Module – III

3.1 Design and construction of aquafarms - Criteria for the selection of site for freshwater pond farms- Design and construction of fish farms

3.2 Nutrition and feeds - Nutritional requirements of a cultivable fish and shellfish - Natural food and Artificial feeds and their importance in fish and shrimp culture

3.3 Culture of Pearl oysters, culture of seaweeds, culture of ornamental fishes

Criteria for the selection of site for freshwater pond farms

Proper site selection is recognized as the first step guaranteeing the eventual success of any aquaculture project and forms the basis for the design, layout, and management of the project . For fish ponds, especially those to be used for coastal/brackishwater aquaculture of high-value species like shrimps, site selection is critical and should be given utmost attention.

Adisukresno (1982), Hechanova (1982), and Jamandre and Rabanal (1975) listed the following guidelines for the selection of a suitable site for coastal fish ponds:

(i**) Soil Quality**: preferably, clay-loam, or sandy-clay for water retention and suitability for diking; alkaline pH (7 and above) to prevent problems that result from acid-sulphate soils (e.g., poor fertilizer response; low natural food production and slow growth of culture species; probable fish kills).
(ii) **Land elevation and tidal characteristics**; preferably with average elevation that can be watered by ordinary high tides and drained by ordinary low tides; tidal fluctuation preferably moderate at 2-3 m. (Sites where tidal fluctuation is large, say 4 m, are not suitable because they would require very large, expensive dikes to prevent flooding during high tide. On the other hand, areas with slight tidal fluctuation, say 1 m or less, could not be drained or filled properly.)
(iii) **Vegetation**; preferably without big tree stumps and thick vegetation which entail large expense for clearing; areas near river banks and those at coastal shores exposed to wave action require a buffer zone with substantial growths of mangrove. (The presence of Avicennia indicates productive soil; nipa and trees with high tannin content indicate low pH.)
(iv) **Water supply and quality**: with steady supply of both fresh and brackish water in adequate quantities throughout the year; water supply should be pollution-free and with a pH of 7.8-8.5.
(v) **Accessibility**: preferably readily accessible by land/water transport; close to sources of inputs such as fry, feeds, fertilizers, and markets, fish ports, processing plants, and ice plants; and linked by communication facilities to major centres.
(vi) **Availability** of manpower for construction and operation.

<u>Design and construction of fish farms</u>

Pond is a body of standing water, either natural or artificial, that is usually smaller than a lake. Pond is defined as an artificial structure used for the farming of aquatic organisms.
Basic factors influencing the Pond Design and construction

1. Location: A land with gentle slope will be more suitable for proper drainage of the water.
2. Construction: A culture pond may be dug into ground or may be partly above the ground
3. Depth: Depth should be 0.5 to 1 Meter at shallow end and 1.5 to 2 meters at the drain end.
4. Shape: the shape of the pond can be Rectangula
5. Drains: Draining of pond should not take more than 3 days. The outlet must be deep and large
6. Water volume: It should not take more than a week to fill the pond.Water volume must be sufficient through out the growing season
7. Dykes should be non leaky and strong to hold the water.

Steps in pond construction

Normally, the pond construction includes the following steps.

Step 1: Prepare the site by removing unwanted things such as the trees, bushes, and rock
Step 2 : Construction of dyke by using the clay
Step 3 : Digging the pond
Step 4 : Inlet and outlet construction
Step 5 : Pond dyke covered with soil and plant grass species (avoid long rooted plants such as Rhodes grass and star grass)
Step 6 : Pond should be fenced to avoid theft and entry of predatory animals

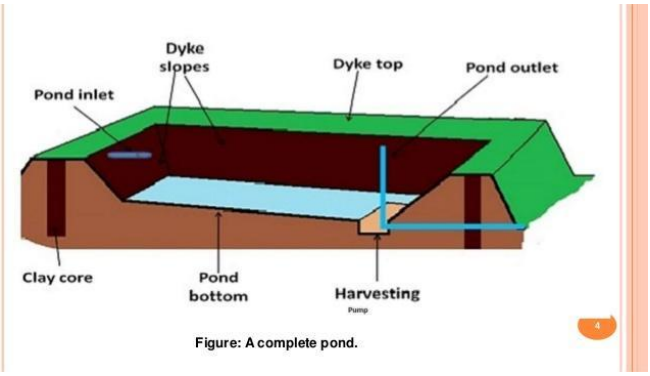


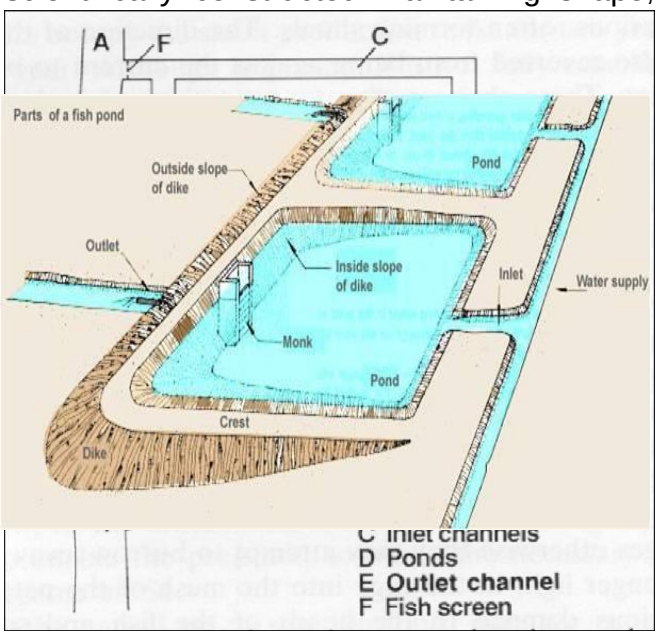
Figure: A complete pond.

Site preparation

The place is cleared of ropes, cables and other items. Trees and bushes and other obstacles that hinder movement of heavy equipment around the site are to be removed - manually / animal power /using machinery. The surface soil which has the highest concentration of roots and organic material is not suitable for pond construction..

The ponds are constructed by two types namely, dug out and embankment pond.

The dug out pond: It is constructed by digging the soil and is most suitable to construct ponds in plain areas. It is to be scientifically constructed maintaining shape, size, depth and other factors.



Embankment pond: It is more appropriate for hilly areas. Dykes may be erected on 1 or 2 sides based on need. This pond is economically viable but not ideal for fish culture because the size, shape and depth of pond cannot be fixed as per scientific fish culture specifications.

Construction of dyke

Dykes should be compact, solid and leak free. A desirable dyke is constructed using 15 - 30 percent of silt, 45 - 55 percent of sand and 30 - 35 percent of clay. A sufficient width of the berm (not less than 1 m) is required to stabilize slope. The embankment slope in horizontal to vertical should be 2:1 in good quality clay soil and 3:1 for loamy silt or sandy soils.

Linings to the dyke: It has got many advantages such as reduction of seepage losses, increasedwater holding capacity etc. It also resists the erosion of dykes and channel banks. Lining also facilities maximum harvesting especially in the case of prawns.

Lining can be done in following ways
1. Concrete lining
2. Soil cement lining
3. Polyethylene film lining
4. Compacted earth lining
5. Brick or cement tile lining

Soil and vegetation coverage of Dyke: To reduce the soil erosion, creeping grass can be

grown on the top and sides of dyke. The banana and coconut trees can be planted in the embankment. The slope of the embankment can be planted with grasses such as Hybrid Napier, gunny grass and elephant grass to supply feed to the grass carps reared in the ponds.

Inlet and outlet construction

Feeder canals are constructed to provide sufficient amount of quality water to the ponds except in ponds which are filled by rainwater. Inlets are provided at top of the pond and screens are used to filter the pumped water to avoid entry of unwanted particles to the culture system. The inlet pipe size has to be designed is such a way that it should not take more than 1 or 2 days to fill the pond.

