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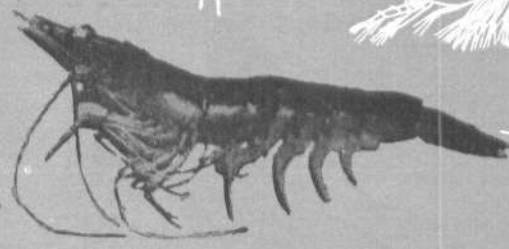
HATCHERY PRODUCTION OF PENAEID PRAWN SEED: *PENAEUS INDICUS*



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HATCHERY PRODUCTION OF PENAEID PRAWN SEED: *PENAEUS INDICUS*

TRANSFER OF TECHNOLOGY

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CONTENTS

1

INTRODUCTION

The different techniques of hatchery production of penaeid prawn seed that have been developed in different countries of the world are generally capital intensive, involving high technology. A developing country such as India with limited resources needs a low-cost technology which is simple enough to be used by semi-skilled workers. The technology presented here is based on a multi-disciplinary research experience from experimental to pilot stage, on induced breeding of marine prawns and hatchery production of penaeid prawn seed during the past decade. It is developed by utilising the locally available resources and materials and is appropriate to the socio-economic conditions prevailing along our coast.

To understand the rationale behind the procedures outlined in the manual some background information on the life history, reproduction and larval biology of penaeid prawns is necessary.

2

BIOLOGY OF PENAEID PRAWNS RELEVANT TO HATCHERY WORK

2.1 *Life Cycle*

Almost all the cultivable species of penaeid prawns belonging to the genera *Penaeus* and *Metapenaeus* have a typical life cycle. The prawns mature and spawn in the sea where the larvae also develop and, after a series of moults, metamorphose into postlarvae. The postlarvae drift towards the coast. Some of them are carried by the tides into the estuaries and backwaters where they settle down and grow rapidly into juveniles. After attaining a particular size which varies with the different species, the juveniles migrate back to the sea for gonadial maturation and spawning. Normally, the females do not attain maturity in the brackishwater environment although males may do so*.

2.2 *Reproduction*

The penaeid prawns are bisexual, the females being generally larger than the males. The sexes can be easily distinguished on the basis of external features. The female has a sperm storing organ called the thelycum (Fig. 1 a) on the ventral side of the head (cephalothorax) between the 4th and 5th walking legs; the oviducts open at the base of the 3rd pair of walking legs. The ovary is found on the dorsal side of the animal along its entire length. The posterior portion of the developing or mature ovary in the abdominal segments is clearly visible through the cuticle when the prawn is held against a source of light. In a fully ripe female ready to spawn, the ovary is dark olive green in colour and has a lateral expansion (Fig. 2) in the first abdominal segment.

* This pattern is typical of *Penaeus indicus, P. monodon* and other species, while in some such as *P. semisulcatus* the entire life history is spent in the marine environment.

The male sexual organ is the petasma (Fig.1 d) which is a modified part of the first pair of swimming legs attached to the ventral side of the first abdominal segment. The two sperm ducts from the male testis open at the base of the 5th pair of walking legs. The

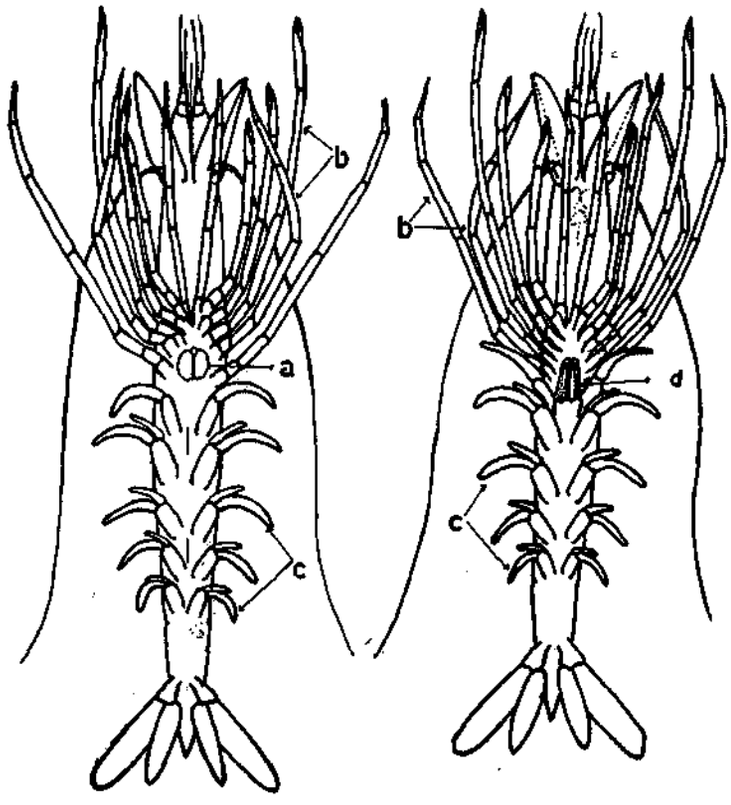


Fig. 1. *Penaeus indicus*: Male (right) and female (left). a. thelycum, b. walking legs, c. swimming legs, and d. petasma.

terminal portion of the sperm duct is enlarged to form the terminal ampoule in which the spermatophore or the sperm packet is stored. It is visible as a white mass at the base of the 5th pair of walking legs in mature males. The non-motile sperms are packed inside the spermatophores which are transferred to the thelycum of the female at the time of mating. Mating takes place soon after the

female moults *i.e.* when it is still in a soft condition. In mated females the spermatophores can be seen as a whitish mass below the transluscent cuticle of the thelycum. At the time of impregnation the ovary of the female is still immature. So there is a time lag between mating and spawning. The spermatophores can be stored inside the thelycum for the duration of the intermoult period

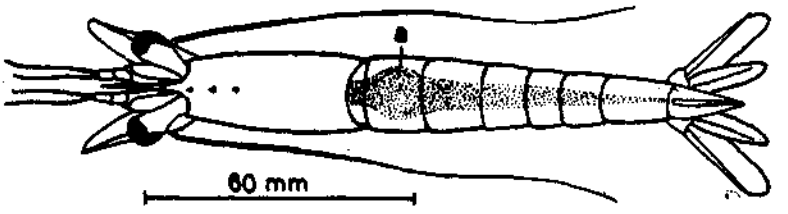


Fig. 2. *Penaeus indicus:* a. Mature ovary.

and are discarded along with the moulted cuticle at the time of moulting. The sperms remain viable for the entire intermoult period and can be used for fertilizing successive batches of eggs if the female happens to spawn more than once during the intermoult period.

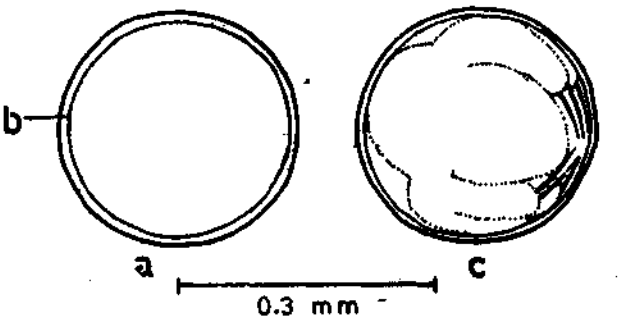
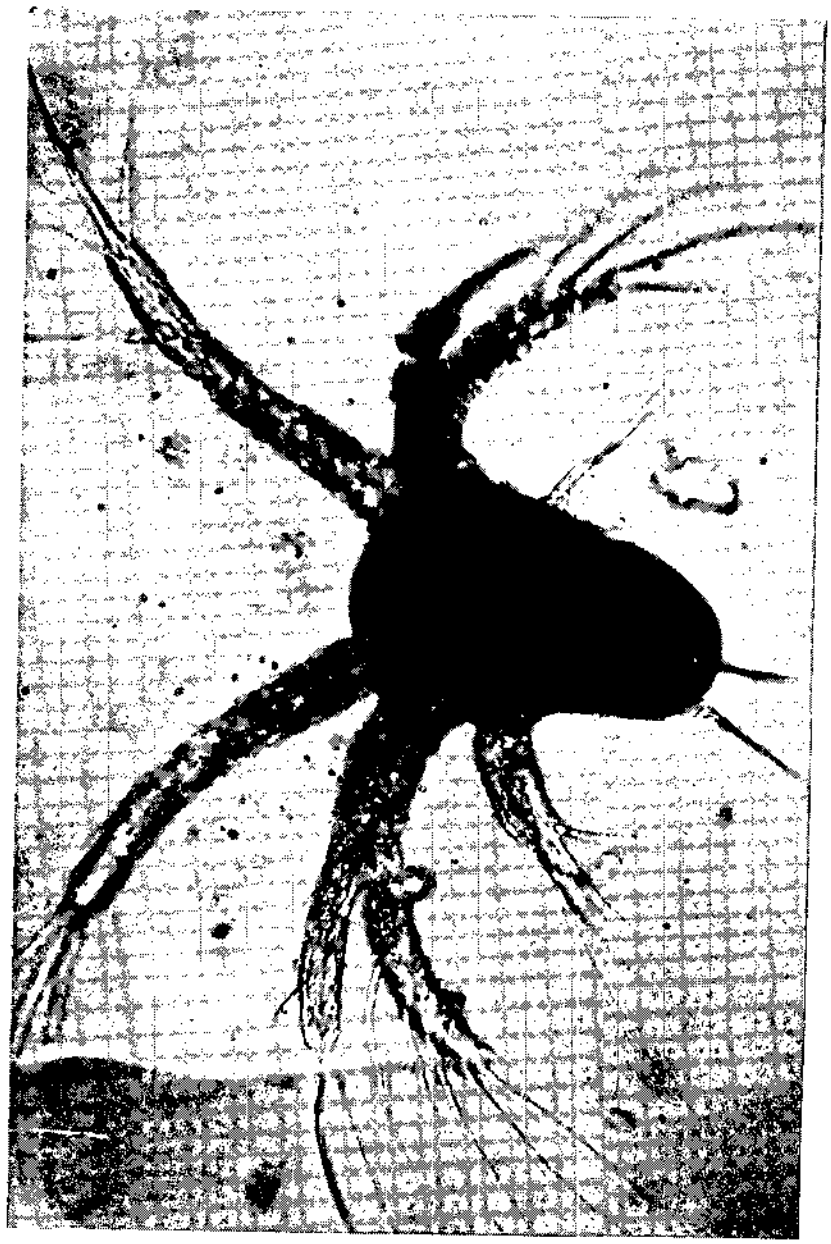


Fig. 3. Egg of *P. indicus:* a. fertilized egg before cleavage, b. perivitelline space and c. egg with developed embryo.

Spawning invariably takes place during the night. When the eggs are shed, the female simultaneously releases the sperms also from the thelycum and fertilization takes place in the sea water. The fertilized eggs sink to the bottom and remain close to the substratum and can be easily stirred up if the water is agitated.



