SCIENTIFIC REPORT OF MARICULTURE RESEARCH AND DEVELOPMENT PROJECT (ATA – 192) IN INDONESIA

MARCH 1986

JAPAN INTERNATIONAL COOPERATION AGENCY

CONTENTS

EFFECT OF DIFFERENT SALINITIES ON THE NAUPLII PRODUCTION OF COPEPOD (*Tigriopus japonicus*)

Achmad Basyari*

ABSTRACT

The experiment was conducted to study the nauplii production of copepods Tigriopus japonicus cultured under different salinities at water temperature of 31°C.

The result showed that the salinity of 30 ppt was the best for the nauplii production of Tigriopus japonicus. The occurrence of 3 gravid females and number of 39.3 nauplii/day were obtained.

ABSTRAK : PENGARUH PERBEDAAN SALINITAS TERHADAP PRODUKSI NAUPLII COPEPODA (Tigriopus japonicus)

Penelitian dilakukan untuk mengetahui tingkat produksi nauplii copepoda Tigriopus japonicus pada salinitas yang berbeda. Perbedaan ini dilakukan pada suhu air yang tetap yaitu 31°C.

Hasil penelitian menunjukkan bahwa, produksi T.japonicus yang terbaik terdapat pada salinitas 30 ppt, dengan jumlah nauplius sebanyak masing-masing 34,8 dan 39,9 ekor per hari.

* Research Institute For Coastal Aquaculture (Sub Balai Penelitian Budidaya Pantai) Bojonegara - Serang.

INTRODUCTION

Harpacticoids copepods i.e. Tigriopus spp. has such remarkable resistance to salinity changes. Normal habitat of Tigriopus spp. is in high pools on rocky shores. These pools are rush by the high spring tides, but not intervening tides. The salinity in these pools can be variety depend on the natural condition. RANADE (1953) has shown that Tigriopus brevicornis can live normally in salinity ranging from 4.2 to 90.0 ppt. LEE and HU (1981) has studied that T.japonicus tolerated a salinity change from 1.8 to 36.0 ppt. and half of the best population survived for 10 hours in distiled water. KASAHARA and AKIYAMA (1976) indicated that dormant salinity for the species was 130 - 150 ppt.

This paper attemps to study the effects of salinity and temperature to the population growth of T.japonicus, prior to the mass culture of copepods.

MATERIAL AND METHOD

The experiment was conducted at the Laboratory of Aquaculture Physiology, Kagoshima University, Japan on 1984.

Adult Tigriopus japonicus was cultured under different salinities namely : 0, 3, 6, 9, 12, 15, 18, 21, 24, 30 and 33 ppt. They were introduced into 50 ml capacity bottles which were filled with 40 ml Chaetoceros-water at density of 5 ind./bottle. Chetoceros density was maintained at a density of 20 X 10^4 cells/ml. The water temperature of 31^{o}C was maintained using a water bath (model Uni Bath KU - 22).

Daily occurrences of gravid female and nauplii were determined microscopically. Culture water was filtered through a plankton net of 120 μm mesh size (for adult) and 62.5 μm mesh size (for the nauplii). Gravid females retained in the 120 μm plankton net were counted, there after replace them back into culture vessels. The nauplii retained in

after replace them back into culture vessels. The nauplii retained in the 62.5 µm plankton net were counted, before being transfered into a stocking tank of 30 liter (Figure 1).

Comparations among the occurrences of gravid female and number of nauplii at different salinity treatment were analysed using a single classification analysis of variance as described by Sokal and Rohlf (1969). Distribution of carapace length was measured under microscope by using an eye piece micrometer.

RESULT AND DISCUSSION

The occurrences of gravid female were highly significant different ($P > 0.01$) among salinities treatments (Table 2). An average highest occurrences of 3.6 gravid females were obtained at salinity of 30 ppt (Table 1).

Table 1. An average daily occurrence of Tigriopus japonicus gravid. female and number of nauplii during cultured period under different salinities treatment.

Tabel 1. Jumlah rata-rata induk Tigriopus japonicus dengan matang telur dan jumlah nauplius setiap hari selama periode percobaan dengan perlakuan perbedaan salinitas.

SALINITY (°/₀₀)	OCCURRENCE OF GRAVID FEMALE	NUMBER OF NAUPLII
0	0.7	1.8
3	1.4	3.9
6	1.6	20.7
9	1.6	23.1
12	1.6	25.0
15	1.7	21.1
18	1.8	23.1
21	2.2	31.8
24	2.6	35.6
30	3.6	39.5
33	2.7	22.5

Statistically the total number of nauplii was significant different ($P<0.05$) among salinities treatments (Table 3). The result of Duncan's Multiple Range Test showed that the differences among salinities treatments are highly significant (P 0.01). The salinity of 30 ppt was the best in term of highest population gravid females and nauplii. The salinity ranked may be as follow 30 = 33, 24, 21, 18, 15, 12, 9, 6, 3, 0 ppt. The lowest of 1 nauplius was obtained at salinity of 0 ppt. The mortal was happened on day-3 for those cultured under 0 ppt. salinity (Figure 1).

The most suitable salinity for Tigriopus sp. was less than normal sea water (TAKANO, 1968). LEE and HU (1981) found that T.japonicus has a wide range salinity tolerance from 1.8 to 36.0 ppt. They found that T.japonicus cannot survive long at low salinity level. In these study the best population growth was occured at salinity of 30 ppt. IGARASHI (1960), demonstrated that the development of T.japonicus was highest in 80% sea water solution and decreased by increasing the concentration up to 160% sea water solution. Moreover, he indicated that 3.4 ppt salinity was the lower limit for normal development of T.japonicus. LEE and HU (1981) found that the highest mean average number of T.japonicus nauplii per female was about 36 nauplii at salintiy of 30 ppt, and they showed that there were significant different in nauplii production at different salinity ($P<0.05$). In these study, the highest mean average of nauplii was 34.8 and 39.5 per day at salinity of 30 ppt.

ACKNOWLEDGMENTS

The author indebted to Prof.Dr. Hachiro Hirata, chief of Aquaculture Physiology Faculty of Fisheries, Kagoshima University, Japan, for his guidance and suggestion during this experiment. Thanks also due to Ir.Edward Danakusuman MSc., shief of Research Institute For Coastal Aquaculture, Serang, for his reading this manuscript and valuable help during the arrangement of this paper.

REFERENCES

DAVID C.C.,1981. Mechanisms of hatching in Aquatic Invertebrate eggs II. Oceanogr. Mar.Biol.Ann.Rev., 19,95-123.

GOMEZ K.A. and A.A. GOMEZ, 1976. Statistical procedures for Agricultural research with emphasis on rice. The International Rice Research Institute. Manila, Phillipines.

HICK R.F. and B.C.COULL, 1983. The ecology of marine meiobenthic Harpacticoid Copepods. Oceanogr. Mar.Biol.Ann.Rev., 21,67-175.

KAHAN D., UHLIG G., SCHWENZER D. and HOROWITZ L., 1982. A simple method for cultivating Harpacticoid Copepods and offering them to fish larvae. Aquaculture, 26,303-310.

LEE C.S and HU F., 1981. Salinity tolerance and salinity effects on broods size of Tigriopus japonicus Mori. Aquaculture, 22,377-381.

UYE S.I., 1981. Fecundity studies of neritic Calanoid Copepods Acartia clausi Giesbrecht and A.steuri Smirnov: A simple empirical model of daily egg production. J.Exp.Mar.Biol.Ecol., 50,255-271.

YAMASAKI S. and J.T. CANTO, 1980. Culture experiments on the Harpacticoid Copepods Tisbintra elongata Mori and evaluation of that species as food organisms for milkfish larvae. Mem.Fac.Fish., Kagoshima Univ., 29,275-291.

Table 2. Analysis of variance for total number of occurrences of gravid female Tigriopus japonicus under different salinities at 31°C.

Source of variation	df	ss	ms	Computed F	Tabular F 5%	Tabular F 1%
Among salinities. (treatment)	10	35.86	3.586	3.16**	2.00	2.66
Within salinities. (error)	55	62.50	1.136			
Total	65	98.36				

** Highly significant different ($P < 0.01$)

Table 3. Analysis of variance for total number of Tigriopus japonicus nauplii during 6 days cultured period, under different salinities at 31° C.

Source of variation	df	ss	ms	Computed F	Tabular F 5%	Tabular F 1%
Among salinities. (treatment)	10	7949.02	794.902	3.40**	2.00	2.66
Within salinities. (error)	55	12847.42	233.589			
Total	65	20796.44				

** Highly significant different ($P < 0.01$)

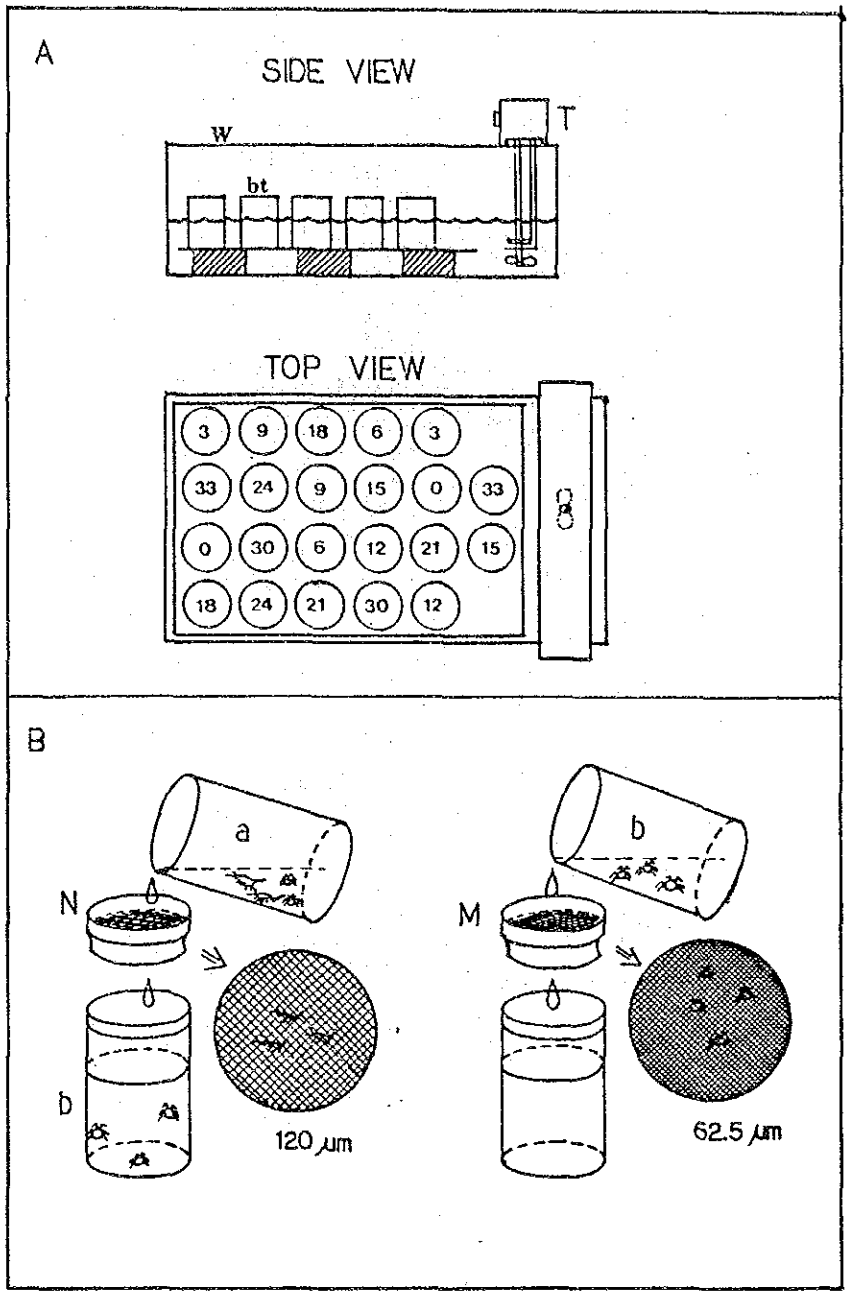

Figure 1. Schematic diagram of culturing T.japonicus using water bath system in different salinities treatment. B. Daily harvesting;
a. Harvesting gravid female by plankton net of 120 um mesh size (N),
b. Harvesting nauplii by plankton net of 62.5 um mesh size (M).

Gambar 1. Diagram percobaan kultur T.japonicus dalam bak kontrol dengan perlakuan perbedaan salinitas. B; Pemanenan harian;
a. Induk dengan matang telur di panen dengan plankton net ukuran 120 um(N)
b. Nauplii dipanen memakai plankton net ukuran 62.5 um (M).

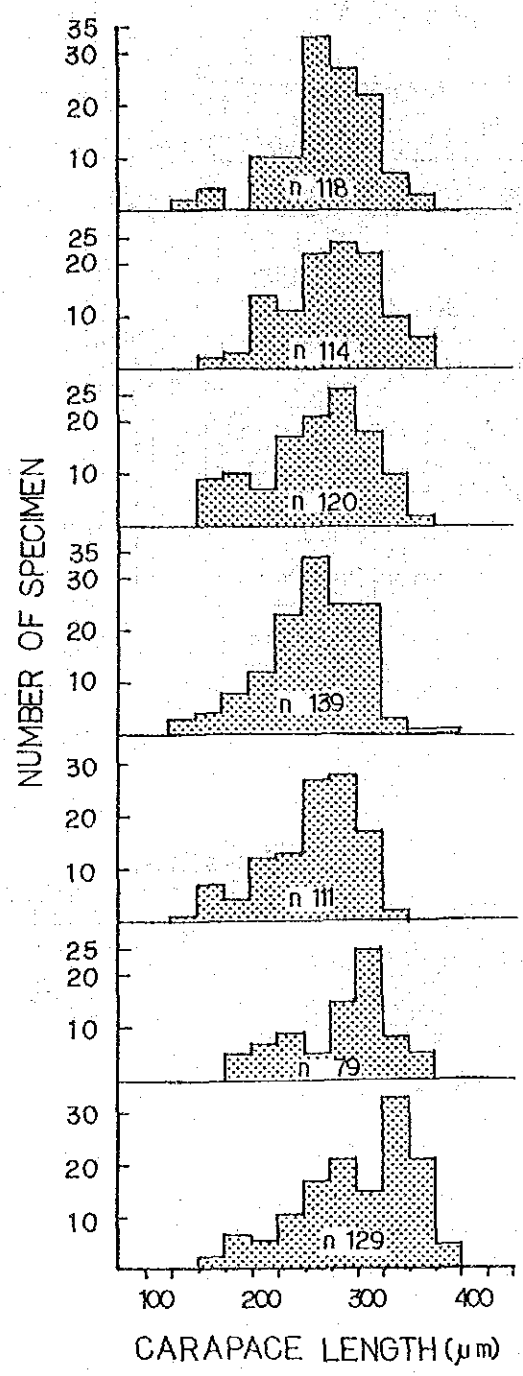

Figure 2. Frequency distribution of carapace length of T.japonicus cultured on Chaetoceros-Water.

Gambar 2. Distribusi frekwensi panjang carapace T.japonicus yang di pelihara dalam media Chaetoceros.

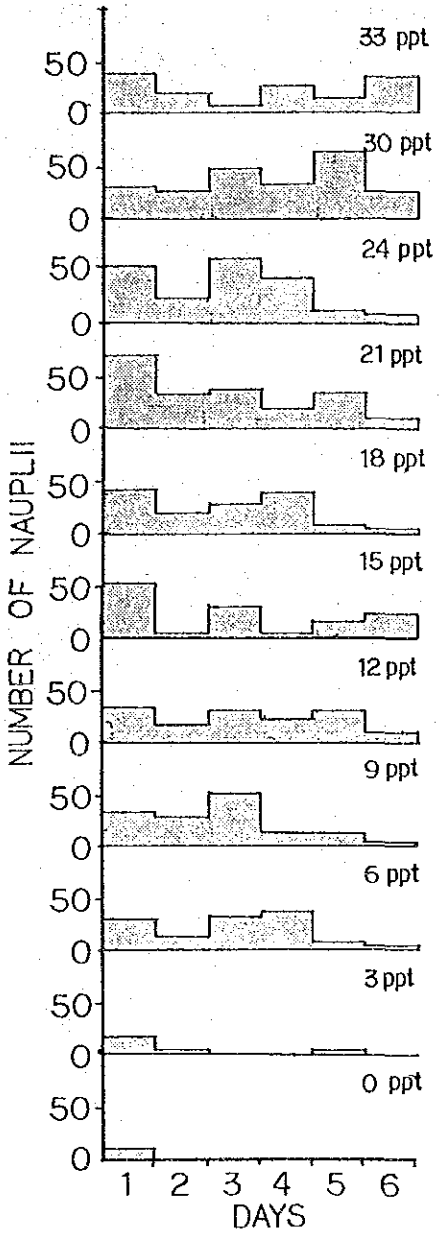

Figure 3. Daily number of nauplii T.japonicus at different salinities treatment.

Gambar 3. Jumlah harian nauplii T.japonicus pada perlakuan perbedaan salinitas.

STUDIES ON REARING OF RABBITFISH – I
EFFECT OF DIFFERENT PROTEIN LEVEL ON THE GROWTH OF *SIGANUS JAVUS*

Achmad Basyari* and Hideyuki Tanaka**

ABSTRACT

The experiment was conducted in 60-liters aquaria using filtered sea water at The Research Institute For Coastal Aquaculture Bojonegara Serang-West Java on August 1981. This study was aimed to clarify the optimum level of protein content in the food.

Diets with four different protein contents namely : 58%, 46%, 35% and 29% were provided and offered to the Siganus javus of 4.79 g in average body weight. Feed were given four times a day. Siganus javus showed better growth in feed containing the protein contents of 35% to 46%. Water temperature and pH were ranged between 28.3 - 29.4 ^{o}C and 7.70 - 8.02, respectively.

ABSTRAK : STUDI TENTANG PEMELIHARAAN IKAN BERONANG SIGANUS JAVUS DENGAN PAKAN BUATAN YANG BERBEDA KANDUNGAN PROTEINNYA

Percobaan ini dilakukan dalam aquarium berkapasitas 60 liter di Sub Balai Penelitian Budidaya Pantai Bojonegara pada bulan Agustus 1981. Tujuan penelitian ini adalah untuk mengetahui kebutuhan protein yang optimum dalam pertumbuhan ikan beronang liris (Siganus javus) yang berat rata-ratanya adalah 4,79 gram.

Makanan dibuat dalam bentuk pellet dengan empat macam kandungan protein yang berbeda yaitu 58%, 46%, 35% dan 29%. Makanan diberikan empat kali sehari.

* Research Institute For Coastal Aquaculture Serang-West Java

** Japan International Cooperation Agency (JICA) Japan

Selama enam minggu percobaan, temperatur air berkisar antara 28,3 - 29,4°C, sedangkan pH air laut berkisar antara 7,70 - 8,02. Beronang liris yang diberi pakan dengan kandungan protein antara 35% dan 46% pertumbuhannya lebih baik daripada yang diberi pakan dengan kandungan protein 29% dan 58%.

INTRODUCTION

Siganids are now attracting the attention of mariculturists in many parts of the Indo-Pasific and in Israel (LAM, 1974). Some of the reasons that they are primarily herbivorus in nature but may turn to other diets. A series of studies have been made on the food habits of Siganids (SUYEHIRO; HIATT and STRASBURG; OKADA; JONES; HELFMAN; DREW; TSUDA and BRYAN in LAM, 1974). They have all shown that Siganids both juvenile and adults are primarily herbivorus, they could fed on a wide variety of food offered. They have well adaptation in captivity and grow rapidly on a diet of natural foods or artificial food pellets.

DREW in LAM (1974a) found in his experiment that, S.canaliculatus has been showed to feed on all kinds of food offered such as Enhalus sp.(eel grass), tapioka leaves, grass, Hydrilla sp.(freshwater aquatic plant), chicken food pellets, cooked rice, dried shrimps and even fish scraps of their own species, algae, unsalted crackers and pieces of tuna. TSUDA (1974) found in his observations of juvenile Siganus spinus and S.argenteus in the field, they feed on any algae which they could physically bite and ingest.

Thus, Siganids are potentially omnivorus eventhough they may primarily herbivorus in nature. They could be cultured by food containing lower protein contents as compared with the other fish species.

The study was aimed to clarify the optimum level of protein requirement in term of their growth, fed on diets of different protein contents.

MATERIAL AND METHOD

Siganus javus fry was collected from the zostera zone in Banten Bay waters. The fry were then acclimated to eat compound feed containing of carp diet and minced fish meat.

Twenty fishes of 4.7 g in average body weight was used in this experiment (Table 1).

Table 1. The number and size of Siganus javus was used in the experiment.

Tabel 1. Ukuran dan jumlah ikan beronang liris (Siganus javus) yang digunakan dalam percobaan.

	TREATMENT			
	A	B	C	D
FISH NUMBER	20	20	20	20
AVERAGE BODY WEIGHT (g)	4.69	4.74	5.29	4.43
TOTAL BODY WEIGHT (g)	93.80	94.80	105.80	88.60

Four pieces 60-liter quaria with a circulating filtration system were used for the experiment. The fry was fed with different protein content diets. Those were 58%(A), 46%(B), 35%(C) and 29%(D).
The feed was made from a mixing of diet for Red Sea Bream (made in Japan) and mixed with wheat flour, tapioka starch, sago stacrh, vitamins mix and minerals. The composition is showen in Table 2.
The composition of compound feeds were then analysed chemically by The Research Institute For Freshwater in Bogor (Table 3). The feed was served to the fry in dry forms of about 1, 1.5 and 2 mm in diameter.

Feeding frequency was 4 times a day (08.00, 11.00, 14.00 and 17.00 hours), fry was fed until satiation.

In order to control the pH of sea water, mixture of sodium bicarbonate ($NaHCO_3$) and sodium cabonate (Na_2CO_3) was added to the medium a dosage of 2.0 mg/l. Water temperature and pH were observed

daily at 08.00 and 13.00.

The body weight was measured every two weeks using an analytical balance (model Libror E.D - 200 Shimadzu). The total length was also measured every two weeks.

Table 2. The composition of feed used in the experiment

Tabel 2. Komposisi pakan yang digunakan dalam percobaan

INGRIDIENT (g)	FOOD TREATMENT				TOTAL (g)
	A	B	C	D	
Compound food for Sea Bream	1000 (100%)	750 (75%)	530 (53%)	420 (42%)	2700
Flour *	-	250 (25%)	470 (47%)	580 (58%)	1300
Vitamin	20 (2%)	20 (2%)	20 (2%)	20 (2%)	80

* Composition of flour is : Wheat flour 50%
Tapioka starch 25%
Sagu starch 25%

Table 3. The chemical analysis of compound foods which were used in the experiment.

Tabel 3. Hasil analisa kimia bahan pakan yang digunakan dalam percobaan.

INGRIDIENT (g)	FOOD NO.			
	A	B	C	D
Moisture	12.42	12.25	11.94	12.45
Crude protein	58.79	46.63	35.26	29.64
Fat	2.67	2.67	2.00	2.00
Ash	16.23	12.29	8.31	4.59
Crude fibre	0.12	1.86	0.88	0.50
Calcium	0.80	0.79	0.83	1.70
Phosphat	2.40	1.81	1.44	1.27

RESULTS AND DISCUSSION

Siganus javus fry showed better growth in feed containing the protein contents of 35% to 46%. Despite the fact that feed of high protein contents showed comparatively good results at the initials stage of the experiment. Feeding activity was inactive among fish by the feed of high protein content since the beginning of the experiment.

