Breeding and hatchery management of tiger shrimp *Penaeus monodon* 2

Gulshan Kumar
School of Fisheries

HATCHERY DESIGN AND CONSTRUCTION

Basically, there are two hatchery systems being adopted. The large-tank hatchery which was developed in Japan is still the popular system applied in many Asian countries such as Taiwan, Thailand, Philippines and Indonesia.

The small tank hatchery which originated from Galveston USA, has been applied in the Philippines and to same extent in Malaysia and Thailand. Recently a modification of the above systems has been developed which combined the beneficial characteristics of both systems taking into consideration the limitation of spawner supply.

Hatchery technology

Hundinaga(1935), a japanese scientist, was the first to successfully breed and rear the larvae subsequently under controlled conditions in the laboratory.

After this a series of development have been taken place in different parts of the world as a follows up of the above works which helped in the commercial production of shrimp seed for farming. The hatchery system for prawn culture are primarily of two types.

a) Japanese system/community culture/fertilised system/ large-tank hatchery
b) Galveston system/ small tank hatchery

Japanese system/ large-tank hatchery :

In this system spawning, hatching and larval rearing are done in the same container. In this system, large cement concrete tanks of 60 to 200 ton capacity provided with aeration and rotating agitators were used. Tanks were cleaned, dried and filled with fresh sea water to a height of 0.4 meter. Spawners were introduced @ one spawner per m^3 of tank capacity in cage nets. After spawning, spawners are removed with cage nets, leaving the eggs and hatched out larvae in the tank.

Rearing of the larvae is done in the same tank. The water is regularly fertilized with nutrients to promote bloom of diatom(this provide ideal food for protozoea). Vigorous aeration is carried out. From the I mysis to 4^{th} day of postlarvae, fresh seawater is pumped into tank every day until the water level is raised to two meters. For mysis, supplementary feed in the form of artemia eggs are used. For post larvae crushed and washed clam meat was also given.

This system is not practiced at present because of following disadvantages:

1. There is uncertainty due to lack of control over the production of desired species of phytoplankton at the appropriate time.
2. There is frequent development of bloom of undesirable species of planktonic organism such as dinoflagellates leading to mass mortality of larvae.
3. High initial strength of nauplii resulted in poor survival rate, due to water pollution resulting from the accumulation of metabolites produced by larvae and feed residue.
4. Greater proportion of food added to the system remain unutilized.

Galveston system/ small tank hatchery:

This system was developed in the galveston laboratry, USA(cook and Murphy, 1966).

In this system, rearing of brood stock, spawning, hatching, larval rearing and live feed culture are done separately in separate containers.

Spawning is carried out in small indoor plastic pools. Newly hatched nauplii are transferred to larger(2000 litre capacity) plastic pools @ 50 nauplii/litre of water.

Simultaneously separate cultures of mixed phytoplankton predominated by chaetoceros and culture of rotifer (branchionus) and cladoceran (moina) were under taken in lab.

Sea water of 32±2 ppt were pumped into large containers where it is filtered through 60µ mesh cloth before use in operation.

From second day after spawning i.e. last nauplius stage onwards, 200 litres of mixed phytoplankton culture, predominantly chaetoceros(2 lakh cells/ml) is pumped into culture tank after reducing equal quantity of water from it every day as protozoea feed on phytoplankton.

From mysis stage, in addition to the above feed, frozen branchionus @ 100 rotifr/larvae/day is given.

When it metamorphose into postlarvae feeding on diatom is discontinued and moina @20 /larvae/day is given.

Throughout the rearing periods, vigorous aeration of water is provided. Constant check is made on the quality of seawater and slow exchange of 15 to 25% of water is made after the larvae reaches mysis stage.

- Water should be clean unpolluted sea water free of suspended impurity and planktonic organisms.
- Temperature (28°c ±2) is found to be most suitable. Lower temp retard growth of eggs and larvae. Avg. (24-32°c) suitable for development of penaeid larvae.
- Salinity (27-34ppt) is suitable.
- pH should not exceed 8.2-8.5
- Ammonia and nitrite level should not above 0.1mg/l and 6.5mg/l respectively.
- Dissolved oxygen maintained through continuous aeration.

Modern shrimp hatchery:

A modern shrimp hatchery should have the following essential units.

a) Brood stock rearing/maturation unit

b) Spawning unit

c) Hatching unit

d) Larval rearing unit

e) Artemia cyst hatching unit

f) Algal culture unit

Brood stock rearing/maturation unit:

If from wild, the breeders are brought in hatchery through transportation in 40-50 liters of water @ 4-6 no per bag. Then acclimatized to the hatchery condition. Care should be taken and treated with 100 ppt formalin for ½ hr for disinfection. Any disease sign dip treatment in antibiotic (50ppm oxytetracyclin/erythromysin/perfuran) for 10 minutes. Such healthy breeder are then transferred to maturation tank.

The major constraint in hatchery operation of tiger shrimp is the limited supply of spawners from the wild. Hence, eyestalk ablation techniques can be used to augment the scarcity of spawner supply. Thus, maintaining ablated shrimp in maturation tanks would ensure a constant supply of gravid females.

The shape of maturation tanks can either be circular, rectangular or oval. The tank capacity may vary from 5 to 40 tons with depth ranging from 1.2 to 2 meters. If the shrimps are kept for less than 5 weeks, bottom substrate is not needed in the tank. The tank is installed with an inlet pipe from the wall and a double cylinder standpipe at the center for drainage. This system facilitate continuous flow-through of sea water.

Brood stock maintenance:

Water: should be clean, clear and free of pollution; Water height- 60 to 100 cm; water flow rate- 10 litre/minute; DO- at sturation level; salinity- 30 to 36 ppt; temp- 21 to 31°C; pH- 8 to 8.5(should not be less than 7.3 as it affect the calcification of cuticle and normal moulting process).

