TECHNICAL DEVELOPMENT ON GREEN MUSSEL CULTURE IN BANTEN BAY

Masahiro HOSOYA[1] and Muchari[2]

ABSTRACT: Experiments for culturing green mussel, Mytilus (Perna) viridis Linne were conducted at Pulau Tarahan waters by using the spat obtained from the survey on the natural spatfall. Results were analyzed for the purpose of developing the suspended rope culture method which showed high productivity. Drying tolerance was also observed for developing the transplantation technique.

Floating bamboo collectors were used for the spat collection of this species in July 1981 and resulted 6,944 spat per square meter successfully. First growth experiment was conducted by basket hanging method to gather data on differences in culturing depth and density during the period of October 1980 to February 1981, and resulted no difference in depth and higher growth in lower density. Second growth experiment was conducted by suspended rope culture method during the period of September 1981 to February 1982, and resulted the monthly growth of 7.3mm in shell length and culturing density of 230 spat per meter was recomended. Drying tolerance was also observed for 3 to 24 hours in October 1981 and resulted high survival rate for over 24 hours, while low rate was observed under the low temperature conditions.

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ABSTRAK : Pengembangan teknik budidaya kerang hijau di-Teluk Banten.

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Percobaan budidaya kerang hijau, Mytilus (Perna) viridis Linne.telah dilakukan di Perairan Pulau Tarahan untuk mempelajari kemungkinan pengembangannya dengan cara tali gantung. Benih diambil dari hasil pengumpulannya di perairan.

Toleransi kerang hijau pada lingkungan tanpa air juga telah dipelajari pada bulan Oktober 1981 untuk telaah transplantasinya.

Kolektor bambu terapung digunakan untuk mengumpulkan benih pada bulan Juli 1981 dan menghasilkan 6944 benih/m^2. Pengamatan pertumbuhan kerang hijau dilakukan dengan dua cara yaitu ; Pertama,dengan kantong jaring yang digantung untuk mempelajari pengaruh kedalaman pemeliharaan dan kepadatannya terhadap pertumbuhan (Oktober 1980 - February-1981). Kedua,dilakukan dengan untaian tali pemeliharaan (September 1981 - February 1982). Dari percobaan pertama didapatkan tidak ada perbedaan derajat pertumbuhan pada berbagai kedalaman dan pertumbuhan cepat pada kepadatan yang rendah. Dari percobaan kedua didapatkan pertumbuhan 7.3 mm/bulan dan kepadatan dengan 230 benih per m untaian merupakan jumlah yang disarankan. Didapatkan pula bahwa kerang hijau dapat hidup lebih dari 24 jam pada kondisi lingkungan tanpa air pada suhu normal, tetapi kurang baik pada temperatur rendah.

INTRODUCTION

Green mussel, *Mytilus (Perna) viridis*, is one of the important shellfish species in Indonesia. A small amount of this species collected from the natural stock is sold at the markets of Jakarta. Some observations and experiments on its culture have been still under way in recent years.

Cooperative development for culturing this species between National Oceanology Institute and Jaya Ancol Oceanorium was commenced in the year 1979, when natural seeds of this species were found settled in quantity in the coastal area of Ancol, the north coast of Jakarta. Three culture methods, that is, suspended rope culture method, small bamboo raft method and bamboo bouchet method have been developed, and the production of 50 tons was recorded in 1981 by the bamboo bouchet method using 5,200 poles with the assistance of Jakarta Municipal Authorities.

Ancol Laboratory of Marine Fisheries Research Institute also carried out experiments of culturing this species in Ketapang waters, 30km west of Jakarta. Retno and Wardana (1980) reported that difference in culture depth of 1, 2, 3m and the location in the waters did not influence their growth, 7 months were taken to produce the marketable size and the average growth during 10 months was 7mm per month in shell length. Retno (private communication) also mentioned that the result from the spat collection showed 7,500 spat per square meter, their spatfall season was from April to June and this species was dominant in the said waters.

Indonesia-Japan Mariculture Research and Development Project in August 1978 with the view of supplying animal proteins are now being implemented in Banten Bay located on the north coast of West

Java. And the technical development of fish and shellfish culture has been advanced under the project.

Environmental conditions of the Bay for mariculture were observed under the project and reported that Banten Bay was an open-type bay with the current inflow from the open sea, therefore, the environmental conditions were assumed stable as a whole except for a part of the coastal area. Pinctada sp., Anadara sp., Mytilus sp., Crassostrea sp. and Musculus sp. were important for the development of shellfish culture (Hosoya and Muchari, 1981 a and b).

This report showed the results of the spat collection, the growth and the transplantation technique of the green musse of Banten Bay from 1980 to 1982.

METHODS

Experiment on the spatfall

Knowledge of the natural spatfall of green mussel was obtained from the annual survey on the natural spatfall of bivalves which consisted of the observation on the appearance of bivalve larvae and the survey on the natural spat collection conducted from February 1980 to February 1981. Bivalve larvae were observed twice a month periodically by the quantitative sampling of 100 liter vertical haul using plankton net of the standard XX13 for a general micro plankton at the 10 stations fixed in the Bay. The spat collection was made by shell type and net type collectors at the main stations in the Bay. The collectors were hung at 1m layer and below 1m layer at intervals of 2m, and hauled up after one month. The species and the number of spat were observed. This survey was conducted eight times in one year.

The experiment on the mass spat collection was conducted by the floating bamboo collectors in the east area of the Bay from April to July in 1981 after the suitable place and period for the spat collection of this species had been decided. This collector was developed especially for this species which was considered to show the gregarious settlement at the surface layer. This collector with the spatting area of $3.6m^2$ was made of bamboo screen fixed to the floating bamboo frame(Fig. 1).

Experiment on the growth

Experiments on the growth of the green mussel were conducted twice in Pulo Tarahan waters. The data on environmental conditions and planktons were obtained from the twice-a-month periodical observation.

The first experiment was conducted from October 1980 to March 1981 using 4,500 spat obtained from the survey of the natural spat collection in July 1980. This experiment aimed to study their growth and survival by using the hanging basket method. The data were obtained from the different densities of 50, 100, 200 and 400 individuals per basket in the depth of 1, 3 and 5m. Those baskets, size of 30 x 30 x 10cm, were cleaned once a week by the water jet pump.

The second experiment was conducted by using the suspended rope method from September 1981 to February 1982, using spat obtained from the experiment on the mass spat collection conducted in July 1981. Spat of 34.6mm in average shell length were fixed onto the nylon rope of 20mm in diameter by using small-mesh net for covering. Culturing density ranged approximately from 300 to 850 per meter and culturing depth ranged from 1 to 4m.

Experiment on the transplantation

Experiment on the transplantation, especially on the tolerance to drying, was conducted in September 1981 by using 2,200 spat of 38.4mm in average shell length. Those spat were kept in the four drying conditions, such as outdoors, indoors, indoors with moisture and in the refergerator. After having kept in above mentioned conditions for 3, 6, 12, 18 and 24 hours, they were put in the separate aquaria and their tolerance was observed from the survival rate within 72 hours.

RESULTS

Experiment on the spatfall

The appearance of bivalve larvae showed the two peaks in Banten Bay, that is, the period from April to early July and from late August to early October (Fig. 2). The appearance of bivalve larvae in each station and the results of the spat collection were analyzed for deciding the suitable species, period and place in Banten Bay. From the analysis, 1) Pinctada sp., Anadara sp., Mytilus sp. and Musculus sp. at station 2 and 3 from May to July, 2) Pinctada sp. at station 6, 7 and 8 from June to July, 3) Pinctada sp., Crassostrea sp. and Mytilus sp. at station 3 from September to October, 4) Unknown species at station 10 in October, and 5) Musculus sp. at station 2 in December seem to be suitable (Table 1, Fig. 3). The fluctuations of the number of five dominant species of spat collected in this Bay revealed that it was possible to collect green mussel from June to July at station 2 and 3 in the east area of the Bay. And green mussel showed a tendency of more spatting in 1m layer (Table 2 and 3).

The mass spat collection was conducted by using the folating bamboo collector in 1981 and it showed a gregarious settlement (6,944 spat/m^2) of green mussel.

<u>Experiment on the growth</u>

Concerning environmental conditions at Pulo Tarahan waters, water temperature ranged from 28.1°C to 31.6°C, salinity from 30‰ to 35‰, transparency from 1.4m to 4.3m, hydrogen ion concentration from 8.0 and 8.4 and disolved oxygen from 6.0ppm to 8.4ppm. Concerning the fluctuation of plankton, phytoplanktons increased from November to January, May, July and August, and *Chaetoceros*, *Thallasiothrix*, *Rhizosolenia*, *Coscinodiscus* and *Bacteriastrum* were main species, and zooplankton increased in January, from March to May and from July to September, and *Copepoda*, *Noctiluca*, *Ceratium* and *Oikopleura* were main species (Fig 4 and 5).

The first growth experiment of the green mussel showed that culturing depths of 1, 3, and 5m resulted no significant differences. Culturing density of 50, 100, 200 and 400 individuals per basket showed remarkable difference in growth of 23.0mm, 18.3mm, 15.2mm and 13.4mm for three months respectively. Survival rate was more than 93% in three months. They grew from 29.3mm to 53.5mm in average shell length in 50 individuals section and their average growth was 7.6mm per month(Fig. 6 and 7).

The second growth experiment was carried out by using suspended rope method and it resulted in growth from 34.6mm to 81.2mm in their average shell length during 191 days, and their average growth was 7.3mm per month. They gained from 4.2g to 35.1g in body weight during the same period. Comparing with the results of the culturing experiment in Malaysia by Sivalingam(1977), those results were better in shell length, while almost same in body weight. As culturing density was ranged from 300 to 850 individuals per meter, the growth of individuals in high culturing density was retarded when they reached more than 60mm in average shell length. As a result, "thinning" was required when the culturing density was higher than optimum. Six months were taken to reach to the marketable size of 80mm in average shell length with in the final culturing density of 200 individuals per meter(Fig. 8).

Those results indicated that their growth depended heavily upon the culturing density in the green mussel culture at Pulau Tarahan waters.

Experiment on the transplantation

Concerning the tolerance to drying at low temperature, survival rate was 56% in 6 hours and 0% in 12 hours. Low temperature treatment usually used for transporting shellfish in temperate waters was not suitable for this tropical species. However, at the normal temperature, it seems no difficulties in transportation(Table 4).

DISCUSSIONS

Spatfall

The period and place for spat collection of green mussel in Banten Bay seem to be suitable in the east area of the Bay from June to July. The method by the floating bamboo collector seems to be suitable because only green mussel could be gregariously collected by this method. It seems to depend on the settlemental ecologies of other species in the natural sea. Possibility of mass spat collection of this species is high in Banten Bay by using the above-mentioned method, although it is rather difficult to collect spat by using the net type collector.

The transition of the spat on the floating bamboo collector were as follows ; 1) sea weed, 2) barnacles, 3) Pinctada sp., 4) green mussel. And this phenomenon is pointed out in the report on Mytilus californianus in Monterey Bay, California.(Hewatt, 1935)

Until nowadays, the culture of edible mussel, Mytilus edulis, has made a remarkable progress and the studies on the larval ecology have considerably advanced. However, studies on M.viridis are still in progress. The settlement ecology should be studied and an easier spat collection method should be developed in Banten Bay.

Growth

Culturing density is one of the important factors to influence the growth. Suspended rope culture method seems advantageous for getting the high productivity. In this experiment, the optimum culturing density of the marketable size was about 200 individuals per meter, and the higher density was not appropriate because it causes the retardation of growth and selfdrops. Regarding the density of 200 individuals per meter, the survival rate was 93% in three months, therefore the initial density of 231 individuals per miter seems optimum for six months culture by the following formula.

$$X \times (0.93)^2 = 200$$

$X = 231$ X ; initial culturing density

In Galicia Bay of Spain, culturing density in the rope culture was 300 individuals per meter when "thinning" was done at the size of 40mm in shell length (Figueras, 1976). Considering its survival rate and culturing period in Spain, its density is almost the same as that of Banten Bay.

Another great factor controlling growth of shellfish is the primary productivity in the environmental waters, of which value is said generally low in the tropical waters. However, considering the current velocity is 0.15 meters per second, the current velocity effects well their growth in Pulo Tarahan waters.

Accordingly, culturing density in suspended rope culture is an important factor which controls growth of green mussel. Instructions should be made under this consideration for developing this culture in near future.

Culturing depths of 1, 3, and 5m are not relevant to their growth and they are expected to grow equally at any depth of layer.

Tarnsplantation

Sivalingam (1977) mentioned that this species had 50% survival salinity tolerance at 24% and 80%, 50% survival temperature tolerance at 10°C and 35°C and 50% pH survival tolerance at 3.5 and 9 for the period of two weeks. Those ranges of tolerance are so wide that there is no difficulty in transplanting to the other common waters in the tropics except the estuary area. Our experiment also showed no difficulty in the tolerance to drying for 24 hours. Therefore, it seems no difficulty in expanding its culture to the neighboring waters by transplantation.

CONCLUSIONS

1. It was possible to collect spat of green mussel in the east area of Banten Bay from June to July by floating bamboo collector. Spat was collected 7,000 per square meter.
2. Spat of 35mm in shell length grew to marketable size of 80mm within about 6 months by the suspended rope method. Average monthly growth was 7.3mm.
3. Difference of growth by culturing depths was not recognized.
4. Culturing density was the main factor to control growth. Optimum initial culturing density was considered as 230 spat per meter.
5. Transplantation was easy and the expansion of culturing area was possible.

ACKNOWLEDGEMENTS

We should like to take this opportunity of expressing our thanks to Dr. Hisashi Kan-no, who was a short term expert on shellfish culture, to Miss Tuti Hariati as a temporary counterpart from September to December in 1980 and to other members of the stuff of this project for a donation enabling this work to be done. We also wish to express our hearty thanks to Mr. Tokio Asazu for a full revision of this manuscript in English.

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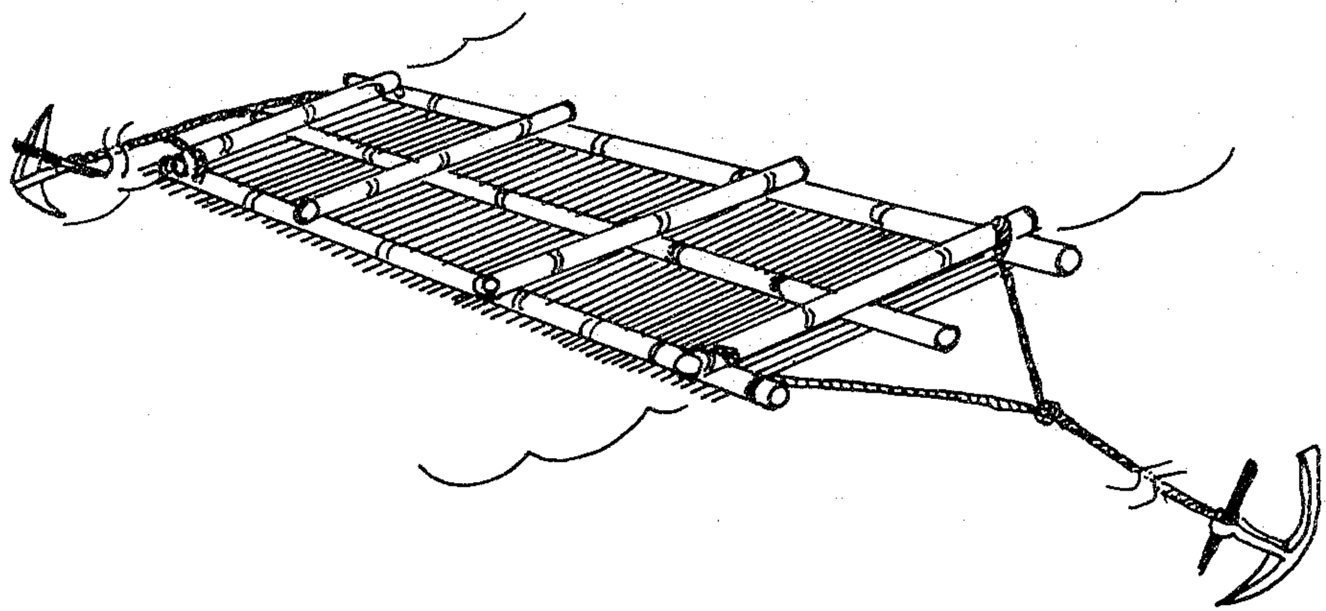

Fig. 1. Bamboo screen collector fixed to the floating bamboo frame.

Table 1. Suitable period , place and species of bivalves for the spat collection in Banten Bay.[1)]

No.	Period	Place	Species
1.	May - Jul	st. 2&3	*Pinctada* sp. *Anadara* sp. *Mytilus* sp. *Musculus* sp.
2.	Jun - Jul	st.6,7&8	*Pinctada* sp.
3.	Sep - Oct	st. 3	*Pinctada* sp. *Crassostrea* sp. *Mytilus* sp.
4.	Oct.	st. 10	Unknown
5.	Dec.	st. 2	*Musclus* sp.

1) Hosoya and Muchari (1981 b).

Table 2. Number of spats of *Anadara* sp., *Mytilus* sp., and *Musculus* sp. on the third spat collection at station 2.[1)]

Depth \ Species	*Anadara* sp.	*Mytilus* sp.	*Musculus* sp.
1m	2,375	3,028	3,139
3m	10,003	2,586	1,735
Total	12,378	5,614	4,874

1) Hosoya and Muchari (1981 b).

Table 3. Number of spats of *Mytilus* sp. and *Anadara* sp. collected by Net type collector at station 3 during 12 June to 14 July, 1980.[1)]

Species / Depth	*Mytilus* sp.	*Anadara* sp.
1m	3,023 (4.5 x 3.0 mm)	2,375 (4.5 x 3.0 mm)
3m	2,586 (4.3 x 3.0 mm)	10,003 (4.2 x 3.3 mm)

1) Hosoya and Muchari (1981 b).

Table 4. Results of the experiment on the transplantation technique of Green Mussels, *Mytilus viridis*
Tolelrance on the drying condition (I)

Shellfish sector.

Group	I	II	III	IV	Control
Condition	under the sunlight	under the cover	under the net wet	in the refrigerator	in the sea water
w.t. range	25.1-28.4 °C	25.8-28.6 °C	24.9-28.2 °C	3.6-10.5 °C	
Survival rate after 72 hours					99 & 100 %
3 hours drying	100 %	100 %	100 %	99 %	
6 hours drying	98 %	99 %	100 %	56 %	
12 hours drying	100 %	100 %	100 %	0 %	
18 hours drying	98 %	100 %	95 %	0 %	
24 hours drying	98 %	97 %	87 %	0 %	
average SL x SH	38.3 x 18.4 mm				
Weather	Cloudy (sometime small rainfalls)				

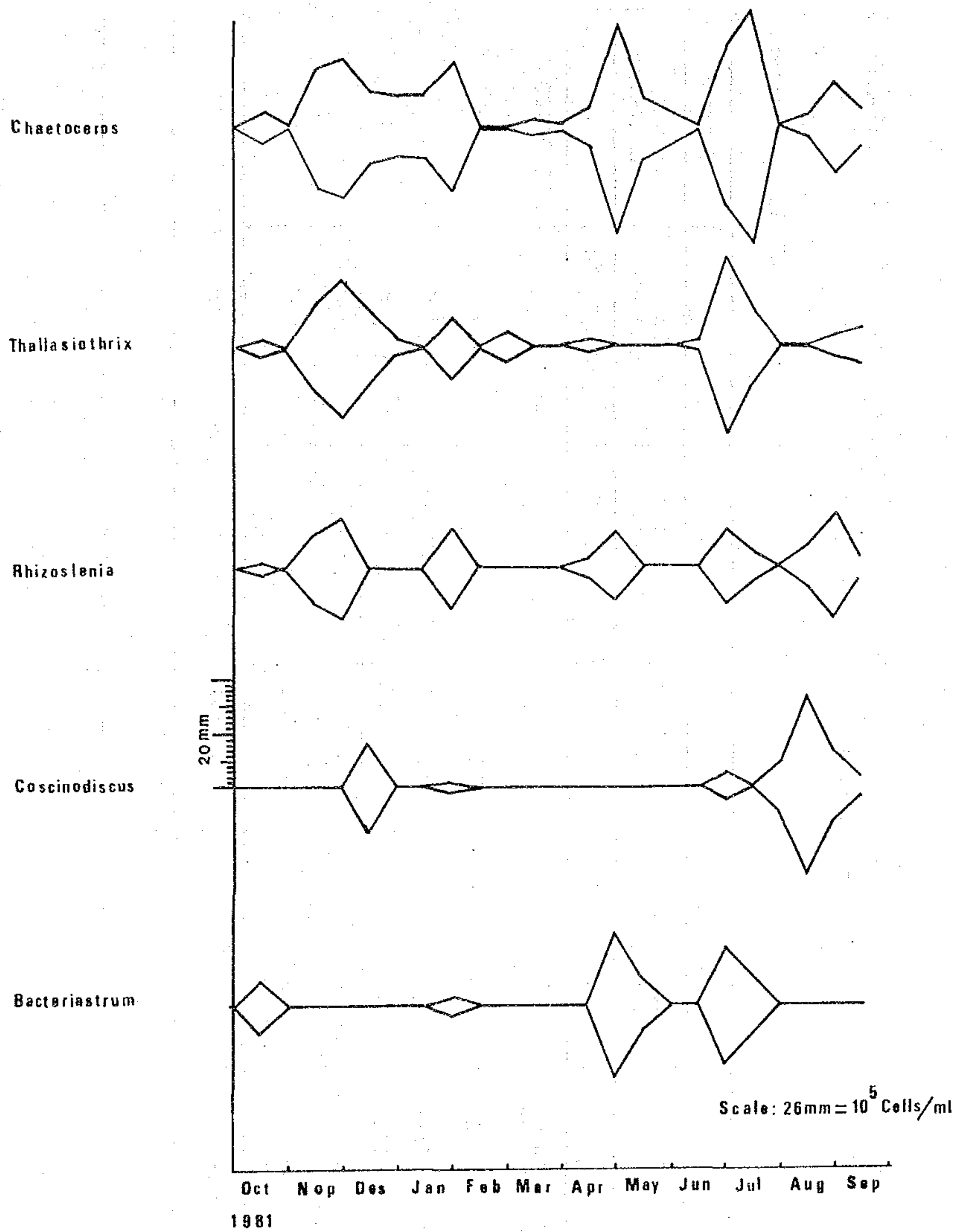

Fig 4 Phytoplankton at Pulo Tarahan Waters.

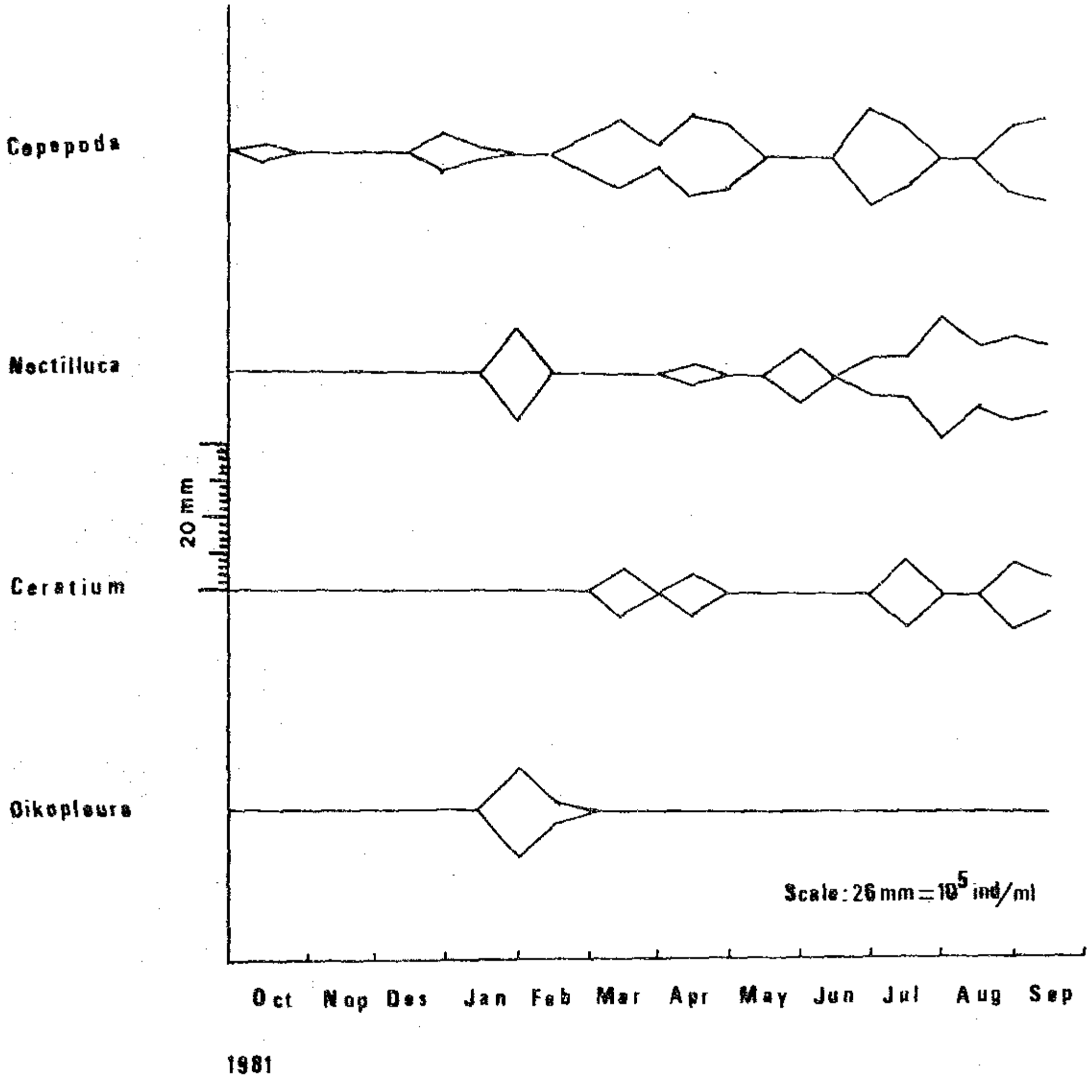

Fig. 5 Zooplankton at Pulo Tarahan Waters

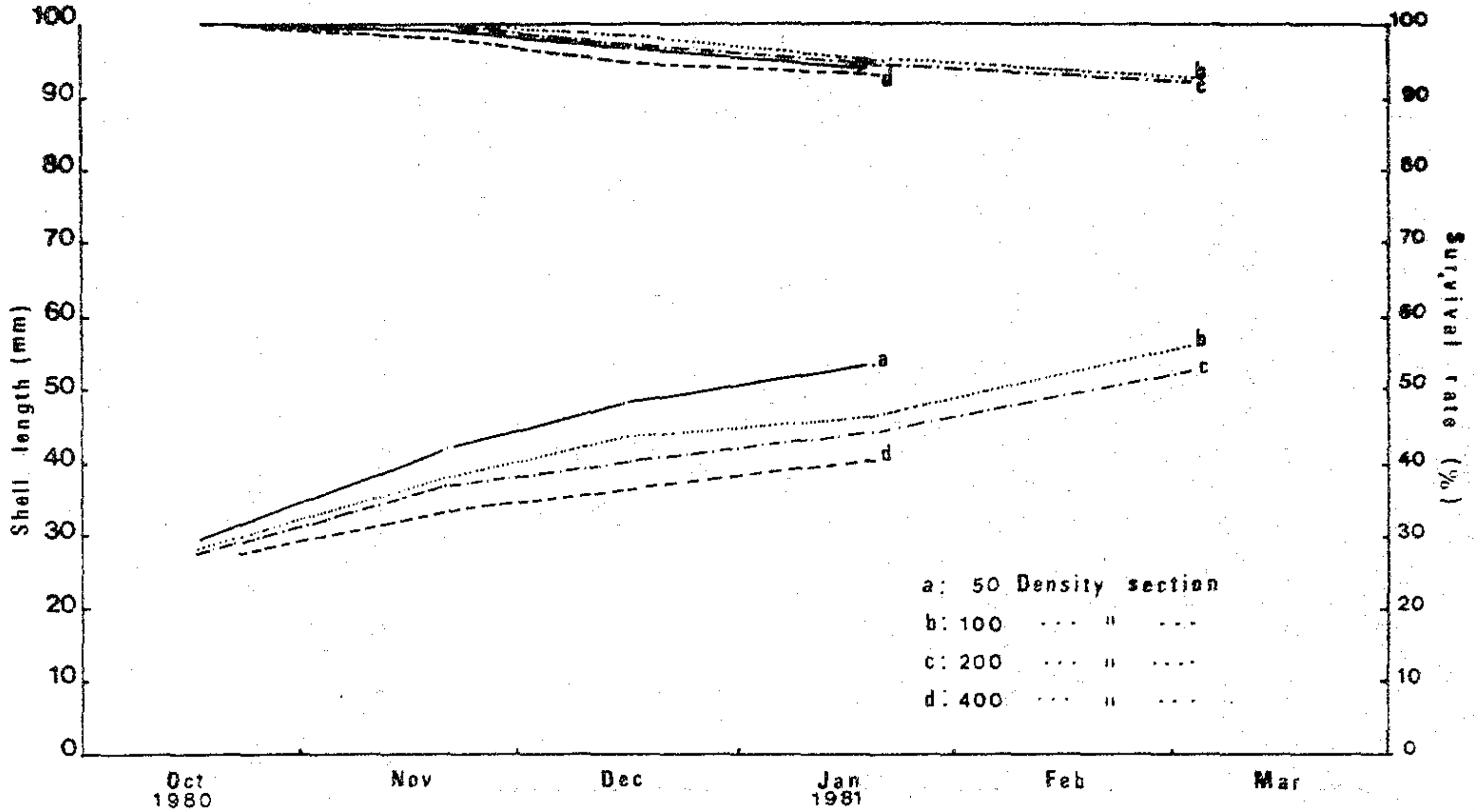

Fig. 6. Experiment the growth of <u>Mytilus viridis</u>. Mean growth of each section.

