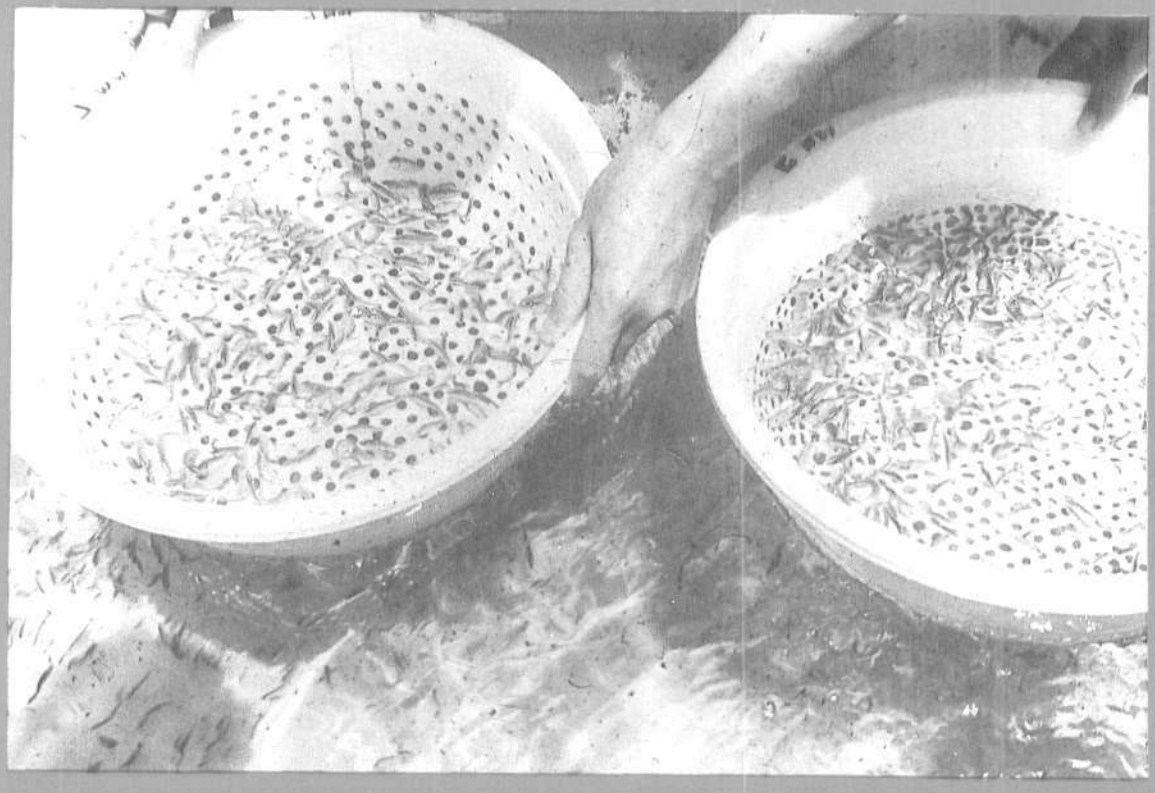
ISSN 0254-380 X

भाकृअप
ICAR

समुद्री मात्स्यिकी सूचना सेवा
MARINE FISHERIES INFORMATION SERVICE

No. 109

MARCH 1991



तकनीकी एवं विस्तार अंकावली
TECHNICAL AND EXTENSION SERIES

केन्द्रीय समुद्री मात्स्यिकी अनुसंधान संस्थान कोचिन, भारत
CENTRAL MARINE FISHERIES RESEARCH INSTITUTE COCHIN, INDIA