Light: reduction in intensity of light to 10 to 40% of the natural day light is reported to have beneficial effect on growth and maturation of gonads. For this purpose, fluorescent lights covered with dark blue acrylic sheets are used in maturation division. Photoperiod regime can be 12 hr light-12 hr dark.

Feeding: meat of squid/mussel/clam @ 12-15% of the body weight are used for good result. pelleted feed containing 50% protein and 10% PUFA(EPA, DHA & arachidonic acid) @ 2% of the total bodyweight are stated to enhance gonadal maturation. Feeding can done 4 time a day.

Spawning tanks:

Spawning tanks should be circular with a flat or conical-shaped bottom(more prefered).

Water holding capacity may vary from 50 liters to 1.5 tons. The tank can be made of fiberglass, Plexiglass, plastic or marine plywood.

The tanks are used to temporarily hold the gravid females until spawning. A perforated plastic sheet is kept at the junction of conical and cylindrical part for resting the spawner.

During spawning, released eggs sink to the conical part but female cannot enter the same for eating eggs.

Larval rearing tanks:

Two types of rearing tanks are being used to rear the newly hatched larvae.

In Japan and Taiwan, larger tanks with a capacity of more than 50 tons are being used.

In Southeast Asia, most of the hatcheries use smaller larval rearing tanks of about 3 tons capacity.

Hatchery operators called the latter system of larval rearing as the Small-Tank Hatchery System which originated from the Galveston Laboratory in the USA and the former system as the Large-Tank Hatchery System which originated in Japan.

Small Tank System

The larval rearing tank may be circular, rectangular or oval in shape with tank capacity ranging from 0.8 to 3 tons.

The bottom of circular tanks may either be flat or conical. Rectangular or oval-shaped tanks always have flat bottom.

The circular tank is usually 1.8 m in diameter and 1.2 m in depth with a central double cylinder standpipe drainage system which can be used for continuous flow of sea water.

when the larvae reach mysis or post larval stage. Rectangular tank is about 1.5 × 5 × 1 m in size.

The drainage pipe is set at the side of the tank. The drain pipe is also used for harvesting.

In all types of tanks, sea water is delivered into the tank through an inlet pipe installed at the top of the tank.

Big Tank System

The tanks used are rectangular or square in shape with capacity varying from 50 to 2000 tons or more (5 × 5 × 2m or 20 × 50 × 2m). The tanks can either be located outdoors or if located indoors, transparent roofing should be provided to allow for sources of sunlight **(Fig.4). In a big** tank system, spawning, hatching and larval rearing operations are done in the same tank. The larvae are reared for 35–40 days (PL25-PL30).

Live food culture tanks

In mass cultivation of live food organisms, size of tanks used usually ranges from 1 to 20 tons.

The tanks can be made of either fiberglass, polyethylene, marine plywood or concrete. On the average, the total tank capacity for live food culture is about 20% of the total tank capacity for larval rearing.

The criteria used for selecting spawners from the wild are:

a. stage IV ovary

b. complete appendages

c. the back is not broken

d. presence of spermatophore underneath the thylecum; and

e. the color of the shrimp especially P. monodon should be pink with a faint greenish tint.

Spawners which are slightly reddish could be due to stress caused by abrupt lowering of the water temperature during transportation by fishermen who try to delay spawning. Stressed spawners give very low spawning rates.

There are several ways by which spawners are transported from the field to the hatcheries.

They can be transported in:

a. live fish holding compartment in the boat with running water system (very convenient for hatcheries close to the fishing ground).

b. holding tank with aerated seawater at controlled temperature (22–24°C) using ice in plastic bags and transported by trucks.

c. plastic bags injected with oxygen and packed in styrofoam boxes. The water temperature can be controlled by using ice mixed with sawdust. In this case, the rostrums of shrimps could be covered with plastic caps to prevent puncturing of plastic bags, and bamboo or PVC tubes: the spaweners are immobilized in separate tube without overstraining them. While transporting in boats, the shrimps are held in cool (22–24°C) aerated water in tanks but are transferred to plastic bags with oxygenated water while transporting on land.

Tube transport along with reduced temperature reduces the frequency of untimely spawning in transit and/or injuring themselves.

Treatment of spaweners

Upon arrival, each spawner is normally placed directly in a spawning tank without any further treatments. However, during winter or when there is known spread of disease, spawners are usually treated with either (a) Treflan (trade name), 0.5–1 ppm (b) KMnO4, 3ppm or © Formalin, 25 ppm for 10–15 minutes.

Spawning activity

In nature, adult shrimps mate after the females have molted.

Spawning usually occurs while swimming with the spermatophore in the thylecum and eggs are released from the genital pore which is located at the base of the third pereiopod; sperms are likewise discharged into the water through an apperture at the base of the fourth pereiopod.

Fertilization is external. Spawning usually occurs between 02:00 to 03:00 hours at water temperature and salinity ranging from 25 to 30°C and 28 to 32 ppt, respectively.

Egg collection and treatment

After spawning, the animal is removed from the tank the following morning. The eggs are then cleaned either by siphoning into egg collectors **(Fig. 28A) or draining 2/3 of the water through a** filter net that effectively retains the eggs within the tank **(Fig. 28B).**

When draining is completed, the scum is then removed using a scoop net with a mesh size bigger than the shrimp eggs. The tank is then filled up with new seawater **(Fig. 29).** During the cold season, fungus and bacteria are likely to infect the eggs during incubation.

Preventive treatment normally consists of dipping the eggs in 1 ppm of methylene blue or 0.5 ppm of malachite green for 10 minutes or 3 ppm $KMnO_4$ for 30 minutes.