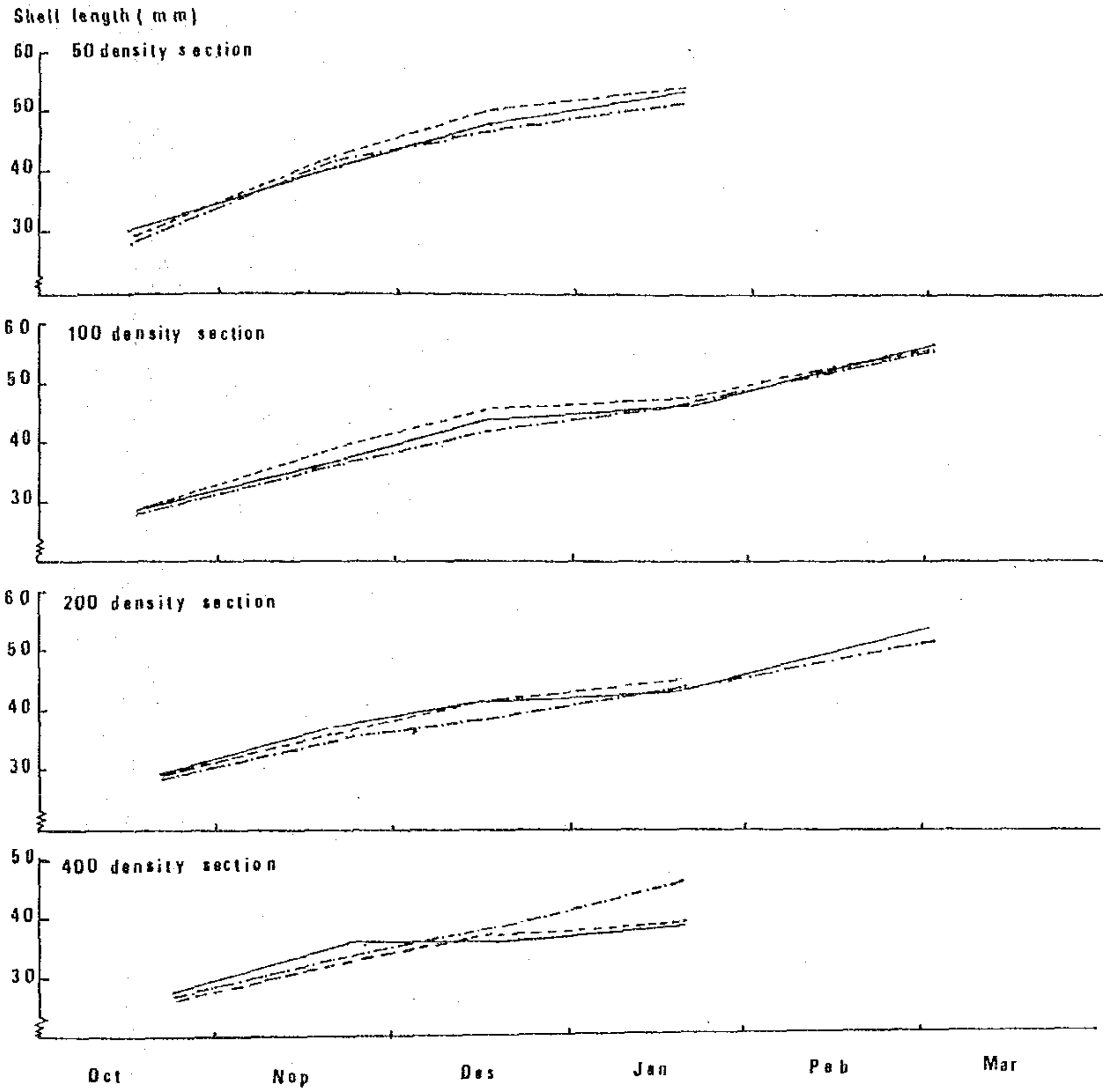

Fig.7. Growth of mytilus viridis (at the depth of 1,m 3,m 5,m)

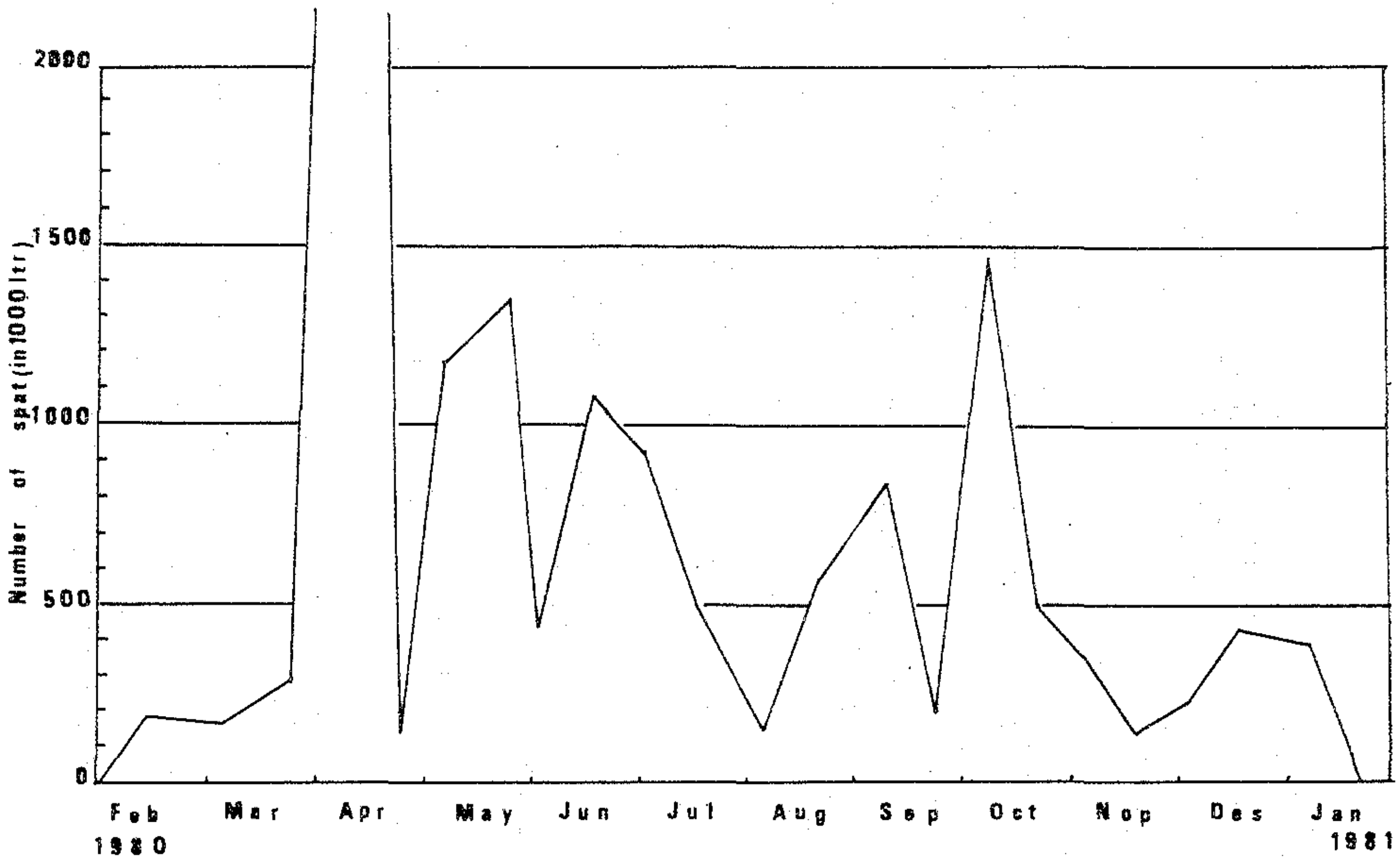

Fig 2 Seasonal fluctuation of the appearance of bivalve larvae in Banten Bay. (in 1,000)

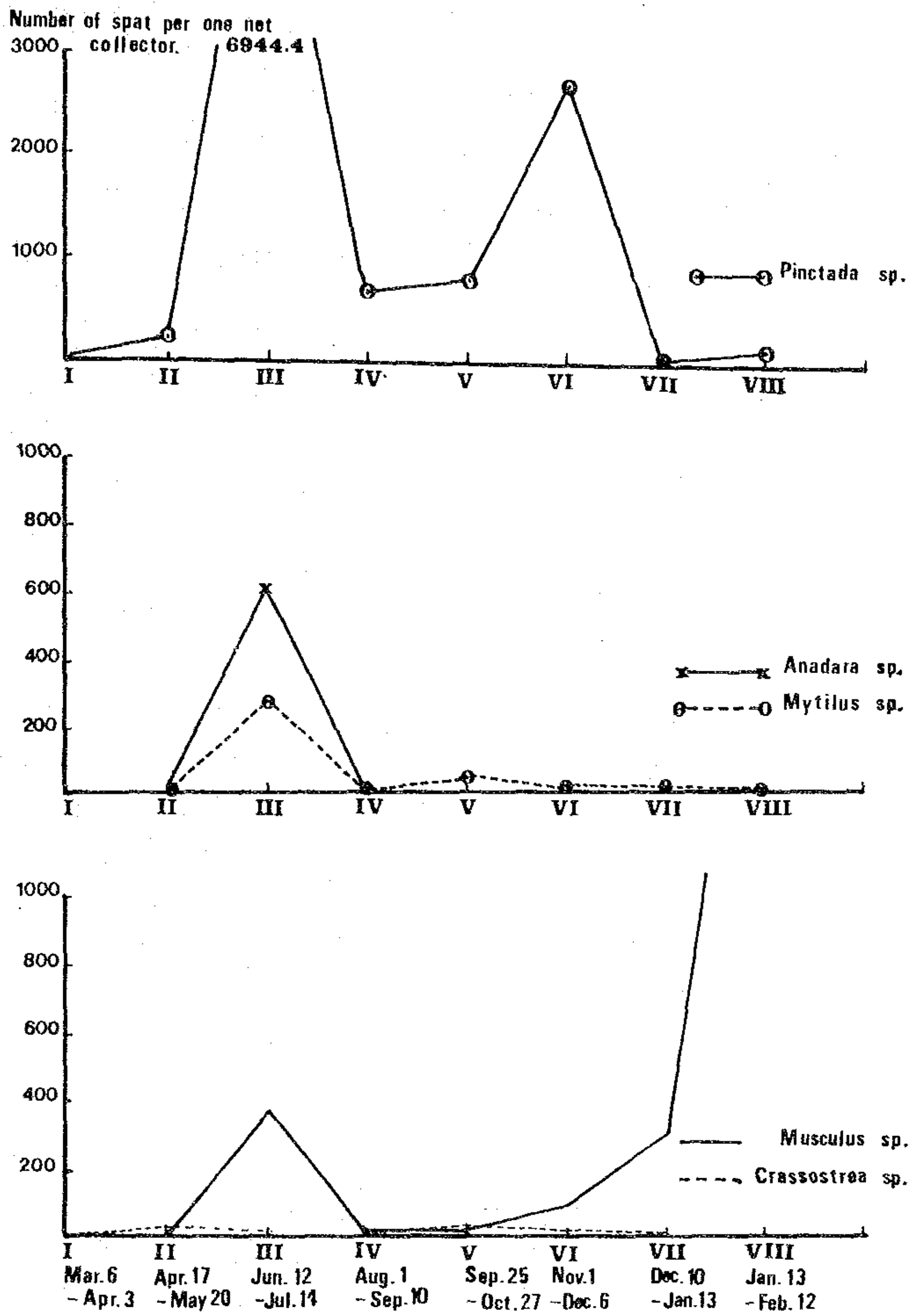

Fig 3. Number of each species of spat collected in Banten Bay. (Hosoya and Muchari, 1981 b)

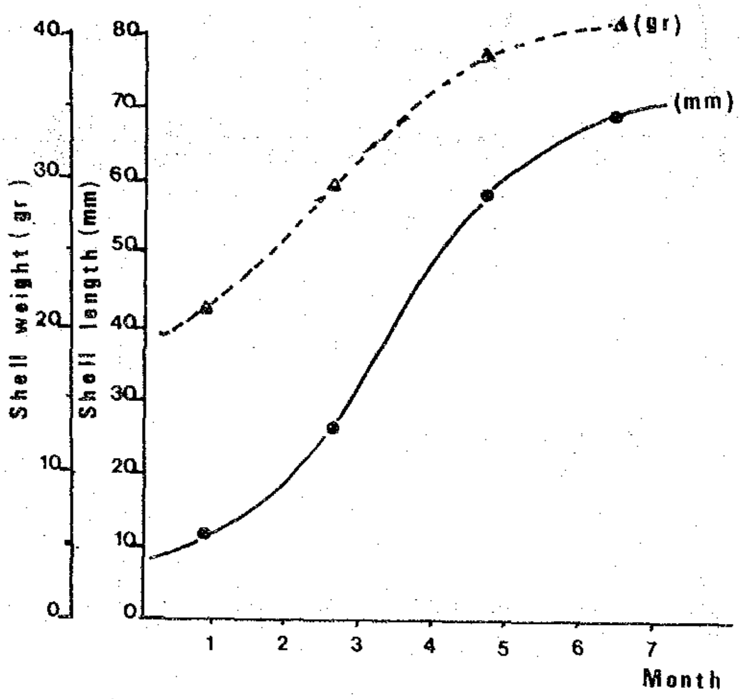

Fig. 8. Growth of Mytilus viridis in Banten Bay.

DEVELOPMENT OF THE NEW TYPE COLLECTOR, SO CALLED BUTTERFLY ROPE COLLECTOR, FOR THE GREEN MUSSEL CULTURE IN BANTEN BAY

Muchari* and Masahiro Hosoya**

ABSTRACT : Recent works enabled the green mussel culture in Banten Bay. But the method of resetting spat onto the culture rope is considered to be burden for the local fishermen concerning manpower and economics. New type collector, so called "Butterfly rope collector" was developed as a new method.

ABSTRAK : Perkembangan kolektor baru : Kolektor kupu - kupu dalam budidaya kerang hijau di Teluk - Banten.

Penelaahan kerang hijau di Teluk Banten telah menunjukkan keberhasilan budidayanya. Akan tetapi, metoda menempelkan kembali benih alami pada untaian tali pembesarannya masih dianggap pekerjaan yang berat bagi nelayan ditinjau dari kebutuhan tenaga dan nilai ekonomisnya.

Tipe kolektor baru yaitu kolektor kupu - kupu telah dikembangkan untuk lebih mendayagunakan teknik budidaya kerang hijau tersebut.

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INTRODCTION

In the process of the technical development on shellfish culture in Banten Bay, West Jawa, authors reported that environmental conditions of the bay were suitable for mariculture and for the natural spat collection of green mussel, oysters and ark shells (Hosoya and Muchari 1981 a and b).

Especially on the green mussel, Mytilus (Perna) viridis (Linne), authors developed the suspended culture method and reported that both the spat collection and the culture could be made in a big scale through the development of bamboo screen collector and the transplantation technique (Hosoya and Muchari 1981 c).

Thus, those studies enabled the green mussel culture in Banten Bay, but the method of resetting spat onto the culture rope, which widely used in the mussel culture in Spain, was considered to be a burden for local fishermen on manpower and economics.

Authors present here a brief report on the newly developed "Butterfly rope collector" which does not need the resetting treatment of the spat onto the culture rope.

Possibility of green mussel spat collection during May to July at the east part of Banten Bay was proved through the observation on the spat collection conducted from February 1980 to January 1981. Green mussel spat was attached more onto the collector set at 1m layer than onto that at 3m layer. And the dominant settlement of green mussel spat on the bamboo float observed at that time (Hosoya and Muchari 1981 b).

Waterstrat (1979) reported that the settlement of Mytilus edulis in the tank was observed intensively at depth of 0cm to 15cm with the percentage of more than 50% comparing the deeper layer. Same tendency was observed in the case of the natural spat collection of green mussel in this bay. And the bamboo was an effective substance for the green mussel spat collection since the dominant settlement of this species was observed on bamboo, while spat of ark shell and pearl oyster besides green mussel were attached on net type collectors. By those knowledge from the observation, the floating bamboo screen collector shown in Figure 1 was tried as the spat collector in 1981. And 6944 spat of green mussel per one squere meter were collected by this method. At the same time, the ecological succession on the collector was observed as follows; seaweeds first attached, barnacles second, Pinctada sp. third and after it grew and dropped, green mussel attached and finally grew into dominant (Hosoya and Muchari 1981 c). This phenomenon on Mytilus califonianus was also pointed out by Hewatt (1935).

At this point, spat collection method using bamboo screen was considered as an useful technique, but the easy method to reset the spat directly onto the culture rope was required.

Through the experiment, green mussel spat did not attach on the nylon rope and generally bivalve spat which had byssus prefered filamentous substances as the settlement substrate. Then new collectors made by net pieces and fiber bunchs which were into the culture rope were considered. These new collectors were tried in this experiment.

METHOD

Facilities were set at the surface layer by using bamboo floats. Three different materials, such as nylon net piece (8mm mesh, 25 x 7cm), "waring" net pieces (3mm mesh, 25 x 7cm) and nylon fiber bunch (25cm) which were inserted into the nylon culture rope with an interval of 15cm were used as the collector (Figure 2 and 3).

"Waring" net is the net material which is commonly used for the lift net fishery, so called "Bagan", and cheap and local made. The rope collector which nylon net piece were inserted was named on "butterfly" rope collector" from its figure. Experiment was conducted during March to May 1982 at the east part in Banten Bay.

RESULTS AND DISCUSSION

Results were shown in Table 1.

248 spat of green mussel attached onto the nylon net piece and 440 spat attached onto the nylon fiber bunch in an average number of spat per one piece or one bunch. And no spat attached onto "waring" net piece.

DISCUSSION

Result showed an interesting fact that green mussel spat did not attach to the "waring" net. Cause of this phenomenon is uncertain but seems to depend on the difference of materials or mesh sizes. Experience of the local fishermen might select "waring" net as the suitable materials of bagan fishery because there were no spatfall of bivalve onto this net.

The spat attached onto the nylon fiber bunch more than the nylon net piece but in the process of moving to the culture raft, a lot of the spat dropped on the nylon fiber bunch. It depends on the weakness of the fixation and the firm fixation can be seen on nylon net piece. Thus, considering the procedure, the nylon-net-piece type seems suitable as the collector.

The same size of net piece could collect almost same number of spat which ranged from 230 to 270. Number of attached spat differs by materials and shapes. Study on this point can clarify the technique which controls the number of spat at the spat collection.

This technic seems to bring the easy and economical method for resetting and thinning spat of green mussel.

ACKNOWLEDGMENT

The authors wish to express deepest appreciation to all the staff of Indonesia-Japan Mariculture Research and Development Project for their assistance and for their kind advice in the preparation of the manuscript.

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Table 1. Average number of green mussel spat attached on to one net piece and one fiber bunch of the collector.

Type of collector	number of spat
Nylon net piece (8mm mesh)	248
"Waring" net piece (3mm mesh)	0
Nylon fiber bunch	440

