Journal of Fisheries Sciences©
14 (5) 2023 01-11 • RESEARCH ARTICLE

Recent Advances in Coastal Finfish Aquaculture

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AUTHORS' CONTRIBUTION: (A) Study Design · (B) Data Collection . (C) Statistical Analysis · (D) Data Interpretation · (E) Manuscript Preparation · (F) Literature Search · No Fund Collection

ABSTRACT

With the introduction of the "blue revolution", aquaculture has become one of the most important growing sectors in the food production systems. Many new developments have been made and are implicated in the aquaculture industry, especially in the finfish department which contributes globally to around 42% of the total fish production. This chapter summarizes the recent advancements and improvements in the culture of four major coastal finfish species which are Asian sea bass (*Lates calcarifer*); milkfish (*Chanos chanos*); grey mullet (*Mugil cephalus*); pearl spot (*Etroplus suratensis*). It also gives an insight of how the fishes are cultured in captivity starting with brood stock development, captive maturation, spawning through hormonal administration, larval rearing and nursery and then grow out phase. With all these new developments in the culture techniques, the growth and survival rate of the fishes have increased to a much greater extent hence benefitting the aquaculture industry.

Keywords: Coastal aquaculture; *Lates calcarifer; Chanos chanos; Mugil cephalus; Etropus suratensis*

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Word count: 9,523 **Figures:** 00 **Tables:** 09 **References:** 20

Received: 17.03.2023, Manuscript No. IPFS-23-13597; **Editor assigned:** 20.03.2023, PreQC No. IPFS-23-13597 (PQ); **Reviewed:** 03.04.2023, QC No. IPFS-23-13597; **Revised:** 17.05.2023, Manuscript No. IPFS-23-13597 (R); **Published:** 25.05.2023

INTRODUCTION

The increasing demand of fish and decline of capture fishes from wild has promoted the growth of aquaculture globally. Aquaculture contributes around 42% of the total fish production and is mostly dominated by Asian countries. It has been a major growth sector in the business market in past 10 years due to the development of various technologies, species diversification and marketing networks. The importance of coastal aquaculture that can feed a village, increase economy and have a proper utilization of water resources has been well-established. In India, coastal aquaculture is an old practice of traditional culture systems in West Bengal, Goa, Kerala, Tamil Nadu, Karnataka and Orissa. Many fishes are being cultivated in brackish water farm due to demand and consumer preference which include sea bass (*Lates calcarifer*); grey mullet (*Mugil Cephalus*); milkfish (*Chanos chanos*); pearlspot (*Etroplus suratensis*) [1-5].

Recent advances and developments have been made and are implicated in coastal finfish aquaculture. Two of the major requirements for development and expansion of aquaculture is seed production and feed. Various seed production technology has been introduced based on the characteristics and requirement of the species. The technology includes brood stock development, induced maturation, spawning through hormone administration, feed and water quality management [6,7].

Asian sea bass

Asian sea bass (*Lates calcarifer*), also known as the bhetki or barramundi in India and other parts of Asia and as 'giant seaperch' in Australia, is a Euryhaline and Eurythermal fish which inhabits both freshwater and brackish water. This species has made its name in the field of aquaculture due to its taste and quality of flesh: For which it is recognized as a highly suitable culture species in ponds and cages. Sea bass can be easily identified through its body shape type with elongated, compressed body and a pointed head; its scales are ctenoid, large have a greenish silver colour similar to the body of the fish. Sea bass spends their developing stages in shallow water bodies like fresh water, back water and estuaries and then migrate to the sea for maturation and spawning. Sea bass are protandrous hermaphrodite which means they change gender from male to female. They become sexually matured males at the age of three to four years of age; males then become female from five to six years of age and grow in length up to 80 cm. The sea bass culture technique was first developed by Thailand in the year 1970's. Other than Thailand, it is also cultivated in Australia, Hong Kong, Singapore and most of the south-east Asian countries in both brackish water and freshwater ponds and cages in the coastal waters. In India, mostly in the Bengal region the Sea bass are cultivated in ponds, bheries, paddy fields and canals. The following article tells about the recent trends and techniques which have been implemented in the Asian sea bass (*Lates calcarifer*) culture [8-10].

Farming practices

In most countries, sea bass are cultivated either in ponds or net cages. In ponds it is cultivated either in brackish water or freshwater ponds. While for the latter, stationary or floating net cages are used in coastal waters.

One of the major problems for culturing sea bass is cannibalism, which can be seen from larval rearing up to juvenile stages.

Brood stock development

The first step to the culture of sea bass is seed production which is accomplished through brood stock development. Two common sources of brood stock are wild caught adults and those from ponds and cages (2-5 years of age). It is more preferable to use ponds or cage reared brood stock as it is already used to the culture conditions and will be easier to develop them into brood fish. Although in the absence of 2-3 years of cultured stock, wild caught adults are used. Once they are caught, they are allowed to acclimatize under cage or pond conditions for a period of six months after which they are ready to be used as spawners [11-15].

Brood stock maintenance

There are certain parameters and conditions for the maintenance of brood stock.

Water quality management: There should water exchange of about 70%-80% daily other than some physiochemical parameters are to be followed Table 1.

Tab. 1. Physiochemical parameters for brood stock maintenance.

Physiochemical parameters for brood stock maintenance.	
Temperature	28°C-32°C
Salinity	29-32 ppt
Alkalinity	80-120 ppm
pH	6.8-8.0
Dissolved oxygen	Above 5 ppm
Phosphate	Less than 10 ppm
Unionized ammonia	Less than 5 ppm

Feed management: Trash fish such as sardines/tilapia are used as feed for brood stock development stages. Uneaten foods are removed from the tanks to prevent water pollution.

Health management: Caligus sp., Lernanthropus sp. are some common parasites found in sea bass. *Diplectanum latesi* is one of the most problematic parasites during the broodstock maintenance. Treatments with 100 ppm formalin and 1 ppm organophosphorus pesticide dichlorovos is said to be effective against such parasites.

Materials and Methods

Captive maturation and spawning

The criteria to select adult fish as brood fish are based on:

- Size, weight and body shape.
- Absence of injuries, infections and parasites.
- Fast swimmers and should respond quickly to feeds.
- No abnormalities.

Asian sea bass (*Lates calcarifer*) are breed in two ways: natural spawning under controlled conditions and induced spawning through exogenous hormone administration.