After that, the eggs are transferred to a cleaner tank for further incubation and subsequent hatching. From the incubation/hatching tank, samples of eggs are counted to determine the number of eggs spawned per female.

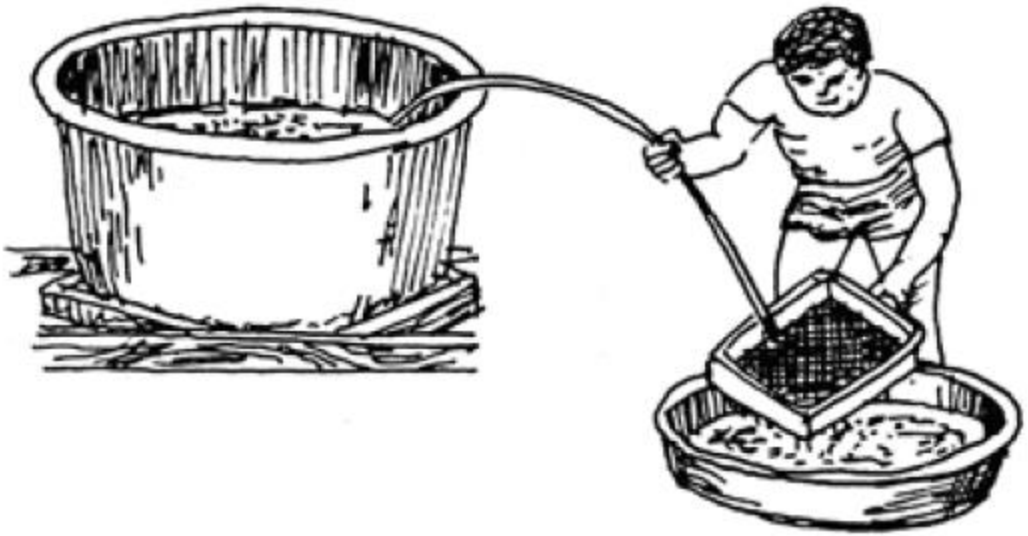


Fig. 28a. Egg collection

Fig. 28b. Cleaning of eggs by changing water

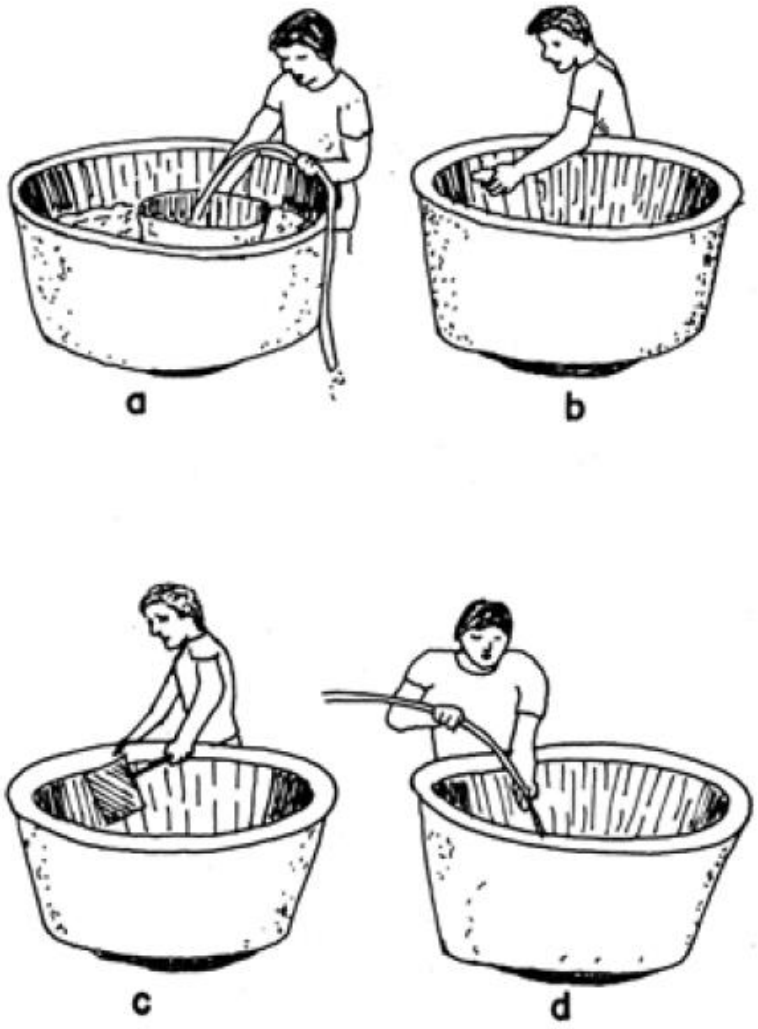


Fig. 29. Cleaning of spawning tank

HATCHING AND TRANSPORTATION OF NAUPLII

Eggs of most species of shrimps hatched out within 12–18 hours after fertilization at temperature and salinity range of 26–30°C and 30–32 ppt, respectively.

Determination of hatching rate:

The density of nauplii is estimated a day after hatching. Nauplii from three 100 ml water samples taken from the spawning tank are counted and averaged. The total number of nauplii in the tank is then obtained by multiplying the volume by the average density.

To determine the hatching rate, the following formula is employed:

$$\text{Hatching rate (\%)} = \frac{\text{No of nauplii counts}}{\text{No. of egg count}} \times 100$$

Nauplii are then directly transferred to larval rearing tanks.