भारतीय कृषि अनुसंधान परिषद
INDIAN COUNCIL OF AGRICULTURAL RESEARCH

SEED PRODUCTION AND COMMERCIAL CULTURE OF THE SEABASS, *LATES CALCARIFER* (BLOCH) AT SINGAPORE AND ITS LESSONS FOR INDIA

P. BENSAM
Central Marine Fisheries Research Institute, Cochin
and
P. NAMMALWAR
Madras Research Centre of CMFRI, Madras

The "Seabass" or the "Giant perch", *Lates calcarifer* is of prime quality value fish in whichever locality it occurs. Distributed mostly in the central and eastern Indian Ocean region, it is common in Australia, Burma, India, Indonesia, Malayasia, Papua (New Guinea), Philippines, Singapore and Thailand. In view of its easy adaptability to low saline waters including fresh water, this fish has assumed great value for culture in recent years. Popularly called "Bhekti" in India, it is found along both the east and west coasts, but is more common in Bengal region where it is cultured in ponds, canals, *bheries* and paddy fields. The Central Marine Fisheries Research Institute has been carrying out experiments for achieving its artificial propagation. The All India Co-ordinated Project on Brackishwater Prawn and Fish Farming of the Indian Council of Agricultural Research has collected data on the availability of the seed resources of this fish along the east coast, Kerala and Goa as well as carried out some experiments on its culture during the seventies. That artificial production of its seeds is possible has been proved in Thailand by collecting spawners from the wild. This is followed by breeding the fish in tanks under captivity and production of the first batch of induced-bred fry there in 1973.

In Singapore, the first successful breeding by using hormonal injection has been achieved in 1982 at the Marine Aquaculture Section of the Primary Production Department (PPD), Government of Singapore. Since then the Department has been refining the technique, resulting in an annual production of about one million seeds in

recent years. Also, commercial culture of the Seabass in floating net cages in the sea, which was started in the seventies, has been refined. With these technologies, the PPD, in co-operation with the FAO/UNDP Network of Aquaculture Centres in Asia (NACA) and the International Development Research Centre of Canada (IDRC) have organised a Workshop at Changi (Fig. 1) in 1986 for transfer of the technology to other countries in Asia. The present authors have participated in the Workshop at Singapore, from 1 - 9 - 1986 to 10 - 10 - 1986. Since artificial seed production and intensive culture of the Seabass are yet to be realised in India, the salient features of these aspects observed at Singapore are presented in this paper.

Seed production

Various aspects of seed production carried out at Singapore may be considered as follows:

Spawner characteristics and requirements

L. calcarifer matures at the age of about 3 years at Singapore, when it measures about 60 cm in total length (TL). Since it is a protandrous hermaphrodite, usually younger fish in the age group of 3 to 5 years, 60- 120 cm T L and 2 - 7 kg in weight are males and older fishes in the group of 4 to 7 years, 110 - 150 cm T L and 3 - 12 kg are females.

The broodstock for seed production is obtained either by collection from the sea or by raising from young stages in floating net cages in the sea. In the former case, a period of six months is required for the fish to recover from the stress of capture as well as for conditioning to the confined environment of the net cages. The stock is kept in such localities in the sea as are sheltered from strong waves of not more than 2 m height and away from strong currents of not more than 1 m/sec. The hydrological conditions suitable for the stock are : 28 - 31°C temperature, 27 - 31‰ salinity and more than 5 mg/l dissolved oxygen. The holding net cages are of 5 m length (L), 5 m width (W) and 3 m height (H), with mesh sizes of 2.5 cm. Stocking density is not more than 10 kg biomass/m^2. To ensure effective water circulation, the net cages which are fouled are changed every month. The stock is fed with trash fish such as *Upeneus* and *Sciaena*, at a rate of 2 - 3% of body weight. Experience has shown that effective interplay of the sexes and higher fertilisation take place only when males and females of the same age group are selected for breeding. However, the sexes of different age groups can be induced to spawn when they are conditioned by keeping them together for a period of 4 to 5 months.

The spawners should be healthy, active and free from parasites, diseases and injuries. They are examined once in 3 - 4 months for selection to breeding. After selection, the fish is lifted up with a scoop net and its head and eyes are covered with a black hood, in order to prevent the fish from struggling while handling. In females, the intraovarian ova are sampled by catheterisation and such of those which contain spherical, nonadhesive ova with a mean diameter of 0.45 mm or more are taken for induced breeding. Among males, such of those which ooze out white and creamy milt under gentle pressure with hands are the suitable ones.

