Bay of Bengal Programme

Development of Small-Scale Fisheries

DEMONSTRATION OF SIMPLE HATCHERY TECHNOLOGY FOR PRAWNS IN SRI LANKA

BOBP/WP/43

SWEDISH INTERNATIONAL DEVELOPMENT AUTHORITY

FOOD AND AGRICULTURE ORGANISATION OF THE UNITED NATIONS

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Executing Agency

Food and Agriculture Organization
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Funding Agency

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This report describes the facilities and documents the procedures for the operation of a "backyard" hatchery for *Penaeid* prawns, put up for demonstration and training purposes in Pitipana, Sri Lanka. It concludes that the technology demonstrated is appropriate and that the aims set have been reached; it also identifies the constraints that should be lifted if this hatchery is to become a permanent training facility of the Coastal Aquaculture Research Station at Pitipana. The hatchery was one of the components of a project aimed at developing a small-scale prawn culture region. The project undertakes trials of prawn culture in pens in the lagoons of Koggala, Negombo and Puttalam. Under the terms of this project, the Ministry of Fisheries, Sri Lanka, renovated and adapted facilities already existing for shrimp breeding, while BOBP contributed expertise, provided some imported equipment and met running costs.

This report was compiled by BOBP's D Reyntjens (Aquaculturist Associate Professional Officer) and is based on the reports of the consultant, Dr K H Mohammed, the records maintained at the hatchery, and also on personal observations made in the last quarter of 1985. Mr R A D B Samaranayake, Assistant Director of Inland Fisheries and project leader, other team members and Mr. Reyntjens's colleagues, Mr J A J Janssen and Mr P Funegaard, also contributed to the project.

This paper, and the project it describes, form part of the activities of the small-scale fisheries project of the Bay of Bengal Programme (BOBP) funded by SIDA (Swedish International Development Authority) and executed by the FAO (Food and Agriculture Organization of the United Nations). The project seeks to develop, demonstrate and promote technologies and methodologies to improve the conditions of small-scale fisherfolk. The project covers five countries in the region — Bangladesh, India, Malaysia, Sri Lanka and Thailand.

CONTENTS

INTRODUCTION

During the 7th Advisory Committee meeting held in January 1983 in New Delhi, Sri Lanka sought the technical cooperation of the Bay of Bengal Programme in formulating and implementing an aquaculture development plan in Sri Lanka. The plan to establish a commercial prawn hatchery (under a fisheries project sponsored by the Asian Development Bank) and the anticipated development of a national prawn culture industry were expected to generate demand for technical manpower trained in hatchery techniques. A makeshift hatchery for training and demonstration was considered a useful contribution to aquaculture development in this context.

A project that was to help set up a backyard prawn hatchery and introduce pen culture techniques was agreed on in January 1984. Under this scheme, Dr K H Mohammed, formerly Head of Division (Crustacea) at the CMFRI (Central Marine Fisheries Research Institute) was recruited as a consultant to assist BOBP in implementing the hatchery part of the project.

During a preparatory visit in April/May 1984, Dr Mohammed recommended modifications to existing facilities at the Coastal Aquaculture Research Station (CARSP) in Pitipana, Negombo so that it could house a hatchery. He also recommended materials that would have to be procured.

The Pitipana station is run by the Ministry of Fisheries and situated on the west coast of Negombo lagoon, close to the sea mouth)Appendix 1). It has a pond complex with an approximate water area of 3.6 ha and seven concrete tanks. Built in the 1950's for experimental milkfish culture, it later became a distribution centre for milkfish juveniles collected from the wild.

One of the buildings of the Pitipana station is being used for the backyard hatchery set up with BOBP assistance (Appendix 3). The scientific staff of the station includes an Officer-in-Charge (QIC(; an aquaculturist in charge of the hatchery; and another aquaculturist in charge of the extension service and also of the prawn pen set up in the lagoon nearby under the same project. All three are biologists. The OlC and the aquaculturist in charge of the hatchery reside within the compound of the station.

After completing the necessary modifications and purchasing needed equipment, Dr Mohammed demonstrated the technology developed by himself and his former CMFRI colleagues to the project staff during a second 8-week consultancy in September/October 1984. In January 1985 he led a 10-day workshop on *Penaeid* prawn breeding and larval rearing. The hatchery nearly came to a halt in June 1985 when the counterpart trained by the consultant left for a private hatchery. It was revived in the last quarter of 1985 when the aquaculturist now in charge of the hatchery took over.

2. PHYSICAL FACILITIES

2.1 The hatchery

The hatchery is she)tered in **a 20 m x 28 m** building of the CARSP. The facilities that existed were modified by the Ministry of Fisheries as recommended by the consultant, in order to adapt them for prawn hatchery work. Twelve concrete tanks were made leakproof and fitted with controllable outlets. Three concrete spawning tanks (capacity – 300 litres) and two brood-stock tanks (capacity – 8 tonnes) were installed. Transparent plastic sheets have replaced some of the asbestos roofing to provide daylight. BOBP provided three collapsible 300 litre pools – these can be used in case there are more than three spawners at a time. In the absence of a broodstock maturation programme, the broodstock tanks are used as water storage tanks. (Appendix 3).

2.2 The nursery

The hatchery's nursery consists of a series of collapsible pools, imported by BOBP from India, placed on a sand foundation under a shelter. There are four 5t tanks and three 7t tanks in all. Two of the 7t tanks are used often as water settling and storage tanks. Nursery rearing of hatchery-produced juveniles was also attempted in happas in the lagoon.

2.3 The aeration system

An air grid was constructed under the supervision of the consultant so that the water in the tanks could be well aerated. The apparatus consists of some airtight PVC piping (length – 100 metres,

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diameter – 50 mm) connected to a Japanese made root blower (imported by BOBP) which is installed in the store room. A generator provided by the Ministry of Fisheries serves as a back-up in case of power failure. The system is adequate and very reliable. However, there is no provision against blower failure.

2.4 The seawater supply system

The present supply of water is pumped up from a shallow well beside the lagoon. Although it is essentially lagoon water, it does not undergo the rapid changes of salinity associated with water from a lagoon surface. However, during the rainy season, the salinity of the pumped water drops well below the minimum level of 28 ppt considered suitable for prawn propagation. It is not clear whether the lagoon water is polluted and whether this affects survival when used during high salinity periods.

Presently, the sea water is brought in a fry transport vehicle (bowser) belonging to the Ministry of Fisheries. Water is pumped from the shore into the bowser with a portable pump, and then transported to the hatchery. The actual water storage capacity of the hatchery is 30t while the total water capacity is around lOOt. Water is supplied from the storage tanks by means of a 0.5 hp electric pump. The pumps were supplied by BOBP. This sea water supply system was proved to be highly unreliable, considerably hampering the working of the hatchery. The bowser has a very limited capacity (1St) and is available for no more than two days a week. The pump became heavily corroded after a year's operation and has to be sent more than occasionally for repairs. The bowser is also heavily corroded. A temporary solution was found in an agreement with a private hatchery. Their 4t bowser supplied water at a cost of Rs. 100 per load. However, the only arrangement that can ensure stability in hatchery operation is a separate sea water supply line : either an expensive pipeline with a pump station or a stainless steel bowser with a portable pump adapted for pumping sea water. The hatchery also needs a settling tank and a head tank to easily distribute the sea water.

2.5 The phytoplankton rearing facilities

Suitable diatom species are essential feed for shrimp and prawn during the early stages of their development. Six fibreglass tanks were made available by the Ministry of Fisheries for culture of diatom species and were set up on cement flooring near the hatchery building. The tanks are not sheltered from rain. Recently, a set of fluorescent lamps were purchased and installed above a fibreglass tank indoors to help ensure a minimum amount of algae during the rainy season. This also helps to produce some adequate inoculum for further cultures. Ideally, phytoplankton culture should be undertaken in larval rearing tanks. This would help to control water quality and ensure the successful feeding of the protozoa. This is not possible because there is not yet enough daylight in the hatchery and because the only easily available N-source is urea. By hydrolysis urea produces ammonia which is toxic to larvae. It would be best to use a nitrate as originally recommended by the consultant, and as is done, for instance, in Japanese shrimp hatcheries.

3. SPAWNERS AND SPAWNING

For spawner collection, the hatchery has to rely on commercial prawn trawlers. The gravid female prawns are selected after each haul and kept alive on board in buckets filled with seawater. When landed they are packed in polythene bags with seawater and oxygen and transported to the hatchery.