Natural spawning

Natural spawning is done by changing some parameters like pH, temperature, salinity which will stimulate the maturation process and create an environment to that of the Marine environment. To maintain a stable condition, seawater is pumped into the maturation tank and is recycled through biological and pressure sand filters. Through this process spawning can occur throughout the year, it has paved a way for the development of seed under controlled conditions throughout the year.

Induced spawning through hormone injection

The development of induced spawning of sea bass in captivity through hormonal administration was made in the year 1987. In many cases fish breeding through hormonal techniques are based on intramuscular and intraperitoneal injection.

The most common hormone used is the crude extract of pituitary gland of mature fishes like salmon and carp. In a review article by Celia A. Hoga, he has mentioned all the hormones which are currently being used for spawning of different fish species. Many large hormones such as Gonadotropin releasing hormone (Gnrh) which is extracted from both mammals and salmons, LHRHa (Luteinizing Hormone Releasing Hormone analogue), Gonadotropin Releasing Hormone analogs (GnRHa), Human Gonadotropin (GtHs), dopamine antagonists such as pimozide, domperidone, metoclopramide and reserpine and synthetic hormones similar to gonadotropins (Ovopel) have been tested in several species to induce or block sexual maturation. The brood fish are stocked in pre spawning tank for two months and the females are checked twice in a month for ovarian maturity. Hormonal treatments won't work unless the female eggs reach the vitellogenic (or post-vitellogenic) stage. To check if it has reached vitellogenic stage, ovarian biopsies is performed with a polyethylene cannula and the diameter of the egg is performed. The female is ready for hormone injection if it has a diameter of 0.4-0.5 mm. For males, milt will ooze if the abdomen is pressed gently. Before injection, spawners are weighed and hormone dosage requirement is compute. According to Garcia the median effective dose of female mature sea bass is 24.7 ug LHRHa/kg. This single dose is effective to trigger all the possible spawning occurrences in sea bass. Though many countries follow a standard dosage level of LHRHa which is 60-70 ug/kg body weight for Females and 30-35 ug/kg body weight for males. The hormone is injected intramuscularly in the early hours of the day. Gender ratio between female and male is 1:2, spawning takes place after 30-36 hrs. Post hormonal injection. Spawning normally takes place in the evening hours, to achieve better spawning and fertilization, new moon or full moon days are preferable. The fertilized eggs float on the surface while unfertilized opaque eggs sink to the bottom [16-20].

Egg collection and hatching

The floating eggs whose average diameter is about 0.75 mm are collected through scoop method by using a suitable mesh size cloth. The eggs are collected and stocked at 80-100 no. eggs/L in Incubation tank where they are hatched after 17-18 hrs of fertilization while the unfertilized eggs which were settled to the bottom were removed by siphoning.

Larval rearing and feed management

Larval rearing of sea bass is usually done through two processes: Intensive culture and extensive culture techniques. In most parts of Asia, intensive culture techniques are performed where the larvae are cultured in a controlled environment. The live feeds which are fed to the larvae are also cultured under controlled conditions. While in extensive culture techniques, the larvae are cultured in an uncontrolled environment (ponds). Although extensive culture techniques is not that much performed as there is little authority over certain parameters such as water quality, disease, density and feed. Healthy hatched larvae measure 1.4-1.6 mm in length and are transferred to larval rearing tank. Larval rearing tanks can be circular or rectangular, although circular tanks are more preferred as the latter has a difficulty in removing the siphoning dirt which is formed around the corners. These tanks are equipped with roofs that protect larvae from direct sunlight. Larval phase of Sea bass extends up to 21 days and during this time period there is variation in feed requirements, type and quantity of feed. At the initial, larvae are stocked at a density of 40-50 nos/L which reduces depending on the age and size of the larvae.

On the tenth day, the density is 20-25 nos/L, which is then reduced and maintained at 10-15 nos/L after the fifteenth day. For the first three days, larvae are not fed anything as they obtain nutrients from yolk sac. Unicellular green algae such as *Chlorella* sp., *Tetraselmis* sp., *Nannochloropsis sp.* or *Isochrysis* sp. are added to the larval rearing tanks for maintaining Water quality and are also fed to live feeds (zooplanktons) such as rotifers.

All feeds have criteria that must be met such as:

- The feed should be of adequate density so that the larvae can easily find the food without extensive searching.
- Should be of a size that can be easily ingested.
- Should evoke a feeding response.

Sea bass larvae feed on rotifers (*Brachionus plicatilis* or *B. rotundiformis*) during the early stages of larvae development. Up to day 7 rotifers are given as feed with size smaller than 120 um after which assorted sized rotifers are given. From Day 9 to Day 21, brine shrimp *Artemia franciscana* in the naupli stage is given as feed to the larvae.

The density of rotifers in the larval rearing tank from 3rd day to 12th day is 3-5/ml while the density of brine shrimp nauplii (*Artemia*) in the tank from day 10th to day 23rd is 2-3 ml. As the larvae develops, they ingest bigger particles, they are fed sub adult or adult *Artemia* biomass at 1 ind/ml or higher. All the feeds are given in 4 doses at an interval of 6 hrs. Other live feed such as freshwater cladocerans (*Moina macrocopa*) are also used to feed sea bass larvae.

The production of high quality fish is restrained due to the inadequate nutritional supply of live feeds such as rotifers and artemia. In an article written by copepod (*Cyclopina kasignete*). Was supplemented to sea bass larvae in combination with *Rotifers* and *Artemia*. It was found out that the larvae preferred copepods rather than rotifers and artemia and it also resulted in better growth, survival and increased content of essential fatty acids which is required for a high quality fish. This study paved the way for copepods to be used as live feed for sea bass larvae. Although there's a disadvantage as mass production of copepod in captivity is very low. Other than copepods, protozoa can be the potential candidate to be used as live feed during the first feeding stages due to its varying morphological characteristics though it has to be scientifically proven.

Water management during larval rearing

30%-40% of water exchange is done daily during the larval rearing phase to maintain water quality in the tank. Algal water is added daily up to 15th day, other than that temperature should be maintained between 27°C-29°C with salinity around 30 ppt. Starting from 5th day, Daily morning the rearing tank should be siphoned off with feces and debris that are accumulated in the bottom and corners.

Nursery rearing

By 20th day the larvae will metamorphose into fry and have a size of 1.0-2.5 cm. The larvae are then transferred into nursery rearing tanks or ponds. Nursery rearing is the period between hatchery and grows out system. Nursery rearing takes place for a period of 30-45 days after which they are stocked in grow out systems. In hatchery nursery rearing is done in cement tanks, in hapa ponds, nursery ponds etc. There are certain conditions which have to be followed during this period like grading of larvae is done every week to avoid cannibalism and better survival rate. The fry can be stocked in higher densities in Nursery tanks and ponds, stock able size which is about 5-10 gm. One of the major problems during nursery rearing is cannibalism, CIBA, Chennai has given a study on why grading is important to avoid cannibalism and also frequent feeding should be given for better growth and survival.

