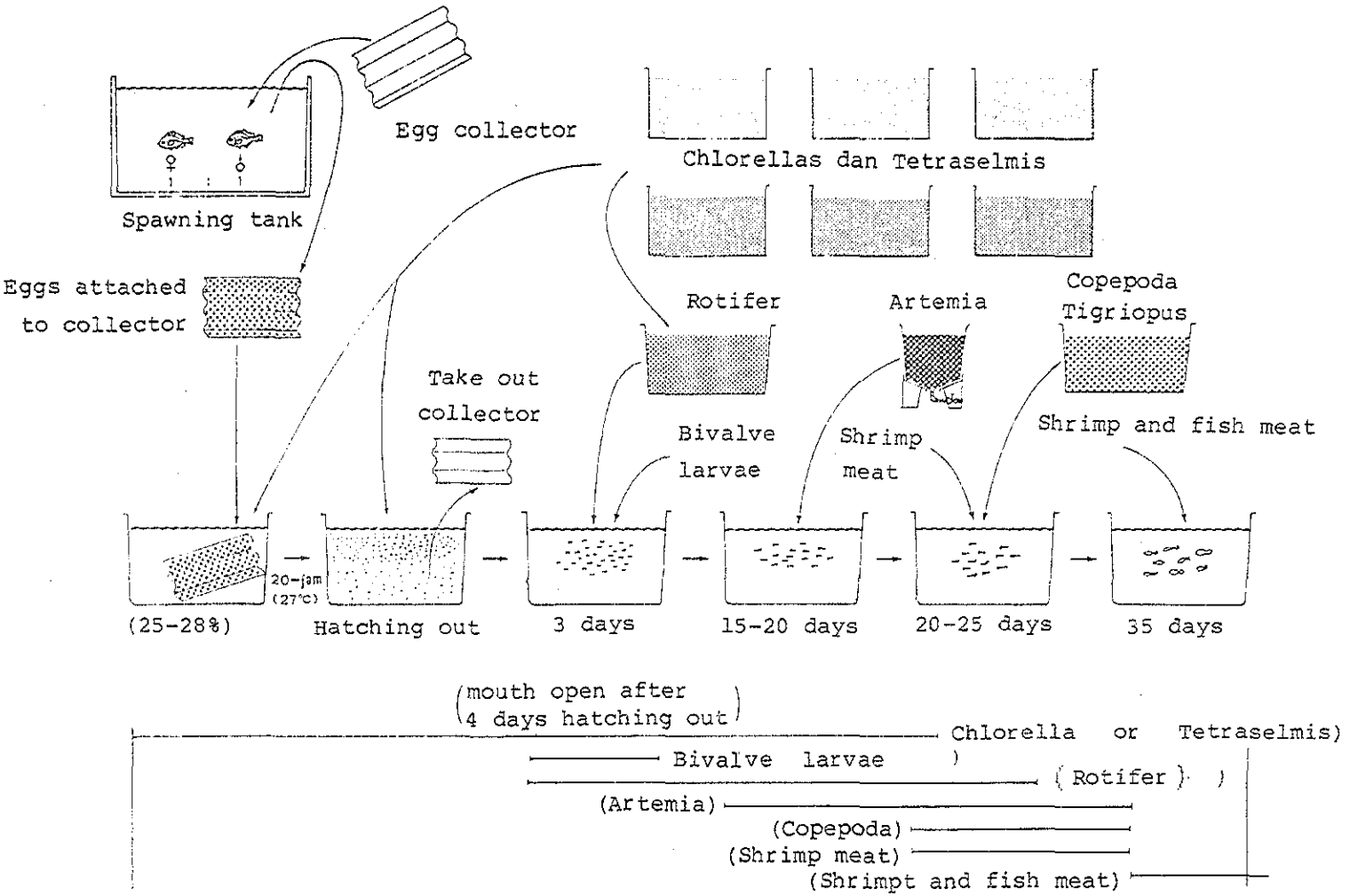


Fig. 38 Larval Rearing Method of Siganus guttataus

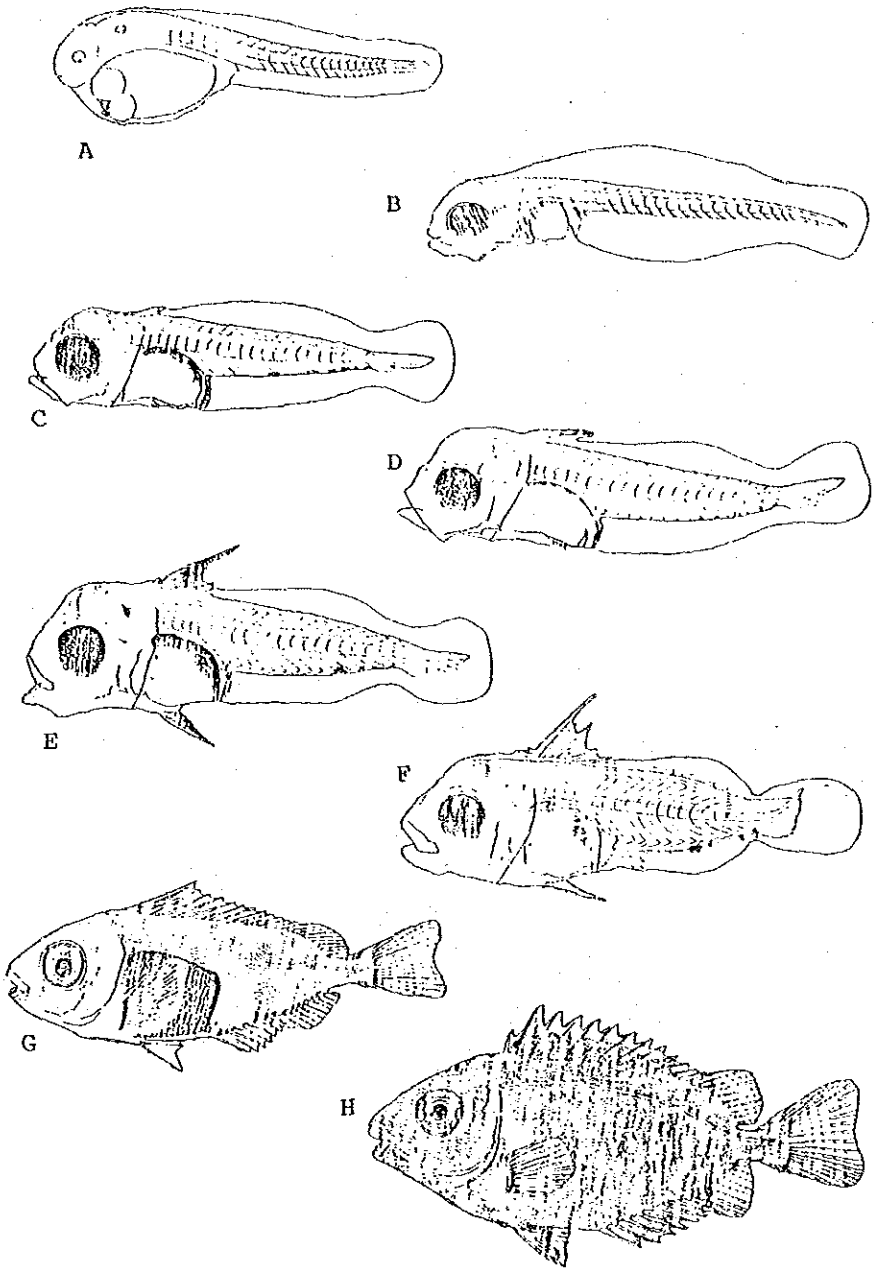


Fig. 39 Early development of S. guttatus.

A. Just hatched larva. 1.70 mm in total length;
B. Larva 12 hours after hatching. 2.75 mm;
C. 36 hours after hatching. 2.80 mm;
D. 8 days after hatching. 4.05 mm;
E. 10 days after hatching. 4.52 mm;
F. 14 days after hatching. 5.10 mm;
G. 18 days after hatching. 6.76 mm;
H. 26 days after hatching. 18.21 mm;
I. 32 days after hatching. 26.15 mm;

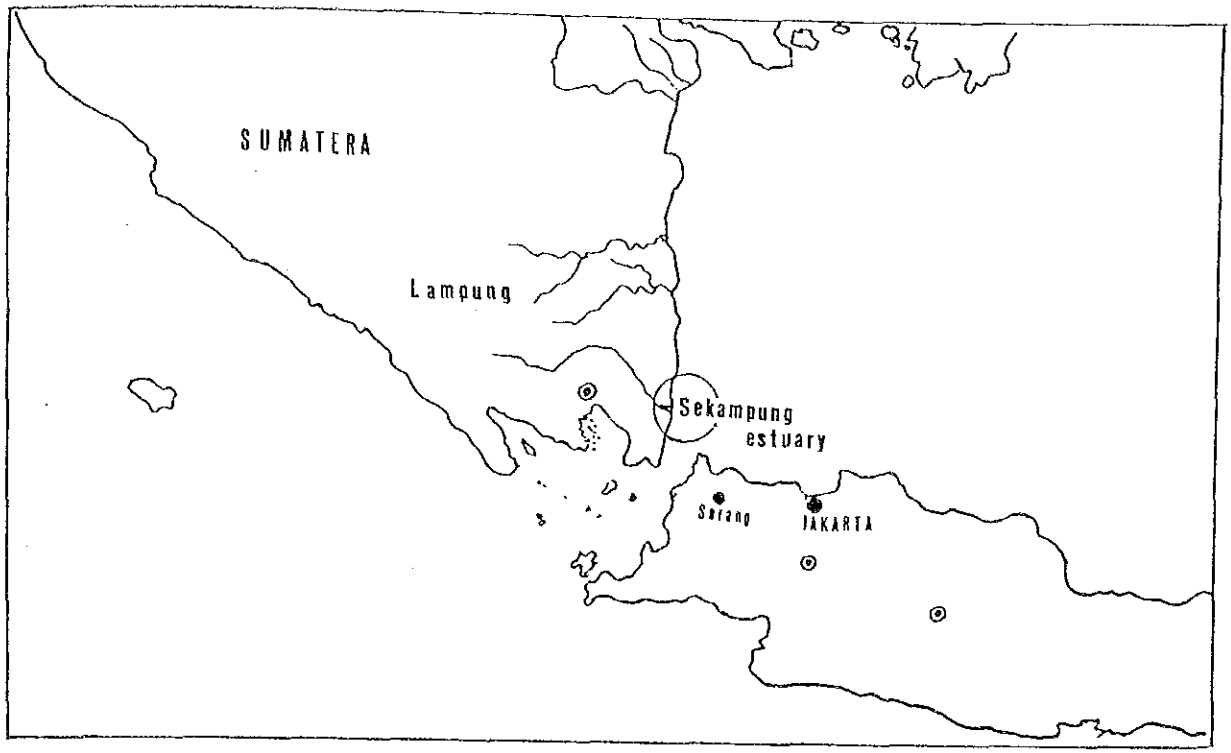


Fig. 40 Location of Sekampung River

Photo 41 Sekampung Estuary

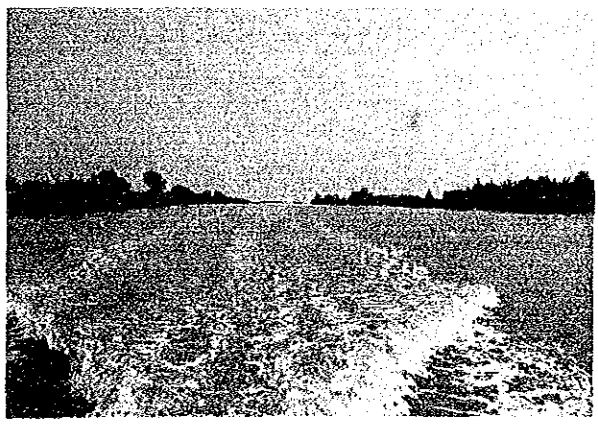


Photo 42 Sekampung Estuary

3) Consideration

The resources of rabbit fish is very rich in Banten Bay, therefore, fries can be easily collected. The cost of feed for rabbit fish is low, comparing other carnivorous fishes because this species is required for low protein diet. And also rabbit fish is highly evaluated in some markets because of its good quality meat.

From the result of the 10 months rearing experiment of four species, the body weight of S. guttatus, S. javus, S. canaliculatus and S. virgatus were 260 to 270 g, 210 to 220 g, 170 to 180 g and about 120 g, respectively.

For culture industry, the desirable species should grow fast, be vigorous, be high market value and be easily obtained seed. S. canaliculatus is less resistant to the change of circumstances. During the pond culture experiment of S. javus and S. canaliculatus, as the fall in salinity occurred in the rainy season, all S. canaliculatus died, while S. javus were still alive. However, S. canaliculatus has high price in some markets in Indonesia.

From the result of the previous several experiments, rabbit fish tends to suffer suddenly the damage by parasite or bacterial diseases, so preventive measures are required. On the other hand, the high mortality was completely prevented by feeding fresh fish in combination with moist pellet propary formulated with some vegetables in the experiment of 1984 and 1985.

From the above reasons, S. guttatus, S. javus and S. canaliculatus seem to be promising species for mariculture of Indonesia.

3-3-2 Giant seaperch

The distribution of giant seaperch, Lates calcarifer, spreads over the Western Pacific including the South Japan sea area, and as far as Indian Ocean.

Giant seaperch is regarded as one of the important mariculture species in Indonesia and other tropical countries. This species is known to the natives as "Kakap" in Indonesia.

It seems that little number of giant seaperch inhabit in Banten Bay, because small number of giant seaperch sometimes are harvested with milkfish in brackish water pond.

Therefore, investigation of the habitat of giant seaperch was conducted in the adjacent sea area of Banten Bay from the start of this project.

From the result of this investigation, the areas of estuaries of big rivers in east coast of Lampung, South Sumatera are selected, and young and adult fish for the culture experiment have been collected.

Concerning those collected fish, various culture experiments were conducted in the Bojonegara Experimental Station.

1) Collection of natural seed

Natural seeds of giant seaperch, Lates calcarifer are collected in the area of Sekampung estuary in the east coast of Lampung, South Sumatera by the research survey.

The collecting methods are set net "Sero" and gill net. Season for the seeds of 20 to 200 g in body weight is from February to June. And number of collected seeds were about 30 to 150 fish by a set net "Sero" in a day.

2) Result of experiment

(1) Research survey of Giant Seaperch

A research was conducted from May 1982 to August 1983 at the estuary of Sekampung river on the east coast of Lampung, South Sumatera (Fig. 40, and Photo 41, 42). The main purpose of this research was to investigate the spawning season of giant seaperch (L. calcarifer) and to collect its adult young fish and fry. The collecting methods are set net "Sero: and gill net (Photo 43 - 48). As a result, a total of 786 live giant seaperchs were collected, out of which 30 spawners weighed over 4 kg and 468 young and fry weighed up to 200 g. By sizes of fish and period of collection, it was roughly assumed that the spawning season of giant seaperch may begin in September and continue till February. And as to corroborate this assumption, 17 days fry of giant seaperch were transported from Thailand, whose result showed, although some difference were recognized, almost similar accordance was obtained relating to the growth of raised fry and size of collected fish.

The seasonal appearance of giant seaperch in each size and the number collected by this research survey are shown in Table 8 and Fig. 41.

Photo 43 "Sero" Set Net

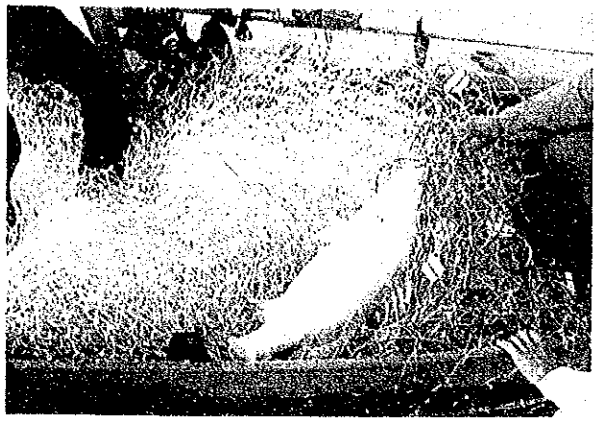


Photo 46 Giant Seaperch Caught by Gill Net

Photo 44 Sero Set Net

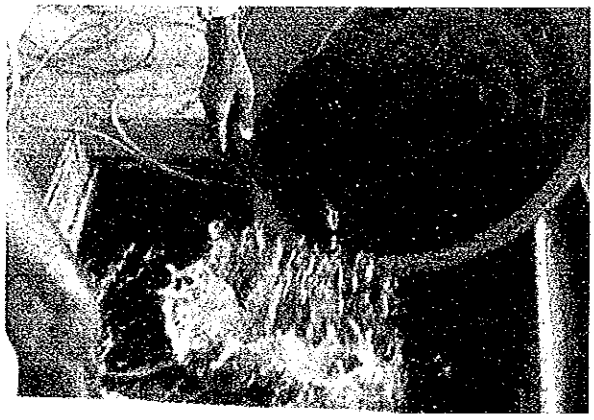


Photo 47 Giant Seaperch young

Photo 45 Gill Net

Photo 48 Giant Seaperch young

Table 8 Giant Seaperch, Lates calcarifer, Collected at the Estuary of Sekampung River on the East-coast of Lampung, South Sumatera

Month	Days	No. of fish	No. of fish with different size						
			20-50g	50-100g	100-200g	200-500g	500g-1kg	1-4kg	4-12kg
1982									
May	3	126	0	12	41	46	25	2	0
Jun	3	27	0	0	15	10	2	0	0
Oct	4	7	0	0	0	0	0	3	4
Nov	4	7	0	0	0	0	2	2	3
Dec	9	17	0	0	0	0	1	7	9
1983									
Jan	4	6	0	0	0	0	0	3	3
Feb	5	25	10	2	0	2	0	0	11
Mar	4	397	41	27	265	64	0	0	0
Jun	4	164	2	3	50	95	14	0	0
Aug	3	10	0	1	1	4	4	0	0
Total	43	786	53	43	372	221	48	17	30

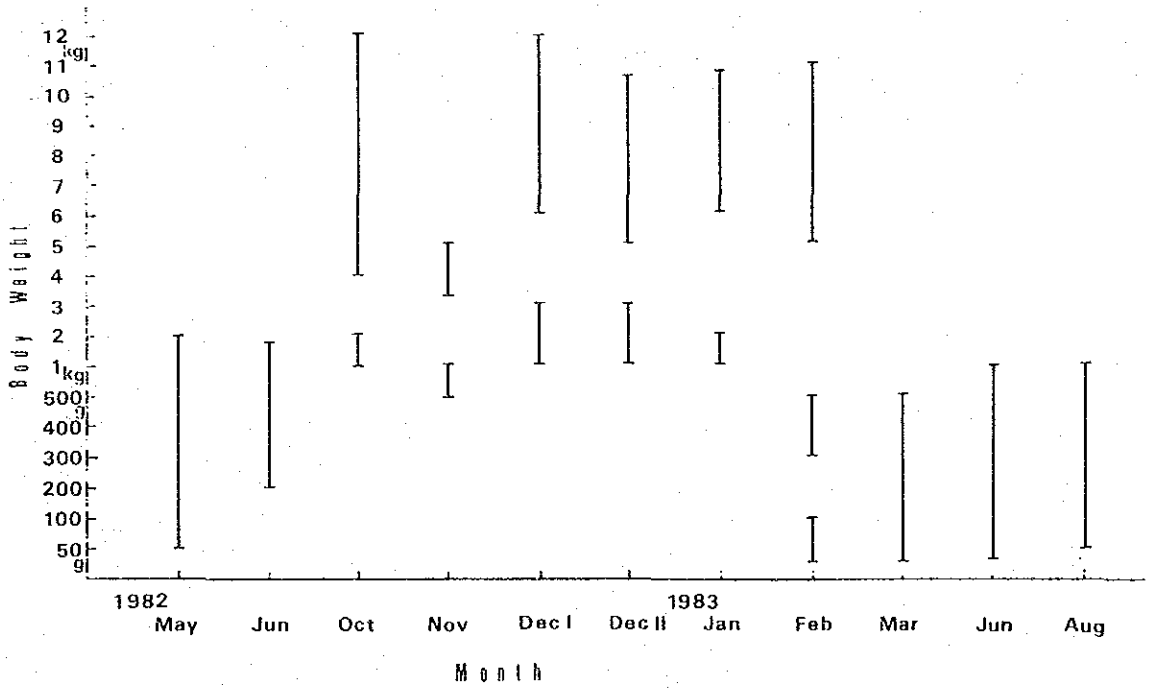


Fig. 41 Monthly Body Weight Distribution of Giant Seaperch Lates calcarifer in Sekampung Estuary on the East Coast of Lampung, South Sumatera

(2) Culture experiment

The rearing experiments in the floating net cage was conducted from August 1982 to August 1983.

