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SHRIMP SEED PRODUCTION AT SEAFDEC/AQD

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Broodstock management and seed production techniques have evolved from laboratory and verification tests that are conducted to increase survival and growth rates of cultured fish species. The present methods of induced maturation and hatchery rearing of shrimp (*Penaeus monodon*) used at the SEAFDEC Aquaculture Department are examples.

Broodstock management

The use of wild or pond-reared adults that are induced to mature in captivity is a timely solution to the declining supply of wild-caught gravid shrimps. Since the successful use of the ablation method by Santiago (1977), induced maturation has been practiced at SEAFDEC. Quite a number of big hatcheries have also adopted the technique but many still prefer wild spawners as nauplii source due to the pond growers' bias against fry from ablated spawners. Eggs from ablated females have been shown to exhibit lower hatching rates (Vogt et al. 1989; Tan-Fermin 1991). Although pond-reared broodstock can be successfully induced to mature (Santiago 1977; Primavera 1978; Millamena 1989), they can not compete yet with ablated wild-caught adults which give a faster turnover, that is, they produce in 4-8 weeks the same number of nauplii that pond broodstock can give in 8-12 weeks (Primavera 1988).

Shrimp that are induced to mature are held in covered maturation tanks. [Tests have shown that good reproductive performance can be attained with green light (Primavera and Caballero 1989).] These maturation tanks are previously disinfected with 150 ppm formalin or detergent and thoroughly rinsed. Tanks are then filled with seawater (30-36 ppt) to a depth of 1 m.

Malesand females(60 g or 100 g, respectively)aredisinfected with 50 ppm formalin for 1 h and acclimated for about a week. Broodstock kept for more than a month without disinfection may acquire viral or bacterial diseases. After 50% have molted, females are ablated through the incision or the heated forcep method (Primavera 1978, 1989). Animals are then stocked at a density of 2-7/ m^2 (Primavera 1989) and at a ratio of 1 male to 1-2 females (Pudadera et al. 1980). Sampling to determine maturation is done 3-4 days after ablation.

Shrimp are fed pellets at 1-3% of body weight per day (Millamena et al. 1986) and mussel, squid, crab meat, or trashfish at 10-15%. Feeds are given separately to avoid selective feeding. Pellets are usually fed in the morning. Marine annelids (*Perenereis*), a good source of fatty acids essential to shrimp maturation, are given once or twice a week.

Water in tanks is totally replaced once weekly. Siphoning of excess feeds is done regularly. Feeding trays are also used to lessen frequency of siphoning.

Hatchery

The hatchery techniques adopted by SEAFDEC are based on the small tank hatchery system (Mock and Murphy 1971) where natural food culture, spawning, and larval rearing are conducted in separate tanks. The community or large tank system (Shigueno 1975) has been tried but high mortalities were encountered due to deterioration of water quality caused by uncontrolled algal blooms.

Hatchery operation begins with proper scheduling of activities, including natural food production and preparation of tanks and facilities. Scale-up production of natural food must be scheduled properly so that phytoplankton will be available when shrimps molt to the first protozoeal stage (Fig. 1). Tanks must be ready; tank preparation includes washing with detergent or hydrochloric acid and rinsing with clean freshwater. Disinfection with 200 ppm chlorine for one hour is also recommended (Po et al. 1989). After washing, tanks are dried under the sun whenever possible. New tanks need to be filled with fresh or seawater for at least a week to avoid mortalities due to toxic effects of chemicals (epoxy paint or even cement) used during construction. Tanks may or may not be placed under a roofed structure (Parado-Estepa et al. 1991).

Wild spawners that are used as sources of nauplii must be carefully selected to obtain high fertilization and hatching rates of eggs. Spawners must be disease-free, hard-shelled, and with spermatophore. It is best to choose shrimp with gonads at stages III or IV (Motoh 1981; Primavera 1988). A reliable method of determining stage would be to measure the ovarian width at the first abdominal segment; an ovarian width of at least 20 mm indicates readiness for spawning (Tan-Fermin and Pudadera 1989). If shrimp with gonads at stage II are chosen, ablation may still be necessary to induce maturation and subsequent spawning.

Spawners are usually disinfected with 200 ppm formalin prior to stocking in tanks (Po et al. 1989). Spawners are separated individually or in small groups to prevent contamination of the whole stock in case one or a few of the spawners are disease carriers. Disease is further prevented by washing the eggs right after spawning or before defecation of spawners. The feces of spawners have been identified as a source of luminescent bacteria (Lavilla-Pitogo et al. 1990a, 1990b).

During stocking and throughout the culture, sudden changes in the condition of the rearing water must be avoided. Stress, and consequently mortality, may occur if larvae or postlarvae are not given time to acclimatize. Temperature and salinity of the rearing water should be similar to the water used during transport or the broodstock source.

Stocking at lower densities is less risky since lower incidences of disease have been experienced. Nauplii are stocked at 50 individuals/1 in the larval tanks and reared until the early postlarval stage (PL1 or PL5). They are harvested and restocked in clean nursery tanks at 10,000-15,000/t. Larval tanks may also be used as nursery tanks.

The nauplius has yolk stored in its body, and it does not require food. Larvae are given phytoplankton (*Skeletonema, Chaetoceros* or *Tetraselmis*) starting on the first protozoeal stage. These phytoplankton are maintained at a density of 20,000 - 50,000 cells/ml in the rearing water. The density is determined with the use of the microscope and hemacytometer.

Dried preserved algal cells of diatoms or *Spirulina* are available commercially and can be used during the protozoeal stages. However, complete substitution of diatoms with these preserved algae must still be tested and evaluated. Algal cells can be preserved using the method described by Millamena et al. (1990).