Nursery rearing in hatcheries

In hatcheries, sea bass fry are stocked either in circular or rectangular nursery tank at a density of 5-10 ton capacity. Mostly outdoor tanks are preferred. The tank should be equipped with inlet and outlet pipes for water exchange. Along with this it should have an *in situ* biological filter for maintenance of water quality, aeration facility, etc. these tanks are prepared one week prior to stocking of fry.

After stocking, these frys are fed with adult artemia biomass as they were already inclined to it during the larval rearing stage. In combination with artemia, supplementary feed mainly moina, minced fish and shrimp meat is also given.

Feeding rate should be 100% by giving feed daily 3-4 times a day after which it should be reduced by one week to 80%, 60%, 40% and then 20% in the fifth week. Water exchange should be up to 70%. After 4 to 5 weeks the size of the seed will be 4-6 cm weighing 1.5-3 kg.

According to achieve seeds with survival rate of 80%, the stocking density should be 1,000 nos/m^3. Although in most countries, nursery rearing in tanks is not done due to the accumulation of feeds in the bottom of the tank which might lead to bacterial infection and frequent injuries caused by constant contact with tank walls.

Nursery rearing in ponds

Nursery rearing of sea bass is done in either freshwater or brackish water ponds. Before stocking, the fry must acclimatize to the salinity and temperature of the pond to prevent loss. Sea bass should be stocked at a density of 20-30 nos/m^2 in the early hour of the day. Here also, the sea bass fry feed on artemia biomass. In an experiment performed by Dr. I Daet on nursery rearing pond, he found out that the growth of sea bass with respect to its feed greatly affects its growth and survival rate besides that he also found out that through lower stocking density, lower feed competition and higher weight gain in sea bass could be achieved. This would also prevent cannibalism to a great extent.

Nursery rearing in cages/hapas

Nursery rearing of sea bass fry in cages is one of the most commonly practiced methods in every country. It is very easy to manage and is also cost effective. Natural condition for the fry is maintained through water flow at the cage site.

Uneaten food and other metabolites are washed away through the flow of water. Mostly floating net cages are used where the cages have a mesh size of 1 mm made with polyethylene/nylon webbings and are afloat with cylindrical plastic containers or barrels or Styrofoam. The cage is stabilized by zinc placed pipe anchored to the bottom. It is suggested to use Galvanized Iron (GI) pipes rather than high density polyethylene pipes for floating net cages. To avoid cannibalism, the sea bass fry is graded every 15 days. Along with that the net cages are checked for damage caused by other animal such as crab. The net cages are also cleaned every day to remove any suspended particles or fouling activities present in the cage. The feeding technique is similar to that followed in the tank. In a study by Fermin AC, Ma EC, Bolivar, Gaitan A. They suggested the use of illuminated floating net cages for nursery rearing of sea bass fry as they found that through artificial illumination, natural zooplanktons were attracted to the cage which served as natural food for the fish. They also added that this technique might prove to be cost effective in the future.

After the nursery phase (30-45 days), the fry have a weight of 5-10 gm, they are then ready for transfer into grow out ponds.

Grow out

During the grow out stage, sea bass are reared from juvenile size to marketable size (300-400 g), the culture period may vary from 3-4 months. The grow out stage may carry out either in ponds or cages. In an experiment performed by Venkatachalam, Kandasamy, Krishnamoorthy, Narayanasamy, he suggested the use of integrated mangrove for the culture of lates calcarifer Asian sea bass as the survival rate and growth of sea bass under integrated mangrove was higher than open aquaculture systems. Also the salinity and water quality under IMAS (Integrated Mangrove Aquaculture System) was favorable to the fish. This system could be applied in the future for higher production of sea bass.

Cage culture

Fish culture in cages has been identified as one of the eco-friendly intensive culture for increasing fish production. The cage culture can be practiced in open sea and coastal waters. According to Kungvankij, there are criteria for site selection of cage culture:

- Should be installed in lagoons, protected bays, inland sea and sheltered coves.
- Should be installed in an area where tidal fluctuation is not that strong.
- Avoiding bio-fouler and other environmental hazards.
- Salinity range (13-30 ppt).

The cage culture system has many advantages such as high stocking densities which assure high survival rate, eco-friendly and natural with low capital investment. The design of the cage may be square or rectangular depending upon the culturist with size of 20-100 m². As discussed above in the nursery rearing stage, the cages are made of polyethylene/nylon webbings with mesh size of 2-8 cm depending on the size of the fish. In general, there are two types of cages which are used: Floating cages and fixed cages.

Floating cages

In this system, the net cages are attached to a wooden, Galvanized iron pipe or bamboo frames and kept afloat with the help of plastic cylindrical containers or barrels. The corners of the cages are anchored to the bottom with the help of attached concrete weights. These floating net cages have a depth of 2-3 m, with 1.5-2.5 m immersed in water.

Stationary cages

The net cages are tied to a wooden or bamboo poles installed at the four corners. These cages are usually installed in shallow bays.

Stocking densities in these cages is 40-50 fish per m², which is reduced to 10-20 fish per m² when the size of the fish is 150-200 g. The culturist must have spare cages for grading of fish according to their size to avoid cannibalism. These cages are checked regularly for any damages or leaks caused by other fishes. Also unwanted substances which are accumulated in the cages are removed.

Feed management in cages

The feed used are extruded pellets and chopped trash fish as per the availability and cost. Floating pellets are most used as it can be easily fed to the fish. It is usually given twice daily, one in the morning and other in the afternoon. The feeding rate of 8-10% is given for fish with weight less than 100 g, 5% for fish more than 100-600 g and so on. The feeding rate decreases as the weight of the fish increase. Philipose KK, has recommended the use of oil sardines as feed which has given him higher growth and survival rates when compared to earlier studies.

Pond culture

Sea bass culture in ponds is an extensive type of culture which is implicated as polyculture or monoculture. In polyculture, two or more fish's species are produced while in monoculture only a single species is produced. In polyculture, forage fish such as Tilapia are grown in combination with sea bass. Forage fish should be such that it depends on natural food and does not compete with the main species in terms of feeding habits. Kungvankij recommends physiochemical parameters which have to be followed in culturing of sea bass in ponds (Table 2).