The whole process causes the spawners considerable stress. The hauls take a long time (about one hour) and more time elapses before the catch is sorted and the selected prawns are put into buckets with seawater. The buckets are often overcrowded and also exposed to the sun. The water in them is hardly changed. Most portable aerators do not work due to the combined effects of seawater corrosion and the carelessness of operators. The spawners are usually collected from Chilaw, 50 km north of Negombo. Transporting spawners to the hatchery usually takes more than two hours in difficult conditions, causing them additional stress.

Ideally, spawners should be collected in Negombo by trawlers operating especially for this purpose. The haul ought to be short (about 15 minutes) and the prawns picked up as soon as they are on board. Moreover, trawlers should use larger meshes than those currently deployed. Larger meshes will trap less debris and small immature prawns – consequently, gravid female prawn will not be crushed as much.

There are indications of a seasonal and geographical variation in the availablity of spawners. Penaeus indicus is the most common species and is available all the year round. P. monodon is available mainly in the early months of the year but is seldom found in the Puttalam lagoon where P. semisulcatus is predominant. Competition between private hatcheries and the BOBP-sponsored hatchery has led to a sharp rise in the prices of gravid female prawn. Just over one year ago a prawn (of any species) was sold for Rs. 25. Now a gravid female tiger prawn fetches between Rs. 100 and Rs. 250 -- other commercial species fetch between Rs. 25 and Rs. 100.'

After arriving at the hatchery, the gravid female prawns are placed separately in the spawning tacks which are prepared an hour in advance. They are filled with 150 to 200 litres of filtered sea wator in which Na-EDTA is dissolved at a ration of lg for every 100 litres. Spawning usually occurs during the first or the second night after capture. The spent females are removed and the tank is cleaned of the scum that forms on the sides of it. The density of the eggs and the nauplii after the eggs have hatched is estimated. At a temperature of 28 C, embryonic development takes over twelve hours.

4. LARVAL FEED

The second larval stage, the protozoa, is a filter-feeder. Diatorns such as Chaetoceros sp and Skeletonema sp are suitable feed on account of their size and nutritional value. The hatchery does not have facilities to maintain pure cultures of these algae species. However, these species were found to dominate the algae blook which develops when fertilizers are added to seawater.

The current practice at the hatchery is, therefore, to fertilize filtered seawater and then use the phytoplankton bloom thus produced. The following fertilizer mixture is often used :

Urea	12 ppm
TSP	06 ppm
Na-silicate	06 ppm
Na EDTA	06 ppm

No vitamins or trace minerals are added. Usually, the diatom cell density reaches ZOO-300 thousand cells per ml on the third day of culture when the weather is fair.

Batch cultures are harvested once. Semi-continuous cultures are less wasteful of facilities and chemicals and can be maintained up to two weeks. For this culture practice, the daily production is harvested and the original volume made up with fresh seawater and fertilizers. Currently, both types of cultures are undertaken at the hatchery since enough experience has not been gained to plan reliable semi-continuous cultures to meet anticipated needs (for further details see Appendix 4)

A formulated diet for prawn larvae made out of locally available ingredients in India and denominated NPCL-17 in CMFRI publications'" (NPCL. stands for Narakkal Prawn Culture Laboratory) had been developed by the consultant and his CMFRI collaborators. Using a formulated feed greatly simplifies hatchery work and saves on expenses since maintaining zooplankton cultures and purchasing *Artemia sp* cysts are expensive.

However, some of the ingredients for this feed are not easily available in Sri Lanka. These have been replaced by other ingredients after the original stock brought by the consultant was exhausted, The new formulation has not been rigorousty tested. There are Indications that it might be less effective since survival is improved by using small quantities of *Artemis* sp naupiii and a micro-encapsulated whole egg diet. The new formula is probably nutritionally less balanced but, nevertheless, very valuable in present hatchery work (for further details regarding diet see Appendis 5).

' About 26 Sri Lanka rupees 1 U S $

. * Mohammed K H et al A simplified hatcherv technique for mass production of penaeid prawn seed using formula feed. Indian J Fish 1983 vol 30 no. 2 320 332

5. LARVAL REARING

5.1 Procedures

The larval rearing procedures are based on a technology devised in India at the Central Marine Fisheries Research Institute by the consultant and his collaborators. The salient features are

- It obviates the use of live zooplankton as larval food by using a formulated diet.
- It presupposes the existence of an active ecosystem promoted by high daylight intensities. Primary producers (diatoms) provide food for the larvae and maintain water quality. Bacterial transformers aerobically break down metabolites and detritus, thus providing food for the larvae (bacterial biomass) and nutrients for the algae.
- There is no continuous fresh seawater flow and the larvae are kept at a relatively low density (50,000 per m^3). Water quality is maintained for the first four days by gradually increasing the water level in the rearing tanks and thereafter by changing one-third of the total volume every day. Moreover, the tanks are cleaned daily.

A few minor modifications have been introduced to the routine steps that are recommended. More phytoplankton is given, as the volume recommended did not appear sufficient and since the early protozoa did not seem to benefit at all from the locally made formulated diet. For late protozoa, the formulated diet is supplemented with a micro-encapsulated whole egg larval diet (see Appendix 5) and late mysis stages are fed a limited amount of *Artemia sp* nauplii. The operators use their experience in deciding how much food is to be given. Usually, the post-larvae are kept until they are five days old IPL-51, after which they are moved to the outdoor nursery tanks. The production and feeding schedules are listed in Appendix 7.

5.2 Results

The survival rate from the nauplii to the PL-5 stage is low and depends on the experience of the hatchery staff (see Appendix 8). It may be noted that the average survival rate was about 25 per cent when the consultant was supervising operations at the hatchery. There was no seawater shortage during that time. The publications describing this new technology mention survival rates for *P. indicus* close to 67 per cent. They also acknowledge that the primary production probably played an important role. The amount of light in the CARSP hatchery at the moment is not sufficient to sustain algae growth in the rearing tanks.

This is detrimental to the rearing environment and also to the nutritional value of the diatoms fed to the larvae. Nevertheless survival rates of 67 per cent for *P. indicus* and 30 per cent for *P. monodon* were achieved in individual rearing tanks recently.

In the absence of comprehensive records of hatchery operations, it is difficult to be certain about the other factors responsible for low survival rates apart from water shortage. However, the main factor was most probably insufficient feeding, particularly in the early larval stages. It was noticed that protozoa were often nnt dragging a faeces thread as they typically do when they are actively feeding. A relatively high mortality rate in the late mysis stages and in the post-larvae perhaps indicate an unbalanced diet. Doubts about the water quality in the rearing tanks remain since only the dissolved oxygen could be checked. It was consistently close to saturation. (Graphs of survival and mortality rates are contained in Appendix 9).

6. NURSERY REARING

The nursery is a necessary intermediary between the hatchery and growing out facilities. Post-larvae produced are too small to be directly stocked and rearing them to a suitable size (2-3 cml in the hatchery is not convenient in terms of both survival and occupation of the hatchery facilities. Post-larvae adopt a benthic life, which results in the overcrowding of the relatively small area of the hatchery tanks. This leads to stress, increased cannibalism and hence lower survival rates.

Such methods of nursing post-larvae at the CARSP hatchery have been attempted but never systematically. Trials were conducted mainly in plastic collapsible pools specially purchased for this purpose, but also in happas in the lagoon and in some old concrete tanks of CARSP. No records of stocking densities, type of feed, amount of feed, survival rates etc. were kept. One can only say that stocking was erratic — it ranged from 10,000 to 70,000 PL-S's in the plastic pools — and was determined essentially, if not only, by the space available. Result : a low survival rate of between 10 and 30 per cent after two to three weeks.

The nursery phase has clearly become a bottleneck. Low survival rates nullify the improved performance of the hatchery and the shortage of stockable size juveniles can make it impossible to implement an extension programme to small-scale farmers. The bigger prawn culture ventures are prepared to take *P. monodon* PL-S's and nurse them themselves but this results in the nursing facilities being occupied by species which are less in demand.