Water source to the pond:

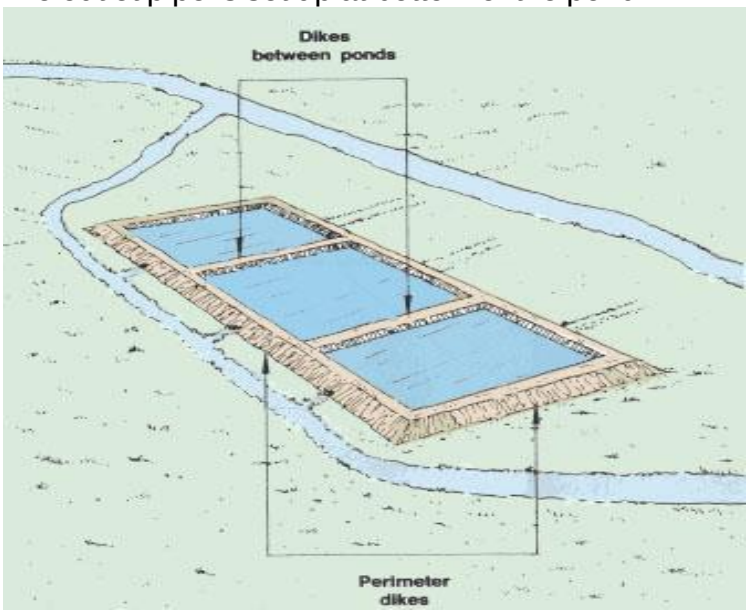
1. Ponds can be fed by groundwater:

2. Rain-fed ponds: Rain-fed ponds are supplied from rainfall and surface runoff.

3. Ponds can be fed from a water body such as a stream, a lake, a reservoir or an irrigation canal.

4. Pump-fed ponds are normally higher than the water level and can be supplied from a well, spring, lake, reservoir or irrigation canal, by pumping.

The outlet pipe is set up at bottom of the pond.



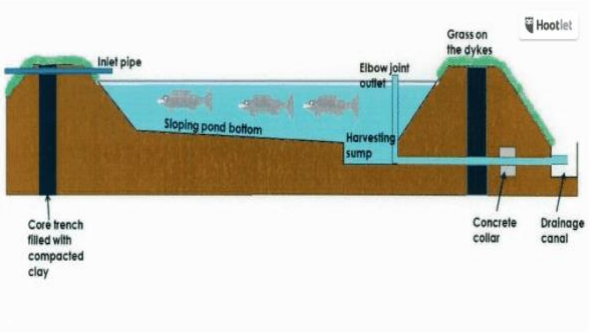
It is used to dewater the pond during harvest and partial draining for pond water exchange to maintain the water quality of the pond during the culture period.

The outlet is constructed prior to pond dyke construction.

Drainage system

The water supply to the pond is to be monitored through the inlets and outlets and for that different types of water control structure are in use. Monk is used as outlet structure.

Drainage Through an out let pipe: A



A cross section of a completed pond showing the position of various structures.

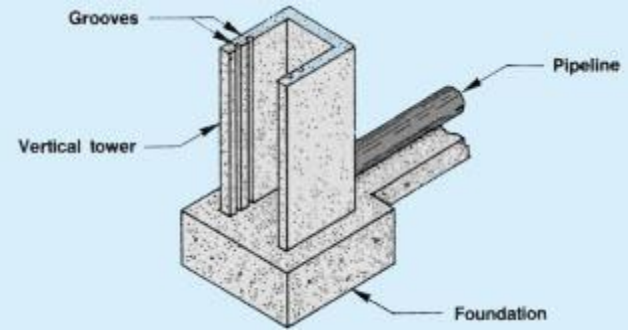
drainage system is used to empty the pond. It consists of the outlet system for letting water out of the pond and the drainage ditches which carry the water away from the pond.

The best and easiest way to have a good drainage system is to build the pond in a place which provides a good slope.

One of the easiest ways to drain the pond is to place a bamboo or plastic pipe through the base of the wall into the middle of the pond. The end of the pipe, which is inside the pond, should have a screen over it to keep fish from entering the pipe. The other end of the pipe is plugged with wood or clay. To drain the pond during harvest time, the plug is pulled out.

Drainage through Monk Outlet: The monk is a type of sluice gate. It is one of the oldest and most common pond draining structures. It consists of a vertical tower closed with wooden boards to regulate the water level. A screen keeps the farmed fish from leaving the pond. It is built of bricks or cement

blocks, concrete or reinforced concrete because, to last for a long time
The complete monk outlet consists of:
1. a vertical three-sided tower (called the monk) 2. grooves to fix the wooden boards and screens



Screens of various eye sizes are put in the grooves to drain water and prevent the escape of fish.

Types of ponds

Specific kinds of ponds are required for specific life stage development of fishes - such as nursery, rearing, stocking, treatment and broodstock pond. The rectangular pond is preferred than round shaped corners as it prevents the fish escape during harvest. An ideal length and breadth ratio of the pond is 3:1 is ideal, with breadth not more than 30 - 50 m. The total farm area can be divided as - nursery - 5 % of total farm area, rearing pond - 20 %, stocking pond - 70 %, and treatment pond - 5 % of the total farm area.

- **Hatching ponds:** These are small pits of 8'x4'x2' (feet) and are used for hatching the fertilized eggs.

- **Nursery ponds:** These ponds have a size of 50'x50x'3' or 4' and are used for keeping spawn or fry @ rate of about 50 'lakhs per ha and are reared for a period of of a few hours to 3 days

- **Rearing ponds:** These ponds are of 90'x30'x4' size and are used for rearing advanced fry or early fingerlings (25 mm to 50 mm) for a period of 30 to 60 days. The stocking rate is 12 lakhs per hectare.

- **Stocking ponds:** These ponds have a fairly large size with a depth of about 6 feet. They are used to rear fingerlings for growing them to a table size fish. Upto 8 months. The stocking rate is usually 5000/ha.

- **Broodstock ponds:** These ponds are used for keeping the brood fishes to be used for breeding to get pure seed. The size is generally 50'x20'x8"-1 2".

- **Marketing ponds:** These ponds are used for keeping marketable size fish for selling in live condition.

• **Bio pond or treatment ponds** - these are large settling tanks, where the water used for fishponds is purified biologically. They may also be used as stocking pond. However, an even flat bottom is recommended for easy netting operation.

Pond fencing
The ponds are fenced to protect from theft. Live fences also serve as windbreak, increase farm diversity, provide privacy to farm and improve the appearance of the fish farm. There are several ways to make fences. These include live fence, piled fence, woven fence, post and rail fence, wire fence, wire netting fence and stone wall. Each type of fence has its own advantages and disadvantages. Wired net fence is primarily used in fish farms to stop intruders and protect the fish stock.

NUTRITIONAL REQUIREMENTS OF A CULTIVABLE FISH AND SHELLFISH

SUPPLEMENTARY FEEDING

When the availability of zooplankton declines in pond, the supplementary feeding is done. A continuous high population of zooplankton cannot be maintained in pond water. The fish spawn do not accept artificial feed for first two to three days when they start feeding. Artificial feeding is done after this period. Generally, a mixture of powdered rice bran and oil cake in 1:1 ratio is given as supplementary feed. Powdered small millet can be used in place of rice bran because of better digestibility by Indian major carps. The daily ration to be given

depends on the weight of spawn or fry. A mixture of artificial feed and zooplankton is better for good growth as compared to artificial feed alone.

The criteria for the selection of a fish feed are:

(i) Ready acceptability, (ii) Easy digestibility, (iii) High conversion values, (iv) Abundant availability and (v) Low cost

The nutritive value of the artificial feed should be similar to that of natural food.

NUTRITIONAL REQUIREMENTS OF CULTIVABLE FISHES OR SHRIMPS/The major food nutrients required by fish are:

(a) Protein (b) Carbohydrate (c) Lipids or tats (d) Vitamins (e) Minerals and trace elements.

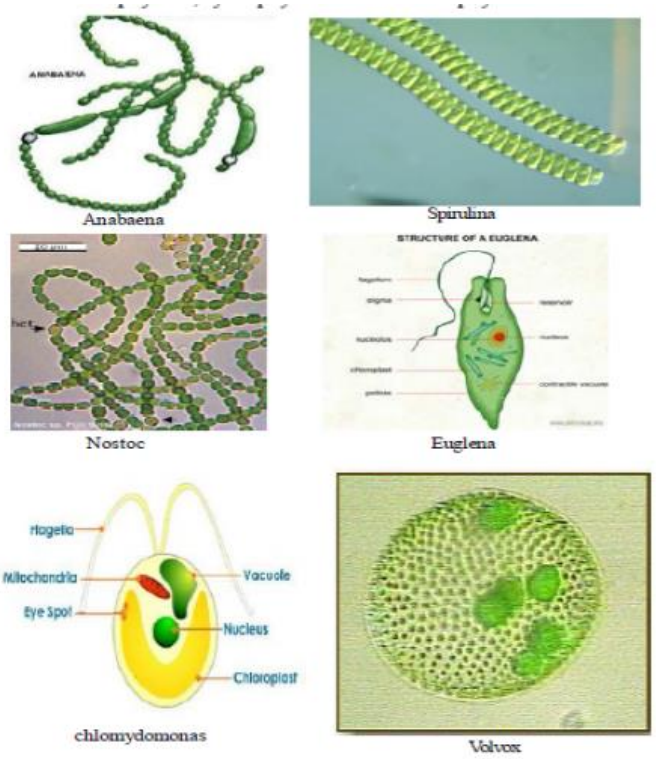
(a) Protein: Protein acts as source of energy in the absence of fat and carbohydrate. The protein requirement depends on the species, size and the environment in which it lives. The optimum protein content in fish feed ranges between 25-40%. Small sized fish require more protein for growth as compared to large ones. The protein requirement ranges between 30-40% of the feed.

