AQUACULTURE EXTENSION MANUAL NO 9
Second Edition

ISSN 0115-5369

Prawn Hatchery Design and Operation

AQUACULTURE DEPARTMENT
SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER

AQUACULTURE EXTENSION MANUAL No. 9 ISSN 0115-5369
Second Edition

PRAWN HATCHERY DESIGN AND OPERATION

This manual was prepared by the

WORKING COMMITTEE ON PRAWN HATCHERY

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AQUACULTURE DEPARTMENT
Southeast Asian Fisheries Development Center

ISSN 0115-5369

First edition, 1984
Second edition, 1985
First printing, April 1985
Second printing, October 1985
Third printing, February 1987
Fourth printing, March 1989

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PRAWN HATCHERY DESIGN AND OPERATION

I. INTRODUCTION

The development of the prawn industry greatly depends on a steady supply of fry. Since limited numbers of fry can be obtained directly from the sea, research efforts in recent years have focused on improving prawn hatchery techniques to increase fry production (Fig. 1).

There are a number of prawn hatchery techniques practised by operators. They have evolved from continuing studies to simplify ways of rearing and feeding prawn larvae that will ensure high survival and production of fry.

To operate a prawn hatchery, you need to consider the following:

- Site selection
- Hatchery facilities and equipment
- Knowledge of prawn larval stages
- Spawner and broodstock collection and transport techniques
- Larval rearing techniques
- Postlarval rearing techniques
- Fry harvest, packing, and transport techniques

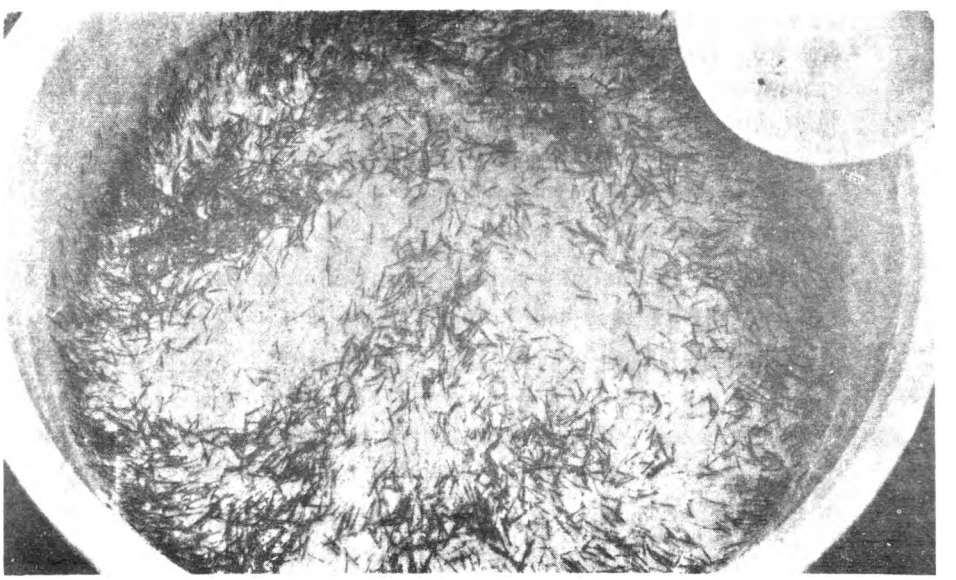


Fig. 1. Hatchery-bred prawn fry

Each of these aspects is fully explained and illustrated in the following sections.

The simplified procedure, however, does not eliminate the need for a trained technician who can fine-tune the techniques and identify problems that need immediate solutions from time to time in different sites.

II. SITE SELECTION

Site is an important factor to consider in putting up a prawn hatchery. In choosing a suitable site, consider the following: spawner source, location, climate, seawater quality, availability of electric power, accessibility and freshwater supply.

A. Spawner Source

It is ideal for hatcheries to be near the source of wild prawn spawners and broodstock. You have to know the seasonality and volume of prawn catch in the prospective area. Fishermen in the locality can help you determine the best collection site, and the number and type of gear used. Many of them have already acquired expertise in identifying and handling spawners and broodstock.

B. Location

The hatchery should be located near the seashore where clean seawater can be pumped to the hatchery easily and economically. The site must be free from pollution, that is, away from sources of agricultural and industrial wastes. It should also be away from rivers and streams that can lower the seawater salinity and can bring down water from ricefields or densely populated communities to the prospective site.

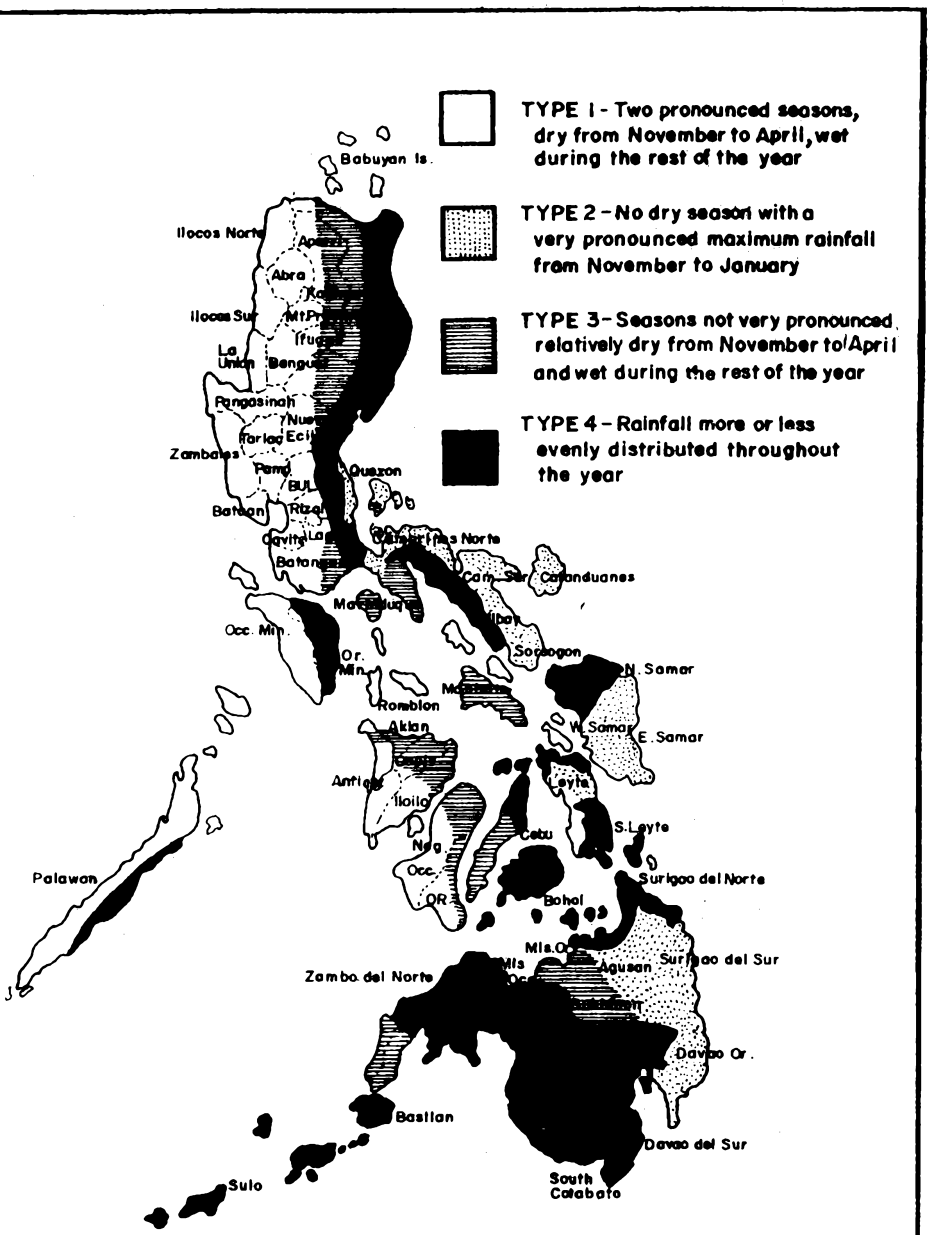
C. Climate

Climate in the Philippines is classified into four weather types (Fig. 2), namely:

Type 1 -- Two pronounced seasons, dry from November to April, wet during the rest of the year

Type 2 – No dry season with a very pronounced maximum rainfall from November to January

Type 3 -- Seasons not very pronounced, relatively dry from November to April and wet during the rest of the year



From Phil. Almanac and Handbook of Facts, 1975, p. 35.

Fig. 2. Climatic types of the Philippines

Type 4 -- Rainfall more or less evenly distributed throughout the year

The prospective hatchery must be located, if possible, in areas were there are Types 1 and 3 climatic conditions.

D. **Seawater Quality**

Seawater for hatchery use must have a salinity range from 30 to 35 parts per thousand (ppt.). To know the suitability of seawater for prawn larval rearing, conduct at least 3 trial runs in small containers (500 to 1,000 liters capacity) using seawater from the proposed site during both dry and rainy seasons (Fig. 3). The production of prawn postlarvae (PL) from eggs to PL_{20} (that is, 20 days of postlarval life and about 32 days after hatching) with at least 5% survival rate indicates the likelihood of success in actual operations.

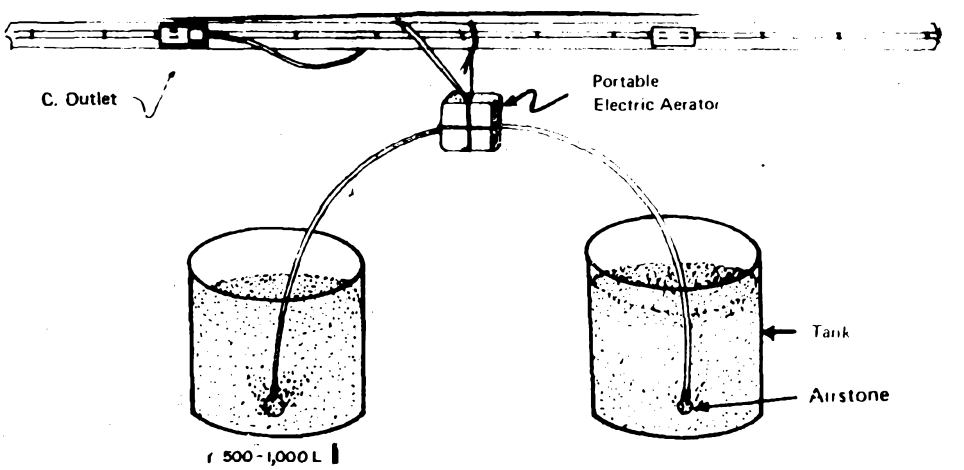


Fig. 3. Trial runs using small containers

E. **Availability of Electric Power**

Continuous electric power is needed during the entire larval rearing period for running aerators, pumps, lights and other hatchery equipment. Have a stand-by generator available in case of power failure.

F. **Accessibility**

The hatchery should be accessible by land or by water for convenient marketing of fry and for transporting supplies, materials, and other necessities (Fig. 4).

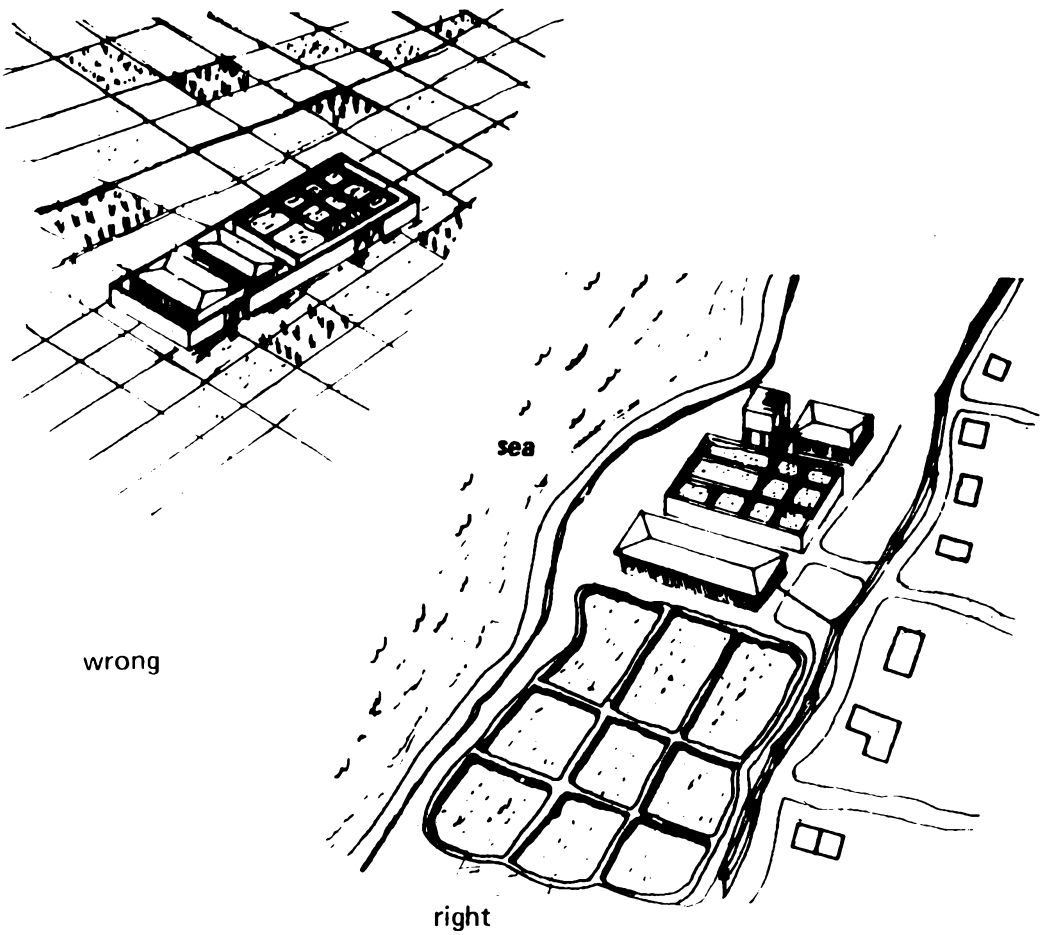


Fig. 4. Correct location of a prawn hatchery.