Tab. 2. Physiochemical parameters for culture of *Lates calcarifer* in ponds.

Physiochemical parameters and values	
pH	7.5-8.5
Dissolved oxygen	4-9 ppm
Salinity	10-30 ppt
Temperature	26-32°C
Ammonia	Less than 1 ppm
Turbidity	Less than 10 ppm

The design of the pond is mostly rectangular in shape, with area ranging from 800 m² to 2 hectares. Depth of the pond should be about 1-2 m. Each pond is equipped with an inlet and outlet gate to provide water exchange. Pond bottom is flat and slopes toward the drainage gate (outlet). In polyculture system, during pond preparation organic fertilizer (chicken manure) is applied to the pond and then the water level is gradually increased to grow natural food.

Stocking densities of sea bass juveniles varies in both polyculture and monoculture system. The stocking density in the former is 3000-5000 per ha while in the latter is 10,000-20,000 per ha. Before stocking, the juveniles are first acclimatized to pond conditions.

Water exchange is done daily in monoculture system while in polyculture 50% of water replacement is done once in three days (to maintain natural food in the pond).

The feeding regime in monoculture system is the same as that of the cage culture, while in polyculture system, supplementary feed is not required as sea bass juveniles feed on forage fish like Tilapia, milkfish, groupers, etc. this might reduce the dependency of farmers on trash fish.

Asian sea bass (*Lates calcarifer*) is one of the important species for finfish farming in many countries. The developments made by various scientists and agencies has led to the increase in growth and survival rate of the fish and too much extent has reduced cannibalism which is one of the major issues faced by aquaculture industry in sea bass culture.

Milkfish (*Chanos chanos*)

Milkfish (*Chanos chanos*) is the only species which belong to the family Chanidae with a wide distribution in the tropical and sub-tropical regions of the Pacific and Indian Ocean. It is an herbivorous, euryhaline, hardy, fast growing and disease resistant fish which contribute significantly to overall aquaculture production in Asia. They feed on planktons, benthic algae and plant detritus under natural conditions and also accept pelleted feed under culture conditions. It can attain a size of 400-500 gm in 5-6 months under culture conditions. Milkfish (*Chanos chanos*) is one of the most fundamental aquaculture species in many countries such as Philippines, Indonesia and Taiwan with culture practices originating about 700 years ago in Indonesia. In India, the popularity of culturing milkfish is increasing especially in Tamil Nadu and Kerala where they are cultured either in monoculture or polyculture system. Many characteristics of milkfish make it a suitable fish for cultivation in brackiswater ponds, oceanic waters as well as hyper saline Lagoons.

Collection of fry

Milkfish fry can be obtained either from coastal areas or littoral areas. It can also be produced in captivity. However, the supply of fry in the recent years is decreasing due to habitat degradation, high deemed of seeds, etc. The demand for milkfish fry has stimulated studies on mass fry production to eventually breakthrough the dependence on the natural seed supply.

Fry from captive brood stock and spawners

Lacanilao and Marte reported that successful development of milkfish brood stock began in 1980 with spontaneous maturation of 5 year old milkfish in floating net cages. To develop broodstock, milkfish juveniles are stocked and fed in floating net cages or concrete tanks or ponds until they reach sexual maturity. The brood stock reach maturity in 5 years when grown in floating net cages and 8-9 years when grown in ponds or concrete tanks.

Fry from wild

In India, the wild seeds are collected during the month of March-June and November-December (breeding season of Milkfish) from the coasts of Tamil Nadu, Kerala and Andhra Pradesh. The equipments used to collect milkfish fry from the wild include different types of nets where fry concentration is more.

Villaluz and Lee described various fishing mechanisms used for capturing fry which includes:

- Fry barriers or fences which are fixed structures that lead the fry into a concentrated area depending on the desirable condition of the wind and currents.
- Filter bags which are nets that capture the fry as they pass through a course of water.
- Seine, scoop and drag nets are also used which surround the fry and conduct them into a small area.

Following collection, the milkfish fry must be separated from other fishes. The separation is done by identifying fry with three black spots (two black spots on the head and another on the center of the fish body) and well-defined movements. The fry is then acclimatized to the pond condition by diluting the sea water in the container (in which they are transported to ponds or tanks) up to ten parts of fresh water.

Spawning

In the brood stock cages or tank, the stocking density should not exceed more than 1 kg/m³. Adult milkfish naturally mature during the spawning season when they are 4-5 years old and weigh around 3 kg or more. Maturation can also be induced artificially through administration of exogenous hormones like Luteinizing Hormone Releasing Hormone (LHRH-a), fish pituitary gonadotropin (salmon pituitary homogenate and carp pituitary homogenate), Human Chorionic Gonadotropins (HCGs) and gonadal steroids (estradiol 17-β and 17 α-methyltestosterone) or through environmental manipulation like change in salinity, pH, temperature and photoperiod etc. Lee and his colleagues in a path breaking experiment found out that a combination of LHRH-a cholesterol pellets and 17α- Methyl Testosterone (17α-

MT) capsules effectively stimulated maturation of milkfish and induced them to spawn under captivity. Hormone therapy can be administered in the form of food, pellet, implants, intramuscular and intraperitoneal injections. The required dosage of hormone should be 200 µg/kg for a better fertilization rate. Spontaneous spawning without hormone treatment has also been achieved in captive brood stock in floating net cages in Philippines. In 2015, ICAR-CIBA, Chennai had first time successfully achieved induced breeding in milkfish. The brood stock of milkfish were maintained in a cement tank for more than 8 or 9 years. After several numbers of hormone treatment, they successfully achieved gonadal maturity and spawning. The fertilized egg diameter was 1.23 mm and the size of the hatched larvae was 3.4 mm.

Ako and his colleagues studied the physical and chemical difference of milkfish (*Chanos chanos*) eggs from naturally and induced spawns and found out that the fatty acid concentration, essential amino acid concentration and the egg diameter was significantly high in naturally spawned eggs while the number of eggs per spawning was more in case of induced spawned eggs (Ako, Tamaru, Lee, chemical and physical difference in milkfish (*Chanos chanos*) eggs from naturally and hormonally induced spawn, 1994).

The milkfish spawn 48 hrs after hormone therapy. There are certain parameters to be followed in the breeding tanks or ponds which include Ya, Villaluz, Soriano and Santos (Table 3).

Tab. 3. Parameters to be followed in breeding tanks for milkfish (*Chanos chanos*).