(b) Carbohydrate: Carbohydrates are considered as energy feed. In fish, carbohydrates either remains stored in liver as glycogen or are converted into fat, which acts as reserve energy source during food deficiency. Its requirement depends on the species. The optimum requirement of carbohydrate for ranges from 25-30% of the feed

(c) Lipids: Lipids are also known as energy source. They act as carrier of other fat-soluble vitamin like vitamin A, D and K. Generally cultured fishes require a lipid concentration between a range of 4 to 6% of feed.

(d) Vitamin: Vitamins particularly water soluble except choline and inositol act as co-factors or co-enzymes and are not synthesized in the fish body. Though actual dietary requirement of vitamins is not still known, it is advisable to know the availability of vitamins in the supplementary feed given to fish before providing vitamin premix in the artificial feed. The requirement of vitamin also depends upon the size, age, growth of fish and the environmental factors.

(e) Minerals and trace elements: These are required in very small quantity in the diet. The important minerals are calcium, phosphorus, potassium, chlorine, sodium and magnesium, where as, the trace elements are copper, cobalt, vanadium, iron, iodine, manganese,



selenium, zinc, chromium and aluminium.

NATURAL FOOD AND ARTIFICIAL FEEDS AND THEIR IMPORTANCE IN FISH AND SHRIMP CULTURE

Natural food organism in pond

A variety of natural fish food organism are found in water body. The natural food provides the constituents of a compete and balanced diet. The demand of natural food varies from species to species. For example catla prefer zooplankton and silver carp prefers phytoplankton. At younger stage, the fish may feed on plankton, and the same fish may prefer animal food as an adult.

Recommended nutrient levels for shrimp feed on percentage fed basis

Shrimp	Protein (%)	Fat (	Fiber (%)	Ash (%)	Moisture (%)	Calcium (%)	Phosphorus (%)

size (gm)		%)					
0.0-0.5	45	7.5	Max.4	Max.15	Max.12	Max.2.3	Min. 1.5
0.5-3.0	40	6.7	Max.4	Max.15	Max.12	Max.2.3	Min. 1.5
3.0-15.0	38	6.3	Max.4	Max.15	Max.12	Max.2.3	Min. 1.5
15.0-40.0	36	6.0	Max.4	Max.15	Max.12	Max.2.3	Min. 1.5

(Source : Lin, 1994)

Importance of Natural food

Natural feeds have high protein and fat contents which promote the growth of the fish. Hence, it is necessary to increase the live food in the aquatic ecosystem to improve the growth to improve the growth of the fish.

Fish production in water body is directly or indirectly dependant on the abundance of plankton. Water quality determines the quality and quantity of plankton. Plankton are two kinds phyto plankton and zooplankton

Phytoplankton

Fishes consume the phytoplankton which is found abundantly in well managed ponds. Phytoplankton gives green colour to the water due to the presence of chlorophyll. Plankton are generally made up of mostly unicellular algae which are either solitary or coronial.

Phytoplankton are autotrophs. Algae of three major classes which from the main food in phytoplankton. These are chlorophyceae, cyanophyceae and bacillariophyceae.

Chlorophycaea These are called green algae due to the presence of chlorophyll. The chlorophyceae members useful as fish food are Chlamydomonas, Volvox, Eudorina, Pandorina, Chlorella, Oedogonium, Spirogyra, Pediastrum, Microspora, Cladophora, Clostridium, etc.

Cyanophyceae : These are commonly known as blue green algae. Examples are Nostoc, Oscillotoria, Anabaena, Microcystis, Spirulina, Merismopedia, Arthrospira etc.

Bacillariophycaea : These are called diatoms. They are unicellular organisms with different shapes and sizes. These may be yellow or golden brown or olive green in colour. The reserve food materials are fat The diatoms consumed by fish are Diatoma, Navicula , Cocconies, Synedra, Tabellaria, Meridion, Fragilaria, , Pleurosigma, Amphioleura, , Cyclotella, etc.

ZOOPLANKTON

Plankton consisting of animals is called zooplankton . Zooplankton is abundant in the shallow areas of water body.

Protozoa Protozoans are most primitive unicellular and microscopic. These organism are found abundantly in fish ponds are useful as natural fish food Eg. Amoeba, euglena, paramecium etc.

Crustacea The aquatic animals with 5 pairs of appendages and branchial respiration are included in the class crustacea. The crustaceans vary from microscopic to large animals . Crustacean form major component of zooplankton. In zooplankton the micro crustaceans are useful as food of fish and prawns. For example , nauplii of Artemia are used in prawn hatcheries.

(a) Copepoda : These are animals with 5 pairs to thoracic appendages , abdomen without appendages, forked telson, two pairs of

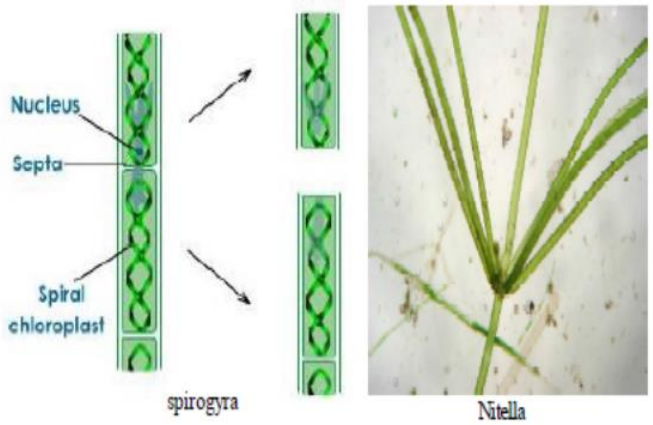


Fig 6.1 Phytoplankton

antennae and body with head thorax, and abdomen. The copepods inhabit freshwater. The sizes of the body of the copepods is 0.3 to 3.5 mm. Eg. Cyclops, Mesocyclops, Diaptomus, etc, are useful as fish food organism.,

(b) Cladocera : Which are bivalved should shaped with or without shell, The size of these shelled crustacean varies from 0.2 to 3.0 mm. Eg. Daphnia, Ceriodaphnia, Moina. Sinocephalus etc are useful as fish food organism.

(c) Ostracoda : The animals with bivalved carapace Eg. Cypris, Stenocypris etc, are consumed by fish.

Rotifera Rotifera are readily from other planktonic material by the presence of their major ciliated wheel-like structure they are called wheel animalcules. range from 40 microns to 2.5 mm in size. Usually rotifers like Keratella Phlodina, Rotaria. Hexarthra, Filinia, Brachionus Epiphanes etc., are useful as food organism.

Annelids Animals with metameric segmentation , eucoel, nephridia and setae are included in the phylum annelida. The animals which belong to classes polychaeta and oligochaete are useful as fish food organism. These are found at the bottom of the water body are generally consumed by bottom-dwelling fish,. eg. Tubifex , Glycera and earth worm

Insects Animals with 3 pairs of legs of wings, jointed appendages and a chitinous body wall are included in class Insecta. Insects and their larvae form main food item of any fishes., Aquatic insects are often preyed upon by fish trout, catfishes murrels etc. Hemiptera, diptera , coleoptera, ephemeroptera and plecoptera insects dominate as fish food

Eg. Mosquito larvae, larvae of dragon flies belostomitide, odonat etc. .

Mollusca The animals with a soft body, shell and foot are included in the phylum Mollusca . Bottom-dwelling fish consume them. The gastropodes are found in the diet of carnivorous and omnivorous fishes.

Amphibia Amphibian The fishes consume the tadpoles among amphibians.

Fishes Carnivorous (piscivorous) fish feed on a variety of other adult fishes ,. Fish like murrels etc, feed on other fishes. Small fishes are consumed by some carnivorous fish. Some fishes are cannibalistic in nature.