G. Freshwater Supply

Continuous freshwater supply is necessary in the hatchery for lowering salinity when acclimating postlarvae, for washing and for other uses (Fig. 5).

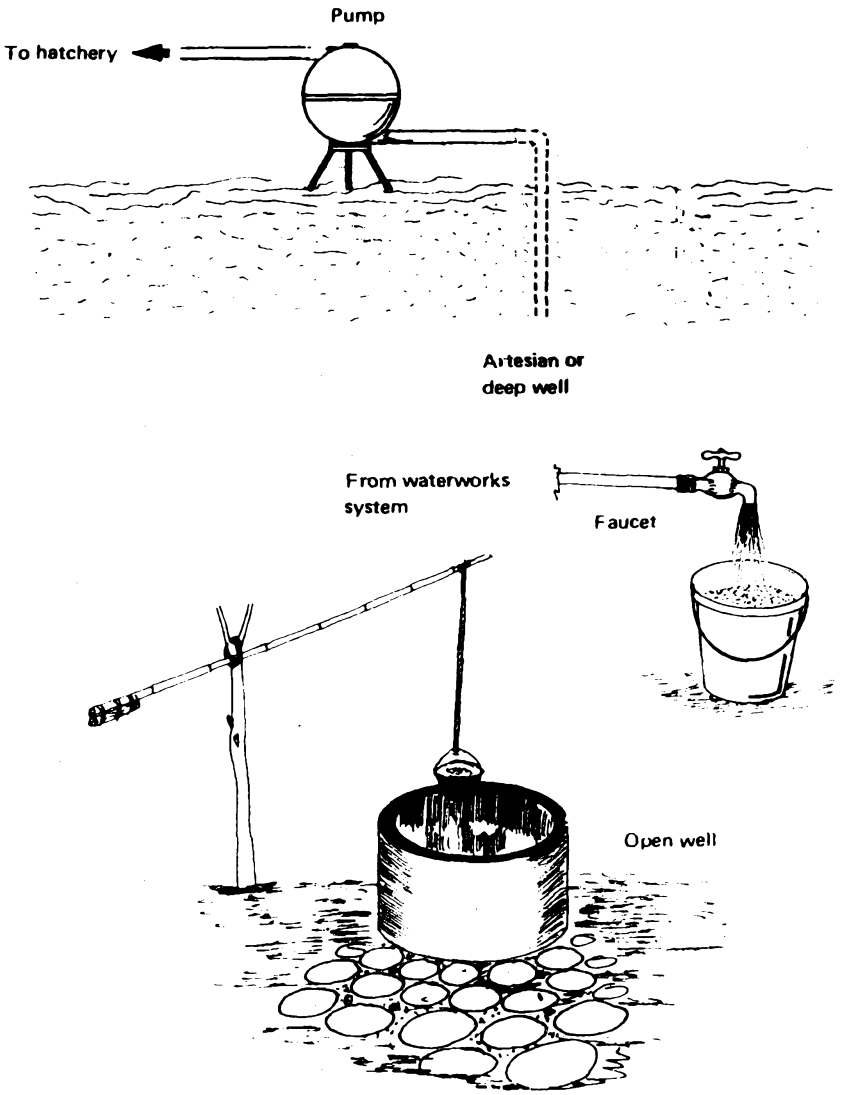
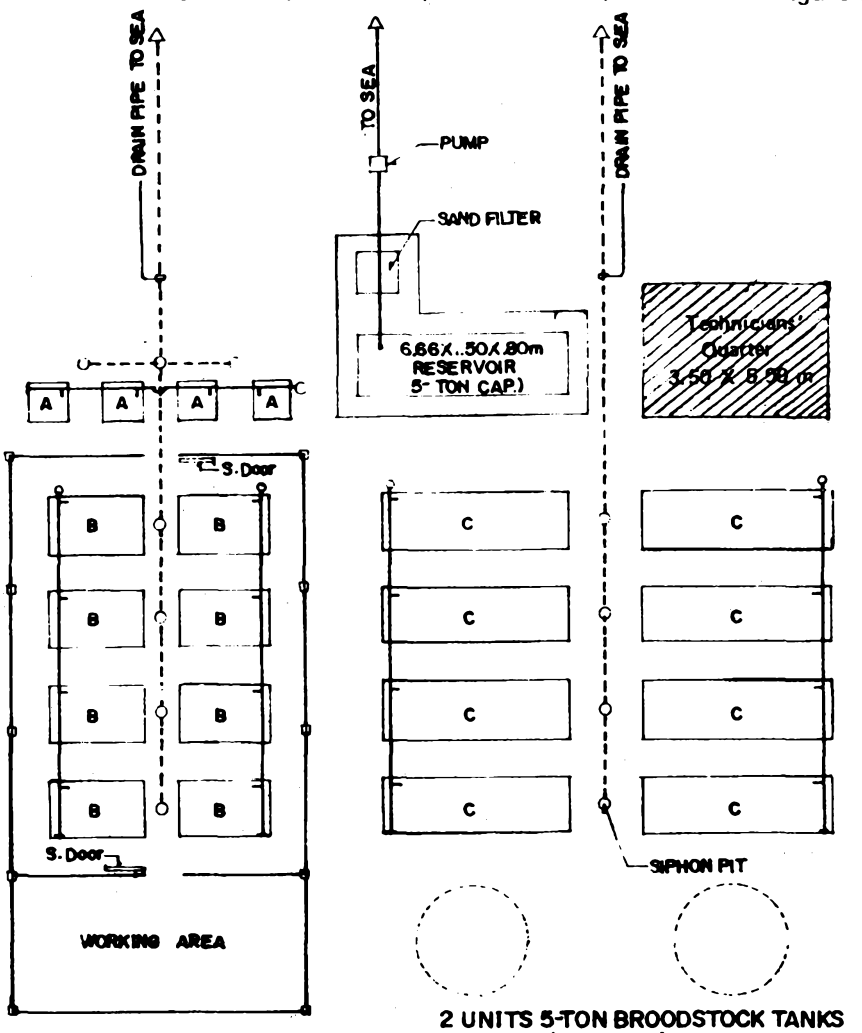


Fig. 5. Sources of freshwater supply

III. HATCHERY FACILITIES AND EQUIPMENT

A prawn hatchery must have complete facilities and necessary equipment for successful operation. It should have suitable tanks for larval and postlarval rearing; algal or phytoplankton cultures; and air and seawater supply systems. A building to accommodate at least the larval tanks and other important hatchery materials and equipment should be installed.

A suggested lay-out for a prawn hatchery is shown in Figure 6.



LEGEND

A	1.00X1.00m ALGAL TANKS (1-TON CAPACITY)
B	1.50X2.50m LARVAL TANKS (3-TON CAPACITY)
C	1.50X5.00m POSTLARVAL TANKS (6-TON CAPACITY)
O	SUPPLY PIPE

Fig. 6. Lay-out of a prawn hatchery (Gabasa and Suñaz, 1983)

A. Larval and Postlarval Rearing Tanks

Tank capacity varies from 1 to 20 tons. For economical operations, a larval rearing tank should have a water-holding capacity of 3-5 tons while a postlarval (nursery) rearing tank should hold 6-10 tons, both at 1 meter depth. A 3-ton larval rearing tank can hold from 150,000 to 300,000 nauplii obtained from a single spawner.

Tanks may be made of concrete, fiberglass or marine plywood. These may be circular, rectangular or square with sloping bottom for convenient harvesting (Fig. 7). Slope should be towards the long side at about 5 cm for every 1 meter. The tank should be elevated about 20 cm from floor level for easy draining. A 2-meter gap between two rows of tanks is ideal to allow ample working space. The whole floor area should be levelled and, if possible, cemented for convenience.

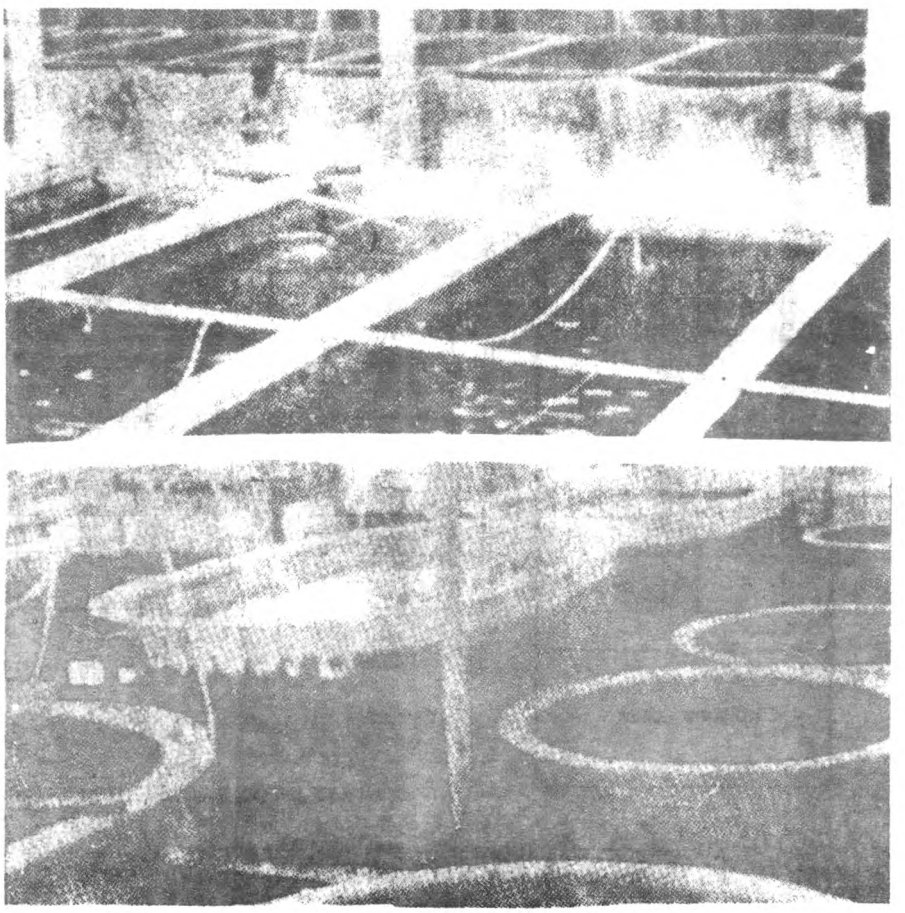


Fig. 7 Various tank designs

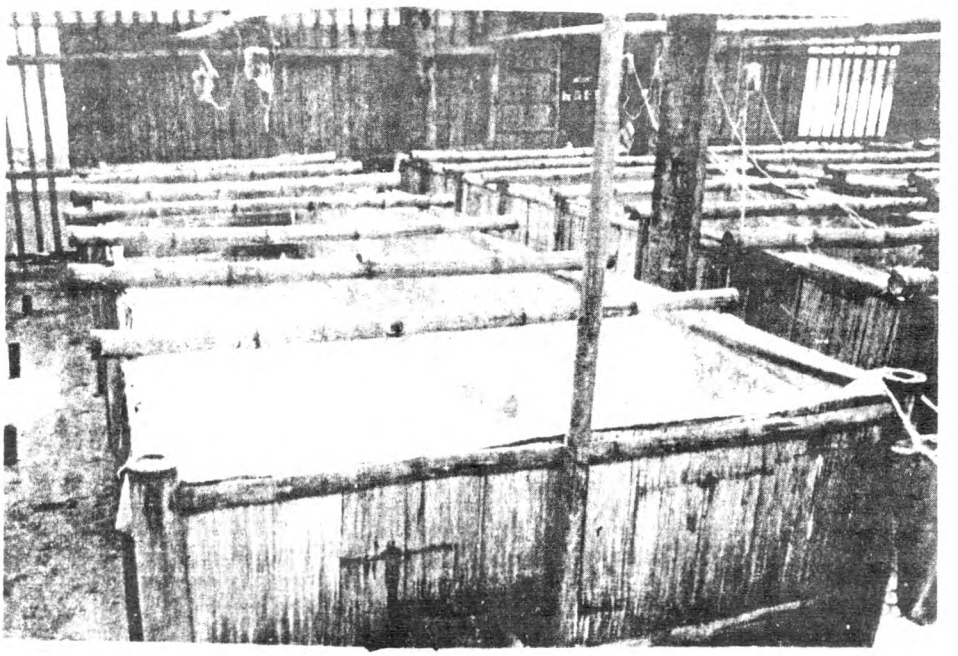


Fig. 8. Rows of bamboo tanks with plastic sheet lining

Tanks may also be constructed using inexpensive and locally available materials like bamboo and wooden slats with plastic sheet lining for holding water (Fig. 8). Bamboo poles are used for tank support frame and lateral braces, while flattened bamboo or wooden slats are used for tank side walls. For inside bottom and side lining, use polyethylene sheet with a maximum width of 3 meters and gauge thickness of 0.06 mm. About 5 meters of plastic will be needed for a 3-ton tank. The plastic sheet lining should be doubled for added safety (Fig. 9).