Hormonal treatment

Two hormones are used for induced breeding of the Seabass, viz, (a) Luteinising Hormone - Releasing Hormone a (LH-RH a) and Human Chorionic Gonadotropin (HCG), both found to be equally effective. The dosage depends upon the maturity condition and weight of the spawner, lower if the maturity is advanced and vice versa. Generally, the dosage rate for LH - RH a is 6 - 75 µ g/ kg weight of the fish and for HCG 40 - 250 IU/ kg. The dilution is so adjusted that the volume of each injection is lesser than 2 ml/ fish. If more than 2 ml is to be injected, the solution is divided into two equal parts and injected at two different sites of the body. Since intra peritoneal injections are likely to injure vital internal organs, intra muscular injections are preferred. The usual site is at about 3 to 4 cm below the soft dorsal fin, where a scale is lifted up and the needle is inserted into the muscle at about 45° inclination for about 1 cm depth. After injecting, the needle is drawn out gently and the fish is carefully transported to the hatchery in a fibreglass tank, for releasing into the spawning tank.

Hatchery practices

The lay-out of a hatchery for producing 2,50,000 seeds of the Seabass at a time is shown in Fig. 2. For experimental purposes however, smaller tanks of fibreglass or concrete of 10 to 40

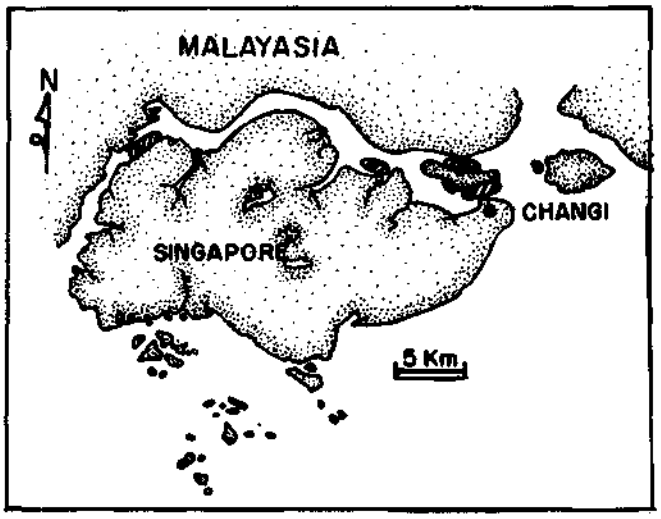


Fig. 1. Map of Singapore showing the four localities in Johore Straits between Malayasia and Singapore indicated in obliquely striped lines as well as Changi where the Marine Aquaculture Section is situated.

m^3 capacity in circular or rectangular shape may be used. It has been observed that spawning in larger tanks of 40 - 100 m^3 has produced eggs of better quality than those in smaller tanks. The number of spawners in each tank is so adjusted that for each 1 kg biomass of fish there is 1 m^3 of water. To ensure effective fertilisation, the number of males in each tank should be equal to or preferably one or more higher than the number of females. Spawning tanks are provided with continuous flow of fresh sea water and moderate aeration.

After hormonal treatment, usually 3 to 6 spawnings are observed within the first six days,

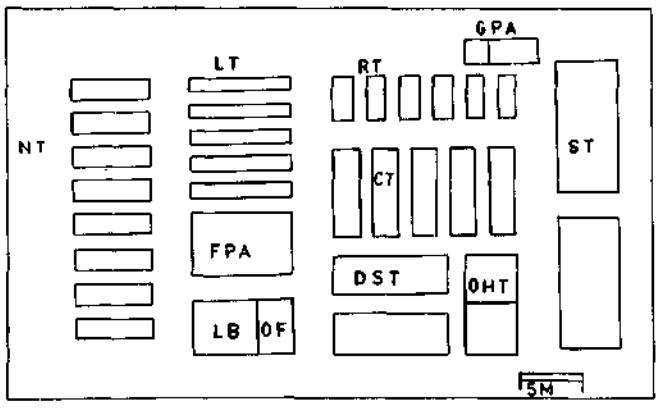


Fig. 2. Lay out of a hatchery for production of 2, 50, 000numbers of Seabass fry of 2.5 cm TL at a time (By courtesy of Mr. Lim Lian Chuan of Marine Aquaculture Section). C. T. Chlorella rearing tanks, DST. Dormitory for Scientists and technical staff, FPA. Feed preparation area, GPA. Generator, pump sets and accessories, LB. Laboratory, LT.Larvae rearing tanks, N. S. Nursery tanks, OF.Office, RT. Rotifer rearing tanks, ST. Spaqner tanks.