Prawns Fishes also feed on decapods (prawns) . The carnivorous and omnivorous fishes feed on small prawns.

Culture of Plankton for live food feeding

Unialgae (algae belonging to same species) are obtained by the isolation and culturing in artificial conditions. Diatoms, chlorella are cultured in this way

Zooplankton like moina, artemia are cultured in artificial culture in prawn hatcheries. Lablab

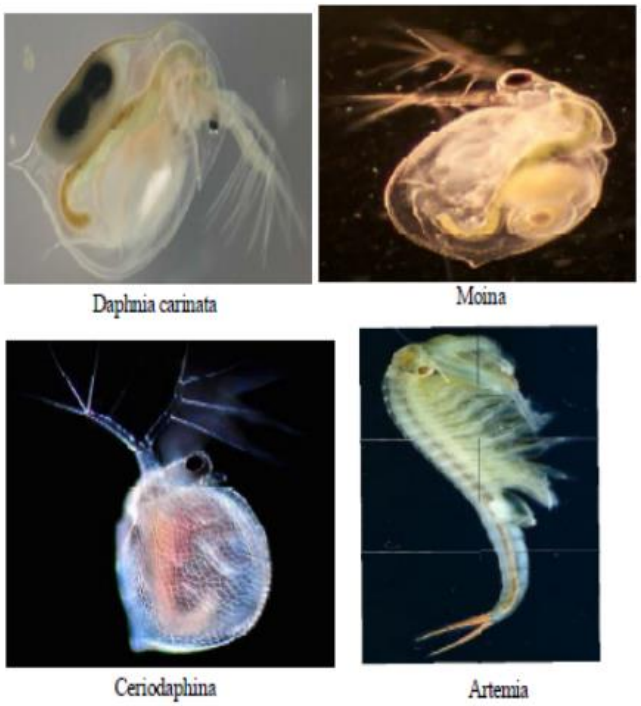
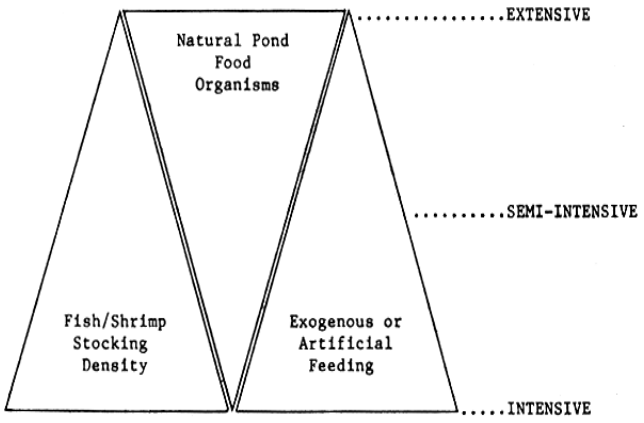


Fig 6.2 Zooplankton

is a mixture of zoo and Phyto planktons which is cultured artificially

Artificial feeds and their importance in fish and shrimp culture



Formulated feed

Rearing of spawn, fry and fingerlings until they become stock able size and their subsequent culture in grow out ponds require appropriate and nutritionally balanced diet for enhancing production. This is been of the essential requisites in the development of aquaculture. The advantages of formulated feed are

1. Proper formulated feed are in replica of exact nutritional requirement of fish. Therefore by understanding the nutritionally well balanced feeds which could be formulated using low cost feed stuff available locally.
2. Ingredients of formulated feeds can complement one another and arise the food utilization rate.
3. Proteins can supplement one another so as to satisfactory improve most of the essential amino acids content of the feed, thereby raising the protein utilization.
4. Large quantities of feeds can be prepared at a time good shelf-life so to be convenient to preserve, which can be used at the time of supple mentary feeding.
5. Feed ingredient sources can be broadened with preferred and less preferred ingredients with additives like antibiotics and drugs to con trol fish disease.
6. High efficiency of feed can be achieved by judicious manipulation of feed ingredients and can be made commercially feasible.
7. By adding a binding agent to produce feeds, the leaching of nutrients in water is diminished and wastage is reduced.
8. Dispersing over large farm area is quite possible as formulated feeds are convenient transport. These are suitable for automatic feeding, for which automatic feed dispensing devices could be successfully employed.

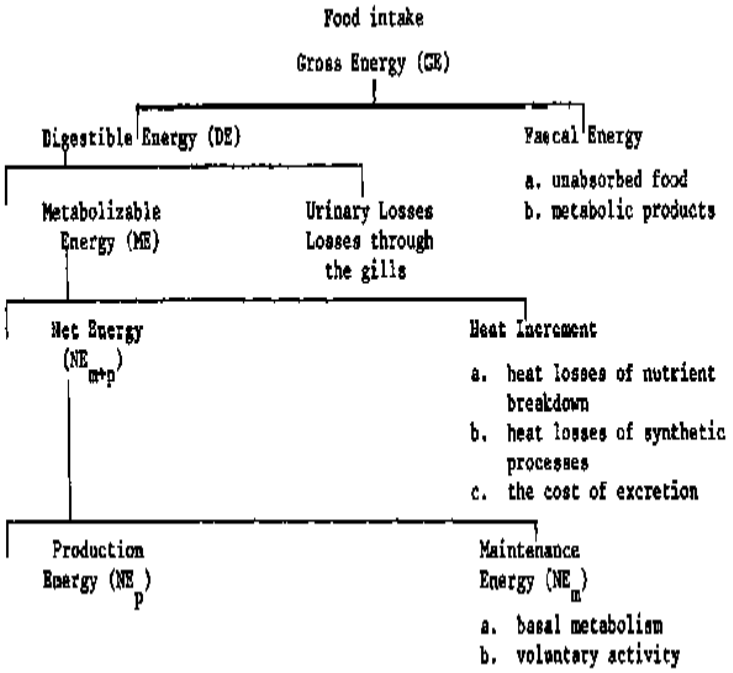
(a) Suspended : It is required feed, prepared with Acetes, Squilla and clams . Its preparation is discussed in chapter VG.

(b) Pelletised feed : This si a nutritionally well balanced solid feed and can be used off the shelf as and when required. This type of feed contains only ingredients of precisely known as composition and for this reason such diets are very expensive.

Use of Artificial Fish Feed: Merits & Demerits

1. Introduction: Good nutrition in animal production systems is essential to economically produce a healthy, high quality product. In ormental fish farming, nutrition is critical. Fish nutrition has advanced dramatically in recent years with the development of new, balanced commercial diets that promote optimal fish growth and health and also body colour.

2. **Types of feeds** 1. Natural fish feed- Live feed 2. Artificial fish feed Live feed: Live feed or fish food organisms are microscopic organisms naturally present in the aquatic



environment as primary food for the larvae of fin fish and shell fish. Their size ranges from a micron to few millimetres. They are tiny forms which suits the mouth size of all kinds of fin fish and shell fish larvae.

3. • Prepared or artificial fish feeds may be either complete or supplemental. Complete diets supply all the ingredients (protein, carbohydrates, fats, vitamins, and minerals)

necessary for the optimal growth and health of the fish.

4. Artificial feed may be of different kinds
Pellets. These may be floating or sinking pellets
Flakes- are flat in structure
Granular form – they are very small and round shape. They are similar to grains.
Moist feed – It is prepared daily and fed to fishes – the moisture content is 35%.
Paste feed – This is mainly prepared for young ones of all. The feed ingredients are made into paste and fed to the fishes squeezing through mesh.

5. **Preservatives**, such as antimicrobials and antioxidants, are often added to extend the shelf life of fish diets and reduce the rancidity of the fats. Vitamin E is an effective antioxidant. Commonly available commercial anti-oxidants are butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT) and ethoxyquine. Sodium and potassium salts of propionic, benzoic or sorbic acids, are commonly available anti-microbials added at less than 0.1% in the manufacture of fish feeds. Other common additives incorporated in the fish feeds are chemo attractants and flavourings, such as fish hydrolysates and condensed fish soluble (typically added at 5% of the diet). Basically, attractants enhance fish pallatibility and its intake.

6. **Storage Procedure** of Fish Feed: Freezer bags serve to store the prepared feeds, and using a bag vacuum sealer will greatly extend the shelf-life of both ingredients and the feed. The feed can be stored double bagged in the freezer but should be discarded after 6 months. Ideally, dried larval feeds are not frozen but stored in the refrigerator for no longer than 3 months.