Parameters	Units
Salinity	More than 32 ppt
Temperature	26°C-34.5°C
Dissolved oxygen	5 mg/l
Un-ionized ammonia	Less than 0.05 mg/l

After collection from tanks and cages, the eggs are kept in a 400 liter fiberglass tank with mildly aerated seawater of salinity (28-34 ppt) and temperature (28°C-30°C). The milkfish eggs have a diameter of 1.1-1.2 mm.

Larval rearing

The larvae are stocked in a larval rearing tank post hatching at a density of 30 nos/l. For the first three days, the larvae obtain nutrients from the yolk then they are fed with rotifers (*Branchionus plicatilis*) on day 4th. The rotifers are cultured in *Chlorella* sp. According to few reports, application of *Isochrysis galbana* and *Tetraselmis chuii* have shown improved survival rate in milkfish larvae. After day 15th post hatch, newly hatched artemia nauplii is introduced along with rotifers as feed for the milkfish larvae. Gapasin and duray suggested the use of rotifers and artemia with enriched DHA diets that gave him increased growth and survival rate during the nursery stage and also reduced the risk of opercular deformities. Certain parameters has to be followed in the larval rearing tanks (Table 4).

Tab. 4. Parameters for larval rearing of milkfish (*Chanos chanos*).

Parameters	Units
Temperature	25.6-31°C
Salinity	32-35 ppt
Dissolved oxygen	5.5 ppm

Nursery rearing

In many countries like Philippines and Indonesia, shallow water culture is practiced for the nursery rearing of milkfish fry. The fry are grown in brackish water ponds where benthic algae growth is triggered through organic or inorganic fertilization. The milkfish then grazes on the benthic algae. If the algal level depletes, then the supplementary feed is also provided. In shallow water culture system, the ponds usually have a depth of 30-40 cm.

Another practice which is also being used is the deep water culture that was developed in the mid 1970's in response to the declining profit from shallow water culture. The deep water culture practice provide a more stable environment and can extend to the grow out phase during the winter season. Deep water ponds usually have a depth of 2-3 m. The productivity of deep water farming is three times more than the traditional methods followed.

The nursery rearing is done for both fingerlings caught from wild and those which are hatchery bred. Mostly, bio flock based system is preferred for wild milkfish fry as it is economically viable and more profitable than other culture methods which resulted in the preferred size of the fingerlings after 30 days with survival rate of 80%. Before stocking, nursery pond preparation must be carried out which include pond draining, drying, soil sealing, pond bottom and bund repair, predator eradication, liming, tilling and letting freshwater in. After preparation, the pond is fertilized with organic/inorganic fertilizer. Once algal bloom develops, more saline water is added to the pond. After a period of 3-7 days, a complex of blue green algae, diatom, bacteria, nematode worms develop at the bottom of the pond called "Lab-Lab". These algae serve as food for the milkfish fry during the nursery phase.

The milkfish fry are then stocked at a density of 20-30 no/m² in the nursery pond and then fed with "Lab-Lab". Urea and chicken manure should be used to apply in the nursery pond in contrast to soil and chicken manure to maintain the continuous growth of natural food "Lab- Lab". A study was performed by Soomro, et al., to compare the growth rate and survival rate when fry was grown in combination with soil and chicken manure, followed by urea and chicken manure and commercial pellet food which served as control. They found out that the growth rate was similar in UC and SC though higher size distribution frequency was achieved in SC (soil and chicken manure), while the number of surviving fishes was more in case of UC (Urea and chicken manure) thus paving the way for the use of urea and chicken manure. Along with natural food (Lab-Lab), rice bran, corn barn, pea (*pisum sativum*) feed or formulated feed can also be provided. Once the milkfish fry grow upto the size of 5-8 cm, they are transferred to ponds or pen for grow out culture where they reach the marketable size.

Grow out

Milkfish fingerlings can be grown in different brackish water culture systems in 6-12 months to reach the marketable size:

Pen culture: First pen culture of milkfish was developed in Philippines in the year 1979. Pen culture is practiced in both freshwater and brackish water ponds.

In this system, the fish along with planktons (Lab-lab or Lumut), also feeds on forage at the bottom. If necessary, supplementary feed is also given. The stocking density should be 30,000-40,000 nos/ha. Within 4-5 months, the fish reaches harvest size of 250-275 g with survival rate of 80%.

Cage culture: It is a sustainable and environment friendly approach to increase fish production. Sea cages can be situated in areas away from coral reefs and mangroves with proper mooring systems. Besides having higher productivity and environment friendly, sea cage farming can also be situated near the market area. The stocking density should be 5-30 fingerlings/m³. Unlike pen and pond culture, here supplementary floating feed (27%-31% crude protein) should be given. For sites with strong winds and waves, sinking pellets can be used. Recent development is the intensive culture of milkfish in Floating net cages where the stocking density is 100/m³ which resulted in productivity of 24 k/m³ after 5-6 months.

Pond culture

Polyculture: In this system, the milkfish is reared along with mud crabs, shrimps, molluscs, seaweeds, sea bass, rabbit fish, Tilapia and many other fish species. Polyculture system is practiced in many countries where it has increased the productivity of the fish. Polyculture with shrimps and crab is more popular and profitable as they benefit each other in terms of habitat and feed requirements. Compared survival rate and growth of milkfish when grown in polyculture with tiger shrimp (Penaeus monodon) and monoculture in pond. They found that survival rate and net aggregate production was significantly high in polyculture system with Tiger shrimp than monoculture, thus suggesting the use of polyculture for better production. Polyculture of milkfish is also done with white Indian shrimp (Penaeus indicus) which is ecologically and economically beneficial for the fish farmers. Suggested that stocking density should be used for polyculture of milkfish with mud crab (Syclla serrata) for better production, survival rate and also for good feed conversion rate. The stocking density suggested for milkfish: 2500/ha; Crab: 5000/ha. It was also reported that milkfish may have a direct or indirect role towards increasing the natural food amount for crabs and avoid cannibalism in them.

Monoculture: In this system, artificial feed (floating pellets) is provided along with natural food to gain high production in a short period of time. The preferred stocking density by should be 300/ha which will result in better survival, feed conversion and production rate with very less mortalities.

Extensive traditional farming: The traditional ponds have a water depth of 40-60 cm where the stocking density preferred is 1000-15000 fingerlings/acre. In this system, no artificial feed is required as the fish solely depend on natural food (Lab-Lab and lumut). Fish farming done with Lab-Lab feed can produce a final harvest of 1.5-2.5 tons/hectare/year while with Lumut feeding yields only 500-600 kg/ha/year.