The fish collected from Lampung area were divided into 3 groups: I. 41 fish with 199 g in average body weight, II. 46 fish with 478.7 g in average body weight and III. 25 fish with 1149,4 g in average body weight.

They were put into each of three 5 m x 5 m net cages. And daily feeding ratio was about 5% total body weight, provided sardine and horse mackerel as feed. The average body weight at the end of the experiment were 1817.1 g, 793.8 g and 3327.9 g in I, II and III group, respectively.

Food conversion rate of I, II, and III were 6.5 to 7.5, 4.7 and 11 to 13, respectively. (Table 9 and 10, and Fig. 42 and 43)

Table 9 Growth Ratio and Food Conversion Ratio of Giant Seaperch, Lates calcarifer Cultured in Floating Net-cage

Observation period Date/month/year	No. of fish (ind.)		ABW (g)		Feed (kg)	DGR (%)	FCR	Mortality (%)
	Initial	Final	Initial	Final				
18/08 - 20/09 '82	35	35	199.4	240.4	10.80	0.55	7.5	0
20/09 - 20/10	35	34	240.4	325.9	17.30	1.00	6.5	2.85
20/10 - 23/11	34	34	325.9	425.9	22.44	0.79	6.6	0
23/11 - 20/12	34	34	425.9	580.0	30.48	1.10	5.8	0
20/12 - 22/01 '83	34	18	580.0	712.0	15.99	0.62	6.7	47.05*
22/01 - 21/02	18	18	712.0	872.5	19.65	0.64	6.8	0
21/02 - 30/03	18	18	872.5	1041.0	21.83	0.52	7.2	0
30/03 - 02/05	18	18	1041.0	1261.0	26.13	0.58	6.6	0
02/05 - 01/06	18	18	1261.0	1474.0	28.65	0.52	7.5	0
01/06 - 29/06	18	18	1474.0	1675.0	28.95	0.47	8.0	0
29/06 - 16/08	18	18	1675.0	1871.1	33.82	0.23	9.4	0
18/08/82-16/08/83	35	18	199.4	1871.1	256.04	0.44	7.1**	2.85

*) Stolen **) Average
Note: DGR = Daily growth ratio
FCR = Food conversion ratio

Table 10 Growth Ratio and Food Conversion Ratio of Giant Seaperch, Lates calcarifer Cultured in Floating Net-cage

Observation period Date/month/year	No. of fish (ind.) Initial/Final		ABW (g) Initial/Final		Feed (kg)	DGR (%)	FCR	Mortality (%)
18/08 - 20/09 '82	25	22	1149.4	1317.5	29.83	0.41	7.1	12.0
20/09 - 20/10	22	22	1317.5	1457.1	29.26	0.34	9.5	0
20/10 - 23/11	22	22	1457.0	1579.0	25.85	0.24	9.6	0
23/11 - 24/12	22	22	1579.0	1693.0	24.93	0.25	9.9	0
24/12 - 27/01 '83	22	22	1693.0	1954.0	37.95	0.39	6.6	0
27/01 - 24/02	22	22	1954.0	2195.2	37.46	0.41	7.0	0
24/02 - 02/04	22	22	2195.2	2470.0	39.29	0.32	6.5	0
02/04 - 02/05	22	22	2470.0	2674.0	41.50	0.26	9.2	0
02/05 - 01/06	22	22	2674.0	2890.0	42.25	0.26	8.9	0
01/06 - 01/07	22	22	2890.0	3086.1	42.98	0.22	9.9	0
01/07 - 16/08	22	22	3086.1	3327.9	52.79	0.16	9.9	0
18/08/82-16/08/83	25	22	1149.4	3327.9	404.09	0.29	8.5*	12.0

*) Average
Note: DGR = Daily growth ratio
FCR = Food conversion ratio

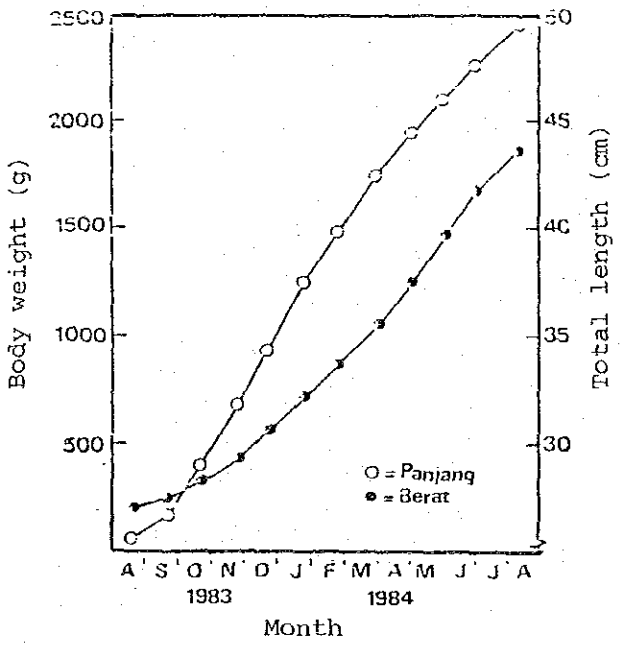


Fig. 42 Growth Curve of Giant Seaperch, L. calcarifer in group I

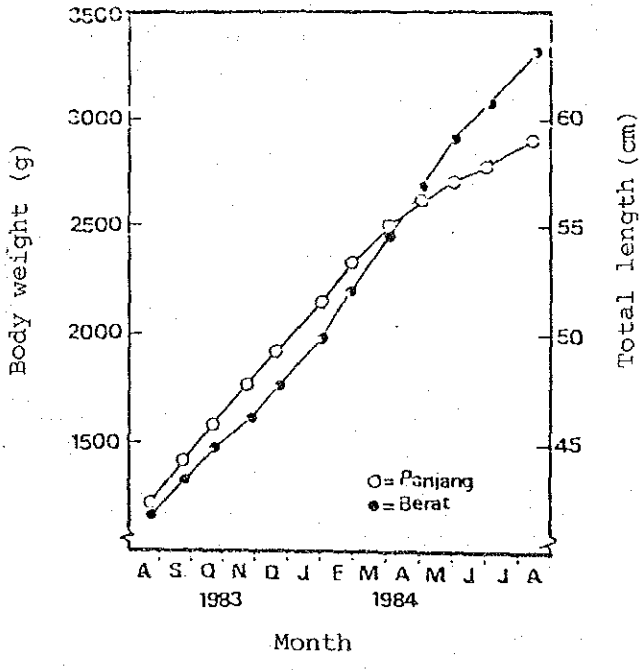


Fig. 43 Growth Curve of Giant Seaperch, L. calcarifer in group II

The rearing experiment of different feed in floating net cage was conducted from July to September 1983.

The fish collected from Lampung area were divided into four groups: I. 39 fish feeding with raw fish, II. 39 fish with tilapia meat, III. 39 fish with raw fish and commercial formulated diet for carp (protein 40%) and IV. 38 fish with commercial formulated diet (protein 40%). They were put into each of four 2 m x 2 m net cages. The daily feeding ratio was about 8% total body weight. The initial average body weight were 295.0 g, 287.1 g, 277.9 g and 298.4 g and at the end of experiment, 464.5 g, 453.5 g, 433.0 g and 365.5 g, in I, II, III, and IV group, respectively. (Table 11, and Fig. 44)

Table 11 Initial and Final Average Total Length and Average Body Weight of Giant Seaperch, L. calcarifer

Group	Period		No. of fish		A.T.L.(cm)		A.B.W.(g)	
	start	final	initial	final	initial	final	initial	final
I	1983 7.28	1983 9.26	39	39	26.9	31.2	295.0	464.5
II	"	"	39	39	26.5	31.0	287.1	453.5
III	"	"	39	39	25.9	31.1	277.9	433.0
IV	"	"	38	24	26.8	29.1	298.4	365.5

The rearing experiment on different feed in juvenile stage was conducted from August 1 to 31, 1983.

The fries transported from Thailand were used for this experiment. They were divided into four groups: I. 20 fish feeding with commercial formulated diet for carp (protein 40%), II. 20 fish with green mussel meat, III. 20 fish raw fish and commercial formulated diet for carp (protein 40%) and IV. 20 fish with raw fish. They were put into each of four 100-l aquaria. The initial average body weight were 0.55 g and at the end of experiment, 0.845 g, 1.201 g, 3.439 g and 5.995 g in I, II, III and IV group respectively. (Photo 49, Table 12, and Fig. 45)

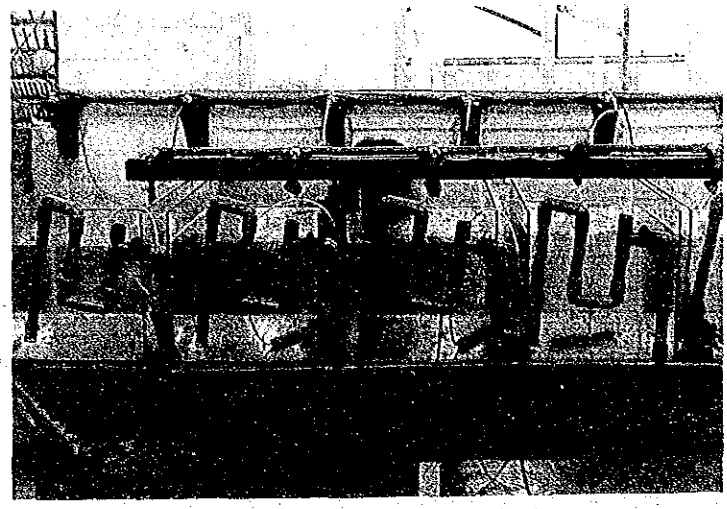


Photo 49 Experimental Aquarium

Table 12 Data on the experiment of different feed in the juvenile stage of Lates calcarifer.

Group	No.of fish		A.B.W.(g)		Feed	Conversion	Period
	Start	End	Start	End	efficiency	factor(wet)	
I	20	19	0.55	0.845	11.9	8.4	30 days
II	20	14	0.55	1.201	4.87	5.7	30 days
III	20	20	0.55	3.439	15.88	1.75	30 days
IV	20	20	0.55	5.995	21.76	1.28	30 days

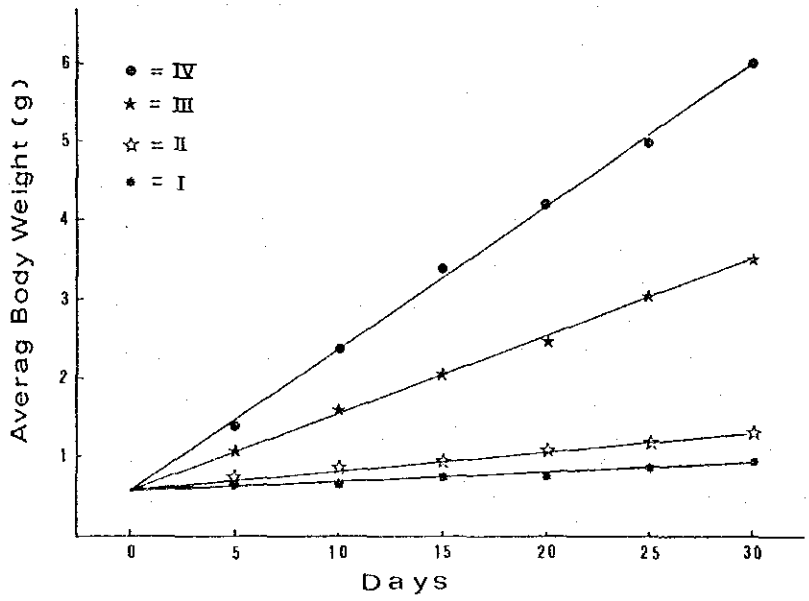


Fig. 45 Growth Curve of Lates calcarifer in Different Feeds

The experiment on optimum feeding ratio in juvenile stage was conducted from September 1 to 22, 1983.

The fries transported from Thailand were used for this experiment. They were divided into five groups: I. 30 fish with 20% feeding ratio, II. 30 fish with 30% feeding ratio, III. 30 fish with 40% feeding ratio, IV. 30 fish with 50% feeding ratio and V. 30 fish with 60% feeding ratio.

They were put into each of five 500-l polycarbonate tanks. The initial body weight were 2.66 g and at the end of the experiment, 7.45 g, 9.23 g, 10.56 g, 10.70 g and 10.20 g in I, II, III, IV and V group, respectively. (Table 13).

Table 13 Data on the Experiment on Optimum Feeding Ratio in the Juvenile Stage of Lates calcarifer

Feeding ratio	No. of fish		A.T.L. (cm)		A.B.W. (g)	
	Start	End	Start	End	Start	End
20	30	30	5.92	8.30	2.66	7.45
30	30	30	5.92	8.94	2.66	9.23
40	30	30	5.92	9.29	2.66	10.56
50	30	30	5.92	9.32	2.66	10.70
60	30	30	5.92	8.84	2.66	10.20

Transportation experiment of giant seaperch fry from Thailand to Indonesia was conducted June 19 to 21, 1983. 2,300 fry with 0.646 cm in average total length were transported by packing in plastic bag with oxygen, from National Institute of Coastal Aquaculture, Songkhla, Thailand, to Bojonegara Experimental Station, West Java, Indonesia (Photo 50 - 53). Before transportation, those fries were acclimated to fresh water at N.I.C.A., Songkhla. The survival rate at arrival in Bojonegara Experimental Station was about 98% and the time required for this transporation was about 38 hours.

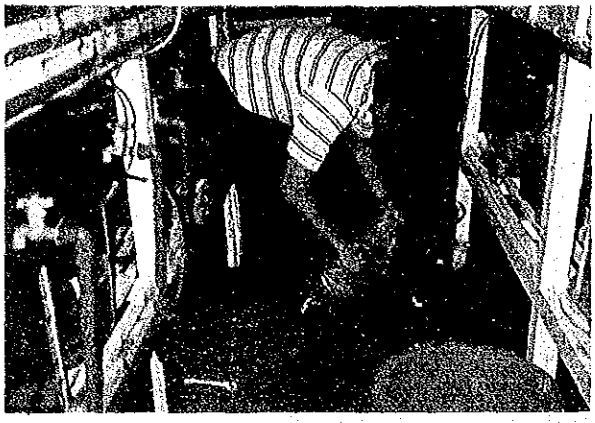


Photo 50 Packing of Giant Seaperch Fry

Photo 52 Resting the Fry in a Way of Transportation

Photo 51 Put Oxygen

Photo 53 Fries after Transportation

The rearing experiment of giant seaperch fries transported from Thailand was conducted from June to September 1983. Before starting experiment, they were acclimated from fresh water to sea water. At that time, survival rate was 100% even though fries were transferred directly from fresh water to sea water. About 2,300 fries were reared in 1 ton polycarbonate tank after acclimation to seawater.

They were fed with Artemia, Copepoda and fish meat. At the end of experiment, 533 fish with about 9.5 g in average body weight were survived and survival rate during this experiment was 23.2%. And maximum size and minimum size were 16.3 cm in total length and 53.07 g in body weight, and 5.4 cm in total length and 1.95 g in body weight, respectively. During the experiment, size selection was carefully conducted to prevent cannibalism. (Table 14 and Photo 54).

Photo 54 Giant Seaperch Fry, 21 Days after Hatching

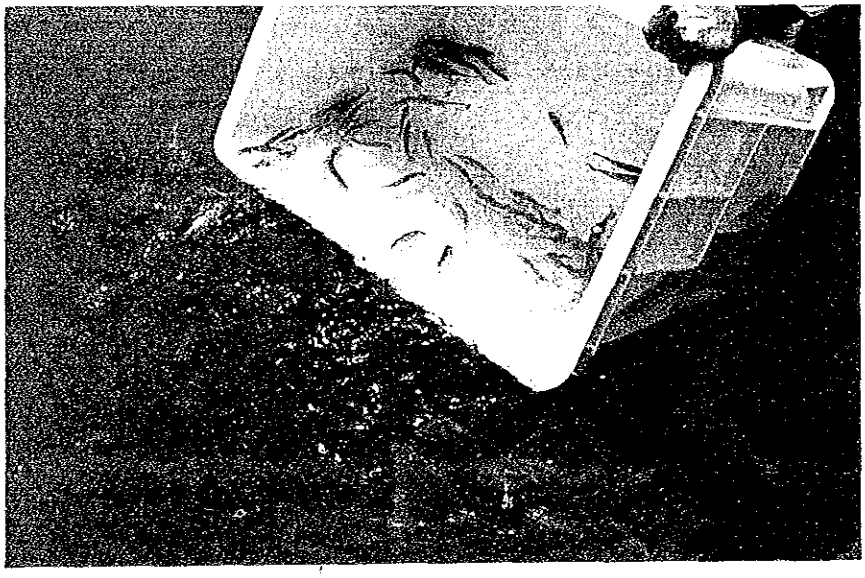


Photo 55 Juvenile Released into Floating Net Cag

Table 14 Data on the Rearing Experiment of Lates calcarifer Fry

Date	No. of fish	Survival rate(%)	A.T.L.(cm)	A.B.W.(g)	Days after hatching	Note
1983						
Jun. 19	2,300		0.646			
21	1,720	74.8	0.990		25	
Jul. 4	1,512	65.7	1,378		32	
11	1,442	62.7	1,767		39	Divided 2 groups
16	1,150	50.0	1,932	0.113	44	
21	850	37.0	2,175	0.158	49	
Aug. 1	623	27.1	2.887	0.346	60	Divided 3 groups
16	603	26.2	4.525	1.448	75	
31	593	25.8	5.012	2.318	90	
Sep. 9	570	24.8	6.241	3.927	99	
22	533	23.2	8.474	9.495	112	

The rearing experiment on giant seaperch transported from Thailand in floating net cage was conducted from October 1983 to April 1984. The juveniles with about 10 g in average body weight were transferred to floating net cage from October to December 1983. (Photo 55). They were divided into three groups depending on size, and put into two net cages of 3 m x 3 m and one net cage of 2 m x 2 m. At the end of experiment 86 fish with 148.2 g in average body weight, 124 fish with 363.8 g in average body weight and 165 fish with 661.5 g in average body weight survived in 2 m x 2 m, 3 m x 3 m and 3 m x 3 m net cage, respectively. The survival rate during the period from June 1983 to April 1984 was 16.3% (Table 15, and Fig. 46).