7. **How to feed the Fish**? Feeding should be done at regular time everyday. It is vital that fishes are offered a relatively small amount of food, which should be consumed within 5 – 10 min of being placed in the tank. Overfeeding and under-feeding should be avoided. Overfeeding results in polluting water quality(ammonia concentration) due to accumulation of uneaten feed and faecal matter. Under feeding results reduced growth rate of fishes due to insufficient feed.

8**. Amount of Feed given**: Per day = Biomass × Percentage of body weight of feed per day

Biomass can be calculated using the following formula.

Biomass = Stocking density (in nos.) × Survival rate × Average body weight.

9. **Merits and Demerits of Artificial Fish Feed**:

Merits: Specifically formulated for aquacultural use.
These are properly balanced with different types of nutrients.
Contains essential nutrients to meet the requirements of different species.
Can be manipulated to suit developmental stages for a range of species.
Consistent quality.
Readily available. •
Wide variety and types.
Demerits: • Expensive to purchase . • Requires refrigerated storage. • Overfeeding with artificial feed may cause water pollution. • Improper storage may cause contamination.

10. Conclusion: artificial feeds are required for semi intensive and intensive practises. In intensive culture systems. Feed represents the major expense, often accounting for over 50% of total variable operating costs. This the development of feeds that are efficient and economical is fundamental to successful shrimp farming. This requires the understanding of nutritional
in items of protein, lipids, carbohydrates vitamins and minerals.

Pearl culture

In this article we will discuss about:- 1. Meaning of Pearl Culture 2. Important Pearl-Producing Oys-ters 3. Distribution in Indian Waters 4. Biology of Pearl Oyster 5. Formation of Pearl 6. Artificial Pearl Culture 7. Large-Scale Pearl Culture.

History

Fishing of pearl oyster in order to obtain pearl is known to Indians since ancient days. The chief sources of pearls are marine pearl oysters, however the fresh-water molluses are

also known to produce pearls but they are of poor quality and almost worthless. Pearl is known to human beings since ancient times. A pearl due to its delicate appearance and shine has retained its position as a costly ornamental object. Due to its properties, it occupied important place in the crown of great emperors and queens. The origin of pearl is not known to us however Chinese records show that pearl was known to them as far back as 2300 B.C.

Pearl producing oysters

The pearl oyster belongs to genus Pinctada, family pteriidae, and class bivalvia and phylum mollusca.

a. Pinctada fucata
b. Pinctada chemnitzi
c. Pinctada margaritifow
d. Pinctada anomioides
e. Pinctada atrapurpurea

Distribution of Pearl oyster beds

The main sites of production of pearl are the Persian Gulf, Gulf of Manaar (Ceylon), Sulusea (near Philippines). Besides these, coast of Australia and shores of Central America

Nowadays Japan has surpassed all the countries in the bulk of pearl production by invention of pearl culture techniques.

Pearl Fisheries of India:

Pearl oyster beds in India are present on both eastern and western coasts. However, the east coast is more productive and extensive than the west coast. The two zones of Indian coast known for pearl oysters are

(A) Gulf of mannar:

The Indian pearl fisheries in the Gulf of Mannar along with Sri Lanka produces the true oriental pearls of the finest quality. The species common to this area is Pinctada fucata. Gulf of Mannar has 72 beds,

(B) Gulf of kutch: In the Gulf of Kutch there are about 42 pearl oyster reefs, known as 'Khaddas'.

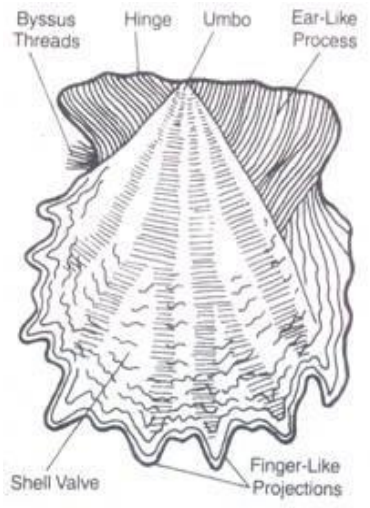


Fig. 38. External features of a pearl oyster.

How pearl produced

Pearl is secreted by the mantle of the pearl oyster as a protection against foreign objects which may be sand particles, minute larval forms or other such things. To study the mode of formation of pearl it is essential to know the structure of the shell and mantle.

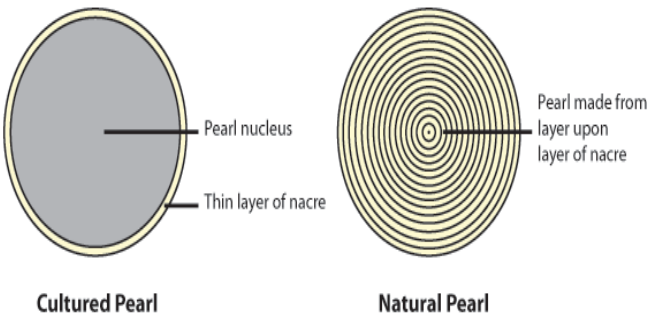
Shell of pearl oyster is composed of three distinct layers. They are as follows.

Periostracum: It is the outermost, greenish-brown, thin, translucent layer made up of an organic substance "Conchiolin". It is secreted by mantle. It serves to protect the underlying layers from harmful effects of weak carbonic acid in water.

Prismatic Layer: It is the middle layer secreted by mantle. This layer is made up of minute crystals of calcium carbonate, It gives strength and rigidity to the shell.

Nacreous Layer: It is the inner most layer of the shell and is better known as mother of pearl", because this layer is responsible for the formation of pearl. It consists of alternate layers of calcium carbonate and conchiolin This layer is also secreted by mantle and its function is to protect the delicate surface from harmful effects of the foreign particles. that pearls are formed due to irritation caused to the mantle by the entry of foreign bodies.

Internal structure of a natural and cultured pearl



Whenever any sort of foreign body enters and gets between the mantle and shell, it becomes enclosed in a sac of mantle epithelium. This foreign body now acts as an irritant and stimulates the mantle epithelium to secrete concentric layers of nacre around this foreign

body. These layers when harden becomes pearl. (Fig. 40) Size of pearl is directly proportional to the degree of irritation cause by foreign agents. Time taken for the formation of a pearl of average size is three to five years.

Places	Diameter of the nucleus	Diameter of the pearl	Time taken for culture
1. Gulf of Mannar (India)	3 mm	3.63 mm	6 months 11 days
2. Ego (Japan)	3.05 mm	3.70 mm	2 years

The chemical analysis of a pearl shows that it contains about 90% calcium carbonate, 5% organic substances and 5% water and other residues.

The natural pearl is rarely a sphere, as it assumes the shape of the nucleus. The process is very slow and continues for the whole life of an oyster. The value of a natural pearl depends on its size, shape, colour and lusture.

Biology of Pearl Oyster:

The oyster usually breeds several times in succession. The larvae are free-swimming and feed upon microscopic organisms. They undergo metamorphosis and finally settle, at the bottom, in large numbers. The young oyster has a fast growth rate and attains about 50 mm size in a year. Pearl oysters feed on small algae found in the water column through filtering large amounts of water.

Formation of Pearl:

If a small foreign particle, an inert material, e.g. sand particle, hard object, etc.; living object, e.g. parasite, penetrates the mantle of the oyster, the cells of the mantle get attached to it.

The foreign particle forms the nucleus over which more or less concentric layers of mother of pearl is secreted.