mostly between 9.00 P. M and 2.00 A. M. Generally, the first spawning gives only a smaller number of eggs, about 0.28 million/female or even less. The bulk spawning takes place mostly on the first, second and third days following the day of hormone injection. The total number of eggs spawned ranges from 0.83 to 3.09 million/ female, with mean at 1.73 million. After spawning, the eggs are collected from the spawning tank by a soft egg collecting hand net of 0.2 mm mesh, on the morning after spawning. These eggs are placed in plastic buckets for separation of unfertilised and fertilised eggs, the former by siphoning them out from the bottom where they sink. For incubating the eggs, small, circular, fiberglass tanks of 1 m^3 capacity provided with moderate aeration are used. The density of live eggs in these tanks can be upto 0.2 to 0.3 million per each. The eggs are 0.80 to 0.85 mm in diameter, with mean at 0.82 mm. A single oil globule of 0.25 to 0.27 mm in diameter is present. The first hatching at a water temperature of 27 - 28°C occurs at about $15^1/_2$ hours after fertilisation; and by the 16th hour all the eggs are found to hatch out.

Rearing of larvae and fry

The larvae and postlarvae are reared at first in indoor tanks until they metamorphose into fry, by about the 20th day after hatching. Circular or rectangular tanks of 1 to 40 m^3, provided with a sloping bottom, a drain pipe and moderate aeration are used for this purpose. After cleaning the tanks and the accessories, the healthy eggs are transferred to them at about 1 or 2 hours before hatching, at a density of 10,000 to 30,000/ m^3. Egg capsules, dead eggs etc are siphoned out. In the afternoon of the second day after hatching ,the mouth is formed and the postlarvae measuring 2.5 mm T L are ready to feed. To begin with, the postlarvae are fed with the rotifer *Brachionus plicatilis* by adding the latter at a low density of 2 - 3/ ml of water on the second day. The density is increased to 3 - 5/ ml from the 3rd to the 10th days and to 5 - 10/ ml from the 11th to the 15th days. By the 11th day the postlarvae measure about 4.5 mm T L and are ready to accept the nauplii of *Artemia*. The rate of supply of the latter is less than 0.2/ ml until the 12th day, increased to 0.5 - 1.0/ ml from the 13th to the 20th days. The fresh water crustacean *Moina macrura* may also be supplied in small numbers of 0.10 to 0.15/ ml from the 18th to the 20th days. In order to serve as the food of rotifers, the microalgae *Chlorella* and *Tetraselmis* are cultured in plastic

bags (Fig. 3) and are added to the rearing tanks. These algae increase the oxygen content of the water and bring down the concentration of ammonia in it, thus serving as "water conditioner" for rearing the early stages.

In the course of the first 20 days after hatching when they grow to about 8 mm T L, the postlarvae have undergone metamorphosis, become pigmented dark in colour with vertical stripes and present a brownish appearance, then they are called "fry". Survival from hatching to the fry stage of rearing is about 35 - 42%.

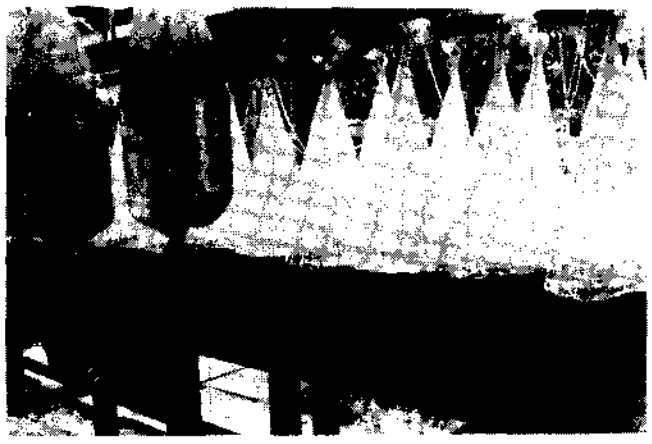


Fig. 3. Photograph of plastic bags with *Chlorella* under culture.