7. DISPOSAL OF POST-LARVAE

As the hatchery was set up for training and demonstration purposes, what to do with the ppst-larvae was not really looked into. Initially, the limited amount produced was either used in some rearing experiments or stocked in the plastic collapsible pools, happas and concrete tanks, where the population slowly shrank to zero level. Later, an agreement was reached between BOBP and the Ministry of Fisheries to sell the post-larvae — preference was to be given to small-scale farmers over big private ventures. On 2nd November 1985, an advertisement was placed in one English and two Sinhalese newspapers. Quite a number of potential buyers responded but nearly all appeared to have only fresh water ponds and required *Macrobrachium sp.*

One farmer from the Negombo area bought 2000 PL-5's of *P. monodon* for Rs. 200. It was agreed that the extension officer of CARSP would assist him in nursing them in a happa. UnfortunaLely, a storm destroyed the happa, freeing the post-larvae in the pond (325 m^2) thus making it much more difficult to assess their survival and growth rates. On the whole, selling *P. monodon* has proved to be easy, but only to the bigger private prawn ventures. They are not interested in other species. Small-scale farmers most probably require a well structured extension service if they are to be involved in prawn culture. They would rather buy stockable size post-larvae. This requires efficient nursery rearing at the hatchery.

8. TRAINING

Training was imparted in two ways. During his consultancy periods, Mr Mohammed worked in collaboration with the project counterpart staff. The aquaculturists in charge of the hatchery and, in particular, the Officer-in-charge, were encouraged to absorb the technology through in-service training. A ten-day formal training course was conducted for 11 staff officers of the Ministry of Fisheries, the National Aquatic Resources Agency and Kelaniaya University. Two private farmers were selected but did not turn up. The participants were exposed to detailed practical and theoretical aspects of spawning marine *Penaeid* prawns in the confines of a hatchery and the technique of rearing the larval forms. Spawners of the three main commercial species *(P. indicus, P. monodon, P. semisulcatus)* were obtained and spawned within two days at the beginning of the course.

One batch of larvae obtained from a single specimen of *P. semisulcatus* reached the post-larval stage on the last day of the training course (see Appendix 10 for details of the programme of the training course).

However, the training course should be seen only as a promotional activity; its impact on the industry is probably limited. The private sector was not represented at all. However, none of the participants have secured jobs with direct responsibilities in hatchery production or nursery rearing in this sector after they were trained. One of them is now working on a private prawn farm, but as a pond manager. Since there are presently only three private hatcheries in Sri Lanka, the total demand for technical manpower in this sector is very limited and not likely to expand significantly in the near future. The private prawn farms usually resort to foreign expertise and train their employees themselves. They can also easily hire the services of the project counterpart staff simply by offering much higher salaries. This actually happened once when the counterpart who was working with the consultant left for a private shrimp farm disrupting the operation of the hatchery. It is therefore advisable to have two persons working in the hatchery at the same time. Besides ensuring that operations continue uninterrupted, this will most probably help meet all the requirements for technically trained manpower.

9. CONCLUSIONS

The following conclusions may be drawn about the operation of the backyard prawn hatchery.

The technology used is feasible and also probably cost-efficient. At the present price of 10 cts, per PL-5 (100 cents make a Sri Lankan rupee), a monthly production of 110,000 PL-5's is sufficient to cover the operation costs (see Appendix 11 for further details). Whenever results were unsatisfactory, it was either due to lack of experience on the part of the hatchery staff or to logistical problems. A major impediment to the regular functioning of the hatchery was inadequate seawater supply.

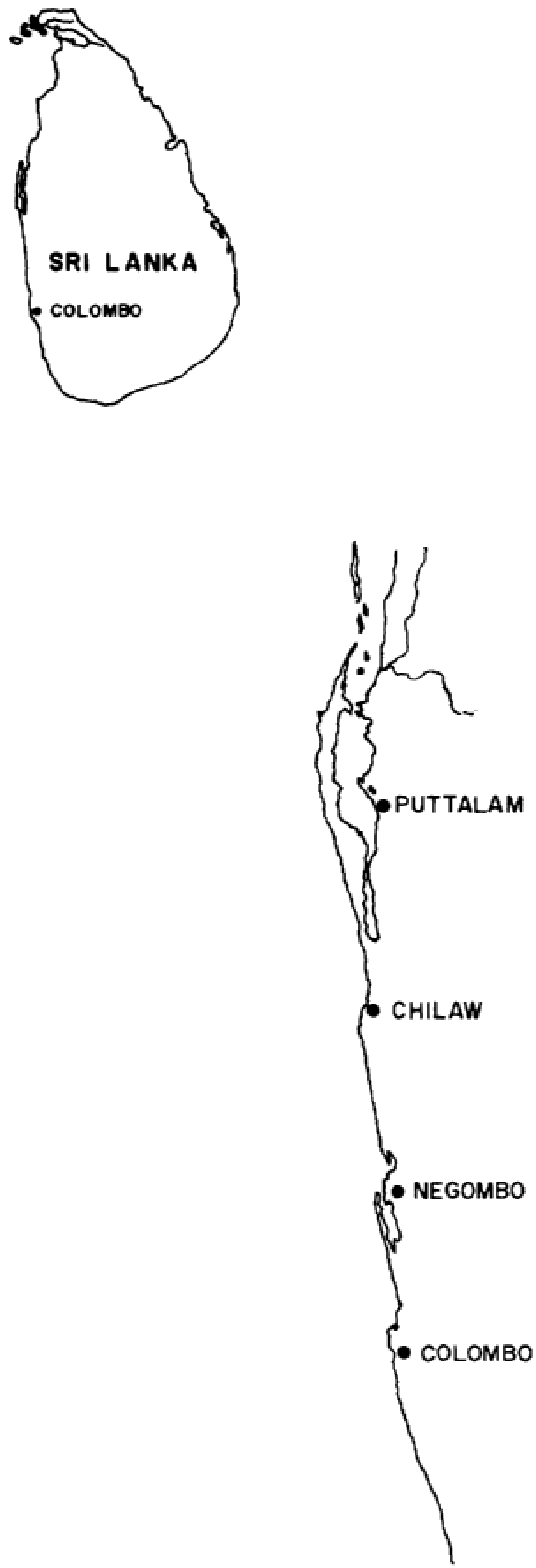
Keeping in mind that the hatchery was built only for the purposes of training and demonstration, its present location is the best that is available. It has several drawbacks, however. The Coastal

Aquaculture Research Station, Pitipana, is not situated in an area with a clear aquaculture potential. The soil is unsuitable for pond construction. The Negombo lagoon is shallow, and prawn pen culture trials have yielded only poor results. Pollution caused by human waste and industry is a major hazard. There is no fresh water supply and the power supply is erratic. Besides it is not a spawner collection area. The coast is too exposed for marine aquaculture. A hatchery that aims at production or at scientific experimental work would probably be best located elsewhere. But if the Pitipana hatchery is to become a permanent training facility, the following suggestions may be considered

- introducing a separate sea water supply line consisting of a stainless steel bowser and a sea water corrosion-proof portable pump;
- replacing more of the asbestos roofing with transparent plastic sheets. This will allow growing diatoms indoors;
- improving the nursery rearing phase to produce enough stockable size juveniles to support the structured extension service and programme needed to reach the small-scale farmers;
- keeping in mind that the best training in an efficiently run hatchery is in-service training.
- Assigning more than one scientific staff member to the hatchery so that he can replace the aquaculturist in charge in case he is transferred or goes on leave.