Table 15 Data on the Rearing Experiment of Lates calcarifer

Date	No. of fish	Survival rate(%)	A.T.L.(cm)	A.B.W.(g)	Days after hatching
1983					
Oct. 10	469	20.39	10.422	16.194	130
Nov. 16	444	19.30	14.969	48.745	167
30	437	19.00	16.896	67.705	181
Dec. 10	435	18.91	78.857	78.530	191
Feb. 2	384	16.70	24.791	208.272	245
Apr. 23	375	16.30	31.500	445.300	325

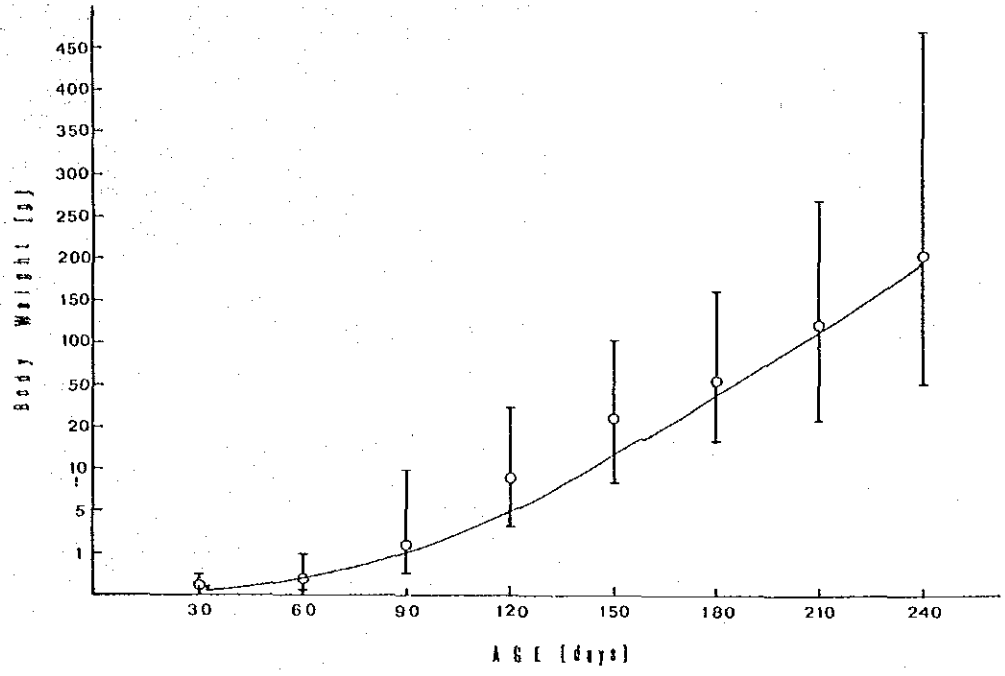


Fig. 46 Growth Curve of Giant Seaperch Transported from Thailand

(3) Experiment of Seed Production

The experiment of Induced spawning of giant seaperch have been repeatedly conducted until now. 49 adult fish, that is, 20 fish with 6 to 12 kg in body weight and 29 fish with 4 to 6 kg in body weight are being raised as spawners. Nine of them with 7 to 12 kg in body weight are being raised in 125 m^3 concrete tank (Photo 56), fed with high protein and low fat diet and another 40 fish are being raised in floating net cages.

The hormon injections have been repeatedly tried to several adults by using pituitary gland of silver carp and gonadotropine. However, fertilized eggs could not be obtained yet, while one female was matured by hormon injections and a few males released semen. (Photo 57 - 59).

3) Consideration

There are 8 species of giant seaperch in the world, mostly in tropical area. Three species, identified as Lates calcarifer, Lates japonicus and L. cavifrons, inhabit in the brackish or sea water area (Fig. 47). Giant seaperch collected from South Sumatera is identified as Lates calcarifer. From the result of research survey on this species,

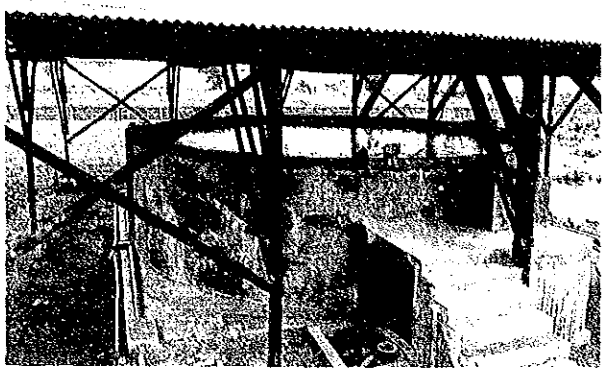


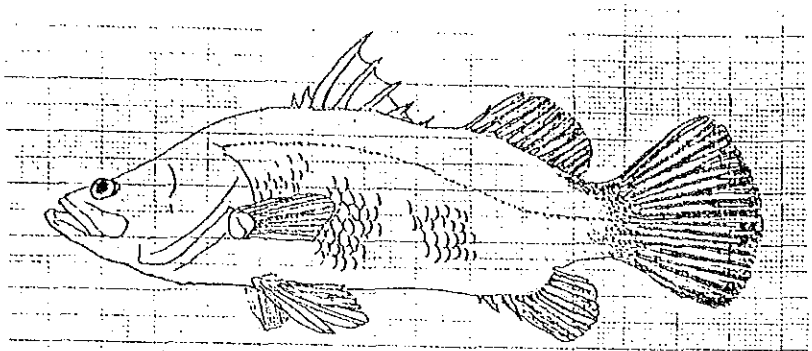
Photo 56 125 m^3 Tank

Photo 57 Preparation of Hormone Injection

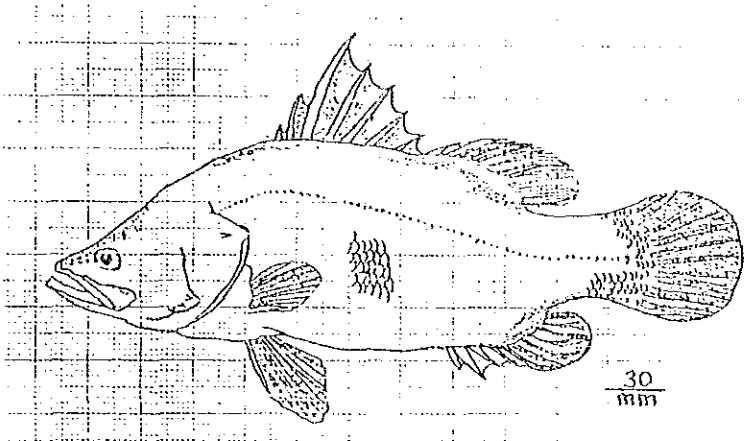
Photo 58 Giant Seaperch Adults for Hormone Injection

Photo 59 Hormone Injection

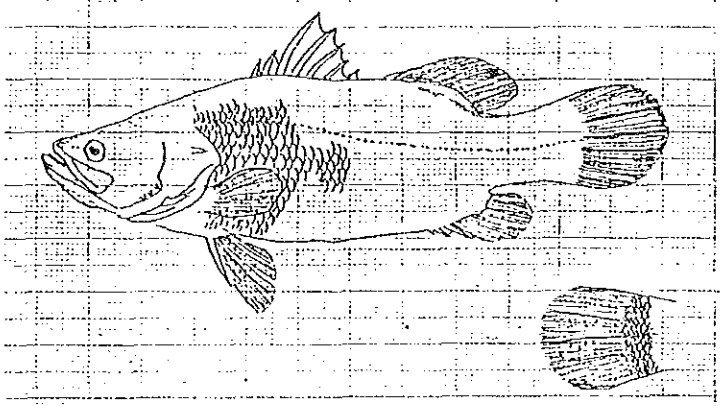
the spawning period seems to be from September to February rainy season, and period for collecting seed seems to be from February to June. The research survey on the spawning season and spawning ground of giant seaperch in South Sumatera area seems to play an important role to develop giant seaperch culture in Indonesia. From the above reasons, various culture experiments on this species collected from South Sumatera area were conducted in project. And also the transporation experiment of fry from Thailand to Indonesia was conducted. In those experiments, the seeds with about 200 g body weight, collected by this research survey, were reared into the adult fish with 3 to 5 kg in body weight, and also the fries with 0.646 cm in total length transported from Thailand were reared into the adult fish with 2 to 4 kg in body weight, with a good growth ratio and strong resistant to diseases. From the results of those experiments, many valuable basic knowledge on mariculture were obtained. The cultured fish in Bojonegara Experimental Station were highly evaluated in a taste by the party concerned because cultured fish is rather fatty than natural one.



Lates calcarifea, way sekampung, East Coest. South Sumatra, Indonesia
by Mariculture Research Development Proyect (ATA-192)
Hiroki Eda & Ketut Sugama, May, 1984.
319 mm, in total length



Lates japonicus sp nov. holotype NSMT-P 21751, 269 mm SL.
Urado Bay, Kochi, Japan
Japanese-Journal of Ichthyology vol 30, No 4, 1984
Lates japonicus a new centropomid Fish from Japan
Masao Katayama and Yasuhiko Taki. Page 365



Lates cavitrons ALLEYNE & MACLEAY from Australia
(A) 6557.346 mm in total length) : (B) right side of
caudal of the same specimen as shown in (A)
Note the difference between the two sides in the
number of Lateral lines of caudal fin (tiroe as
against two).

Page 47. Notes on Some Japanese and Australian
Fishes of the Family Contropomidae.
Masao Katayama, Tokiharu Abe and Tri-Thue Nguyen.

Fig. 47 Three Species of Giant Seaperch Lates calcarifer, L. janonicus and

Therefore, the giant seaperch culture is considered to be one of promising industry in Indonesia. As a future theme, the ecological investigation should be conducted in wide area, and spawner, young and fry should be obtained in a certain amount.

Further, cheap and fresh trash fish should be obtained for the mariculture industry and also suitable formulated diet for this species should be developed. Fish pen culture, pond culture and floating net cage culture are suitable as the method of mariculture industry in Indonesia.

3-3-3 Snappers

Snappers are deemed a promising species from the viewpoint of resources as well as commercial business. At present, comparing with other useful species, the value in use and evaluation in the market are regarded rather low, so it will be necessary for the people engaged in fisheries to make efforts to propaganda and let other people recognize the excellence of the meat and way of use.

We have conducted the fundamental experiments on more than 4 species, Lutjanus altifrontalis, L. johni, L. monostigma and L. argentimaculatus, etc., studying the profits and problems when those species are cultured, from the stand point of mariculture.

Since it was ascertained that fry or juvenile of snappers were distributing in Banten Bay, we at first tried any possible way to collect various kinds of species and then conducted the experiment in order to select a promising mariculture species.

We finally selected 3 species, Lutjanus altifrontalis, L. johni and L. argentimaculatus as mariculture species in Indonesia.

1) Collection of natural seed

A small number of fry of snappers, mainly Lutjauna altifrontalis, can be collected in Banten Bay from January to May.

Seine net "Bondet" and light fishing are used as the methods of fry collection. Juvenile and young are collected only by line fishing method in the are of the mouth of Banten Bay.

2) Result of experiment

(1) Research Survey

Research survey on collection of natural seeds of some snappers was conducted from April to July and from October to December 1983. The location of collection was around Pamojang Besar Island, with a depth of 5 to 7 m among sandy bottoms or beside "Bagan" around the island. Another location was around Pamojang kecil Island (Fig. 42). The collection was done usually in the morning by hand line method. The fishes kept right away in a fish tank of boat after fishing and transferred to the raft at the Bojonegara Experimental Station, where their weight and length were measured and then they were stocked in floating net cages.

In first survey, 205 fish of L. johni with 135 g in average body weight, 185 fish of L. altifrontalis with 85 g in average body weight, 31 fish L. monostigma with 55 g in average body weight and 154 fish of Lethrinus lentjan with 55 g in average body weight were collected.

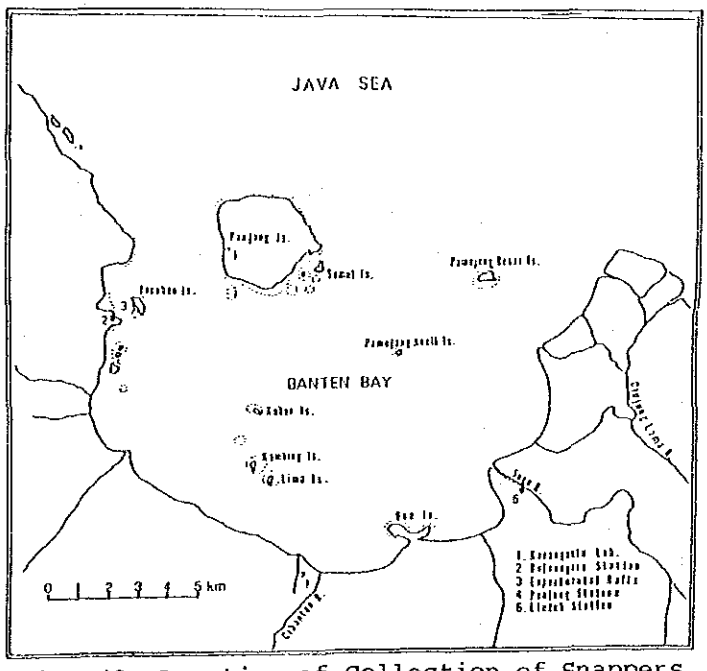


Fig. 48 Location of Collection of Snappers

In the second survey, 420 fish of L. johni with 192 g in average body weight and 228 fish of L. altifrontalis with 112 g in average body weight were collected. (Table 16 and 17, and Fig. 49).

Table 16 Results of Experimental Capture of Snappers Seeds Around the Pamojang Besar island in Banten Bay

Period	1st survey			2nd survey			Total	
	April-July 1983 (16 days)			Oct.-Dec. 1983 (10 days)			26 days	
Species	No.of fish (%)	TBW*2 (kg)	MBW*3 (grs)	No.of fish (%)	TBW (kg)	MBW (grs)	No.	TBW (kg)
Lutjanidae								
Lutjanus johni	205	27.68	135	420	80.64	192	625	108.32
L. alti-frontalis	185	15.63	85	228	25.54	112	413	41.17
L. mono-stigma	31	1.71	55				31	1.71
L. argenti-maculatus	0			1	0.23	225	1	0.23
Lethriaidne								
Lethrinus lentjan	154	8.49	55				154	8.49
Total	575	53.51		649	106.41		1224	159.92

Note: *1: Fishing days
*2: Total body weight
*3: Mean body weight

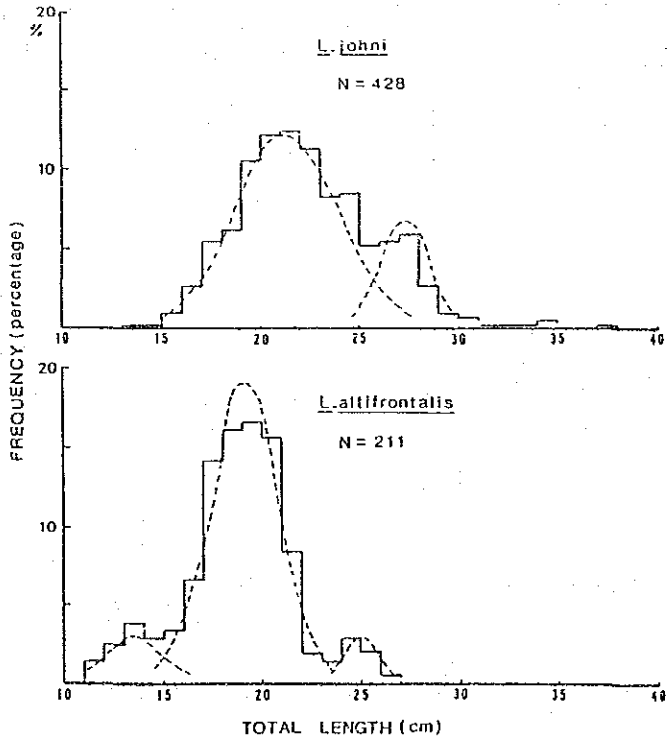


Fig. 49 Size Frequency Distribution of L. Johni and L. altifrontalis caught during the 2nd Experiment

Table 17 Length-weigtht Relationship of L. Johni and L. altifrontalis from Banten Bay

Species	L*1-W*2 relationship	Correlation coefficient	No. of samples	Range in total length of samples (cm)
Lutjanus johni	$W = 1.7236 \times 10^{-2}.L^{2.9506}$	r = 0.968	n = 236	13.2 - 29.5
L. alti-frontalis	$W = 2.1163 \times 10^{-2}.L^{2.8937}$	r = 0.987	n = 121	12.2 - 26.4

Note: *1: Total length (cm)
*2: Body weight (grs)

(2) Culture experiment

The rearing experiment on L. johni in the floating net cage was conducted from July 1983 to May 1984. Ninety eight of fished with 21.1 cm in average total length (145.0 g average body weight) were used in this experiment. The fishes were cultured on the net-cage 3 x 3 x 3 m, and were fed twice a day with Sardinella spp. until obtaining satiation.

The result showed that the fish grew until 1128.0 g in average body weight within 225 days. The daily growth rate(DGR) was found to be 0.69% B.W. The relationships between body weight (BW) and DGR was $Y = 3.95\ X^{0.84}$ and that between BW and daily feeding rate was $Y = 21.67\ X^{-2.49}$. Food conversion ratio was 6.7 and mortality 7%. (Table 18,and Fig. 50).

Table 18 Daily Growth Ratio, Daily Feeding Ratio, Food Conversion Ratio and Mortality of Golden Snapper, Lutjanus johni cultured in Floating Net-cage

Observation period (Date/month)	No.of fish (ind.)		ABW (gr)		Feed kg	DFR (%)	DGR (%)	FCR	(%)
	Start	End	Start	End					
10/07-30/08 '83	98	92	145.0	206.2	42.0	8.4	1.16	8.8	6
10/08-26/09	92	91	206.2	306.0	53.4	8.1	1.39	6.0	1
16/09-27/10	91	49	306.0	472.0	57.0	6.8	1.38	5.5	46
17/10-28/11	49	49	472.0	601.3	54.0	6.4	0.75	8.6	0
18/11-27/12	49	49	601.3	752.8	58.8	6.1	0.77	7.9	0
/12-01/02 '84	49	49	752.8	915.0	63.0	4.4	0.56	7.9	0
/02-12.03	49	49	915.0	1128.0	81.4	4.1	0.52	7.8	0
/07/83-12/03/84	98	49	145.0	1128.0	409.6	3.8	0.69	6.7	7

Escape clash by boat

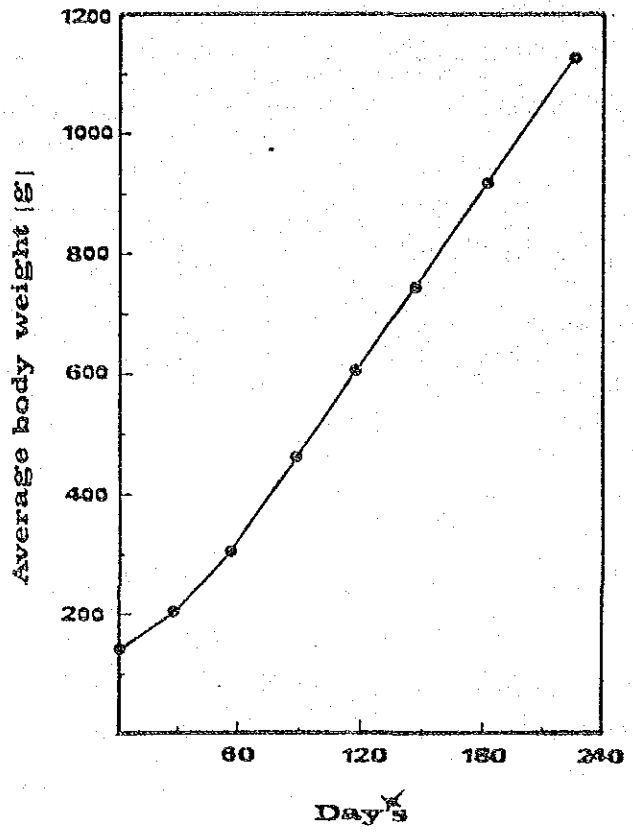


Fig. 50 Growth Curve of Golden snapper, Lutjanus johni cultured in floating net-cage

The rearing experiment on the growth of high-frontal red snapper, L. altifrontalis, cultured in floating net-cage was carried out at Bojonegara Experimental Station from July, 1983 to March, 1984. The aim of this study is to get candidate species for mariculture.

One hundred and eight of fishes of 22.3 cm A.T.L. and 199.9 g A.B.W. were used in this experiment. (Photo 60).

The results showed that fish grew until 893.5 g A.B.W. within 225 days of culture. The daily drowth ratio was found as 0.56%. Food conversion ratio was found as 9.8 and the mortality was relatively small (3.7%). (Table 19, and Fig. 51).