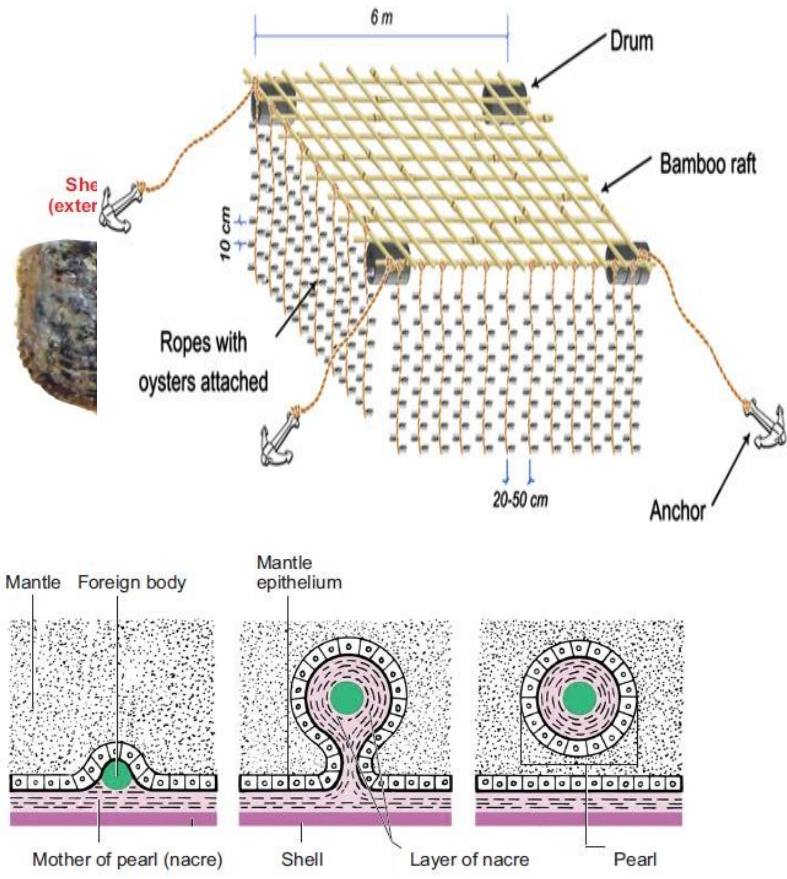


Figure 13. 12 Pearl and Pearl Formation

In case the particle penetrates deep enough, a sac or cyst is first formed around the particle and pearl formation occurs within the sac. With time, due to more secretion, it enlarges in size and the pearl is formed.

Artificial Pearl Culture:

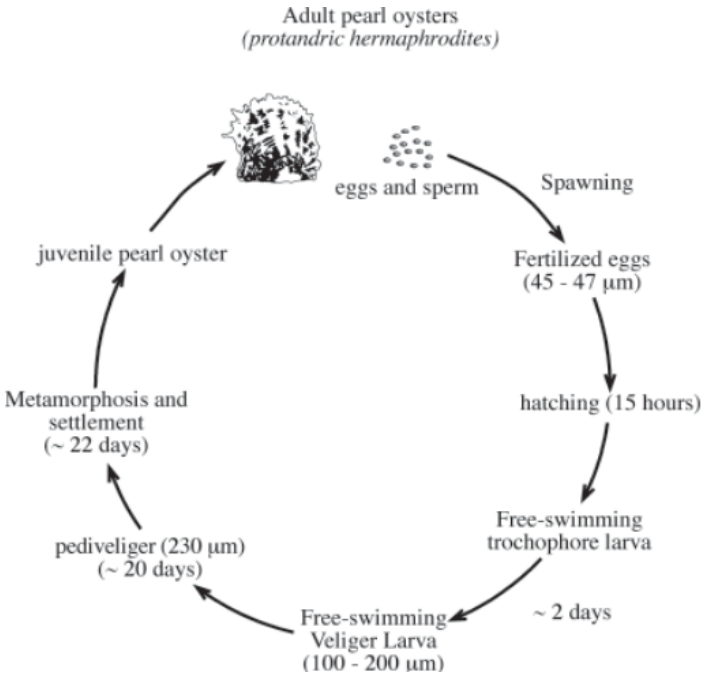
Japan was the first to develop scientific pearl culture in 1907. Introduction of large particles of desired shape and size made it possible to get pearls of different shapes and sizes.

The basic principle of Pearl-Culture is to introduce some foreign materials between mantle and shell of the oyster, which out of irritation will produce nacrous layers around that foreign body which in time will become pearl.

PROCESS OF PEARL CULTURE

The process of pearl culture includes the follwing steps.

Step 1: Construction of pearl farm. It includes 2 steps



a**. Selection of farm site:** A site is selected that provides- constant temperature, protection from waves, shallow waters.

b**. Construction of pearl farm:** Wooden Rafts of 5x5 meters are placed in seawater using proper anchors. Lines of ropes are hung on to these rafts.

Step 2: Collecting oysters

After the construction of pearl farm, the divers set out to the bottom of the sea, to collect the oysters. Oysters are generally located on a flat rock bottom . The shells collected, are cleaned, sized, and placed into baskets for storage until they are transferred to the pearl farm. The larvae of the oyesters can also be collected. That process is called spat collection. These larvae are again grown upto 2 years so that they can be seeded (introduction of foreign particle)

Step 3: Seeding

Two-three year old healthy oysters are considered for surgical implantation known as seeding. This is a very delicate operation and involves three stages:

Preparation of the graft: A donor oyster is sacrificed to obtain mantle. Mantle is needed by the host oyster to accept the nucleus. Nucleus is a foreign particle usually a sand or glass particle.

Attaching the graft: The oyster is opened with special wedges and pliers, sand/glass particle is introduced between the shell and mantle and the oyster is then returned back to the water. The inserted core irritates the oyster, provoking it to gradually coat the core with thin layers of mother of pearl nacre. After some time, the oysters are collected, and x-rayed to see whether the implants have been accepted. Oysters which have rejected the implant are returned to the water and are once again operated. The oysters which have accepted the implant are transferred to the pearl farm.

Step 4: Caring the oyster

The shells which have been grafted are transferred to the pearl farm are placed in baskets or ropes attached to the floating rafts. The oyster can produce more than one pearl in its lifetime.


Fig. 9.1 Ulva


Fig. 9.2 Entomorpha


Fig. 9.3 Sargassum

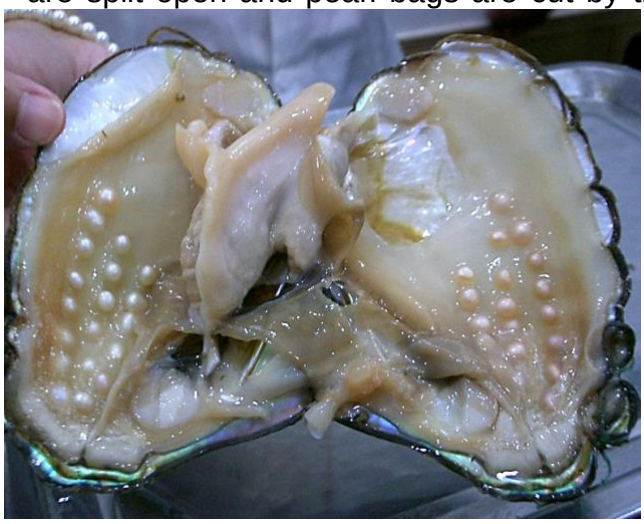

Fig. 9.4 Gelidiella


Fig. 9.5 Ectocarpus

Step 5: Harvesting

After 2-3 years, the oysters are harvested. It is necessary to make a trial harvest to determine

whether the pearls have a sufficient coating. If it is not sufficient then an additional six months to a year of culturing is necessary. The oysters are split open and pearl bags are cut by the



scalpel to remove the pearls.

Step 6: Sorting pearls

There are many different steps involved with the sorting of pearls. Firstly, the pearls are sorted according to their size, colour and lustre. They are marketed.

Seaweed culture

Introduction

Sea weeds of marine algae are primitive plants and they constitute one of the commercially important marine living resources. They grow in the littoral and sublittoral region upto 20 or 25 depth in the sea also in the estuaries.

They belong to four groups namely green. Brown red, blue green algae based on the kind of pigments present in them.

Sea Weed Morphology

Seaweed have no leaves, flower, fruits, seeds, or roots to take up water and nutrients. Sea weeds may be small or very large simple or branched. Flat and leaf kettle or thick and spongy. The blades can be leaf like or tubulous structures.

Like terrestrial plant they are often flattened so that they have large surface are for absorbing as much light possible. The blades are also responsible for taking nutrients out of water.

The following are important sea weeds

A. Geliediela Sp. Eg. Geliediela acerosa, Gracilaria edulis, Gracilaria crassa , Gracilaria verrrucosa

B. Alginophytes Eg. Sargassum wightii, Sargassum myriocustum, Turbinaria coroides

C. Carrageenophytes Eg. Hypnea muciformis, Mypnea valentiae

Economic Importance of sea weeds

1. Commercially useful products are extracted from the sea weed in the form of agar, agaroid, algin, sodium alginate, carrageenam etc.

2. Agar and algins are used as gelling stabilizing and thickening agents in food and various products.

3. By product of sea weeds are used in confectionery pharmaceuticals, dairy ,textile, paper , paint and varnish industries.

4. Many protein rich sea weeds are used for human consumption .E.g. ulva, Entermorpho, codium (green algal) sargassum, porphyra, gracilaria,. Laurencia, acanthophora (red alage) etc.