According to TSUDA and BRYAN (1974) on their experiment showed that Siganus canaliculatus after 42 weeks fed by Enteromorpha and trout chow (containing 40% protein) increased in weight from 0.5 to 65 g. Those was nearly double the weight of those fishes whose fed by diet consisted only of Enteromorpha (containing of about 11 - 27% protein).

In this experiment the growth of Siganus javus fed by 58% protein was lower than those fed by 35% or 46% protein. The initial average body weight of 4.74 and 5.29 g, which fed by 35% (treatment B) and 46% (treatment C) were increased to 12.75 and 13.00 g, respectively, at the termination of experiment. The increased of 11.50 and 10.50 g in average body weight were obtained in 58% (treatment A) and 29% (treatment D), respectively.

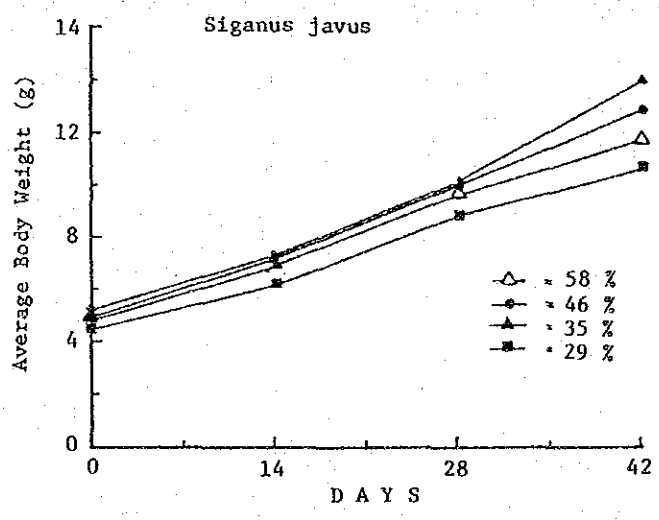

Figure 1.: The growth of Signaus javus reared in 60-liters aquaria, fed by diets of different protein contents.

REFERENCES

GUNDERMANN, N. , D.M. POPPER and T.LICHATOWICH. 1983. Biology and life cycle of Siganus vermiculatus (Siganidae, Pisces). Pasific Science, 37(2),165-180.

MAY R.C., D. POPPER and J.P. McVEY. 1974. Rearing and larval development of Siganus canaliculatus (Park)(Pisces;Siganidae). Micronesia 10(2),255-298.

TOBIAS W.J., P.G.BRYAN, W.J.FITZGERALD Jr., 1976. Studies on the genus Siganus (Rabbitfish) in Guam waters. University of Guam Marine Laboratory. Tech. Rep. no. 27.

TSUDA R.T.,, P.G.BRYAN, 1974. Juvenile-Adult rearing of Siganus (Pisces: Siganidae) in Guam. University of Guam. Marine Laboratory 19-25.

VON WESTERNHAGEN, H. 1973. The natural food of the rabbitfish Siganus oramin and Siganus striolata. Mar.Biol., 22,367-370.

VON WESTERNHAGEN, H.,, 1974. Food preferences in cultured Rabbitfish (Siganidae). Aquaculture 3,109-117.

VON WESTERNHAGEN, H. and H.ROSENTHAL, 1976. Induced multiple spawning of reared Siganus oramin (Scheneider)(=S.canaliculatus Park). Aquaculture, 7,193-196.

Table 4. The growth of Siganus javus fed by diets of 58% (1), 46% (2), 35% (3) and 29% protein contents (4), reared in 60-liters aquaria of ciculated filtered sea water system.

Period	Aug. 24th				Sep. 7th				Sep. 21st				Oct. 4th			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Fish no.	20	20	20	20	19	20	20	20	19	20	20	20	19	20	20	20
A.B.W.(g)	4.69	4.74	5.29	4.43	6.90	7.10	7.14	6.06	9.49	10.08	10.00	8.68	11.50	12.75	13.00	10.50
T.B.W.(g)	93.90	94.80	105.90	88.70	131.30	142.00	142.90	121.30	180.40	201.60	200.00	173.70	218.50	255.00	260.00	210.00
Mortality					1	0	0	0	0	0	0	0	0	0	0	0
Total food (g)					50.00	61.00	74.10	65.00	91.40	113.20	132.20	124.50	100.30	120.20	140.70	121.60
F.C.R.					1.34	1.29	2.00	2.02	1.86	1.90	2.32	2.38	2.63	2.25	2.34	3.35
D.F.R.					3.16	3.68	4.26	4.49	4.09	4.71	5.51	6.03	3.59	3.76	4.37	4.53
D.G.R.					2.72	2.85	2.13	2.22	2.26	2.48	2.38	2.54	1.37	1.67	1.86	1.35

A.B.W. = Average Body Weight
T.B.W. = Total Body Weight
F.C.R. = Food Convertion Ratio
D.F.R. = Daily Feeding Ratio
D.G.R. = Daily Growth Rate

$$F.C.R. = \frac{\text{Total Food}}{TBW_t - TBW_0}$$

$$D.F.R. = \frac{\text{Total Food}}{\frac{N_0 + N_t}{2} \times \frac{W_0 + W_t}{2} \times t} \times 100$$

$$D.G.R. = \frac{\frac{W_t - W_0}{W_t + W_0}}{\frac{2}{t}} \times 100$$

SOME BIOLOGICAL DATA OF GROUPER *EPINEPHELUS TAUVINA* IN BANTEN BAY

Achmad Basyari* and Hideyuki Tanaka**

ABSTRACT

The study was conducted to understand a property of the species Epinephelus tauvina, prior to the future studies of seedling production and their culture through the observation of morphology and gonad maturity.

One hundred and thirteen fishes were collected, of which 9 individuals (8%) was males, 38 individuals (33.6%) was females and 66 individuals (58.4%) was unknown. The maximum size of 91.5 cm in total length and 13.2 kg in body weight was obtained. The length weight relationship was found as $W = 0.0107\ L^{3.0828}$. The highest gonad index value of 4.4% of body weight at size of 65 cm was obtained, whereas, indicated that the spawning season occured in June to September and November to February. So far no matured males were observed (gonad index less than 1% of body weight).

ABSTRAK : BEBERAPA ASPEK BIOLOGI IKAN KERAPU EPINEPHELUS TAUVINA DI TELUK BANTEN

Studi ini dilakukan untuk mengetahui kemungkinan pembenihan dan pemeliharaan jenis ikan kerapu Epinephelus tauvina di masa mendatang melalui penelitian tentang morpologi dan kematangan gonadnya.

* Research Institute For Coastal Aquaculture (Sub Balai Penelitian Budidaya Pantai) Bojonegara-Serang, Indonesia.

** Japan International Cooperation Agency (JICA) Japan.

Dari sejumlah 113 ekor ikan yang dikumpulkan selama setahun terdapat 9 ekor(8%) jenis jantan, 38 ekor(33.6%) jenis betina dan 66 ekor (58%) tidak diketahui jenis kelaminnya. Ukuran yang didapat adalah 91.5 cm panjang totalnya dan 13.2 kg beratnya. Sedangkan hubungan panjang berat adalah $W = 0.0107\ L^{3.0828}$. Nilai gonad indek yang tertinggi adalah 4.4% dari berat badan ikan pada ukuran 65 cm. Musim pemijahan diduga terjadi pada bulan Juni sampai September dan November sampai Februari. Selama pengamatan tidak didapat jenis jantan dewasa (nilai gonad indeknya dibawah 1% dari berat badannya).

INTRODUCTION

Epinephelus tauvina (Forskal) is very important commercial fish species and is highly esteemed as a food fish in Kuwait and The Arabian Gulf Countries (HUSSAIN et al. 1980). It is widely distributed from East Africa through the Indian Ocean to the East Indies,Japan and Hawaii (HUSSAIN et al. 1980 a). Also this species is one of the important commercial marine fishes in Indonesia (DANAKUSUMAH and IMANISHI, 1984).

The knowledge of ecology of spawning season, spawning behavior and egg development (UKAWA et al., 1966; HUSSAIN et al., 1967; CHEN et al., 1977 in HUSSAIN et al., 1980). Also the larval development (MITO et al., 1967) were essential in order to develop the hatchery tehnique prior to produce large number of fries, either for culture to marketable size.

This study was conducted in order to understood the life history of Epinephelus tauvina in Banten Bay, either for future studies of seedling production and their culture.

MATERIAL AND METHOD

The fishes were collected once a week at the Karangantu Fish Landing Place (Serang-West Java) from January to December 1981. The total length, body length (Standard length), body weight, body height were measured. Gonads were examined and weighed. The diameter of 100 eggs per sample were measured under profile projector (model MITUTOYO Pj-300). The length of intestine was measured, and the length-weight relationship was also analysed statistically.

RESULT AND DISCUSSION

The total number of 113 fishes collected were consisted of 9 individuals (8%) males, 38 individuals (33.6%) females and 66 individuals (58.4%) unknown. Whereas, the size in term of total length was ranged of 71 - 91 cm (for males), 31 - 86 cm (for females) and 11 - 86 (unknown) (Table 1).

The plotted monthly data against gonad index and egg diameter (Figure 1) showed that there are two spawning season occurred in a year, June to September and November to February. HUSSAIN et al.(1980) demonstrated in their laboratory experiment that E.tauvina spawning from April to June, at water temperature of 23^{o}C and salinity of 37 ‰. HASTING et al (1980) found that oocyte maturation continued until matured egg were present in late April or early May.

The highest gonad index of 4.4% of body weight was obtained on late of June. The biggest egg diameter of 603 µm was obtained in mid of July. The intestinal length of E.tauvina which was fairly long as compare with the other carnivorus fishes was inproportion to the total length of body and it is proportion range change at the inflextion point at around 80 cm in total length (Figure 2). CHEN et al.(1977) reported, that the diameter of the fertilized eggs of E.tauvina was 900 µm, while HUSSAIN et al.(1975) reported that an average eggs dia-

Table 1. Total length and sex frequency distributions of Epinephelus tauvina collected from January to December 1981 at Karangantu Fish Landing Place.

Tabel 1. Frekuensi distribusi panjang total dan jenis kelamin ikan kerapu jenis Epinephelus tauvina yang dikumpulkan dari Tempat Pelelangan Ikan Karangantu (Januari - Desember 1981).

TOTAL LENGTH (cm)	MALE (ind.)	FEMALE (ind.)	UNKNOWN (ind.)
11 - 15	-	-	6
16 - 20	-	-	11
21 - 25	-	-	11
26 - 30	-	-	10
31 - 35	-	2	-
36 - 40	-	-	1
41 - 45	-	-	-
46 - 50	-	1	3
51 - 55	-	1	2
56 - 60	-	3	-
61 - 65	-	7	-
66 - 70	-	11	2
71 - 75	2	8	-
76 - 80	-	1	4
81 - 85	2	2	9
86 - 90	3	2	7
91 - 95	2	-	-
TOTAL (100%)	9 (8%)	38 (33.6%)	66 (58.4%)

meter of E.tauvina was 770 µm. This difference in egg size may be due to the condition of the brood stock available. HUSSAIN et al (1980) in their experiment of natural spawning E.tauvina in captivity, the spawning occurred in April continued to June. However, in Banten Bay it was found that the spawning season occured in June to September.

Ovaries maturation started in individuals whose total length was reached about 55 cm (Figure 3), and it attained to the highest peak at the size of about 65 cm in total length. Gonad weight of almost all females sampled were more than 1% of their body weight, while the gonad weight of all males sampled was less than 1% of their body weight. In the present observation, the total length of males were ranging

between 71 and 91 cm. This was similar to the natural males found by TAN and TAN (1974). They found that, fully matured males were longer than 74 cm in standard length and weight of 11 kg or more.

CHEN et al. (1977) found that the natural reversal from female to male might occur as late as age of 9 years. On the other hand, the success of breeding is depending on the availability of male rather than females.

The length-weight relationship was found as $W = 0.0107\ L^{3.0828}$ (Figure 4). However, TENG S.K. (1978) found the length-weight relationship of young grouper was $W = 0.01472\ L^{2.98418}$

Table 2. Monthly number of E.tauvina and an average gonad weight, gonad index and length of intestine of fishes which collected at Karangantu Fish Landing Place.(1981).

Tabel 2. Jumlah bulanan ikan kerapu yang didapat dari Tempat Pelelangan Ikan Karangantu, dengan nilai rata-rata berat gonad, gonad indek dan panjang usus ikan.

MONTH	NUMBER (ind.)	MALE (ind.)	FEMALE (ind.)	UNKNOWN (ind.)	G.W.* (g)	G.I.** (%)	L.I*** (cm)
Jan.	2	-	1	1	62.0 -	1.5 -	98.0 -
Feb.	28	2	3	23	19.7 ± 19.6	0.4 ± 0.4	38.0 ± 38.2
Mar.	11	1	1	9	20.0 -	0.4 -	35.9 ± 34.4
Apr.	10	2	5	3	22.9 ± 22.3	0.5 ± 0.6	94.2 ± 50.4
May	11	-	9	2	13.3 ± 8.2	0.3 ± 0.2	107.9 ± 34.4
Jun.	9	-	6	3	31.5 ± 62.5	0.7 ± 1.5	95.7 ± 21.2
Jul.	15	-	8	7	15.6 ± 12.0	0.3 ± 0.3	113.0 ± 38.6
Aug.	2	-	1	1	5.5 ± 2.0	0.1 ± 0.0	103.0 -
Sep.	10	-	1	9	65.6 -	1.2 -	71.4 ± 47.3
Oct.	5	2	1	2	14.1 ± 8.8	0.2 ± 0.2	127.8 ± 25.7
Nov.	8	2	2	4	10.8 ± 4.3	0.1 ± 0.0	135.5 ± 13.3
Dec.	2	-	-	2	-	-	128.7 ± 24.4
TOTAL	113	9	38	66			

* = Gonad weight; ** = Gonad Index; *** = Length of Intestine.

REFERENCES

CHUA T.E. and S.K. TENG, 1978. Effect of feeding frequency on the growth of young estuary grouper Epinephelus tauvina (Forskal), cultured in floating net-cages. Aquaculture, 14,31-47.

COLEMAN F., 1981. Protogynous hermaproditism in the Anthiinae Serranid fish Holanthias martinicensis. Copeia, 4,893-895.

HASTING P.A. and A.BORTONE, 1980. Observation on the life history of the belted Sandfish, Serranus subligarius (Serranidae). Env.Biol.Fish. 5(4),365-374.

HUSSAIN N.A and M.HIGUCHI, 1980. Larval rearing and development of the brown spotted grouper, Epinephelus tauvina (Forskal). Aquaculture 19,339-350.

TENG S.K. and T.E. CHUA, 1978. Effect of stocking density on the growth of estuary grouper, Epinephelus salmoides Maxwell, cultured in floating net-cages. Aquaculture, 15,273-287.

WITHLER F.C. and L.C. LIM, 1982. Preliminary observation on chilled and deep-frozen storage of grouper (Epinephelus tauvina) sperm. Aquaculture, 27,389-392.

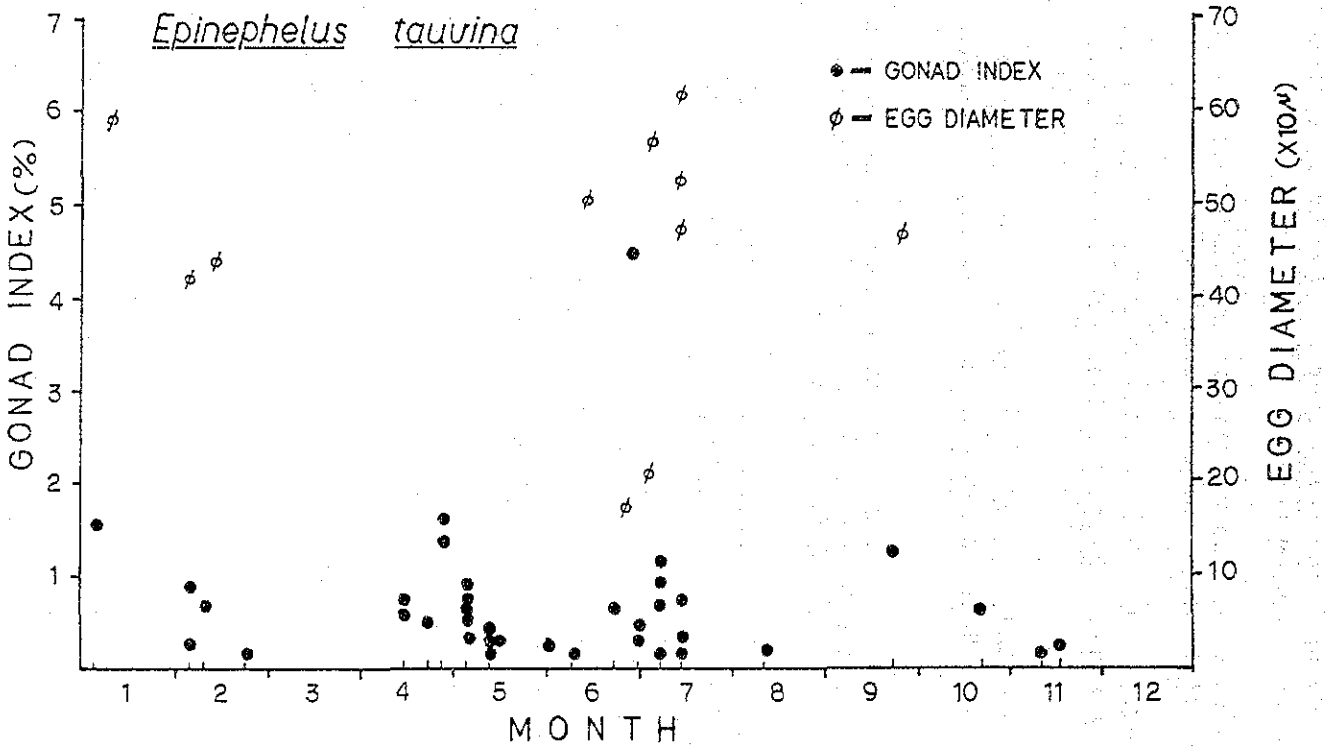

Figure 1. The occurrence of spawning season of E.tauvina, June to September and November to February, as indicated by the highest value of gonad index and the biggest of egg diameter.

Gambar 1. Musim pemijahan ikan kerapu E.tauvina pada bulan Juni-September dan November-Februari, yang ditandai dengan nilai tertinggi indek gonadnya dan ukuran diameter telur yang terbesar.

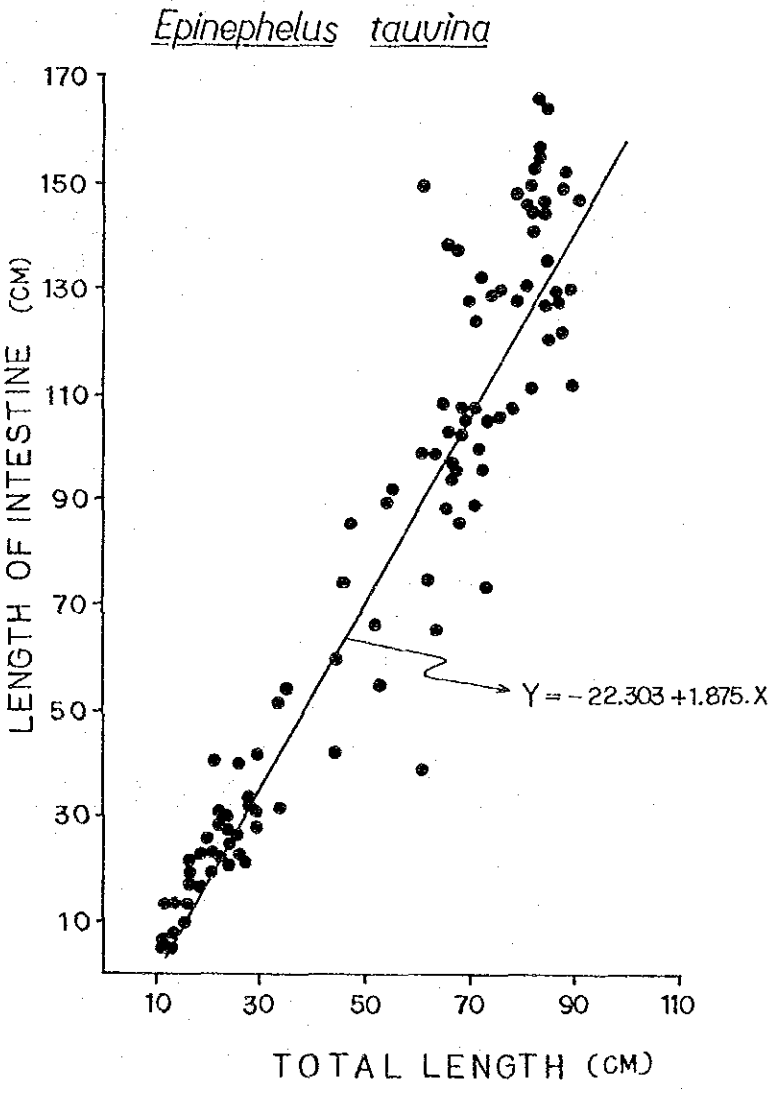

FIGURE 2 . Showing the proportion rate of intestine length changed it at the inflextion point of around 80 cm in total length.

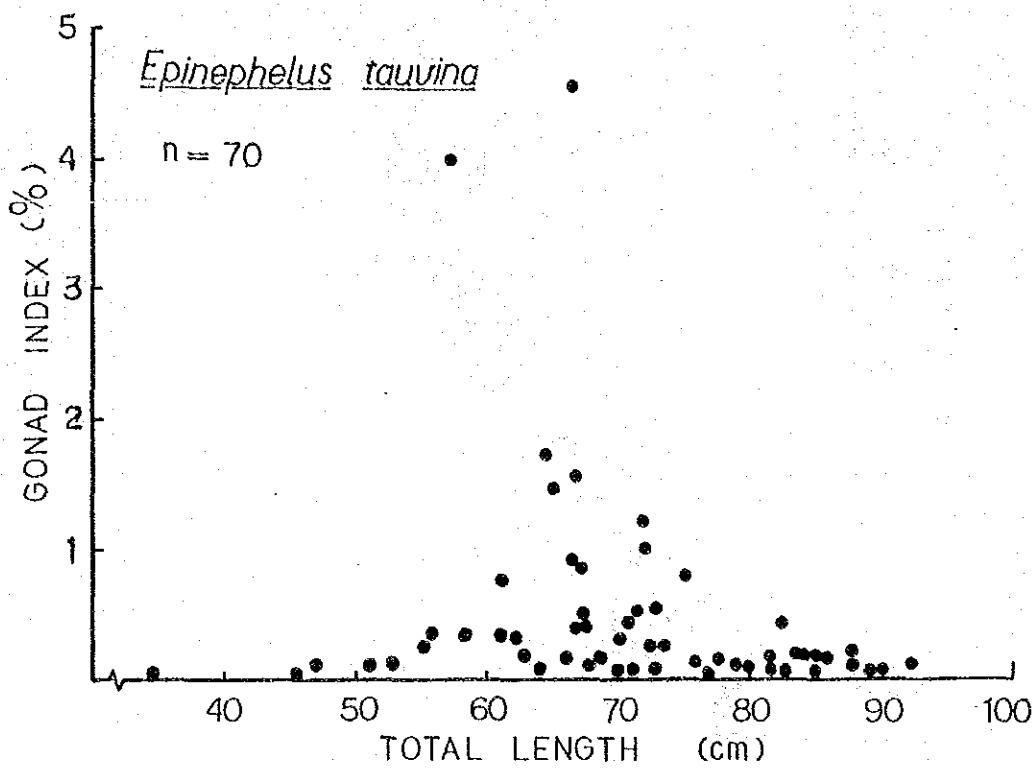

Figure 3. The ovaries maturation of E.tauvina occurred at a size of 65 cm in total length, with the gonad index value of 4.4%.