The use of inexpensive and readily available materials like bamboo and plastic is appropriate for small ventures. A big expense is not incurred when the hatchery is yet on a trial run and losses are minimized when a change in design or expansion of the hatchery is undertaken.

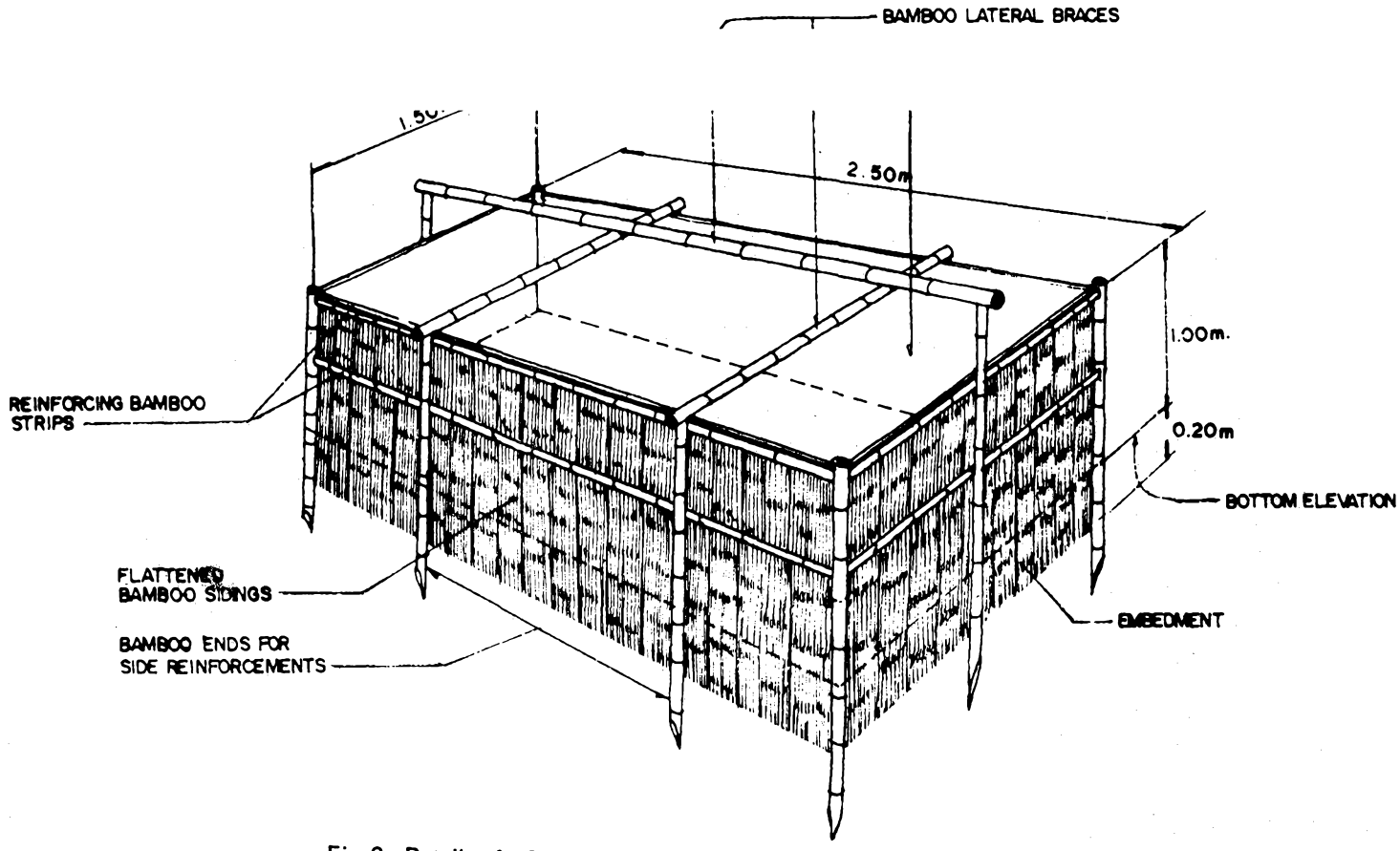


Fig. 9. Details of a 3-ton larval tank made of bamboo and plastic sheet lining (Gabasa and Sunaz, 1983).

B. **Algal Culture Tanks**

Small and shallow tanks of not more than 1 ton capacity and about 0.5 m deep should be used for algal or phytoplankton culture. This is because adequate light is necessary for faster algal growth. The tanks may also be made of bamboo and plastic materials.

C. **Air Supply**

Aeration is essential in a hatchery to provide oxygen in the culture water and to keep larvae and food in suspension. It is commonly supplied by an elèctric blower, a compressor or a portable aerator. To save electricity, however, portable electric aerators (5 watts, 2-way type) are recommended (Fig. 10). Here are some advantages of using portable aerators:

1. tanks can be aerated separately (two aerators for every tank), thereby, reducing energy consumption when the hatchery is partially operating; and
2. there are no aeration lines to clean and disinfect regularly.

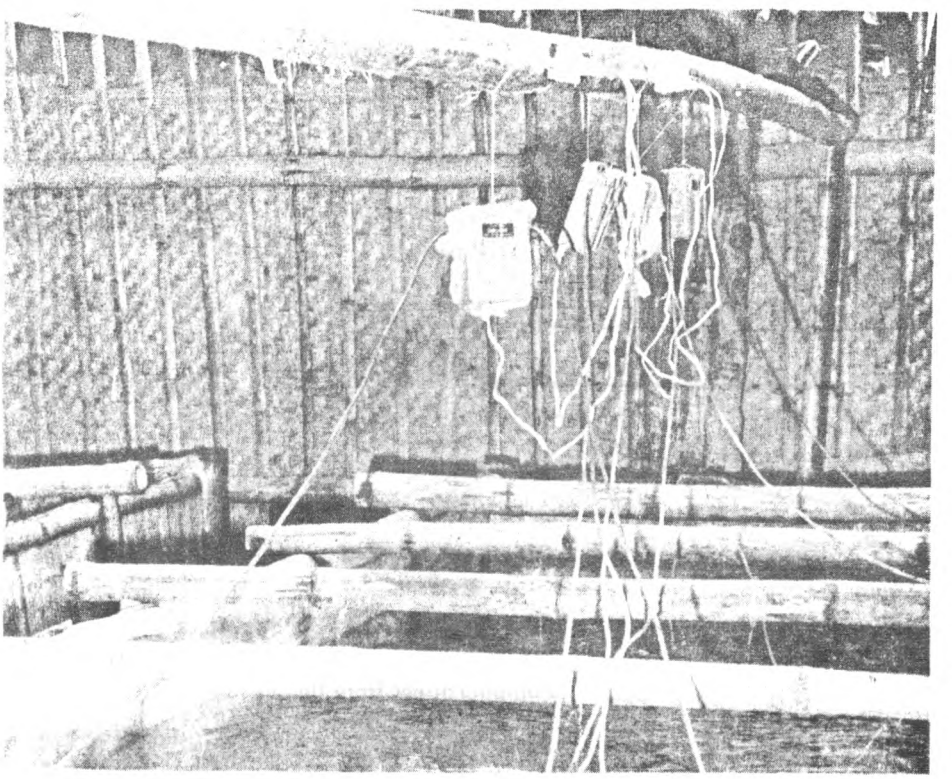


Fig. 10. Portable electric aerators used in bamboo tanks

D. **Seawater Supply**

Hatchery operations require adequate seawater. Water can be drawn from the sea to the hatchery in any of 4 ways each using electric motor (746 watts 1 Horsepower) pump. Choose the one best suited to the site.

1. *Pumping direct from the sea* – Use a single suction line laid a few feet above the seabed. The intake pipe opening should be fitted with a screen to prevent fish and other unwanted organisms from being sucked in. Draw water direct to the hatchery where it may be filtered before use (Fig. 11).

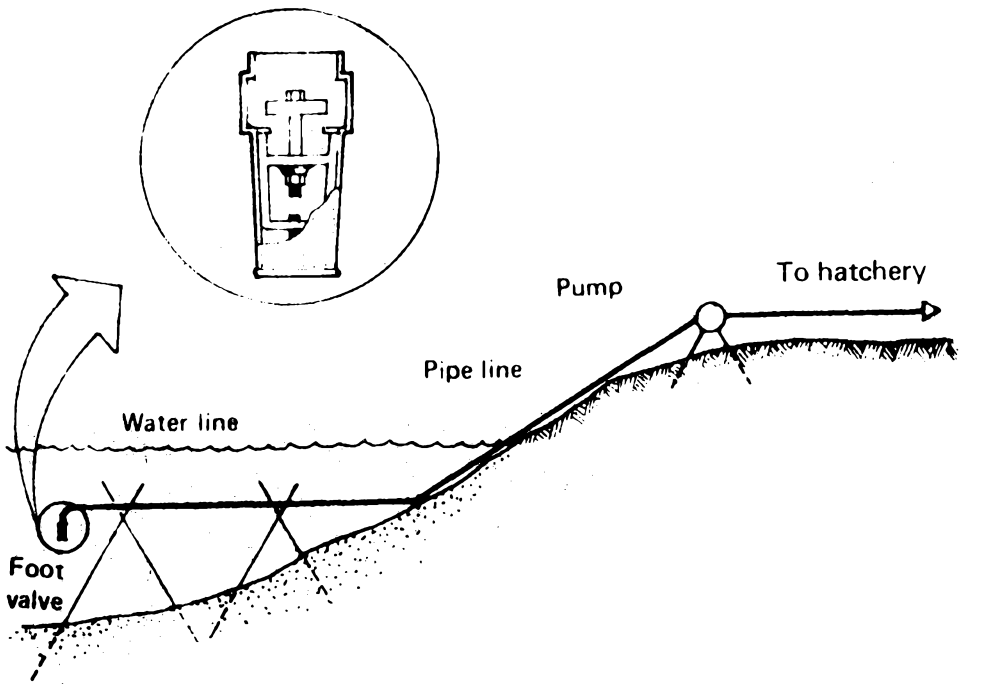


Fig. 11. Pumping direct from the sea

2. *Pumping from a sump pit* – Seawater is pumped to the hatchery from a sump pit which is supplied by an embedded pipeline extended offshore (Fig. 12).

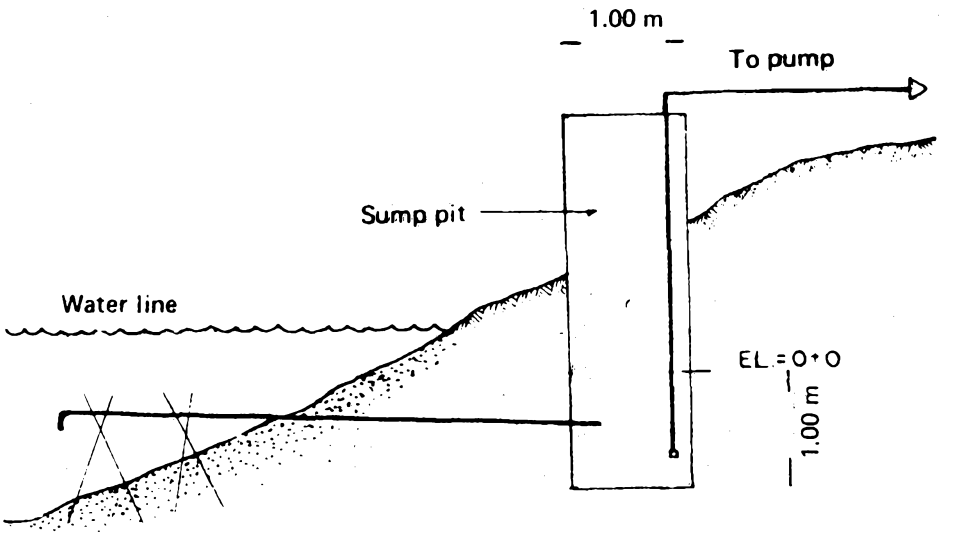


Fig. 12. Pumping from a sump pit.

3. *Pumping from inshore well* – Construct a culvert inshore well within tidal range near the hatchery. Arrange gravel at the bottom of the well to prevent sand from being sucked into the intake pipe. Seawater is filtered here and can be pumped directly to the hatchery tanks without further filtration (Fig. 13).