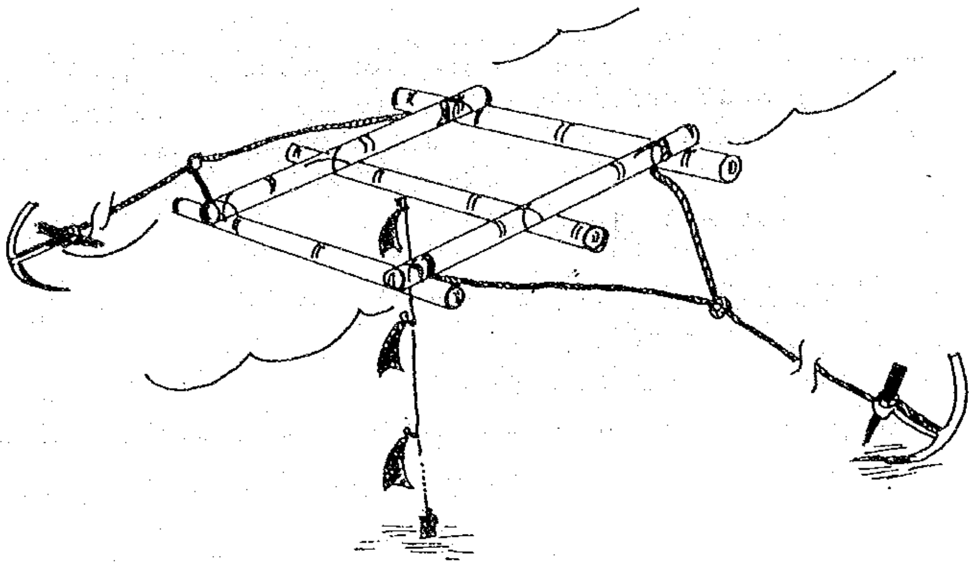


Fig. 1a Onion bag (nylon net) collector

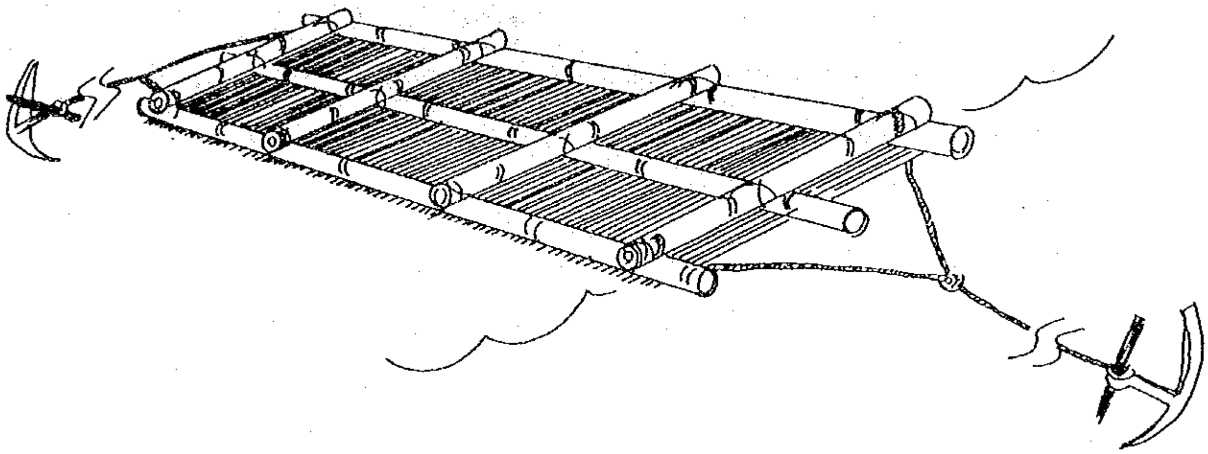


Fig. ~~1b~~ 1 Floating bamboo screen collector

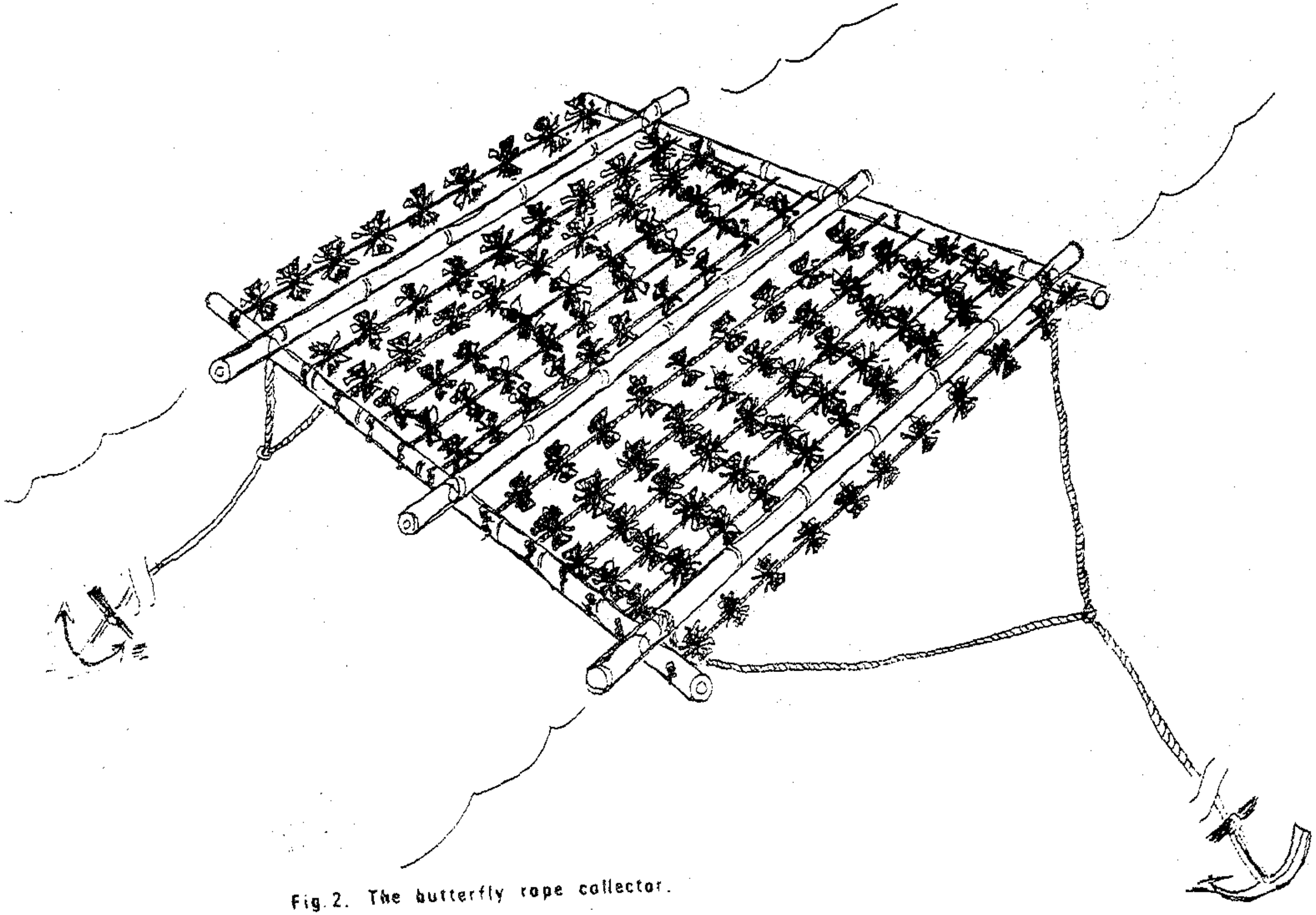
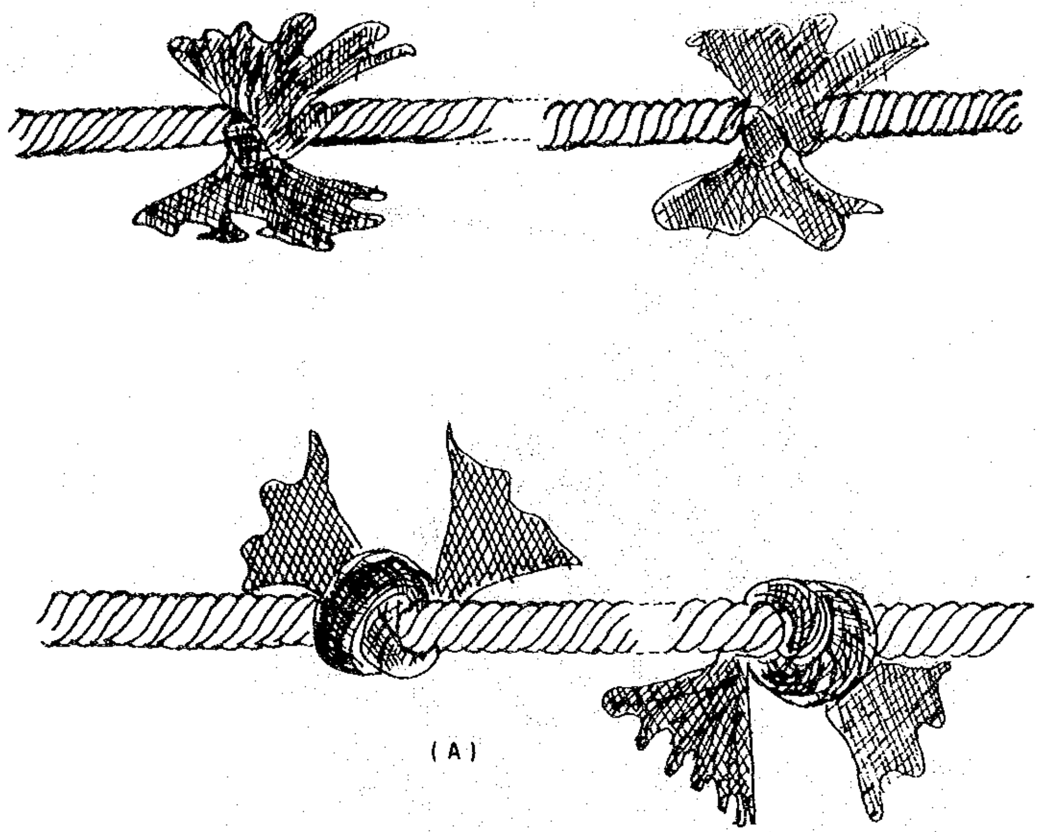
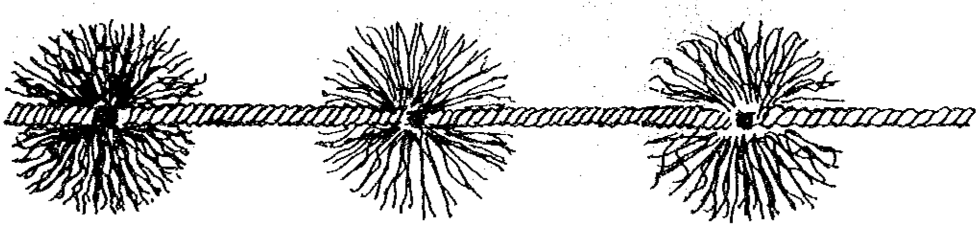


Fig.2. The butterfly rope collector.



(A)



(B)

Fig.3. Butterfly rope collector
A; Nylon net piece
B; Nylon fiber bunch

BOTTOM CONDITION OF BANTEN BAY WITH SPECIAL REFERENCE TO THE SILT CONTENT DISTRIBUTION

1) Muchari and 2) Masahiro Hosoya

ABSTRACT : As one of the basic studies of the environmental conditions for mariculture in Banten Bay, survey on the bottom conditions, especially referring to the analysis of mud particles, was conducted twice during the period of October to December 1981 and May to June 1982 for making distribution maps of bottom silt contents of Banten Bay.

The observation was made at seventy-nine points chosen out of the points fixed at each thirty second of latitude and longitude. The bottom mud of each point was sampled by Eikman-Barge sampler and was sifted down by sieves of six different mesh sizes of 2mm, 1mm, 0.5mm, 0.25mm, 0.105mm and 0.053mm. Each sample was dried and each dry weight was represented by the integral curve of weight composition, and its median size was divided into the following seven catagories : 1) granule, 2) very coarse, 3) coarse, 4) medium sand, 5) fine sand, 6) very fine sand and 7) silt.

Most of the bottom in Banten Bay was silt. The silt contents distribution maps showed that the sandy areas were limited to the west part of the Pontang Estuary, the east shore of the Bay near Linduk Estuary, Cengkok Estuary, the southern part of the Panjang Island, around the Kubur Island and northern part of Tanjung Kapo. Sandy area of the east part of the bay was expanded in the rainy season. It seems of the influence of two rivers located at the east part of the bay. And possibility on the expansion of the natural shellfish ground were pointed out.

ABSTRAK : Pengamatan penyebaran partikel lumpur didasar perairan Teluk Banten.

Oleh : Muchari Maan [1] dan Masahiro Hosoya [2]

Penelitian dasar perairan Teluk Banten khususnya analisa penyebaran partikel lumpurnya telah dilaksanakan pada bulan Oktober hingga Desember 1981 dan bulan Mei hingga Juni 1982.

Pengamatan dilaksanakan di 79 tempat pengambilan contoh. Contoh lumpur diambil dengan alat Eikman-Barge dan disaring dengan enam saringan yang mata saringannya masing-masing : 2.000 mm, 1.000 mm, 0.500 mm, 0.250 mm, 0.105 mm, 0.053 mm. Tiap contoh kemudian dikeringkan dan ditimbang berat keringnya. Hasilnya dibedakan dalam tujuh katagori yaitu : 1) Kerikil 2) Pasir Kasar sekali 3) Pasir Ka sar 4) Pasir 5) Pasir Halus 6) Pasir halus sekali dan 7) Debu.

Dasar perairan Teluk Banten sebagian besar terdiri dari debu. Dasar yang berpasir tersebar di sebelah barat muara Kali Pontang, sebelah timur muara Kali Soge (Linduk), dimuara Kali Cengkok, sebelah selatan Pulau Panjang, sekitar Pulau Kubur dan sebelah utara Tanjung Kopo. Dasar yang berpasir dibagian timur teluk meluas selama musim hujan. Kemungkinan perluasan hamparan kerang-kerangan dibahas pula dalam tulisan ini.

INTRODUCTION

Mariculture Research and Development Project by the goverment of Indonesia and Japan started in August 1978 for the development on fin-fish and shellfish culture in Banten Bay.

Hosoya and Muchari (1981) reported on the oceanographic conditions in this bay that Banten Bay was open-type and the current inflow from the open sea seemed to control its environment, and it was assumed that the environment of the bay was suitable for mariculture as a whole except for the part of coastal area.

Shellfish distribution generally depends on bottom condition since most of them are benthic. Kan-no (1966) mentioned on his ark shell study in Senday Bay that the ark shell fishery ground corresponded to the silt region. The shell crowded near the muddy line-zone. From the ecological point of view of the shellbed constitution, it seemed that the hydrographical silt-deposition mecanism, the concentration action of the muddy line which effected the settlement of the young, and oxidized condition were important factors for luxuriance of shell.

Banten Bay seems to contain much silt. River and coastal water are colored brownish and contain a lot of muddy particles. Influences of river water inflow seemed to be occured in the rainy season.

For the purpose to observe the influence of abundant muddy paricles from the river, survey on bottom conditions of Banten Bay with special reference to the silt content distribution was conducted twice, that is, before and after rainy season.

MATERIAL AND METHODS

The survey of bottom condition, especially referring to analysis of mud particles was conducted twice during the period of October to December 1981 and May to June 1982. Observation was made at seventy-nine points chosen out of the point fixed at each 30 second of latitude and longitude (Fig. 1 and 2). Mud of each point was sampled by Eikman-Barge bottom sampler No. 2007-B size of 20x20x20cm. Approximately 20g of mud was sampled after mixed well and the water content was measured by using the drying oven, Type SS IKD Scientific Co. Ltd. Note : The constant weight was occured after 2 hours drying at 110°C (Fig 3).

Approximately 150g of mud sample was sifted down by six sieves, mesh sizes of 2.000mm, 1.000mm, 0.500mm, 0.250mm, 0.105mm and 0.053mm. After sifted down, samples were dried at 110°C for two hours and each dry weight was represented by integral curve of weight composition, and its median size was divided into the following seven categories : 1) granule, 2) very coarse, 3) coarse, 4) medium sand, 5) fine sand, 6) very fine sand and 7) silt.

RESULTS

1. Result of the survey during the period of October to December 1981, before rainy season (Fig. 4).

   1.1. Coarse sand was limited in southern part of Panjang Island.

   1.2. Medium sand were found in southern part of Panjang Island, southern part of Kubur Island, Pelabuhan estuary and northern part of Tanjung Kapo.

   1.3. Fine sand were found in Domas estuary, Cingkok estuary, southern part of Panjang Island, southern part of Kubur Island, Pelabuhan estuary and northern part of Tanjung Kapo. 90%, 70% and 50% of silt line were shown in the Fig. 4.

2. Result of the survey during the period of May to June 1982, after rainy season. Sandy area was expanded in the east part of the Bay. 90%, 70% and 50% silt lines were shown in the Fig. 5.

DISCUSSION

Most part of the bottom in Banten Bay is covered by silt. This silt accumulation might come from the inflow of the rivers of which water contains abundant buownish muddy particles. Silt area (silt content was over 50%) occupied over 80% of the area in the bay. Silt accumulation reached to over 30cm and no animal could obtain as a Meiobenthos during the survey. Standard of the quality for fishery waters (Japan 1965) showed that the excessive silt accumulation was unsuitable as the water environment for mariculture because it prevents the settlement of larvae. Thus the most area of the bay was considered as the area for shellfish culture ground. Fortunately, the shellfish culture method can prevent the unsuitable influences from the bottom and this technique should be applied for the usage of the silt area in this bay.

Sandy areas were limited in this bay. Before the survey, it seemed that silt was expanded by the rainfall of the rainy season but the result showed the expansion of sandy area occured near the estuarine area of Pontang and Soge rivers. In those area, the silt expansion occured distinctly during the two surveys before and after rainy season. This result shows the influence of those two rivers and in fact the accumulation of the sand was observed near the estuarine after the rainy season.

Those sandy area duplicated to the shellfish distribution area which had been observed in the shellfish distribution survey conducted in 1981 (unpublished, Fig. 6).

ACKNOWLEDGEMENT

The authors wishes to express deepest appreciation to all the staff of Indonesia-Japan Mariculture Research and Development Project for their kind advice and assistance.

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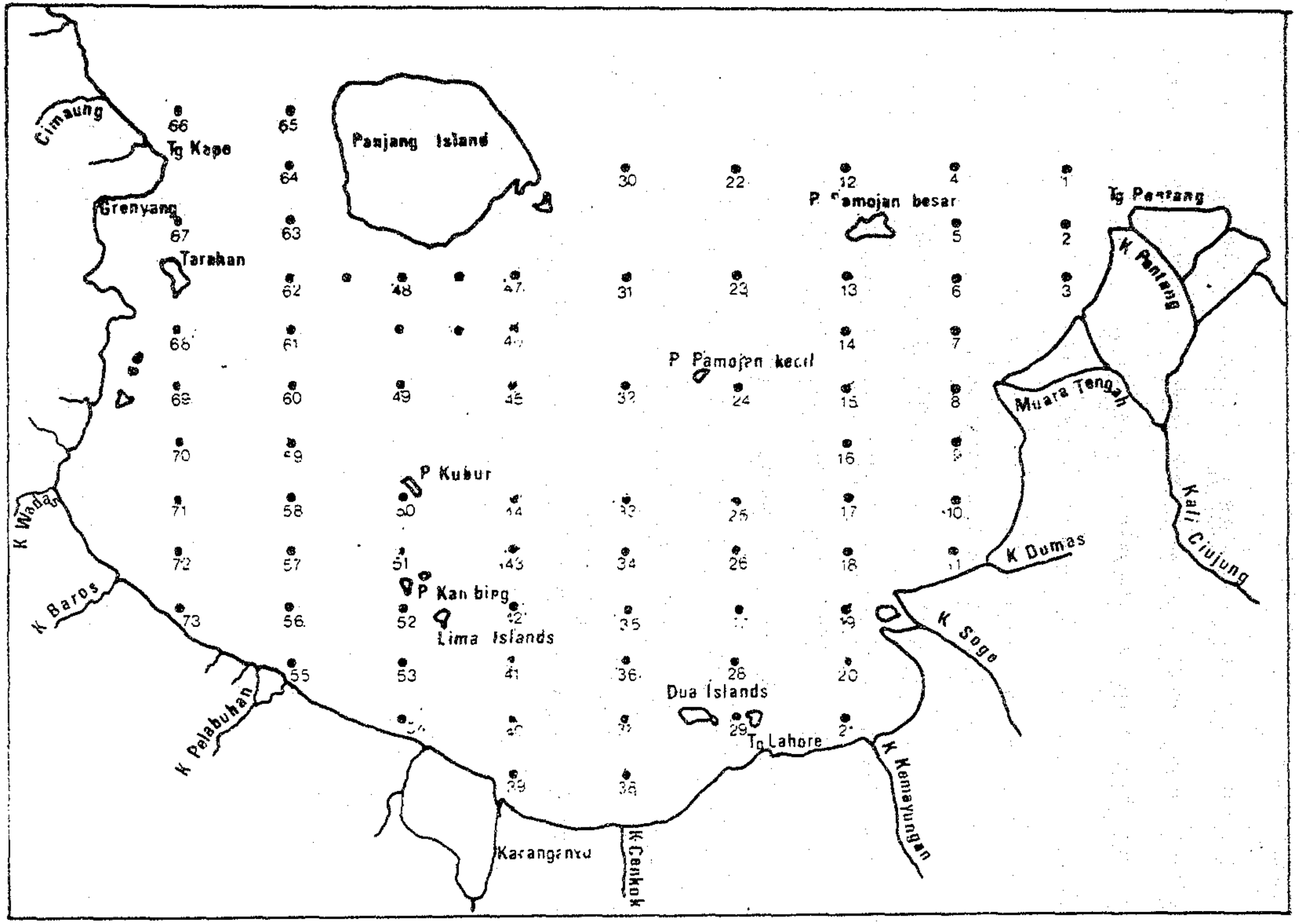


Fig. 1 Stations observed on the first survey of bottom condition in Banten Bay, October 1981.

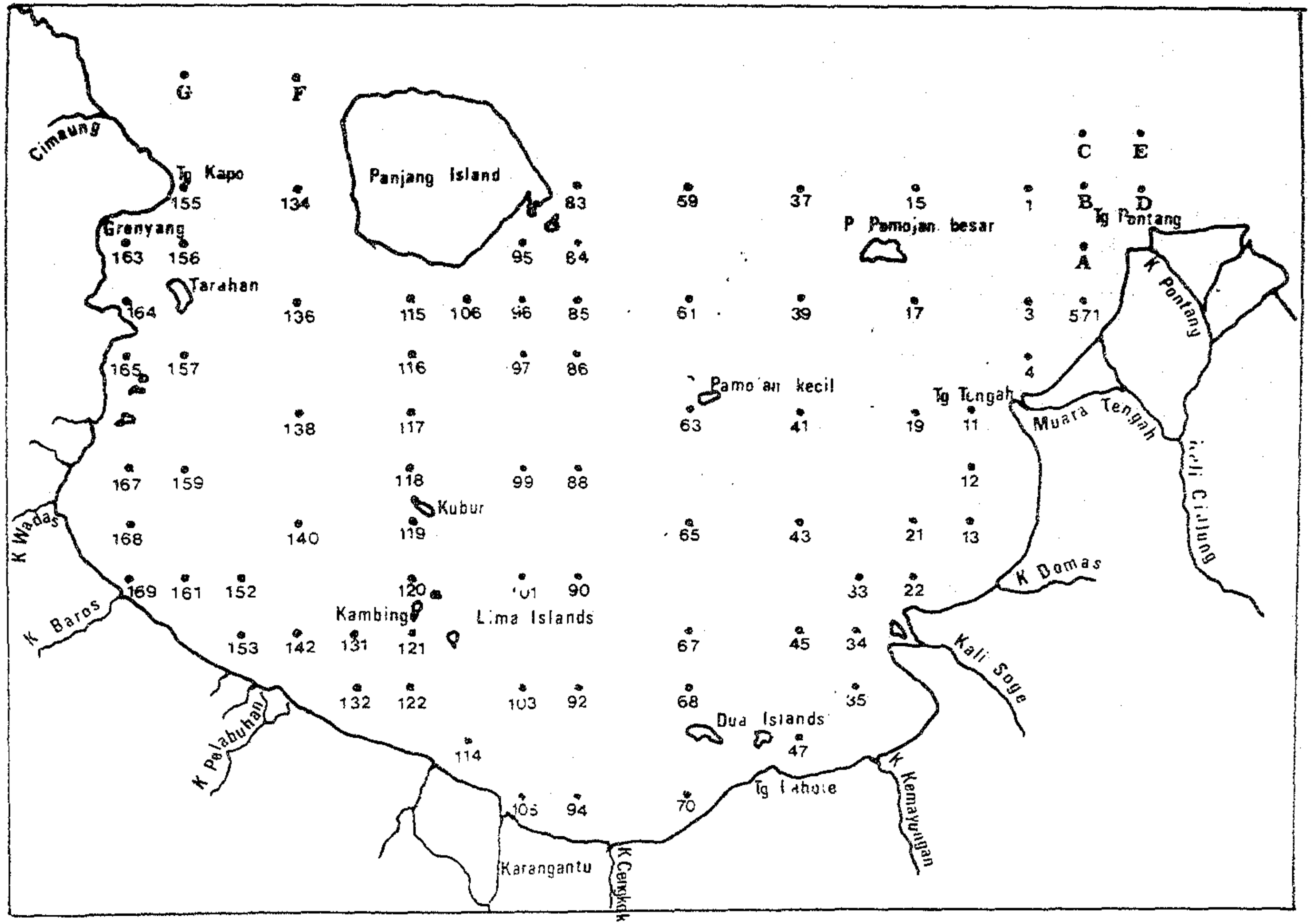
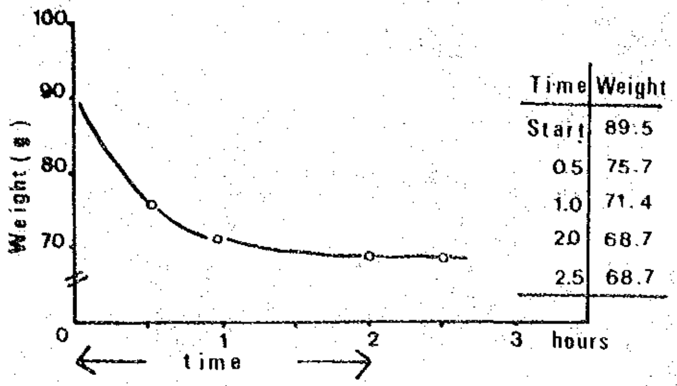


Fig.2. Stations observed on the second survey of bottom condition in Banten Bay, May 1982.



Time	Weight
Start	89.5
0.5	75.7
1.0	71.4
2.0	68.7
2.5	68.7

Fig. 3. Time for constant weight.

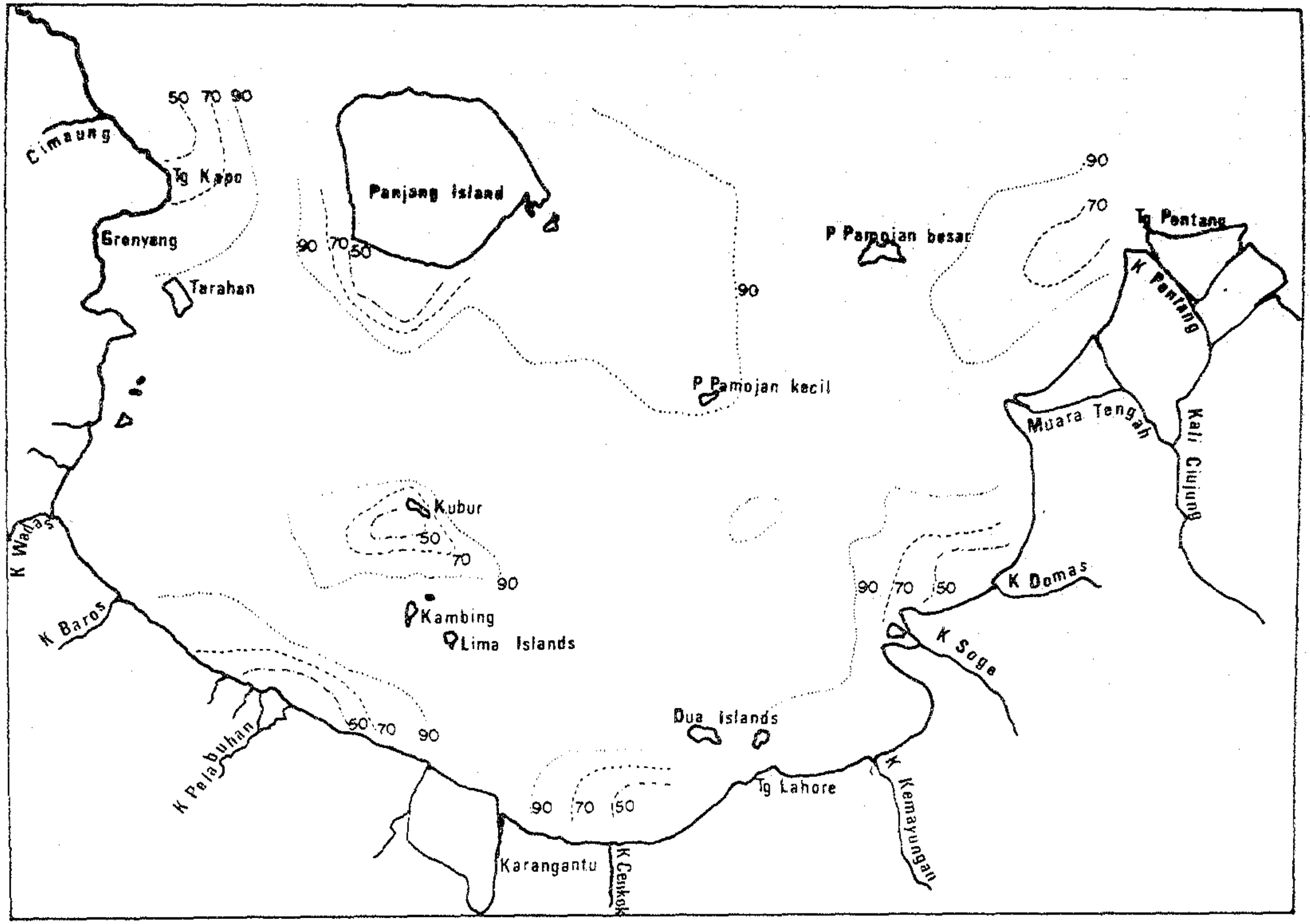


Fig 4. Silt content distribution in Banten Bay, October - December 1981 (before rainy season)

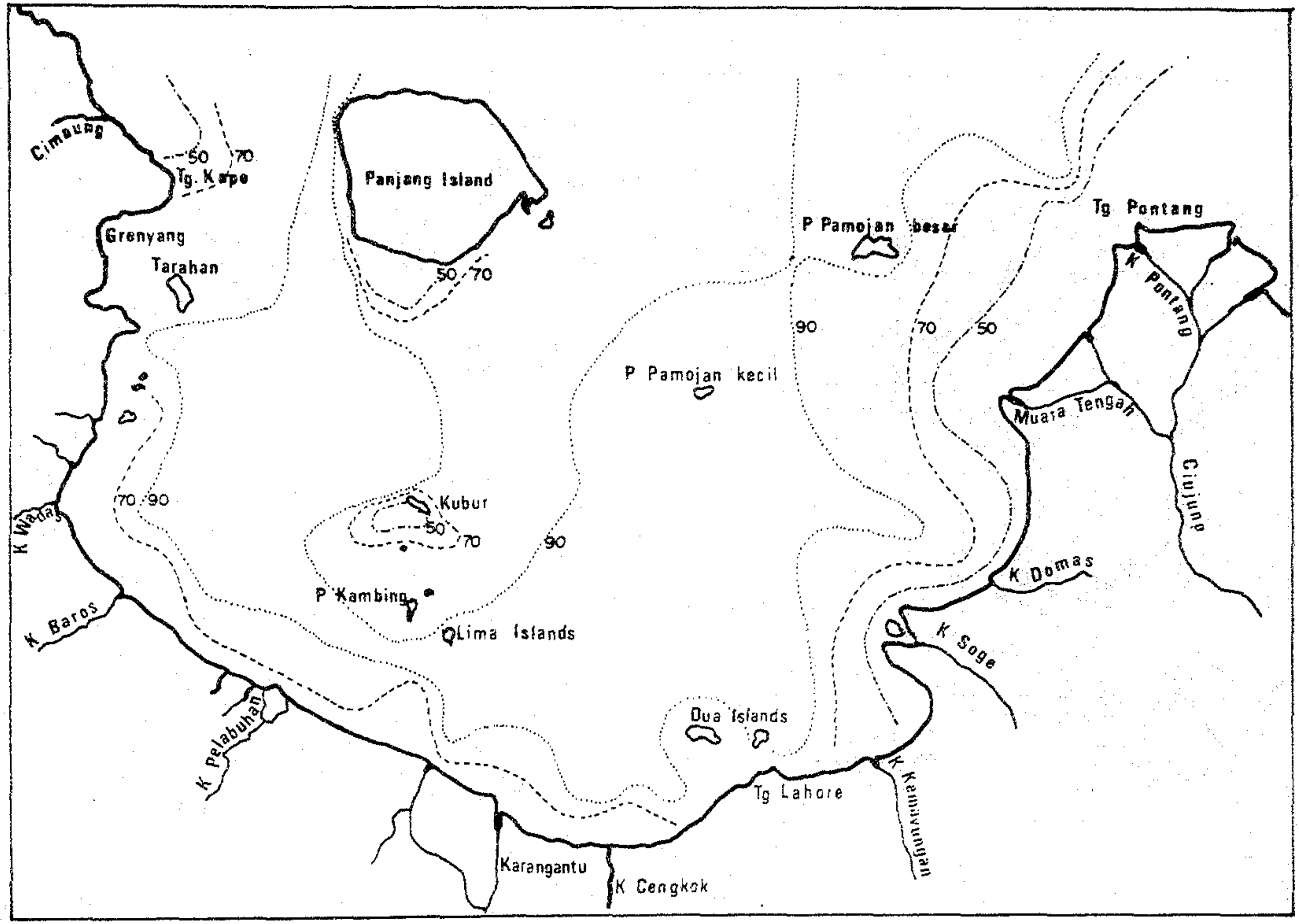


Fig 5. Silt content distribution in Banten Bay, May – June 1982 (after rainy season)