Eggyolk can be used for feeding of the protozoea and the mysis stages (Quinitio and Reyes 1983). However, this was found to be deficient in some polyunsaturated fatty acids, an important component of larval diet. Artificial diets, called microparticulates because of their small particle size, can be given during the protozoeal stage. SEAFDEC has formulated a carageenan-microbound diet for larval rearing (Bautista et al. 1989; Bautista et al. 1991) but numerous diet formulations are also commercially available.

Animal protein is essential at the mysis stage. Although microparticulate diets contain animal protein, newly hatched *Artemia* nauplii is, so far, still the best food for the mysis and postlarval stages. *Artemia* cysts should be disinfected with hypochlorite (Sorgeloos et al. 1986) as unwashed *Artemia* cyst is a possible source of luminescent bacterial contamination (Lavilla-Pitogo 1990b). A summary of the suggested feeding schedule is given in Fig. 1.

To ensure that metabolites in the water do not exceed tolerable levels, water must be replaced regularly. With lower density rearing, water change can be started when the animals have all metamorphosed to the postlarval stage. This water management and stocking scheme is better than daily water change from the protozoeal stage onwards because it causes lesser stress and lower metabolite levels.

As in stocking, temperature and salinity of the water before and after water change must not differ by more than 1°C or 2 ppt, respectively. Levels of some water parameters recommended are given in Table 1.

Water for rearing is previously treated with 5-10 ppm hypochlorite and neutralized with sodium thiosulfate. As an oxidizing agent, hypochlorite kills or retards the growth of possible harmful microorganisms. It has been shown that chlorine reduces bacterial population by 90% (Baticados and Pitogo 1991). However, chlorine is also toxic to larvae or postlarvae so water must be neutralized before use. Water is also treated with 5-10 ppm EDTA (ethylene diamine tetraacetic acid) to chelate heavy metals (Licop 1988a).

During rearing, fungicide such as Trifluralin is applied every other day to prevent contamination with fungi. The fungicide being photosensitive is usually applied early in the morning or late in the afternoon.

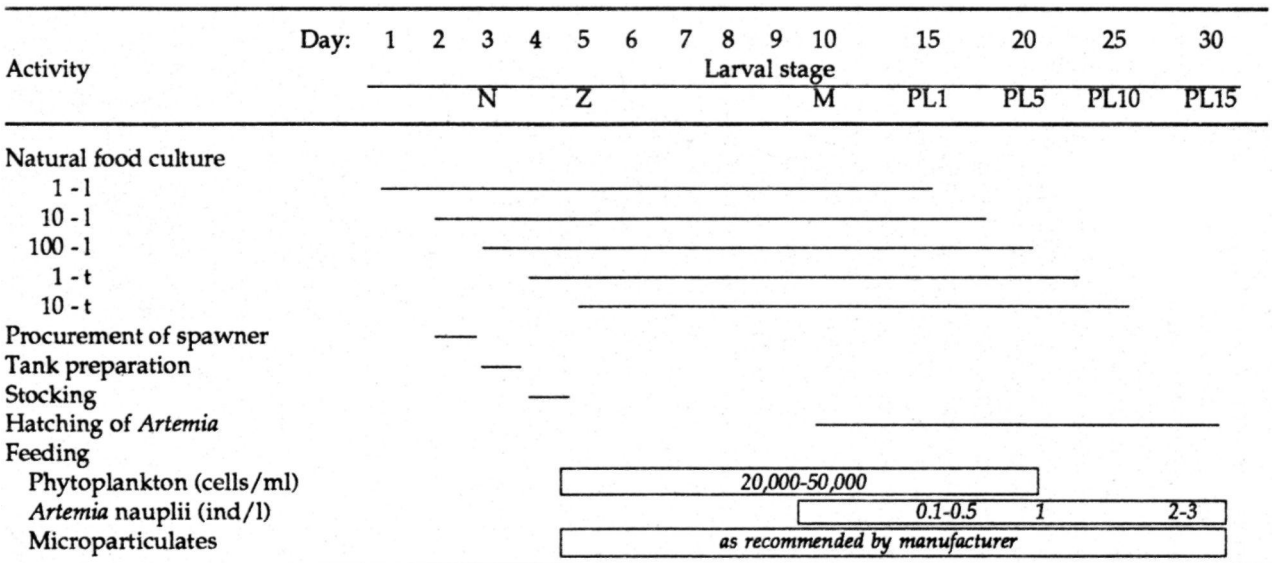

Fig. 1. Larval rearing of shrimp, *Penaeus monodon.*

Table 1. Recommended ranges of some water parameters suitable for a shrimp hatchery

Parameter	Range
Temperature	27-30°C
Salinity	30-36 ppt
pH	7.8-8.5
Dissolved oxygen	>3.5 ppm
Unionized ammonia (NH_3)	<0.1 ppm
NO_2-N	<0.02 ppm

Nursery

The nursery phase consists of rearing the early postlarval stage to older and more hardy and tolerant stage. In the hatchery, nursery rearing usually refers to the period from PL1-5 until PL15-20. Shrimps are harvested at the early postlarval stage, then transferred to other larval or nursery tanks.

Feeds during the nursery phase include Artemia nauplii or adults and formulated diets. Other feeds such as trashfish, squid, or mussel meat are not commonly used due to the resulting pollution in the rearing water.

Substrates are usually installed in the nursery tanks to provide solid surfaces on which the shrimp can cling to, provide shelter and protection from cannibalism during molting, and provide surface area on which food organisms can grow on.

Problems

One of the most pressing problems is the lack of shrimp spawners or adults. Thus, there is a need to give greater emphasis on broodstock development and induced maturation. Research on the refinement of hatchery techniques with emphasis on cost efficiency and disease prevention must continue.

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