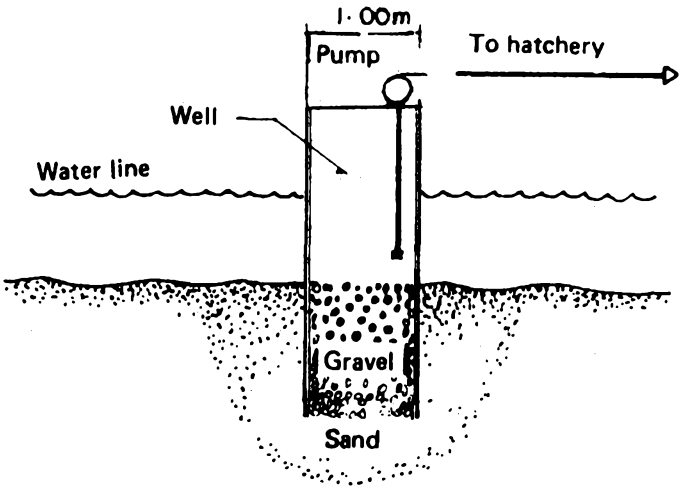


Fig. 13. Pumping from inshore well

4. *Pumping from seabed using perforated PVC pipes* — Attach a series of perforated polyvinyl chloride (PVC) pipes to a central intake pipeline embedded in the sand within tidal range. Close one end of each PVC pipe and attach the other end to the main pipe. Wrap individual PVC pipes with 1 cm thick foam to filter seawater that pass through the side holes. Pump seawater directly to the hatchery tanks (Fig. 14).

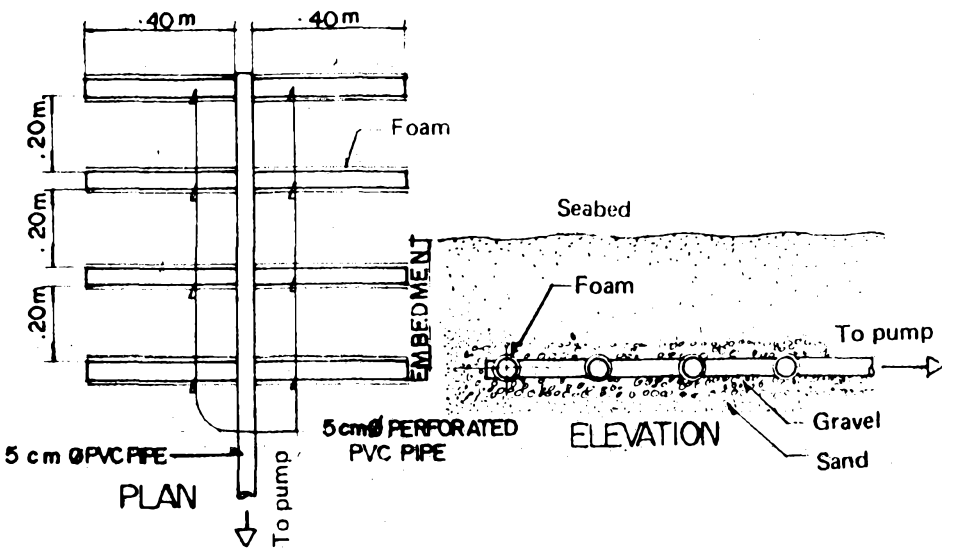


Fig. 14. Pumping from seabed using perforated PVC pipes

Filtration

Pass seawater through a filtration unit consisting of layers of sand and graded gravel (Fig. 15).

It is necessary in the hatchery to reduce turbidity of seawater and to remove debris and undesirable marine organisms like fish eggs and larvae. Introduce seawater at the top of the filtration unit.

The filtration tank may be a separate unit or incorporated as a component of the reservoir. It is usually made of marine plywood or concrete. The unit can be cleaned by periodic backwashing.

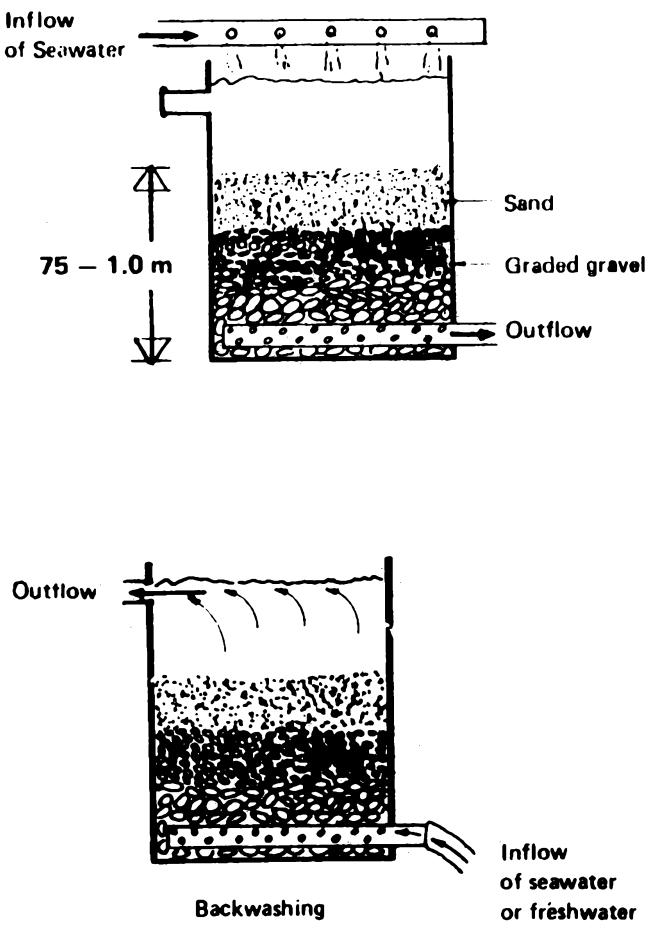


Fig. 15. Cross-section of a sand and gravel filtration unit

Storage and distribution

A hatchery should have a reservoir to facilitate changing of water when needed. A reservoir should have a capacity of 30-50% of the maximum total water consumption per day. It should be elevated to allow water to flow by gravity for distribution to all tanks (Fig. 16). In the absence of a separate reservoir, empty tanks in the hatchery can be used to store water.

PVC pipes are commonly used for seawater distribution. Rubber hose or bamboo pole (with nodes removed) may be used as substitute.

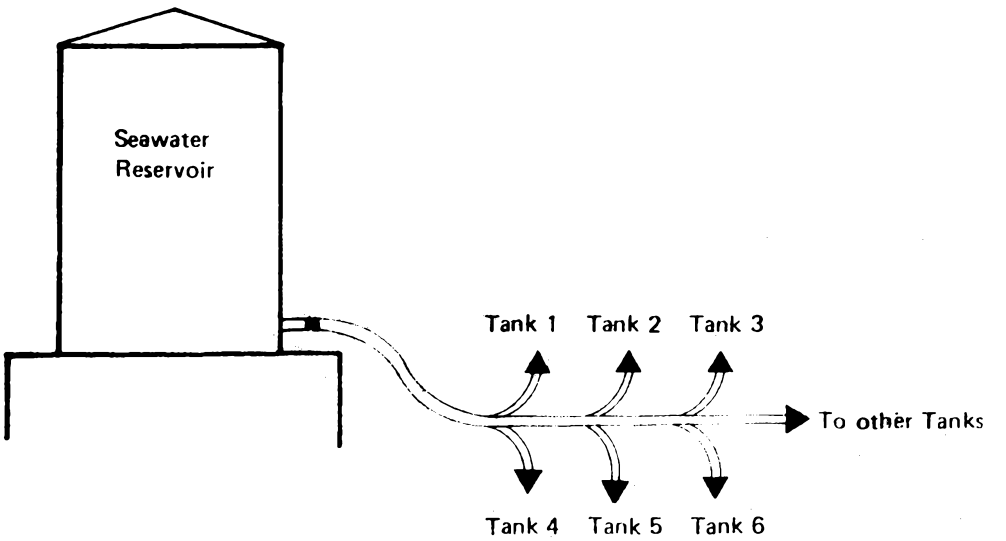


Fig. 16. Distributing seawater to tanks by gravity

E. Building

A concrete building is not necessary to house the hatchery. Locally available materials such as nipa, bamboo and coconut lumber can be used to construct a building to house larval rearing tanks (Fig. 17). Nursery tanks may be placed outdoors and covered individually with plastic sheet or canvas. Provide areas for monitoring, storage, and for technicians' quarters.

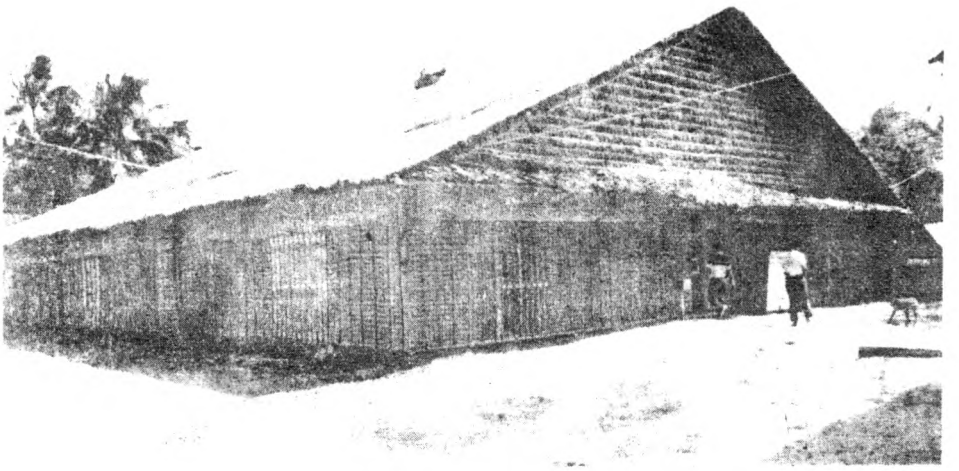


Fig. 17. Hatchery building made of inexpensive, locally available materials

F Hatchery Equipment

The basic equipment needed in a hatchery are:

1. Beaker or any transparent plastic or glass container, 200 ml to 1 L capacity – for counting and checking the condition of the larvae (Fig. 18)

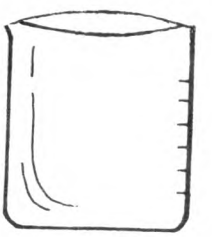


Fig. 18. Beaker

2. Thermometer (alcohol or mercury type) – for monitoring water temperature in the tank (Fig. 19)

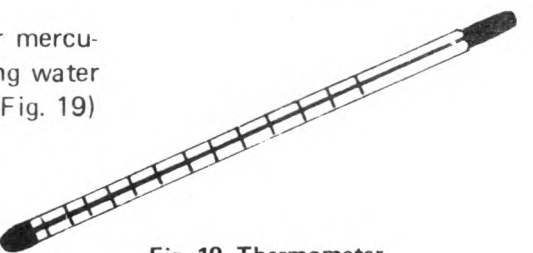


Fig. 19. Thermometer

3. Hemacytometer – for counting algae (Fig. 20)

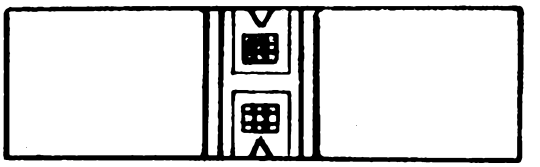


Fig. 20. Hemacytometer

4. Refractometer – for monitoring water salinity (Fig. 21)

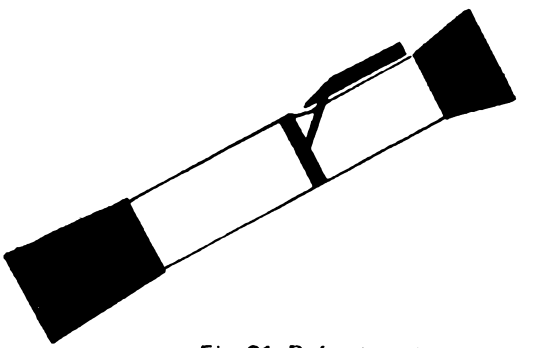


Fig. 21. Refractometer

5. Hydrometer – for measuring specific gravity of water (which will indirectly measure salinity). This can be used as substitute for refractometer (Fig. 22)