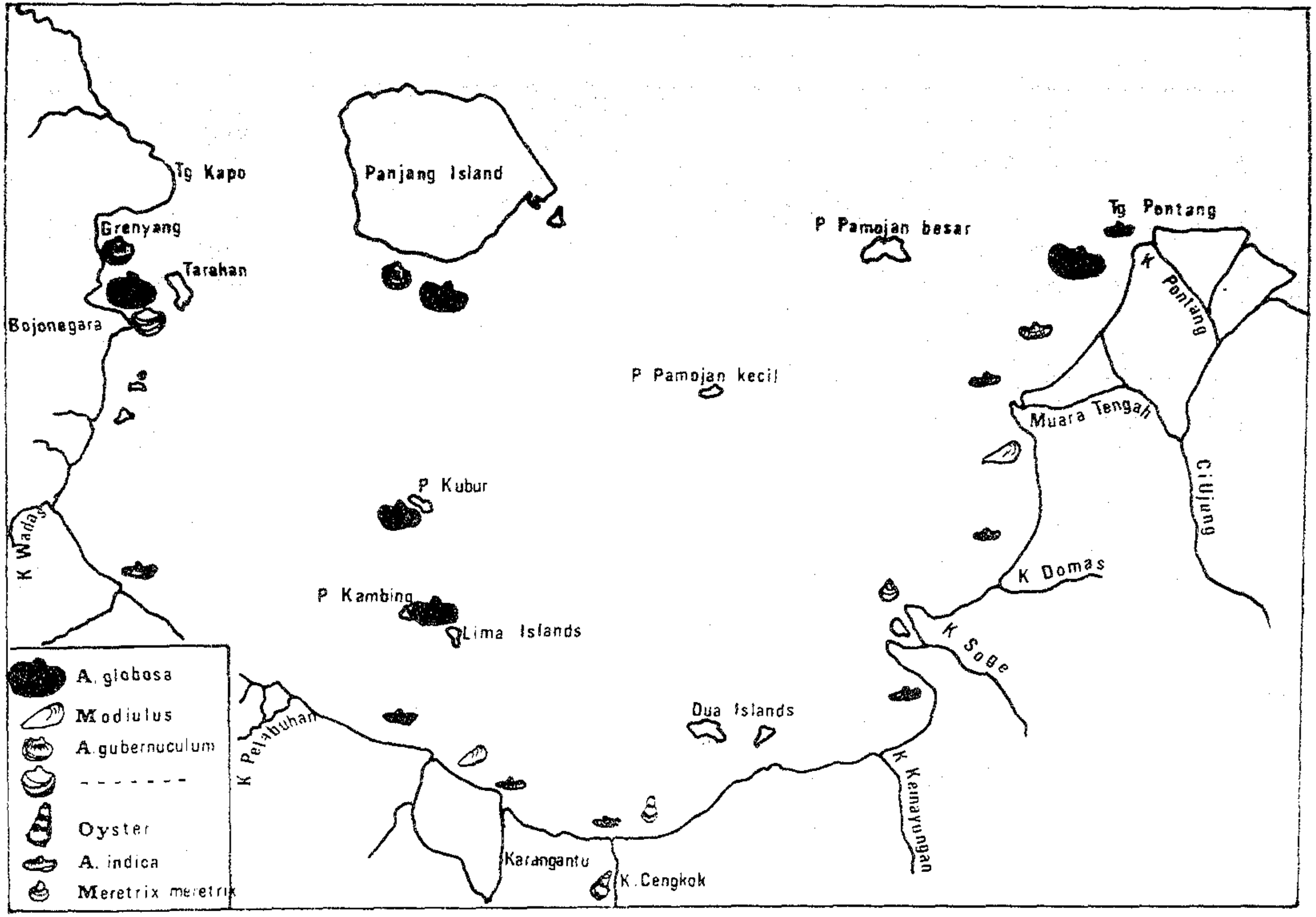
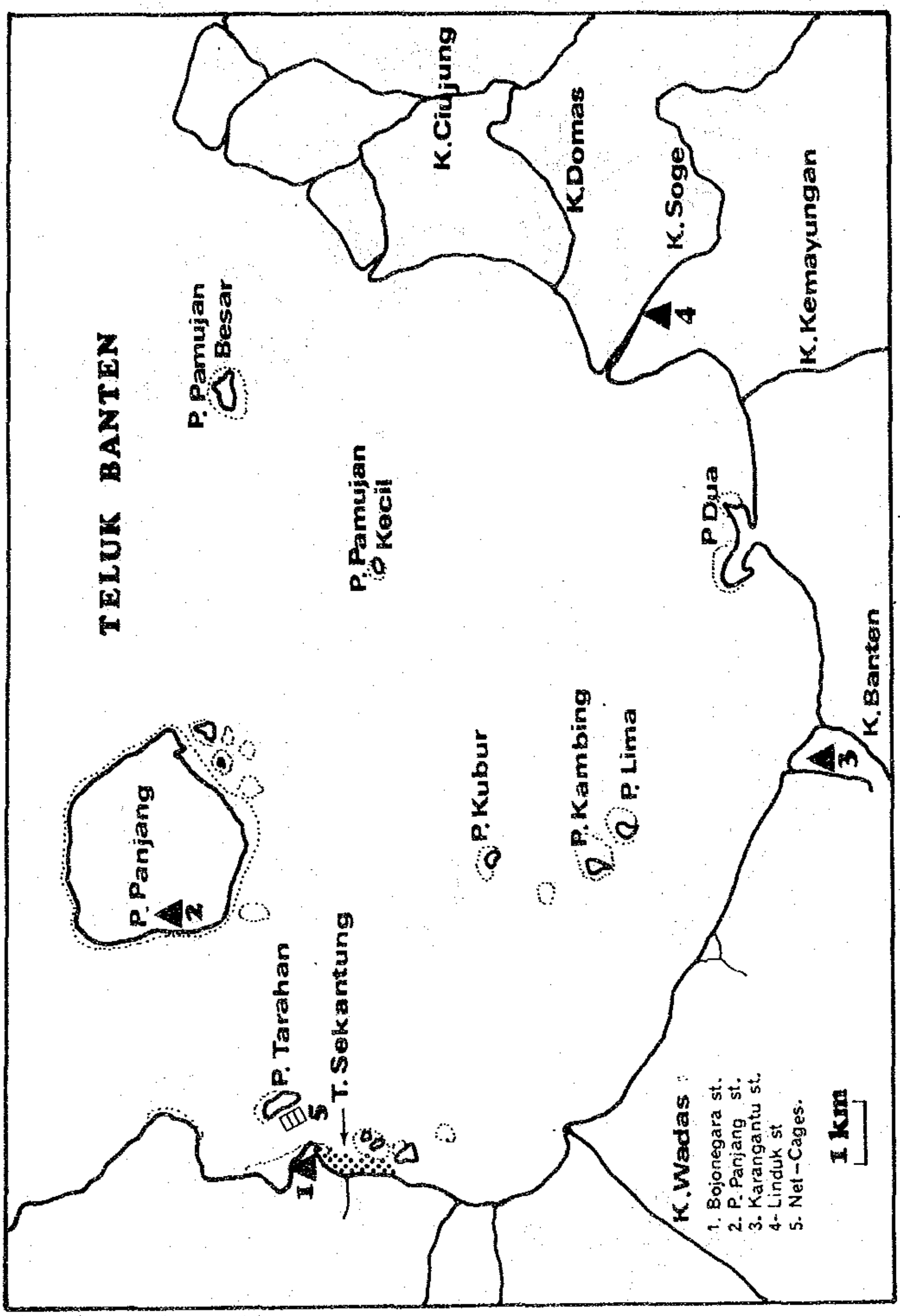


Fig 6 Shell distribution in Banten Bay, March to June 1981.


TELUK BANTEN
P. Pamujan Besar
P. Pamujan Kecil
K. Ciujung
K. Domas
K. Soge
K. Kemayungan
P. Dua
K. Banten
P. Panjang
P. Kubur
P. Kambing
P. Lima
P. Tarahan
T. Sekantung
K. Wadas
1. Bojonegara st.
2. P. Panjang st.
3. Karangantu st.
4- Linduk st
5. Net-Cages.
1 km

GROWTH RATE AND FIVISION PERIODICITY OF THREE MARINE DIATOMS COLLECTED FROM GOKASHO BAY, JAPAN

Mustahal* and Tsuneo Honjo**

ABSTRACT

Growth rate and division periodicity of three diatoms had been studied under laboratory condition. Skeletonema costatum, Chaetoceros sp, and Rhizosolenia sp were isolated from natural water. Diatoms were cultured in 0.4-ml vessels and 100-ml flasks.

Average growth rates of Skeletonema costatum was 0.66 $div.d^{-1}$ both in 0.4-ml vessels and 100-ml flasks. Average growth rate of Chaetoceros sp was 0.55 $div.d^{-1}$ in 0.4-ml vessels and 0.68 $div.d^{-1}$ in 100-ml flasks, respectively. Average growth rate of Rhizosolenia sp was 0.50 $div.d^{-1}$ in 0.4-ml vessels and 0.68 $div.d^{-1}$ in 100-ml flask. The diatoms devided both in light and dark regimes.

Abstrak: Laju pertumbuhan dan periode pembelahan pada tiga diatoma yang diisolasi dari Teluk Gokasho, Jepang. Oleh: Mustahal * dan Tsuneo Honjo **

Laju pertumbuhan dan periode pembelahan pada tiga diatoma telah dipelajari dalam laboratorium. Skeletonema costatum, Chaetoceros sp, dan Rhizosolenia sp diisolasi dari air laut. Diatoma tersebut kemudian ditumbuhkan dalam tabung-tabung berkapasitas 0,4-ml maupun dalam erlenmeyer 100-ml. Rata-rata laju pertumbuhan Skeletonema costatum 0,66 pembelahan/hari dalam tabung 0,4-ml maupun erlenmeyer 100-ml. Laju pertumbuhan Chaetoceros sp 0,55 dan 0,68 pembelahan/hari masing-masing dalam tabung 0,4-ml dan erlenmeyer 100-ml

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Laju pertumbuhan Rhizosolenia sp dalam tabung 0,4-ml dan erlenmeyer 100-ml rata-rata masing-masing adalah 0.50 dan 0.68 pembelahan/hari. Diatom membelah pada waktu terang dan gelap.

INTRODUCTION

Since many years, batch culture method had been widely used for studying the autecological relationship between specific growth rate and environmental variables in diatoms. The method is using acclimatized cells cultured in aged enriched seawater (WERNER, 1977, DROOP, 1973, EPPLEY, 1977, PAASCHE, 1973, JITTS, et al., 1964, HIRATA ,1975). HONJO and TABATA, (1985) found a better method for estimating the specific growth rate and division periodicity by culturing newly isolated cells in enriched intact seawater. Moreover, they demonstrated higher growth rate of newly isolated Olithodiscus luteus in their method than that of the previous method.

In present experiment, we observed the specific growth rate and division periodicity of three diatoms collected from Gokasho Bay Japan. The culture medium used in this experiment was intact filtered seawater enriched with Norimax solution, and the medium of Guillard 'f'.

MATERIAL AND METHOD

During from 24 September to 22 October 1985, samples from surface seawater were collected from station 'A' in Gokasho Bay, Japan. Three diatoms Skeletonema costatum, Chaetoceros sp and Rhizosolenia sp were isolated with micropipette under microscope. Isolated cells were individually inoculated into the tissue culture vessels (NUNC®) consist of 96 chamber of 0.4-ml each. The medium in each chamber was adjusted to 0.1-ml. The medium was made from filtered seawater in which the cells were isolated. The seawater sample was filtered with 0.45 um membran filter unit (MILLEX-HV, Millipore Corporation) added 0.01 ml of Norimax® solution (Chemical Dojin Co) into 10-ml of filtered seawater.

After inoculation, the culture vessel kits were kept at 24^{o}C under 3.000 lux of "cool white" fluorescent lamp. Light oeriodicity was adjusted as 14 hours light and 10 hours dark. The number of cells in each chamber was counted under the inverted microscope.

The grown cells of diatoms were transfered into 30-ml medium of Guillard'f' in 100-ml flasks, and cultured in similar condition. The cells were counted twice a day. The growth rate (k) were calculated using a formula described by HONJO and TABATA, (1985):

$$\underline{k} = \ln (C_1/C_o).1/(t_1-t_o).\ln 2$$

where, C_o and C_1 were cell numbers times t_o and t_1.

RESULT

The isolated diatom cells cultured in small vessels showed different growth rates. Minimum and maximum growth rates of Skeletonema costatum, Chaetoceros sp, and Rhizosolenia sp were 0.32-1.18, 0.52-0.92, and 0.42-0.55 div.d^{-1}, respectively. Skeletonema costatum, Chaetoceros sp and Rhizosolenia sp showed the average of growth rates as 0.66, 0.55 and 0.50 div.d^{-1}, respectively (Figure 2).

On the other hand, the average growth rates of Skeletonema costatum Chaetoceros sp and Rhizosolenia sp cultured in 30-ml flask were 0.66, 0.68 and 0.68 div.d^{-1}, respectively(Figure 3). The diatoms were devided through both light and dark regimes. However, the division rate of Skeletonema costatum was higher in light period than in dark period (Figure 3).

DISCUSSION.

Diatom is known as an important food organism in mariculture. The use of cultured marine diatoms for cultivation of echinoderms, mollusc, and shrimp is initiated in 1910 by ALLEN and NELSON (WERNER ,1977). many workers also have been studying the growth rate of diatoms and its relationship to the environmental factors (BRAAUD ,1937 in WERNER, 1977). They were usually used synthetic medium or aged enriched seawater as the medium, and used acclimatized cells in laboratory condition for estimating growth rate and division periodicity in natural waters (DROOP, 1973, JITTS, et al., 1964, EPPLEY, 1977, WERNER, 1977, HIRATA, 1975). In the present study, the newly isolated diatom cells were cultured directly without adaptation period. These diatoms may still have their natural feature before they make an adaptation to the cultured medium.

The growth rates of Skeletonema costatum, Chaetoceros sp, and Rhizosolenia sp usually observed by many workers using flask batch culture. The diatoms growth rates between 0.34-4.2 have been previously reported (JITTS et al., 1964, McALLISTER, et al., 1964, DROOP, 1970, PAASCHE, 1973, TANAKA, 1984). In the present study cultivation of Skeletonema costatum, Chaetoceros sp, and Rhizosolenia sp in small vessels of 0.4-ml showed average growth rates of 0.66, 0.55 and 0.50 div.d^{-1}, respectively. Moreover, in flask culture experiment using Guillard 'f' medium the growth growth rates of Skeletonema costatum, Chaetoceros sp and Rhizosolenia sp was found as 0.66, 0.68 and 0.68 div.d^{-1}, respectively. Although these cell division rates can not be compared directly to the previous results because of difference of the cultural condition and growth medium, the results obtained in the present study suggest that those three diatoms cells devided through light and dark regimes. Anyhow, we found that the cells number in light period was higher than that of dark period.

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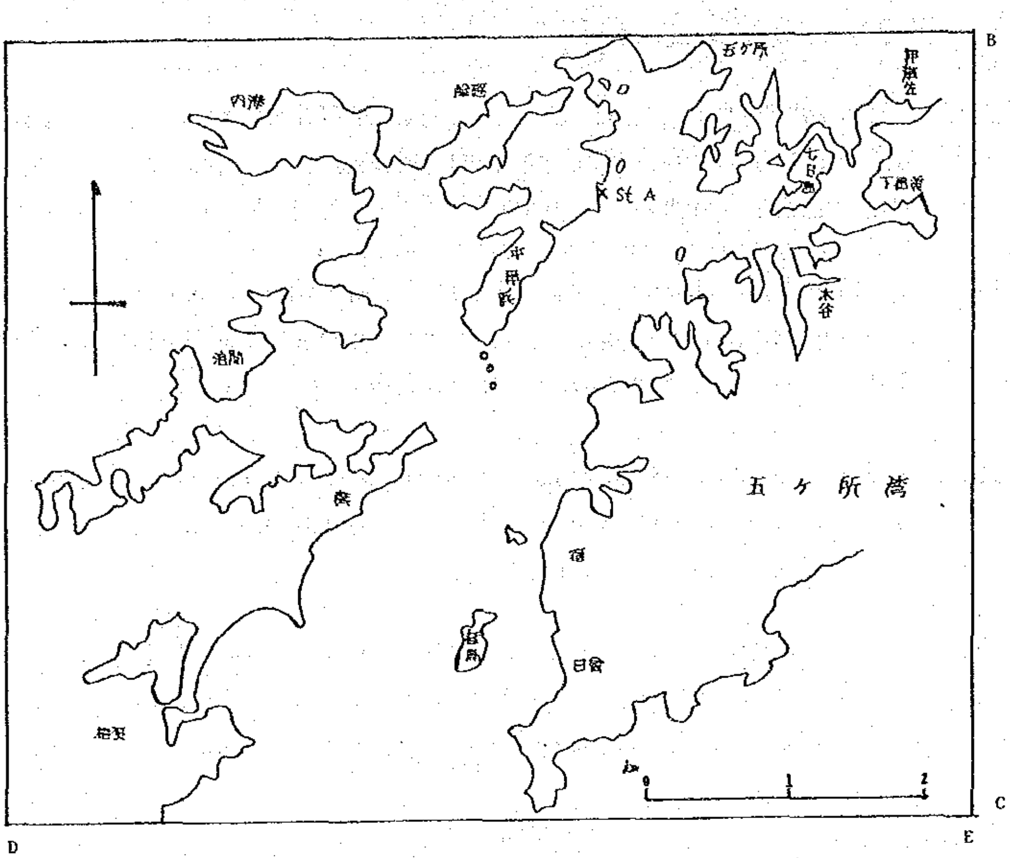

Figure 1. Map of Gokasho Bay, Japan. A = sampling location.
B = $34^{0}19'$ N.A. C = $34^{0}17'$ N.A. D = $136^{0}41'$ E.L.
E = $13^{0}44'$ E.L. N.A.= Northern altitude
E.L.= Eastern latitude

Gambar 1. Peta Teluk Gokasho. A = lokasi sampling
B = $34^{0}19'$ L.U. C = $34^{0}17'$ L.U. D = $136^{0}41'$ B.T.
E = $136^{0}44'$ B.T. L.U.= Lintang utara
B.T.= Bujur timur.

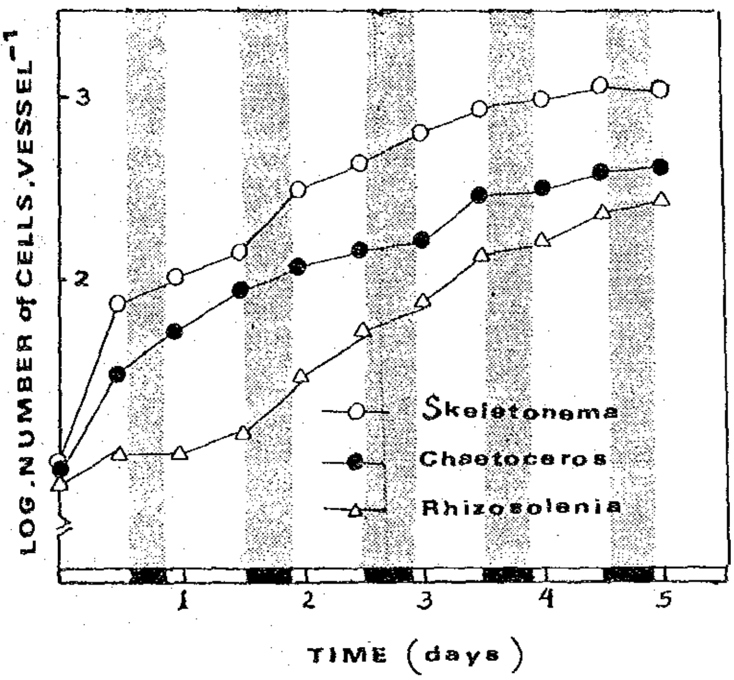

Figure 2. Growth rate of Skeletonema costatum, Chaetoceros sp and Rhizosolenia sp cultured in 0.4-ml vessels using Norimax medium. Dark-areas showed dark period.

Gambar 2. Laju pertumbuhan Skeletonema costatum, Chaetoceros sp, dan Rhizosolenia sp dalam tabung 0,4-ml dengan medium Norimax. Daerah gelap menunjukkan periode gelap.

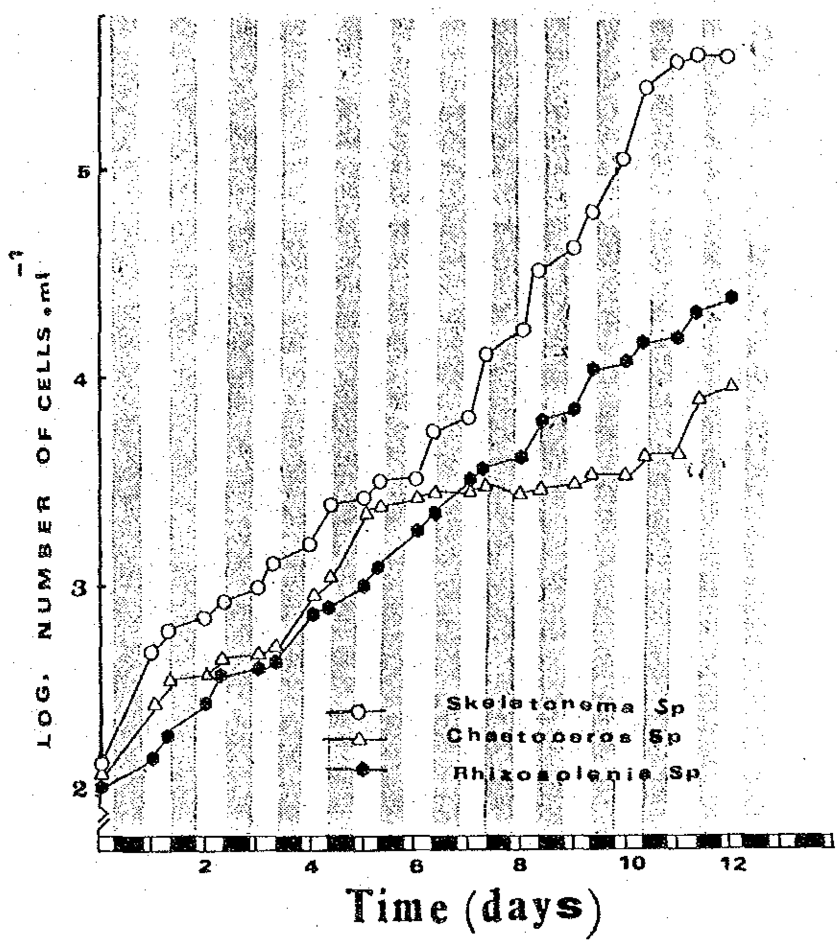

Figure 3. Growth rate of Skeletonema costatum, Chaetoceros sp, and Rhizosolenia sp cultured in 100-ml flask capacity using Guillard 'f' medium. Dark-areas showed dark period.

Gambar 3. Laju pertumbuhan Skeletonema costatum, Chaetoceros sp and Rhizosolenia sp dalam tabung 100-ml dengan medium Guillard'f'. Daerah gelap menunjukkan periode gelap.

PENGARUH PERBEDAAN SALINITAS TERHADAP PERTUMBUHAN POPULASI *Chaetoceros simplex*

Mustahal* dan Edward Danakusumah*

ABSTRAK

Percobaan pengaruh perbedaan salinitas terhadap pertumbuhan populasi Chaetoceros simplex telah dilakukan dalam kondisi laboratorium (pada suhu 19-22°C dengan intensitas cahaya 5000 lux). Medium yang digunakan ialah larutan Miquel yang telah dimodifikasi, ditambah sodium silikat 15 ppm.

Percobaan ini menggunakan sepuluh tingkatan salinitas: (0, 5, 10, 15, 20, 25, 30, 35, 40, dan 45 ppt).

Hasil percobaan ini menunjukkan bahwa Chaetoceros simplex dapat tumbuh baik pada salinitas antara 25-35 ppt. Tetapi yang terbaik adalah pada salinitas 30 ppt

ABSTRACT: Effect of different salinities on the population growth of Chaetoceros simplex. By: Mustahal and Edward Danakusumah.

Experiment on the effect of different salinities On the population growth of diatom Chaetoceros simplex had been conducted under laboratory condition (temperature of 19-22°C light intensity of 5000 lux). Salinities used in this experiment were 0, 5, 10, 15, 20, 25, 30, 35, 40, and 45 ppt. Medium used was that of modified Miquel solution in combination with 15 ppm sodium silicate.

The result showed that Chaetoceros simplex were grew well at salinities of 25 to 35 ppt. However the best growth was found at salinity of 30 ppt.

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PENDAHULUAN

Chaetoceros sp adalah diatoma yang merupakan jasad pakan yang penting bagi larva udang penaeid (HIRATA, 1975; JONES et.al. 1979; SABARUDDIN dan B. MARTOSUDARMO, 1980) dan larva kerang (ANONYMOUS, 1980)

Sejak dikenal sebagai fitoplankton yang dapat dibudidayakan sebagai makanan alami, telah banyak dilakukan penelitian mengenai sifat fisiologi diatoma tersebut, terutama mengenai kebutuhan unsur-unsur hara khususnya silikat yang merupakan unsur penting bagi pertumbuhan diatoma (JORGENSEN, 1952; LEWIN, J.C. 1955).

Pertumbuhan diatoma selain unsur-unsur hara juga dipengaruhi oleh beberapa faktor lingkungan. Salinitas adalah faktor penting dalam budidaya fitoplankton laut. (HIRATA, 1981). Maksud percobaan ini ialah untuk mengetahui berapa tingkat optimum salinitas *Chaetoceros* sp yang mempengaruhi pertumbuhannya.

Hasilnya diharapkan dapat membantu dalam mengembangkan budidaya *Chaetoceros* sp dalam menunjang penyediaan makanan alami bagi larva udang dan kerang.

BAHAN DAN METODA

Chaetoceros simplex yang digunakan dalam percobaan ini berasal dari Oyster Research Institute Sendai, Jepang. Mereka dibudidayakan dalam medium Miquel yang telah dimodifikasi ditambah sodium silikat 15 ppm.(lihat lampiran Tabel 1), pada suhu 19 - 22°C dan intensitas cahaya 5000 lux. Percobaan ini dilakukan dalam erlenmeyer berkapasitas 500 ml. Padat penebaran adalah 200 x 10^3 sel/ml.

Dalam percobaan ini *Chaetoceros simplex* dibudidayakan dalam sepuluh tingkatan salinitas yang berbeda yaitu: 0, 5, 10, 15, 20, 25, 30, 35, 40, dan 45 ppt. Masing-masing perlakuan mempunyai tiga ulangan. Salinitas yang lebih rendah dari air laut dibuat dengan menambahkan akuades. Sedangkan salinitas yang lebih tinggi dari air laut dibuat dengan menambahkan garam dapur (NaCl).

Perhitungan densitas *Chaetoceros simplex* dilakukan setiap hari menggunakan sebuah haemocytometer (Thoma). Densitas yang tertinggi pada setiap perlakuan dianalisa dengan Rancangan Acak Lengkap (STEEL and TORRIE, 1960) dan diperbandingkan dengan Uji Jarak Duncan (ZAR, 1974). Kecepatan pertumbuhan relatif (*k*) dihitung dengan rumus seperti yang dikemukakan oleh HIRATA, *et al*. (1981)

$$\underline{K} = \frac{\log 10\ N/No \times 3.22}{t_1 - t_o}$$

dimana N = Jumlah sel pada waktu t_1

N_o = Jumlah sel pada waktu t_o

3.22 = Konstanta pertumbuhan relatif

HASIL DAN PEMBAHASAN

Pertumbuhan populasi *Chaetoceros simplex* pada salinitas yang berbeda-beda dapat dilihat pada gambar 1. Densitas tertinggi pada hari ke sepuluh digambarkan sebagai kecepatan relatif (*k*) (Gambar 2).

