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Freshwater Prawns Hatchery and Nursery Management

The three phases of freshwater prawn culture are hatchery, nursery, and pond grow out. This publication provides detailed information on the design and operation of a freshwater prawn hatchery and nursery facility that would enable the producer to culture juveniles for stocking his own production ponds or for sale to other grow-out operations.

The hatchery and nursery stages are labor intensive and exacting, and require relatively high expertise for success. A limited number of postlarvae and juvenile suppliers currently exist, and an increase in demand will eventually lead to more enterprises that deal exclusively in the production and sale of seedstock. For information on pond production and grow out, request Extension Publication 2003 from your county Extension agent.

Hatchery/Seedstock

Procurement of Seedstock

Production of freshwater prawn seedstock begins with maintaining a healthy broodstock population. In temperate climates, obtain broodstock from the harvest crop and transfer to tanks or raceways located within a temperature-controlled building. Water temperature for broodstock holding should range between 77 °F and 82.4 °F. Stock broodstock at a density of 1.15 oz/gal (1g/L) at a ratio of 10 females to 2 to 3 males. For every blueclaw (BC) male there should be 3 to 4 orange claw (OC) males, assuming a 4- to 5-month holding period before collection of egg-bearing females for larval production. (For definitions of the various life stages, request Extension Information Sheet 1525 from your county Extension agent.) Feed the broodstock a 35-percent crude protein, high-energy 85 kcal/oz (3.0 kcal/g), pelleted diet containing at least 0.5 percent highly unsaturated fatty acids. Feed them at a rate of 1 to 3 percent of their body weight per day, divided into 2 to 3 feedings of equivalent amounts. Equip your holding tanks or raceways with material that will maximize use of the entire water column for prawns to separate and inhabit.

A mature female produces approximately 28,571 eggs/oz (1,000 eggs/g) of wet weight. At the

recommended range of holding temperature, a series of color changes (from bright yellow to orange to brown to a gray green) characterizes development of the eggs. Eggs with a gray-green color will hatch within 24 to 72 hours. Females with eggs in the advanced state of development can be removed from partially drained holding tanks and transferred directly to special hatching tanks containing water of similar temperature and a salinity of 0 to 5 ppt (g/L), where eggs usually hatch at night. By positioning a low-intensity light above the overflow pipe, larvae are attracted and thereby collected in a separate, adjoining tank. A small mesh screen, 3.5 x 10-5 to 4.7 x 10-5 in (90 to 120 micrometers), on the overflow pipe prevents larvae from escaping from the collection tank. Water from the collection tank then flows to another tank or back to the hatching tank.

During the following day, the concentration of larvae in the collection tank is determined and the appropriate number of larvae are then transferred to rearing tanks at an initial stocking density ranging from 189 to 300 per gallon (50 to 80/L). Stock the larvae collectively from eggs hatched during a 1- to 4-day interval. A following day's group of larvae should be stocked only after those stocked the previous day have been fed and evidence at least partially full guts. This procedure minimizes cannibalism of late-stocked individuals by earlier stocked individuals and ensures that a smaller range of larval stages occurs at any one time during the culture period. The duration of the harvest period is also minimized if a narrow range of larval stages (sizes) is maintained.

Culture Conditions

Larval culture must be conducted under indirect light with an intensity ranging from 30,000 to 700,000 lux, a level typical of a partly cloudy to a clear day. Natural light is supplemented by intense artificial light daily during the early morning and late afternoon. Never use artificial light as an exclusive substitute for natural light. Larvae may be cultured in recirculating systems at a water temperature of 82.4 to 86 °F (28 to 30 °C) and a salinity of 12-15 ppt (g/L). Use of recirculating systems allows for efficient use of water and reduction of heating costs. Recirculating systems require a biological filter to avoid the accumulation of nitrogenous waste products (ammonia, nitrite) that can be toxic at certain levels. Biological filters consist of a high-surface area substrate (media) upon which bacteria live and transform ammonia, the principal waste product of larval prawns, to nitrite and then nitrate.