Rearing fry into fingerlings

On metamorphosis into fry by the 20th day when they measure about 7 - 10 mm T L, they have become stronger and are adaptable to rearing in outdoor tanks and "Hapa" net cages in the sea itself. For outdoor rearing, circular tanks of 1 to 8 m^3 capacity and having 0.8 to 1.0 m height are used. Stocking density varies depending upon the size of the fry, 5,000/m^3 for those smaller than 1 cm; 4,000/m^3 for those of 1 - 1.5 cm; and 2,000/m^3 for those of 1.5 - 2.5 cm T L. Generally, hapa cages are used to rear fry longer than 1cm. These are made up of soft, knotless nylon material with a mesh size of 0.5 to 1.0 mm, in the diamensions of 1.2 m L, 0.6 m W and 0.8 m H. To protect the hapa cages from strong currents in the sea, fibreglass tanks without the bottom are used to enclose them. Survival from the 20th to the 60th day, when the fry attain about 3.5 cm is about 40%. Fry smaller than 1 cm are fed with naupli and preadults of *Artemia* and *Moina* at rates of 0.25 to 1.0 and 0.15/ ml respectively. From the size of 1 to 1.5 cm, they are fed with minced meat of trash fish and *Acetes*. This is done by using a "feeding cylinder", made of nylex and covered with a 3 mm mesh of knotless nylon. The minced food is smeared on the surface of the cylinder and the young ones can be seen pecking at the smeared food. After 1.5 cm the fry can accept minced trash fish alone; and they are fed to satiation three times a day, morning, late morning and late afternoon, at a rate of 8% of their body weight.

Since the Seabass is cannibalistic, the larger ones eating up the smaller, it is essential to grade them from the fry stage onwards into different size groups. This is effected by using plastic basins with circular perforations of the desired diameter at the bottom, for selecting the larger sizes and for leaving out the smaller ones. The fry are reared in this manner in hapa cages in the sea until they attain about 7 - 10 cm T L, when they are about 2 - 3 months old. At this stage they are ready for stocking in large meshed grow-out net cages, for commercial culture.

Commercial culture

Intensive commercial culture of the Seabass at Singapore is carried out at present only in net cages in the sea, confined to the Johore Straits, between Malayasia and Singapore, vide Fig. 1. As in 1986, there are four localities of farming, one in the northwest and three in the north - east. There are 64 farms, occupying a total area of 33 ha. The farming practices may be dealt with as follows:

Selection of sites

The site for net cage farming should favour the setting up and maintenance of the grow-out structures and the environmental conditions should be optimal for the survival and growth of the fish. Topographically, sheltered areas are the best, protected from strong winds and waves. Bays, estuaries, lagoons and inland seas are the ideal ones. The waves should not be more than a height of 0.5 to 1.0 m, because stronger waves are hazardous to the farming structures. In order to facilitate flow of water below the cage for removal of uneaten food, faeces and debris from below the net cages, the water depth should be atleast 2 m more than the height of the cages. If the latter is 2 - 3 m, the water depth should be atleast 5 m. Since strong water currents result not only in excessive strain to the farming

structures but also distort the nets and affect the growth of the fish stocked, the maximum speed of the currents should be ideally less than 0.5 m/ sec, and in any case should not exceed 1 m/ sec. In high turbidities, fouling organisms can grow well on nets and silt particles clog the gills and lead to suffocation for the fish. Hence, the water should be clear and the turbidity should be less than 5 mg/ l. For farming tropical fishes the suitable mean water temperatures are between 27 and 31°C, which is ideally available in Johore Straits. The dissolved oxygen should be preferably 5 ppm or more, but should not be less than 4 ppm; optimum salinity should be 26 - 31‰ ; pH should be 7.8 to 8.3; and Chemical Oxygen Demand should be 3 mg/ l or less. Areas of excessive phytoplankton growth have to be avoided, as also areas of heavy growth of fouling organisms like barnacles, tunicates, algae and worms. Besides, the farming area should be accessible from the shore.

Construction of rafts and floating net cages

The timbre used for rafts is derived from the tree, *Dryobalanops aromatica*. For suspending a net cage of 5 m x 5 m the logs selected are 7 m L, 0.10 m W and 0.07 m H. For fastening them, suitable bolts, nuts, nails, washers and brackets are used. The semi diagrammatic representation of such a single unit is presented in Fig. 4; and the lay out of a farm with 32 such raft units is shown in Fig. 5 A. For floats, plastic drums of 200