Pada salinitas 15 - 35 ppt, densitas *Chaetoceros simplex* meningkat dengan cepat mulai hari ke tiga. Hal ini sesuai dengan penelitian terdahulu yang mendapatkan bahwa mikroalga umumnya mempunyai toleransi yang luas terhadap salinitas (Mc LACHLAN *dalam* LAING, 1980 dan FABREGAS, *et al.*, (1984). Hal ini menurut Ben-AMOTZ dan AVRON *dalam* FABREGAS *et al.*(1984) ialah dengan jalan merubah kadar gliserol dalam selnya sehingga dapat mengatur tekanan osmosenya. Analisa statistik menunjukkan perbedaan yang nyata (Tabel 2).

Densitas tertinggi yaitu 4,5 juta sel/ml terjadi pada salinitas 30 ppt pada hari ke sepuluh. Pada salinitas 25, 35, dan 40 ppt pertumbuhan populasinya relatif hampir sama. Sedangkan pada salinitas 45 ppt dan salinitas di bawah 20 ppt pertumbuhan populasinya sangat lambat.

Tingkat pertumbuhan terbaik (*k*: 0,50) terjadi pada salinitas 30 ppt, kemudian diikuti oleh salinitas 35 ppt, (*k*: 0,49); 25 ppt, (*k*: 0,47); 40 ppt, (*k*: 0,46); 45 ppt (*k*: 0,45); 20 ppt (*k*: 0,43); dan 15 ppt(*k*: o,40).

Pertumbuhan *Chaetoceros simplex* berangsur-angsur menurun dengan naiknya salinitas dari 30 ke 45 ppt.(Gambar 2). Hal ini mungkin disebabkan oleh proses mekanisme osmoregulasi yang terhambat, sehingga mempengaruhi proses pertumbuhan, fotosintesa dan respirasi. Naiknya salinitas akan memurunkan kecepatan fotosintesa dan respirasi, tetapi pengaruhnya lebih besar pada fotosintesa (NAKANISHI dan MONSHI, 1965).

Menurut OGATA dan MATSUI (1965), kecepatan fotosintesa maksimum terjadi pada air laut biasa. Sedangkan pada salinitas yang lebih rendah atau lebih tinggi dari air laut biasa terjadi depresi fotosintesa.

Dari hasil percobaan dapat diambil kesimpulan bahwa salinitas yang baik untuk pertumbuhan *Chaetoceros simplex* adalah 25 - 35 ppt. Sedangkan salinitas yang terlalu tinggi atau terlalu rendah dari air laut semula sangat menghambat pertumbuhannya. Oleh karena itu dalam budidaya *Chaetoceros simplex* disarankan untuk menggunakan salinitas air laut biasa.

UCAPAN TERIMA KASIH

Penulis mengucapkan terima kasih kepada Mr. Taranosuke Yoshimitsu dan tim expert JICA yang telah memberikan bantuan dan saran selama penelitian hingga selesainya tulisan ini.

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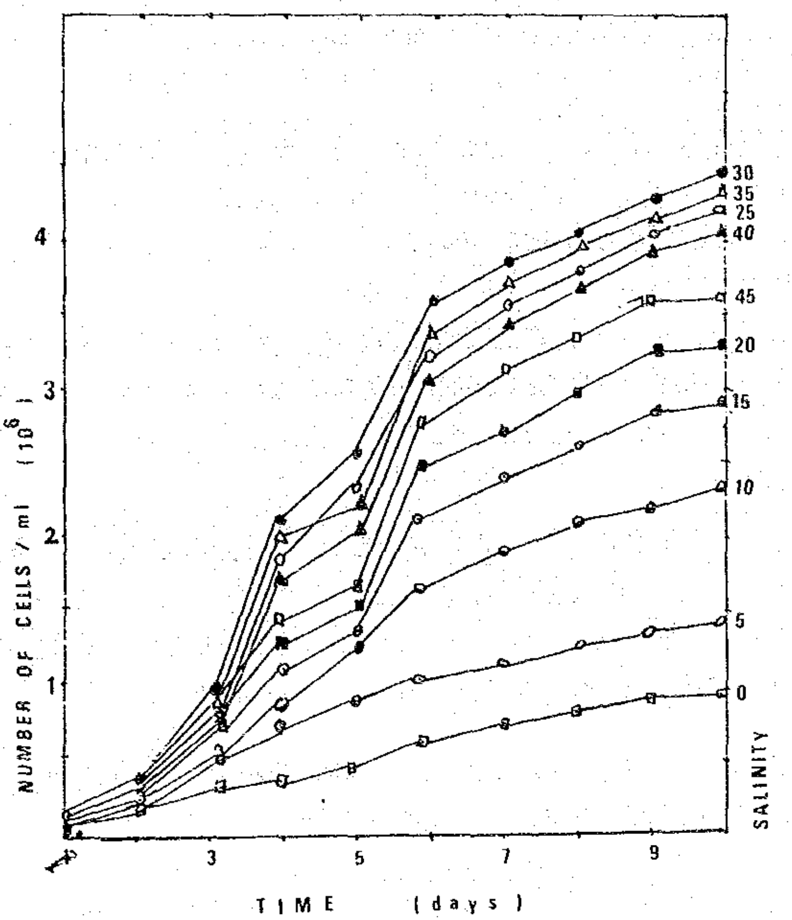
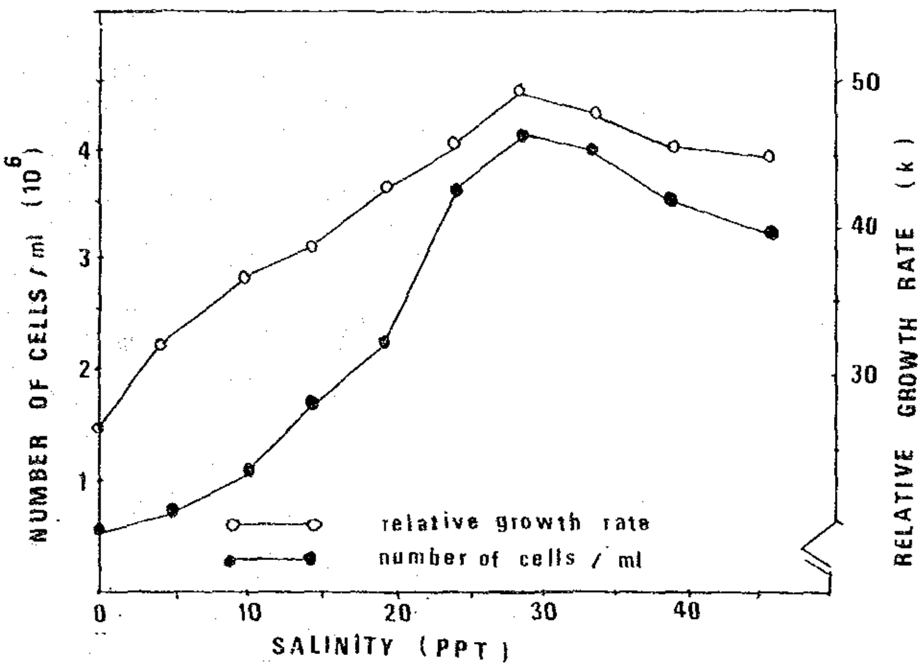


Gambar 1. Pertumbuhan Chaetoceros simplex yang dipelihara pada salinitas yang berbeda.

Figure 1. Growth of Chaetoceros simplex cultured under different salinities.



Gambar 2. Perbandingan densitas <u>Chaetoceros simplex</u> tertinggi yang dipelihara pada salinitas berbeda dan kecepatan pertumbuhan relatif (<u>k</u>).

Figure 2. Comparison of the densities of <u>Chaetoceros simplex</u> cultured under different salinities and its relatives growth (<u>k</u>).

LAMPIRAN

Tabel-1. Komposisi larutan Miquel yang telah dimodifikasi (ANONYMOUS, 1980)

Table-1. Composition of Modified Miquel solution. (ANONYMOUS, 1980).

No. Bahann No. Material	Komposisi (mg/l) Composition (mg/l)
1. KNO_3	101
2. Na_2HPO_4	50
3. $CaCl_2$	33,36
4. HCl (12 N)	14
5. $FeCl_2$	38,72
6. $MnCl_2$	43,22
7. $ZnCl_2$	3,12
8. $CuSO_4$	0,47
9. $CoCl_2$	1,21
10, Na_2MoO_4	12,61
11. EDTA	3
12. H_3BO_3	3,42

Tabel-2. Analisa sidik ragam terhadap densitas tertinggi *Chaetoceros simplex* yang dipelihara dalam salinitas yang berbeda

Table-2. Analysis Of Variance for the highest density of *Chaetoceros simplex* cultured under different salinity in combination with 15 ppm sodium silicate concentration.

Source of variation	df	Sum of squares	Mean squares	F comp	F table
Among different salinities	9	54	6	3,69**	P(0.05)=2,2[illegible] P(0.01)=3,45
Error	20	423,41	1,622		
Total	29	477,41			

** = highly significant.

PENGARUH PERBEDAAN KADAR SILIKAT TERHADAP PERTUMBUHAN POPULASI *Chaetoceros simplex*

Mustahal* dan Edward Danakusumah*

ABSTRAK

Percobaan pengaruh perbedaan kadar silikat terhadap pertumbuhan populasi Chaetoceros simplex telah dilakukan di dalam laboratorium, pada suhu 20,5 $\pm$ 1,5°C dalam intensitas cahaya 5000 lux. Tujuan percobaan ini adalah untuk mengetahui tingkat kebutuhan silikat yang optimum. Percobaan ini dilakukan dalam 6 tingkat kadar silikat yang berbeda (0, 5, 10, 15, 20 dan 25 ppm) dengan salinitas 30 ppt.

Hasilnya menunjukkan bahwa Chaetoceros simplex dapat tumbuh baik pada kadar silikat 10 - 20 ppm. Pertumbuhan terbaik terjadi pada kadar silikat 15 ppm.

Abstract: Effect of different silicate concentration on the population growth of Chaetoceros simplex. By: Mustahal * and Edward Danakusumah *

Effect of different silicate concentration on the population growth of Chaetoceros simplex were conducted under laboratory conditions at constant temperature of 20.5 $\pm$ 1.5°C and light intensity of 5.000 lux. The purpose of this experiment is to know the optimal requirement of silicate for Chaetoceros simplex population growth. This diatom was cultured under 6 different level of silicate, namely: 0, 5, 10, 15, 20 and 25 ppm.

The result showed that Chaetoceros simplex were grew well under 10 to 20 ppm silicate concentration. The best population growth was found at 15 pp.

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*Sub Balai Penelitian Budidaya Pantai Bojonegara - Serang.

PENDAHULUAN

Chaetoceros spp merupakan jasad pakan alami yang penting bagi larva udang (DANAKUSUMAH, et al., 1985, HIRATA, 1975, JONES, et al., 1979, PLATON, 1978, SABARUDDIN dan MARTOSUDARMO, 1980, WERNER, 1977) dan larva kerang (ANONYMOUS, 1980). Keberhasilan budidaya masa Chaetoceros spp sangat menentukan keberhasilan suatu hatchery udang dan kerang-kerangan.

Silikat merupakan unsur hara yang paling penting bagi pertumbuhan Chaetoceros. Silikat ini berguna untuk pembelahan sel, pembentukan valva, cangkang atau dinding sel, dan untuk metabolisme lainnya (LEWIN, 1954 dalam WERNER, 1977). Penelitian terdahulu mendapatkan bahwa diatoma laut mengandung 96,5% silikat (LEWIN, 1954 dalam WERNER, 1977, RAVEN, 1982). Kebutuhan silikat berbeda-beda pada tiap species diatoma. Hal ini tergantung pada kadar silikat yang terkandung dalam mediumnya, dan laju pembelahan sel atau pertumbuhannya (LEWIN, 1954 dalam WERNER, 1977).

Dalam budidaya masa Chaetoceros spp diperlukan silikat yang relatif banyak. Dalam rangka optimasi hasil maka perlu diketahui kebutuhan silikat yang optimal untuk budidaya masa Chaetoceros.

BAHAN DAN METODA

Chaetoceros simplex yang digunakan dalam percobaan ini berasal dari Oyster Research Institute Sendai, Jepang. Mereka dibudidayakan dalam medium Miquel yang telah dimodifikasi (lihat lampiran Tabel 3) pada suhu 20,5 $\pm$ 1,5°C dan intensitas cahaya sebesar 5000 lux. Percobaan ini dilakukan dalam erlenmeyer berkapasitas 500-ml. Padat penebaran awal 2 x 10^5 sel/ml. Chaetoceros simplex dibudidayakan dalam 6 tingkat kadar silikat yang berbeda yaitu: 0, 5, 10, 15, 20 dan 25 ppm dengan salinitas medium 30 ppt. Rancangan percobaan yang dipakai adalah rancangan acak lengkap (STEEL dan TORRIE, 1960). Masing-masing perlakuan mempunyai tiga kali ulangan. Perhitungan densitas populasi Chaetoceros simplex dilakukan setiap hari menggunakan sebuah haemocytometer (Thoma). Densitas tertinggi pada setiap perlakuan diperbandingkan dengan uji jarak Duncan (ZAR, 1974).

Kecepatan relatif (k) dihitung dengan rumus seperti yang dikemukakan oleh HIRATA (1981):

$$\underline{k} = \frac{\log.10\ N/N_o \times 3{,}22}{t_1 - t_o}$$

dimana N = Jumlah sel pada waktu t_1

N_o = Jumlah sel pada waktu t_o

3,22 = Konstanta pertumbuhan relatif

HASIL DAN PEMBAHASAN

Grafik pertumbuhan Chaetoceros simplex dalam kadar silikat yang berbeda-beda dan perbandingan densitas yang tertinggi sebagai kecepatan relatif (k) masing-masing dapat dilihat pada gambar 1 dan 2.

Pada kadar silikat 10 - 20 ppm, densitas Chaetoceros simplex bertambah dengan cepat mulai hari ketiga setelah inokulasi. Analisa statistik terhadap densitas tertinggi pada kadar silikat tersebut menunjukkan beda nyata (P 0.01). Densitas tertinggi adalah sekitar 4,5 juta sel/ml terjadi pada kadar silikat 15 ppm setelah 10 hari pemeliharaan. Pada kadar silikat 20 - 25 ppm densitas selnya lebih rendah dan mediumnya cepat menjadi keruh. Hal ini mungkin terlalu banyak silkat yang ditambahkan ke dalam medium. Pada kadar silikat 0 - 5 ppm pertumbuhan Chaetoceros simplex sangat lambat dibanding perlakuan yang lain. Pada pengamatan secara mikroskopis bentuk selnya tidak rata pada dindingnya, sedangkan pada kadar silikat yang lain bentuk selnya normal dan dindingnya rata. Hal ini disebabkan pada Chaetoceros simplex seperti juga pada diatoma umumnya sangat ditentukan oleh kadar silikat dalam pembentukan dinding selnya (LEWIN, 1954, dalam WERNER, 1977, RAVEN, 1982). Silikat merupakan faktor pembatas bagi pertumbuhan diatoma.(SVERDRUP, et al., 1978). Oleh karena itu kekurangan unsur silikat dalam medium tersebut (0 dan 5 ppm) menyebabkan pertumbuhannya terganggu.

Tingkat pertumbuhan yang paling baik terjadi pada kadar silikat 15 ppm (k:0,52), kemudian diikuti oleh kadar silikat 10 ppm (k:0,51), 20 ppm (k:0,50), 25 ppm (k:0,48 dan 5 ppm (k:0,46).

Tabel 1. Kepadatan tertinggi *Chaetoceros simplex* yang dipelihara dalam kadar silikat yang berbeda.

Table 1. Highest density of *Chaetoceros simplex* cultured under different silicate concentration.

Kadar silikat Silicate concentration (ppm)	Kepadatan tertinggi Highest density (10^6. cells/ml)	Pada Hari ke Reached at (days)
Control	1.2	10
5	1.7	10
10	4.2	10
15	4.5	10
20	3.3	10
25	2.6	9

Dari hasil percobaan tersebut dapat kami ambil kesimpulan bahwa *Chaetoceros simplex* dapat tumbuh baik pada kadar silikat antara 10 - 20 ppm. Pertumbuhan yang terbaik adalah pada kadar silikat 15 ppm. Dalam rangka optimasi biaya budidaya masa *Chaetoceros simplex* kami sarankan supaya menggunakan silikat dengan kadar 10 ppm.

UCAPAN TERIMA KASIH

Penulis mengucapkan terima ksih kepada Tim Expert JICA beserta para teknisi yang telah membantu dalam penelitian hingga selesainya tulisan ini.

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ZAR, J.H. 1974. Biostatistical analysis. Prentice Hall Inc. Englewood. Cliffs N.J 620 pp.

Tabel 2. Analisa sidik ragam terhadap densitas tertinggi *Chaetoceros simplex* yang dipelihara dalam kadar silikat yang berbeda.

Table 2. Analysis of variance for highest density of *Chaetoceros simplex* cultured under different silicate concentration in combination with 30 ppt salinity.

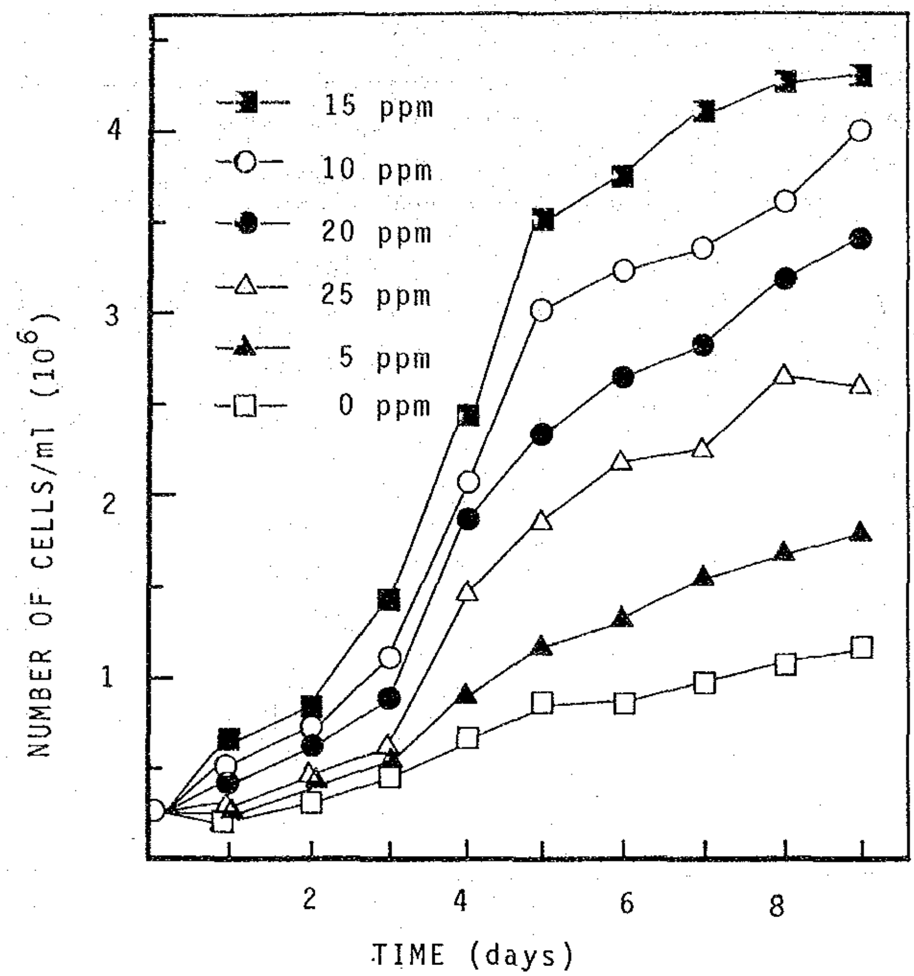
Source of variations	df	Sum of squares	Mean square	F comp.	F Table
Among different silicate concent.	5	29,1956	5.8391	21.580**	P(0,05)=3,11 P(0,01)=5,05
Error	12	3,2469	0,2705		
Total	17	32,4425			

** Highly significant

Tabel 3. Komposisi larutan Miquel yang telah dimodifikasi (ANONYMOUS, 1980)

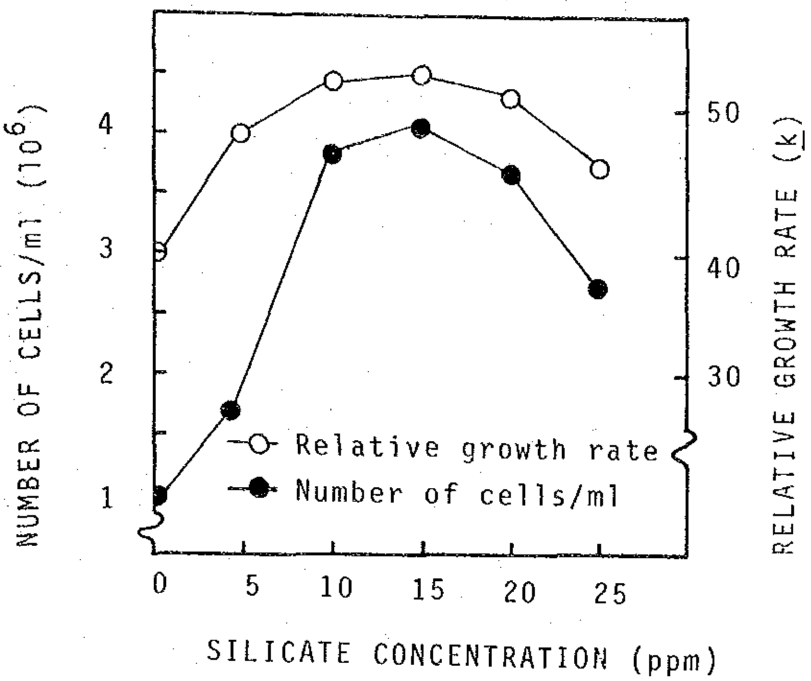
Table 3. Composition of modified Miquel solution (ANONYMOUS, 1980)

No. Bahan Nu. Material	Komposisi (mg/ml) Compositions (mg/ml)
1. KNO_3	101,00
2. Na_2HPO_4	50,00
3. $CaCl_2$	33,36
4. HCl (2N)	14,00
5. $FeCl_2$	38,72
6. $MnCl_2$	43,22
7. $ZnCl_2$	3,12
8. $CuSO_4$	0,47
9. $CoCl_2$	1,21
10. Na_2MoO_4	12,61
11. EDTA	3,00
12. H_3BO_3	3,42



Gambar.1. Pertumbuhan Chaetoceros simplex yang dipelihara dengan kadar silikat yang berbeda.

Figure.1. Growth of Chaetoceros simplex cultured under different silicate concentration



Gambar.2. Perbandingan densitas Chaetoceros simplex tertinggi yang dipelihara pada kadar silikat yang berbeda dan kecepatan pertumbuhan relatif (k)

Figure.2. Comparison of the densities of Chaetoceros simplex cultured under different concentration of silicate and its relatives growth (k).

PENGAMATAN PADA PERTUMBUHAN IKAN KERAPU LUMPUR
***Epinephelus tauvina* (Forskal) DAN KERAP MACAN**
***Epinephelus fuscoguttatus* (Forskal)**
DALAM KURUNG-KURUNG APUNG

Philip Teguh Imanto*)

ABSTRAK :

Pengamatan pada pertumbuhan ikan kerapu-lumpur Epinephelus tauvina (Forsskal) dan kerapu-macan Epinephelus fuscoguttatus (Forsskal) yang dipelihara dalam kurung-kurung apung telah dilaksanakan di Sub Balai Penelitian Budidaya Pantai Bojonegara - Serang. Penelitian ini ditujukan dalam rangka pengumpulan informasi mengenai jenis ikan laut yang baik untuk budidaya.

Jumlah ikan yang digunakan dalam pengamatan ini adalah 15 ekor ikan kerapu-lumpur (865 g/ekor) dan 20 ekor ikan kerapu-macan (867,5 g/ekor).

Hasil pengamatan selama 60 hari menunjukkan rata-rata pertumbuhan kerapu-lumpur mencapai 7,63 gram per hari (0,7% berat badan/hari) dengan nilai konversi pakan 7,05 ; pertumbuhan kerapu-macan adalah 3,5 gram per hari

*) Sub Balai Penelitian Budidaya Pantai (Research Station for Coastal Aquaculture) Bojonegara - Serang, INDONESIA.

(0,36% berat badan/hari) dengan nilai konversi pakan 14.

ABSTRACT : Observation on Growth of Groupers *Epinephelus tauvina* (Forsskal) and Epinephelus *fuscoguttatus* (Forsskal) in Floating Net Cages.

Observation on growth of groupers *Epinephelus tauvina* (Forsskal) and *Epinephelus fuscoguttatus* (Forsskal) cultured in floating net cages was carried out at Bojonegara Research Station for Coastal Aquaculture. The Experiment was aimed to get information on the growth rate of these groupers.

Fifteen individuals of *E. tauvina* (865 g in ABW) and 20 individuals of *E. fuscoguttatus* (867,5 g in ABW) were used for the experiment.

The result showed that the daily individual growth of *E. tauvina* was 7,63 g (0,7% ABW) and Food Conversion Ratio was found as 7,05. The daily individual growth of *E. fuscoguttatus* was 3,5 g per day (0,36% ABW) and Food Conversion Ratio was found as 14.

PENDAHULUAN.

Perairan pantai Indonesia mempunyai potensi untuk pengembangan budidaya ikan laut. Sehubungan dengan pengembangan budidaya pantai, sangat diperlukan informasi untuk menunjang kegiatan usaha budidaya, Di perairan teluk Banten telah dilakukan serangkaian percobaan pembesaran beberapa jenis ikan laut dalam kurung-kurung apung untuk mencari jenis ikan yang cocok untuk dibudidayakan.

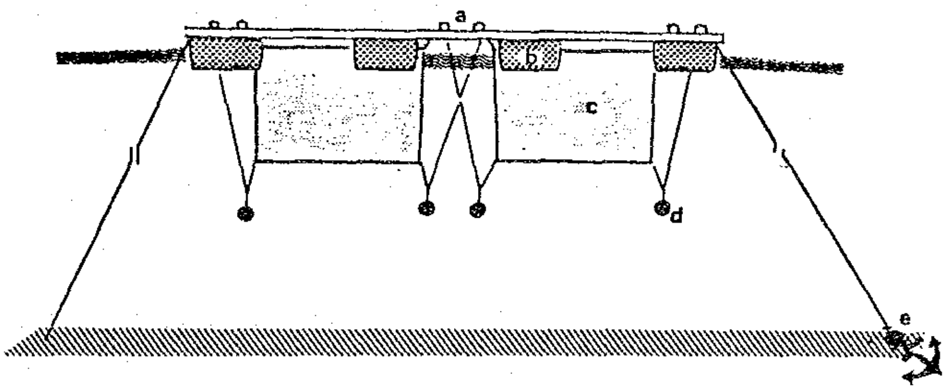
Ikan kerapu termasuk famili Serranidae dikenal sebagai jenis ikan konsumsi dan mempunyai nilai ekonomis yang penting. Penyebarannya meliputi daerah tropik dan subtropik (RANDALL dan Ben-TUVIA, 1983). NELSON (1976) menyebutkan bahwa terdapat sekitar 370 species yang hidup di dunia. Dua dari species ini yaitu kerapu-lumpur *Epinephelus tauvina* (Forsskal) dan kerapu-macan *Epinephelus fuscoguttatus* (Forsskal) juga ditemukan di perairan teluk Banten. KATAYAMA (1975) menyebutkan bahwa *E. tauvina* dan *E. fuscoguttatus* penyebarannya meliputi perairan Laut Merah sampai ke perairan Philipina, Tahiti, Kepulauan Okinawa dan perairan Jepang Selatan.