Gambar 3. Indung telur yang matang terjadi pada ikan kerapu E.tauvina dengan ukuran panjang total 65 cm dengan nilai indek gonadnya 4.4%.

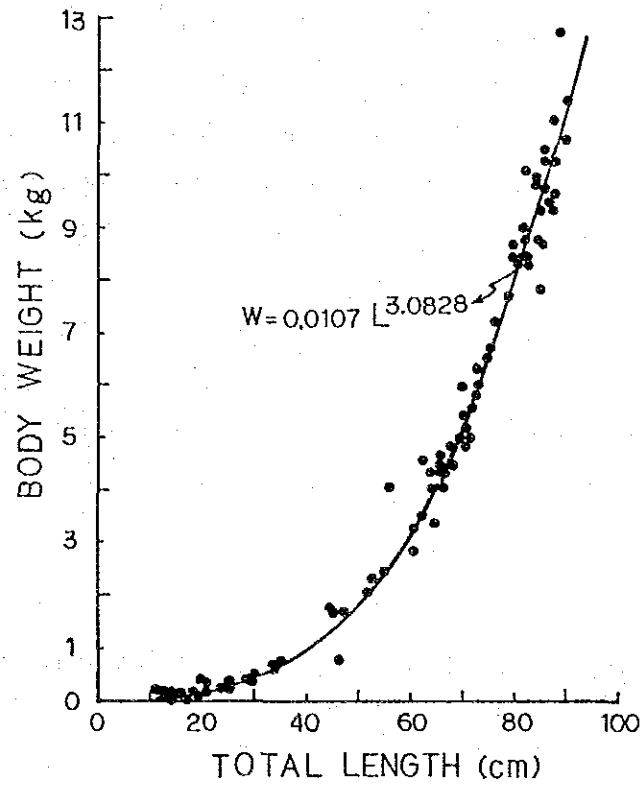

Figure 4. Length-weight relationship of E.tauvina (n = 113 individuals) which were collected from January to December 1981 at Karangantu Fish Landing Place.

Gambar 4. Hubungan panjang berat ikan kerapu E.tauvina (n = 113 ekor) yang dikumpulkan sejak bulan Januari - Desember 1981 di Tempat Pelelangan Ikan Karangantu.

SOME BIOLOGICAL STUDY ON SNAPPER *LUTJANUS SANGUINEUS* IN BANTEN BAY

Achmad Basyari* and Hideyuki Tanaka**

ABSTRACT

Observations on morphology and gonad maturity of red snapper Lutjanus sanguineus collected at Karangantu Fish Landing Place had been conducted from January to December 1981. The observation was aimed to study it is biology.

Total number of collected fishes during the observation period was 203 individuals. The fishes were consisted of 149 males and 54 females. The spawning season apparently occured along the year. The gonad index value ranged of 2 - 3% and the eggs diameter was ranged between 383 and 457 µm.

ABSTRAK : STUDI TENTANG ASPEK BIOLOGI IKAN JENAHA JENIS LUTJANUS SANGUINEUS DI TELUK BANTEN

Ikan jenaha (kakap merah) jenis Lutjanus sanguineus telah menjadi obyek studi di perairan Teluk Banten dalam rangka usaha pembenihan dan pembudidayaannya di masa mendatang.

Setiap minggu pengukuran morpologi termasuk panjang, berat, lebar dan tinggi badan ikan dilakukan, serta pengamatan gonadanya selama satu tahun, dari bulan Januari - Desember 1981.

Jumlah ikan yang dapat dikumpulkan adalah 149 ekor jantan dan 54 ekor betina, yang mempunyai variasi nilai indeks gonada antara 2 - 3% dan diameter telur bervariasi antara 383 - 457 µm. Diduga musim pemijahan terjadi di sepanjang tahun.

* Research Institute For Coastal Aquaculture Bojonegara-Serang, Indonesia.
** Japan International Cooperation Agency (JICA) Japan.

INTRODUCTION

The red snappers (Lutjanidae) have commercial importance value in the world (ARNOLD et al. 1978). Little is known of the life history of red snappers. In recent years a decline in landings of this desirable species may be indicate the population declining (BELL,1978).

Knowledge of morphology and gonad maturity of this species is necessary due to understand the spawning season through the year and it is produce a large number of fries. This study was aimed to understand the spawning season through the year, and considering the future development of aquaculture in Banten Bay.

MATERIAL AND METHOD

Sample were collected once a week at Karangantu Fish Landing Place from January to December 1981. Total length, body weight, body depth and body width were measured. Gonads and the diameter of 100 eggs were measured. Sample of eggs was taken out from four point of gonad, left and right lobe with two point (Figure 1). Length-weight relationship was computed using formula described by RICKER (1968).

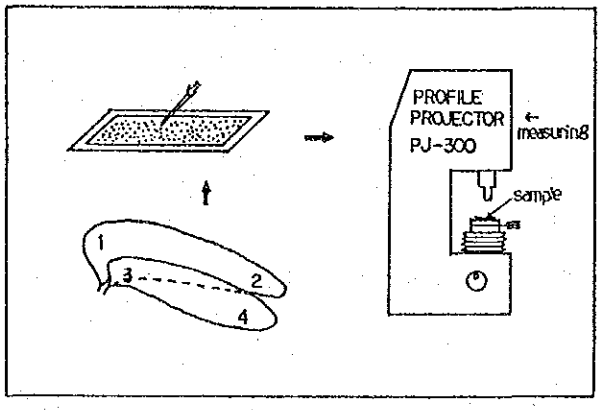

Figure 1. Sampling method of eggs diameter measurement, taken from four point of ovary.

Gambar 1. Metoda sampling telur ikan yang akan diukur diameternya, sampel diambil dari empat tempat pada ovari.

RESULTS AND DISCUSSION

A total number of 203 individuals was collected during the observation period. The fishes were consisted of 149 males (60-67 cm in total length and 3.0-3.8 kg in body weight), and 54 females (54-63 cm in total length and 2.5-3.7 kg in body weight) (Table 1 and Table 2).

According to data collected, it is considered that the spawning season occured almost through the year, with gonad index ranged of 2-3% of body weight for female (Figure 2).

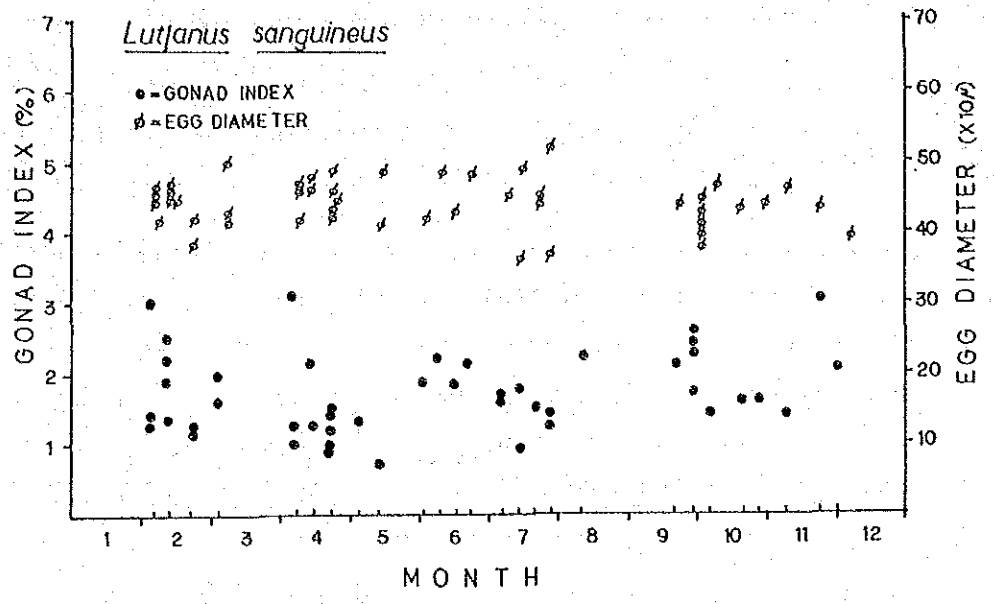

Figure 2. The spawning season of L.sanguineus, indicated by the highest gonad index value and the biggest eggs diameter. Those plotted data are the females fish only.

Gambar 2. Musim pemijahan ikan jenaha L.sanguineus, yang ditandai oleh nilai tertinggi indek gonadnya dan diameter telur yang terbesar. Data-data tersebut hanya untuk ikan jenis betina.

Red snapper Lutjanus campechanus were succesfully spawned under laboratory conditions in May and June (ARNOLD et al.,1978 and NANCY et al.,1980).

In the present study, females of 2.5-3.7 kg body weight have an eggs diameter of 383-457 um (Table 1). VERNON et al.(1983) found that females with 0.8-1.7 kg in body weight, contained eggs with an average diameter of 354 and 365 um, respectively.

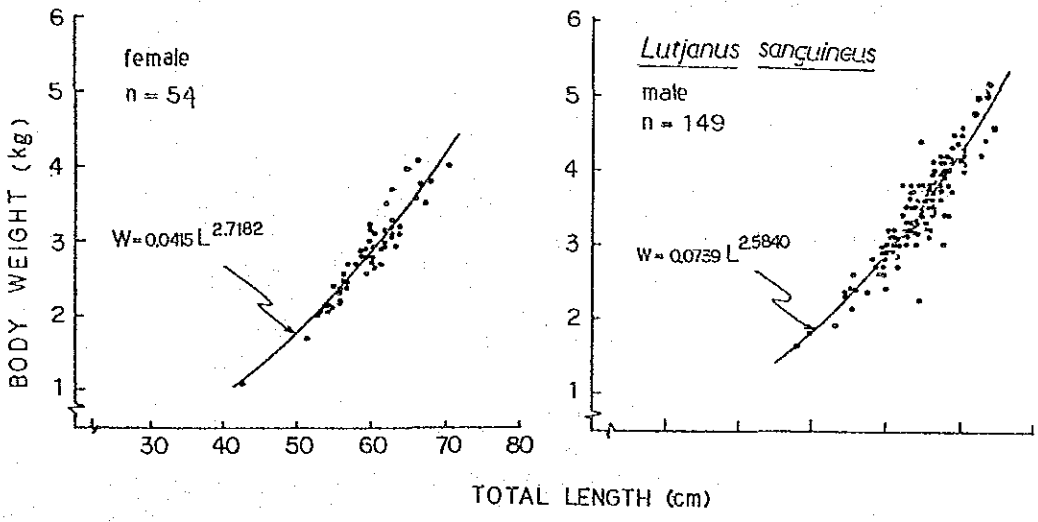

Figure 3. The length-weight relationships of L.sanguineus, for male (n = 149 individuals) and female (n = 54 individuals).

Gambar 3. Hubungan panjang berat ikan jenaha L.sanguineus untuk jenis jantan (n = 149 ekor) dan betina (n = 54 ekor).

Figure 3 showing the relationships between length and weight for the females and males, which expressed in the equation of $W = 0.0739\ L^{2.58}$ and $W = 0.0415\ L^{2.72}$, respectively. The length frequency distribution of females and males are showed in Table 3 and figure 4, the highest distributions of 62.5 - 65 cm in total length was obtained from total samples. The biological minimum size of around

52.5 cm was obtained (Figure 5). KUNGVANKIJ, 1971 in LE VAN TU (1972), reported that the biological minimum size of this species was about 32 cm and the gonad index value less than 0.1% of body weight.

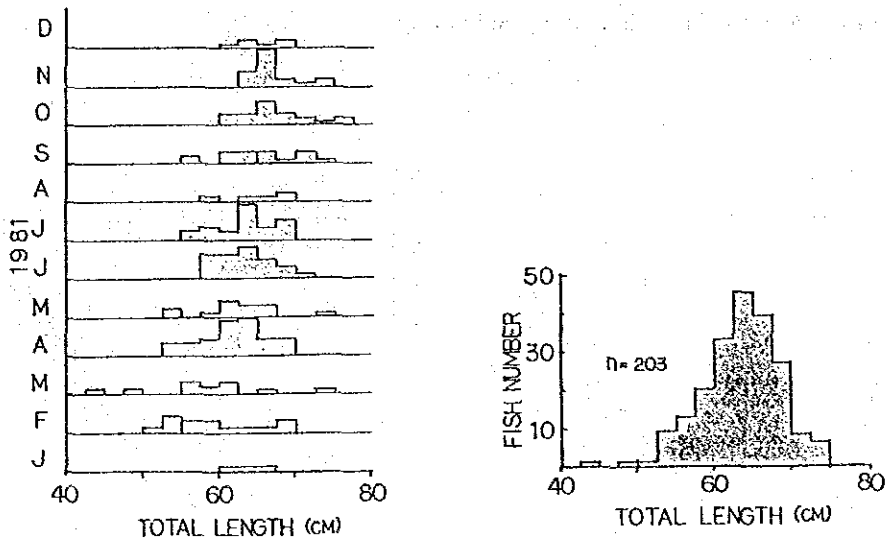

Figure 4. The length frequency distributions of L.sanguineus, the maximum size of about 60.0 - 65.0 cm in total length were obtained during a year.

Gambar 4. Frekuensi distribusi panjang ikan jenaha L.sanguineus, panjang maksimum yang didapat selama setahun adalah antara 60.0 - 65.0 cm panjang totalnya.

The gonad index of 5.8 and 6.4 were the highest for females, however, the value of less than 1, was obtained for males fish.(Figure 5).

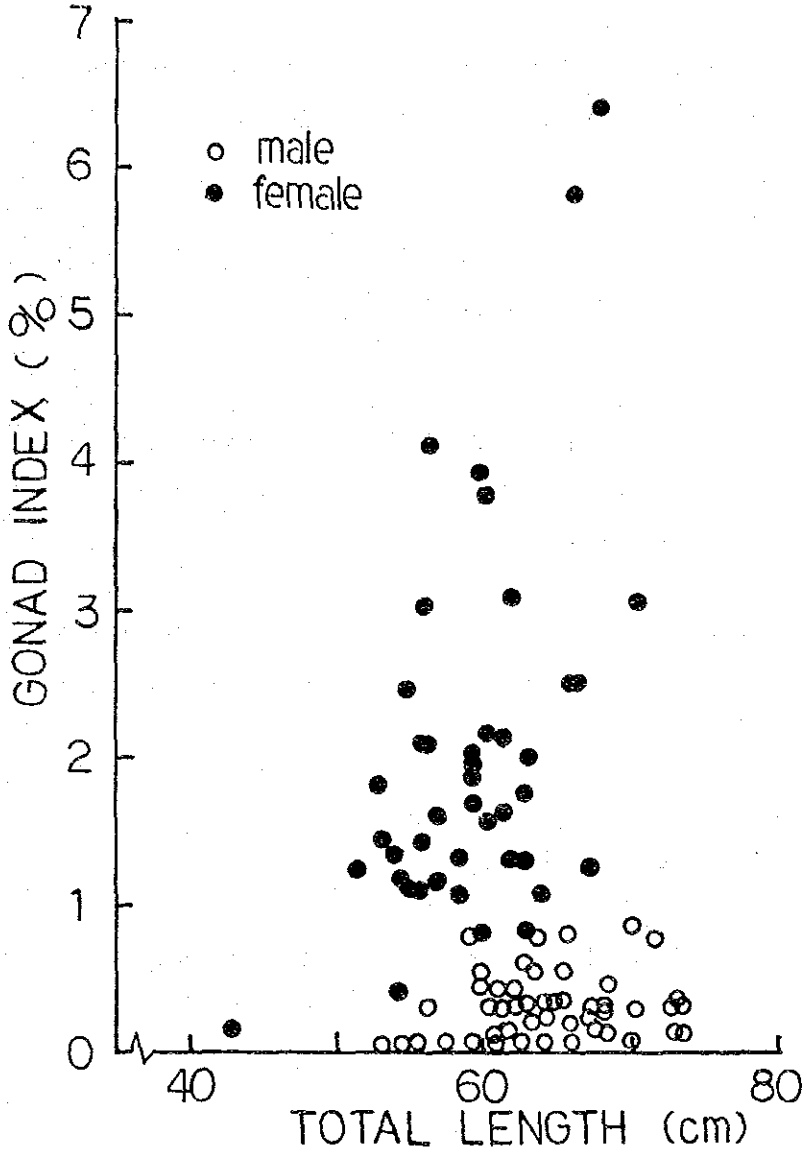

Figure 5. The total length against the gonad index for female and male fish of L.sanguineus. The biological minimum size was about 52.5 cm in total length, however, the highest gonad index of 5.8 and 6.4 were occurred in fish of 66 and 68 cm in total length, respectively.

Gambar 5. Hubungan panjang total ikan dengan nilai gonad indeknya. Ukuran minimum ikan yang dewasa adalah sekitar 52.5 cm panjang totalnya sedangkan nilai indek gonad yang tertinggi adalah 5.8 dan 6.4 pada ikan dengan ukuran 66 dan 68 cm.

REFERENCES

ANDERSON Jr. W.D., 1981. A new species of Indo-West Pasific Etelis (Pisces: Lutjanidae) with comments on other species of the genus Copeia, 4,820-825.

ARNOLD, C.R., J.M. WAKEMAN, T.D. WILLIAM and G.D.TREECE, 1978. Spawning of red snapper (Lutjanus campechanus) in captivity. Aquaculture, 15,301-302.

LE VAN TU, 1972. The fecundity and Biological minimum size of five commercially important species in the South China Sea. Working papers of Trainees. Vol. 2,72-93.

MINTON, R.V., J.P. HAWKE and W.M. TATUM, 1983. Hormone induced spawning of red snapper Lutjanus campechanus. Aquaculture, 30,363-368.

RABALAIS, N.N., STEVEN, C.R. and C.R. ARNOLD, 1980. Description of eggs and larvae of laboratory reared red snapper (Lutjanus campechanus). Copeia, 4,704-708.

RAJ, U. and S. JOHNSON, 1983. A new species of Paracaesio (Pisces: Lutjanidae) from the Fiji Islands. Copeia, 2,450-453.

Table 1. The biodata of females red snapper Lutjanus sanguineus, collected at Karangantu Fish Landing Place (n = 54 individuals).

Tabel 1. Biodata ikan jenaha jenis Lutjanus sanguineus yang didapat dari Tempat Pelelangan Ikan di Karangantu (n = 54 ekor).

F E M A L E

M O N T H	NUMBER	T.L.* (cm)	B.W.** (g)	G.W.# (g)	G.I.## (%)	EGGS DIAMETER (um)
February	11	57.4 ± 5.6	2502.0 ± 679.9	67.3 ± 67.5	2.53 ± 1.6	431.4 ± 23.3
March	4	54.0 ± 7.4	2170.0 ± 743.8	49.0 ± 41.1	1.97 ± 1.6	451.0 ± 43.7
April	10	59.1 ± 3.3	2768.0 ± 345.2	37.2 ± 21.3	1.34 ± 0.7	440.0 ± 23.3
May	2	56.5 ± 2.8	2485.0 ± 572.7	24.2 ± 22.1	0.92 ± 0.6	445.5 ± 50.2
June	5	61.0 ± 1.5	2832.0 ± 195.2	51.3 ± 4.7	1.82 ± 0.2	456.6 ± 46.2
July	9	61.5 ± 3.4	3195.5 ± 560.3	67.5 ± 70.6	1.99 ± 1.7	451.7 ± 86.3
August	1	59.0	2870.0	59.7	2.08	-
September	6	62.8 ± 5.1	3110.0 ± 616.3	70.7 ± 36.8	2.12 ± 0.8	382.6 ± 23.9
October	3	62.3 ± 1.6	3115.0 ± 431.2	51.7 ± 9.0	1.66 ± 0.1	418.0 ± 16.6
November	2	66.3 ± 0.2	3347.5 ± 583.4	69.5 ± 34.6	2.01 ± 0.7	443.5 ± 30.4
December	1	63.2	3710.0	77.5	2.90	396.0
Total	54					

* = Total length; ** = Body weight; # = Gonad weight; ## = Gonad Index

Table 2. The biodata of males red snapper Lutjanus sanguineus, collected at Karangantu Fish Landing Place (n = 149 individuals).

Tabel 2. Biodata ikan jenaha jenis Lutjanus sanguineus yang didapat dari Tempat Pelelangan Ikan di Karangantu (n = 149 ekor).

M A L E S

M O N T H	NUMBER	T.L.* (cm)	B.W.** (g)	G.W.# (g)	G.I.## (%)
January	3	63.4 ± 2.7	3380.0 ± 681.5	3.3 ± 0.6	0.09 ± 0.0
February	6	62.7 ± 4.0	3082.5 ± 629.6	2.9 ± 1.6	0.09 ± 0.0
March	8	60.5 ± 7.2	3086.2 ±1032.1	5.6 ± 4.8	0.17 ± 0.1
April	29	63.2 ± 3.9	3429.3 ± 575.8	7.8 ± 6.4	0.22 ± 0.2
May	15	63.1 ± 4.1	3484.0 ± 651.8	4.9 ± 3.4	0.14 ± 0.1
June	24	63.9 ± 3.4	3436.7 ± 525.0	7.9 ± 5.6	0.23 ± 0.2
July	15	64.4 ± 3.8	3552.0 ± 552.6	8.5 ± 4.4	0.25 ± 0.1
August	4	66.7 ± 2.5	3580.0 ± 915.2	14.5 ±16.4	0.35 ± 0.4
September	10	65.7 ± 5.4	3827.3 ± 677.8	8.8 ± 5.6	0.23 ± 0.1
October	15	67.0 ± 3.3	3769.7 ± 651.9	11.1 ± 9.1	0.29 ± 0.2
November	17	67.2 ± 2.7	3838.8 ± 524.7	6.7 ± 3.7	0.17 ± 0.1
December	5	65.6 ± 3.0	3856.0 ± 481.9	8.5 ±12.0	0.22 ± 0.3
Total	149				

* = Total length; ** = Body weight; # = Gonad weight; ## = Gonad Index

Table 3. Length frequency distribution females and males of red snapper Lutjanus sanguineus, collected at Karangantu Fish Landing Place (n = 203 individuals).

Tabel 3. Distribusi frekwensi panjang ikan jenaha Lutjanus sanguineus betina dan jantan yang didapat di Tempat Pelelangan Ikan Karangantu (n = 203 ekor).

TOTAL LENGTH (cm)	MONTH 1 F	1 M	2 F	2 M	3 F	3 M	4 F	4 M	5 F	5 M	6 F	6 M	7 F	7 M	8 F	8 M	9 F	9 M	10 F	10 M	11 F	11 M	12 F	12 M	TOTAL
42.5 - 45.0					1																				1
45.0 - 47.5																									
47.5 - 50.0						1																			1
50.0 - 52.5			1																						1
52.5 - 55.0			4				2	1	1	1															9
55.0 - 57.5			3		2	1	2	1					1	1			1	1							13
57.5 - 60.0			1	2	1	1	2	2	1		2	4	2	1	1										20
60.0 - 62.5	1		1		3		2	8		4	2	4	2				2	1	2	1				1	34
62.5 - 65.0	1		1				2	9		3	1	7	3	6		1	1	2	1	2	1	3	1	1	46
65.0 - 67.5	1		1		1			4		3		5	1	2		1	1	2	1	2	1	9		1	36
67.5 - 70.0			2	1				4		2		3		5		2		1		1		2		2	25
70.0 - 72.5										1							1	2	1	2		1			8
72.5 - 75.0						1		1										1		1		2			6
TOTAL	0		11		4		10		2		5		9		1		6		5		2		1		203
	3		6		8		30		14		23		15		4		10		9		17		5		

F = Female; M = Male.