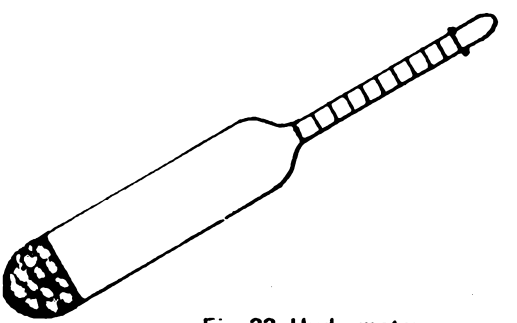


Fig. 22. Hydrometer

6. Refrigerator – for storing stock cultures of algae and feeds for postlarvae

7. Microscope — for monitoring feed density (Fig. 23)

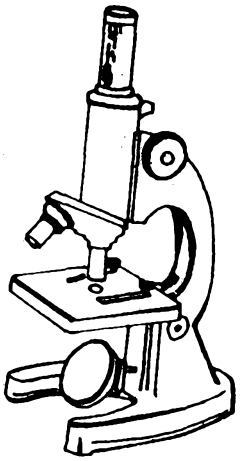


Fig. 23.Microscope

8. Drainers of varying types and mesh sizes — for draining the water (Fig. 24)

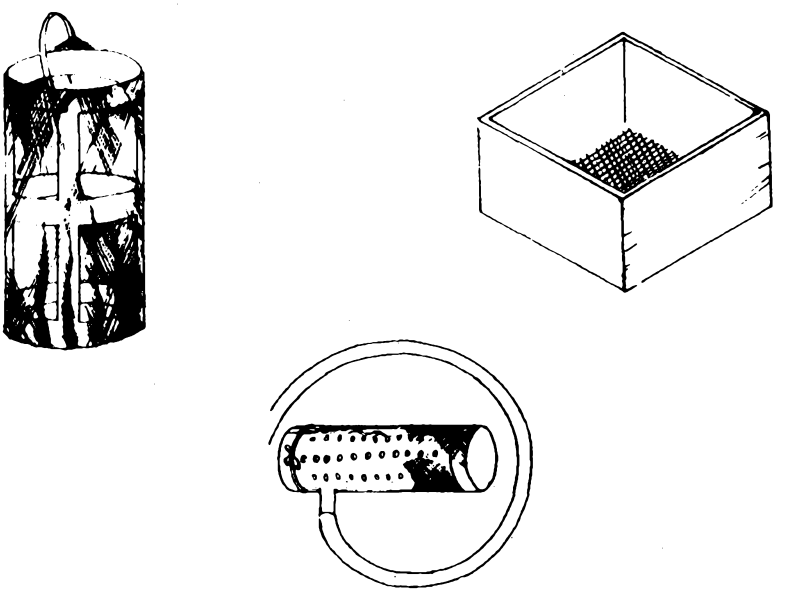


Fig. 24. Kinds of drainer

9. Harvesting box – for harvesting fry (Fig. 25)

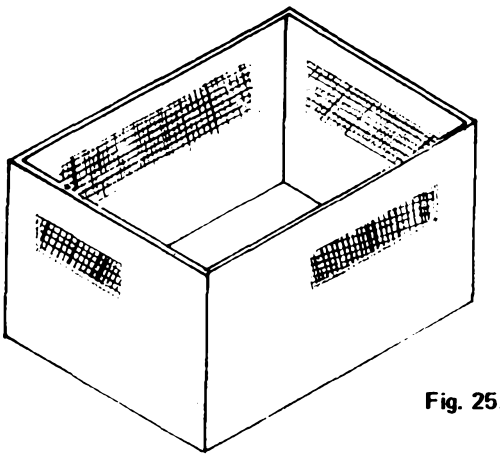


Fig. 25. Harvesting box

10. Scoop nets – for scooping larvae or fry from tanks or from harvesting box (Fig. 26)

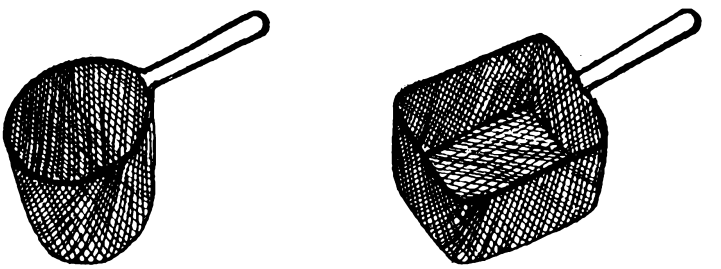


Fig. 26. Scoop nets

IV. LARVAL STAGES OF PRAWN

Hatchery operators and technicians should be familiar with the various prawn larval stages (Fig. 27) to guide them in proper feeding and other hatchery procedures.

Hatching of eggs usually occurs about 12 to 15 hours after spawning. The newly-hatched larva, called nauplius, does not feed yet but subsists on the yolk reserves found in its body. Feeding starts at protozoea stage which is indicated by thread-like feces trailing behind. The larvae swim in a forward motion picking food at random. At mysis stage, the larvae start to feed on animal organisms in addition to algae. They swim forward to backward and occasionally bend their abdomen in quick jerks. The postlarval stage follows mysis. The postlarva at this stage resembles an adult prawn and becomes more carnivorous in feeding.

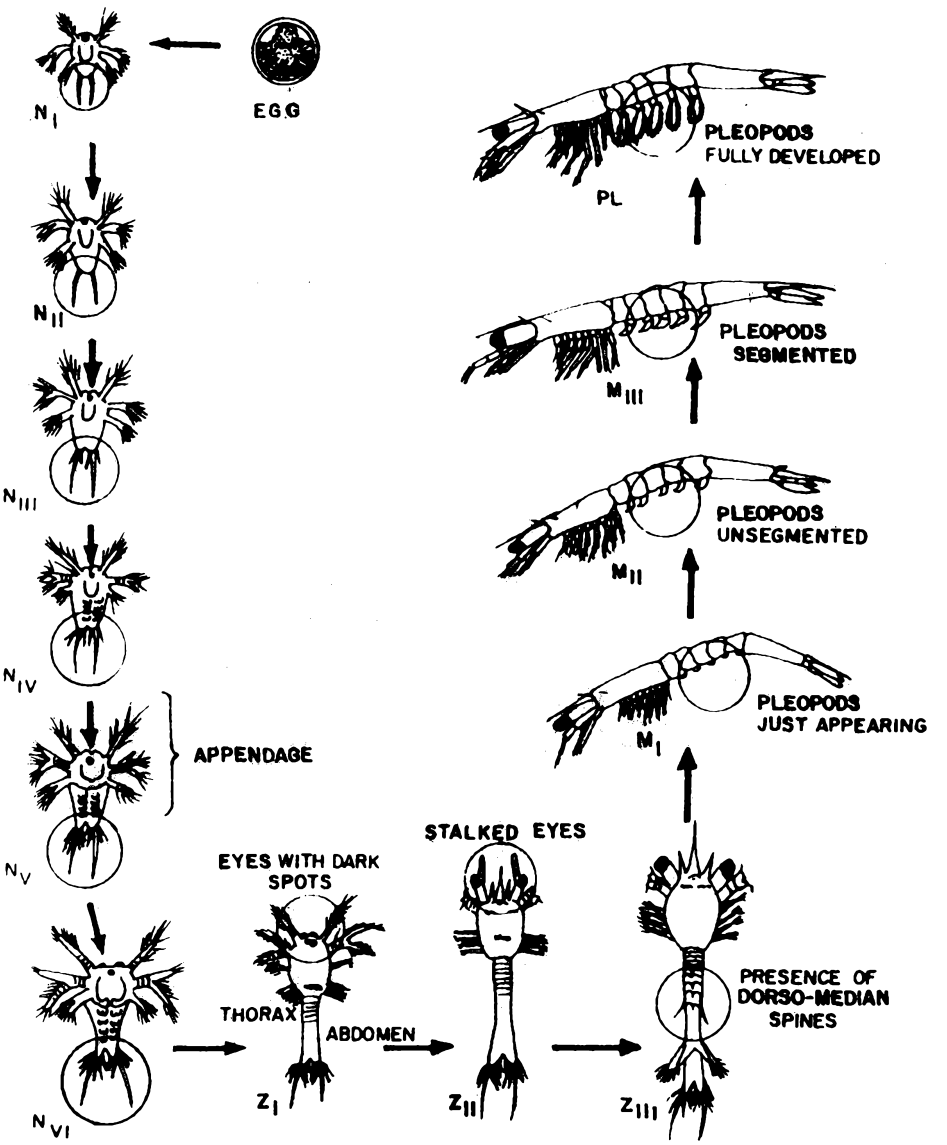


Fig. 27. Larval Stages of prawn (After Motoh, 1979)

V. SPAWNER AND BROODSTOCK COLLECTION AND TRANSPORT

A prospective hatchery operator must know where spawners are abundant. If the source is far from the hatchery site, proper methods of spawner collection and transport should be considered.

Wild spawners are usually caught in fish corrals or by trawl nets. Experienced collectors select mature prawns by examining the back portion of the body against light to observe ovary formation (Fig. 28). Only spawners with late maturing or mature ovaries are selected and brought to the hatchery (Fig. 29).

If wild spawners are scarce, have an alternate source – broodstock. Select male and female prawns weighing at least 50 g and 80 g, respectively, which will serve as broodstock. Induce a female to mate and spawn by ablating one eyestalk. Details on the ablation procedure may be found in *Broodstock of Sugpo (P. monodon* Fabricius) (Primavera, 1983).

Fig. 28. Examining the back portion of prawn spawner against light.

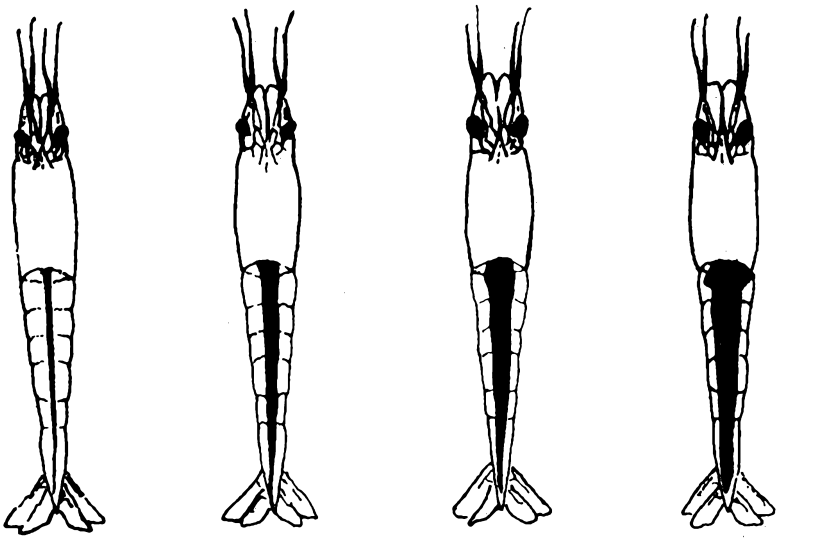


Fig. 29. Different stages of ovarian maturity of prawn showing the dorsal exoskeleton (Primavera, 1983).

Spawners or broodstock are transported using either of these methods:

1. Place spawners or broodstock in a covered canvas or hydro-tank with battery-operated aerators. Accommodate up to 200 adult prawns in a one-ton tank if travel time is 4-5 hours. It is advisable to transport spawners or broodstock in the early morning or late afternoon to minimize stress due to high temperature during daytime (Fig. 30).

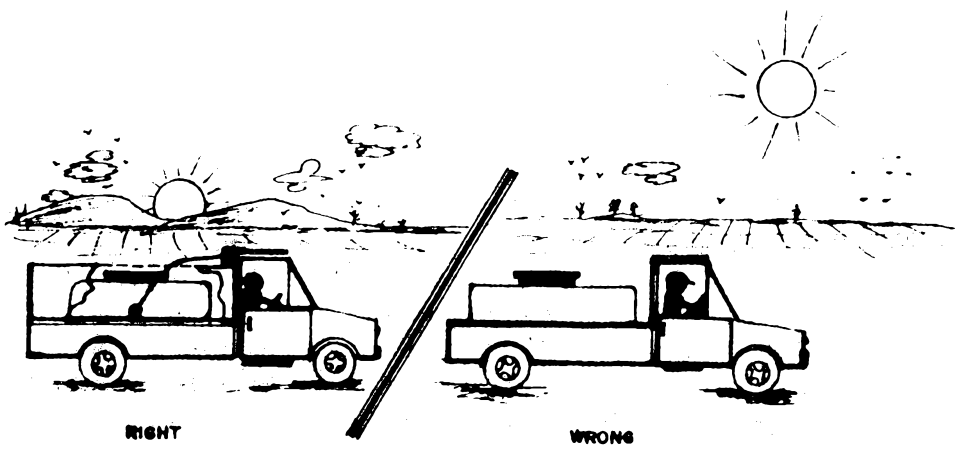


Fig. 30. Transporting prawn broodstock or spawners.

2. Wrap spawners individually in screen and put them inside 5 cm diameter perforated PVC pipes. Place these in double polyethylene plastic bags at 3 pieces per 5-6 liters of seawater. Add oxygen before bags are tied with rubber bands (Fig. 31). Lower temperature by placing wrapped ice cubes on top of plastic bags.

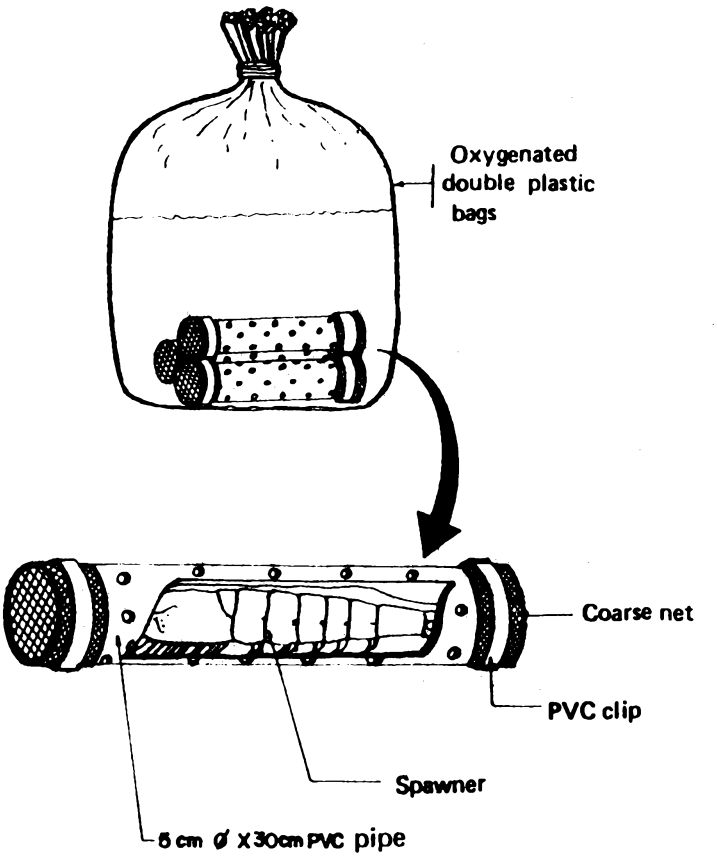


Fig. 31. Perforated PVC pipes, each with individual spawner, are placed in oxygenated bags for transport.

