Factors Determining Spawning Success in *Penaeus monodon* Fabricius

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Abstract

Spawning success in relation to the size of spawner, clumping of eggs, percentage of spawning and frequency of spawning was studied in *Penaeus monodon*. The results indicated positive correlation between the size of spawner and the fecundity and hatching percentage, but not the start of hatching. Hatching characteristics were influenced by clumping of eggs or abortive spawning; the greater the clumping, the longer the time taken for hatching, resulting in a lower hatching percentage. The start of hatching time increased when the frequency of spawning increased. Lower hatching rate was observed as the frequency of spawning increased.

Introduction

Aquaculture plays a major role in increasing fish production in tropical countries like India. India's vast coastal belt and conducive environment has led to the rapid expansion of shrimp farming activities. The tiger shrimp *Penaeus monodon* contributes a major share to shrimp production in India. If management of a hatchery is to be successful, full attention must be given to the processes of spawning and hatching. Many researchers have optimized different conditions like light, temperature, pH and oxygen for successful spawning and hatching. But few studies have been done on other factors which affect spawning success such as size of spawner, clumping of eggs or abortive spawning, percentage of spawning and frequency of spawning. This paper discusses the results of a study of factors in spawning success carried out on *P. monodon.*

Material and Methods

Adult *P. monodon* were collected from the sea at Ovari and Idinthakarai off Tamil Nadu, India, during the month of August 1999.

One hundred males and 100 females weighing more than 75 g and 125 g each respectively, were selected. The selected animals were transported to the hatching site in a special tank (Babu and Marian 1998). On arrival at the hatchery, the animals were treated with 50 ppm formalin for 10 minutes. The treated animals were then transferred to the maturation tank in 1:1 ratio (male and female) and fed with squid and crab meat at 15% of body weight. Sardines and encapsulated adult Artemia were also given at 20% of body weight daily (Babu and Marian 1998). From the second day of stocking 50 – 100% water was exchanged in the maturation tank.

One hundred female spawners were unistalk ablated after five days of collection from the sea. The time of ablation was determined by the health condition of the spawners. The maturation room was provided with photoperiods of 12 hrs light and 12 hrs darkness. The temperature, salinity, dissolved oxygen and pH were maintained at 30 ± 1°C, 30 ± 1ppt, 5 mg/l and 7.5 ± 0.5 respectively.

The water used in the maturation system was not chlorinated but was filtered through a gravity flow sand filter. The maturing animals were treated with 2 ppm Furozolidone and 0.2 ppm Treflan for bacterial and fungal diseases respectively.

Start of hatching was assessed by checking five 500 ml glass beakers, each containing 100 eggs, collected from the spawning tank with the water taken from the same tank. Strong aeration was allowed in both the tank and glass beaker in order to keep the eggs in suspension. In order to assess the start of hatching, the eggs present in the beakers were observed every 10 minutes, 14 hrs after spawning. Percentage of hatching was calculated 19 hrs after spawning. The calculation was made by counting the hatched-out nauplii from five samples taken at different places of the hatching tank with a 100 ml beaker.

Total number of eggs in the hatching tank was calculated by taking 10 samples in different places of the spawning tank by random sampling using a 100 ml beaker.

Clumping of eggs was noted even in the highly aerated spawning tank under optimum conditions. The percentage of clumping was calculated by weighing the clumped and individual eggs separately by an electronic digital balance. From the total of both clumped and individual eggs, the percentage of clumping was calculated. Ten animals of different size groups were studied for relationship between percentage hatching and size of spawners and hatching; size of spawners and fecundity; percentage clumping and hatching rate/time.

In the case of partially spawned spawners, the spawned eggs were collected separately and weighed. The remaining unspawned eggs were taken out along with the ovary by a longitudinal incision on the dorsal side of the animal. All eggs were carefully separated from the ovary and weighed. From the total weight of the spawned and unspawned (collected from ovary) eggs, the percentage of spawning was calculated.

Frequency of spawning refers to the number of times the same spawners are allowed to spawn. In this study, the same spawners were allowed to spawn three times after ablation by separating them after each spawning. Five replicates were maintained for each set of experiments.

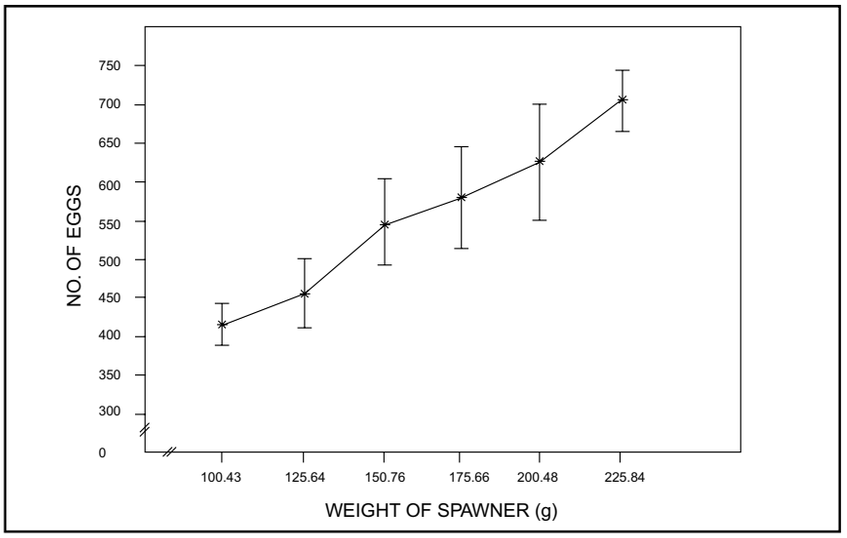

Fig. 1. Relationship between weight of* P. monodon *spawner and fecundity.