Bull. Pen. Perikanan Vol. 2, No. 2, 1982 : 115 – 118

ACUTE MORTALITY OF RABBITFISH (*SIGANIDS*) CAUSED BY MONOGENETIC TREMATODES

Hideyuki Tanaka*) and Achmad Basyarie)**

ABSTRACT

Preliminary rabbitfish culture has been conducted in the station of the Research Institute For Marine Fisheries in Serang. During early experiments mass mortality of the juveniles has occured due to the trematoda infection. Methods of treatments are discussed in this paper.

INTRODUCTION

Rabbitfish (Beronang, Siganus sp) has been recently considered as one of the fish candidates for tropical mariculture, because rabbitfish is such a herbivorous species that can be cultured by low protein food with a high market value particularly in the tropical Indo-Pacific region (LAM 1974). However, the commercially-based culturing method for rabbitfish has not been established so far.

The Indonesian-Japan Mariculture project has also paid attention to the mariculture potential of rabbitfish, and a preliminary experiment on rabbitfish culture has started by using floating net-cages in Banten Bay, West Java, since 1980. It was this year when the full-scaled experiments on its culture was to be carried out that high mortality of fish occurred in the net-cages because of infestations of monogenetic trematodes on the gills.

MASS MORTALITY

The fish began to die around the end of February in a net-cage of young rabbitfish which were captured and stocked last December. In mid-March, an infestation of monogenetic trematodes was found on its gill filament. Its mortality did not stop in spite of various repeated treatment until the application of pesticide Dipterex was made in June. There has been no mortality by this parasite so far after the treatment by Dipterex.

After all, during this outbreak of the mass mortality from February to June, this parasite killed all of the 25,000 fry or more (3-4 cm. TL) which were captured in March, and all of the 800 young (5-7 cm. TL) captured in December and 80% of fry captured in April and May were also killed.

TREATMENT AND DISCUSSION

There are only a few report on the disease ot cultured rabbitfish. These reports describe that monogenetic trematodes which seems to be problematic rabbitfish culture (Lam 1974, Tobias 1976). However, no report has been found on how to treat and control the parasite of rabbitfish.

Although, during this outbreak of mortality, the treatments by salt-sea water baths and freshwater baths were applied repeatedly and that by a formalin bath was tried to stop the infestation by this parasite, these were not effective (table 1).

*) Marine Research and Development Project, Serang, West Java.
**) Sub Research Institute for Marine Fisheries, Serang, West Java.

Table 1. *Kinds of treatments before application of Dipterex.*

Treatments	Concentration	Duration (minute)
1. Salt-sea water	70°/oo (salinity)	5
2. —— " ——	80°/oo (salinity)	8
3. Freshwater	–	8
4. —— " ——	–	12
5. Formalin	250 ppm	10

In general, organophosphate pesticides are often used to eradicate the monogenetic trematodes attached on gills of fish (Sarig 1971, Poupard 1978, Herwig 1979, Brown and Gratzek 1980). Accordingly, double treatments by Dipterex (organophosphate, synonyms : Dylox; Masoten; Neguvon; Trichlorofon) which is available here were introduced. This was so effective that the mortality decreased drastically after the first treatment and stopped completely in 24 hours after the second treatment (Table 2).

Table 2. Eradication of the monogenetic trematodes on gills of rabbitfish by short-term baths with Dipterex.

Date	Treatment	Concentration (ppm)	Duration (Min)	Mortality (No. of fish)
June 10	1 st	50	4 – 5	–
11				13
12				10
13				6
14				1
15				2
16				0
17	2 nd	30	8 – 16 +)	2
18				5
19				0
.				.
.				.

+) Variations depend on the size of fish.

Since a short-term bath treatment in such highly concentrated chemicals especially as pesticides is also very dangerous to fish, it is very important to be careful in the determination of dosage and the duration of bath. Table 3 shows the results of experiments on lethal doses of Dipterex to rabbitfish.

Table 3. Result of experiment on lethal dose of Dipterex to rabbitfish (Experiments carried out at 29 – 30°C, salinity : 32 – 34°/oo

	Fish species	Average TL (cm)	Consentration of Dipterex (ppm)	Time of death (minute)
1.	*Siganus javus*	3	50	4
2.	–– " ––	3	30	28
3.	–– " ––	9 – 11	50	9
4.	–– " ––	15	30	15
5.	*S. Canaliculatus*	3	30	39
6.	–– " ––	8 – 12	50	9
7.	*S. guttatus*	3	30	40
8.	*S. Virgatus*	5 – 8	50	9

Microscopic observations have found two species of monogenetic trematodes attached on the gills. These species, however, have not been identified yet.

RESULTS

The fish began to die from around the end of February in a net-cage of young rabbitfish which were captured and stocked last December. In mid-March, an infestation of monogenetic trematodes was found on its gill filàments. Its mortality did not stop in spite of various repeated treatments until the application of pesticide Dipterex was made in June. There has been no mortality by this parasite so far after the treatment by Dipterex.

After all, during this outbreak of the mass mortality from February to June, this parasite killed all of the 25,000 fry or more (3 - 4 cm. TL) captured in December and 80% of fry captured in April and May were also killed.

ACKNOWLEDGEMENTS

Our thanks go to Mr. Roestami Djajadiredja, chief of Inland Fisheries Research Institute, who provided us with Dipterex, as well as to Mr. Santoso Koesoemadinata, Pestiside Section of Inland Fisheries Research Institute for his efforts in its procurement.

REFERENCES

Brown, E.E. and Gratzek, J.B. 1980. Fish Farming Handbook Avil Publishing Company, Connecticut, 391 pp.

Herwig, N. 1979. Handbook of Drugs and Chemicals Used in the Treatment of Fish Diseases. Charrles C Thomas Publisher, Illinois, 272 pp.

Lam, T.J. 1974. Sigganids : Their Biology and Mariculture Potential. Aquaculture, 3 : 325 – 354.

Poupard, C.F. 1978. Therapy of fish diseases. In fish Pathology R.J. Roberts (Editor), pp. 268 – 275. Bailliere Tindall, London.

Sarig, S. 1971. The prevention and Treatment of Disease of Warm water fishes under subtropical Conditions with Special Emphasis on Intensive fish farming. Book 3, S.F. Snieszko and H.R. Axelrod (Editors). T.F.H. Publications, Jersey City, N.J. 127 pp.

Tobias, W.J. 1976. Ecology of *Siganus argenteus* (Pisces : Siganidae) in relation to its mariculture potential on Guam. In Studies on the genus *Siganus* (Rabbitfish) in Guam Waters R.T. Tsuda et al, pp. 58 – 93. Technical report No. 29, Marine Laboratory, Univ. of Guam.

***

STUDIES ON THE USE OF BIOCONVERSION MEDIUM – I FOR CULTIVATION OF MARINE DIATOM

(Chaetoceros calcitrans)

Edward Danakusumah[1)]

ABSTRACT

Study on the use of bioconversion medium for culture of marine diatom (Chaetoceros calcitrans) had been conducted in a swing-culture apparatus under laboratory condition. Chaetoceros was cultured under 5 different concentrations of bioconversion medium, namely : 0.0 (control), 0.5, 1.0, 2.0 and 4.0 ppt in combination with 15 ppm of sodium silicate.

The result showed that sterilized bioconversion medium was consisted of 527 mg at. NH_4-N.l^{-1}, 0.0012 mg at. NO_2-N.l^{-1}, 6.23 mg at NO_3-N.l^{-1} and 5.55 mg at. PO_4-P.l^{-1}. The most effective concentration of bioconversion medium was 2 ppt. The averages highest density in trials A and B were 4.437 x 10^6 cells.ml^{-1} (obtained in the ninth day) and 4.370 x 10^6 cells.ml^{-1} (obtained in the tenth day), respectively.

1) Research Station for coastal Aquaculture (Sub Balai Penelitian Perikanan Laut) Serang. Jalan Pelabuhan Ikan, Karangantu, Serang. Indonesia.

Abstrak : Studi telaah penggunaan bioconversion medium -I: Untuk budidaya diatom, Chaetoceros calcitrans.
oleh : Edward Danakusumah.

Studi telaah penggunaan bioconversion medium untuk budidaya Chaetoceros calcitrans telah dilakukan di dalam laboratorium dengan menggunakan sebuah swing-culture apparatus. Chaetoceros dibudidayakan dengan bioconversion yang disterilkan pada 5 konsentrasi yang berbeda-beda, yaitu: 0,0 (kontrol), 0,5; 1,0; 2,0 and 4,0 ppt. Pada masing-masing perlakuan ditambahkan 15 ppm sodium silikat.

Hasil analysa kimiawi menunjukkan bahwa bioconversion medium mengandung 527 mg at.NH_4-N.l^{-1}, 0,0012 mg at. NO_2-N.l^{-1}, 6,23 mg at.NO_3-N.l^{-1} dan 5,55 mg at.PO_4-P.l^{-1}. Konsentrasi bioconversion medium yang paling efektip untuk budidaya Chaetoceros adalah 2 ppt. Rata-rata densitas tertinggi dalam percobaan A adalah 4,437 x 10^6 sel ml^{-1} dicapai pada hari yang ke 9 dan dalam percobaan B adalah 4,370 x 10^6 sel.ml^{-1} dicapai pada hari kesepuluh.

INTRODUCTION

Marine diatom, Chaetoceros spp. are important natural foods for zoeal larvae of penaeids (HIRATA et al., 1975; JONES et al., 1979; MOTOH, 1979; VILLEGAS and KANAZAWA, 1980; VILLEGAS et al., 1980; KITTAKA, 1981; YAMASAKI et al., 1981). Culture technique of diatoms is well developed using agricultural fertilizers as source of nitrogen and phosphorus (HIRATA, 1975; KITTAKA, 1981; PLATON, 1978; SHIGUENO, 1975; SIMON, 1978; VILLEGAS and

KANAZAWA, 1980).

As results of agriculture development many biological waste products accumulate which, if not utilized, would cause adverse effects as pollutants in many areas. In the yellowtail, Seriola quinqueradiata farming in Nagashima, Kagoshima Prefecture, Japan, dead fish are burned by the fishermens in order to prevent pollution in the area. This practice incurs extra cost for buying oil. Maximum utilization of such waste products will have a tremendous positive impact on aquaculture. Pollution is avoided while a productive use of the waste is made.

Bioconversion is defined in this paper as biodegradation of fish product materials by microorganisms through the process of fermentation. After a certain period of time, the ferment is utilized for culture of the marine diatom. Silicon is an element limits the growth of diatoms (SVERDRUP et al., 1978). In the culture of Chaetoceros spp. sodium silicate is usually added to the medium at a concentration of 15 ppm (SIMON, 1978).

HIRATA and MURAKOSHI (1977) demonstrated that different air volumes supplied causing different population growth rate of Chlorella.
Exachange of gases in the culture medium is very important. However, it is very difficult to maintain same volume of air supply to each treatment in a small-scale experiment. In order to maintain the same air volume supply to every treatment, a swing-culture apparatus for phytoplankton was created.

This work is a part of the studies undertaken by the comprehensive research on the use of bioconversion medium which was made from dead (trash) yellowtail (Seriola quinqueradiata). Besides, effectiveness of the swing-culture apparatus is also examined.

MATERIALS AND METHODS

Dead yellowtail, Seriola quinqueradiata coming from fishfarms were mixed with freshwater at a ratio of 1 : 1. It was then stored outdoors in a covered tank for about 1 year. The supernatant so-called "bioconversion medium" was filtered with a plankton net (38 µm in mesh size) before being sterilized with an autoclave (Sakura ASW-240 C). The concentrations of dissolved inorganic nitrogen and phosphorus in the sterilized bioconversion medium were analysed. The methods employed for analysis were those of STRICKLAND and PARSONS (1972).

Natural sea water after being filtered and sterilized was used as medium for culture of the marine diatom. Natural sea water was allowed to pass through a sand filter apparatus. It was then chemically sterilized with hypochlorite solution at a concentration of 150 ppm and this condition was kept for about 24 hours before being neutralized with 45 ppm sodium thiosulphate.

The experiment was conducted in a swing-culture apparatus (Fig. 1) placed in an incubator (Sanyo MIR-250) with temperature controlled at 23.0 $\pm$ 0.5 $^{\circ}$C. Two pieces of 10 watts-fluorescent lamps were used as light source.

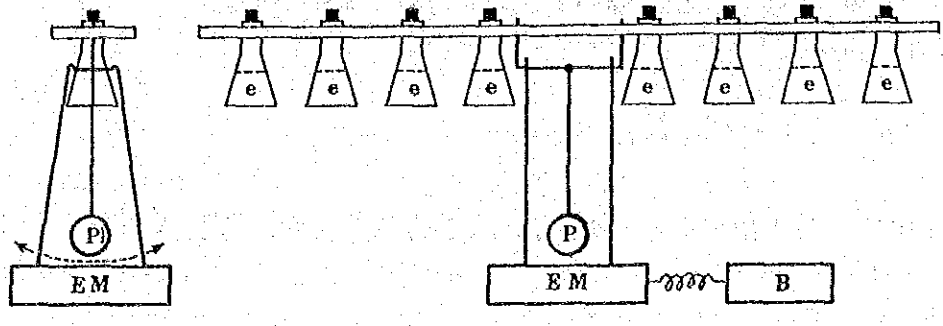

Figure 1. Schematic diagram showing swing-culture apparatus for phytoplankton. P = pendulum, EM = electro-magnet, e = 30-ml erlenmeyers, B = battery. Designed by HIRATA (1983)

Gambar 1. Skema alat swing-culture yang dipakai untuk percobaan budidaya fitoplankton.

Marine diatom was cultured under different concentrations of sterilized bioconversion medium namely, 0.0 (control), 0.5, 1.0, 2.0 and 4.0 ppt in combination with 15 ppm sodium silicate. The average initial density was 0.26×10^{6} cells.ml^{-1}. The experimental design used was the Completely Randomized Design maintaining three replications per treatment. The average highest densities were compared using Duncan's Multiple Range Test (GOMEZ and GOMEZ, 1976). The densities of diatom were observed daily using a haemocyto-

meter (Burker-Turk). The experiment was terminated when the population of diatoms reached death phases. The same experiment was repeated twice.

RESULTS

The analysis result of dissolved inorganic nitrogen and phosphorus concentrations in the sterilized bioconversion medium was consisted of 527 mg at. NH_4-N.l^{-1}, 0.0012 mg at. NO_2-N.l^{-1}, 6.23 mg at. NO_3-N.l^{-1} and 5.55 mg at. PO_4-P.l^{-1}.

The population growth of Chaetoceros calcitrans in trials A and B showing graphically in Fig. 2. The average highest densities and peaks of growth in both trials A and B are shown in Table I. Those cultured under 2 ppt bioconversion medium in combination with 15 ppm sodium silicate showed the average highest peaks in both trials. The average highest densities were 4.435 x 10^6 cells.ml^{-1} reached on the ninth day and 4.370 x 10^6 cells.ml^{-1} obtained on the tenth day of culture in trials A and B, respectively. Analysis of variance on the highest densities of Chaetoceros cultured under different concentration of bioconversion medium showed highly significant differences ($P < 0.01$) in both trials (Tables 2 and 3). The result of Duncan's Multiple Range Test showed that differences among treatment means are highly significant ($P < 0.01$). The efficiency (in terms of population densities of Chaetoceros) of different concentrations of the medium used may be ranked as follows: 2 ppt, 1.0 ppt, 4.0 ppt, 0.5 ppt and 0.0 ppt (control). Likewise, trial A showed similar trends as in trial B. The result of Duncan's Multiple Range Test showed that differences

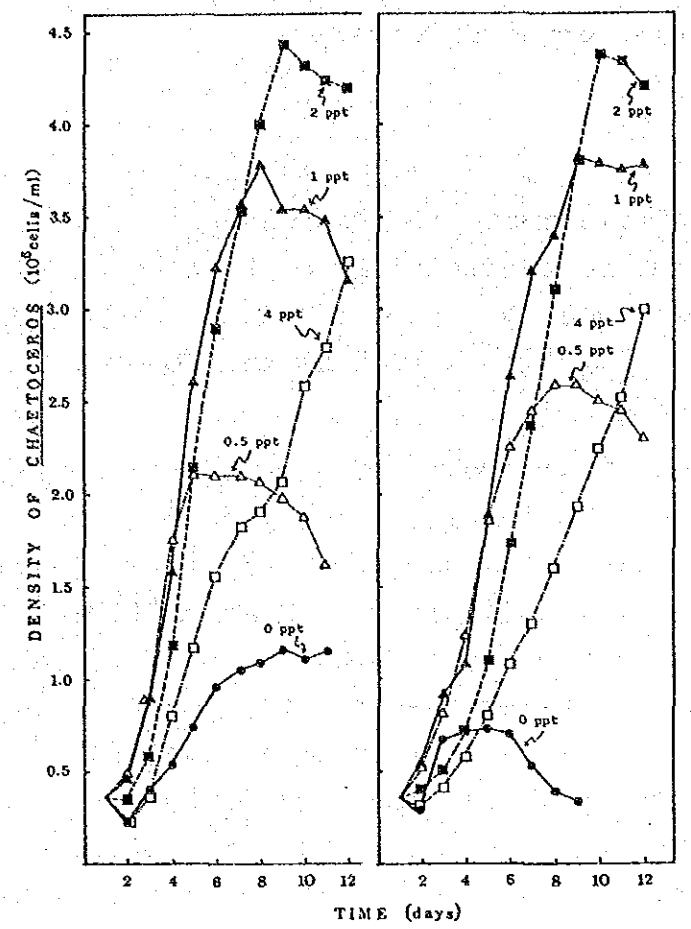

Figure 2. Population growth of Chaetoceros calcitrans cultured under different concentrations of bioconversion medium in combination with 15 ppm sodium silicate at 23.0 ± 0.5 °C. Each point is an average of three replications.

Gambar 2. Pertumbuhan populasi Chaetoceros calcitrans yang dipelihara dalam konsentrasi bioconversion medium yang berbeda pada suhu 23.0 ± 0.5 °C.

Table 1. Average highest densities and peaks of growth of Chaetoceros calcitrans cultured under different concentrations of bioconversion medium in combination with 15 ppm sodium silicate with temperature controlled at 23.0 ± 0.5°C.

Tabel 1. Rata-rata densitas tertinggi dan waktu yang dibutuhkan oleh Chaetoceros calcitrans untuk mencapai puncak populasi.

Bioconversion Medium (ppt)	Average Highest Density (10^6 cells. ml^{-1})		Peak of Growth (days)	
	A	B	A	B
0.0 (control)	1.165	0.733	11	5
0.5	2.097	2.578	7	8
1.0	3.780	3.820	8	9
2.0	4.435	4.370	9	10
4.0	3.260	2.997	12	12

Table 2. Analysis of variance for the highest density of *Chaetoceros calcitrans* cultured under different concentrations of bioconversion medium in combination with 15 ppm sodium silicate. (Trial A).

Tabel 2. Analisa sidik ragam terhadap densitas tertinggi Chaetoceros calcitrans yang dipelihara dengan bioconversion medium pada tingkat yang berbeda (Percobaan A).

Source of Variations	df	Sum of Squares	Mean Square	F comp.	F table
Among different concentrations of bioconversion medium	4	20.71378	5.17844	101.48**	P(0.05)= 3.06 P(0.01)= 4.89
Error	10	0.51031	0.05103		
Total	14	21.22409			

**highly significant.

Table 3. Analysis of variance for the highest density of Chaetoceros calcitrans culture under different concentrations of bioconversion medium in combination with 15 ppm sodium silicate. (trial B).

Tabel 3. Analisa sidik ragam terhadap densitas tertinggi Chaetoceros calcitrans yang dipelihara dengan bioconversion medium pada tingkat yang berbeda. (Percobaan B).

Source of Variations	df	Sum of Squares	Mean Square	F comp.	F table
Among different concentrations of bioconversion medium	4	23.43696	5.85924	115.00**	P(0.05)=3.06 P(0.01)=4.89
Error	10	0.50948	0.05095		
Total	14	23.94648			

**highly significant.

among treatment means are highly significant maintaining the same ranking of treatments as shown above.

DISCUSSIONS

The present research has demontrated the effective use of bioconversion medium in combination with sodium silicate in the culture of marine diatom, Chaetoceros calcitrans. In the present study, highest densities of 4.437 and 4.370 x 10^6 cells.ml^{-1} were obtained using 2 ppt bioconversion medium in combination with 15 ppm sodium silicate. HOSSAIN (1982) reported higher densi-

ty of 8.51 x 10^6 cells.ml^{-1} using the same concentration of 40-day old bioconversion medium. However, no control to check the influence of other fertilizers present in the medium were conducted. In the present study, the concentration of silicate in the bioconversion medium was not measured. However, there were may be silicates present as shown by a population growth of 1.165 and 0.733 x 10^6 cells.ml^{-1} of Chaetoceros growth under the control treatment of 0 ppt bioconversion medium. Furthermore, the presence of fertilizers in the Chaetoceros seeds before inoculation may have also contributed the said population densities.

The concentration of inorganic NH_4-N was found about 85 times higher than that of the NO_3-N. LUDWIG as cited by CONWAY (1977) had demonstrated that algae cultured under nitrate and ammonium as the nitrogen sources preferentially used ammonium, the nitrate was not utilized until the ammonium had almost disappeared.

The analysis of dissolved organic nitrogen and phosphorus concentration was not covered in the present experiment. However, both dissolved inorganic and organic compounds of phosphorus and nitrogen were found to be directly of indirectly utilized by producers without the necessity of any further chemical breakdown by bacteria (ODUM, 1971). FISHER and COWDELL (1982) demonstrated that directly or indirectly some organic nitrogen compounds can function as a ready source of nitrogen for diatoms and probably other phytoplankters.

The same pattern of population growth in trial A as in trial B demonstrated effectiveness of the swing-culture apparatus. The advantages of using swing-culture apparatus are (i) movement of the swing-flasks promo-

te same amount of air diffusion which increases the dissolve CO_2 into the culture media, (ii) relatively small volume of flasks (30-ml) enable for dim-light to penetrate into the culture medium, (iii) relatively small size (28 cm in arm length) makes it possible to set-up in an incubator and (iv) relatively cheap in price.

Result of the present experiment have demonstrated the possibility of a recycling-aquaculture from yellowtail to marine diatom. In the future, a larger-scale culture of Chaetoceros should be investigated as possible feed for penaeid larvae. The use of bioconversion medium for culture of other marine plankton such as Chlorella is also suggested to be investigated.

ACKNOWLEDGEMENT

The author would like to express his gratitute to Dr. H.HIRATA for his supervision throughout the course of this study, and Mr. S. KADOWAKI, Mr. T. NAKASONO and Mr. T. KASEDO for their valuable help during the experiment. This work was financing by the Japanese Ministry of Education so thanks are due.

LITERATURE CITED

CONWAY, H.L., 1977. Interactions of inorganic nitrogen in the uptake and assimilition by marine phytoplankton. Mar. Biol., 39, 221 - 232.

FISHER, N.S. and R.A. COWDELL, 1982. Growth of marine planktonic diatoms on inorganic and organic nitrogen. Mar. Biol., 72,142-155.

GOMEZ, K.A. and A.A. GOMEZ, 1976. Statistical procedures for agricultural research with emphasized on

rice. IRRI., Manila, Philippines. 294 pp.