Transportation of nauplii

At the nauplii stage, the larvae hardly feeds and thus depends on its yolk for development. This stage is easy to transport even for long durations. In some cases, where the site of the established hatchery is far from the spawner collecting areas, it is more advantageous to transport the nauplii instead of the spawners which are more prone to stress. The nauplii are transported to the hatchery in two ways:

a. plastic containers - Only strong and healthy larvae should be transported. This is done by concentrating the nauplii at the water surface with a light source at night, gather them by scooping with a plastic or glass container. The larvae are then transferred into plastic jars which are half-filled with seawater. The container is then gradually filled up. A 20 liter plastic container can contain a maximum number of 500,000 nauplii. The open end of the container must be properly sealed to prevent leakage. The survival rate after 6–8 hours during transportation is more than 50%.

b. plastic bags - Each bag containing about 6–8 liters of water can be stocked with 200,000 nauplii. The water in the bags are oxygenated and the open end is closed with rubber bands. The survival rate is about 80–90% if transport takes about 4–6 hours **(Fig. 30).**

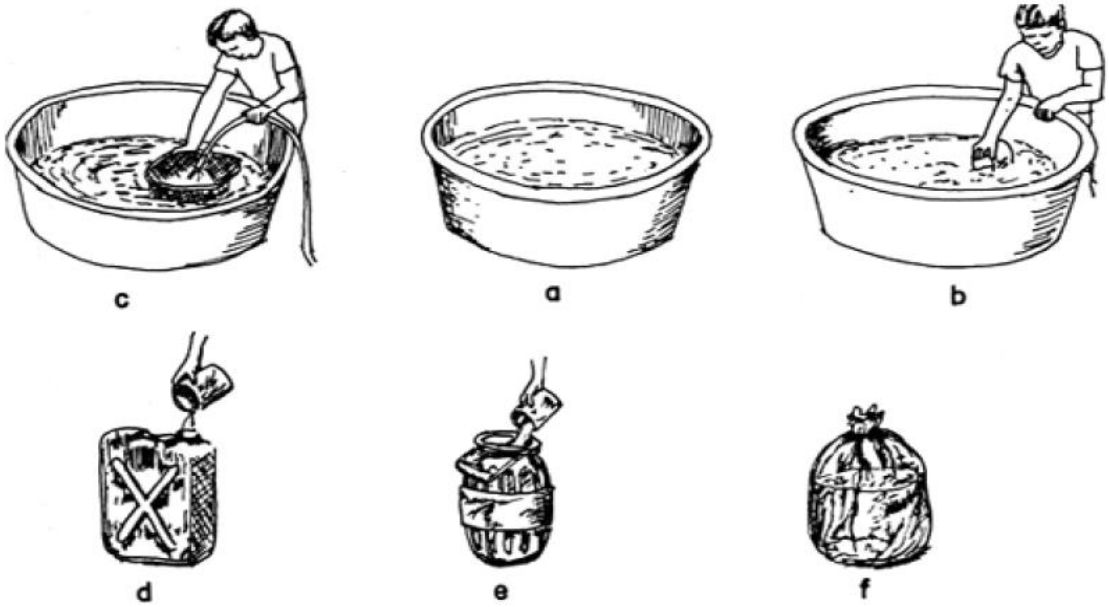


Fig. 30. Harvesting of nauplii and transport containers.

a. stop aeration

b. allow nauplii to swim toward the surface then collect nauplii using beaker

c. drain the water through a filter net for total harvest

d. jerrycan

e. plastic jar

d. plastic bag

LARVAL REARING

From the spawning tank, smaple of eggs are counted to determine the number of eggs spawned per female. In normal condition, fertilized eggs hatched within 12–15 hours.

The hatching rate is measured by assessing the number of hatched nauplii. Nauplii are then transferred directly into the 40-ton tanks if the number of nauplii is between 0.5 million and 1 million.

They are then reared directly in the large tank up to the 25th post larval day. On the other hand, if the number of nauplii is less than 0.5 million, they are stocked in 2.5-ton indoor tanks at a density of 100–150 larvae/liter.

The larvae are reared either to the third mysis stage (M3) or one day old (P1) post larvae. They are then transferred to the outdoor 40-ton nursery tanks for further nursing

Larval rearing in small indoor tanks

After hatching, the newly hatched nauplii are stocked at a density of 100–150 nauplii per liter in the 2.5-ton larval rearing tanks with fresh filtered seawater filling up to 3/4 of tank capacity. No feed is required at the nauplii stage since the nauplius still utilizes its yolk as food. However, diatom are inoculated immediately after stocking to ensure availability of feed when the nauplii molt into the protozoea stage.

Protozoea stage: This is a critical stage of larval rearing. The larvae at this stage start feeding on external food and feed on minute and easily digested microscopic algae such as Skeletonema costatum, Chaetoceros sp. and Tetraselmis sp. The optimal feeding of phytoplankton in the rank is 50,000 cells/ml for Skeletonema or Chaetoceros and 10,000 cells/ml for Tetraselmis. Thus, feeding must start one day ahead of the expected time of metamorphosis, that is, feeding starts from nauplii four. The quantity of feed given is 10 µg/larva/day and 50 µg/larva/day for dry and wet processed crustacean tissue respectively.

On the other hand, there is a bright prospect in the use of wet or dry processed invertebrates tissue or encapsulated or microencapsulate feeds in shrimp hatchery feeding strategy.

The use of these types of feed can reduce production cost as well as make the feeding regime of shrimp larvae more convenient especially for small-scale or backyard hatcheries which can not afford to have a phycology laboratory.

The use of marine invertebrates as food organisms can be purchased at low prices and in large quantities since these are available locally. The commonly used food organisms are paste shrimp (Acetes sp.), rock shrimp (Metapenaeus sp.), stomatopod (Oratosquilla sp.) blood cockle (Anadara sp.) and mussel (Perna sp.).