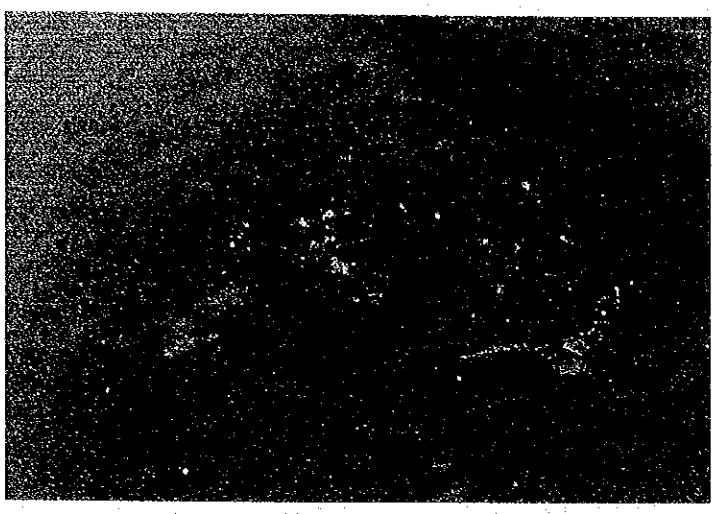


Photo 60 Feeding of L. altifrontalis

Table 19 Calculation on Daily Growth Ratio, Daily Feeding Ratio, Food Conversion Ratio and Mortality of Hight Frontal Red Snapper Lutjanus altifrontalis during Experiment

Observation period (Date/month)	No.of fish (ind.)		ABW (gr)		Feed (kg)	DFR (%)	DGR (%)	FCR	(%)
	Start	End	Start	End					
83. 30/7-30/8	108	104	199.9	289.8	60.2	7.5	1.18	7.8	3.7
31/8-28/9	104	104	289.8	352.3	67.5	7.0	0.67	10.4	0
29/9-27/10	104	104	352.3	480.0	84.6	6.6	1.06	6.2	0
28/10-28/11	104	104	480.0	539.5	97.8	5.8	0.36	15.8	0
29/11-27/12	104	104	539.5	634.0	100.2	5.6	0.56	10.2	1.7*
83. 28/12-1/2.84	102	102	634.0	787.0	132.0	5.2	0.62	8.5	0
2/2-12/3	102	102	787.0	893.5	142.0	4.1	0.32	13.1	0
30/7.83-12/3.84	108	102	199.9	893.5	683.3	5.3	0.56	9.8	3.7

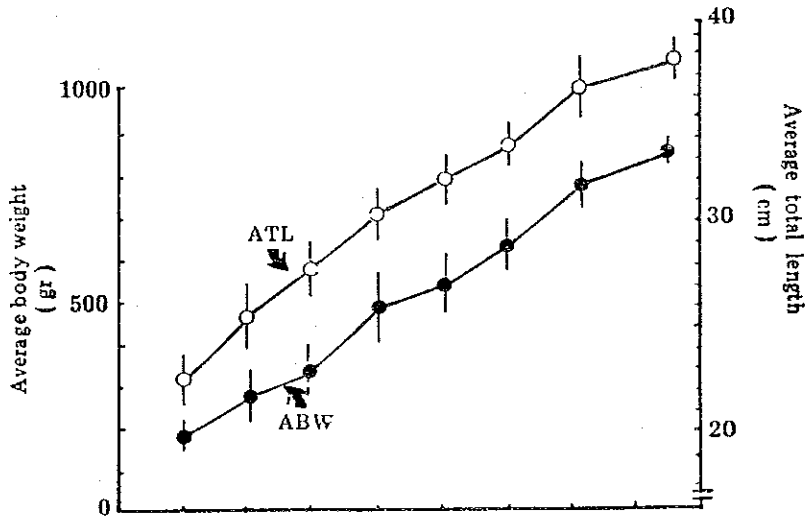


Fig. 51 Growth Curve of Hight-frontal Red Snapper (Lutjanus altifrontalis) Cultured in Floating Net-cage

The experiment on effect of commercial formulated diet for carp (protein 40%) on the growth of L. altifontalis was conducted from May to August 1985. L. altifrontalis fry with an average body weight 11.05 g and average total length 8.4 cm were cultured in two floating net-cages (1.0 x 1.0 x 1.5 m) at a rate of 102 fish/cage. In cage I, the fishes were fed moisture pellet and cage II, were fed chopped raw trash fish. The fishes were fed twice in a day at a rate of 10-11% total body weight/day. The result of this study showed that the fishes fed with moisture pellet grew slower than fed with chopped raw trash fish and were statistically significant different (p 0.05). (Table 20, and Fig. 52 and 53).

Table 20 Weight Gain, Net Yield, Food Conversion Ratio and Mortality of Red Snapper, Lutjanus altifrontalis with Different Diet

Item	Diet	
	Moisture pellet	Row fish chopped
Weight gain(g)	50.76	90.71
Net yield(kg/m^3)	4.25	8.66
Food conversion ratio	6.76	4.64
Mortality	14.71	11.74

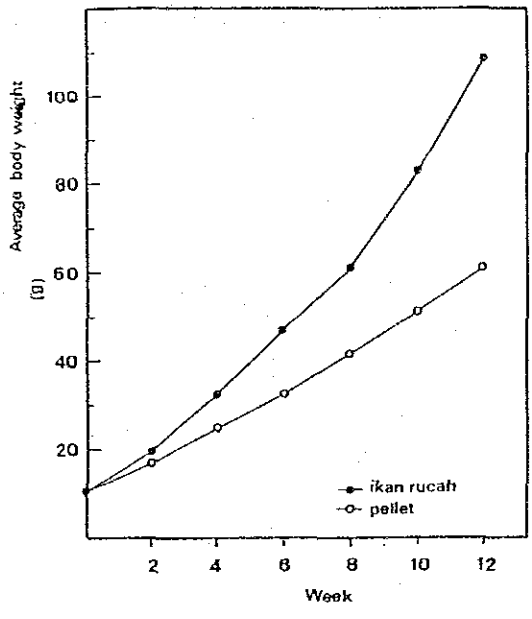


Fig. 52 Growth Curve in Different Feed

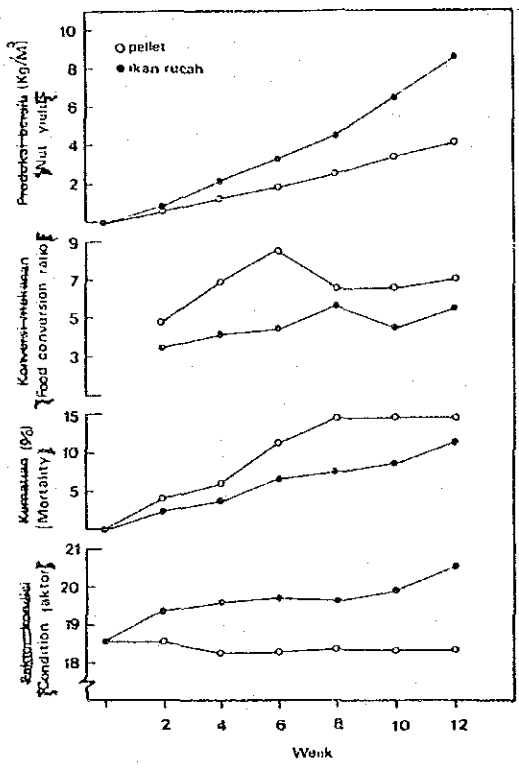


Fig. 53 Data on the Experiment

During the period of 1982 to 1984, the rearing experiment on L. monostigma, L. argentimaculatus and Lethrinus lentjan were conducted. The initial average body weight of these 3 species were 114 g, 15.5 g and 55.2 g, respectively, and at the end of experiment, 199 g after 7 months, 71.3 g after 2 months and 161 g after 10 months rearing period (Table 21).

Table 21 Data on the Rearing Experiment

Species	No. of fish		A.B.W. (g)		Weight increment (g)	Period (month)
	Start	End	Start	End		
L. monostigma	17	9	114	119	85	7
L. argentimaculatus	11	11	15.5	71.3	55.8	2
Lethrinus lentjan	44	38	55.2	161	105.8	10

3) Consideration

Among snappers, L. johni grew best, and L. agrifrontalis and L. argnetimaculatus followed (Gig. 54). Though the market value of these snappers in Indonesia is low, it seems their value will be improved by means of the contrivances in processing or cooking. (Photo.61)

Throughout the year, the stagnation period of these 3 snappers were not observed. These snappers are resistant against diseases, hence it seems to be suitable species for mariculture industry.

3-3-4 Groupers

Groupers are highly evaluated in some markets in indonesia and other tropical countries. Therefore, we conducted research survey, collection and culture experiment of groupers distributed in Banten Bay area.

We made a periodical survey once or twice a year, at availing the research vessel to purchase adult and young fish and also we conducted the transport experiment at the same time.

Concerning the collected groupers, more than 4 species, Epinephelus tauvina, E. fuscoguttatus, E. merra, E. summana, etc., various culture experiment were conducted in Bojonegara experimental station and Epinephelus tauvina was selected for mariculture species.

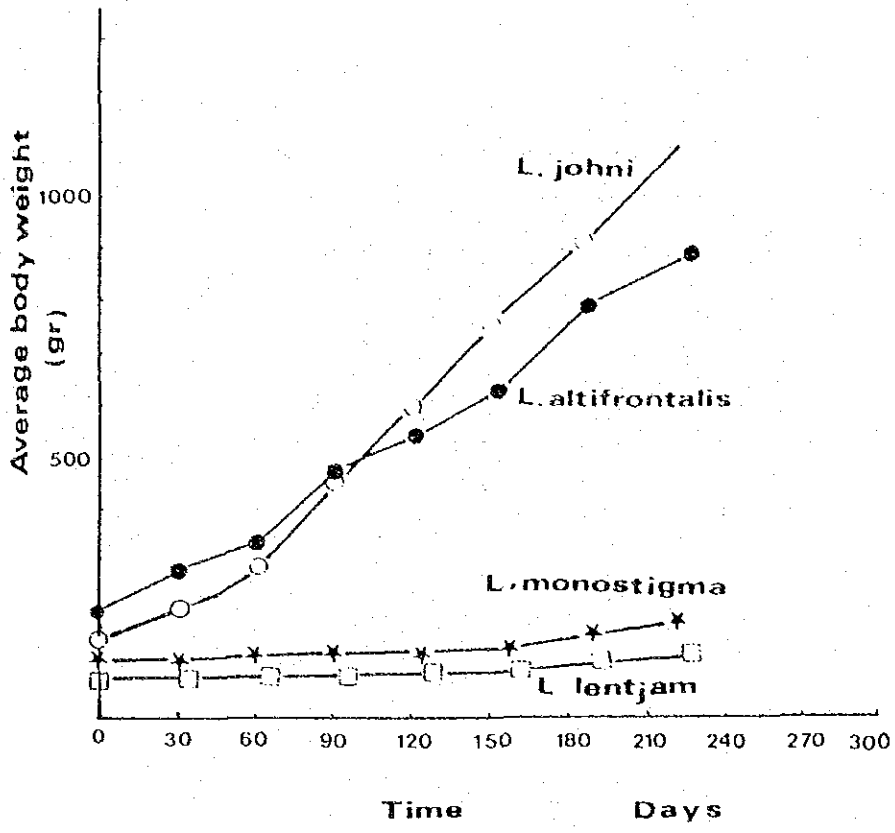


Fig. 54 Growth Curve of Snapper (Lutjanus spp)

Photo 61 Cultured Snapper, L. johni, of Marketable Size

1) Collection of natural seed

A large number of fry and juvenile of grouper, maily Ephinephelus tauvina, was collected firstly in 1985 in Banten Bay, especially in the area of Zostrea zone, from January to May

Seine net "Bondet" and scoop "Sudu" (Fig. 55) are used as the methods of fry or juvenile collection. Size of fry and juvenile are about 2 to 3 cm and 5 to 10 cm in total length, respectively.

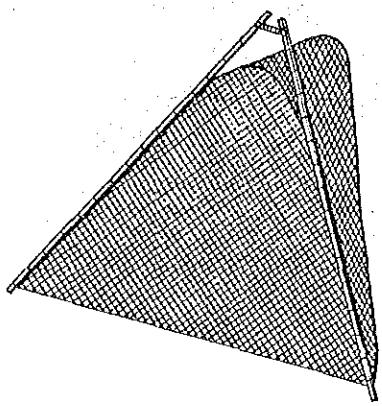


Fig. 55 Scoop Net (Suda)

2) *Result of experiment*

(1) Research survey of groupers

Research survey on collection of natural seeds of some groupers was conducted from April to July and from October to December 1983.

The location of collection was around Pamojang Besar Island and Pamojang Kecil Island with the depth of 5 to 7 m among sandy bottoms.

In first survey, 22 fish of Epinephelus tauvina with 249 g in average body weight and 31 fish of E. bleekeri with 191 g in average body weight were collected. In second survey, 44 fish of E. tauvina with 171 g in average body weight was collected (Table 22).

Table 22 Result of Experimental Capture of Groupers Seeds around the Pamojang Besar Island

Period / Species	1st survey April-July 1983 (16 days)			2nd survey Oct.-Dec. 1983 (10 days)			Total 26 days	
	No.of fish (%)	TBW*2 (kg)	MBW*3 (grs)	No.of fish (%)	TBW (kg)	MBW (grs)	No.	TBW (kg)
Serranidae Epinephelus tauvina	22	5.48	249	44	7.52	171	66	13.0
E. bleekeri	31	5.92	191				31	5.92
E. spp	6	1.15	191	3	0.23	78	9	1.38
Total	59	12.55		47	7.75		106	20.3

Note: *1: Fishing days
*2: Total body weight
*3: Mean body weight

Survey of Groupers, Epinephelus spp. fry in natural waters were carried out from January to May 1985. This survey was aimed to get information of fry season and species composition of groupers fry in Banten Bay.

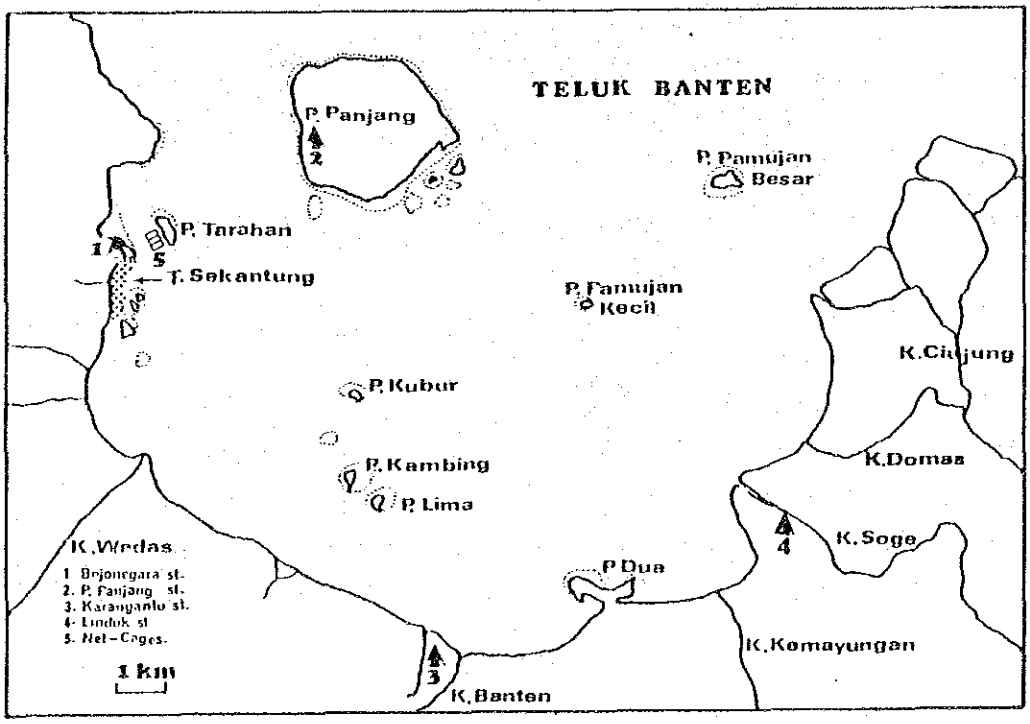


Fig. 56 Location of T. Sekantung Area when Groupers Seeds were Collected

Fries were caught once in a week, in shallow waters amongst the sea weed, Enhalus spp. by beach seine. Total number of groupers collected during this survey were 1,137 fish.

During this survey, the peak season of groupers fry was occurred from February to April 1985, E. tauvina is dominant species (67.6%), followed by E. morhua (19.7%) as a second species respectively. However, E. septemfasciatus (8.7%), E. merra (0.8%), E. bleekeri (0.4%), E. fuscoguttatus (0.1%), and Plectropoma spp. (2.6%) were caught in small numbers. (Table 23, and Fig. 56-60).

Table 23 Catch of Groupers Fries, Epinephelus spp. in Sekantung Inlet

Period	Total number after 5 times hauling sein net	Species(%)						
		A	B	C	D	E	F	G
2 Jan.	9	55.6	20.2	11.1	11.1	0	0	0
9 Jan.	15	73.3	20.0	6.7	0	0	0	0
16 Jan.	11	72.7	18.2	0	0	9.0	0	0
23 Jan.	26	84.6	15.4	0	0	0	0	0
30 Jan.	13	86.7	13.3	0	0	0	0	0
6 Feb.	134	82.1	14.2	2.9	1.0	0	0	0
13 Feb.	129	78.3	18.8	8.9	0	0	0	0
20 Feb.	108	53.7	18.5	8.3	0	0	0	19.4
27 Feb.	109	69.7	21.0	5.5	0	0	1.0	2.8
6 Mar.	111	72.0	14.4	9.9	0	2.0	0	2.0
13 Mar.	137	77.4	14.6	5.8	0	0	0	2.2
20 Mar.	117	59.8	23.0	11.1	0	0.1	0	5.0
27 Mar.	173	59.5	23.7	13.3	0	0	0.1	2.9
4 Apr.	150	75.3	16.6	6.7	0	1.4	0	0
11 Apr.	115	72.2	20.0	6.9	1.0	1.0	0	0
18 Apr.	97	56.7	31.9	11.3	0	0	0	0
25 Apr.	80	56.3	25.0	16.3	2.5	0	0	0
2 May.	81	50.6	28.4	11.1	7.4	0	0	2.5
9 May.	31	54.8	29.0	12.9	3.2	0	0	0
29 May.	35	57.1	8.6	17.1	8.5	0	0	8.5
Total	1137	67.6	19.7	8.7	0.8	0.4	0.1	2.6

Species:
A = E. tauvina C = E. septemfasciatus E = E. bleekeri G = Plectropomas sp.
B = E. morhua D = E. merra F = E. fuscoguttatus

