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EFFECT OF LOW SALINITIES ON THE SURVIVAL AND GROWTH OF *PENAEUS MONODON* (FABRICIUS)

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ABSTRACT

Effect of low salinity on the growth and survival of *P. Monodon* was studied under controlled conditions. Results indicated that even though low salinities had a highly significant influence on the growth rate of juveniles (P< 0.001), salinities ranging from 9 to 20 ppt did not influence growth rate. Large fluctuations in salinities ranging from 4 to 20 ppt were not a major factor influencing the survival (P>0.05). The probit regression line for the relation between the logarithmic salinity level (x) and mortality (y) was found to be y = 5.9820 + 13322x.

INTRODUCTION

Growth and survival of *Penaeus monodon* (Fabricius) are influenced by a number of ecological factors, salinity being one of the most important of them. (Chakraborti *et al.*, 1986). There are few reports on the growth of adult *P. monodon* in ponds of fluctuating physico-chemical conditions (Verghese *el al.*, 1975; Hideo, 1979; Manik *el al.*, 1979; Sebastian *et al*, 1980 and Chakraborti *et al*, 1985 and 1986). However, studies on the growth and survival of early stages of this species under low saline conditions are lacking. Lack of prior knowledge on the levels and rates at which this species can adapt to lower salinities has led in the past to unrealistic conclusions. Knowledge on these aspects has great implications in extending the culture of *P.monodon* to the low saline areas. Besides, information on tolerance of early stages of this species to wide fluctuations in low salinities and lowest lethal salinity has great significance for the proper maintenance of the post larvae in the nurseries.

MATERIALS AND METHODS

Juveniles of *P. monodon* raised in the Regional Shrimp Hatchery of Department of Fisheries of Kerala at Azhicode were used as experimental materials. The Juveniles (25-35mm/180-260 mg) wer* brought to the laboratory in oxygen - packed polythene seed transport bags.

Growth studies were conducted in circular - cement cisterns (lm dia. x 1 m depth) of holding capacity 750 litres. The tanks were aerated intermittently and provided with removable hideout. Water in the tanks was changed partially every fortnight. Twenty numbers of animals were slowly acclimated and released to different test salinities (1.5 + 0.5; 4.5 ± 0.5 ; 9.5 ± 0.5 ;14.5 ± 0.5 and 19.5 ± 0.5 as the control). Feeding was done with Tata's pelleted commercial prawn feed of 3 mm diameter *aMbitum* (carbohydrate 47% : protein 30% : fat 7% : crude-fibre 4-5% : moisture 10-12%: sand/silica 2-3%: vitamin/ minerals trace).

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Salinity tolerance studies were carried out in cylindrical glass troughs of 10 litre capacities. Three batches of ten animals each were subjected to gradually decreasing salinities from 20 ppt down to 2 ppt at 2 ppt intervals and from 2 ppt downward at still shorter intervals. The animals were maintained at each salinity for a period of 24 hours before the salinity was changed. Cumulative mortality at each salinity in which at least fifty per cent of the animals survived at the end of 24 hours was considered within the tolerable range and rest as lethal. The effect of sudden fluctuations in salinities was also studied. The animals were slowly acclimated to five different concentrations of acclimation salinity (5, 10, 15, 20 and 25 ppt) and maintained for five days PH 7.40 ± 0.36 and temperature of water 28° C ± 0.5). From each acclimation salinity, fifteen numbers of juveniles were transferred to the test salinities (1.5 ± 0.5 ppt; 4.5 ± 0.5; 9.5 ± 0.5; 14.5 ± 0.5 and 19.5 ± 0.5). Feed was given in small quantities for maintenance and the animals were reared for 120 hr and frequent observations were made to record survival percentage.