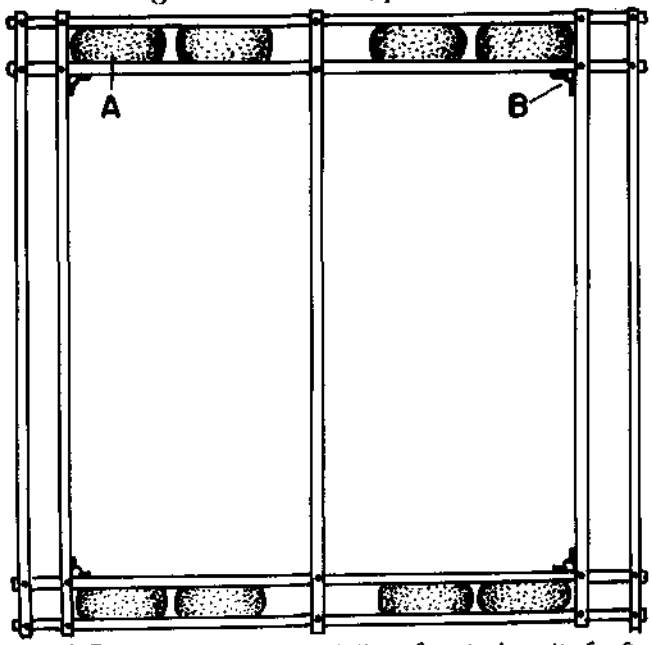


Fig. 4. Diagrammatic representation of a single unit of raft frame, with floats (A) and metal brackets (B).

capacity are used. The number of floats is so adjusted that there is atleast 70% of replacement of water; thus 400 drums for the farm shown in Fig. 5 A. The caps of the drums are sealed off with bitumen or fibreglass sealent; and, the drums as well as the logs are painted with antifouling paint, before assembling.

Net cages in Singapore are made of synthetic fibres such as polyamide (P A) and ployethylene (P E). The latter is cheaper, with a higher breaking strength and abrasion resistance than the former. Depending upon the sizes of Seabass stocked, three kinds of cages are used in intensive culture, viz, Hapa, Nursery and production cages. The first two are smaller than the third, measuring from 2 m L x 2 m W x 2 m H to 5 x 5 x 2 - 3 m H. The hapa are made of knotless netting, while the nursery and production cages are of knotted material. Depending upon the size of the fish to be stocked, meshes of the hapa range from 7 to 10 mm, while those of nurseries from 9 to 25 mm. Production net cages vary from 3 - 5 m L x 3 - 5 m W x 2 - 3 m H, with mesh sizes of 25 to 50 mm. They are either rectangular or square in shape. For setting a net cage, it is lowered in water within its raft frame, the main line is secured tightly to each corner of the raft and each bottom corner is fastened to the lower end of a pipe (Fig. 5 B) running through a metal bracket at each corner (Fig. 5 C) by a rope system. Anchors used for mooring are of the conventional type such as metal blocks or containers filled with concrete (Fig. 5 D). Photograph of part of a farm constructed is shown in Fig. 6.

Culture practices

Fingerlings of 7 to 10 cm T L are stocked in hapa, in the range of 100 - 150/ m^3 and reared there for about a month, till they attain the size of 12 - 15 cm T L, weighing 80 - 100 g. In hapa cages the fingerlings are supplied with chopped pieces of trash fishes about 0.3 to 0.7 cm in size, while in nursery cages the size of pieces can be about 1 cm and in production cages it can be upto about 2.5 cm. The rate of feeding in hapa and nurseries is 10% of body weight (B W), while in production cages it is 5 to 8% of B W. For fishes of 500 g weight or more, only a quantity of about 3% B W is needed. Feeding is done once or twice in a day, usually in the morning and/ or towards the evening, at slack tides to prevent food particles from being washed off. After 2 to 3 months, the stock measuring 15 - 20 cm T L and weighing