Intensive farming: In this system, the stocking density is increased with higher feed input. Final harvest of 12-15 ton/ha/year can be achieved after 6-8 months of culture.

Integrated Multi trophic Aquaculture system (IMTA): This system can also be defined as fed aquaculture where fish is grown with seaweed or shellfish aquaculture. Applying IMTA will not only reduce the coastal pollution but will also increase the aquaculture productivity. Many trials with seaweeds (Gracilaria bailinae and Kappaphycus alvarezii), sea cucumber have been investigated in the past.

Milkfish (*Chanos chanos*) is one of the most ideal fish for farming due to its wide characteristics. In the recent years, numerous progresses have been made for the mass propagation, seed production of milkfish fry by research institutes, private hatcheries and government agencies. In countries like Philippines, Indonesia, Taiwan the milkfish fry is obtained from hatcheries instead of relying on wild caught fry. In 2015, CIBA-Chennai Achieved induced breeding in milkfish for first time which paved the way for seed production of milkfish in India.

Grey mullet (*Mugil cephalus*)

Flathead grey mullet (*Mugil Cephalus*) is a catadromous (move into the sea to breed) and euryhaline fish which belongs to the family Mugilidae. It has a very wide distribution and contributes significantly to the economy of Southeast Asian countries. It is often found in Estuaries and Freshwater environment. Adults are found in water with salinity ranging from 0-75% while Juveniles can tolerate wide range of salinities. It is an omnivorous fish which grazes on plant detritus and micro flora at lower trophic level and is a suitable candidate for mono and polyculture. It is also one of the most important species for aquaculture due to its highly valuable roe which is also called as "grey gold". Flathead grey mullet contributed to around 36.2% of the total aquaculture production in the world.

In India, *M. cephalus* is reared in polyculture with seeds collected from the wild, while the intensive monoculture of this species is yet to be developed.

Results and Discussion

Culturing practices

Brood stock maturation: The brooders of flathead grey mullet can be procured during the early stages of fish from the wild or from those raised under captive conditions. After obtaining they are transported to holding tanks in barrels or drums using 2- phenoxyethanol (2 mL/10 L water) as anaesthesia with dosage concentration of 300 mg l^{-1}.

Certain conditions and parameters have to be followed for brood stock maturation (Table 5).

Tab. 5. Parameters for brood stock management of *Mugil cephalus*.

Parameters for brood stock management	
Salinity	30 ppt
Temperature	22.7°C
Oxygen	6 mg/l
pH	7.8

Spawning

Natural spawning of grey mullet in captivity does not occur very often, therefore most of the farmers rely on induced spawning through hormone administration. There have been many developments for induced spawning using different hormones such as:

- Use of Carp Pituitary Homogenate (CPH) dosage level of 20 mg/kg followed after 24 hrs with LHRH-a (Luteinizing Hormone-Releasing Hormone) dosage level of 200 ug/kg. This is most cost effective method to induce spawning in female grey mullet.

- Use of Salmon Pituitary Gonadotropin (SG-G100), HCG (Human Chorionic Gonadotropin) which provides a readymade source of Gonadotropin. The use of which has been well described by Kuo, Nash, Shehadeh.

- Use of combined treatment of dopamine D_2 receptor antagonist and gonadotropin releasing hormone which has more potential to induce maturation and spawning in mullet.

Males are administered with 17-α-methyl-testosterone with dose level of 10 mg. Fertilization occurs in a small fibre-glass tank where the gender ratio of male to female is 3-2:1. After fertilization, eggs are produced at a rate of 600-850/g female body weight with diameter ranging between 880-980 u. The eggs are then collected and transferred to Incubation jars where the temperature is maintained at 22°C-24°C.

Larval rearing

Hatching takes place after 50-60 hrs of fertilization after which the larvae are transferred to indoor tanks with continuous water circulation and aeration. Larval rearing phase is most important for the survivability and development of mullet for which proper tank, stocking density and light control should be administered. According to a study by Nash for better survivability of larvae, a large kriesel tank should be used where stocking density should be 10,000 larvae with artificial light control. During larval rearing phase, for the first three days the larvae obtain nutrients from yolk, after which they are fed with rotifers and artemia. One of the major requirements of live feed used in aquaculture industry is high amount of fatty acid. *Rotifers* and *Artemia* contain inadequate amount of Fatty acid so in order to obtain the desired amount, many studies have been performed and are implicated to accomplish the fatty acid requirements. One such study performed by Tamaru wherein he cultured rotifer *Brachionus plicatilis* in combination with baker's yeast and *Nannochloropsis* oculate and after feeding it to larvae of grey mullet, it resulted in a satisfied requirement of fatty acids.

Another study which was performed is the enrichment of *Artemia nauplii* by using menhaden oil, polysorbate emulsifier and tap water to improve resistance of the larvae to physical stress, this experiment resulted in elevated level of fatty acid (n-3 highly unsaturated fatty acid) in *Artemia nauplii* and when these artemia where fed to larvae in combination with rotifers, it also increased the resistance to stress.

It is best to use phytoplankton in the background for the larval rearing of mullet which will imporve the growth and survivability of mullet (*Mugil cephalus*) but keeping in mind the level of unionized ammonia for the culture of phtoplankton *N. oculate* should be below the tolerance level of the grey mullet.

Nursery rearing

When larvae reach size of 10-2 mm, they are transferred to nursery indoor ponds. Prior to stocking in nursery ponds, they are kept in acclimatization tank. The stocking density in nursery ponds is about 125/m² where they rely on natural food. There are many nursery rearing methods used for the culture of mullet which includes fertilization or feeding, combined fertilization feeding, fertilization compost application and fertilization periphyton systems. The most commonly used is combined fertilization feeding and fertilization periphyton system which result in better performance of the fish.

Fertilized feeding system: In this system, the pond is first sun dried and lime is applied to the pond bottom after which it is fertilized with cattle manure, urea and superphosphate. After which *M. cephalus* were stocked at a density of 15000 nos/ha. Formulated feeds are given which are prepared from rice, wheat, mustard cake, fish meal and flour. Through this system mullet fry obtain weight of about 96 g after 150 days.

Fertilized periphyton system: This is a very ecofriendly and sustainably practiced system. Here along with lime application and fertilizers, bamboo poles are used which are inserted vertically in the pond and serve as a substrate for the growth of periphyton (that serve as food for the fish). Mullet fry are stocked at a density of 30,000 nos/ha. The fish obtain a weight of 28 g after 120 days. Although this method is not that much used due to the low production of mullet fingerling.