Clean, sterilize, and flush the larval culture system before initial filling. Water used for the initial filling should pass through a 5-micrometer bag filter. After the system is filled and operational, add a chlorine-based sterilizing agent to achieve a concentration of 10 ppt (g/L). Dechlorinating agents are not required if this sterilization procedure is performed several days before stocking. Such a protocol is recommended because the presence of dechlorinating agents has been implicated with mortality of prawn larvae. If only fresh water is available, you must add a commercially available salt mixture and thoroughly mix with the fresh water to achieve the appropriate salinity for culture. Use only proven high-quality salt mixtures because different salt mixtures can dramatically affect growth and cause mortality.

Water in the larval culture system is pumped from a collecting reservoir (sump) through a sand filter, passing an ultraviolet light unit and through a biological filter before it enters into the tank

where the larvae are cultured. The volume of the biological filter should be approximately 6 percent of the volume of the entire culture system. The rate of water flow through the biological filter should range from 30 to 100 percent of the volume of the entire system per hour. Highest stocking rates of newly hatched larvae (100/L) will require the highest turnover rates (70 to 100 percent per hour). The sand filter should contain sand particles of an 850-micrometer size to achieve efficient removal of particulate matter before the water is again exposed to the ultraviolet light unit and the biological filter. The removal of particulate matter from the water enhances the efficiencies of the ultraviolet light and biological filter. The ultraviolet light exposure dramatically reduces the concentration of bacteria and accordingly reduces the potential incidence of pathogenic bacteria. The sand filter must be flushed (backwashed) -- once to several times daily, depending upon the size of the larvae and the amount of food fed -- to avoid accumulation of particulate organic material, which can clog or cause channeling, thereby reducing the efficiency of removal. Other types of systems designed for the removal of particulate material from recirculating systems are available.

Preparing and Maintaining Media for the Biological Filter

The water volume of the biological filter should be at least 6 percent of the volume of the culture tanks it will serve. A variety of biological filter media can be used. However, the media should provide a large surface area for bacterial growth, with a portion consisting of calcareous material (e.g., small, crushed oyster shells or coral). Media should be held in bags fashioned from fiberglass window screen to facilitate storing and handling.

The biological filter media are activated in a separate preconditioning container by introducing other media that already have established populations of nitrifying bacteria. Once appropriately conditioned, quantities of the biofilter media are then transferred to the actual biological filter unit as needed (i.e., as the biomass of the larvae in the culture tank increases). Temperature, 82.4 to 86.0 °F (28 to 30 °C), and salinity, 12 ppt (g/L), in the culture and activating tanks should be the same; constant, vigorous aeration is required. The procedure for activating substrate for the biological filter follows:

1. Determine the expected daily maximum ammonia-nitrogen load in the larval culture system, based on the desired level of postlarval production. Based on empirical data, the maximum rate of production of ammonia-nitrogen (ammonia-N) in a closed, recirculating system for *M. rosenbergii* larviculture is about (30 micrograms /larvae/day) 1.05 x 10-6 oz/larvae/day. If the maximum expected amount produced within the system in a 24-hour period (i.e., the amount produced by 2 million larvae), is 2.12 oz (60 g) of ammonia-N then 8.00 oz (226.8 g) of ammonium chloride (i.e., .035 oz (1.0 g) of ammonium nitrogen per .133 oz (3.78 g) of ammonium chloride) should be completely oxidized by the biological filter media's being "activated" in the preconditioning tank. A bag of crushed coral weighing 4.98 lb (2.26 kg) usually contains a good population of nitrifying bacteria that will nitrify (oxidize) 0.035 oz (1.0 g) of ammonium chloride (NH_4Cl) in 24 hours. Therefore, 227 bags of crushed coral would be used to nitrify 2.11 oz (60 g) of ammonia-N. Maximum coral volume, representing less than 4 percent of the total rearing volume, is reached by the 17th day of rearing or a larval stage index equal to 8.5.