The eggs of *Penaeus indicus* are about 0.3 mm in diameter with a narrow perivitelline space (Fig. 3). The embryonic development is rapid; the nauplius larva hatches out 10–14 hrs after spawning, depending on the temperature of the sea water.

2.3 *Larval stages*

The *nauplius* is pear-shaped with 3 pairs of appendages (Fig. 4). The nauplius moults every 3–5 hours and passes through 6 nauplius sub-stages (N 1 – N 6). The nauplius swims actively towards a weak source of light. The nauplius does not have a mouth or alimentary canal and hence does not feed. It subsists on the yolk material still present inside the body. After about 2 days, the nauplius metamorphoses into the protozoea.

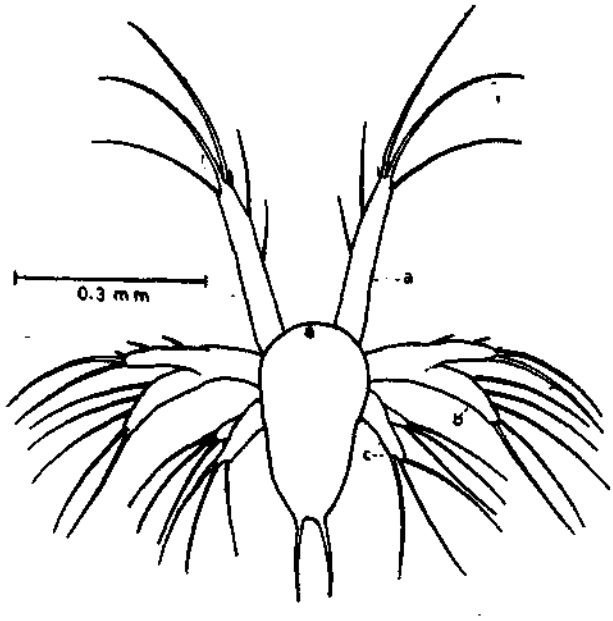


Fig. 4. Nauplius (N 1) of *P. indicus:* a. antennule, b. antenna and c. mandible.

The *protozoea* has 3 substages. The 1st protozoea (PZ 1) stage has a broad 'head' and a narrow 'tail' with a forked end; the head has sessile eyes and frontal organs (Fig. 5). In the 2nd protozoea stage (PZ 2) the eyes become stalked and the rostrum

develops (Fig. 6). In the 3rd protozoea (PZ 3) stage the abdominal segments develop dorsomedian spines and the uropod buds appear near the forked end of the tail (Fig. 7). The protozoea has an ali-

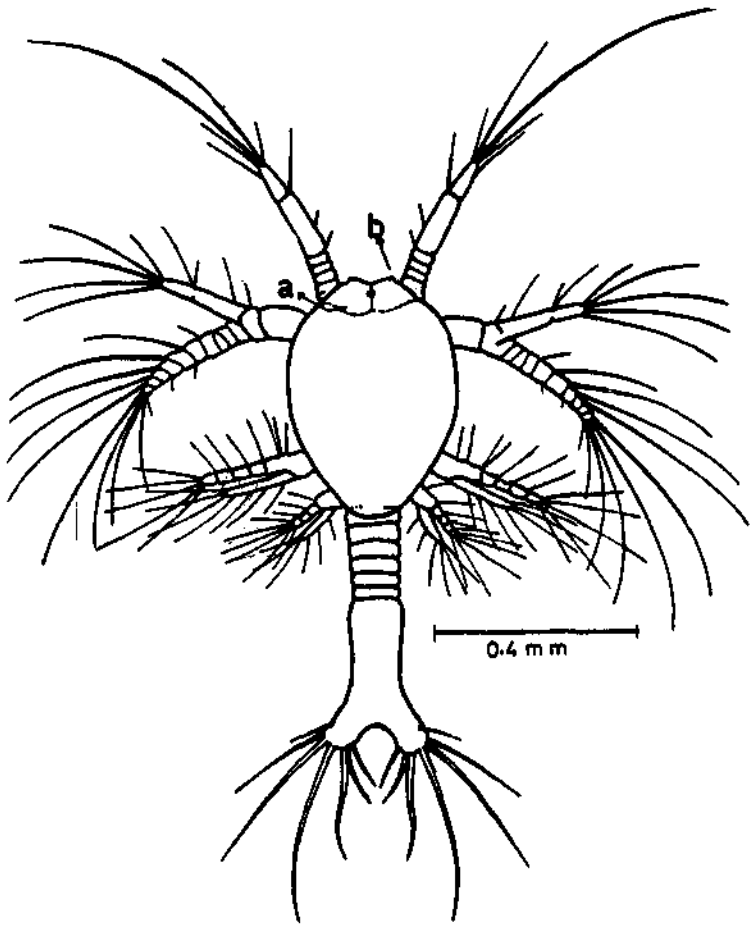
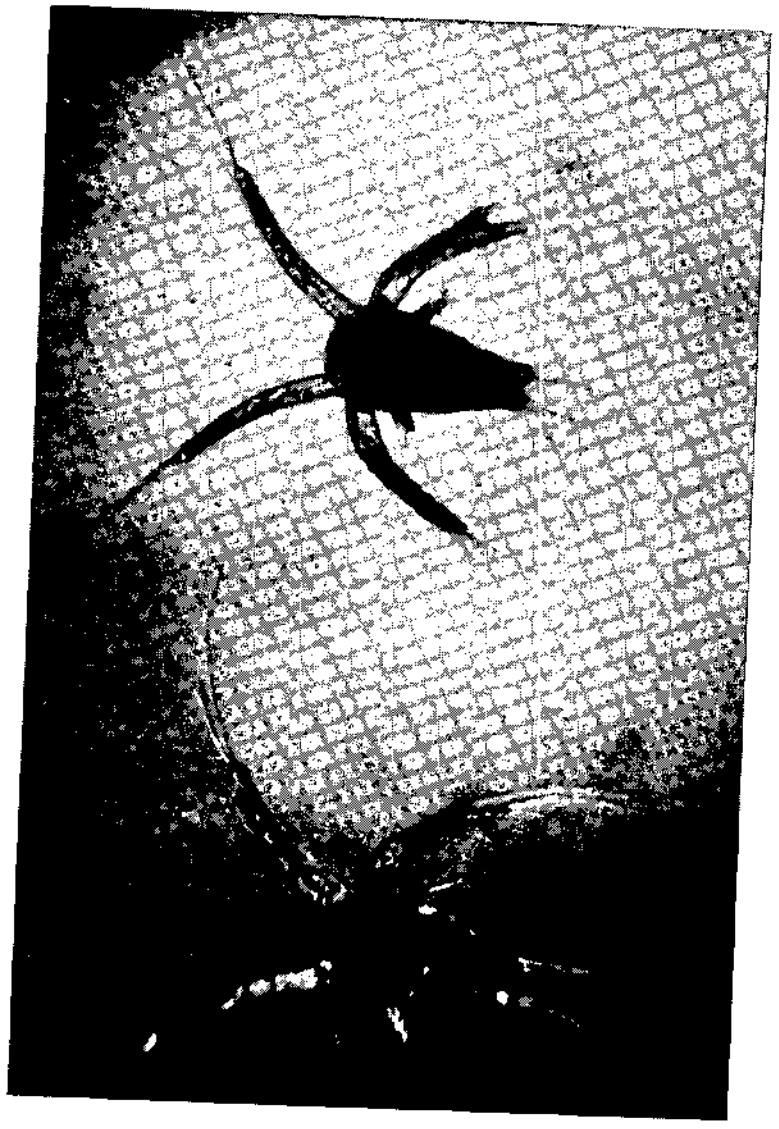


Fig. 5. First protozoea (PZ 1) of *P. indicus:* a. sessile eye, and b. frontal organ.

mentary canal, mouth and feeding appendages and starts feeding on the unicellular algae present in sea water. It has an efficient filtering mechanism to sieve the algal cells from the water. The protozoea swims actively in the water and is strongly attracted



towards light. This stage lasts for 3–4 days and is succeeded by the mysis stage.

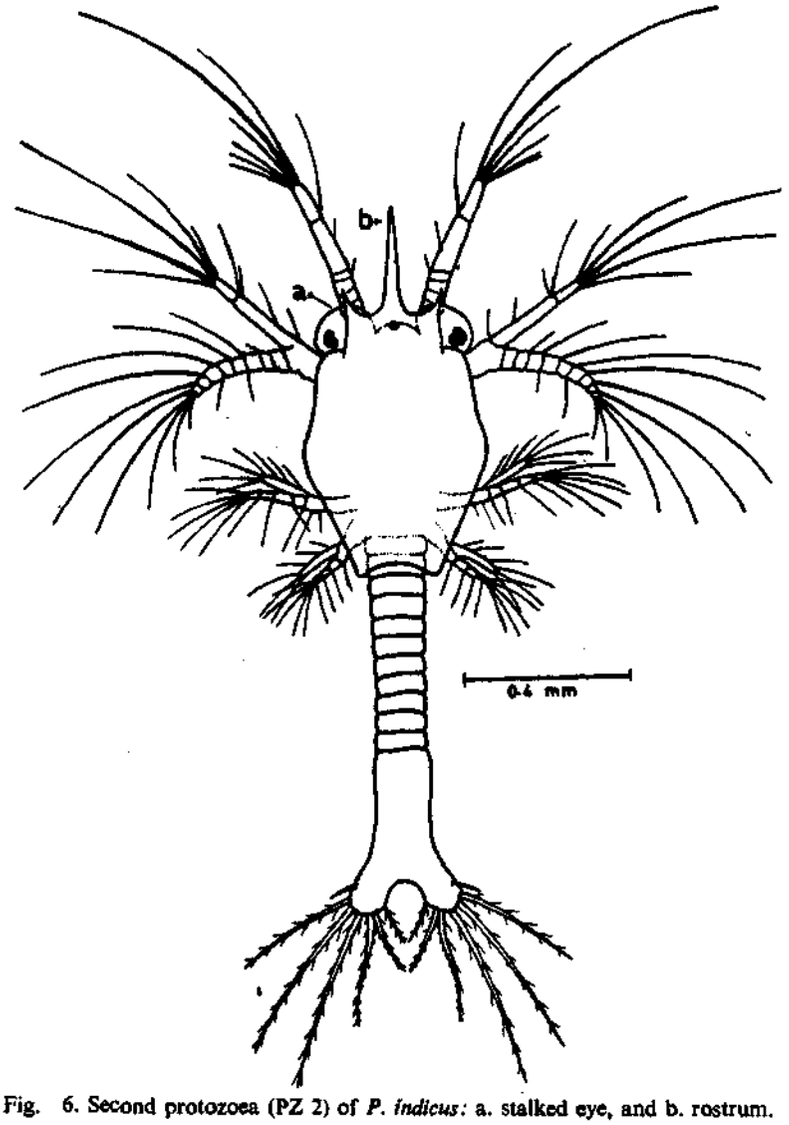


Fig. 6. Second protozoea (PZ 2) of *P. indicus:* a. stalked eye, and b. rostrum.