APPENDIX : I

LOCATION MAP



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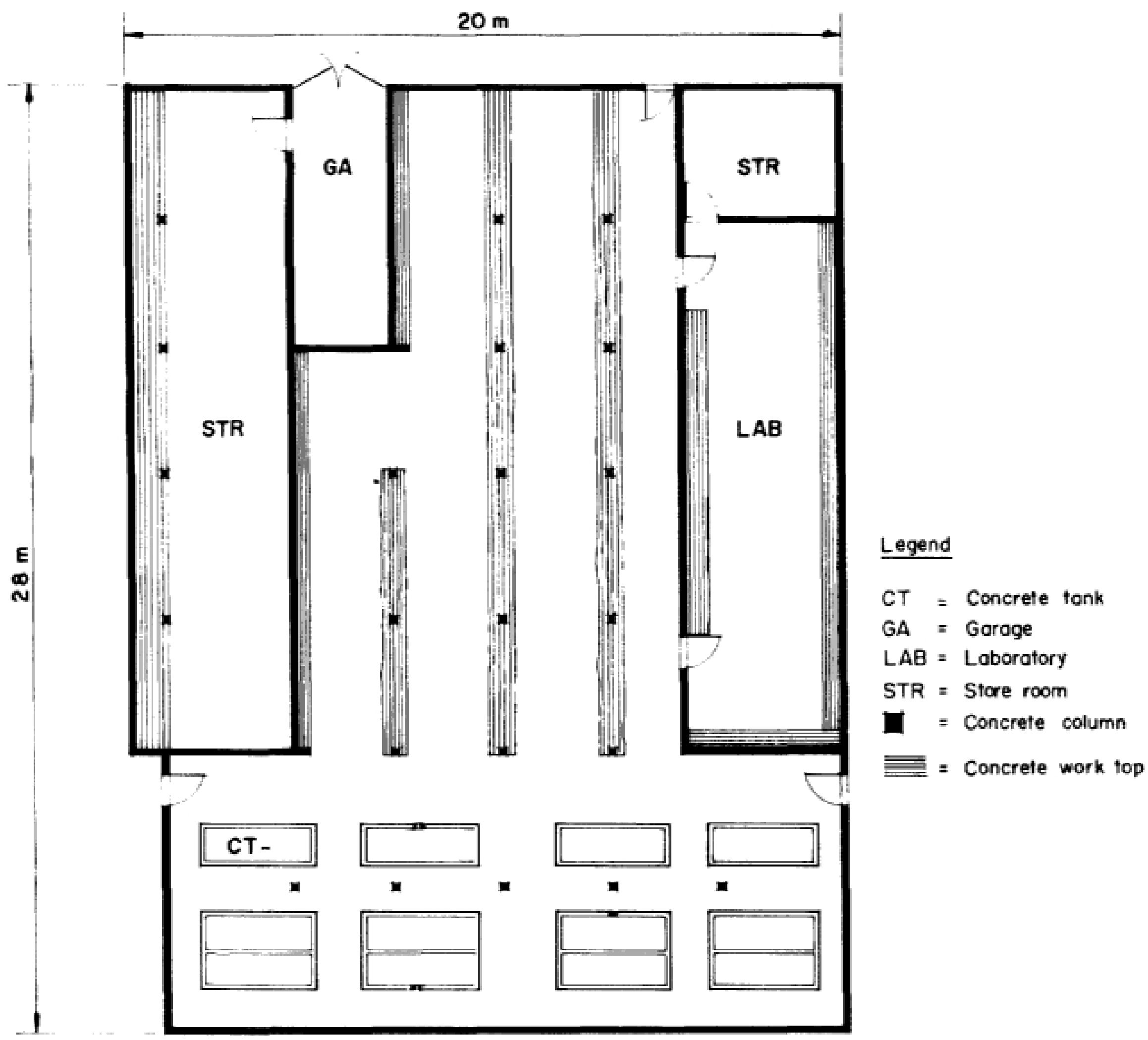
APPENDIX 2 LAY OUT OF THE HATCHERY BUILDING OF THE COASTAL AQUACULTURE RESEARCH STATION, PITIPANA, BEFORE RENOVATION BY THE MINISTRY OF FISHERIES.



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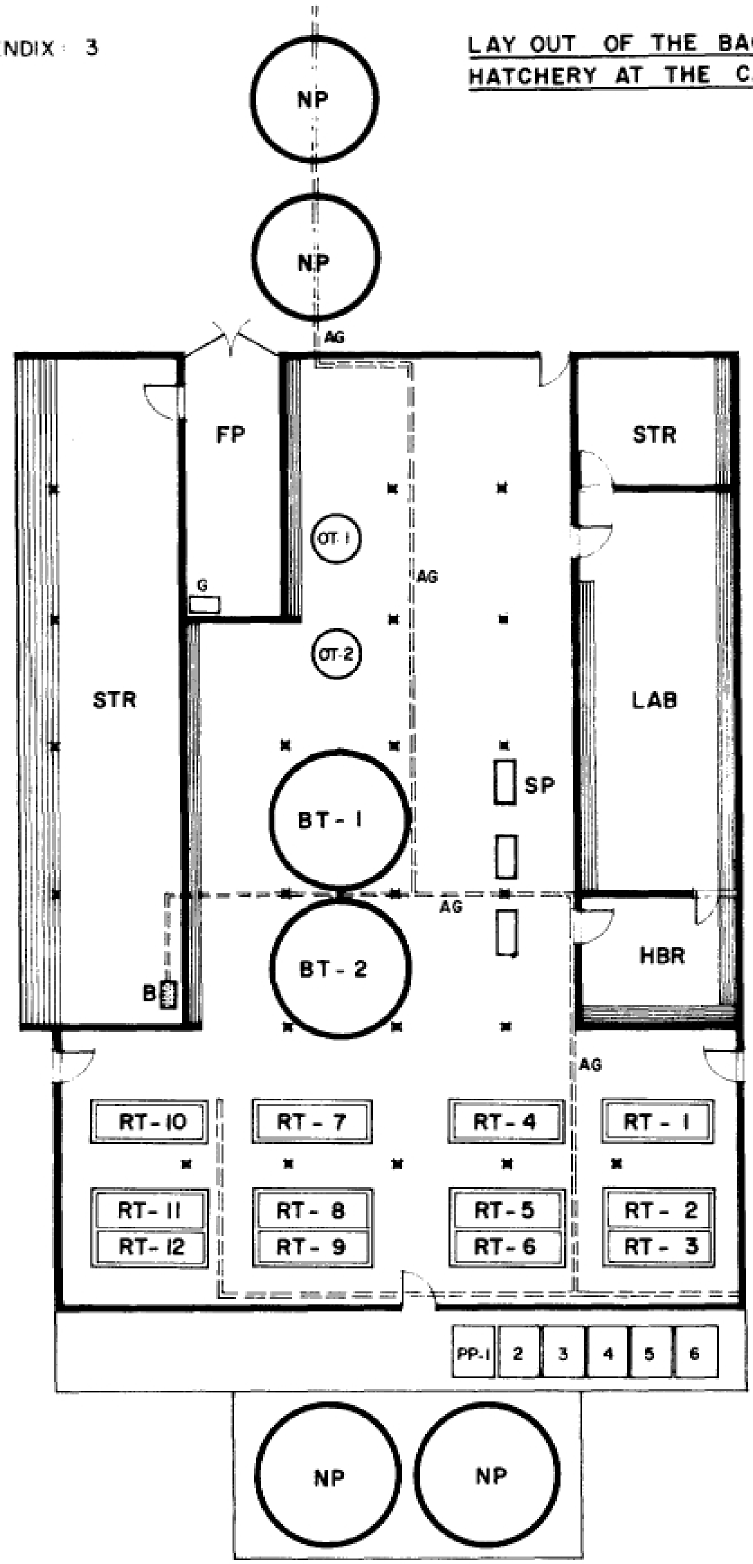
APPENDIX : 3

LAY OUT OF THE BACKYARD SHRIMP HATCHERY AT THE CARSP



Legend

- AG = Air supply grid
- B = Air blower
- BT = Brood stock tank
- FP = Feed processing
- G = Generator
- HBR = Hatchery biologist room
- LAB = Laboratory
- NP = Nursery pool
- OT = Observation tank
- PP = Phytoplankton tank
- RT = Rearing tank
- SP = Spawning pool
- STR = Store room
- ■ = Concrete column
- ▤ = Concrete work top

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Appendix 4

SEMI-CONTINUOUS ALGAE CULTURE IN AN OUTDOOR ONE TONNE-FIBREGLASS TANK

In this method for culturing phytoprankton, the daily production is harvested by removing a certain volume (Vh) of the culture. Vh is presented by the formula

Vh = (d – **c)/d. V where V = total volume of the culture;**
d = cell density before harvest;
c = constant (cells/mi) chosen by the operator.

After harvesting the volume Vh, **the original volume V is made up again with fresh sea water and nutrients. The cell density then ought to be c.**

Daily production depends on a number of factors including meteorological ones, but can be influenced by the operator by choosing the nutrient levels and the constant cell density c. This in turn will influence the **species composition of a mixed culture as one particular species is likely** to be best adapted to the nutrient levels in the culture and to the dilution rate. As a general rule, it can be **stated that high Si-levels and a high dilution rate (c small) will favour the diatoms over the green algae.**

In this particular experience, in the absence of any other clue, the *Skeletonema sp* density at the end of the second day of growth was chosen as c lc = 53,000 **cells/ml). The nutrient levels were those normally used at CARSP. In this way the culture was maintained for more than one week** (V = 900 litres).