HIRATA, H. 1975. An introduction to the rearing methods of prawn Penaeus japonicus Bate in Japan. Mem. Fac. Fish., Kagoshima Univ., Japan. 24,7-12.

HIRATA, H. and M. MURAKOSHI, 1977. Effects of aeration volume on the growth of Chlorella in culture. Mem. Fac. Fish., Kagoshima Univ., Japan. 26,15-21.

HIRATA, H., Y. MORI and M. WATANABE, 1975. Rearing of prawn larvae Penaeus japonicus fed on soycake particles and diatoms. Mar. Biol., 29,9-13.

HOSSAIN, M.A., 1982. Studies of rearing of prawn Penaeus japonicus Bate under bioconversion system. MS-thesis, Fac. Fish., Kagoshima Univ., Japan. 195 pp.

JONES, D.A., A. KANAZAWA and S. ABDELRAHMAN, 1979. Studies on the presentation of artificial diets for rearing the larvae of Penaeus japonicus Bate. Aquaculture, 17,33-43.

KITTAKA, J., 1981. Largae scale production of shrimp for releasing in Japan and in the United States and the results of the releasing programme at Panama City, Florida. Kuwail Bull. Mar. Sci., 2,149-163.

MOTOH, H., 1979. Larvae of decapod Crustacea of the Philippines-III. Larval development of the giant tiger prawn Penaeus monodon reared in the laboratory Bull. Japan. Soc. Sci. Fish., 45(10), 1201-1216.

ODUM, E.P., 1971. Fundamental of ecology. Toppan Co. Ltd., Tokyo Japan. 574 pp.

PLATON, R.R., 1978. Design, operation and economics of a small scale hatchery for the larval rearing of sugpo, Penaeus monodon Fab. Aquaculture Dept. SEADEC, Philippines, Aquaculture Extension Manual no. 1, 29 pp.

SHIGUENO, K., 1975. Shrimp culture in Japan. Association for International Promotion, Tokyo, Japan. 153 pp.

SIMON, C.M., 1978. The culture of diatom, Chaetoceros gracilis and its use as a food for penaeid protozoeal larvae. Aquaculture, 14, 105-133.

STRICKLAND, J.H.D. and T.R. PARSONS, 1972. A practical handbook of seawater analysis. Bull. Fish. Res. Board of Canada, no. 167.

SVERDRUP, H.U., M.W. JOHNSON and R.H. FLEMING, 1978. The Oceans, their physics, chemistry and general biology. Modern Asia 12th Ed., C.E. Tuttle Co., Tokyo, Japan. 1087 pp.

VILLEGAS, C.T., and A. KANAZAWA, 1980. Rearing of the larval stages of prawn, Penaeus japonicus Bate, using artificial diets. Mem. Kagoshima Univ., Res. Center S. Pac., 1(1),43-49.

VILLEGAS, C.T., T.L. LI and A. KANAZAWA, 1980. The effects of feeds and feeding levels on the survival of a prawn, Penaeus monodon larvae. Mem. Kagoshima Univ., Res. Center S. Pac., 1(1),51-55.

YAMASAKI, S., M. USUGI and H. HIRATA, 1981. Rearing of prawn, Penaeus japonicus fed on rotifers Brachionus plicatilis. Mem. Fac. Fish., Kagoshima Univ., Japan. 30,289-294.

STUDIES ON THE USE OF BIOCONVERSION MEDIUM – II FOR CULTIVATION OF *Chlorella saccharophila*

Edward Danakusumah*

ABSTRACT

Studies on the use of bioconversion medium for cultivation of Chlorella saccharophila had been conducted under laboratory condition at 23.0 ± 0.5°C. This study was aimed to develop a model of recycling -aquaculture. Bioconversion, a medium produced from fermentation of dead yellowtail (Seriola quinqueradiata) was used as fertilizer. Chlorella was cultivated under 5 different concentrations of the medium, namely: 0.0, 0.5, 1.0, 2.0 and 4.0 ppt.

The result showed that a highly significant difference ($P < 0.01$) among treatments. The efficiency of bioconversion medium may be ranked as follows: 1.0 ppt, 2.0 ppt, 4.0 ppt, 0.5 ppt and 0.0 ppt (control). Those treated with 1.0 ppt bioconversion medium reached an average highest density of 32.1 x 10^6 cells/ml on the 23th day of culture.

ABSTRAK: Studi Tentang Penggunaan Bioconversion Medium-II: Untuk Budidaya Chlorella saccharophila. Oleh: Edward Danakusumah*

Studi penggunaan bioconversion medium untuk budidaya Chlorella saccharophila telah dilakukan di dalam laboratorium pada suhu 23,0 ± 0,5°C. Studi ini ditujukan untuk menciptakan suatu model recycling di bidang budidaya laut. Percobaan ini menggunakan bioconversion medium yaitu suatu pupuk yang dibuat dari bangkai ikan yellowtail Seriola quinqueradiata. Chlorella dibudidayakan dalam 5 tingkat konsentrasi

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

pupuk yang berbeda yaitu 0,0, 0,5, 1,0, 2,0 dan 4,0 ppt.

Hasil analisa sidik ragam memperlihatkan adanya perbedaan nyata ($P < 0,01$) antara masing-masing perlakuan. Tingkat konsentrasi bio-conversion medium yang terbaik adalah 1,0 ppt, disusul oleh 2,0 ppt, 4,0 ppt, 0,5 ppt dan 0,1 ppt. Chlorella yang dipelihara dalam 1,0 ppt menghasilkan rata-rata densitas tertinggi 32,1 x 10^6 sel/ml pada hari ke-23.

INTRODUCTION

Chlorella spp are important natural food organisms for rotifer (Brachionus plicatilis) and indirectly for fish and prawn larvae. Rotifer cultured with Chlorella have a better nutritional value compared with that of the baker's yeast (WATANABE et al., 1978) which will influence the survival rate of the cultured larvae.

Culture technique of Chlorella is well developed since three decades ago using agricultural fertilizers as source of nitrogen and phosphorus (SISFFA, 1964; PLATON, 1978) and Clewat-32 as additional trace metals (HIRATA, 1975).

In Nagashima, Kagoshima Prefecture, Japan, tons of dead yellowtail Seriola quinqueradiata as wastes of net-cage culture are burned by the fishfarmers in order to prevent pollution in the area. Maximum utilization of such waste products will have a tremendous possitive impact on aquaculture. One of the possibilities is to make the waste for fertilizer. Bioconversion, a medium made fermentation of such dead fish was demonstrated as a good nutrients source for culture of marine algae such as Chaetoceros calcitrans (DANAKUSUMAH, 1985) and Chlorella saccharophila (HOSSAIN, 1982).

Optimum salinity and water temperature for culture of Chlorella saccharophila were found between 15 - 35 ppt (with the best population growth at 25 ppt) and between 20 - 23°C, respectively (HIRATA et al., 1981).

This experiment was conducted in the Laboratory of Fisheries Science, Faculty of Fisheries, Kagoshima University, Japan in summer 1983. This work is a part of the studies undertaken by the comprehensive research on the use of bioconversion medium which was made from dead Seriola quinqueradiata. This study is aimed to develop a model of recycling-aquaculture from an aquacultural waste to food organisms. The possibilities are discussed in this paper.

MATERIAL AND METHOD

Method for preparing bioconversion medium was previously described by DANAKUSUMAH (1985). The supernatant so-called "bioconversion medium" was filtered through a plankton net (38 um in mesh size) before being starilized with an autoclave (Sakura ASW 240-C). The concentration of dissolved inorganic nutrients were 527 mg-at NH_4-N/1, 0.0012 mg-at NO_2-N/1, 6.23 mg-at NO_2-N/1 and 5.55 mg-at PO_4-P/1 (DANAKUSUMAH, 1985).

Natural sea water after being filtered and sterilized was used as medium for culture of Chlorella saccharophila. Method for sterilizing natural sea water was described by DANAKUSUMAH (1985). The experiment was conducted in a series of 100-ml erlenmeyers placed in an incubator (sanyo MIR-250) with temperature controlled at 23.0 $\pm$ 0,5^{o}C. No airation provided during the experiment. Two pieces of 10-watts fluorescent lamps were used as light source.

Chlorella was culture under different concentrations of sterilized bioconversion medium, namely: 0.0, 0.5, 1.0, 2.0 and 4.0 ppt. The average density of Chlorella was 2.5 x 10^6cells/ml. Experimental design used was Completely Randomized Design maintaining four replications per treatment. The average highest densities were compared using Duncan's Multiple Range Test (GOMEZ and GOMEZ, 1976). Densities of Chlorella were observed daily using a haemocytometer (Burker-Turk) and a microscope. The experiment was terminated when the population densities of Chlorella reached death phases,

RESULT

The population growth of Chlorella saccharophila are shown graphically in Figure 1. The average highest densities dan peaks of population growth are shown in Table 1. Chlorella cultured under 1 ppt bioconversion medium showed an average highest peak of 32.1 x 10^6 cells/ml reached on the day-23. The analysis of variance of the

Table 1. The average highest densities and peaks of Chlorella saccharophila cultured under different concentrations of bioconversion medium.

Tabel 1. Rata-rata densitas tertinggi dan waktu yang dibutuhkan oleh Chlorella saccharophila untuk mencapai puncak populasi.

Bioconversion Medium (ppt)	Average Highest Density* (10^6cells/ml)	Peak of Growth (days)
0.0 (control)	11.64	10
0.5	21.26	15
1.0	32.15	23
2.0	29.33	24
4.0	26.76	27

* Highly significant difference.

average highest densities is shown in Table 2. Highly significant differences ($P < 0.01$) among of Chlorella cultured under different concentrations of bioconversion medium were obtained. The result of Duncan's Multiple Range Test showed that differences among treatment means are also highly significant ($P < 0.01$). The efficiency (in terms of producing highest pupolation density of Chlorella) of the different concentrations of bioconversion medium used may be ranked as follows: 1.0 ppt, 2.0 ppt, 4.0 ppt, 0.5 ppt and 0.0 ppt (control).

Table 2. Analysis of variance of the highest densities of Chlorella saccharophila cultured under different cancentrations of bioconversion medium.

Tabel 2. Analisa sidik ragam terhadap rata-rata densitas tertinggi Chlorella saccharophila yang dibudidayakan pada tingkat koncentrasi bioconversion medium yang berbeda.

Source of Variations	df	Sum of Squares	Mean Square	F comp.	F table
Among different concentrations of bioconversion medium	4	10.24650	2.56163	42.93**	P(0.05)=3.06 P(0.01)=4.89
E r r o r	15	0.89503	0.05967		
T o t a l	16	11.14153			

**highly significant.

In the present experiment, the lag phases and peaks of population growth seem to be influenced by the concentration of bioconversion medium. Higher concentration shows realtively longer lag phase. Beside, the higher concentration seems to cause higher peak. Chlorella cultured under 1.0 ppt bioconversion medium shows higher peak than that of the 0.5 ppt and the control treatment. Those treated under 2.0 ppt and 4.0 ppt bioconversion medium have not been showing higher peaks when the experiment terminated. However, probably, their peaks might be higher. Moreover, time needed for reaching the peaks of population growth is longer in the higher concentration of the medium.

DISCUSSION

Nitrogen and phosphorus are major nutrient elements required for normal growth of algae (KUHL, 1962; ODUM, 1971; SVERDRUP et al., 1942). In general mass culture of phytoplankton is usually provided using

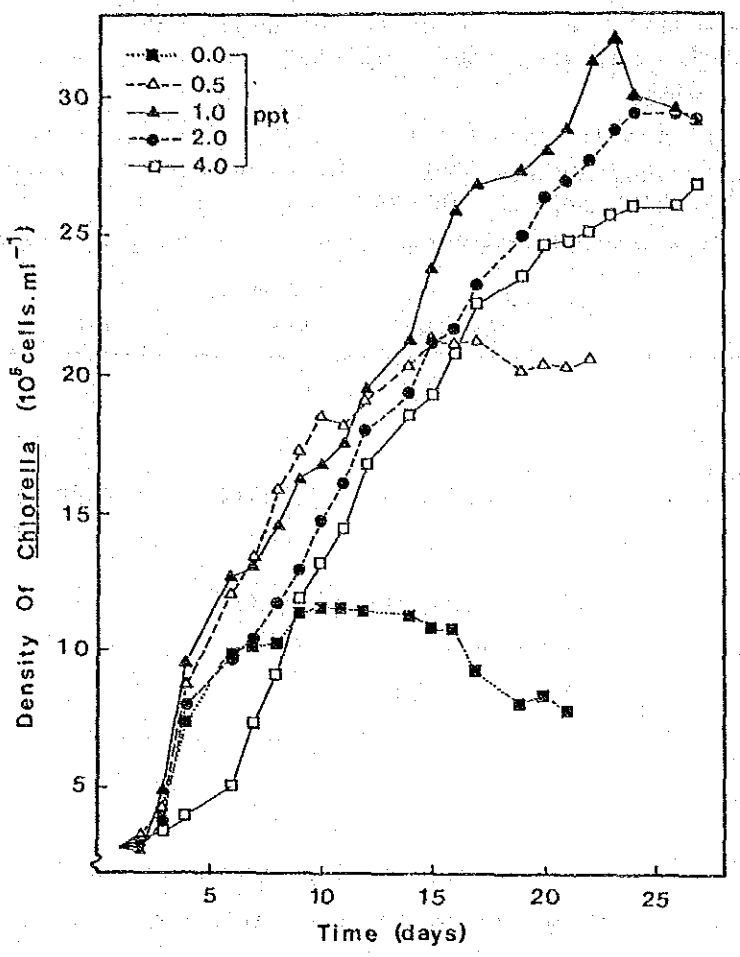

Figure 1. Population growth of Chlorella saccharophila culture under different concentrations of bioconversion medium at 23.0 ± 0.5 °C. Each point is an average of four replications.

Gambar 1. Pertumbuhan populasi Chlorella saccharophila yang dibudidayakan pada tingkat bioconversion medium yang berbeda pada suhu 23.0 ± 0.5°C. Setiap titik adalah rata-rata dari empat ulangan.

agricultural fertilizers such as urea, ammonium sulphate, potassium nitrate, potassium dihydrogen orthophosphate, triple super phosphate and sodium silicate (for diatom only) (GUILLARD, 1983; HIRATA, 1979; PLATON, 1978; SISFFA, 1964). In small scale culture EDTA, trace metals and some vitamins are usually added (GUILLARD, 1983; HIRATA, 1979; STARR, 1978).

The analysis of dissolved organic nitrogen and phosphorus content

was not covered in this experiment. The total content of organic and inorganic nitrogen and phosphorus in this bioconversion medium is probably much higher than the present data. It was demonstrated elsewhere that directly or indirectly some organic nitrogen compounds can be function as a ready source of nitrogen for diatoms and other phytoplankters (FISHER and COWDELL, 1982) without the necessity of any further chemical breakdown by bacteria (ODUM, 1971). Some amino acids can be rapidly utilized by phytoplankton (DORTCH after POULLET and JESEQUEL, 1983) and urea can serve as sole nitrogen source for Chlorella (SYRETT, 1962). In the present experiment, the concentration of inorganic ammonium-N is about 85 times higher than the inorganic nitrate-N (DANAKUSUMAH, 1985). LUDWIG as cited by CONWAY (1977) demonstrated that algae cultured under nitrate and ammonium as the nitrogen sources preferentially utilized the ammonium; the nitrate was not utilized unti the ammonium had almost disappeared. Nitrate uptake is inhibited until ammonium ion falls below 1 ug-at/l (CAPERON and ZIEMANN, 1976). Organic and inorganic nitrogen enrichment support equal growth of phytoplankton (FISHER and COWDELL, 1982).

In the present study, undissolved organic phosphorus is found settled at the bottom of the medium stock. The sediment is a part of broken bones. ODUM (1971) found that dissolved organic and inorganic phosphorus can be directly or indirectly utilized by producers without the necessity if any further chemical breakdown by bacteria. KUHL (1962) demonstrated that good growth of phytoplankton occured in nutrient solution of 0.1 - 2.0 ppm phosphorus; concentration below 0.05 ppm and higher than 20 ppm were limiting and inhibitory.

The present experiment has demonstrated the bioconversion medium is suitable fertilizer for culture of Chlorella saccharophila. Beside, a model of recycling-aquaculture from aquacultural waste into Chlorella is demonstrated. In the future, the use of Chlorella produced from such waste for culture of marine rotifer (Brachionus plicatilis) is suggested to be investigated.

ACKNOWLEDGEMENT

I would like to express my deepest gratitude to Dr Hachiro Hirata of the Faculty of Fisheries, Kagoshima University, Japan for his valuable supervision throughout this study. Thanks are also addressed to Mr Sushaku Kadowaki, Mr Terayuki Nakasono and Mr Teruo Kasedo for their valuable help during the experiment. This study is financed by the Ministry of Education, the Government of Japan so thanks are also due to.

LITERATURE CITED

CONWAY, H.L., 1977. Interactions of inorganic nitrogen int the uptake and assimilation by marine phytoplankton. Mar.Biol., 39,221-232.

CAPERON, J. and D.A. ZIEMANN, 1976. Synergistic effects of nitrate and ammonium ion on the growth and uptake kinetics of Monochrysis lutheri in continuous culture. Mar.Biol., 36,73-84.

DANAKUSUMAH, H., 1985. Studies on the use of bioconversion medium-I: For cultivation of marine diatom (Chaetoceros calcitrans) (In preparation).

FISHER, N.S. and R.A. COWDELL, 1982. Growth of marine planktonic diatoms on organic and inorganic nitrogen. Mar.Biol., 72,142-155.

GOMEZ, K.A. and A.A. GOMEZ, 1976. Statistical procedures for agricultural research with special emphasized on rice. IRRI, Manila, Philippines, 294 pp.

GUILLARD, R.R.L., 1983. Culture of phytoplankton for feeding marine invertebrates. in Culture of marine invertabrates, C.J. Berg, Ed. Hutchinson Ross Press., Pensylvania, USA., pp 108-132.

HIRATA, H., 1975. Preliminary report on the photoperiodic acclimatation for growth of Chlorella cells in sychronized culture. Mem.Fac. Fish., Kagoshima Univ., Japan, 24,1-6.

HIRATA, H., 1979. Cultivation of fish fry and its live food. European Maricult.Soc., Special Publ., 4,361-375.

HIRATA, H., I. ANDARIAS and S. YAMASAKI, 1981. Effects of salinity and temperature on the growth of marine phytoplankton Chlorella saccharophila. Mem.Fac.Fish., Kagoshima Univ., Japan, 30,257-262.

HOSSAIN, M.A., 1982. Studies on rearing of prawn Penaeus japonicus Bate under bioconversion system. MS-thesis Fac.Fish., Kagoshima Univ., Japan, 195 pp.

KUHL, A. 1962. Inorganic phosphorus uptake and metabolism. in Physiology and biochemistry of algae, R.A. Levin Ed., Academic Press., New York, USA.

ODUM, E.P., 1971. Fundamental of ecology. Toppan Co. Ltd., Tokyo, Japan, 574 pp.

PLATON, R.R., 1978. Design, operation and economics of small scale hatchery for the larval rearing of sugpo, Penaeus monodon Fab., Aquaculture Dept. SEAFDEC, Philippines, Aquaculture extension manual nO. 1, 29 pp.

POULLET, S.A. and V.M. JESEQUEL, 1983. Relatioship between dissolved free amino acids, chemical composition and growth of marine diatom Chaetoceros debile, Mar.Biol.,77,93-100.

Seto Inland Sea Farming Fisheries Association, 1964. Cultivation of live food organisms. Newsletter of Saibai Gyogyo, Japan, 2,4 (in Japanese).

STARR, R.C., 1978. The culture collection of algae at the University of Texas, Austin, J.Phycol., 14 suppl., 47-100.

SVERDRUP, H.U., M.W. JOHNSON and R.H. FLEMING, 1942. The oceans, their physics, chemistry and general biology. Prentice-Hall. New York, USA, 1087 pp.

SYRETT, P.J., 1962. Nitrogen assimilation, in Physiology and biochemistry of algae. R.A. Levin Ed., Academic Press., New York, USA.,

WATANABE, T., T. ARAKAWA, C. KITAJIMA and S. FUJITA, 1978. Nutritional evaluation of proteins living feeds used in seed production of fish, Bull.Japan.Soc.Sci.Fish., 44,985-988.

STUDIES ON THE USE OF BIOCONVERSION MEDIUM – III FOR MASS CULTURE OF ROTIFER (*Brachionus plicatilis*)

Edward Danakusumah

ABSTRACT

Study on the use of bioconversion medium indirectly for mass culture of rotifer (Brachionus plicatilis) had been conducted outdoors in 600-ton capacity tank. This study was aimed to develop a model of recycling aquaculture based on the biotechnology. One ppt of bioconversion medium (produced from fermented dead yellowtail Seriola quinqueradiata) was used as fertilizer for culture of Chlorella saccharophila. Rotifer was inoculated to the same tank when the Chlorella density was about reaching peak of population growth.

Result showed that highest density of Chlorella was 15.4, 12.4, and 18.0 x 10^6 cells.ml^{-1} obtained in trials A, B and C, respectively. Highest density of rotifer was 36.0, 4.9 and 29.0 ind.ml^{-1} obtained in trials A, B and C, respectively. The total harvested zooplankton was consisted of 67.9% rotifer and 32.1% other species combined. The relative efficiency from dead yellowtail to total zooplankton was 25.5% (17.3% to the rotifer and 8.2% to the other species).

ABSTRAK: Studi Tentang Penggunaan Bioconversion Medium -III. Untuk Budidaya Masa Rotifera (Brachionus plicatilis). Oleh Edward Danakusumah.

Studi tentang penggunaan bioconversion medium untuk budidaya rotifera (Brachionus plicatilis) telah dilakukan

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

dalam tangki berkapasitas 600-ton. Studi ini ditujukan untuk menciptakan suatu model recycling di bidang akwakultur yang berdasar pada bioteknologi.

Bioconversion medium adalah suatu pupuk organik yang dibuat dari fermentasi bangkai ikan Seriola quinqueradiata. Satu ppt medium ini digunakan untuk budidaya-masa Chlorella saccharophila, kemudian setelah densitas Chlorella hampir mencapai puncaknya rotifera diinokulasikan.

Hasil penelitian ini menunjukkan bahwa densitas Chlorella tertinggi adalah 15,4, 12,5 dan 18,0 x 10^6sel.ml^{-1} dalam percobaan A, B dan C. Densitas rotifer yang tertinggi adalah 36,0, 4,9 dan 29,0 ind.ml^{-1} pada percobaan A, B dan C. Total zooplankton yang dipanen terdiri dari 67,9% rotifera dan 32,1% species lainnya. Relatip efisiensi dari bangkai ikan menjadi total zooplankton adalah 25,5% yang terdiri dari 17,3% rotifera dan 8,2% species lainnya.

INTRODUCTION

Recently, rotifers (Brachionus spp) became the most important natural food organisms for culture of marine fish larvae and prawn larvae. Large-scale production of rotifers had been attempted as a possible economic alternative to Artemia nauplii (SEAFDEC after VILLEGAS and KANAZAWA, 1980).

Culture methods for rotifer had been well established many years ago using various phytoplanktons and yeasts. Among them Chlorella spp are the most popular ones (BenAMOTZ and FISHLER, 1982; CHOTIYAPUTTA and HIRAYAMA; 1978, HIRATA, 1974, 1977, 1979, 1980; HIRATA et al., 1981, 1982; IMADA et al., 1979 and KITAJIMA et al., 1980). Chlorella spp are usually cultured using common agricultural fertilizers (SISFFA, 1964; PLATON, 1978) plus Clewat-Ca and Clewat-32 as additional trace metals (HIRATA, 1975).