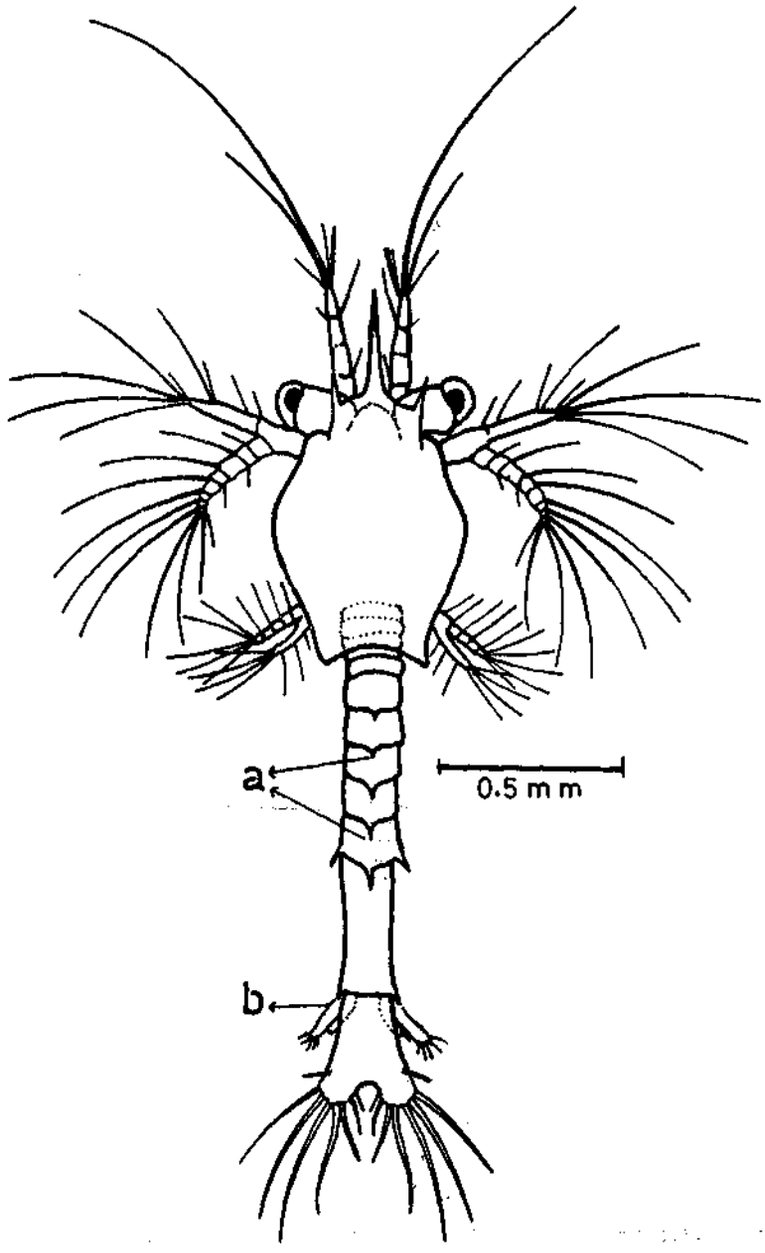
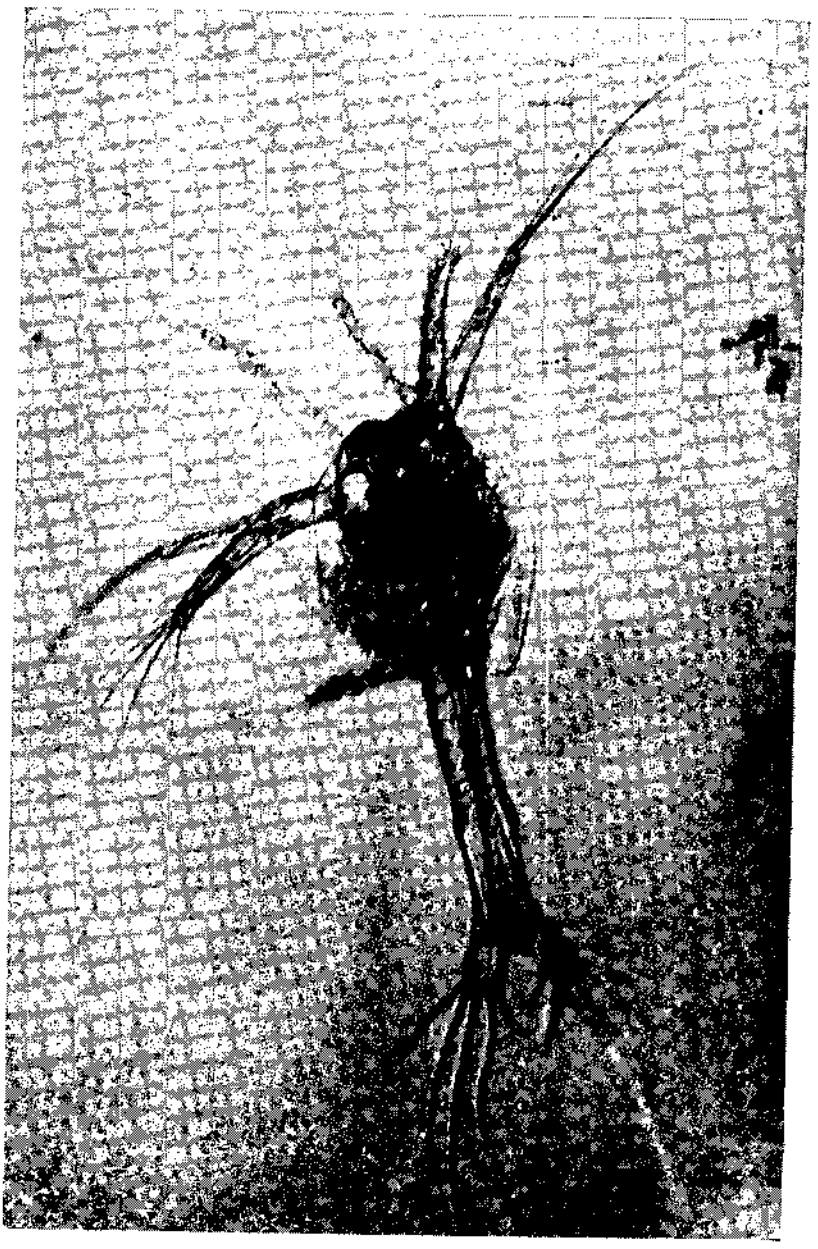


Fig. 7. Third protozoea (PZ 3) of *P. indicus* : a. dorsomedian spines, and b. uropod buds.



The *mysis* stage also has 3 substages which look very much alike except for the development of pleopod buds (swimming leg rudiments) in the two later substages. The 1st mysis (M 1) has no

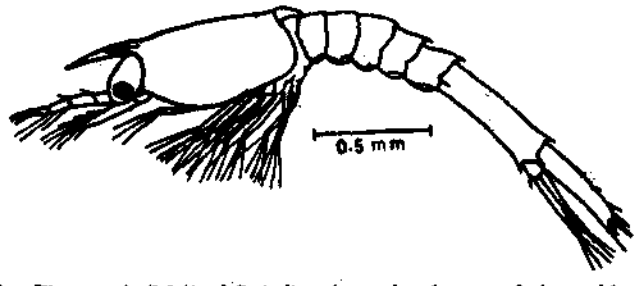


Fig. 8. First mysis (M 1) of *P. indicus* (note the absence of pleopod buds).

pleopod buds (Fig. 8). The 2nd mysis (M 2) has pleopod buds (Fig. 9). In the 3rd mysis (M 3) the pleopod buds become two-segmented (Fig. 10). In the mysis stage also the larvae retain the

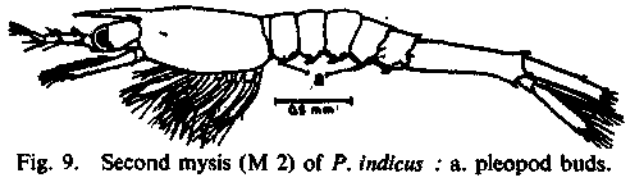


Fig. 9. Second mysis (M 2) of *P. indicus* : a. pleopod buds.

filtering mechanism for feeding on algal cells. The claws on the first three walking legs are not functional and cannot be used for capturing moving prey; the legs bear only swimming setae. The

Fig. 10. Third mysis (M 3) of *P. indicus:* a. two-segmented pleopod buds.

mandibles are weak and resemble those of the protozoea. The mysis do not swim actively like the protozoea and are also less responsive to light. They hover in the water column with the head

pointing obliquely downwards. The mysis stage lasts for 3–4 days before metamorphosing to the 1st postlarval stage.

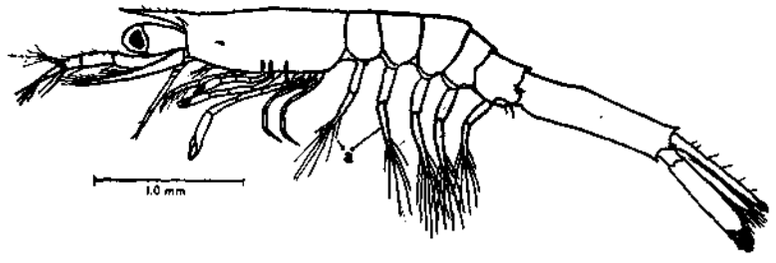
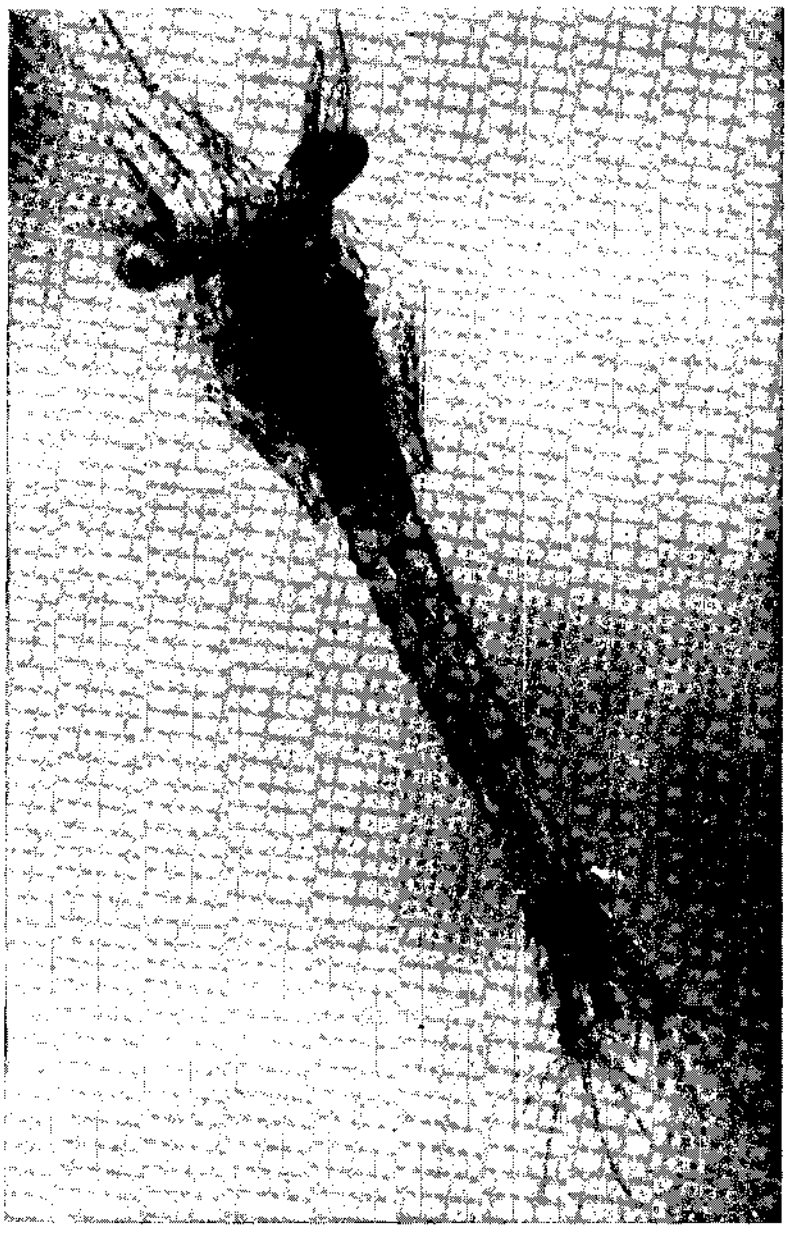


Fig. 11. First postlarva (PL 1) of *P. indicus* : a. pleopods with setae.