Microencapsulate diets on the other hand is the latest research product in feeding strategy. However, studies using this type of feed are still in progress. The recommended feeding rate according to Jone (1984) is 16 µg/larva/day and increased daily by 20%.

Mysis stage

The larvae at this stage will start feeding on rotifers (Brachionus plicatilis) or the brine shrimp nauplii required depends on the density of shrimp larvae being reared. Each mysis larvae consumes about 100–200 rotifers or about 20–50 artemia nauplii per day or a standard ratio of about 5 grams dry Artemia cysts is required per cubic meter of rearing water.

During this stage, the tank bottom is already filled with dead organisms and must be siphoned out daily. Once the larvae reaches the first day of postlarval stage (P1), they can be transferred to the bigger nursery tanks.

One day before transferring the postlarvae to the outdoor tanks, the nursery tanks should be first filled up with fresh filtered seawater to allow adequate blooming of diatom. The postlarvae is stocked at a density of 15–20 larvae/liter.

Larval rearing in large nursing tanks

The initial water level in the 40-ton nursery tanks during stocking is 100 cm. The nauplii density is usually about 20–50 per litre.

Immediately after stocking, diatom starters are inoculated to ensure bloom of the desirable species. Technical grade fertilizers can be used directly to enhance algae growth. The fertilizers used are: KNO3 (potassium nitrate) 3 ppm; Na2HPO4 (Di sodium phosphate) 0.3 ppm.

It is pertinent to monitor the types and density of algae in big tanks to ensure that the optimal density is maintained. During the protozoea stage, about 10–20 cm of fresh filtered seawater is then added daily.

However, the amount of water added is dependent on the diatom growth. When diatom density is below the desired level in the culture tank, more cultured diatom and fertilizers are added to accelerate algal bloom.

On the other hand, over-blooming of algae should also be controlled by shading or by draining out a portion of water and replenished with fresh seawater.

Mysis stage

The same operational procedure for rearing of mysis stage used in the small-tank system is employed in the outdoor nursery tanks. After water level in nursery tank has been filled to its full rearing capacity, approximately 30% of the water is changed daily.

Postlarvae stage Early postlarval stages (P1-P6) are fed with brine shrimp nauplii at a rate of 100–200 per postlarvae per day. Once the postlarvae reached the sixth day (P6), they are fed with finely minced mussel or cockle meat or larval pellet feed while Artemia feeding is stopped at P9.

Beyond this stage, the larvae are fed solely on minced mussel or cockle meat or articicial diets 3 to 4 times daily. In the meantime, polyethyelene nets were provided as a substrate for the larvae.

Good water quality should be strictly maintained especially during this phase of larval rearing. While 30–40% of the rearing water is being changed daily, efforts must be made to ensure saturation of dissolved oxygen concentration in the water and low concentration of ammonia (0.1 ppm).

Hence regular siphoning of tank bottom to remove excess feeds, metabolic wastes and dead algae is an important and routine hatchery function.

When 50-70% of the rearing water has been drained, continuous flow-through of fresh seawater is maintained for 2–3 hours. Such flow-through operation enables the suspended (solid) particles to be drained out and water clarity maintained.

Sometimes, when over-blooming of diatom becomes uncontrollable, or the sediments accumulated at the tank bottom is too thick, which deteriorate water quality rapidly, it is necessary to transfer the larvae to another well-prepared tank.

It is highly important to ensure that there is no drastic fluctuation of environmental conditions. Efforts must be made to maintain stable condition in the tank and the water quality maintained within the allowable limits:

Salinity 30–32 ppt

Dissolved oxygen-saturation

ROUTINE HATCHERY MANAGEMENT

The maintenance of optimal environmental conditions is necessary for maxima growth and survival of the cultured organisms.

Maintenance of water quality

Salinity - Biologically, most penaeid shrimps do not breed in brackish water while mating, spawning and even hatching of eggs take place only in the open sea.

Salinity in spawning grounds normally ranges from 30 to 36 ppt. Thus, seawater salinity in spawning tanks should be maintained at 30–32 ppt to ensure good hatching rates.

Moreover, low salinity affects larval growth during the first 15 days of rearing. Though abrupt or extreme variations in salinity may adversely affect larval survival, slight variations in salinity is not detrimental.

Temperature - Temperature directly affects the metabolic system of any given species. In penaeid shrimps, eggs do not hatch at temperatures lower than 24°C.

Larvae usually grow and molt faster at higher temperature. The optimum temperature is 26–31°C. Below this level, larvae do not grow well and molting may be delayed.

The protozoea of P. monodon, for instance, molt to mysis stage within 4 days at temperatures ranging from 28°C to 31°C, however, molting takes 6 days when temperature drops to 24–26°C.

Slight increase in water temperature above threshold may be lethal in the tropic species. Gradual variations in temperature throughout the day is not critical, however, sudden changes even as narrow as 2°C can cause high mortalities due to stress and temperature stock.

Dissolved oxygen - Dissolved oxygen is a critical factor in larval rearing. High mortalities can occur if aeration stops even for only one hour.

pH and nitrogenous compound - Normal pH of seawater ranges from 7.5 to 8.5. The pH value is a key indicator of changes in the water environment of the rearing tank relative to ionized and un-ionized ammonia. This is so because NH3 and NH4 ratio in water is pH dependent.

If pH value is high, this signifies increased levels of un-ionized ammonia (NH3) which is toxic to larvae. Ionized ammonia (NH4 +) however, is not toxic because it is unable to pass through the gill membrane of the larvae. Safe ammonia concentrations in water should not exceed 1.5 ppm for NH4 + and 0.1 ppm for NH3.

Feeds and feeding schemes

Shrimp larvae at the first protozoan stage cannot efficiently seek food as the swimming appendages have yet to develop. Hence, the feeds must be present in sufficient quantity.

