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Seasonal Variation in Growth and Survival of *Penaeus monodon* Larvae Under Hatchery Conditions

George J.P.* and Deepa Nair
Central Marine Fisheries Research Institute
P.B. No.1603, P.O. Tatapuram
Cochin - 682 014, India

The present paper deals with various aquatic abiotic parameters which influence the spawning, hatching and larval metamorphosis of *Penaeus monodon* in controlled conditions. Water temperature, salinity and dissolved oxygen as well as general hygienic conditions were found to be the critical factors for the successful gonadal hydration, breeding and survival of young ones of *Penaeus* spp. Optimum ranges of hydrographic parameters were temperature 28-30°C, salinity 28-33 ppt and dissolved oxygen close to saturation. The larvae were fed on diatoms (*Chaetoceros* sp.), *Artemia* cysts and egg custard. The algal culture was maintained in the hatchery itself under conducive conditions. The hygienic conditions of the hatchery were maintained by using chemicals such as chlorine, EDTA and formalin. Antibiotics like oxytetracycline and chloramphenicol were used as prophylactic measures in order to prevent outbreak of diseases and infections. The present experiments conducted in Maharashtra revealed that best results in spawning, larval survival and growth could be obtained during September-October months, when temperature and salinity were in favourable ranges.

Key words : Water quality, feed management, growth, survival, shrimp farming, *Penaeus monodon*, Maharashtra

With the rapid expansion of penaeid shrimp farming in many countries, the need for producing large quantities of quality prawn seed under controlled conditions is keenly felt and suitable systems are being developed. According to Silas (1980) and Mohamed (1983), among the 55 species of prawns available in India, eleven species are suitable for farming and among them *Penaeus indicus* and *P. monodon* are widely cultured. However, the hatchery technology developed for these two species in India depends entirely on wild gravid spawners collected from sea by trawl fishing during peak spawning season (Rajyalakshmi, 1998). The results of controlled breeding and larval rearing of penaeid prawns are governed by biological factors like size, age, maturation stage and physicochemical parameters such as temperature, pH, salinity and proper larval feeding. The technique in the seed production of *P. monodon* in controlled conditions involves brood stock rearing, induced maturation, spawning and hatching, live feed culture, larval and post larval rearing and hatchery management. In this paper, an attempt has been made to study the water quality parameters and its influence on seasonal variation in growth and survival of *P. monodon* larvae under hatchery conditions in the north-west coast of India.

Materials and Methods

The experiments were carried out in a private shrimp hatchery complex in Maharashtra. The water intake system was designed in such a way that as the water passed through a filter bed while pumping, it was chlorinated to 5-10 ppm level and allowed to react for a period of 1-2 h to ensure eradication of all pathogens. The seawater was then recirculated through rapid sand filter. Further, the residual chlorine was chemically neutralized by adding sodium thiosulphate. EDTA (10 ppm)

* Corresponding author

was also added to get clean water. It was allowed to settle for an hour before using in the hatchery. Continuous aeration of such treated seawater was done by oil free electric air blower to maintain dissolved oxygen level. Experiments were conducted during monsoon (July-August), post-monsoon (September-October), winter (December-January) and summer (March-April), in order to determine optimum conditions and appropriate seasons for *P. monodon* seed production.

Eight FRP tanks of 250 l capacity each were used for spawning purpose. The prospective breeders were acclimatized to specially treated seawater conditions of the hatchery before transferring into the spawning tank. The broodstock was then treated with 100 ppm formalin for half an hour for disinfection and then transferred to maturation tanks. The males and females were then segregated and males were treated with 20 ppm oxytetracycline or chloramphenicol and kept for half an hour before transferring them into maturation tanks. The females were also transferred to maturation tanks after eye stalk ablation.

Healthy gravid females were dipped in 500 ppm formalin for five minutes, rinsed in holding bath and then transferred to spawning tanks. Ablated females usually spawned within 4 to 5 days and spawning usually took place during 22:30-00:30 h. Spawning tanks with gravid females were treated with 10 ppm EDTA and 4 ppm chloramphenicol. The lights were turned out to maintain darkness and noise was kept at a minimum level to create a conducive environment for spawning. Egg evaluation was carried out in the morning. Total egg count, percentage of fertilization, total nauplii count and percentage of hatching were estimated by sampling.

Eight tanks of 10 t capacity each were used for larval rearing. The larvae were acclimatized by adding water from the larval tank into the acclimation containers for nearly 20 min before introducing the nauplii into the larval tanks. Aeration was provided and the population estimated periodically. The critical physicochemical parameters in the larval rearing tanks were estimated twice a day. Larvae were fed with *Chaetoceros* sp. and *Artemia* cysts. Eight tanks with a volume of 23 m^3 each were used for rearing of post-larvae after acclimatization. The physicochemical parameters were recorded and periodic assessment of the population in the tank was carried out. Post-larvae were fed with egg custard and freshly hatched *Artemia* cysts.

Egg custard was given at the rate of 15 g twice a day for PL-8 to PL-10, 20 g twice a day for PL-10 to PL-15 and 25 g five times a day for PL-15 to PL-20. Freshly hatched *Artemia* nauplii was given at the rate of 2 nos.ml^{-1} thrice daily for PL-3 to PL-6, 2 nos.ml^{-1} thrice daily for Pl-7 to PL-12 and 3 nos.ml^{-1} once daily for PL-13 to PL-20.

Parameters such as temperature, pH, salinity and dissolved oxygen were monitored daily and all the parameters were determined as per APHA (1985).