The *first postlarva* (PL 1) superficially resembles the 3rd mysis except for the development of setae on the pleopods (Fig. 11). But there is a drastic change in the feeding appendages. The filter feeding mechanism is lost abruptly and the mandibles lose the weak serrations and acquire a sharp cutting edge. The first three walking legs lose the swimming setae and their claws become functional, capable of grasping larger particulate matter. The postlarva ceases to be a filter feeder and becomes capable of capturing and eating zooplankton. The attraction to light is also lost. The transition from the postlarval stage to the juvenile stage is very gradual and is not marked by metamorphic changes.

The hatchery phase (from nauplius to PL 5) takes 13–14 days.

The nursery phase lasts for about 15–20 days after the PL 5 stage, till the post larvae reach the stockable size of 20–25 mm.



3

HATCHERY SITE REQUIREMENTS

Selection of site for constructing the hatchery is a crucial factor. It has a major influence on the success of the technical operations and the economic viability of the hatchery.

The following are important criteria to be considered for choosing a site for the hatchery.

1. The sea water should be of good quality and have a salinity of 28–34 ppt throughout the year. For this the site should be far away from river mouths so that the sea water is not diluted by the freshwater discharge from the rivers. Flood water from the rivers also brings in a lot of silt and detritus adding to the turbidity of the water.

2. It should not be located near sources of thermal, sewage or industrial pollution.

3. The sea bottom near the site should be sandy or rocky, not muddy. The seashore should be flat or gently sloping.

4. Freshwater (either from tap or from wells) should be available at the site.

5. The area should be easily approachable by good roads and should be near a town with amenities for the hatchery staff to live in.

6. The site should be situated in the neighbourhood of prawn farms. The proximity to a fishing harbour would be advantageous so that obtaining adult prawns for the broodstock will be easier.

7. Areas subject to sea erosion or soil erosion should be avoided.

8. The area should not be affected by cyclones and floods.

9. Electricity supply should be available in the vicinity, from which connections could be taken to the hatchery without heavy expenditure.

4

HATCHERY FACILITIES

The infrastructure facilities needed for a hatchery capable of producing 35 million PL 5 per year, are discussed below.

4.1 *Buildings*

The main section of the hatchery complex is a 32 x 13 m glass-roofed shed (Fig. 12). In the centre of the shed there is a 5 m wide, 30 m long, 2.1 m high concrete platform supported on concrete pillars to accommodate the algal culture tanks and spawning tanks as shown in Fig. 12 and 13. On either side of the raised platform is a 80 cm wide, 1.2 m high cat-walk running the entire length of the hatchery. The larval rearing tanks are arranged along the outer side of the cat-walk (Fig. 13). The glass roofing should be so constructed that the hot air near the roof can escape through suitable air vents. The concrete flooring should be provided with proper slope and covered gutters for draining the spilled water and keeping the hatchery clean and dry. In most places the sides of the shed need not have brick walls but may be protected by chicken mesh or welded mesh to keep out crows and other intruders. But in areas were strong dusty winds prevail during the summer months and cold winds blow during winter the hatchery should have brick walls on the sides with sufficient numbers of windows for ventilation and light.

At one end of the hatchery is a 20 x 5.5 m asbestos roofed section with a laboratory, store room, feed preparation room, duty room and toilet. The maturation pools can be kept in a 11 x 6 m asbestos roofed enclosure on one side of the hatchery (Fig. 12). A 6 x 2 m asbestos shed at the far end of the hatchery can accommodate the generator and the air blowers.

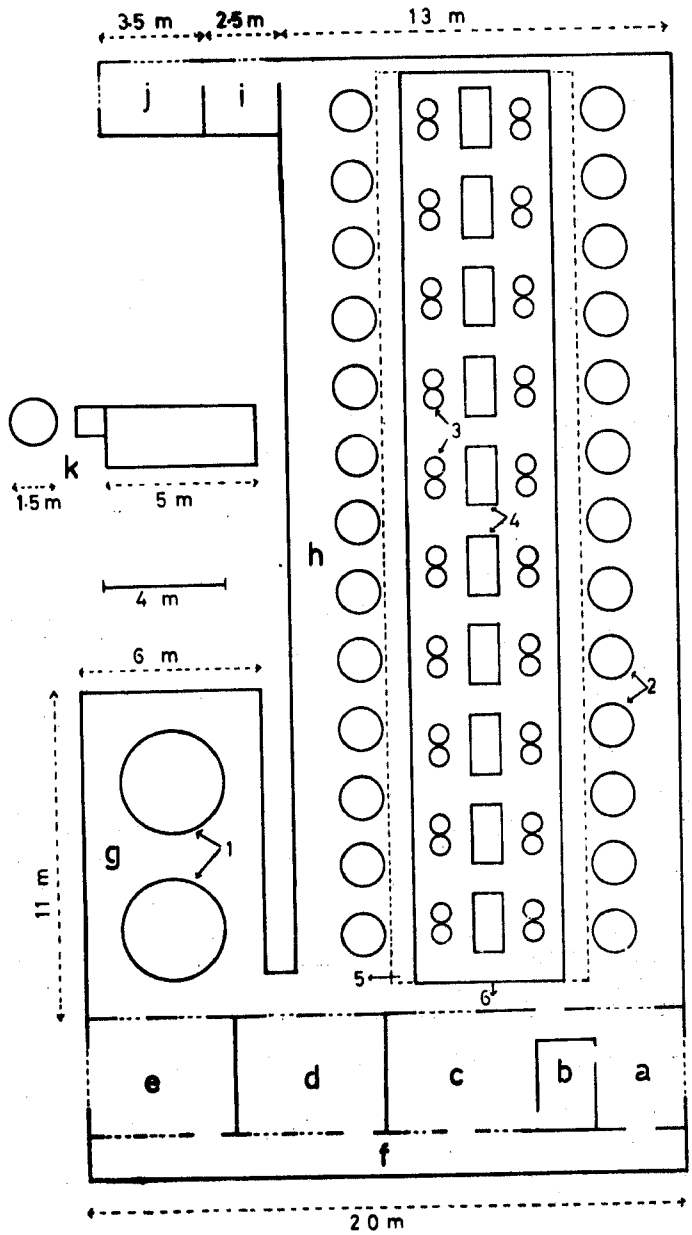


Fig. 12. Lay-out of hatchery complex: a. duty room, b. toilet, c. laboratory, d. feed preparing room, e. store, f. verandah, g. maturation shed, h. larval rearing shed, i. air blower room, j. generator room and k. freshwater sump and overhead tank. 1. maturation tanks, 2. larval rearing tanks, 3. spawning tanks. 4. algal culture tanks, 5. cat-walk and 6. raised platform.

4.2 *Sea water and freshwater supply*

Sea water supply system consists of an intake point, pump house, storage tank/sump, overhead tank and PVC pipe lines (75 and 50 mm dia) to distribute the sea water (Fig. 14). For pumping sea water from the sea to the sump two (one as standby) 5 H.P. electric or diesel pumpsets, with open-type gunmetal impeller and stainless steel shaft are necessary. For pumping water from the sump to the overhead tank two (one as standby) 2 H.P. electric pump sets with centrifugal gunmetal impeller and stainless steel shaft and 50 mm dia. PVC pipelines are sufficient. The daily sea water requirement for the hatchery is estimated as 20,000 litres. It is suggested that the capacity of the storage tank/sump should be 40,000 litres and that of the overhead tank 20,000 litres. The overhead tank should have enough height to supply sea water to the hatchery and broodstock tanks by gravity flow. If it is possible to install a submerged sand filter at the intake point the sea water can be pumped directly into the overhead tank, avoiding the need for a storage sump/tank. Otherwise, the storage tank/sump should be provided with a settling chamber separated from the main storage section by a baffle and designed in such a way that the sediment from the tank can be removed with ease.

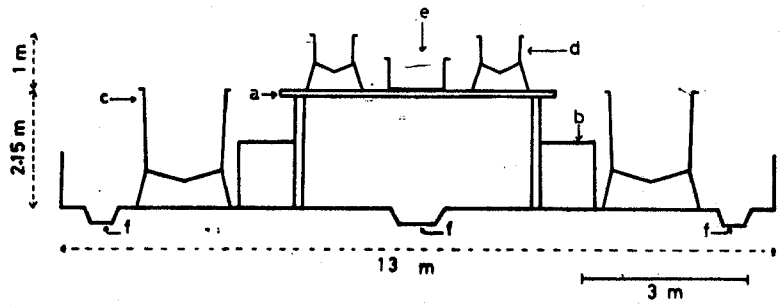


Fig. 13. Cross section of larval rearing area: a. raised concrete platform, b. cat-walk, c. larval rearing tank, d. spawning tank, e. algal culture tank, and f. gutter.

Freshwater is needed for cleaning the tanks, the hatchery and the maturation shed, and for drinking and sanitary purposes. Ground water or tap water can be used. The freshwater system consists of storage sump (10,000 litres), overhead tank (5,000 litres), electric pumpsets (1 H.P.) and 40 mm dia. pipelines to distribute the water (Fig. 14).