RESULTS

Growth rate variations in salinities between 1 and 2 ppt (Table 1) revealed that from an initial increase of 4.43 to 8.95 mg/day, it dropped to 6.44 and remained steady recording 6.63 mg/day till the end of the experiment, while in test salinities between 4 and 15 ppt, growth rate variations generally followed an increasing trend throughout the experiment. In 4.5 ± 0.5 ppt the increasing growth rate values recorded were 10.48, 14.86,14.58 and 16.11 mg/day while in 9.5 ±

TABLE 1. ***Experimental values (X + S. D)for growth, survial and physical-chemical conditions in the growth experement of P. mondon***

Factor*	Test salinity levels (ppt)				
	1.5±0.5	4.5±0.5	9.5±0.5	14.510.5	19.510.5
Av. initial wt. (g)	0.248	0.191	0.241	0.197	0.214
Av. final wt. (g)	0.619	1.094	0.986	0.949	0.928
Stocking density (nos/m^2)	25	25	25	25	25
Survival percentage	50	715	90	100	87.5
Growth rate (mg/day)					
14 days	4.43	10.48	7.53	7.00	10.29
28 days	8.95	14.86	10.59	9.44	13.22
42 days	6.44	14.58	11.44	13.05	13.94
56 days	6.63	16.11	13.30	13.41	12.74
Av. daily gain (mg/day)	6.63	16.11	13.29	13.41	12.74
Air temperature (°C)	3O±0.63	3O±0.63	30±0.63	3010.63	3010.63
Water temperature^C)	27.4±0.49	27.6±0.58	27.7±0.75	27.610.45	28.7511.4 pH
pH	• 7.4410.32	7.5410.31	7.57±0.32	7.4010.33	7.2610.24
Dissolved oxygen(ppm)	5.46±0.70	4.64±2.37	5.54±0.79	4.9410.68	6.4811.4
Alkalinity (ppm)	34.7512.86,	67.8±17.79	65112.54	67.6115.12	65.2114.%

TABLE 2. *Survival percentage of posllarvae in different test salinities over120 hr exposure period after acclimation at indicated salinities*

Acclimation salinity (PPT)	Test salinity levels (ppt) <1	4.5 ±0.5	9.5±0.5	14.5±0.5	19.5±0.5
5	Nil	89.95	96.65	89.%	93.30
10	Nil	93.30	93.30	93.30	93.30
15	Nil	93.30	89.95	79.95	93.30
20	Nil	50.00	80.00	83.30	86.65
25	Nil	56.60	69.95	86.60	83.30

TABLE 3 . *Cumulative mortality ofpostlarvae exposed to salinity gradually decreasing from 20 to 0.2 ppt. (10 numbers per replicate)*

Experimental period (days)	Salinity (ppt)	Replicates 1	2		Total number of animals present	Cumulative survival (%)	Cumulative mortality (%)
1	20.00	10	10	10	30	100.00	0.00
2	18.00	10	10	10	30	100.00	0.00
3	16.00	10	10	10	30	100.00	0.00
4	14.00	10	10	9	29	96.70	3.33
5	12.00	10	10	9	29	96.70	333
6	10.00	10	10	9	29	96.70	333
7	8.00	10	9	8	27	90.00	10.00
8	6.00	9	9	8	26	86.70	13.33
9	4.00	8	8	8	24	80.00	20.00
10	2.00	7	8	8	23	76.70	23.30
11	1.00	6	7	7	20	66.70	33.30
12	0.75	5	7	7	19	63.34	36.66
13	0.50	4	5	7	16	53.34	46.66
14	0.20	3	3	1	7	23.24	76.66

0.5 ppt they were 7.53,10.59,11.44 and 13.30 mg/day. In 14.5 ± 0.5 ppt the corresponding growth rate values were 7.0, 9.44, 13.05 and 13.41 mg/day. However, in 19.5 ± 0.5 ppt, an initial increase in growth rate from 10.29 to 13.22 and 13.94 declined to 12.74 mg/day towards the end of the experiment. Summing up the whole results, overall growth rate was highest in 4.5 ± 0.5 ppt (16.11 mg/day: 72.5% survival) followed by 14.5 ± 0.5 ppt (13.41 : 100%) 9.5 ± 0.5 ppt (13.29:90%) and 19.5 ± 0.5 ppt (12.74 : 87.5%). Least growth rate and survival was observed in less than 1 ppt (6.63: 50%).

Analysis of variance showed that variations in the growth rate of juveniles in the different test salinities were highly significant (P< 0.001). However, mean values of growth rates between 9 and 20 ppt did not differ significantly.