5. Edible sea weeds are used in soup, salad, curry etc.

6. Jelly jam, chocolate, pickle and wafer can be prepared from certain sea weeds.

7. Some of the sea weeds are utilized as cattle feed.

8. Sea weed are also used as fertilizers in the form of green manure.

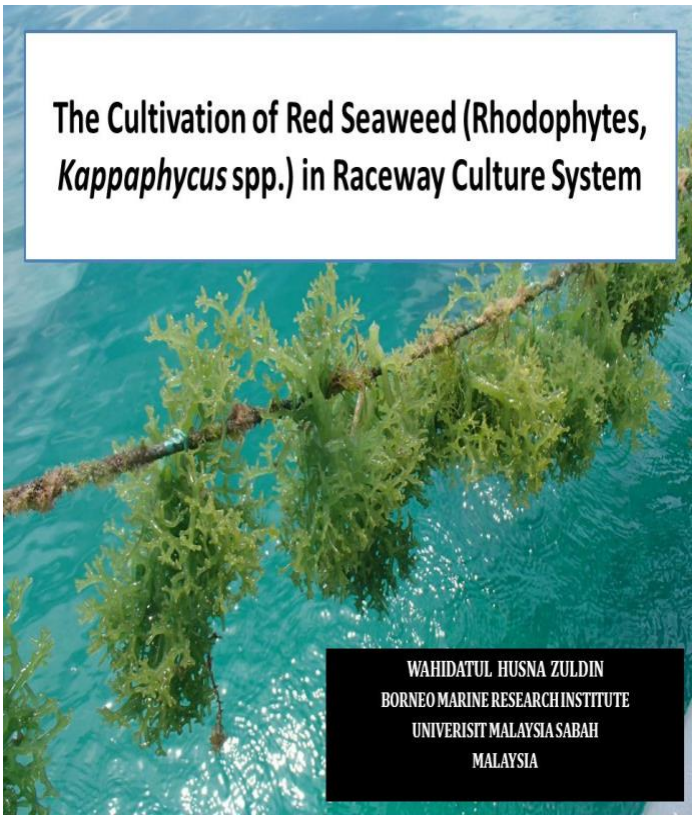
9. Certain sea weeds have medicinal values they used in drugs.

10. Sea weed rich in iodine, bromine, vitamin, and they contain more than 60 trace elements carbohydrates , antibiotics and antioxidants etc.

Important sea weeds in India

The important and common occurring agaropytes in different localities of Indian coast are Gelidiella acerosa, gelidiella sp,. Gracilaria spp. Gelidium pp and pterocladia heteroplatos.

Among the red algae only Gelidiela Aceroa, gracilaria edulis. G.corticata var, corticata, foliifera and g.verrusoca are available in exploitable quantities. Species of sargassum turbinaria cystroseria, Hormophysa spatoglosum , Rosenvingae, chnoospora are the important algin yielding sea weeds of Indian water.



Among the brown algae, sargassum , turbinaria, cystoseira nd hormophysa grow in harvest able quantities.

The carrageen and red algas hypnea also occur in exploitable quantity at various parts of the coastline. At present in India the seaweed are used a raw material only for the production of agar and sodium alginate. There are about 25 actively functioning agar and algin industries situate at different place in the maritime states.

Culture of sea weeds

Culture in brackish water Culture in sheltered brackeshwater :

This involves the floating of webbings supported on all our sides by wooden frames. The webbing consist of rope of hemp and primary fibre of nylon twines which are serving as artificial substrate. Each webbing 5x2.5m sizes will have 130 meshes are installed on poles driven in the intertidal or sub tidal area.

It is essential that the flat surface of the webbing is close to the water throughout the culture period which is about 3 months.

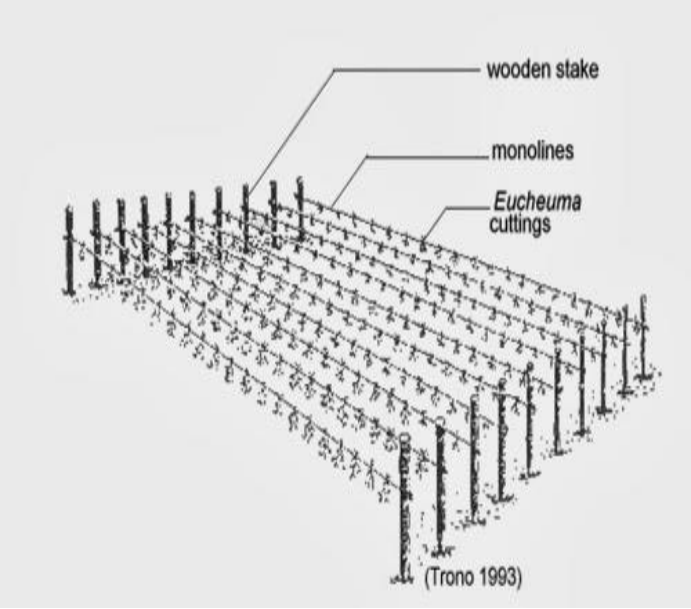
The cuttings (4cm size) of the matured mother plants which serve as seeds are tied at 100-150g/m2 to the mesh intersection of the nylon webbings or to the twisted portions of the coir ropes. These fragments show quick regeneration and rapid growth by developing many new shoots

In cultivation unit of 1-4ha 200 webbing may be installed. The harvesting is done by cutting the grown weeds with the help of knives. An yield of 50t clout be obtained from an area of

one ha.

Culture in brackish water ponds :

Brackish water pond suitable for fish and prawn culture can also called utilized from cultivating several species of sea weeds.



Philippines produces large quantities of the green alga Caulerpa race mosa in brackish water ponds every year to meet the demand in vegetable markets.

The basic plan of culture practice for the brackish water ponds is more or less similar to that of open brackish water or near shore area. However these ponds should be fertilized in order to enhance the grow sea weeds. Ammonium sulphate is mainly applied as fertilizer

Plastic bags(punched with every minute pores containing required quantities of fertilizer are hung from culture frames. Such an arrangement would allow nutrients solution to leach out slowly for the absorption of the growing sea weeds.

Alternatively the nutrients solution may be periodically sprinkled by manual labour or be sprayed mechanically.

A yield of 80/ha could be obtained from the unit area. Since seaweed culture unlike fish culture involves easy and inexpensive management phases and is ulcerative and unutilized brackishwater areas could be readily brought under this culture.

Sea weed culture in sea

Sea weeds can be cultured in two days bottom culture and raft culture.

Bottom culture is the oldest form of sea weed farming, but this practice is declining. In this culture seaweed zoospores are made to attach to the stones twigs or bamboo baskets. The zoospores develop into the weed under good condition yields exceed 10 metric tones/ha

Raft culture in raft culture single or double line tube rafter is used to culture sea weeds. The cylindrical bamboo baskets are tied together in rows and hung form raft. The basket are open at the top.

Along each side of basket is arranged a hump rope form which the young sea weeds are attached by inserting the strip between the strands of the ropes. Tubes of bamboo or rubber are arranged together to form a raft. A rope runs along the tubes. After several months, when the saprophyte have grown to six feet there are harvested with the help of boats.

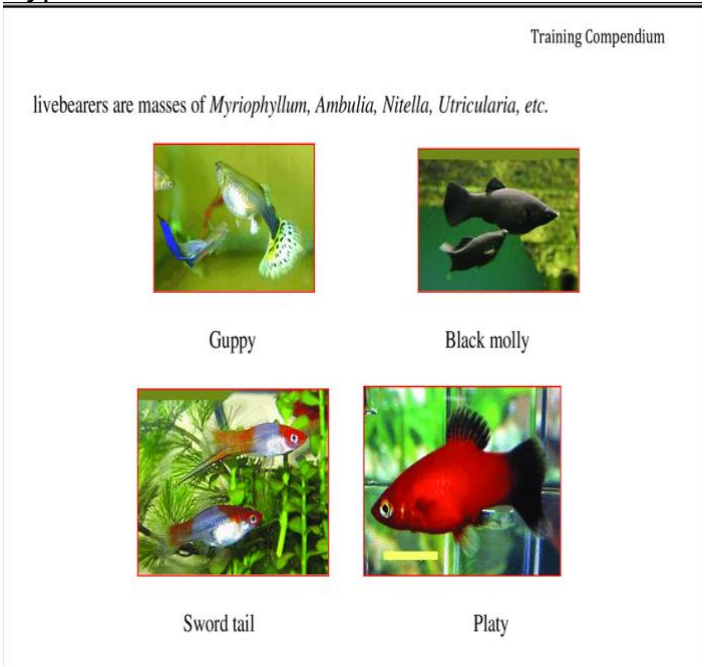
CULTURE OF ORNAMENTAL FISHES

Introduction

Ornamental fishes of India are contributing about 1% of the total ornamental fish trade. These fishes are exported to the tune of 69.26 tons, having the value of Rupees 566.66 crores in 2014 – 15. On an average, an Annual growth rate of about 11 percent has been recorded during the period 1995 to 2014.