Penelitian pada ikan kerapu (*Epinephelus* spp) telah banyak dilakukan orang, di antaranya penelitian mengenai hermaphroditisme (TAN dan TAN, 1974), tingkat kematangan dan pemijahan (SELVARAJ dan RAJAGOPALAN, 1973), budidaya (CHUA dan TENG, 1978 ; DANAKUSUMAH dan IMANISHI, 1984), pemeliharaan larva (HUSSAIN, *et al*. 1975 ; HUSSAIN dan HIGUCHI, 1980).

Dalam tulisan ini disajikan hasil pengamatan terhadap laju pertumbuhan dua jenis ikan kerapu yaitu kerapu-lumpur E. tauvina dan kerapu-macan E. fuscoguttatus. Penelitian ini dilakukan di Sub Balai Penelitian Budidaya Pantai Bojonegara - Serang, antara bulan Juli dan September 1982.

BAHAN DAN METODA.

Ikan percobaan dikumpulkan dari hasil tangkapan di sekitar perairan teluk Bantèn. Ikan-ikan tersebut kemudian dipelihara di dalam kurung-kurung apung yang berukuran 2x2x2 m (Gambar 1) dan diberi pakan ikan tembang/ sardin.



Gambar 1 : Kurung-kurung spung tampak samping.
a. rangka, b. pengapung, c. kurung-kurung, d. pemberat, e. jangkar.

Figure 1 : Side view of Floating net cage. a. raft, b. float, c. net, d. sinker, e. anker.

Kurung-kurung A diisi dengan 15 ekor kerapu-lumpur *E. tauvina* dan B diisi dengan 20 ekor kerapu-macan *E. fuscoguttatus*. Jumlah pakan sebanyak 6% berat badan per hari diberikan dua kali (jam 09.00 dan jam 16.00).

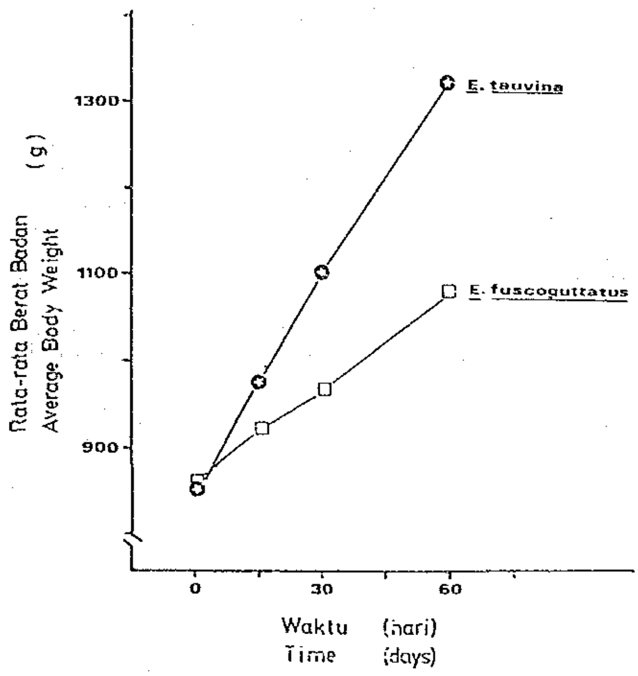
Penghitungan laju pertumbuhan, konversi pakan, pertumbuhan harian, dilakukan dengan menggunakan rumus yang dikemukakan oleh YAMAGUCHI (*dalam* SUGAMA, 1983).

HASIL DAN PEMBAHASAN.

Hasil pengamatan selama 60 hari menunjukkan bahwa pertambahan berat per ekor ikan kerapu-lumpur *E. tauvina* sebesar 7,63 g per hari, sedang kerapu-macan *E. fuscoguttatus* sebesar 3,5 g per hari. Laju pertumbuhan pada kerapu-lumpur 0,7% dari berat badan per hari dan pada kerapu-macan 0,36% dari berat badan per hari. Menurut DANAKUSUMAH dan IMANISHI (1984) nilai ratio pertumbuhan harian dari kerapu-lumpur *E. tauvina* (Forsskal) berkisar antara 0,59% - 1,83% dari berat badan tergantung ukuran ikan. Semakin besar berat ikan nilai ratio pertumbuhan harian semakin kecil (HONMA, 1971).

Nilai konversi pakan (FCR) memperlihatkan perbedaan yang besar antara kedua jenis kerapu ini. Kerapu-lumpur FCR rata-rata sebesar 7,05 (antara 5,6 - 8,45) sedangkan pada kerapu-mapan nilai FCR-nya adalah 14 (antara

10,3 - 15,6). Menurut CHUA dan TENG (1978) makin besar jumlah pemberian pakan, nilai konversi pakan juga semakin besar. Disamping itu, tingginya nilai konversi pakan juga disebabkan adanya pakan yang tidak tercerna (SUGAMA, 1983) atau ukuran dan jenis pakan yang kurang disukai. DANAKUSUMAH dan IMANISHI (1984) mendapatkan bahwa dengan bertambahnya berat badan ratio pakan per hari akan menurun.



Gamber 2 : Kurva pertumbuhan kerapu E. tauvina dan E. fuscoguttatus yang dipelihara didalam kurung-kurung apung.

Figure 2 : Growth curve of E. tauvina and E. fuscoguttatus cultured in floating net cages.

Selama pengamatan tidak ada ikan yang mati ataupun terserang parasit, hal ini mungkin disebabkan jumlah padat penebaran yang sangat kecil (2,5 - 3,3 ekor per m^3) densitas ini jauh lebih rendah dari padat penebaran optimal yang dicoba oleh TENG dan CHUA (1978) 60 ekor per m^3 (1,6 kg/m^3). Semakin besar jumlah padat penebaran, angka kematian cenderung untuk meningkat.

Ikan kerapu-lumpur memperlihatkan laju pertumbuhan harian yang lebih cepat dan nilai konversi pakan yang lebih rendah daripada ikan kèrapu-macan. Mengingat bahwa harga kedua species ini di pasaran adalah sama, maka dapat dipastikan bahwa budidaya ikan kerapu-lumpur mempunyai masa depan yang lebih cerah.

Penelitian pada jenis ikan kerapu-lumpur <u>E. tauvina</u> perlu dilanjutkan untuk mengetahui jumlah pakan optimal, pertumbuhan optimalnya dan penelitian pemijahan untuk memproduksi benih.

UCAPAN TERIMAKASIH.

Dalam kesempatan ini kami ingin menyampaikan rasa terima-kasih kepada Mr. Hideyuki Tanaka, tenaga ahli JICA dan juga Bapak Edward Danakusumah, Kepala Sub Balai Penelitian Budidaya Pantai Bojonegara - Serang, yang telah memberi pengarahan dan petunjuk dalam melaksanakan penelitian hingga terlaksananya penyajian tulisan ini.

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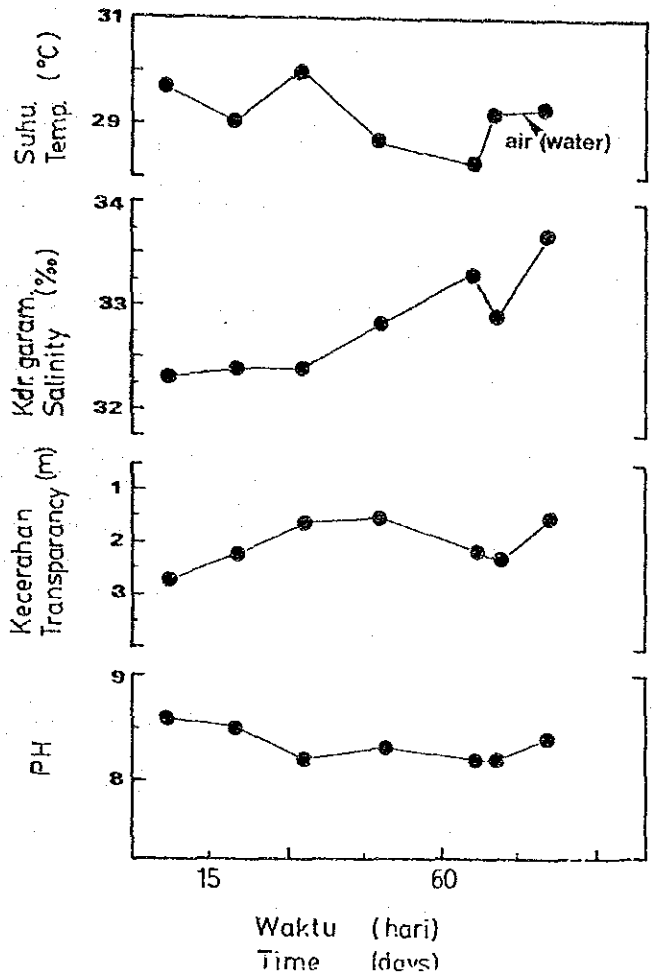
Table 1 : Data ikan kerapu-lumpur, *E. tauvina* dan kerapu-macan, *E. fuscoguttatus* dalam kurung-kurung apung.

Data of groupers *E. tauvina* and *E. fuscoguttatus* cultured in floating net cages.

	Satuan	*E. tauvina*	*E. fuscoguttatus*
Periode	(hari)	60	60
Jumlah ikan mula-mula	(ekor)	15	20
Jumlah ikan akhir	(ekor)	15	20
Mortalitas	(%)	0	0
Berat badan rata-rata awal	(g)	865	867,5
Berat badan rata-rata akhir	(g)	1322,7	1077,5
Pertambahan berat harian per ekor	(g)	7,63	3,50
Jumlah pertambahan berat total	(g)	6865,50	4200,00
Ratio pertumbuhan harian	(%)	0,70	0,36
Jumlah makanan	(g)	48400,00	58800,00
Konversi pakan		7,05	14,00
Effisiensi pakan	(%)	14,18	7,14



Gambar 3 : Data kondisi perairan di kurung-kurung apung selama bulan Juli-September 1982.

Figure 3 : Water condition data in floating net cages from July to September 1982.

Lap. Pen. Perikanan Laut No. 30 Th. 1984 : 43 – 54

PERTUMBUHAN BENIH IKAN BERONANG (*Siganus* spp.) DI TELUK BANTEN

Subhat Nurhakim*

ABSTRAK : Pertumbuhan relatif harian dari beberapa jenis benih ikan beronang pada setiap kondisi lingkungan perairan telah didapatkan selama penelitian ini.

Hasil pengujian menunjukkan bahwa perbedaan pertumbuhan benih lebih dipengaruhi oleh kepadatan tanaman (sebagai makanan) pada lingkungannya dan komposisi ukuran benih, dibandingkan dengan perbedaan jenis.

ABSTRACT: A study on the growth of *Siganus* spp. fry in Banten Bay, by Subhat Nurhakim. Daily relatif growth of some species of Siganus fry in different location is detected during this study. A comparison show that the growth is more affected by the density of plants and size composition of fry than by the differences of species.

PENDAHULUAN

Pemilihan jenis dan lingkungan hidup yang tepat untuk budidaya merupakan salah satu persyaratan yang harus ditelaah lebih dulu sebelum usaha tersebut dilaksanakan. Penelitian ini bertujuan untuk mengetahui faktor-faktor yang mempengaruhi pertumbuhan benih dialam. Dalam pelaksanaan nya dipilih tiga tempat yaitu Teluk Grenyang, Pulau Kambing dan Pulau Panjang yang masing-masing mempunyai kondisi perairan yang berbeda.

Ada informasi tentang faktor yang mempengaruhi terhadap pertumbuhan benih, diharapkan akan merupakan salah satu pedoman dalam menuju keberhasilan budidayanya.

BAHAN DAN CARA

Pertumbuhan didapatkan dengan "Modal Class Progression Technique", yaitu dengan cara menghubungkan puncak-puncak *ukuran panjang berdasarkan waktu penangkapan (Pauly, tidak* bertahun).

Garis-garis penghubung antar puncak ukuran panjang selanjutnya diberi nomor, dan dari setiap garis penghubung dapat dicari pertumbuhan relatifnya dengan memakai rumus :

$$h = \frac{l_2 - l_1}{t_2 - t_1}$$ (Ricker, 1958 *dalam* Pauly)

dimana :

h = pertumbuhan relatif

$l_2 - l_1$ = selisih antara ukuran panjang yang ditunjukan pada awal dan akhir garis penghubung

$t_2 - t_1$ = waktu yang diperlukan untuk mencapai panjang yang ditunjukan pada akhir garis penghubung dari panjang pada awal garis penghubung.

Selanjutnya untuk menentukan panjang rata-rata yang berhubungan dengan pertumbuhan relatifnya dipergunakan rumus $(l_2 - l_1)/2$, dimana l_1 dan l_2 adalah sama dengan yang dimaksud pada keterangan terdahulu.

Pertumbuhan rata-rata antara jenis yang berbeda pada lokasi yang sama maupun pertumbuhan rata-rata jenis (spesies) yang sama antar lokasi yang berbeda kemudian diuji dengan metoda Klasifikasi Satu Arah (Walpole, 1968; Steel dan Torrie, 1960).

HASIL DAN PEMBAHASAN

Hasil pengujian data memberikan petunjuk bahwa lokasi mempengaruhi pertumbuhan relatif jenis benih. Pertumbuhan tertinggi benih *S. canaliculatus* didapatkan di Teluk Grenyang (Tabel 1, 1a dan 1b). Sedangkan untuk jenis (spesies) yang berbeda *(S. canaliculatus, S. javus, S. virgatus)* tapi tertangkap pada lingkungan yang sama tidak menunjukkan perbedaan yang nyata (Tabel 2, 2a dan 3, 3a).

* *Balai Penelitian Perikanan Laut.*

Pertumbuhan relatif rata-rata setiap spesies benih pada masing-masing lokasi penelitian disajikan pada tabel berikut.

Tabel mengenai pertumbuhan relatif rata-rata ikan beronang pada setiap lokasi penelitian.
Table on average relative growth of Siganus fry for each areas.

Lokasi	Jenis (Spesies)	Pertumbuhan relatif harian	Dugaan pertumbuhan bulanan
		.... mm	....
Teluk Grenyang	*S. canaliculatus*	0.75	22,50
	S. javus	0,76	22,80
Pantai Barat Pulau Panjang	*S. canaliculatus*	0,42	12,60
	S. virgatus	0,44	13,20
Pantai Barat Pulau Kambing	*S. canaliculatus*	0,46	13,80

Perbedaan pertumbuhan berdasarkan lokasi. sesuai dengan pengamatan Drew (1971) *dalam* Lam (1974) yang mendapatkan pertumbuhan *S. rivulatus* sebesar 14 mm per bulan untuk yang hidup di "enriched dockside" sedangkan yang hidup didaerah hutan bakau (mangrove) hanya 3 mm per bulan.

Perbedaan pertumbuhan yang terjadi pada penelitian ini diduga ada hubungannya dengan sediaan makanan dan komposisi ukuran ikan beronang pada masing-masing lokasi penelitian.

Kesenangan ikan beronang akan satu jenis tanaman terhadap yang lainnya tidak mempunyai hubungan dengan nilai kalori yang dikandungnya (Vilaluz, 1953 *dalam* Westernhagen, 1974). Oleh karena itu dalam usaha untuk memenuhi kebutuhan akan komponen-komponen dasar yang diperlukan, jenis ikan beronang berusaha mencukupinya dengan makan yang banyak sepanjang hari (Hasse *et al.*, 1977). Mengingat tanaman tingkat tinggi maupun epipitnya merupakan makanan utama dari ikan beronang dewasa dan juwananya (Lam, 1974; Westernhagen, 1973a,b : Bryan, 1975), maka perbedaan jumlah tanaman pada suatu perairan berarti berbeda pula makanan yang tersedia untuk kebutuhan hidupnya.

Kebiasaan makan yang terjadi pada satu kelompok ikan dipengaruhi oleh komposisi ukuran yang terdapat pada kelompoknya (Langler *et al.*, 1962). Pada kelompok ikan beronang, bila ikan muda terdapat dalam jumlah yang lebih banyak dari pada dewasanya, ikan yang lebih muda sering didapatkan istirahat sementara ikan beronang yang lebih tua mencari makan. Sedangkan bila yang tua lebih banyak terdapat pada suatu kelompok, mereka akan makan bersama-sama (Hasse *et al.*, 1977).

Dari hasil penelitian yang dilakukan didapatkan volume tanaman 1 m^2 di Teluk Grenyang lebih besar bila dibandingkan dengan yang terdapat di pantai barat Pulau Panjang dan Pulau Kambing. Demikinlah pula komposisi ukuran pada ketiga lokasi penelitian menunjukkan perbedaan. Pada gambar 1 dan 4 dapat dilihat bahwa ukuran ikan yang tertangkap di teluk Grenyang lebih seragam. Sedangkan pada gambar 2, 3 dan 5 yang menunjukkan komposisi ukuran ikan beronang di pantai barat pulau Panjang dan pulau Kambing terlihat ukuran ikan beronang yang tertangkap lebih beragam, dimana ikan yang lebih besar tertangkap lebih sedikit.

Kenyataan tersebut diatas kiranya dapat mendukung dugaan bahwa perbedaan pertumbuhan antara jenis (spesies) benih yang tertangkap disebabkan oleh sediaan makanan dan komposisi ukuran ikan beronang pada masing-masing lingkungan hidupnya.

KESIMPULAN

Dari hasil pengujian data yang diperoleh, didapatkan petunjuk bahwa tidak adanya perbedaan pertumbuhan benih yang disebabkan oleh perbedaan spesies, pertumbuhan rupanya lebih dipengaruhi oleh kerapatan tanaman pada lingkungan hidupnya yang merupakan makanan utamanya dan komposisi ukuran pada kelompoknya.

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Tabel 1. Pertumbuhan relatif juwana *S. canaliculatus* pada ketiga lokasi penelitian.
Table 1. Relative growth of S. canaliculatus for 3 locations of survey.

Ulangan	Teluk Grenyang	Pantai Barat P. Panjang	Pantai Barat P. Kambing	
	.... mm / hari	....	....	
1	0.75	0,43	0,60	
2	0,86	0,47	0,50	
3	0,86	0,43	0,43	
4	0,79	0,44	0,50	
5	0,86	0,43	0,43	
6	0,65	0,43	0,43	
7	0,65	0,43	0,43	
8	0,60	0,43	0,43	
9	–	0,43	0,43	
10	–	0,39	0,43	
11	–	0,39	0,43	
12	–	0,39	0,43	
Jumlah	6,02 ($T_{1.}$)	5,09 ($T_{2.}$)	5,47 ($T_{3.}$)	16,58 ($T_{..}$)
Rata-rata	0,75	0,42	0,46	

Tabel 1a. Analisa Pertumbuhan juwana (Juvenile) *S. canaliculatus* antara ketiga lokasi penelitian.
Table 1a Growth analysis of S. canaliculatus fry for 3 locations at survey.

Sidik ragam

Sumber	db	Jumlah kuadrat	Kuadrat tengah	F hitung	F tabel 0,05	F tabel 0,01
Lokasi	2	0,5920	0,2960	74,00**	3,33	5,42
Sisa	29	0,1171	0,0040			
Total	31	0,7091				

$$\text{Jk Total} = \sum_{1=1}^{3} \sum_{j=1}^{n_1} x_{ij}^2 - \frac{T_{..}^2}{n.}$$

$$= 9{,}2996 - 8{,}5905 = \underline{0.7091}$$

$$\text{JK Lokasi} = \sum_{i=1}^{3} \frac{T_{i.}^2}{n_i} - \frac{T_{..}^2}{n.}$$

$$= 9{,}1825 - 8{,}5905 = \underline{0.592}$$

Tabel 1b Uji Duncan terhadap pertumbuhan relatif benih *S. canaliculatus* antara ketiga lokasi penelitian.
Table 1b Duncan test of relative growth of S. canaliculatus for 3 locations studied areas.

N = 32 k = 3

S_p^2 = 0,004

$S_y = S_p\sqrt{1/2\ (1/n_1 + 1/n_2 + 1/n_3)}$

= 0,0633 x 0,3819 = 0,0242

db = 29 α = 0,05

P	2	3
r_p	2,89	3,03
R_p	0,0699	0,0733

Lokasi	Teluk Grenyang	Pantai Barat P. Kambing	Pantai Barat P. Panjang
Pertumbuhan rata-rata	0,75	0,46	0,42

Tabel 2. Pertumbuhan relatif juwana (juvenile) *S. canaliculatus* dan *S. javus* di Teluk Grenyang.
Table 2. Relative growth of S. canaliculatus and S. javus in Grenyang Bay.

Ulangan	*S. canaliculatus*	*S. javus*	
	.... mm / hari		
1	0,79	0,85	
2	0,75	0,67	
3	0,86	0,83	
4	0,86	0,78	
5	0,86	0,65	
6	0,65	–	
7	0,65	–	
8	0,60	–	
Jumlah	6,02 ($T_{1.}$)	3,79 ($T_{2.}$)	9,81 ($T_{..}$)
Rata-rata	0,75	0,76	

Tabel 2b. Analisa pertumbuhan antara *S. canaliculatus* dan *S. javus* di Teluk Grenyang
Table 2b. Growth analysis between S. canaliculatus and S. javus in Grenyang Bay

Sidik ragam

Sumber	db	Jumlah kuadrat	Kuadrat tengah	F hitung	F tabel 0,05	F tabel 0,01
Spesies	1	0,0001	0,0001	0,0095	4,84	9,65
Sisa	11	0,1158	0,0105			
Total	12	0,1159				

$$\text{JK Total} = \sum_{i=1}^{2} \sum_{j=1}^{n_i} x_{ij}^2 - \frac{T_{..}^2}{n.}$$

$$= 7{,}5187 - 7{,}4028 = \underline{\underline{0{,}1159}}$$

$$\text{JK Spesies} = \sum_{i=1}^{2} \frac{T_i^2}{n_i} - \frac{T_{..}^2}{n.}$$

$$= 7{,}4029 - 7{,}4028 = \underline{\underline{0{,}0001}}$$

Tabel 3. Pertumbuhan relatif juwana *S. canaliculatus* dan *S. virgatus* di pantai barat P. Panjang.
Table 3. Relative growth of S. canaliculatus and S. virgatus fry in western part of P. Panjang.

Ulangan	*S. canaliculatus*	*S. virgatus*	
	....	mm / hari	....
1	0,44	0,50	
2	0,43	0,43	
3	0,47	0,43	
4	0,43	0,43	
5	0,43	0,43	
6	0,43	0,43	
7	0,43	0,43	
8	0,43	–	
9	0,43	–	
10	0,39	–	
11	0,39	–	
12	0,39	–	
Jumlah	5,09 ($T_{1.}$)	3,08 ($T_{2.}$)	8,17 ($T_{..}$)
Rata-rata	0,42	0,44	

Tabel 3a. Analisa pertumbuhan antara *S. canaliculatus* dan *S. virgatus* di pantai barat P. Panjang.
Table 3a. Growth analysis of S. canaliculatus and S. virgatus in western part of P. Panjang.

Sidik ragam

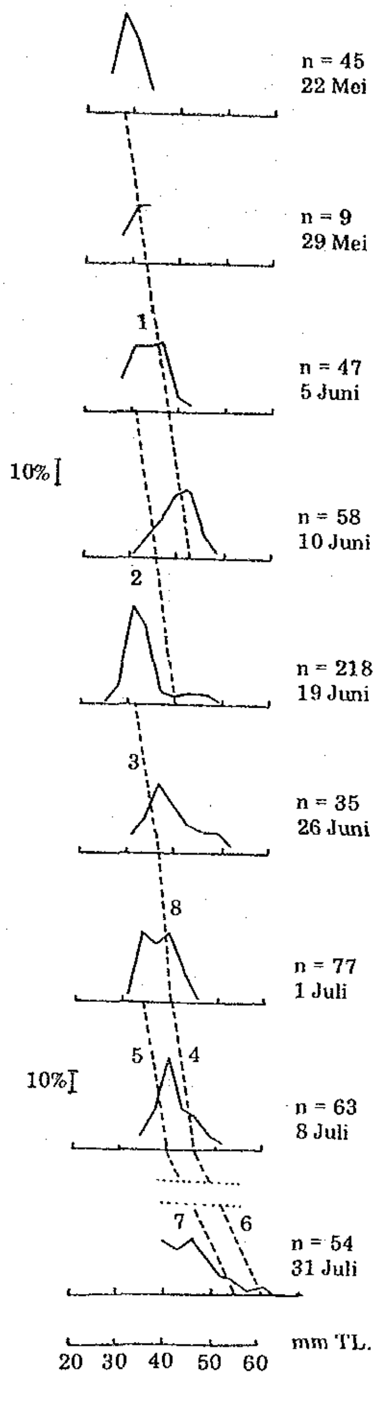
Sumber	db	Jumlah kuadrat	Kuadrat tengah	F hitung	F tabel 0,05	F tabel 0,01
Spesies	1	0,0011	0,0011	1,830	4,45	8,40
S i s a	17	0,0103	0,0006			
T o t a l	18	0,0114				

$$\text{JK Total} = \sum_{i=1}^{2} \sum_{j=1}^{n_i} x_{ijk}^2 - \frac{T_{..}^2}{n.}$$

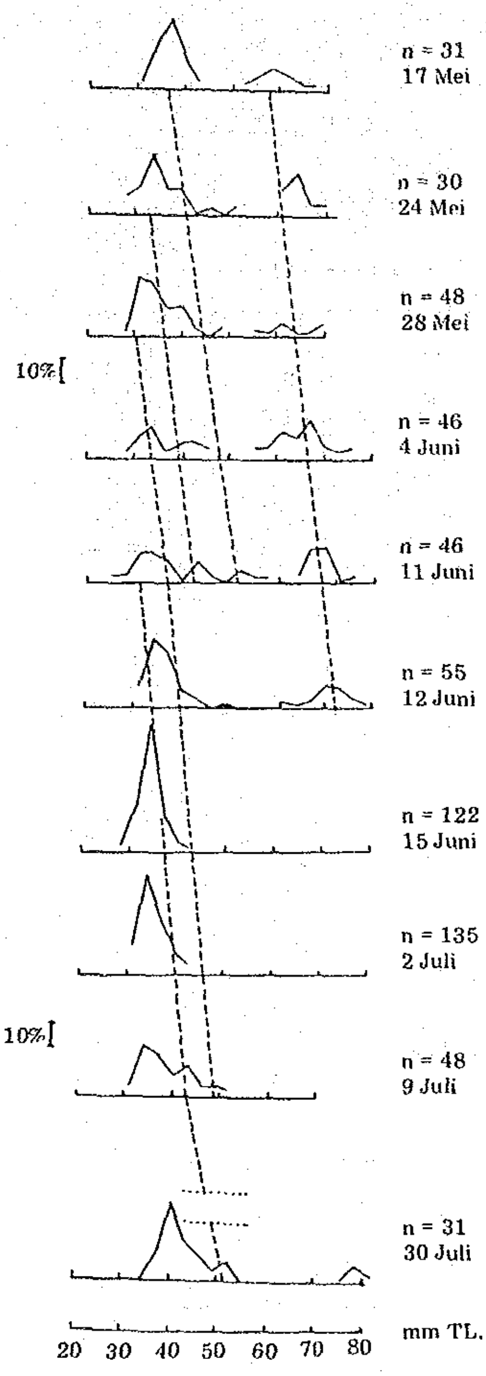
$$= 3,5245 - 3.5131 = \underline{\underline{0,0114}}$$

$$\text{JK Spesies} = \sum_{i=1}^{2} \frac{T_i^2}{n_i} - \frac{T_{..}^2}{n.}$$

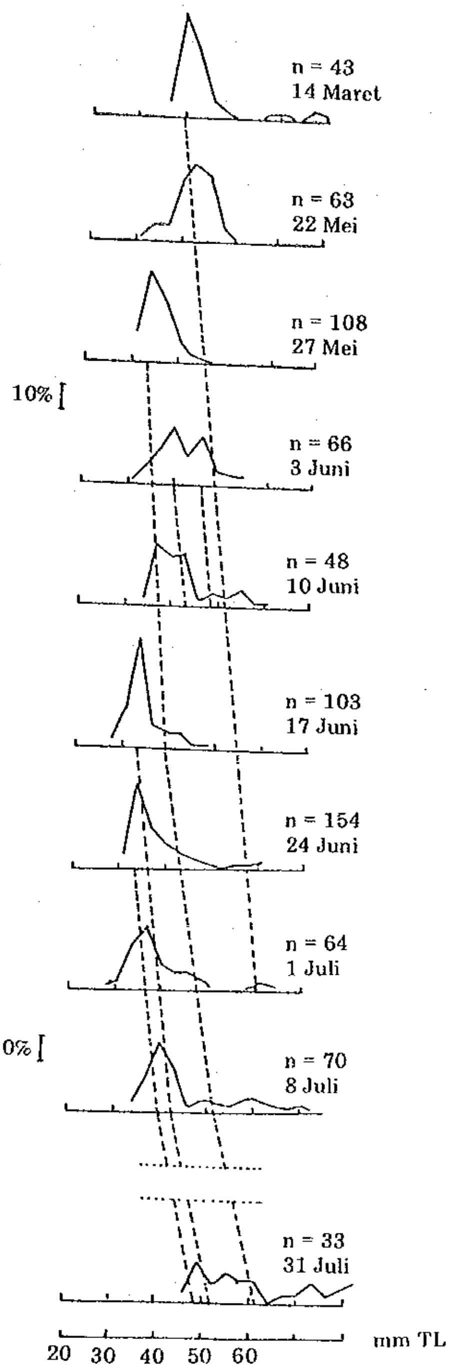
$$= 3,5142 - 3.5131 = \underline{\underline{0,0011}}$$



Gambar 1. Distribusi panjang *S. canaliculatus* yang tertangkap di Teluk Grenyang
Figure 1. Length frequency distribution of S. canaliculatus caught at Grenyang Bay.