Day	-	1	2	3	4	5	6	7	8	9
cells/ ml x 10^3	0	53	210	115	130	190	90	**72**	**60**	
Vh (l)	0	0	675	486	540	656	**370**	180	**108**	

After some time, production declined probably because of increased pollution of the rearing medium and because of the absence of vitamins and oligo-elements. However, since the period in which **diatoms are needed is limited to a few days in a week, and there is normally only one batch starting each week, these results may be considered adequate.**

Appendix 5

ARTIFICIAL LARVAL FEEDS USED AT THE CARSP BACKYARD HARCHERY

Ingredients of NPCL-17 and of the locally-made formulated feed

NCPL-17 Ingredients	Composition	Locally made formulated feed ingredients	Composition
Dried prawn head powder	25%	Dried prawn head powder	25%
Dried mantis prawn powder	25%	Dried mantis prawn powder	25°,o
Ground nut oil cake powder	37.5%	Soyabean powder	37.5%
Fish meal	12.5%	Fish meal	12.5%
Multivitamins and minerals	trace	Multivitamins and minerals	trace
Tapioca powder	20%of feed base	Wheat flour (binder)	20%of feed base

***Preparation procedures for micro-encapsulated whole egg larval diet (Adapted from "Fish Feed Technology" ADCP/REP/80- li-p** 360)*

Steps	Procedure

1. Crack egg into heat resistant container
2. Beat egg vigorously with fork or paddle; egg may also be homogenized with a mechanical blender
3. Rapidly pour boiling water (approximately 150 cc for each egg) into homogenate and stir constantly. A fine opalescent suspension is obtained.
4. Make up to desired volume with cold water.
5. A 50 g egg contains about 12 g of dry matter. Feed by the spoonful or scoopful directly to fish (prawns). The feed may also be applied as a spray using a 'knapsack' type sprayer.
6. Store unused feed in a tight container in a refrigerator.

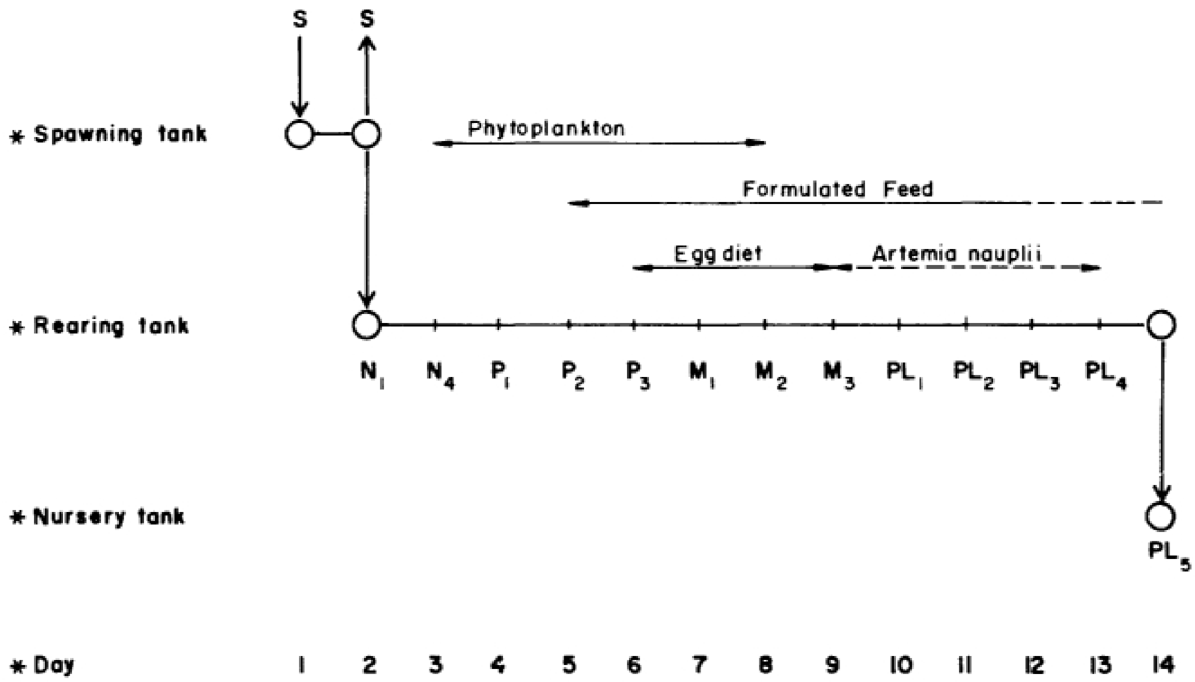
Appendix 6

RECOMMENDED HATCHERY ROUTINE*

1. Collect spawner personally by making trips on commercial trawlers.
2. Transfer the spawner to the transportation container as quickly as possible and avoid all situations that would cause stress to the spawner.
3. Use aerators while in transit and keep the temperature of water low.
4. Prepare the spawning tanks in advance. Add 1 gm of EDTA sodium salt for every 100 litres of water.
5. Each spawner in separate tank with 200 litres filtered sea water. Provide good aeration at all times.
6. Do not put on the light or otherwise disturb the prawn at the time of spawning.
7. Remove the spawner to the maintenance tank soon after spawning and clean the sides of the spawning tank.
8. Estimate number of eggs. Differentiate viable and nonviable eggs.
9. Estimate number of hatched nauplii.
10. Harvest and stock the nauplii in rearing tanks at the rate of 100,000 per M^3 of water.
11. Day 1 – fill the rearing tanks with sea water only to one-third capacity at the time of stocking nauplii; add 1/2 gram of NPCL-17.
12. Day 2 – nauplii. Remove sediment in the morning. Raise water level to half the capacity of tank. Add 100 litres of mixed phytoplankton, 1 gm NPCL-17.
13. Day 3 – Protozoa 1. Remove sediment, raise water level to three-fourth capacity. Add 1 gm NPCL-17.
14. Day 4 – Protozoa 2. Remove sediment, raise water level to full capacity of tank. Add 1 gm of NPCL every six hours.
15. Day 5 – Protozoa 3. Remove sediment, reduce water level by one-third and make it up with new filtered sea water. Food 1 gm NPCL every six hours.
16. Day 6 – Mysis 1. Remove sediment, reduce water level by one-third and replenish with new filtered sea water. Food 1 gm NPCL every six hours.
17. Day 7 – Mysis 2. Remove sediment, remove and replenish one-third of the water. Food 1 gm NPCL every six hours. Use judgement and increase quantity of feed if necessary.
18. Day 8 – Mysis 3. Repeat the previous day's procedures.
19. Day 9 – Mysis 3. Some post-larvae 1. Repeat the previous day's procedure.
20. Day 10 – Post-larvae 1 and 2. Repeat procedures.

* Recommended by Dr K. H. Mohammed, Consultant.

APPENDIX 7. **PRODUCTION AND FEEDING SCHEDULE**



Legend :

S : Spawner, N : Nauplii, P : Protozoea, M : Mysis, PL : Post Larvae.

Depending on the temperature and on the species cultured the production of PL-5's will take two to three weeks. At 28°C it takes f.i. for P. Indicus 14 days.

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Appendix 8

PRODUCTION OF *PENAEID* POST LARVAE

Batch	Species & number of spawners	Collection date of spawners	No. Nauplii stocked x 10^3	No. PL-5 x 10^3	Survival %
El	1Pi	11/10	93	40	43
1	4Pi	17/10	440	170	39
2	3Pi	26/10	316	5	1
3	8Pi	2/11	970	17	2
4	1Pi	3/11	60	40	67
5	1Pi	4/11	60	0	0
6	1Pi	28/11	90	20	22
7	1Pi	4/12	160	40	25
8	1Pi	27/12	80	18	23
9	5Pi	3/1	290	55	19
10	2Pi	8/1	185	0	0
11	1Ps	25/1	60	12	18
12	1Pi	26/1	82	2	2
	1Ps		60	0	0
13	1Pm	27/1	600	45	8
14	1Pm	28/1	200	40	20
15	1Pm	7/2	200	0	0
16	iPs	17/2	4.80	0	0
17	1Ps	20/2	200	3	2
18	1Pm	22/2	120	7	6
19	1Ps	13/3	80	1	1
20	1Ps	14/3	160	10	6
21	1Pi	16/3	100	4	4
22	1Pm	4/4	50	10	20
	1Pi	—	50	15	30
	2Ps	—	203	62	31
23	1Ps	8/4	200	0	0
24	1Pm	23/4	300	10	3
25	2Pi	25/4	380	60	16
26	4Ps	3/5	166	20	13
27	1Pi	6/6	80	10	13
28	2Pi	13/6	150	6	4
27′	5Pm	6/7	50	15	30
28′	5Pm	11/7	25	0	0
29′	3Pi	12/7	308	11	4
30	4Pi	17/7	280	84	30
31	1Pm	23/7	150	NA	NA
32	1Pi	29/8	40	NA	NA
33	1Pi	19/9	138	NA	NA
34	xPi	27/9	780	NA	NA
35	1Pi	10/10	142	71	50
	3Pm	—	529	117	22
36	1Pi	24/10	136	52	38
37	3Pi	7/11	134	510	38

