

GROWTH AND SURVIVAL OF *PENAEUS MERGUIENSIS* POSTLARVAE AT DIFFERENT SALINITIES

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Abstract

The growth and survival of postlarval *Penaeus merguensis* were examined to optimize conditions and improve farm production. Postlarvae were subjected to one of four salinities (5-35 ppt) for a period of 28 days. Results indicated maximum survival at 25 ppt while the best growth rate was obtained at 15 ppt. The highest performance index was obtained at 15 ppt. Hence, 15 ppt was found to be the optimum salinity for the production of *P. merguensis* postlarvae. The fast growth rate and good tolerance of *P. merguensis* larvae to a wide range of salinity in captivity indicate that *P. merguensis* is a promising candidate for aquaculture.

Introduction

The banana prawn, *Penaeus merguensis* de Man, native to the Indo-Pacific region, is an important species of considerable commercial value and forms 5.5% of the total world shrimp production (Yap, 1999). Its substantial reproductive capability, fast growth, ability to attain maturity in a captive environment, ease of

breeding and producing postlarvae and wide range of salinity tolerance makes it a promising candidate for aquaculture. It has been cultured for a long time in extensive ponds in Southeast Asia (Hoang, 2001) and Vietnam (Truong *et al.*, 1995) and, more recently, in semi-intensive ponds in Australia (Hoang,

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2001). Integrated rice-shrimp farming in coastal areas of South Vietnam (Le, 1992) and polyculture with fish in the Fiji Islands (Gundermann and Popper, 1977) are some of the other culture practices in which this species is raised. But the failure of some initial trials to grow *P. merguensis* on a semi-intensive or intensive scale has caused modern farmers to be reluctant to take up the culture of this species (Hoang, 2001), hence, the need to optimize larviculture conditions.

Inconsistencies in growth and survival of penaeid shrimps in ponds can be attributed to many causes, the most important of which appears to be salinity or a combination of salinity and temperature (Venkataramaiah *et al.*, 1972). In tropical countries such as India, salinity assumes greater importance among the various abiotic factors. It influences postlarvae as they ascend the brackishwater areas after completion of their larval phase in the sea. Salinity plays a vital role during larval and juvenile phases by affecting functional and structural responses and, thereby, survival, growth and distribution. Studies of the response of juveniles to different environmental factors can provide information on the optimum conditions for maximizing the productivity of animals in culture.

Higher growth rates were reported in many penaeid shrimps including *P. aztecus* (Venkataramaiah *et al.*, 1972), *P. indicus* (Nair and Krishnankutty, 1975; Vijayan and Diwan, 1995), *P. monodon* (Rajyalakshmi and Chandra, 1987), *P. vannamei* (Bray *et al.*, 1994; Samocha *et al.*, 1998), *P. semisulcatus* (Harpaz and Karplus, 1991) and *Metapenaeus dobsoni* (Kuttyamma, 1982). Dall (1981) interpreted the preference of postlarvae for low salinity as a useful adaptation to their natural habitats. In comparison to commercial species of penaeids, very little is known about the growth of *P. merguensis*. Vinod *et al.* (1996) studied the effect of salinity on growth, food intake and conversion efficiencies of juvenile *P. merguensis*. Growth and productivity of juvenile *P. merguensis* in natural and laboratory systems were studied by Staples *et al.* (1984). The present study was conducted to understand the effect of

various salinities on the growth and survival of *P. merguensis* postlarvae.

Materials and Methods

Postlarvae of *P. merguensis* were collected from the Kali estuary (salinity 20 ppt) in North Karnataka, India, with a 2 mm mesh seine net and transported to the laboratory in oxygenated bags. On reaching the laboratory, they were segregated and postlarvae of almost similar lengths were used for the experiment. Growth studies were conducted in plastic tubs each with an effective water volume of 40 l and one airstone for aeration.

Survival and growth in four salinities (5, 15, 25 and 35 ppt) were studied in triplicate conditions for four weeks. Salinity was measured with a portable refractometer (ERMA). A group of 25 animals was stocked into each tub filled with sea water of salinity 20 ppt. The young shrimps were acclimated to the required salinity either by diluting the sea water if a lower salinity was required or by adding brine to obtain a higher salinity. Acclimation in all treatments was achieved within four days.

During the experimental period the shrimps were fed commercial shrimp feeds (C.P. Feed, 37% protein) *ad libitum*. Feces and uneaten food were siphoned out of the containers and 30% of the water was replaced daily before feeding.

Initial measurements were obtained from a sample of ten postlarvae from the source population. The animals were observed daily and ten animals were randomly sampled from each treatment for measurement of total length and weight at fortnightly intervals. After excess water was removed, the length of each specimen was measured to the nearest 0.5 mm and weight to the nearest 0.1 mg. At the end of the experiment, the total number, average weight and average length of the surviving shrimp in each tank were noted.

Growth was calculated as the difference between the initial and final weights and lengths. Specific growth rates (SGR) were calculated using the formula: $SGR = (\ln_{fw} - \ln_{iw}) \times 100/\text{time}$, where fw is final wet body weight and iw is initial wet body weight.

Performance index (PI; Rosas *et al.*, 1999) was calculated to evaluate the effects of salinity on both growth and survival, thus combining the two responses. This index was calculated as follows: PI = growth rate in mg/day at 28 days x survival in %.

Data were subjected to one-way ANOVA to establish differences between treatments. Differences were considered significant if $p < 0.05$.