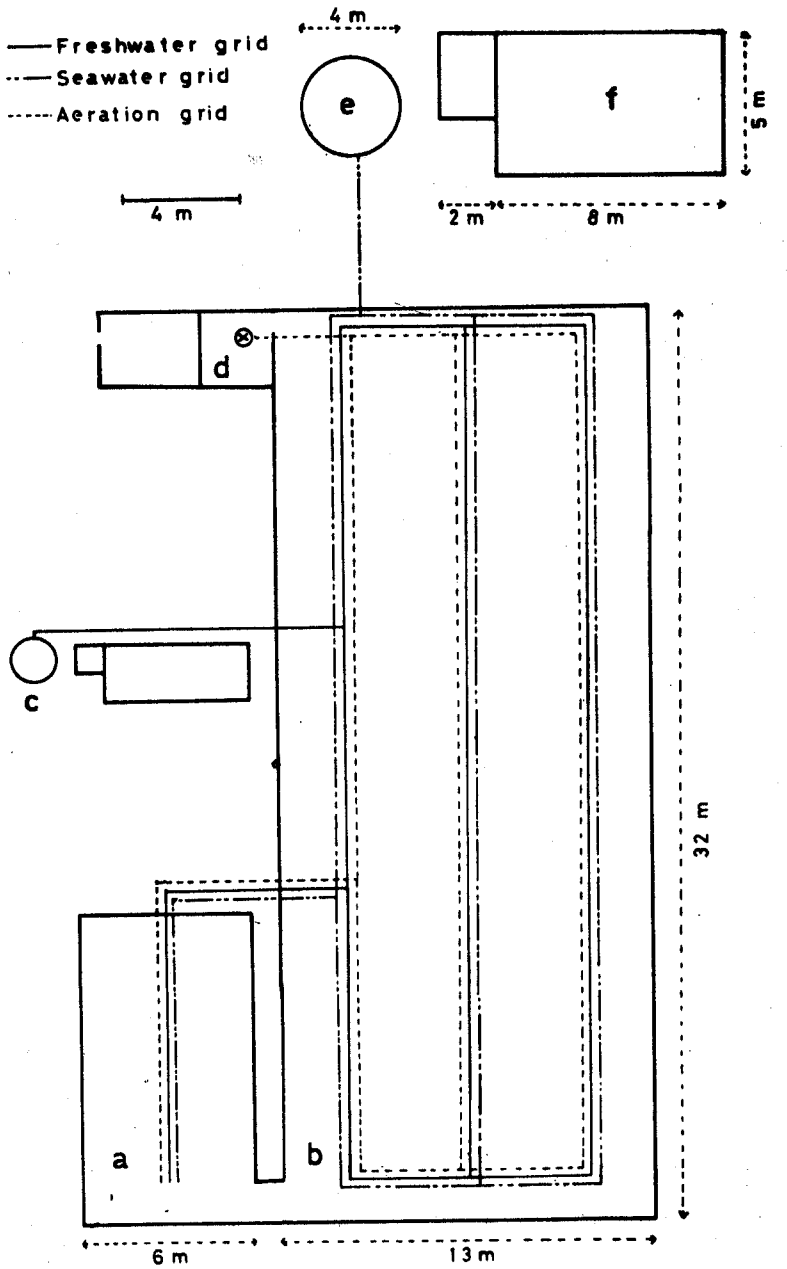


Fig. 14. Plan of grids for the distribution of air, sea water and freshwater: a. maturation shed, b. larval rearing shed, c. overhead tank for freshwater, d. air blower, e. overhead tank for sea water, and f. sea water sump and pump house.

The plumbing arrangements in the hatchery should be such that all the fibreglass tanks can be filled and drained by gravity flow. This will save a lot of manual labour.

4.3 *Aeration system*

The aeration system consists of air blowers, PVC air grid, polythene aeration tubes, air stones and regulators. Rootes type twin-lobe air blowers which supply large volumes of oil-free air at low pressure are preferable to conventional compressors which supply relatively small volumes of air at very high pressures usually contaminated by oil. A 5 H.P. air blower capable of delivering 160 cu.m of air per hour at a pressure of 0.3 kg/cm² will meet the requirements of a hatchery capable of producing 35 million PL 5 per year. It is advisable to connect two such air blowers to the aeration grid and work them alternately every half an hour. The air grid (Fig. 14) is constructed from 50 mm PVC pipes.

4.4 *Generator*

A standby 10 KVA, 3 phase generator operated by a 16 H.P. diesel motor is a necessity in a hatchery since electricity failures or loadshedding may happen frequently.

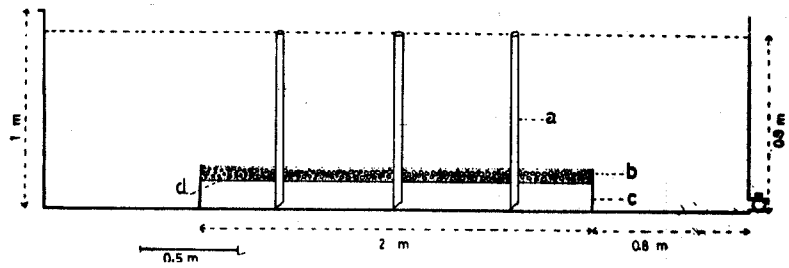


Fig. 15. Maturation pool: a. air lift, b. layer of gravel c. wooden frame, and d. false bottom.

4.5 *Maturation pools*

For making the prawns mature in captivity, two 10,000 litre capacity, circular (3.6 m diameter, 1.0 m height) fibreglass pools are needed (Fig. 15). The inside surface of the pools should preferably be black in colour to avoid stress to the prawns. A subgravel biological filter 2 x 2 m in area and fitted with nine air-lifts (made of 40 mm PVC pipes) which can recirculate the sea water in the

pool through the 60 mm layer of gravel at the rate of 150 litres per minute is kept inside the maturation pool. The nitrifying bacteria which naturally colonise the gravel bed, oxidise the toxic ammonia excreted by the prawns into harmless nitrates. The air-lifts also serve to keep the water in the pool well oxygenated.

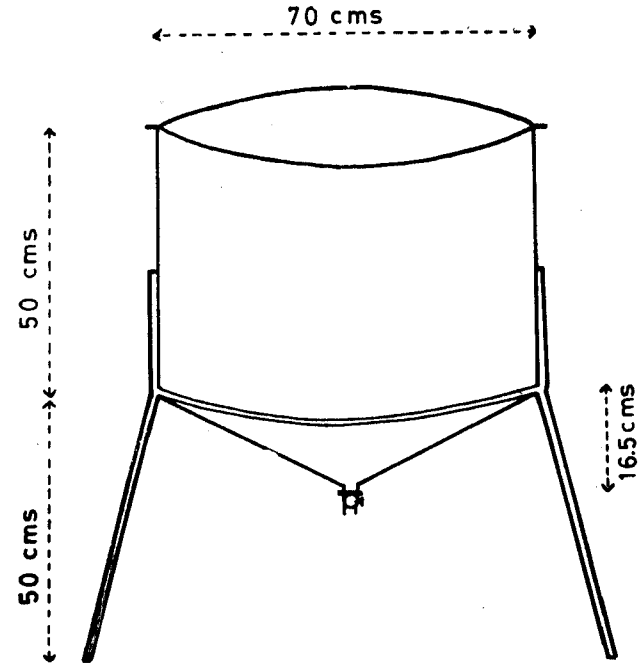


Fig. 16. Spawning tank.

4.6 *Spawning tanks*

They are cylindro-conical fibreglass tanks capable of holding 200 litres of water (Fig. 16). The inner surface of tanks should be black in colour. Three iron legs coated with fibreglass are fused to the body of the tanks for support. The conical bottom has a central drain fitted with a polypropylene ball valve. An air stone placed at the bottom of the cone maintains a good circulation of water preventing settlement of the eggs and improving the hatching rate. For the hatchery under consideration 40 spawning tanks are. required.

4.7 *Larval rearing tanks*

These tanks made of fibreglass, are also cylindro-conical in shape with fused fibreglass-coated iron legs for support and have the capacity to hold 2,000 litres of water (Fig. 17). The conical bottom has a short central drain pipe fitted with a polypropylene ball valve. Two airstones kept at the bottom of the cone keep the larvae and the algal cells uniformly distributed in the tank.

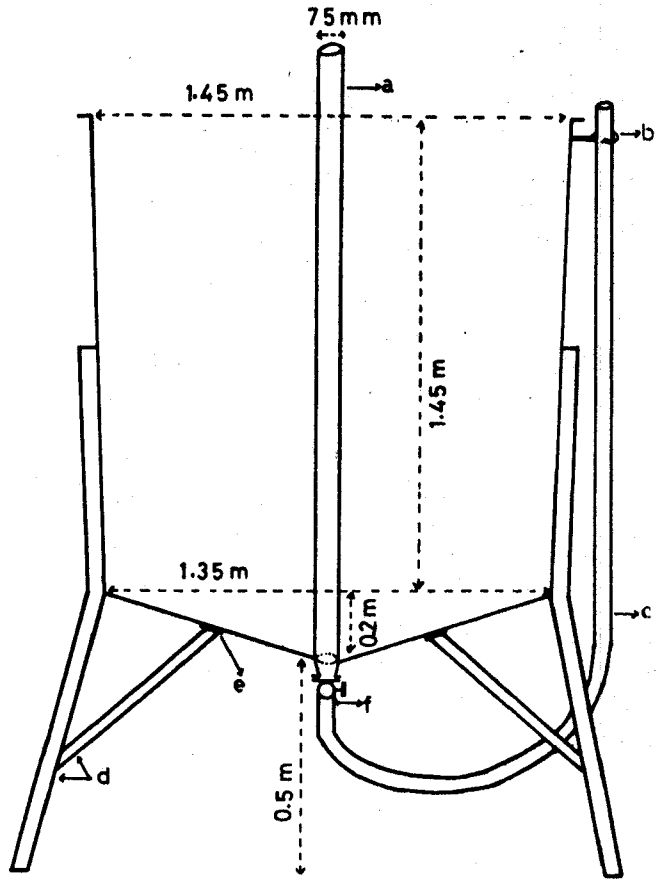


Fig. 17. Larval rearing tank: a. PVC stand pipe, b. clamp, c. 50 mm flexible PVC hose, d. iron-angle supports (50 x 7 mm) coated with fibreglass, e. circular iron-angle support coated with fibre glass, and f. 50 mm ball valve.

Twentysix larval rearing tanks are needed for the hatchery. The tanks should have a light-blue inner surface which is smooth and scratch resistant.

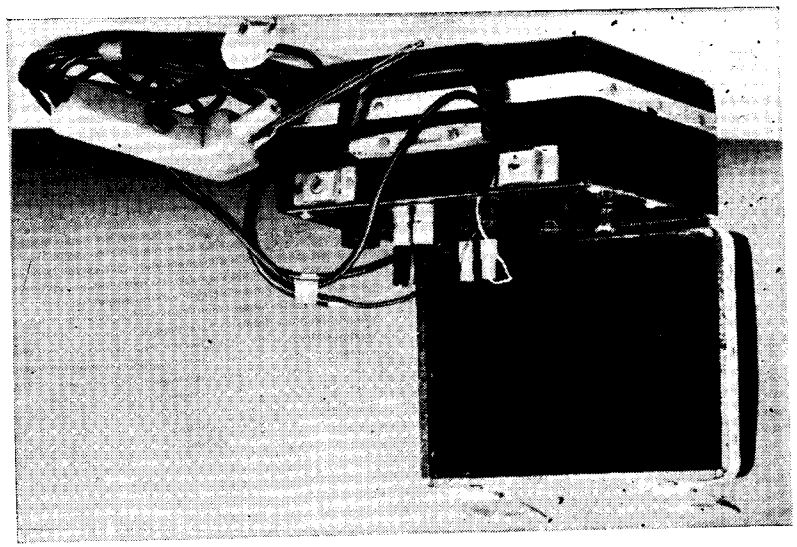
Portable plastic tanks of the appropriate size can also be used for maturation, spawning and larval rearing. They are cheaper than fibreglass tanks, but last only for 2 years and require more manpower to clean and maintain.