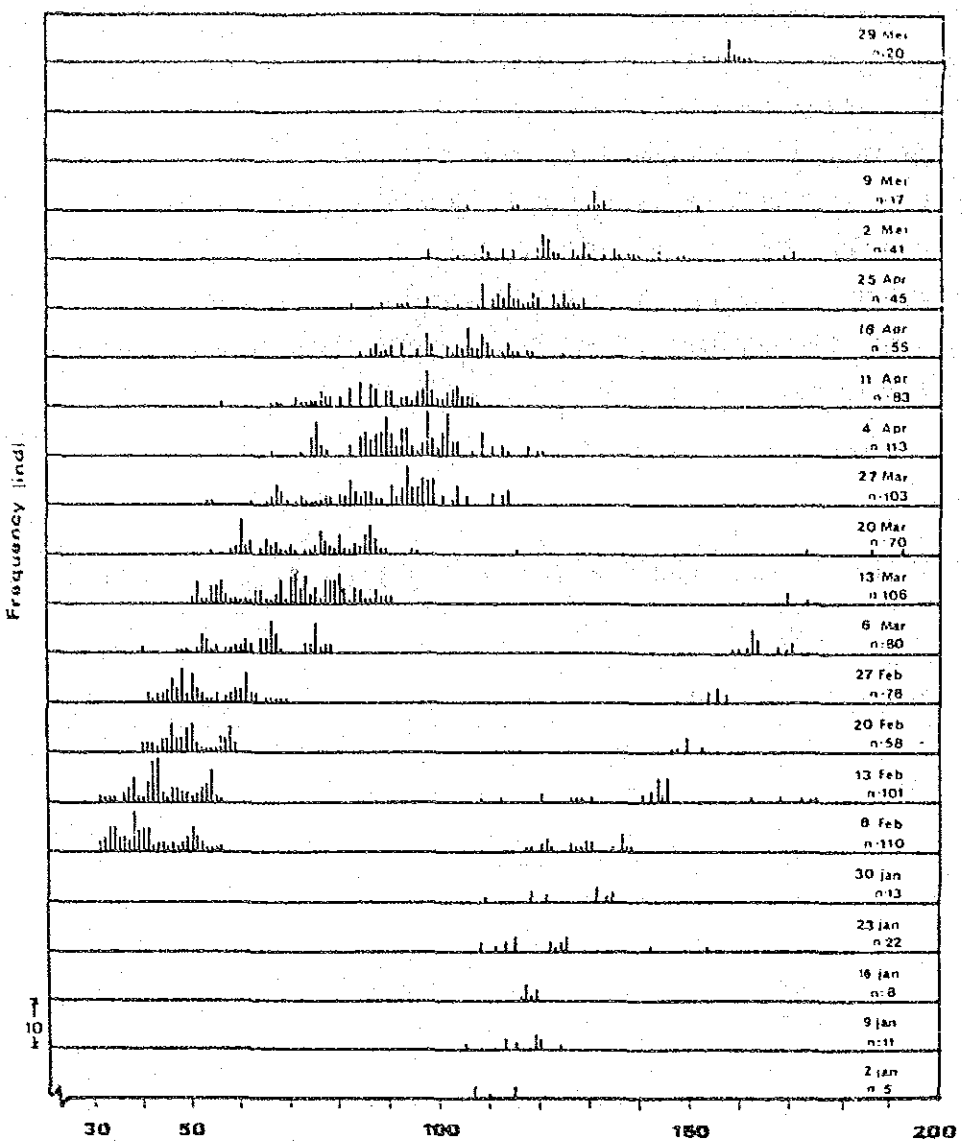


Fig. 57 Total Length Frequency of E. tauvina Collected in Sekantung Area

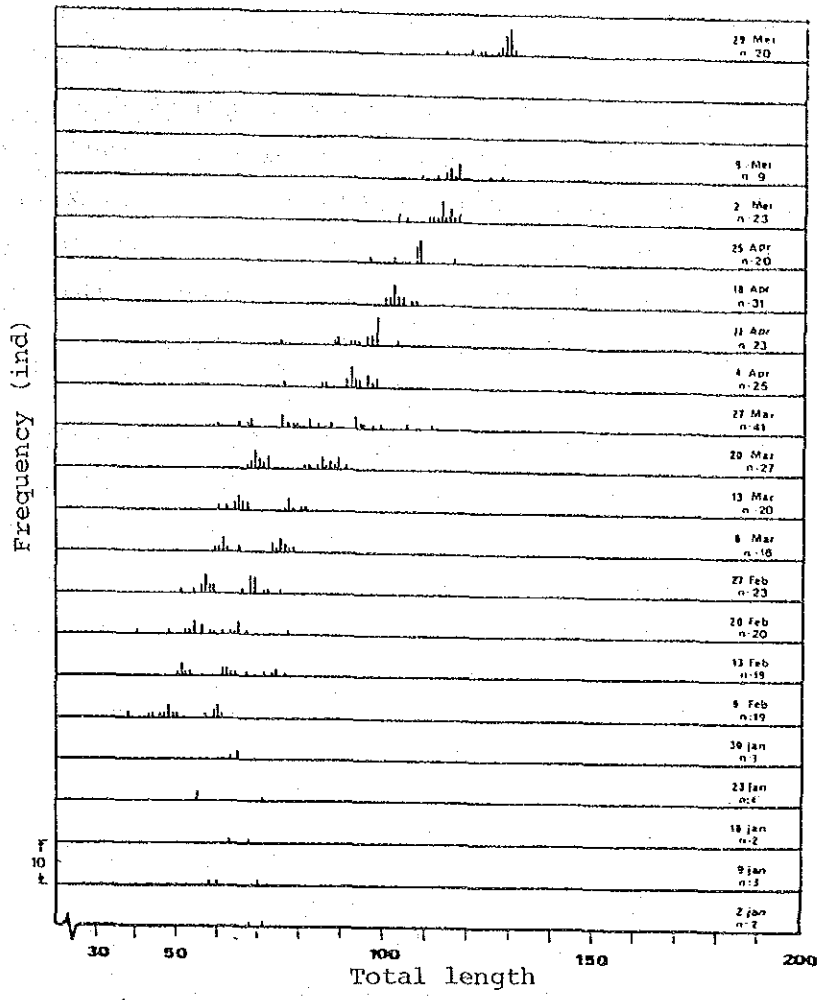


Fig. 58 Total Length Frequency of E. morhua Collected in Sekantung Area

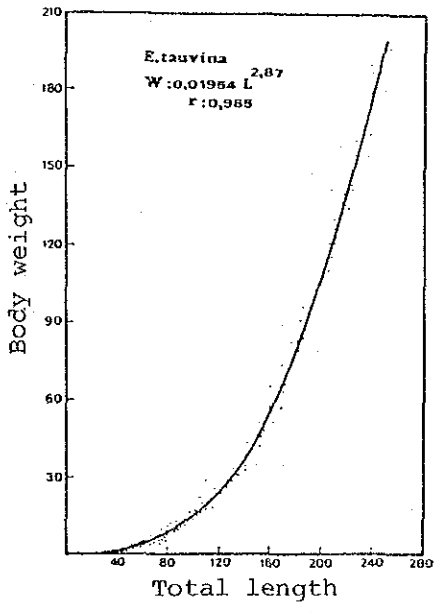


Fig. 59 Length-weight Relationship of E. tauvina from Banten Bay

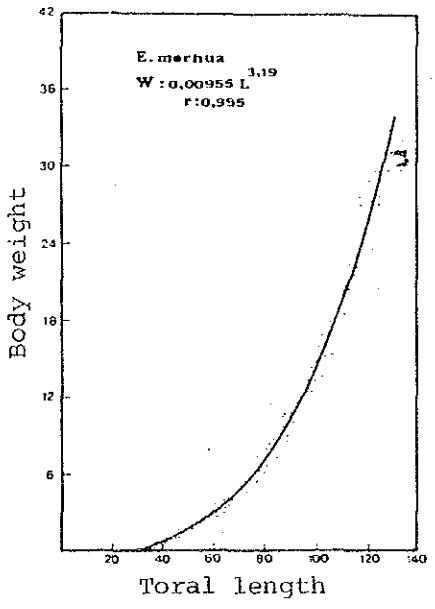


Fig. 60 Length-weight Relationship of E. morhua from Banten Bay

(2) Culture experiment

Experiment on the satiation of grouper, Epinephelus tauvina were conducted outdoors in 2 ton capacity tanks with continuous flowing filtered sea water. The experiment aimed to study satiation rate (SR) of grouper as a basic knowledge for practical culture. Eight groups of fish (103.4 - 822.7 g ABW) were used in this experiment. They were fet with miscellaneous trash fish (dominated by anchovy).

The information on the relationships between body weight (BW) and satiation rate (SR). BW and daily growth rate (DGR) are given (Fig. 61).

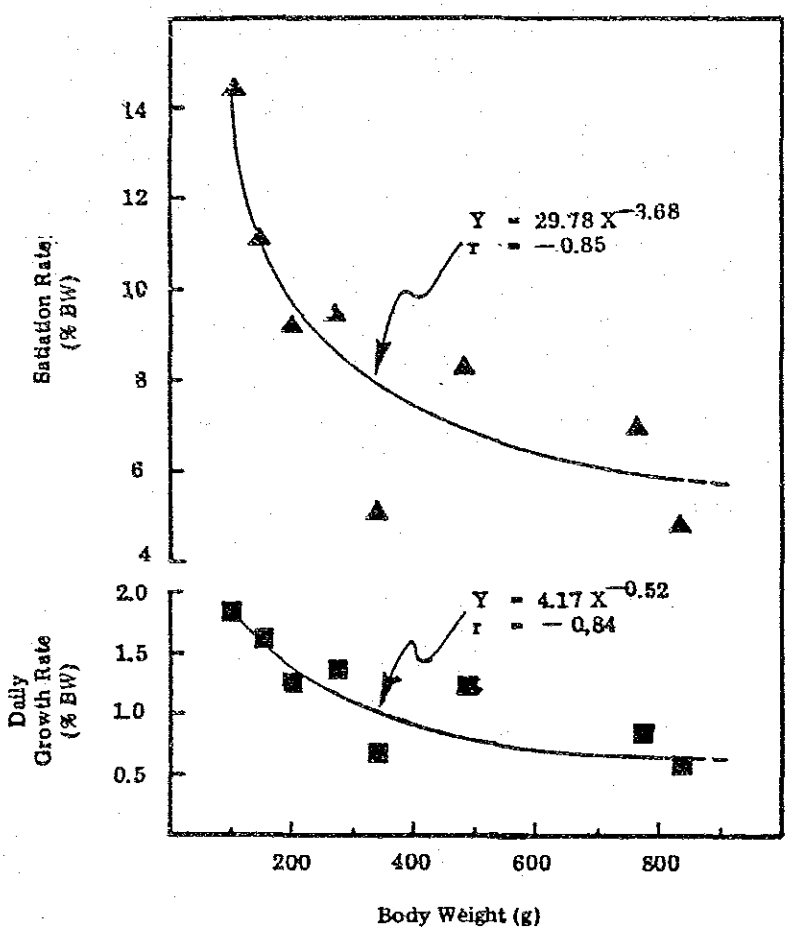


Fig. 61 Satiation Rate and Daily Growth Rate of Grouper Epinephelus tauvina (Forskal) fed on fresh micellaneous Fish

A preliminary study on rearing of grouper, Epinephelus tauvina (Forskal) in the net cages had been conducted at Bojonegara Experimental Station. The experiment aimed to study the daily growth rate and food conversion ratio. Four groups of fish were reared in net cages (2 x 2 x 2 m). They were fed daily with miscellaneous fish (dominated by anchovy).

The result showed that daily individual growth rate was 0.9, 0.9, 0.8 and 0.4% body weight (BW) for those cultured at initial BW of 129 g in net cage-1 (N-1), 195 g in N-2, 266 g in N-3 and 789 g in N-4, respectively. Food conversion ratio was 5.0, 7.7, 8.2 and 9.5 for those reared in N-1, N-2, N-3 and N-4 respectively. The ranges of water temperature and salinity were 24.0 - 27.2^{o}C and 30 - 33%, respectively. (Table 24, and Fig. 62 and 63).

Table 24 Data of the Grouper Epinephelus tauvina Cultured in the Floating Net-cages

Item	Unit	Net-cages			
		N-1	N-2	N-3	N-4
Period	(day)	70	112	70	98
Initial No. of fish	(ind)	53	39	26	16
Final No. of fish	(ind)	39	38	26	16
Mortality	(%)	26.4	2.6	0	0
Initial ABW	(g)	129	195	266	789
Final ABW	(g)	248	395	411	1,080
Initial Total BW	(g)	6,834	7,593	6,906	12,620
Final Total BW	(g)	13,034	15,319	10,686	17,288
Total Gained Weight	(g)	6,200	7,726	3,780	4,668
Daily Individual Gained Weight per fish	(g)	1.7	1.8	2.1	3.0
Daily Growth Rate	(%BW)	0.9	0.9	0.8	0.4
Total Food Consumed	(g)	30,750	59,490	31,180	44.120
Food Conversion Ratio		5.0	7.7	8.2	9.5

Notes: ind = individual, BW = body weight, ABW = average body weight

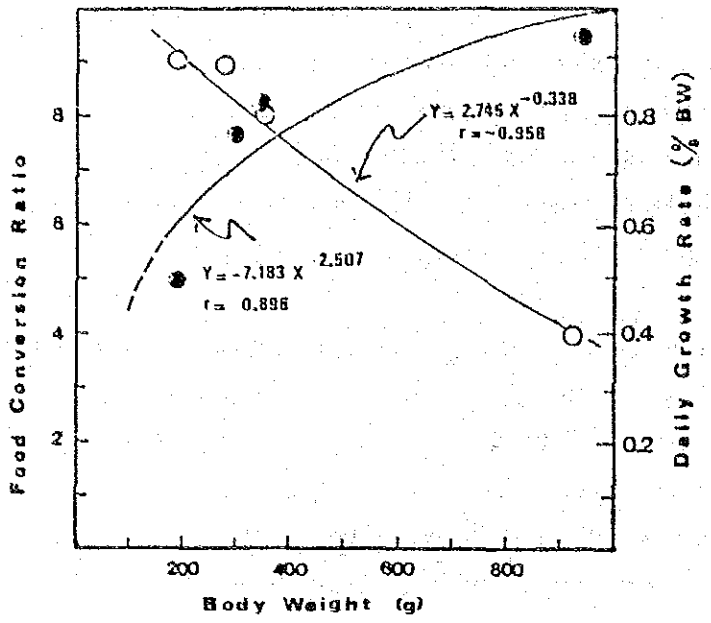


Fig. 62 Relationship between Body Weight and Food Conversion Ratio, Body Weight and Daily Growth Rate

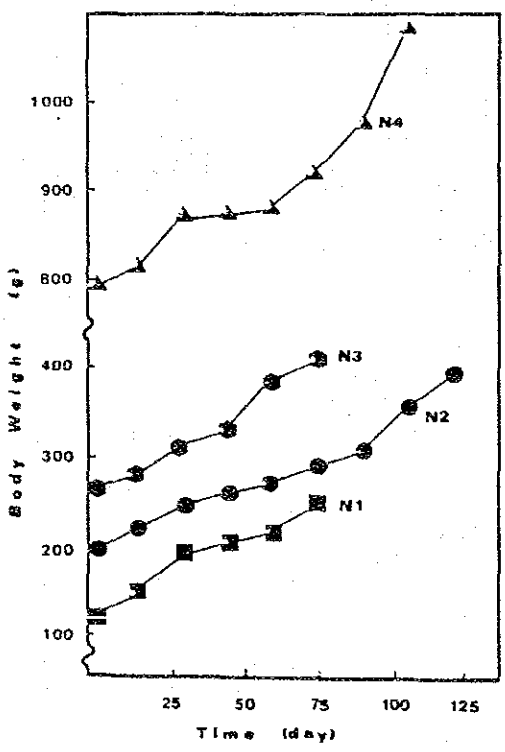


Fig. 63 The Growth (in term of average body weight) of Grouper, Epinephelus tauvina Culture in Floating Net Cages

Observation on the growth of some species of Groupers (E. tauvina, E. fuscoguttatus, E. bleekeri, E. merra and E. summana) were conducted in floating net-cages from January to November 1984. This study aimed to get candidates species for mariculture.

The fishes were cultured in floating net cage (2 x 2 x 2 m) and were fed twice in a day with Sardinella spp. Result of this study is shown in table 25 indicate that, estuary grouper, E. tauvina, grew faster and food conversion ratio lower than other species (Fig. 64).

Observation on growth of groupers Epinephelus tauvina and Epinephelus fuscoguttatus cultured in floating net cages was carried out at Bojonegara Experimental Station from July to September, 1982. The experiment was aimed to get information on the growth rate of these groupers.

Fifteen individuals of E. tauvina (865 g in A.B.W.) and 20 individuals of E. fuscoguttatus (867.5 g in A.B.W.) were used for the experiment.

The result showed that the daily individual growth of E. tauvina was 7.63 g (0.7% A.B.W.) and food conversion ratio was found as 7.05. The daily individual growth of E. fuscoguttatus was 3.5 g per day (0.36% A.B.W.) and food conversion ratio was found as 14. (Table 26, and Fig. 65).

Table 25 Growth Ratio and Food Conversion Ratio of Groupers, Epinephelus spp. Cultured in Floating Net-cage

Item	K-I E. tauvina	K-II E. tauvina	K-III E. fusco-guttatus	K-IV E. bleekeri	K-V E. merra	K-VI E. summana	K-VII E. summana
Period of observation	300	300	300	300	300	300	300
Initial No. of fish	14	29	22	38	16	19	23
Final No. of fish	14	29	22	31	16	16	22
Mortality	0	0	0	18.4	0	15.8	4.3
Initial ABW	730.0	110.3	655.5	129.1	515.8	468.2	170.7
Initial TBW	10220.0	3198,7	14421.0	4905.8	8240.0	8895.8	3926.1
Final ABW	2349.0	1619.2	1051.7	287.7	890.0	930.0	550.1
Final TBW	32886.0	46956.8	23137.4	8918.7	14240.0	14880.0	12102.2
Total Food Consumption	172.3	223.2	95.0	49.8	61.2	60.4	72.8
Daily Growth Ratio	0.35	0.58	0.15	0.25	0.18	0.22	0.35
Food Conversion Ratio	7.6	5.1	10.9	12.4	10.2	10.1	8.9

ABW = Average body weight, TBW = Total body weight

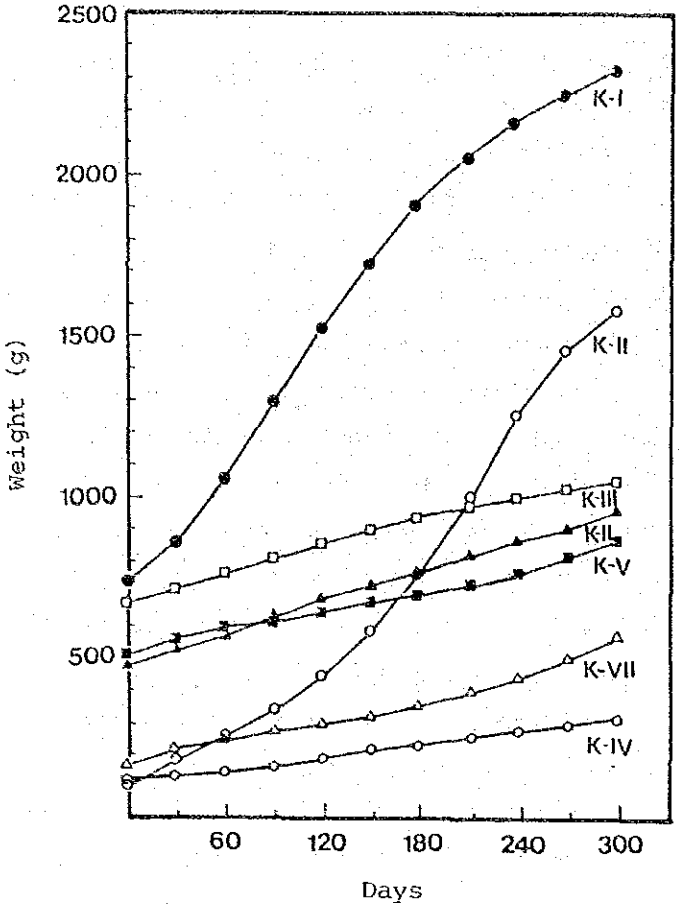


Fig. 64 Growth Curve of Groupers, Cultures in Floating Net Cage

Table 26 Data of Groupers E. tauvina and E. fuscoguttatus Cultured in Floating Net-cages

	Satuan	E. tauvina	E. fuscoguttatus
Period			
	(days)	60	60
Initial No. of fish	(number)	15	20
Final No. of fish	(number)	15	20
Mortality	(%)	0	0
Initial ABW	(g)	865	867.5
Final ABW	(g)	1322.7	1077.5
Daily Growth Per Fish	(g)	7.63	3.50
Daily Growth Ratio	(%)	0.70	0.36
Total Feeding	(g)	48400.00	58800.00
Food Conversion Ratio		7.05	14.00
Feed Efficiency	(%)	14.18	7.14

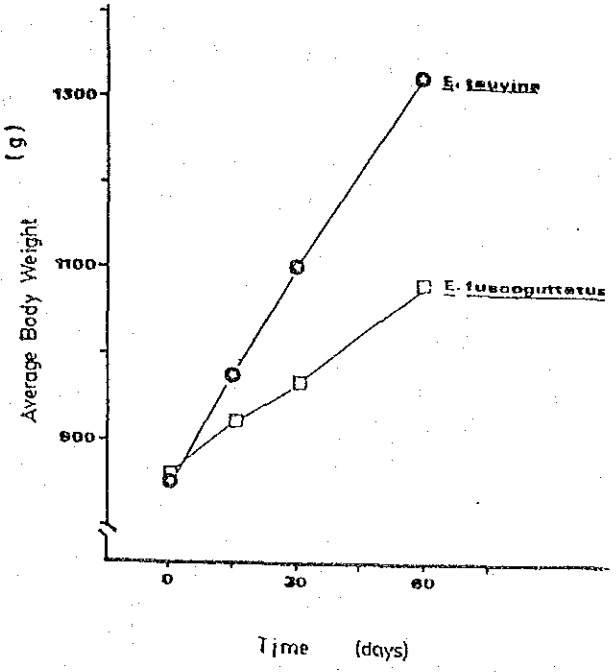


Fig. 65 Growth Curve of E. tauvina and E. fuscoguttatus Cultured in Floating Net Cages

Study on food habits and growth of Epinephelus tauvina and Epinephelus morhua fry was carried out from February to May 1985. Food habits were measured by stomack content analysis method. Natural relative growth was estimated using modal class progression technique.