Results

Survival of postlarvae. Growth and survival are given in Table 1. The highest survival was obtained at 25 ppt (80%) while the lowest was recorded at 5 ppt (22%). Survival of over 50% was obtained at the salinities of 15 and 25 ppt.

Statistical analysis of the data indicated that salinity exerted a significant effect on the survival rate of the postlarvae ($p < 0.05$).

Growth of postlarvae. Although *P. merguensis* can grow in a wide range of salinities by virtue of its euryhaline nature, the best growth was recorded at 15 ppt. Pronounced differences in growth were visible from the second week onwards. This was confirmed by analysis of the specific growth rates. Growth rates decreased with the increase in salinity from 15 to 35 ppt. The highest performance index was obtained at 15 ppt (177.797) while the lowest was obtained at 5 ppt (45.80). Statistical analysis indicated that salinity significantly affected ($p < 0.05$) the growth of the postlarvae.

Table 1. Growth and survival (\pm standard deviation) of *Penaeus merguensis* postlarvae reared at different salinities.

Parameter	Salinity			
	5 ppt	15 ppt	25 ppt	35 ppt
Avg initial length (mm)	9.23	9.17	9.30	9.20
Avg final length (mm)	23.43	25.03	21.37	20.43
Growth rate (mm/day)				
14 days	0.84 \pm 0.05	0.91 \pm 0.04	0.76 \pm 0.07	0.73 \pm 0.02
28 days	0.51 \pm 0.06	0.57 \pm 0.05	0.43 \pm 0.02	0.40 \pm 0.03
Avg initial weight (mg)	3.21	3.25	2.76	2.84
Avg final weight (mg)	61.33	84.00	45.00	34.67
Growth rate (mg/day)				
14 days	1.19 \pm 0.15	1.66 \pm 0.32	0.93 \pm 0.05	0.59 \pm 0.13
28 days	2.08 \pm 0.41	2.89 \pm 0.28	1.48 \pm 0.26	1.13 \pm 0.45
Specific growth rate	4.67 \pm 0.15	5.15 \pm 0.27	4.19 \pm 0.18	3.77 \pm 0.7
Survival (%)	22.0	61.5	80.0	43.0
Performance index	45.8 \pm 7.8	177.8 \pm 31.6	118.08 \pm 13.6	48.55 \pm 15.7

Discussion

The experiment illustrated the well-developed euryhaline character of *P. merguensis*. Postlarvae raised at different salinities varied in survival and growth, and were highest at 25 ppt and 15 ppt, respectively. Growth is the manifestation of the net outcome of energy gains and losses within a framework of abiotic and biotic conditions (Brett and Grovers, 1979). Although growth can indicate the physiological state of larvae, it may not be an adequate reflection if it is not accompanied by other indices of the general state of the organism. Thus, to evaluate production with more precision, performance index was selected as an index grouping both parameters together. The salinity of 15 ppt was found to be optimum for producing *P. merguensis* postlarvae based on this index. The study, therefore, provides convincing evidence of the importance of salinity in improving the growth performance of the postlarvae.

Salinity is thought to act on two independent aspects of physiology: osmoregulation and growth. Osmoregulation in crustaceans depends primarily on the salt pump (usually located at the gut and/or gills) and low integumentary permeability to salt and water (Davernport, 1985). Exposure to low salinity increases the activity of Na(+)/K(+)-ATPase in postlarvae and later stages. Neuroendocrine control of osmoregulation also appears during postlarval stages. Thus, an integrated series of events in postlarvae links the appearance of osmoregulatory tissues, the increase of Na(+)/K(+)-ATPase activity, the occurrence of hyperregulation at low salinity and an increase in salinity tolerance (Charmantier *et al.*, 2001). Other studies have suggested that the crustacean sodium pump may be controlled by a dopamine/cyclic AMP system (Lohrman and Kamemoto, 1987; Sommer and Mantel, 1988, 1991), methyl farnesoate (Lovett *et al.*, 2001) or gill tissue concentration of polyamines (Lovett and Watts, 1995).

The fact that survival and growth were optimal at different salinities indicates that, although the species can survive in a wide range of salinity due to its high degree of eury-

halinity, the best growth takes place only within the optimal range (Kinne, 1970 a,b). It has been hypothesized that osmoregulatory costs are lowest in an iso-osmotic environment and that the consequent energy savings allows increased growth. Outside the optimum range, growth was comparatively low. In extreme salinities, shrimps must expend considerable energy on osmoregulation, at the expense of other processes such as growth. The superior growth rate at 15 ppt may also be attributed to more efficient consumption and utilization of food or the consistent growth associated with a higher molting frequency. The results of the present study corroborate the fact that *P. merguensis* postlarvae, like many other penaeid shrimps, do well in sea water of lower salinity.

The preference of younger penaeids for low salinity waters was found to agree with the species' preferred habitat in natural environments. Of the many penaeid shrimps that penetrate estuaries, *P. merguensis* seems to be a natural candidate for rearing in waters of low salinity. This study found a high coincidence between the experimentally determined optimum conditions for production and prevailing conditions in the natural environment in which *P. merguensis* spends its postlarval and juvenile phases (Goswami and George, 1978; Goswami and Goswami, 1992; Parulekar and Achuthankutty, 1993; Ronquillo and Saisho, 1993), explaining why these shrimp perform well at a lower salinity. By extrapolating the laboratory results, it could be predicted that postlarvae moving into an estuary when the salinity is optimum would grow quickly and with minimum mortality. As the highest biomass was obtained at 15 ppt, ponds with a salinity around this level year-round would provide the ideal conditions.

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