In aquaculture industry one of the important requirement is the feed regimen. Different fish has different feed regime based on their characteristics and prey preference. *Mugil cephalus* is a bottom feeder which feed on plant detritus and natural food. Many supplementary feeds have been developed which has proven to be quite effective. One such development is the algal meal based feed which comprises of 20% ulva meal in combination with yeast enriched with vitamin E. This meal not only supported growth enhancement of the fish but also improved its muscle quality and firmness.

Grow out culture

The grow out system of mullet is performed either in monoculture or polyculture. Polyculture of mullet is more preferred because of higher productivity. It is also suggested to culture mullets in ponds receiving heated effluents from power plant as it would provide a desirable growth and survival rate which would lead to better yield.

Monoculture

Monoculture of *Mugil cephalus* is still in development due to the availability of suitable seeds for stocking. In some countries like India, attempts have been made for the monoculture for *Liza vaigiensis* and *Valamugil seheli* with survival rate estimated between 72%-84%.

Polyculture

The main goal of polyculture is to enhance the productivity of fish by utilizing all the possible resources whithin an aquatic environment. In polyculture, two or more fish are reared together wherein one fish may serve as food for the other fish (eg: Sea bass) or one fish may enhance the growth and survival of the other fish. Other than finfishes, mullet is also polycultured with crustaceans like shrimps and crabs. In polyculture system with shrimps, *Mugil cephalus* maintain the ecological balance by consuming organic humus, leftovers from shrimps, algae and feed which might cause harmful pollution and pathogens in the ponds. The most commonly used shrimp is the tiger shrimp (*Penaeus monodon*). In the recent years, efforts have been made to culture the white shrimps (*L. vannamei*) and banana prawns (*Penaeus merguiensis*) with *Mugil cephalus* in a shrimp polyculture system. One such study by ghosh where he cultured white shrimp (*L. vannamei*) with mullet (*Mugil cephalus*) in floating cages resulted in higher survival, Feed Conversion Rate (FCR) and growth than those white shrimps cultured in monoculture system.

Many new advances and techniques have been developed and impplicated in terms of polyculture of mullet with fin fishes. In 2005, an experiment was performed in Kenya where mullet (*M. cephalus*) and milkfish (*Chanos chanos*) were grown together in earthern ponds and their growth and survival rate was checked during the wet and dry season. it was found out that the survival rate and growth was more during the dry season between 87%-90% with physiochemical parameters same as those of the culture requirements.

Another experiment was performed where nutrient recovery and sludge management of sea bream (*Sparus aurata*) and Mullet (*M. cephalus*) were checked when co-cultured together in Integrated Multi Trophic Aquaculture system (IMTA). The co-culture of these two fishes reduced sludge by 8% and increased nitrogen assimilation and emmission by 7%-8%. The growth and survival rate of these two fishes in IMTA sytsem also increased by 9% suggesting the use of this system for future in increasing the production of mullet.

Pearl spot (*Etroplus suratensis*)

Pearl spot (*Etroplus suratensis*) also known as green chromide (or Karimeen in Kerala) belongs to the family Cichlidae. Most commonly pearl spot are found in brackish water lakes and inland waters of India and Sri Lanka. It is endemic to peninsular India extending from South Canara to Malabar on the west coast to Chilka Lake on the east coast. Pearl spot can easily adapt to diverse habitats and hence it has been transplanted into certain inland water bodies of many states. Pearl spot is a preferred food as well as ornamental fish in many parts of India such as Tamil Nadu, Kerala, Goa, Andhra Pradesh and Odisha. This species also found in freshwater reservoirs, rivers and lakes but it can breed only in fresh water. Pearl spot generally feeds on planktons, small prawns and small worms. Aquaculture of pearl spot is quite simple and cost effective, since it is omnivorous in nature. It is easier to breed compared to other brackish water fishes. The only factor that is holding back the pearl spot aquaculture expansion is low availability of seeds.

Collection

Availability of pearl spot seed is seen throughout the year mostly in the eastern and south western coasts of India. However, it is abundantly obtained during the months of May-July and November-February. Seeds of pearl spot are collected from brackish water as well as freshwater tanks and ponds. The fish has the tendency to accumulate together to feed on epiphytic growth. Using this opportunity, one simple method is followed on a large scale for seed collection. In this method, about weeks prior of seed collection day, few branches or twigs are kept submerged in water. The juveniles gather on a large scale for feeding are then trapped with the help of trap or a net. According to few reports, the fecundity of pearl spot is found to be quite low, which is the main reason for difficulty in seed productivity. However, Central Institute of Brackishwater Aquaculture (CIBA), Chennai has reported successful demonstration of hatchery seed production of pearl spot.

Bloodstock development

Pearl spot is heterosexual in nature. Numbers of females are quite high compared to males in the ecosystem. But the fish is monomorphic and hence gender differentiation is difficult. Therefore, it is generally assumed that the gender ratio of the breeders is almost 1:1. After sometime, natural mortality of breeders is observed. To compensate this loss, new breeders are added to the already existing stock. They attain sexual maturity after one year and grow up to 10 cm in size. After maturation, certain characteristics are observed in males and females.

In males, the color band on surface of the body becomes darker and more evident. The greenish blue iridescence along with pearly white spots becomes flashy. Also numerous dark pigmentation can be observed on the ventral part of the body in males. Mainly the male pearl spot turns out to be appealingly dark, after maturation. Whereas females appear in muddy yellowish darker color.

Mukundan and James opined that, pearl spot contains following nutritive components along with great amount of meat (Table 6).

Tab. 6. Amounts of nutritive components in pearl spot.

Components	Percentage
Fat	17.5
Phosphorus	1.65
Calcium	0.5
Ash	1.08
Iron	4.9
Water	79.7

However, it is strenuous to manage their reproductive behavior such as pairing, nest building, courtship and also parental care; which results in unsuccessful seed production and complications in captive breeding. It is reported that pearl spot can be bred in earthen ponds, cement tanks or specialized raceways with preparation for artificial substratum. Still, pearl spot seed production is uncertain.

Physico chemical parameters

It is necessary to monitor water quality parameters such as temperature, salinity, pH, dissolved oxygen, total alkalinity and hardness on daily basis. Fishes should be disinfected using $KMnO_4$ before stocking.