On the other hand, diatoms often over bloom in the rearing tank especially those in the outdoor hatchery. This causes high mortality due to attachment of diatom on the appendages of the larvae which makes them unable to move and molt properly.

In addition, over blooming of diatom collapses easily the next day and this results in water fouling. Therefore, programming of natural food culture and maintaining feeds at sufficient levels only is an important operational strategy.

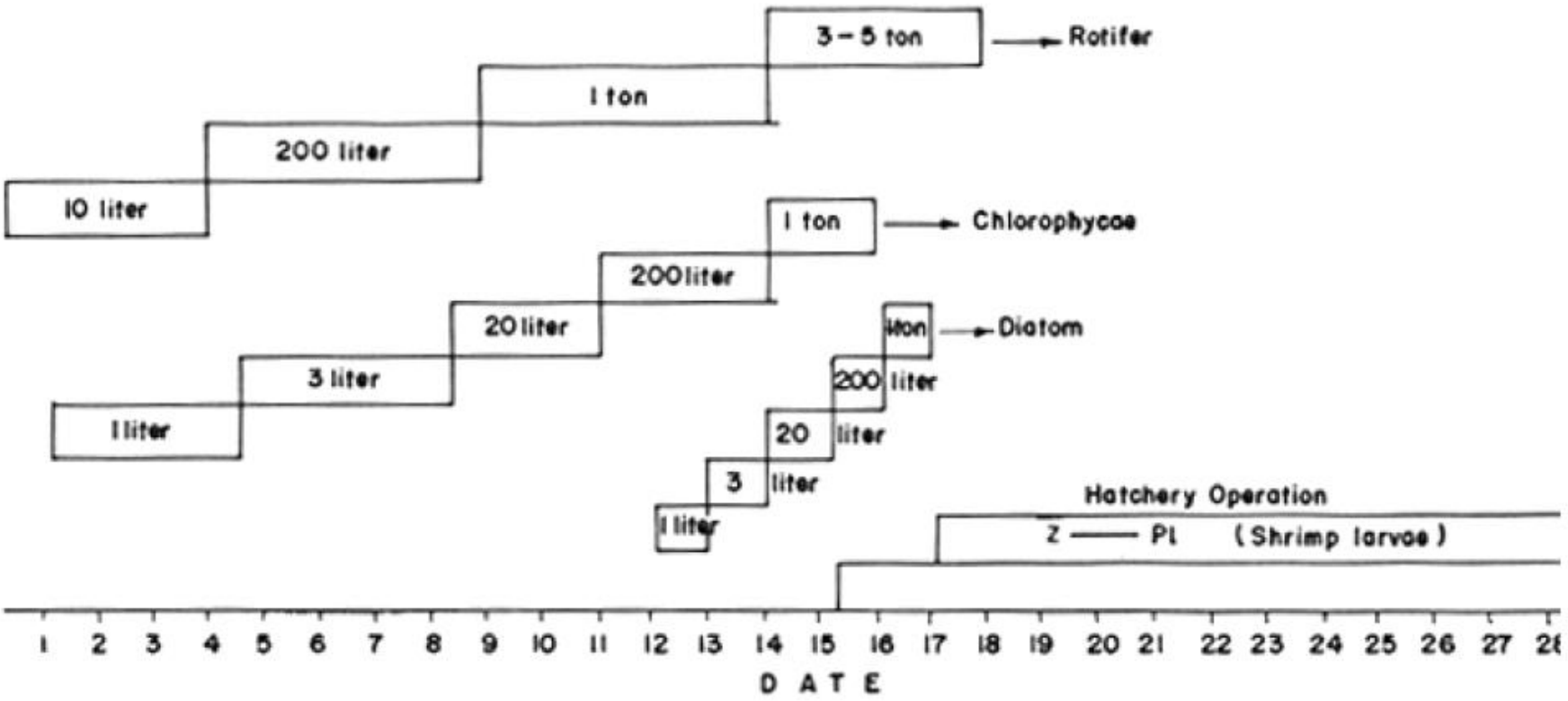


Fig. 32 A. PROGRAMMING OF NATURAL FOOD CULTURE FOR HATCHERY

To monitor if the feed is sufficient in the rearing tank, the density of diatoms is counted daily before and after water management.

Diatoms are counted by using a haemacytometer while Brachionus and Artemia densities are established by head count. Once diatoms in the larval rearing tank become brown, new diatom cultures are added to meet the density requirement of the larvae.

The approximate density sufficient for larvae in the rearing tank is 50,000/ml for Chaetoceros sp. or Skeletonema costatum and 10,000/ml for Tetraselmis sp. Brachionus must be maintained at 20 individuals/ml and Artemia at 50 grams for every 100,000 postlarvae.

Overblooming of diatoms during summer days is controlled by shading the larval rearing tank or by draining out a portion of the water and replenishing with fresh filtered seawater.

Monitoring

Environmental parameters such as water temperature, salinity and pH should be checked twice daily.

Meanwhile, the estimated number of larvae at each stage of development should also be recorded.

The average number of larvae per liter will give an idea of total amount of larvae. However, larval estimates can be done until P4 only because the larvae changes to demersal feeding habit after this stage.

The precise number of larvae will be known during harvest when head counts are done.

NURSERY OF POST LARVAE

Since small tank nurseries normally produce up to P5 - P6 postlarvae only, such stages cannot be stocked directly in grow-out ponds.

Therefore, nursing of postlarvae from the small hatchery is still necessary.

Nursing of postlarvae can be done in many ways, viz: in concrete tank, earthen pond or in net cages.

Concrete tanks:

Concrete tanks are prepared by filling up with filtered seawater provided with aeration and pure cultures of diatom added to preserve water in good condition and make it less transparent.

