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Survival rate of *Penaeus monodon* Fabricius larvae fed *Chaetoceros* sp. and bread yeast

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Rearing of penaeid prawn larvae using cultures of diatoms and other planktonic organisms has been achieved with varying degrees of success. In 1962, Hudinaga and Miyamura concluded that a feeding density of 5-10 x 10^4 cells/mL of the diatom *Skeletonema costatum* is best for protozoeal stages of *Penaeus japonicus* larvae. On the other hand, Liao and Huang (1972) arrived at an optimal density of 5 x 10^4 cells/mL for the zoeal stages of *P. monodon* and *P. japonicus* using mixed diatoms, predominantly *S. costatum* and *Nitzschia costatum*. Hirata (1975) and Hirata et al (1975) compared the growth and survival rate of *P. japonicus* using different levels of soybean cake particles, *Chaetoceros rigidus* and their combinations. Soycake particles fed at a rate of 0.16 mg per zoea per day gave a survival rate of 85.9% in a zoeal period of 6 days. However, growth was smallest in this group. Diatom feeding at a rate of 50-100 x 10^4 cells/mL gave the best growth and the lowest survival. A combination of the two produced the best result.

Differences in conclusion may be due to differences in species, culture conditions, degree of management and types of feed used. The mass seed production of *P. monodon* is still new in the Philippines. Therefore, investigations into the use of different feeds, feeding rates and combinations of such feed are both urgent and imperative. This study was conducted to evaluate the effects of the diatom *Chaetoceros* sp., breadyeast and their combination on the survival of *P. mondon* larvae.

Feeding experiments were conducted using sixteen 0.5-ton cyclindrical fiberglass tanks. In each trial, the larvae came from a single spawner. At the end of the nauplius stage (N_6), the larval population was divided among the sixteen tanks, each filled with 300 L filtered seawater and provided with aeration. A stocking density of 10 larvae/L of seawater was used. Two replicates were used in a randomized complete stock design.

Chaetoceros sp., bread yeast and their combination were used as food from Z_1 to M_2 stage. Feeds and feeding levels are shown in Table 1. A total of five trials were conducted. However, data of the three successful trials will be reported as the larvae in the two trials were infected with *Lagenidium* and *Gregarina* during the zoeal stage causing total mortality. Diatom density was monitored daily using a thoma hermacytometer. Density was maintained at the desired level either by draining or adding fresh seawater or cultured diatom. Number of larvae in each tank was recorded daily by taking four random samples of water from the tank with a 1-L beaker. A count was made of all larvae in the four samples and the average number per liter was used in estimating the total population. Seawater salinity ranged from 27-30 ppt and temperature ranged from 25-32°C during the rearing period.

Mean survival rates of *P. mondon* larvae from Z_1 to M_2 stage for the three trials are shown in Table 2. Individual trial analyses showed no significant difference treatments except in Trial III in which treatments are significantly different at 5% level. Combination of *Chaetoceros* sp. at the rate of 10-50 x 10^3cells/mL and 1 gm/ton/day of breadyeast gave the highest survival rate of 74.92% followed by 1 and 3 gm/ton/day with 64.43 and 58.34% survival rates, respectively. Comparison of treatment means using Duncan's Multiple Range Test (Steel and Torrie, 1960) however showed no significant differences at 5% level between treatments at varying levels of the

same field. When the results of the three trials were pooled, statistical analysis (Table 3) showed no significant differences among treatments. Highest survival rate of 76.79% was obtained when the larvae was fed with a combination of *Chaetoceros* sp. and breadyeast at the rate of 10-50 x 10^3 cells/mL and 1 gm/ton/day, respectively. This treatment combination consistently produced high survival rates in all trials.

Feeding the larvae with *Chaetoceros* or breadyeast alone resulted in lower survival rates than their combinations. For *Chaetoceros* feeding, a maximum survival rate of 53.36% was obtained at a feeding level of 10-50 x 10^3 cells/mL.This might be due to the rise in pH as *Chaetoceros* sp. feeding density increases. The pH in tanks with high feeding density rose up to 9.0 compared to pH 8.5 for the lowest feeding density. Furukawa (1973) observed that a great increase in phytoplankton is usually accomapnied by a rise in pH. When pH rises above 8.5 as a result of phytoplankton bloom, he observed that a large number of *P. japonicus* larvae were deformed and resulted in high mortality.

Survival rate of the larvae was also greatly influenced by the amount of breadyeast feeding, becoming higher with increasing amounts of breadyeast. Growth, however, was slowest in this group with a delay of one day to metamorphose from Z_1 to M_2 stage as compared to the larvae

Table 1. Feeds and feeding rates used for Penaeus monodon larvae from Z_1 to M_2

Treatments	Feeds	Feeding Rate (cells per ml)
A	*Chaetoceros* sp.	10-50 x 10^3
B	*Chaetoceros* sp.	50-10 x 10^3
C	*Chaetoceros* sp.	100-150 x 10^3
D	Breadyeast	1 g per ton per day
E	Breadyeast	2 g per ton per day
F	Breadyeast	3 g per ton per day
G	*Chaetoceros sp.* plus Breadyeast	10-50 x 10^3 plus 1 g per ton per day
H	*Chaetoceros* sp. plus Breadyeast	10-50 x 10^3 plus 2 g per ton per day

Table 2. **Mean survival rates of *Penaeus monodon* larvae from Z_1 to M_2 at varying levels of *Chaetoceros* sp. and breadyeast.**

Treatments	Survival Rate (%)			
	Trial I	Trial II	Trial III	Mean
A	75.56	79.89	74.92 a	76.79
B	75.33	68.40	28.38 abcd	57.37
C	80.40	37.99	46.67 abcd	53.36
D	43.72	56.25	25.32 bcd	41.76
E	48.68	18.07	58.34 abc	41.69
F	73.40	22.24	7.22 d	34.29
G	15.85	0.00	69.43 ab	28.43
H	27.44	10.00	12.98 cd	16.81

Table 3. **Analysis of variance of combined data from three trials.**

Sources of Variation	df	Mean Square	F Value	
			Computed	Tabulated (0.05)
Trial	2	777.62	1.46 n.s.	3.74
Treatment	7	1,040.47	1.95 n.s.	2.76
Eror	14	499.46		

n.s. — not significant

fed with either *Chaetoceros* alone or a combination of the diatom and breadyeast.

In general, *P. monodon* larvae fed with the combination of *Chaetoceros* sp. resulted in higher survival rates than those fed with either *Chaetoceros* sp. or breadyeast alone. This might be attributed to the complementary nutrient value of diatom and breadyeast. Results obtained in this study agree well with the findings of Hirata et al (1975). They obtained best growth and higher survival rates when the larvae were fed with a mixture of soycake particles and diatoms than those fed with either soycake particles or diatom alone.

Using *Chaetoceros* alone, a feeding level of 10-50 x 10^3 cells/ml apparently seemed to be optimal. Feeding in excess of the optimal level prompted high mortality. This study also demonstrates that breadyeast could be supplied usefully in combination with *Chaetoceros* sp. or other diatoms in the mass culture of *P. monodon* larvae.

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