Result of this study indicated that, shrimp was found as dominant food. The daily relative growth of E. tauvina and E. morhua fry was found as 0.80 and 0.61 mm, between those were statistically highly significant (P 0.01). (Table 27 - 31, and Fig. 66 and 67).

Table 27 Stomack Content Fry of Groupers, E. tauvina and E. morhua

	Organism	
Group of food	Indonesia name	Scientific name
Udang	Repon	Mysid
	Krosok	Parapenaeus sp.
	Dogal	Metapemaeus sp.
	Jerbung	Penaeus marquensis
	Windu	Penaeus monodon
Ikan	Teri	Stolephorus spp.
	Beronang	Sicanus spp.
	Tempang	Sargineila sp.
	Abangan/Jenaha	Lutjanu spp.
	Lencam	Lethrinus sp.
	Belanak	Mugil sp.
Lain-lain	Cumi-cumi	Lolico sp.

Table 28 Index of Relative Importance Food Organism on Stomack of Grouper, E. tauvina

Food organism	N (%)	V (%)	F (%)	IRP
Shrimp	73.9	78.8	100	15.270
Fish	25.7	28.6	28.2	1.31
Others	0.4	0.3	0.8	0.560
	100.0	100.0		

Table 29 Index of Relative Importance Food Organism on Stomack of Grouper, E. morhua

Food organism	N (%)	V (%)	F (%)	IRP
Shrimp	77.9	77.7	100	15.760
Fish	19.1	22.0	31.6	1.299
Others	1.0	0.3	5.3	6.890
	100.0	100.0		

Table 30 Relative Growth of E. tauvina and E. mornua Fry in Sekantung Bay

Replication	E. tauvina (mm/hari)	E. morhua (mm/hari)	
1	0.43	0.43	
2	0.43	0.43	
3	0.57	0.43	
4	0.57	0.57	
5	0.71	0.71	
6	0.71	0.57	
7	0.96	0.71	
8	1.00	0.43	
9	1.00	0.43	
10	0.57	0.43	
11	0.57	0.71	
12	0.43	0.71	
13	0.71	0.86	
14	0.71	0.71	
15	0.86	0.71	
16	1.00	0.71	
17	1.14	0.71	
18	1.00	0.71	
19	1.14		
20	1.14		
21	0.71		
22	0.86		
23	1.00		
24	1.00		
Total	19.12 (T_1)	10.97 (T_2)	30.09 (T..)
Average	0.80	0.61	
Estimation of Monthly Growth	24.0	18.3	

Table 31 Analysis Variance on the Growth of Epinephelus tauvina and E. morhua Fry

	df	Sum of squares	Means of square	F Computation	F Table	
Species	1	0.3606	0.3606	8.95**	4.08	7.31
Error	40	1.6102	0.0403			
Total	41	1.9708				

** Highly significance

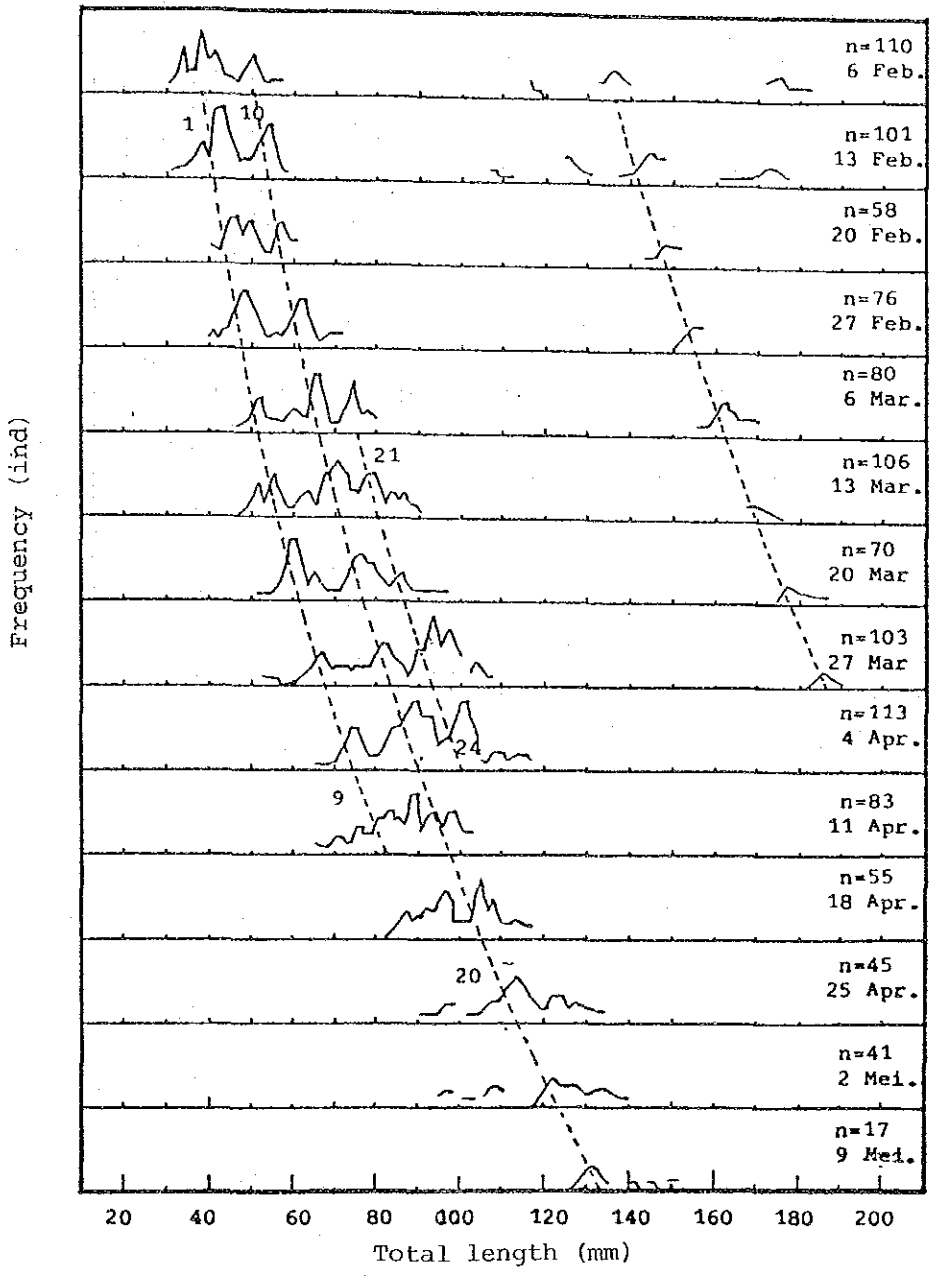


Fig. 66 Frequency Distribution of E. tuavina Fry Caught in Sekantung Bay

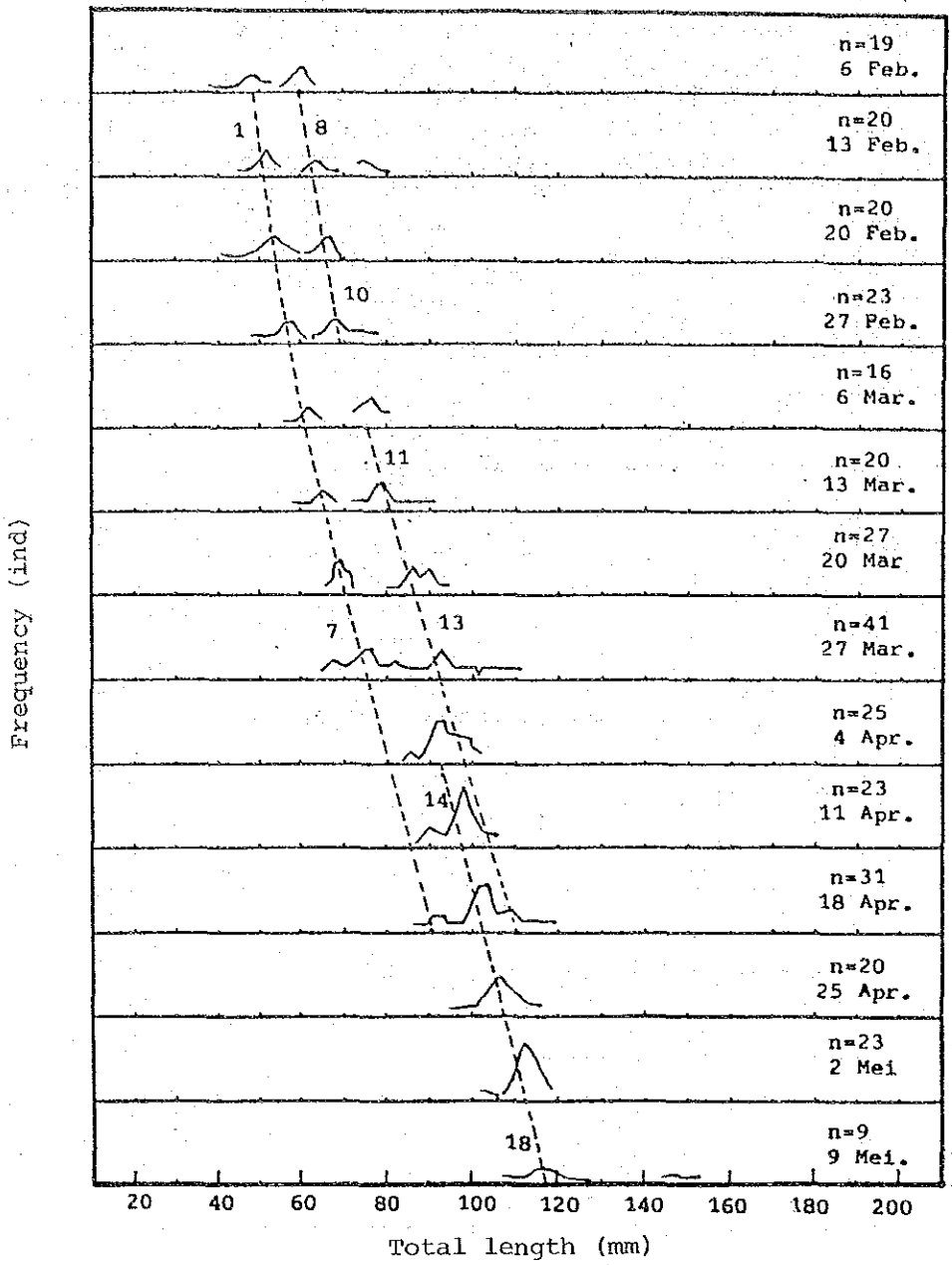


Fig. 67 Frequency Distribution of E. morhua Fry Caught in Sekantung Bay

Studies on the effect of feeding frequency on the growth of estuary grouper, Epinephelus tauvina were conducted in floating net cages from June to August, 1985. Three of feeding frequency (one, tow feeding per day and one feeding in 2 days) with fish size ranging from 80.9 - 83.3 g in body weight were studied. The fish were fed to satiation in each feeding.

Result of the present study indicates that fish fed once in 2 days grew equally fast and showed best food conversion ratio than those at fish fed once and twice daily. At the end of the experiment the net yield in feeding frequencies twice, once daily and once in 2-days are 6.93, 6.36 and 5.93 kg/m^3, respectively. During experiment, no mortality were observed for all feeding tested. (Table 32 - 35, and Fig. 68 and 69).

Table 32 Feeding Frequency, Size and Number of Estuary Grouper Used for Experiment

Feeding frequency	Size of fish				Number of fish stocked
	Mean length (cm)	SD*	Mean weight (g)	SD*	
2 times daily (2/1)**	17.4	0.77	80.9	8.1	50
1 time daily (1/1)	17.5	0.82	83.2	8.3	50
1 time in 2 days(1/2)	17.5	0.98	83.3	8.4	50

SD* = Standard deviation of the mean. ( )** = Notation

Table 33 Average Growth Rate (Increased Body Weight per Day) of Estuary Grouper with Different Feeding Frequency

Feeding frequency (No. of feeding/day's)	Number of weeks					
	0-2	2-4	4-6	6-8	8-10	0-10
	(g/day)					
2/1	1.40	2.23	2.13	1.98	2.17	1.98
1/1	1.42	2.14	2.03	1.87	1.62	1.82
1/2	1.47	1.85	1.56	1.79	1.78	1.69

Table 34 Analysis of Variance (F-values) of the Effect of Feeding Frequency on the Net Yield, Mean Fish Weight, Food Conversion Ratio and Condition Factor or Estuary Grouper

	Net yield pet cage	Mean fish weight	Food conversion ratio	Condition factor
Feeding frequency	0.23(NS)	2.14(NS)	27.78**	5.36(NS)

**P 0.01 NS = Not significant.

Table 35 Food Consumption of Estuary Grouper in Floating Net-cages with Different Feeding Frequency

Food consumption	Number of week	Feeding frequency (No. of feeding/day) 2/1	1/1	1/1
Weight of food eaten per fish (g/2-week)	0-2	101.0	80.0	59.0
	2-4	129.0	104.0	81.0
	4-6	135.0	108.8	84.6
	6-8	139.0	110.0	91.6
	8-10	155.6	111.0	95.0
	Av.*	131.9	102.6	82.2
Weight of food eaten per fish per feeding (g)	0-2	3.9	6.2	9.8
	2-4	4.9	8.0	13.5
	4-6	5.2	8.3	14.1
	6-8	5.3	8.5	15.3
	8-10	5.9	8.5	15.8
	Av.*	5.0	7.9	13.7

Av. = Average

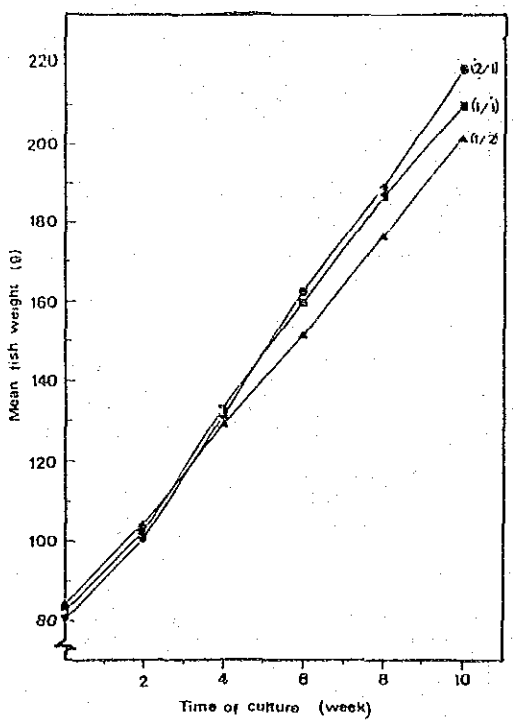


Fig. 68 Mean Weights of Estuary Groupers with Different Feeding Frequency

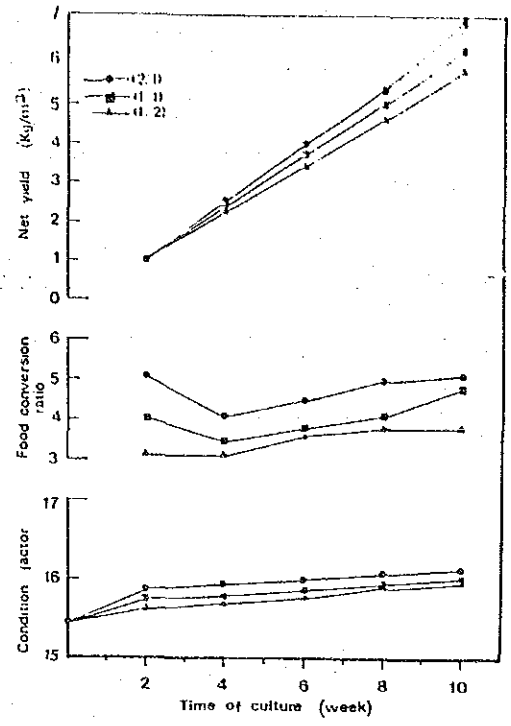


Fig. 69 Net Yield, Food Conversion Ratio and Condition Factor of Estuary Grouper with Different Feeding Frequency.

The experiment was conducted to determine the optimum stocking density for growth of grouper from June to September 1985. The young fish with an average body weight of 113.5 g were cultured in floating net cage (1.0 x 1.0 x 1.5 m) with mesh size of 10.0 mm. Four stocking densities (25, 50, 75 and 100 fish/m^3) were studied. The fish were fed with chopped trash fish (Sardinella spp.) once in a day up to satiation. Result of the present experiment indicated that fish stocked at density of 50 fish/m^3 grew equally fast and showed no differences on food conversion ratio, mortality rate and condition factor compared to those at stocking density of 25 fish/m^3. At the end of the experiment net yield at stocking density of 50 fish/m^3 were not significant different than those at stocking densities of 75 and 100 fish/m^3. The net yield were 4.26, 8.18, 8.36, 8.56 kg/m^3 at stocking density of 25, 50, 75 and 100 fish/m^3 respectively.

In order to produce maximum yields with minimum cost, the stocking density of 50 fish/m^3 is recommended as a optical stocking demsity. (Table 36 - 38, and Fig. 70 - 72).