***Table 1. Influence of clumping of eggs on spawning in* P. monodon.**

% of clumping	Start of Hatching (hrs)	% Hatching
0	14.40 ± 0.30	92.6 ± 2.4
21.36 ± 1.26	15.10 ± 1.50	64.7 ± 2.6
40.50 ± 1.29	15.50 ± 1.20	30.8 ± 4.7
60.37 ± 1.40	17.10 ± 1.35	22.6 ± 3.6
81.65 ± 1.82	18.00 ± 1.54	8.5 ± 6.8

Table 2. Rate of spawning in relation to success of spawning.

Spawning (%)	Start of hatching (hrs)	Hatching (%)
21.75 ± 3.00	14.50 ± 0.53	63.4 ± 2.7
40.50 ± 2.08	15.30 ± 0.43	77.8 ± 3.4
60.54 ± 2.64	14.50 ± 0.34	90.6 ± 2.9
79.59 ± 2.08	14.30 ± 0.52	92.3 ± 1.8
97.20 ± 1.81	14.40 ± 0.45	95.2 ± 2.1

Table 3. Frequency of spawning related with % hatching and start of hatching.

Frequency of spawning	Start of hatching (hrs)	Hatching (%)
First spawning	14.20 ± 0.45	95.4 ± 3.6
Second spawning	15.40 ± 0.32	84.7 ± 4.1
Third spawning	15.50 ± 0.50	76.8 ± 6.8

Result

On average, 76% of spawners spawned for the first time in each batch. There was a direct relationship between percentage of hatching and weight of spawners (r+ >0.9). In the 100.6 ± 4.57 g size group, the percentage of hatching was 86.40 ± 2.16. In the other size groups viz. 125.35 ± 3.43 g, 150.62 ± 7.4 g, 200.45 ± 7.25 g, 225.56 ± 4.60 g and 250.22 ± 8.30 g there was an increase in percentage of hatching in the order of 88.36 ± 2.36, 89.25 ± 3.40, 90.25 ± 2.21, 91.5 ± 3.41 and 93.75 ± 3.38, respectively. But the size of spawners had no effect on the start of hatching (r=0.3).

Size of spawners was observed to play a major role in the fecundity of individuals. Fecundity increased with increase in size of animals from 416 050 in size group of 100.43 g to 703 110 in size group of 225.8 g. (Fig. 1)

Increase in the percentage of egg clumping resulted in a decrease in the hatching percentage and also delayed the start of hatching (Table 1). As clumping percentage increased from 0 to 81.65, the start of hatching time also increased from 14.40 ± 0.30 to 18.0 ± 1.54 hrs. When the clumping percentage

increased to 81.65% from 0%, the percentage of hatching decreased to 8.50 ± 6.86% from 92.6 ± 2.4 %.

When the percentage of spawning decreased from 97.20 ± 1.81 to 21.75 ± 3.00, the hatching percentage also decreased to 63.4 ± 2.7 from 95.2 ± 2.10 but there was no remarkable change in the start of hatching; it fluctuated between 14.30 and 15.30 hrs (Table 2).

A positive relationship was observed between frequency of spawning and start of hatching and percentage hatching (Table 3). In the first spawning, hatching started at 14.20 ± 0.45 hrs and the hatching percentage was 95.40 ± 3.6. In the second spawning, the start of hatching and hatching percentage were 15.40 ± 0.32 hrs and 84.7 ± 4.1% respectively. In the third spawning, the start of hatching was 15.50 ± 0.50 hrs and the percentage of hatching was 76.8 ± 6.8% (Table 3).

Discussion

Variations in reproductive quality of shrimp brood stock have been reported to be primarily genetic in nature (Coyama et al. 1991). But the present study shows that some factors like spawner size, amount of clumping of eggs, types of spawning and frequency of spawning also influence spawning success by changes in hatching rate and start of hatching. Motoh (1981) established a positive correlation between fecundity and female size in terms of carapace length and Villegas et al. (1986) demonstrated a positive correlation between fecundity and spawner weight. The present study also showed a positive relation between the weight of spawners and hatching percentage. But no relationship was observed between the size of spawner and start of hatching.

Primavera (1982) working with ablated females of *P. monodon* found that the rematuration rate decreased from 23.2 to 5.9% in the second and third spawnings respectively. The present study showed a decreased hatching rate from the first spawning to the third spawning (Table 3). This may be due to the decrease in fatty acid profile of the ovary from the first spawning to the subsequent spawning (Marte 1982).

Clumping or aborted spawning which occurs frequently during the spawning of *P. monodon* also affected spawning success. Some workers have opined that it is due to the lack of sufficient aeration during spawning. But observation during the present experiment substantiates that it is due to the inherent reproductive failure in spawning and stress. The rate of clumping was higher when the animal was under stress or when a white necrotic spot appeared in the matured ovary due to microsporidial attack (Babu and Marian 1998).

In this study, it was observed that two types of spawning take place in *P. monodon*, i.e. full spawning and partial spawning. Partial spawning has been shown to be stress induced during transport of spawners to the hatchery (Babu and Marian 1998). Stress increases cortisol release and decreases the secretion of ovarian ascorbic acid. This induces the animal to spawn partially. The reduced hatching rate with successive spawning could be attributed to reduced availability of body reserves and lower deposition of spermatophore in the helical receptacle.

It is clear from the present study that there is a need for an in-depth study of the problem of clumping of eggs, partial spawning and increasing the spawning success with repeated spawnings.

It is also clear that to run a hatchery profitably, special attention must be paid to: the selection of bigger size spawner; spawners with empty space in the ovary must be avoided; stress free transport must be ensured; and frequent use of the same spawners must be avoided.

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