Ideal stocking density of the larvae is about 50/cubic meter of water. It is advisable to use substrates to increase surface area in the nursery tank, because postlarvae have a habit of clinging to the wall and tank bottom. Polyethylene nettings can be used and being synthetic, they do not decompose in water and can last longer without deterioration.

The early stages of larvae are fed with Artemia, while the older ones are given chopped mussel or cockle meat. Young and adult Artemia may also be added to the diet throughout the nursery period which takes about a month. Water is changed daily at 50% of the total capacity. Flow through system is permitted in the nursery tank as this results in good growth and survival rates.

Earthen pond:

Nursery pond size ranges from 500 to 2000 L and water depth at 40–70 cm. The nursery pond should have at least one gate installed with a fine screen (1 mm mesh size) to prevent predators and competitors from entering **(Fig. 33).** P9-P10 are suitable sizes for stocking in the nursery ponds.

Stocking density is 100–150 individuals per square meter. Prior to stocking, the pond should be completely drained and dried until soil cracks. In cases where the pond cannot be completely drained, derris root (Rotinone) may be applied at 20 kg/ha to eradicate predators. Derris root is crushed until it breaks, soaked on water overnight and the resulting milky solution applied.

Fertilizers are applied at 1000 kg/ha and 50 kg/ha for organic (chicken manure) and inorganic (Ammonium sulphate) fertilizers, respectively. Water exchange depends upon the time of spring tide when water can enter the pond. Chopped mussel or cockle meat are fed to the larvae at the rate of 10% the total biomass. The culture period lasts 30–45 days when larvae becomes P40 or P60.

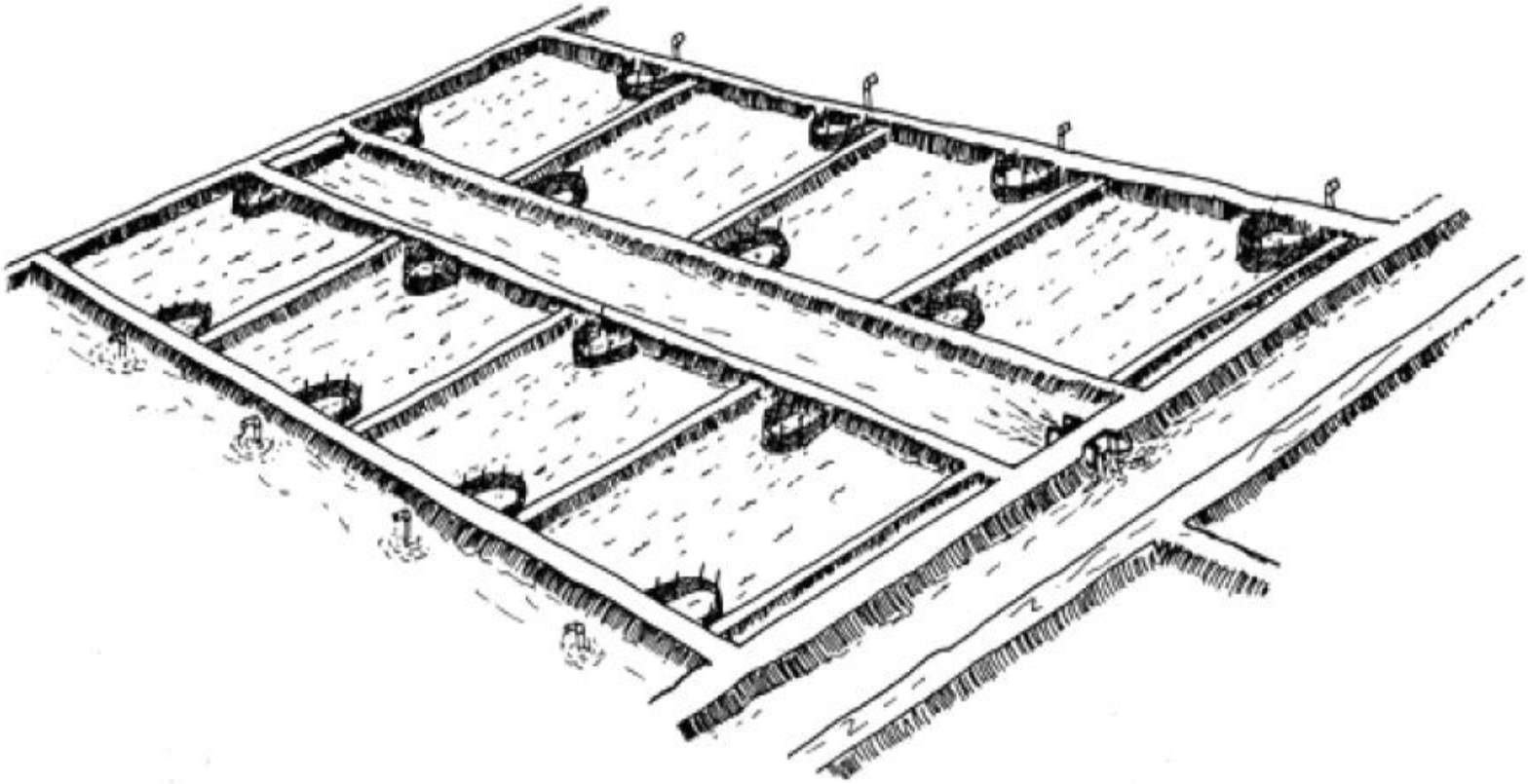


Fig.33. NURSERY POND

Nursery cages

Cages made of synthetic netting can either be floating or stationary in calm water in bays, lagoons or fishponds.

Sites for installation of the nursery cages should be as far as possible free from biofouling because nursery cages are made of very small mesh size nettings which can be easily covered up by bio-foulers and thus prevents water exchange. The cages are normally supported by frame and by floating bouys made of bamboo or styrofoam drums.