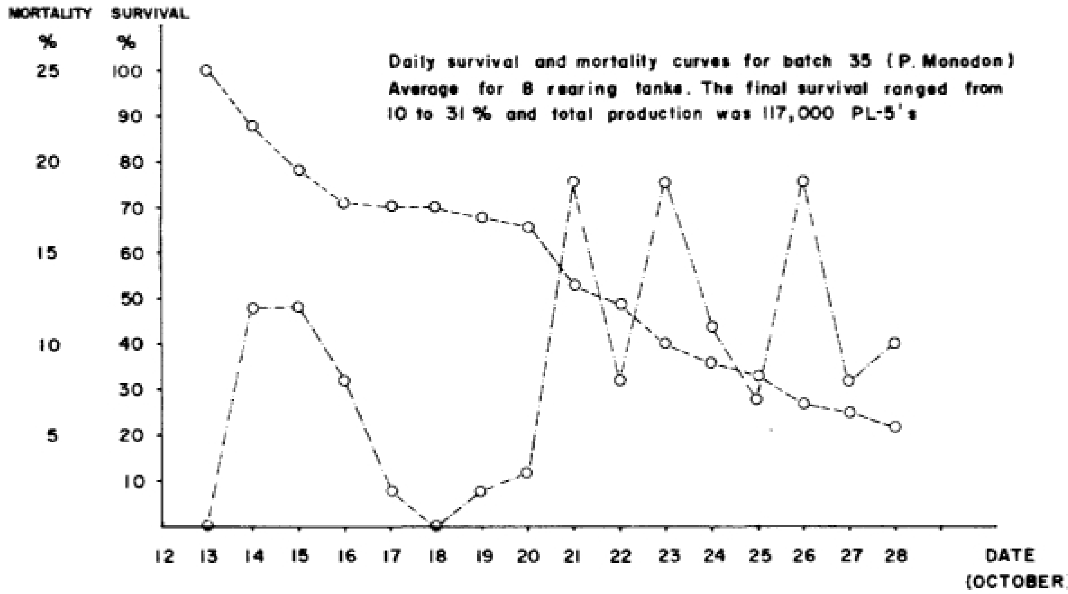
Batch	Species & number of spawners	Collection date of spawners	No. Nauplii stocked x 10^3	No. P1-S x 10^3	Survival
Total per species (excluding batch 31 to 34)					
	48Pi		4,131	771	19
	19Pm		**2,074**	244	**12**
	12Ps		1,609	96	6
Total	**79 Spawners**		**7, 814**	**1,111**	**14**

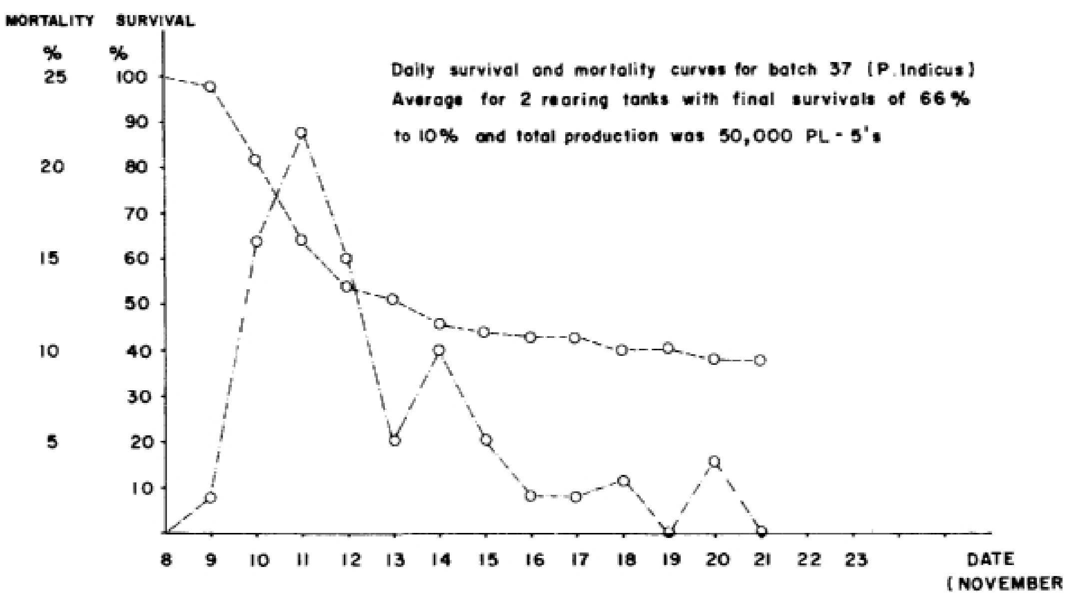
Remarks

- **NA** stands for data not available
- Pi stands for ***P. indicus***
- **Pm for *P. monodon* and**
- **Ps for *P. semisulcatus***

APPENDIX 9.

SURVIVAL AND MORTALITY CURVES





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Appendix 10

PROGRAMME OF THE TRAINING COURSE IN MARINE SHRIMP BREEDING AND LARVAL REARING

January 24, 1985 (Thursday)

1.	1430 hrs	**Introduction**
2.	1530 hrs	**Lecture 1 "Recent developments in marine prawn hatchery techniques and biology of *penaeid* prawns relevant to hatchery production of prawn seeds" — K.H. Mohammed**
3.	l700hrs	**Getting acquainted with hatchery equipment, aeration system, sea water system etc. — Samarasinghe & B Perera.**
4.	1800 hrs	Lecture 2 **"Selection of spawners, transportation and spawning procedures" — K.H. Mohammed.**

January 25, 1985 (Friday)

1.	0300-1600 hrs	**Collection of spawners from Chilaw and Negombo and transportation to hatchery — J.A. Janssen & Samarasinghe.**
2.	1600-1800 hrs	**Preparation of spawning tanks and placing prawns for spawning — K.H. Mohammed & B.Perera.**
3.	2100-1400 hrs.	**Observation of spawning act — removal of spawner — nature of spawning — K.H. Mohammed.**
4.		**Start phytoplankton cultures — by those who remain in hatchery — K.H. Mohammed.**

January 26, 1985 (Saturday)

1.	0000-0800 hrs	Trace development of embryo differentiate **viable eggs — Lecture 3 and** discussion — K.H.Mohammed & **B.Perera.**
2.	0900 hrs	**Estimate number of eggs spawned, clean and service spawning tank — Samarasinghe, K.H. Mohammed & B. Perera.**
3.	1000 hrs	**Lecture 4 : "Hatched out larvae, larval stages, estimation of stock and stocking in rearing tanks" — K.H.Mohammed.**
4.	1200 hrs	**Observation of hatching of eggs. Make sketch of nauplii — Samarasinghe.**
5.	1530 hrs	**Preparation of rearing tanks — B. Perera, Samarasinghe & K.H. Mohammed.**
6.	1700 hrs	**Stocking of larvae in rearing tanks — B. Perera, Samarasinghe & K.H.Mohammed.**

January 27, 1985 (Sunday)

1.	0730 hrs	**Observation of larvae, servicing of rearing tanks, estimation of stock, introduction of phytoplankton as food of larvae, supplementary feeding by formula feed — Samarasinghe.**
2.	1100 hrs	**Lecture 5 : "Food of larvae and feeding schedule" — K.H. Mohammed.**
3.	1500 hrs	**Pen preparation — B. Perera.**

January 28, 1985 (Monday)

1.	0730 hrs	**Observation of larvae, servicing of rearng tanks, larval feeding — Samarasinghe.**
2.	AN	**Official inauguration of training course.**
3.	1800 hrs	**Observation of the larvae-feeding — Samarasinghe.**

January 29, 1985 (Tuesday)

1.	0730 hrs	**Observation of larvae — servicing of rearing tanks, larval feeding — Samarasinghe.**
2.	1100 hrs	**Lecture 6 : "Developing live feed culture for feeding larvae" — K.H. Mohammed.**
3.	1430 hrs	Seed **collection** — feed **preparation for prawns in grow-out systems. Feeding group** 1 — **J.A. Janssen & B. Perera.**
4.	2000 hrs	Slide show — **J.A. Janssen.**

January 30, 1985 (Wednesday)

1. 0730 hrs Observation of larvae-servicing of rearing tank — larval feeding — Samarasinghe.
2. 1100 hrs Lecture 7 : "Importance of water management and aeration for rearing *penaeid* prawn larvae" — K.H. Mohammed.
3. 1430 hrs Pen erection — Feed preparation for prawns in grow out systems, feeding Group II — J.A. Janssen & B. Perera.
4. 1600 hrs Slide projection, Discussion — Samaranayake.