2. Initially, 10 percent of the total required ammonium chloride (NH_4Cl), or another inorganic source of ammonia, is added to the water containing the media.

3. After a few days, check the levels of total ammonia-N and nitrite nitrogen (nitrite-N). Low-range ammonia (0.0-0.8 ppm (mg/L) ammonia-N) and nitrite (0.0-0.2 ppm (mg/L) nitrite-N) test kits for saltwater are satisfactory for such determinations. If both levels are below detection, then add the same amount of ammonium chloride as in step 2. If either total ammonia or nitrite is still present, do not add any additional ammonium chloride, and recheck after another 24 hours.

4. Continue to add the predetermined amount of ammonium chloride (see step 2), and check the levels of ammonia-N and nitrite-N. When this amount of ammonium chloride is completely nitrified within 24 hours, double the amount and follow the same procedure.

5. As each level of ammonia is consumed within the desired 24-hour period, double the amount of ammonia until the maximum required load is consumed daily (i.e., within 24 hours). Generally, 4.98 lb (2.26 kg) of crushed coral media containing a good population of nitrifying bacteria will nitrify (oxidize) 0.035 oz (1.0 g) of ammonium chloride in 24 hours.

6. Once the maximum load is achieved, the production cycle can begin. The nitrifying bacteria on the substrate remaining in the preconditioning tank must still be maintained at the maximum level of ammonia and nitrite consumption. As the media are removed, the amount of ammonia needed for maintenance decreases accordingly.

Feeds and Feeding

No dry, nutritionally complete, artificial diet for consistently successful larval culture of *M. rosenbergii* currently exists. Therefore, live food must be used. Newly hatched nauplii of *Artemia* (brine shrimp) have been successfully used as a nutritionally complete diet. *Artemia* are available as cysts (dormant, unhatched eggs) from a variety of commercial sources. Newly hatched *Artemia* with an undigested yolk sac are an excellent source of nutrition but can also introduce disease organisms into the larval culture tank. Therefore, cysts should be sterilized, fully or partially decapsulated, and hatched under clean conditions.

One procedure includes:

1. Cyst hydration: Cysts are hydrated by immersion in freshwater or seawater, <35 ppt (g/L) at 77 °F (25 °C), for 1 hour.

2. Sterilization and decapsulation: Cysts are then sterilized and decapsulated through the addition of 0.140 oz (4 g) of commercial calcium hypochlorite (HTH) per gallon of hydration water. Cysts remain in the sterilizing bath for 20 minutes.

3. Washing and deactivation: Cysts are thoroughly washed on a 0.0047-in (120 micrometers) screen with freshwater or seawater until the odor of chlorine is no longer detected. Toxic chlorine residues that may adsorb to the decapsulated cysts can be

deactivated by dipping them two times into a 0.1 N hydrochloric acid (HCl) or acetic acid (CH3COOH) solution. The deactivation should be performed no more than one-half minute, followed by another washing of the cysts. During the decapsulation process, keep the cysts away from direct sunlight.

Hatching of cysts is best achieved in conical bottomed, funnel-shaped PVC containers that are equipped with a valve at the narrow end to facilitate separation and removal of nauplii and wastes. Stock cysts at <= 0.20 oz/gal (1.5 g/L) in natural or artificial salt solutions at a salinity of 10-12 ppt (g/L). The hatching medium can be enriched with 2 ppt (g/L) of sodium bicarbonate (NaHCO3). The pH should not drop below 8, and temperature should be kept within the range of 77 °F to 86 °F (25 to 30 °C). Provide aeration to maintain dissolved oxygen levels above 2 ppm (mg/L). The hatching tanks should be well illuminated from above, with four 60-watt fluorescent lightbulbs (1,000 lux) at a distance of 7.87 in (20 cm). After approximately 24 hours, harvest hatched *Artemia* nauplii according to the following procedure:

1. Turn off air; remove standpipe (if one is used), heater, and airstones, and cover with a dark lid or black plastic for 15 to 20 minutes.