Seed production

Central Institute of Brackish water Aquaculture (CIBA), Chennai carried out various methods of seed production. Few of them are as follows:

Seed production in ponds: Systematic pond (draining, liming, weed fish eradication, manuring for promoting phytoplankton bloom) was prepared. Then in pond of area 100 m² and 1.2 m depth with the salinity ranging from 15 to 30 ppt, about 50 brooders were stocked. Artificial feeds made up of groundnut oil cake, rice bran and fish meal covered with vitamins and minerals were fed once early in morning. From 5 sets of breeding, approximately 3,500 fry were observed in a year.

Breeding in RCC tanks: Breeding of pearl spot was standardized using 20 t RCC tanks. 4 inches of soil base was prepared at the bottom of the tank. Before stocking the tank with mature pearl spot brooders, hide outs and earthen tiles for the proper attachment of eggs were prepared inside the tank. The density 20 fishes per tank were maintained on the basis of the male female ratio of 2:3. Male and female fishes can be identified by the presence of a projected genital papilla. In mature males, the genital papilla appears to be slender and pointed; whereas, in mature females it is broader, swollen with tip blunt and reddish. According to the report, eggs were found to be deposited on the tiles and on the walls of the tanks. Water levels were lowered so as to collect the fry at regural monthly intervals. 1200–3500 seed per batch can be obtained by using RCC tank breeding system.

Seed production in small net cages/hapas: This method has been carried out in secondary discharge pond of fish hatchery with the following conditions: Gentle water flow and salinity of about 25-30 ppt. Small net cages/hapas are fixed by using casurina poles. In this method, ceramic tiles are used for the attachment of eggs. Each cage was stocked with 1:1 male female ratio. Pair formation takes place naturally once the fishes are released inside the cages.

Aggressive behavioral pattern can be observed while the fish breeds and protects the egg or larvae. During the stage of breeding, nest formation is observed in this system, leading to the pit formation into the soil container. Within 2–2.5 months, around 200–300 seed can be produced using this system.

Seed production in outdoor green water tanks using formulated maturation feeds: With proper nourishment and suitable rearing system, any fish can achieve maximum reproductive potential. CIBA have reported of formulating a maturation feed that constitute right amount off amino acids and fatty acids. According to the report, maximum breeding execution was observed in pearl spot by using the mentioned formulated diet and outdoor green water tanks. CIBA achieved high fry yield and frequent spawning by using the formulated feed and suitable set up. Parental fish as well as fry can be under control by using this seed production technique, also the set up (water and feed management) is economically feasible (Table 7).

Tab. 7. Difference in yield after using formulated feed.	Average yield	Maximum yield
	2500 fry production/pair/spawning	3480 fry/production/pair/spawning
	Repeated spawning/year=4 times	Repeated spawning/year=8 times

Feeding

Right quality and quantity of feed is one of the most important measures to be taken care for breeders. Researchers suggest that breeders should be fed with nutritious feed within 3-4 days after stocking. Pearl spot generally feeds on small prawns, small worms and planktons. Artificial feeds are also provided in many hatcheries either in dough or pellet form. At the bottom of the pond, feeding trays are adjusted. These trays should be cleaned (outside the pond) and monitored routinely so as to avoid infections or diseases (Tables 8 and 9).

Tab. 8. Artificial feed composition.	Compound	Percentage
	Groundnut oil cake	40%
	Rice bran	45%
	Fish meal	15%
	Vitamins and minerals	2.5 kg/100 kg feed

Tab. 9. Feed requirements during developmental stages.	Developmental stages	Feeds
	Young ones	Zooplankton.
	Advanced fry	Aquatic insect larvae, filamentous algae, vegetable matter.
	Adult pearl spot	Filamentous algae, aquatic macro vegetation, planktons, small prawns, worms, insect larvae.

Grow out culture

The pearl spot is cultured traditionally in Kerala on great extent. It is cultured in the "pokkali' fields (paddy fields). This field gives an annual yield of 3–5 tons, out of which 20% yield is obtained from pearl spot. Pearl spot can be cultured using the two systems monoculture and polyculture. Out of both the systems, polyculture system of pearl spot with milkfish and mullets give great economic yield. The demand of polyculture system is high. Due to the herbivorous nature of the pearl spot, there is no chance of cannibalism making polyculture system more preferable.

Within 10 months, the fish can grow up to the market size, weighing 120-150 g. Even though the growth rate of pearl spot is slow, optimum yield can be obtained by increasing the stocking density. According to the report, the stocking densities ranging from 20,000-30,000/ha under monoculture system, an average production of around 1,000 kg/ha/year can be obtained. In rural areas, the fish rearing practice is also carried out in the backyard ponds and tanks.

Conclusion

Aquaculture is one of the important fast growing food sectors in the world which provide high quality protein and vitamins. Sustainable growth of this sector depends on culture of many shellfishs and finfishes. This chapter contains the various developments which are done in the culture of coastal finfishes. Four major species of coatsal finfish aquaculture which have a very high demand are Asian sea bass; grey mullet; milkfish; pearlspot. In Asian sea bass (lates calcarifer), one of the major problem in culturing is cannibalism which can be seen from larval to Juvenile stages. Cannibalism can be avoided by using various techniques such as low stock density and use of polyculture system during the grow out phase. There are also possibilities for culturing sea bass during nursery phase in illuminated floating net cages which can attract natural zooplanktons that will serve as food for the sea bass. For milkfish (*Chanos chanos*) seed production technology has been achieved in the recent years, thus removing the dependency on wild caught fry. Different culture techniques have also been generated for milkfish like the use of IMTA (Integrated Multi Trophic Aquaculture) which provide better survivability and growth rate as compared to the normal culture techniques practiced. Grey mullet (*Mugil cephalus*) due to its high market value is an important species for sustainable aquaculture systems like IMTA and polyculture with fins fishes and shellfishes. Grey mullet can also be grown in ponds or rivers receiving heated effluents from power plant which will result in more production. Pearl spot (*Etroplus suratensis*) is a potential fish for brackish water aquaculture with high market value. Many researches have been done in terms of seed production for pearl spot though captive induced breeding of this fish has still not been reported yet. In the future we can definitely see the possibilities of overcoming seed production constraints in finfishes. In terms of live feeds, copepods can be used which contains high amount of essential fatty acid which is the basic requirements of finfish culture, though mass production of copepods is very low. Other than copepods, protozoa can also be used due to its varying morphological characteristics. Many experiments have also been performed for the use of rotifers and artemia nauplii enriched with HUFA boosters which not only provide better meat and flesh quality but also give higher growth rate and feed conversion rate.

Acknowledgment

The author is grateful to the management of the AMET university for giving the opportunity and providing facilities to carry out this work.

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