January 31, 1985 (Thursday)

1. 0730 hrs Observation of larvae — servicing of rearing tank — larval feeding — Samarasinghe.
2. 1100 hrs Lecture 8 : "Nursery management for better survival of post-larvae" — K.H. Mohammed.
3. 1430 hrs Report writing exercises evaluating the training course — J.A. Janssen & K.H. Mohammed.

February 1, 1985 (Friday)

1. 0730 hrs Observation of larvae—servicing of tanks—larval feeding-maintenance of phytoplankton culture — Samarasinghe.
2. 1430 hrs Pen checking/repairs to damaged netting, sampling and estimation of stock, harvesting techniques, feed preparation for prawns in grow out systems, feeding group III — Janssen & B. Perera.
3. 1700 hrs Lecture 9 : "Role of hatcheries in the development of shrimp culture" — Dr.M. Karim.

February 2, 1985 (Saturday)

1. 0730 hrs Observation of larvae, servicing of rearing tanks, larval feeding — Samarasinghe.
2. 1000 hrs Lecture 10 "Larval mortality, contamination of medium remedial measures" — K.H. Mohammed.
3. 1100 hrs Lecture 11 : "Recent shrimp breeding experiments in Sri Lanka" — Samarasinghe.
4. 1200 hrs Lecture 12 : "Trials in pen culture for shrimp in Sri Lanka" — B. Perera.
5. 1430 hrs Water area survey — J.A. Janssen & B. Perera.

February 3, 1985 (Sunday)

1. 0730 hrs Observation of larvae, servicing of rearing tanks, feeding larvae — Samarasinghe.
2. 1000 hrs Concluding session — Samarasinghe.

Appendix 11

VIABILITY OF THE HATCHERY

The following calculations provide a rough estimate of the operating costs of the backyard hatchery were it to operate on a regular basis. Most of the figures were obtained through discussions with the project staff. It is assumed that an average of six rearing tanks are run per month.

		In SRL rupees
1.	Salaries – aquaculturist in charge	1,700
	– non-skilled labour (100 m/d)	3,700
		5,400
2.	Consumable items	
	– chemicals and fertilizers	200
	– feeds	400
	– materials	100
	– water	1,200
		1,900
3.	Fuel and electricity	1,500
4.	Spawners	1,500
5.	Miscellaneous	300
	Total	10,600

To cover these operational expenses, the hatchery must sell 110,000 PL–5's per month at the current price of 10 cts each. As the current stock density of 67,000 nauplii per rearing tank, the production figure corresponds to a survival rate of 30 per cent, It is believed that this survival rate can be achieved by the hatchery. Should the performance of the nursery improve, much less needs to be produced as the selling price of older post-larvae are much higher. Depending on the species, PL-30's sell for anything between 30 and 40 cts each.

Publications of the Bay of Bengal Programme (BQBP)

The BOBP brings out six types of publications

Reports I BOBP "REP .1 describe and analyze completed activities such as seminars, annual meetings of BOBP's Advisory committee, and projects in member-countries for which BOBP inputs have ended.

Working Papers (BOBP/WP. are progress reports that discuss the findings of ongoing BOBP work

Manuals and Guides BOBP.'MAG I are instructional documents for specific audiences

Miscellaneous Papers I BOBP 'MIS- .I concern work not originated by BOBP staff or consultants but which is relevant to the Programme's obiectives.

Information Documents (BOB P INF I are bibliographies and descriptive documents on the fisheries of member-countries in the region.

Newsletters (Bay of Bengal News), issued quarterly, contain illustrated articles and features in non technical style on BOBP work and related subjects.

A list of publications follows.

Reports (BOBP/REP ..)

1 Report of the First Meeting of the Advisory committee. colombo, Sri Lanka, 28-29 October 1976. IPublished as Appendix 1 of IOFC/DEV/78/44.1. FAO, Rome, 1978)

2. Report of the Second Meeting of the Advisory committee. Madras, India, 29-30 June 1977. lPublished as Appendix 2 of IOFc/DEV!78/44 1, FAO, Rome, 1978)

3. Report of the Third Meeting of the Advisory Committee. Chittagong, Bangladesh, 1-10 November 1978. Colombo, Sri Lanka, 1978. (Reissued Madras, India, September 1980)

4. Role of Women in Small-Scale Fisheries of the Bay of Bengal Madras, India, October 1980.

5. Report of the Workshop on Social Feasibility in Small-Scale Fisheries Development Madras, India, 3-8 September 1979. Madras, India, April 1980.

6. Report of the Workshop on Extension Service Requirements in Small-Scale Fisheries. Colombo, Sri Lanka, 8-12 October 1979. Madras, India, June 1980

7. Report of the Fourth Meeting of the Advisory Committee Phuket, Thailand, 27-30 November 1979. Madras, India, February 1980,

8. Pre-Feasibility Study of a Floating Fish Receiving and Distribution Unit for Dubla Char, Bangladesh. G. Eddie, M. T. Nathan, Madras, India, April 1980.

9. Report of the Training Co irse for Fish Marketing Personnel of Tamil Nadu. Madras, India 3-14 December 1979. Madras, India, September 1980.

10.1 Report of the Consultation on Stock Assessment for Small-Scale Fisheries in the Bay of Bengal. Chittagong, Bangladesh, 16 21 June 1980. Volume 1 : Proceedings. Madras, India. September 1980.

10.2 Report of the Consultation of Stock Assessment for Small-Scale Fisheries in the Bay of Bengal Chittagong, Bangladesh, 16-21 June 1980. Volume 2 Papers. Madras, India, October 1980.

11. Report of the Fifth Meeting of the Advisory Committee. Penang, Malaysia, 4-7 November 1980. Madras, India, January 1981.

12. Report of the Training Course for Fish Marketing Personnel of Andhra Pradesh; Hyderabad, India, 11-26 November 1980. Madras, India, September 1981.

13. Report of the Sixth Meeting of the Advisory Committee. Colombo, Sri Lanka, 1-5 December 1981. Madras, India, February 1982.

14 Report of the First Phase of the 'Aquacultiire Demonstration for Small-Scale Fisheries Development Project' in Phang Nga Province, Thailand. Madras, India, March 1982.

15. Report of the Consultation-cum Workshop on Development of Activities for Improvement of Coastal Fishing Families. Dacca, Bangladesh, October 27-November 6, 1981. Madras, India, May 1982.

16. Report of the Seventh Meeting of the Advisory Committee. New Delhi, India, January 17-21, 1983 Madras, India, March 1983.

17. Report of Investigations to Improve the Kattumaram of India's East Coast. Madras, India, July 1984.

18. Motorization of Country Craft, Bangladesh. Madras, india, July 1984.

19. Report of the Eighth Meeting of the Advisory Committee. Dhaka, Bangladesh, January 1619, 1984. Madras, India, May 1984.

20. Coastal Aquaculture Proiect for Shrimp and Finfish in Ban Merbok, Kedah, Malaysia Madras, India, December 1984.

21. Income-Earning Activities for Women from Fishing Communities in Sri Lanka. Edeltraud Drewes. Madras, India, September 1985.

22. Report of the Ninth Meeting of the Advisory Committee. Bangkok, Thailand, February 2526, 1985. Madras, India, May 1985.

23. Summary Report of BOBP Fishing Trials and Demersal Resource Studies in Sri Lanka. Madras, India, March 1986.

24. Fisherwomen's Activities in Bangladesh · A Participatory Approach to Development Patchanee Natpracha Madras, India, May 1986

25 Attempts to Stimulate Development Activities in Fishing Communities of Adirampattinam, India Patchanee Natpracha, V.L C Pietersz Madras, India, May 1986.