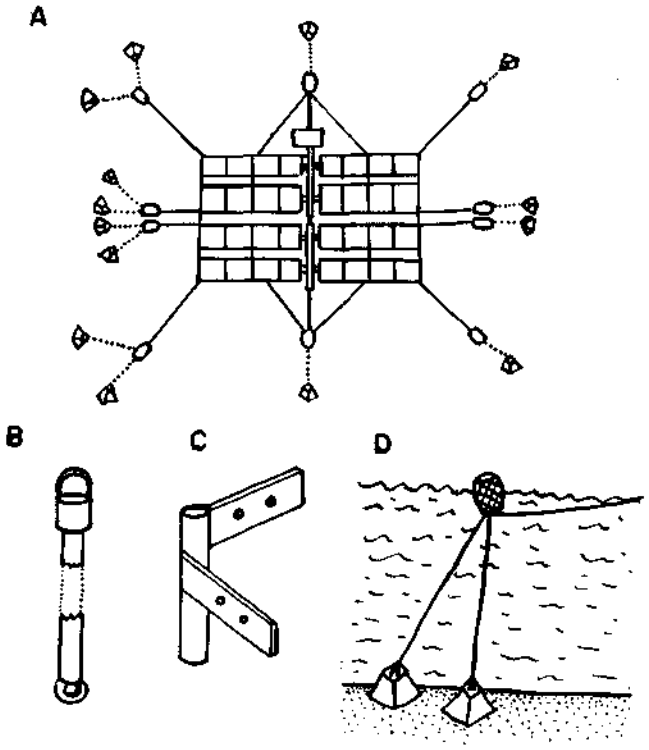


Fig. 5. Diagrammatic representation of some aspects of floating net cages. A. Lay out of a 32 raft units farm, B. Metal pipe used for securing the ropes of net cages at the corners, C. Metal bracket used at each corner for attaching the pipe, D. Mode of anchoring the raft system at each corner of the farm.

about 200 - 250 g is transferred from the Nursery cages in which the stocking density is 45 - 50/ m^2, into the production cages at a stocking density of 40/ m^2. In about 3 to 5 months time from stocking in the Production cages, the fishes grow to the marketable size of 30 - 40 cm T L and weight of 600 - 800 g. The Food Conversion Ratio is 4.5: 1. In some farms pelletted food made of fish meal, meat meal, soybean/ coconut meal, fish oil, vitamin and minerals with 70% protein, 3% fat, 20% binder, 5% micronutrients and 2% antibiotics has been under experimentation. The survival from the hapa stage till harvesting in the production cages is 90 - 95%.

Maintenance of farms

For proper maintenance of the net cages, floats and ropes, marine fouling is the main problem encountered at Singapore. The fouling organisms are mostly barnacles, tunicates and algae, rapid fouling being observed in areas of low tides. Since fouling reduces water circulation and add to the weight of the farm structures, the net cages, floats and ropes are changed once in two or three

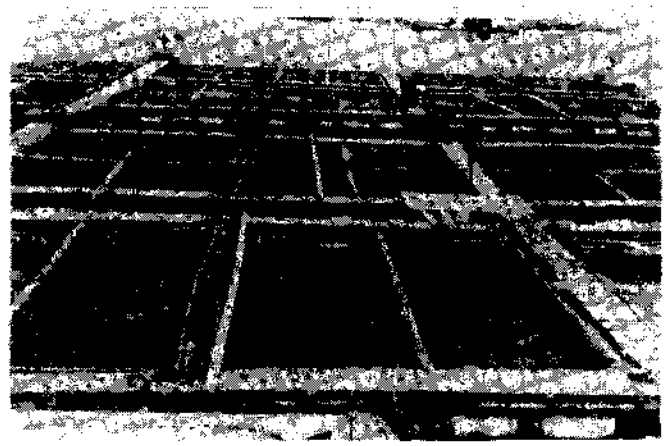


Fig. 6. Photograph of a part of the farm constructed by the Marine Aquaculture Section, PPD,Government of Singapore.

months, depending upon the intensity of fouling. The fouling organisms are scrapped off and the structures can be used again and again. With such maintenance of the farm structures, their life span has been observed to go up to a minimum of five years.

Diseases and therapy

At Singapore, two diseases are found to affect the cultured Seabass; (a) Loss of scales and skin of the head, due to infection by the protozoan, *Cryptocaryon irritans*; and (b) Vibriosis, leading to inflammation and haemorrhage of the affected area. The former is cured by keeping the fish in 220 ppm of formalin for half an hour to one hour. In the early stages of Vibriosis, the antibiotics Sulphonamide or Oxytetracycline is administered for seven days, at a rate of 0.5 g/ kg of food or even Chloromphenicol at a rate of 0.2 g/ kg for four days.

Production and economics

For harvesting, the net cages are hauled up and the fishes are caught by using large scoop nets. A Production cage of 5 m L x 5 m W x 3 m H has been yielding 600 kg, after 6 to 7 months of culture. A raft unit of 32 such cages, occupying an area of 5,000 m^2 has been yielding 19.2 tonnes per harvest and 38.4 t/ year. After taking into account the expenses, the net profit has been calculated to be a total of S $ 77,200/- per year (about Rs. 4,50,000/-).