Spawners should reach the hatchery on the same day they are caught. If spawning occurs prior to transport, wait until the eggs hatch into nauplii and prepare to transport them.

Turn off the aeration, then partly cover the tank. Siphon the nauplii that gather in the lighted portion into a clean plastic container by using a 1.0 cm plastic tubing (Fig. 32). Fill each container with seawater up to the brim to minimize shaking during transport. Each 20-L container can accommodate from 300,000 to 400,000 nauplii without oxygenation for 4 to 5-hour transport time.

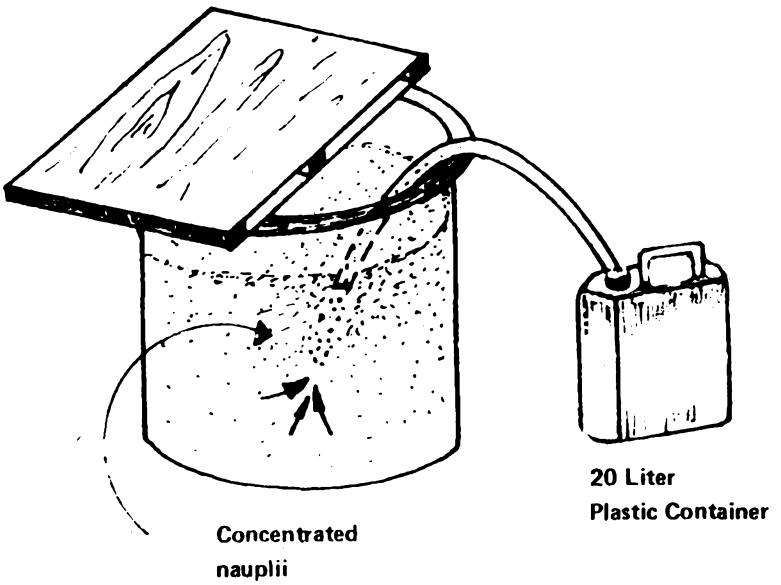


Fig. 32. Siphoning nauplii into a plastic container for transport.

VI. LARVAL REARING

Larval rearing is the most important part in prawn hatchery operations. It involves spawning and hatching of the eggs, stocking of nauplii, providing adequate feeds and observing the right feeding scheme. Success of fry production lies in properly carrying out these procedures.

A. Spawning and Hatching

Wild or ablated spawners are made to spawn in tanks provided with aeration and clear filtered seawater with salinity of 30-35 ppt and temperature of 28-30°C. Spawning usually takes place between 10 PM and 4 AM and lasts from 2 to 7 minutes.

Remove spawners from the tank the morning after spawning has taken place, which is evidenced by the appearance of pink-orange scum on the water surface and walls of the tank. Spawning

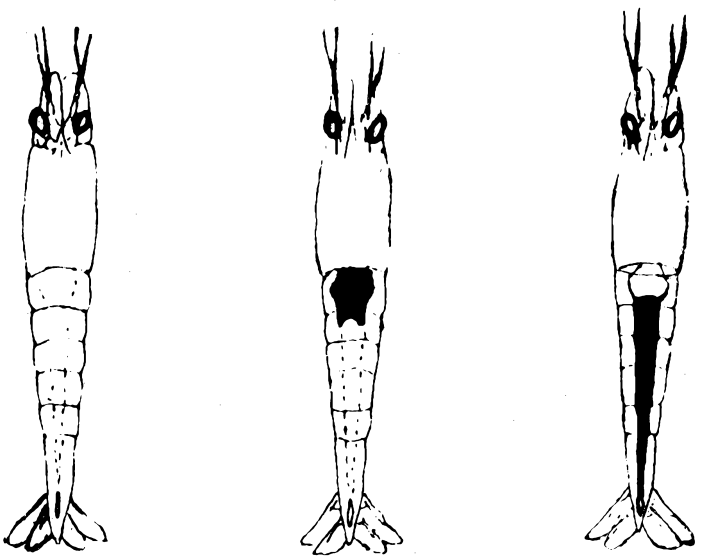


Fig. 33. External appearance of ovaries of prawn after spawning.

is considered complete when all eggs in the ovary, from the anterior to the posterior lobes, have been extruded. Spawning is partial when there are some eggs left in any of the lobes (Fig. 33). Transport and handling stress may cause non-spawning or partial spawning. Prawns that partially spawn may either spawn again or resorb their ovaries.

The number of eggs produced by one gravid prawn in a complete spawning ranges from 100,000 to 400,000 for ablated females and 200,000 to 1,000,000 for wild unablated females. Eggs hatch into nauplii from 12 to 15 hours after spawning.

1. **Egg rinsing**

Rinse the eggs by draining water from the spawning tank through a hose with strainer (mesh size = 0.25 mm) while introducing new seawater.

2. **Egg counting**

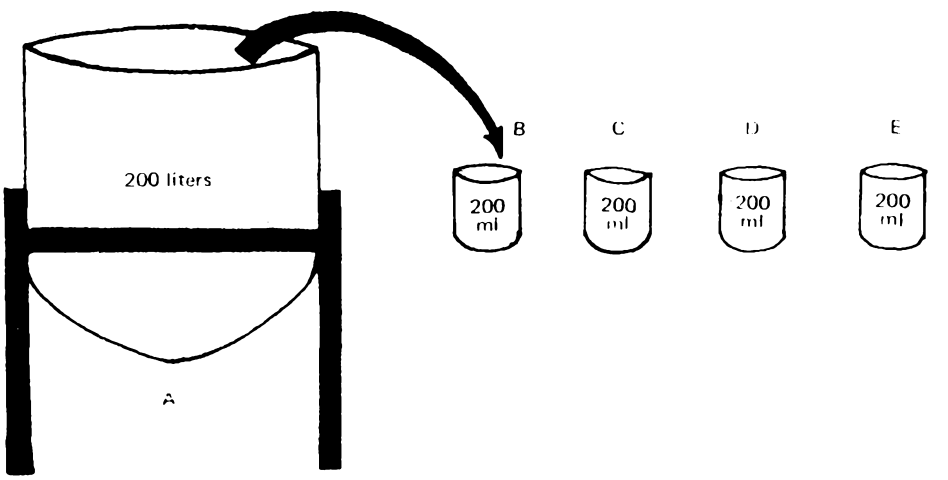
Determine the total number of eggs in each tank (Fig. 34) by following these steps.

a. Agitate water in the tank to keep the eggs in suspension and evenly distributed.

b. Take at least four 200 ml samples in a beaker.

c. Count the eggs by computing the average of the four samples and multiplying this by 5 to arrive at the number of eggs per liter (5 x 200 ml = 1,000 ml or 1 liter).

d. Multiply the number of eggs present per liter by the total water volume (in liters) to get the estimated total population of eggs in the tank



$$\text{Eggs in A} = \left(\frac{\text{eggs in B + C + D + E}}{4} \right) \text{X 5 X 200}$$

Fig. 34. How to count eggs

The above procedure is also used to estimate the number of larvae except that about 3-4 one liter samples are taken from a 3-ton tank.

B. **Stocking Nauplii**

Transfer larvae to the rearing tank while they are still at the nauplius (N_{II} -N_V) stage. Initial stocking density in larval rearing tanks ranges from 50 to 100 larvae/liter. Before stocking, clean the rearing tank thoroughly by scrubbing and rinsing with water.

C. **Feeds and Feeding**

A hatchery operator should be familiar with types of feeds and feeding methods to ensure proper nutrition of the larvae.

1. Algae (Phytoplankton) culture

Phytoplankton are microscopic plants used as food for prawn and shrimp larvae (Fig. 35). The culture of this live diet is important especially in the early stage when prawns start feeding. Mass culture of selected species of algae should be started 2-3 days before feeding and should be maintained throughout the larval rearing period.

Tetraselmis sp. (10-15 μm)

Skeletonema sp. (5-8 μm)

Chaetoceros sp. (4-6 μm)

Fig. 35. Commonly used algae for feeding.

a. **Outdoor mass culture of selected algae**

(1) Place filtered seawater in culture tank

(2) Fertilize with 100 g of 46-0-0 (N-P-K) or urea and 10 g of 16-20-0 inorganic fertilizer per ton of seawater.

(3) Add 50-100 l algal starter per ton of seawater and aerate.

(4) Harvest algae after 1 or 2 days when blooming occurs, which is indicated by a brownish color for diatoms *(Skeletonema* or *Chaetoceros)* and greenish for *Tetraselmis.* Use this either for feeding or as starter for subsequent culture

Monospecies algal starters can be obtained from the SEAFDEC Aquaculture Department Phycology Laboratory and from other existing hatcheries.

b. **Outdoor mass culture of mixed diatoms**

Mixed diatoms *(Chaetoceros, Rhizosolenia, Navicula, Thallasiosira* and *Nitzschia)* are found in seawater. Mass culture of these can be done using this method:

(1) Place unfiltered seawater in algal tank.

(2) Fertilize with 100 g to 46-0-0 and 10 g of 16-20-0 per ton of seawater.

(3) Aerate and leave for 2 or 3 days until water turns brown, indicating mixed diatom population bloom. This can be used for feeding or as starter for next culture.

Some diatom species, however, are available only at a certain season, thus, other species that bloom may not be useful.

2. **Preparing other larval feeds**

a. **Egg Yolk**

Hard-cooked chicken egg yolk can be used as feed for prawn larvae. They are economical and convenient to prepare and are readily available.

Here's how to prepare egg yolk for feeding (Fig. 36).

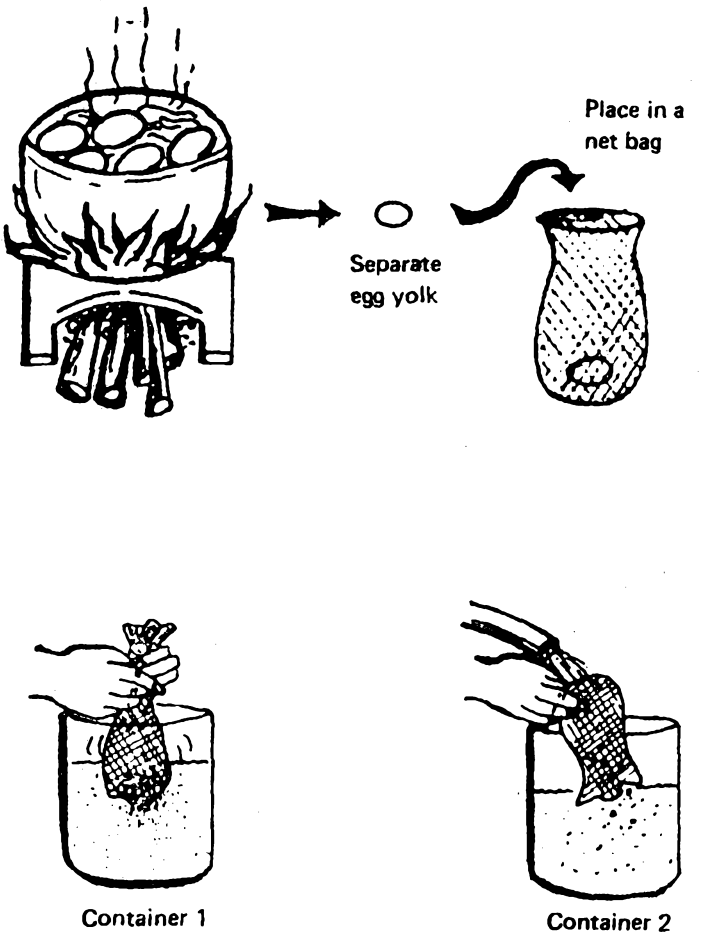


Fig. 36. Preparing egg yolk for feeding

(1) Boil chicken eggs for about 10-15 minutes. One egg yolk enough to feed a 10-ton tank of larvae at one time.

(2) Allow eggs to cool.

(3) Separate egg yolk from shell and egg white

(4) Place only the egg yolk inside a small net bag 15 x 8 cm (mesh size of 40-100 microns) which serves as strainer.

(5) Submerge the bag in seawater while holding its mouth. Dissolve egg yolk by alternate squeezing and swirling in seawater in container 1. Set aside.

(6) Dilute retained egg particles in the bag with seawater in container 2 (about 16-19 g egg yolk in 1 liter seawater). This mixture is now ready to be used for feeding.

b. *Artemia* (Brine Shrimp) Cysts

Artemia cysts are "eggs" with hardened shell that can withstand long storage in a dry state without affecting its viability. *Artemia* nauplii are a good food for prawn mysis and postlarvae.

To hatch *Artemia* cysts:

(1) Weigh desired number of grams of *Artemia* cysts (1 gram will yield approximately 300,000 cysts).

(2) Place cysts in a hatching container with clean seawater. The container should be conical, transparent and provided with a bottom stopper. Five grams of cysts correspond to every liter of seawater (Fig. 37).