Table 36 Initial Stocking Density, Initial Biomass and Size of Grouper, Epinephelus tauvina Used for Experiment

Initial stocking density (fish/m^3)	Initial biomass stocked (kg/m^3)	Size of fish stocked: Mean length (cm)	SD*	Mean weight (g)	SD*
25	2.83	19.39	1.05	113.03	15.65
50	5.53	19.32	0.94	110.55	14.33
75	8.72	19.58	1.02	116.26	15.70
100	11.40	19.44	1.23	114.04	15.49

*SD = Standard deviation

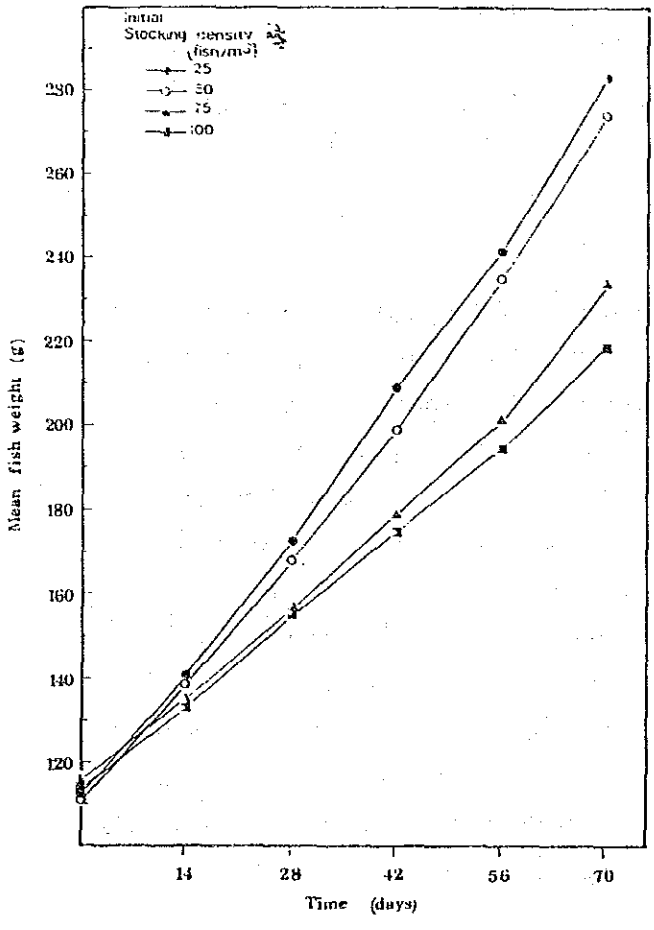


Fig. 70 Mean Weight of Grouper, Epinephelus tauvina with Different Stocking Density

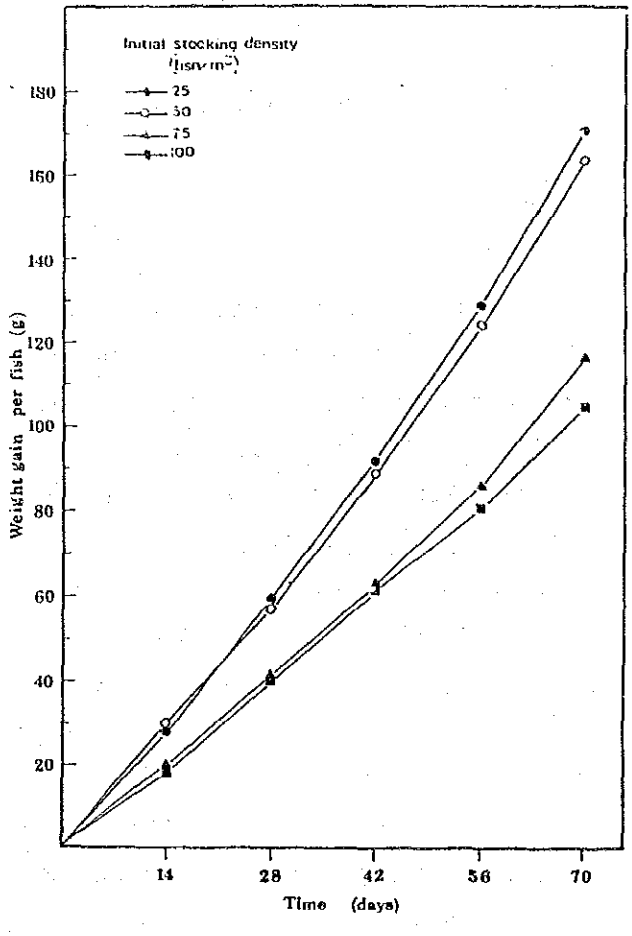


Fig. 71 Weight Gain of Grouper, Epinephelus tauvina with Different Stocking Density

Table 37 Food Conversion Ratio of Grouper, Epinephelus tauvina with Different Stocking Density

Stocking density (fish/m^3)	Food Conversion Ratio	
	Mean*	Range
25	3.48	3.43-3.56
50	3.51	3.48-3.54
75	4.58	4.12-4.84
100	5.54	4.86-6.32

* = Mean ratio was obtained by averaging all every fortnights measurement during experiment.

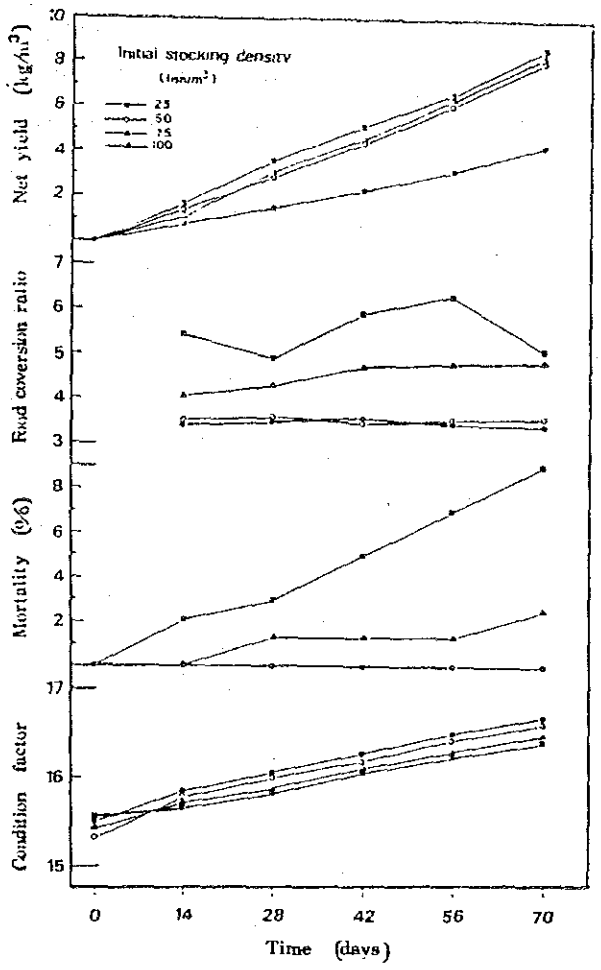


Fig. 72 Net Yield, Food Conversion Ratio, Mortality and Condition Factor of Grouper, Expinephelus tauvina Cultured with Different Stocking Density

Table 38 Analysis Variance (F-value) of the Effect of Stocking Density on the Various Growth Parameter of Groupers, Epinephelus tauvina cultured in Floating Net-cage

	Mean weight	Weight gain per fish	Net yield	Food conversion ratio	Mortality	Condition factor
Stocking density	6.47**	12.26**	18.00**	45.93**	16.06**	4.32(NS)

** p 0.01; (NS) = Not significant

The experiment was conducted to determine the optimum food ratio for the growth of young estuary grouper, Epinephelus tauvina (Forskal) from June to August 1985. Young fish with an average body weight of 10.5 g were stocked in four floating net cages (1.0 x 1.0 x 1.5 m) at stocking density of 60 fish per cage. The fish in each net cage were given different food ratio ranging from 5 to 20% wet weight of fish. The fish were fed once in a day.

The result showed that the maintenance, optimum and maximum food ratio were 1.3, 8.8 and 19.0% wet weight of fish respectively. At the end of experiment the net yield were higher with the higher food ratio. For the economic production, the ratio should be approximately 8.8% body weight supplied every day. (Table 39 - 41, and Fig. 73 - 75).

Table 39 Initial Data for Experimental Fish

Food ratio (% wet weight of fish)		Size of fish				Number of fish (ind.)
		Total length (cm)		Body weight (g)		
Pre-scribed	Actual (mean ± SD*)	Mean	SD*	Mean	SD*	
5	5	9.2	0.72	10.9	2.46	60
10	10	9.2	0.80	10.6	2.31	60
15	15	9.0	0.74	10.1	2.10	60
20	19.5 ± 1.03**	9.1	0.82	10.5	2.23	60

* SD = Standard deviation

** During experiment, 20% food ratio was in excess, the amount

Table 40 Mortality Rate with Different Food Ratio

Time (days)	Food ratio (% wet weight of fish) 5	10	15	19.5
0	0	0	0	0
15	6.67	1.67	0	3.33
30	6.67	1.67	0	3.33
45	10.00	3.33	0	5.00
60	16.67	5.00	1.67	6.67

Table 41 The Condition Factor with Different Food Ratio

Time (days)	Food ratio (% wet weight of fish) 5	10	15	19.5
0	13.93	13.79	14.83	13.82
15	13.93	14.89	14.84	14.88
30	13.89	14.92	15.74	15.66
45	13.83	15.93	16.06	16.42
60	13.75	16.23	16.55	16.71

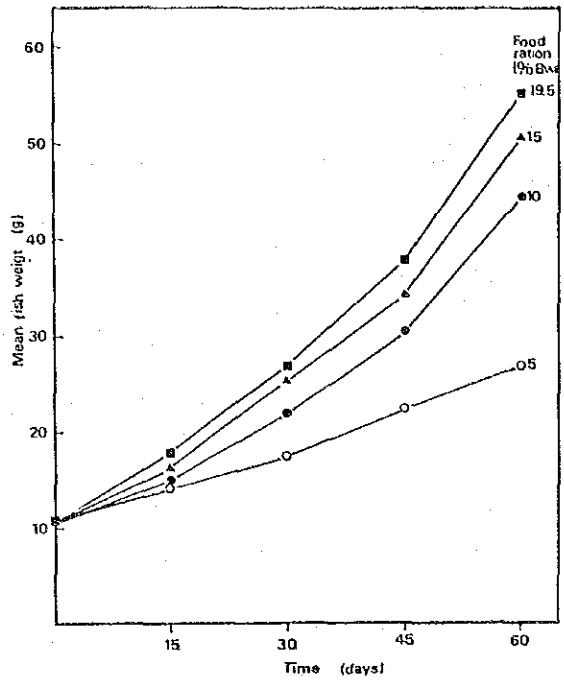


Fig. 73 Growth Curve in Various Food Ratio

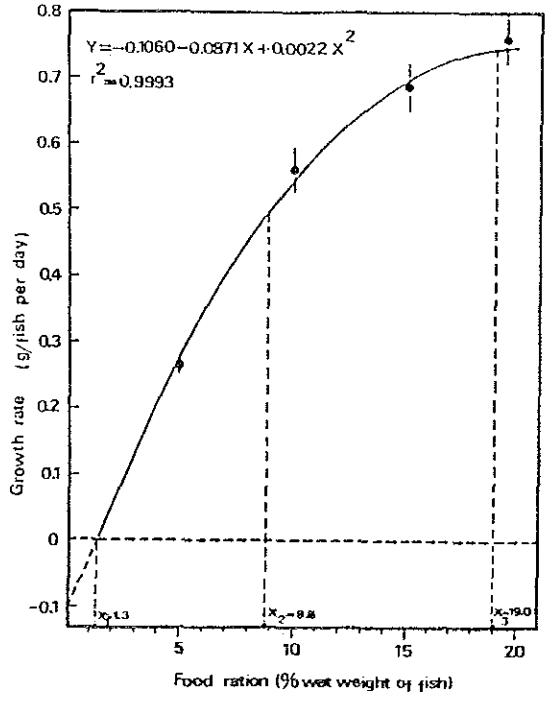


Fig. 74 Relationship between Food Ratio and Daily Growth Rate

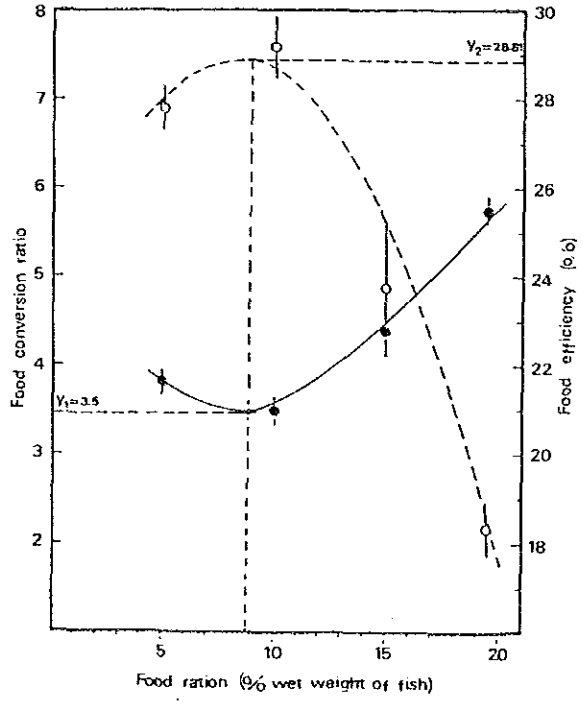


Fig. 75 The Relationship between the Food Conversion Ratio, Food Efficiency and the Food Ratio

(3) Experiment of seed production

At the present, 49 adult of E. tauvina with 4 to 6 kg in body weight and 37 adult of E. fuscoguttatus, with 4 to 5 kg in body weight are being raised in floating net cages of Bojonegara Experimental Station. (Photo 62).

Those adults are reared as spawners of future seed production and testosteron injections have been also conducted for sexual reverse from female to male. However, any effective result are not obtained yet.

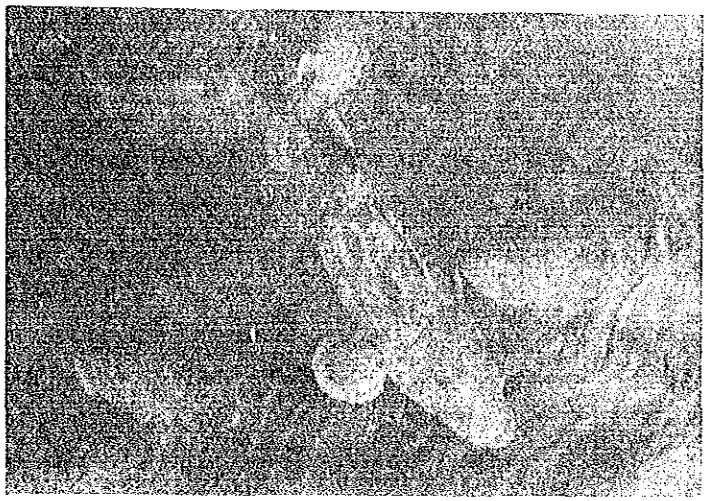


Photo 62 Epinephelus tauvina Adult

3) Consideration

Because of its marketability, the culture of groupers in the tropical sea area is considered very valuable. It is necessary to examine which species is suitable for mariculture industry among goupers which inhabit in the local area. Research survey was conducted on more than six species of groupers in Banten Bay. Epinephelus tauvina is dominated in this area.

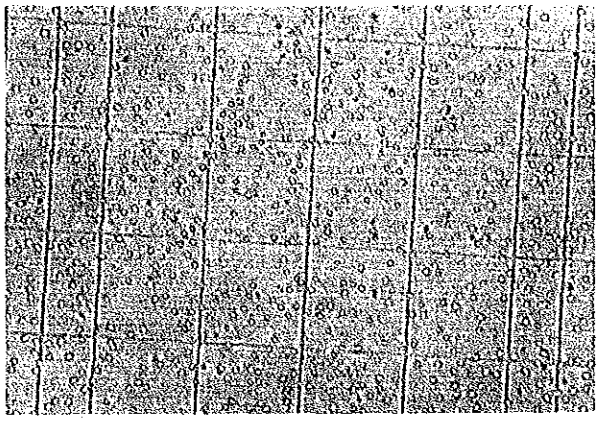


Photo 63 Chlorella sp. (x 400)

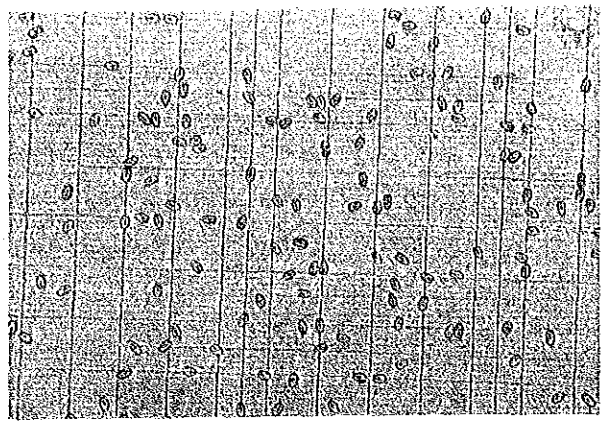


Photo 64 Tetraselmis tetrathele (x 200)

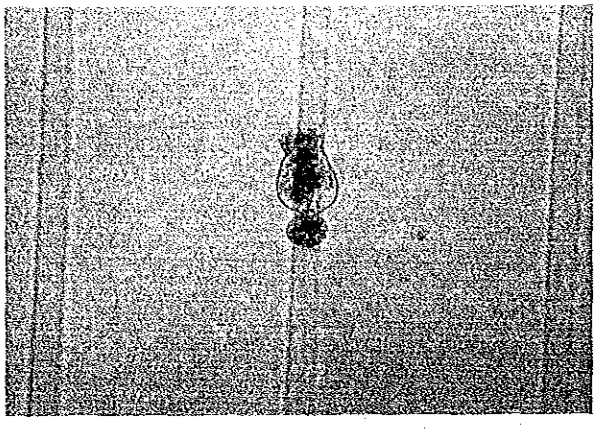


Photo 65 Rotifer, Brachionus plicatilis (x 100)

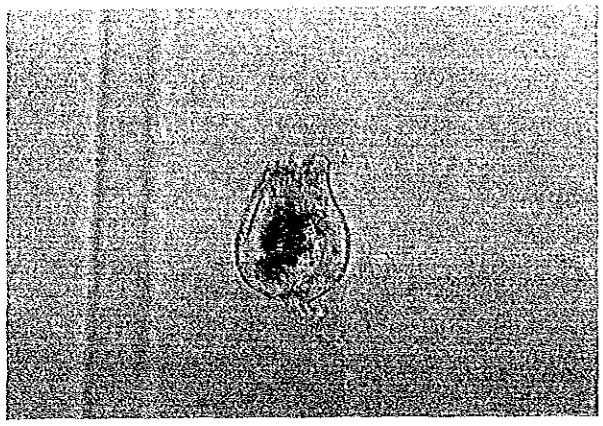


Photo 66 Rotifer, Brachionus plicatilis (x 200)

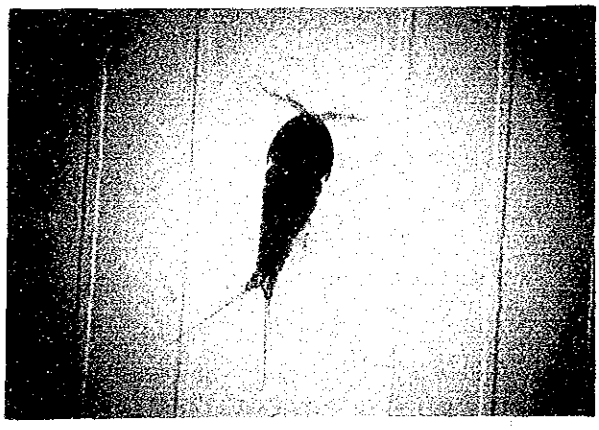


Photo 67 Tigriopus japonicus (x 40)

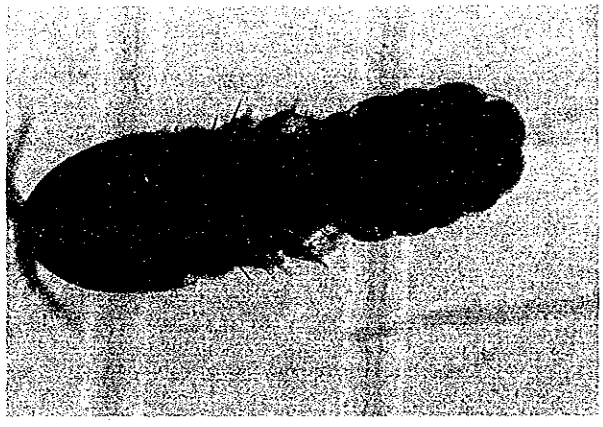


Photo 68 Tigriopus japonicus (x 100)

Therefore, mainly concerning this species, various rearing experiment were conducted at Bojonegara Experimental Station. From the result of experiment, growth rate and survival rate of this species, were high. The natural seeds also can be obtained easily in this area. And this species has a high price in some market in Indonesia and neighbouring countries.

From the above reasons, E. tauvina is most suitable species among other groupers for mariculture industry in Indonesia. For developing mariculture industry of groupers in Indonesia, the ecological survey should be conducted in wide area and also in order to provide enough amount of seed, seed production technique should be advanced.