Lessons for India

At present in India, the marine finfish species receiving priority attention for experimen-

tal culture and breeding in marine sector are the milkfish *Chanos chanos*, the mullets *Mugil cephalus*, *Liza macrolepis*, *Liza* spp. and the related ones, *Siganus*, *Etroplus* and the like. Although the Seabass is available in India and is esteemed much more than any of the fishes indicated above, adequate attention has not been paid so far on its propagation and culture, except efforts by the Central Marine Fisheries Research Institute and survey of the seeds and culture by All India Co-ordinated Project on Brackishwater Prawn and Fish Farming during the seventies. That this species could be successfully bred and cultured in Thailand, Singapore and Philippines leads one to ponder as to why it cannot be bred and cultured in India also. With knowledge on the induced breeding technique available, it is possible to develop induced breeding and seed production in India also. Hence, it is high time now that the Seabass is brought into the list of priority species in the marine sector in India, for breeding and culture. Besides, research projects, preferably pilot ones on this aspect may also be included in the priority areas of brackish water sector. Since there are good markets for the seeds of the Seabass in Philippiness and Singapore, it will be possible to export the seeds and to earn foreign exchange for the country. It is worthwhile in this regard for agencies like the Marine Products Export Development Authority to initiate seed production of the Seabass for export.

As per some publications, the Seabass breeds in the inshore sea along Muthupet coast in the southeast coast of India from October to December and it grows to an average size of 45.8 cm in the first year of its life. It is observed that for breeding purpose the fish has to migrate from Chilka Lake into the sea. In culture ponds it is known to attain 1.5 to 3 kg in the first year and 5 kg in the second year. The fish is also stated to breed in Chilka Lake and its growth in the first four years is 28.7, 49.2, 68.7 and 79.7 cm respecitvely. Also, it has been stated that it breeds in the mouth of estuaries along the southeast coast as well as that it breeds in the sea only. From these, it may be said that nothing definite is known at present on the breeding and biology of this species in India. Hence, it is an essential prerequisite to undertake a detailed study of the biology, breeding and migration of this fish in different parts of the country as well as a survey of the maturity and spawning in different ecosystems. With the knowledge available on the characteristic features of the eggs, larvae, postlarvae and fry of the Seabass from Thailand it should be possible to identify the various early developmental stages, for mapping up the spawning areas and seed resources centres in space and time.

For breeding and culture of organisms, one essential prerequisite is the availability of suitable centres and sites. When compared to the sheltered Johore Straits of Singapore, generally speaking, the Indian coastal waters are not sheltered but are exposed to strong winds, waves, currents and tidal conditions, either throughout the year or during certain seasons. Hence, for large scale culture of the Seabass in India, coastal ponds may be more suitable than coastal waters. Also, along the coastal areas of India there are ecological niches such as bays, lagoons and estuaries which may be suitable for the culture of the Seabass for varying periods of six months to one year in floating net cages. In areas where floating cage culture is not possible throughout the year, rearing upto fingerling stage may be carried out in coastal ponds during the unfavourable period and rearing for fattening may be carried out in floating production cages in the sea during the calm season of the year. Also, in localities which are not deep enough for floatation, pen enclosures may be more suitable. With these aims in mind, a survey of the coastal areas to locate sites suitable for pond, pen and net cage culture of the Seabass in space and time appears to be necessary.

The availability of trash fish such as sardines, silver bellies and sciaenids in order to feed the stocked material appears to be quite good in India at present. Besides this, it appears necessary to develop a balanced diet acceptable to various growth stages of the Seabass. Some amount of basic research seems to be essential to formulate a pelletted food and to prepare it on a large scale depending upon the need.

The authors are indebted to Dr. P. S. B. R. James, Director, Central Marine Fisheries Research Institute and to the Indian Council of Agricultural Research, for sponsoring them to the workshop. Grateful thanks are due to the PPD, Government of Singapore, NACA and IDRC, for affording the opportunity and for financial support. Also, sincere thanks are due to Dr. P. V. Rao, Scientist, CMFRI, for kindly going through the paper, offering comments and providing some literature.