Salinity tolerance studies revealed a complete mortality of the juveniles in less than 1 ppt, within 2 hr of their transfer regardless of pre-acclimation (Table 2). However, in test salinities between 4 and 20 ppt, survival ranged from 50 to 96.65%. An uniform survival of 93. 3% was observed in test salinities between 4 and 20 ppt when the juveniles were pre-acclimated at 10 ppt. However, analysis of variance showed that fluctuations in salinities between 4 and 20 ppt, did not influence the survival of juveniles significantly (P>0.05).

When salinity was gradually decreased, survival percentage of juveniles decreased recording 90, 86.7,76.7,66.7, and 53.34% at 8,6,2,1 and 0.75 ppt respectively (Table 3). At 0.5 ppt the survival rate was 53.34% while salinity less than 0.5ppt proved to be lethal for the juveniles. The probit regression line for the relation between logarithmic salinity (X) and morality (Y) was determined to be Y = 5.9820+ 1.3322^3X.

DISCUSSION

In the brackish water ponds in the Philippines, Hideo (1979) reported that *P. tnonodon* juveniles grew to 50-100 g under 10 to 20 ppt while in West Bengal, Verghese *et al.* (1975) observed a growth rate of 4.36 g/month for this species when salinity of the pond water varied from 5.44 to 36.5 ppt. In the present study, it was observed that even though low salinities influenced the growth of juveniles (P<0.001), salinity ranging from 9 to 29 ppt had no significant effect on the growth rate of juveniles. Reports on the optimum growth of this species (0.36g/day) in grow-out ponds when exposed to salinities between 10.9 and 22.42 ppt as reported by Sundararajan *et al.* (1976) correlate well with the result of this study and confirm that optimum growth could be maintained over a range of low salinities. The superior growth rate in salinities between 4 and 20 ppt can be attributed to the better efficiency of consumption and utilization of food. But according to Paloheimo and Dickie (1966) both consumption and utilization of food for growth depend to a lesser extent on salinity concentrations. Better growth of juveniles may also be due to the consistent growth rate associated with higher moulting frequency (Mintardjo *et al,* 1979 as given in Manik *et al,* 1979). However, the poor growth observed in less than 1 ppt can be attributed to the stress undergone by the juveniles and the increase in energy lost due to osmoregulation. Besides, very low salinity levels may, affect the physiological process of the prawn, thus interfering with the nutritional pathway and chitin synthesis.

The present study indicated that fluctuation in salinities between 4 and 20 ppt is not a major factor affecting the survival of juveniles. However, a general reduction in survival in less than 1 ppt within 2 hrs of their transfer regardless of acclimation was presumably the result of the immediate stress. At low salinity levels, the prawns maintain their osmotic and ionic balance by decreasing the rate of water transport across the gut, as well as the rate of sodium and chloride extrusion through the gills (Manik *et al.,* 1979). The prawns can survive only when the cells are able to tolerate the decreased haemolymph sodium and chloride. When this becomes too little for the cells to maintain ionic balance, the prawn would die. In culture systems, Ferraris *et al,* (1986) observed that mortality of juveniles of *P. monodon* occurred when moulting coincided with salinity fluctuations. When moulting occurred at very low salinity levels, more energy and time were required to normalize the haemolymph osmolarity. This long time interval increased the vulnerability of the animal to cannibalism and prolonged their inability to forage for food. However, when the change of salinities was done at shorter intervals, 53.34% survived in 0.5 ppt. Comparing this result with those when the juveniles were subjected to higher degree of salinity fluctuations, it can be seen that, a gradual changing condition permitted better survival of the juveniles. Analysis of probit regression line Y = 5. 9820 + 1.3322 X (X = salinity level and Y = mortality) implies that the lowest lethal salinity (LC 50) for juveniles is 0.5959 ppt with its upper and lower limit being 0.3722 and 0.7901 ppt respectively. The LC 70 and LC 90 values calculated were 1.3514 and 0.2206 ppt respectively. These results can explain how juveniles of *P. monodon* can penetrate into estuaries and survive extreme low salinities in natural environments during monsoon period.

The present study shows that although juveniles of *P. monodon* could tolerate very low salinity upto 0.5 ppt, their growth rate was optimal beyond 4 ppt.

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