3-4 Food Organisms Culture

The establishment of food organisms culture is most important for developing seed production of useful fishes and crustaceans. At present, Chlorella sp. Tetraselmis tetrathele, rotifer (Brachiounus plicatilis) and Tigriopus japonicus are being cultured at Bojonegara Experimental Station. (Photo 63 - 68). The method of those food organisms culture are mentioned as follows:

3-4-1 Pure Culture

1) Chlorella sp.

Chlorella is an unicellular green algae (Chlorophyta) with a diameter of approximately 2 to 3 μm. The chlorella has a remarkably important role in seed production as feed for rotifer. The chlorella used in Bojonegara Experimental Station is introduced from Japan. The various culture experiments were conducted by using this chlorella and the culture method was established.

Strain of chlorella is preserved in phytoplankton stocker (Photo 69) of which temperature is kept with 20°C. Those strain are cultured in by using 1-l to 10-l flask in the plankton room kept with 20°C of Bojonegara Experimental Station (Photo 70). The medium for pure

culture chlorella is used with Miquel solution added with P6 - metal solution (Table 42 and 43). The sterilized filtered sea water is used for this pure culture. The system of pure culture is shown in Fig. 76. The air which is sent in to culture flask is filtered by Millipore filter (0.45 μm) (Photo 77). CO_2 gas is also added into culture flask 5 to 7 second every day. The light intensity is around 5,000 lux by using fluorescent lamps. The density of chlorella reaches 150 - 250 x 10^6 cell/ml in pure culture method at Bojonegara Esperimental Station.

Table 42 Miquel Solution*

A solution;	KNO_3	20.2 g
	H_2O	100.0 g
B solution;	$Na_2HPO_4.12H_2O$	4.0 g
	$CaCl_2.6H_2O$	4 ml
	HCl	2 ml
	$FeCl_3$ (dissolved)	2 ml
	H_2O	80 ml

* Add 2 ml of A solution and 1 ml of B solution into 1l of seawater.

Table 43 P-6 Metal Solution

	(Provasoli et al)
H_2O	100 ml
Na_2.EDTA	300 mg
Fe(as Cl)	8 mg
Mn(as Cl)	12 mg
Zn(as Cl)	1.5 mg
Co(as Cl)	0.3 mg
Cu(as SO_4)	0.12 mg
B(as H_3BO_3)	60 mg
	H = 7.5

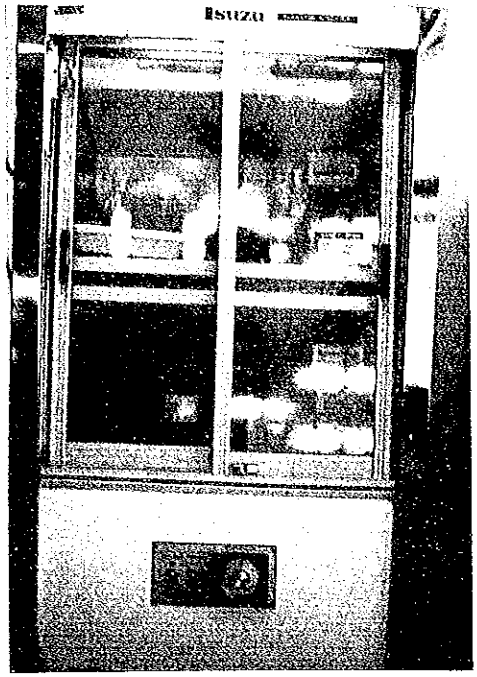


Photo 69 Phytoplankton stocker

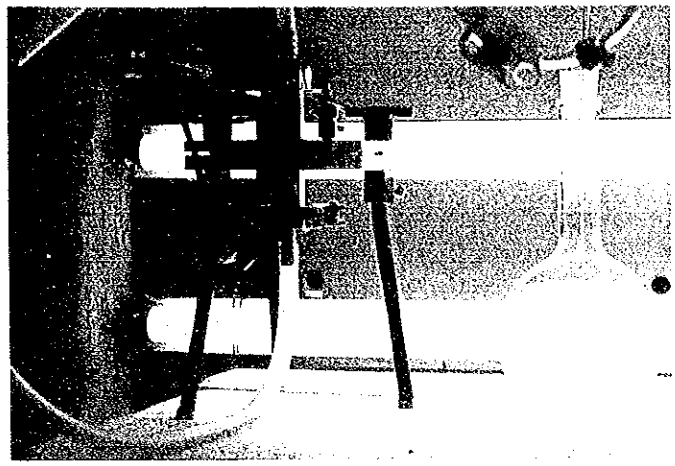


Photo 71 Millipore filter (0.45μm)

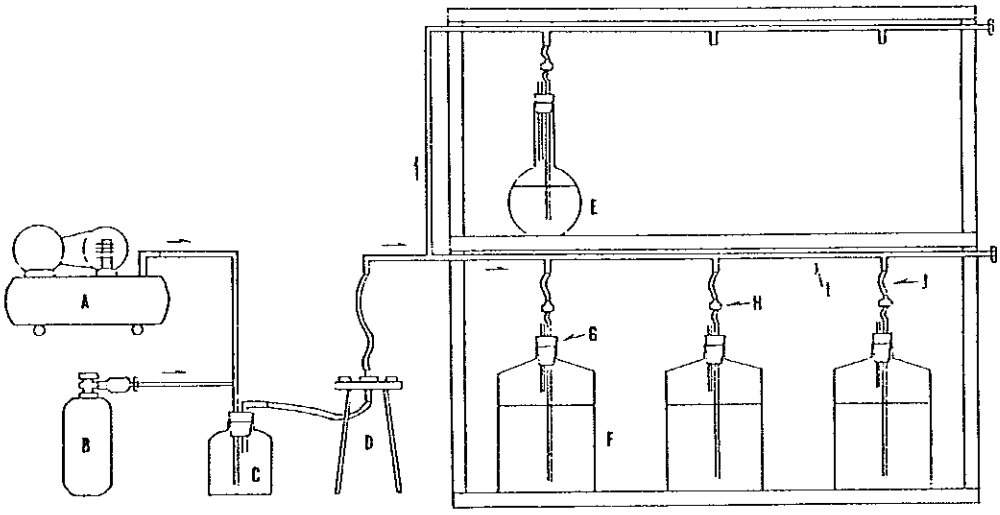


Fig. 76 System of Sending Air and CO_2 in Phytoplankton Culture Room of Bojonegara Experimental Station

A: Air compressor, B: CO_2 gas cylinder, C: Gas mixing tank,
D: Millipore filter, E: 5-l flask, F: 10-l glass bottle,
G: Rubber cap, H: Millipore filter, I: Glass tube,
J: Vinyl tube

Photo 70 Phytoplankton culture bottles in the plankton room

2) Tetreselmis Tetrathele

Tetraselmis terathele is an unicellular flagellate with length of 9.8 to 15.3 μm, width of 6.0 to 10.5 μm and thickness of 4.3 to 8.5 μm. The cell volume (320 m^3) is 20 to 30 times larger than that of chlorella. T. tetrathele is used in South East Asian Countries where water temperature is in a range of 25 to 35°C throughtout the year, and it was seemed to be cultured instead of chlorella.

The pure culture method is same as chlorella above mentioned. The density of T. tetrathele reaches to 1 to 1.5 x 10^6 cells/ml in pure culture at Bojonegara Experimental Station.

3) Isolation methods

When observed contamination, the isolation should be conducted. Two methods, pipet method and agar medium method, are being used in Bojonegara Experimental Station. Pipet method is conducted by capillary pipet. The aimed phytoplankton is picked up by this pipet under the microscope. (Photo 72 - 76).

Agar medium method is conducted by using the agar with adequate medium for the aimed phytoplankton. The aimed phytoplankton with contamination is inoculated onto the medium. After this inoculated phytoplankton propagated will in the medium, the aimed phytoplankton is picked up by capillary pipet and inoculated into test tube. (Photo 77 -88).

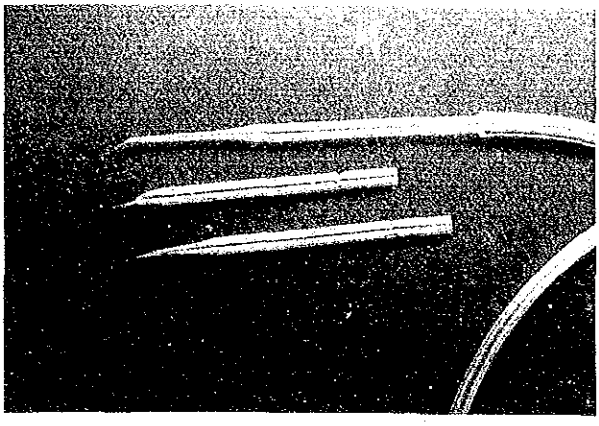


Photo 72 Capillary pipet

Photo 73 Pick up

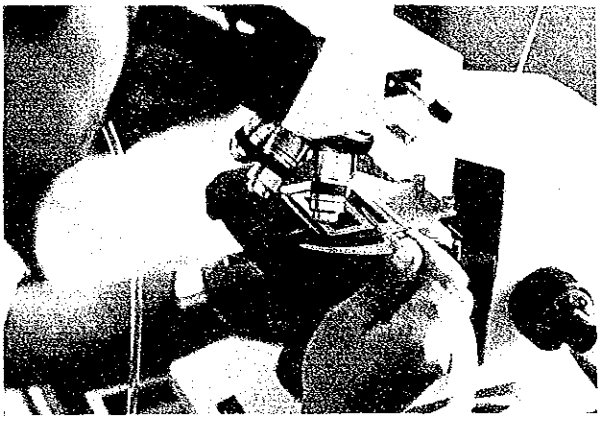


Photo 74 Transfer fo small chamber

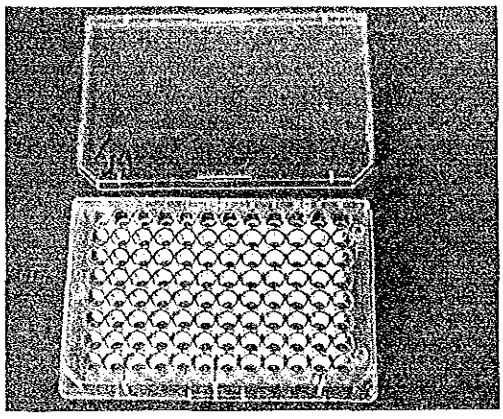


Photo 75 Small chamber

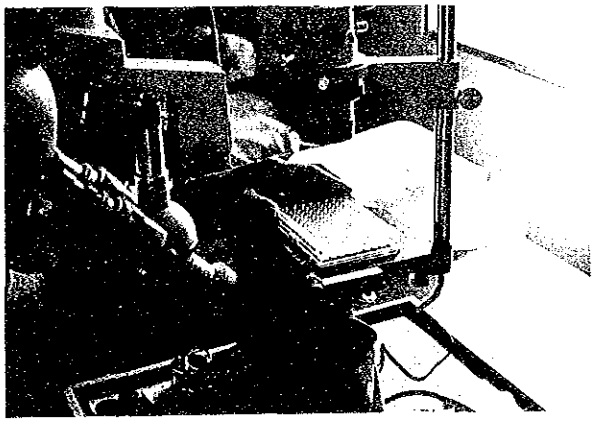


Photo 76 Observation of Phytoplankton

Photo 77 Weight the amount of agar

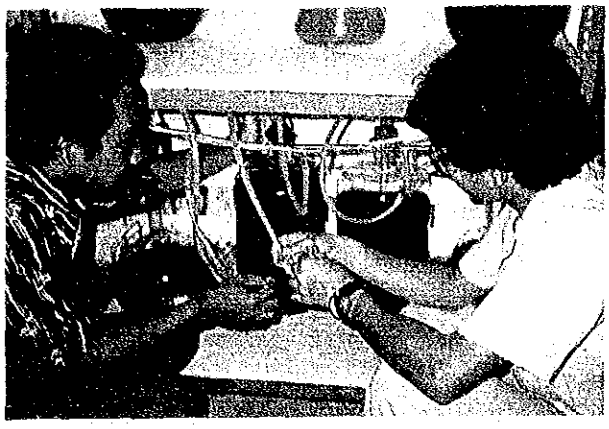


Photo 80 Get sample of chlorella

Photo 78 Disolved agar

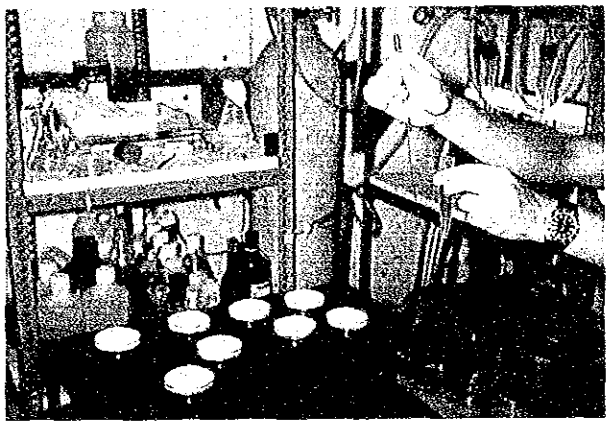


Photo 81 Sample of chlorella in test tube

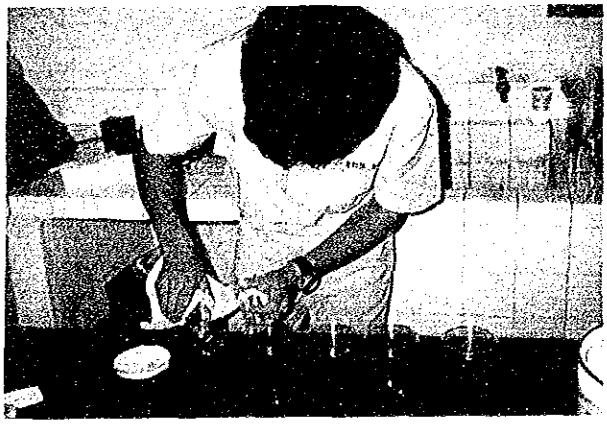


Photo 79 Put agar into sterilized shale

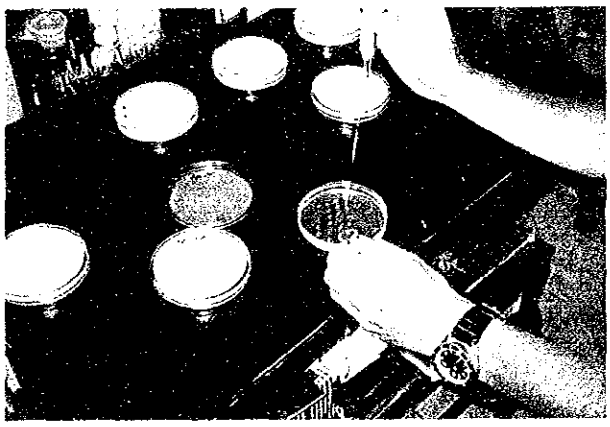


Photo 82 Inoculate chlorella into agar medium

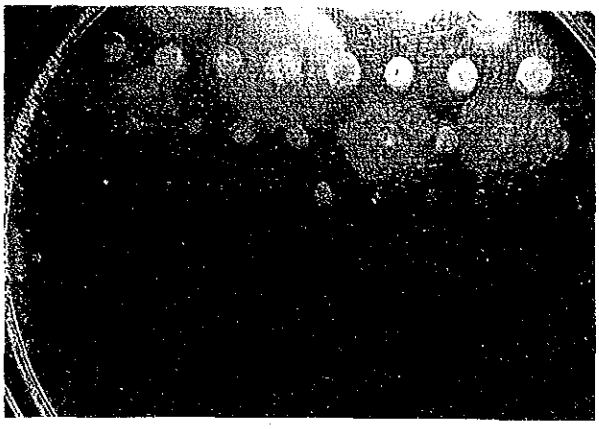


Photo 83 Colony of chlorella

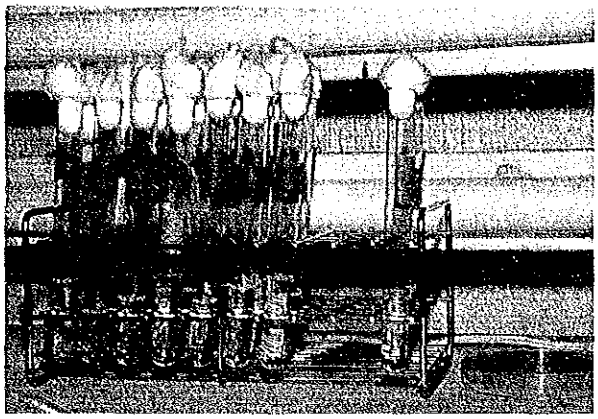


Photo 86 Keep the test tubes in the culture room

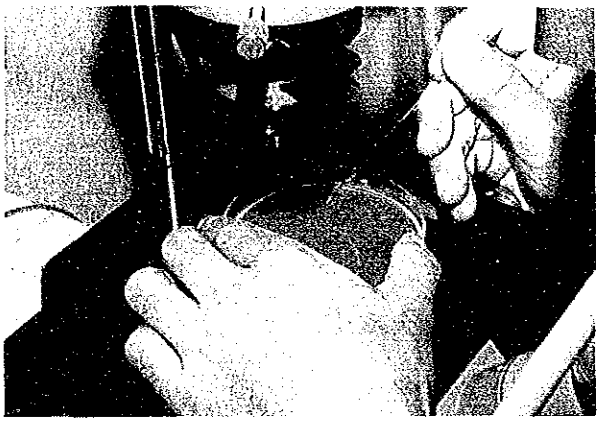


Photo 84 Pick up chlorella

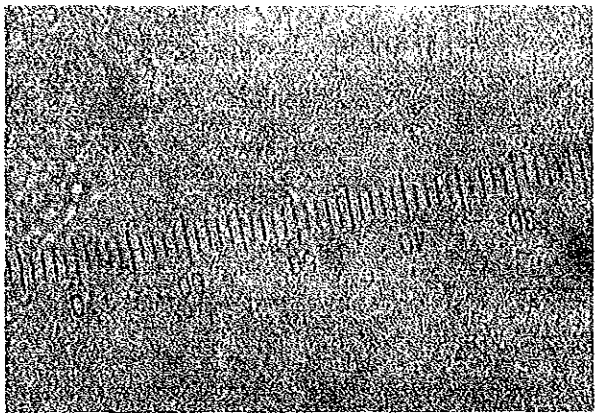


Photo 87 Chlorella without Contamination

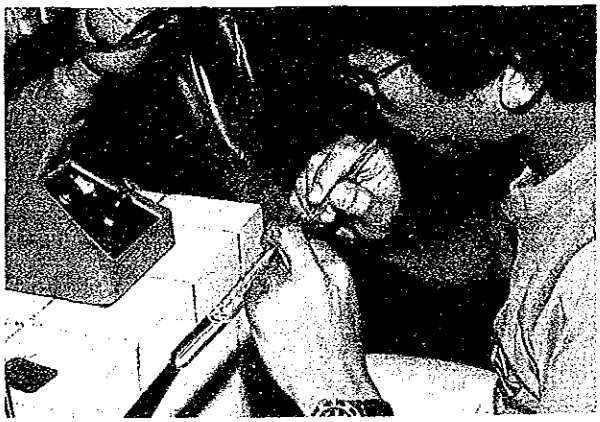


Photo 85 Inoculated into test tube

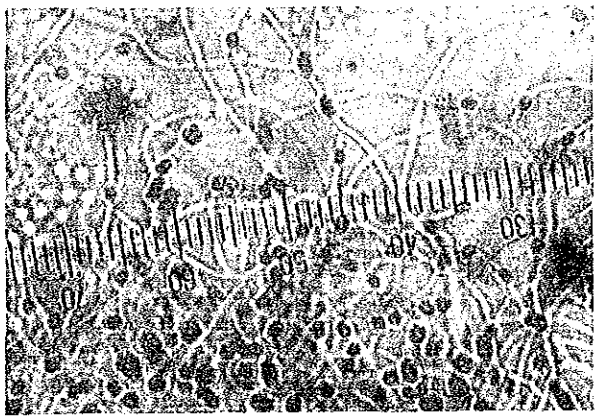


Photo 88 Blue green algea