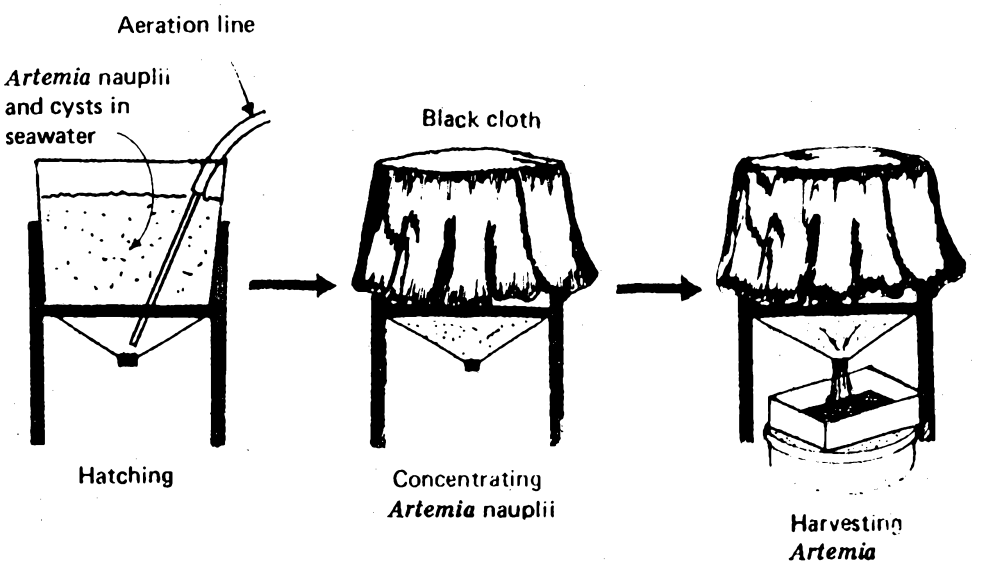


Fig. 37. Incubating and harvesting *Artemia* nauplii

(3) Incubate for 24-48 hours under continuous aeration.

(4) After incubation, remove aeration for 10-20 minutes to allow egg capsules to float. Cover the upper half of the container with black cloth to allow nauplii to concentrate at the bottom.

(5) Remove bottom stopper and drain nauplii into a clean strainer or basin.

(6) Rinse nauplii with seawater.

3. **Determining amount of feed**

a) **Algae**

The amount of algal food to be fed to the larvae is computed as follows:

Without previous feeding

$$\text{Vol. of algae to be added} = \frac{\text{Vol. of water in rearing tank} \times \text{Desired algal density in rearing tank}}{\text{Algal density in culture tank}}$$

Example:

$$\text{Vol. of algae to be added} = \frac{3{,}000\ \text{l} \times 5{,}000\ \text{cells } \textit{Skeletonema}/\text{ml}}{1{,}000{,}000\ \text{cells } \textit{Skeletonema}/\text{ml}}$$

$$= 15\ \text{liters}$$

With previous feeding

$$\text{Vol. of algae to be added} = \frac{\text{Vol. of water in rearing tank} \times \left(\text{Desired algal density in rearing tank} - \text{Algal density in rearing tank}\right)}{\text{Algal density in culture tank}}$$

Example:

$$\text{Vol. of algae to be added} = \frac{3{,}000\ \text{l} \times \left(2{,}500\ \text{cells} - 1{,}000\ \text{cells } \textit{Tetraselmis}/\text{ml}\right)}{300{,}000\ \text{cells}/\textit{Tetraselmis}/\text{ml}}$$

$$= 15\ \text{liters}$$

The counting procedure for algae is shown in Appendix 1.

After several runs, estimate the amount of algae to feed by observing the gut contents of the larvae and the color of the culture mdeium.

b) **Egg Yolk**

Feed larvae using egg yolk solution at 100 ml per ton of seawater (100 ml divided by 3-4 times feeding in one day) to maintain 5-15 particles/ml in the rearing tank.

c) **Artemia**

(1) Using a pipette, take live samples of *Artemia* nauplii from the larval rearing tank and from the pail of harvested (concentrated) *Artemia* nauplii (Fig. 38).

(2) Place these in separate petri dish or clear bowl and count the nauplii.

(3) Compute the amount of nauplii to be fed using the same formula for algae.

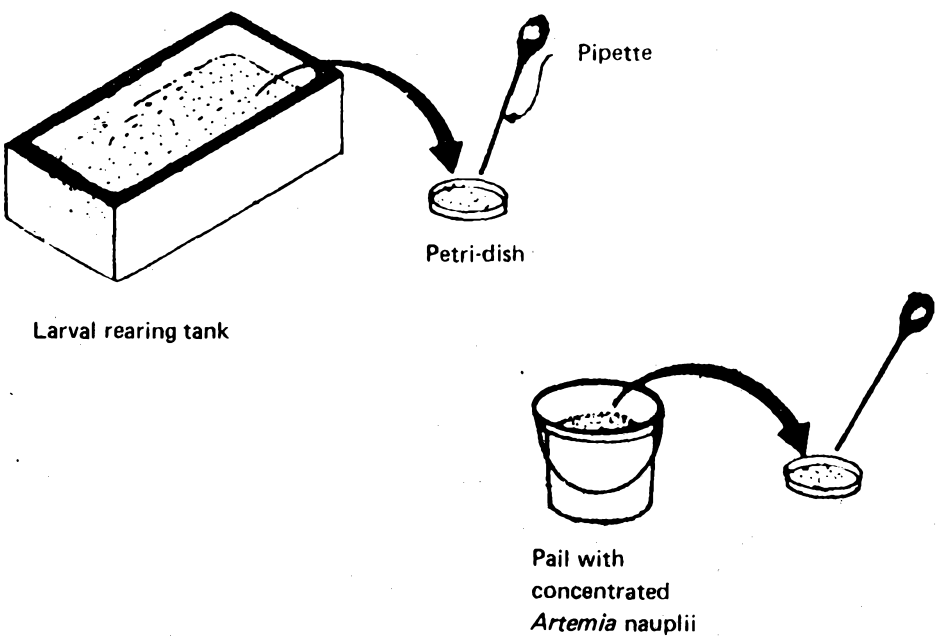


Fig. 38. Counting *Artemia* nauplii

4. Feeding scheme

Recommended feeding method is shown in Table 1

Introduce algae in tank before the nauplii (N_{v1}) molt to become protozoea. Maintain the density of algae in the rearing tank at 2,500 to 10,000 cells/ml depending on the species used. If algae fail to bloom, bread yeast may be added as supplementary food for protozoea while waiting for the algae to bloom. Feed egg yolk at late protozoea I to mysis III. Add *Artemia* in the diet starting mysis II until early postlarval stage at the rate of 2-5 *Artemia*/ml. Although zooplankton may be used as feed at mysis stage, they may be difficult to mass produce to meet hatchery needs.

D. Water Management

Water quality in the larval rearing tanks deteriorate due to accumulation of fecal matter and decomposition of uneaten food. Daily water change of 30% of the total water volume starting protozoea$_{1,1}$ has been found to be an effective way of maintaining good water quality for larval growth and development.

A simple way of changing water is by using a siphon with a strainer at the intake-end. Mesh size of the strainer depends on the stage of larval development during water change. Be sure the temperature and salinity of the water source are close to that of the culture water. Observe caution in changing water during and after heavy rains to avoid turbidity and change in salinity and temperature.

Regular siphoning of sediments at the bottom of culture tanks is helpful in maintaining good water quality. This can be done 2 or 3 times a week.

Table I. Recommended Feeding Schemes for *P. monodon* Larval Rearing

Stages	Nauplius	Protozoea	Mysis	Postlarvae
	N_I N_{II} N_{III} N_{IV} N_V N_{VI}	Z_I Z_{II} Z_{III}	M_I M_{II} M_{III}	PL_1 PL_2 PL_3 PL_4 PL_5 PL_6 ... PL_N
No. of Days	1.5 days	5-6	4-5	First day of postlarvae is termed PL_1 & 2nd day PL_2 & so on
Scheme 1	no feeding	*Skeletonema* or *Chaetoceros*; 5,000-10,000 cells/ml Egg yolk particles; 5-15 particles/ml		*Artemia* nauplii; 2-5 *Artemia*/ml
Scheme 2	no feeding	*Tetraselmis*; 2,500-5,000 cells/ml Egg yolk particles; 5-15 particles/ml		*Artemia* nauplii; 2-5 *Artemia*/ml
Scheme 3	no feeding	Mixed diatoms; 5,000-10,000 cells/ml Egg yolk particles; 5-15 particles		*Artemia* nauplii; 2-5 *Artemia*/ml

VII. POSTLARVAL REARING

Postlarval rearing is another important phase in hatchery operation. The postlarvae (PL_3 to PL_5) are transferred to the postlarval rearing or nursery tanks to avoid overcrowding of fry and to vacate the larval rearing tanks for the next run.

It is advantageous to nurse the early postlarvae in tanks instead of stocking them directly in nursery ponds. Technicians will be able to (1) better control feeding levels and water quality, (2) eliminate organisms that may prey or compete with the prawn, (3) stock more fry, and (4) facilitate harvesting.

A. Stocking density

About 3,000 to 5,000 postlarvae per ton of seawater can be stocked in the nursery tank.

B. Substrates

Provide nursery tanks with substrates to serve as additional surface area for postlarvae to cling to and for growth of benthic organisms which may serve as food. Substrates serve also as protection against cannibalism, that is, the tendency of postlarvae to feed on each other due to overcrowding.

Most commonly used substrates are made of bamboo slats, fine nylon material, and polyprophylene netting material. They are installed in a vertical position but in various formations like straight row, S-form or zigzag, depending on the needs and size of the tank (Fig. 39).

C. Feeds and Feeding

Most food of prawn larvae up to PL_5 consist of phytoplankton and brine shrimp nauplii. At PL_6, gradually introduce the postlarvae to mussel meat, trash fish and *Acetes* (small shrimp used in making "bagoong"), whichever is locally available, until they become eventually used to these kinds of food.

Wash finely chopped trash fish and mussel meat in a screen net before feeding. Feed 2-3 times a day either by broadcasting or by placing feeds in feeding trays. Adjust feed ration according to the amount of uneaten food and corresponding growth of the postlarvae. To be able to know this, observe the feeding habit of postlarvae.

D. Water Management

Change water in the nursery tank 4 times a week. Siphon excess feeds and change 30-50% of the total water volume in the tank regularly.

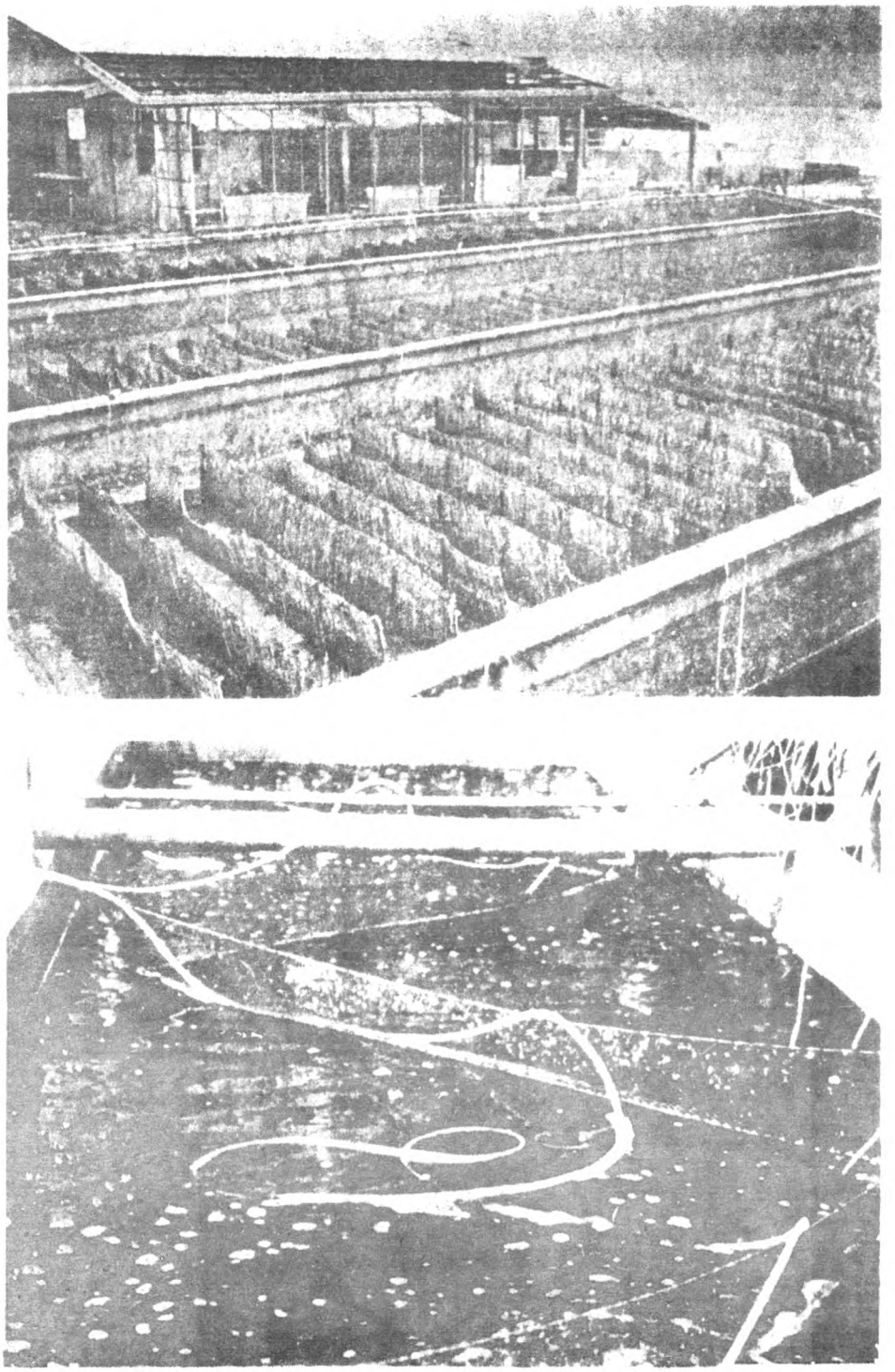


Fig. 39. Bamboo and nylon substrates in nursery tanks

VIII. HARVESTING, PACKING AND TRANSPORTING

A. Harvesting

Harvest fry this way (Fig. 40).