Bioconversion medium made from fermentation of dead fish had been proved as a good mediumforculture of Chlorella and Chaetoceros (DANAKUSUMAH, 1985a, 1985b; HOSSAIN, 1982).

As result of agricultural development many biological waste products accumulate which if not utilized, would cause adverse effect as pollutant in many areas. In the yellowtail (Seriola quinqueradiata) farming in Nagashima, Kagoshima Prefecture, Japan, tons of dead fish (caused by natural mortality) are burned by fishermen in order to prevent pollution in the area. Maximum utilization of such waste product will have a tremendous positive impact on aquaculture (DANAKUSUMAH, 1985a). Models of recycling -aquaculture from dead yellowtail (Seriola quinqueradiata) to marine phytoplanktons Chaetoceros calcitrans and Chlorella saccharophila had been demonstrated by DANAKUSUMAH (1985a, 1985b).

This work is a part of the studies undertaken by the comprehensive research on the use of bioconversion medium which was made from fermentation of dead yellowtail (Seriola quinqueradiata). It is aimed to develop a model of recycling-aqnaculture from the said material to rotifer (Brachionus plicatilis) through Chlorella saccharophila based on the biotechnology. The possibilities are discussed in this paper.

MATERIAL AND METHOD

Dead yellowtail, Seriola quinqueradiata coming from fishfarms were mixed with freshwater at a ratio of 1 : 1. It was then stored in a covered plastic tank for about 1 year. The supernatant so-called bioconversion medium was filtered using a plankton net (38 µm in mesh size) before being used for cultivation of Chlorella saccharo-

phila. The process of making and using of the bioconversion medium is illustrated in Figure 1. Concentration of dissolved inorganic nitrogen and phosphorous were analysed. The method employed for analysis were those of STRICKLAND and PARSONS (1972).

This experiment was conducted outdoors in 600-ton capacity tank using natural sea water (33‰) as culture medium. The sea water was fertilized with 1 ppt of biocon - version medium and inoculated with Chlorella saccharophila at a density of 0.5 x 10^6cells.ml^{-1}. The tank was well aerated. When population density of Chlorella about reaching the peak of population growth, rotifer was inoculated at a density of 2 - 3 ind.ml^{-1}. The trial was repeated three times.

Densities of Chlorella and rotifer were observed daily using a haemocytometer (Burker-Turk) and a binocular microscope. Physico-chemical parameters such as water temperature, pH and salinity were observed daily. Water temperature and pH were observed daily using a pH-meter (YEW model pH-51). Salinity was observed using a refracto-salinometer (ATAGO model S-100).

Experiment was terminated when the density of Chlorella decreased to 1 x 10^6cells.ml^{-1}. Rotifer and other bigger species combined were harvested using nets of 90 and 255 µm in mesh size, respectively. The Relative Efficiency (RE) is computed using the following formula:

$$RE = WWR/WWY \times 100\% ,$$

where: WWR = Wet weight of rotifer.
WWY = Wet weight of dead yellowtail (equals to 49.88% of the used bioconversion medium.

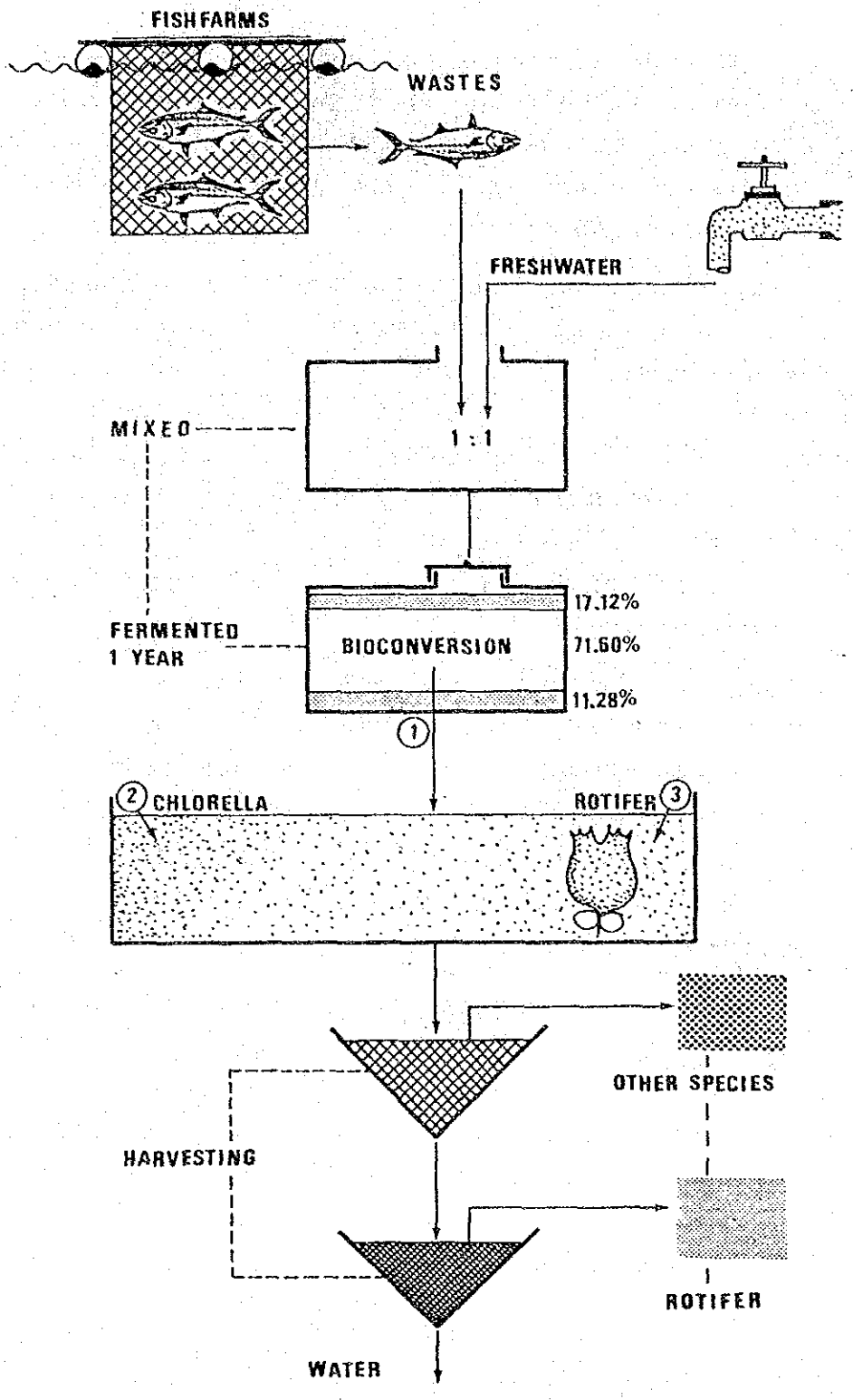

Figure 1. Schematic diagram showing the process of making and using of the bioconversion medium for cultivation of rotifer.

RESULT AND DISCUSSION

After one year fermentation period, the ferment was composed of 17.12% floating materials, 71.60% supernatant which was considered as bioconversion medium and 11.28% sediment such as bones and others. Result of dissolved inorganic nitrogen and phosphorous analysis showed that the supernatant was consisted of 556.00 mg atom NH_4-N.l^{-1}; 0.0042 mg atom NO_2-N.l^{-1}; 6.20 mg atom NO_3-N.l^{-1} and 5.56 mg atom PO_4-P.l^{-1}.

The daily changes of water temperature, pH and salinity, densities of Chlorella and rotifer are illustrated in Figure 2. The maximum, minimum and average values of pH, water temperature and salinity are summarized in Table 1. The densities of Chlorella and rotifer, composition of harvested zooplankton and relative efficiency are summarized in Table 2.

In the present experiment, average highest density of Chlorella was 15.3 x 10^6cells.ml^{-1} obtained between the 11 and 13 day of culture. An average highest density of 32.1 x 10^6cells.ml^{-1} was previously obtained using the same medium in a small-scale experiment under laboratory condition (DANAKUSUMAH, 1985b). FUKUSHO (1980) found that highest density of Chlorella minutissima cultured outdoors in 200-ton capacity tanks was ranging between 9.7 and 14.5 x 10^6cells.ml^{-1}.

Highest densities of rotifer were 36.0, 4.9 and 29.0 ind.ml^{-1} obtained in trials A, B and C, respectively. The harvested zooplankton was consisted of 67.9% rotifer and 32.1% other species combined which was naturally grew without being inoculated into the tanks. When the initial density of rotifer was 2 - 3 ind.ml^{-1}, the average harvested zooplankton consisted of 85% rotifer and 15% other species combined (refers to Table 2, trials A and C).

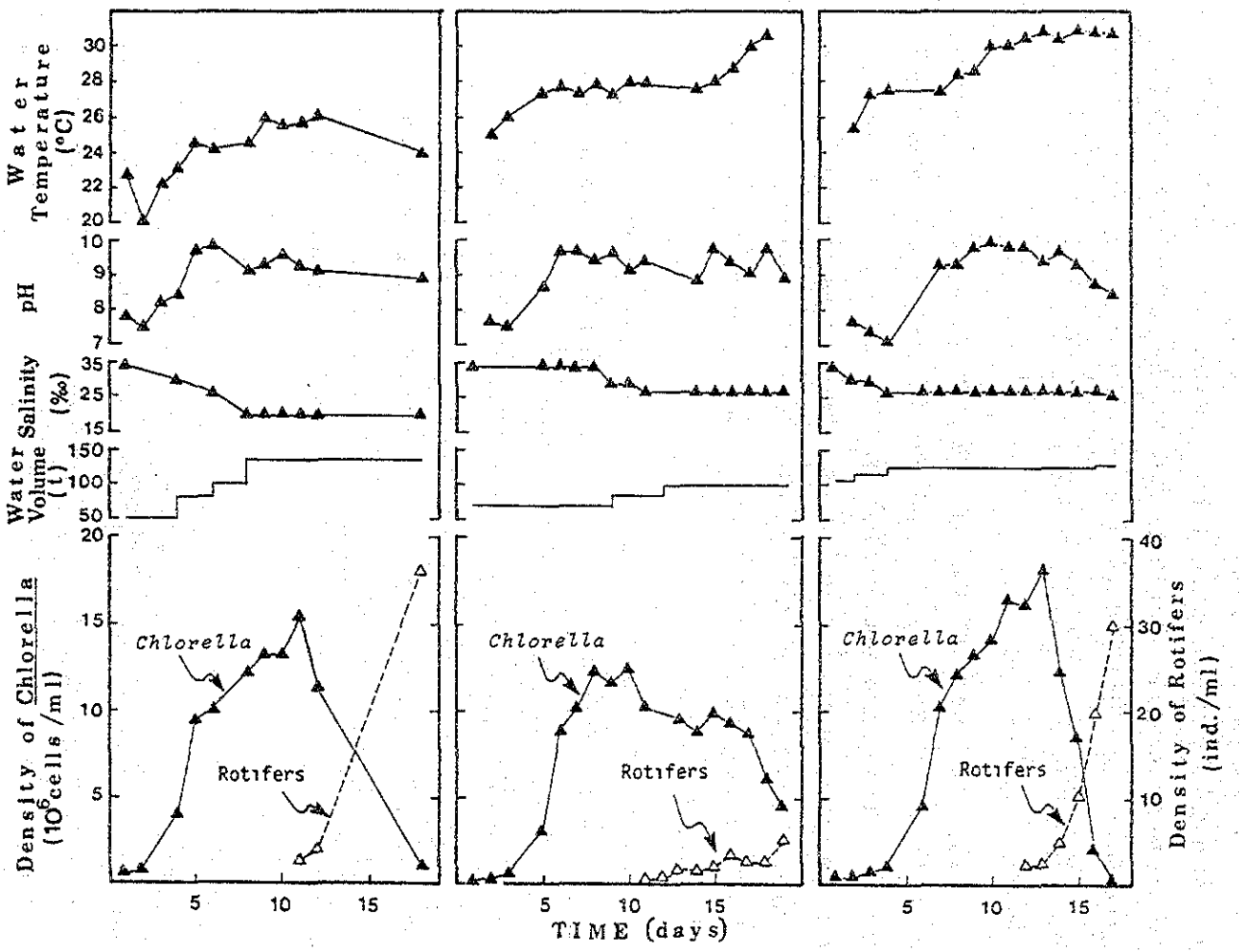

Figure 2. Daily changes of water temperature, pH and salinity in the tanks and the densities of Chlorella and rotifer.

Table 1. Physico-chemical parameters monitored in the culture tank of Chlorella saccharophila and rotifer (Brachionus plicatilis).

Trial	pH			W.T.(°C)			Salinity(‰)	
	Max.	Min.	Ave.	Max.	Min.	Ave.	Initial	Final
A	9.84	7.50	8.89	26.0	20.1	24.3	34	20
B	9.80	7.55	9.12	30.6	25.1	28.0	34	27
C	9.92	7.12	9.03	31.0	25.4	29.1	34	26

Note: Decreasing salinity attributed to additional rain water.

However, when the initial density of rotifer was 0.5 ind.ml^{-1}, the harvested zooplankton consisted of 12% rotifer and 88% other species combined (refers to Table 1, trial B). In the present experiment, the other species combined was consisted of copepod, mosquito larvae and chironomids. They were seemed to be compete for feed possible prey on rotifer. Invertebrate predation of planktonic rotifer had been reviewed by WILLIAMSON (1983). Filtration rate of rotifer on Chlorella sp was found between 12,000 (HIRAYAMA and OGAWA, 1972) and 13,500 cells. hr^{-1} (MAEDA., 1979).

Relative efficiency (RE) in terms of dead yellowtail to the total zooplankton was 25.5% or in terms of dead yellowtail to the rotifer was 17.3% (refers to Table 2). Bacteria Growth Ability (ZOBELL and FELTHAM, 1937) was not covered in this experiment. However, there is strong possibility that the wastes are also recycled by bacteria -feeding rotifer as described by GATESOUPE and LUQUET (1981). Moreover, HIRATA et al. (1982) and YASUDA and

Table 2. Densities of Chlorella saccharophila and rotifer (Brachionus plicatilis) cultured outdoors in 600-ton capacity tank, composition of harvested zooplankton and the relative efficiency.

Trial	Density				Harvested Zooplankton				Used Bioconversion Medium*	Relative Efficiency from dead fish to:	
	Chlorella (10^6 cells.ml^{-1})		Rotifer (ind. ml^{-1})		Rotifer		Others			Rotifer	Others
	Initial	Highest	Initial	Final	(kg)	(%)	(kg)	(%)	(kg)	(%)	(%)
A	0.6	15.4	2.7	36.0	15.3	88.4	2.0	11.6	140	21.9	2.9
B	0.3	12.5	0.5	4.9	1.3	11.6	9.9	88.4	100	2.6	19.8
C	0.5	18.0	2.3	29.0	15.3	82.7	3.2	17.3	130	23.6	4.9
Average	0.47	15.3	1.8	23.3	—	—	—	—	—	—	—
Total	-	-	-	-	31.9	67.9	15.1	32.1	370	17.3	8.2

*Bioconversion medium was consisted of 49.88% dead fish and 50.12% freshwater.

TAGA (1980) demonstrated that rotifers ate bacteria.

The ranges of water temperature in trials A, B and C were between 20.1 and 26.0°C, 25.1 and 30.6°C, 25.4 and 31.0°C, respectively. HIRATA et al. (1981) found that ideal water temperature for culture of Chlorella saccharophila was between 20 and 23°C. The optimum water temperature for culture of rotifer was 25°C as demonstrated by HIRAYAMA and KUSANO (1972) and 30°C as proven by ITO et al. (1981).

The ranges of salinity in trials A, B and C were between 20 and 34 ppt, 27 and 34 ppt and 26 and 34 ppt, respectively. The ideal salinity for culture of Chlorella saccharophila was 25 ppt (HIRATA et al., 1981).

Bioconversion medium made from fermented dead fish was previously demonstrated as good medium for culture of Chlorella in a small-scale culture (DANAKUSUMAH, 1985b; HOSSAIN, 1982). The present study is demonstrating the same system in a large-scale. Moreover, it is demonstrated a model of recycling-aquaculture from aquacultural waste product to the rotifer through the Chlorella. Another model of recycling-aquaculture such as the use of secondary sewage for culture of bivalve-mollusc through Phaeodactylum tricornutum (MANN and RYTHER, 1977) and the use of mineralized biodeposit for culture of rotifer through Chlorella saccharophila (HIRATA, 1974, 1979, 1980) had also been demonstrated.

In the present experiment, the harvested rotifer was deep freezed and will be used in the next experiment for culture of prawn larvae. DANAKUSUMAH (1984) demonstrated that the use of frozen and live rotifer as kuruma prawn (Penaeus japonicus Bate) larval feed showed no significant difference on its survival rate.

ACKNOWLEDGEMENT

I wish to thank Dr Hachiro Hirata for his supervision throughout the course of this study. Thanks are also express to Mr Shusaku Kadowaki, Mr Terayuki Nakasono and Mr Teruo Kasedo for their technical assistance. This research was supported by the Ministry of Education, of the Government of Japan.

LITERATURE CITED

Ben-AMOTZ, A. and R. FISHLER, 1982. Induction of Sexual Reproduction and Resting Egg Production in Brachionus plicatilis by a Diet of Salt Grown Nannochloris oculata. Mar.Biol.,67,289-294.

CHOTIYAPUTTA, C. and K. HIRAYAMA, 1978. Food Selectivity on the Rotifer Brachionus plicatilis Feeding on Phytoplankton. Mar.Biol.,45,105-111.

DANAKUSUMAH, E., 1984. Culture of Kuruma Prawn (Penaeus japonicus) Larvae fed with Frozen and Living Rotifer. Lap.Pen.Perikanan Laut. 31,33-37.

DANAKUSUMAH, E.,1985a. Studies on the Use of Bioconversion Medium - I: For Cultivation of Marine Diatom (Chaetoceros calcitrans). Lap.Pen.Perikanan Laut, (in press).

DANAKUSUMAH, E., 1985b. Studies on the Use of Bioconversion Medium - II: For Cultivation of Chlorella saccharophila. (in preparation).

GATESOUPE, F.J. and P. LUQUET, 1981. Practical Diet for Mass Culture of the Rotifer, Brachionus plicatilis : Application to Larval Rearing of Sea-Bass Dicentrarchus labrax. Aquaculture, 22,149-163.

HIRATA, H., 1974. An attemp to Apply an Experimental microcosm for the Mass Culture of Marine Rotifer, Brachionus plicatilis Muller. Mem.Fac.Fish., Kagoshima Univ., 23,163-172.

HIRATA, H., 1977. Zooplankton Cultivation and Prawn Seed Production in an Artificial Ecosystem. Helgolander Wiss. Meeresunters, 30,230-242.

HIRATA, H., 1979. Rotifer Culture in Japan. European Mariculture Society (Special Publ.), 4,361-375.

HIRATA, H., 1980. Culture Methods of the Marine Rotifer, Brachionus plicatilis. Mini Rev. Data File Fish.Res., Fac.Fish., Kagoshima Univ., 1,27-46.

HIRATA, H., I. ANDARIAS and S. YAMASAKI, 1981. Effects of Salinity and Temperature on the Growth of Marine Phytoplankton Chlorella saccharophila. Mem.Fac.Fish., Kagoshima Univ., 30,257-262.

HIRATA, H. and W.D. NAGATA, 1982. Excretion Rates and Excreted Components of the Rotifer Brachionus plicatilis O.F. Muller in Culture. Mem.Fac.Fish., Kagoshima Univ., 31,161-174.

HIRAYAMA, K. and T. KUSANO, 1972. Fundamental Studies on Physiology of Rotifer for Its Mass Culture - II. Influence of Water Temperature on Population Growth of Rotifer. Bull.Japan.Soc.Sci.Fish., 38(12),1357-1363.

HIRAYAMA, K. and S. OGAWA, 1972. Fundamental Studies on Physiology of Rotifer for Its Mass Culture - I. Filter Feeder of Rotifer. Bull.Japan.Soc.Sci.Fish., 38 (11),1207-1214.

HOSSAIN, M.A., 1982. Studies on Rearing of Prawn Penaeus japonicus Bate Under Bioconversion System. MS-Thesis, Fac.Fish., Kagoshima Univ., Japan. 192 pp.

IMADA, O., Y. KAGEYAMA, T. WATANABE, C. KITAJIMA, S. FUJITA and Y. YONE, 1979. Develcpment of a New Yeast as a Culture Medium for Living Feeds Used in the Pro - duction of Fish Seed. Bull.Japan.Soc.Sci.Fish., 45 (8),955-959.

ITO, S., H. SAKAMOTO, M. MORI and K. HIRAYAMA, 1981. Morphological Characteristics and Suitable Temperature for Growth of Several Strains of the Rotifer, Brachionus plicatilis. Res.Report Fac.Fish., Nagasaki Univ., 51,9-16.

KITAJIMA, C., T. ARAKAWA, F. OOWA, S. FUJITA, O. IMADA, T. WATANABE and Y. YONE, 1980. Dietary Value for Red Sea Bream Larvae of Rotifer Brachionus plicatilis Cultured with a New Type of Yeast. Bull.Japan. Soc.Sci.Fish., 46(1),43-46.

MAEDA, M., S. YAMASAKI and H. HIRATA, 1980. Food Conversion Rates of Brachionus plicatilis in a Feed Back Culture System. Mini Rev.Data File Fish.Res., 1,107-116.

MANN, R. and J.H. RYTHER, 1977. Growth of Six Species of Bivalve Molluscs in a Waste Recycling-Aquaculture System. Aquaculture, 11,231-245.

PLATON, R.R., 1978. Design, Operation and Economics of Small Scale Hatchery for the Larval Rearing of Sugpo, Penaeus monodon Fab. Aquaculture Dept. SEAFDEC, Philippines, Aquaculture Extension Manual no. 1, 29 pp.

Seto Inland Sea Farming Fisheries Association, 1964. Cultivation of Live Food Organisms. Newsletter of Saibaigyogyo, 2,4. (in Japanese).

STRICKLAND, J.H.D. and T.R. PARSONS, 1972. A Practical Handbook of Sea Water Analysis. Bull.Fish.Res.Board of Canada, no. 167.

VILLEGAS, C. and A. KANAZAWA, 1980. Rearing of the Larval Stages of Prawn, Penaeus japonicus Bate Using Artificial Diet. Mem.Kagoshima Univ.Res.Cetre S.Pac., 1(1), 43-49.

WILLIAMSON, C.E., 1983. Invertebrate Predation on Planktonic Rotifers. Hydrobiologia, 104,385-396.

YASUDA, K. and N. TAGA, 1980. Culture of Brachionus plicatilis Using Bacteria as Food. Bull.Japan.Soc.Sci. Fish., 46(8),933-939 (in Japanese).

ZOBELL, C.E. and C.B. FELTHAM, 1937. Bacteria as Food for Certain Marine Invertebrates. J.Mar.Res., 1,312-327.

Lap. Pen. Perikanan Laut No. 31 Th. 1984 : 33 — 37

CULTURE OF KURUMA PRAWN (*Penaeus japonicus*) LARVAE FED WITH FROZEN AND LIVING ROTIFER

Edward Danakusumah *

ABSTRACT: Studies on the use of frozen and living rotifers *(Brachionus plicatilis)* for culture of kuruma-prawn *(Penaeus japonicus)* larvae has been conducted in a series of 1800 — ml capacity bottles under laboratory conditions.