Results and Discussion

Seasonal variation in survival of *P. monodon* larvae from nauplii to PL-5 stage, PL-5 to PL-20 stage and nauplii to PL-20 stage are represented in Fig. 1. It was observed that in June the water became very turbid and salinity started decreasing making this period unsuitable for culture operations. However, salinity started increasing in July-August and fluctuated between 12 and 20 ppt while temperature and pH ranges were 28-31°C and 7.4-8.1, respectively. The average survival from nauplii to post-larvae (PL-5) was 54.2% and from PL-5 to PL-20, 45.15%. The average survival rate from nauplii to PL-20 was 23.0%. The higher mortality was due to low salinity during later stages of development of larvae as compared to early stages.

The larvae reared during September-October showed better survival rate from

nauplii to PL-5 stage with 67.52%. As the larval development progressed they exhibited better survival rate with 90.28% from PL-5 to PL-20. The survival rate from nauplii to PL-20 stage was 60.16%. The larvae showed optimum growth and optimum intake of food during the period when salinity ranged from 28 to 33 ppt, temperature varied between 20 and 30°C and pH fluctuated between 7.9 and 8.2.

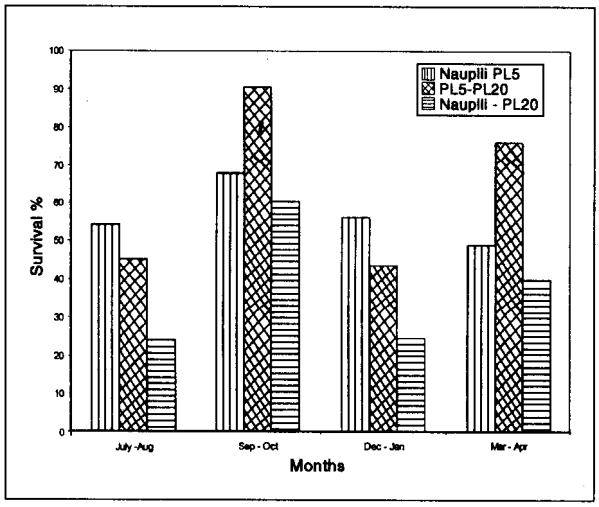

Fig. 1. Comparison of percentage survival of *Penaeus monodon* larvae during different seasons.

During winter months, especially December-January, the temperature decreased and the larvae reared at temperature between 23.2 and 25°C and salinity between 33 and 35 ppt showed retarded growth and reduced feed intake. The survival rate from nauplii to PL-5 was 55.75% while from PL-5 to PL-20 it was 43.12% and in the case of nauplii to PL-20, only 24.25%

During summer months (March-April), the temperature ranged from 32 to 34°C while salinity fluctuated between 34 and 37 ppt and pH was in the range of 7.9-8.4. Under these conditions, the survival rate from nauplii to PL-5 was 45.8% whereas from PL-5 to PL-20 it was 75.81% and from nauplii to PL-20, 39.39%.

The study revealed that the larvae of *P. monodon* survive and grow in hatchery conditions during the months of September-October when critical water parameters such as temperature and salinity were in the range of 28-30°C and 28-33 ppt, respectively. Temperature was a limiting factor in terms of larval survival and influenced their growth rate. The shrimp species are capable of maintaining proper metabolic functions in between the lethal extremes but survival and growth are still affected. Thermal tolerance studies conducted by Motoh (1981) in three different age groups (post-larvae, early juveniles and juveniles) of *P. monodon* revealed that all three age groups could tolerate a low temperature of 10°C for a short period of time. Survival rate was 98% for all three stages studied. However, beyond 39°C there was heavy mortality. The thermal tolerance stated by Motoh (1981) for *P. monodon* post-larvae seems to be extreme. Hudinaga (1942) found that temperature ranging from 24 to 32°C is best suited for development of penaeid larvae. In the nauplius stage of the larvae, the development is mainly controlled by the temperature of the medium and effect of temperature on development is reduced when the larvae start feeding, from potozoea stage onwards (Mohamed, 1983). According to Verghese *et al.* (1975) food intake in *P. monodon* is lower at temperature below 24°C. In the present investigation, it has been observed that temperature ranging from 28 to 30°C is optimum for penaeid larval development which falls within the range reported by Hudinaga (1942).

The salinity tolerance varies from species to species among penaeids, though most species are relatively euryhaline. Spawning and embryonic development of penaeid species represent critical life stages which can be affected by salinity. The experiments conducted by Motoh (1981) showed that the species tolerate very low salinity. Rajyalakshmi & Chandra (1987) reported that *P. monodon* exhibited higher survival rate at 15 ppt. Nevertheless, the survival rate decreased when the rearing time was extended which shows that this species can survive in very low salinity but only for a short period. The results of the present

experiments show that the optimum salinity range for penaeid larvae is between 29 and 33 ppt which is in accordance with Hudinaga (1942) who reported that salinity ranging from 27 to 34 ppt was very conducive for development of penaeid prawns.

Proper growth and development in *Penaeus* spp. require that both salinity and temperature remain within certain limits, which will vary depending on the species. Silas *et al.* (1978) observed that that the temperature of 26.5 to 28.5°C and salinity of 30.2 to 33.5 ppt, were quite appropriate for rearing larvae of *P. monodon*. Mohamed (1983) reported that filtered clean seawater with temperature of 28±2°C and salinity ranging from 28 to 30 ppt were suitable for achieving best results in spawning and greater survival of larvae of penaeid prawns in controlled conditions. In the present investigations it was found that during the months of September-October when temperature and salinity persist in favourable ranges viz., 28 to 30°C and 28 to 33 ppt, respectively, the best results in spawning and larval development of *P. monodon* could be obtained in the hatchery.

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