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A STUDY OF FACTORS INFLUENCING THE HATCH RATE OF *PENAEUS VANNAMEI* EGGS. III. PRESENCE OF THE FEMALE AFTER SPAWNING

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ABSTRACT A comparison was made of the hatch rate (percent hatch) of *Penaeus vannamei* eggs. The study was comprised of 100 spawns from mated *Penaeus vannamei* females. In one treatment, 50 female shrimp were removed from the isolation spawning tanks after spawning occurred but prior to hatching of eggs, producing 49.7% mean hatch rate. In the other treatment, 50 female shrimp were left in the tanks until after the eggs had hatched, producing an average hatch rate of 35.0%. A significant difference in the hatch rates of eggs was observed between spawns with and without presence of the female at time of hatching ($P < 0.0135$).

Introduction

Commercial seed production for shrimp aquaculture has been accomplished by captive reproduction. Mated ovigerous female shrimp are usually removed from large maturation tanks and placed in separate spawning tanks. In the isolation spawning tanks, females may be spawned singly or in groups. The spawned shrimp often are not removed until the next day and in some cases even after the eggs have hatched, approximately 12 hours after spawning. Females can also be spawned in the same large tanks in which maturation has occurred (Simon 1982, Chen et al.1991), and variation of this scenario could be developed for large-scale commercial use. Several researchers have recommended removal of the female after spawning. Kittiwattanawong et al. (1990), working with *P. monodon*, recommended that the female be removed in order to reduce the incidence of disease transmittal to the newly-hatched larvae. Cook and Murphy (1966), working with *P. aztecus*, removed the female after spawning, reportedly to prevent the female from ingesting the eggs. In addition to the practice of isolating females in separate tanks for spawning, some facilities rinse and transfer eggs to clean water hatching tanks. As data was unavailable on the effect of removing the female after spawning, the present study was undertaken with *P. vannamei*.

Material and Methods

Female shrimp were matured and mated in large commercial-sized tanks operated according to standard practices (Ogle 1992). In the evening, female shrimp were "sourced" (checked for the presence of a spermatophore) and removed from the maturation tank if mating had occurred. Each shrimp was placed in a separate spawning tank and checked several hours later for spawning. The circular 1 m^2 fiberglass spawning tanks were 0.6 m deep and 1.12 m in diameter and contained 200 l of seawater obtained from Davis Bayou in the Mississippi Sound. The seawater was settled to remove solids and the ambient salinity was increased to 30 ppt by adding an artificial sea salt (Marine Environment, San Francisco, CA). The water was pumped through a 5 micron filter. Seawater was changed and spawning tanks cleaned after each spawning. Moderate aeration was provided by a single airstone.

The study was conducted over a two-month period, with females chosen randomly for either of two treatments. In one treatment, 50 females were removed from the spawning tanks and returned to the maturation tank after spawning. In the other treatment, 50 females were left in the spawning tanks until the next morning when the eggs had hatched.

Hatch rates were estimated from the number of eggs at spawning and the number of nauplii after hatching. Numbers were determined by subsampling. Water in the spawning tank was stirred and five 10 ml subsamples were collected. Subsamples were taken from the four compass directions and the center of the tank, transferred to a petri dish and the number of eggs or nauplii enumerated. Data were averaged and analyzed by ANOVA and significant ($P < 0.05$) differences noted.

On one occasion, water samples were taken after hatching, one from the tanks with the female and one from the tanks without a female. A control sample was obtained from a tank with no female shrimp or eggs present. Samples were analyzed for pH, total ammonia and nitrite in accordance with U.S. Environmental Protection Agency (1983) procedures.

Results

Hatch rates averaged 49.3% (S.E. 3.50%) and varied from 2.7% to 96% for tanks in which the females were removed after spawning. Hatch rates averaged 35.0% (S.E. 4.30%) and varied from 1.5% to 97.2% for the tanks in which the females were not removed. A significant difference in the hatch rates of eggs was observed between spawns with and without presence of the female at time of hatching ($P<0.0135$).

Water quality deteriorated slightly due to the presence of the female as compared to a control tank without shrimp (Table 1). Nitrogen values of the water in the control tank were higher than expected for oceanic water. This may be due to the use of eutrophic estuarine water for the hatching studies. The pH declined and total ammonia and nitrite increased slightly for spawning tanks in which the females were not removed.

DISCUSSION

The presence of the female might have been expected to decrease the hatch rate of the eggs due to deterioration of the water quality, which apparently was the case.

It can be speculated that the lowered hatch rate associated with females left in spawning tanks could be related to metabolic products of the females, e.g., feces and ammonia in the culture water, which would contribute to bacterial, fungal, and other microbial attacks on the eggs themselves. If this is the case, it is possible that bacterial or fungal inhibitors may be beneficial.

Since the presence or absence of the female after spawning created a significant effect on the hatch rate, the decision to remove the female must be determined by the needs of the individual facility. Commercially, it appears to be easier and cheaper to mass spawn shrimp, leave the females in the tank after spawning and harvest the larvae in mass. This process involves the use of one tank instead of several tanks which greatly reduces the time required to harvest and refill. One disadvantage of this method is the inability to determine individual female performance, which is known to be highly variable. McGovern (1988) and Oyama et al. (1989) reported that a small percentage of females are responsible for the majority of nauplii production. Researchers will continue to spawn shrimp individually in order to collect data on performance and attempt to understand the variability. Small individual spawning tanks are easier to clean and treat and allow selection of the best individual spawns. Additionally, cleanliness or disease transmittal concern have led some to remove the females (Kittiwattanawong et al. 1990). However, this approach requires maintenance of a large number of spawning tanks. The use of more tanks in limited space may necessitate use of less than ideal size tanks, therefore reducing the overall hatch rates (Ogle 1995). The present study shows that significantly lower percent hatch occurs when females are left in the spawning tank through hatching. This provides additional information for researchers and commercial facility managers to use to optimize spawning systems in which many factors influence results.

TABLE 1
Water quality after 24 hours

	pH	Total Ammonia (ppm)	Nitrite
No shrimp or eggs present	8.11	0.323	0.076
Female removed after spawning	8.12	0.282	0.073
Female not removed after spawning	7.98	0.384	0.105

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