1. Drain the tank by lowering the water level first to about ¼ of the total water volume to reduce water pressure and to minimize stress on fry. This can be done by siphoning the water using a hose fitted with a screen.
2. If the tank has a drain pipe installed at the bottom, open it and allow the remaining water with fry to flow to the harvesting box or a basin. When drain pipe is not installed, scoop the fry and transfer these directly to a basin. The number of basins will depend on the number of fry to be harvested. The basins should be of the same size and should contain the same amount of water.
3. Headcount some harvested fry in a basin. For example, if you have about 5,000 fry in a given volume of water in a basin, place the same estimated number in each of the remaining basins. After harvesting and counting, the fry are now ready for packing and transport.

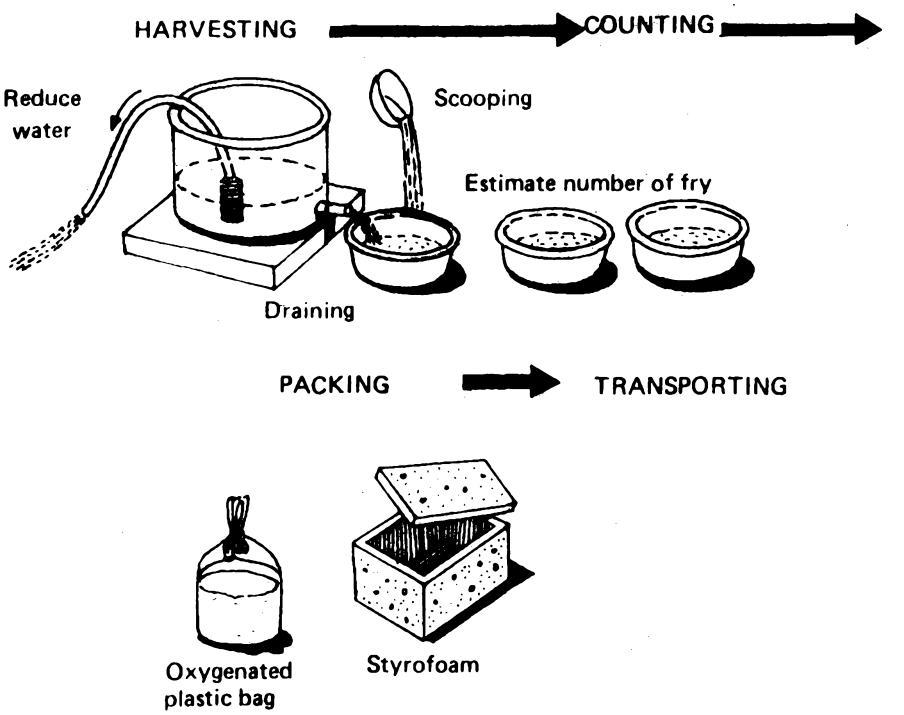


Fig. 40. Harvesting, counting and packing procedure

B. **Packing and Transporting**

Pack prawn fry properly for transport to the growout ponds. The number of fry placed in a container will depend on their size and age, travel time and distance, and means of transportation.

Packing procedure:

1. Put the fry in a double plastic bag measuring 50 x 90 cm. For 6 hours transport time, put about 2,000 PL_{25} to PL_{30} in a bag containing 5 liters of seawater. Decrease the number to 500 for older fry (PL_{40} to PL_{50}).
2. To ensure high fry survival, inject oxygen into the bag's mouth, then tie with rubber bands.
3. Place oxygenated plastic bags containing fry either in styrofoam boxes, pandan bags or pails (Fig. 41).

Fig. 41. Packing of fry for transport

4. If travel time is more than 6 hours, maintain temperature in the container at 22-24°C by placing wrapped ice on top of the plastic bags. At low temperature, oxygen consumption and molting frequency are decreased. Reoxygenation and changing of water may be needed when transport time exceeds 12 hours.

Live fry transported to nearby ponds may be placed in holding tanks provided with aeration. Upon reaching the destination, acclimate fry to the temperature and salinity of the pond before stocking.

IX. DISEASES

Prawn larvae like other marine animals are subject to almost all forms of infection caused by viruses, bacteria, fungi or protozoans. Injury from excessive handling, over-crowding, temperature and salinity, inadequate nutrition, and poor water quality can stress prawns and leave them vulnerable to infection. These can be detected by frequently observing the larvae. Common manifestations are empty digestive tract, weak or disoriented swimming, broken or deformed extremities, reddening of the body, and incomplete molting. Infection can be prevented by maintaining good water quality, adequate nutrition, and by reducing stress to the larvae and postlarvae and postlarvae.

X. ECONOMICS

Every prospective hatchery operator will be interested to know if he can profit from operating a prawn hatchery. He needs to know the estimates of costs and income involved in the whole operation.

The information provided in Table 2 is based on early 1984 prices.

Table 2. Costs and income analysis of a one-year operation of an 8-larval rearing tank hatchery system.

Fixed Expenses		
Depreciation	₱	21,530
Business Tax		100
Interest Tax		23,157
Repair & Maintenance		7,700
	₱	52,487
Variable Expenses		
Salaries and Wages	₱	39,000
Supplies and Materials		35,730
Spawners		60,000
Electricity		6,950
Sales Tax		3,000
	₱	144,680
Total Expenses		₱ 197,167.00
Gross Sales (600,000 pcs. P_{35} at P500/1,000 pcs)		300,000.00
Net Income Before Income Tax		102,833.00
Income Tax		25,992.00
Net Income After Income Tax	₱	76,841.00
Return on Investment		50%
Payback Period		1.6 years

Table 3. — Inventory and cost of physical facilities, equipment and land for an 8-tank hatchery system made of bamboo and plastic sheet materials.

Items	*Number*	*Cost*
1. Larval rearing tank (3 tons) ₱505	8	₱ 4,040
2. Nursery tank with cover (6 tons) ₱1,000	8	8,000
3. Algal tank with cover (1 ton) ₱400	4	1,600
4. Building including working area	1	6,000
5. Technician's quarters	1	4,500
6. Water pump (1 HP)	2	3,600
7. Aerator (5 watts) + outlets	43	8,820
8. Water intake structure	1	3,000
9. Water distribution and drainage lines (bamboo)	1	140
10. Electric wiring and lighting		2,820
11. Sand filter	1	2,000
12. Seawater reservoir (10 ton)	1	10,000
13. Microscope (student type)	1	3,500
14. Refractometer	1	2,000
15. Hemacytometer	1	500
16. Water buckets, pails, basins	4, 4, 4	800
17. Refrigerator	1	5,000
18. Rubber hose and plastic tubing		680
19. Stand-by generator (16 HP)		10,000
20. Land (1,000 m^2)		30,000
TOTAL		₱ 107,000

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Appendix I

How to Count Algae

1. Use hemacytometer and place a cover slip over the center.
2. Take water samples from tanks and place in a test tube.
3. Shake test tube to distribute algae uniformly; get a few drops from the test tube.
4. Place a drop in the V-groove of the hemacytometer near the edge of the cover slip. Samples should be free from bubbles and should be evenly distributed when focused under low magnification of microscope.
5. Count the algae in the 4 (A-D) corner blocks under high magnification of microscope (Fig. 42).

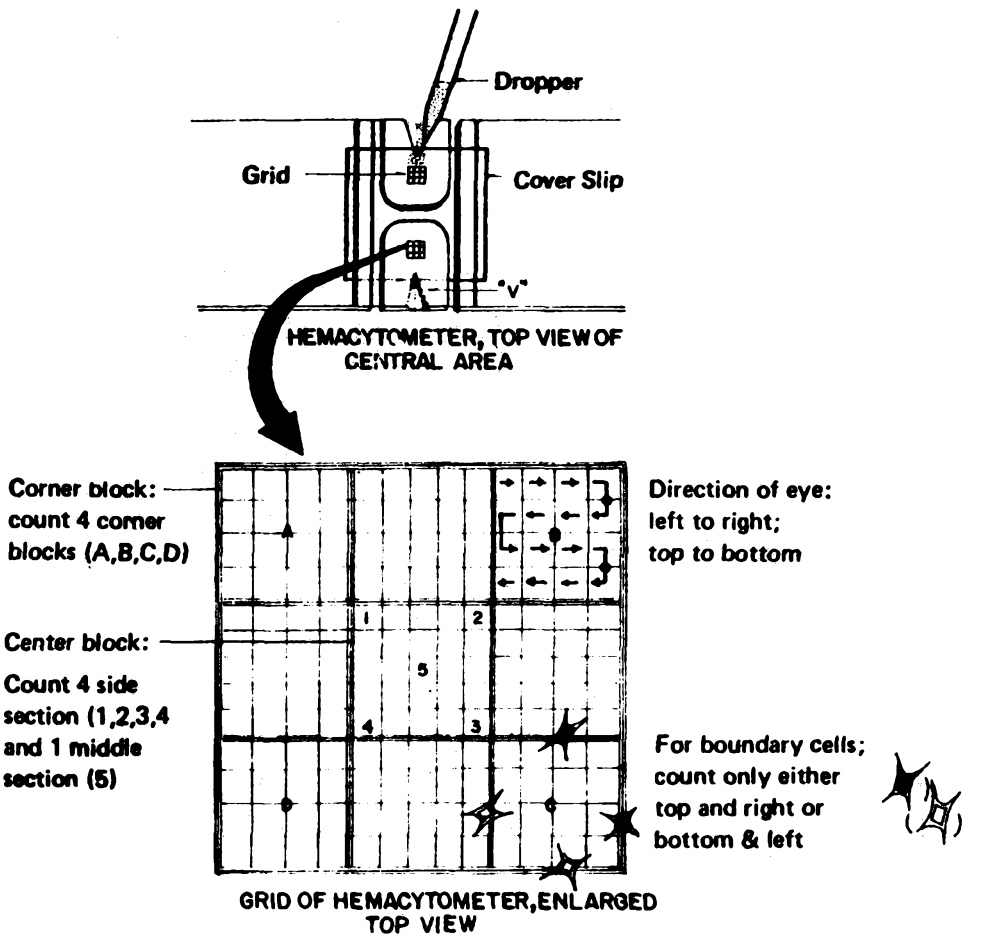

Fig. 42. Hemacytometer for counting algae

For cells falling on the boundary line of the corner block, count only those on the left and bottom boundary lines (L-shape) or those cells on the right and top boundary lines (inverted L-shape). Cells occurring in chains should be counted individually (Fig. 43).

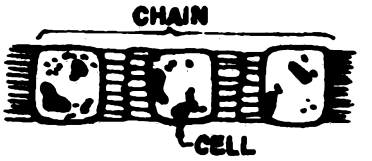

Fig. 43. *Skeletonema* cells

Computation:

$$\text{No. of cells/ml} = \frac{\text{Total no. of cells in 4 blocks}}{\text{No. of blocks (= 4)}} \times 10^4$$

Example:

$$\text{No. of cells/ml} = \frac{150}{4} \times 10{,}000$$

$$= 375{,}000 \text{ cells/ml}$$

6. If the cell density is too high (above 10^6 cells/ml), use the center block. Count the phytoplankton in the 4 corner squares and the middle square of the center block.

Computation:

$$\text{No. of cells/ml} = \text{Total no. of cells in 5 sections} \times 5 \times 10^4 =$$

or

$$\text{No. of cells/ml} = \frac{\text{Total no. of cells in 5 sections}}{20} \times 1{,}000{,}000$$

Example:

$$\text{No. of cells/ml} = \frac{68}{20} \times 1{,}000{,}000$$

$$= 3{,}400{,}000$$

Appendix 2

HATCHING PERFORMANCE OF COMMONLY AVAILABLE *ARTEMIA* CYSTS

	Nauplii Size	Hatching Percentage 24 Hrs.	48 Hrs.	Hatching Efficiency 24 Hrs.	48 Hrs.
1. San Francisco Bay Brand	512 microns	89	90	8.4	6.6
2. Sanders (Great Salt Lake)	492 "	36	63	8.3	6.2
3. China	522 "	62	85	8.2	7.3
4. Jackson	500 "	18	41	25.5	10.6
5. Biomarine (Great Salt Lake)	470 "	31	56	13.3	10.3

PRAWN HATCHERY DESIGN AND OPERATION

Aquaculture Extension Manual No. 9 ISSN 0115-5369
Second Edition, Fourth Printing, March 1989

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