26. Report of the Tenth Meeting of the Advisory Committee. Male, Maldives, 1718 February 1986 Madras, India, April 1986.

27. Activating Fisherwomen for Development through Trained Link Workers in Tamil Nadu, India Edeltraud Drewes Madras, India, May 1986

28. Small Scale Aquaculture Development Project in South'Thailand Results and Impact E Drewes. Madras, India, May 1986.

29. Towards Shared Learning An Approach to Nonformal Adult Education for Marine Fisherfclk of Tamil Nadu, India. L. S. Saraswathi and Patchanee Natpracha lln preparationl

30. Summary Report of Trials with Large Mesh Driftnets in Bangladesh. Madras, India, May 1986.

Working Papers (BOBP WP

1. Investment Reduction and Increase in Service Life of Kattumaram Logs. R. Balan, Madras, India, February 1980.
2. Inventory of Kattumarams and their Fishing Gear in Andhra Pradesh and Tamil Nadu, T. R. Menon. Madras, India, October 1980
3. Improvement of Large Mesh Driftnets for SmallScale Fisheries in Sri Lanka.' G. Pajot. Madras, India, June 1980
4. Inboard Motorisation of Small G.R P. Boats in Sri Lanka. Madras, India, September 1980.
5. Improvement of Large Mesh Driftnets for Small Scale Fisheries in Bangladesh G. Pajot. Madras, India, September 1980.
6. Fishing Trials with BottomSet Longlines in Sri Lanka. G. Pajot, K. T. Weerasooriya. Madras, India, September 1980.
7. Technical Trials of Beachcraft Prototypes in India, O. Gulbrandsen, G. P. Gowing, R. Ravikumar. Madras. India. October 1980
8. Current Knowledge of Fisheries Resources in the Shelf Area of the Bay of Bengal. B. T. Antony Raja. Madras, India September 1980
9. Boatbuilding Materials for SmallScale Fish('Hos in India, Martras, India, October 1980.
10. Fishing Trials with High Opening Bottom Trawls in Tamil Nadu, India G. Pajot, John Crockett, Madras, India, October 1980
11 The Possibilities for Technical Cooperation between Developing Countries (TCDCI in Fisheries E. H. Nichols. Madras, India, August 1981.
12. Trials in Bangladesh of Large-Mesh Driftnets of Light Construction, G. Pajot, T. K. Das. Madras, India, October 1981.
13. Trials of Two-Boat Bottom Trawling in Bangladesh. G Pajot, J. Crockett. Madras, India, October 1981.
14. Three Fishing Villages in Tamil Nadu, Edeltraud Drewes Madras, India, February 1982.
15. Pilot Survey of Driftnet Fisheries in Bangladesh. M. Bergstrom. Madras, India, May 1982
16. Further Trials with Bottom Longlines in Sri Lanka. Madras, India July 1982.
17. Exploration of the Possibilities of Coastal Aquaculture Development in Andhra Pradesh Soleh Samsi, Sihar Siregar and Martono Madras, India, August 1982.
18 Review of Brackishwater Aquaculture Development in Tamil Nadu Kasemsant Chalayondeja and Anant Saraya Madras, India, September 1982.
19 Coastal Village Development in Four Fishinq Cemmunities of Adirampattinam, Tamil Nadu, India. F. W. Blase Madras, India, December 1982.
20 Further Trials of Mechanized Trawling for Food Fish in Tamil Nadu, G Pajot, J Crockett, S Pandurangan, P V. Ramamoorthy. Madras, India, December 1982
21. Improved Deck Machinery and Layout for Small Coastal Trawlers, G. Pajot, J Crockett, S. Pandurangan and P. V. Ramamoorthy. Madras, India, June 1983
22 The Impact of Management Training on the Performance of Marketing Officers in State Fisheries Corporations. U. Tietze. Madras, India, June 1983.
23 Review of Experiences with and Present Kn, wledge about Fish Aggregating Devices. M Bergstrom. Madras, India, November 1983
24 Traditional Marine Fishing Craft and Gear of Orisse P. Mohapatra. Madras, India, April 1986.
25. Fishing Craft Development in Kerala Evaluation Report. 0. Gulbrandsen, Madras, India, June 1984
26 Commercial Evaluation of IND-13 Beachcraft at Uppada, India R Ravikumar. Madras, India, June 1984.
27. Reducing Fuel Costs of Fishing Boats in Sri Lanka ln preparationl

28. Fishing Trials with Small-Mesh Driftnets in Bangladesh.
G. Pajot and T K. Das. Madras, India, March 1984.

29. Artisanal Marine Fisheries of Orissa : a Techno-Demographic Study.
M. H. Kalavathy and U. Tietze, Madras, India, December 1984.

30. Mackerels in the Malacca Straits. Colombo. Sri Lanka, February 1985.

31 Tuna Fishery in the EEZs of India, Maldives and Sri Lanka, Colombo, Sri Lanka, February 1985.

32. Pen Culture of Shrimp in the Backwaters of Killai, Tamil Nadu : A Study of Techno-economic and Social Feasibility
Rathindra Nath Roy. Madras, India, January 1985.

33. Factors that Influence the Role and Status of Fisherwomen, Karuna Anbarasan,
Madras, India, April 1985.

34. Pilot Survey of Set Bagnet Fisheries of Bangladesh. Abul Kashem. Madras, India, August 1985.

35. Pen Culture or Shrimp in the Backwaters of Killai, Tamil Nadu. M. Karim and S. Victor Chandra Bose.
Madras, India, May 1985.

36. Marine Fishery Resources of the Bay of Bengal. K. Sivasubramaniam.
Colombo, Sri Lanka, October 1985.

37. A Review of the Biology and Fisheries of *Hilsa Ilisha* in the Upper Bay of Bengal. B. T Antony Raja.
Colombo, Sri Lanka, October 1985.

38. Credit for Fisherfolk : The Adirampattinam Experience R. S. Anbarasan and Ossie Fernandez.
Madras, India, March 1986.

39. The Organization of Fish Marketing in Madras Fishing Harbour. M. H. Kalavathy.
Madras, India, September 1985.

40. Promotion of Bottom Set Longlining in Sri Lanka.
K. 1. Weerasooriya, S. S. C. Pieris, M. Fonseka. Madras, India, August 1985.

41 The Demersal Fisheries of Sri Lanka. K. Sivasubramaniam and R. Maldeniya.
Madras, India, December 1985.

42. Fish Trap Trials in Sri Lanka. (Based on the report of Ted Hammermanl.
Madras, India, January 1986.

43. Demonstration of Simple Hatchery Technology for Prawns in Sri Lanka. Madras, India, June 1986.

44. Pivoting Engine Installation for Beachlanding Boats A. Overa, R. Ravikumar. Madras, India, June 1986.

Manuals and Guides (BOBP/MAG/.

1. Towards Shared Learning Non-formal Adult Education for Marine Fisherfolk. Trainers' Manual
Madras, India, June 1985.

2. Towards Shared Learning Non-formal Adult Education for Marine Fisherfolk. Animator's Guide.
Madras, India, June 1985.

3. Fishery Statistics on the Micro-computer A BASIC version of Hasselblad's NORMSEP Program.
Colombo, SriLanka, June 1986.

Miscellaneous Papers (BOBP/MIS/.

1. Fishermen's Cooperatives in Kerala A Critique. John Kurien. Madras, India, October 1980.

2. Consultation on Social Feasibility of Coastal Aquaculture.
Madras, India, 26 November-i December 1984. Madras, India, November 1985.

Information Documents (BOBP/INF!,

1. Women and Rural Development in the Bay of Bengal Region : Information Sources,
Madras, India, February 1982.

2. Fish Aggregation Devices : Information Sources. Madras, India, February 1982.

3. Marine Small-Scale Fisheries of India A General Description. Madras, India, March 1983.

4. Marine Small-Scale Fisheries of Andhra Pradesh : A General Description. Madras, India, June 1983.

5. Marine Small-Scale Fisheries of Tamil Nadu A General Description. Madras, India, December 1983.

6. Marien Small-Scale Fisheries of Sri Lanka : A General Description. Madras, India, November 1984.

7. Marine Small-Scale Fisheries of Orissa A General Descriptiors. Madras, India, December 1984.

8. Marine Small-Scale Fisheries of Bangladesh : A General Description. Madras, India, September 1985.

9. Food and Nutrition Status of Small-Scale Fisherfolk in India's East Coast States A Desk Review and Resources
Investigation. V Bhavani. Madras, India, April 1986.

Newsletters (Bay of Bengal News)

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