4.8 *Algal culture tanks*

These tanks made of fibreglass, are oval or rectangular in shape (2 x 1 x 0.6 m) and each has the capacity to hold 1000 litres of water. The tanks should be white in colour on the inner surface to reflect light for enhancing photosynthetic activity. Two air stones are kept in each tank. Ten such algal culture tanks are needed for the hatchery under consideration.

4.9 *Other equipments*

For transferring algal cultures and nauplii to the rearing tanks 50 mm PVC flexible hoses are needed. A deep freezer is required for storing feeds, etc. For examining the condition of the larvae and for checking the algal cell concentration, a compound microscope is necessary. A pH meter, salinometer, colorimeter, chemical balance and thermometers are also essential for monitoring water quality. Glassware such as beakers, embryo cups, petridishes, microscope slides, cover slips, conical flasks, burettes, pipettes etc. are also needed. Plasticware such as buckets, bins and basins and bolting cloth of mesh sizes varying from 50–250 microns will also be required. A high speed kitchen mixie, hot air oven and hand pelletiser are needed for preparing the particulate feed. A small electrocautery apparatus is also needed for eyestalk ablation (please see Annexure III for list of equipments).



5

HATCHERY OPERATIONS

5.1 *Induced maturation*

The unilateral eyestalk ablation technique is used for inducing the prawns to mature in captivity.

5.1.1 *Size of prawns*

The size of the prawns used is critical. In the case of *P. indicus* the females should be larger than 145 mm in total length (>20 g) and the males larger than 140 mm total length (>17 g). The prawns may be collected either from the sea or from the culture ponds. The females of this size collected from sea or ponds are usually impregnated, but have immature ovaries, and the males are fully mature with the white spermatophores visible at the base of the 5th walking legs. Eyestalk ablation is done only on females and not on males.

5.1.2 *Eyestalk ablation*

A small portable electrocautery apparatus is used for eyestalk ablation. One of the eyes is cut by passing the red hot loop of the cautery through the middle of the eyestalk. The optic ganglia and the related neurosecretory centres which produce an ovary inhibiting hormone are removed by this process. Cauterisation seals the cut end and prevents bleeding. Mortality due to cauterisation is nil.

5.1.3 *Management of maturation pools*

The ablated females are introduced into the maturation pool along with a few males. The male to female ratio need not exceed

1:4. If the females are all impregnated there is no need for males. However, to impregnate females that may moult in the maturation pool it is advisable to keep a few males in the maturation pool. In a 10,000 litre pool where the biological filter is functioning well, 50 *P. indicus* (40 females and 10 males) can easily be maintained.

Water quality and other conditions conducive for maturation

Parameter	*Permissible range*
Salinity	29–34 ppt
Temperature	27–29°C
pH	8.0–8.2
Dissolved oxygen	4.0–5.5 ml/litre
Total ammonia	0.02–0.07 ppm
Nitrite	0.003–0.02 ppm
Light intensity during day time in the shed	500–3600 lux

Under these conditions about 70% of the ablated females mature and spawn within 4–5 days after eyestalk ablation.

The pH of the sea water in the pool is maintained between 8.0 and 8.2 by addition of sodium carbonate (*ca.* 25 g/m³ of water every day) or slaked lime (*ca.* 25 g/m³ of water every alternate day). The prawns are fed with clam or mussel meat @ 12.5–15.0% of prawn biomass per day in the evening. The unused food and faecal pellets are siphoned out in the morning.

The temperature, pH and dissolved oxygen content of the sea water are measured in the morning and evening. The salinity of the water may be checked once in two days. If the salinity increases above 34 ppt due to evaporation it may be brought down by adding freshwater to maintain the salinity between 29 and 34 ppt.

In a commercial hatchery, although everyday monitoring of ammonia and nitrite levels is not required, base-line information as well as occasional checks on these parameters are essential. In case of acute water quality management problems, expert advice may be needed.

If prawns suitable for ablation are readily available, it is advisable to discard the spent females and use a fresh batch of ablated females for every hatchery run. The sea water in the maturation

Female *Penaeus indicus* with mature ovary.

pool is also totally replaced before introducing a fresh batch of ablated females into the pool. If it is difficult to get large sized prawns for eye ablation, the spent females can be reintroduced into the pool for rematuration.

5.2 *Spawning*

The females with fully mature ovary (Fig. 2) are removed with a dipnet from the maturation pool and transferred in the evening to the spawning tanks each containing 200 litres of sea water filtered through a 50 micron mesh bolting cloth. Only one spawner is kept in each tank. The temperature of water is 27–30°C, salinity 30–34 ppt and the pH 8.0–8.2. Mild aeration is given. Disodium salt of EDTA is added to the water @ 0.1 gm per 100 litres of water. The tank is covered with a black lid to protect the female from strong light and to prevent it from jumping out of the tank. The lights are switched off during night. Spawning usually takes place between 8 p.m. and 2 a.m. The female is removed early in the morning and returned to the maturation pool, if it is in good condition for rematuration.

5.2.1 *Counting of eggs and nauplii*

For estimating the number of eggs produced, the eggs are dispersed in the water by thorough mixing and three 100 ml samples are taken with a beaker. The number of eggs in each sample is counted and the average number in 100 ml calculated. The total number of eggs is estimated thus:

$$\text{Av. no. of eggs in sample} \times \frac{\text{Vol. of water in tank (litres)}}{0.1}$$

The nauplii hatch out by afternoon and the number of nauplii in the tank is estimated following the procedure adopted for counting the eggs.

To separate the nauplii from the dead eggs, the aeration is stopped and a beam of light from a torch or other source is directed on the water surface. The nauplii attracted by the light, congregate at the surface while the dead eggs sink to the bottom from where they are siphoned out along with the sediments. The light is turned off and the counted nauplii in the spawning tank are allowed to flow into the rearing tank through a flexible PVC hose attached to the ball valve at the bottom of the tank.

5.3 *Larval rearing*

The nauplii are transferred to the larval rearing pools at a stocking density of 1,50,000 per 2-tonne tank (75,000 nauplii/m^3). The sea water supplied to the rearing pools is filtered through a 50 micron mesh bolting cloth bag.

5.3.1 *Management of larval rearing pool*

The pools are managed as shown in Table 1. A sense of involvement and a feeling for the larvae are necessary to achieve success in larval rearing. It should be remembered that Table 1

TABLE 1. *Management of larval rearing pools*

Day	Stage	Seawater removed (litres)	Algal culture added (litres)*	Particulate feed (g)*	Seawater addition (litres)	Total vol. of water made upto (litres)
1	N 2	—	—	—	1000	1000
2	N 5	—	100	—	—	1100
3	PZ 1	—	150–200	—	700–750	2000
4	PZ 2	500	150–250	—	250–350	2000
5	PZ 3	500	150–250	—	250–350	2000
6	M 1	500	150–250	—	250–350	2000
7	M 2	500	150–250	—	250–350	2000
8	M 3	500	150–250	10–15	250–350	2000
9	PL 1	750	100–150	12–15	600–650	2000
10	PL 2	750	100–150	12–25	600–650	2000
11	PL 3	750	100–150	12–25	600–650	2000
12	PL 4	750	100–150	12–25	600–650	2000
13	PL 5	750	100–150	12–25	600–650	2000

* Procedures for preparing algal cultures and particulate feeds are given in Annexure I and II respectively.

gives only guideline procedures. By paying careful attention to water quality and condition of the larvae, the volume of water exchanged and the amount of feed given should be judiciously varied to meet the exigencies of the situation.

Water quality and other conditions conducive for larval rearing

Parameter	*Permissible range*
Salinity	29–34 ppt
Temperature	26.0–32.5°C
pH	8.0–8.5
Dissolved oxygen	3.0–8.0 ml/litre
Light intensity during day time	20,000–1,25,000 lux
Total ammonia	<0.1 ppm
Nitrite	<0.05 ppm

The first four parameters can be monitored daily. Ammonia and nitrite levels may be monitored 2–3 times a week. The water from the larval rearing tanks is removed by keeping a siphon inside an open filter box (100 micron mesh size) to prevent the loss of larvae. The algal culture is allowed to flow from the culture tank directly into the larval rearing tanks through flexible PVC hose for feeding the larvae. The concentration of algal cells in the larval tanks is usually 30,000–40,000 cells/ml and is not allowed to fall below 20,000 cells/ml. Algal cell counts are made using a rafter-cell. After some experience in larval rearing it is possible to judge whether the algal concentration in the larval tanks is adequate by observing the feeding condition of the larvae and the colour of the water in the tanks. The algal counts can then be discontinued. The daily ration of particulate feed is given in five divided doses and the total quantity given is adjusted according to the feeding condition of the larvae. The larvae are examined under the microscope every two hours to see if the gut is full and also to note their general condition. The sediments are not removed usually. But if turbidity is too high the sediments have to be siphoned out after stopping the aeration for about 10 minutes. Good aeration prevents water spoilage. The presence of algal cells in the medium stimulates the natural growth of copepod and rotifer populations which also serve as food for the prawn larvae in the postlarval stages.

When the larvae are in healthy condition they swarm at the surface during the nauplius and protozoea stages, if the aeration is stopped for about 10 minutes; during the mysis stage they are more dispersed in the water column. When the feeding conditions are good the protozoea can be seen with long faecal string trailing from their posterior end.

On rainy days algal cultures may not develop well; on such occasions baker's yeast (dissolved in freshwater) @ 2–3 gm/m³ per day may be added to the larval tanks during the protozoea stage and the particulate feed @ 5–10 gm/m³ per day during the mysis stage, as a special measure.

5.3.2 *Larval counts and harvesting*

In the rearing tanks larval counts are taken when the developing larvae reach the PZ 1, M 1 and PL 1 stages. After vigorous aeration and gentle mixing, four samples are taken from 4 different places in the larval tank in 1 litre beakers and the larvae counted. The average number of larvae per litre of the sample is raised to the total volume of water in the tank to get an estimate of the total number of larvae. The postlarvae are harvested at PL 5. After reducing the water level by siphoning, the ball valve is opened and the postlarvae are collected in buckets. Sample counts are made to get an estimate of the number of PL 5 before they are given to the farmers or for stocking them in nurseries. On an average 50% of the nauplii stocked in the tanks reach the PL 5 stage.