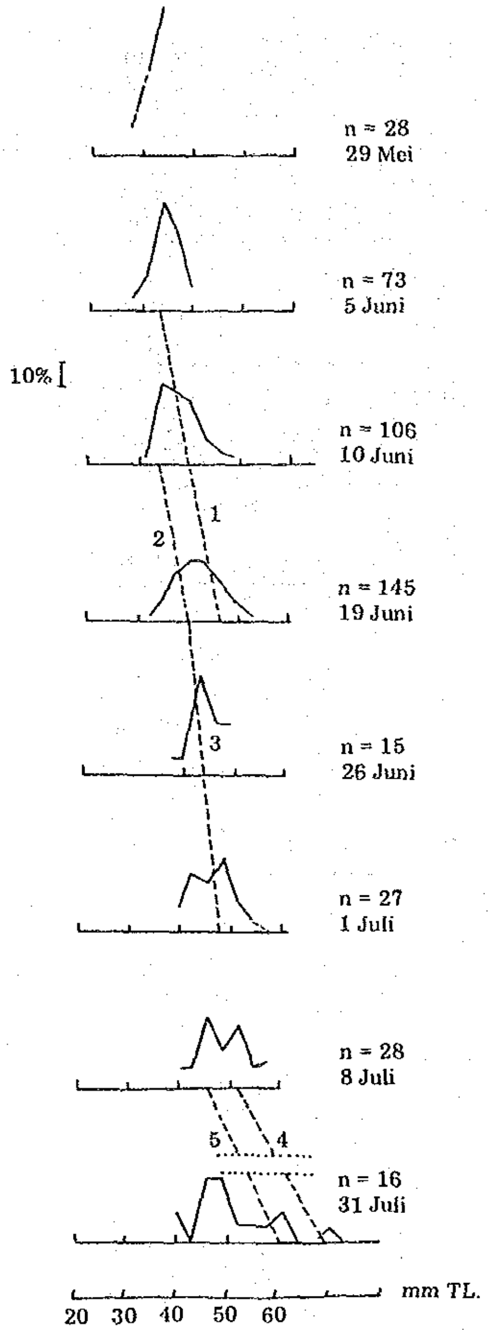


Gambar 2. Distribusi panjang *S. canaliculatus* yang tertangkap di pantai barat Pulau Kambing
Figure 2. Length frequency distribution of S. canaliculatus, caught in western part of P. Kambing

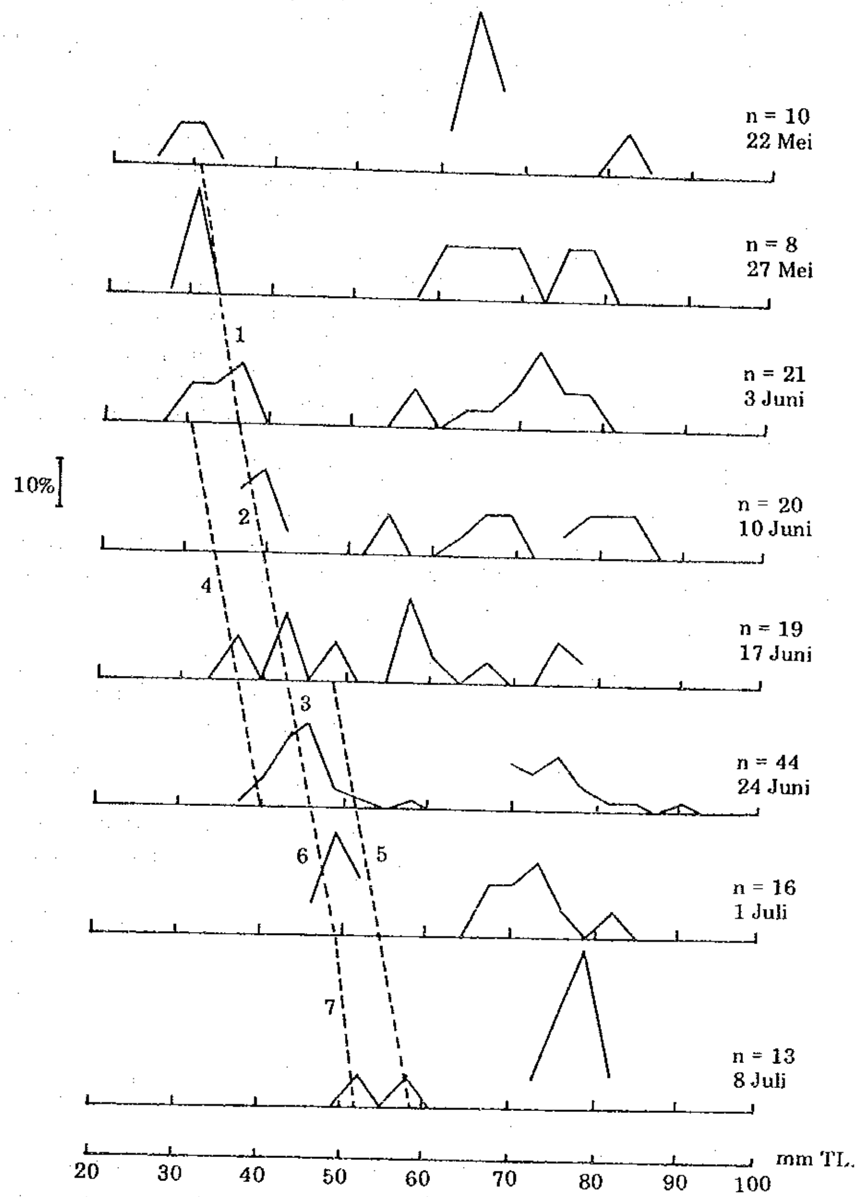


Gambar 3. Distribusi panjang *S. canaliculatus* yang tertangkap di pantai barat Pulau Panjang

Figure 3. Length frequency distribution of S. canaliculatus, caught in western part of P. Panjang.



Gambar 4 Distribusi panjang *S. javus* yang tertangkap di Teluk Grenyang
Figure 4 Length frequency distribution of S. javus, caught in Grenyang Bay



Gambar 5. Distribusi panjang *S. virgatus* yang tertangkap di pantai barat Pulau Panjang
Figure 5. Length frequency distribution of S. virgatus, caught in western part of P. Panjang.

PENDUGAAN KEPADATAN *Chlorella spp.* DENGAN METODA PERBANDINGAN TRANSPARANSI

Waspada

ABSTRAK : Pendugaan kepadatan Chlorella dengan metoda perbandingan transparansi telah dilakukan antara bulan Nopember - Desember 1983 dalam tanki berkapasitas 10-m^3 pada Sub Balai Penelitian Budidaya Pantai Bojonegara.

Hasil analisa statistik menunjukkan bahwa hubungan antara transparansi dengan kepadatan Chlorella sp adalah $Y=4494.531104\ X^{-1.85845}$; (r=-0.96802).

ABSTRACT : Studi on estimation of Chlorella sp density using a comparative transparancy method. By Waspada

Estimation of Chlorella sp density using a comparative transparancy method had been conducted in an outdoors 10-m^3 tank at Research Station for Caostal Aquaculture, Bojonegara.

The relationship between transparancy density of Chlorella sp was found as $Y=4494.531104\ X^{-1.85845}$; (r=-0.96802).

PENDAHULUAN

Chlorella sp termasuk phytoplankton berbentuk bulat dan ada yang berbentuk oval dengan diameter 3 - 5 μm (Rascio et al, 1980). Chlorella sp adalah produser primer yang menggunakan sinar matahari, CO_2 dan mineral untuk membentuk dirinya(Boyd, 1982). Dalam budidaya laut Chlorella digunakan untuk pakan zooplankton dan secara tidak langsung untuk pakan larva udang dan ikan. Dengan kata lain produksi benih ikan dan udang tergantung pada tersedianya Chlorella. Chlorella biasanya dibudidayakan dengan pupuk pertanian seperti ZA, Urea dan TSP. Disamping itu kehadiran Chlorella di dalam tanki pemeliharaan larva dapat membantu menjaga

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kwalitas air (Nuraini, 1983).
Cara budidaya *Chlorella sp* yang biasa dilakukan dengan padat penebaran 1 - 2 x 10^6 sel/ml. Waktu yang diperlukan untuk mencapai kepadatan tertinggi bervariasi tergantung pada beberapa faktor yaitu: kwalitas benih, padat penebaran, intensitas cahaya, pupuk dan aerasi.

Penghitungan kepadatan *Chlorella sp* biasanya dilakukan dengan menggunakan Thoma haemocytometer dan sebuah mikroskop. Metoda ini biasa digunakan dalam penelitian karena mempunyai tingkat ketelitian yang tinggi. Dalam pembenihan udang atau ikan dimana volume pekerjaan besar sekali, metoda ini dianggap kurang praktis. Untuk memudahkan pekerjaan ini perlu dicarikan metoda yang lebih praktis. Pendugaan kepadatan *Chlorella sp* dengan metoda perbandingan transparansi diharapkan dapat menggantikan metoda penghitungan dengan Thoma haemocytometer.

Percobaan ini dilakukan di Sub Balai Penelitian Budidaya Pantai pada bulan Nopember - Desember 1983.

BAHAN DAN CARA

Pemeliharaan *Chlorella sp* dilakukan dalam sebuah tanki berkapasitas 10 m^3. Tanki untuk pemeliharaan *Chlorella sp* harus dicuci sampai bersih kemudian diisi dengan air laut yang sudah disaring pasir(sand filtered) dan disaring lagi dengan plankton-net(mesh size 24 μm). Pupuk yang digunakan dalam percobaan ini adalah 100 ppm $(NH_4)_2SO_4$, 10 ppm Urea dan 30 ppm TSP. Padat penebaran adalah 1 x 10^6 sel/ml.

Penghitungan kepadatan *Chlorella sp* dengan menggunakan sebuah Thoma haemocytometer dan mikroskop. Pengukuran transparansi dilakukan dengan menggunakan sebuah secchi-disc. Hasil pengukuran transparansi dan penghitungan kepadatan sel *Chlorella sp* di analisa dengan analisa regresi (Dixon *et al*, 1969).

HASIL DAN PEMBAHASAN

Hasil analisa regresi pendugaan kepadatan *Chlorella* dengan metoda perbandingan transparansi menunjukkan persamaan $Y=4494.531104\ X^{-1.35845}$; (r=-0.96802). Hubungan antara transparansi dengan kepadatan sel *Chlorella* *sp* dapat dilihat pada Gambar 1. Semakin rendah transparansi semakin tinggi kepadatan *Chlorella* *sp*. Pendugaan kepadatan *Chlorella* *sp* dengan metoda perbandingan transparansi ini diharapkan dapat mempermudah pekerjaan di pembenihan.

Berdasarkan persamaan regresi di atas dan mengingat efisiensi tenaga pelaksanaan pada pembenihan udang dan larva ikan, maka penulis menganjurkan pendugaan kepadatan *Chlorella* *sp* dengan metoda pengukuran transparansi. Hasilnya dikonversikan dengan menggunakan tabel di bawah ini.

Tabel 1. Estimasi kepadatan *Chlorella* *sp* berdasarkan transparansi

Tabel 1. Estimation *Chlorella* *sp* density based on transparancy value

Transparansi Transparancy (cm)	Kepadatan Density (10^6 sel/ml)
60	2
50	3
40	5
30	8
25	11
20	17
18	21
16	26
14	33
12	44
10	62

UCAPAN TERIMA KASIH

Penulis mengucapkan terima kasih kepada E. Danakusumah Kepala Sub Balai Penelitian Budidaya Pantai Bojonegara Serang dan Team Expert JICA serta semua pihak yang telah membantu dalam penulisan ini.

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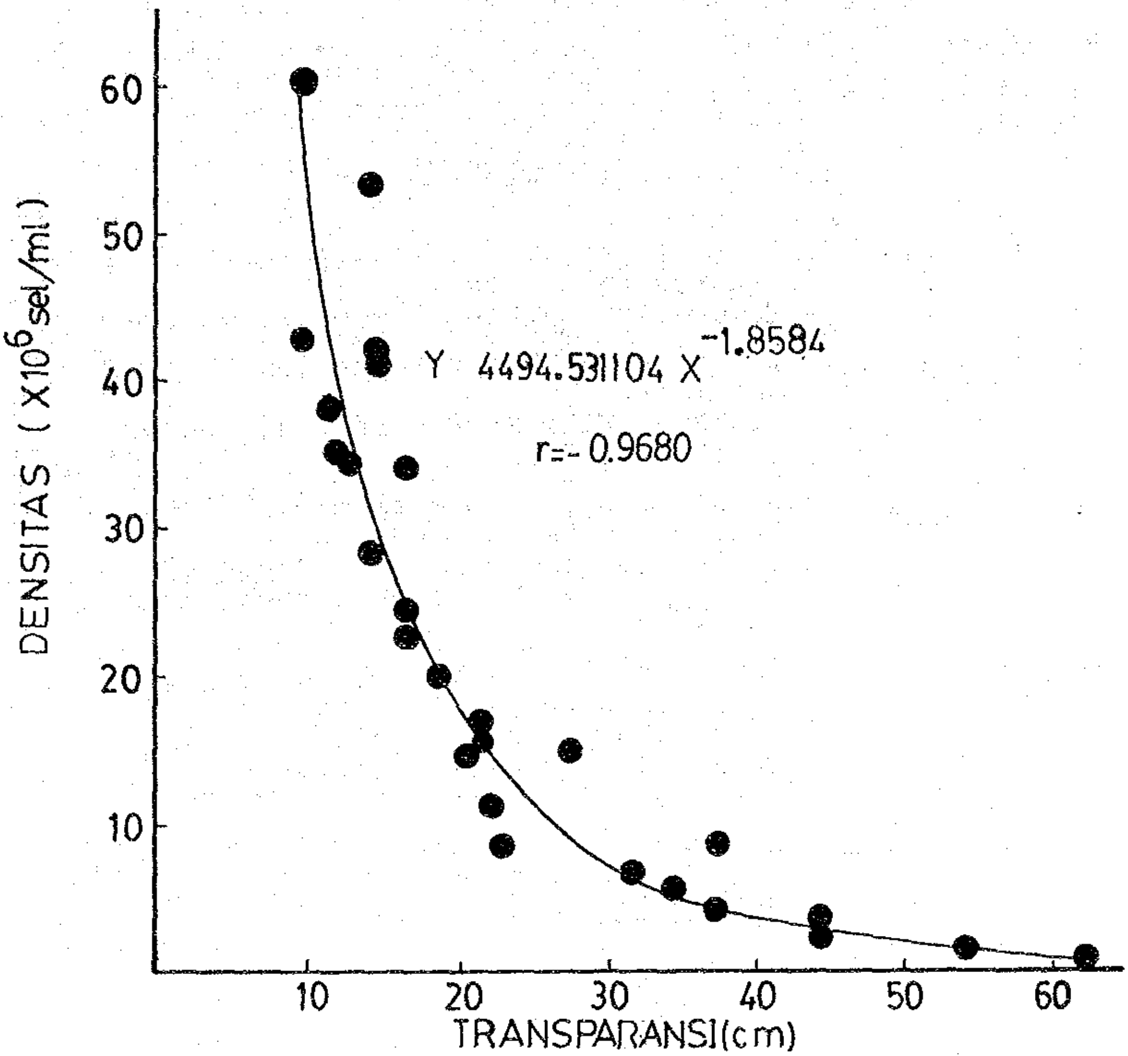

Gambar 1. Hubungan antara kepadatan <u>Chlorella sp</u> dengan transparansi

Figure 1. Relation between <u>Chlorella sp</u> density with transparancy.

PRELIMINARY EXPERIMENT ON THE CULTURE OF *TETRASELMIS* SP. IN THE MEDIA WITH DIFFERENT AMOUNT OF FERTILIZERS

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ABSTRACT

Six experiments were carried out using various combinations of ammonium sulfate, urea, calcium superphosphate and clewat 32 in order to find out the suitable amount of the fertilizers for Tetraselmis sp. in Research Institute for Coastal Aquaculture (Sub Balai Penelitian Budidaya Pantai) Bojonegara, Serang, west-jawa, Indonesia.

From the results, clewat 32 did not show any apparent effect or growth of Tetraselmis. Through the experiment, when the concentration of calcium superphosphate was 0 g/m^3 or more than 60 g/m^3, the growth of Tetraselmis was unstable or low. When more than 300 g/m^3 of ammonium sulfate was used in combination with 30 g/m^3 calcium superphosphate, the growth was low. However, all the other combinations of fertilizers did not show any apparent effect.

RINGKASAN

Penelitian ini bertujuan untuk mengetahui kombinasi dosis pupuk yang cocok untuk budidaya phytoplankton, Tetraselmis sp. di Sub Balai Penelitian Budidaya Pantai. Kombinasi pupuk yang digunakan terdiri dari Ammonium Sulfat, Urea, Calcium Superposfat dan Clewat 32.

Hasil penelitian menunjukkan bahwa Clewat 32 tidak memperlihatkan pengaruh yang berbeda terhadap pertumbuhan Tetraselmis sp. Pertumbuhan Tetraselmis sp. tidak stabil atau berjalan lambat pada perlakuan yang diberi pupuk Calcium Superposfat dengan dosis 0 gr/m^3 atau lebih besar dari 60 gr/m^3. Hasil yang sama juga didapatkan pada perlakuan yang diberi kombinasi pupuk Ammonium Sulfat dengan dosis 300 gr/m^3 dan pupuk Calcium Superposfat sebesar 30 gr/m^3. Kombinasi pupuk yang lainnya juga tidak memperlihatkan pengaruh yang berbeda.

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INTRODUCTION

At present, chlorella is mainly used as the food of rotifer which is the primary food for fish or crustacean larvae in the world. However, the large-scale culture of chlorella is not stable in a high-temperature water(Hirata, 1980). Therefore, many Institutes and fisheries experimental stations have started culturing Tetraselmis as the substitution of chlorella in Japan and the food value of the rotifer cultured with Tetraselmis seems high(Fukusho et al., 1984). Actually, National Institute of Coastal Aquaculture, Songkhla, Thailand which is located in the tropical area has been also utilizing Tetraselmis as the food of rotifer and producing a large number of seabass fries.

In Research Institute for Coastal Aquaculture Bojonegara, Serang, west-jawa, Indonesia, Tetraselmis has been cultured for 4 years and the same method of the cultivation with chlorella has been adopted to Tetraselmis, that is, the fertilizers, 150 g/m^3 of ammonium sulfate, 30 g/m^3 of calcium superphosphate and 10 g/m^3 of urea, has been used for Tetraselmis culture in consideration of chlorella culture method in Japan.

However, it is considered that nutrition requirement of Tetraselmis is different from chlorella and also the water quality of this area is different from Japan. Therefore, this paper aimed to investigate the suitable amount of fertilizers for culturing Tetraselmis in this Institute.

MATERIALS AND METHODS

30-l panlite tanks were used for this experiment. The sand-filtered seawater which was sterilized for 24 hours by sodium hypochlorite and neutrilized by sodium thiosulfate was filled into the 30-l panlite tanks. Tetraselmis sp. was inoculated into the 30-l panlite tanks with the initial density of 0.7 - 5.3 x 10^4 cells/ml. Tetraselmis used for this experiment had been cultured during at least 4 days in 1-m^3 panlite tanks with the medium of 150 ppm of ammonium sulfate, 30 ppm of calcium superphosphate and 10 ppm of urea.

Water temperature, salinity and PH were observed daily in the morning.

Table 1 shows the amount of fertilizers used for this experiment.

RESULTS

First experiment(17th Oct. - 25th Oct.)

This experiment aimed for examining the various concentrations of clewat 32 in combination with 150 g/m^3 ammonium sulfate, 10 g/m^3 urea and 30 g/m^3 calcium superphosphate. The result of the daily change of the density of Tetraselmis is shown in fig. 1.

Water temperature of tank no. 1, 2, 3, 4 and 5 during the experiment were 27.8 ± 1.07, 27.8 ± 1.21, 27.7 ± 1.25, 27.4 ± 1.09 and 27.5 ± 1.09°C, salinity were 36.2 ± 0.70, 35.9 ± 0.93, 36.3 ± 0.66, 36.1 ± 0.93 and 36.5 ± 0.67‰ and PH, 8.28 ± 0.121, 8.20 ± 0.117, 8.16 ± 0.182, 8.11 ± 0.181 and 8.12 ± 0.197 respectively.

Tank no. 2 had the highest density(17.0 x 10^4 cells/ml) at the end of experiment but the highest density during the experiment was 24.6 x 10^4 cells/ml which was observed on 6th day in tank no.1.

The contamination of Protozoa and diatoms was observed in all the tanks in the experiment.

Second experiment(27th Oct. - 4th Nov.)

This experiment aimed for examining various concentrations of urea in combination with 150 g/m^3 ammonium sulfate and 30 g/m^3 calcium superphosphate. The result of the daily change of the density is shown in fig. 2.

Water temperature of tank no. 1, 2, 3, 4 and 5 were 27.0 ± 0.45, 27.1 ± 0.40, 27.1 ± 0.30, 27.1 ± 0.30 and 27.2 ± 0.32°C, salinity were 36.5 ± 0.83, 36.5 ± 0.66, 36.3 ± 0.61, 36.1 ± 0.65

and 36.1 ± 0.68‰ and PH, 7.93 ± 0.342, 8.03 ± 0.210, 8.06 ± 0.130, 8.12 ± 0.094 and 8.14 ± 0.084.

Tank no.5 had the highest density(22.5 x 10^4 cells/ml) at the end of experiment but the highest density during the experiment was 40.9 x 10^4 cells/ml which was observed on 5th day in tank no.1.

The contaminatiion of Protozoa and diatoms was observed in all the tanks in the experiment.

Third experiment(7th Nov. - 18th Nov.)

This experiment aimed for examining the various concentrations of calcium superphosphate in combination with 150 g/m³ ammonium sulfate. The result of the daily change of the density is shown in fig. 3.

Water temperature of tank no. 1, 2, 3, 4 and 5 were 27.9 ± 0.52, 27.6 ± 0.82, 27.7 ± 0.64, 27.5 ± 0.79 and 27.3 ± 1.02°C, salinity were 36.8 ± 1.03, 37.0 ± 1.41, 36.5 ± 0.81, 36.5 ± 0.81 and 37.3 ± 1.47‰ and PH, 8.06 ± 0.260, 8.11 ± 0.206, 8.11 ± 0.140, 8.00 ± 0.141 and 7.77 ± 0.159 respectively.

Tank no. 2 had the highest density(44.8 x 10^4 cells/ml) at the end of experiment but the highest density during the experiment was 48.0 x 10^4 cells/ml which was observed on 6th day in tank no. 1.

The contamination of Protozoa and diatoms was observed in all the tanks in the experiment.

Fourth experiment(7th Nov. - 19th Nov.)

This experiment aimed for examining the various concentrations of ammonium sulfate in combination with 30 g/m³ calcium superphosphate. The result of the daily change of the density is shown in fig. 4.

Water temperature of tank no. 1, 2, 3, 4 and 5 were 27.9 ± 0.51, 27.5 ± 0.55, 27.6 ± 0.54, 27.5 ± 0.58 and 27.5 ± 0.81°C, salinity were 36.9 ± 1.15, 36.9 ± 1.16, 36.7 ± 1.05, 37.1 ± 1.06 and 37.4 ± 1.30‰ and PH, 8.32 ± 0.104, 8.04 ± 0.221, 7.85 ± 0.374, 7.69 ± 0.399 and 7.39 ± 0.541 respectively.

Tank no. 2 had the highest density(43.3 x 10^4 cells/ml) at the end of experiment but the highest density during the experiment was 48.9 x 10^4 cells/ml which was observed on 11th day in tank no.1.

The contamination of Protozoa and diatoms was observed in all the tanks in the experiment.

Fifth experiment(20th Nov. - 30th Nov.)

This experiment aimed for examining the various concentrations of ammonium sulfate and urea in combination with 30 g/m³ calcium superphosphate. The result of the daily change of the density is shown in fig. 5.

Water temperature of tank no. 1, 2, 3, 4 and 5 were 27.3 ± 1.07, 27.3 ± 0.92, 27.3 ± 0.70, 27.0 ± 0.85 and 26.9 ± 0.85°C, salinity were 36.4 ± 0.94, 36.0 ± 0.61, 35.6 ± 0.47, 36.0 ± 0.77 and 36.5 ± 1.01‰ and PH, 8.14 ± 0.212, 8.28 ± 0.120, 8.34 ± 0.062, 8.34 ± 0.084 and 8.42 ± 0.101 respectively.

Tank no. 5 had the highest density(41.4 x 10^4 cells/ml) at the end of experiment but the highest density during the experiment was 43.9 x 10^4 cells/ml which was observed on 9th day in tank no. 1.

The contamination of Protozoa and diatoms was observed in all the tanks in the experiment.

<u>Sixth experiment(20th Nov. - 30th Nov.)</u>

This experiment aimed for examining the various concentrations of urea in combination with 30 g/m^3 calcium superphosphate. The result of the daily change of the density is shown in fig. 6.

Water temperature of tank no. 1, 2, 3, 4 and 5 were 27.2 ± 1.05, 27.1 ± 0.91, 26.9 ± 0.76, 26.9 ± 0.76 and 26.8 ± 0.98°C, salinity were 36.6 ± 1.02, 35.9 ± 0.66, 36.4 ± 0.66, 35.8 ± 0.78 and 36.4 ± 1.03‰ and PH, 8.44 ± 0.107, 8.32 ± 0.058, 8.26 ± 0.080, 8.31 ± 0.511 and 8.28 ± 0.084 respectively.