2. Unhatched cysts and egg shells will rise to the surface and be dark brown. *Artemia* nauplii are bright orange and are located near the bottom of the hatching tank or within the water column.

3. Slowly drain the water containing the newly hatched nauplii from the bottom of the container through a 0.0047-in (120-micrometer) mesh screen until the dark-brown *Artemia* egg shells begin to reappear.

4. Thoroughly rinse nauplii with fresh or brackish water.

5. Newly hatched nauplii arising from 1.75 oz (50 g) of hatched cysts can be safely stored in 34 oz (1 L) of water and should be placed in an insulated container and chilled to not <41 °F (< 5 °C) by the introduction of ice packs. This procedure decreases the metabolism of the nauplii, thereby preserving a high nutritional value.

The hatching rate of cysts varies according to storage time and conditions as well as origin and commercial brand. Generally, 150,000 hatched *Artemia* nauplii can be expected from 0.035 oz (1 g) of cysts. Most larvae begin feeding one day after hatching (larval stage 2). Frequent feedings of live food, *Artemia* nauplii, rather than one or two feedings spread over a long period of time, should be practiced because nutritional value of *Artemia* in the water column will decrease over time as the *Artemia* remove the nutrients contained in the yolk sac.

Generally, the initial feeding of the prawn larvae consists of frozen cubes of *Artemia* nauplii followed by a 1.1 qt (1 L) volume of newly hatched live *Artemia* that have passed through a 0.0047-in (120 micrometer) harvest screen. The *Artemia* nauplii to larva ratio should be initially maintained at 6-8:1, and the density of *Artemia* should be checked at 20-minute intervals. When the ratio falls below the recommended level, add additional *Artemia* in .55-to 1.1-qt (0.5 to 1 L) increments during the early part of the larval cycle and at 1.1-to 1.7-qt (1 to 1.5 L) increments in the later stages of the cycle. A suggested feeding rate of nauplii, according to day poststocking and stage, is presented in **Table 1.**

No later than midmorning, collect a sample of larvae (50-100), and examine them under a dissecting microscope to determine whether their guts are full. Full or mostly filled guts indicate healthy individuals. Empty or almost empty guts are an indicator of poor culture conditions (i.e., poor water quality, high levels of bacteria, or insufficient levels of food provided). Excess *Artemia* that are produced should be frozen in ice cube trays to be available for use during early morning or when poor hatches occur.

Table 1.

Stage-dependent rates for feeding of *Artemia* nauplii and for the supplemental diet. Recommended particle size of the supplemental diet and mesh size of the screen of the overflow for flushing out uneaten food in the larval culture tank.

Day of cycle	Stage index	Artemia per larva		Supplemental feed		Particle size	Flushing screen
		a.m.	p.m.	upper (mg)	lower (mg)	(micrometer)	(micrometer)
1	1	0	0	-	-	-	250
2	1.5	3	3	-	-	-	
3	1.8	3	3	-	-	-	
4	2.2	9	8	-	-	-	
5	2.7	10	9	-	-	-	
6	3.2	12	10	-	-	-	300
7	4.0	16	14	(0.08)	(0.08)	300-500	
8	4.8	22	20	(0.09)	(0.08)		
9	5.4	27	23	(0.11)	(0.11)		
10	5.6	32	28	(0.18)	(0.15)		
11	6.4	38	32	0.3	0.2	500-700	500

12	6.9	42	38	0.38	0.25		
13	7.2	47	43	0.43	0.3		
14	7.9	49	45	0.55	0.4		
15	8.3	51	47	0.65	0.5	700-900	700
16	8.9	53	48	0.75	0.6		
17	9.1	54	51	0.8	0.6		
18	9.6	54	51	1.1	0.6	900-1200	
19	9.8	56	54	1.2	0.75		
20	1st	58	58	1.2	0.8		
Postlarvae							
21		65	65	1	0.8		
22		58	58	1	0.9		
23		58	58	0.85	0.9		
24		56	56	0.85	0.8		
25		53	53	0.75	0.7		
PL		62	62	0	03		