6

PROBLEMS AND PRECAUTIONS

6.1 *General hygiene and cleanliness*

Cleanliness of the hatchery premises, equipment and personnel is of paramount importance in the successful rearing of the prawn larvae. After every hatchery run all the fibreglass tanks, plastic buckets, aeration tubes and stones, should be cleaned and washed with bleaching powder, rinsed with freshwater and dried thoroughly before starting the next batch. The pipelines carrying sea water and freshwater should be disinfected once in two months by pumping water mixed with bleaching powder through the system and allowing the chlorinated water to remain in the pipes for about 4 hrs and then flushing out with freshwater. Chlorine is highly toxic in seawater and hence the pipes and other equipment treated with bleaching powder should be washed thoroughly in freshwater to get rid of chlorine completely. Everyday morning the overnight stagnant water in the pipes should be allowed to go waste and should not be used for filling the hatchery tanks.

The hatchery personnel should wear clean clothes and wash their hands and arms with soap before going into the hatchery. The floor of the hatchery should be kept as dry as possible. This becomes easy if care has been taken in providing suitable drains and slope to the flooring at the time of construction of the buildings. The glassware used for handling the larvae should be periodically disinfected, washed clean and kept dry. By taking these precautions bacterial and fungal diseases of larvae can be avoided. Prevention is better than cure in the case of prawn diseases also. It is not advisable to use prophylactic doses of antibiotics in the larval rearing tanks as this may lead to development of resistant bacterial strains.

6.2 *Care of algal cultures*

Algal cultures in the declining phase should not be used for feeding the larvae. On hot, sunny days the algal bloom develops and declines very rapidly. So the amount of inoculam should be reduced suitably to avoid too rapid a decline. Algal cultures grown from inoculam taken from previous day's culture decline after one week of subculturing. To avoid this it is advisable to start new cultures every week by fertilizing fresh sea water collected from the sea.

6.3 *Care of maturation pools*

Mature prawns are highly susceptible to handling stress. So, for removing them from the maturation pools to the spawning tanks a dip-net made of soft netting material should be used and the prawns should not be chased around too much in the process of capturing them. The gravel in the biological filter should be washed every two months with sea water to get rid of the organic matter that accumulates in the interspaces between the gravel pieces. The washed gravel should not be dried, but quickly replaced in the filter so that the nitrifying bacteria growing on the surface of the gravel are not killed.

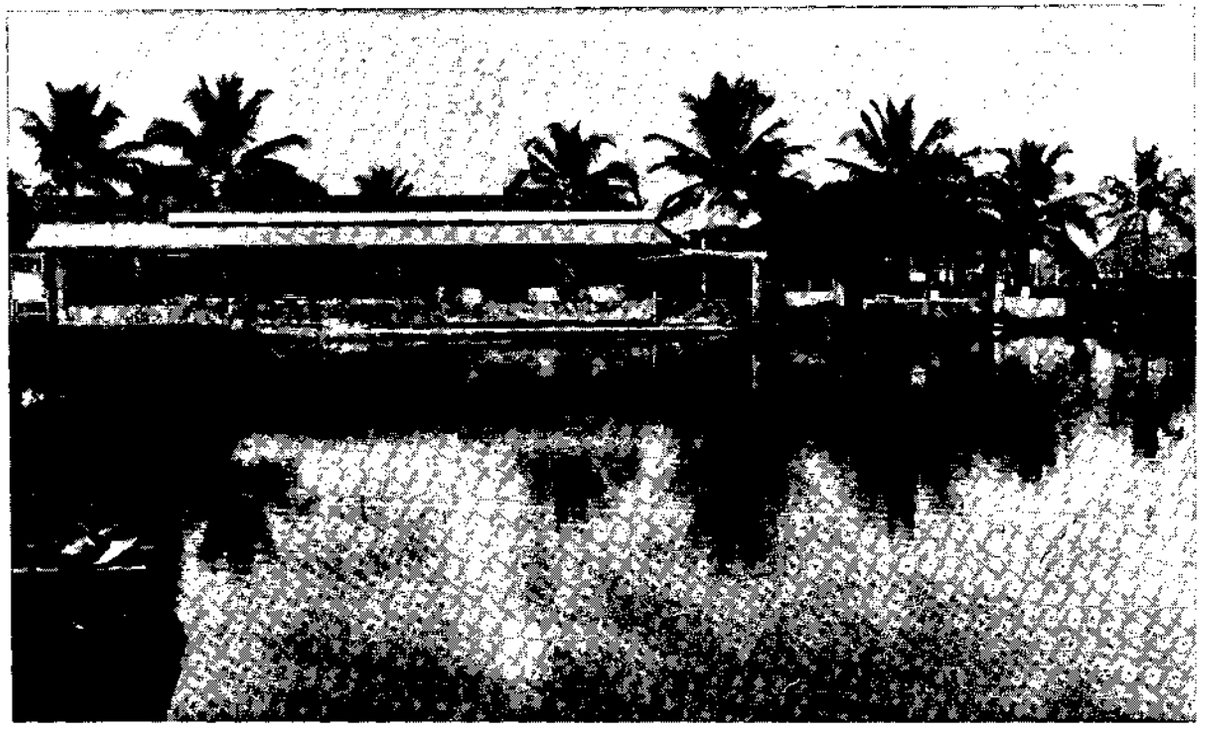
It has been observed that if the sea water temperature in the maturation pools exceeds 29°C the maturation process is adversely affected. On hot summer days it may be necessary to keep the temperature below 29°C by keeping blocks of ice tied in polythene bags floating on the surface of the water.

Temperatures below 25°C affect the maturation of the broodstock, retard algal growth and delay larval development. Such low temperatures are met with during the height of winter on the east coast and along the Gujarat Coast.

6·4 *Diseases*

Broodstock animals should be checked for diseases such as Myxobacteriosis, Pseudomonasis, Staphyloccosis, shell disease due to *Vibrio*, Flavobacteriosis and muscle necrosis. The gross clinical symptoms of these diseases of prawns as well as the drugs and administrative dosages are given in CMFRI Special Publication No. 17 (Handbook of diagnosis and control of bacterial diseases in finfish and shellfish culture).

In the case of larvae, the fungus *Lagenedium sp.* has been identified as an important pathogen and if detected, the entire stock has to be discarded and the tanks and pipe systems disinfected by chlorine treatment indicated above.



7

PERSONNEL REQUIRED

One supervisor with training in hatchery management, one technician with hatchery training, four skilled workers (one of them a mechanic) and two helpers will be sufficient to manage a hatchery with a capacity to produce 35 million PL 5 per year. One staff member (by rotation) should be on duty every night to look after the hatchery. With good plumbing arrangements for filling and emptying the fibreglass tanks by gravity flow, the staff proposed can easily manage the hatchery.

8

ECONOMICS

The production capacity and economics of the hatchery for *Penaeus indicus* is worked out below on the basis of research data obtained at the Narakkal Prawn Hatchery Laboratory of the CMFRI during the period 1981-1985.

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Production Capacity of The Hatchery

No. of maturation pools in the hatchery	..	2
No. of ablated females kept in a pool	..	40
Total No. of ablated females (40 x 2)	..	80
No. of females that mature and spawn within 4–5 days (70% of ablated females)	..	56
Av. No. of eggs per ablated female	..	80,000
Av. No. of nauplii per spawner	..	70,000
Total No. of nauplii from 56 spawners	..	39.2 lakhs
No. of 2 tonne capacity larval rearing tanks in the hatchery	..	26
No. of nauplii stocked in one rearing tank	..	1.5 lakhs
Total No. of nauplii used per hatchery run (26 x 1.5 lakhs)	..	39 lakhs
Av. survival rate from N1 to PL5	..	50%
Total no. of PL5 expected from 26 tanks per hatchery run	..	19.5 lakhs
Duration of each hatchery run (N1–PL5)	..	13–14 days

If the hatchery site is chosen properly it should be possible to have at least 18 hatchery runs per year, allowing for time lost in cleaning-up operations, adverse weather conditions, etc. Therefore annual production of PL 5 from 18 hatchery runs @19.5 lakhs/run will be 350 lakhs or 35 millions.

Capital Expenditure

A. Buildings

		Rs.
Hatchery shed with glass roofing, 416 sq.m. area @ Rs. 750/- per sq.m.	..	312,000
Maturation shed with asbestos roofing, 66 sq.m. — Rs. 500/- per sq.m.	..	33,000

Store room, laboratory room, duty room etc. with asbestos roofing, 110 sq.m. @ Rs. 700/- per sq.m.	..	77,000
Generator/Air blower room, 12 sq.m. area @ Rs. 500/- per sq.m.		6,000
Total		428,000

B. Fibreglass tanks

		Rs.
26 Nos. 2 tonne capacity cylindroconical larval rearing tanks with fused legs for support @ Rs. 5000/- each	..	130,000
40 Nos. 200 litre capacity cylindroconical spawning tanks with fused legs for support @ Rs. 750/- each	..	30,000
10 Nos. 1 tonne capacity algal culture tanks @ Rs. 2000/- each	..	20,000
2 Nos. 10 tonne capacity circular maturation tanks @ Rs. 15,000/- each	..	30,000
Total		210,000

C. Major equipment

		Rs.
Sea water and freshwater supply systems	..	300,000
10 KVA Generator with 16 H.P. diesel motor	..	38,000
5 H.P. Twin-lobe air blower 2 Nos. @ Rs. 15,000/- each	..	30,000
0.5 H.P. Electric pumps 2 Nos @ Rs. 2500/- each	..	5,000
Deep freezer - 1	..	10,000
Aeration grid - PVC	..	10,000

Microscope, pH meter, salinometer, chemical balance, and colorimeter	..	15,000
Hot air oven, mixie and hand pelletiser	..	7,000
Furniture	..	25,000
Total	..	440,000
Total capital cost (A + B + C)		10,78,000

RECURRING EXPENDITURE

		Rs.
A. Interest @ 15% on 10,78,000	..	161,700
B. Depreciation		
@ 5% on building and fibreglass tanks	..	31,900
@ 10% on equipment	..	44,000
C. Salaries		
One Supervisor @ Rs. 2,000/- p.m. One Technician @ Rs. 1,500/- p.m. Four skilled workers @ Rs. 1,000/- p.m. Two helpers @ Rs. 600/- p.m.		104,400
D. Contingencies		
Plastic ware, flexible PVC hoses, glass ware, bolting cloth, etc.	..	5,000
Energy cost (Electricity and Diesel)	..	10,000
Chemicals	..	3,500
Cost of broodstock prawns	..	5,000
Cost of clams for feeding brood stock	..	1000
Other contingencies	..	3,000
E. Maintenance	..	10,000
F. Annual lease for land	..	2,500
Total recurring cost (A to F)	..	382,000

PROFIT (FOR THE FIRST YEAR)

		Rs.
Selling price of 35 million PL5 @ Rs.16/- per thousand	..	560,000
Annual income	..	560,000
Annual expenditure	..	382,000
Annual Gross Profit	..	178,000
Annual Repayment of loan (depreciation Rs. 75,900 + Rs. 75,000 from profit)	..	150,900
Net profit after repayment of loan at the end of first year of operation	..	103,000
Percentage of net profit on capital cost at the end of first yeat of operation	..	9.55%
Cost of production per 1000 PL 5 (inclusive of interest on loan and depreciation)	Rs.	10.9
Benefit-cost ratio (Rs. 178,000/382,000)	..	0.466
Profit-investment ratio (Rs. 178,000/10,78,000)	..	0.165

At this rate of loan repayment (*i.e.* @ Rs. 150,900/year) the entire loan will be repaid in about 7 years.