Stationary cages are held up by bamboo or wooden poles **(Fig. 34).** Postlarvae (P6–7) is suitable for stocking in cages at a stocking density of 1000–2000 per cubic meters of water. Feeding scheme is similar to that in earthen pond nursery.

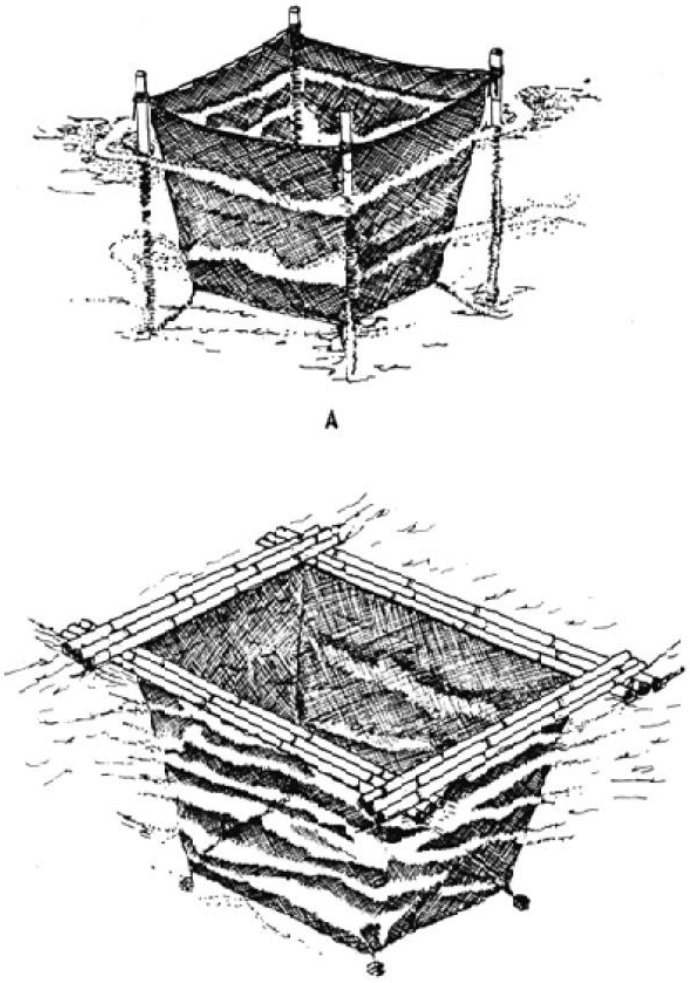


Fig. 34 Nursery Cages

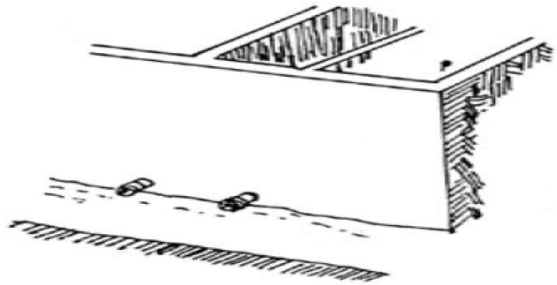
A. **stationary cages**
B. **floating cages**

HARVEST AND TRANSPORT OF LARVAE

P21-P25 is suitable for harvesting from nursery tanks because this size can be stocked directly to the pond and easily be transferred.

The larvae in nursery tanks can be harvested by first reducing the water level to about 1/3 of its depth and then can be collected from the bag net positioned at the tip of the drained pipe.

This method is efficient enough to collect all the larvae. The postlarvae can also be harvested with a scoop net, dip net or seine net after 2/3 of the tank water has been drained. This method however, is time-consuming.



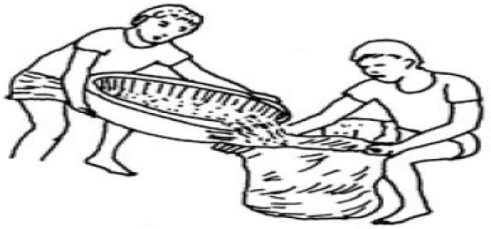
a. Drain 2/3 of tank water using filter box

b. install bag net outside drain pipe; open drainage

c. collect larval from bagnet

d. transfered harvested basins

e: made the head count then distributed in other plastic basins: density compared by occular inspection low water temp. 24°c



f: place known amount of larvae in plastic bag

g. introduce oxygen 2/3 local volume of bag

h.fashen upper end of bag with rubber band

i. place bags in styrofoam boxes

The number of harvested postlarvae is estimated from a single water basin of known volume from which animals within have been individually counted.

This basin serves as a constant where visual comparisons are made with the rest of the harvest in similar basins.

This method is reliable especially if the size of the larvae is uniform.

Methods of transporting postlarvae:

a. Tanks - Postlarvae can be transported in plastic, fiberglass or canvass tanks of a suitable transport size (500–1000 liters) and provided with aeration. Temperature of water can be lowered by floating plastic bags with ice. Postlarvae at a density of 200–500/liter can be transported for 10 hours without heavy mortalities.

b. Plastic bag - Very often, postlarvae are transported in polyethyelene bags provided with oxygen. The bag (60 cm × 40 cm) is first filled with 6–8 liters of fresh seawater and then packed with 3000–5000 postlarvae. The density may be reduced if the expected transport time is longer. After properly tightening the mouths of the bags, they are placed in styrofoam boxes or plastic buckets. Temperature is reduced to about 22–25°C by crushed ice mixed with sawdust on the bottom, side and top of the styrofoam box. Under these conditions, postlarvae may be kept alive for more than 12 hours during transport.