Supplemental Feed

Supplemental feed is usually provided during midmorning and late afternoon, approximately 7 to 10 days after a larval cycle begins. The guts of the larvae should be as full of *Artemia* as possible before provision of supplemental feed. During supplemental feeding, a large mesh screen is positioned around the standpipe to allow uneaten *Artemia* and feces to be flushed from the culture tank. Ingredient composition of a typical supplemental diet is fish or squid, chicken eggs, beef liver powder, and a marine fish oil that should contain a comparatively high level of highly unsaturated fatty acids (**Table 2**). A recommended procedure for the preparation of supplemental feed follows:

1. Thaw squid or fish at room temperature or in a microwave oven for at least 10 minutes. Clean squid by removing pen, ink sac, skin, eyes, and beak; or clean fish by removing scales, skin, and bones. Sterilize 3.18 min/lb (7 to 8 min/kg) on high setting in microwave. Homogenize fish or squid in a commercial-grade food processor until well blended (i.e., smooth texture with no chunks).

2. Mix chicken eggs, marine fish oil, and beef liver powder well and then add to squid or fish homogenate.

3. Add a binder ingredient (e.g., alginate) gradually, and continue mixing slowly until the paste that is formed begins to form balls and detaches from the walls of the food processor.

4. Take the paste and form thin patties by hand or with a press, and place in a plastic bucket containing about 4 to 5 ppt (g/L) of calcium chloride (CaCl2). Extra CaCl2 can be added to the water to increase the rate of binding. The outer layer of paste will begin to harden quickly. After the outer layer of the patties assumes a rubbery texture, press a pattie between your hands and then slide your hands in opposite directions. This procedure will result in the formation of a thinner pattie. After the patties have been separated and have attained a rubbery texture, they are processed in a food mill. Later in the larval cycle, the food mill should be replaced with a 1/16-in (1.6 mm) cheese grater. This procedure will result in an increase in the number of larger particles obtained from the mixture. If smaller particles are desired, manually push the material through sieves to obtain proper particle sizes. Suggested mesh sizes are 0.009 in (250 micrometers), 0.017 in (425 micrometers), 0.024 in (600 micrometers), 0.033 in (850 micrometers), and 0.039 in (1000 micrometers). Thoroughly rinse the sieved diet to remove fine particles that can foul the water and contribute to bacterial growth within the culture tank. Drain the feed before storing refrigerated (several days) or frozen. The size of particle fed normally ranges from 0.012 in (250 micrometers) to 0.039 in (1,000 micrometers), depending on the size of larvae.

Table 2.

Ingredient composition of supplemental diet

Ingredients	Percent wet weight

Squid, cleaned	85
Cod liver oil	2
Eggs	10
Beef liver powder	3

Separation of Larvae and Postlarvae

After 11 larval stages have been completed, larvae metamorphose into postlarvae (PL). After a significant proportion of larvae (25 to 33%) transform to postlarvae, the remaining larvae are transferred to another culture tank. Generally, 2 or 3 transfers of larvae occur per production cycle. Conduct separation during the mid- to late-morning after postlarvae have eaten and are clinging to the wall of the culture tank. Larvae are localized in a feeding ring around the circumference of the tank. Larvae are netted from this area of concentration and moved to another tank. Exercise care to ensure that water in the transfer tank has the same qualities.

After the transfer has been completed, pump 1/2 to 2/3 of the water from the tank where the postlarvae remain to another holding tank and sterilize for future use. The postlarvae are now ready for acclimation to fresh water, which should be added gradually so the salinity eventually decreases to 0 ppt within a 24- to 36-hour period. At this time, determine the mean weight of individual postlarvae by weighing a specific number of postlarvae. In order to estimate the total number of postlarvae produced per production cycle and to control the density stocked into tanks in the nursery phase, weigh the groups of postlarvae collected as they are transferred to the nursery. Knowledge of the total biomass (weight) harvested and the mean individual weight will permit an estimate of numbers stocked. Generally, survival in the hatchery culture phase ranges from 40 to 80 percent.