The interest payable will decrease and the net profit increase by Rs. 22,635 every year from the 2nd year of operation onwards.

The cost of construction, labour cost and price of fibreglass tanks, etc. vary widely in different parts of the country. The figures given are only indicative and apply to conditions obtaining in Kerala. The salary of the staff should be reasonable to attract efficient people to work in remote places where the hatcheries may have to be located. The selling price of PL 5 is also taken as only Rs. 16/- per thousand and can be increased depending on local demand. Hence, the profit shown is the minimum that can be realised. It may be noted that a profit of 9.55% over the capital investment is realised even at the end of the first year of operation

whereas many industries start showing a profit only after a gestation period of 2–3 years. Further, as the loan is repaid in full in about 7 years time, the annual profit percent will increase at a very rapid rate *viz.* 13.55% at the end of 2nd year, 19.10% at the end of 3rd year and so on.

CASH FLOW STATEMENT

	Pre-operating period	First Year
	Rs.	Rs.
Estimated cash inflow		
Loan	10,78,000	—
Sales	—	5,60,000
Total estimated receipts	10,78,000	5,60,000
Estimated disbursements		
Buildings	4,28,000	—
Purchase of fibreglass tanks	2,10,000	—
Purchase of equipment	4,40,000	—
Payment of salaries	—	104,400
Maintenance of equipment	—	10,000
Contingencies	—	27,500
Rent for land	—	2,500
Interest on loan	—	1,61,700
Repayment of loan	—	1,50,900
	10,78,000	4,57,000
Net inflow	nil	1,03,000
Cash balance beginning	nil	nil
Cash balance ending	nil	1,03,000

9

NURSERY PHASE

It is not economical to keep the postlarvae beyond the PL 5 stage in the hatchery as the growing postlarvae need more space for growth and survival. But the PL 5 are too small to be stocked directly into the grow-out ponds. It takes about 15–20 days for the PL 5 to attain a size of 20–25 mm when they can be stocked in grow-out ponds. Hence, a separate nursery becomes a necessity.

Experiments have shown that if cement tanks or plastic pools are used in the nursery phase, the 75,000 PL 5 obtained from a 2000 litre larval tank will have to be transferred to a 10,000 litre capacity nursery tank with good aeration facilities and fed entirely on particulate diet to get a survival rate of 60–70% at the PL 20 stage. This shows that the size of the nursery tank should be at least 5 times larger than that of the hatchery tank. Therefore, the cost of production of seed size prawns from PL 5 stage will be higher.

For the present, a practical solution to the problem is to have the nursery as an integral part of the grow-out ponds. This is possible in areas where the pond salinity is above 20 ppt. The PL 5 stage is quite hardy and it can withstand sudden change of salinity from 30 ppt (in the hatchery) to 20 ppt (in the nursery pond). But it is highly vulnerable to predation. Hence, the nursery pond should be absolutely free of predators. In one corner of a grow-out pond a small area can be enclosed by earthen bunds and treated with ammonia or mahua oil cake to get rid of all predators. This treatment also has a fertilizing action resulting in the production of plankton and epifauna on which the postlarvae feed and grow well. When they attain the stocking size the nursery bund can be broken in places to allow the prawns to move out into the grow-out pond.

Some preliminary experiments have indicated that it is possible to stock a well prepared earthen nursery pond @ 500 PL 5 per m^3 and get stockable size seed with good survival in 15–20 days time. The normal stocking density of *P. indicus* in grow-out ponds in the Ernakulam District of Kerala is about 50,000/ha. In order to obtain this number of *P. indicus* seed, a nursery area of 200 m^3 is more than adequate. The expenditure for preparing a nursery pond of this size will be minimal.

ANNEXURE I

Algal Culture

For starting the algal culture, fresh sea water (30–34 ppt salinity) is filtered through a 50 micron mesh bolting cloth and kept in 1000 litre capacity, white fibreglass tanks placed under the glass-roofed shed. The sea water is fertilized with the following chemicals:

Sodium nitrate	..	12 ppm
Potassium orthophosphate	..	3 ppm
Sodium silicate	..	6 ppm
EDTA di-sodium salt	..	6 ppm

Two air-stones connected to the aeration grid in the hatchery are kept in each tank. The intensity of sunlight in the shed varies from 20,000 to 1,20,000 lux during day time and the temperature of the sea water from 28°C–35°C. Under these conditions the diatom cells present in the filtered sea water multiply rapidly and give rise to a golden-brown bloom of diatoms in 24–48 hrs. Although a number of species of diatoms may be originally present in the sea water, under the conditions indicated above, *Chaetoceros* spp. become the dominant diatoms forming 75–90% of the cells in the culture. The other diatoms are *Thalassiosira, Skeletonema* and *Nitzschia* accounting for the remaining 10–25%. The concentration of diatom cells in a culture ready for use is 3-4 lakhs cells/ml of culture. This culture is used for feeding the prawn larvae and also as an inoculam for developing batch cultures on succeeding days. Cultures are started everyday using the previous day's culture for inoculating (@ 30–35 litres per m^3 of seawater) the filtered sea water ferti lized with the chemicals as given above. The algal cultures are ready for use 16–20 hrs after inoculation. On cloudy days, the diatoms may take a longer time to develop; the quantum of inoculam should therefore be increased to compensate for the slower growth rate.

ANNEXURE II

Preparation of Particulate Diet

Inexpensive raw materials such as prawn head waste (from the prawn peeling sheds), mantis shrimp (discarded from the trawlers), groundnut oil cake, fish meal and tapioca are used as the main ingredients. These materials are sundried, separately ground to a fine powder in a commercial mill and stored in air tight tins.

A 'feed base' is first prepared by thoroughly mixing the following items in the proportions indicated.

Prawn head powder	..	25 parts (by weight)
Mantis shrimp powder	..	25 „
Ground nut oil cake powder	..	37 „
Fish meal powder	..	13 „

To every kilogram of 'feed base' 200 g of tapioca powder, 2 g of calcium lactate or carbonate and 1 g of potassium dihydrogen orthophosphate are added. This mixture is blended with 40% by weight of water to obtain moist granules, spread on trays and steamed in a cooker (without pressure) for 10–15 minutes. The cooked material when half-cooled is fortified with vitamins and minerals by adding one tablet (powdered) of Vitaminets Forte (Roche) to every kilogram of 'feed base' and made into a dough. It is extruded through a hand pelletiser using a 3 mm die and dried in a hot-air oven at 65°C for 12 hrs.The dried pellets are powdered in a high-speed kitchen mixie and sieved through bolting cloth having a mesh size of 250 microns. The particulate feed is stored in air tight containers. It is better to prepare a fresh batch of particulate feed every month. Only about 6 kg of feed will be needed per month for the hatchery.

The proximate composition of the particulate feed is as follows:

Proteins	..	36.8 %
Lipids	..	10.1 %
Carbohydrates	..	29.8 %
Ash	..	18.9 %
Moisture	..	4.4 %

Mantis shrimp can be replaced with crustaceans such as *Acetes, mysids*, small crabs and shrimps discarded by trawlers or with adult brine shrimp where they are easily available in plenty. Even the waste of cuttlefish and squids thrown away by the processing industry can be utilized. All these materials have an aminoacid profile closely similar to that of penaeid prawns and are also rich in polyunsaturated fatty acids that are essential for the proper growth of penaeid prawns.

ANNEXURE III

List of Essential Hatchery Equipment

Equipment/Facility	*Quantity required*
Generator (10 KVA) ..	1
Twin-lobe air blowers (5 H.P., 160 m^3 FAD, 0.3 kg/cm^2) ..	2
Fibreglass circular maturation tanks (10,000 litres capacity) ..	2
Fibreglass cylindro-conical larval rearing tanks (2000 litres capacity) ..	26
Fibreglass cylindro-conical spawning tanks (200 litres capacity) ..	40
Fibreglass rectangular algal culture tanks (1000 litres capacity) ..	10
Deep Freezer ..	1
Microscope ..	1
pH meter ..	1
Salinometer ..	1
Photoelectric colorimeter ..	1
Chemical balance ..	1
Thermometers (0–50°C) ..	6
Hot air oven ..	1
Kitchen mixie ..	1

Hand pelletiser	.. 2
Pressure cooker	.. 1
Electrocautery apparatus	.. 1
Laboratory glassware	
1000 ml Beakers	.. 12
100 ml Beakers	.. 12
100 ml Conical flasks	.. 12
Volumetric pipettes (assorted sizes)	.. 12
Burettes (10 ml)	.. 3
Petri dishes (75 mm)	.. 12
Embryo cups (50 mm)	.. 6
Microscope slides (in boxes)	.. 2
Cover slips (in boxes)	.. 2
Pipettes with teats	.. 25
Dissection set	.. 1
Plastic ware	
Buckets (15 litres capacity)	.. 24
Bins (50 litres capacity)	.. 12
Basins (50 litres capacity)	.. 12
Aluminium trays (50 x 30 cm)	.. 12
PVC flexible hoses (50 mm dia.)	.. 50 m
Bolting silk cloth 50 microns	.. 20 m
100 microns	.. 20 m
250 microns	.. 10 m
Sea water distribution grid made of 75 mm and 50 mm rigid PVC pipe lines and ball valves.	.. as required
Freshwater distribution grid made of 40 mm rigid PVC pipe lines and ball valves.	.. as required
Aeration grid made of 50 mm rigid PVC pipe lines with nozzles, 5 mm polythene tubes, plastic connectors, plastic regulators and aeration stones.	.. as required
Sea water intake, pumping and storage systems (see text).	
Freshwater storage and pumping systems (see text)	
Hatchery Building Complex (see text).	

12. A code list of common marine living resources of the Indian Seas. 1983, 150 pp.

13. Application of genetics in aquaculture. 1983, 90 pp.

14. Manual of research methods for invertebrate endocrinology. 1983, 114 pp.

15. Production and use of *Artemia* in aquaculture. 1984, 74 pp.

16. Manual on marine toxins in bivalve molluscs and general consideration of shellfish sanitation. 1984, 100 pp.

17. Handbook on diagnosis and control of bacterial diseases in finfish and shellfish culture. 1984, 50 pp.

18. Proceedings of the workshop on sea turtle conservations 1984, 136 pp.

19. Mariculture research under the Centre of Advanced Studies in Mariculture. 1984, 109 pp.

20. Manual on pearl culture techniques. 1984, 42 pp.

21. Prawn farming in Kerala. 1984. (In press).

22. Water quality management in aquaculture. 1985, 96 pp.

23. Hatchery production of penaeid prawn seed : *Penaeus indicus*. 1985, 41 pp.