The results show that there is no significant difference ($P < 0.01$) between the survival rates of prawn larvae fed with frozen rotifers and that fed with the living ones. The average survival rate is 52% in both treatment.

ABSTRAK : Pemeliharaan larva udang-kuruma *(Penaeus japonicus)* dengan pakan rotifera beku dan rotifera hidup, oleh Edward Danakusumah.

Studi telaah penggunaan rotifera beku dan rotifera hidup *(Brachionus plicatilis)* untuk budidaya larva udang kuruma *(Penaeus japonicus)* telah dilakukan di dalam laboratorium. Percobaan ini dilakukan dengan menggunakan botol-botol yang berkapasitas 1800—ml.

Hasil analisa sidik ragam terhadap survival rate menunjukkan tidak berbeda nyata ($P < 0.01$) antara larva udang—kuruma yang diberi pakan rotifera beku dan rotifera hidup. Rata-rata survival rate adalah 52% pada ke dua perlakuan.

INTRODUCTION

Culture technique of kuruma-prawn *(Penaeus japonicus)* larvae had been well developed in Japan since many years ago (HIRATA, 1975). However, many difficulties still occur. Prawn larvae is very sensitive to changes of environmental conditions. Many factors are synergistically effect the larvae. Among the environmental factors, feed is the most important one.

Success of prawn seed production depend upon the suitable feed supply. Living marine diatoms such as *Chaetoceros* spp., *Skeletonema costatum*, *Nitzschia* spp had been demonstrated in Japan as suitable food organisms for the larvae (HIRATA, 1975, 1979; HIRATA, *et al.*, 1978; HUDINAGA, 1942; HUDINAGA, and KITTAKA, 1966; JONES *et al.*, 1979; SHIGUENO, 1975; VILLEGAS and KANAZAWA, 1980). The use of living natural food organisms are probably the best. However, the preparation and maintainance of the living stock is difficult. The preparation of living rotifers stock is consequently to the culture tanks of *Chlorella*. Relatively big number of *Chlorella* tanks are needed for this purpose. In prawn hatcheries, when the larvae is not being produced, the larval culture tanks could be used for rotifers production. The harvested rotifers could be stored in a refrigerator and used as feed. Frozen rotifers are expectedly to replace the use of living rotifers as feed for the larvae.

This experiment was conducted in the Laboratory of Aquaculture Physiology, Faculty of Fisheries, University of Kagoshima. It is aimed to study the suitability of frozen rotifers as compared with the living ones for producing postlarvae—1 of prawn.

MATERIAL AND METHOD

Natural sea water (salinity 33‰) was used as culture medium after being filtered with a filter paper (5 μm in pores). The culture medium was strongly aerated. Apparatus for culture experiment and water—sampler for estimation the prawn larvae density are shown in Figure 1.

Zoea-1 as test animal was coming from a single gravid female. They were cultured indoors in a series of 1800—ml capacity bottles at an initial density of 100 zoea-1 per liter. The zoea-1 was fed with marine diatom *(Chaetoceros* spp) maintaining at a density of 50 — 70 x 10^3 cells per ml. (JONES *et al.*, 1979; VILLEGAS and KANAZAWA, 1980). The zoea-2 was fed with frozen rotifers (treatment 1) and living rotifers (treatment 2) at a rate of 500 rotifers perlarvae per day until they reach postlarvae-1. The treatments were maintained at three replications.

Cultured rotifers were fed with *Chlorella* spp which was cultured using agricultural fertilizers as described by SISFFA (1964). Harvested rotifers were freezed using a common refrigerator for one month period before being fed to the larvae (treatment 1).

In order to maintain good water condition, 20% of the water cultured volume was exchanged daily (YAMASAKI *et al.*, 1981). The density of prawn larvae was observed daily by randomly sampling. At the end of experiment the culture media were drained and the larvae was counted. The average survival rates were compared using a model-1 Anova as described by SOKAL and ROHLF (1973). Water temperature and pH were measured daily using a digital pH-meter (YEW pH—meter model 51). Dissolved oxygen was measured daily using a DO-meter (YSI model 57).

RESULT AND DISCUSSION

Daily average survival rate of prawn larvae, water temperature, pH and dissolved oxygen are shown graphically in Figure 2. The average survival rate was 52% in both treatments (no significant difference at $P < 0.01$). This results indicated that frozen rotifer was effective for culture of prawn larvae as the living one.

The quality of rotifers (in terms of calorie content) depends upon the availability of *Chlorella* in the culture medium. YAMASAKI *et al.* (1981) found that the calorie content of rotifer was 5.1 Kcal and 4.6 Kcal per gram rotifer when the density of *Chlorella* in the culture medium of rotifer was 0.5×10^6 cells per ml and zero , respectively, Moreover, the quality of rotifer (in terms of essential fatty acid) depends upon the given feed. Rotifer cultured with baker's yeast showed lower essential fatty acid content compared with that cultured with *Chlorella* (WATANABE *et al.*, 1983).

The negative effect of using frozen rotifer as prawn larval feed is that the remainder may polute the culture medium causing the increase of ammonia. Ammonia is very toxic to prawn (WICKINS, 1976) and fish (RIMON and SHILO, 1981). The daily changes of ammonia concentration in the culture medium was not covered in the experiment. However, daily changes of 20% culture medium (YAMASAKI *et al.*, 1981) seemed effective to depress the ammonia concentration below the lethal limit.

The ranges of water temperature, pH and dissolved oxygen were 24.2 and 27.8°C, 8.1 and 8.3, 5.8 and 6.3 ppm, respectively. HIRATA (1975) mentioned that the ideal water temperature, pH and dissolved oxygen were 20 and 25°C, 7.8 and 8.4, 5 and 7 ppm, respectively.

The result of present experiment demonstrated that the frozen rotifer was as effective as the living one. However, for a longer storing period the nutritive value might decrease. In the future, the quality changes of frozen rotifer due to storing period should be investigated. Moreover, the effectiveness of different ages of the frozen rotifer for prawn larvae culture should also be investigated.

ACKNOWLEDGEMENT

The author wish to thank Dr Hachiro Hirata and his assitant Mr Shigesa Yamasaki at the Laboratory of Aquaculture Physiology, Faculty of Fisheries, University of Kagoshima, Japan for their helpful critics and comments.

REFERENCES

HIRATA, H., 1975 An introduction to the rearing method of prawn *Penaeus japonicus* Bate in Japan. Mem. Fac. Fish., Kagoshima Univ., 24,7 — 12.

HIRATA, H., 1979. Oceanic ranching of the prawn, as an aspect of modern aquaculture on Japan, Report of the Seminar of Fisheries Technology Education on July 11 — Agugust 1, 1979. Kagoshima Univ . and JICA., pp 123 — 136.

HIRATA, H., M. MACHIORI and A. SHINOMIYA, 1978. Rearing of prawn *Penaeus japonicus* Bate with reference to ecological succession. Mem. Fac. Fish., Kagoshima Univ., 27 (1), 295 — 303.

HUDINAGA, M., 1942. Reproduction, development and rearing of *Penaeus japonicus* Bate. Japan. J. Zool., 10, 305 — 393.

HUDINAGA, M. and J. KITTAKA, 1966. Studies on food and growth of the larval stages of prawn *Penaeus japonicus* with reference to the application to practical mass culture. Inf. Bull. Plankton. Japan., 13, 84 — 94.

JONES. D.A., A. KANAZAWA and S. ABDELRAHMAN. 1979 Studies on the preservation of artificial diets for rearing of the larvae of *Penaeus japonicus* Bate. Aquaculture, 17, 33 — 43.

RIMON, A. and M. SHILO, 1981. Limits of intensification of fish breeding. European Mariculture Society (Special Publ.), 6, 57 — 64.

Seto Inland Fisheries Farming Association, 1964. Cultivation of live food organisms. News Letter of Saibaigyogyo. 2,4. (in Japanese)

SHIGUENO, K., 1975. Shrimp culture in Japan. Association for International Technical Promotion, Tokyo, Japan. 153 pp.

SOKAL, R. R. and F. J. ROHLF, 1973. Introduction to biostatistics. Toppan Co. Ltd., Tokyo, Japan. 368 pp.

VILLEGAS. C. and A. KANAZAWA, 1980. Rearing of the larval stages of prawn, *Penaeus japonicus* Bate using artificial diet. Mem. Kagoshima Univ. Res. Center S. Pac., 1 (1), 43 — 49.

WATANABE, T., C. KITAJIMA and S. FUJITA, 1983. Nutritional values of live organisms used in Japan for mass propagation of fish : A review. Aquaculture, 34, 115 — 143.

WICKINS, J. F., 1976. Prawn biology and culture. Ocean ogr. Mer. Biol. Ann. Rev., 14, 435 —607.

YAMASAKI, S., M. USUGI and H. HIRATA, 1981. Rearing of prawn, *Penaeus japonicus* fed on rotifer, *Brachionus plicatilis*. Mem. Fac. Fish., Kagoshima Univ., 30, 289 — 294.

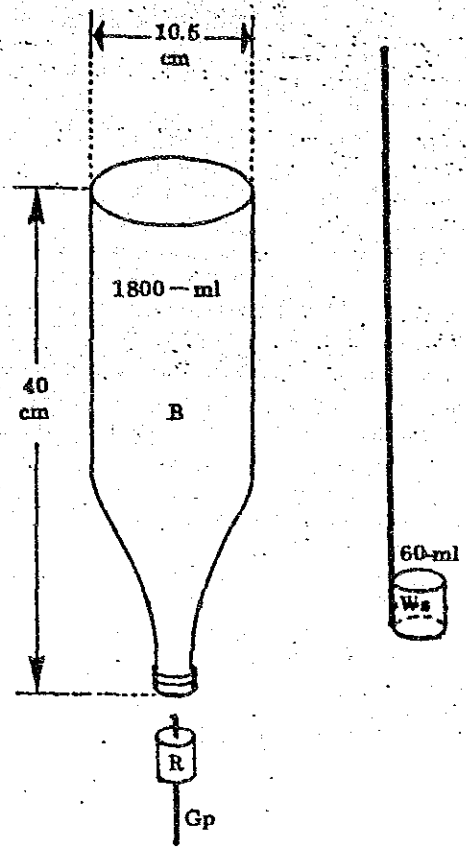

Figure 1. Apparatus for culture experiment of prawn larvae and water sampler for estimation the prawn larvae density. B = bottle without bottom, R = rubber plug, Gp = glass pipe for aeration, Ws = water sampler.

Gambar 1 Alat yang dipakai untuk percobaan budidaya larva udang dan alat pengambil contoh air untuk pendugaan densitas larva. B = botol tanpa dasar, R = sumbat karet, Gp = pipa aerasi dari kaca, Ws = alat pengambil contoh air.

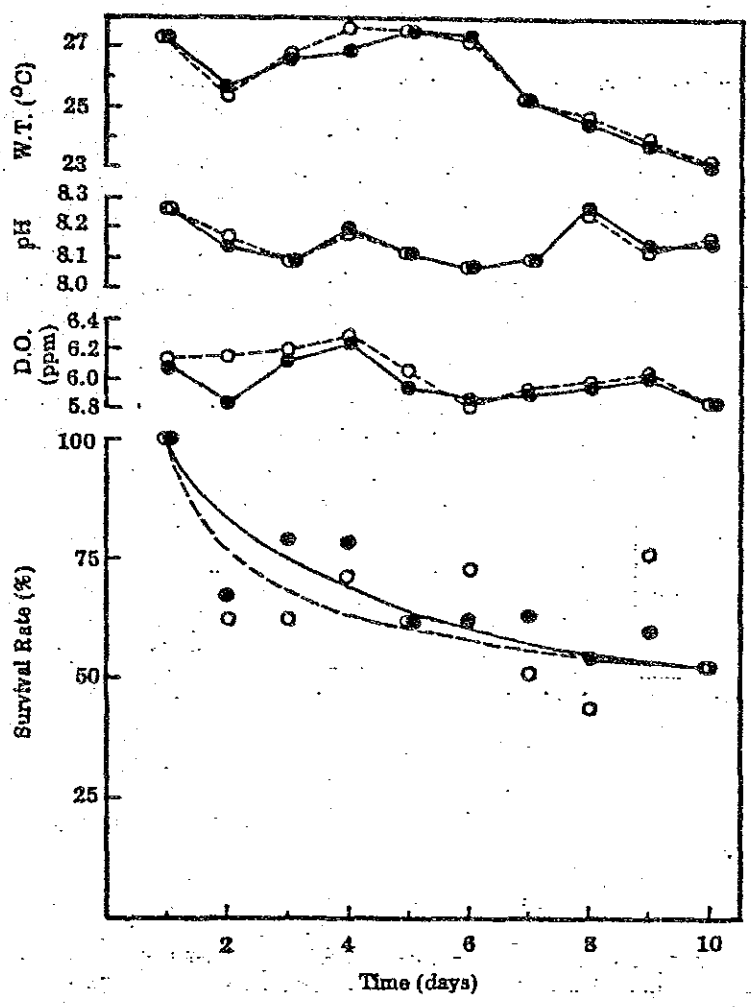

Figure 2. Daily changes of average survival rate of *Penaeus japonicus* Larvae, dissolved oxygen, pH and the water temperature. Each point is an average of three replications.

Gambar 2. Rata-rata survival rate larva udang Penaeus japonicus, kelarutan oksigen, pH dan suhu air. Setiap titik merupakan rata-rata dari tiga ulangan.

BEBERAPA ASPEK BIOLOGI IKAN BERONANG (*Siganus* spp.)

Edward Danakusumah

Sub Balai Penelitian Budidaya Pantai Bojonegara

Pendahuluan.

Ikan beronang (Siganus spp) adalah merupakan ikan yang potensial untuk dibudidayakan (LAM, 1974; LAM dan SOH, 1975; POPPER et al., 1979). Ikan ini mempunyai daerah penyebaran yang sangat luas mulai dari Laut Tengah, Lut Merah, Samudera Hindia, Indo-Australia, Pasifik Barat bahkan sampai ke perairan Jepang Selatan (GEORGE, 1972; BENTUVIA dan KISSIL, 1973; POPPER et al., 1983). Famili Siganidae diduga mempunyai anggota sebanyak 27 - 30 spesies yang hidup di seluruh dunia (WOODLAND dalam GUNDERMANN et al., 1983; HERRE dan MONTALBAN, 1928). Koleksi ikan beronang di Lembaga Oseanologi Nasional menurut BURHANUDDIN et al. (1975) ada 10 spesies yaitu Siganus ornamin (S. canaliculatus), S. guttatus, S. javus, S. virgatus, S. chrysospilos, S. puellus; S. vermiculatus, S. corallinus, S. vulpinus dan S. spinus. Delapan spesies di antaranya ditemukan di perairan Teluk Banten (MERTA, 1980).

Ukuran maksimum yang dapat dicapai oleh ikan beronang adalah 40 cm (1.800 g) (GUNDERMANN et al., 1983). Di beberapa negara seperti Guam, Palau, Solomon, Fiji, Filipina, Indonesia, Singapura dan Israel ikan ini sangat digemari (MANACOP, 1937; LAM, 1974; Von WESTERNHAGEN dan ROSENTHAL, 1976 dan GUNDERMANN et al., 1983). Di Indoresia, spesies yang mempunyai harga tinggi adalah S. guttatus (di Sulawesi Selatan Rp 3.500,-/kg) dan S. canaliculatus (di Kep. Riau menjelang tahun baru Cina harganya Rp 6.000,-/kg).

Judul makalah yang dipresentasikan pada Workshop Budidaya Laut di Bandar Lampung, 28 Okt - 1 Nov, 1985.

Musim Berpijah.

Ikan beronang mempunyai musim berpijah antara bulan Januari sampai dengan September tergantung pada spesies dan tempatnya. Di Fiji S. vermiculatus memijah antara bulan Februqri sampai dengan September (GUNDERMANN et al., 1983). S. canaliculatus (S. oramin) di Singapura dan di Filipina menijah antara bulan Januari sampai dengan April (LAM, 1974 dan MANACOP, 1937). Sedangkan di Palau ikan ini memijah antara bulan Maret sampai dengan Juli (HASSE et al., 1977). Di Teluk Banten pemijahan in terjadi pada bulan Januari-Februari dan Juli-Agustus. Di Laut Tengah dan Laut Merah, S. luridus memijah mulai bulan Maret dan S. argenteus memijah antara bulan Juni sampai dengan Agustus (POPPER et al., 1979). Tetapi GEORGE (1972) menemukan bahwa sampai bulan September masih ada ikan S. rivulatus yang memijah di tempat yang sama.

Beberapa peneliti menemukan bahwa saat memijah sangat dipengaruhi oleh fase bulan. Di alam, ikan beronang memijah sekitar bulan baru demikian pula pemijahan alami yang terjadi di dalam tangki percobaan. S. vermiculatus memijah pada hari ke 7 - 8 setelah bulan baru (GUNDERMANN et al., 1983). Sedangkan S. canaliculatus (S. oramin) memijah 4 - 6 hari setelah bulan baru (HASSE et al., 1977 dan MANACOP, 1937). POPPER et al.(1979) juga menyatakan bahwa S. luridus dan S. rivulatus memijah setelah bulan baru tetapi tidak disebutkan pada hari yang ke berapa. WASPADA (1984) melaporkan bahwa S. virgatus biasanya memijah antara 3 - 7 hari sebelum atau 5 - 7 hari setelah bulan purnama. Pada umumnya ikan beronang memijah pada malam hari tetapi POPPER et al. (1979) pernah menemukan bahwa S. luridus dan S. rivulatus memijah masing-masing pada siang hari dan pagi hari di dalam tangki percobaan.

Fekunditas.

Ikan beronang mempunyai fekunditas yang relatip tinggi. Jumlah telur yang terkandung tergantung pada besar ikannya. Di Filipina, MANACOP (1937) menemukan bahwa S. oramin betina dengan panjang badan 21,4 cm mengandung telur sebanyak 419.000 butir sedangkan yang panjangnya 16,4 cm mengandung telur sebanyak 363.000 butir. GUNDERMAN et al. (1983) memperkirakan fekunditas S. vermiculatus dengan panjang total 12 cm (berat badan 240 g) mengandung telur sebanyak 350.000 butir. Hasil penelitian di Palau yang dilakukan oleh HASSE et al. (1977) terhadap S. canaliculatus menemukan bahwa fekunditas ikan ini berkisar antara 295.000 sampai 750.000 butir. Selanjutnya dilaporkan bahgonad terberat yang pernah ditemukan adalah 12,8 persen dari berat badan induknya. WASPADA (1984) mengemukakan bahwa fekunditas S. virgatus berkisar antara 250.000 sampai 304.000 butir. Ikan beronang mempunyai telur yang lengket (adhesive). Telur yang telah dibuahi selalu kedapatan melekat pada benda-benda di dasar perairan. Diameter telur ikan beronang berkisar antara 0,4 sampai 0,7 mm (MANACOP, 1937, WASPADA, 1984 dan GUNDERMANN et al., 1983).

Benih-alami.

Dalam budidaya laut penyediaan benih merupakan hal yang sangat penting. Penyediaan benih dapat dilakukan dengan cara terkontrol pada hatchery atau dengan cara mengumpulkan benih alami. Penyediaan ikan beronang secara masal dengan cara terkontrol masih merupakan masalah yang belum terpecahkan. Walaupun pemijahan secara terkontrol di dalam laboratorium (skala kecil) telah berhasil dilakukan terhadap beberapa spesies seperti Siganus rivulatus, S. luridus, S. argenteus, S. fuscescens, S. virgatus dan S. canaliculatus (POPPER et al., 1973; GORDIN dalam POPPER et al., 1979; POPPER et al., 1979; FUJITA dan UENO, 1954; WASPADA, 1984, MANACOP, 1937; WILSON, 1974; MAY et al., 1974; WESTERHAGEN dan ROSENTHAL, 1976). Di lain pihak penyediaan benih-alami lebih mudah dan lebih murah apabila lokasi, musim dan jenis alat tangkapnya telah diketahui.

Di Teluk Banten kelimpahan benih-alami masih relatip besar. Beberapa spesies benih ikan beronang didapati di perairan ini. Mereka adalah Siganus canaliculatus, S. guttatus, S. virgatus, S. javus, S. chrysospilos, S. vermiculatus (NURHAKIM, 1984a). Benih ikan ini dijumpai di lokasi Teluk Grenyang, pantai Barat P. Panjang dan pantai Barat P. Kambing. Komposisi benih ikan beronang berbeda di ke tiga lokasi tersebut. Benih S. canaliculatus selalu didapati dalam kelimpahan tertinggi (lebih dari 80 persen) (NURHAKIM, 1984a). Diduga bahwa tingginya komposisi benih ini erat hubungannya dengan kelimpahan stok induk di alam. Hal ini sesuai dengan hasil penelitian MERTA (1980). Benih S. canaliculatus di perairan Teluk Grenyang mempunyai kelimpahan yang relatip jauh lebih tinggi dibandingkan dengan benih ikan yang sama pada perairan lainnya.(Tabel 1). Hal ini disebabkan karena kelimpahan

pakan-alami (tumbuhan) ikan beronang lebih banyak ditemukan di perairan Teluk Grenyang (Tabel 3). Kecepatan pertumbuhan relatip S. canaliculatus dapat dilihat pada Tabel 2. DREW dalam LAM (1974) mendapatkan bahwa pertumbuhan S. rivulatus yang hidup di "enrich dockside" adalah 14 mm per bulan sedangkan yang hidup di perairan mengrove hanya 3 mm per bulan. S. canaliculatus dapat hidup dengan baik terutama di daerah yang ditumbuhi rumput laut (sebagian besar Enhalus sp) dan pada rataan terumbu karang atau daerah mangrove dan muara sungai (SOH dan LAM, 1973; LAVINA dan ALCALA, 1973; DREW dalam LAM, 1974 dan WOODLAND dalam HUTOMO, 1978)

Siganus javus mempunyai habitat yang lebih luas. Mereka dapat hidup dari mulai perairan laut, payau dan tawar (BEAUFORT dan CHAPMAN, 1951; HERRE dalam LAM; 1974, WOODLAND dalam HUTOMO, 1978). BURHANUDDIN et. al. 1975) mendapatkan S. javus di muara Sungai Kapuas, Kalimantan.

Siganus virgatus menyukai perairan karang yaitu pantai Barat P. Panjang (NURHAKIM, 1984). Hal ini sesuai dengan pendapat HERRE dan MONTALBAN (1926), SOH dan LAM dalan LAM (1974) dan WOODLAND dalam HUTOMO (1978).

Benih ikan beronang di Teluk Banten sering tertangkap bersama-sana dengan benih ikan lainnya seperti kerapu, Lutjanus, Labridae dan belanak. Hal ini sesuai dengan yang dikemukakan oleh HASSE et al.,(1977).

Tabel 1/. Hasil tangkapan rata-rata benih ikan beronang di beberapa lokasi penangkapan di Teluk Banten. (Nurhakin, 1984a).

Spesies	Teluk Grenyang		Pantai Barat P. Panjang		Pantai Barat P. Kambing	
	Ind.	%	Ind.	%	Ind.	%
S. canaliculatus	107,5	87,5	19,8	80,8	14,4	86,9
S. guttatus	1,9	1,6	0,1	0,3	0,3	1,9
S. virgatus	0	0	4,5	18,1	0,6	3,5
S. javus	12,7	10,4	0	0	0,8	5,0
S. chrysospilos	0	0	0,2	0,8	0,4	2,7
S. vermiculatus	0,8	0,7	0	0	0	0

Tabel 2. Pertumbuhan relatip harian dan dugaan pertumbuhan relatip bulanan ikan beronang pada tiga lokasi di Teluk Banten. (Nurhakim, 1984b).