Nursery

A nursery, also referred to as postlarval or juvenile, phase of culture, has become a standard part of culture practices for many commercial aquaculture species. This phase was originally developed for *M. rosenbergii* culture in temperate climates to increase the length of the growing season, which is limited by water temperatures in production ponds. This phase has also been adopted to produce larger animals for stocking, thereby reducing stocking mortality caused by predation. The nursery phase has also been used as a management practice in tropical climates in an attempt to increase stocking size.

Nursery culture can be accomplished in a variety of ways, including small enclosed ponds or tanks in climate-controlled buildings. To conserve water and heat, water recirculation systems are recommended, but you can also use flow-through systems equipped with heaters. The depth of the ponds or tanks (pools) should not exceed 4 ft (1.2 m) and should be equipped with structure (artificial habitat) throughout the water column to increase the total available surface

area. The habitat will result in wider distribution of the prawns, significantly reducing the incidence of cannibalism. To achieve the best growth and survival, an initial stocking density of not greater than 19-23 PL/gal (5 to 6 postlarvae/L) is recommended, and water temperature should range between 78.8 to 82.4 °F (25 to 28 °C). Postlarvae may be fed a commercially available trout diet containing a high level of crude protein and energy and being a particle size that can be readily consumed. The total daily ration is divided into two or more separate feedings. Three times per week frozen beef liver is fed as a substitute (on a dry weight basis) for one of the trout diet feedings. The level of the daily ration may need to be adjusted, based upon whether or not the amount of food provided is entirely consumed. Under these culture conditions, the nursery phase should produce within 50 to 60 days individuals with a mean individual weight of 0.011 oz (0.3 g). The nursery phase should not exceed 60 days due to the increased incidence of mortality by cannibalism as the individual mean weight increases, and the increased potential for the occurrence of adverse conditions of water quality. Generally, 65 to 75 percent survival can be expected at the end of the nursery phase.

Size Grading of Nursery Populations

Size grading of juveniles from nursery-grown populations before stocking into production ponds was found to be an effective method for increasing individual mean harvest weight and total yield over those achieved with ungraded individuals. Size grading has increased the prospects for economically successful freshwater prawn culture. This stock manipulation procedure separates faster and slower growing prawns, ultimately disrupting the typical social hierarchy formed among males. When these separate populations are transferred to production ponds, growth of smaller males is no longer negatively impacted by the faster growing individual males. Smaller males may increase growth rates to compensate for the initial retarded growth rates (compensatory growth) that developed during the nursery phase. The result at harvest is a dramatic reduction in the range of sizes, particularly due to the reduction in the percentage of small males that are generally considered to be of low or no market value for this species. Accordingly, total yield and potential revenue increase.

Size grading can be performed with modified bar graders or with those that are used to grade fish. The type of separation achieved will depend upon bar width as well as the weight (size) distribution of the population of prawns. Experiments have demonstrated that a good relationship exists between bar width and mean weight of the largest prawns that pass through oriented parallel to the bars. Determine the prawn size (weight) -- bar width relationship for the specific size grading technique used. A 50%-50% (upper-lower) or 40%-60% (upper-lower) numerical separation is advised so the entire population can be used for stocking. However, even both populations arising from a 70%-30% (upper-lower) separation have been successfully used. Conduct size grading with sufficient aeration to avoid stressful conditions. Juveniles move toward a flow of water, and this behavior may assist in the development of passive grading techniques. Other, more active, grading techniques would involve the movement of a grader through a population or the movement of a population through a stationary grader. No specific grading procedure is recommended. The choice would be based upon the experience and resources available to the culturist.

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