India has great potentials in Ornamental fish production due to the presence of rich biodiversity of species, favourable climatic conditions and availability of cheap labour. Kerala, Tamil Nadu and West Bengal mainly practice ornamental fish farming in India.

Aquariculture: The culture of ornamental fishes is called as aquariculture. Ornamental fish culture is the culture of attractive, colourful fishes of various characteristics, which are reared in a confined aquatic system. Farmers and hobbyists mainly grow it. Ornamental fishes are also known as living jewels. There are more than 30,000 fish species reported around the world, of this about 800 belong to ornamental fishes. Most of the ornamental fishes survive in freshwater. They come under eight closely related families namely, Anabantidae, Callichthyidae, Characidae, Cichlidae, Cobitidae, Cyprinodontidae, Cyprinidae and Poeciliidae.



Aquarium fishes are mainly categorized into two groups namely, egg layers (oviparous) and live bearers (ovo-viviparous). Majority of aquarium species are egg layers and normally external fertilization occurs

Criteria for Selection of Ornamental Fishes:

While selecting suitable aquarium fishes it is essential to follow the following lines:

(1) Aquarium fishes selected should be attractive and brilliantly coloured.

(2) Selected species should be compatible to each other.

(3) Fishes introduced into the aquarium should be healthy, disease-free and should be collec-ted from reliable sources.

(4) Fishes that are sluggish should be avoided. Behaviour of the fishes should be lively with well-spread fins and should be actively swim-ming.

(5) The sizes of the fishes kept in the aquarium should be uniform (as far as possible), as larger fishes may harm the smaller ones.

Important Ornamental Fishes

Following are some species of aquarium fishes, which can be easily obtained from aquarium shops. Gold fish (Carassius carassius), Guppy (Lebistes reticulates), Mollies (Mollienesia latipinna), Angel fish (Pterophyllum eimekei), Gambusia affinis, Colisa latia, Barbus ticto, Betta splendens, Tilapia macrocephala, Trichoguster trichopterus, Dania melabarius honey gourami, rosy barb, zebra fish, glass fish, loach, silver shark, angel, red-tailed black shark, red finned shark etc.

Food and Feeding of Ornamental Fishes:

For better growth and survival of aquarium fishes it is essential to provide them with mixed and balan-ced diet. Algae which often grow on the pebbles, glass panes and in water of the aquarium, serve as a good source of food for sword tails, kissing gouramis and mollies.

Various protein-rich live fish food such as Cyclops, Daphnia, Rotifers, Tubifex, earthworms, mosquito larvae, chironomid larvae, artemia nauplii, etc. are considered as excellent food.

Freshly chopped earthworm, shrimp, fish paste, scraped boiled fish or raw liver are also considered as good food items. There are commercially prepared dried food meant for aquarium fishes which is easily available from requisite shops.

The dried food generally constitutes a mixture of cereal, milk powder, prepared egg, dried Daphnia, fish or shrimp. These are dried, powdered and mixed together and formed into pellets or flakes.

Shreded shrimps can also be added to it to improve the food quality. Hard boiled egg yolk can also form useful food. Wheat-germ can also be given from time to time as it contains

large amount of Vitamin B. Adequate amount of Calcium, Phosphorus and iodine should also be given to the fishes to prevent ill health and shunted growth.

BREEDING OF ORNAMENTAL FISHES:

Fishes breed naturally in natural environments. They usually do not breed in captive conditions.

Hence, captive breeding of such economic ornamental fishes is very important

The various aspects of breeding comprise selecting the breeding pair, conditioning the brood fishes, observing spawning and raising its young. According to the breeding habits of fish, the breeding tanks have to be prepared.

Fishes either produce egg or live young. Egg layers comprises egg-scatterers, egg depositors, egg buriers (bubble-nest builders), mouth brooders, nest builders, etc. In live-bearing fishes live youngs are released by the females.

Breeding of ornamental fish follows these steps

(a) Identification of sexes:

In the case of live- bearers identification of sexes is essential. The mature males contain small “bumps” like white spots on the head or pectoral fins. They ooze milt when pressure is applied on the belly. The mature female has a ‘gravid spot’ on the abdomen, and the belly is comparatively swollen.

(B) Selection Of Breeding Pair:

A breeding pair is selected that are already showing courting behaviour, when they show interest to each other.

(C) Egg-Layers Or Oviparous:

Fertilisation is external in oviparous fishes. The fry of these fishes are small and helpless whey they hatch. The egg- layers depending on the type of eggs laid, may be of two types — (i) Adhesive eggs which have the ability to attach to any substratum and (ii) Non-adhesive eggs.

Another method of dividing the egg layers of ornamental fishes is according to their spawning habit. They are of the following types:

(i) Egg scatterers: The egg scatterers, such as Zebra Danio, Goldfish, etc., show little or no parental care. Fishes like Siamese Fighter Fish have a tendency to eat up their own eggs when they are released. So the eggs or the fishes should be removed to another tank after spawning gets over.

Goldfish breeding: Although goldfish (Carassius aural us) has a lifespan of 10 years, the male and female mature in the first and second years, respectively. The selected breeders are segregated sex-wise. At the time of breeding two males and one female are released into the breeding aquarium, which has been erected for the purpose.

At the time of mating, the males chases the female and pre-spawning intimation takes place. The eggs laid by the females are fertilised by the milt of the males. The fertilised eggs being adhesive surface of the bottom. These fertilized eggs are transferred to another tank. They hatch into hatchlings. They are fed with zoo plankton or artemia.

(ii) Egg depositors: The egg depositors, such as Rasbora doniconius, Hemichronis bimaculatus, Aequidens sp. etc., show highest degree of parental care.

The Cichlid fishes deposit their eggs in a hole dug at the bottom. Before spawning the egg depositors forcibly evict any other fish from the surrounding area by chasing them away.

(iii) Mouth brooders: The female tilapia, being a mouth brooder, picks up the fertilized eggs into its mouth and incubates them in its throat. Even after hatching, the female tilapia carries the spawn and young ones in its mouth. During this incubation period of two weeks, the female does not take any food.

(iv) Nest builders: The gouramis (Colisa lalia, C. fasciata, etc.) and their relatives are the most popular among the nest builders. The male generally builds the nest and also guards

the eggs from any intruders including the female.

(D) Live Bearers Of Ovoviviparous:

The live-bearers directly release the young ones. They also have an easy breeding habit. The eggs of these fishes are fertilised internally in the belly pouch of the female.

After one copulation, the female collects the sperms which is enough to fertilise 2 to 3 batches of eggs. The live-bearers are known to be cannibalistic and feed on their young ones. The young ones must be separated as soon as they are released from female. The breeding tanks may be provided with plants for the safety of the young ones.

. Some of the common live-bearers are Guppy (Poecilia reticulatua), Molly (Mollienisia latipinna), Sword tail (Xiphophorus helleri), etc.

(E) Feeding Of Fry:

Food should not be given to the new brood until they are able to consume it, because the unconsumed food would decay and pollute the tank. The fry of live-bearers are able to feed immediately, but the young ones of egg-laying fishes would often remain immobile for several hours while they consume the remainder of their yolk sac.

Commercially available fry food can be had in aquarium shops and is available in liquid or powdered form. The size of the particles should be such that the fry can eat it. Generally brine shrimp, microworms and Infusoria can be fed to new fry.

Management of Water Quality Parameters

Ornamental fishes are more sensitive to poor water quality. Many ornamental fish will perish in due to slight changes in the temperature, oxygen, ammonia, pH, salinity changes. Hence water quality is most critical. Regular water exchange along with proper aeration overcomes this type of problem in the tanks.

Preventive Health Management

The most common diseases of ornamental fishes are reported to be white spot, mouth fungus, tail and fin rot. The easily available chemicals and medicines for health management are common salt @15-30 g/L used as bath treatment for 30 min as disinfectant, methyline blue @2.5 g/L added in aquarium water for water purification and copper sulfate or potassium permanganate @0.5-1 g/L used as bath treatment for 1 min as disinfectant