Lokasi	Spesies	Pertumbuhan relatip harian (mm/hari)	Dugaan Pertumbuhan relatip bulanan (mm/bulan)
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

Tabel 3. Volume rata-rata tanaman air yang terdapat di-alam satu meter persegi luas dasar perairan di tiga lokasi (NURHAKIM, 1984a).

Jenis tanaman	Teluk Grenyang (cm3)	Pantai Barat P. Panjang (cm3)	Pantai Barat P. Kambing (cm3)
Enhalus	2.629,51	150,00	727,50
Syringodium	66,92	707,00	180,00
Thalasia	0	0	319,00
Cymodocea	107,53	28,33	14,00
Halodule	0	0	17,00
Halophila	0	5,00	0,20
Sargasum	0	143,33	0
Amphiphora	0	0	0,50
Halimeda	90,77	1,67	437,50
Padina	0	6,67	0
Cladophoropsis	8,46	0	0
Sponge	11,54	0	0

Tabel 4 . Hubungan panjang-berat beberapa spesies ikan beronang Siganus spp.

S p e s i e s	Negara/ Lokasi	$W=aL^b$	S u m b e r
S. canaliculatus	T. Banten	$W=0,00002L^{2,9641}$	MERTA, 1980
	GUAM	$W=0,01630L^{2,9600}$	TSUDA et al., 1974
(betina)	PALAU	$W=0,11000L^{2,4600}$	HASSE et al., 1977
(jantan)		$W=0,03630L^{2,8600}$	
S. guttatus	T. Banten	$W=0,00002L^{2,9333}$	MERTA, 1980
	K. Seribu	$W=0,00930L^{3,1585}$	DJAMALI, 1978
(S. concatenata)	Jerman (dr Filipina)	$W=0,00850L^{3,3897}$	VonWESTERNHAGEN and ROSENTHAL, 1975
S. javus	T. Banten	$W=0,00003L^{2,9650}$	MERTA, 1980
S. virgatus	T. Banten	$W=0,00002L^{3,0661}$	MERTA, 1980
	K. Seribu	$W=0,00025L^{2,6173}$	DJAMALI, 1978
S. chrysospilos	T. Banten	$W=0,00001L^{3,1001}$	MERTA, 1980
	K. Seribu	$W=0,00005L^{2,9669}$	DJAMALI, 1978
S. corallinus	K. Seribu	$W=0,00002L^{3,5858}$	DJAMALI, 1978
S. vermiculatus	T. Banten	$W=0,00001L^{3,0875}$	MERTA, 1980
	K. Seribu	$W=0,01900L^{3,1000}$	GUNDERMANN et al., 1983.

DAFTAR PUSTAKA

Ben TUVIA and G.W. KISSIL, 1973. Experiments in rearing rabbitfish (Siganus rivulatus) in sea water. Aquaculture, 1.359-364.

BURHANUDDIN, S. MARTOSEWOJO, M. HUTOMO and A. DJAMALI, 1975. The genus of Siganus in the collection of the National Institute of Oceanology (Siganidae). Mar. Res. Indonesia, 15,21-36.

DJAMALI, A., 1978. Beberapa aspek biologi berbagai jenis ikan beronang (Siganidae) di perairan sekitar P. Kongsi Wilayah Pulau-pulau Seribu, Teluk Jakarta. Oseanologi di Indonesia, 9,43-49.

GEARGE, C.J., 1972. Notes on breeding and movements of the rabbitfishes, Siganus rivulatus (Forskal) and S. luridus (Ruppel) in the coastal waters on the Lebanon. Ann. Mus. Sta. Nat. Genova, 79,32-44.

GUNDERMANN, M., D.M. POPPER and L. LICHATOWICH, 1983. Biology and life cycle of Siganus vermiculatus (Siganidae, Pisces). Pacific Sci., 32(2),165-180.

HASSE, J.J., B.B. MADRAISAU and J.P. McVEY, 1977. Some aspect of the life history of Siganus canaliculatus (Park)(Pisces:Siganidae) in Palau. Micronesia, 13(2), 297-312.

HERRE, A.W. and H.R. MONTALBAN, 1928. The Philippines Siganids. Philippine J. Sci., 35(2),151-185.

HORSTAMN, U., 1975. Some aspects of the mariculture of different Siganid species in the Philippines. Philippines J. Sci. 2,5-20.

LAM, T.J., 1974. Siganids: Their biology and mariculture potential. Aquaculture, 3,325-354.

LAM, T.J. and C.L. SOH, 1975. Effect of photoperiod on gonadal maturation in the rabbitfish, Siganus canaliculatus Park 1797. Aquaculture, 5,407-410.

LAVINA, E.M. and A.C. ALCALA, 1974. Ecological studies on Philippines Siganid fishes in Southern Negras. Philippines. Siliman J., 2(2),191-210.

MANACOP, P.R., 1937. The artificial fertilization of dangit Amphanthus oramin (Bloch and Schneider). Philippines J. Sci. 62,229-237.

MAY, R.C., D.M. POPPER and J.P. McVEY, 1974. Rearing and larval development of Siganus canaliculatus (Park) (Pisces: Siganidae). Micronesia. 258-298.

NURHAKIM, S., 1984a. Komposisi spesies benih ikan beronang (Siganus spp) berdasarkan lingkungan hidupnya di perairan Teluk Banten. Lap.Penel.Perikanan Laut, 30, 1-16.

NURHAKIM, S., 1984b. Pertumbuhan benih ikan beronang (Siganus spp) di Teluk Banten. Lap.Penel.Perikanan Laut, 30,43-54.

POPPER, D., R. PITT and Y. ZOHAR, 1979. Experiments on the propagation of Red Sea siganids and some notes on their reproduction in nature. Aquaculture, 16,177-181.

TSUDA, R.T., P.G. BRYAN, W.J. FITZGERALD and W.J. TOBIAS, 1974. Juvenile-adult rearing of Siganus (Pisces:Siganidae) in Guam. SPC 7th Tech.Meet.Fish Nuku Alofa, Tonga, July 15-19, 1974. 4 p (unpublished).

Von WESTERNHAGEN, H.V., 1973. A preliminary study on the food preferences of Siganus concatenata (Cuvier and Valenciennes). Philippines Scient, 10,61-73.

Von WESTERNHAGEN, H. and H. ROSENTHAL, 1975. Rearing and spawning of siganids (Pisces: Teleostei) in a closed sea water system. Helgolander wiss. Meeresunters, 27, 1-18.

Von WESTERNHAGEN, H. and H. ROSENTHAL, 1976. Induced multiple spawning of reared Siganus oramin (Schneider) (=S. canaliculatus Park). Aquaculture, 7,193-196.

WASPADA, 1984. Pemijahan dan pemeliharaan larva ikan kea kea (Siganus virgatus). Lap.Penel.Perikanan Laut. 30, 35-42.

WILSON, P.T., 1974. MMDC Progress. Micronesia Maricult. Demonstr.Cent. Newsletter. 4-6.

WOODLAND, D.J. and G.R. ALLEN, 1977. Siganus trispilos, a new species of Siganidae for the Eastern Indian Ocean. Copeia. 4,617-620.

Jurnal Pen. Perikanan Laut No. 33 Th. 1985 : Hal 77 – 82

LARVAL REARING OF KURUMA PRAWN (*Penaeus japonicus* Bate) FED WITH YEAST, DIATOM AND ROTIFERS

Edward Danakusumah*, Achmad Basyarie* and Muchari Maan*

ABSTRACT : Study on the use of different natural food organisms such as baker's yeast, marine yeast, marine diatom *(Chaetoceros* spp) and frozen rotifer *(Brachionus plicatilis)* for larval rearing of *Penaeus japonicus* Bate had been conducted under laboratory condition.

The results showed that the average survival rate was best in the prawn larvae fed with marine diatom (77%), followed with that of frozen rotifer (69%). Marine yeast and baker's yeast showed lower average survival rate til 24% and 0%, respectively. The ranges of pH and water temperature were 8.14 – 8.32 and 23.9 – 27.5°C, respectively.

ABSTRAK : Budidaya larva udang kuruma *(Penaeus japonicus* Bate) menggunakan pakan ragi, diatom dan rotifera. Oleh : Edward Danakusumah, Achmad Basyarie dan Muchari Maan.

Studi tentang pengaruh pemberian jasad pakan alami yaitu ragi roti, ragi–laut, diatom *(Chaetoceros* spp) dan rotifera (Brachionus plicatilis) beku terhadap survival rate larva udang kuruma *(Penaeus japonicus* Bate) telah dilakukan dalam botol-botol (kapasitas 1800–ml).

Hasil penelitian menunjukkan rata-rata survival rate tertinggi dicapai oleh larva udang yang diberi pakan diatom (77%) diikuti oleh larva yang diberi pakan rotifera beku (69%). Ragi–laut dan ragi-roti menunjukkan angka rata-rata survival rate masing-masing sebesar 24 dan 0%.

INTRODUCTION

In prawn hatcheries, the mass culture of phytoplankton, especially marine diatom such as *Chaetoceros* are often fail because of bad weather, heavy contamination and other reasons. On the contrary the success of larval prawn culture is depend on the availability of marine diatoms. Some researchers had investigated alternative feeds for culture of zoea larvae; Soycake particles (HIRATA *et al.*, 1975) and microencapsulated diet (JONES *et al.*, 1979; KANAZAWA *et al.*, 1982; VILLEGAS and KANAZAWA, 1980) had been demonstrated as effective feeds for the zoeal larvae. Baker's yeast and marine yeast (HIRATA 1979, 1980) were proved as suitable feeds for rotifers when the *Chlorella* spp. are not available. These yeasts are probably can be used as feed for the larvae.

The present experiment of feeding trial on the survival rates of prawn *(Penaeus japonicus* Bate) larvae had been conducted in the Laboratory of Aquaculture Physiology, Faculty of Fisheries, University of Kagoshima, Japan. This study was aimed to investigate the effect of different feeds (baker's yeast, marine yeast, marine diatom and frozen rotifer in combination with the marine diatom) on the survival rate of kuruma prawn larvae.

The aimed of study is to examine the effectiveness of each food organisme on the survival rate of the larvae.

* Research Station for Coastal Aquaculture (Sub Balai Penelitian Budidaya Laut) Bojonegara, Jalan Pelabuhan Perikanan, Karangantu, Serang, Indonesia.

MATERIAL AND METHOD

Test animal (zoea–1) was coming from single gravid female which caught from the sea. Gravid female was released to spawn in an outdoors concrete tank (1–ton capacity). The zoea–1 was then transferred to the indoors laboratory and used as test animals.

The experimental cultural apparatus used was previously described by DANAKUSUMAH (1984). Hundred and fifty zoea–1 were released to each culture bottle (initial density was 100 zoea l^{-1}). The zoea was fed with 4 different feeds : baker's yeast, marine yeast, marine diatom *(Chaetoceros* spp) and frozen rotifer *(Brachionus plicatilis)* in combination with the marine diatom. Baker's yeast (treatment–1) and marine yeast (treatment–2) were fed to the larvae at a rate of 1 mg/larvae^{-1}/day^{-1}. Marine diatom (treatment–3) was maintained at a density of 50 – 70 x 10^3 cell/ml^{-1} through the whole period. In treatment–4, the zoea–1 was fed with marine diatom at a density of 50 – 70 x 10^3 cell/ml^{-1} and from the zoea–2 they were fed with frozen rotifers at a rate of 500 rotifers larvae^{-1}/day^{-1}. In order to maintain good water quality, 20% water volume was changed daily (YAMASAKI *et al.*, 1981). The media were strongly aerated.

The daily survival rates were observed using a water sample as described by DANAKUSUMAH (1984). At the end of the experiment, the total number of larvae were counted. Water temperature and pH were observed daily using a handy pH–meter (YEW model–51)

Experimental design used in this experiment was Completely Randomized Design (SOKAL and ROHLF, 1976). Each treatment was maintained at three replications. Average survival rates in every treatment were compared using Duncan's Multiple Range Test (GOMEZ and GOMEZ, 1976).

RESULT AND DISCUSSION

Daily average survival rate, pH and water temperature are shown graphically in Figurae 1. The highest average survival rate 77% was reached by the larvae fed with marine diatom *(Chaetoceros* spp). Those fed with frozen rotifer *(Brachionus plicatilis)* in combination with the marine diatom showed an average survival rate of 69%. The average survival rates of those fed with marine yeast and baker's yeast were 24% and 0%, respectively. Average survival rates and larval compositions are listed in Table 1. Statistical analysis showed highly significant difference ($P < 0.01$) among treatments (refers to Table 2). The results of Duncan's Multiple Range Test may rank as follow : treatment–3 (fed on marine diatom), treatment–4 (fed on frozen rotifer in combination with the marine diatom), treatment–2 (fed with marine yeast) and treatment–1 (fed with baker's yeast).

Many authors had reported that the use of marine diatoms such as *Chaetoceros* spp, *Nitzhia closterium, Skeletonema* spp *Melossira* spp and *Thalassiosira* spp for culture of prawn larvae were met great success (HIRATA, 1975; HUDINAGA, 1942; HUDINAGA and KITTAKA, 1966; KAFUKU and IKENOUE, 1983; KITTAKA, 1981; SHIGUENO, 1975; SIMON, 1978). In the present study, larvae fed with marine diatom showed a higher average survival rate compared with those fed with frozen rotifer in combination with marine diatom. However, larval compositions of those fed with the frozen rotifer in combinations with marine diatom showed 100% of postlarvae–1 or 103 individual compared with 80% of postlarvae–1 or 92 individual in the larvae fed with marine diatom only. The average survival rate of those fed with marine yeast was in the third rank. However, on the fifth day of culture, the larvae fed with the marine yeast showed an average survival rate of 91%. It was higher than those fed with the frozen rotifer (refers to Table 1). In small scale experiments, average survival rate of prawn larvae cultured with *Chaetoceros* spp ranged between 53.8 and 60.0% (JONES *et al.*, 1979). HUDINAGA and KITTAKA (1966) demonstrated that mixed planktonic diatoms, benthic diatoms, oyster larvae, oyster eggs, frozen oyster eggs and rotifers were suitable as feed for culture of kuruma prawn larvae.

The average water temperature was 25.7°C with a minimum of 23.9°C and a maximum of 27.5°C. HUDINAGA (1942) found that tolerable water temperature for culture of zoea and mysis ranged between 15–33°C and 13–34°C, respectively. While the ideal water temperature ranged between 20 – 25°C (HIRATA, 1975).

In prawn hatcheries when the culture of marine diatom was not enough, frozen rotifer as well as live rotifer can be used as larval feed from the second zoea (DANAKUSUMAH, 1984). From the result of the present experiment we would like to suggest that when the culture of marine diatom failed, marine yeast can be used as larval feed instead of the marine diatom until substage of mysis–1. After that, the larvae should be fed with other feed such as rotifers.

ACKNOWLEDGEMENT

This study was supported by Japan International Coorperation Agency. The authors would like to express their thanks and gratitude to Dr. H. Hirata and his research assistance Mr. S. Yamasaki (Laboratory of Aquaculture Physiology, Faculty of Fisheries, University of Kagoshima) for their valuable critics and comments.

LITERATURE CITED

DANAKUSUMAH, E., 1984. Culture of Kuruma-prawn *(Penaeus japonicus* Bate) Larvae Fed with Frozen and Living Rotifer. Laporan Penelitian Balai Penelitian Perikanan Laut (in press).

GOMEZ, K.A. and A.A. GOMEZ, 1976. Statistical precedures for agricultural research with emphasized on rice. IRRI, Manila, Philippines, 294 pp.

HIRATA, H., 1975. An introduction to the rearing method of prawn *Penaeus japonicus* Bate in Japan. Mem. Fac. Fish., Kagoshima Univ., 24, 7–12.

HIRATA, H., 1979. Rotifers culture in Japan. European Mariculture Society (Special Publ.), 4,361–375.

HIRATA, H., 1980. Culture methods of the marine rotifer, *Brachionus plicatilis.* Mini. Rev. Data File Fish. Res Fac. Fish., Kagoshima Univ., 1, 27–46.

HIRATA, H., Y. MORI and M. WATANABE, 1975. Rearing of prawn larvae, *Penaeus japonicus,* fed on soycake particles and diatoms. Mar. Biol. 29, 9–13.

HUDINAGA, M., 1942. Reproduction, development and rearing of *Penaeus japonicus* Bate. Japan. J. Zool., 10, 305 – 393.

HUDINAGA, M. and J. KITTAKA, 1966. Studies on food and growth of the larval stages of prawn *Penaeus japonicus* with reference to the application to practical mass culture. Inf. Bull. Plankton. Japan., 13, 84 – 94.

JONES, D.A., A. KANAZAWA and S. ABDELRAHMAN, 1979. Studies on the preservation of artifical diets for rearing of the larvae of *Penaeus japonicus* Bate. Aquaculture, 17, 33 – 43.

KANAZAWA, A., S. TESHIMA and H. SASADA, 1982. Culture of prawn larvae with micro–particulate diets. Bull. Japan. Soc. Sci. Fish., 48 (2), 195–199.

KAFUKU, T. and H. IKENOUE, 1983. Modern Methods of Aquaculture in Japan. Kodansha Ltd. Tokyo, Japan.

KITTAKA, J., 1981. Large scale production of shrimp for releasing in Japan and the United States and the results of the releasing programme at Panama City, Florida. Kuwait Bull. Mar. Sci., 2, 149 – 176.

SHIGUENO, K., 1975. Shrimp culture in Japan. Associateion for International Technical Promotion, Tokyo, Japan. 153 pp.

SIMON, C.M., 1978. The culture of diatom *Chaetoceros gracilis* and its used as food for penaeid protozoeal larvae. Aquaculture, 14, 105–133.

SOKAL, R.R. and F.J. ROHLF, 1973. Introduction to biostatistics. Toppan Co. Ltd., Tokyo, Japan. 368 pp.

VILLEGAS, C. and A. KANAZAWA, 1980 Rearing of the larval stages of prawn, *Penaeus japonicus* Bate using artificial diet. Mem. Kagoshima Univ. Res. Centre S. Pac., 1 (1), 43 – 49.

YAMASAKI, S., M USUGI and H. HIRATA, 1981. Rearing of prawn, *Penaeus japonicus* fed on rotifer, Brachionus plicatilis. Mem. Fac. Fish., Kagoshima Univ., 30, 289 – 294.

Table 1. Average survival rates and composition of kuruma prawn *(Penaeus japonicus* Bate) larvae cultured under different feeds.

Tabel 1. Rata-rata survival rates dan komposisi larva udang kuruma (Penaeus japonicus Bate) yang dipelihara dengan pakan berbeda.

Treatment	Fifth day										Eighth day							
	Average Survival		Composition								Average Survival		Composition					
	Rate (%)	Number (ind)	Z–2 (%)	Z–2 (ind)	Z–3 (%)	Z–3 (ind)	M–1 (%)	M–1 (ind)	M–2 (%)	M–2 (ind)	Rate (%)	Number (ind)	M–2 (%)	M–2 (ind)	M–3 (%)	M–3 (ind)	P–1 (%)	P–1 (ind)
Baker's yeast	40	60	20	12	80	48	–	–	–	–	0	0	–	–	–	–	–	–
Marine yeast	91	136	–	–	37	50	53	72	10	14	24	36	63	23	37	13	–	–
Marine diatom *(Chaetoceros* sp)	93	139	–	–	3	5	40	56	57	79	77	115	3	3	17	20	80	92
Frozen rotifer * *Brachionus plicatilis)*	79	118	–	–	–	–	27	32	73	68	69	103	–	–	–	–	100	103

* in combination with the marine diatom.

Table 2. Analysis of variance of the survival rates of kuruma prawn *(Penaeus japonicus* Bate) larvae cultured under different feeds.

Tabel 2. Analisis sidik ragam untuk nilai survival rate larva udang kuruma (Penaeus japonicus Bate) yang dipelihara dengan pakan berbeda.

Source of Variations	df	Sum of Squares	Mean Square	$F_{comp.}$	F_{table}
Among treatments	3	12107	4007.5	53.77**	10.60 P(0.01)
Error	8	596	74.5		5.12 P(0.05)
Total	11	12703			

** highly significant difference.

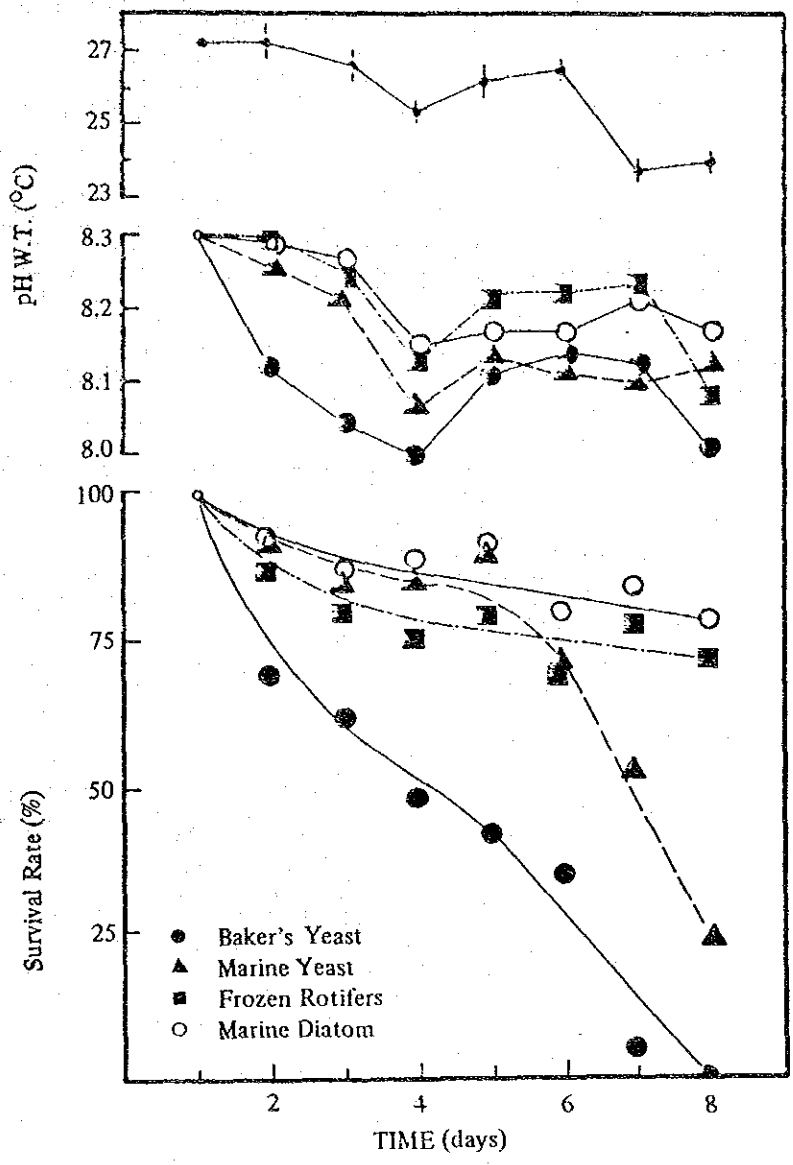

Figure 1. Average survival rates of prawn *(Penaeus japonicus* Bate) larva cultured with different feeds. PH and water temperature of the media are also presented.

Gambar 1. Rata-rata survival rate larte larva udang (Penaeus japonicus Bate) yang dipelihara dengan pakan berbeda. pH dan suhu air juga disajikan.