Tank no. 1 had the highest density(40.0 x 10^4 cells/ml) at the end of experiment and this density was also the highest density during the experiment.

The contamination of Protozoa and diatoms was observed in all the tanks in the experiment.

CONSIDERATION

In the large-scale phytoplankton culture, the suitable amount of fertilizers depens on the locations which have the different water quality. Hirata(1977) mentioned that concerning ammonium sulfate, there is no apparent effect in the concentrations of 100 - 800 ppm in the area of Kagoshima prefecture but the best effect in 50 ppm in the area of Kumamoto prefecture in Japan and also the amount of calcium superphosphate was suitable in the concentration of 20 - 100 ppm. Takasaki(1983) mentioned that the most suitable combinations of ammonium sulfate, urea and calcium superphosphate for chlorella culture were 50 - 100, 0 and 15 - 30 g/m^3 or 0, 10 - 60 and 15 - 30 g/m^3, respectively in Ehime prefecture, Japan. Clewat 32 is used for the purpose of adding micrometals. Iwasaki(1979) mentions that th growth of many phytoplanktons are accelerated by adding iron and manganese.

This experiment was carried out in the same way of Takasaki's method to find out the most suitable amount of fertilizers of ammonium sulfate, urea, calcium superphosphate and clewat 32 in Bojonegara station, west jawa, Indonesia. From the results of experiment, the growth of Tetraselmis was unstable or low in the concentrations of 0 and more than 60 g/m^3 calcium superphosphate in combination with 150 g/m^3 ammonium sulfate and also in the concentrations of more than 300 g/m^3 ammonium sulfate in combination with 30 g/m^3 calcium superphosphate. However, all the other combinations of the experiment did not show any apparent effect. Therefore, it seems that 75 - 150 g/m^3 ammonium sulfate in combination with 15 - 30 g/m^3 calcium superphosphate or 10 - 30 g/m^3 urea in combination with 15 - 30 g/m^3 calcium superphosphate is enough for Tetraselmis culture in Bojonegara station. This amount of fertilizers is much smaller than the present amount, 150 g/m^3 ammonium sulfate, 10 g/m^3 urea and 30 g/m^3 calcium superphosphate.

However, the contamination of Protozoa and diatoms was observed through the experiment and the enviromental conditions of each experiment were not quite same because sunlight was not equally taken into all the experimental vessels. Therefore, the further experiment should be carried out under the improved conditions and also the same kind of experiment should be carried out in the rainy season because the water quality seems different from the dry season.

ACKNOWLEDGEMENT

Authors with to express their gratitude to all staffs of Research Institute for Coastal Aquaculture(Sub Balai Penelitian Budidaya Pantai) Bojonegara, Serang, Indonesia, for their kind help during the experiment and also to Mr. T. YOSHIMITSU, expert of Japan Cooperation Agency and team leader of this project, for giving an opportunity of this experiment.

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Table 1. Komposisi pupuk yang digunakan dalam budidaya <u>Tetraselmis</u> sp.

Table 1. The components of the fertilizers in each experiment(g/m^3 seawater)

Experiment (Duration)	Medium	Ammonium sulfate	Urea	Calcium superphosphate	Clewat 32*
	1	150	10	30	0
I	2	150	10	30	2
(17.Oct. - 25.Oct.)	3	150	10	30	4
	4	150	10	30	6
	5	150	10	30	8
	1	150	0	30	
II	2	150	5	30	
(27.Oct. - 4.Nov.)	3	150	10	30	
	4	150	20	30	
	5	150	40	30	
	1	150		0	
III	2	150		15	
(7.Nov. - 18.Nov.)	3	150		30	
	4	150		60	
	5	150		120	
	1	0		30	
IV	2	75		30	
(7.Nov. - 19.Nov.)	3	150		30	
	4	300		30	
	5	600		30	
	1	150	0	30	
V	2	100	25	30	
(20.Nov. - 30.Nov.)	3	50	50	30	
	4	25	75	30	
	5	0	100	30	
	1		0	30	
VI	2		10	30	
(20. Nov. - 30.Nov.)	3		30	30	
	4		60	30	
	5		120	30	

* Teikoku-kagaku Sangyo Co. Ltd. Japan.

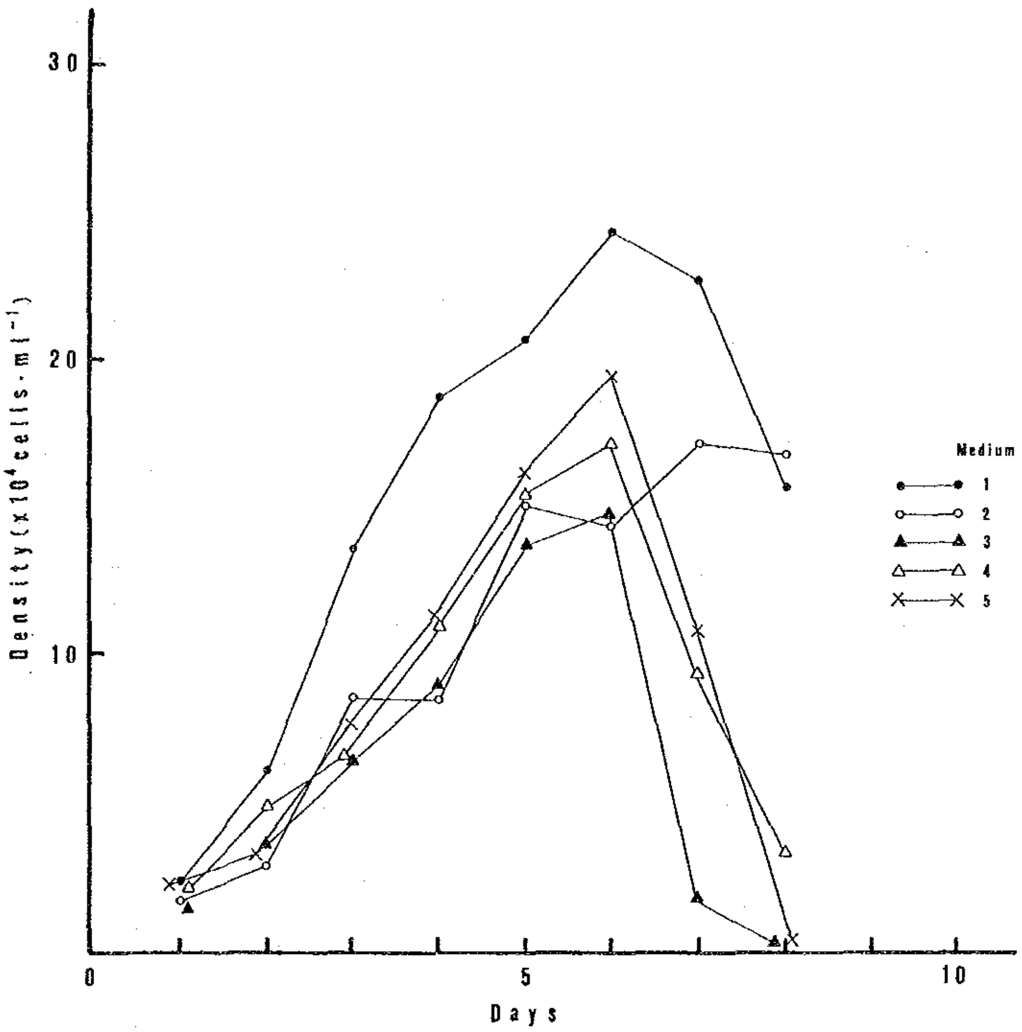

Fig. 1. Daily change of the density of *Tetraselmis* sp. in cultures using various concentrations of clewat 32.

Gambar 1. Pertumbuhan populasi *Tetraselmis* sp. yang dibudidayakan dengan konsentrasi Clewat 32 yang berdeda.

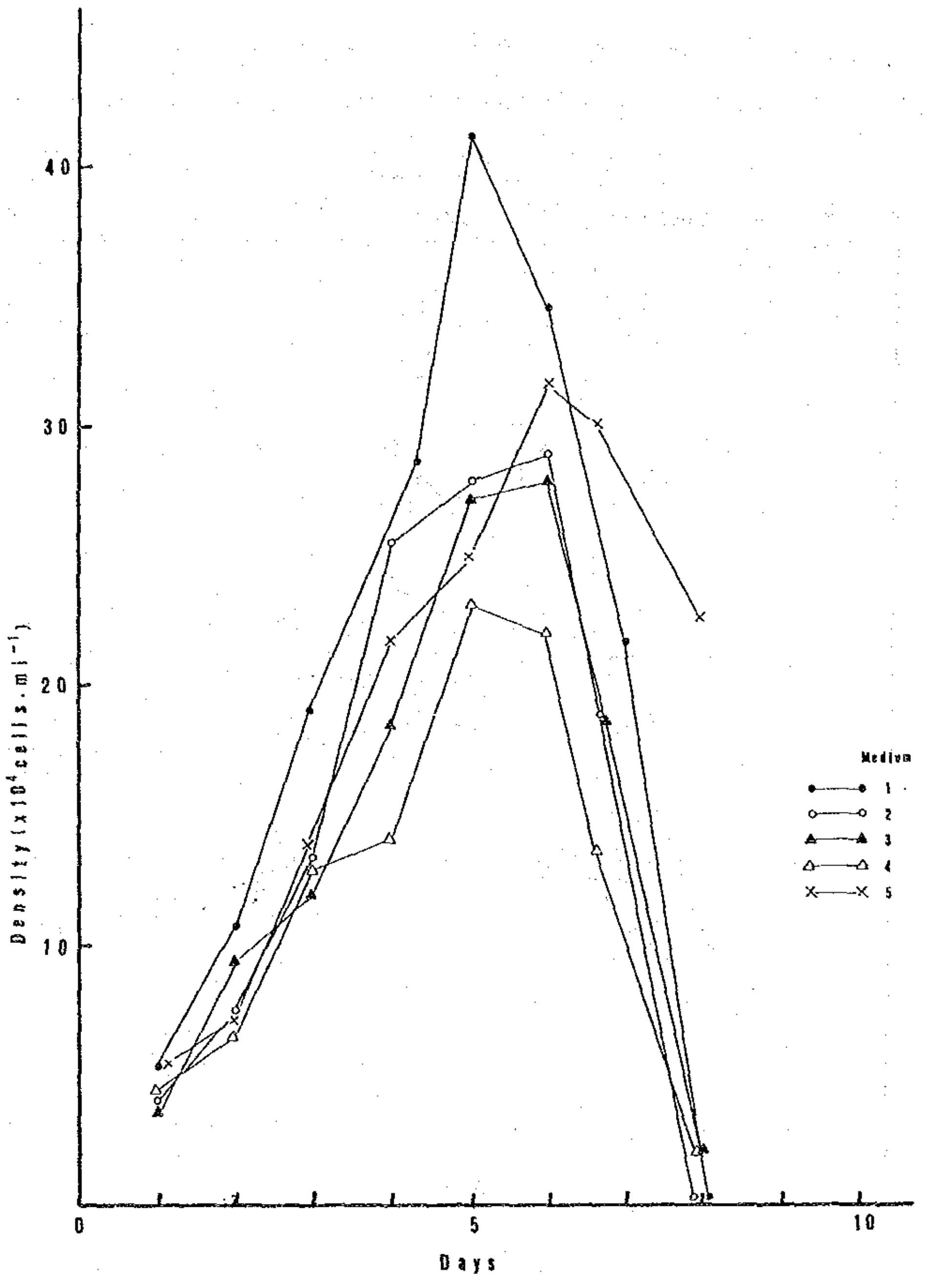

Fig. 2. Daily change of the density of <u>Tetraselmis</u> sp. in cultures using various concentrations of urea.

Gambar 2. Pertumbuhan populasi <u>Tetraselmis</u> sp. yang dibudidayakan dengan konsentrasi pupuk urea yang berbeda.

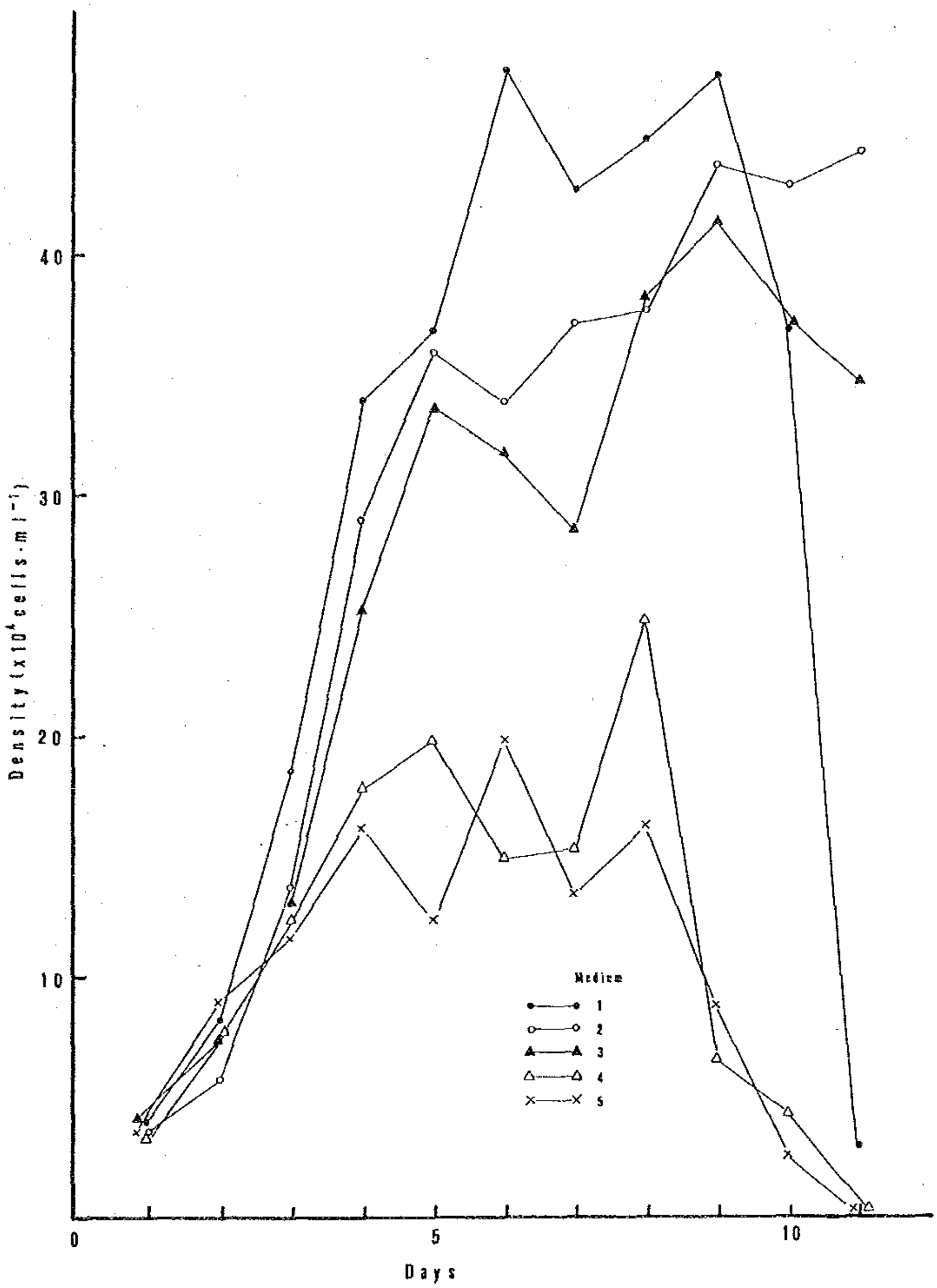

Fig. 3. Daily change of the density of Tetraselmis sp. in cultures using various concentrations of calcium superphosphate.

Gambar 3. Pertumbuhan populasi Tetraselmis sp. yang dibudidayakan dengan konsentrasi pupuk calsium superfosfat yang berbeda.

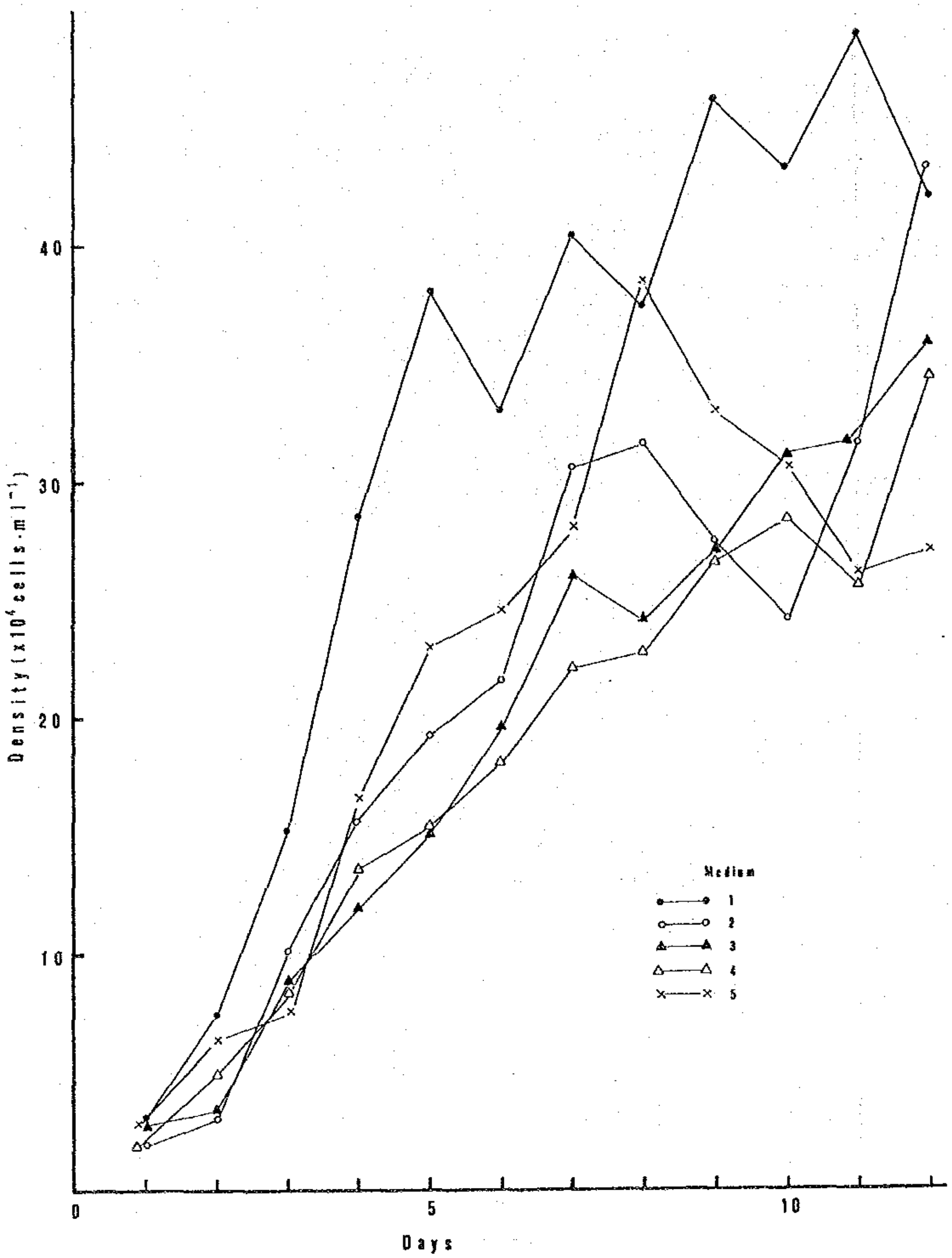

Fig. 4. Daily change of the density of
<u>Tetraselmis</u> sp. in cultures using various
concentrations of ammonium sulfate.

Gambar 4. Pertumbuhan populasi <u>Tetraselmis</u> sp. yang dibudidayakan dengan konsentrasi pupuk ammonium sulfat berbeda.

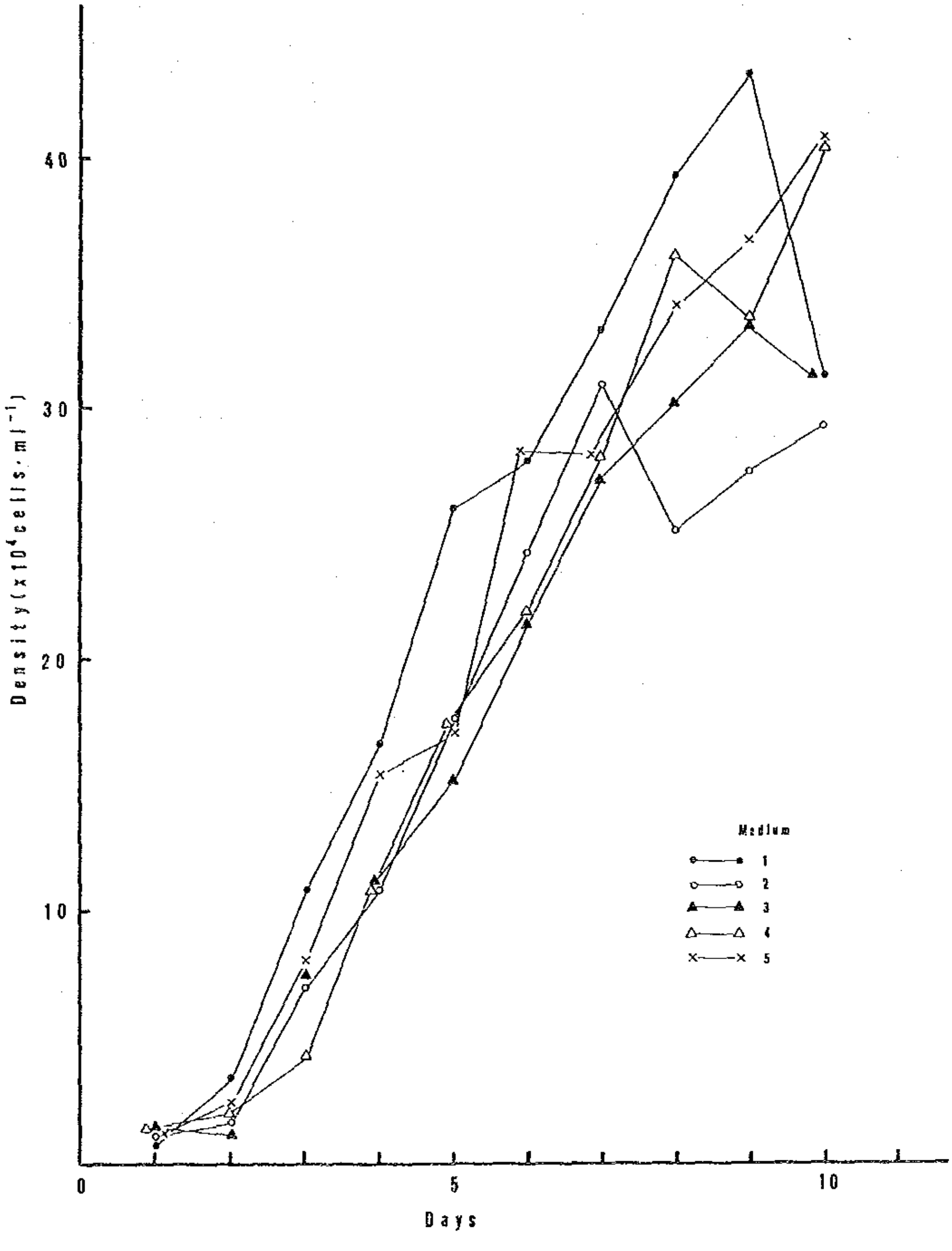

Fig. 5. Daily change of the density of Tetraselmis sp. in cultures using various concentrations of ammonium sulfate and urea.

Gambar 5. Pertumbuhan populasi Tetraselmis sp. yang dibudidayakan dengan konsentrasi pupuk ammonium sulfat dan urea yang berbeda konsentrasinya.

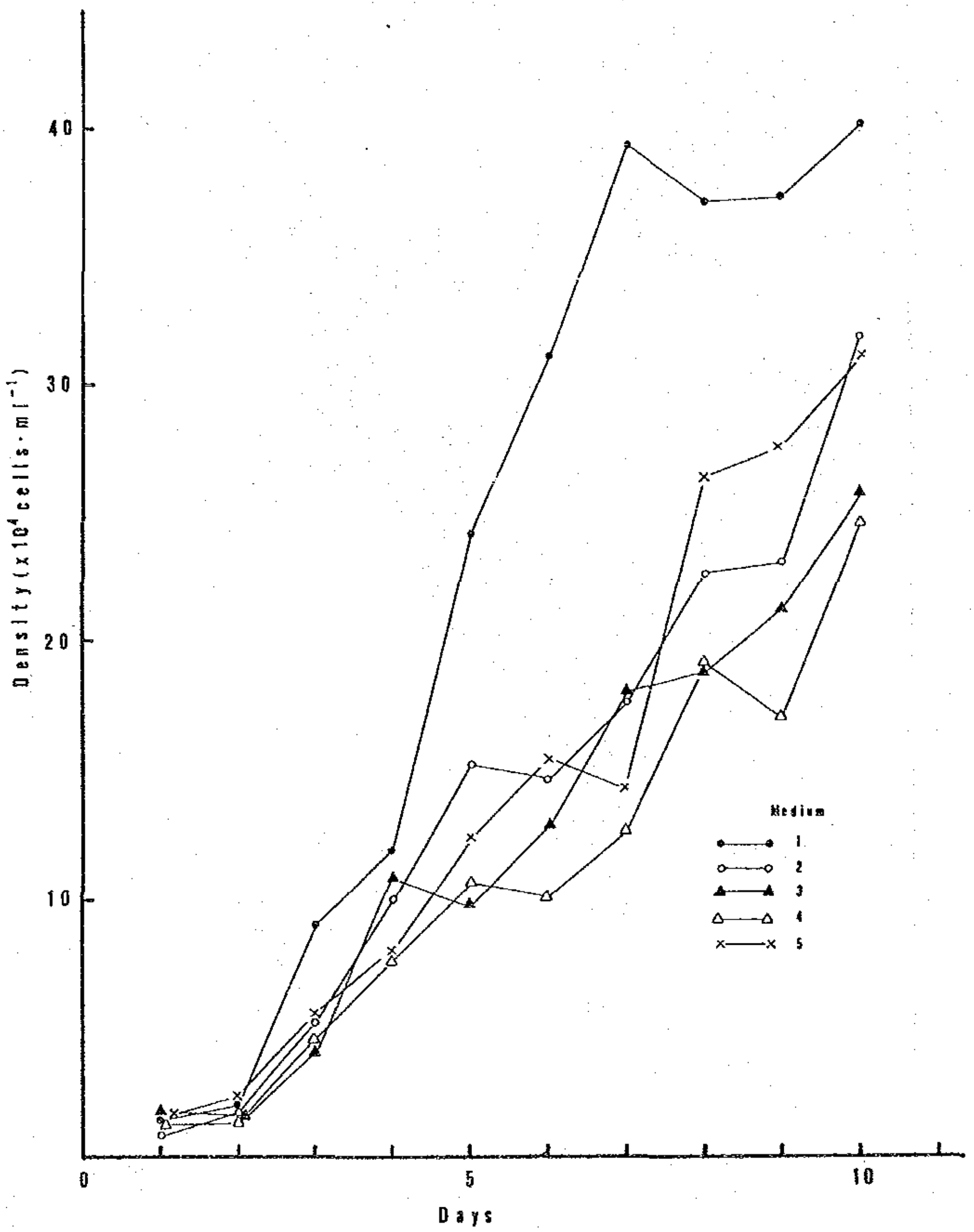

Fig. 6. Daily change of the density of *Tetraselmis* sp. in cultures using various concentrations of urea.

Gambar 6. Pertumbuhan populase *Tetraselmis* sp. yang dibudidayakan dengan konsentrasi pupuk urea hang berbeda.

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